Environment

Hudson Bay Mining and Smelting Co., Limited

Reed Mine
Environmental Baseline Assessment

Prepared by:

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Project Number:

60160706 (402.19.3)

Date:

February 2013

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AECOM: 2012-01-06

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February 22, 2013

Mr. Stephen West
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PO Box 1500
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Flin Flon, Manitoba
R8A 1N9

Dear Mr. West:

Project No: **60160706 (402.19.3)**

Regarding: **Reed Mine**
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 of our office directly at (204) 928-9241.

Sincerely,
AECOM Canada Ltd.

Ron Typliski, P.Eng.
Vice-President, Manitoba District
Canada West Region

MH:dh
Encl.

Distribution List

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Revision Log

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AECOM Signatures

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Executive Summary

Hudson Bay Mining and Smelting Co., Ltd. (HBMS), in a joint venture with VMS Ventures Inc. (VMSV), plans to develop a zinc/copper mine in the area of Reed Lake, south of Provincial Trunk Highway (PTH) 39. The site is located approximately 50 km southwest (80 km by road) of the Town of Snow Lake and is currently referred to as the Reed Mine Project (the "Reed Project" or "Reed Mine" or "Reed Copper Project"). This document describes the baseline conditions found in the Reed Project area at the time of assessments conducted in 2010 and 2011.

The Reed Project is located within Grass River Provincial Park. Defined as a Natural Park, the purpose of the park includes preserving areas that are representative of the natural region and accommodates a diversity of recreational opportunities and resource uses. The Park will "*Accommodate commercial resource uses such as forestry and mining, where such activities do not compromise the other park purposes"* (Manitoba Conservation, 2011). With the proposed Project area located on the south side of PTH 39 entirely within the Reed AEP site, away from Reed Lake and its recreational facilities, and in a historical clear-cut area, the potential of the Project to compromise the other park purposes is limited. Mining has historically occurred within the boundaries of the park including HBMS' former Spruce Point Mine, located on the south shore of Reed Lake that was in operation from 1982 to 1988 and is now decommissioned.

The upper Grass River Watershed, in which the Reed Project is contained, is designated *High Quality Waters*. As such, any proposed discharges from the Reed Project into the High Quality Waters should not result in any exceedances of water quality standards and will involve the protection of all life stages of all resident organisms at all times. The governmental regulators may adjust specific numerical guidelines, or additional guidelines may be used to screen any sampling events, to reflect this additional degree of protection.

The terrestrial assessments conducted during this study, included the vicinity of the proposed mine site, access road, Unnamed Lakes 2 and 3 as well as Whitehouse Creek. An aerial reconnaissance survey was conducted of the entire Reed Project area during this time. The aquatic assessment conducted during this study included the aquatic species and habitat within the water bodies and surrounding wetlands.

Based on the analysis of water samples collected from nearby water bodies, iron and ammonia concentrations exceeding the applicable water quality guidelines were observed during the 2010 program. In general, the lowest metal concentrations were measured in the Grass River samples. These findings are consistent with the designation of the waters in the upper Grass River watershed as *High Quality Water*. Arsenic, cadmium, chromium, copper, lead, mercury, selenium, and zinc concentrations in sediment collected from water bodies in the Reed Project area exceeded applicable sediment quality guidelines. Over half of the sediment samples exceeded sediment quality guidelines for selenium. Water bodies in the study area were classified as moderately productive on the basis of nutrient concentration, invertebrate biomass, and fish community. In addition, results of the field program indicate that the lakes with the highest potential to be influenced by a mining operation are shallow, lack well-defined hydraulic connection and have limited channelized flow, and contain limited aquatic resources.

The proposed mine site is located on a flat rock area of shallow Palaeozoic bedrock south of PTH 39 and Reed Lake in Grass River Provincial Park. The potential mine site is located in a previously clear-cut area and was largely undeveloped at the time of the field investigations conducted in 2010 and 2011, with the exception of trails and small clearings developed as part of mineral exploration and historic logging activities.

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List of Acronyms

ABA	Acid Base Accounting
AGP	Acid Generating Potential
ANP	Acid Neutralizing Potential
BCI	Bray-Curtis index
BC MELP	British Columbia Ministry of Environment, Lands, and Parks
BIC	Benthic Invertebrate Community
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Agency
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	Catch-Per-Unit-Effort
CWQG	Canadian Water Quality Guidelines
DFO	Department of Fisheries and Oceans Canada
DO	Dissolved Oxygen
EA	Environmental Assessment
EBS	Environmental Baseline Study
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
HBED	Hudson Bay Exploration and Development Company
HBMS	Hudson Bay Mining and Smelting Co., Limited
HT	Hold Times
HudBay	HudBay Minerals Inc.
ICP-MS	Inductively Coupled-Mass Spectrometry
MCDC	Manitoba Conservation Data Centre
MEL	Mineral Exploration Lease
MMER	Metal Mining Effluent Regulations
MSQG	Manitoba Sediment Quality Guidelines
MWQSOG	Manitoba Water Quality Standards, Objectives, and Guidelines
NNP	Net Neutralizing Potential
PEL	Probable Effect Level
PTH	Provincial Trunk Highway
PR	Provincial Road
PRSD	Percent Relative Standard Deviation
QA/QC	Quality Assurance/Quality Control
RPMD	Relative Percent Mean Difference
RTL	Registered Trap Line
SD	Standard Deviation
SDI	Simpson's Diversity Index
SQG	Sediment Quality Guidelines
SEL	Severe Effect Level
TN	Total Nitrogen
TP	Total Phosphorous
TIC	Total Inorganic Carbon
TOC	Total Organic Carbon
UTM	Universal Transverse Mercator
VEC	Valued Ecosystem Components
VMS	Volcanogenic Massive Sulphide
VMSV	VMS Ventures Inc.

1. Introduction

1.1 Company Profile

The proponent of the proposed Reed Mine is Hudson Bay Mining and Smelting Co., Limited (HBMS), a wholly owned subsidiary of HudBay Minerals, Inc. (HudBay). HBMS is currently active in Manitoba in the Flin Flon and Snow Lake areas. Flin Flon was founded in 1927 by HBMS which mined copper and zinc resources in the region. A rail line reached the mine in 1928, and HBMS invested in the mine, smelter, and a 101 MW hydroelectric power plant at Island Falls, Saskatchewan in the 1920s. The town grew considerably during the 1930s as farmers, left impoverished by the Great Depression, abandoned their farms, and came to work at the mines. 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 several mines in the area including Photo Lake, Rod, Chisel Lake, Chisel North, Stall Lake, Osborne Lake, Spruce Point, Ghost Lake, and Anderson Lake.

1.2 History of HBMS Development in Flin Flon and Snow Lake

HBMS operates the 777 and Trout Lake Mines in Flin Flon, Manitoba. The 777 Mine is located immediately adjacent to Flin Flon, Manitoba and production commenced in January 2004. The Trout Lake Mine is located approximately 6 km from Flin Flon, Manitoba and commercial production began in 1982. The ore from the 777 and Trout Lake Mines are processed at the HBMS Flin Flon Metallurgical Complex. The Flin Flon Metallurgical Complex produces zinc and copper concentrates from ore mined at the 777 and Trout Lake mines. Zinc from Snow Lake is processed at the HBMS Flin Flon zinc plant (cell house and zinc casting plant) that produces refined zinc. Since closure of the Flin Flon copper smelter in June 2010, copper concentrate has been shipped out of Manitoba for further processing.

The Chisel Lake Mine, located 16 km southwest of Snow Lake, was opened in 1958, and was the first copper zinc mine in the Snow Lake area. This was followed two years later with the opening of the Stall Lake Mine, located 7 km east of Snow Lake, and in 1968, a third mine at Osborne Lake was opened. In 1979, an ore concentrator was commissioned near the Stall Lake Mine, and five mines were in operation near Snow Lake. In 1988, the Chisel Lake Mine site was expanded with the development of an open pit mine. The Chisel open pit mine was closed in 1994, and was followed by the opening of the Photo Lake Mine, located approximately 3 km east of the Chisel open pit mine. The Photo Lake Mine was operational from 1994 to 1998. Between 1998 and 2000, a decline ramp was driven from the bottom of the Photo Lake Mine to the current 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.

Located just north of the old Chisel Lake Mine, the Chisel North Mine has been operational since 2000 and has a production of approximately 16,000 tons of zinc per year. Production from Chisel North Mine ceased in early 2012. HBMS is currently in advanced exploration for the proposed Lalor Mine, 3 km west of the Chisel North Mine. The Lalor Zone was discovered in the spring of 2007. The Lalor site has been under continuous exploration by means of diamond drilling since 2007 when subsequent drilling confirmed the occurrence of several base metal horizons comprised primarily of zinc, with lesser amounts of copper, silver, gold and lead, which is very similar to the mineralization seen at the operating Chisel North Mine. Since 2008, exploration drilling has been successful in intersecting additional gold-bearing horizons, all at greater depths from surface than the base metal horizons. An access ramp to the Lalor deposit is currently being driven from the Chisel North mine with an explorations shaft also planned for development. The ramp and shaft together will provide for safe ventilation and access to the depths where the gold and gold/copper zones are located with production scheduled to begin in 2014.

The Snow Lake Concentrator was commissioned in 1979 and operated continuously until shutdown in early 1993 following ore depletion at the Chisel Lake and Stall Lake Mines. The concentrator was reopened in 1994 to process ore from the Photo Lake Mine and later to process ore from the Chisel North Mine. The Snow Lake Concentrator has two separate crushing/grinding/flotation circuits. The smaller of the circuits is being used to mill stockpiled Chisel North ore at a rate of 313,000 tonnes per year. In September 2008, the Chisel North Mine and Snow Lake Concentrator were placed on care and maintenance shutdown and re-opened on March 2010.

1.3 Background

The Reed Project area is located 50 km west-southwest (80 km by road) of the Town of Snow Lake and consists of 23 claims controlled by VMSV within an area of 3,780 hectares and a single Mineral Exploration Lease (MEL) (8,434 ha). On July 6, 2010, VMSV announced the signing of a joint venture agreement with a subsidiary of HBMS. The joint venture includes four mineral claims (CB5503, P5030E, MB8413, and MB8412) and covers an area of 917 ha. Option agreements with HBMS were also signed on the surrounding properties of the joint venture and include the Northwest Zone Option (five mineral claims – 899 ha); Super Zone Option (six mineral claims - 756 ha); Northeast Zone Option (8 mineral claims – 1,595 ha) and the Tower Zone Option (mineral claim MB5188 – 111 ha). VMSV retains MEL 268A which lies south of the joint venture/option properties and covers 6773 ha (VMSV, 2011).

This document describes the Reed Project and baseline environmental conditions at the proposed mine site. The Study Area for the environmental baseline study consists of the proposed mine site, access road, potentially affected water bodies, and reference water bodies that will be used to assess background conditions throughout development and operations in the Reed Project area. The terrestrial assessment includes the land upon which the proposed mine site, access route, and supporting structures may be constructed. The aquatic assessment includes the aquatic species (from field investigation and desktop review), habitat, and baseline water and sediment chemistry within the following eleven potentially affected and reference water bodies:

- Reed Lake
- Unnamed Lake 1
- Unnamed Lake 2
- Unnamed Lake 3
- Unnamed Lake 4
- Unnamed Lake 5
- Grass River
- Whitehouse Creek
- Unnamed Creek 2
- Unnamed Creek 3
- Unnamed Creek 4

2. Project Description

2.1 Location

The Reed Project is located 50 km southwest of the Town of Snow Lake (80 km by road) within Grass River Provincial Park (Drawing - 01). Existing exploration and proposed site development is located south of Provincial Trunk Highway (PTH) 39 along an existing logging/exploration road and northeast of Unnamed Lake 2.

2.2 Reed Deposit Exploration History

Based on targets identified in the 1970s, the area in and around the Reed deposit has been under exploration in some form since 1974. In 2007, VMSV, under a mineral exploration license, an agreement with HBMS and other business arrangements, engaged in extensive airborne and ground geophysical surveys and numerous drilling campaigns, culminating in the “discovery hole” announced on October 4, 2007. VMSV drilling had intersected a 33.50 m interval of copper rich mineralization on the property boundary between HBMS claims and other interests.

Subsequent drilling by VMSV confirmed the occurrence of three base metal zones, comprised primarily of copper and zinc with lesser amounts of silver and gold. In 2007 and 2008, VMSV drilled a total of 71 holes totaling 22,200 m on the Reed Property. Exploration continued in 2008 and 2009 with additional airborne and ground surveys.

On July 5, 2010, HBMS concluded a joint venture agreement with VMSV for exploration and development of the Reed deposit. VMSV has committed to a 30% participating interest and HBMS to acquire a 70% participating interest in the 917 ha area that hosts the Reed deposit (the Reed Property). HBMS is the operator and has overall management responsibility for the joint venture. (HBMS, 2011)

In 2010 and 2011, Hudson Bay Exploration and Development (HBED) drilled an additional 35 holes (including one wedge) for delineation of the Reed deposit at optimum core angles, reducing the drill spacing to a range of 25 m to 50 m. All holes were drilled from surface by Rodren Drilling using NQ core size. (HBMS, 2011)

Based on the results of exploration drilling, the three base metal zones contain copper rich resources of 2.55 million tonnes in the "indicated" category and 0.17 million tonnes in the "inferred" category. HBMS included these resources in a diluted and recovered mine plan and estimated 2.4 million mineable tonnes for the deposit that forms the basis of a preliminary economic assessment.

In October 2011, the Director of Mines approved the Reed Advanced Exploration Project (AEP) which included the Reed AEP Closure Plan. Construction of the Reed AEP infrastructure is currently underway, with the decline anticipated to be operational by mid-2013. HBMS anticipates commencement of mining activities in the shallowest depths of the deposit concurrently with advanced exploration of the deeper levels of the deposit.

3. Existing Environment

In 2010 and 2011, baseline terrestrial and aquatic investigations were commenced in anticipation that discoveries in the region of the Reed 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 in the vicinity of Reed Mine site, access route, and supporting structures.

A terrestrial ground survey of the Reed Project area was conducted in August 2010 to examine the local floral communities and assess the potential for the occurrence of rare and endangered species. A supplemental survey was conducted in June 2011 to search for early flowering plants and nesting migratory songbirds that may not have been recorded previously. An aerial reconnaissance survey covering the Reed Project region was also conducted.

Aquatic baseline studies were conducted in September 2010 and June 2011, which included potentially affected and reference water bodies within the Reed Project region (six lakes, five creeks and one river). The aquatic baseline studies included the collection and analysis of water, sediment and fish tissue samples, an assessment of lake bathymetry and classification and enumeration (from field investigation and desktop review) of aquatic species and benthic invertebrates.

3.1 Physical Environment

The Reed Project is located on the transition zone between the northern Boreal Shield and southern Boreal Plains Ecozones (Drawing - 02).

3.1.1 Cormorant Lake Ecodistrict

The southern portion of the Reed Project is contained in the Cormorant Lake Ecodistrict, part of the Mid-Boreal Lowland Ecoregion within the Boreal Plains Ecozone. This portion of the Reed Project area is characterized by relatively level hummocky morainal plains covered by thin, discontinuous glacial till veneers ranging from 0.1 m to 30 m in depth. The area slopes generally to the east at 0.5 m per km with slopes ranging from level to 0.5% on hummocky terrain and 5% to 10% on subdued upland areas. Drainage is generally by small creeks and rivers and is locally contained within the Grass River watershed. The dominant soils are well to imperfectly drained Eluviated Eutritic Brunisoils with poorly to very poorly drained gleysolic soils and organic soils covering large areas (Smith *et al.*., 1998).

3.1.2 Reed Lake Ecodistrict

The northern portion of the Reed Project is contained within the Reed Lake Ecodistrict, part of the Churchill River Upland Ecoregion within the Boreal Shield Ecozone. This portion of the Reed Project area is characterized by hummocky morainal plains covered by stony, sandy morainal veneers and glaciolacustrine blankets. The Project area marks the boundary between the relatively level Palaeozoic limestone belt of the Manitoba Plains and the hilly Kazan Upland section of the Precambrian Shield. Steeply sloping irregular bedrock ridges are common with peat-covered depressions underlain by clayey glaciolacustrine sediments. Slopes vary from level in the peats to up to 30% along irregular hummocky surfaces. Local strong relief is provided by rocky cliffs. Drainage is dominated by the Grass River drainage network, but is draining generally eastward at 0.6 m to 1.0 m per km. Soils are mostly well to excessively drained Dystric Brunisoils that develop on shallow water worked glacial tills. Exposed bedrock is dominant throughout the region with localized Eutric Brunisoils and Grey Luvisoils. Widely distributed patches of permafrost are found in the peat lands (Smith *et al.*., 1998).

3.2 Geology

3.2.1 Local Geology

The Reed Project volcanogenic base metal massive sulphide mineralized zone is hosted within a sequence of volcanic rocks and exhalite and is strongly indicative of volcanogenic massive sulphide type base metal mineralization. It is overlain by distinctive layers of magnetite and chert. The rocks that underlie and contain the sulphide deposit are weakly altered felsic volcanic rocks and metasedimentary rocks derived largely from a felsic source that have been intruded by a fine-grained diabase (VMSV, 2011).

The deposit consists of two separate lenses, the first referred to as the “A” Zone, and a second called the “B” Zone. The two zones are distinct in their chemistry and origin. Zone “A” is considerably richer in zinc than Zone “B” and appears to be part of a debris flow or sulphide material that originally broke off another, possibly larger, sulphide body and was transported down a slope at the time the deposit was originally formed. This mineralization is stratigraphically controlled, meaning it seems to be confined within the same rock layers that the original deposit was emplaced. The central mass of the mineralizing system, where Zone “A” originated, is therefore located elsewhere. Zone “B” is much richer in copper and appears to be structurally controlled rather than stratigraphically controlled like Zone “A”. This mineralization is interpreted to be re-mobilized from another yet to be identified sulphide body and extends to depth (VMSV, 2011).

3.2.2 Surficial Geology

Glacial Lake Agassiz sediments compromise the dominant surficial geology units. Glaciolacustrine silts and clays blanket most areas below 295 m, the estimated water limit of Glacial Lake Agassiz (Mihychuk, 1993). Till in the area is generally moderately to very strongly calcareous medium textured till consisting of almost completely of Palaeozoic rocks from the Hudson Bay Lowland and the Interlake region of southern Manitoba with little Precambrian material. This till is of varying thickness underlain by flat low-lying Palaeozoic limestone. Further north the till becomes non-calcareous and sandy loam textured as the Precambrian bedrock underlies the till. Lacustrine clay deposits occur mainly in depressions with organic deposits accumulated in poorly drained areas.

3.2.3 Bedrock Geology

The Reed Lake area is characterized by a veneer of Red River Formation dolomitic limestone of the Western Canada Sedimentary Basin that overlies the Precambrian rocks of the Flin Flon-Snow Lake greenstone belt. The underlying greenstone belt comprises juvenile volcanic rocks intruded by tonalite, granodiorite, and granite. The presence of variably altered mafic and felsic volcanic flows, pyroclastic and volcaniclastic rocks and related intrusions. Interbeds of greywacke, siltstone, sandstone, and chemical sedimentary rocks such as graphite-pyrite and chert-magnetite are also present.

3.3 Soils

The majority of the Reed Project area is dominated by well to imperfectly drained Eluviated Eutric Brunisoils that have developed with veneers and blankets of moderately to very strongly calcareous, cobbly to gravelly, loamy textured, water worked, and glacial till. Soil development is generally shallow, less than 15 cm thick (Veldhuis, 1980). Poorly drained Gleysolic soils and moderately decomposed organic soils are widespread and cover extensive areas. Cryosolic soils are associated with the permafrost occurring in the peat lands. Minor Grey Luvisolic soils have developed on glaciolacustrine sediments near the margins of lakes. Excessive stones and cobbles along with shallow rooting depth and poor drainage are the major difficulties associated with these soils. Further north the dominant soils are well to excessively drained Dystric Brunisols that have developed on shallow, sandy and stony veneers of water-worked glacial till overlying bedrock. Significant areas consist of peat-filled depressions with very poorly drained Typic and Terric Fibrisolic and Mesisolic Organic soils overlying loamy to clayey glaciolacustrine sediments. Significant areas of Eutric Brunisols, Gray Luvisols, and peaty Gleysols can be found on upland areas of clayey and silty glaciolacustrine sediments. These deposits, in the form of veneers and blankets, are common around the lakes and in river valleys. The *Interim Soil Survey Report of the Cormorant Lake Area* published for the Canada Soil Survey encompasses the Reed Project Area (Tarnocai, 1975). The detailed soil descriptions for the Reed Lake area are shown in Drawing - 03 and the legend is included as Appendix A.

The soils within the Reed Project area have developed beneath boreal forest cover and under subarctic climatic conditions with or without permafrost. Under these environmental conditions, a low order of chemical weathering and partially mobilized and partially translocated clay, iron and aluminum indicate weak podzolic processes in the mineral soils. Organic soils generally formed from fen forest and sphagnum peat materials accumulate extensively under the prevailing climatic conditions (Tarnocai, 1975).

The Reed Project area has a mean annual soil temperature of approximately 3°C or less and a mean summer soil temperature between 5°C and 7°C at a depth of 50 cm. The mean annual air temperature of this zone between -1°C and -4°C and the mean annual precipitation is between 407 mm and 432 mm. Permafrost commonly occurs in peat deposits (Tarnocai, 1975).

3.4 Climate

The Reed Lake area has a typical mid-continental climate with short summers and long, cold winters, with occasional warm spells. The average growing season is 158 days with about 1,250 growing-degree days.

The closest weather station to the Reed Project is located near Baker's Narrows at the Flin Flon airport, 70 km west of Reed Lake. The Flin Flon airport is located at a sea elevation of 304 m and is considered accurate for the Reed Project area.

The region is characterized by short, cool summers and long, very cold winters. The mean annual air temperature at the Flin Flon airport is -0.2°C. The daily average temperature ranges between 18°C in July and -21°C in January. Total annual precipitation at the Flin Flon airport is includes 339 mm of rain and 141 cm of snow. July has the highest average rainfall (77 mm), whereas November has the highest average snowfall (25 cm). Freeze-up of small bays and lakes occurs in mid November, with break-up occurring in mid May. There is an average of 115 frost-free days.

Wind speed is nominal for the Flin Flon/Snow Lake region. Average monthly winds for the area are 10 km/h, with 40% of the wind direction originating from the northwest, northeast, or north. In the fall and winter, the wind speeds create mild wind chill conditions. The average temperature, precipitation, and wind conditions measured at the Flin Flon airport each month is provided in Table - 3.1.

Table - 3.1: Average Temperature and Precipitation for the Reed Project Area

	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
Monthly Total 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														
Monthly Average Wind Speed (km/h)	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

** Data obtained from Environment Canada Flin Flon A meteorological station (2012a)*

"A": World Meteorological Organization “3 and 5 rule” (i.e., no more than three consecutive and no more than five total missing for either temperature or precipitation) between 1971 and 2000.

Specific measurements of air quality in the area of the Reed Project are not available. However, it is expected that the air quality in this area is very good compared with larger cities and commercial and industrial areas in Manitoba. There are no industrial operations that release to the air near the Reed Project area. The closest industrial activity is at the existing Stall Lake Concentrator and the City of Flin Flon, located approximately 54 km and 80 km from the Reed Project site, respectively. Occasional regional impediments to air quality, though uncommon, may occur in this region. This could include smoke from forest fires and vehicle emissions.

3.5 Heritage Resources

Grass River Provincial Park

The Reed Project is located within the Grass River Provincial Park. The Park encompasses an area of 2,279 km^2 and is characterized by the rivers and lakes of the Grass River watershed. Defined as a Natural Park its stated purpose is:

> *“To preserve areas that are representative of the Churchill River Upland portion of the Precambrian Boreal Forest Natural Region, and the Mid-Boreal portion of the Manitoba Lowlands Natural Region and accommodates a diversity of recreational opportunities and resource uses.”* (Manitoba Conservation 2011)

The park is intended to:

- *Preserve woodland caribou habitat and the high water quality of the Grass River;*
- *Promote canoeing, camping and fishing opportunities, and permit related facilities and services;*
- *Promote public appreciation and education of the cultural and natural history of the Grass River; and*
- *Accommodate commercial resource uses such as forestry and mining, where such activities do not compromise the other park purposes. (Manitoba Conservation 2011)*

The upper Grass River Watershed, which includes the Grass River Provincial Park, was designated a High Quality Water by the Canadian Council of Ministers of the Environment (CCME) and *Manitoba Water Quality Standards*, *Objectives*, and *Guidelines* (MWQSOG) (Williamson 2002). Although forestry operations are not currently active in the Park, historic areas of clear cutting were observed and are under a process of natural regrowth. There is also a history of mining activity in the park, including operation of the former Spruce Point Mine on the south shore of Reed Lake from 1981 to 1992. The mine site has been fully decommissioned and the site is a current exploration target for Rockcliff Resources Inc. (Rockcliff 2011).

Approximately 30 km east of the Reed Project area, Tramping Lake is the site of one of Manitoba's largest known concentrations of aboriginal petrographs. 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 are thought to have been created 1,500 to 3,000 years ago by the Algonkian-speaking ancestors of the Cree and Ojibway First Nations. While the precise age of the Tramping Lake petrographs has not been determined, other archaeological artefacts found in the area suggest that habitation of the area dates back 3,000 - 5,000 years (Great Canadian Rivers 2011).

A review of information from the Historic Resources Branch of Manitoba Culture, Heritage and Tourism and initial discussion with government officials familiar with the region does not provide any indication of historic or heritage resources at the Reed Project or surrounding area. To determine the potential impact of the Reed Project on Heritage Resources (including sites of cultural, traditional, historic and/or scientific significance), a request was made to Heather Docking of the provincial Historic Resources Branch on June 29, 2011 to conduct a Heritage Resources Review of the Project area in order to determine if there are any known heritage resources in conflict with the Reed Project. Heather Docking responded via email on June 30, 2011 indicating there were no archaeological resources at all locations within the Reed Project region.

3.6 Socio-Economic Environment

The Town of Snow Lake and the City of Flin Flon are the two main communities that will have the greatest socio-economic impact from the development of the Reed Project.

3.6.1 The Town of Snow Lake

The Town of Snow Lake is an important mining and service centre for the region. According to the 2011 census data from Statistics Canada, Snow Lake has a population of 723 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. (Statistics Canada, 2012a)

Snow Lake is situated mid-way between Thompson, Flin Flon, and The Pas. Year-round road access is provided to Snow Lake by Provincial Road (PR) 392, and the town has a small airstrip located a few kilometres northeast of the town limits. The community is serviced directly by Manitoba Hydro transmission lines and has telephone access through Manitoba Telephone System. Gasoline and diesel service is located within the city. Potable water is obtained from Snow Lake, and is treated in a water treatment plant located in Snow Lake. Other services such as a hospital, fire hall and police/RCMP station are located in Snow Lake along with a hockey arena, curling rink, golf course and other recreational facilities.

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, and Anderson Lake and in current production at 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. The Snow Lake Concentrator was commissioned in 1979 and operated continuously until shutdown in early 1993 following ore depletion at the Chisel Lake and Stall Lake Mines. The concentrator was reopened in 1994 to process ore from the Photo Lake Mine and later to process ore from the Chisel North Mine.

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 other important land uses in this region.

3.6.2 The 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). The City of Flin Flon is the major 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. Parts of the community are in both Manitoba and Saskatchewan.

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 also operates an airport located to the east of the city near Baker's Narrows. Flin Flon is serviced directly by Manitoba Hydro transmission lines and has telephone and cellular access through Manitoba Telephone System. Other services such as a hospital, fire hall and police/RCMP station are located in Flin Flon along with a hockey arena, curling rinks, golf course, public swimming pool and numerous sports fields for recreational opportunities.

The Flin Flon area has had an active mining history for more than 80 years. In 1910, a group of prospectors discovered gold on the west side of Amisk Lake, the first major discovery of gold west of the Ontario border. A gold strike at Amisk Lake three years later was the first significant mineral discovery in the region, and resulted on an increase in exploration activity in the region that ultimately led to the discovery of the Flin Flon deposits. In 1927, HBMS took over controlling interest in the main Flin Flon deposits and by 1930 the mine, smelter, hydroelectric dam and railroad were in full operation in Flin Flon. Up until 1936, the ore was mined by the open pit method, and following 1936 two shafts were developed, North Main and South Main. The last ore from the main Flin Flon deposit was extracted in 1992. Between 1948 and 1978 HBMS opened up several smaller mines in the Flin Flon area.

Flin Flon boasts a wide variety of services. In addition to mining, Flin Flon has a strong tourism industry, which includes hunting, fishing, camping, and boating.

3.6.3 First Nations

There are no First Nations located within the area of the proposed mining development. The Opaskwayak Cree Nation, located near The Pas, is the only Manitoba First Nation located within 75 km of the Reed Project and is the most easily accessible First Nation from the Reed Project area by road. Opaskwayak Cree Nation is the home to over 4,500 people of Cree descent. The Mathias Colomb first nation at Pukatawagan and Mosakahiken Cree Nation at Moose Lake are both within 100 km of the Reed Project area.

None of these First Nations are located in the same watershed as the Reed Project.

3.6.3.1 Trappers

The Manitoba Conservation office in Snow Lake has confirmed that there is one trap line in the in the Reed Project area, operated by Kirk Melnick (Phone, 2011).

3.6.3.2 Cottages or Remote Residences

Reed Lake has no cottage subdivision, but several provincial campgrounds are located on Reed Lake and within the Grass River Provincial Park. Cranberry Lake (45 km west) and Wekusko Lake (50 km east) are the closest lakes with cottage subdivisions to the Reed Project area.

3.6.3.3 Lodge Owners

There are two lodges in operation on Reed Lake: Petersons' Reed Lake Lodge and Grass River Lodge. Peterson's Reed Lake Lodge is located on Four Mile Island and is only accessible by boat, while the Grass River Lodge is located on the south shore of Reed Lake adjacent to the provincial campground. The Wekusko Falls Lodge is located on Trampling Lake, but its area of operations including recreational, fishing, and hunting, overlaps the Reed Project Area, with outpost cabins on Dolomite Lake and Moody Lake.

4. Terrestrial Environment

4.1 Terrestrial Survey

A terrestrial survey of the Reed Project area was conducted on August 24, 2010 to examine the local floral communities and assess the potential for the occurrence of rare and endangered species within the area. A supplemental survey was conducted on June 3, 2011 to search for early flowering plants and nesting migratory songbirds that may not have been recorded previously. An aerial reconnaissance of the Reed Project region was also conducted.

The Reed Project area was surveyed by random walk for early flowering plant species and evidence of wildlife use and nesting by migratory songbirds. Primary among the survey goals was revealing any local habitats that may harbour rare and endangered species. The survey focused on plant community types in the development area, looking for local floral associations that might indicate species of concern. Ground studies included cleared areas as an assessment of any potential loss of important habitats.

The area was flown by helicopter for an initial aerial survey to allow photography and GPS mapping of points of interest followed by a ground survey. No structured botanical assessment was performed and the ground survey was carried out by walking the area as thoroughly as possible, looking for points of interest and recording species observed on the ground. Wildlife occurrence was recorded through tracks and sign, and direct observation. Photographs were collected, but no sampling was included in the survey.

The Reed Project area is located in the Mid-Boreal Lowland Ecoregion as defined by the Manitoba Conservation Data Centre (MCDC). The Mid-Boreal Lowland is a mixed forest ecoregion established on shield rock with fens and bogs developed extensively across the landscape. Bedrock outcrops are common and typically support open lichen woodlands. The Reed Project area is on the northern extent of this Ecoregion and shares vegetation and wildlife characteristics with the Churchill River Upland Ecoregion to the north.

4.2 Vegetation

Three distinct floral communities were identified in the terrestrial study area: a large clear-cut area, a mature mixed wood forest with a dense canopy, and a wet fen. Plant species identified in each of the three major local environments during the terrestrial survey are shown in Appendix B Tables - 01 to 03. Expected plant species for this region are shown Appendix B Table - 06.

None of the species listed in the MCDC rankings for the Mid-Boreal Lowland or Churchill River Upland Ecoregions (Appendix B Table – 04) were found in the Reed Project site. A description of the MCDC rankings is summarized in Appendix B Table – 05. The vegetation within the Reed Project region is typical for this Ecoregion. In the mature upland area, Dwarf Bilberry (*Vaccinium caespitosum*) and sedge (*Carex* sp.) were found in the Reed Project area but not observed on the Project Site. For the Mid-Boreal Lowland Ecoregion, Dwarf Bilberry is globally listed in the MCDC rankings as demonstrably widespread, abundant and secure throughout its range. Provincially, it is ranked as rare. Located in the Mid-Boreal Lowland and Churchill River Upland Ecoregions, various *Carex* sp. are ranked by MCDC as globally demonstrably widespread, abundant and secure throughout its range and provincially ranked as rare to uncommon, but status is uncertain in the province (Appendix B Table – 04).

4.2.1 Clear-Cut Area

The large clear-cut area is in the process of regrowth and appears to be proceeding naturally through a hardwood forest stage. No supplemental planting was done in this old clear-cut area. Trees in this area are not yet mature, canopy is fairly closed, and trees are young, averaging about 2 m in height. The area is diverse in ground cover

(Appendix B Photo - 15), with many open areas and trails allowing growth of shrubs and grasses. Soil depth is shallow, with many rock outcrops (Appendix B Photo - 20) and sphagnum comprising about 50% of ground cover. Grassy areas with sedge pockets and shrubs make up the balance of the understory (Appendix B Photo - 17).

The existing clear-cut area is an ideal location for surface facility development. The area is uniform in species composition and distribution (Appendix B Photo - 01) and covers a large area in the region. This area also shows the greatest signs of previous disturbance including: drilling/logging access roads (Appendix B Photos - 05, 06, 21), large cleared areas (Appendix B Photos - 09, 13), and former building foundation/lay down areas (Appendix B Photo - 11).

A MTS communication tower (Appendix B Photo - 13) is also located within this floral community. It is unlikely that unusual or rare species, growth forms, or habitats will occur in this area outside of that in existence throughout the clear-cut area. The clear-cut is re-establishing normal and expected hardwood species and typical ground cover. Overall, as a recently disturbed area, clearing and mining activities in this area will produce minimal additional local impact.

4.2.2 Mature Mixed Wood Forest Area

The mature open stand is part of the mature and diverse forest stands that occur along the shore of Reed Lake and the Grass River in this region. These stands are very diverse environments, with old growth trees (Appendix B Photo - 19) and a very diverse ground cover (Appendix B Photo - 02). Poplar stands in the proposed development area contain some very large mature trees, showing exceptional growth and height for an aspen (Appendix B Photo - 18). White Spruce stands similarly contain some very large mature trees. This and the overall diversity of species indicate the high productivity of soils in the upland areas of this region.

The mature forest biome is extensive and is composed of White Spruce, poplar, and birch, interspersed with small black spruce bogs (Appendix B Photo - 07). Tree sizes are very large, with tall mature poplar common in the area. The canopy is more open as is typical in a mature forest stand. Ground cover is a mixture of sphagnum, grassy areas, and sedge. Shrubby growth is common with ground plants comprising a mixture of typical boreal ground species interspersed with open area growth.

The mature upland forests, however, offer a very rich diversity of wildlife habitats. As such, they are of special concern for rare and endangered species, especially along watercourses and near lakeshores where edge habitats result in the most diverse floral communities found in the region. This is also true for nesting migratory songbirds, which thrive on the diversity of forest types and plant species in these areas. The removal of mature forest in the Project area is of concern. As such, a study of this area for rare and endangered species, nesting migratory birds, and wildlife habitat value was conducted in the spring of 2011. No occurrences were noted in the 2011 study. However, if possible, most facilities should be located in the old clear-cut area, and clearing in the mature forest stands limited to the minimum necessary.

4.2.3 Wet Fen Area

The third floral community is wet fen with tamarack margins, in some cases bordering open lakes (Appendix B Photo - 08). These areas show typical fen vegetation with deep accumulations of sphagnum covered in bog birch and alder. The wet fen environment borders both the mature stands and clear-cut areas to the south. This is a typical wet fen environment with floating sphagnum mats and larch trees. The larch trees attain normal height near the hard rock boundaries of the fen, but taper off towards open water in the centre (Appendix B Photo - 03). The sphagnum mats are covered in typical fen vegetation such as bog birch and several areas support extensive growth of pitcher plants, an insectivorous plant species (Appendix B Photo - 04). It is unlikely that any mining facilities will be located in these areas. Although this area is biologically interesting in terms of fen vegetation, it offers little in terms of wildlife habitat.

4.3 Wildlife

Although the Reed Project site is located in the transitional zone of two Ecoregions, the wildlife is more typical of the Churchill River Upland Ecoregion to the north. Moose are fairly common in the area, especially along waterways while White-tailed deer have moved in from the south and their numbers are increasing. Several wolf packs that roam through various sections of Grass River Provincial Park are the ungulates' (moose, caribou and deer) main predator. Other predators such as lynx, marten, fisher and wolverine are found in varying numbers. Mink and otter are common in the lakes and rivers. Colonial nesting birds such as double-crested cormorants, great blue herons, white pelicans, gulls and terns can be seen on the lakes. A gull-tern colony has been recorded on Reed Lake (Manitoba Conservation, 2011). Other potential wildlife species that may occur in this region are shown in Appendix B Table - 07. No species at risk were observed during the terrestrial surveys conducted in 2010 and 2011.

4.3.1 Boreal Woodland Caribou

The Reed Boreal Woodland Caribou range is in the area of the Reed Project. Manitoba Conservation lists the Reed Range to be of medium conservation concern and numbering between 100 to 150 individuals (Manitoba 2005). It is believed that the provincial boreal Woodland Caribou population is stable; however, Boreal Woodland Caribou are listed as "threatened" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Manitoba's boreal woodland caribou populations were listed as threatened under The Endangered Species Act in June, 2006. (Manitoba 2005).

Boreal Woodland Caribou have several distinct habitat requirements that have both spatial and temporal scales (Manitoba 2005). Boreal Woodland Caribou range throughout most of the Grass River Provincial Park during the year, and are most often associated with mature forest for most of their seasonal range. The Boreal Woodland Caribou use treed muskeg during the winter for foraging and the many islands on Reed Lake are used as important calving habitat as cows and their calves tend to stay on the predator-free islands during the summer. They may also be seen crossing PTH 39, especially in the early morning and at dusk.

Boreal Woodland Caribou are known to avoid an area with a high degree of human disturbance. The local region has very high quality habitat, which varies according to the season. Winter range and spring calving areas are highly critical. Habitat quality can be assessed using GIS techniques, and it is recommended that a study be conducted within the Project area. Known use areas can be located with information provided by Manitoba Conservation, Wildlife and Ecosystem Protection Branch. The extent of potential disturbance of this species, and the value of the local habitat would be the subject of further study.

4.4 Terrain Analysis

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. Digital provincial forest inventory maps were used to determine the vegetation cover types present in the Reed Lake area (Drawing - 04). This GIS information was used to correlate the terrain units documented in the existing reports with vegetation types to attempt to extrapolate the probable soil units of the area.

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 Palaeozoic Limestone and is neutral to slightly basic. 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 Aspen. The aspen areas tend to occur in the better-drained areas, due primarily to increased slope or limestone bedrock near surface, 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 Aspen. Most lacustrine deposits occur as pockets and blankets of limited extent. 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 of poor drainage 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 and where deposits are deeper or in depressions.
- **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 peat lands 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 Organic over Water 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 inferred by extrapolating from the surrounding unmodified terrain units. Included in these areas are power lines, urban development, roads, and other area clearing activities. A terrain map based on this analysis has been provided as Drawing - 05.

5. Aquatic Environment

5.1 Hydrology

5.1.1 Regional Hydrology

The Cormorant and Reed Lake Ecodistrict is part of the Grass River-Burntwood River watershed, within the larger Nelson River drainage system. The area generally drains northeastward through Reed Lake and Wekusko Lake, other medium sized lakes in the region, and an irregular bedrock-controlled network of streams that are all part of the Grassy River watershed.

As a result of varying topography created by hummocky bedrock surfaces, the drainage conditions vary. Regional drainage generally falls at about 0.6 m to 1.0 m per km. Similar to much of the Boreal Shield ecozone, contiguous and isolated wetlands cover between 20% and 40% of the Reed Lake area.

Water levels in the area are generally at or near surface in the spring and early summer and drop as the year progresses. Water retained in wetlands surrounding Reed Lake may provide water during drier climate periods. These low-lying depressions are generally underlain by poorly drained clayey glaciolacustrine sediments. Bedrock areas and associated till uplands are generally well drained.

5.1.2 Project Area Hydrology

The Reed Project area is contained within the Reed Lake Regional Watershed (Drawing - 02). This watershed has a gross contributing area of 817 km^2, with an upstream contributing watershed area of 3,023 km^2. The major downstream receptor for all drainage in the Reed Project area is the Grass River of which Reed Lake is a part. The eastern portion of the Project area is defined by Unnamed Lake 4 and Unnamed Lake 5, which are drained by Unnamed Creeks 1 and 2 respectively. This drainage system joins Unnamed Creek 4 prior to its outflow into Reed Lake. The western portion of the Project area is defined by Unnamed Lake 2 and its drainage into Whitehouse Creek. This drainage system joins the Grass River prior to its discharge into Reed Lake. Unnamed Lake 1 and Unnamed Lake 3 are both lakes characterised by depressional lows, where there is no clearly defined inflow or outflow from these water bodies and the contributing area and receptors are intermittent flow from wetlands surrounding part or all of these water bodies.

Regionally, runoff from bedrock and upland areas collects in peat-filled lows, which slowly releases excess water to surrounding lakes and creeks. Groundwater tables are high in most wetlands and in low areas bordering the wetlands. Wetlands are widespread around the proposed location of the Reed Project, particularly to the south where there are widespread areas of muskeg and string bogs (Drawing - 04). Areas to the north of the Reed Project area are generally well drained.

5.1.2.1 Unnamed Creek 1

Unnamed Creek 1 (Drawing - 01) was selected as part of the desktop review of the area as the hydraulic connection between Unnamed Lake 4 and Unnamed Lake 5. During the aerial reconnaissance conducted during the field-sampling program, it was discovered that no stream channel existed between Unnamed Lake 4 and Unnamed Lake 5. Both lakes were separated by an area of bog/fen and the hydraulic connection was disseminated over the area. As such, Unnamed Creek 1 was removed from the aquatic baseline programs.

5.2 Groundwater

Based on conditions in similar environments, the regional groundwater flow, in particular in the overburden, is likely strongly controlled by the topography and bedrock surface in the region. Recharge of groundwater can be expected to occur in elevated areas. From there, groundwater flow will generally follow the topography and drain to the low-lying areas where it will discharge to surface water bodies and wetlands. Groundwater tables are high in most peat lands and in low areas bordering the peat lands. Water 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 the groundwater flow directions.

A search of Manitoba Water Stewardship Groundwater Well Database (GWDrill, 2009) indicates there are no water well records in the Reed Project area. There are no groundwater wells in use within a distance of at least 5.0 km from the proposed Reed Property. Bedrock groundwater wells, when present, are connected to fractures or discontinuities that are connected to the local water table and are not likely regionally interconnected.

5.3 Lake Bathymetry

Bathymetric surveys were performed on all unnamed lakes during the 2010 field program (Table - 5.1). The bathymetric surveys were conducted 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 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 numerous points to aid in modelling the lake bottom surface.

The unnamed lakes were generally shallow (i.e., maximum depths did not exceed 2 m). Surface area and volume were lowest in Unnamed Lake 2 and highest in Unnamed Lake 5, while average depth and average grade were highest in Unnamed Lake 2 and lowest in Unnamed Lake 1 (Table - 5.1). These parameters are typical of other small headwater lakes in the region. The sediment was generally highly organic with limited distribution of cobble or mineral soils in most unnamed lakes. Unnamed Lake 4 and Unnamed Lake 5 had significant cobble/boulder distribution.

Table - 5.1: Summary of Bathymetric Surveys

Waterbody	Maximum Depth (m)	Average Depth (m)	Area (m^2)	Volume (m^3)	Average Grade (%)
Unnamed Lake 1	1.5	0.97	556,400	542,500	0.80
Unnamed Lake 2	1.5	1.11	73,800	82,200	2.90
Unnamed Lake 3	1.8	1.10	120,600	132,600	1.60
Unnamed Lake 4	1.7	1.05	360,700	379,400	1.60
Unnamed Lake 5	1.8	1.01	872,300	877,800	1.30

Bottom topography ranged from relatively homogenous in Unnamed Lake 1 (Drawing - 06) and Unnamed Lake 2 (Drawing - 07), to a bowl-shape in Unnamed Lake 3 (Drawing - 08), to more complex in Unnamed Lake 4 (Drawing - 09) and Unnamed Lake 5 (Drawing - 10). Unnamed Lake 5 was different from the other lakes in the bottom topography, where several reef-type structures and emergent rocks were prevalent throughout the lake.

Water levels demonstrated significant seasonal fluctuations. During the terrestrial survey conducted in July 2010, Unnamed Lake 2 was observed to have 3 m to 5 m of bottom exposed from shore (Appendix C Photo - 196, 197). Significant rainfall following this survey resulted in higher water levels observed during the aquatic survey performed in September 2010. The June 2011 supplemental baseline work confirmed that the water levels are significantly lower in the spring. The deepest portion of Unnamed Lake 2 was less than 0.6 m with significant exposed sediment along the shore in June 2011. The connection with Whitehouse Creek was limited and there was no observable flow between the creek and lake. The connection was less than 1 m wide at points and less than 0.5 m deep.

Reed Lake is a large lake with a maximum depth of over 30 m. It has complex bottom topography (particularly in the northern section of the lake) with several deep holes, reef structures, and emergent rocks. Reed Lake is nearly 14 km by 19 km at its widest north-south and east-west axis. In the southern sampling area, at stations RDL-5 and RDL-6 as shown in Drawing 12, the depth was uniform and did not exceed 1 m. The lake sediments in these areas were highly organic with small amounts of mineral soils. The northern sampling sites (i.e., near the Grass River confluence) were typically less than 6 m in total depth and the sediments were characterized by a high mineral content.

5.4 Aquatic Sampling

The following sections provide detailed descriptions of methods related to field sampling, laboratory analysis, and data analysis utilized during the fall 2010 and spring 2011 field programs. Sampling sites were accessed by helicopter, boat, and road where possible. Sampling site locations were recorded as Universal Transverse Mercator (UTM) Zone 14U NAD83 coordinates using a hand-held GPS unit.

5.4.1 Water Quality

The objective of the water quality sampling program was to collect *in situ* measurements and submit surface water samples for analysis from sites in 11 water bodies in the Reed Project area in fall 2010 (Drawing - 01). Two sites were sampled in all unnamed lakes, Whitehouse Creek and Grass River. Reed Lake had six water quality stations while the unnamed creeks each had a single sampling site (Drawings - 06 to 19). No water samples were submitted for analysis during the spring 2011 program.

In situ water quality parameters such as pH, temperature (°C), specific conductance (µS/cm), turbidity (NTU), and dissolved oxygen (mg/L), were collected at the surface and 0.5 m from bottom from each site using a Horiba U-53 Multi-Parameter Unit. Secchi disk depth was also measured at each station. Weather and qualitative descriptions of the site were also recorded at each sampling site.

Samples submitted to the laboratory for analysis were collected from the surface at all sites. Surface water samples were collected by directly submerging the water bottles. Preservatives, if required, were added immediately to the sample and mixed. For analysis of dissolved mercury and metals, samples were not filtered in the field and therefore filtering and preservation was done at the analytical laboratory upon receipt of the samples. Samples were kept cool to the maximum extent possible and out of direct sun. Samples were shipped to ALS Laboratory Group in Winnipeg, within the specified holding time, for analysis of the following:

- 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; and
- Biological (i.e., chlorophyll *a* and pheophytin *a*)

Water quality data was compared to national guidelines that have been generated for various water quality parameters, with the purpose of protecting aquatic life. CCME *Canadian Water Quality Guidelines* (*CWQG*) for the protection of aquatic life (PAL) (CCME, 2006) was applied to the water quality data collected during this survey. In addition, the trophic status of each waterbody will be described using the categories based on total phosphorus concentrations as developed by CCME (2004) (Table 5.2).

Table - 5.2: 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

Waters within the Upper Grass River watershed (i.e., upstream of Wekusko Lake) are designated as High Quality Waters (Williamson 2002). Proposed discharges into High Quality Waters should not result in any exceedance of water quality standards and will involve the protection of all life stages of all resident organisms at all times.

Additionally, the *Manitoba Water Quality Standards, Objectives, and Guidelines* (Williamson 2002) state that any degradation that may jeopardize the high quality use should not occur unless:

"Such proposed projects or developments which will result in new, additional or increased discharges of pollutants into such waters should be required to utilize the best available combination of treatment, land disposal, re-use and discharge technologies to control such wastes, including the use of best management practices to curb erosion."

It is understood that the specific numerical guidelines may be adjusted, or additional guidelines may be used to screen these samples to reflect this additional degree of protection by the governmental reviewers. Characterization of the water quality in the Project area will establish baseline conditions where non-background exceedances beyond applicable water quality guidelines will be avoided using the best available appropriate treatment and discharge methods.

5.4.2 Sediment Quality

Sediment samples were collected from all relevant water bodies located in the Reed Project area in fall 2010 (Drawings - 06 to 19). The sediment quality sites were collected in conjunction with the water quality sampling sites. No sediment samples were submitted for analysis during the spring 2011 program.

Samples of surficial sediments were collected using an Ekman dredge or Petit Ponar (sampling area of 0.023 m2), depending on substrate. Acceptable grab samples were retrieved to the surface and water was decanted from the sampler. The upper 5 cm of sediment was sub-sampled by filling 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 to the maximum potent possible, out of direct sun, and submitted to an ALS Laboratory Group in Winnipeg for analysis of:

- Total metals by ICP-MS
- Total mercury by cold vapour techniques

- Nutrients (i.e., phosphorus, nitrogen and total organic carbon)
- Moisture; and
- Particle size by pipette method

Qualitative descriptions of the sediments (i.e., colour, odour, and composition), water depth, and UTM coordinates were recorded at each site.

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* (CCME 2007) and the *Manitoba Sediment Quality Guidelines and Probable Effect Level* (PEL) (Williamson 2002).

5.4.3 Phytoplankton

Samples for enumeration and identification of phytoplankton were collected in conjunction with water quality sampling in fall 2010. One sample was collected from each of the water bodies, except for the unnamed creeks, by directly filling sample bottles (provided by the laboratory) from approximately 0.3 m below the water surface. Samples were then preserved with sufficient quantities of Lugol's solution to form a tea-coloured solution, stored in a dark and cool location and submitted to ALS Laboratory Group in Winnipeg for analysis of algal biomass and taxonomic identification.

5.4.4 Zooplankton

Samples for enumeration and identification of zooplankton were collected in conjunction with phytoplankton sampling in fall 2010. Zooplankton samples were collected using a 1.0 m long, 63 µm mesh size conical net, complete with a weighted PVC cod-end attached to a single 0.25 m diameter steel hoop frame. A horizontal tow was performed, whereby the net was lowered horizontally at the stern of the boat and pulled the length of the boat twice. Upon retrieval, zooplankton captured were washed into the sample jar and fixed with 70% ethanol. Sampling equipment was rinsed prior to and following sampling at each side with ambient water. Samples were kept cool to the maximum extent possible, out of direct sun, and shipped to ALS Laboratory Group in Winnipeg for analysis of biomass and identification.

The estimate of abundance for each taxon per tow was calculated as the number of individuals per cubic metre of water (individuals/m^3). Volume of water filtered was estimated by multiplying the net mouth area (0.049 m^2) by the length and number of horizontal tows.

5.4.5 Benthic Invertebrate Community

The benthic invertebrate community (BIC) was characterized in all water bodies and corresponded with sediment quality sampling in fall 2010. At each replicate station, two samples of surficial sediments were collected using an Ekman dredge or Petit Ponar (sampling area of 0.02 m^2), depending on substrate. The first sample was submitted for metals analysis and the second (taken from the other side of the boat to ensure the grab was from undisturbed sediments) was submitted for BIC identification and enumeration. Acceptable grab samples were retrieved to the surface and water was decanted from the sampler. Grab samples were deposited in a 500 µm bucket to remove fine materials. The Ekman or Ponar samplers were triple-rinsed with ambient water between replicates. Sample jars were preserved with 10% buffered formalin or 70% ethanol and labelled at the end of each day.

The BIC descriptors that were calculated and reported were recommended by Environment Canada (2002) and include total invertebrate diversity; taxon (family) richness, 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., numbers/m²). Taxon (family) richness is the total number of families collected at the station.

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. SDI is calculated 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

BCI is a measure of dissimilarity between two sites, where a maximum value of one (1) for two sites indicates different communities and a minimum value of zero (0) for two sites indicates identical communities. The BCI is calculated for each station, relative to the overall median. The BCI is calculated as below:

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

Where:

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

5.4.6 Fish Community

A comprehensive fish study was conducted in all relevant water bodies within the Project area. Fish collection was attempted using several types of sampling gear in fall 2010, including:

- Small mesh gill nets: three 10 m long 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
- Backpack electrofisher: Smith-Root model LR24; settings were adjusted according to target fish and water chemistry
- Baited Gee minnow traps; and
- Seine net: one (1) 7.62 m long by 1.5 m high

Supplemental fish sampling was conducted in Whitehouse Creek in spring 2011. Originally, Unnamed Lake 2 was targeted for additional fish sampling, but low water levels in the spring 2011 made fishing impractical in this lake. One additional sampling method was used during the spring 2011 program:

- Hoop Nets: Five 64 cm diameter hoops with 0.9 m by 0.9 m square frame (total body length of 5.5 m). The two detachable wings were 4.6 m long and 0.9 m tall. Mesh was 1.3 cm.

Fish were collected under Scientific Collection Permit Number 53-10 for fall 2010 and 24-11 for spring 2011 issued by the Manitoba Water Stewardship Aquatic Ecosystem Section. Habitat was characterized along with UTM coordinates, water depth, depth of sampling gear and limnological parameters. All captured fish were enumerated, identified to species, measured, and weighed. A small sub-sample of forage fish species captured was retained for taxonomic verification in the AECOM laboratory in Winnipeg.

The effort expended for each fish species was standardized by calculating catch-per-unit-effort (CPUE). The CPUE was calculated as follows:

$$CPUE_{MT} = n/hr$$

$$CPUE_{HN} = n/hr$$

$$CPUE_{EF} = n/sec$$

$$CPUE_{GN} = n/A_{GN}/hr$$

$$CPUE_{SN} = n/A_{SN}/hr$$

Where:

MT = minnow trap; HN = hoop net; EF = electrofisher; GN = gill net; SN = seine net
n = number of fish captured; A = area; hr = hour

In addition to CPUE calculations, summary statistics (i.e., mean, standard deviation, minimum and maximum) of length and weight of captured fish were calculated. Condition factor (K) was calculated for individual fish as follows (Environment Canada 2002):

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

Where:

W = weight (g)
L = fork length (mm)

Length-weight relationships were calculated for each species using least squares regression analysis on $\log_{10}$ transformed fork lengths and weights. Weight-length relationships were expressed as follows:

$$Log_{10} W = a + b(Log_{10} L)$$

Where:

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

5.4.7 Fish Habitat

For the aquatic habitat assessment, water depths and habitat characteristics such as woody debris, aquatic macrophytes, and substrates were documented at all water bodies visited during the fall 2010 survey. Additionally, substrates were characterized using a combination of Ekman grab samples and a probe along various points. In spring 2011, supplemental fish habitat information was to be collected from Unnamed Lake 2 and Whitehouse Creek. Specifically, access to Unnamed Lake 2 from Whitehouse Creek was to be assessed for providing habitat connectivity for fish populations.

5.4.8 Metal Residues in Fish

It is anticipated that the EIA will require description of baseline metal concentrations in fish tissues. Fish were collected by the methods described in Section 5.4.6. Fish were identified to species, measured, and weighed. At least ten fish from the unnamed lakes, Reed Lake, and Grass River were submitted for analysis. Insufficient fish catch in Whitehouse Creek precluded submission of fish tissue for analysis. Fish tissue samples were not submitted in spring 2011. Laboratory tissue requirements necessitated submission of whole fish, rather than separate samples of liver and muscle for metals analysis. Samples were submitted to ALS Laboratory Group in Winnipeg for analysis of the following parameters:

- Total metals
- Total mercury; 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.

Metal residues of whole-body forage fish were compared to *Manitoba Aquatic Life Tissue Residue Guidelines for Human Consumption* (Willamson 2002). The three applicable guidelines include arsenic (3.5 µg/g), lead (0.5 µg/g), and mercury (0.5 µg/g).

5.5 Aquatic Sampling Results

5.5.1 Water Quality

During the fall 2010 program, 23 water samples were submitted for analysis: six samples from Reed Lake, two each from all other lakes, Whitehouse Creek and Grass River and one from each creek (Appendix C Table - 01). A field duplicate water sample was collected from Unnamed Creek 4. Water bodies measured during the fall 2010 survey of Reed Lake area were alkaline and well oxygenated (Appendix C Table - 02). There was no evidence of thermal stratification.

Water bodies in the Project area were characterized as mesotrophic with the exceptions of Reed Lake, Unnamed Lake 3 (characterized as meso-eutrophic), and Unnamed Creek 4 (characterized as oligotrophic) (Table - 5.3). Nutrient and chlorophyll *a* concentrations were lowest in Whitehouse Creek (Appendix C Table - 01). Reed Lake had the highest average chlorophyll *a* concentration, and Unnamed Lake 3 generally had the highest nutrient concentration. Ammonia concentrations exceeded CCME CWQG PAL guideline in Unnamed Lake 1 and Unnamed Lake 3.

Table - 5.3: Trophic Status of Water bodies in the Reed Project Area, Fall 2010

Waterbody	Trophic Status	Average TP (mg/L)
Reed Lake	Meso-eutrophic	0.0223
Unnamed Lake 1	Mesotrophic	0.0161
Unnamed Lake 2	Mesotrophic	0.0172
Unnamed Lake 3	Meso-eutrophic	0.0222
Unnamed Lake 4	Mesotrophic	0.0166
Unnamed Lake 5	Mesotrophic	0.0127
Unnamed Creek 1	Mesotrophic	0.0171
Unnamed Creek 3	Mesotrophic	0.0119
Unnamed Creek 4	Oligotrophic	<0.010
Whitehouse Creek	Mesotrophic	0.0137
Grass River	Mesotrophic	0.0197

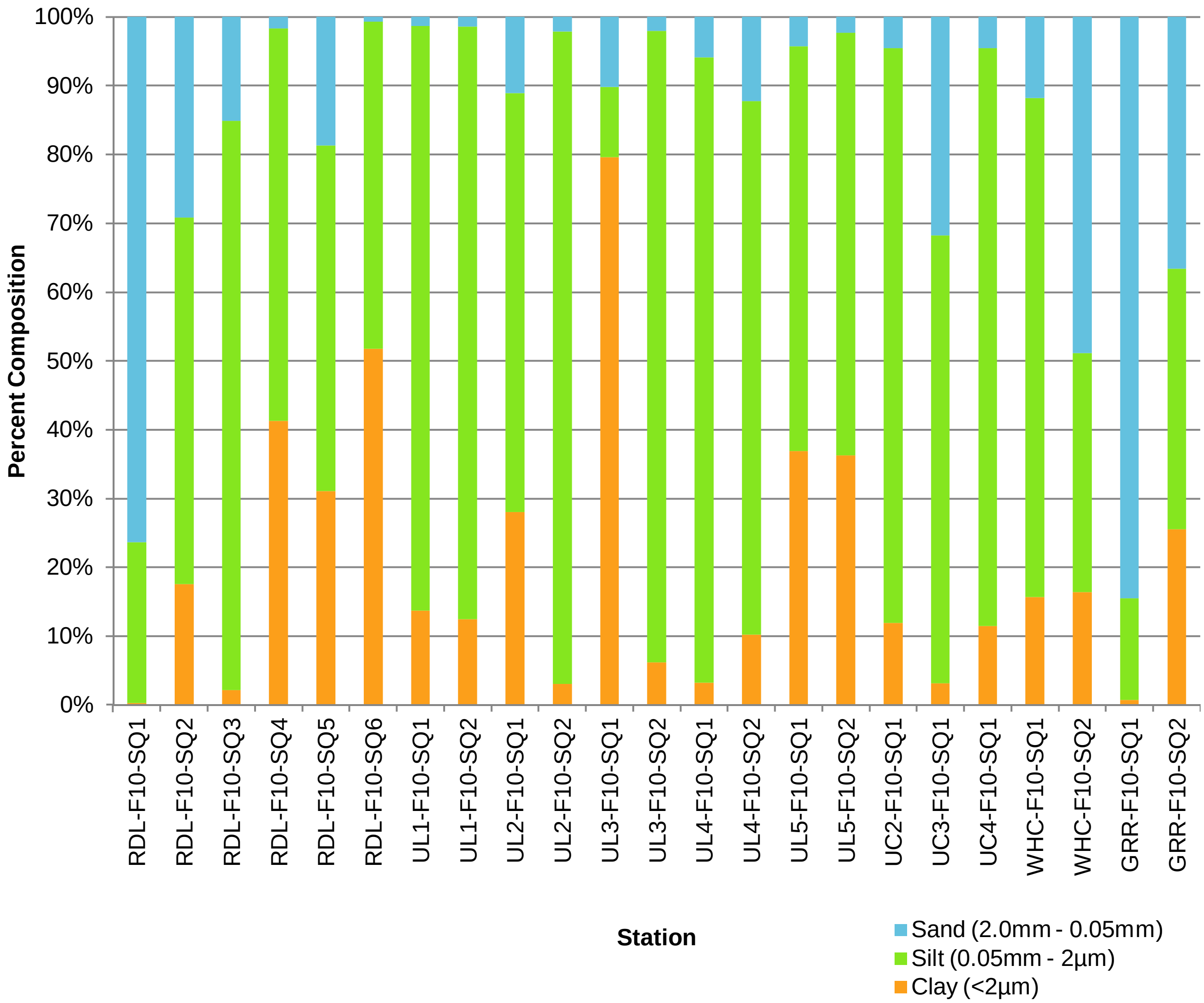
Notes: TP = total phosphorus.

Fewer than half the metals were observed at detectable concentrations (Appendix C Table - 01). Total iron concentrations in water samples collected from Unnamed Creek 2 (0.49 mg/L) and Unnamed Creek 3 (0.46 mg/L) exceeded the CCME CWQG PAL guideline (0.3 mg/L). There were no other exceedances of the CCME CWQSG PAL guidelines.

5.5.2 Sediment Quality

Nutrients, metals, and moisture were analyzed in three (3) replicate samples at each station for all water bodies in the Reed Project area in fall 2010 (Appendix C Table - 03; Drawings – 06 to 19). Particle size was analyzed in one replicate at each station, as high organic content required the use of a different, more expensive method of analysis. In general, sediments from all water bodies were highly organic (Appendix C Table - 03). Silt dominated the particle size distribution for the majority of sediment samples (Appendix C Table - 09; Figure 5.1), with three exceptions. Sand dominated the particle size distribution at one location in Reed Lake (RDL-F10-SQ1) and one location in the Grass River (GRR-F10-SQ1), while clay dominated the particle size distribution of at one location in Unnamed Lake 3 (UL3-F10-SQ1) (Appendix C Table - 03; Figure 5.1).

Figure - 5.1: Particle Size Distribution, Fall 2010



RDL = Reed Lake, UL1 = Unnamed Lake 1, UL2 = Unnamed Lake 2, UL3 = Unnamed Lake 3, UL4 = Unnamed Lake 4, UL5 = Unnamed Lake 5, UC2 = Unnamed Creek 2, UC3 = Unnamed Creek 3, UC4 = Unnamed Creek 4,WHC = Whitehouse Creek, GRR = Grass River

There were a number of sediment quality exceedances in the Reed Project area during the fall 2010 program (Table - 03). Overall, 42 of the samples taken exceeded at least one sediment quality guideline. The most frequent exceedance was selenium concentrations, where concentrations ranged from 1 mg/kg to 2 mg/kg and over half of the samples exceeded the CCME CSQG of 1 mg/kg (Appendix C Table – 03; Table - 5.4). Arsenic, cadmium, and chromium also had exceedances in 16%, 17%, and 14% of samples, respectively. Only one arsenic concentration (14.5 mg/kg in UL2-F10-SQ1A) exceeded two of the applied sediment quality guidelines (Appendix C Table - 03). Concentrations of copper, lead, mercury, and zinc exceeded sediment quality guidelines in fewer than 10% of samples (Table 5.4). Concentrations of the remaining metals did not exceed the sediment quality guidelines.

Table - 5.4: Sediment Chemistry Exceedances, Fall 2010

Parameter	CCME CSQG (Residential/Parkland)	Manitoba SQG		DL	Overall Exceedances			
		Guidelines	PEL		n	%	Min	Max
Arsenic	12	5.9	17.0	0.10	11	16%	6.51	14.5
Barium	500	-	-	0.50	-		-	-
Cadmium	10	0.6	3.5	0.020	12	17%	0.63	1.87
Chromium	64	37.3	90.0	1.0	10	14%	39.9	62.1
Copper	63	35.7	197	1.0	2	3%	36.2	36.5
Lead	140	35.0	91.3	0.20	2	3%	47.3	48.1
Mercury	6.6	0.17	0.486	0.050	5	7%	0.17	0.20
Nickel	50	-	-	0.50	-	-	-	-
Selenium	1	-	-	0.50	35	51%	1.00	2.06
Thallium	1	-	-	0.10	-	-	-	-
Uranium	23	-	-	0.020	-	-	-	-
Vanadium	130	-	-	0.50	-	-	-	-
Zinc	-	123	315	10	6	9%	126	164
Zirconium	200	-	-	0.10	-	-	-	-

Sources: Canadian Council of Ministers of the Environment (CCME) Canadian Soil Quality Guidelines (CSQG) for Residential/Parkland Use (CCME 2007) and Manitoba Water Quality Standards, Objectives and Guidelines (Williamson 2002).
All units are mg/kg dry weight. Minimum and maximum values for concentrations that exceed at least one guideline are shown.
PEL = probable effects level; DL = detection limit; % = percent.

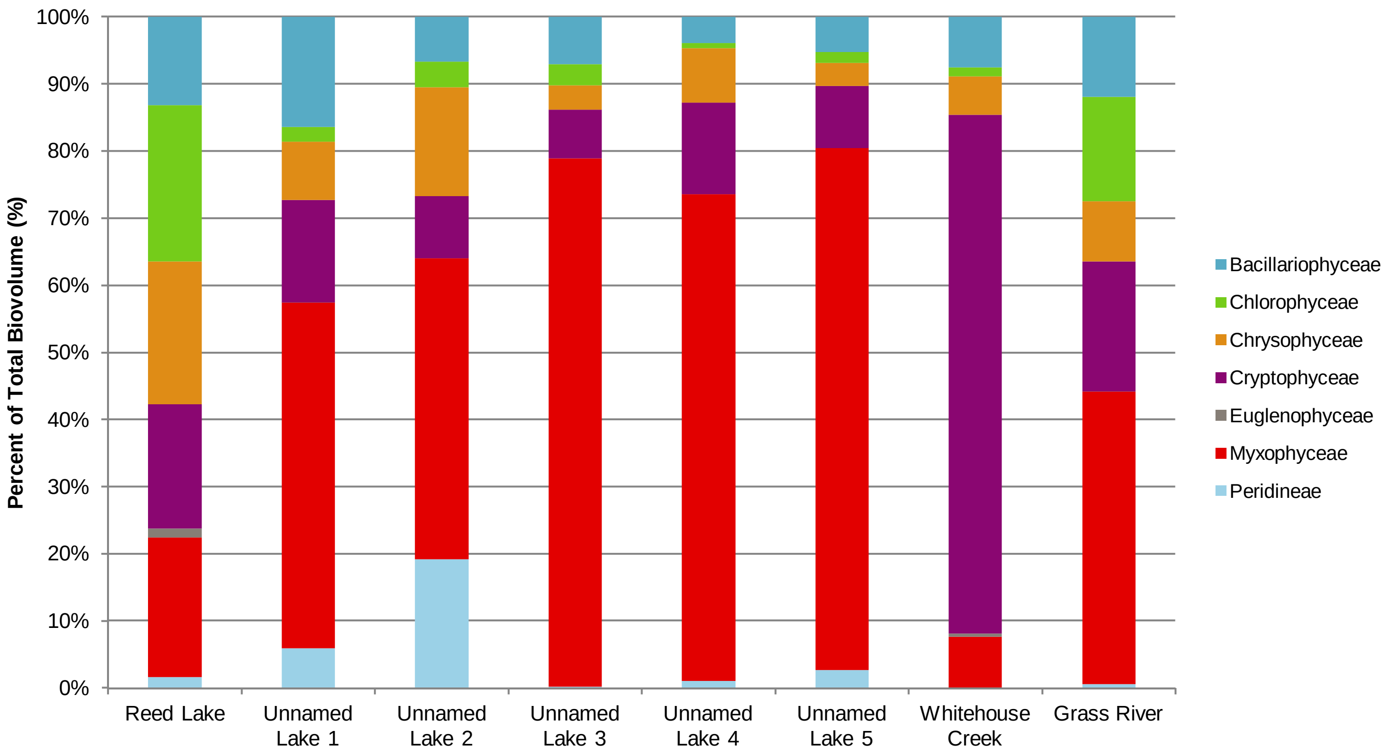
5.5.3 Phytoplankton

One sample was collected for phytoplankton enumeration and taxonomic composition from all water bodies, with the exception of the unnamed creeks in fall 2010 (Appendix C Table - 04). Whitehouse Creek had the lowest overall biovolume (0.19 mm^3/L) and species diversity (18 species) while Reed Lake and Grass River had the highest species diversity (46 species) and Unnamed Lake 3 had the highest overall biovolume (15.9 mm^3/L). Seven (7) classes of phytoplankton were identified in the samples collected (Appendix C Table - 04).

For the unnamed lakes and Grass River, *Myxophyceae* dominated the relative species abundance by accounting for 44% to 79% of the total biovolume (Appendix C Table 04; Figure 5.2). *Cryptophyceae* dominated the Whitehouse Creek phytoplankton biovolume (77%). In Reed Lake and Grass River, there is a more even distribution of biovolume among several phytoplankton classes.

In general, total biovolume is higher in water bodies with correspondingly high nutrient concentrations. However, chlorophyll *a* and phaeophytin *a* concentrations do not show a similar correlation to total biovolume.

Figure - 5.2: Relative Biovolume of Phytoplankton Classes, Fall 2010



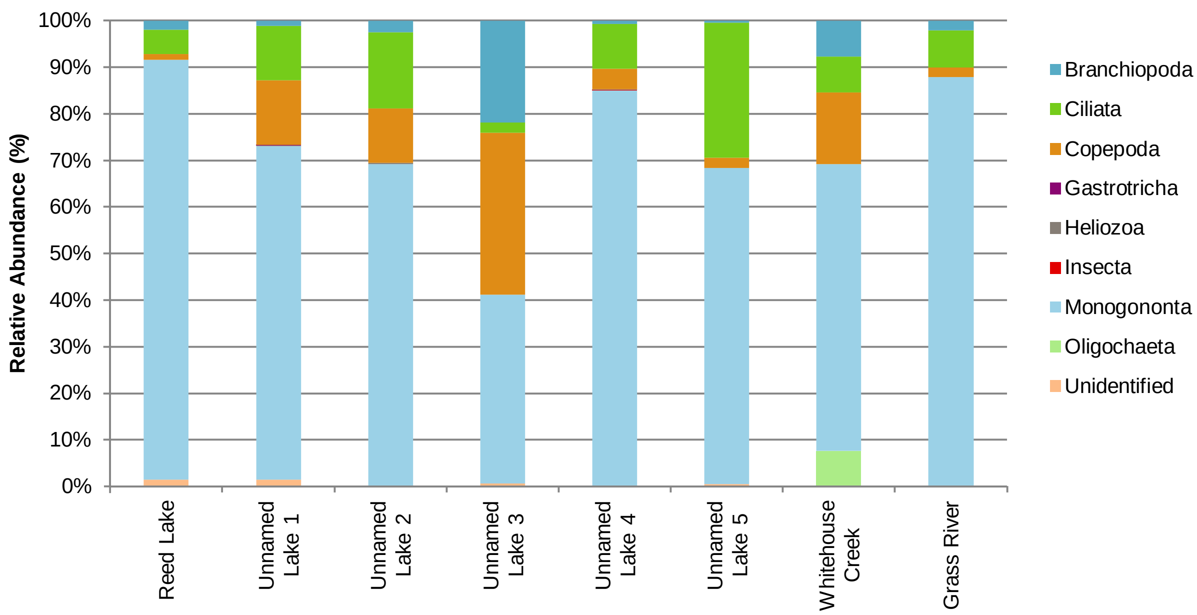
5.5.4 Zooplankton

Two horizontal zooplankton tows were performed in all water bodies, with the exception of the unnamed creeks in fall 2010 (Appendix C Table - 05). Total abundance (number of individuals per cubic metre) ranged from 1,515 n/m^3 (Whitehouse Creek) to 4,530 n/m^3 (Unnamed Lake 1). Eight classes of zooplankton were identified in samples collected from the Reed Project area (Appendix C Table - 10; Figure 5.3). Unnamed Lake 2 had the highest species diversity with 20 species identified.

For all samples, *Monogononta* species composed 41% (Unnamed Lake 3) to 90% (Reed Lake) of the zooplankton community (Appendix C Table - 10; Figure 5.3). The zooplankton community in Unnamed Lake 3 had a higher relative abundance of *Branchiopoda* and *Copepoda* that accounted for over half of the relative abundance, where these classes composed between 3% and 23% of the community in the other water bodies (Figure 5.3).

Gastrotricha, *Insecta*, and *Oligochaeta* were found in only one waterbody each: Unnamed Lake 1, Unnamed Lake 4, and Whitehouse Creek, respectively. Despite that these animals are generally considered a part of the benthic community and not the zooplankton community; they were not omitted from this report.

Figure - 5.3: Relative Abundance of Zooplankton Classes, Fall 2010



5.5.5 Benthic Invertebrate Community

A total of sixty-nine BIC samples were collected from twenty-three stations in eleven water bodies in the Project area in fall 2010. However only one replicate from each station was submitted for taxonomic identification and enumeration (Appendix C Table - 06). The remaining two replicates per station were archived for future use.

Benthic invertebrate family richness and species density ranged from 1 to 14 taxa and from 1,000 to 63,050 individuals per m^3 (Appendix C Table - 06; Table - 5.6). Family richness was highest in Reed Lake

(RDL-F10-BIC1A) (Drawing - 12). SDI ranged from 0.17 to 0.88 (Table - 5.5). BCI values ranged from 0.08 in Unnamed Lake 1 (UL1-F10-BIC1A) to 0.85 in the Grass River (GRR-F10-BIC2A). In the Grass River (GRR-F10-BIC2A), SDI was lowest and species density was highest (Table - 5.5). At this station, with over 90% of the sample dominated by *Cladocera*, the descriptors show a sample that is dissimilar to the overall median community composition (with the highest BCI value) and a low diversity (even with high density).

Table - 5.5: Benthic Invertebrate Community Indices, Fall 2010

Waterbody	Station ID	Family Richness	SDI	B-C
Reed Lake	RDL-F10-BIC1A	24	0.79	0.78
	RDL-F10-BIC2A	20	0.82	0.61
	RDL-F10-BIC3A	5	0.78	0.32
	RDL-F10-BIC4A	8	0.88	0.54
	RDL-F10-BIC5A	13	0.63	0.46
	RDL-F10-BIC6A	15	0.76	0.33
Unnamed Creek 2	UC2-F10-BIC1A	13	0.80	0.35
Unnamed Creek 3	UC3-F10-BIC1A	10	0.76	0.48
Unnamed Creek 4	UC4-F10-BIC1A	12	0.77	0.34
Unnamed Lake 1	UL1-F10-BIC1A	5	0.58	0.40
	UL1-F10-BIC2A	10	0.77	0.08
Unnamed Lake 2	UL2-F10-BIC1A	21	0.57	0.51
	UL2-F10-BIC2A	20	0.25	0.71
Unnamed Lake 3	UL3-F10-BIC1A	9	0.72	0.18
	UL3-F10-BIC2A	6	0.64	0.30
Unnamed Lake 4	UL4-F10-BIC1A	4	0.75	0.65
	UL4-F10-BIC2A	5	0.75	0.44
Unnamed Lake 5	UL5-F10-BIC1A	11	0.84	0.38
	UL5-F10-BIC2A	1	-	0.25
Grass River	GRR-F10-BIC1A	19	0.81	0.52
	GRR-F10-BIC2A	19	0.17	0.85
Whitehouse Creek	WHC-F10-BIC1A	7	0.48	0.48
	WHC-F10-BIC2A	16	0.85	0.23

Notes: SDI = Simpson's Diversity Index; B-C = Bray-Curtis

Overall, the dominant taxon groups included *Diptera*, *Amphipoda*, and *Oligochaeta* (Appendix C Table - 06; Appendix C Table - 07). Chironomids were the only taxon identified in all eleven water bodies and there were thirty-five taxonomic units that were unique to a single waterbody. *Diptera* often has the highest relative abundance, ranging from 0% to 87% (Appendix C Table - 07). *Cladocerans* comprised a small portion of the total abundance in most samples with the exception of the Grass River (GRR-F10-BIC2A), where it comprised over 90% of the total abundance (Appendix C Table - 15). The generally high abundance of *Ephemeroptera* generally indicates good environmental conditions, as they are sensitive to pollution (Hubbard, 1978).

Low invertebrate densities and diversity may indicate poor habitat quality (e.g., Unnamed Lake 5), whereas excessively high densities may indicate nutrient enrichment, toxic conditions, or physical disturbance of habitat (e.g., Grass River). High diversity and evenness indicate better and more stable environmental conditions, while low values can indicate stresses on the system. Overall, there was a range of community composition and diversity, even within water bodies (e.g., Reed Lake, Grass River, and Whitehouse Creek).

5.5.6 Fish Community

5.5.6.1 2010 Results

Seine nets, minnow traps, gill nets and a backpack electro fisher were used to collect fish in the Project area between September 12 and September 19, 2010 (Appendix C Table - 08). In total, 1,231 individuals representing fifteen fish species were captured in ten water bodies (Table - 5.6) from a potential total of thirty-one native fish species in the overall Nelson River watershed as listed in The *Freshwater Fishes of Manitoba* (Stewart & Watkinson 2004). The Project area is contained within the distribution of all the captured fish, with the exception of the Pearl Dace (*Margariscus margarita*). However, this is likely an artefact of incomplete sampling records and not species absence (Stewart and Watkinson 2004). Fathead Minnow and Brook Stickleback comprised the majority of the fish captured. No fish were captured in Unnamed Creek 3.

Table - 5.6: Fish Species Captured, Fall 2010

Species Name	Common Name	Abbr.
Culaea inconstans	Brook Stickleback	BRST
Lota lota	Burbot	BURB
Notropis atherinoides	Emerald Shiner	EMSH
Pimephales promelas	Fathead Minnow	FTMN
Etheostoma nigrum	Johnny Darter	JHDR
Salvelinus namaycush	Lake Trout	LKTR
Coregonus clupeaformis	Lake Whitefish	LKWH
Rhinichthys cataractae	Longnose Dace	LNDC
Esox lucius	Northern Pike	NRPK
Margariscus margarita	Pearl Dace	PRDC
Cottus cognatus	Slimy Sculpin	SLSC
Notropis hudsonius	Spottail Shiner	SPSH
Sander vitreus	Walleye	WALL
Catostomus commersoni	White Sucker	WHSC
Perca flavescens	Yellow Perch	YLPR

The highest overall CPUE was with the small mesh gill net (6.1 n/m^2/hr) in Reed Lake and no fish were captured with the seine net (Appendix C Table - 08). Where successful, gill nets had higher CPUE in the unnamed lakes (Appendix C Table - 09). Low CPUE associated with electro fishing may be to a lower abundance of fish present in the creeks and/or limitations of gear or habitat. Reed Lake has the highest species diversity (67%) while Unnamed Lake 1, Unnamed Lake 3, Unnamed Creek 2, and Unnamed Creek 4 had the lowest species diversity (7%) (Appendix C Table - 09).

Large-bodied fish were captured in Grass River, Unnamed Lake 2, and Reed Lake. During the fall 2010 survey, Unnamed Lake 2 had an open-water connection to Whitehouse Creek (which ultimately reaches the Grass River and into Reed Lake). The large-bodied fish in Unnamed Lake 2 were likely the last to migrate out to overwinter in Reed Lake or possibly Whitehouse Lake. Unnamed Lake 2 had been identified as a possible freshwater source for the proposed mine in 2010 and an additional fish survey was recommended to assess access and movement of fish into this lake. In the spring of 2011, extremely low water levels in Unnamed Lake 2 made fish assessment impossible and the likelihood of large bodied fish residing in the lake unlikely.

The biological information (e.g., length, weight, and health) from 773 individual fish is presented in Appendix C Table - 10 and summary statistics for fish captured is presented in Appendix C Table - 11. In general, fish were in good health. External parasites (white cysts or black spot) and fin erosion were present in fish from Reed Lake, Unnamed Lake 2, Unnamed Lake 4, and Unnamed Lake 5. Fin erosion in large-bodied fish was likely associated with the gill net. The largest and smallest (in terms of length) fish were Northern Pike collected from Reed Lake and Pearl Dace collected from Unnamed Creek 2, respectively.

Condition is generally good for all species. Variability among species are likely due to differences in body shape, energy allocation, and overall health, while variability among water bodies (within a species) are likely due to differences in health, food source, age distribution and environmental conditions.

The regression equations for the relationship between $\log_{10}$ transformed length and weight are presented in Appendix C Table - 12. The regression equations are influenced by the same factors as condition, as described above. In general, the correlation coefficient is high, with the exception of Brook Stickleback in Unnamed Lake 4 and Unnamed Lake 5 where a number of individuals with low condition values reduce the correlation coefficient.

5.5.6.2 2011 Results

During the spring survey, conducted between June 3 and June 5, 2011, hoop nets and a backpack electrofisher were used to collect fish in Whitehouse Creek (Appendix C Table – 08). In total, 22 fish representing four species (Brook Stickleback, Iowa Darter, Pearl Dace and Northern Pike) were captured in Whitehouse Creek at three locations (Appendix C Table – 08). Unnamed Lake 2 was not fished due to extremely low water levels observed in the spring 2011 (Section 5.5.6.1).

Fish captured during the spring 2011 survey were in good condition (Appendix C Table – 10 and 11). Brook Stickleback from Whitehouse Creek had similar regression equations to those captured in other waterbodies (Appendix C Table – 12).

During the low water levels seen during the spring and early summer, the connection between Whitehouse Creek and Unnamed Lake 2 is not accessible, at the very least, to large-bodied fish. In addition, the culverts under PTH 10 were perched during the 2011 spring survey. Fish utilization of Whitehouse Creek and Unnamed Lake 2, particularly for large-bodied fish would be dependent upon water levels. Juvenile Northern Pike were captured during the 2011 spring program, suggesting that overwintering habitat may be available in Whitehouse Lake (upstream) or, less likely, in isolated pools in Whitehouse Creek.

5.5.7 Fish Habitat

Detailed habitat comments (along with photographs) were noted at each fishing effort. Fish habitat in the Reed Project area included a range of features and general habitat types. Fishing was performed in a variety of habitat types in each waterbody (Appendix C Table - 08). A habitat and bathymetric map was produced for unnamed lakes, Whitehouse Creek and Grass River (Drawings - 20 to 28).

A variety of fish habitats were noted in the water bodies within the Project area. In general, the area is characterized by low-lying headwater lakes and creeks (with the exception of Grass River and Reed Lake). Upstream, unnamed lakes and creeks were less diverse than Reed Lake, Whitehouse Creek, and Grass River and provided limited potential for foraging, spawning, and overwintering habitat for small and large-bodied fish. The majority of cover in these upstream water bodies included vegetation (overhanging, submergent and emergent) with patchy distribution of cobble, boulders, woody debris, and depth as cover. Most of the shoreline consisted of fen or bog areas. Unnamed Lake 4 (Drawing - 23) and Unnamed Lake 5 (Drawing - 24) provided the most diverse cover types, shoreline complexity and greater depths.

The unnamed lakes (except Unnamed Lake 2) show limited or no connectivity to other lakes and only support small-bodied fish communities. Unnamed Lake 2 (Drawing - 21), which had a channel connecting it to Whitehouse Creek, was the only unnamed lake in which large-bodied fish (Northern Pike and White Sucker) were captured. There would be very limited overwintering habitat available in the unnamed lakes, as ice thickness can be greater than 1.2 m in this region.

Grass River, Whitehouse Creek, and Reed Lake provide a diversity of foraging, spawning, and overwintering habitats for small and large-bodied fishes. These water bodies wave well-defined watercourses and provide stable habitat for fishes.

The Grass River is a large, complex river extending 545 km from Webster Lake to its confluence with the Nelson River, with numerous widened areas forming lakes and several rapids. The Grass River within the Project Area hosts a variety of habitat types from riffle areas, where the cover types available include large woody debris, turbulence, and cobble and boulder substrate to flat runs, where the substrate is organic and silt with submergent and emergent vegetation along the river margins. It is generally confined by mature dense forest, with wetted width generally 10 m greater than channel width. As a more stable watercourse, it provides abundant foraging and spawning habitat for small and large-bodied fish species.

Whitehouse Creek was characterized by a range of habitat types (Drawings - 25, 26). The diversity of habitats in Whitehouse Creek provides abundant habitat for forage and spawning activities, primarily for small-bodied fish. If water levels were sufficient, habitat would also be available for feeding and spawning for large-bodied fish. Whitehouse Lake may also provide overwintering habitats for large-bodied fish, as suggested by the spring 2011 capture of juvenile Northern Pike near the connection between Whitehouse Creek and Unnamed Lake 2.

Reed Lake is a large lake on the Grass River system. It hosts a diversity of fish species and provides abundant areas for foraging, spawning, and overwintering habitat for large and small-bodied fish. There are several deep areas (i.e., in excess of 30 m) and the shoreline habitat provides abundant cover (i.e., substrate, emergent and submergent vegetation, woody debris and depth).

5.5.8 Metal Residues in Fish

A total of 68 small bodied fish (*i.e.,* Brook Stickleback, Fathead Minnow, Slimy Sculpin and Yellow Perch) were submitted for analysis of whole-body metal concentrations and seven large-bodied fish (i.e., Northern Pike and White Sucker) were submitted for analysis of liver and muscle metal concentrations (Appendix C Table - 13 and 14). Overall, concentrations in tissues were similar across species.

Concentrations of metals in fish tissue were generally low and none exceeded the MWQSOG aquatic life residue guidelines for human consumption for arsenic, lead, or mercury (Appendix C Table - 13 and 14). Overall, there was no consistent trend with respect to correlation of metal concentration and condition; metal concentrations had both weak positive (e.g., mercury, cadmium, and selenium) and negative (e.g., cesium, copper, and zinc) correlations to condition.

Only Brook Stickleback and Fathead Minnow were submitted for metals analysis in more than one (1) waterbody (Appendix C Table - 13). Whole-body metals concentrations in Brook Stickleback analyzed from Unnamed Lake 1 were generally higher than fish analyzed in Unnamed Lake 3 (Appendix C Table - 13). Whole-body metal burden was higher in Fathead Minnow from Unnamed Lake 5 as compared to Fathead Minnows from Unnamed Lake 4 (Appendix C Table - 13).

Overall, large-bodied fish submitted for analysis, metal concentrations were sometimes higher in one tissue (liver versus muscle) over the other. Two examples of this tissue-specific metal burden are copper and mercury. Copper was detected in liver tissues at concentrations of 5 to 43 times higher than in the corresponding muscle tissue. Conversely, mercury concentrations in muscle were 0.9 to 3 times higher than in the accompanying liver tissue. Overall, concentrations of metals in the large-bodied fish were similar. However, the tissue specific metal concentrations differed (*i.e.,* highest concentrations were in the liver for Northern Pike and in the muscle for White Sucker).

5.6 Quality Assurance and Quality Control

5.6.1 Methodology

All laboratory analyses were conducted at an accredited analytical laboratory, which employs standard laboratory QA/QC measures. As part of the field QA/QC program and as recommended by the *Metal Mining Effluent Regulations Technical Guidance Document* (Environment Canada 2002), sediment was collected in triplicate at each station. Replicates were separated by at least 15 m. Surface water analysis included one field blank and one trip blank in association with the field program. The field blank was filled with deionized water in the field and was stored and transported with field samples. The trip blank was filled with deionized water by the laboratory prior to the field program and was stored and transported with field samples but never opened. In addition, four replicate samples were collected at one sampling site in Reed Lake. There are no field QA/QC samples associated with zooplankton, phytoplankton, or fish tissue analysis.

Water and sediment samples were assessed to evaluate precision and identify potential sample contamination issues. No methods for this analysis is described in Manitoba, therefore methods were followed as described in the British Columbia *Ministry of Environment, Lands, and Parks* (BC MELP) (1998). These include:

- Field QA/QC
    - Field and trip blanks; and,
    - Field replicates (Percent Relative Standard Deviation [PRSD])
- Laboratory QA/QC (e.g., method blanks and matrix spikes)

PRSD was calculated for duplicate water samples to quantify the precision of analytical results as follows:

$$\mathrm{PRSD} = 100 * \{\mathrm{SD}/\bar{x}\}$$

Where:

SD = standard deviation of replicates
$\bar{x}$ = mean of replicates

Precision was considered poor if PRSD values were greater than 18%. If one of the duplicate values were less than five times the detection limit, PRSD values were not calculated.

Sediment samples were collected in replicate (i.e., separate sub-stations) and not in duplicate (i.e., one grab split into two samples). In this case, PRSD was used to assess the relative station homogeneity and not necessarily as a screening tool to verify analytical precision.

Field and trip blank results were also examined for evidence of sample contamination. Values for any parameter that exceeded five times the analytical detection limit were considered indicative of sample contamination and/or laboratory error. Additionally, results were examined for potential outliers, transcription, and/or analytical errors.

Values flagged as suspect were verified against laboratory analytical reports and/or requests were made to the laboratory to verify the results through sample reanalysis and/or verification of reporting accuracy.

5.6.2 Results

When comparing the results from the duplicate water samples, no PRSD values exceeded the cut off of 18% (Appendix C Table - 15). Field and trip blanks contained detectable concentrations of several water quality parameters, however, the concentrations were less than five times the analytical detection limits (with the exception of silicate, nitrate+nitrite, nitrate, total sodium, and total strontium). Re-analysis was requested for these five analytes and the recheck values were within acceptable QA/QC limits (Appendix C Table - 15).

An additional screening was performed to ensure that total metal concentrations exceeded dissolved metals concentrations. Where detectable concentrations exceeded five times the analytical detection limit, no dissolved metals concentrations exceeded the total metal concentration.

A number of analytes exceeded laboratory recommended hold times (HT) prior to analysis of water samples (Table - 5.7). However, the majority of these (i.e., dissolved organic carbon, silicate, total dissolved solids, total organic carbon, total suspended solids, and turbidity) were analyzed within a reasonable time from the expiry time. The hold time recommended for pH is commonly exceeded (0.25 hr) and it is recommended that lab measurements be verified with field measurements.

Table - 5.7: Exceedances of Hold Times (HT)
Recommended by ALS Laboratories for Water Samples

Parameter	HT	Max HT Exceedance	HT Unit
Carbonaceous BOD	48	72	hours
Chlorophyll-a & Pheophytin-a	48	96	hours
Dissolved Organic Carbon	28	30	days
pH	0.25	120	hours
Silicate by Colorimetric analysis	28	33	days
Total Dissolved Solids	7	8	days
Total Inorganic Carbon	24	230	hours
Total Organic Carbon	28	30	days
Total Suspended Solids	7	8	days
Turbidity	48	66	hours

The precision of results determined after hold time is affected by the stability or volatility of the compound, the preservative or processing of the sample (e.g., filtering) and site conditions (i.e., extreme climate or contamination). Although it is not possible to quantify the exact effect of hold time exceedance, for the purposes of this study, it is assumed that impact associated with analyzing samples past hold time is negligible.

By comparing sediment replicate samples, PRSD values ranged from 0.1% to 323% (Appendix C Table - 16). The most homogenous station (i.e., with the lowest average PRSD of 4%) was RDL-SQ5 while the most heterogeneous station (i.e., with the highest average PRSD of 55%) was GRR-SQ2. The sediment station in Unnamed Creek 3 had some of the highest individual PRSD values (e.g., molybdenum concentrations had a PRSD value of 323%). A recheck was requested from the lab and confirmed the highest concentration.

There were two outliers in the fish biological data: BRST001 from Unnamed Lake 4 (weight recorded as 0.1 g) and BRST008 from Unnamed Creek 2 (weight recorded as 0.22 g). Both weights were removed from summary statistics and regression analysis.

6. Summary

6.1 Vegetation Component

The three distinct floral communities that were identified in the terrestrial study area: a large clear-cut area, a mature mixed wood forest with a dense canopy, and a wet fen. None of the species listed in the MCDC rankings for the Mid-Boreal Lowland or Churchill River Upland Ecoregions were found in this area.

The large clear-cut area is in the process of regrowth and appears to be proceeding naturally through a hardwood forest stage. No supplemental planting was done in this old clear-cut area and trees in this area are not yet mature, canopy is fairly closed, and trees are young, averaging about 2 m in height. The area is diverse in ground cover, with many open areas and trails allowing growth of shrubs and grasses. Soil depth is shallow, with many rock outcrops and sphagnum comprising about 50% of ground cover. Grassy areas with sedge pockets and shrubs make up the balance of the understory.

A MTS communication tower is also located within this floral community. It is unlikely that unusual or rare species, growth forms, or habitats will occur in this area outside of that in existence throughout the clear-cut area.

The mature open stand is part of the mature and diverse forest stands that occur along the shore of Reed Lake and the Grass River in this region. These stands are very diverse environments, with old growth trees and a very diverse ground cover. This and the overall diversity of species indicate the high productivity of soils in the upland areas of this region. The mature forest biome is extensive and is composed of White Spruce, poplar, and birch, interspersed with small black spruce bogs. Tree sizes are very large, with tall mature poplar common in the area. The canopy is more open as is typical in a mature forest stand. Ground cover is a mixture of sphagnum, grassy areas, and sedge. Shrubby growth is common with ground plants comprising a mixture of typical boreal ground species interspersed with open area growth.

The mature upland forests, however, offer a very rich diversity of wildlife habitats. As such, they are of special concern for rare and endangered species, especially along watercourses and near lakeshores where edge habitats result in the most diverse floral communities found in the region. This is also true for nesting migratory songbirds, which thrive on the diversity of forest types and plant species in these areas. No occurrences of rare and endangered species were noted in the 2011 study. However, if possible, most facilities should be located in the old clear-cut area, and clearing in the mature forest stands limited to the minimum necessary.

The third floral community is wet fen with tamarack margins, in some cases bordering open lakes. These areas show typical fen vegetation with deep accumulations of sphagnum covered in bog birch and alder. The wet fen environment borders both the mature stands and clear-cut areas to the south. The sphagnum mats are covered in typical fen vegetation such as bog birch and several areas support extensive growth of pitcher plants, an insectivorous plant species. This area is biologically interesting in terms of fen vegetation, however it offers little in terms of wildlife habitat.

6.2 Wildlife Component

Waterbodies in the Reed Project area are best known for Northern Pike, Walleye, and Whitefish, while Lake Trout are mainly confined to Reed Lake itself. Moose are fairly common in the area, especially along waterways while White-tailed deer have moved in from the south and their numbers are increasing. Several wolf packs that roam through various sections of Grass River Provincial Park are the ungulates' (moose, caribou and deer) main predator. Other predators such as lynx, marten, fisher and wolverine are found in varying numbers. Mink and otter are common in the lakes and rivers. Colonial nesting birds such as double-crested cormorants, great blue herons, white pelicans, gulls and terns can be seen on the lakes. A gull-tern colony has been recorded on Reed Lake (Manitoba Conservation, 2011).

The Reed Boreal Woodland Caribou range is in the area of the Reed Project. Manitoba Conservation lists the Reed Range to be of medium conservation concern and numbering between 100 to 150 individuals (Manitoba 2005). It is believed that the provincial boreal Woodland Caribou population is stable; however, Boreal Woodland Caribou are listed as "threatened" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Manitoba's boreal woodland caribou populations were listed as threatened under The Endangered Species Act in June, 2006. (Manitoba 2005).

Boreal Woodland Caribou have several distinct habitat requirements that have both spatial and temporal scales (Manitoba 2005). Boreal Woodland Caribou range throughout most of the Grass River Provincial Park during the year, and are most often associated with mature forest for most of their seasonal range. The Boreal Woodland Caribou use treed muskeg during the winter for foraging and the many islands on Reed Lake are used as important calving habitat as cows and their calves tend to stay on the predator-free islands during the summer. They may also be seen crossing PTH 39, especially in the early morning and at dusk.

Boreal Woodland Caribou are known to avoid an area with a high degree of human disturbance. The local region has very high quality habitat, which varies according to the season. Winter range and spring calving areas are highly critical. Habitat quality can be assessed using GIS techniques, and it is recommended that a study be conducted within the Project area. Known use areas can be located with information provided by Manitoba Conservation, Wildlife and Ecosystem Protection Branch. The extent of potential disturbance of this species, and the value of the local habitat would be the subject of further study.

6.3 Aquatics Component

In a limited number of water samples, iron and ammonia concentrations exceeding the applicable water quality guideline. No other exceedances above applicable water quality guidelines were observed during the fall 2010 program. In general, the lowest metal concentrations were measured in the Grass River samples. These findings are consistent with the designation of the waters in the Upper Grass River watershed as High Quality Water.

Substrate in the water bodies was dominated by silt, with few exceptions (two sites dominated by sand and one site dominated by clay). Arsenic, cadmium, chromium, copper, lead, mercury, selenium, and zinc concentrations in sediment collected in the Study Area exceeded applicable sediment quality guidelines. Over half of the sediment samples exceeded sediment quality guidelines for selenium. Selenium is often associated with clay content in rocks, particularly with Cretaceous marine shales and limestone (which is typical in this region, particularly in the southern region of the Project area). (Huggins, 2005)

Water bodies in the Project area were classified as moderately productive on the basis of nutrient concentration, invertebrate biomass, and fish community. Unnamed Lake 3 had the highest phytoplankton biomass of all water bodies, dominated by Microcystis, a cyanobacterium which can produce toxins and create large blooms. The invertebrate communities (i.e., zooplankton, phytoplankton, and benthic invertebrates) were often dominated by one taxonomic group. Low invertebrate densities and diversity may indicate poor habitat quality, whereas excessively high densities may indicate nutrient enrichment, toxic conditions, or physical disturbance of habitat. Metal concentrations in sediment (e.g., selenium) were not correlated with diversity or density of the benthic invertebrate communities.

Fish health across all water bodies was considered good and there were no exceedances of the tissue residue guideline. There was limited evidence for tissue-specific metal concentration. Selenium, despite being elevated in the sediments, showed no correlation to concentrations in fish tissue. Smaller fish tended to have higher selenium concentrations, potentially reflecting their food sources (i.e., benthic organisms) however, this relationship was very weak.

Fish habitat in the Project area is typical of the region. Overwintering habitat, particularly for large-bodied fish is limited in the unnamed lakes and creeks. Large-bodied fish were captured in Unnamed Lake 2, due to the open connection to Whitehouse Creek and these fish were not likely permanent residents in the lake. As Unnamed Lake 2 had been identified as the potential future water source for exploration and mining activities, detailed fish habitat descriptions and supplemental fishing efforts in Unnamed Lake 2 and Whitehouse Creek were recommended and performed in spring 2011. Fishing effort was not performed in Unnamed Lake 2 due to low water levels in spring 2011. The connection between Unnamed Lake 2 and Whitehouse Creek at the time of assessment was not continuous and would not have provided fish in Whitehouse Creek access into Unnamed Lake 2. Additionally, due to the low water levels, the culverts at PTH 10 were perched at the downstream side. However, juvenile Northern Pike were captured near the connection between Whitehouse Creek and Unnamed Lake 2, suggesting that, at least for the juveniles, large-bodied fish are able to over-winter in Whitehouse Lake.

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