MacKenzie River Watershed

Assessment Report

Lakehead Region Conservation Authority

Conserve Today...For A Better Tomorrow

MacKenzie River Watershed Assessment Report

2013

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Lakehead Region Conservation Authority
Conserve Today...For A Better Tomorrow

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The 2013 MacKenzie River Watershed Assessment Report was completed by Allyson Stuart and Virginia Lane, Assistant Water Resource Technologists. Scott Drebit, GIS Technician/Planner of the Lakehead Region Conservation Authority and Tammy Cook, Watershed Manager, provided guidance, input and revisions towards the completion of this report.

This report has been prepared in-house at the Lakehead Region Conservation Authority for internal purposes to document the condition of the MacKenzie River watershed for 2013.

Executive Summary

The MacKenzie River watershed is partially located within the organized Municipality of Shuniah (Geographic Townships of MacGregor and McTavish), the Township of Dorion and is also largely located within an unorganized area comprised of Crown land. The watershed spans approximately 368 square kilometres and has a surface water drainage area of approximately 14.73 square kilometres, which includes several lakes and tributaries. Many of the tributaries found within the MacKenzie River watershed are unnamed. The MacKenzie Creek, Walkinshaw Creek, Beck Creek, Tastan Creek and MacKenzie River are the named watercourses found within the watershed. MacKenzie River flows into Lake Superior. The watershed is fed by many lakes which include Sparks, Beaver, Walkinshaw and MacKenzie. The general slope of the watershed is 1.87 percent.

The majority of the Mackenzie River watershed is Crown land (86.4 percent) and the remainder is privately owned (13.6 percent). A wind farm, installed in 2011, slightly overlaps into the furthermost northeast area of the MacKenzie River watershed. This power generation station, known as the Greenwich Wind Farm, is capable of generating 275, 000 megawatt hours of renewable energy per year.

The surficial geology of the Mackenzie River watershed is mainly bedrock (63 percent) although alluvial, esker, kame, outwash, glaciolacustrine, and moraine plains are also present. The bedrock is mostly composed of massive granodiorite to granitic rocks of the Neo – to Mesoarchean era. The MacKenzie Interlobate Moraine is also located within the watershed and is a significant geomorphological feature supporting drainage and the water table within the area. The prevailing soil type throughout the watershed is Rockland soil which covers approximately 89 percent of the watershed. The remaining soil types found within the MacKenzie River watershed include Wolfpup, Nolalu, Glen and Organics – Innes Lake, in order of decreasing area.

The MacKenzie River watershed is located within the boundaries of the Boreal forest region. The overstory is dominated by white birch, white spruce, black spruce and balsam fir. There are a variety of other plants present in the watershed including ferns, shrubs, herbs, mosses and lichens. The wildlife observed within the watershed included black bear, moose, red fox, red-tailed hawk, garter snake and a variety of minnows and invertebrates. The flora and fauna inventory indicated that the Mackenzie River watershed supports a healthy population of diverse plants and animals.

There are currently eight species at risk, living in the boundaries of the MacKenzie River watershed. Of these eight species, two are endangered and two are threatened, with the remaining four being designated as special concern. There are eight confirmed sightings of invasive species within the watershed, including purple loosestrife and rusty crayfish. The potential exists for other invasive species to be present in the watershed, but there are no confirmed sightings for additional species.

For this report, ten sample sites located within the MacKenzie River watershed were chosen based on a variety of attributes including: accessibility, physical features, land use designation, and proximity to anthropogenic features that may alter water quality.

At each of the ten sample locations, surface water samples and field measurements were conducted during two sampling periods, June 18-20 and July 9-11, 2013. Surface water samples were analyzed by ALS Laboratory Group for conductivity, total dissolved solids, turbidity, total ammonia, nitrate, nitrite, total phosphorus, *Escherichia coli (E. coli,)* and a total metal analysis. Field measurements taken with an YSI Sonde unit included water temperature, pH, conductivity, turbidity and dissolved oxygen. Field and laboratory results were compared to the Ministry of Environment's *Provincial Water Quality Objectives (PWQO)*, 1994 and the *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table*, produced by the Canadian Council of Resource and Environment Ministers (CCREM), updated 2012.

As there is no current PWQO for total coliforms, results were compared to the pre-1994 PWQO criterion (1,000 MPN/100 mL). During the June sampling period, Sites 6, 8 and 9 were in exceedance of the PWQO. During the July sampling period, every site, with the exception of Site 10, exceeded the PWQO. The total coliform concentrations in 2013 ranged from 110 MPN/100 mL to greater than 2,420 MPN/100 mL, for the watershed.

All sites were above the PWQO criterion of 0.075 mg/L for aluminum, during at least one sampling period. Aluminum exceedance concentrations ranged from 0.083 mg/L (Site 3) on July 9, 2013 to 0.239 mg/L (Site 8) on July 10, 2013.

All sites displayed results that exceeded the PWQO criterion of 0.30 mg/L for iron during the July sampling period, with the exception of Site 10. During the June sampling period, Sites 3, 6 and 8 were in exceedance of the PWQO. Iron exceedance concentrations ranged from 0.341 mg/L (Site 8) on June 19, 2013 to 0.683 mg/L (Site 8) on July 10, 2013.

Copper exceeded the PWQO criterion of 0.001 mg/L (interim) at Site 5 on July 9, 2013 (0.0017 mg/L), Site 6 (0.0013 mg/L) on July 10, 2013 and Site 10 (0.0011 mg/L) on June 20, 2013. Each exceedance was determined using the interim hardness category for 0-20 mg/L $CaCO_3$.

Site 6 exceeded the PWQO criterion of 0.030 mg/L for phosphorus during the June sampling period with a concentration of 0.0303 mg/L.

The stream banks, primarily composed of bedrock and boulders, were stable and showed little to no signs of erosion. The water crossings appeared to be functional; however, Bridge 1, which is a decommissioned CN Railway bridge, should be monitored in the future as it is no longer in use and may begin to deteriorate, and Culvert 1, which is located on Crown land, had a buildup of woody debris and should be monitored during high water periods.

The MacKenzie River watershed was also assessed using the *Guide to Developing Conservation Authority Watershed Report Cards*, 2011. Using this guideline, surface water quality and forest conditions for the MacKenzie River watershed were used to determine a grade for the watershed. Surface water quality maintained an excellent rating with very few exceedances of phosphorus and low concentrations of *E. coli* within the MacKenzie River watershed. Forest conditions also scored an excellent rating with very high forest coverage and a high percentage of riparian forest cover. Overall the quality of the MacKenzie River watershed in 2013 was determined to be in excellent health, and graded an A based on the surface water quality and the forest condition.

Upon completion of the 2013 MacKenzie River Watershed Assessment, the following recommendations have been made for consideration:

- It is recommended that an update to the 2013 MacKenzie River Watershed Assessment be completed in the next five to ten years, staff and funding permitting.
- The Watershed Report Card for the Lakehead Watershed should be updated when new or updated assessments are completed for the MacKenzie River Watershed.
- Wetland conditions and groundwater quality should be assessed if possible, to aid in the grading process for the Watershed Report Cards.
- Additional sampling should be conducted in the spring to observe the water quality differences between high and low flow seasons.
- Future studies should consider sampling downstream from the new twin bridges built on Highway 11/17.
- Benthic, fish and bird surveys should be considered for future sampling, to help indicate overall health of the aquatic and forest ecosystems.

A copy of this report should be provided to the Township of Dorion and the Municipality of Shuniah for reference purposes. The Ontario Ministry of Natural Resources, Thunder Bay District Office should also be provided a copy of the report as the Crown land portion of the watershed is within their jurisdiction. The Report should be kept on file at the LRCA Administration Office for review by interested parties.

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1 Introduction

The MacKenzie River watershed is located within the organized Township of Dorion, the Municipality of Shuniah (Geographic Townships of MacGregor and McTavish), and unorganized Crown land, as shown on the Map M-1: Key Plan. The Crown land (86.4 percent) makes up the majority of the watershed and the remainder is privately owned (13.6 percent). The privately owned property is located within the Municipality of Shuniah in the southern portion of the watershed near Highway 11/17 and Lake Superior. Areas regulated by the Lakehead Region Conservation Authority (LRCA), as well as the Township boundaries, can be found on Map M-2: Regulated Area. It is noted that the area of jurisdiction and areas regulated by the Authority only include the organized Municipalities and Townships, not the Crown land.

A watershed can be defined as all the land and water within the confines of a drainage divide. Numerous tributaries (i.e. streams and creeks) and significant lakes (Beaver Lake, Sparks Lake, and Walkinshaw Lake) are present within the MacKenzie River watershed. In essence, the MacKenzie River watershed consists of all the surrounding land that naturally drains its lakes, streams, wetlands and precipitation runoff into the MacKenzie River which then flows into Lake Superior.

The MacKenzie River watershed spans an area of approximately 368 square kilometres. The headwaters of the main branch initiate near the Township intersection of Dorion and McTavish and Crown land. White Granite Lake and Beaver Lake are the northernmost lakes in the watershed, which appear to flow into MacKenzie Lake. It is unclear which of these three lakes is the headwater of the MacKenzie River watershed.

The MacKenzie River is primarily bedrock-controlled and the main branch runs 10.87 kilometres in length and drains directly into Lake Superior. The river is typically fast flowing throughout its length, with few slow moving pools in the main branch of the MacKenzie River. The many tributaries to the main river however, have a range of slow and fast moving water, as well as some low-lying wetland type areas. Many of the watercourses are first-order streams which are un-branched, and often unnamed, tributaries. These tributaries originate from small lakes or groundwater sources.

The prevailing soil type throughout the watershed is Rockland, which is shallow soil overlying bedrock. The remaining soil types - Nolalu, Glen, Organics - Innes Lake, and Wolfpup - congregate along the MacKenzie Interlobate moraine in the southern portion of the watershed.

Forest composition of the MacKenzie River watershed is typical of the boreal forest region. The most common tree species in the area are coniferous and include black spruce, white spruce, jack pine, balsam fir, tamarack, and eastern white cedar, as well as deciduous species including trembling aspen, balsam poplar, and white birch. A large variety of shrubs, herbs, graminoids, mosses and lichens are also present in the understory. There is a diverse community of fauna supported by the boreal forest

including songbirds, bats, bald eagle, black bear, moose, snowshoe hare, frogs and toads, and many fish species, in addition to the many other species present.

The objective of this report is to document the conditions of the MacKenzie River watershed, especially surface water quality, as observed in June and July of 2013. This information will ultimately be used to develop and maintain programs to sustain a healthy ecosystem, consistent with the Natural Hazards and Natural Heritage Policies of the Province of Ontario. The main objectives of this assessment report are to:

- Summarize the physical, biological and socio-economic attributes of the watershed
- Collect surface water quality data
- Collect field measurements
- Conduct an inventory of the forest ecosystem and fauna observed within the watershed
- Conduct an inventory of soil, streambed substrate and streambank cover observed within the watershed
- Document active erosion sites
- Document the physical condition of all MacKenzie River water crossings (bridges/culverts)
- Interpret results to record the health status of the watershed

2 Background

2.1 *Physical Attributes*

2.1.1 Topography

Many tributaries within the MacKenzie River watershed are unnamed, although they are significant connections between the headwaters and the confluence of MacKenzie River and Lake Superior. The topography of the watershed greatly influences the flow patterns of the surface waters. The MacKenzie River watershed has a general slope of 1.87 percent and an illustration of the stream gradient can be seen on Figure 1: MacKenzie River Watershed Stream Gradient.

The topography of the area is characterized by hummocky terrain within the moraine area and esker, kame and outwash plains. Bedrock exposure is common throughout the watershed and includes bedrock knobs, plains and ridges. Bedrock knobs constitute 92.2 percent of the total bedrock and are characterized by an irregular surface having complex multiple slopes of varying steepness. Bedrock plain units constitute 2.5 percent of the total bedrock area and are characterized by a low-lying, undulating to rolling surface. Bedrock ridge units makeup 5.3 percent of the total bedrock area and consist of long, narrow, sub-parallel and intersecting bedrock ridges of varying heights.

The highest elevation within the watershed is approximately 555 metres above sea level and occurs at Northing 5381921 Easting 347668. This elevated point is topographically underlain by bedrock consisting of the diorite-monzonite-granodiorite suite. The lowest point of elevation within the watershed is located near the confluence of the MacKenzie River and Lake Superior at 183.4 metres above sea level (5376624 N / 356578 E). The topography of the MacKenzie River watershed is illustrated on Map M-3: Topography.

2.1.2 Geology & Soils

Bedrock

Bedrock geology can be influential for channel morphology, which is an important driving factor in aquatic ecosystem structure and health. Such a relationship could provide a critical link between hydrologic processes at larger scales and local scale aquatic ecosystem variables. The bedrock exposure within the MacKenzie River watershed comprises 63.2 percent of the total landform surface area. The MacKenzie River watershed is a part of the geological area known as the Quetico Subprovince. The western portion of the subprovince is separated from the eastern portion by the Nipigon Embayment. The typical sedimentary assemblages found in the Quetico Subprovince also contain abundant muscovite-bearing granitic rocks and massive granodiorite to granite found in the MacKenzie River watershed.

The bedrock geology within the watershed is a product of Precambrian depositional events between 900,000 million years and 3.4 billion years ago. The oldest rocks within the watershed are metavolcanics, which are mafic to intermediate in composition; and the youngest geologic event included the Sibley Group, made up of conglomerates, sandstones and shale (see Table 2.1: MacKenzie River Watershed Bedrock Geology). The Archean metavolcanics have a moderate colour index and make up approximately four percent of the rock formations within the watershed. The Sibley Group represents a very small percentage (0.2 percent) of the watershed at the eastern perimeter. These rock units formed when sediment eroded from the Superior Province and washed into a shallow lake on the top of an older rock complex (Ministry of Northen Development, Mines & Forestry, Ontario, 1994). The remaining geologic groups are described in Table 2.1: MacKenzie River Watershed Bedrock Geology and a visual representation can be found on Map M-4: Bedrock Geology.

Table 2.1-1: MacKenzie River Watershed Bedrock Geology

General	Rock Type	Eon	Era	Area km^2
Sibley Group	Conglomerate, sandstone, shale	Proterozoic	Mesoproterozoic (0.9 to 1.6 Ga)	0.745
Mafic and related intrusive rocks (Keweenawan age)	Logan and Nipigon sills (1109 Ma): diabase sills	Proterozoic	Mesoproterozoic (0.9 to 1.6 Ga)	3.352
Sedimentary rocks (Animikie Group)	Wacke, shale, iron formation, limestone, minor volcanic rocks	Proterozoic	Paleoproterozoic (1.6 to 2.5 Ga)	0.412
Massive granodiorite to granite	Massive to foliated granodiorite to granite	Archean	Neo to meso-archean (2.5 to 3.4 Ga)	265.6
Mafic to intermediate metavolcanic rocks	Basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks and related migmatites	Archean	Neo to meso-archean (2.5 to 3.4 Ga)	14.69
Muscovite – bearing granitic rocks	Muscovite – biotite and cordierite – biotite granite, granodiorite – tonalite	Archean	Neo to meso-archean (2.5 to 3.4 Ga)	68.48
Diorite – monzonite – granodiorite suite	Diorite, tonalite. monzonite, granodiorite, syenite and hypabyssal equivalents (saturated to oversaturated suite)	Archean	Neo to meso-archean (2.5 to 3.4 Ga)	14.69

Surficial Geology

Throughout northwestern Ontario there is a close relationship between landform features and sediment types. During the advancement of the Laurentide Ice Sheet, sub-glacial till was deposited in the form of drumlins, drumlinoid ridges, crag and tail features and undifferentiated ground moraines which have resulted in a structured topographic landscape. Approximately 20,000 years ago when the ice sheet began to recede, entrained materials in the ice melted out as ablation till. Melt-waters left behind sand and gravel within esker outwash systems and moraines. These esker outwash systems cover about 7.3 percent of the MacKenzie River watershed and are composed of sandy deposits along the MacKenzie Creek and the MacKenzie River. Morainal deposits cover about 28.0 percent of the watershed and include ground moraines, as well as the MacKenzie Interlobate Moraine located in the southern region of the watershed and east of Bittern Lake. The MacKenzie Interlobate Moraine was formed between the Superior and Dog Lake ice lobes prior to 10,200 years before present. The interlobate deposits of the moraine contain undifferential till composed of moderately compact fine sand, and approximately 40 percent clast content of medium to very coarse pebbles. Significant amounts of potentially useable aggregate resources of sand and gravel are present within the moraine. The surficial matrix is composed of calcareous components with silt and clay present. Outwash and ice-contact deposits surround the MacKenzie Interlobate Moraine.

In addition to these glacial features, 0.59 percent of the watershed is composed of glaciolacustrine plains and 63.17 percent is bedrock. Other landform features present in the watershed include organic accumulations and alluvial deposits amounting to 0.44 and 0.50 percent, respectively. The glaciolacustrine plains are typically composed of a range of grain sizes depending on the location of the plain. The organic accumulations are centrally located and include various amounts of peat and muck in marshes, fens, swamps and bogs. The alluvial feature is located adjacent to Sparks Lake congregating at the MacKenzie Creek and Walkinshaw Creek confluence. Deposits within this area consist of fine to medium sand and the soil types found within this area are sandy, gravelly loam. A visual representation of the surficial geology of the watershed is shown on map M-5: Surficial Geology. Due to the common bedrock exposure, overburden is relatively thin and usually less than 14 metres in thickness.

Soils

Soils within the Mackenzie River watershed include Rockland, Wolfpup, Nolalu, Glen and Organics – Innes Lake. Rockland comprises 89.68 percent of the entire watersheds soil composition and is characterized as a “nonsoil”, with less than ten cenitmetres of soil overlying bedrock. Wolfpup soil type makes up 5.44 percent of the watershed and is an eluviated eutric brunisol with a noncalcareous sand and gravel outwash material, of sedimentary rock origin. It is located at the southern-most area of the watershed and provides good drainage. The remainder of the soil types within the watershed includes Glen, Nolalu, and Organics – Innes Lake, comprising 4.88 percent. Glen is located within

the esker/kame/outwash plain and features gleyed and eluviated eutric brunisols with similar composition to Wolfpup soil, although drainage is imperfect. Nolalu soils are located along the southeastern perimeter of the watershed and are an orthic eutric brunisol composed of non-calcareous fine-sandy loam glacial till derived from shale with good drainage. The Organics – Innes Lake soils are located surrounding Bittern Lake and are typic humisols distinguished by well decomposed organic material with very poor drainage capability. The distribution of each type of soil throughout the watershed is illustrated on Map M-6: Soils, and a description of the soil types are presented in Appendix A: Soils.

2.1.3 Climate

The MacKenzie River watershed is similar to the Thunder Bay region, in that it is a modified continental climate influenced by Lake Superior. From the months of July to March the westerly winds prevail, whereas the easterly winds prevail the remainder of the year (LRCA, 1985). These winds modify the climate of Thunder Bay and the surrounding regions. The mean daily temperatures (degrees Celsius) and precipitation levels (millimetres) were recorded at the Thunder Bay Airport from 1971 to 2000 (Environment Canada, 2011) as shown in Table 2.1-1. This table also summarizes the extreme daily precipitation in millimetres recorded within a 24-hour period and the date it occurred.

Table 2.1-2: Average Monthly Temperature and Precipitation for Thunder Bay, 1971-2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Daily (degrees Celsius)	-14.8	-12	-5.5	2.9	9.5	14	17.6	16.6	11	5	-3	-11.6
Precipitation												
Total Precipitation (millimetres)	31.3	24.9	41.6	41.5	66.5	85.7	89	87.5	88	62.6	55.6	37.5
Extreme Max. Daily Precipitation (millimetres)	51.6	33.5	41.9	69.3	76.2	49.3	53.8	87.1	131.2	47.8	63	42.7
Date (yyyy /dd)	1956 /20	1951 /26	1957 /14	1954 /30	1971 /24	1947 /04	1973 /27	1973 /19	1977 /08	1968 /09	1973 /21	1948 /05

The average monthly temperatures (degrees Celsius) and precipitation levels (millimetres) were recorded at the Thunder Bay Airport for 2013 (Environment Canada, 2013), as shown below.

Table 2.1-3: Average Monthly Temperature and Precipitation for Thunder Bay, January-July 2013

	Jan	Feb	Mar	Apr	May	June	July
Average Temperature							
Daily (degrees Celsius)	-10.2	-11.5*	-6.4	0.1*	7.6	14.2	17.3
Precipitation							
Total Precipitation (millimetres)	17.7*	3.4*	12.6	42.4*	143.6	53.8*	131.8

*The value displayed is based on incomplete data

The average monthly temperature for the June and July sampling periods was 15.8 degrees Celsius, and the average monthly precipitation was 92.8 millimetres during the same time frame. In comparison with the historical data, the 2013 temperature reached the exact same average of 15.8 degrees Celsius for the June and July monthly average. The 2013 precipitation for June was 31.9 millimetres less than the recorded historical average precipitation. The precipitation for July 2013 was 42.8 millimetres greater than the recorded historical average precipitation.

2.1.4 Hydrology

Watershed Characteristics

The MacKenzie River covers an area approximately 368 square kilometres which includes a surface water drainage area of approximately 14.73 square kilometres. The numerous waterbodies located within the watershed (Table 2.1-3) make up approximately 4.8 square kilometres of the watershed landmass. The three lakes that were sampled included Sparks Lake, Walkinshaw Lake and Beaver Lake which comprise approximately 14 percent of the total lake area within the watershed. Most tributaries connect to the significant creeks, rivers and streams found in Table 2.1-3. Walkinshaw Creek, Beck Creek, Tastan Creek, MacKenzie Creek and MacKenzie River make up less than one percent of the total watercourse length within the area. The remaining 99 percent of the watercourses are unnamed streams. The drainage pattern of the watershed generally flows south towards the confluence with Lake Superior.

Table 2.1-4: Named Waterbodies/Watercourses within MacKenzie River Watershed

Name	Type	Thermal Condition	Surface Area (km^2)	Length (km)
Waterbodies				
Beaver Lake	-	Unknown	0.2340	-
Bittern Lake	Flowing	Cool Water	0.1726	-
Crag Lake	-	Unknown	0.0812	-
Dick Lake	-	Unknown	0.0443	-
Five Minute Lake	-	Unknown	0.0423	-
Hades Lake	Standing	Warm Water	0.1420	-
MacKenzie Lake	Standing	Cold Water	0.6519	-
Magone Lake	Standing	Cold Water	0.2830	-
Mason Lake	-	Unknown	0.0798	-
Moose Lake	Standing	Cold Water	0.1843	-
Moosehorn Lake	-	Unknown	0.1650	-

Name	Type	Thermal Condition	Surface Area (km^2)	Length (km)
Waterbodies				
Nalla Lake	Standing	Cold Water	0.4659	-
Nybergs Lake	-	Unknown	0.0575	-
Paradise Lake	Standing	Cold Water	0.0483	-
Pearson Lake	Standing	Cold Water	0.0645	-
Question Mark Lake	Standing	Cold Water	0.2671	-
Roll Lake	-	Unknown	0.0732	-
Sparks Lake	-	Unknown	0.0719	-
Sprat Lake	Standing	Cold Water	0.2545	-
Tartan Lake	Standing	Cold Water	0.3299	-
Tastan Lake	Standing	Cold Water	0.1111	-
Thruline Lake	-	Unknown	0.0502	-
Twenty Minute Lake	Standing	Cold Water	0.1325	-
Two Pound Lake	Standing	Cold Water	0.1158	-
Walkinshaw Lake	Standing	Cool Water	0.3578	-
White Granite Lake	-	Unknown	0.1837	-
Young Lake	Standing	Cold Water	0.1079	-
Watercourses				
Beck Creek	Creek	Unknown	-	1.969
MacKenzie Creek	Creek	Cold Water	-	23.36
MacKenzie River	River	Cold Water	-	10.87
Tastan Creek	Creek	Unknown	-	3.321
Unnamed Streams	Stream	Unknown	-	508.1
Walkinshaw Creek	Creek	Cold Water	-	10.56

Hydrogeology

The Thunder Bay Area Regional Aquifer Characterization, Groundwater Management and Protection Report July 2005, illustrated that the MacKenzie River watershed is in a zone with medium to high intrinsic susceptibility to contamination, in which the groundwater within these zones are more likely to become contaminated. The increased groundwater contamination susceptibility is due to the relatively thin overburden and the proximity of the water table to the ground surface. Site specific contamination controls for this watershed area should be determined as urban development persists.

2.2 *Biological Attributes*

2.2.1 Flora

The MacKenzie River watershed is located on the north shore of Lake Superior within the Boreal forest region of Ontario, as shown on Figure 2: Canada's Forest Regions. A forest region is a geographic zone with a vegetation cover that is fairly uniform in terms of dominant species and stand types. The boreal forest region is the dominate forest region in Ontario, covering 46.3% of Ontario's land area and comprising 58% of Ontario's forests. The most common tree species observed in this region include conifers black spruce, white spruce, jack pine, balsam fir, tamarack, and eastern white cedar, as well as deciduous species trembling aspen, balsam poplar, and white birch. The boreal

forest also contains many shrubs, herbs, mosses and lichen species within its understory. Plant species identified at the sample sites are listed in Appendix B: Common and Scientific Names of Identified Flora and Fauna.

2.2.2 Fauna

The fauna of a watershed is heavily dependent upon the forest region in which it lies. The boreal forest region is home to many insects, mammals, birds, amphibians and reptiles. The most commonly observed animals include, but are not limited to the black bear, white-tailed deer, bald eagle, American crow, American toad and garter snake. The watershed is part of the Ontario Ministry of Natural Resources (OMNR) Wildlife Management Unit 13 and Fisheries Management Zone 6.

The rivers, streams and lakes of the watershed are host to a wide variety of fish species. Many of the lakes within the watershed are cool or cold water lakes which will play a role in determining which species of fish will be present. The fish species known to be present in the watershed are shown below in Table 2.2-1. The area has seen yearling and fingerling Brook trout stocking from 2009-2013 and Splake stocking for multiple years as well.

Table 2.2-1: Fish Species Present within the MacKenzie River Watershed

Fish Species	Known Populations	Years Stocked
Brook trout	Roll Lake Five Minute Lake Tartan Lake Paradise Lake Question Mark Lake Moose Lake Nalla Lake	Roll Lake: 2010, 2012 Five Minute Lake: 2009, 2010, 2013 Tartan Lake: 2009 Paradise Lake: 2009, 2011, 2013
Burbot	Tartan Lake	N/A
Common white sucker	N/A	N/A
Lake herring	N/A	N/A
Lake trout	MacKenzie Lake Nalla Lake	N/A
Longnose Sucker	N/A	N/A
Northern pike	N/A	N/A
Rainbow trout	N/A	N/A
Smallmouth bass	N/A	N/A
Splake	Tartan Lake	2003-2005, 2007, 2011, 2013
Yellow perch	Walkinshaw	N/A

Source: Ontario Ministry of Natural Resources, Fish On-line, 2012

2.2.3 Species at Risk

Ontario has more than 200 species at risk living in its forests and lakes, all at varying degrees of risk. The MacKenzie River watershed is home to eight of them. There are approximately 11 other species at risk in the Thunder Bay area, that have potential to exist within the MacKenzie River watershed. The surrounding area is considered in addition to the watershed boundary limits, as it is also boreal forest region which would allow for movement of individuals in and out of the watershed boundary. Below is a table showing the species at risk, with documented sightings in the MacKenzie River watershed and immediate surrounding area.

Table 2.2-2: Species at Risk in the MacKenzie River Watershed

Species Name		Status of Risk
Common Name	**Scientific Name**	
Bald eagle	*Haliaeetus leucocephalus*	Special concern
Eastern whip-poor-will	*Caprimulgus vociferus*	Threatened
Golden eagle	*Aquila chrysaetos*	Endangered
Little brown bat	*Myotis lucifugus*	Endangered
Northern brook lamprey	*Ichthyomyzon fossor*	Special concern
Peregrine falcon	*Falco peregrinus*	Special concern
Shortjaw cisco	*Coregonus zenithicus*	Threatened
Snapping turtle	*Chelydra serpentina*	Special concern

Source: Ontario Ministry of Natural Resources, Species at Risk – Thunder Bay Region, 2013

2.2.4 Invasive Species

Invasive species are a threat to native plants and animals and can disturb the entire ecosystem in which they are a part of. Invasive species that may be present in the MacKenzie River watershed according to the OMNR and Ontario Federation of Anglers and Hunters' Invasives Tracking System, 2013, include, but are not limited to: giant hogweed, purple loosestrife, japanese knotweed, spiny water flea, rusty crayfish and rainbow smelt. There are many other invasive aquatic species that may be present in or near the confluence of the MacKenzie River with Lake Superior, but there is no confirmation that species such as sea lamprey, ruffe, zebra mussel or threespine stickleback have travelled upstream of the MacKenzie River.

2.3 *Socio-Economic Attributes*

2.3.1 Planning and Development Controls

Land Tenure

The majority of the MacKenzie River watershed is provincially owned Crown land (86.4 percent). Privately owned land constitutes 13.6 percent. Land ownership in the watershed is illustrated on Map M-7: Land Ownership.

Areas of Jurisdiction

The hydrological boundaries of the MacKenzie River watershed fall within the organized Municipality of Shuniah, (27.1 percent), which includes the Geographic Townships of MacGregor and McTavish, and also exists within the organized Township of Dorion (0.88 percent). Map M-8: Site Plan, illustrates the location of the MacKenzie River watershed within the geographic Township boundaries. Table 2.3-1 outlines the watershed area within each Township boundary.

Table 2.3-1: Areas of Jurisdiction within the MacKenzie River Watershed

Geographic Boundaries	Total Area (km^2)	Municipal Area within MacKenzie River Watershed (km^2)	Municipal Area within MacKenzie River Watershed (%)
Township of Dorion	218.72	3.22	0.88
Municipality of Shuniah			
Township of MacGregor	287.16	91.52	24.87
Township of McTavish	300.96	8.36	2.27
Total	806.84	103.10	28.02

Within the boundaries of the MacKenzie River watershed the Lakehead Region Conservation Authority (LRCA) area of jurisdiction extends within the Township of Dorion and the Municipality of Shuniah. Of the total MacKenzie River watershed area, 264.91 square kilometres (72 percent) is located outside of the LRCA area of jurisdiction. Conversely, 103.1 square kilometres (28 percent) of the watershed is located within the LRCA area of jurisdiction.

Within the LRCA area of jurisdiction, the Authority administers the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses O. Reg. 180/06 under the *Conservation Authorities Act.* Areas considered regulated include Provincially Significant Wetlands and 120 metres adjacent, all watercourses, all land zoned Hazard Land or Use Limitation, steep slopes and 15 metres landward and one kilometre lakeward from the 100 year flood level on Lake Superior (i.e. 183.9 metres Geodetic Survey of Canada). Activities within the approximate regulated area may require a permit from the Authority.

Land Use Designation/ Zoning

Municipal Official Plans contain long term goals and policies that serve as guidelines for future land use and development. The MacKenzie River watershed is affected by two Official Plans: Municipality of Shuniah and the Township of Dorion. Land use designations within the MacKenzie River watershed can be found on Map M-9: Zoning.

The policies of the Official Plan and all land use designations are implemented through zoning by-laws. Zoning provides an additional level of detail, particularly with respect to

the range of permitted uses and any specific conditions which must be satisfied such as buffering, suitable distances between uses and parking requirements.

Within the Township of Dorion the only zone that exists within the MacKenzie River watershed boundary is rural. The following is a definition of the Rural zone from the Township of Dorion Zoning by-laws.

Rural Zone

No person shall, within any Rural Zone, use any lot or erect, alter, or use any building and/or structure for any purpose except in accordance with the following; a) Agriculture b) Commercial fishing, fish hatchery c) Forestry, including a bush camp for forestry staff d) Fishing or hunting camps e) Institutional use, church, church camp, public works yard for roads authority f) Park, conservation uses, and/or watershed management g) Railway, gas pipeline, utilities h) Mining exploration and/or mining i) Wayside pit/ quarry j) Portable asphalt plant k) One single detached residential dwelling l) One single detached seasonal residential dwelling on an original lot as described by the initial patent m) Group home n) Garden suite o) Home occupation, home profession, home industry p) Accessory uses, buildings, structures.

Within the Municipality of Shuniah, the MacKenzie River watershed has been zoned as:

- Rural
- Aggregate Extraction
- Aggregate Extraction/Processing
- Community Residential
- Highway Commercial
- Open Space

The following definitions are taken from the Municipality of Shuniah Zoning by-laws.

Rural Zone

A Rural zone designation is intended to preserve low density rural residential character for Townships and Municipalities. Rural designations allow for a variety of compatible land uses including agriculture, guest cottages, wind farms, mineral exploration, forestry, stables and riding academies, parks, conservation uses and home occupation. Rural zones are located throughout the watershed and make up the largest zoning type.

Aggregate Extraction Zone

There are five areas zoned as Aggregate Extraction located within the MacKenzie River watershed. The permitted use of aggregate extraction within the Municipality of Shuniah does not include use of land building, and no building or structure shall be permitted within this zone except for: pits and/or quarries for extracting sand, clay, gravel, earth, soil, stone, shale, or peat; stockpiling of excavated materials; screening, sorting, and washing or other processing of excavated material, excluding crushing; wayside pits and/or quarries; buildings, structures, and/or uses accessory, subordinate, and exclusively devoted to a permitted use, which shall not include a dwelling unit. Aggregate extractive activity must also be 30 metres away from any public road or allowance. No excavation,

building or equipment or stockpiling of material shall be located within 120 metres of an abutting property used for residential, recreational, institutional, or commercial purposes. Blasting is also regulated in which it will not take place within 450 metres of any building except on-site buildings. A minimum 30 metre setback shall be maintained between any use in this zone and an abutting residential dwelling.

Aggregate Extraction/Processing Zone

One area within the MacKenzie River watershed is zoned as Aggregate Extraction – Processing and does not permit the use of land building, building, or structure to be permitted within this zone except for the following: pits and/or quarries for extraction of aggregate resources and/or stockpiling, as well as processing which includes screening, sorting, crushing and washing of excavated materials. Aggregate extractive activity must also be 30 metres away from any public road. No excavation, building or equipment or stockpiling of material shall be located within 120 metres of an abutting property used for residential, recreational, institutional, or commercial purposes. Blasting is also regulated in which it will not take place within 450 metres of any building except on-site buildings.

Community Residential

The Community Residential zone within the MacKenzie River watershed is located along the southeast area of Sparks Lake. Site 4 was located within this zone at a private residence. The permitted uses for this zone includes: a permanent dwelling, church, school, day nursery, group home, park, home occupation and accessory structures. Lot requirements within this zone include a minimum lot width of 60 metres and a minimum lot area of 0.8 hectares. Any accessory building shall not be used for human habitation.

Highway Commercial Zone

The Highway Commercial zone is located in close proximity to Site 2, along Highway 11/17. The permitted uses for this zone include: automobile servicing, restaurant, convenience store, weigh station, hotel and sales of tourist goods or any structure related to these uses. Lot requirements within this zone include a minimum width of 60 metres and a minimum lot area of 0.8 hectares. A minimum of 10 percent of the total lot area shall be provided and maintained as landscaped area within this zone.

Open Space Zone

The Open Space zone is located between Site 1 (the confluence) and Site 2. Permitted uses of this zone include: conservation use; marina, boat launching and related parking; as well as park and public recreation, which does not include a dwelling unit. This zone does not include any lot size requirements.

Environmental Protection

Areas that require environmental protection are zoned accordingly and usually include areas and resources within the Municipality which exhibit a fragile environment, including: wetlands, watercourse, waterbodies, significant habitat of fish, fowl or wildlife, areas of scientific interest, and significant archaeological or cultural resources.

Areas prone to erosion and flooding can also be designated as environmental protection zones. All waterways and waterbodies have a minimum setback of 15 metres. Setbacks may be increased for larger watercourses or features that have been evaluated and found to warrant additional protection. Development or site alteration in or abutting environmental protection zones must be proven to not cause any harm to the area before proceeding.

2.3.2 Existing Land Uses

MacKenzie 1 Paleological Study

Within recent years a significant archaeological site was discovered where the new four-lane Highway 11/17 was proposed to be constructed. This site was named MacKenzie 1 and is located near the MacKenzie River, upstream of Site 2. Many thousands of artifact tools have been recovered from this large site and it has been suggested that they are remnants of inhabitants who camped along the shoreline of the glacial Lake Minong, approximately 9,000 years before present. This site may have been occupied shortly after deglaciation and would have been an ideal location close to the shoreline of the lake, as well as a broad river drainage system. Most of the stone tools and tool debris, from production, were made of taconite, which has only been found in Northwestern Ontario and parts of Minnesota. Extensive recovery of the artifacts and any given information regarding the paleontology of the site was collected within two years so that construction of the new four-lane highway could resume.

Greenwich Wind Farm

The Greenwich Wind Farm, owned and operated by RES Canada and Enbridge Incorporated, is a 99 Megawatt wind turbine facility consisting of 43 wind turbines in the Township of Dorion. They are expected to expand to 73 turbines in the future. There is a photo of wind turbine 8 on Figure 3: Wind Turbine 8 at Greenwich Wind Farm. The wind farm is in the upper northeast corner of the MacKenzie River watershed, with a total of 13 wind turbines located in the watershed (see Figure 4: Greenwich Wind Farm site map). Site 10 was located within the project boundary on Beaver Lake.

A major concern of wind farms is the impact they have on bat and bird populations in the area. A two-year post construction monitoring program is being conducted by an undisclosed environmental engineering firm. During this two-year program a 50 metre radius check of each turbine is conducted daily for deceased bats and birds. The birds typically show evidence of a wind turbine blade strike whereas bats mostly do not have any external injury. In other wind turbine studies, approximately 90 percent of the bats found at wind turbines show internal hemorrhaging typical of a condition known as barotrauma. This is a condition that occurs when the bats fly into the low pressure zone created by the turbine blades, which causes their pliable lungs to expand rapidly and collapse, causing death.

MacKenzie River Twin Bridges

The MacKenzie River Twin Bridges are part of the new TransCanada Highway realignment, approximately 20 kilometres east of Thunder Bay. The bridges have been developed over a deep gorge of the MacKenzie River basin. The project included the development of the twin, two-lane bridges which span over a total length of 180 metres and are the largest field-cast Ductal Ultra-High Performance Concrete bridge project in North America. The bridges are supported by abutments on the high river banks, founded directly on bedrock.

2.3.3 Proposed Land Uses

Panoramic Resources Ltd. – Thunder Bay North Project

The Thunder Bay North Project is a platinum, palladium, copper and nickel exploration project owned by Panoramic Resources Ltd., approximately 50 kilometres northeast of Thunder Bay. The mining claims cover an area of 400 square kilometres with possible expansion of up to 720 square kilometres, with Current Lake being the centre of the deposit. The project is in the scoping phase with drilling and baseline environmental assessments being conducted. The claim area covers the northeast portion of the MacKenzie River watershed, stretching east of Fitzpatrick Lake southeast to Bittern Lake. The mine would be both open pit and underground which could cause significant changes to the landscape and watershed ecosystem of the MacKenzie River.

3 Methods and Materials

A summary of the sampling techniques used is included in Appendix C: Techniques for Data Collection.

3.1 *Site Selection*

Ten sites were chosen throughout the MacKenzie River watershed to assess the overall health of the watershed. Each site was chosen based on its accessibility and its proximity to natural or anthropogenic features that may alter water quality.

The last site sampled on June 20, 2013 and July 11, 2013 was Site 10 which was located on Road N within the Greenwich Wind Farm and was chosen to obtain water samples from the northernmost portion of the watershed. Sampling was also conducted at this site to determine if any anthropogenic alteration of the water quality (i.e. sediment-loading etc.) is apparent due to the construction of the wind turbines.

On the second day of sampling, Site 9, Site 8, Site 7, and Site 6 were sampled on June 19, 2013 and July 10, 2013. Site 9 was located 20 kilometres down Escape Lake Road, east of Highway 527 and was chosen for its accessibility. This site would reflect the water draining from many of the northern tributaries. Site 8 was the most western sampling site within the watershed and is adjacent to Highway 527, where access to Walkinshaw Lake was available for sampling. Site 7 was located 8.5 kilometres down Magone Road, east of Highway 527, on a water crossing said to be named “Amethyst Creek”. At this site a confluence was apparent between an unbranched first-order stream (unnamed) and “Amethyst Creek”. The samples taken from this site therefore represented two watercourses downstream from the confluence point. Site 6 was located on Kingfisher Road, 600 metres north of Magone Lake Road where the water crossing is unnamed. The samples taken from Site 6 represented the water flowing east from Magone Lake which is also fed by tributaries from Walkinshaw Lake.

The first five sites were sampled on both June 18, 2013 and July 9, 2013. Sampling at Site 5 was conducted to determine the water quality of the Walkinshaw Creek which drains directly into MacKenzie Creek. Site 4 was located on Sparks Lake and represented a rural residential area within the watershed. This site would reflect any anthropogenic impacts from the permanent dwellings. Site 3 represented the samples for MacKenzie Creek, which flows east and eventually merges with Walkinshaw Creek. Site 2 was located downstream from Highway 11/17 and was chosen to determine if any anthropogenic alteration of the water quality is apparent due to the close proximity of MacKenzie River to the highway. Site 1 represented the confluence of the MacKenzie River with Lake Superior. This site was chosen in order to signify the cumulative water quality data for the entire watershed. The samples taken from all of the sites portray the positive or negative attributes that had originated in the MacKenzie River watershed and eventually flow into Lake Superior.

Many other sites would have been significant to the assessment of the MacKenzie River watershed, but were inaccessible. The UTM coordinates and elevation of each site were marked using the Trimble Geo XH GPS unit. The site locations are shown on Map M-8: Site Plan.

3.2 *Quantitative Assessment*

Several parameters were measured to assess surface water quality of the MacKenzie River watershed. Surface water samples were collected by LRCA staff and summer students in new bottles supplied by ALS Laboratory Group. The samples were transported on ice to the ALS Laboratory Group at 1081 Barton Street, Thunder Bay, Ontario, and analysed to determine conductivity, total dissolved solids (TDS), turbidity, nutrients (ammonia-total nitrogen, nitrate, nitrite and phosphorus), bacteria (*Escherichia coli* and total coliforms) and total metals (notable iron and lead).

Sampling was conducted on two separate occasions for each site, to enable comparisons and reveal discrepancies. The first data set was sampled on June 18, 19 and 20, 2013. The second data set was collected on July 9, 10 and 11, 2013.

Methodology for water sample collection was based on the Provincial Water Quality Monitoring Network (PWQMN), Ministry of the Environment, protocol. Grab samples were collected at a distance from the stream bank and towards the main current by wading or by using a reaching pole. Effort was taken to enter the stream downstream of the sampling location in order to disturb as little sediment as possible. Additionally, samples were taken downstream from any water crossings and/or outlet culverts and were taken facing upstream towards the current. In cases where current was not detectable (stagnant water) or the current was flowing in the opposite direction (influenced by wind direction), samples were still collected facing upstream. Samples were collected at a depth of 0.3 metres below the surface of the water to avoid capturing any floating debris.

ALS Laboratory Group provided four collection bottles for each site to conduct the following tests: routine, nutrient, metal and bacterial analysis. The routine analysis sample bottles and lids were rinsed twice before a true sample was collected. The ALS Laboratory Group pre-charged the nutrient sample bottles with sulfuric acid and the total metals bottles were pre-charged with nitric acid to preserve the samples taken, and were not rinsed before filling. Bottles for bacterial analysis were also not rinsed as they were pre-charged with sodium thiosulphate preservative and special care was taken not to open the bottle until the true sample was to be filled. All filled sample bottles were transported on ice for delivery to the laboratory.

Field parameters of water temperature, pH, conductivity and dissolved oxygen were measured using an YSI 6000 QS multi-parameter water quality sampler at the same time as water sample collection. The following additional field parameters were also measured: air temperature by mercury thermometer; channel width using a measuring tape reel; channel depth using a weighted measuring tape reel; and velocity was measured

using a stick, measuring tape, stop watch and appropriate calculations. Velocity was only measured for water flowing downstream (not in stagnant waterbodies producing only windblown results). A list and description of the water quality parameters are attached in Appendix D: Summary of Water Quality Parameters.

3.3 *Applicable Criteria*

Surface water quality results from the MacKenzie River watershed were compared to applicable criteria published in the *Provincial Water Quality Objectives* (PWQO) by the Ontario Ministry of Environment and Energy (MOEE), July 1994. The goal of the PWQO is to "ensure that the surface waters of the province are of the quality which is satisfactory for aquatic life and recreation". Applicable criteria published in the *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table* by the Canadian Council of Resource and Environment Ministers (CCREM), September 2012 were also used for comparison to nitrate and nitrite results for the MacKenzie River watershed. The information in these guidelines and supporting text is used to complement the PWQO and Interim Objectives.

The applicable criteria published in the PWQO and CCREM water quality guidelines are attached in Appendix E: Water Quality Guidelines. Total Coliform results were compared to the pre-1994 PWQO, as there are no current criteria available.

3.4 *Qualitative Assessment*

Watershed health can also be assessed by qualitative monitoring (i.e. visual inspection). The composition of in-stream substrate, forest soil, stream bank riparian community, shoreline vegetation and condition of the stream bank can all affect water quality. The presence or absence of certain flora and fauna can indicate the status of the watershed to provide suitable habitat. Several field guides were used to identify terrestrial and aquatic species. Each site was given a Vegetation Type (V-type) allocation based on the *Field Guide to the Forest Ecosystem Classification for Northwestern Ontario* (Sims *et al.* 1997) or a Wetland Type (W-type) based on the *Field Guide to the Wetland Ecosystem Classification for Northwestern Ontario* (A. Harris *et al*. 1996). Sites were assessed based on vegetation that could be seen from the site, with no distinct sample area, using a dichotomous key. It is important to note that these classifications are a general overview of a larger area and no site was exactly the same as another. Differences or inconsistencies between the V-types should be expected. Vegetation and Wetland Types and a detailed description of common species for each site are attached in Appendix F: Forest and Wetland Ecosystem Classification. Fauna was also assessed by identifying the species and number of individuals observed at each site. Common and Latin names of plant and animal species are attached in Appendix B: Common and Scientific Names of Identified Flora and Fauna.

An inventory of MacKenzie River water crossings (bridges and culverts) was also conducted. Physical dimensions were measured, Universal Transverse Mercator (UTM)

coordinates and pictures were taken and general observations were noted, including high water marks, stability of fill and any restriction of flow. Culvert and bridge locations can be found on Map M-10: Bridge and Culvert Sites. The bridge and culvert assessments are attached in Appendix G: Bridge Assessments and Appendix H: Culvert Assessments.

3.5 *Watershed Report Card Rating*

The Conservation Authorities in Ontario have developed the Watershed Report Card (WRC) as a means of reporting and designating watershed health through the use of environmental indicators and to utilize the information to better target programs and measure environmental change. Four resource categories are measured in the Watershed Report Cards which include surface water quality, forest conditions, wetland conditions, and groundwater quality. The grading system for each resource category is recognized as A-Excellent; B-Good; C-Fair; D-Poor; F-Very Poor.

Surface water quality and forest conditions were identified for the MacKenzie River watershed. The three indicators used to assess surface water quality for the watershed are total phosphorus, *Escherichia coli (E. coli*), and benthic macroinvertebrates (data not available). The average point score of the surface water indicators is used to determine the overall surface water quality grade. No wetland or groundwater data was available for the watershed.

Forest conditions utilize three indicators to determine the grade for the quality of the forest, which include forest coverage, forest interior percentage and percentage of riparian zone forested. Forest cover is the percentage of the watershed that is forested. Forest interior is the area of forest that lies more than 100 metres from a forest edge. Forest riparian zone measures the amount of forest cover within 30 metres adjacent to all open watercourses. Northern Ontario Forest Cover criteria are currently being developed.

Table 3.5-1: 2011 Surface Water Quality Indicator Guidelines

					Overall Surface Water Quality Grade	
Total Phosphorus (mg/L)	***E. coli* (#100 mL)**	**Benthic Invertebrates**	**Point Score**	**Grade**	**Final Points**	**Final Grade**
<0.020	0-30	0.00-4.25	5	A	>4.4	A
0.020-0.030	31-100	4.26-5.00	4	B	3.5 - 4.4	B
0.031-0.060	101-300	5.01-5.75	3	C	2.5 - 3.4	C
0.061-0.180	301-1000	5.76-6.50	2	D	1.5 - 2.4	D
>0.180	>1000	6.51-10.00	1	F	<1.5	F

Table 3.5-2: 2011 Forest Conditions Indicator Guidelines						
					Overall Forest Conditions	
% Forest Cover	% Forest Interior	% Riparian Zone Forested	Point Score	Grade	Final Points	Final Grade
>35.0	>11.5	>57.5	5	A	>4.4	A
25.1 - 35.0	8.6 - 11.5	42.6- 57.5	4	B	3.5 - 4.4	B
15.1 - 25.0	5.6 - 8.5	27.6 - 42.5	3	C	2.5 - 3.4	C
5.0 – 15.0	2.5 - 5.5	12.5 - 27.5	2	D	1.5 - 2.4	D
<5.0	<2.5	<12.5	1	F	<1.5	F

3.6 *Materials*

Materials used during the assessment included:

- Chest waders
- Cooler and ice packs
- Clipboard and observation chart paper
- Dip net
- Digital camera
- Field guides
- Fluorescent orange vests
- Latex gloves
- Measuring tape reel
- Measuring tape reel with lead weights (for measuring depth)
- Mercury thermometer
- Metre stick
- Reaching pole
- Road map
- Sampling bottles and preservatives, provided by ALS Laboratory Group
- Scissors
- Shovel
- Stopwatch
- Trimble Geo XH GPS
- Tweezers
- Writing utensils
- YSI 556 MPS metre
- Ziploc bags

Field guides referenced for the assessment included:

- Field Guide to the Forest Ecosystem Classification for Northwestern Ontario (Sims *et al.,* 1997)
- Field Guide to the Wetland Ecosystem Classification for Northwestern Ontario (A. Harris *et al.,* 1996)
- Field Guide to Trees and Shrubs 2nd Edition (Petrides, 1958)
- Native Trees of Canada 8th Edition (Hosie, 1990)
- ROM Field Guide to Wildflowers of Ontario (Dickinson *et al.*, 2004)

- Wetland Plants of Ontario (Newmaster *et al.*, 1997)
- Atlas of the Breeding Birds of Ontario (Cadman *et al.*, 2007)

4 Results

Site photos and descriptions from each sampling site are in Appendix I: Site Photography and Substrate. The laboratory water quality results and PWQO criteria have been compared and attached in Appendix J: Laboratory Water Quality Results Summary Tables. The original Laboratory Certificates of Analysis and Analytical Reports have been attached in Appendix K: Laboratory Certificates of Analysis and Test Results.

The results for the MacKenzie River watershed are summarized in the tables below for each site.

4.1 *Site 1*

Site 1 was located 130 metres west of McKenzie Beach Avenue and was accessed through a slightly overgrown trail. This site represented the confluence of MacKenzie River flowing into Lake Superior. Samples were taken downstream from a privately owned decommissioned CN railway bridge once known as the Kinghorn (see Appendix G: Bridge Assessments). The downstream flow of the MacKenzie River water was emerging at an even velocity, whereas the upstream waters cascaded down incised bedrock and maneuvered around bedrock boulders. This site was chosen to provide an indication of the quality of the water from the watershed, flowing into Lake Superior.

The in-stream substrate at the sampling site was dominated by cobbles, gravel and large boulders. Few emergent aquatic flora were present within the confluence. Many herring gulls and common loons were spotted within the area. Bank stability along the shoreline, as well as the slopes on which the railway bridge was built, appear to be stable. Abundant vegetation surrounding the area included dominant species such as sweet gale, slender willow, clover and cow vetch. The dominant tree species were white birch, white spruce and white pine. The adjacent property was privately owned with transplanted tree and shrub species present. Fishermen were seen leaving the site on July 9, 2013.

During the second sampling period, on July 9, 2013, total coliforms, aluminum, and iron exceeded the PWQO guidelines at Site 1. Total coliforms maintained a concentration of 2,000 MPN/100mL which exceeded the pre-1994 PWQO criterion of 1,000 MPN/100mL. Aluminum exceeded the PWQO criterion of 0.075 milligrams per litre (mg/L) during the same sampling period with a concentration of 0.154 mg/L. Iron exceeded the PWQO guidelines (0.300 mg/L) at a concentration of 0.384 mg/L.

Table 4.1-1: Location Reference for Site 1

Location Description	Confluence of the MacKenzie River flowing into Lake Superior; decommissioned CN rail bridge
UTM Coordinates	5376624 Northing / 0356578 Easting
Altitude/Elevation	183.4 metres above sea level

Table 4.1-2: Field Measurements for Site 1			
Parameter	**Unit**	**Date:** 18-JUN-13	**Date**: 09-JUL-13
		Time: 09:50	**Time**: 09:20
Water Temperature	ºC	14.57	16.56
Conductivity	uS/cm	58	47
Dissolved Oxygen	mg/L	15.36	9.74
Dissolved Oxygen	%	150.5	99.6
pH		7.65	7.99
Turbidity	NTU	0.13	0.55
Air Temperature	ºC	17	19
Channel Width	m	38	39
Sample Depth	m	0.6	0.5
Velocity	m/s	N/A	0.571

Table 4.1-3: Laboratory Water Quality Results for Site 1				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 18-JUN-13	**Date:** 09-JUL-13
			Time: 10:55	**Time:** 09:20
Bacteriological				
Escherichia Coli	MPN/100mL	100	7	30
Total Coliforms	MPN/100mL	1000 (prior to 1994)	550	**2000**
Physical				
Conductivity (EC)	uS/cm	N/A	59.5	52.3
pH		6.5-8.5	7.54	7.34
Total Dissolved Solids	mg/L	N/A	51	55
Turbidity	NTU	<10% of natural	0.63	1.10
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	0.027	<0.020
Chloride (Cl)	mg/L	N/A	0.83	0.86
Nitrate-N (NO3-N)	mg/L	N/A	0.050	0.050
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	<0.0050	0.0095
Sulfate (SO4)	mg/L	N/A	3.04	2.08
Metals				
Aluminum (Al)	mg/L	0.075	0.0587	**0.154**
Cadmium (Cd)	mg/L	0.0002 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0014	0.0019
Iron (Fe)	mg/L	0.300	0.235	**0.384**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	1.34	1.34

Bold indicates exceedance above PWQO guidelines

Table 4.1-4: Flora Observed at Site 1			
FEC V-Type: V4 White Birch Hardwood and Mixedwood			
Forest Density / Stream Cover	0% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam fir White birch White pine White spruce	Green alder Red osier dogwood Slender willow Sweet gale Tall meadow rue Wild red raspberry Wild gooseberry Willow	American vetch Bog aster Buttercup Clover Common strawberry Cow vetch Goats beard King devil hawkweed Ox-eye daisy Swamp thistle Yarrow Yellow hawkweed	Fern Horsetail Schreiber's moss
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.1-5: Fauna Observed at Site 1	
Fauna Species	
Amphibians	-
Birds	Common loon Common merganser American robin Herring gull Red-winged blackbird White-throated sparrow
Crustaceans	-
Fish	-
Insects	Beetles Blackflies Dragonfly larvae Monarch butterflies
Mammals	Snowshoe hare (including kits) White-tailed deer
Mollusca	-
Reptiles	-

Table 4.1-6: Physical Features Observed at Site 1							
FEC S-Type: S8 Moist / Coarse Loamy							
Moderately moist to very moist, coarse loamy soils. Developed in a range of parent materials. Associated with a broad range of vegetation conditions. When developed in morainal parent materials a high coarse fragment content is present. Most of these soils are classified as Gleysols.							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
~15%	~25%	~50%	~10%	-	-	-	-
Bank Stability / Erosion	Stable / Abundant vegetation						

4.2 Site 2

Site 2 was located at the Highway 11/17 MacKenzie River water crossing. The MacKenzie River flowed through a valley-shaped depression, and access to the site was characterized by a steeply sloping trail off of MacKenzie Beach Road. The culvert-style cement bridge (Appendix G: Bridge Assessments) at this site was supported by granitic bedrock which was also the main component for the in-stream substrate. The turbulent water at this site cascaded down a few white water terraces at the bridge mouth, and travelled through a gully between incised bedrock. Further downstream the river seemed to reach a wider flow path and began to meander. Continuous mechanical weathering of the bedrock from the constant flow of the river was apparent by the smooth surfaces of the bedrock. The water retained a tea-stained colour and during the July 9, 2013 site visit a large accumulation of foam collected in low velocity areas. During both site visits a constant water spray was reaching the shoreline, which allowed small depressions to accumulate water. This site was chosen to determine its water quality and if any anthropogenic alteration could have been associated with Highway 11/17.

Lichen species were flourishing on the consolidated parent rock along the riparian area. Rip rap was found along each side of the bridge. The terrestrial vegetation was slightly elevated and was distanced several metres from the rivers potential high-water mark. The elevated vegetation was experiencing erosion to some extent, although the deeply rooted tree and shrub species at the base of the slope allowed some cohesion to prevent complete instability. Animal prints which resembled a white-tailed deer were spotted along the riparian zone. Shrubby cinquefoil and serviceberry were common as well as northern blue flag iris at this site. Dominant tree species included white birch, balsam fir and white spruce.

Total coliforms, aluminum, and iron exceeded the PWQO guidelines during the second sampling period on July 9, 2013. Total coliforms were above the pre-1994 PWQO criterion of 1,000 MPN/100mL with a value of >2,420 MPN/100mL. Aluminum results doubled the PWQO criterion (0.075 mg/L) with a value of 0.150 mg/L. Iron concentrations were above the PWQO (0.30 mg/L) at a level of 0.38 mg/L. No exceedances were determined during the first sampling period on June 18, 2013.

Table 4.2-1: Location Reference for Site 2	
Location Description	MacKenzie River; bridge crossing Highway 11/17
UTM Coordinates	5377478 Northing / 0356662 Easting
Altitude/Elevation	209.65 metres above sea level

Table 4.2-2: Field Measurements for Site 2			
Parameter	**Unit**	**Date:** 18-JUN-13 **Time:** 11:03	**Date:**09 -JUL-13 **Time:** 11:00
Water Temperature	ºC	14.73	16.60
Conductivity	uS/cm	57	45
Dissolved Oxygen	mg/L	15.15	9.65
Dissolved Oxygen	%	148.5	98.7
pH		7.63	7.63
Turbidity	NTU	0.17	0.47
Air Temperature	ºC	15	18
Channel Width	m	4.0	7.2
Sample Depth	m	0.8	1.1
Velocity	m/s	0.2	N/A

Table 4.2-3: Laboratory Water Quality Results for Site 2				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 18-JUN-13 **Time:** 11:03	**Date:** 09 -JUL-13 **Time:** 11:05
Bacteriological				
Escherichia Coli	MPN/100mL	100	7	31
Total Coliforms	MPN/100mL	1000 (prior to 1994)	370	**>2420**
Physical				
Conductivity (EC)	uS/cm	N/A	58.1	49.7
Total Dissolved Solids	mg/L	N/A	53	56
Turbidity	NTU	<10% of natural	0.79	1.07
pH		6.5-8.5	7.56	7.39
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	0.032	<0.020
Chloride (Cl)	mg/L	N/A	0.63	0.78
Nitrate-N (NO3-N)	mg/L	N/A	0.052	0.047
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0057	0.0095
Sulfate (SO4)	mg/L	N/A	3.04	2.09
Metals				
Aluminum (Al)	mg/L	0.075	0.0617	**0.150**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0014	0.0018
Iron (Fe)	mg/L	0.300	0.245	**0.382**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	1.23	1.22

Bold indicates exceedance above PWQO guidelines

Table 4.2-4: Flora Observed at Site 2			
FEC V-Type: V4 White Birch Hardwood and Mixedwood			
Forest Density / Stream Cover	5% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam fir Balsam poplar Cedar Trembling aspen White birch White spruce	Bog aster Large-leaved aster Mountain ash Prickly wild rose Shrubby cinquefoil Serviceberry Showy mountain ash Sweet gale Wild gooseberry Wild red currant Willow	Cow vetch Dandelion Northern blue flag iris	Interrupted fern Meadow horsetail Pixie cup lichen Reindeer lichen
Aquatic Macrophytes and Algae			
Emergent	Cattail	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.2-5: Fauna Observed at Site 2	
Fauna Species	
Amphibians	-
Birds	American crow
Crustaceans	-
Fish	-
Insects	Tiger swallowtail butterfly
Mammals	White-tailed deer
Mollusca	-
Reptiles	-

Table 4.2-6: Physical Features Observed at Site 2							
FEC S-Type: SS5 Shallow – Moderately Deep / Sandy							
Shallow to moderately deep, sandy soils. Bedrock depth below the mineral soil surface ranges between 20 and 100 cm. Developed primarily in morainal parent materials. Typically associated with mixedwood and conifer stands. These are dry to fresh soils with textures ranging from very coarse to very fine sands.							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
~80%	~20%	-	-	-	-	-	-
Bank Stability / Erosion	Stable/ Abundant vegetation						

4.3 Site 3

Site 3 was located on MacKenzie Station Road and represented samples for MacKenzie Creek. At this site, the creek was passing under a relatively small bridge made from timbers and steel struts (Appendix G: Bridge Assessments). Upstream from the bridge the water was flowing parallel to the MacKenzie Station Road. An overflow area was present on the opposite side of the stream path, which resulted in flooding and saturation. The flow path then meandered towards the bridge and out into the sampling area. The in-stream substrate was composed of cobbles, gravel, sand, muck and also included aquatic vegetation.

This site was classified as a low shrub shore fen. The riparian zones seemed to contain water-logged mounds or hummocks supporting wetland vegetation and allowing stability along the banks. Tree populations within the low-lying wetland were either scarce or deceased. Sedges and meadow rue were dominant species at the site. The treed vegetation within the surrounding area was mostly located along the upper slopes which were south of the sampling site. Egg masses and small blacknose shiners were present during the June 19, 2013 sampling session and a garter snake was seen on July 9, 2013. During the second sampling session on July 9, 2013 a small waterfall was heard further downstream.

The lab results from sampling on June 19, 2013, showed that the iron content in the water samples exceeded the PWQO guideline for this element. The second sampling period on July 9, 2013, determined that total coliforms, aluminum and iron exceeded the PWQO guidelines at this time. Total coliforms concentrations exceeded the pre-1994 PWQO criterion (1,000 MPN/100mL) with a sample concentration of >2,420 mg/L. Aluminum exceeded the PWQO criterion (0.075 mg/L) with a sample concentration of 0.0828 mg/L. Sample concentration of iron (0.478 mg/L) also exceeded the PWQO criterion (0.300 mg/L).

Table 4.3-1: Location Reference for Site 3

Location Description	MacKenzie Creek; MacKenzie Station Road bridge
UTM Coordinates	5379021 Northing / 0354319 Easting
Altitude/Elevation	275.61 metres above sea level

Table 4.3-2: Field Measurements for Site 3

Parameter	**Unit**	**Date:** 18-JUN-13 **Time:** 12:04	**Date:** 09-JUL-13 **Time:** 12:30
Water Temperature	ºC	14.35	15.80
Conductivity	µS/cm	105	75
Dissolved Oxygen	mg/L	13.64	8.09
Dissolved Oxygen	%	133.8	80.7
pH		7.41	7.58
Turbidity	NTU	0.44	0.83
Air Temperature	ºC	19	21
Channel Width	m	8.3	10.0
Channel Depth	m	0.3	0.76
Velocity	m/s	N/A	0.28

Table 4.3-3: Laboratory Water Quality Results for Site 3				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 18-JUN-13 **Time:** 12:04	**Date:** 09-JUL-13 **Time:** 12:30
Bacteriological				
Escherichia Coli	MPN/100mL	100	6	30
Total Coliforms	MPN/100mL	1000 (prior to 1994)	770	>**2420**
Physical				
Conductivity (EC)	uS/cm	N/A	107	76.4
pH		6.5-8.5	7.49	7.26
Total Dissolved Solids	mg/L	N/A	76	66
Turbidity	NTU	<10% of natural	1.16	1.40
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	0.060	0.056
Chloride (Cl)	mg/L	N/A	1.44	0.89
Nitrate-N (NO3-N)	mg/L	N/A	0.199	0.063
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	<0.0050	0.0078
Sulfate (SO4)	mg/L	N/A	5.99	3.26
Metals				
Aluminum (Al)	mg/L	0.075	0.0385	**0.0828**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0013	0.0017
Iron (Fe)	mg/L	0.300	**0.365**	**0.478**
Lead (Pb)	mg/L	0.003 (interim)	<0.0010	<0.0010
Sodium	mg/L	N/A	1.95	1.35

Bold indicates exceedance above PWQO guidelines

Table 4.3-4: Flora Observed at Site 3			
Vegetation Type: W15 Low Shrub Shore Fen			
Forest Density / Stream Cover	5% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam fir Balsam poplar Black spruce Cedar Tamarack White birch	Green alder Meadow rue Prickly wild rose Red osier dogwood Serviceberry Wild red raspberry Willow	Bog aster Clover Common strawberry Cow vetch Marsh cinquefoil Northern bluebell Northern blue flag iris Orange hawkweed Oxe-eye daisy Purple-stemmed aster Swamp thistle Yellow hawkweed	Meadow horsetail Sedge Swamp horsetail

Aquatic Macrophytes and Algae			
Emergent	Common reed	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	Common marestail Slender pondweed Richardson's pondweed	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.3-5: Fauna Observed at Site 3	
Fauna Species	
Amphibians	-
Birds	-
Crustaceans	-
Fish	Blacknose shiner
Insects	Black ants Blackflies Bumblebees Butterflies Deerflies Dragonflies Leeches Tiger swallowtail butterflies Water striders
Mollusca	-
Mammals	-
Reptiles	Garter snake

Table 4.3-6: Physical Features Observed at Site 3							
Soil Type: N/A							
Sedges and low shrubs grow on peaty hummocks.							
In-stream Substrate							
Bedrock	**Boulders**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	-	~40%	~30%	~20%	~5%	~5%	-
Bank Stability/Erosion	Very stable / abundant vegetation						

4.4 Site 4

Site 4 was a privately owned property on Sparks Lake, accessed from MacKenzie Station Road. The sampling was conducted along the shoreline of Sparks Lake and represented a residential area. The substrate within the lake was mostly composed of sand with some gravel present. Aquatic vegetation was prominent and characterized by emergent, submergent and free-floating aquatics. Several freshwater leeches were seen within the waters and many goose feathers as well as goose feces were present along the shore. The banks of the shoreline were very stable with vegetation including mowed herbs and grasses. The type of vegetation was difficult to distinguish due to the landscaped and manicured yard which surrounded the sampled shoreline; however it was determined that

the vegetation varied between two black spruce types. The water activity seemed stagnant with little to no wave action on either sampling day.

The laboratory results showed that the aluminum found in the water samples on June 18, 2013 exceeded the PWQO for this element. The sampling period on July 9, 2013 determined that total coliforms, aluminum and iron exceeded the PWQO guideline at this time. Total coliforms were above the pre-1994 PWQO criterion of 1,000 MPN/100mL with a value of >2,420 MPN/100mL. Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 0.135 mg/L. Iron exceeded the PWQO criterion (0.300 mg/L) with a value of 0.504 mg/L.

Table 4.4-1: Location Reference for Site 4

Location Description	Sparks Lake, 452 MacKenzie Station Road; private property
UTM Coordinates	5379776 Northing / 0354457 Easting
Altitude/Elevation	279.99 metres above sea level

Table 4.4-2: Field Measurements for Site 4

Parameter	**Unit**	**Date:** 18-JUN-13 **Time:** 13:20	**Date:** 09-JUL-13 **Time:** 13:30
Water Temperature	ºC	19.89	20.73
Conductivity	uS/cm	50	55
Dissolved Oxygen	mg/L	12.16	7.58
Dissolved Oxygen	%	134.2	81.6
pH		7.57	7.57
Turbidity	NTU	0.25	0.51
Air Temperature	ºC	23	21
Channel Width	m	N/A	N/A
Sample Depth	m	1.0	0.9
Velocity	m/s	N/A	N/A

Table 4.4-3: Laboratory Water Quality Results for Site 4

Parameter	**Unit**	**PWQO Guidelines**	**Date:** 18-JUN-09 **Time:** 13:20	**Date:** 09-JUL-13 **Time:** 13:30
Bacteriological				
Escherichia Coli	MPN/100mL	100	5	19
Total Coliforms	MPN/100mL	1000 (prior to 1994)	110	**>2420**
Physical				
Conductivity (EC)	uS/cm	N/A	51.3	57.6
pH		N/A	7.25	7.21
Total Dissolved Solids	mg/L	N/A	49	52
Turbidity	NTU	<10% of natural	0.94	1.21
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	0.029
Chloride (Cl)	mg/L	N/A	0.28	0.24
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	<0.030
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0076	0.0098
Sulphate (SO4)	mg/L	N/A	3.57	3.02

Parameter	Unit	PWQO Guidelines	**Date:** 18-JUN-09 **Time:** 13:20	**Date:** 09-JUL-13 **Time:** 13:30
Metals				
Aluminum (Al)	mg/L	0.075	**0.105**	**0.135**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0018	0.0017
Iron (Fe)	mg/L	0.300	0.232	**0.504**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	0.99	0.96

Bold indicates exceedance above PWQO guidelines

Table 4.4-4: Flora Observed at Site 4

FEC V-Type: V34 Black Spruce / Labrador Tea / Feathermoss (Sphagnum) / V31 Black Spruce – Jack Pine / Tall Shrub / Feathermoss

Forest Density / Stream Cover	0% stream cover

Terrestrial Species

Trees	Shrubs	Herbs	Ferns / Horsetails / Mosses / Grasses
Balsam fir White birch Black spruce Jack pine Tamarack Trembling aspen White spruce	Prickly wild rose Red osier dogwood Speckled alder Sweet gale Wild red raspberry Willow	Birdsfoot trefoil Bog aster Clover Dandelion Marsh cinquefoil Plantain Small daisy Yellow hawkweed	Club moss Sedges

Aquatic Macrophytes and Algae

Emergent	Cattail	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	Common bladderwort Flat-stemmed pondweed Slender pondweed	**Attached Algae**	-
Free Floating	Yellow pond lily	**Slimes or Crusts**	-

Table 4.4-5: Fauna Observed at Site 4

Fauna Species	
Amphibians	Wood frog
Birds	Canada geese Common loon Red-winged blackbird American robin
Crustaceans	-
Fish	Northern Pearl dace

Fauna Species	
Insects	Black ants Blackflies Doubledays bluet dragonfly Leaches Mosquitoes Pearl crescent butterfly Tiger swallowtail butterfly Water boatmen Water spider
Mammals	-
Mollusca	Freshwater clams
Reptiles	-

Table 4.4-6: Physical Features Observed at Site 4

FEC S-Type: N/A (private property)							
Mowed lawn along shoreline and surrounding area.							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	-	-	~5%	~90%	~5%	-	-
Bank Stability/Erosion	N/A (lake site)						

4.5 Site 5

Site 5 was located on Walkinshaw Road and samples were collected from Walkinshaw Creek at the location of a wooden bridge (Appendix G: Bridge Assessments). This site was accessed from Walkinshaw Road approximately five metres downslope from the road, on an overgrown path. The slopes alongside the road were fairly stable with little to no erosion occurring. Abundant vegetation along the riparian zone and along the road slope promoted bank stability at this site. The river contained some white-water turbulence, especially during the second site visit, due to a heavy rainfall prior to the visit. The substrate was composed of boulders, cobbles, gravel and sand. Aquatic vegetation was not present during either site visit. The terrestrial vegetation included dominant species such as white birch, balsam fir, white spruce, mountain maple, mountain ash, bush honeysuckle, blue bead lily and bunchberry.

The laboratory results showed that the aluminum found in the water samples on June 18, 2013 exceeded the PWQO for this element. The second sampling period determined that total coliforms, aluminum, copper and iron exceeded the PWQO guidelines on July 9, 2013. Total coliforms exceeded the pre-1994 PWQO (1,000 MPN/100mL) with a sample concentration of >2,420 mg/L. Aluminum exceeded the PWQO criterion (0.075 mg/L) with a sample value of 0.196 mg/L. Copper exceeded the PWQO criterion of 0.001 mg/L (criterion correlated with hardness between 0-20 mg/L $CaCO_3$; see Appendix E: Water Quality Guidelines) with a sampled value of 0.0017 mg/L. Sample values of iron (0.427 mg/L) also exceeded the PWQO criterion (0.300 mg/L).

Table 4.5-1: Location Reference for Site 5	
Location Description	Walkinshaw Creek; Walkinshaw Road bridge
UTM Coordinates	5380526 Northing / 0355391 Easting
Altitude/Elevation	279.99 metres above sea level

Table 4.5-2: Field Measurements for Site 5			
Parameter	**Unit**	**Date:** 18-JUN-13	**Date:** 09-JUL-13
		Time: 14:00	**Time:** 14:10
Water Temperature	ºC	16.88	16.76
Conductivity	uS/cm	50	39
Dissolved Oxygen	mg/L	13.86	9.21
Dissolved Oxygen	%	142.3	94.6
pH		7.74	7.54
Turbidity	NTU	0.37	0.54
Air Temperature	ºC	24	21
Channel Width	m	9.4	8.2
Sample Depth	m	0.6	0.8
Velocity	m/s	0.44	1.08

Table 4.5-3: Laboratory Water Quality Results for Site 5				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 18-JUN-13	**Date:** 09-JUL-13
			Time: 14:00	**Time:** 14:10
Bacteriological				
Escherichia Coli	MPN/100mL	100	1	15
Total Coliforms	MPN/100mL	1000 (prior to 1994)	550	**>2420**
Physical				
Conductivity (EC)	uS/cm	N/A	51.6	42.6
pH		6.5-8.5	7.44	7.24
Total Dissolved Solids	mg/L	N/A	52	45
Turbidity	NTU	<10% of natural	0.74	0.96
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	0.59	1.27
Nitrate-N (NO3-N)	mg/L	N/A	0.065	0.040
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0100	0.0116
Sulfate (SO4)	mg/L	N/A	2.91	1.86
Metals				
Aluminum (Al)	mg/L	0.075	**0.0906**	**0.196**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 or 0.001 (interim)	0.0015	**0.0017**
Iron (Fe)	mg/L	0.300	0.272	**0.427**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	1.23	1.38

Bold indicates exceedance above PWQO guidelines

Table 4.5-4: Flora Observed at Site 5			
FEC V-Type: V4 White Birch Hardwood and Mixedwood			
Forest Density / Stream Cover	40% stream shaded		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns/Horsetails/ Mosses/Grasses**
White birch Balsam fir Balsam poplar Black ash Jack pine White spruce	Beaked hazel Dwarf raspberry Honeysuckle High-bush cranberry Mountain ash Mountain maple Pin cherry Red currant Red osier dogwood Serviceberry Skunk currant Speckled alder Wild red raspberry	Blue bead lily Canada mayflower Common strawberry Cow vetch Dandelion Large-leaved aster Pearly everlasting Rose twisted stalk Wild columbine Wild strawberry Yarrow Yellow hawkweed	Interrupted fern Juniper moss Lady fern
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.5-5: Fauna Observed at Site 5	
Fauna Species	
Amphibians	-
Birds	-
Crustaceans	-
Fish	-
Insects	Blackflies Mosquitoes Tiger swallowtail butterfly
Mammals	-
Mollusca	-
Reptiles	-

Table 4.5-6: Physical Features Observed at Site 5							
FEC S-Type: N/A							
Data not available							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~25%	~30%	~30%	~15%	-	-	-
Bank Stability/Erosion	Stable/ Abundant vegetation						

4.6 Site 6

Site 6 was located on Kingfisher Road which was approximately 600 metres north of Magone Road. The watercourse was unnamed and represented the water flowing east from Magone Lake. This site was located in the midst of a large valley with higher elevated hills on either side. This sampling site was located at the highest elevation (452.24 metres above sea level) of all the samples taken. The watercourse passed under a wooden bridge on Kingfisher Road (see Appendix G: Bridge Assessments). The water flow at this site seemed to have a low velocity upstream from the bridge, with a large area that contained overflow. The area surrounding the overflow appeared saturated with stunted tree growth, low shrubs and grasses. The hills on either side of the valley, as well as the banks downstream from the bridge, supported an abundant vegetation growth including many tree, shrub and herb species.

Terrestrial vegetation within the higher elevated areas included white birch and balsam fir, whereas mountain ash, mountain maple, red osier dogwood, common evening primrose and sedges dominated the lower riparian zones. Very minor twin waterfalls were separated by a small vegetated island downstream from the bridge. An increased water table and velocity was seen during the July 10, 2013 sampling period. The substrate located within the watercourse was composed of boulders, cobbles and sand. Some aquatic species were present during sampling including emergent flora and minnows. Bank stability seemed to be very stable and no erosion was progressing along the riparian banks.

Phosphorus, aluminum, copper, iron and total coliforms exceeded the PWQO at Site 6 on at least one sampling date. Phosphorus, at a concentration of 0.0303 mg/L on June 19, 2013, exceeded PWQO criterion of 0.0300 mg/L. Aluminum, at concentrations of 0.0997 mg/L and 0.185 mg/L, exceeded the PWQO limits of 0.0750 mg/L on both June 19 and July 10, 2013, respectively. During the July 10, 2013 sampling period, copper exceeded the 0.0010 mg/L criterion (criterion correlated with hardness between 0-20 mg/L $CaCO_3$; see Appendix E: Water Quality Guidelines) with a value of 0.0013 mg/L. Iron exceeded the PWQO criterion of 0.300 mg/L with concentrations of 0.356 mg/L and 0.360 mg/L on June 19 and July 10, 2013, respectively. On both sampling dates total coliforms exceeded the 1,000 MPN/100 mL pre-1994 PWQO criterions with concentrations of 2,400 MPN/100 mL and greater.

Table 4.6-1: Location Reference for Site 6	
Location Description	Unnamed watercourse; Kingfisher Road, north of Magone Road
UTM Coordinates	5386563 Northing / 0349154 Easting
Altitude/Elevation	452.24 metres above sea level

Table 4.6-2: Field Measurements for Site 6			
Parameter	**Unit**	**Date:** 19-JUN-13 **Time:** 10:00	**Date:** 10-JUL-13 **Time:** 09:25
Water Temperature	ºC	15.75	19.45
Conductivity	uS/cm	59	43
Dissolved Oxygen	mg/L	10.87	7.55
Dissolved Oxygen	%	110.4	83.4
pH		8.0	7.65
Turbidity	NTU	0.26	0.40
Air Temperature	ºC	22	21
Channel Width	m	5.3	6.4
Sample Depth	m	0.2	0.55
Velocity	m/s	0.051	0.392

Table 4.6-3: Laboratory Water Quality Results for Site 6				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 19-JUN-13 **Time:** 10:00	**Date:** 10-JUL-13 **Time:** 09:25
Bacteriological				
Escherichia Coli	MPN/100mL	100	24	15
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**>2420**	**2400**
Physical				
Conductivity (EC)	uS/cm	N/A	61.1	46.4
pH		6.5-8.5	7.24	6.76
Total Dissolved Solids	mg/L	N/A	42	40
Turbidity	NTU	<10% of natural	1.08	1.06
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	0.146	<0.020
Chloride (Cl)	mg/L	N/A	3.70	4.42
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	<0.030
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	**0.0303**	0.0114
Sulphate (SO4)	mg/L	N/A	2.60	1.90
Metals				
Aluminum (Al)	mg/L	0.075	**0.0997**	**0.185**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 or 0.001(interim)	0.0012	**0.0013**
Iron (Fe)	mg/L	0.300	**0.356**	**0.360**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	2.97	3.10

Bold indicates exceedance above PWQO guidelines

Table 4.6-4: Flora Observed at Site 6			
FEC V-Type: V4 White Birch Hardwood and Mixedwood			
Forest Density / Stream Cover	10 – 20% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns/Horsetails/ Mosses/Grasses**
Balsam fir Black spruce Trembling aspen White birch	Bindweed Honeysuckle Mountain ash Mountain maple Red osier dogwood Serviceberry Wild red raspberry	Birdsfoot trefoil Clover Common evening primrose Dandelion Fringed bindweed Low sweet blueberries Mermaidweed Northern blue flag iris Oxe-eye daisy Yellow hawkweed	-sedges
Aquatic Macrophytes and Algae			
Emergent	Arrowhead White fragrant lily	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	Yellow pond lily	**Slimes or Crusts**	-

Table 4.6-5: Fauna Observed at Site 6	
Fauna Species	
Amphibians	American toad
Birds	Blue jay Red-tailed hawk Common raven White-throated sparrow
Crustaceans	-
Fish	Brook stickleback
Insects	Blackflies Caddis fly larvae Deer flies Dragonflies Dragonfly larvae Water boatmen Water striders
Mammals	Eastern chipmunk
Mollusca	Snails
Reptiles	-

Table 4.6-6: Physical Features Observed at Site 6							
FEC S-Type: S4 Fresh / Silty – Silt Loamy							
Fresh, silty or silt loamy soils. Primarily developed in lacustrine and glaciofluvial parent materials. Upland black spruce stands are often associated with these soils.							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~35	~40	~25	-	-	-	-
Bank Stability/Erosion	Stable/ Abundant vegetation						

4.7 Site 7

Sampling at Site 7 was conducted at "Amethyst Creek" at the Magone Road crossing, approximately 8.5 kilometres east from Highway 527. This site allowed flow through two large culverts (Appendix H: Culvert Assessments). Upstream, the swift waters of "Amethyst Creek" cascaded down a bedrock step. A small unnamed creek merged with "Amethyst Creek" upstream of the culverts. The unnamed creek may have originated from a wetland found northeast of the site. The converging side creek maintained riffles flowing over a rocky substrate containing cobbles.

The waterfall flowed over a bedrock surface, containing quartz and amethyst veins. Boulders, cobbles, gravel and sand made up most of the in-stream substrate directly surrounding the sampling area. The riparian zones on either side of the creek had abundant vegetation allowing for stability along the banks of the shoreline. The vegetation within the site area contained a rich variety of flora including dominant species such as black spruce, serviceberry and bunchberry. A large mass of foam built up in a low-velocity pooling area near the edges of the culverts. Large tree and driftwood accumulations also built up near the mouth of the culverts which may have been deposited during high spring floods. A young black bear was seen in close proximity to this site on July 7, 2013. Other animals seen on route to this location included a mink and a red fox.

During the first sampling period on June 19, 2013, an aluminum concentration of 0.102 mg/L was found to exceed the PWQO guidelines of 0.075 mg/L. The second sampling period also exceeded the PWQO with a value of 0.194 mg/L on July 10, 2013. The July 10 sampling period also determined that total coliforms and iron exceeded the PWQO criteria. The pre-1994 PWQO criterion for total coliforms is 1,000 MPN/100mL and was exceeded with a concentration of >2,420 MPN/100 mL. Iron at Site 7 exceeded the PWQO criterion (0.300 mg/L) with a sample concentration of 0.506 mg/L.

Table 4.7-1: Location Reference for Site 7	
Location Description	"Amethyst Creek" confluence with unnamed creek; 8.5 kilometres east down Magone Road
UTM Coordinates	5386841 Northing / 0353701 Easting
Altitude/Elevation	393.26 metres above sea level

Table 4.7-2: Field Measurements for Site 7			
Parameter	**Unit**	**Date:** 19-JUN-13	**Date:** 10-JUL-13
		Time: 11:15	**Time:** 10:45
Water Temperature	ºC	12.84	15.50
Conductivity	uS/cm	45	37
Dissolved Oxygen	mg/L	14.94	9.2
Dissolved Oxygen	%	140.6	92.4
pH		7.90	7.54
Turbidity	NTU	0.21	0.34
Air Temperature	ºC	25	20
Channel Width	m	4.2	5.0
Sample Depth	m	0.30	0.25
Velocity	m/s	0.51	0.75

Table 4.7-3: Laboratory Water Quality Results for Site 7				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 19-JUN-13	**Date:** 10-JUL-13
			Time: 11:15	**Time:** 10:45
Bacteriological				
Escherichia Coli	MPN/100mL	100	<1	11
Total Coliforms	MPN/100mL	1000 (prior to 1994)	370	**>2420**
Physical				
Conductivity (EC)	uS/cm	N/A	46.3	40.1
pH		6.5-8.5	7.24	7.24
Total Dissolved Solids	mg/L	N/A	46	36
Turbidity	NTU	<10% of natural	0.61	0.92
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	0.30	0.12
Nitrate-N (NO3-N)	mg/L	N/A	0.055	0.046
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0056	0.0096
Sulphate (SO4)	mg/L	N/A	2.65	1.66
Metals				
Aluminum (Al)	mg/L	0.075	**0.102**	**0.194**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0013	0.0016
Iron (Fe)	mg/L	0.300	0.285	**0.506**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	0.97	0.82

Bold indicates exceedance above PWQO guidelines

Table 4.7-4: Flora Observed at Site 7			
FEC V-Type: V19 Black Spruce Mixedwood / Herb Rich			
Forest Density / Stream Cover	40% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns/Horsetails/ Mosses/Grasses**
Black spruce Tamarack White birch	Honeysuckle Pincherry Red osier dogwood Serviceberry Speckled alder Sweet gale Wild red raspberry	Bunchberry Cow parsnip Dandelion Fragrant bedstraw Large-leaved aster Marsh marigold Interrupted fern Pearly everlasting Rose twisted stalk Wild columbine Woody blue violet Yarrow Yellow hawkweed	Lady fern
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	Duckweed	**Slimes or Crusts**	-

Table 4.7-5: Fauna Observed at Site 7	
Fauna Species	
Amphibians	
Birds	American robin Ruffled grouse
Crustaceans	-
Fish	-
Insects	Blackflies Dragonflies Spring azure butterfly Tiger swallowtail butterfly Waterstrider
Mammals	American red squirrel Black bear (near site) Mink (near site) Red fox (near site)
Mollusca	-
Reptiles	-

Table 4.7-6: Physical Features Observed at Site 7							
FEC S-Type: SS6 Shallow – Moderately Deep / Coarse Loamy							
Shallow to moderately deep, coarse loamy soils. Bedrock is encountered between 20 and 100 cm below the mineral soil surface. Usually developed in morainal parent materials. Often a significant component of black spruce is present. Soils of this type may integrate with those of S3.							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
~30%	~15%	~30%	~20%	~5%	-	-	-
Bank Stability/Erosion	Stable/ Abundant vegetation						

4.8 Site 8

Site 8 was located at Walkinshaw Lake, adjacent to Highway 527. This lake was positioned in the most westerly point within the watershed boundaries and is an outlet source flowing south to Magone Lake. Walkinshaw Lake was a cool water standing lake that spans 0.358 square kilometres. When sampling was conducted at the shoreline of the lake, abundant shrubs and herbs were present as well as aquatic flora. This site was characterized as a low shrub shore fen with dominant species including cattails, Labrador tea, sweet gale and horsetails, as well as abundant sedges growing on rolling hummocks. The stagnant water within the lake did not sustain any wave action and therefore the velocity was not applicable. The substrate of the lake was almost entirely made up of muck. A minnow trapper was seen collecting live minnows from traps.

Aluminum, iron and total coliforms sampled on June 19, 2013 and July 10, 2013 exceeded the PWQO at Site 8. Aluminum, at a concentration of 0.117 mg/L on June 19, 2013 and 0.239 mg/L on July 10, 2013, exceeded PWQO guidelines of 0.075 mg/L. Iron exceeded the PWQO guidelines of 0.300 mg/L with concentrations of 0.341 mg/L on June 19, 2013 and 0.683 mg/L on July 19, 2013. Total coliforms exceeded the pre-1994 PWQO guideline of 1,000 MPN/100mL with concentrations of >2,420 MPN/100mL on both sampling dates.

Table 4.8-1: Location Reference for Site 8	
Location Description	Walkinshaw Lake; adjacent to Highway 527
UTM Coordinates	5388692 Northing / 346997 Easting
Altitude/Elevation	467.05 metres above sea level

Table 4.8-2: Field Measurements for Site 8			
Parameter	**Unit**	**Date:** 19-JUN-13	**Date:** 10-JUL-13
		Time: 12:30	**Time:** 12:15
Water Temperature	ºC	19.98	18.54
Conductivity	uS/cm	129	117
Dissolved Oxygen	mg/L	12.52	5.45
Dissolved Oxygen	%	137.7	61.20
pH		7.47	See lab results
Turbidity	NTU	0.86	0.55
Air Temperature	ºC	26	21
Channel Width	m	N/A	N/A
Sample Depth	m	0.3	0.67
Velocity	m/s	N/A	N/A

Table 4.8-3: Laboratory Water Quality Results for Site 8				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 19-JUN-13	**Date:** 10-JUL-13
			Time: 12:45	**Time:** 12:15
Bacteriological				
Escherichia Coli	MPN/100mL	100	<1	15
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**>2420**	**>2420**
Physical				
Conductivity (EC)	uS/cm	N/A	127	89.7
pH		6.5-8.5	7.00	6.83
Total Dissolved Solids	mg/L	N/A	91	71
Turbidity	NTU	<10% of natural	1.40	1.17
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	24.4	13.6
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	<0.030
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0160	0.0116
Sulfate (SO4)	mg/L	N/A	2.39	2.14
Metals				
Aluminum (Al)	mg/L	0.075	**0.117**	**0.239**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0015	0.0023
Iron (Fe)	mg/L	0.300	**0.341**	**0.683**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	13.4	9.67

Bold indicates exceedance above PWQO guidelines

Table 4.8-4: Flora Observed at Site 8			
Vegetation Type: W15 Low Shrub Shore Fen			
Forest Density / Stream Cover	0% (lake site)		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns/Horsetails/ Mosses/Grasses**
White birch Black spruce Tamarack Trembling aspen	Labrador-tea Sweet gale	Buttercup Large-leaved aster Leatherleaf Northern blue flag iris Musk grass Sphagnum	Horsetail Sedges Sphagnum
Aquatic Macrophytes and Algae			
Emergent	Cattail	**Floating Algae**	-
Rooted Floating	Fragrant white lily	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.8-5: Fauna Observed at Site 8	
Fauna Species	
Amphibians	Green frog
Birds	Mallard duck Herring gull
Crustaceans	-
Fish	Northern Redbelly dace
Insects	Dragonfly Doubledays bluet dragonfly Leech
Mammals	Eastern Chipmunk
Mollusca	-
Reptiles	-

Table 4.8-6: Physical Features Observed at Site 8							
FEC S-Type: N/A (lake site/wetland)							
Floating mat of sphagnum							
In-stream Substrate							
Bedrock	**Boulders**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	-	-	-	-	-	~100%	-
Bank Stability/Erosion	N/A (lake site)						

4.9 Site 9

Site 9 was situated 20 kilometres east of Highway 527 on Escape Lake Road. The unnamed watercourse found at this site passed under a wooden-framed bridge (Appendix G: Bridge Assessments). This easily accessible site made it an ideal location to sample downstream from the bridge. The discharge of the unnamed watercourse cascaded over

large boulders, cobbles, gravel and sand. Minimal bank erosion and adequate stability was provided by the well vegetated banks and stable rocks at this site. The terrestrial vegetation found along the riparian zones included abundant trees, shrubs, and herbs. Dominant species at this site included trembling aspen, black spruce, jack pine, wild red raspberry, clover and meadow rue. No aquatic flora was noted within the sampling site. Four ducklings were spotted travelling down the swift current without the mother.

Aluminum and total coliforms sampled on June 19, 2013 and July 10, 2013 exceeded the PWQO guidelines at Site 9. Aluminum, at a concentration of 0.116 mg/L on June 19, 2013, and 0.145 mg/L on July 10, 2013, both exceeded the PWQO criterion of 0.075 mg/L at the time the samples were taken. Total coliforms exceeded the pre-1994 PWQO guideline of 1,000 MPN/100mL with concentrations of 1,200 MPN/100mL on June 19, 2013 and >2,420 on July 10, 2013. Iron also exceeded the PWQO criterion of 0.300 mg/L on July 10, 2013 with a concentration of 0.579 mg/L.

Table 4.9-1: Location Reference for Site 9

Location Description	Unnamed watercourse; 20 kilometres east down Escape Lake Road
UTM Coordinates	5398045 Northing / 364094 Easting
Altitude/Elevation	408.72 metres above sea level

Table 4.9-2: Field Measurements for Site 9

Parameter	**Unit**	**Date:** 19-JUN-13 **Time:** 13:56	**Date:** 10-JUL-13 **Time:** 13:30
Water Temperature	ºC	15.25	17.25
Conductivity	uS/cm	42	47
Dissolved Oxygen	mg/L	13.88	8.58
Dissolved Oxygen	%	137.6	88.70
pH		7.52	7.39
Turbidity	NTU	0.26	0.31
Air Temperature	ºC	28	21
Channel Width	m	2.6	3.0
Sample Depth	m	0.37	0.35
Velocity	m/s	0.375	0.786

Table 4.9-3: Laboratory Water Quality Results for Site 9				
Parameter	**Unit**	**PWQO Guidelines**	**Date:**19-JUN-13 **Time:** 13:56	**Date:** 10-JUL-13 **Time:** 13:30
Bacteriological				
Escherichia Coli	MPN/100mL	100	4	10
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**1200**	**>2420**
Physical				
Conductivity (EC)	uS/cm	N/A	43.8	51.0
pH		6.5-8.5	7.03	7.38
Total Dissolved Solids	mg/L	N/A	47	41
Turbidity	NTU	<10% of natural	0.61	0.82
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	0.23	0.18
Nitrate-N (NO3-N)	mg/L	N/A	0.045	0.076
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0077	0.0131
Sulfate (SO4)	mg/L	N/A	1.73	1.06
Metals				
Aluminum (Al)	mg/L	0.075	**0.116**	**0.145**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	0.000020
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0015	0.0015
Iron (Fe)	mg/L	0.300	0.230	**0.579**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	0.87	0.86

Bold indicates exceedance above PWQO guidelines

Table 4.9-4: Flora Observed at Site 9			
FEC V-Type: V10 Trembling Aspen – Black Spruce – Jack Pine / Low Shrub			
Forest Density / Stream Cover	30 – 40% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns/Horsetails/ Mosses/Grasses**
Balsam poplar Jack pine Trembling aspen White birch White spruce	Speckled alder Low sweet blueberry Mountain maple Northern wild black currant Red osier dogwood Wild red raspberry Willow	Red clover Cow vetch Indian paintbrush Interrupted fern Marsh marigold Meadow rue Mullen Oxe-eye daisy Yarrow	Interrupted fern
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	Fragrant white water lily	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.9-5: Fauna Observed at Site 9	
Fauna Species	
Amphibians	-
Birds	Ducklings (4, no mother present)
Crustaceans	-
Fish	-
Insects	Black ants Mosquitoes Spiders Tiger swallowtail butterfly
Mammals	-
Mollusca	-
Reptiles	-

Table 4.9-6: Physical Features Observed at Site 9							
FEC S-Type: S4 Fresh / Silty – Silt Loamy							
Fresh, silty or silt loamy soils. Primarily developed in lacustrine and glaciofluvial parent materials. Silty soils are rare, occurring mainly northeast of Lake Superior.							
In-stream Substrate							
Bedrock	**Boulders**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~40%	~40%	~10%	~10%	-	-	-
Bank Stability/Erosion	Stable/ Abundant vegetation						

4.10 Site 10

Site 10 was located at Beaver Lake along Road N, within the Greenwich Windfarm. Beaver Lake has an unknown thermal temperature but the lake seemed to maintain a warm temperature during the two sampling dates. The lake was positioned at a lower elevation than Road N and access was approximately 40 metres through the bush at the cleared parking spot on the north side of Beaver Lake. An increase in elevation progressed north of Road N within the Greenwich Windfarm area, and featured 13 wind turbines within the MacKenzie River watershed.

The lake substrate was composed of muck, and the surrounding shoreline in which sampling was conducted, contained abundant vegetation. Some peaty hummocks were vegetated and emerging close to the shoreline. Dominant tree species included black spruce and white birch. Erosion was not apparent along the shoreline of Beaver Lake. Bank stability along the bush trail entering the site seemed very stable with abundant ground cover. Some large fallen trees were found along the shoreline and in the lake. The water clarity seemed fair, and maintained a tea-stained colour. Fish species were present within the sampling area and were grazing beneath the aquatic fragrant white lilies. The invasive species known as giant hogweed was seen on route to Site 10, along Road G. A moose, a large black bear, a white-tailed deer and a groundhog were also seen in close proximity to Site 10.

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Samples taken at this site exceeded the PWQO guideline (0.075 mg/L) for aluminum with concentrations of 0.173 mg/L and 0.106 mg/L on June 20 and July 11, 2013, respectively. Copper also exceeded the PWQO criterion (0.0010 mg/L) on June 20, 2013 with a sample value of 0.0011 mg/L.

Table 4.10-1: Location Reference for Site 10	
Location Description	Beaver Lake; Road N, located within the Greenwich Windfarm
UTM Coordinates	5402055 Northing / 368509 Easting
Altitude/Elevation	410.25 metres above sea level

Table 4.10-2: Field Measurements for Site 10			
Parameter	**Unit**	**Date:** 20-JUN-13	**Date:** 11-JUL-13
		Time: 11:45	**Time:** 12:00
Water Temperature	ºC	21.26	22.05
Conductivity	uS/cm	32	28
Dissolved Oxygen	mg/L	10.56	8.73
Dissolved Oxygen	%	120.0	100.0
pH		7.45	7.76
Turbidity	NTU	2.05	1.24
Air Temperature	ºC	23	30
Channel Width	m	N/A	N/A
Sample Depth	m	0.75	0.6
Velocity	m/s	N/A	N/A

Table 4.10-3: Laboratory Water Quality Results for Site 10				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 20-JUN-13	**Date:** 11-JUL-13
			Time: 11:45	**Time:** 12:00
Bacteriological				
Escherichia Coli	MPN/100mL	100	<1	1
Total Coliforms	MPN/100mL	1000 (prior to 1994)	460	920
Physical				
Conductivity (EC)	uS/cm	N/A	27.8	31.1
pH		6.5-8.5	6.91	7.08
Total Dissolved Solids	mg/L	N/A	41	20
Turbidity	NTU	<10% of natural	2.75	1.82
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	0.060
Chloride (Cl)	mg/L	N/A	0.74	0.72
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	<0.030
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0165	0.0133
Sulphate (SO4)	mg/L	N/A	2.18	2.13
Metals				
Aluminum (Al)	mg/L	0.075	**0.173**	**0.106**
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.001 (interim)	**0.0011**	<0.0010
Iron (Fe)	mg/L	0.300	0.140	0.148
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	0.62	0.67

Bold indicates exceedance above PWQO guidelines

Table 4.10-4: Flora Observed at Site 10			
FEC V-Type: V19 Black Spruce Mixedwood / Herb Rich			
Forest Density / Stream Cover	0% (lake site)		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns/Horsetails/ Mosses/Grasses**
Balsam fir Black Spruce Eastern white cedar White birch White spruce	Leatherleaf Mountain maple Pincherry Serviceberry Sweet gale Wild red raspberry	Aster Blue bead lily Dandelions Feathermoss Oxe-eye daisy Red clover Yellow hawkweed	Pixie cup Plume Sphagnum
Aquatic Macrophytes and Algae			
Emergent	Bindweed Rushes	**Floating Algae**	-
Rooted Floating		**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	Fragrant white water lily	**Slimes or Crusts**	-

Table 4.10-5: Fauna Observed at Site 10	
Fauna Species	
Amphibians	-
Birds	American kestrel (near site) Herring gull
Crustaceans	-
Fish	Northern redbelly dace Northern pearl dace
Insects	Black ants Blackflies Deerflies Doubledays bluet dragonflies Horseflies Mosquitoes
Mammals	Moose (near site) Groundhog (near site) White-tailed deer
Mollusca	-
Reptiles	-

Table 4.10-6: Physical Features Observed at Site 10							
FEC S-Type: S5 Fresh / Fine-Loamy							
Most commonly developed in lacustrine parent materials. Associated with shrub-rich, hardwood dominated stands. This soil type is commonly classified as Brunisols or Luvisols.							
In-stream Substrate							
Bedrock	**Boulders**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	-	-	-	-	-	~100%	-
Bank Stability/Erosion	N/A (lake site)						

4.11 Watershed Report Card Results

The overall surface water quality grade for the MacKenzie River watershed maintained a total averaged point score that is greater than 4.4. With minimal exceedances for phosphorus and *E. coli*, the rating of the surface water quality for MacKenzie River watershed was determined to have a grade of A.

The forest coverage for the MacKenzie River watershed was 342.9 square kilometres (93.2 percent), interior forest coverage was 270.36 square kilometres (73.5 percent) and the riparian forest cover was 26.59 square kilometres (66.6 percent). These percentages generated a total point score of fifteen (average of 5) for the forest conditions, which determined a grade A.

Table 4.11-1: MacKenzie River Watershed Surface Water Indicators and Overall Grade Calculation							
Site Number	**Average Total Phosphorus (mg/L)**	**Average E. coli (MPN/ 100mL)**	**Average of Benthic Invertebrates**	**Total Point Score**	**Grade**	**Overall Surface Water Quality Grade**	
						Final Points	**Grade**
1	0.0073	18.5	N/A	10	A	5	A
2	0.0076	19	N/A	10	A	5	A
3	0.0064	18	N/A	10	A	5	A
4	0.0087	12	N/A	10	A	5	A
5	0.0108	8	N/A	10	A	5	A
6	0.0209	19.5	N/A	9	A	4.5	A
7	0.0076	6	N/A	10	A	5	A
8	0.0138	8	N/A	10	A	5	A
9	0.0104	7	N/A	10	A	5	A
10	0.0149	1	N/A	10	A	5	A

Table 4.11-2: MacKenzie River Watershed Forest Conditions and Overall Grade Calculation						
					Overall Forest Conditions	
% Forest Cover	**% Forest Interior**	**% Riparian Zone Forested**	**Total Point Score**	**Grade**	**Final Points**	**Final Grade**
93.2	73.5	66.6	15	A	5	A

5 Discussion

The MacKenzie River watershed was sampled at ten different locations, chosen based on accessibility and possible contamination sources, as well as attempting to reach all areas of the watershed. Two site visits were completed for each site, the first sampling period ran June 18, 19, 20 and the second sampling period on July 9, 10, 11. Data for vegetation type is unavailable for Site 3 and Site 8 due to presence of wetlands as opposed to forest, and was keyed out to a wetland type from the use of photos and field notes, therefore may be inaccurate. Soil type data is unavailable for Sites 3-5 due to lack of proper soil sampling equipment. Bridge measurements for Site 2 are incomplete due to inaccessibility.

The average air temperature for the June, 2013 sampling period was 22.2°C which exceeded the monthly average temperature of 14.2°C for June, 2013 as well as the historical average of 14°C for June, 1971-2000 in Thunder Bay. The average air temperature for the July sampling period was 21.3°C which exceeded the monthly average temperature of 17.3°C for July, 2013 as well as the historical July average of 17.6°C. Precipitation for the month of June in 2013 was 53.8 millimetres, which is just over half the historical monthly average of 85.7 millimetres, for Thunder Bay from 1971-2000. In July, precipitation totaled 131.8 millimetres which exceeded the historical monthly average of 89 millimetres for July, 1971-2000. During the June sampling period, the sky was mostly clear, with a few clouds for the first two days, while the third day was mostly cloudy. During the first two days of sampling in July, it was very cloudy. A thick fog hung for most of the first day as well, especially at sites near Lake Superior. The third day was partly cloudy with a heavy haze in the air.

Water temperature ranged from 12.84°C to 19.89°C in June and 15.5°C to 22.05°C in July which can be seen on Figure 5: MacKenzie River Watershed Water Temperature. A comparable trend can be seen during both sample periods. The cooler water temperatures were present in the moderate to fast flowing streams and rivers, with Site 7 having the coolest temperatures. The warmer water was observed at sites with slower or negligible velocity, such as the lake sites, with Beaver Lake containing the warmest water for both sampling periods. Site 6, a moderately flowing stream, was an exception during the July sampling period and had a water temperature of 19.45°C, which was warmer than Walkinshaw Lake (18.54°C). This could be related to the wetland area upstream of the sample location, or the dramatic water level increase from heavy rains. Site 3 was consistently the second coolest stream, which is inconsistent with the trend, as the velocity is fairly slow and there is a wetland area upstream, both of which would indicate a warmer temperature. The wetland area could be fed by a groundwater source which would provide a cooling effect to the surface waters. Stream order can also have an effect on water temperature, with lower order streams being cooler than higher order streams.

The stream depth could not be measured for many sites due to inaccessibility or very fast flowing water. Therefore, the sample depth was taken as opposed to a channel depth, often at the deepest spot that could be reached from shore or in chest waders. Lake sites

were measured in a similar manner, only taking into account the depth at which the samples were taken and will not be considered in the following trends. Depths at the remaining sites ranged from 0.2 to 0.8 metres in June and 0.3 to 1.1 metres in July. Water level increased at four (2, 3, 5, 6) of the ten sample sites between June and July. This was likely due to a heavy rainfall event on July 6, with a total of 31.7 millimetres of rain. The largest increase occurred at Site 3, with a difference of 0.46 metres. The other three sites (1, 7, and 9) showed a decrease in water level from June to July and were ≤0.1 metres. These results were considered negligible due to approximate readings in the field and the stream bed topography being extremely variable. This resulted in the depth being measured in slightly different locations during each sampling period.

Stream velocity was measured by observing passing time of a stick over a predetermined length. The velocity of the lake sites was not measureable due to wind effect and lack of unidirectional flow. Average overall watershed velocity was calculated using incomplete data. Velocities from Sites 5, 6, 7, and 9 were used for the June average, in addition to Sites 1 and 3 for the July average. The average watershed velocity for June was 0.344 metres per second (m/s). The average watershed velocity for July was 0.643 m/s. The overall watershed velocity average was 0.493 m/s. The velocity almost doubled from June to July, which would correspond well with the increased amount of precipitation received between June and July sampling periods.

From the ten sample sites chosen, seven of them were water crossings which required a bridge or culvert to support the road. There were six bridges total, with one each at Sites 1, 2, 3, 5, 6, and 9 and a double culvert at Site 7. The bridges with a wooden crib support did not appear to alter flow in a significant way, or change the natural stream course. Site 1 and Site 2 which were constructed with cement supports, did appear to accelerate the velocity of the MacKenzie River, as it narrowed the channel and provided a smooth surface for more linear flow. The fill used in the wooden cribs as well as for footings on either bank, consisted of boulders, cobble and gravel. The fill used was similar to the natural stream bank substrate and aided in bridge support as well as erosion and sedimentation control from road run-off. The culverts at Site 7 did alter the velocity and natural course of the stream by creating two smooth, narrow channels. The culvert design appeared to create a woody and foamy debris buildup on the upstream side, which may inhibit flow or cause wash-out conditions; however the rust line on the culverts did indicate that the culvert size is appropriate for water level fluctuations. Overall, the bridges and culvert assessed during the 2013 sampling period were in excellent condition. Bridge 1 should be monitored for evidence of deterioration as it is no longer in use and culvert 1 should be monitored to ensure that the debris buildup does not become a wash-out concern.

A vegetation assessment was carried out at each site, recording species present within view of each site. Forest Ecosystem Classification Vegetation type V-4: White birch hardwood and mixedwood, was the most common and occurred at four of the sites. The remaining sites still had a similar mixedwood forest type, sometimes favouring coniferous species as opposed to hardwood. The dominant tree species within the MacKenzie River watershed included white birch, black spruce, white spruce and balsam

fir. The shrub layer was very diverse throughout the watershed, with many species present. Some commonly observed species in the shrub layer were red raspberry, red-osier dogwood, serviceberry, sweet gale, speckled alder and willow species. The ground cover and herb layer included wildflowers typical of disturbed sites, most likely due to the habitat provided by the roadsides. The most commonly observed herb and wildflower species included dandelion, ox-eye daisy, red clover, yellow and orange hawkweed, cow vetch and large-leaved aster. No invasive plant species or species at risk were seen at the sample sites within the MacKenzie River watershed.

Aquatic vegetation was present within the watershed at the samples sites, but not abundant overall. Certain sites, such as the lake sites and those with a wetland area upstream, contained the majority of aquatic plant species within the watershed. These included cattail, fragrant white water lily, yellow pond lily, common reed, Richardson's pondweed and northern blue flag iris. Less common aquatic species observed are listed in Appendix B: Common and Scientific Names of Identified Flora and Fauna. Lack of abundant aquatic vegetation at sample sites could be attributed to the substrate being mostly bedrock, boulder and cobble, which does not provide good rooting and nutrients to plants.

No specific fauna survey was conducted; any species observed while visiting the sample sites were recorded and considered for the watershed report. A complete list of fauna observed within the watershed is provided in Appendix B: Common and Scientific Names of Identified Flora and Fauna. The species identified within the watershed were typical of the habitat present and are common northwestern Ontario boreal forest species. Notable terrestrial vertebrates observed included black bear, red fox, moose, white-tailed deer, mallard, red-tailed hawk and the american kestrel. Many songbirds could be heard at each sample site, but could not be positively identified. Songbirds are very indicative of a forests health. The songbird diversity exhibited by a forest can represent how effective forest management practices have been in the area. Certain species are extremely sensitive to forest configuration (cut patterns and fragmentation) and forest composition (species present). A songbird survey could assist in measuring the state of the forests health.

The aquatic ecosystem is much more difficult to explore and survey. Many minnows were seen but only four species were caught using a dip net and identified. With the baitfish species identified, they are only a small representation of the fish populations that may be present within the watershed. A large variety of insects and aquatic invertebrates were seen throughout the watershed including dragonflies, butterflies, water striders, freshwater clams and leeches. A more thorough fish and aquatic invertebrate survey would be beneficial in assessing the water quality of the streams, as they are very sensitive to change and therefore excellent indicators of aquatic ecosystem health. No invasive fauna species or species at risk were observed during the sampling periods.

Erosion was not an issue within the MacKenzie River watershed as it is dominated by bedrock. Three of the ten sites were lake sites, with riparian zone shorelines and did not show any signs of shifting sediment. Site 3 had vegetated stream banks, they were

slightly undercut but there was no cause for concern as it was mostly roots with some organics present and therefore was not considered a serious concern. The remaining sites were bedrock, or boulder and cobble substrate leaving the potential for erosion to be minimal. Sites that had soil present up to the boulder stream banks were thick with trees and shrubs which aid in slope stability.

Turbidity was extremely low for all sites within the MacKenzie River watershed which is illustrated on Figure 6: MacKenzie River Watershed Turbidity. All sites were below the aesthetic objective of the Guidelines for Canadian Drinking Water Quality of ≤5 NTU. The highest recorded turbidity was on June 20, 2013 at Site 10 with 2.75 NTU. The general trend however was higher turbidity in July than June. Seven of the ten sites were greater than 1.0 NTU, possibly due to the increased flow of water from the heavy rainfall event. The lowest recorded turbidity was on June 19, 2013 at Site 7 and Site 9 with 0.61 NTU. Turbidity is an important factor in cold water streams. Many fish and invertebrate species can struggle in murky water, such as trout which require fairly clear water for optimal oxygen intake through their gills.

Colder water can hold more dissolved oxygen (DO) than warmer water and for this reason, PWQO criterion indicate a variation in limits based on water temperature. This range of acceptable DO limits can be seen in Appendix E: Water Quality Guidelines. All sites were above the PWQO criterion for dissolved oxygen based on the stream temperature at the time of sampling and this is illustrated on Figure 7: MacKenzie River Watershed Dissolved Oxygen. The range of dissolved oxygen levels in the MacKenzie River watershed were from 61.2 percent saturation (5.45 mg/L) to 150.5 percent saturation (15.36 mg/L) for Site 8 on July 10 and Site 1 on June 18, respectively.

The PWQO acceptable pH range is 6.5-8.5. The range found within the MacKenzie River watershed was 6.76 on July 10 at Site 6 and 7.56 on June 18 at Site 2, illustrated on Figure 8: MacKenzie River Watershed pH Levels. The average pH lies within a good water quality range, being slightly acidic in some areas of the watershed. The level at which pH would begin to have a negative effect on aquatic life varies, as it is not simply the pH alone that affects plants and animals, but how pH alters the interactions of other parameters and nutrients in the ecosystem.

There is currently no PWQO for conductivity. The highest recorded level was 127.0 microSiemens per centimetre (mS/cm) at Site 8 on June 19, 2013. The lowest recorded level was 27.8 mS/cm on June 20 at Site 10. The conductivity levels are illustrated on Figure 9: MacKenzie River Watershed Conductivity.

Total dissolved solids can be related to conductivity since the dissolved solids are what conduct an electric current through the water. The more dissolved solids present in a solution, the greater the conductive potential as there are more ions present to carry the charge. This relationship can be seen in the watershed data when comparing between Figure 9: MacKenzie River Watershed Conductivity and Figure 10: MacKenzie River Watershed Total Dissolved Solids, the highest readings for TDS and conductivity were at Site 8, and the lowest readings for both parameters were at Site 10. The highest TDS

reading was 91 mg/L at Site 8 on June 19, 2013. The lowest TDS reading found was 20 mg/L at Site 10 on July 10, 2013.

As a limiting nutrient to aquatic vegetation, phosphorus is important to monitor in watersheds to avoid excessive vegetation growth, which can lead to lowered dissolved oxygen. Only one exceedance occurred during the sampling periods of June and July. Phosphorus exceeded the PWQO of 0.03 mg/L on June 19, 2013 at Site 6, with a level of 0.0303 mg/L. This could be considered negligible, as there did not appear to be an excessive amount of plant growth at the site, which would affect the water quality. The remainder of the sites were below the PWQO within a range of 0.005 to 0.0165 mg/L.

Monitoring of bacterial levels in surface water is often limited to *Escherichia coli*, as this is the most common water-borne pathogen that can cause illness and death. The *E. coli* levels at the ten sample sites within the MacKenzie River watershed were all under the PWQO of 100 MPN/100 mL, as shown on Figure 11: MacKenzie River Watershed *Escherichia coli* Levels. The presence of *E. coli* ranged from <1 to 31 MPN/100 mL. Presence of *E. coli* indicates a fecal contamination source nearby, but there are instances when a fecal contamination occurs and testing does not show *E. coli* is present. Total coliforms are among the flora present in the intestinal tract of animals and are often present in much greater numbers than potential pathogens, such as *E. coli*. Therefore, coliforms are easier to isolate and identify within a water sample. In order to better determine the possibility of contamination, total coliforms are measured in surface water as indicators of pathogenic bacteria contamination. No current PWQO exists for total coliforms. Total coliforms exceeded the pre-1994 PWQO of 1,000 MPN/ 100 mL at Site 6, Site 8 and Site 9 on June 19, and all sites, except Site 10, during the July sampling period. The highest level of total coliforms present was >2,420 MPN/ 100 mL. Site 6 and Site 8 both showed this level of total coliforms on June 19. This was also the case for all exceeding sites in July, except Site 1 and Site 6, with levels of 2,000 MPN/ 100 mL and 2,400 MPN/ 100 mL, respectively.

Of the 33 metals that were tested for, only three showed exceedances of their respective PWQO limits. The metals that were in exceedance of their PWQO limit include aluminum, copper, and iron. Sodium does not have a PWQO criterion at time of reporting; however Site 8 displayed substantially higher levels than the other sites.

The PWQO for aluminum is 0.075 mg/L. During the June sampling period, Sites 4-10 experienced exceeding levels of aluminum, ranging from 0.0906 mg/L (Site 5) to 0.1730 mg/L (Site 10). Aluminum was in exceedance of the PWQO with a range of 0.083 mg/L (Site 3) to 0.239 mg/L (Site 8) for all sites throughout the July sampling period. Aluminum is a naturally occurring metal within surface water at low concentrations. Aluminum is released from silicate igneous parent materials such as feldspars, feldspathoids, micas and many amphiboles. Alumino-silicate clays are the result of chemical weathering from the parent host and provide abundant interaction with surface waters. Aluminum is more readily leached from its source when in acidic conditions due to acid rain or water bodies that lack a buffering capacity. In acidic water aluminum

becomes toxic to fish at 0.1 mg/L, affecting gill permeability by creating a slimy layer of aluminum cells.

Copper toxicity is variable based on the hardness of the water. If the hardness level (measured as $CaCO_3$) is >20 mg/L the copper PWQO is 0.005 mg/L. If the hardness is <20 mg/L the copper PWQO is 0.001 mg/L. The laboratory results of copper were interpreted with consideration of the hardness level for each site as seen in Appendix J: Laboratory Water Quality Results Summary Tables. It was found that with the exception of Site 10 in July, sites with hardness <20 mg/L $CaCO_3$ were in exceedance of the corresponding PWQO. Copper exceeded its PWQO of 0.001 mg/L on June 20 at Site 10 with a level of 0.0011 mg/L and during the July sampling period at Site 5 and Site 6 with levels of 0.0017 mg/L and 0.0013 mg/L, respectively.

Iron is extremely prevalent in northern Ontario surface water due to the composition of the bedrock, which includes minerals such as biotite, magnetite and neosilicate olivine. Surface water is often stained a reddish-brown colour due to the iron oxyhydroxide precipitates dissolved in the water. In stratified lakes, the water near the lake bottom may become enriched in organic matter and depleted in oxygen, in which ferrous iron can be retained in solution in water. If high levels of iron are derived from naturally occurring leaching, this is considered normal for the region and often not a threat to water quality. A common by-product of mining in northern Ontario are iron compounds, which when present in aquatic systems, such as tailings ponds, can lead to devastating effects on the water quality, such as dramatically lowered pH. Streams in close proximity to mining activity can experience similar effects to the tailings ponds when contaminated with excessive iron. Exceedances of the PWQO level 0.3 mg/L occurred at all sites, except Site 10, in July. Sites 3, 6, and 8 also showed elevated levels above 0.3 mg/L in June. Since the Panoramic Resources Ltd. Thunder Bay North Project is still in the exploration phase, the elevated iron levels are not likely due to this mining activity at the current state. Levels are more likely due to naturally occurring iron from the predominantly bedrock landscape throughout the watershed.

Sodium does not currently have a PWQO; however Site 8 (Walkinshaw Lake) had higher levels (13.4 mg/L and 9.67 mg/L) of sodium than the remainder of the sites. This could be attributed to the sites proximity to Highway 527, where winter salting occurs. A lake system has a longer residency time than a flowing stream, allowing higher accumulations.

The overall health of the MacKenzie River watershed was determined using the ratings from surface water quality and forest conditions, which were combined to give a grade for the Watershed Report Card. Given the low number of exceedances for phosphorus and that all sites maintained concentrations below the PWQO guidelines for *E.coli,* the overall health of the MacKenzie River watershed surface water quality has maintained an excellent rating (A) for its Watershed Report Card rating. The MacKenzie River forest conditions based on forest coverage, forest interior, and riparian zone forested, were determined to result in an excellent rating (A). Based on this rating and other observed conditions, the MacKenzie River watershed has been determined to have an excellent overall health.

6 Conclusion

The MacKenzie River watershed was determined to be excellent condition with minimal evident anthropogenic impacts. Surface water quality at the time of study was good, with the exceedances of the Provincial Water Quality Objectives being attributed to natural sources. Plant species composition seems characteristic of the boreal forest, with diversity at each site among the overstory, understory and herb layer. A more comprehensive fauna study would give a clear indication of the species and populations present, but at the time of study, multiple species were observed giving a good representation of a typical boreal forest area. Water levels seemed consistent with previous water markings. Erosion was not typically a concern as the stream banks were composed of bedrock and boulders. Stream cover was often provided by shrubs and trees growing along the river banks which also helped prevent erosion. Bridges and culverts were in stable condition with no immediate concern for maintenance.

7 Recommendations

Upon completion of the 2013 MacKenzie River Watershed Assessment, the following recommendations have been made for consideration:

- It is recommended that an update to the 2013 MacKenzie River Watershed Assessment be completed in the next five to ten years, staff and funding permitting.
- The Watershed Report Card for the Lakehead Watershed should be updated when new or updated assessments are completed for the MacKenzie River Watershed.
- Wetland conditions and groundwater quality should be assessed if possible, to aid in the grading process for the Watershed Report Cards.
- Additional sampling should be conducted in the spring to observe the water quality differences between high and low flow seasons.
- Future studies should consider sampling downstream from the new twin bridges built on Highway 11/17.
- Benthic, fish and bird surveys should be considered for future sampling, to help indicate overall health of the aquatic and forest ecosystems.

A copy of this report should be provided to the Township of Dorion and the Municipality of Shuniah for reference purposes. The Ontario Ministry of Natural Resources, Thunder Bay District Office should also be provided a copy of the report as the Crown land portion of the watershed is within their jurisdiction. The Report should be kept on file at the LRCA Administration Office for review by interested parties.

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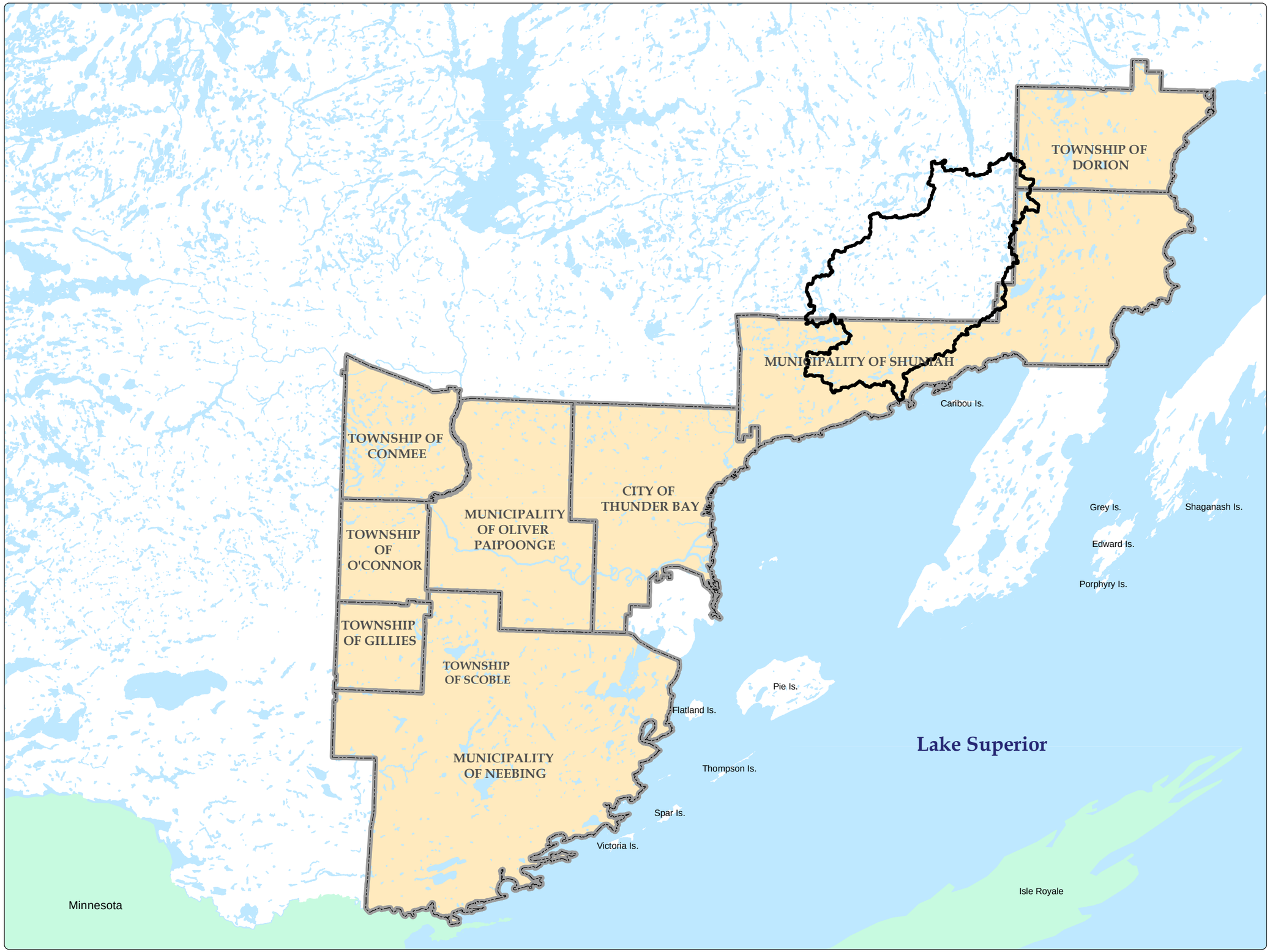
MAPS

Lakehead Region Conservation Authority
Conserve Today...For A Better Tomorrow

MacKenzie River Watershed

M-1: Key Plan



N

Legend

- MacKenzie River Watershed
- Municipal Boundary
- LRCA Jurisdiction Boundary
- Water Body

0 10 20 km

This publication was produced by:
Lakehead Region Conservation Authority
130 Conservation Rd.
Thunder Bay, ON
P7B 6T8

Base data used under license through the members of the Ontario Geospatial Data Exchange.

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Datum: NAD 83
Projection: UTM Zone 16N
Date: July, 2013

Lakehead Region Conservation Authority
Conserve Today...For A Better Tomorrow

MacKenzie River Watershed

M-2: Regulated Area

N

Legend

- Approximate Regulated Area
- MacKenzie River Watershed
- LRCA Owned Lands
- Township Boundary
- LRCA Jurisdiction Boundary

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Provincially Significant Wetland

0 1 2 3 4 5 km

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MacKenzie River Watershed

M-3: Topography

N

Legend

- Highest Point in Watershed
- MacKenzie River Watershed
- Township Boundary

Contour Lines

- 10m Contour Intervals
- 50m Contour Intervals

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 3 4 5 km

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MacKenzie River Watershed

M-4: Bedrock Geology

N

Legend

- MacKenzie River Watershed
- Township Boundary

Bedrock Formation

PALEOPROTEROZOIC
- 22a, Sedimentary rocks

MESOPROTEROZOIC
- 28, Sibley Gp.
- 31a, Mafic and related intrusive rocks (Keweenawan age)

NEO-TO MESOARCHEAN Intrusive Rocks
- 5, Mafic to intermediate metavolcanic rocks
- 13, Muscovite - bearing granitic rocks
- 14, Diorite - monzonite - granodiorite suite
- 15, Massive granodiorite to granite

Surficial Points Features
- QUARRY/MINE WORKINGS
- SAND/GRAVEL PIT
- TALUS

Roads
- Highway
- Road

Permanent Watercourse
- River
- Creek
- Stream

Drainage
- Waterbody
- Wetland

0 1 2 3 4 5 km

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MacKenzie River Watershed

M-5: Surficial Geology

N

Legend

- MacKenzie River Watershed
- Township Boundary

Surficial Points Features

- QUARRY/MINE WORKINGS
- SAND/GRAVEL PIT
- TALUS

Surficial Geology

- Alluvial
- Esker/Kame/Outwash Plain
- Glaciolacustrine Plain
- Moraine
- Organics
- Bedrock

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 3 4 5 km

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MacKenzie River Watershed

M-6: Soils

N

Legend

- MacKenzie River Watershed
- Township Boundary

Thunder Bay Soils

- GLEN (G)
- NOLALU (N)
- ORGANICS - INNES LAKE (In)
- ROCKLAND (R)
- WOLFPUP (W)

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 3 4 5 km

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MacKenzie River Watershed

M-7: Land Ownership

N

Legend

- MacKenzie River Watershed
- Township Boundary
- LRCA Owned Lands

Land Ownership

- Crown Land
- Private Land

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 3 4 5 km

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MacKenzie River Watershed

M-8: Site Plan

N

Legend

- Sampling Sites
- MacKenzie River Watershed
- Township Boundary

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Provincially Significant Wetland

Roads

- Highway
- Road
- Bush Roads

0 1 2 3 4 5 km

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MacKenzie River Watershed M-9: Zoning

N

Zoning Information based on the best available information, not all zones may be depicted.

Legend

- MacKenzie River Watershed
- Township Boundary

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

Township of Dorion Zoning

- Rural Zone

Muncipality of Shuniah Zoning

Community Residential	RC
Shoreline Residential	SR
Shoreline Residential - Black Bay	SR-BB
Shoreline Residential - Moonlight Bay	SR-MB
Shoreline Residential - Back Lots	SR-BL
Shoreline Residential - Holding	SR-H
Mobile Home Residential	MHR
Recreational - Cottage	REC
Recreational - Association	REC-A
Recreational - Lambert Island	REC-LB
Recreational - Bass Lake	REC-BL
Recreational - Black Bay	REC-BB
Recreational - White Birch	REC-WB
Recreational - Remote	REC-RE
Rural	RU
Institutional	IN
Community Commercial	CC
Recreational Commercial	CR
Highway Commercial	CH
Light Industrial	LI
Heavy Industrial	HI
Aggregate Extraction	AG
Aggregate Extraction/Processing	AG-P
Mining Zone	MIN
Open Space	OS
Use Limitation	UL

0 1 2 3 4 5 km

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McKenzie River Watershed

M-10: Bridge & Culvert Sites

N

Legend

- Bridge
- Culvert
- MacKenzie River Watershed
- Township Boundary

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Provincially Significant Wetland

0 1 2 3 4 5 km

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FIGURES

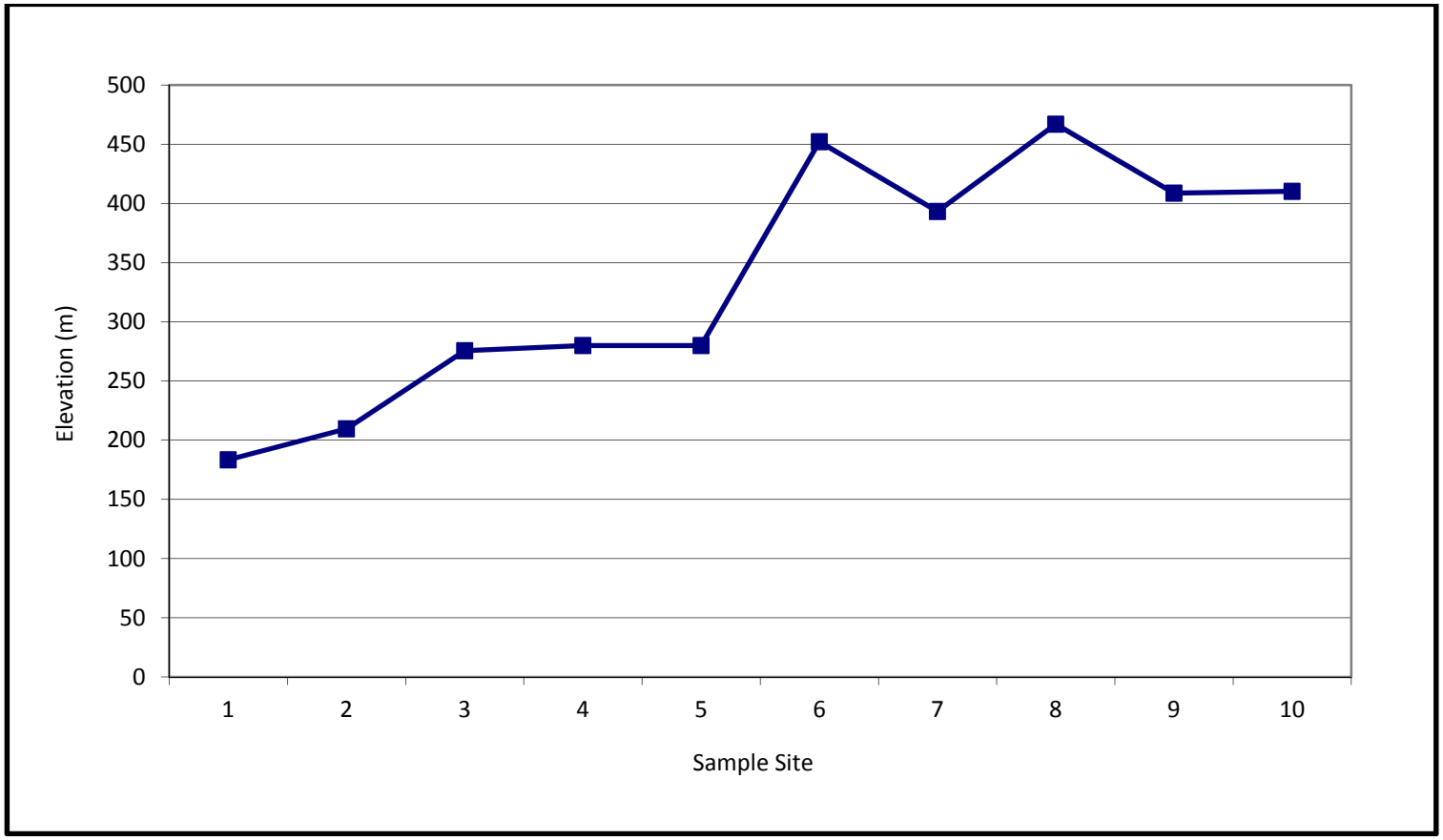


Figure 1: MacKenzie River Watershed Stream Gradient

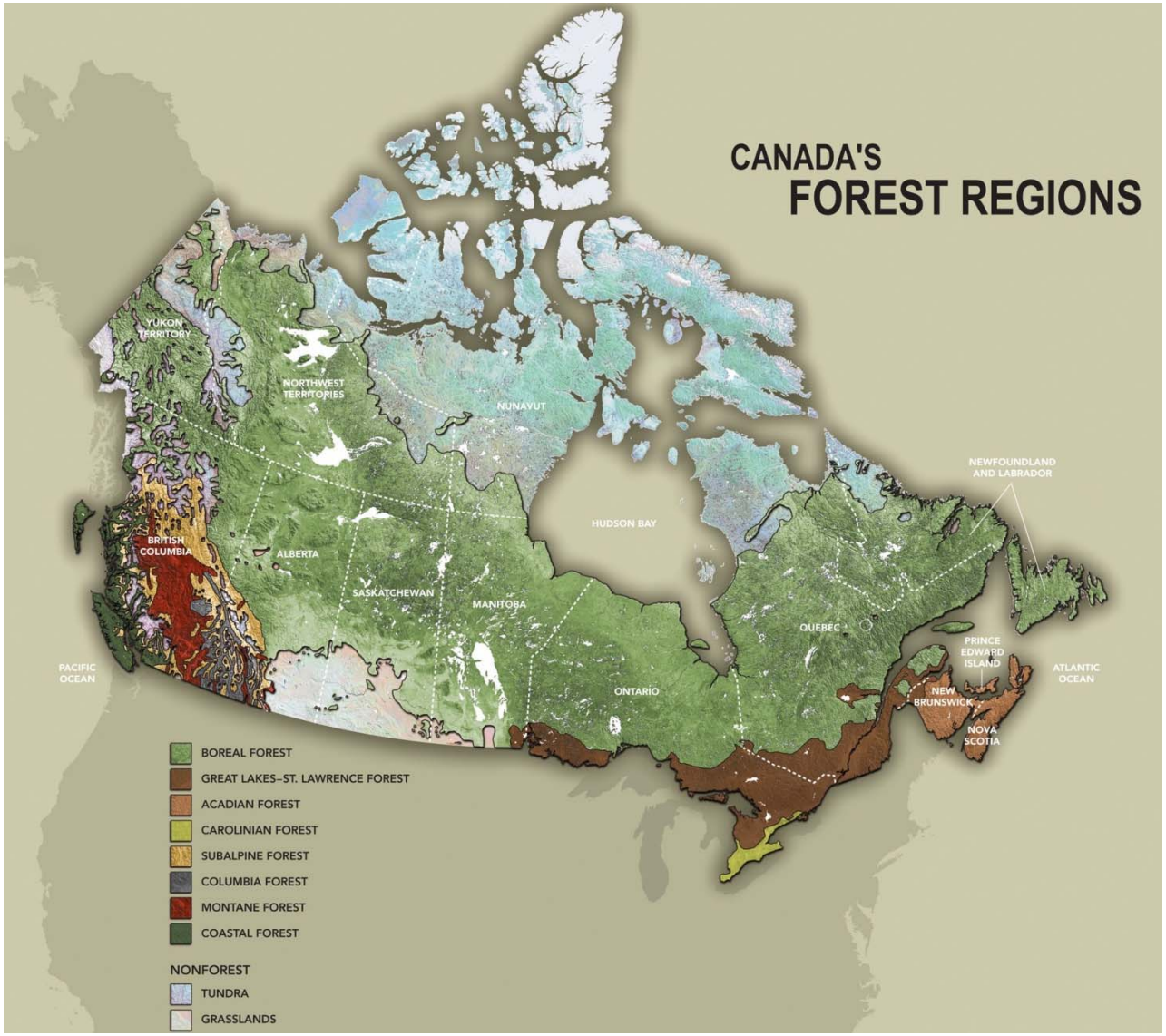


Figure 2: Canada's Forest Regions (Canadian Forest Service, 2013)

Figure 3: Wind Turbine 8 at Greenwich Wind Farm

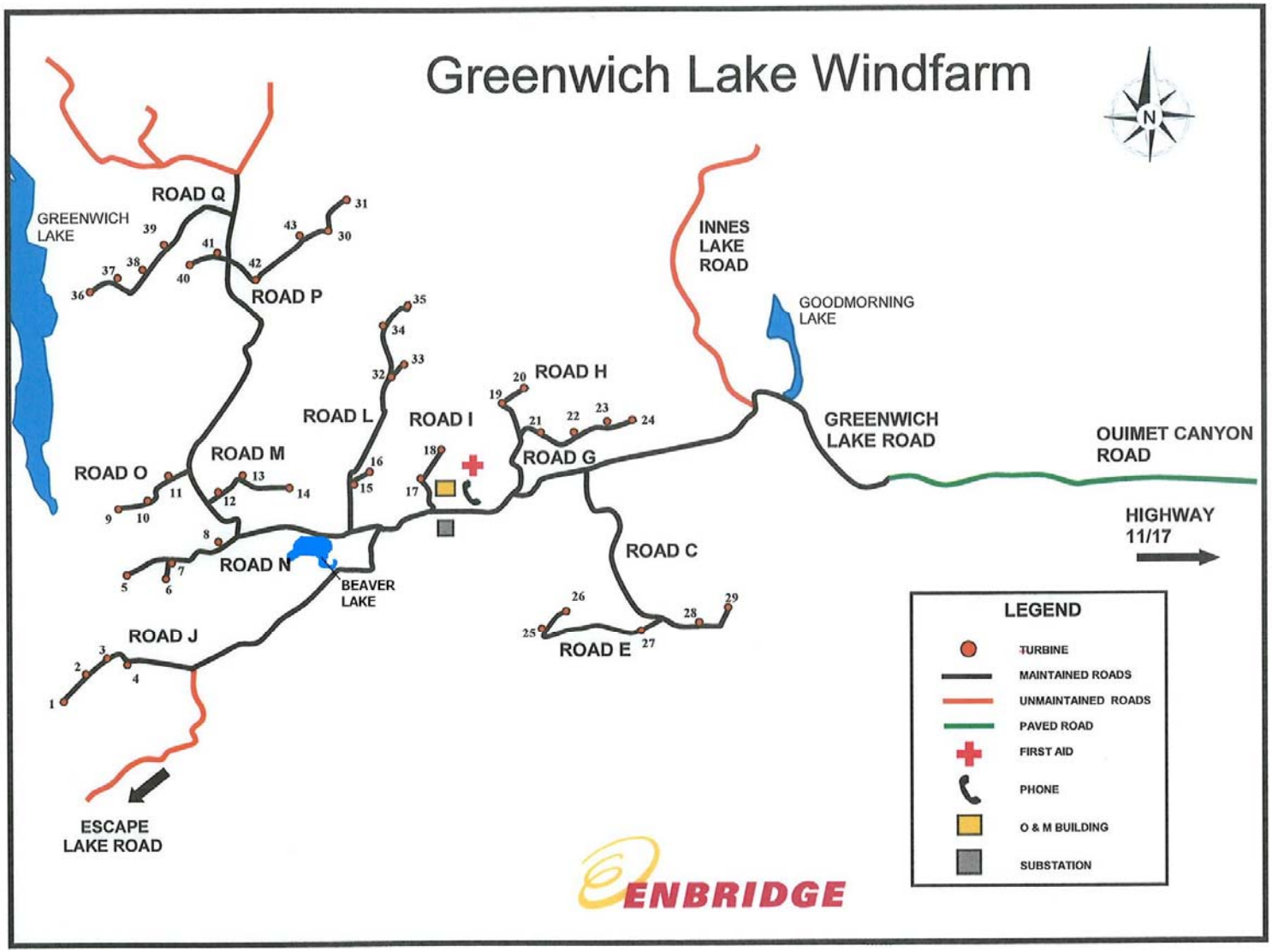


Figure 4: Greenwich Wind Farm site map

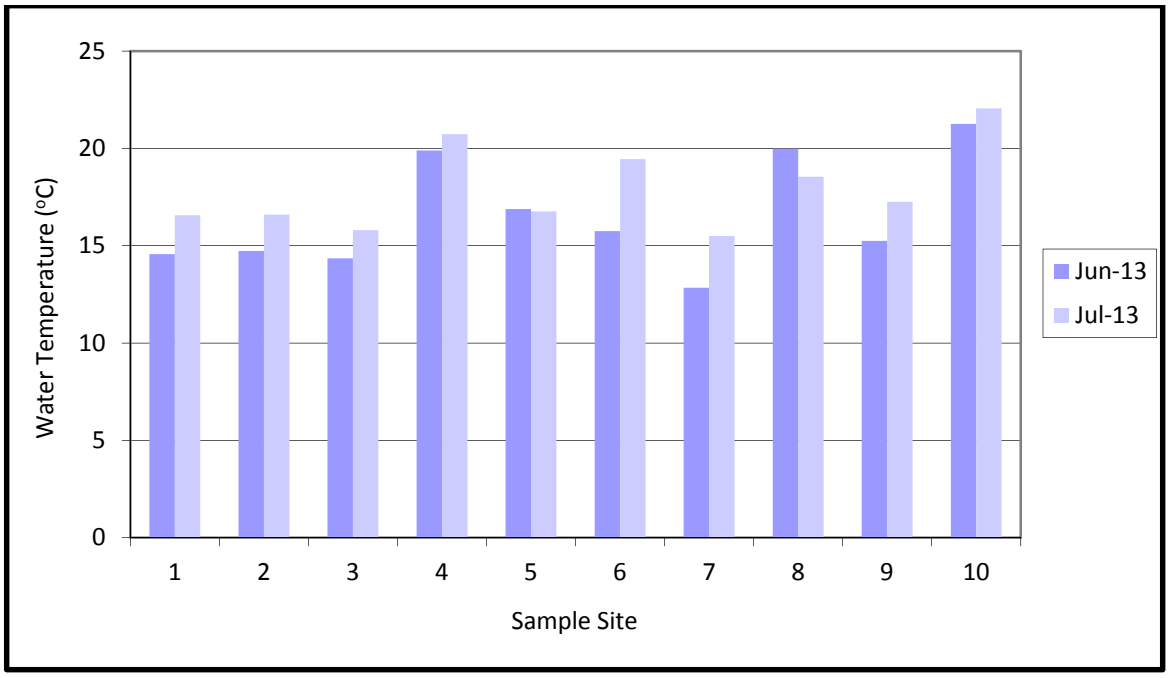


Figure 5: MacKenzie River Watershed Water Temperature

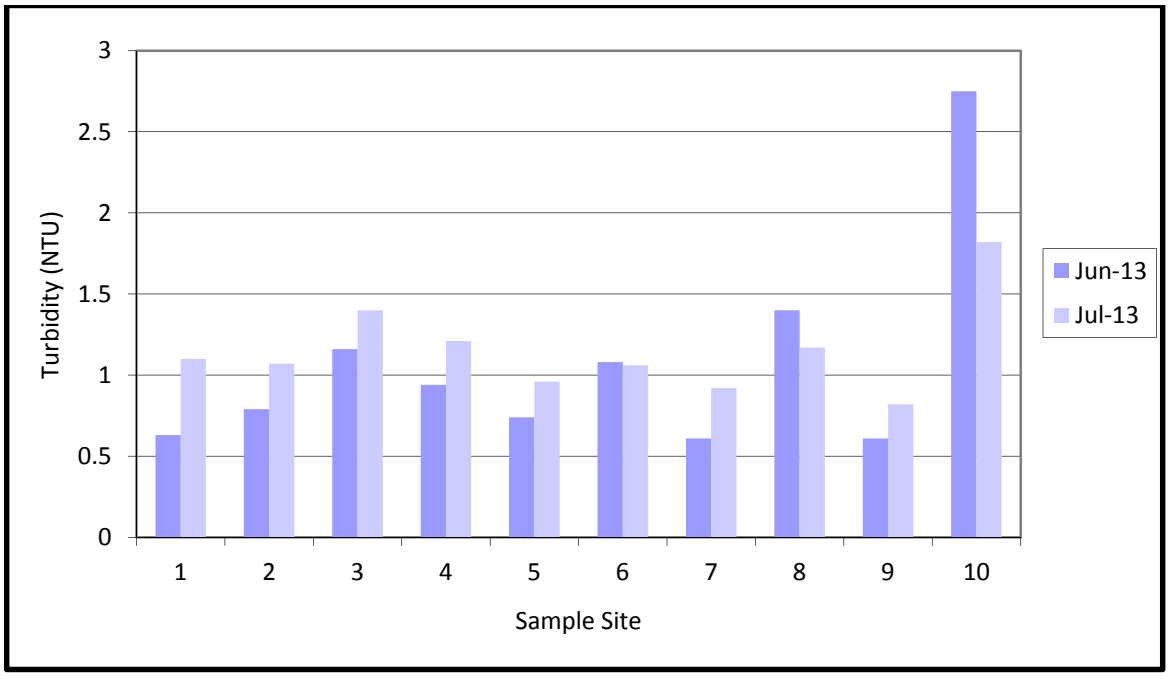
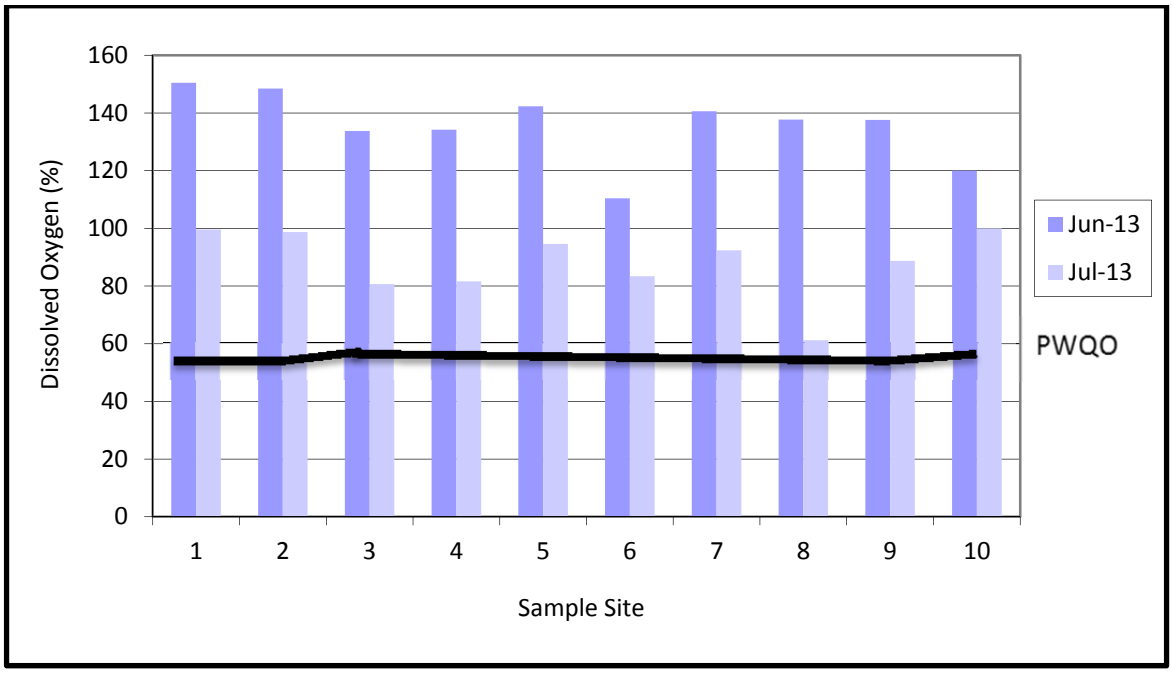


Figure 6: MacKenzie River Watershed Turbidity



Note: PWQO represents the lowest limit that is safe for cold water biota (not an exceedance)

Figure 7: MacKenzie River Watershed Dissolved Oxygen Percentage

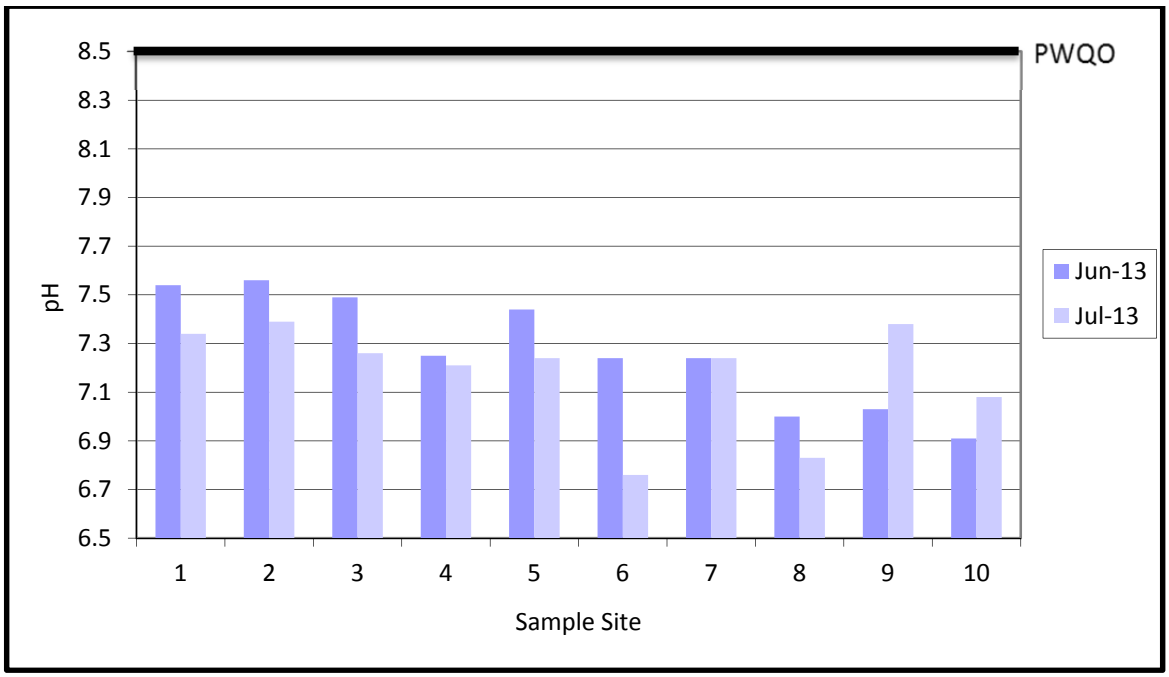


Figure 8: MacKenzie River Watershed pH Levels

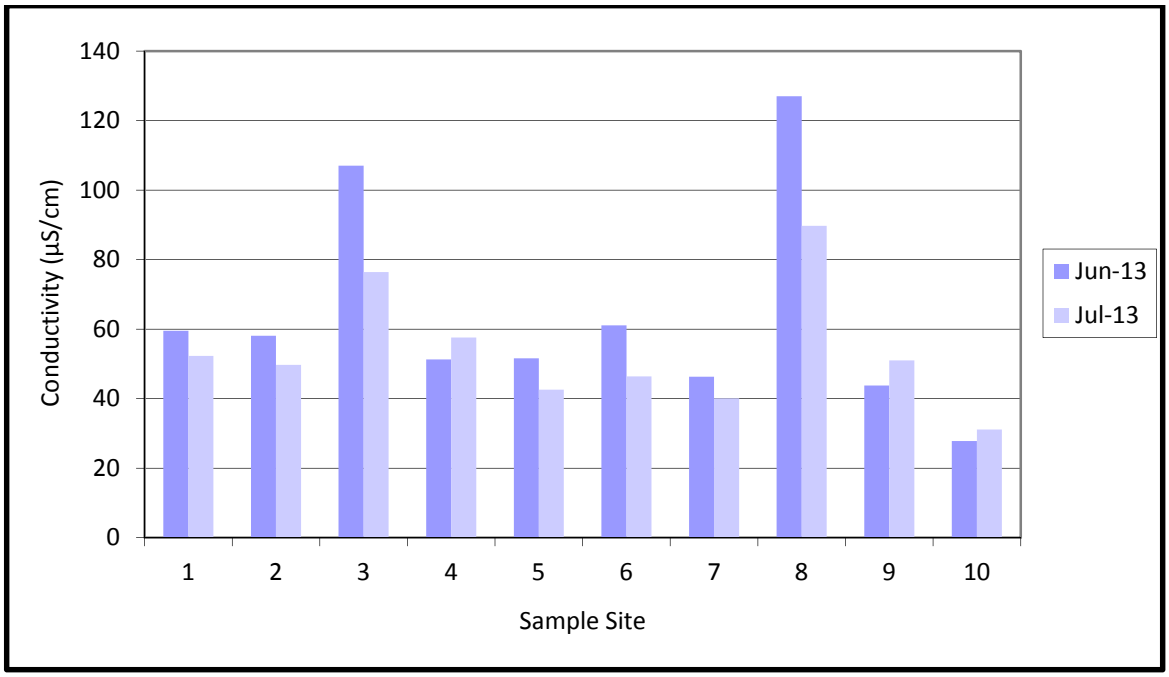


Figure 9: MacKenzie River Watershed Conductivity

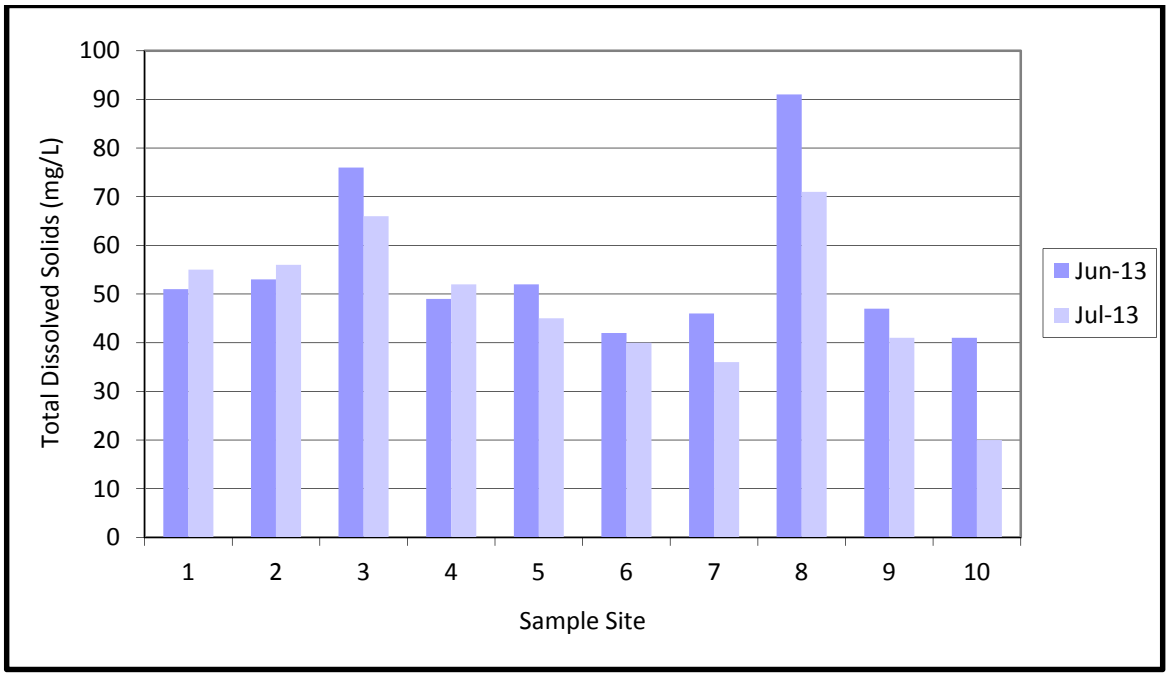


Figure 10: MacKenzie River Watershed Total Dissolved Solids

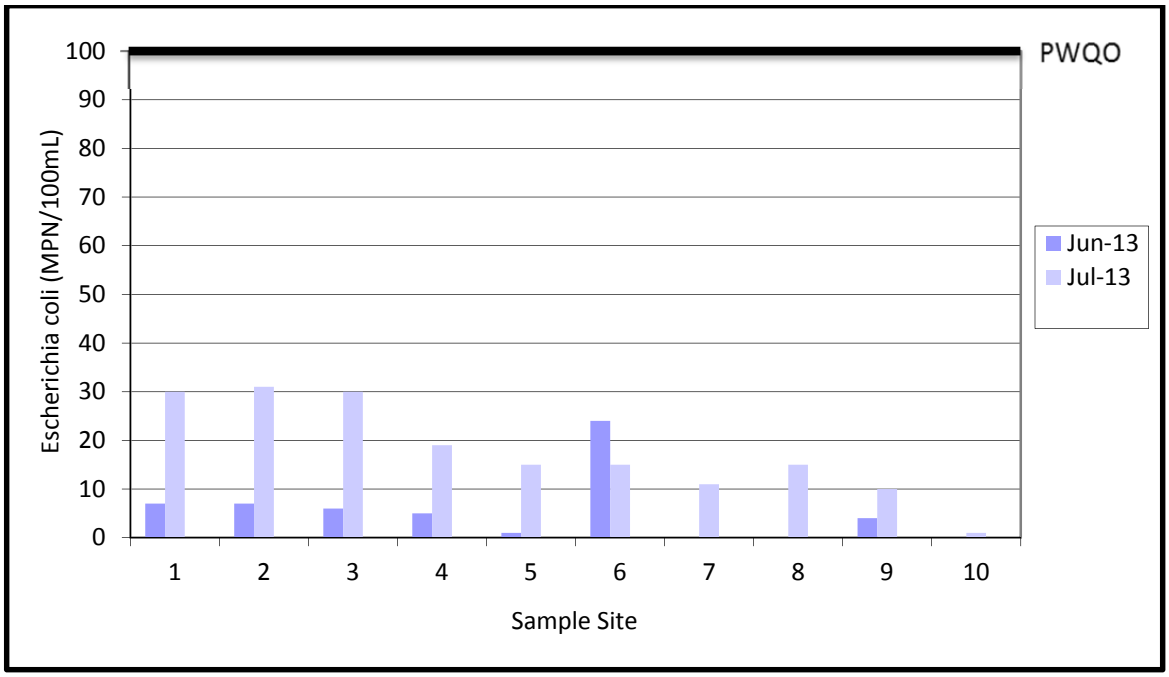


Figure 11: MacKenzie River Watershed *Escherichia coli* Levels

APPENDIX A:

SOILS

Appendix A: Soils

Soil Name	***Subgroup***	***Surface Texture***	***Soil Materials***	***Drainage***
Glen	Gleyed Eluviated Eutric Brunisol	Gravelly sandy loam, sand, sandy loam, peaty phase	Noncalcareous sand and gravel outwash material of shale origin.	Imperfect
Nolalu	Orthic Eutric Brunisol	loam, silt loam, sandy loam, gravelly sandy loam	Non-calcareous fine sandy loam stony glacial till derived from shale.	Good
Organics – Innes Lake	Typic humisol	N/A	Well decomposed organic material, derived from sedges and grasses greater than 160 cm thick	Very poor
Rockland	N/A	Nonsoil	Less than 10 cm soil material overlying bedrock, and exposed bedrock.	N/A
Wolfpup	Eluviated Eutric Brunisol	Gravelly sandy loam, gravelly sand, sandy loam	Noncalcareous sand and gravel outwash material of shale origin.	Good

APPENDIX B:

COMMON AND SCIENTIFIC NAMES OF IDENTIFIED FLORA AND FAUNA

Appendix B: Common and Scientific Names of Identified Flora and Fauna

Flora	
Trees	
Common Name	**Scientific (Latin) Name**
Balsam fir	*Abies balsamea*
Balsam poplar	*Populus balsamifera*
Black ash	*Fraxinus nigra*
Black spruce	*Picea mariana*
Eastern white cedar	*Thuja occidentalis*
Jack pine	*Pinus banksiana*
Tamarack	*Larix laricina*
Trembling aspen	*Populus tremuloides*
White birch	*Betula papyrifera*
White pine	*Pinus strobus*
White spruce	*Picea glauca*

Shrubs	
Common Name	**Scientific (Latin) Name**
Beaked hazel	*Corylus cornuta*
Bush honeysuckle	*Diervilla lonicera*
Fringed bindweed	*Polygonum cilinode*
Green alder	*Alnus viridis*
Highbush cranberry	*Viburnum trilobum*
Honeysuckle spp.	*Lonicera spp.*
Labrador tea	*Ledum groenlandicum*
Mountain ash	*Sorbus americana*
Mountain maple	*Acer spicatum*
Pin cherry	*Prunus pensylvanica*
Prickly wild rose	*Rosa acicularis*
Red-osier dogwood	*Cornus stolonifera*
Saskatoon (serviceberry)	*Amelanchier alnifolia*
Showy mountain ash	*Sorbus decora*
Shrubby cinquefoil	*Potentilla fruticosa*
Skunk currant	*Ribes glandulosum*
Slender willow	*Salix petiolaris*
Speckled alder	*Alnus rugosa*
Sweet gale	*Myrica gale*
Tall meadow-rue	*Thalictrum pubescens*
Twining honeysuckle	*Lonicera dioica*
Wild gooseberry	*Ribes americanum*
Wild red currant	*Ribes rubrum*
Wild red raspberry	*Rubus idaeus*
Willow spp.	*Salix spp.*

Herbs	
Common Name	**Scientific (Latin) Name**
American vetch	*Vicia americana*
Bird's foot trefoil	*Lotus corniculatus*
Blue bead lily	*Clintonia borealis*
Bunchberry	*Cornus candensis*
Buttercup	*Ranunculus repens*
Canada mayflower/ Lily-of-the-valley	*Maianthemum canadense*
Common plantain	*Plantago major*
Cow parsnip	*Heracleum maximum*
Cow vetch	*Vivia cracca*
Dandelion	*Taraxacum officinale*
Dwarf raspberry	*Rubus pubescens*
Fragrant bedstraw	*Galium triflorum*
Goat's beard	*Tragopogon pratensis*
Mullein	*Verbascum thapsus*
Northern bluebell	*Mertensia paniculata*
Northern blue Flag	*Iris versicolor*
Northern bog aster	*Oclemena nemoralis*
Large leaved aster	*Aster macrophyllus*
Low sweet blueberry	*Vaccinum angustifolium*
Orange hawkweed	*Hieracium aurantiacum*
Ox-eye daisy	*Leucanthemum vulgare*
Pearly everlasting	*Anaphalis margaritacea*
Purple stemmed aster	*Symphyotrichum puniceum*
Red clover	*Trifolium pratense*
Rose-twisted stalk	*Streptopus amplexifolius*
Swamp thistle	*Cirsium muticum*
Wild Columbine	*Aquilegia canadensis*
Woodland strawberry	*Fragaria vesca*
Wooly blue violet	*Viola sororia*
Virginia strawberry	*Fragaria virginiana*
Yarrow	*Achillea millefolium*
Yellow hawkweed	*Hieracium pratense*

Ferns/Mosses/Graminoids/Lichens	
Common Name	**Scientific (Latin) Name**
Horsetail - meadow	*Equisetum pratense*
Horsetail - swamp	*Equisetum fluviatile*
Interrupted fern	*Osmunda claytoniana*
Juniper moss	*Polytrichum juniperinum*
Lady fern	*Athyrium filix-femina*
Oak fern	*Gymnocarpium dryopteris*
Pixie cup	*Cladonia pyxidata*
Plume moss	*Ptilium crista-castrensis*
Running clubmoss	*Lycopodium clavatum*
Sphagnum spp.	*Sphagnum spp.*
Three-seeded sedge	*Carex trisperma*

Aquatic Plants	
Common Name	**Scientific (Latin) Name**
Yellow pond lily	*Nuphar lutea*
Common bladderwort	*Utricularia vulgaris*
Common cattail	*Typha latifolia*
Common mare's tail	*Hippuris vulgaris*
Common reed	*Phragmites australis*
Duckweed	*Lemna spp.*
Flat-stemmed pondweed	*Potamogeton zosteriformis*
Fragrant white lily	*Nymphaea odorata*
Marsh cinquefoil	*Comarum palustre*
Marsh marigold	*Caltha palustris*
Mermaid weed	*Proserpinaca pectinata*
Musk grass	*Chara sp.*
Richardsons pondweed	*Potamogeton richardsonii*
Broad-leaved arrowhead	*Sagittaria latifolia*

Fauna	
Reptiles and Amphibians	
Common Name	**Scientific (Latin) Name**
American toad	*Bufo americanus*
Eastern garter snake	*Thamnophis sirtalis*
Green frog	*Rana clamatans*
Wood frog	*Rana sylvatica*

Fish	
Common Name	**Scientific (Latin) Name**
Brook stickleback	*Culaea inconstans*
Northern pearl dace	*Margariscus nachtriebi*
Northern redbelly dace	*Chrosomus eos*
Blacknose shiner	*Notropis heterolepis*

Invertebrates	
Common Name	**Scientific (Latin) Name**
Black fly	*Simuliidae sp.*
Bumble bee	*Bombus spp.*
Canadian tiger swallowtail butterfly	*Papilio canadensis*
Deerfly	*Chrysops niger*
Dragonfly	*Anisoptera spp.*
Freshwater clam	*Bivalvia spp.*
Freshwater leech	*Macrobdella decora*
Mosquito	*Culicidae spp.*
Pearl crescent butterfly	*Phyciodes tharos*
Snail	*Gastropoda spp.*
Spider	*Arachnid spp.*
Spring azure butterfly	*Celastrina ladon*
Water boatmen	*Corixidae sp.*
Water strider	*Gerridae sp.*

Aves	
Common Name	**Scientific (Latin) Name**
American crow	*Corvus brachyrhynchos*
American kestrel	*Falco sparverius*
American robin	*Turdus migratorius*
Black-capped chickadee	*Poecile atricapillus*
Blue jay	*Cyanocitta cristata*
Canada goose	*Branta canadensis*
Common loon	*Gavia immer*
Common merganser	*Mergus merganser*
Common raven	*Corvus corax*
Herring gull	*Larus argentatus*
Mallard	*Anas platyrhynchos*
Red-winged blackbird	*Agelaius phoeniceus*
Ruffed grouse	*Bonasa umbellus*
White-throated sparrow	*Zonotrichia albicollis*
Red-tailed hawk	*Buteo jamaicensis*

Mammals	
Common Name	**Scientific (Latin) Name**
American red squirrel	*Tamiasciurus hudsonicus*
Moose	*Alces alces*
Snowshow hare	*Lepus americanus*
White tailed deer	*Odocoileus virginianus*
Black bear	*Ursus americanus*
Red fox	*Vulpes vulpes*
Groundhog	*Marmota monax*
Eastern chipmunk	*Tamias striatus*
Mink	*Mustela vison*

APPENDIX C:

TECHNIQUES FOR DATA COLLECTION

Appendix C: Techniques for Data Collection

Air Temperature
The air temperature was measured with a basic mercury thermometer.

Channel Width & Depth
The width of the stream was measured using a nylon measuring-tape reel. Channel depth was measured by using a stainless steel meter stick. When maximum channel depth could not be measured due to high velocity water or deep water, a depth measurement was taken at the water sample location.

Conductivity
Conductivity was measured with the YSI 600 QS. The accuracy of the reading was ±0.001 mS/cm or ±1.0%; whichever was greater. The readings were recorded once the probe was completely submerged and all readings stabilized. In addition to conductivity readings taken in the field, laboratory analysis of the samples provided a second reading of conductivity which is included within the results.

Dissolved Oxygen
The YSI 600 QS measured dissolved oxygen for the samples. The readings were recorded once the probe was submerged in the water and all variables were stabilized.

Flora and Fauna Identification
Identification was made in the vicinity of the sample sites, no transects were made. Observation areas were designated as approximately 50 metres from either stream edge. Field guides were used to accurately identify species.

Flow
The velocity of river flow at sites was measured using a stick and nylon measuring-tape reel. Distances measured varied depending upon stream obstructions and variable depth. The flow was then calculated using the equation Q=V*A, where Q is flow/ discharge, V is velocity (distance divided by time), and A is the cross sectional area of the stream.

Latitude, Longitude, and Elevation
The Universal Transverse Mercator (UTM) coordinates for each site were measured with a Trimble Geo XH 2005 hand held GPS unit.

Location
The sample sites were chosen using a 1:50,000 scale topographic map. A comprehensive representation of the watershed was shown by the sample sites chosen. The sample sites were also described in terms of road access and road crossings.

pH
The YSI 600 QS measured pH for the water sample sites. The readings were recorded once the probe was submerged in the water and all variables were stabilized. A pH reading was also taken during the analysis at the laboratory.

Photographs
Photographs were taken at each site using the Olympus Stylus 1030SW shock and water proof camera. Upstream and downstream photographs as well as culvert, bridge, and vegetation photographs were all taken at each site. Substrate photographs were attempted at each site with the waterproof camera.

Surface Water Sampling
Samples were taken at the same position at each site wherever possible, but high water during the second sampling period prevented this in some cases. Grab sampling technique was used when conducting surface water sampling. Sample bottles were pre-charged with preservatives, so this did not have to be done in the field. Sample bottles were submerged 15 to 30 centimeters below the surface of the water body and positioned towards the flow of the water source. Samples were kept cool and delivered to ALS Laboratory for analyzing.

Total Dissolved Solids
The total dissolved solids (TDS) were measured in laboratory.

Turbidity
Turbidity of the water was measured in the laboratory as well as in the field. A LaMotte 2020we Turbidity meter was used for field measurement. The sample collection bottle was filled at each site. The vial provided in the kit was used for a “no-blank” turbidity scan.

Water Temperature
Water temperature was measured with the YSI 600 QS. The readings were taken after the probe was submerged and all variables on the meter were stabilized.

OBBN In-Stream Materials Key

Soil Type
Like stream bed description, soil type on land will impact vegetation and erosion potential. Soil type was categorized using the soil type keys in the FEC Manual for North Western Ontario.

Stream Bed Description

The bed description was described by means of a visual scan of the sample site area, with percentages assigned to the appropriate categories of varying grain sizes, seen below.

Grain Size	Description
Boulder	> 25.6 cm in diameter
Cobbles	6.4 - 25.6 cm in diameter
Gravel	0.2 – 6.4 cm in diameter
Sand	< 0.2 cm in diameter
Silt	Finer inorganic material than sand
Muck	Mainly organic combination of silt and clay
Clay	Inorganic origin with no apparent structure

St**ream Cover**

Stream cover describes the vegetation density along the river bank, no more than 5 metres from the water's edge. Stream cover was divided into three categories of density, as seen below.

Description	% Cover
Dense	75-100% shaded by canopy
Partly Open	25-75% shaded by canopy
Open	0-25% shaded by canopy

APPENDIX D:

SUMMARY OF WATER QUALITY PARAMETERS

Appendix D: Summary of Water Quality Parameters

Physical Properties

The abiotic factors of water quality are very influential on aquatic plants and animals and can have a significant impact on the ecosystem. The following physical parameters were measured either in the field or in the laboratory.

Conductivity

Conductivity is the measure of the ability of water to carry an electrical current expressed in micro seimens per centimeter. The reading is used to determine the total dissolved solids (TDS) in the water sample. There is no PWQO for conductivity.

Dissolved Oxygen

Like terrestrial animals, fish and other aquatic species require oxygen to breathe. It is not the mere presence of dissolved oxygen that is important; the gas has to be above a certain concentration in order to sustain life. As well, oxygen is required to decompose organic matter in the stream. Dissolved oxygen levels will be highest if the water is colder, turbulent (a lot of mixing at the air-water interface) and during the day when aquatic plants have had time to produce oxygen during photosynthesis. PWQO's have an acceptable range for dissolved oxygen in water dependent upon temperature. At 20 degrees Celsius the minimum amount of dissolved oxygen is 5 milligrams per liter.

pH

The pH measures the concentration of hydrogen ions in the water based on a logarithmic scale of 0 to 14. Lower pH is acidic (many free hydrogen ions) and higher pH is alkaline (few free hydrogen ions). The pH of water determines the solubility and biological availability of chemicals constituents such as nutrients (eg. nitrogen, phosphorus) and heavy metals (eg. lead, copper). Geology of the watershed can give the river some buffering capacity to resist changes in pH but overall the range has to stay between 6.5 and 8.5 to protect aquatic life.

Total Dissolved Solids

Total dissolved solids (TDS) measure the amount of inorganic salts and small amounts of organic matter that is dissolved in water. The principal constituents are usually calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulphate, and nitrate (from agricultural use). Most of these originate from natural geological sources yet high levels may indicate runoff from of road salts, runoff from agricultural and erosion from exposed soil/no stream bank vegetation. There is no PWQO for TDS.

Turbidity

Turbidity is the measure of the relative clarity of water. Turbidity in water is caused by suspended matter such as silt, clay and algae that scatter the sunlight. The diversity of species will be affected by how far the sunlight can penetrate the water column. Fish gills will become clogged with a lot of suspended material, as well the material can settle on top of fish spawning grounds (and their eggs). Highly turbid water will appear murky or

dirty. Turbidity will be higher after heavy rainfall, but high levels may also indicate soil erosion.

Temperature

Water temperature is important because it dictates the kind of aquatic life that can live in a stream. Fish, insects, plankton and other aquatic species all have a preferred temperature range. If the temperature goes too far above or below their preferred range, then the number of species will decrease until there is none. Temperature also influences water chemistry which in turn affects biological activity. Chemical reactions generally speed up with warmer temperatures. Temperature is important, as warmer water holds less dissolved oxygen and warmer water will allow bacteria to reproduce and grow more quickly. Temperature can vary depending on the source of the water, depth and velocity of the stream, sunlight intensity and the amount of shade by the shoreline vegetation.

Nutrients

Like terrestrial plants, aquatic plants and algae require nutrients for growth and productivity. The main nutrients of concern are phosphorus and nitrogen.

Phosphorus

Total phosphorus gives a measurement of all forms of phosphorus in the water, but the most important form within this measurement is soluble inorganic phosphate (PO_4) or orthophosphate ion (PO_4^{-3}) because it is the fraction utilized by aquatic plants. While phosphorus is essential to life, too much of it will increase algae growth attached to rocks in the river. Excessive growths of attached algae can use up all the dissolved oxygen leaving other species, like fish, with anoxic (no oxygen) conditions. Nutrient loading may cause a decrease in biodiversity and a decrease in the most ecologically sensitive species. Natural decomposition of organic matter such as leaves, twigs, grass that is washed into the stream during the winter does constitute an important source of nutrients. However, high levels of phosphorus may indicate unnatural sources such as detergent, pesticide and fertilizer runoff from developed watersheds. Milkhouse waste from dairy farms is also a large source of phosphorus and has become one of the main environmental issues surrounding dairy farming.

Nitrogen

Nitrogen (N) is one of the most common gases in our atmosphere. It makes up approximately 78% of the earth's atmosphere. Like phosphorus, these nutrients are often applied to agricultural crops as fertilizers and having too much in the river can increase plant growth and productivity to unhealthy levels. Nitrogen is constantly being recycled through the environment through decomposition, etc. The most important forms that plants can readily use are ammonia, nitrate (NO_3) and nitrite (NO_2). There are many different ways to report nitrogen so it is necessary to note that the results from ALS Laboratory Group were given in Total ammonia-nitrogen (mg/L), Nitrate-nitrogen (NO_3-N mg/L), and Nitrite-nitrogen (NO_2-N mg/L).

Bacteria

Escherichia coli

Escherichia coli (*E. coli*) are naturally found in the intestines of humans and warm-blooded animals. Unlike other bacteria in this family, *E. coli* does not usually occur naturally on plants or in soil and water. The inability of *E. coli* to grow in water combined with its short survival time in water environments means that the detection of *E. coli* in a water system is a good indicator of recent fecal contamination. Potential sources of *E. coli* include: leaking septic systems, runoff from manure storage facilities or wild animal waste (i.e. beavers and Canadian Geese). These bacteria can cause irritation of the skin and eyes when contact is made and can cause gastro-intestinal disorders.

Total Coliforms

Total coliforms are a group of bacteria that are naturally found on plants and in soils, water, and in the intestines of humans and warm-blooded animals. Because total coliforms are widespread in the environment, they can be used as one of the many operational tools to determine the efficacy of a drinking water treatment system. The total coliform group contains various species of the genera *Escherichia, Klebsiella, Enterobacte, Citrobacter, Serratia,* and many others. There is no current PWQO for total coliforms; however the previous guideline was 1000 MPN per 100 mL.

Metals

Most of the metals listed below are found naturally within the earth's crust and weathering of rock can transport them into surface water. The following is a complete list of the metals analysis performed on the water samples and their qualities.

Aluminum

Aluminum is the most abundant metal on Earth, comprising about 8% of the Earth's crust. It is found in a variety of minerals, such as feldspars and micas, which, with time, weather to clays and exposure is inevitable. High levels of aluminum will put strain on the kidneys of animals when they attempt to excrete it but it is not normally fatal. Aluminum and its compounds are often used in food as additives, in drugs, in consumer products and in the treatment of drinking water. Aluminum poisoning has been linked to neurological dementia in kidney dialysis patients and, in recent years, its role in Alzheimer's disease, Parkinson's disease and Lou Gehrig's disease. The intake of large amounts of aluminum can also cause anaemia, osteomalacia (brittle or soft bones), glucose intolerance, and cardiac arrest in humans. The PWQO guideline for aluminum varies with pH, the maximum concentration being 75 μg/L.

Antimony

Antimony is a metallic element that is a blue-white colour in its stable form. Acute intoxication is characterized by abdominal pain, vomiting, diarrhea, dehydration, muscular pain, shock, haemoglobinuria, anuria and uraemia. In addition, severe myocardial symptoms and convulsions have been observed with acute doses of antimonials, as well some deaths were attributed to liver necrosis. The maximum concentration of antimony under PWQO guidelines is 20 μg/L.

Arsenic
Arsenic is a natural element abundantly found within the earth's crust. It may be found in some drinking water supplies, including wells. Long-term exposure (over many years or decades) to high levels of arsenic in drinking water may cause thickening and discoloration of the skin; nausea and diarrhea; decreased production of blood cells; abnormal heart rhythm and blood vessel damage, or numbness in the hands and feet. Short term exposure (days/weeks) to very high levels of arsenic can result in abdominal pain, vomiting and diarrhea, muscular cramping or pain, weakness and flushing of skin, skin rash, numbness, burning or tingling sensation on the palms of the hands and soles of the feet, or loss of movement and sensory response. The maximum concentration of arsenic under PWQO guidelines is 5 μg/L.

Barium
Barium is present as a trace element in both igneous and sedimentary rocks. Although it is not found free in nature, barium occurs in a number of compounds. Barium compounds have a wide variety of industrial applications. They are used in the plastics, rubber, electronics and textiles industries. At high concentrations, barium causes strong vasoconstriction by its direct stimulation of arterial muscle, peristalsis due to the violent stimulation of smooth muscle, and convulsions and paralysis following stimulation of the central nervous system. Depending on the dose and solubility of the barium salt, death may occur in a few hours or a few days. There are currently no PWQO guidelines for barium.

Beryllium
Beryllium is a hard grey metal that is extracted from the earth, refined and reduced to a very fine powder. It occurs as a chemical component of certain rocks, coal and oil, soil, and volcanic dust. People exposed to beryllium are at risk of developing serious debilitating diseases. Chronic beryllium disease (CBD or berylliosis) is a painful scarring of the lung tissue. Less common than CBD, acute (short—term) beryllium disease, causes lung inflammation resembling pneumonia. In severe cases, both diseases may be fatal. The maximum concentration of beryllium under PWQO guidelines depends on hardness. If $CaCO_3$ is >75 mg/L the maximum concentration of beryllium is 1100 μg/L and if the $CaCO_3$ is <75 mg/L the maximum concentration of Beryllium is 11 μg/L.

Bismuth
Bismuth is a brittle metal with a pinkish colour, often found in its native form. Exposure to bismuth at low doses may cause gastrointestinal disorders, low stomach acid, heartburn, bloating, calcification, warts, diarrhea, and gastric ulcers. At large doses it may cause mental confusion, memory problems, tremors, staggering gait, muscle twitching, slurring speech, joint problems, hypoadrenalism, hearing and visual disturbances, hallucinations and coma. There are currently no PWQO guidelines limiting the intake of bismuth.

Boron
Boron is a non-metallic element that is not found in nature in its elemental form but can be found in a number of compounds. Exposure to boron in small doses may cause irritation to the nose, throat and eyes. In larger doses, boron can affect the stomach, liver, kidneys and brain, and may eventually lead to death. The maximum level of boron under PWQO guidelines is 200 μg/L.

Cadmium
Cadmium is an extremely toxic metal even in low concentrations. It is used commercially as a stabilizer in plastic, fungicides for golf courses, television picture tube phosphors, nickel–cadmium batteries, motor oils, and curing agents for rubber. Cadmium poisoning can lead to itai-itai disease, which initiates bone softening, joint pain and kidney failure. The maximum concentration of cadmium under PWQO guidelines is 0.2 μg/L. The interim PWQO guideline states if hardness as $CaCO_3$ is 0-100 the maximum cadmium concentration is 0.1 μg/L and if hardness is >100, the maximum cadmium concentration is 0.5 μg/L.

Calcium
Calcium is the third most abundant metal in the Earth's crust. Calcium is also the most abundant metal in the human body and is the main constituent of bones. Calcium is a dietary requirement and there are no adverse health effects from intake of large doses of calcium. There are currently no PWQO guidelines for calcium.

Chromium
Chromium is a lustrous, hard metal. Chromium (III) is an essential nutrient, but higher intake may cause skin rashes. Chromium (VI) is known to cause various health effects such as skin rashes, upset stomachs and ulcers, respiratory problems, weakened immune systems, kidney and liver damage, alteration of genetic material, lung cancer and death. The maximum concentration of chromium under PWQO guidelines is 1 μg/L for Chromium (VI) and 8.9 μg/L for Chromium (III).

Cobalt
Cobalt is a hard, lustrous, silver-grey metal and is found in various ores. Health effects resulting from exposure to high concentrations include vomiting and nausea, vision problems, heart problems and thyroid damage. The maximum concentration of cobalt under PWQO guidelines is 0.9 μg/L.

Copper
Copper occurs in nature as a metal and in minerals. Copper is an essential element to human metabolism, although intake at higher doses can cause adverse health effects. Acute copper poisoning health effects include vomiting, diarrhea, jaundice, haemolysis, haemoglobinuria, haematuria, and oliguria. In severe cases, the stool and saliva may appear green or blue. In the terminal phases, anuria, hypotension, and coma precede death. The maximum concentration of copper under PWQO guidelines is 5 μg/L.

Iron
Iron is also an abundant metal found in rock. The precipitation of excessive iron creates an objectionable reddish-brown colour to water. Iron may also stain laundry and plumbing fixtures, produce undesirable tastes in beverages, and promote the growth of certain iron-bacteria, leading to the deposition of a slimy coating in water distribution pipes. The PWQO guideline stipulates that the levels of iron in the water must be below 300 μg/L.

Lead
Lead is a very toxic metal to all forms of life, causing neurological damage and even death. Although natural occurrences can occur from precipitation and the weathering of ores, the majority of lead in watercourses comes from anthropogenic sources. The PWQO requirement for lead varies with different alkalinity as $CaCO_3$ (mg/L). The maximum lead concentration is 25 μg/L.

Magnesium
Magnesium is very abundant in nature and is found in many minerals. It is a dietary requirement, but too much can lead to muscle weakness, lethargy and confusion. There are no current PWQO guidelines for magnesium.

Manganese
Manganese is a very common compound that can be found everywhere on earth. It is essential for humans to survive, but toxic when concentrations in the body are too high. Manganese can cause Parkinson, lung embolism and bronchitis. There are currently no PWQO guidelines for manganese.

Molybdenum
Molybdenum is a by-product of copper and tungsten mining. It is used as an alloy for various metals and occurs naturally in soil and rock. Potential health impacts associated with molybdenum include neurotoxicity and reproductive toxicity. The maximum concentration of molybdenum under PWQO guidelines is 40 μg/L.

Nickel
Nickel is a compound that occurs in the environment only at very low levels. An uptake of large quantities of nickel may cause higher risks of cancer, respiratory failure, birth defects and heart disorders. The maximum concentration of nickel under PWQO guidelines is 25 μg/L.

Potassium:
Potassium is a soft silvery white metal, which is a key plant element and is found in most fertilizers. Potassium is also a dietary requirement, but many potassium compounds may cause adverse health effects. Such compounds include potassium alum or potassium cyanide. There are currently no PWQO guidelines for potassium.

Selenium
Selenium is one of the rarer elements on the surface of the earth. It occurs naturally in the environment and is also released by human activities. The health effects of various forms of selenium can vary from brittle hair and deformed nails, to rashes, heat, swelling of the skin and severe pains. Selenium poisoning may become so severe in some cases that it can even cause death. The maximum concentration of selenium under PWQO guidelines is 100 μg/L.

Silicon
Silicon is the most abundant element on earth after oxygen. In drinking water only silicic acid is present, which is relatively safe. However, there are a number of silicon compounds that are carcinogenic. There are currently no PWQO guidelines for silicon.

Silver
Silver does not react with pure water. It is stable in both water and air. Moreover, it is acid and base resistant, but it corrodes when it comes in contact with sulphur compounds. Silver oxide is harmful upon swallowing, because it irritates the eyes, respiratory tract and skin. Silver nitrate is much more harmful, because it is a strong oxidant. It causes corrosion, and an oral uptake can lead to vomiting, dizziness and diarrhea. The maximum concentration of silver under PWQO guidelines is 0.1 μg/L.

Strontium
Strontium is a bright silvery metal that is softer than calcium and even more reactive in water. Acute effects of strontium include vomiting and diarrhea if ingested, and may also cause irritation to the skin. Chronic skin contact may cause dermatitis. There are currently no PWQO guidelines for strontium.

Thallium
Thallium is a silvery-grey metal that is very toxic by inhalation, ingestion and skin absorption. It may act as a systemic poison, neurotoxin, and may cause birth abnormalities. It is also a respiratory and eye irritant. The maximum concentration of thallium under PWQO guidelines is 0.3 μg/L.

Tin
Tin is a soft, pliable, silvery-white metal. Acute effects of tin include skin or eye irritation, headaches, stomach aches, dizziness, and breathlessness. Long-term effects include liver damage, malfunctioning of immune systems, chromosomal damage, shortage of red blood cells, and brain damage. There are currently no PWQO guidelines limiting the intake of tin.

Titanium
Titanium is a white-silvery metallic colour and is always found bound to other elements in nature. There are no known health hazards of titanium in water, but it is known to have adverse health effects in powder form. There are currently no PWQO guidelines for titanium.

Tungsten
Tungsten is a lustrous, silvery-white metal. Acute health effects include irritation to the skin and eyes causing watering and redness. There are no known long-term health effects. The maximum concentration of tungsten under PWQO guidelines is 30 μg/L.

Uranium
Uranium is a hard, dense, malleable, ductile, silver-white, radioactive metal. No harmful radiation effects of natural levels of uranium have been found. However, chemical effects may occur after the uptake of large amounts of uranium, which can cause health effects such as kidney disease. Exposure to uranium radionuclides that form during radioactive decay may cause cancer. The maximum concentration of uranium under PWQO guidelines is 5 μg/L.

Vanadium
Vanadium is a rare, soft, ductile grey-white element found combined in certain minerals and used mainly to produce certain alloys. The uptake of vanadium by humans mainly takes place through foodstuffs, such as buckwheat, soy beans, olive oil, sunflower oil, apples and eggs. Some acute health effects associated with the high intake of vanadium include inflammation of stomach and intestines, sickness and headaches, dizziness, skin rashes, nosebleeds and throat pain. Chronic exposure may cause eye, skin and respiratory problems. The maximum concentration of vanadium under PWQO guidelines is 6 μg/L.

Zinc
Zinc is a lustrous bluish-white metal. Overdoses do not occur very often. Symptoms include nausea, vomiting, dizziness, fevers and diarrhea. The maximum concentration of zinc under PWQO guidelines is 20 μg/L.

Zirconium
Zirconium is a very strong, malleable, ductile, lustrous silver-grey metal. Zirconium and its salts generally have low systemic toxicity. The maximum concentration of Zinc under PWQO guidelines is 4 μg/L.

APPENDIX E:

WATER QUALITY GUIDELINES

Appendix E: Water Quality Guidelines

The following guidelines are taken from the Ministry of the Environment, Provincial Water Quality Objectives (PWQO), July 1994.

Physical

Alkalinity
Alkalinity should not be decreased by more than 25% of the natural concentration.

Dissolved oxygen
Dissolved oxygen concentrations should not be less than the values specified below for cold water biota (e.g. salmonid fish communities) and warm water biota (e.g. centrarchid fish communities):

Dissolved Oxygen Concentration				
Temperature	Cold Water Biota		Warm Water Biota	
°C	% Saturation	mg/L	% Saturation	mg/L
0	54	8	47	7
5	54	7	47	6
10	54	6	47	5
15	54	6	47	5
20	57	5	47	4
25	63	5	48	4

In waters inhabited by sensitive biological communities, or in situations where additional physical or chemical stressors are operating, more stringent criteria may be required. For example, a sensitive species such as lake trout may require more specific water quality objectives.

In some hypolimnetic waters, dissolved oxygen is naturally lower than the concentrations specified in the above table. Such a condition should not be altered by adding oxygen-demanding materials causing a depletion of oxygen.

pH
The pH should be maintained in the range of 6.5 – 8.5:

- to protect aquatic life
- both alkaline and acidic waters may cause irritation to anyone using the water for recreational purposes

Temperature
The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

Waste Heat Discharge

1. Ambient Temperature Changes

   The temperature at the edge of a mixing zone shall not exceed the natural ambient water temperature at a representative control location by more than 10°C (18°F). However, in special circumstances, local conditions may require a significantly lower temperature difference than 10°C (18°F). Potential dischargers are to apply to the MOEE for guidance as to the allowable temperature rise for each thermal discharge. This ministry will also specify the nature of the mixing zone and the procedure for the establishment of a representative control location for temperature recording on a case-by-case basis.

2. Discharge Temperature Permitted

   The maximum temperature of the receiving body of water, at any point in the thermal plume outside a mixing zone, shall not exceed 30°C (86°F) or the temperature of a representative control location plus 10°C (18°F) or the allowed temperature difference, whichever is the lesser temperature. These maximum temperatures are to be measured on a mean daily basis from continuous records.

3. Taking and Discharging of Cooling Water

   Users of cooling water shall meet both the Objectives for temperature outlined above and the "Procedures for the Taking and Discharge of Cooling Water" as outlined in the MOEE publication *Deriving Receiving-Water Based, Point-Source Effluent Requirements for Ontario Waters (1994).*

Turbidity
Suspended matter should not be added to surface water in concentrations that will change the natural Secchi disc reading by more than 10 percent.

Nutrients

Ammonia (un-ionized)
The amount of un-ionized ammonia should not exceed 20 µg/L.

The percentages of un-ionized ammonia (NH3) in aqueous ammonia solution for different temperature and pH conditions are listed in the table below. For example, at 20°C and pH of 8.0, a total ammonia concentration of 500 µg/L would give an un-ionized ammonia concentration of 500 x 3.8/100 = 19 µg/L which is less than the un-ionized ammonia Objective of 20 µg/L.

The table below is taken from the PWQO, percentages are rounded to two significant figures. The equations given may be used to interpolate values between those given in the table:

$f = 1/(10^{pKa-pH} + 1)$, where f is the fraction of NH3

pKa = 0.09018 + 2729.92/T, where T = ambient water temperature in Kelvin (K = °C + 273.16)

Results should be converted to percent and rounded to two significant figures. Extrapolations should not be made beyond the ranges of the table.

Note: Under certain temperature and pH conditions, the total ammonia criteria for the protection of aquatic life may be less stringent than the criteria for other beneficial uses (e.g. public water supply).

Percent NH3 in aqueous ammonia solutions for 0-30 °C and pH 6-10

Temp.	**pH**								
°C	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
0	.0083	.026	.083	.26	.82	2.6	7.6	21.	45.
1	.0090	.028	.090	.28	.89	2.8	8.3	22.	47.
2	.0098	.031	.098	.31	.97	3.0	8.9	24.	49.
3	.011	.034	.11	.34	1.1	3.3	9.6	25.	52.
4	.012	.036	.12	.36	1.1	3.5	10.	27.	54.
5	.013	.040	.13	.39	1.2	3.8	11.	28.	56.
6	.014	.043	.14	.43	1.3	4.1	12.	30.	58.
7	.015	.046	.15	.46	1.5	4.4	13.	32.	60.
8	.016	.050	.16	.50	1.6	4.8	14.	34.	61.
9	.017	.054	.17	.54	1.7	5.2	15.	35.	63.
10	.019	.059	.19	.59	1.8	5.6	16.	37.	65.
11	.020	.064	.20	.63	2.0	6.0	17.	39.	67.
12	.022	.069	.22	.68	2.1	6.4	18.	41.	69.

Temp.	pH								
°C	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
13	.024	.074	.24	.74	2.3	6.9	19.	43.	70.
14	.025	.080	.25	.80	2.5	7.4	20.	45.	72.
15	.027	.087	.27	.86	2.7	8.0	22.	46.	73.
16	.030	.093	.29	.93	2.9	8.5	23.	48.	75.
17	.032	.10	.32	1.0	3.1	9.1	24.	50.	76.
18	.034	.11	.34	1.1	3.3	9.8	26.	52.	77.
19	.037	.11	.37	1.2	3.6	11.	27.	54.	79.
20	.040	.13	.40	1.2	3.8	11.	28.	56.	80.
21	.043	.14	.43	1.3	4.1	12.	30.	58.	81.
22	.046	.15	.46	1.4	4.4	13.	32.	59.	82.
23	.049	.16	.49	1.5	4.7	14.	33.	61.	83.
24	.053	.17	.53	1.7	5.0	14.	35.	63.	84.
25	.057	.18	.57	1.8	5.4	15.	36.	64.	85.
26	.061	.19	.61	1.9	5.8	16.	38.	66.	86.
27	.065	.21	.65	2.0	6.2	17.	40.	67.	87.
28	.070	.22	.70	2.2	6.6	18.	41.	69.	88.
29	.075	.24	.75	2.3	7.0	19.	43.	70.	88.
30	.081	.25	.80	2.5	7.5	20.	45.	72.	89.

The following nitrate and nitrite guidelines are taken from the Canadian Council of Resource and Environment Ministers (CCREM) Canadian water quality guidelines for the protection of aquatic life: Summary table, updated 2012. The information in these guidelines and supporting text is used to complement the Provincial Water Quality Objectives and Interim Objectives.

Nitrate

The amount of nitrate in freshwater should not exceed 13,000 µg NO_3/L to avoid long term effects and should not exceed 550,000 µg NO_3/L to avoid short term effects.
These guidelines are only for protection from direct toxic effects, the guidelines do not consider indirect effects due to eutrophication.

Nitrite

The amount of nitrite in freshwater should not exceed 60 µg NO_2-N/L (197 NO_2/L).
These guidelines are for protection from direct toxic effects, the guidelines do not consider indirect effects due to eutrophication.

Phosphorus
Current scientific evidence is insufficient to develop a firm objective at this time. Accordingly, the following phosphorus concentrations should be considered as general guidelines, which should be supplemented by site-specific studies.

- To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 µg/L.
- A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 µg/L or less. This should apply to all lakes naturally below this value.
- Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 µg/L.

Bacteriological

Escherichia coli
The amount of *Escherichia coli* should not exceed 100 counts per 100 mL of water (based on a geometric mean of at least 5 samples).

Based on a recreational water quality guideline published by the Ontario Ministry of Health in 1992, this Ministry of Health guideline was specifically intended for application by the local Medical Officer of Health to swimming and bathing beaches. It is based upon a geometric mean of levels of *E. coli* determined from a minimum of 5 samples per site taken within a given swimming area and collected within a one month period. If the geometric mean *E. coli* level for the sample series at a given site exceeds 100 per 100 mL, the site should be considered unsuitable for swimming and bathing. *E. coli* was selected for the guideline because studies have determined that, among bacteria of the coliform group, *E. coli* is the most suitable and specific indicator of fecal contamination.

An analytical test with a high degree of specificity for *E. coli* regardless of water sample source, requiring no confirmation procedures, and which produces results in 21 hours has been developed and adopted by both the Ministry of Health, and Ministry of Environment and Energy laboratories.

Where testing indicates sewage or fecal contamination, a site-specific judgment must be made as to the severity of the problem and the appropriate course of action.

As of May 1, 1994, MOEE staff has been advised to base all **new** compliance, enforcement and monitoring activities on the *E. coli* test. Some water managers may find it necessary to continue testing for fecal coliforms or total coliforms. For example, where testing at a long term water quality monitoring station requires a continuous record of results using either the fecal or total coliform test to monitor trends in water quality. As a benchmark for the long term monitoring results, the former objectives for fecal coliforms and total coliforms are referenced for your information. For fecal coliforms the objective was 100 counts per 100 ml (based on a geometric mean density for a series of water samples). For total coliforms the objective was 1000 counts per 100 ml (based on a geometric mean density for a series of water samples).

Metals

Aluminum
Aluminum amounts should not exceed the following:

PH values	Interim PWQO (µg/L)
4.5 to 5.5	15
5.5 < 6.5	No more than 10 % of natural background
6.5 < 9.0	75

Antimony
The amount of Antimony should not exceed 20 µg/L.

Arsenic
The amount of Arsenic should not exceed 5 µg/L.

Barium
There are currently no PWQO guidelines for Barium.

Beryllium
Beryllium amounts should not exceed the following:

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
< 75	11
> 75	1100

Bismuth
There are currently no PWQO guidelines for Bismuth.

Boron
The amount of Boron should not exceed 200 µg/L.

Cadmium
Cadmium amounts should not exceed 0.2 µg/L.

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
0 - 100	0.1
> 100	0.5

Calcium
There are currently no PWQO guidelines for Calcium.

Chromium
Chromium amounts should not exceed the following:

	Interim PWQO (µg/L)
Hexavalent Chromium (Cr VI)	1
Trivalent Chromium (Cr III)	8.9

Cobalt
The amount of Cobalt should not exceed 0.9 µg/L.

Copper
The amount of Copper should not exceed 5 µg/L.

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
0-20	1
>20	5

Iron
The amount of Iron should not exceed 300µg/L.

Lead
Lead amounts should not exceed the following:

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
< 30	1
30 to 80	3
> 80	5

Lithium
There are currently no PWQO guidelines for Lithium.

Magnesium
There are currently no PWQO guidelines limiting the intake of Magnesium.

Manganese
There are currently no PWQO guidelines for Manganese.

Molybdenum
The amount of Molybdenum should not exceed 40 µg/L.

Nickel
The amount of Nickel should not exceed 25 µg/L.

Potassium
There are currently no PWQO guidelines for Potassium.

Selenium
The amount of Selenium should not exceed 100 µg/L.

Silicon
There are currently no PWQO guidelines for Silicon.

Silver
The amount of Silver should not exceed 0.1 µg/L.

Sodium
There are currently no PWQO guidelines for Sodium.

Strontium
There are currently no PWQO guidelines for Strontium.

Tellurium
There are currently no PWQO guidelines for Tellurium.

Thallium
The amount of Thallium should not exceed 0.3 µg/L.

Tin
There are currently no PWQO guidelines for Tin.

Titanium
There are currently no PWQO guidelines for Titanium.

Tungsten
The amount of Tungsten should not exceed 30 µg/L.

Uranium
The amount of Uranium should not exceed 5 µg/L.

Vanadium
The amount of Vanadium should not exceed 6 µg/L.

Zinc
The amount of Zinc should not exceed 20 µg/L.

Zirconium
The amount of Zirconium should not exceed 4 µg/L.

APPENDIX F:

FOREST AND WETLAND ECOSYSTEM CLASSIFICATION

Appendix F: Forest and Wetland Ecosystem Classification

Site 1, Site 2, Site 5, Site 6: V4 – White Birch Hardwood and Mixedwood

Description: Hardwood and mixedwood stands in which white birch is, typically, the only hardwood species in the overstory. These stands are generally herb and shrub rich although poor understory development can be encountered. Occurring generally on fresh to moist, coarse-textured, non-calcareous mineral soils.

Site 1

Site 2

Site 5

Site 6

Common Overstory Species (in descending order):
Betula papyrifera, Abies balsamea, Picea glauca, Picea mariana, Pinus banksiana, Populus tremuloides

Common Understory Species:

Shrubs:	*Abies balsamea, Acer spicatum, Sorbus decora, Diervilla lonicera, Amelanchier spp., Linnaea borealis, Vaccinium angustifolium, Vaccinium myrtilloides*
Herbs:	*Clintonia borealis, Cornus Canadensis, Maianthemum canadense, Aralia nudicaulis, Trientalis borealis, Streptopus roseus, Aster macrophyllus, Lycopodium annotium, Viola spp.*
Mosses:	*Pleurozium schreberi, Ptilium crista-castrensis, Dicranum polysetum*

Forest Floor Cover:

Species	Broadleaf litter	Moss	Conifer litter	Wood
Forest Floor Cover (%)	73	13	5	5

Site 3 and Site 8: W15 - Low Shrub Shore Fen

Description: Low shrub fen, typically on floating mat. Hummocks with Sphagnum and ericaceous shrubs often present, but small in area. Shallow surface pools of water persist throughout the growing season. Typha (cattails) sometimes at high cover. Ground cover consists of leaf and sedge litter, water and bare peat. Substrate is a mat of fibric to mesic peat held together by roots and rhizomes. Edges of lakes and streams with low wave and current energy. Water regime is seasonally flooded.

Site 3

Site 8

Common Overstory Species (in descending order): *Picea mariana, Larix laricina*

Common Understory Species:

Shrubs:	*Chamaedaphne calyculata, Myrica gale, Salix pedicellaris*
Herbs:	*Potentilla palustris*
Graminoids:	*Calamagrostis Canadensis, Carex aquatilis, Carex lasiocarpa, Carex rostrata*

Forest Floor Cover: N/A

Comments:
Site 3 contained slightly more trees than described, however they were all stunted.
Site 8 had a transitional phase from the lake shore to the wetland type W15. The transitional phase included floating aquatic species such as *Nymphaea odorata* and emergent *Typha* (cattail).

Site 4: V34 Black Spruce / Labrador Tea / Feathermoss transition phase to V31 – Black Spruce - Jack Pine / Tall Shrub / Feathermoss

Description: Black spruce – jack pine stands are typical although other conifers can be present in the canopy. The understory is variable in both structure and species composition but, in general, the shrub and/or herb strata are moderately dense. Balsam fir and black spruce are often abundant in the shrub layer. Feathermoss cover can be extensive. Occurring across a range of soil and site conditions but most commonly on deep, fresh, upland mineral soils.

Site 4

Common Overstory Species (in descending order):
Picea mariana, Pinus banksiana, Abies balsamea, Picea glauca, Populus tremuloides

Common Understory Species:

Shrubs:	*Vaccinium myrtilloides, Linnaea borealis, Abies balsamea, Picea mariana, Vaccinium angustifolium, Diervilla lonicera, Rosa acicularis, Gaultheria hispidula, Amelanchier spp., Rubus pubescens*
Herbs:	*Cornus Canadensis, Maianthemum canadense, Clintonia borealis, Aralia nudicaulis, Trientalis borealis, Coptis trifolia, Aster macrophyllus*
Mosses:	*Pleurozium schreberi, Dicranum polysetum, Ptilium crista-castrensis, Hylocomium splendens*

Forest Floor Cover:

Cover type	Broadleaf litter	Moss	Conifer litter	Wood
Forest Floor Cover (%)	11	60	20	6

Site 7 and Site 10: V19 – Black Spruce Mixedwood / Herb Rich

Description: A black spruce mixedwood type with several potential species in the overstory. The understory is typically dominated by a rich herb/dwarf shrub layer. The shrub stratum ranges from dense to open, usually with balsam fir and black spruce as important components. Forest floor cover varies from moss rich to mainly broadleaf litter. Occurring on a range of site conditions although mostly on fresh to moist, mineral soils.

Site 7

Site 10

Common Overstory Species (in descending order):
Picea mariana, Populus tremuloides, Pinus banksiana, Abies balsamea, Betula papyrifera, Picea glauca, Populus balsamifera

Common Understory Species:

Shrubs	*Linnaea borealis, Abies balsamea, Rubus pubescens, Vaccinium myrtilloides, Picea mariana, Rosa acicularis, Amelanchier spp., Vaccinium angustifolium, Sorbus decora, Gaultheria hispidula, Diervilla lonicera, Ledum groenlandicum, Populus tremuloides*
Herbs	*Cornus Canadensis, Maianthemum canadense, Clintonia borealis, Trientalis borealis, Aralia nudicaulis, Coptis trifolia, Petasites palmatus, Aster macrophyllus, Streptopus roseus, Voila renifolia*
Mosses	*Pleurozium schreberia, Ptilium crista-castrensis, Dicranum polysetum, Hylocomium splendens, Rhytidiadephus triquetrus*

Forest Floor Cover:

Cover type	Broadleaf litter	Moss	Conifer litter
Forest Floor Cover (%)	33	49	12

Site 9: V10 Trembling Aspen-Black Spruce-Jack Pine/Low Shrub

Description: Hardwood mixedwoods with black spruce and jack pine as the primary conifer tree species. The herb and low shrub layers are usually rich in broadleaved species, often with abundances of *Diervilla lonicera* and *Aster macrophyllus.* Occurring mainly on deep, fresh, well to rapidly drained mineral soils.

Site 9

Common Overstory Species (in descending order):
Populus tremuloides, Picea mariana, Pinus banksiana, Betula papyrifera, Abies balsamea, Picea glauca

Common Understory Species:

Shrubs:	*Diervilla lonicera, Linnaea borealis, Rubus pubescens, Abies balsamea, Vaccinium myrilloides, V. angustifolium,* trembling aspen, *Rosa acicularis, Amelanchier spp.,Picea mariana, Alnus crispa, Sorbus decora*
Herbs:	*Cornus Canadensis, Maianthemum canadense, Aralia nudicaulis, Clintonia borealis, Streptopus roseus, Aster macrophyllus, Trientalis borealis, Viola renifolia, Coptis trifolia, Epilobium angustifolium, Lycopodium clavatum*
Mosses:	*Pleurozium schreberi, Ptilium crista-castrensis, Dicranum polysetum*

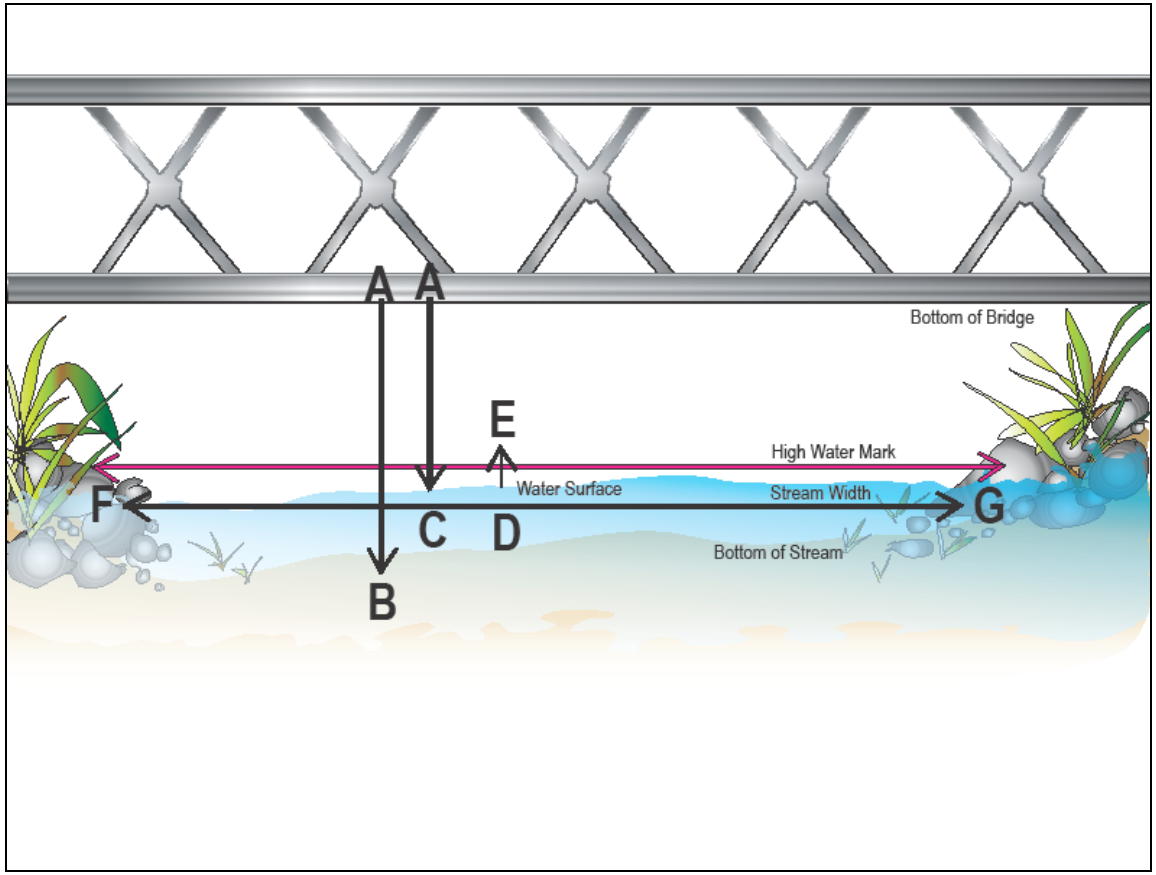
Forest Floor Cover:

Cover type	Broadleaf litter	Moss	Wood	Conifer litter
Forest Floor Cover (%)	73	10	6	10

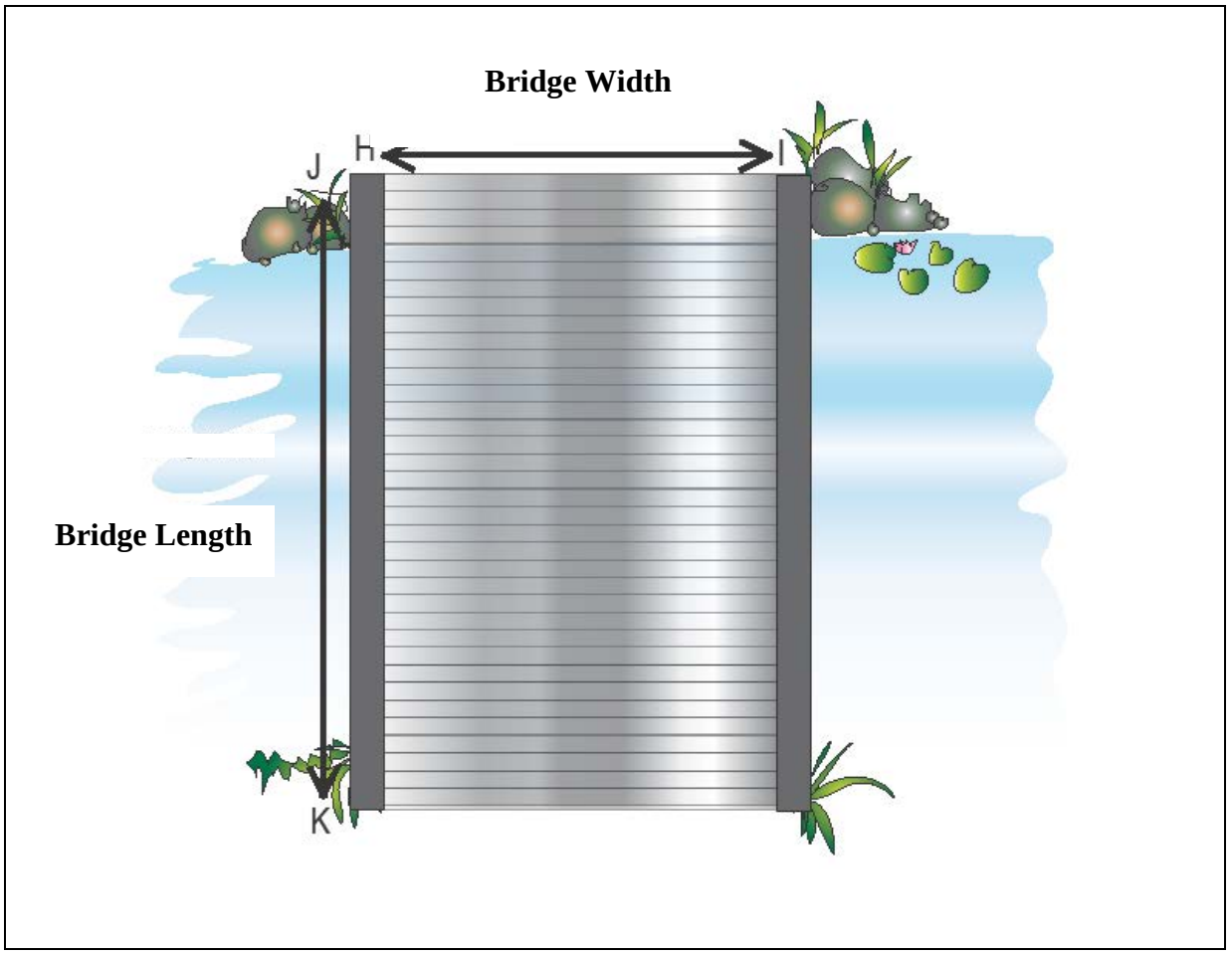
APPENDIX G:

BRIDGE ASSESSMENTS

Appendix G: Bridge Assessments



Bridge Measurement Parameters



Bridge Measurement Parameters

MacKenzie River 2013 Bridge Measurements

Site number	Bridge Number	**A-C** Bottom of Bridge to Water Surface (m)	**A-B** Bottom of Bridge to Bottom of Stream (m)	**D-E** Outlet Pool Water Surface to Outlet Pool High Water Mark (m)	**F-G** Width of Stream (m)	**H-I** Length of Bridge (m)	**J-K** Width of Bridge (m)
1	1	4.6	N/A	0.2	39.0	24.7	4.0
2	2	N/A	N/A	N/A	N/A	N/A	N/A
3	3	1.3	2.2	0.3	10.0	12.0	5.4
5	4	3.0	4.55	0.35	8.2	12.5	4.8
6	5	2.4	3.0	above mark	6.4	9.0	5.1
9	6	1.8	2.25	above mark	3.0	8.0	5.5
Maximum Value		4.6	4.55	0.3	39.0	24.7	5.5
Minimum Value		1.3	2.2	0.15	3.0	8.0	4.0
Average		2.62	3.0	0.65	13.32	13.24	4.96

Bridge 1

Location: Decommissioned CN railway, off of MacKenzie Beach Avenue (Site 1)

GPS Coordinates: Northing 5376624 Easting 0356578

Description: This bridge is a decommissioned railway bridge owned by CN Railway; it was part of the Kinghorn railway. It can be accessed on either side by walking along the rail bed from Coral Beach Road or MacKenzie Beach Avenue. It is constructed of creosote timbers with a steel undercarriage and is private property prohibiting trespassing. The height of the bridge did not appear to alter natural channel characteristics. The width of the bridge appeared to cause interference when the concrete supports came into contact with the water on both sides, creating a narrower and deeper channel than what may have naturally been present. The high water mark was barely visible, and estimated to be 0.2 metres above the current level. There was visible stabilizing fill for this bridge on either side, consisting of boulder to gravel sized rip rap. The banks surrounding the bridge were fairly steep in order to maintain levelness with the raised railway bed. The banks were quite stable due to the large and heavy boulder rip rap holding it together.

Upstream

Downstream

Bridge 2

Location: On Highway 11/17 crossing over MacKenzie River (Site 2)

GPS Coordinates: Northing 5377478 Easting 0356662

Description: This was a concrete culvert style bridge, the roadway has steel and wood guardrails installed. The base of the bridge is supported by granitic bedrock, which gives the bridge stability. The embankments from the highway down to the river are mostly grasses and shrubs, with a channel of riprap on either side of the bridge to filter out road runoff and prevent erosion. The bridge appeared to alter flow significantly, creating a narrower, smooth concrete channel allowing for very fast flow. Due to the high flow rate, bridge size and busy traffic, bridge measurements could not be done. A high water mark was not visible, but due to the lack of soil and vegetation present on the bedrock banks, it is possible that water runs much higher than the current level. Overall, the bridge was in good shape and will experience less traffic in the near future due to the construction of the divided highway twin bridges further upstream.

Upstream

Bridge 3

Location: MacKenzie Station Road crossing over MacKenzie Creek (Site 3)

GPS Coordinates: Northing 5379021 Easting 0354319

Description: This bridge was made of tar timbers and steel struts and included a metal guardrail on each side of the bridge supported by wooden posts. Large wooden cribs supported either side of the bridge. The substrate at the bridge is mostly cobble, with some gravel and sand, most likely from construction. The remainder of the creek, at the sample site, is mostly silt and muck with some gravel and sand. The bridge didn't appear to affect the flow rate since it was a fairly slow moving creek due to the low lying, flooded, wetland area where the bridge was situated, which forms a meandering channel downstream of the bridge. The high water mark could be seen on the cribs, 0.3 metres above the current level. The riverbanks from the bridge were well vegetated with graminoids and shrubs. The downstream banks were slightly undercut but no other evidence of erosion was present. The bridge was still in fairly good condition.

Upstream

Downstream

Bridge 4

Location: Walkinshaw Road crossing over Walkinshaw Creek (Site 5)

GPS Coordinates: Northing 5380526 Easting 0355391

Description: This bridge was a wooden bridge with wooden cribs as supports on either side and a steel V-type support underneath. The bridge deck was wooden planks with residual asphalt evidence. There were steel posts with a cable side railing. The bridge did not appear to drastically affect the flow of water, however the cribs did protrude into the waterway by approximately 0.5 metres on either side, perhaps causing a narrower channel and increased flow rate. The high water mark (0.35 metres) was visible on the wooden cribs, however an emerging birch tree would indicate low water levels at some time, suggesting an extreme variation in the water level. The banks of the creek were boulder and bedrock which provided a stable base for the bridge and there was no evidence of erosion at the site.

Upstream

Downstream

Bridge 5

Location: Kingfisher Road off Magone Road; crossing the Magone Lake outlet (Site 6)

GPS Coordinates: Northing 5386563 Easting 0349154

Description: This was a newer construction wooden bridge with a steel undercarriage and wooden planks on the deck. The wooden support cribs on either side of the bridge were filled in with cobble and gravel as well as geotextile cloth to filter runoff from the road. There were only wooden bumpers along the sides of the bridge with no guardrails or cables. The boulders and cobble at the site were largely from the bridge construction, creating a stable setting as well as erosion control banks leading down from the road. The cribs did not enter the water, however the boulders at the footings of the bridge may have narrowed the channel. When high water level was measured, the current level was above any possible mark due to heavy rains. The bridge was in a low-lying area with steep hills on either side. The bridge is in excellent condition and with regular use should remain in such condition

Upstream

Downstream

Bridge 6

Location: On Escape Lake Road 20 kilometers east of Highway 527 (Site 9)

GPS Coordinates: Northing 5398045 Easting 0364094

Description: This bridge was the same construction as bridge 5, although slightly older, made of wood beams with steel support beams underneath and wooden cribs on either bank filled with gravel and cobble. The deck of the bridge was made of wooden planks with shallow wooden bumpers along the sides. Boulder and cobble were used as a base for the two cribs for stability, which joined well with the natural stream bank and substrate also composed of boulders and cobble. The banks of the river were well vegetated with shrubs which provided excellent rooting for erosion control. A high water mark was not visible on the banks, but due to the lack of soil and vegetation it can be assumed that the water level has been higher than current conditions. The bridge did not interfere with water flow, and the channel width appears to be of natural course. The bridge was well maintained and in good condition.

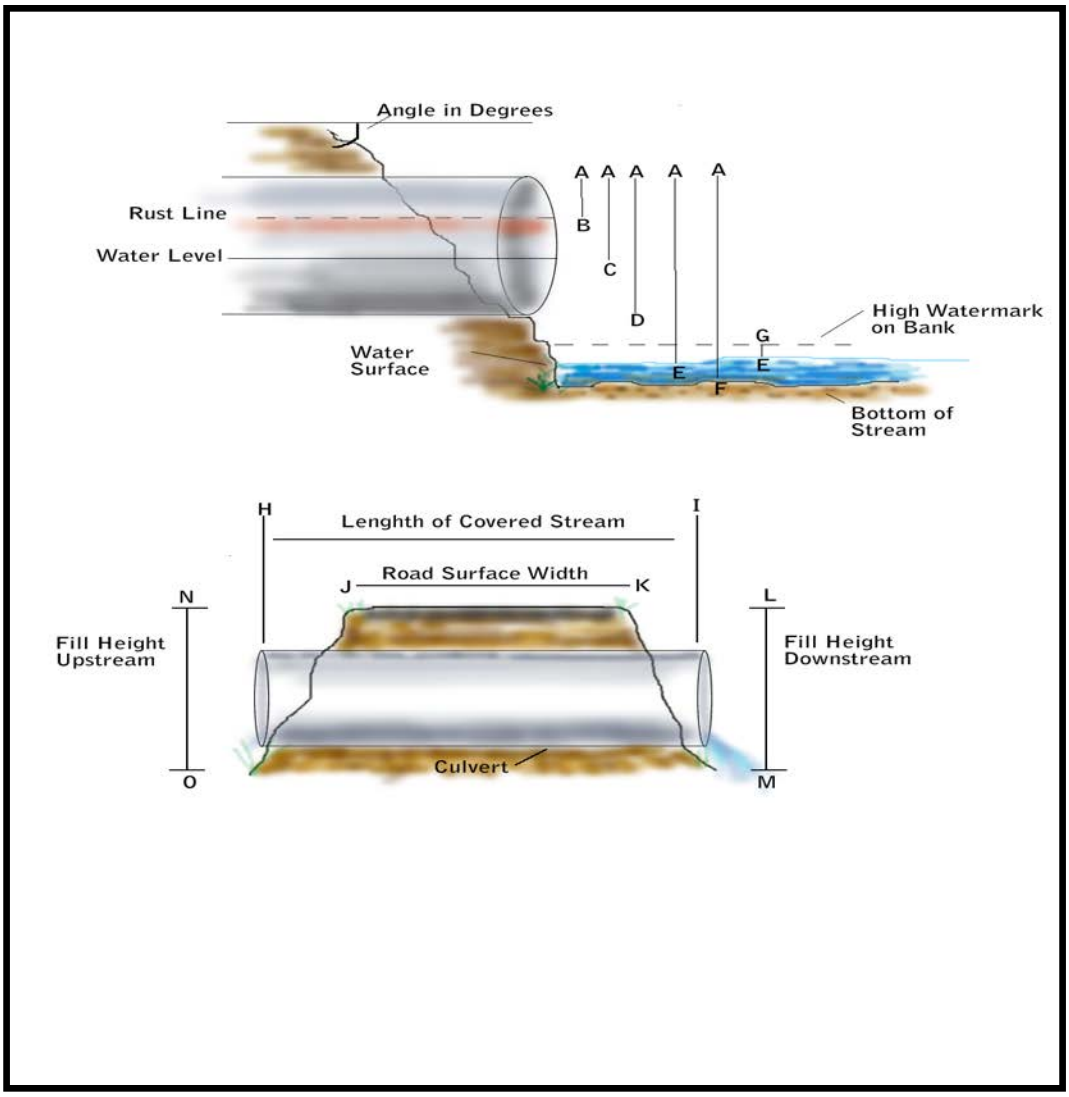
Upstream

Downstream

APPENDIX H:

CULVERT ASSESSMENTS

Appendix H: Culvert Assessments



MacKenzie River 2013 Culvert Measurements

Culvert Number/ Site Number	**J-K** Road Surface Width (m)	**H-I** Length of Covered Stream (m)	**N-O** Fill Height Upstream (m)	**L-M** Fill Height Downstream (m)		**A-D** Width of Opening (m)	**A-B** Inside Top to Rust Line (m)	**A-C** Inside Top to Water Surface (m)	**A-E** Height Above Outlet Pool (m)	**E-G** Water Surface to High Water Mark (m)	**A-F** Inside Top to Bottom of Stream (m)
Culvert1 Site 7	6.5	15.0	3.4	3.8	Upstream	2.0	0.8	1.1	N/A	0.3	2.0
					Downstream	2.0	1.0	1.2	N/A	0.2	2.0

Culvert 1

Location: On Magone Road, 8.5 km east of Highway 527, “Amethyst Creek” (Site 7)

GPS Coordinates: Northing 5386841 Easting 0353701

Description: This double culvert was located at “Amethyst creek”. They were firmly in place under the road, with boulders and dense vegetation growing around them on the roadsides. The flow rate was quite fast due to the small waterfall upstream. The culverts also had an effect on the creek, creating a narrower, smooth surface which increases velocity. The water level was filling approximately half of the culvert and the high water mark was 0.2 - 0.3 metres above the current water level. Therefore, there is no concern at the time for submerged culverts and road wash out due to high water levels. The culverts did however, have a buildup of woody debris and foam on the upstream end. This could restrict water flow through the culverts and cause flooding of the banks on one side of the road.

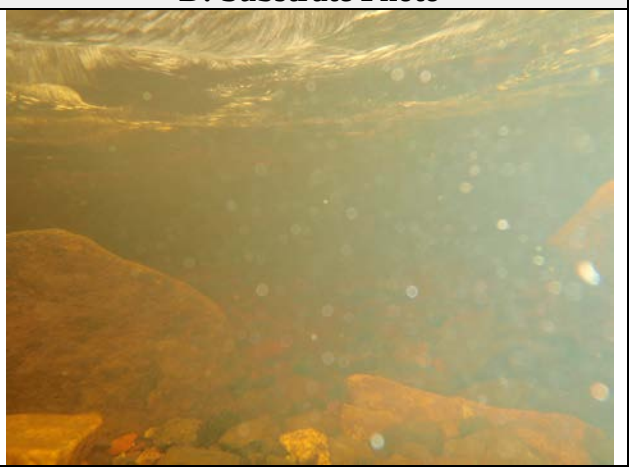
Upstream

Downstream

APPENDIX I:

SITE PHOTOGRAPHY AND SUBSTRATE

Appendix I: Site Photography and Descriptions

Site 1 – Confluence of MacKenzie River, Decommissioned CN rail bridge	
A: Upstream Photo	**B: Downstream Photo**
	
C: Vegetation	**D: Substrate Photo**
	

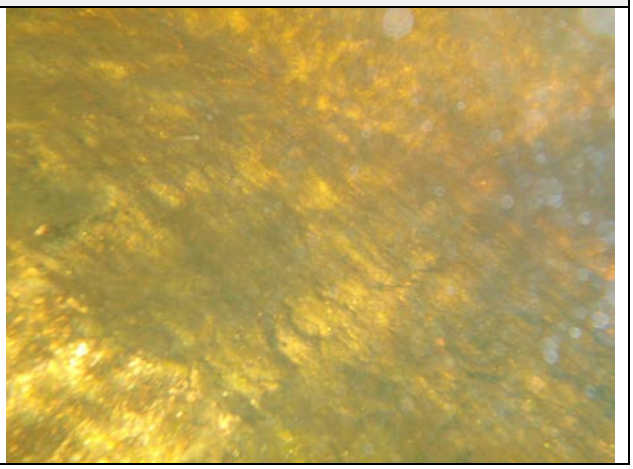
Comments:
Sample Site 1 was located off of MacKenzie Beach Avenue and was chosen to represent the confluence of the MacKenzie River with Lake Superior. Access to the sampling site was along a footpath from the end of MacKenzie Beach Avenue. There is a decommissioned CN railway bridge at the site, which was part of the Kinghorn railway. Large boulders and cobbles were dominant within the river and the water was deep with very fast moving water from the rapids farther upstream. The banks of the confluence appeared stable and were vegetated further back from the water with shrub, herb and grass growth on sandy loam soil. No erosion was apparent along the banks of the channel or the steep slopes leading up to the rail bridge. During the June sampling period many Herring Gulls were congregating around the mouth of the river at the sampling site.

Site 2 – Highway 11/17 crossing on MacKenzie River off MacKenzie Beach Road

A: Upstream Photo

B: Downstream Photo

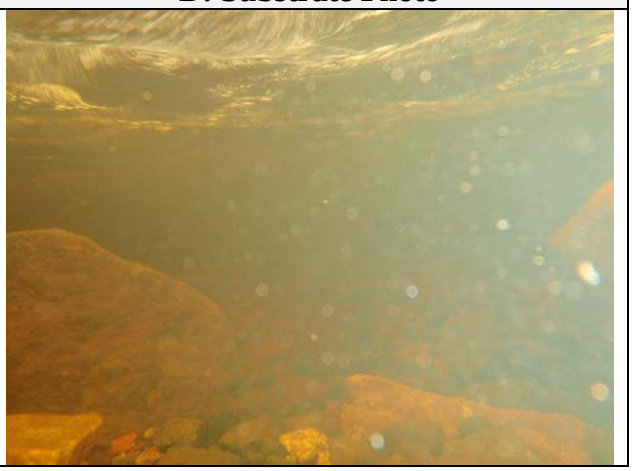
C: Substrate Photo



Comments:

Sample Site 2 was located on MacKenzie Beach Road south of the Highway 11/17 bridge crossing, and was characterized by a large cement bridge with highway traffic crossing it. The water was very fast moving with a stained tea colour. The dominant substrate observed was bedrock, away from the river, the soil type was found to be shallow-moderately deep sandy. There was no evidence of erosion of the boulder and bedrock banks and the forest soil did not appear to be eroding. There was little to no aquatic vegetation observed at this site as water was moving very fast through the cement bridge and bedrock channel. The river had varying widths, which altered the flow rate greatly from one spot to the next. The only vegetation present on the banks of the river was crusty algae, some grasses and herbs. Further back from the river bank, shrubs such as shrubby cinquefoil and high bush cranberry and herbs begin to grow, leading into the forest where mature trees such as white birch, white spruce and balsam fir could be found.

Appendix I: Site Photography and Descriptions

Site 1 – Confluence of MacKenzie River, Decommissioned CN rail bridge	
A: Upstream Photo	**B: Downstream Photo**
	
C: Vegetation	**D: Substrate Photo**
	

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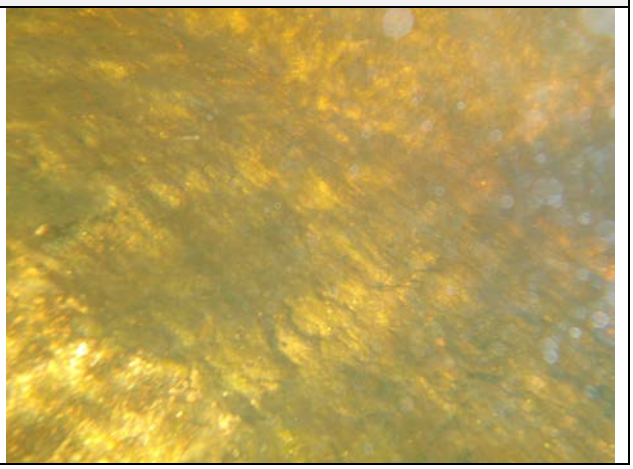
Site 2 – Highway 11/17 crossing on MacKenzie River off MacKenzie Beach Road

A: Upstream Photo

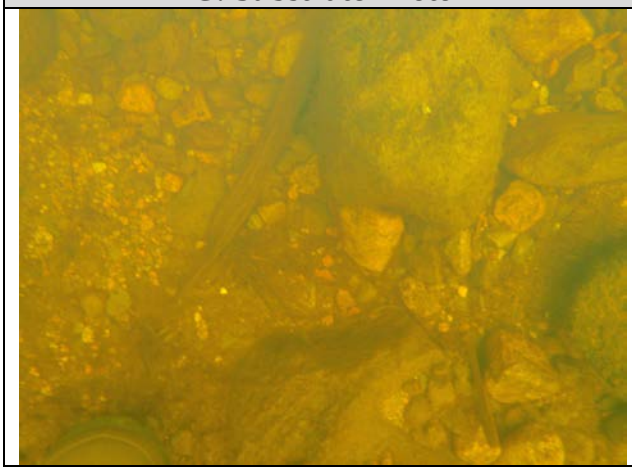
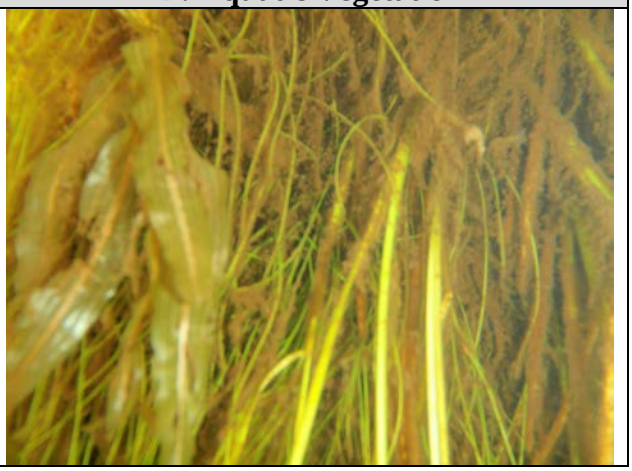
B: Downstream Photo

C: Substrate Photo



Comments:

Sample Site 2 was located on MacKenzie Beach Road south of the Highway 11/17 bridge crossing, and was characterized by a large cement bridge with highway traffic crossing it. The water was very fast moving with a stained tea colour. The dominant substrate observed was bedrock, away from the river, the soil type was found to be shallow-moderately deep sandy. There was no evidence of erosion of the boulder and bedrock banks and the forest soil did not appear to be eroding. There was little to no aquatic vegetation observed at this site as water was moving very fast through the cement bridge and bedrock channel. The river had varying widths, which altered the flow rate greatly from one spot to the next. The only vegetation present on the banks of the river was crusty algae, some grasses and herbs. Further back from the river bank, shrubs such as shrubby cinquefoil and high bush cranberry and herbs begin to grow, leading into the forest where mature trees such as white birch, white spruce and balsam fir could be found.

Site 3 – MacKenzie Creek on MacKenzie Station Road	
A: Upstream Photo	**B: Downstream Photo**
	
C: Substrate Photo	**D: Aquatic Vegetation**
	

Comments:
Site 3 was located on MacKenzie Station Road south of Walkinshaw Road and was characterized by its low-lying wetland appearance. The main channel flows southeast (seen in photo A: Upstream), while a second channel flows from a low-lying wetland area into the main channel at the bridge location. The water was quite shallow and slow moving at the sample site, with a wide channel at the convergence of the two branches, and narrow farther upstream and downstream. The site was a low-lying area with vegetation typical of a treed bog wetland. The banks were mainly composed of shrubby/grassy hummocks both up and down stream, and gravelly sand near the roadside. The streambed substrate was mostly cobble and gravel with some coarse sand. There was no evidence of erosion since the banks were mainly composed of well conglomerated roots and organic soil, and the flow rate is not fast enough to carry the heavy substrate present. The creek contained submerged and floating leaved aquatic vegetation, including tape celery and Richardson's pondweed. A garter snake was observed on the banks at this site. A railway crossing is located approximately 300 metres upstream.

Site 4 – Sparks Lake, MacKenzie Station Road (Private Property)

A: West view

B: East view

C: Substrate Photo

Comments:

Site 4 was located on private residential property on Sparks Lake, off MacKenzie Station Road. The site was characterized by densely vegetated marsh type shorelines with cattail and sedges on either side of the mowed grass lawn. Other aquatic plants found at the site included common bladderwort, flat-stemmed pondweed and three-seeded sedge. The lakeshore was predominantly black spruce and tamarack transitioning to black spruce and jack pine moving upland. The water at this site was stained and is a relatively shallow lake, with a sandy muck bottom. The velocity was not measureable due to wind effect and non-flowing lake water. There were many Red-winged blackbirds present at the sample site during the June site visit, with a nest observed for one mating pair. There was an abundance of Canada goose feathers and scat during the July site visit, indicating their presence. The site also had the most diverse benthic community observed among all the sample sites including freshwater leeches (in photo C above), freshwater clams, water striders, and water boatmen.

Site 5 – Walkinshaw Creek crossing on Walkinshaw Road	
A: Upstream Photo	**B: Downstream Photo**
	
C: Substrate Photo	**D: Emergent white birch (varying water levels)**
	

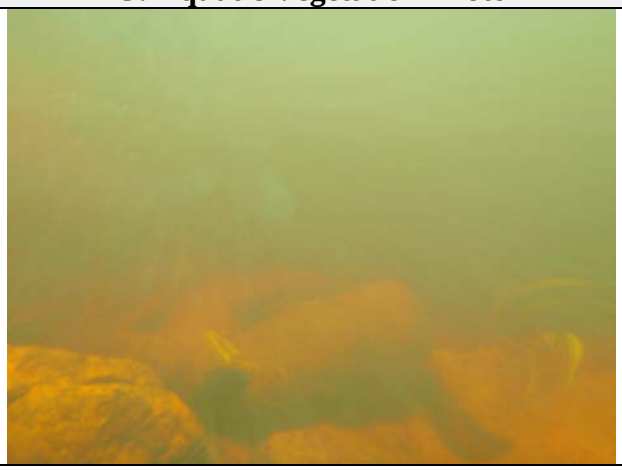
Comments:
Site 5 was located on Walkinshaw Creek at the Walkinshaw Road bridge crossing, east of MacKenzie Station Road. The creek demonstrated a perfect riffle, run, pool sequence. The water was flowing at a quick pace during both site visits. The banks were stable and showed no sign of erosion. The stream substrate was mostly boulders and cobble, with some gravel and sand filling the pore space. There was little to no aquatic vegetation observed at the site. Terrestrial vegetation could be seen emerging from the creek, including a young white birch tree, indicating high water levels. Stream cover (40 percent) was provided by the densely growing shrubs and trees on the creek banks. A cabin is located approximately 100 metres upstream.

Site 6 – Magone Lake outlet, Magone Road

A: Upstream Photo

B: Downstream Photo

C: Aquatic Vegetation Photo



Comments:

Site 6 was located at the Magone Lake outlet, east of Magone Lake on Kingfisher Road. The water crossing was located on Kingfisher Road approximately 600 meters off Magone Road, connecting to Highway 527. The water was very shallow and slow moving during the June site visit. During the July site visit, there was a significant increase in the water level from heavy rains, flooding the streambed that was bare rock during June. This caused the exact sample location to be unreachable and was moved closer to the bridge. There was no substantial erosion occurring at the site, however minor movement of sand may have occurred with the high water. The site was located in a valley between two large hills, creating a wetland area upstream of the bridge. Downstream the creek becomes narrow and picks up velocity as it travels over the rocky channel. Boulders and cobble were the dominant substrate with aquatic vegetation growing in the sand between them. The dominant vegetation observed in the lowland area was sweet gale, fragrant white lily, broad-leaved arrowhead and a variety of graminoids. A red-tailed hawk was observed here during the July visit. The stream cover (20 percent) was provided by the vegetation growing right to the water's edge.

Site 7 – Magone Road, "Amethyst Creek"	
A: Upstream Photo	**B: Downstream Photo**
	
C: Adjacent Creek	**D: Substrate Photo**
	

Comments:

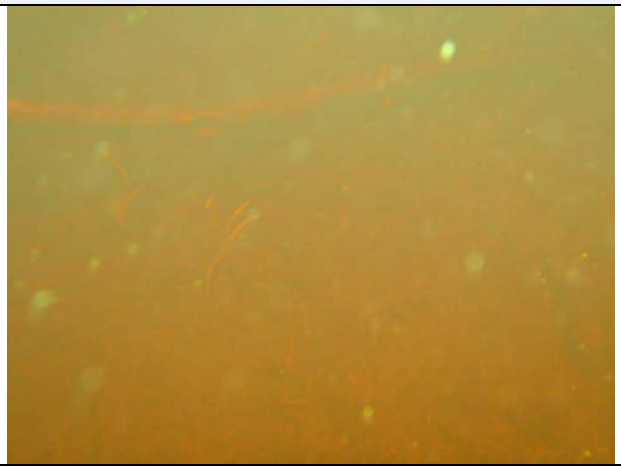
Site 7 was located on Magone Road at "Amethyst Creek", 8.5 kilometers east of Highway 527. The samples were taken upstream of the road crossing due to accessibility. Upstream on the east bank, there is a significant amethyst vein in the bedrock, giving the creek its unofficial name, "Amethyst Creek". There is evidence of harvesting of the gemstone here. A secondary stream was entering the creek from the east bank, which originates at a beaver pond approximately one kilometre away. This site had two culverts installed underneath the road. The flow rate was quite fast due to the waterfall upstream. There was no bank erosion observed, however the smaller substrate particles may experience movement during high water levels. There was some stream cover (40 percent) from thick shrubbery growing out over the stream, as well as mature trees growing on the banks of the river. Some commonly observed plants include white birch, black spruce, pin cherry, speckled alder, bunch berry and honeysuckle. There was a small island of cobble and gravel, the dominant creek substrate, which is where surface water samples were taken from. Black bear, fox, mink and ruffed grouse were seen in the area in July. A fire pit was located at the site as well, indicating hunters or fishermen.

Site 8 – Walkinshaw Lake adjacent to Highway 527

A: North view

B: East view

C: Substrate Photo



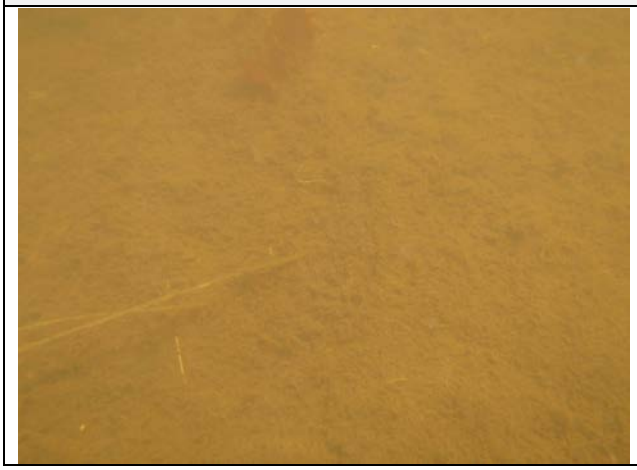
Comments:

Site 8 was located on the west shoreline of Walkinshaw Lake adjacent to Highway 527. This site was distinguished by a boggy shoreline with no defined banks as the shoreline was floating mats of vegetation including sphagnum, sweet gale, northern blue flag and leatherleaf. There were aquatic plants growing in the water which included cat tails, common reed, fragrant white water lily and horsetails. The majority of the trees were situated further back from the lake on terrestrial soil, with the exception of a few black spruce and tamarack. The substrate was mostly muck, while a terrestrial soil type could not be identified due to the lowland area submerged by water. Water at this site was almost completely stagnant due to the lake status (except for minimal wind influence on the surface) and velocity was therefore not determined. A minnow catcher was seen immediately upstream of the site during the July visit. Many green frog tadpoles were seen in the shallow water near the sample site in June, as well as an adult green frog.

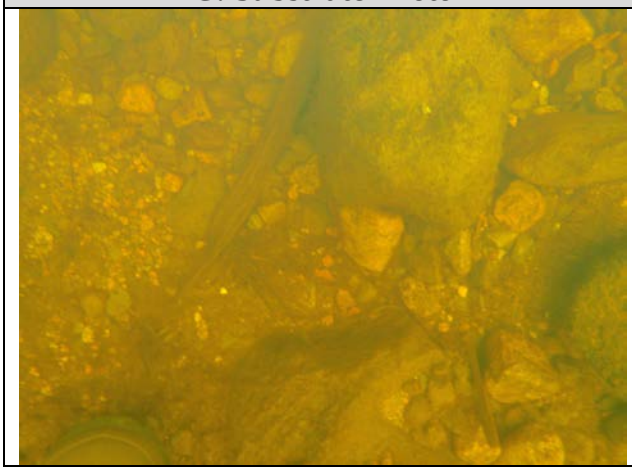
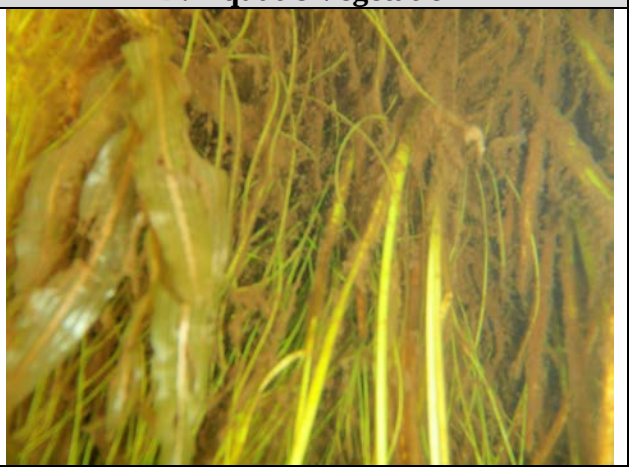
Site 9 – Unknown Creek , Escape Lake Road East off of Highway 527	
A: Upstream Photo	**B: Downstream Photo**
	
C: Substrate Photo	
	

Comments:

Site 9 was located at a water crossing on an unknown creek that flows south, joining a larger river downstream of MacKenzie Lake. Access is on Escape Lake Road 20 kilometers east of Highway 527. The banks to the river were fairly steep with rip rap installed on both sides of the water crossing to eliminate road runoff into the stream. There did not seem to be any erosion present due to the rip-rap installation and boulder and cobble substrate. Site 9 had a varying channel depth due to large boulders, with quickly flowing water. The terrestrial soil type at this site was loamy silt. There was shrub growth right to the water's edge which made it difficult for photo documentation and sampling. There was approximately 30 percent stream cover from this shrub growth. Dominant vegetation in the area included white birch, jack pine, mountain maple, red osier dogwood, balsam poplar, low sweet blueberry and interrupted fern. A flock of mallard ducklings was seen paddling downstream during the July site visit.

Site 10 – Beaver Lake, Greenwich Wind Farm, Organized Township of Dorion	
A: South view	**B: East view**
	
C: Substrate Photo	**D: White-tailed deer**
	

Comments:
Site 10 was located within the Greenwich Wind Farm property on the north shoreline of Beaver Lake. The sample site is reached via Ouimet Canyon Road and Road N within the wind farm property. The sample site was accessed through the bush approximately 40 metres from a gravel parking spot. The substrate of the lake was very mucky and released a sulfur smell when disturbed. Aquatic vegetation was abundant at the sample site with fragnant white lily, water shield, graminoids and pondweeds as well as sweet gale and leatherleaf on floating mats. The forest soil type was a fresh, fine loamy soil supporting dominant vegetation species black spruce, eastern white cedar, balsam fir, white birch, wild raspberry and blue bead lily. The water was very stagnant and was tea colour stained. There were many minnows observed during the July site visit. A moose, white-tailed deer, a groundhog, a black bear and an american kestrel were sighted on the way to the site.

Site 3 – MacKenzie Creek on MacKenzie Station Road	
A: Upstream Photo	**B: Downstream Photo**
	
C: Substrate Photo	**D: Aquatic Vegetation**
	

Comments:
Site 3 was located on MacKenzie Station Road south of Walkinshaw Road and was characterized by its low-lying wetland appearance. The main channel flows southeast (seen in photo A: Upstream), while a second channel flows from a low-lying wetland area into the main channel at the bridge location. The water was quite shallow and slow moving at the sample site, with a wide channel at the convergence of the two branches, and narrow farther upstream and downstream. The site was a low-lying area with vegetation typical of a treed bog wetland. The banks were mainly composed of shrubby/grassy hummocks both up and down stream, and gravelly sand near the roadside. The streambed substrate was mostly cobble and gravel with some coarse sand. There was no evidence of erosion since the banks were mainly composed of well conglomerated roots and organic soil, and the flow rate is not fast enough to carry the heavy substrate present. The creek contained submerged and floating leaved aquatic vegetation, including tape celery and Richardson's pondweed. A garter snake was observed on the banks at this site. A railway crossing is located approximately 300 metres upstream.

Site 4 – Sparks Lake, MacKenzie Station Road (Private Property)

A: West view

B: East view

C: Substrate Photo

Comments:

Site 4 was located on private residential property on Sparks Lake, off MacKenzie Station Road. The site was characterized by densely vegetated marsh type shorelines with cattail and sedges on either side of the mowed grass lawn. Other aquatic plants found at the site included common bladderwort, flat-stemmed pondweed and three-seeded sedge. The lakeshore was predominantly black spruce and tamarack transitioning to black spruce and jack pine moving upland. The water at this site was stained and is a relatively shallow lake, with a sandy muck bottom. The velocity was not measureable due to wind effect and non-flowing lake water. There were many Red-winged blackbirds present at the sample site during the June site visit, with a nest observed for one mating pair. There was an abundance of Canada goose feathers and scat during the July site visit, indicating their presence. The site also had the most diverse benthic community observed among all the sample sites including freshwater leeches (in photo C above), freshwater clams, water striders, and water boatmen.

Site 5 – Walkinshaw Creek crossing on Walkinshaw Road	
A: Upstream Photo	**B: Downstream Photo**
	
C: Substrate Photo	**D: Emergent white birch (varying water levels)**
	

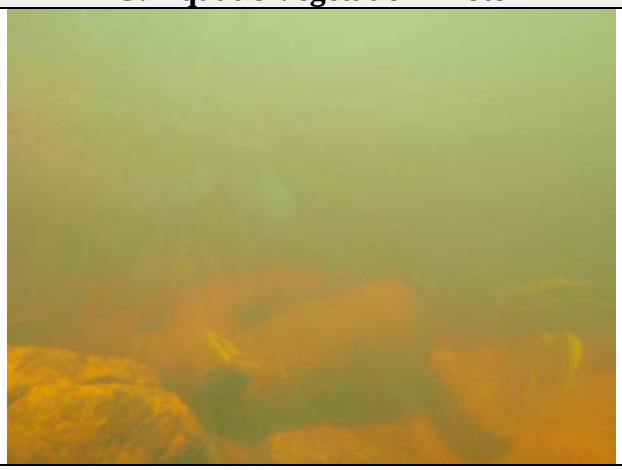
Comments:
Site 5 was located on Walkinshaw Creek at the Walkinshaw Road bridge crossing, east of MacKenzie Station Road. The creek demonstrated a perfect riffle, run, pool sequence. The water was flowing at a quick pace during both site visits. The banks were stable and showed no sign of erosion. The stream substrate was mostly boulders and cobble, with some gravel and sand filling the pore space. There was little to no aquatic vegetation observed at the site. Terrestrial vegetation could be seen emerging from the creek, including a young white birch tree, indicating high water levels. Stream cover (40 percent) was provided by the densely growing shrubs and trees on the creek banks. A cabin is located approximately 100 metres upstream.

Site 6 – Magone Lake outlet, Magone Road

A: Upstream Photo

B: Downstream Photo

C: Aquatic Vegetation Photo



Comments:

Site 6 was located at the Magone Lake outlet, east of Magone Lake on Kingfisher Road. The water crossing was located on Kingfisher Road approximately 600 meters off Magone Road, connecting to Highway 527. The water was very shallow and slow moving during the June site visit. During the July site visit, there was a significant increase in the water level from heavy rains, flooding the streambed that was bare rock during June. This caused the exact sample location to be unreachable and was moved closer to the bridge. There was no substantial erosion occurring at the site, however minor movement of sand may have occurred with the high water. The site was located in a valley between two large hills, creating a wetland area upstream of the bridge. Downstream the creek becomes narrow and picks up velocity as it travels over the rocky channel. Boulders and cobble were the dominant substrate with aquatic vegetation growing in the sand between them. The dominant vegetation observed in the lowland area was sweet gale, fragrant white lily, broad-leaved arrowhead and a variety of graminoids. A red-tailed hawk was observed here during the July visit. The stream cover (20 percent) was provided by the vegetation growing right to the water's edge.

Site 7 – Magone Road, "Amethyst Creek"	
A: Upstream Photo	**B: Downstream Photo**
	
C: Adjacent Creek	**D: Substrate Photo**
	

Comments:

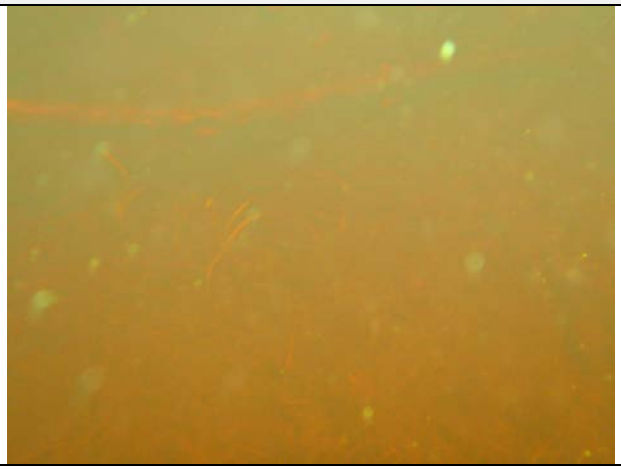
Site 7 was located on Magone Road at "Amethyst Creek", 8.5 kilometers east of Highway 527. The samples were taken upstream of the road crossing due to accessibility. Upstream on the east bank, there is a significant amethyst vein in the bedrock, giving the creek its unofficial name, "Amethyst Creek". There is evidence of harvesting of the gemstone here. A secondary stream was entering the creek from the east bank, which originates at a beaver pond approximately one kilometre away. This site had two culverts installed underneath the road. The flow rate was quite fast due to the waterfall upstream. There was no bank erosion observed, however the smaller substrate particles may experience movement during high water levels. There was some stream cover (40 percent) from thick shrubbery growing out over the stream, as well as mature trees growing on the banks of the river. Some commonly observed plants include white birch, black spruce, pin cherry, speckled alder, bunch berry and honeysuckle. There was a small island of cobble and gravel, the dominant creek substrate, which is where surface water samples were taken from. Black bear, fox, mink and ruffed grouse were seen in the area in July. A fire pit was located at the site as well, indicating hunters or fishermen.

Site 8 – Walkinshaw Lake adjacent to Highway 527

A: North view

B: East view

C: Substrate Photo



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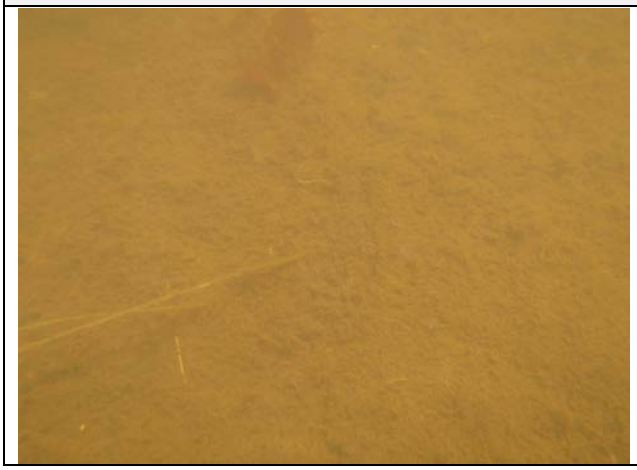
Site 9 – Unknown Creek , Escape Lake Road East off of Highway 527	
A: Upstream Photo	**B: Downstream Photo**
	
C: Substrate Photo	
	

Comments:

Site 9 was located at a water crossing on an unknown creek that flows south, joining a larger river downstream of MacKenzie Lake. Access is on Escape Lake Road 20 kilometers east of Highway 527. The banks to the river were fairly steep with rip rap installed on both sides of the water crossing to eliminate road runoff into the stream. There did not seem to be any erosion present due to the rip-rap installation and boulder and cobble substrate. Site 9 had a varying channel depth due to large boulders, with quickly flowing water. The terrestrial soil type at this site was loamy silt. There was shrub growth right to the water's edge which made it difficult for photo documentation and sampling. There was approximately 30 percent stream cover from this shrub growth. Dominant vegetation in the area included white birch, jack pine, mountain maple, red osier dogwood, balsam poplar, low sweet blueberry and interrupted fern. A flock of mallard ducklings was seen paddling downstream during the July site visit.

Site 10 – Beaver Lake, Greenwich Wind Farm, Organized Township of Dorion	
A: South view	**B: East view**
	
C: Substrate Photo	**D: White-tailed deer**
	

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APPENDIX J:

LABORATORY WATER QUALITY RESULTS SUMMARY TABLES

MacKenzie River Watershed Assessement 2013

Laboratory Water Quality Results Summary Tables

Laboratory Water Quality Results for June 18-20, 2013

Parameter	Units	PWQO Criterion	MR1 MacKenzie River - SITE#1 18-Jun-13	MR2 MacKenzie River - SITE#2 18-Jun-13	MR3 MacKenzie River - SITE#3 18-Jun-13	MR4 MacKenzie River - SITE#4 18-Jun-13	MR5 MacKenzie River - SITE#5 18-Jun-13	MR6 MacKenzie River - SITE#6 19-Jun-13	MR7 MacKenzie River - SITE#7 19-Jun-13	MR8 MacKenzie River - SITE#8 19-Jun-13	MR9 MacKenzie River - SITE#9 19-Jun-13	MR10 MacKenzie River - SITE#10 20-Jun-13	Average June
Physical Tests													
Conductivity (EC)	(uS/cm)	N/A	59.5	58.1	107	51.3	51.6	61.1	46.3	127	43.8	27.8	63.35
Hardness ($CaCO_3$)	(mg/L)	N/A	28.2	27.9	51.7	24.0	25.0	22.4	22.6	27.1	21.4	11.5	26.18
pH		6.5-8.5	7.54	7.56	7.49	7.25	7.44	7.24	7.24	7.00	7.03	6.91	7.27
Total Dissolved Solids	(mg/L)	N/A	51	53	76	49	52	42	46	91	47	41	54.8
Turbidity	(NTU)	<10% of natural	0.63	0.79	1.16	0.94	0.74	1.08	0.61	1.40	0.61	2.75	1.071
Anions and Nutrients													
Alkalinity, Total (as CaCO3)	(mg/L)	25% of natural	24.6	23.9	42.9	20.8	20.7	19.1	19.4	17.5	18.5	9.8	21.72
Ammonia-N, Total	(mg/L)	N/A	0.027	0.032	0.060	<0.020	<0.020	0.146	<0.020	<0.020	<0.020	<0.020	0.0385
Chloride (Cl)	(mg/L)	N/A	0.83	0.63	1.44	0.28	0.59	3.70	0.30	24.40	0.23	0.74	3.314
Nitrate-N (NO3-N)	(mg/L)	N/A	0.050	0.052	0.199	<0.030	0.065	<0.030	0.055	<0.030	0.045	<0.030	0.0586
Nitrite-N (NO2-N)	(mg/L)	N/A	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Kjeldahl Nitrogen	(mg/L)	N/A	0.490	0.492	0.460	0.484	0.528	0.861	0.574	0.754	0.670	0.741	0.6054
Phosphorus (P)-Total	(mg/L)	0.03	<0.0050	0.0057	<0.0050	0.0076	0.0100	**0.0303**	0.0056	0.0160	0.0077	0.0165	0.01094
Sulphate (SO4)	(mg/L)	N/A	3.04	3.04	5.99	3.57	2.91	2.60	2.65	2.39	1.73	2.18	3.01
Bacteriological Tests													
Escherichia Coli	(MPN/100mL)	100	7	7	6	5	1	24	<1	<1	4	<1	5.7
Total Coliforms	(MPN/100mL)	1000 (prior to 1994)	550	370	770	110	550	**>2420**	370	**>2420**	**1200**	460	922
Total Metals													
Aluminum (Al)-Total	(mg/L)	0.075	0.0587	0.0617	0.0385	**0.1050**	**0.0906**	**0.0997**	**0.1020**	**0.1170**	**0.1160**	**0.1730**	**0.09622**
Antimony (Sb)-Total	(mg/L)	0.02	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
Arsenic (As)-Total	(mg/L)	0.005 (interim)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Barium (Ba)-Total	(mg/L)	N/A	0.022	0.022	0.025	0.016	0.023	0.016	0.029	0.020	0.018	0.013	0.0204
Beryllium (Be)-Total	(mg/L)	0.011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bismuth (Bi)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)-Total	(mg/L)	0.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium (Cd)-Total	(mg/L)	0.0001	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
Calcium (Ca)-Total	(mg/L)	N/A	7.36	7.25	13.8	6.23	6.54	5.79	5.84	6.94	5.42	2.86	6.803
Chromium (Cr)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt (Co)-Total	(mg/L)	0.0009	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	(mg/L)	0.001 (<20 mg/L $CaCO_3$) 0.005 (>20 mg/L $CaCO_3$)	0.0014	0.0014	0.0013	0.0018	0.0015	0.0012	0.0013	0.0015	0.0015	**0.0011**	0.0014
Iron (Fe)-Total	(mg/L)	0.3	0.235	0.245	**0.365**	0.232	0.272	**0.356**	0.285	**0.341**	0.230	0.140	0.2701
Lead (Pb)-Total	(mg/L)	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	(mg/L)	N/A	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Magnesium (Mg)-Total	(mg/L)	N/A	2.37	2.37	4.21	2.06	2.11	1.92	1.94	2.37	1.92	1.07	2.234

Bold indicates exceedance of PWQO criteria

Laboratory Water Quality Results for June 18-20, 2013

Parameter	Units	PWQO Criterion	MR1 MacKenzie River - SITE#1 18-Jun-13	MR2 MacKenzie River - SITE#2 18-Jun-13	MR3 MacKenzie River - SITE#3 18-Jun-13	MR4 MacKenzie River - SITE#4 18-Jun-13	MR5 MacKenzie River - SITE#5 18-Jun-13	MR6 MacKenzie River - SITE#6 19-Jun-13	MR7 MacKenzie River - SITE#7 19-Jun-13	MR8 MacKenzie River - SITE#8 19-Jun-13	MR9 MacKenzie River - SITE#9 19-Jun-13	MR10 MacKenzie River - SITE#10 20-Jun-13	Average June
Total Metals Continued													
Manganese (Mn)-Total	(mg/L)	N/A	0.0109	0.0123	0.0252	0.0301	0.0090	0.0707	0.0100	0.0196	0.0087	0.0150	0.02115
Molybdenum (Mo)-Total	(mg/L)	0.004	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nickel (Ni)-Total	(mg/L)	0.025	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Potassium (K)-Total	(mg/L)	N/A	<0.50	<0.50	0.65	0.55	<0.50	0.64	<0.50	0.71	<0.50	<0.50	0.555
Selenium (Se)-Total	(mg/L)	0.1	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Silver (Ag)-Total	(mg/L)	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Sodium (Na)-Total	(mg/L)	N/A	1.34	1.23	1.95	0.99	1.23	2.97	0.97	13.4	0.87	0.62	2.26
Strontium (Sr)-Total	(mg/L)	N/A	0.0223	0.0227	0.0272	0.0153	0.0307	0.0164	0.0345	0.0175	0.0248	0.0106	0.02067
Tellurium (Te)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Thallium (Tl)-Total	(mg/L)	0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Tin (Sn)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	(mg/L)	N/A	<0.0020	<0.0020	<0.0020	0.0063	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0024	0.0043
Tungsten (W)-Total	(mg/L)	0.03	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)-Total	(mg/L)	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Vanadium (V)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Zinc (Zn)-Total	(mg/L)	0.02 (interim)	<0.0030	<0.0030	0.0037	<0.0030	<0.0030	0.0049	<0.0030	0.0034	0.0042	<0.0030	0.00342
Zirconium (Zr)-Total	(mg/L)	0.004	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

Bold indicates exceedance of PWQO criteria

MacKenzie River Watershed Assessment 2013
Laboratory Water Quality Results Summary Tables

Laboratory Water Quality Results for July 9-11, 2013

Parameter	Units	PWQO Criterion	**MR1 MacKenzie River - SITE#1** 09-Jul-13	**MR2 MacKenzie River - SITE#2** 09-Jul-13	**MR3 MacKenzie River - SITE#3** 09-Jul-13	**MR4 MacKenzie River - SITE#4** 09-Jul-13	**MR5 MacKenzie River - SITE#5** 09-Jul-13	**MR6 MacKenzie River - SITE#6** 10-Jul-13	**MR7 MacKenzie River - SITE#7** 10-Jul-13	**MR8 MacKenzie River - SITE#8** 10-Jul-13	**MR9 MacKenzie River - SITE#9** 10-Jul-13	**MR10 MacKenzie River - SITE#10** 11-Jul-13	**Average** July
Physical Tests													
Conductivity (EC)	(uS/cm)	N/A	52.3	49.7	76.4	57.6	42.6	46.4	40.1	89.7	51	31.1	53.7
Hardness ($CaCO_3$)	(mg/L)	N/A	25.1	24.7	36.7	27.9	19.3	15.5	21.4	21.6	26.3	12.6	23.1
pH		6.5-8.5	7.34	7.39	7.26	7.21	7.24	6.76	7.24	6.83	7.38	7.08	7.17
Total Dissolved Solids	(mg/L)	N/A	55	56	66	52	45	40	36	71	41	20	48
Turbidity	(NTU)	<10% of natural	1.1	1.07	1.4	1.21	0.96	1.06	0.92	1.17	0.82	1.82	1.15
Anions and Nutrients													
Alkalinity, Total (as CaCO3)	(mg/L)	25% of natural	19.3	20	31.4	24	15	10.7	16.4	16.6	21.8	10.5	18.6
Ammonia-N, Total	(mg/L)	N/A	<0.020	<0.020	0.056	0.029	<0.020	<0.020	<0.020	<0.020	<0.020	0.06	0.03
Chloride (Cl)	(mg/L)	N/A	0.86	0.78	0.89	0.24	1.27	4.42	0.12	13.6	0.18	0.72	2.31
Nitrate-N (NO3-N)	(mg/L)	N/A	0.05	0.047	0.063	<0.030	0.04	<0.030	0.046	<0.030	0.076	<0.030	0.04
Nitrite-N (NO2-N)	(mg/L)	N/A	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Kjeldahl Nitrogen	(mg/L)	N/A	0.764	0.734	0.687	0.632	0.795	0.771	0.8	0.892	0.895	0.724	0.769
Phosphorus (P)-Total	(mg/L)	0.03	0.0095	0.0095	0.0078	0.0098	0.0116	0.0114	0.0096	0.0116	0.0131	0.0133	0.0107
Sulphate (SO4)	(mg/L)	N/A	2.08	2.09	3.26	3.02	1.86	1.9	1.66	2.14	1.06	2.13	2.12
Bacteriological Tests													
Escherichia Coli	(MPN/100mL)	100	30	31	30	19	15	15	11	15	10	1	18
Total Coliforms	(MPN/100mL)	1000 (prior to 1994)	**2000**	**> 2420**	**> 2420**	**> 2420**	**> 2420**	**2400**	**> 2420**	**> 2420**	**> 2420**	920	**2226**
Total Metals													
Aluminum (Al)-Total	(mg/L)	0.075	**0.154**	**0.150**	**0.083**	**0.135**	**0.196**	**0.185**	**0.194**	**0.239**	**0.145**	**0.106**	**0.159**
Antimony (Sb)-Total	(mg/L)	0.02	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
Arsenic (As)-Total	(mg/L)	0.005 (interim)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Barium (Ba)-Total	(mg/L)	N/A	0.028	0.027	0.025	0.022	0.026	0.013	0.031	0.019	0.022	0.014	0.023
Beryllium (Be)-Total	(mg/L)	0.011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bismuth (Bi)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)-Total	(mg/L)	0.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium (Cd)-Total	(mg/L)	0.0001	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	0.000017	0.00002	<0.000017	0.0000173
Calcium (Ca)-Total	(mg/L)	N/A	06.5	06.4	09.8	07.2	05.1	4.00	05.6	05.8	06.6	3.00	6.001
Chromium (Cr)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.001	<0.0010	<0.0010	0.001
Cobalt (Co)-Total	(mg/L)	0.0009	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	(mg/L)	0.001 (<20 mg/L $CaCO_3$) 0.005 (>20 mg/L CaCO3)	0.0019	0.0018	0.0017	0.0017	**0.0017**	**0.0013**	0.0016	0.0023	0.0015	<0.0010	0.002
Iron (Fe)-Total	(mg/L)	0.3	**0.38**	**0.38**	**0.48**	**0.50**	**0.427**	**0.360**	**0.51**	**0.683**	**0.58**	0.148	**0.445**
Lead (Pb)-Total	(mg/L)	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	(mg/L)	N/A	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Magnesium (Mg)-Total	(mg/L)	N/A	2.13	2.09	3.00	2.38	1.62	1.33	1.82	1.73	2.37	1.24	1.971

Bold indicates exceedance of PWQO criteria

MacKenzie River Watershed Assessment 2013
Laboratory Water Quality Results Summary Tables

Laboratory Water Quality Results for July 9-11, 2013

Parameter	Units	PWQO Criterion	MR1 MacKenzie River - SITE#1 09-Jul-13	MR2 MacKenzie River - SITE#2 09-Jul-13	MR3 MacKenzie River - SITE#3 09-Jul-13	MR4 MacKenzie River - SITE#4 09-Jul-13	MR5 MacKenzie River - SITE#5 09-Jul-13	MR6 MacKenzie River - SITE#6 10-Jul-13	MR7 MacKenzie River - SITE#7 10-Jul-13	MR8 MacKenzie River - SITE#8 10-Jul-13	MR9 MacKenzie River - SITE#9 10-Jul-13	MR10 MacKenzie River - SITE#10 11-Jul-13	Average July
Total Metals Continued													
Manganese (Mn)-Total	(mg/L)	N/A	0.0210	0.0204	0.0248	0.0614	0.0148	0.0357	0.017	0.0632	0.0210	0.026	0.030
Molybdenum (Mo)-Total	(mg/L)	0.004	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nickel (Ni)-Total	(mg/L)	0.025	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0022	<0.0020	<0.0020	0.00202
Potassium (K)-Total	(mg/L)	N/A	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.57	<0.50	<0.50	0.507
Selenium (Se)-Total	(mg/L)	0.1	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Silver (Ag)-Total	(mg/L)	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Sodium (Na)-Total	(mg/L)	N/A	1.34	1.22	1.35	0.96	1.38	3.10	0.82	9.67	0.86	0.67	2.137
Strontium (Sr)-Total	(mg/L)	N/A	0.0241	0.0230	0.0221	0.0189	0.0250	0.0124	0.0313	0.0156	0.0304	0.0110	0.021
Tellurium (Te)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Thallium (Tl)-Total	(mg/L)	0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Tin (Sn)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	(mg/L)	N/A	0.0020	<0.0020	<0.0020	0.0074	0.0022	<0.0020	<0.0020	0.0029	<0.0020	<0.0020	0.003
Tungsten (W)-Total	(mg/L)	0.03	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)-Total	(mg/L)	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Vanadium (V)-Total	(mg/L)	N/A	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	<0.0010	0.001
Zinc (Zn)-Total	(mg/L)	0.02 (interim)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0051	<0.0030	<0.0030	0.004
Zirconium (Zr)-Total	(mg/L)	0.004	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

Bold indicates exceedance of PWQO criteria

APPENDIX K:

LABORATORY CERTIFICATES OF ANALYSIS AND TEST RESULTS

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: Scott Drebit
130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Date Received: 20-JUN-13
Report Date: 28-JUN-13 15:00 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L1319810

Project P.O. #: NOT SUBMITTED
Job Reference: MACKENZIE
C of C Numbers:
Legal Site Desc:

Laura Dowswell
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1319810-1 WATER 18-JUN-13 10:00 MR1 MACKENZIE - SITE #1	L1319810-2 WATER 18-JUN-13 11:15 MR2 MACKENZIE - SITE #2	L1319810-3 WATER 18-JUN-13 12:30 MR3 MACKENZIE - SITE #3	L1319810-4 WATER 18-JUN-13 13:20 MR4 MACKENZIE - SITE #4	L1319810-5 WATER 18-JUN-13 14:00 MR5 MACKENZIE - SITE #5
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	59.5	58.1	107	51.3	51.6
	Hardness (as CaCO3) (mg/L)	28.2	27.9	51.7	24.0	25.0
	pH (pH)	7.54	7.56	7.49	7.25	7.44
	Total Dissolved Solids (mg/L)	51	53	76	49	52
	Turbidity (NTU)	0.63	0.79	1.16	0.94	0.74
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L CaCO3)	24.6	23.9	42.9	20.8	20.7
	Ammonia, Total (as N) (mg/L)	0.027	0.032	0.060	<0.020	<0.020
	Chloride (Cl) (mg/L)	0.83	0.63	1.44	0.28	0.59
	Nitrate (as N) (mg/L)	0.050	0.052	0.199	<0.030	0.065
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020
	Total Kjeldahl Nitrogen (mg/L)	0.490	0.492	0.460	0.484	0.528
	Phosphorus (P)-Total (mg/L)	<0.0050	0.0057 RRV	<0.0050	0.0076 RRV	0.0100
						0.0056
	Sulfate (SO4) (mg/L)	3.04	3.04	5.99	3.57	2.91
Bacteriological Tests	Escherichia Coli (MPN/100mL)	7	7	6	5	1
	Total Coliforms (MPN/100mL)	550	370	770	110	550
Total Metals	Aluminum (Al)-Total (mg/L)	0.0587	0.0617	0.0385	0.105	0.0906
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
	Arsenic (As)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Barium (Ba)-Total (mg/L)	0.022	0.022	0.025	0.016	0.023
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Cadmium (Cd)-Total (mg/L)	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
	Calcium (Ca)-Total (mg/L)	7.36	7.25	13.8	6.23	6.54
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Copper (Cu)-Total (mg/L)	0.0014	0.0014	0.0013	0.0018	0.0015
	Iron (Fe)-Total (mg/L)	0.235	0.245	0.365	0.232	0.272
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Magnesium (Mg)-Total (mg/L)	2.37	2.37	4.21	2.06	2.11
	Manganese (Mn)-Total (mg/L)	0.0109	0.0123	0.0252	0.0301	0.0090
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Nickel (Ni)-Total (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Potassium (K)-Total (mg/L)	<0.50	<0.50	0.65	0.55	<0.50

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1319810-6 WATER 19-JUN-13 10:00 MR6 MACKENZIE - SITE #6	L1319810-7 WATER 19-JUN-13 11:15 MR7 MACKENZIE - SITE #7	L1319810-8 WATER 19-JUN-13 12:45 MR8 MACKENZIE - SITE #8	L1319810-9 WATER 19-JUN-13 13:56 MR9 MACKENZIE - SITE #9	
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	61.1	46.3	127	43.8	
	Hardness (as CaCO3) (mg/L)	22.4	22.6	27.1	21.4	
	pH (pH)	7.24	7.24	7.00	7.03	
	Total Dissolved Solids (mg/L)	42	46	91	47	
	Turbidity (NTU)	1.08	0.61	1.40	0.61	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L CaCO3)	19.1	19.4	17.5	18.5	
	Ammonia, Total (as N) (mg/L)	0.146	<0.020	<0.020	<0.020	
	Chloride (Cl) (mg/L)	3.70	0.30	24.4	0.23	
	Nitrate (as N) (mg/L)	<0.030	0.055	<0.030	0.045	
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Total Kjeldahl Nitrogen (mg/L)	0.861	0.574	0.754	0.670	
	Phosphorus (P)-Total (mg/L)	0.0303	0.0056	0.0160 RRV	0.0077 RRV	
	Sulfate (SO4) (mg/L)	2.60	2.65	2.39	1.73	
Bacteriological Tests	Escherichia Coli (MPN/100mL)	24	<1	<1	4	
	Total Coliforms (MPN/100mL)	> 2420	370	> 2420	1200	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0997	0.102	0.117	0.116	
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	
	Arsenic (As)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Barium (Ba)-Total (mg/L)	0.016	0.029	0.020	0.018	
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Cadmium (Cd)-Total (mg/L)	<0.000017	<0.000017	<0.000017	<0.000017	
	Calcium (Ca)-Total (mg/L)	5.79	5.84	6.94	5.42	
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Cobalt (Co)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Copper (Cu)-Total (mg/L)	0.0012	0.0013	0.0015	0.0015	
	Iron (Fe)-Total (mg/L)	0.356	0.285	0.341	0.230	
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Magnesium (Mg)-Total (mg/L)	1.92	1.94	2.37	1.92	
	Manganese (Mn)-Total (mg/L)	0.0707	0.0100	0.0196	0.0087	
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Nickel (Ni)-Total (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	
	Potassium (K)-Total (mg/L)	0.64	<0.50	0.71	<0.50	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1319810-1	L1319810-2	L1319810-3	L1319810-4	L1319810-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-JUN-13	18-JUN-13	18-JUN-13	18-JUN-13	18-JUN-13
	Sampled Time	10:00	11:15	12:30	13:20	14:00
	Client ID	MR1 MACKENZIE - SITE #1	MR2 MACKENZIE - SITE #2	MR3 MACKENZIE - SITE #3	MR4 MACKENZIE - SITE #4	MR5 MACKENZIE - SITE #5
Grouping	**Analyte**					
WATER						
Total Metals	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Sodium (Na)-Total (mg/L)	1.34	1.23	1.95	0.99	1.23
	Strontium (Sr)-Total (mg/L)	0.0223	0.0227	0.0272	0.0153	0.0307
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Titanium (Ti)-Total (mg/L)	<0.0020	<0.0020	<0.0020	0.0063	<0.0020
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Vanadium (V)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.0037	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1319810-6	L1319810-7	L1319810-8	L1319810-9	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	19-JUN-13	19-JUN-13	19-JUN-13	19-JUN-13	
	Sampled Time	10:00	11:15	12:45	13:56	
	Client ID	MR6 MACKENZIE - SITE #6	MR7 MACKENZIE - SITE #7	MR8 MACKENZIE - SITE #8	MR9 MACKENZIE - SITE #9	
Grouping	**Analyte**					
WATER						
Total Metals	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Sodium (Na)-Total (mg/L)	2.97	0.97	13.4	0.87	
	Strontium (Sr)-Total (mg/L)	0.0164	0.0345	0.0175	0.0248	
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Titanium (Ti)-Total (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Vanadium (V)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Zinc (Zn)-Total (mg/L)	0.0049	<0.0030	0.0034	0.0042	
	Zirconium (Zr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Phosphorus (P)-Total	B	L1319810-1, -2, -3, -4, -5, -6, -8, -9
Method Blank	Aluminum (Al)-Total	B	L1319810-7, -8, -9
Method Blank	Zirconium (Zr)-Total	B	L1319810-7, -8, -9
Duplicate	Aluminum (Al)-Total	DLA	L1319810-1, -2, -3, -4, -5, -6
Duplicate	Lithium (Li)-Total	DLA	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Chloride (Cl)	MS-B	L1319810-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Nickel (Ni)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Barium (Ba)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Iron (Fe)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Nickel (Ni)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Potassium (K)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L1319810-1, -2, -3, -4, -5, -6
Matrix Spike	Ammonia, Total (as N)	MS-B	L1319810-1, -2, -3, -4, -6, -7, -8, -9
Matrix Spike	Ammonia, Total (as N)	MS-B	L1319810-1, -2, -3, -4, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1319810-7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1319810-7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1319810-7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1319810-7, -8, -9
Matrix Spike	Ammonia, Total (as N)	MS-B	L1319810-5
Matrix Spike	Ammonia, Total (as N)	MS-B	L1319810-5
Matrix Spike	Ammonia, Total (as N)	MS-B	L1319810-5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.
DLA	Detection Limit Adjusted For required dilution
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TOT-CAP-TB	Water	Alkalinity, Total (as CaCO3)	APHA 2320 B-Auto-Pot. Titration
CL-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
EC-CAP-TB	Water	Conductivity (EC)	APHA 2510 B-ELECTRODE
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
HARDNESS-CALC-TB	Water	Hardness (as CaCO3)	CALCULATION

Reference Information

MET-T-MS-TB	Water	Total Metals by ICPMS	APHA 3030E/EPA 6020A

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

N-TOTKJ-TB	Water	Total Kjeldahl Nitrogen by Colourimetry	APHA 4500-Norg B (modified)

Total Kjeldahl Nitrogen in aqueous matrices is analyzed using an autoanalyzer with colourimetric detection.

NH3-COL-TB	Water	Ammonia by Discrete Analyzer	APHA 4500-NH3 G. (modified)

Ammonia in aqueous matrices is analyzed using discrete analyzer with colourimetric detection.

NO2-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

NO3-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

P-T-COL-TB	Water	Total Phosphorus by Discrete Analyzer	APHA 4500-P B, F, G (modified)

Phosphorus in aqueous matrices is analyzed using discrete Analyzer with colourimetric detection.

PH-CAP-TB	Water	pH	APHA 4500-H-ELECTRODE
SO4-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

SOLIDS-TDS-TB	Water	Total Dissolved Solids	APHA 2540 C (modified)

Aqueous matrices are analyzed using gravimetry and evaporation

TC,EC-QT97-TB	Water	Total Coliform and E.coli	APHA 9223 B C24
TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

Aqueous matrices are analyzed using nephelometry with the light scatter measured at a 90” angle.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

ADDRESS 1081 Barton Street, Thunder B... ALS CANADA LIMITE... 5 Grou... 23 7598

L1319810-COFC

L1319810

Page 1 of 1

Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. P7B 6T8		
Phone:	807-344-5857	Fax:	807-345-9156
Email:	scott@lakeheadca.com;tammy@lakeheadca.com,info@lakeheadca.com		
Project:	Mackenzie	PO:	
Quote #	Q40232		
Invoice To:	Tammy Cook	Same as Report:	☑ Yes ☐ No
Company:	Lakehead Region Conservation Auth		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. BOX 10427		
Email:	scott@lakeheadca.com		
Account Manager		Sampler:	V. Lane, Al Stewart

Reg 153 (O. Reg 511 Amend) Table:____
Record of Site Condition ☐ Yes ☐ No
PWQO ☒ MISA ☐ MMER ☐ CCME ☐
Guideline Required:
TCLP Regulation 558 ☐ Other:

Service Requested
☒ Regular TAT (7 Days)
☐ Priority TAT 50% Surcharge (3-5 Days)
☐ Emergency TAT 100% Surcharge (1-2 Days)
Specify Date Required:

All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.

Questions below must answered for water samples
Are any samples taken from a regulated DW System? ☐ Yes ☒ No
If yes, an authorized DW COC must be used.
Is the water sampled intended for human consumption? ☐ Yes ☒ No

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, CL, Conductivity, Hardness, TKN	NH3, NO2, NO3, Total Phosphours	pH, SO4, Solids, TC-,EC, Turbidity	Routine	Metals								Number of Containers
MR1	Mackenzie - Site #1	06/18/13	10:00	Grab	x	x	x	X	X								4
MR2	Mackenzie - Site #2	06/18/13	11:15	Grab	x	x	x	X	X								4
MR3	Mackenzie - Site #3	06/18/13	12:30	Grab	x	x	x	X	X								4
MR4	Mackenzie - Site #4	06/18/13	13:20	Grab	x	x	x	X	X								4
MR5	Mackenzie - Site #5	06/18/13	14:00	Grab	x	x	x	X	X								4
MR6	Mackenzie - Site #6	06/19/13	10:00	Grab	x	x	x	X	X								4
MR7	Mackenzie - Site #7	06/19/13	11:15	Grab	x	x	x	X	X								4
MR8	Mackenzie - Site #8	06/19/13	12:45	Grab	x	x	x	X	X								4
MR9	Mackenzie - Site #9	06/19/13	13:56	Grab	x	x	x	X	X								4
					x	x	x	X	X								4
					x	x	x	X	X								4

Special Instructions / Comments

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations: Yes / No? If Yes add SIF
Lane	06/20/13	MB	20/06/13 9:35	9.7	☐ Yes ☐ No	AS	20/06/13 @ 0935	No

**Failure to complete all portions of this form may delay analysis. *TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known or suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use of the form the user acknowledges and agrees with the Terms and Conditions as specified on the back page.

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: Tammy Cook
130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Date Received: 20-JUN-13
Report Date: 28-JUN-13 15:01 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L1320066

Project P.O. #: NOT SUBMITTED
Job Reference: MACKENZIE
C of C Numbers:
Legal Site Desc:

Laura Dowswell
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1320066-1				
	Description	GRAB				
	Sampled Date	20-JUN-13				
	Sampled Time	11:45				
	Client ID	MR 10 MACKENZIE RIVER - SITE #10				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	27.8				
	Hardness (as CaCO3) (mg/L)	11.5				
	pH (pH)	6.91				
	Total Dissolved Solids (mg/L)	41				
	Turbidity (NTU)	2.75				
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L CaCO3)	9.8				
	Ammonia, Total (as N) (mg/L)	<0.020				
	Chloride (Cl) (mg/L)	0.74				
	Nitrate (as N) (mg/L)	<0.030				
	Nitrite (as N) (mg/L)	<0.020				
	Total Kjeldahl Nitrogen (mg/L)	0.741				
	Phosphorus (P)-Total (mg/L)	0.0165				
	Sulfate (SO4) (mg/L)	2.18				
Bacteriological Tests	Escherichia Coli (MPN/100mL)	<1				
	Total Coliforms (MPN/100mL)	460				
Total Metals	Aluminum (Al)-Total (mg/L)	0.173				
	Antimony (Sb)-Total (mg/L)	<0.00060				
	Arsenic (As)-Total (mg/L)	<0.0010				
	Barium (Ba)-Total (mg/L)	0.013				
	Beryllium (Be)-Total (mg/L)	<0.0010				
	Bismuth (Bi)-Total (mg/L)	<0.0010				
	Boron (B)-Total (mg/L)	<0.050				
	Cadmium (Cd)-Total (mg/L)	<0.000017				
	Calcium (Ca)-Total (mg/L)	2.86				
	Chromium (Cr)-Total (mg/L)	<0.0010				
	Cobalt (Co)-Total (mg/L)	<0.00050				
	Copper (Cu)-Total (mg/L)	0.0011				
	Iron (Fe)-Total (mg/L)	0.140				
	Lead (Pb)-Total (mg/L)	<0.0010				
	Lithium (Li)-Total (mg/L)	<0.050				
	Magnesium (Mg)-Total (mg/L)	1.07				
	Manganese (Mn)-Total (mg/L)	0.0150				
	Molybdenum (Mo)-Total (mg/L)	<0.0010				
	Nickel (Ni)-Total (mg/L)	<0.0020				
	Potassium (K)-Total (mg/L)	<0.50				
	Selenium (Se)-Total (mg/L)	<0.0010				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1320066-1				
	Description	GRAB				
	Sampled Date	20-JUN-13				
	Sampled Time	11:45				
	Client ID	MR 10 MACKENZIE RIVER - SITE #10				
Grouping	**Analyte**					
WATER						
Total Metals	Silver (Ag)-Total (mg/L)	<0.00010				
	Sodium (Na)-Total (mg/L)	0.62				
	Strontium (Sr)-Total (mg/L)	0.0106				
	Tellurium (Te)-Total (mg/L)	<0.0010				
	Thallium (Tl)-Total (mg/L)	<0.00030				
	Tin (Sn)-Total (mg/L)	<0.0010				
	Titanium (Ti)-Total (mg/L)	0.0024				
	Tungsten (W)-Total (mg/L)	<0.010				
	Uranium (U)-Total (mg/L)	<0.0050				
	Vanadium (V)-Total (mg/L)	<0.0010				
	Zinc (Zn)-Total (mg/L)	<0.0030				
	Zirconium (Zr)-Total (mg/L)	<0.0010				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Phosphorus (P)-Total	B	L1320066-1
Method Blank	Aluminum (Al)-Total	B	L1320066-1
Method Blank	Zirconium (Zr)-Total	B	L1320066-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L1320066-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1320066-1
Matrix Spike	Sodium (Na)-Total	MS-B	L1320066-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L1320066-1
Matrix Spike	Ammonia, Total (as N)	MS-B	L1320066-1
Matrix Spike	Ammonia, Total (as N)	MS-B	L1320066-1
Matrix Spike	Ammonia, Total (as N)	MS-B	L1320066-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TOT-CAP-TB	Water	Alkalinity, Total (as CaCO3)	APHA 2320 B-Auto-Pot. Titration
CL-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
EC-CAP-TB	Water	Conductivity (EC)	APHA 2510 B-ELECTRODE
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
HARDNESS-CALC-TB	Water	Hardness (as CaCO3)	CALCULATION
MET-T-MS-TB	Water	Total Metals by ICPMS	APHA 3030E/EPA 6020A
This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
N-TOTKJ-TB	Water	Total Kjeldahl Nitrogen by Colourimetry	APHA 4500-Norg B (modified)
Total Kjeldahl Nitrogen in aqueous matrices is analyzed using an autoanalyzer with colourimetric detection.			
NH3-COL-TB	Water	Ammonia by Discrete Analyzer	APHA 4500-NH3 G. (modified)
Ammonia in aqueous matrices is analyzed using discrete analyzer with colourimetric detection.			
NO2-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
NO3-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
P-T-COL-TB	Water	Total Phosphorus by Discrete Analyzer	APHA 4500-P B, F, G (modified)
Phosphorus in aqueous matrices is analyzed using discrete Analyzer with colourimetric detection.			
PH-CAP-TB	Water	pH	APHA 4500-H-ELECTRODE
SO4-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
SOLIDS-TDS-TB	Water	Total Dissolved Solids	APHA 2540 C (modified)
Aqueous matrices are analyzed using gravimetry and evaporation			
TC,EC-18QT97-TB	Water	Total Coliform and E.coli	APHA 9223 B C18
TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer
Aqueous matrices are analyzed using nephelometry with the light scatter measured at a 90” angle.			

Reference Information

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ADDRESS 1081 Barton Street, Thunder Bay Ontario P7B 5N3 Canada | PHONE +1 807 623 6463 | FAX +1 807 623 7598
ALS CANADA LIMITED Part of the ALS Group A Campbell Brothers Limited Company www.alsglobal.com

L1320066

Company:	Lakehead Region Conservation Authority			**Regulatory Information**	**Both questions below must answered for water samples**
Contact:	Scott Drebit			☐ O. Reg 153 (O. Reg 511 Amend) Table:____	Are any samples taken from a regulated DW System? ☐ Yes ☒ No
Address:	130 Conservation Rd. P7B 6T8			Record of Site Condition ☐ Yes ☐ No	If yes, an authorized DW COC must be used.
				PWQO ☒ MISA ☐ MMER ☐ CCME ☐	Is the water sampled intended for human consumption? ☐ Yes ☒ No
Phone:	807-344-5857	**Fax:**	807-345-9156	Guideline Required:	
Email:	scott@lakeheadca.com;tammy@lakeheadca.com;info@lakeheadca.com			TCLP Regulation 558 ☐ Other:	
Project:	MacKenzie	**PO:**		**Service Requested**	**Analysis Request**
Quote #	Q40232			☒ Regular TAT (7 Days)	Please indicate below Filtered, Preserved or both (F, P, F/P)
Invoice To:	Tammy Cook	**Same as Report:**	☑ Yes ☐ No	☐ Priority TAT 50% Surcharge (3-5 Days)	
Company:	Lakehead Region Conservation Authority			☐ Emergency TAT 100% Surcharge (1-2 Days)	
Contact:	Scott Drebit			Specify Date Required:	
Address:	130 Conservation Rd. BOX 10427			All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.	
Email:	scott@lakeheadca.com				
Account Manager		**Sampler:**	V.Lane A.Stuart		

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, CL, Conductivity, Hardness, TKN	NH3, NO2, NO3, Total Phosphours	pH, SO4, Solids, TC-,EC, Turbidity	Routine	Total Metals	Number of Containers
MC 10	MacKenzie River - Site #10	06/20/13	11:45	Grab	x	x	x	x	x	4
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			

L1320066-COFC

Special Instructions / Comments

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations: Yes / No ? If Yes add SIF
Allyson Stuart	06/20/2013	JD	20-Jun-13 2:10	12.8	☑ Yes ☐ No	JD	26-Jun-13	☐

**Failure to complete all portions of this form may delay analysis. **TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known or suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use of the form the user acknowledges and agrees with the Terms and Conditions as specified on the back page.

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: Scott Drebit
130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Date Received: 11-JUL-13
Report Date: 19-JUL-13 14:56 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L1330488

Project P.O. #: NOT SUBMITTED
Job Reference: MACKENZIE
C of C Numbers:
Legal Site Desc:

Bobbie Shortreed
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1330488-1 WATER 09-JUL-13 09:20 MR1 MACKENZIE - SITE #1	L1330488-2 WATER 09-JUL-13 11:05 MR2 MACKENZIE - SITE #2	L1330488-3 WATER 09-JUL-13 12:30 MR3 MACKENZIE - SITE #3	L1330488-4 WATER 09-JUL-13 13:30 MR4 MACKENZIE - SITE #4	L1330488-5 WATER 09-JUL-13 14:10 MR5 MACKENZIE - SITE #5
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	52.3	49.7	76.4	57.6	42.6
	Hardness (as CaCO3) (mg/L)	25.1	24.7	36.7	27.9	19.3
	pH (pH)	7.34	7.39	7.26	7.21	7.24
	Total Dissolved Solids (mg/L)	55	56	66	52	45
	Turbidity (NTU)	1.10	1.07	1.40	1.21	0.96
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L CaCO3)	19.3	20.0	31.4	24.0	15.0
	Ammonia, Total (as N) (mg/L)	<0.020	<0.020	0.056	0.029	<0.020
	Chloride (Cl) (mg/L)	0.86	0.78	0.89	0.24	1.27
	Nitrate (as N) (mg/L)	0.050	0.047	0.063	<0.030	0.040
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020
	Total Kjeldahl Nitrogen (mg/L)	0.764	0.734	0.687	0.632	0.795
	Phosphorus (P)-Total (mg/L)	0.0095	0.0095	0.0078	0.0098	0.0116
	Sulfate (SO4) (mg/L)	2.08	2.09	3.26	3.02	1.86
Bacteriological Tests	Escherichia Coli (MPN/100mL)	30	31	30	19	15
	Total Coliforms (MPN/100mL)	2000	> 2420	> 2420	> 2420	> 2420
Total Metals	Aluminum (Al)-Total (mg/L)	0.154	0.150	0.0828	0.135	0.196
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
	Arsenic (As)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Barium (Ba)-Total (mg/L)	0.028	0.027	0.025	0.022	0.026
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Cadmium (Cd)-Total (mg/L)	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
	Calcium (Ca)-Total (mg/L)	6.53	6.43	9.75	7.24	5.05
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Copper (Cu)-Total (mg/L)	0.0019	0.0018	0.0017	0.0017	0.0017
	Iron (Fe)-Total (mg/L)	0.384	0.382	0.478	0.504	0.427
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Magnesium (Mg)-Total (mg/L)	2.13	2.09	3.00	2.38	1.62
	Manganese (Mn)-Total (mg/L)	0.0210	0.0204	0.0248	0.0614	0.0148
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Nickel (Ni)-Total (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Potassium (K)-Total (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1330488-6 WATER 10-JUL-13 09:25 MR6 MACKENZIE - SITE #6	L1330488-7 WATER 10-JUL-13 10:45 MR7 MACKENZIE - SITE #7	L1330488-8 WATER 10-JUL-13 12:15 MR8 MACKENZIE - SITE #8	L1330488-9 WATER 10-JUL-13 13:30 MR9 MACKENZIE - SITE #9	L1330488-10 WATER 11-JUL-13 12:00 MR10 MACKENZIE - SITE #10
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	46.4	40.1	89.7	51.0	31.1
	Hardness (as CaCO3) (mg/L)	15.5	21.4	21.6	26.3	12.6
	pH (pH)	6.76	7.24	6.83	7.38	7.08
	Total Dissolved Solids (mg/L)	40	36	71	41	20
	Turbidity (NTU)	1.06	0.92	1.17	0.82	1.82
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L CaCO3)	10.7	16.4	16.6	21.8	10.5
	Ammonia, Total (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	0.060
	Chloride (Cl) (mg/L)	4.42	0.12	13.6	0.18	0.72
	Nitrate (as N) (mg/L)	<0.030	0.046	<0.030	0.076	<0.030
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020
	Total Kjeldahl Nitrogen (mg/L)	0.771	0.800	0.892	0.895	0.724
	Phosphorus (P)-Total (mg/L)	0.0114	0.0096	0.0116	0.0131	0.0133
	Sulfate (SO4) (mg/L)	1.90	1.66	2.14	1.06	2.13
Bacteriological Tests	Escherichia Coli (MPN/100mL)	15	11	15	10	1
	Total Coliforms (MPN/100mL)	2400	> 2420	> 2420	> 2420	920
Total Metals	Aluminum (Al)-Total (mg/L)	0.185	0.194	0.239	0.145	0.106
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
	Arsenic (As)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Barium (Ba)-Total (mg/L)	0.013	0.031	0.019	0.022	0.014
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Cadmium (Cd)-Total (mg/L)	<0.000017	<0.000017	0.000017	0.000020	<0.000017
	Calcium (Ca)-Total (mg/L)	4.00	5.59	5.78	6.64	3.00
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	0.0010	<0.0010	<0.0010
	Cobalt (Co)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Copper (Cu)-Total (mg/L)	0.0013	0.0016	0.0023	0.0015	<0.0010
	Iron (Fe)-Total (mg/L)	0.360	0.506	0.683	0.579	0.148
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Magnesium (Mg)-Total (mg/L)	1.33	1.82	1.73	2.37	1.24
	Manganese (Mn)-Total (mg/L)	0.0357	0.0169	0.0632	0.0210	0.0256
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Nickel (Ni)-Total (mg/L)	<0.0020	<0.0020	0.0022	<0.0020	<0.0020
	Potassium (K)-Total (mg/L)	<0.50	<0.50	0.57	<0.50	<0.50
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1330488-1	L1330488-2	L1330488-3	L1330488-4	L1330488-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	09-JUL-13	09-JUL-13	09-JUL-13	09-JUL-13	09-JUL-13
	Sampled Time	09:20	11:05	12:30	13:30	14:10
	Client ID	MR1 MACKENZIE - SITE #1	MR2 MACKENZIE - SITE #2	MR3 MACKENZIE - SITE #3	MR4 MACKENZIE - SITE #4	MR5 MACKENZIE - SITE #5
Grouping	**Analyte**					
WATER						
Total Metals	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Sodium (Na)-Total (mg/L)	1.34	1.22	1.35	0.96	1.38
	Strontium (Sr)-Total (mg/L)	0.0241	0.0230	0.0221	0.0189	0.0250
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Titanium (Ti)-Total (mg/L)	0.0020	<0.0020	<0.0020	0.0074	0.0022
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Vanadium (V)-Total (mg/L)	0.0011	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1330488-6 WATER 10-JUL-13 09:25 MR6 MACKENZIE - SITE #6	L1330488-7 WATER 10-JUL-13 10:45 MR7 MACKENZIE - SITE #7	L1330488-8 WATER 10-JUL-13 12:15 MR8 MACKENZIE - SITE #8	L1330488-9 WATER 10-JUL-13 13:30 MR9 MACKENZIE - SITE #9	L1330488-10 WATER 11-JUL-13 12:00 MR10 MACKENZIE - SITE #10
Sample ID						
Description						
Sampled Date						
Sampled Time						
Client ID						
WATER						
Total Metals	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Sodium (Na)-Total (mg/L)	3.10	0.82	9.67	0.86	0.67
	Strontium (Sr)-Total (mg/L)	0.0124	0.0313	0.0156	0.0304	0.0110
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Titanium (Ti)-Total (mg/L)	<0.0020	<0.0020	0.0029	<0.0020	<0.0020
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Vanadium (V)-Total (mg/L)	<0.0010	<0.0010	<0.0010	0.0010	<0.0010
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.0051	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sulfate (SO4)	MS-B	L1330488-10
Matrix Spike	Phosphorus (P)-Total	MS-B	L1330488-10
Matrix Spike	Barium (Ba)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Nickel (Ni)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Nickel (Ni)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1330488-1, -10, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TOT-CAP-TB	Water	Alkalinity, Total (as CaCO3)	APHA 2320 B-Auto-Pot. Titration
CL-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
EC-CAP-TB	Water	Conductivity (EC)	APHA 2510 B-ELECTRODE
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
HARDNESS-CALC-TB	Water	Hardness (as CaCO3)	CALCULATION
MET-T-MS-TB	Water	Total Metals by ICPMS	APHA 3030E/EPA 6020A
This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
N-TOTKJ-TB	Water	Total Kjeldahl Nitrogen by Colourimetry	APHA 4500-Norg B (modified)
Total Kjeldahl Nitrogen in aqueous matrices is analyzed using an autoanalyzer with colourimetric detection.			
NH3-COL-TB	Water	Ammonia by Discrete Analyzer	APHA 4500-NH3 G. (modified)
Ammonia in aqueous matrices is analyzed using discrete analyzer with colourimetric detection.			
NO2-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
NO3-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
P-T-COL-TB	Water	Total Phosphorus by Discrete Analyzer	APHA 4500-P B, F, G (modified)
Phosphorus in aqueous matrices is analyzed using discrete Analyzer with colourimetric detection.			
PH-CAP-TB	Water	pH	APHA 4500-H-ELECTRODE
SO4-IC-TB	Water	Anions by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
SOLIDS-TDS-TB	Water	Total Dissolved Solids	APHA 2540 C (modified)
Aqueous matrices are analyzed using gravimetry and evaporation			
TC,EC-18QT97-TB	Water	Total Coliform and E.coli	APHA 9223 B C18

Reference Information

TC,EC-QT97-TB	Water	Total Coliform and E.coli	APHA 9223 B C24
TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

Aqueous matrices are analyzed using nephelometry with the light scatter measured at a 90” angle.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

ADDRESS 1081 Barton Street
ALS CANADA DALHOUSIE Patrol

FAX +1 807 623 7598

L1330488-COFC

L1330488 Page 1 of 2

Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. P7B 6T8		
Phone:	807-344-5857	Fax:	807-345-9156
Email:	scott@lakeheadca.com;tammy@lakeheadca.com,info@lakeheadca.com		
Project:	Mackenzie	PO:	
Quote #	Q40232		
Invoice To:	Tammy Cook	Same as Report:	☑ Yes ☐ No
Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd Box 10427		
Email:	scott@lakeheadca.com		
Account Manager		Sampler:	V. Lane & A. Stuart

☐ O. Reg 153 (O. Reg 511 Amend) Table:____
Record of Site Condition ☐ Yes ☐ No
PWQO ☒ MISA ☐ MMER ☐ CCME ☐
Guideline Required:
TCLP Regulation 558 ☐ Other:

Service Requested
☒ Regular TAT (7 Days)
☐ Priority TAT 50% Surcharge (3-5 Days)
☐ Emergency TAT 100% Surcharge (1-2 Days)
Specify Date Required:

All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.

Both questions below must answered for water samples
Are any samples taken from a regulated DW System? ☐ Yes ☒ No
If yes, an authorized DW COC must be used.
Is the water sampled intended for human consumption? ☐ Yes ☒ No

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, CL, Conductivity, Hardness, TKN	NH3, NO2, NO3, Total Phosphours	pH, SO4, Solids, TC-EC, Turbidity	Routine	Metals								Number of Containers
MR1	Mackenzie - Site #1	07/09/13	9:20	grab	x	x	x	X	X								4
MR2	Mackenzie - Site #2	07/09/13	11:15	grab	x	x	x	X	X								4
MR3	Mackenzie - Site #3	07/09/13	12:30	grab	x	x	x	X	X								4
MR4	Mackenzie - Site #4	07/09/13	13:30	grab	x	x	x	X	X								4
MR5	Mackenzie - Site #5	07/09/13	14:10	grab	x	x	x	X	X								4
MR6	Mackenzie - Site #6	07/10/13	9:25	grab	x	x	x	X	X								4
MR7	Mackenzie - Site #7	07/10/13	10:45	grab	x	x	x	X	X								4
MR8	Mackenzie - Site #8	07/10/13	12:15	grab	x	x	x	X	X								4
MR9	Mackenzie - Site #9	07/10/13	13:30	grab	x	x	x	X	X								4
					x	x	x										
					x	x	x										

Special Instructions / Comments

2L-5 #15 SEE SIF

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations: Yes / No? If Yes add SIF
Jurgen Lane	07/11/13 8:30		11-JUL-13 0905	6.2	☑ Yes ☐ No		11-JUL-13 0905	

**Failure to complete all portions of this form may delay analysis. **TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known of suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use of the form the user acknowledges and agrees with the Terms and Conditions as specified on the back page.

#1 6.2 #2 5-8 #3 2L-5

ALS Environmental
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L1330488

Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. P7B 6T8		
Phone:	807-344-5857	Fax:	807-345-9156
Email:	scott@lakeheadca.com;tammy@lakeheadca.com,info@lakeheadca.com		
Project:	Mackenzie	PO:	
Quote #	Q40232		
Invoice To:	Tammy Cook	Same as Report:	☑ Yes ☐ No
Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd Box 10427		
Email:	scott@lakeheadca.com		
Account Manager		Sampler:	V. Lake & A. Stuart

Regulatory Information

- ☐ O. Reg 153 (O. Reg 511 Amend) Table: ___
- Record of Site Condition ☐ Yes ☐ No
- PWQO ☒ MISA ☐ MMER ☐ CCME ☐
- Guideline Required:
- TCLP Regulation 558 ☐ Other:

Service Requested

- ☒ Regular TAT (7 Days)
- ☐ Priority TAT 50% Surcharge (3-5 Days)
- ☐ Emergency TAT 100% Surcharge (1-2 Days)
- Specify Date Required:

All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.

Both questions below must answered for water samples

- Are any samples taken from a regulated DW System? ☐ Yes ☒ No
- If yes, an authorized DW COC must be used.
- Is the water sampled intended for human consumption? ☐ Yes ☒ No

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, CL, Conductivity, Hardness, TKN	NH3, NO2, NO3, Total Phosphours	pH, SO4, Solids, TC, EC, Turbidity	Routine	Metals	Number of Containers
MK10	Mackenzie - Site #10	07/11/13	12:00	grab	x	x	x	x	x	4
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			

L1330488-COFC

Special Instructions / Comments

SEE IF

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations: Yes / No ? If Yes add SIF
Eugenia Lee	07/11/13 4:30		11-JUL-13 1430	21.5	☐ Yes ☑ No		11-JUL-13 1430	

**Failure to complete all portions of this form may delay analysis. **TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known or suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use