



**GOLDCORP CANADA LTD.  
HOLLINGER PROJECT**

**PRE-FEASIBILITY ENVIRONMENTAL BASELINE  
STUDIES**

**AQUATICS ECOSYSTEM EXISTING CONDITIONS  
REPORT**

**Submitted to:**

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**TABLE OF CONTENTS**

	<u>Page</u>
<b>1.0 INTRODUCTION .....</b>	<b>1</b>
1.1 Site History .....	2
1.2 Project Overview .....	2
1.3 General Setting .....	3
1.4 Spatial and Temporal Boundaries .....	5
<b>2.0 METHODOLOGY .....</b>	<b>9</b>
2.1 Secondary Source Information Review .....	9
2.2 Site Characterization Program .....	9
2.2.1 Surface Water Quality .....	9
2.2.2 Sediment Quality .....	10
2.2.3 Benthic Invertebrates .....	10
2.2.4 Aquatic Habitat .....	11
2.2.5 Fisheries .....	12
<b>3.0 RESULTS .....</b>	<b>19</b>
3.1 Regional Setting .....	19
3.2 Porcupine River Watershed .....	19
3.2.1 Water Quality .....	20
3.2.2 Sediment Quality .....	24
3.2.3 Benthic Invertebrates .....	26
3.2.4 Aquatic Habitat .....	27
3.2.5 Fisheries Resources .....	40
3.3 South Porcupine River Watershed .....	41
3.3.1 Water Quality .....	43
3.3.2 Sediment Quality .....	45
3.3.3 Benthic Macroinvertebrates .....	45
3.3.4 Aquatic Habitat .....	46
3.3.5 Fisheries Resources .....	54
3.4 Skynner Creek Watershed .....	57
3.4.1 Water Quality .....	58
3.4.2 Sediment Quality .....	58
3.4.3 Benthic Macroinvertebrates .....	61
3.4.4 Aquatic Habitat .....	62
3.4.5 Fisheries Resources .....	67
3.5 Perch Lake Watershed .....	68
3.5.1 Water Quality .....	68
3.5.2 Sediment Quality .....	69
3.5.3 Benthic Macroinvertebrates .....	69
3.5.4 Aquatic Habitat .....	69
3.5.5 Fisheries Resources .....	74
3.6 Mountjoy River Watershed .....	76



3.6.1	Water Quality .....	76
3.6.2	Sediment Quality .....	76
3.6.3	Benthic Macroinvertebrates .....	76
3.6.4	Aquatic Habitat .....	76
3.6.5	Fisheries Resources .....	77
3.7	Town Creek Watershed .....	77
3.7.1	Water Quality .....	78
3.7.2	Sediment Quality .....	78
3.7.3	Benthic Macroinvertebrates .....	79
3.7.4	Aquatic Habitat .....	79
3.7.5	Fisheries Resources .....	81
3.8	Northwest Watersheds .....	81
3.8.1	Water Quality .....	82
3.8.2	Sediment Quality .....	82
3.8.3	Benthic Macroinvertebrates .....	82
3.8.4	Aquatic Habitat .....	82
<b>4.0</b>	<b>EVALUATION AND DISCUSSION .....</b>	<b>85</b>
4.1	Environmental Constraints and Sensitivities .....	85
4.2	Recommendations .....	88
<b>5.0</b>	<b>REFERENCES .....</b>	<b>89</b>

### LIST OF FIGURES

	<u>Page</u>	
1.1	Site Location and Study Area .....	6
1.2	Surficial Geology .....	7
1.3	Hollinger Baseline Studies Area and City of Timmins Municipal Boundary .....	8
2.1	Historical and AMEC 2007 Water Quality Sampling Locations .....	15
2.2	Historical and AMEC 2007 Sediment and Benthic Sampling Locations .....	16
2.3	Backpack and Boat Electrofishing Survey .....	17
2.4	Minnow Trap Segment Locations .....	18
3.1	Watershed Delineation .....	91
3.2	Watercourse Reach Type Characterization .....	92
3.3	Edwards Lake Shoreline Habitat Type .....	93
3.4	Pearl Lake Bathymetry and Shoreline Habitat Types .....	94
3.5	Clearwater Lake Shoreline Habitat Type .....	95
3.6	McDonald Lake Bathymetry and Shoreline Habitat Types .....	96
3.7	Fuller Mine Pond Bathymetry and Shoreline Habitat Types .....	97
3.8	Simpson Lake Bathymetry and Shoreline Habitat Types .....	98
3.9	Cowboy Lake Bathymetry and Shoreline Habitat Types .....	99
3.10	Skynner Lake Shoreline Habitat Type .....	100
3.11	Perch and Peroli Lake Bathymetry and Shoreline Habitat Types .....	101
3.12	Miller Lake and Miller Pond Bathymetry and Shoreline Habitat Types .....	102
3.13	Gillies Lake Shoreline Habitat Types .....	103

## **LIST OF TABLES**

	<b><u>Page</u></b>
2.1 Fisheries Community Assessment Collection Methods and Utilization with the Local Study Area .....	14
3.1 Water Quality Data – Porcupine River System .....	21
3.2 Sediment Quality Data - Porcupine River System.....	25
3.3 Key Biophysical Parameters and Channel Diagnostics within Local Study Area.....	28
3.4 Summary of Littoral Zone Aquatic Vegetation in Lake and Pond Systems within the Local Study Area.....	34
3.5 Summary of Supralittoral and Eulittoral Vegetation in Lake and Pond Systems within the Local Study Area.....	35
3.6 Summary of Littoral Zone Dimensions and Substrates in Lake and Pond Systems within the Local Study Area.....	36
3.7 Total Fish Species Abundance in Creek Systems within Local Study Area.....	42
3.8 Total Fish Species Abundance in Lake Systems within Local Study Area.....	56
3.9 Water Quality Data – West Watersheds .....	59
3.10 Sediment Quality Data – West Watersheds.....	60

## **LIST OF APPENDICES**

A	Hollinger Baseline Studies Watercourse Reach Type Classification Summary for Watercourse identified within the Local Study Area
B	Hollinger Baseline Studies Shoreline Habitat Classification Summary identified in Lakes and Ponds within the Local Study Area
C	Hollinger Baseline Studies Watercourse Reach Type Schematics identified within the Local Study Area
D	Hollinger Baseline Studies Shoreline Habitat Photographs for Lakes and Ponds within the Local Study Area
E	Hollinger Baseline Studies Water Quality Field Parameters measured at Simpson Lake, Area A Tributary, Area B Tributary, Area C Tributary, and Area D Tributary
F	Hollinger Baseline Studies Dissolved Oxygen Profiles Tables documented in Lake and Pond Systems within the Local Study Area (AMEC 2007 Field Program)

## 1.0 INTRODUCTION

Porcupine Gold Mines (PGM), a joint venture between Goldcorp Canada Ltd. (51%) and Goldcorp Inc. (49%) (Goldcorp), is conducting pre-feasibility level studies to determine the potential for re-developing the former Hollinger and McIntyre Mines area, in Timmins (see Figure 1.1), as a new open pit mine and underground (UG) mining complex. For the purpose of this report, this undertaking is referred to as the Hollinger Project.

The former Hollinger Mine is located immediately adjacent to downtown Timmins and the urban area of Schumacher, on the south side of Highway 101. The former McIntyre Mine is located directly north and east of the former Hollinger Mine site. Ore from the proposed Hollinger Project would be processed at the existing Dome ore processing facility (Dome Mill), located approximately 5 km east of the former Hollinger Mine site. Considerable residual gold resources have been identified at the Hollinger Project Site, and development of the Site would have the added advantage of removing a number of known mine hazards (open stopes, mini pits, and near surface underground workings) that are associated with past activities.

This document deals with Aquatic Environment, and is one of a series of baseline and modelling reports prepared to describe existing environmental conditions, associated with the Hollinger site area, in part to assist with obtaining future environmental approvals to re-open the Hollinger Mine; as well as to assist with project planning and to provide further information for Closure planning.

This introduction, or an abbreviated version of it in some instances, is included in each document, such that the reports can be read independent of one another. Baseline reports are being prepared to describe the following environmental aspects:

- Air Quality;
- Aquatic Environment;
- Cultural Heritage Environment;
- Noise;
- Hydrology;
- Hydrogeology;
- Socio-Economic Setting;
- Terrestrial Environment; and,
- Vibration.

The reports have been prepared by AMEC Earth & Environmental, a Division of AMEC Americas Limited (AMEC), with the exception of the baseline reports related to noise and vibration (Valcoustics Canada Ltd.), the cultural heritage environment (Woodland Heritage Services Limited), and the socio-economic setting (planningAlliance). The latter three entities worked under the direction of AMEC to ensure an appropriate level of study integration.

## 1.1 Site History

The Hollinger gold deposit was discovered in 1909, as one of the three original major Timmins properties, along with that of the Dome and McIntyre Mines. The main Hollinger Mine operated from 1910 to 1968 and further mining took place in the 1970's and 1980's. The Hollinger, McIntyre and Coniaurum underground mine workings are all interconnected, along with those of a number of other smaller mines in the area.

Because of their connection to the McIntyre Mine, the Hollinger underground workings were kept dry while McIntyre operations continued until 1988, when the McIntyre Mine was shut down. The pumps at Hollinger and McIntyre Mines were shut down in 1991, and the underground working allowed to flood. A surface pump was installed in the McIntyre No 11 Shaft in 2000 and currently the upper mine levels are dewatered to a level ranging between 24 to 34 m below ground surface (mbgs), to help manage near-surface groundwater levels in the area. Mine water from the Hollinger, McIntyre and Coniaurum Mines is managed through the McIntyre No. 11 Shaft, with discharge to Little Pearl Tailings Pond. The McIntyre Mine operated from 1911 to 1988.

## 1.2 Project Overview

Goldcorp, through PGM, is planning to develop the Hollinger Project by redeveloping the former Hollinger and McIntyre Mines area as a new open pit and UG mining complex. The open pit complex would involve the sequential development of an open pit, through a series of phased pushbacks that would be used to access shallow ore zones within 200 to 250 mbgs. The UG portion of the mine complex would involve the potential development of two new UG ramps and associated ventilation raises that would be used to access deeper ore zones.

Development of the new Hollinger Project would require comparatively limited new infrastructure, as ore from the Project Site would be hauled to and processed at the existing Dome Mill, with tailings from ore processing to be discharged to the existing Dome Mine tailings deposition area.

The UG operations would consist of the Millerton and Central Porphyry Zone (CPZ) UG operations. Ramps developed at the Millerton and CPZ locations would be developed to approximately 400 mbgs. Mining beyond that point would likely involve shaft hoisting. Opportunities to use existing infrastructure for the deeper mining could potentially involve using the existing Hollinger No. 26 Shaft to develop the Millerton UG, and the McIntyre No. 11 Shaft to develop the CPZ UG. Ramp development and associated UG exploration would be used to confirm UG ore resources, and the viability of UG mining.

Under the current open pit design, there would be a requirement for the disposal of approximately 37,000,000 m<sup>3</sup> of mine rock. The majority of the mine rock (estimated at 20,000,000 to 30,000,000 m<sup>3</sup>) would be retained on the Hollinger Project Site and would be used to backfill and overfill the initially excavated phased mine pits. Rock will also be used to build the Environmental Control Berm and the Transportation Corridor with the remainder being stored at the Dome Mine site.

Infrastructure used and/or developed to support the Hollinger Project would include:

- At the Hollinger Project Site:
  - permanent mine rock and overburden stockpiles;
  - site water collection and drainage systems (if required);
  - potentially some small fuel and petroleum product storage facilities (if required);
  - electrical connections from nearby, currently in place, Hydro One infrastructure; and,
  - natural gas (if required) from nearby, currently in place, Union Gas infrastructure.
  
- Off the Hollinger Project Site:
  - the approximately 4.8 km long Transportation Corridor linking the Hollinger Project Site with the Dome Mill;
  - potentially additional mine rock stockpiles (at the Dome site) (if required); and,
  - mine dewatering system from McIntyre No. 11 Shaft to Little Pearl Tailings Pond.

In addition, the Project would include the construction of an Environmental Control Berm around the Hollinger Project Site. This is a key feature of the Project with the main purpose of the Environmental Control Berm being to manage noise and other effects on nearby receptors.

Throughout the operations phase, mine rock material would be used to progressively backfill the phased mined pits. At closure, the remaining pit will be allowed to flood, and the pit discharge will likely be routed by gravity flow south to either the Skynner Creek or Perch Lake systems, both of which drain to the Mountjoy River. All remaining Project infrastructure would be removed at closure, and the Project Site would be rehabilitated in accordance with established mine closure protocols. In addition, closure will be carried out such that existing safety hazards would be removed. Part of the Closure Plan would be to ensure, through stakeholder input and working collaboration with the City of Timmins' Planning Department, that the Project Site would be landscaped in an aesthetically pleasing manner.

### **1.3 General Setting**

The Timmins area is characterized by a mix of urban and industrial development superimposed on a forested background. The City of Timmins consists of a major downtown urban area, as well as a number of other smaller urban centres scattered throughout the area, with Schumacher, South Porcupine, and Porcupine being the more prominent of these smaller centres. Various other smaller hamlets also occur throughout the area. All of these areas were amalgamated in 1973 to form the City of Timmins.

South Porcupine and other communities to the east are linked to Timmins by Highway 101, with a commercial strip occurring along this highway between downtown Timmins and Schumacher. Highway 655 extends north from Highway 101, with linkages to the Timmins airport via Airport and Laforest Roads, and linkages further north to Xstrata Copper's Kidd Mine site and Highway 11. Several major transmission, gas, water and sewer lines pass through the area, as well as local services.

Timmins was founded as a mining centre, with the three prominent original mines being the Hollinger Mine, the McIntyre Mine, and the Dome Mine. Of these, only the Dome Mine is still in operation. Numerous other smaller mines also operated in the local area (see Section 1.4); many of which were or became linked to the three major mines at one time or another. None of these smaller historic mines are currently active. Above and below grade tailings, associated with these active and former mine sites, are widespread throughout the study area (Figure 1.1). Prominent waste rock piles are associated with the Dome Mine. There is little evidence of waste rock piles associated with the other mining operations, because all the mines, except for the Dome open pit operation, were underground mines. Waste rock produced by these underground mines was typically used as material for construction and backfill operations.

Topography in the Timmins area is dominated by its location at the transition of Precambrian Shield terrain to the south and southwest, and by flat-lying glaciolacustrine silt and clay plains to the north and east. An extensive glaciolacustrine sand plain area lies to the south of Timmins, including dune formations, and extends into the lower, southwest portion of the study area (Figure 1.2). A prominent esker system extends immediately adjacent and parallel to the east side of Highway 655, north from Highway 101. The local topography reaches a maximum of about 365 m above mean sea level (amsl) in the area just southeast of the Hollinger site and north of Gold Mine Road. Further east towards South Porcupine, and within the glaciolacustrine silt and clay plains, the local topography decreases to as little as 280 m elevation.

The geology of the Timmins area is structurally complex, and includes several major fault zones, and anticline/syncline systems, many of which control surface topographic expressions. The Pearl Lake/Little Pearl Pond and the Gillies Lake area are controlled by these features, and as a result are the location of deeper sediment accumulations. Bedrock exposures are widespread and frequent throughout the major portion of the study area, but with much reduced expression in the areas dominated by glaciolacustrine silt, clay and sand plains.

Several small lakes and numerous ponds are scattered throughout the area, with larger numbers of ponds having formed along low gradient creek valleys as a result of beaver activity. Most of the area's drainage is captured by the Porcupine and South Porcupine Rivers, which flow east, converging just upstream of Porcupine Lake, northeast of the Dome Mine site. The Porcupine River is a low gradient system that has its headwaters in the area just north and east of the Hollinger site. The Porcupine River drains into Night Hawk Lake and the Frederick House River system. Areas south and west of the Hollinger site drain to either the Skynner Creek or Perch Lake systems, both of which drain to the Mountjoy River, which flows into the Mattagami River. Areas north and west of the Hollinger site drain to Gillies Lake and the Town Creek system, which drains to the Mattagami River; or slightly further north there are a number of smaller drainages that drain directly west to the Mattagami River.

Virtually all drainages in the area have been affected by existing or past mining activities, which have affected water quality, and to a lesser extent drainage patterns themselves.




The majority of the landscape that has not been developed for urbanization or mining remains in forest cover, with the exception of principal agricultural areas to the north and south of Timmins, near to the Mattagami River, and a number of smaller parcels of land in and around the Porcupine Lake area. Forest communities in the area are virtually all second growth as a result of past logging activities, and fires. Throughout the generally lower-lying, eastern portion of the study area, forest communities are dominated by varying mixtures of Black Spruce and poplar (Trembling Aspen and Balsam Poplar), with White Spruce, Jack Pine, Balsam Fir, Larch and White Birch as common associates. Central portions of the study area, where rock outcroppings are common, show similar forest community types but with a somewhat stronger representation of Jack Pine. Sandy areas north of Gillies Lake bordering Highway 655, and south and west of the Kayorum (Hollinger) tailings stack, show a dominance of Jack Pine, or Jack Pine with poplar. The abundance of poplar in the area is indicative of the level of past disturbance, as poplar species are typically successional and not characteristic of mature forest communities. Virtually all major forest blocks are transected by roads, transmission lines, trails, or other such linear features.

#### **1.4 Spatial and Temporal Boundaries**


To encompass all potential development areas and immediate drainages there from, Local Study Area (LSA) boundaries for natural environment investigations were focused on watershed and riverine boundaries, with the exception of the northwest study area boundary, which was defined by Laforest Road and a narrow strip of land bordering the east side of Highway 655 (Figure 1.1). The narrow strip of land bordering the east side of Highway 655 was included because this area includes a small trailer park and a single residence north of the trailer park, which have the potential to be affected by possible Hollinger related developments. Biophysical environmental studies are limited to this larger area, but depending on the specific discipline, may focus only on the relevant portions of the LSA.

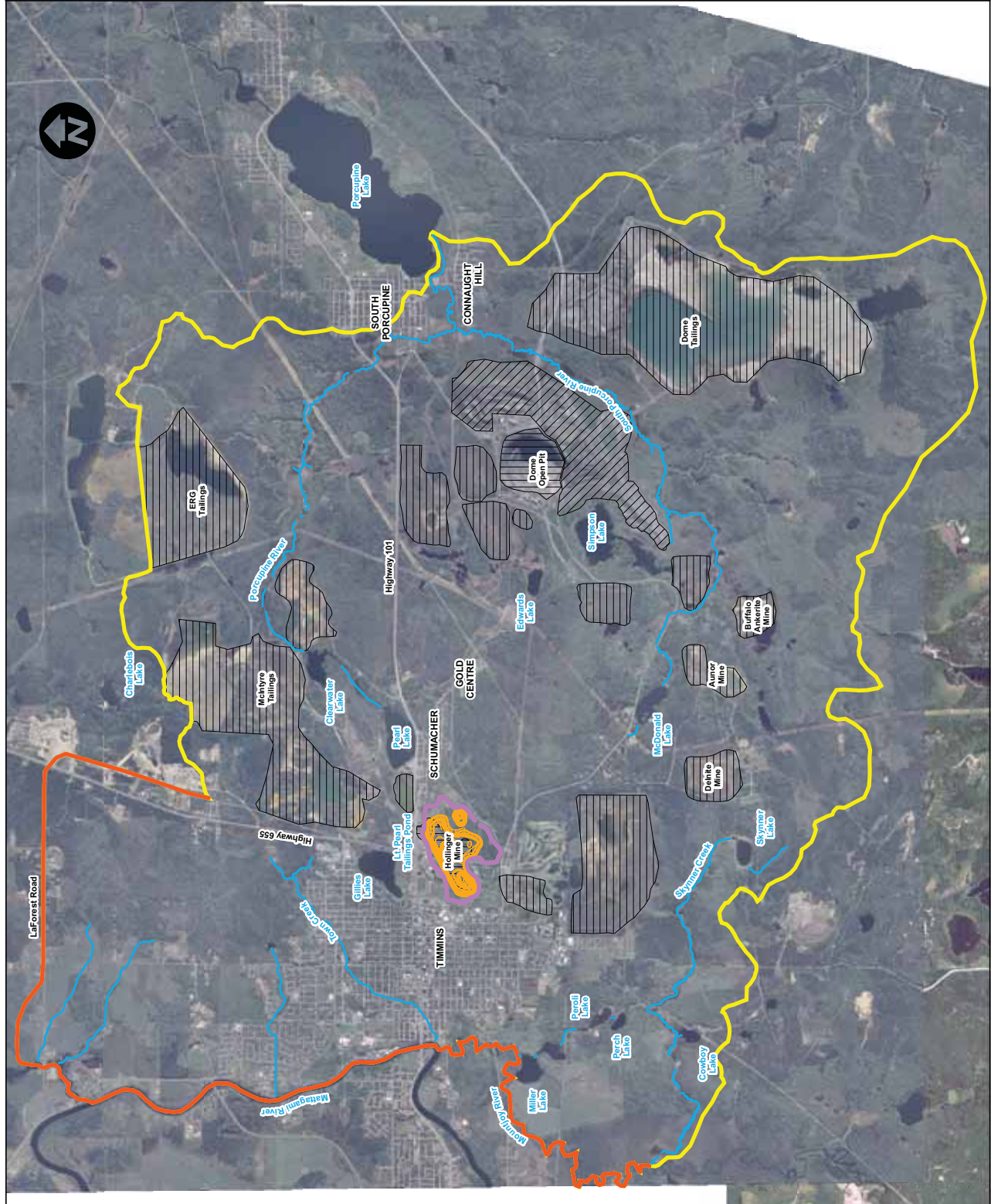
The socioeconomic study area (SESA) is based on the City of Timmins limits, which encompass both urban and rural areas (Figure 1.3).

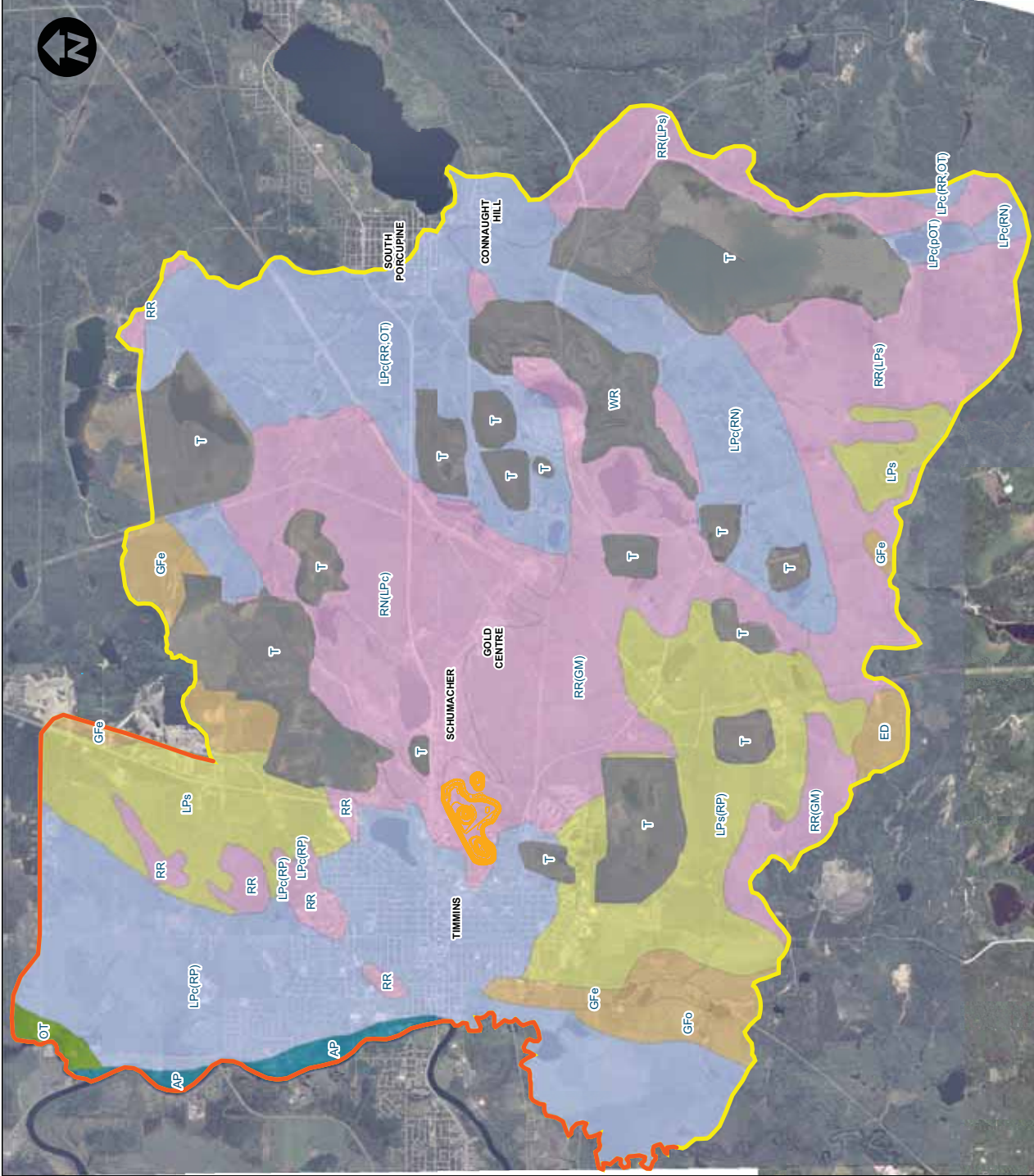
**Legend:**

-  Study Area (Watershed Boundary)
-  Study Area (Riverine and Road Boundary)
-  Mine Openings to Surface
-  Existing Tailings Deposits
-  Existing Waste Rock Deposits
-  Proposed Open Pit
-  Environmental Control Berm Outline
-  River or Creek



	
<b>HOLLINGER BASELINE STUDIES</b>	
TIMMINS	ONTARIO
<b>Site Location and Study Area</b>	
SCALE: 1:52,500	DATE: September 2007
PROJECT No: TC171607	FIGURE: 1.1
	REV: 2





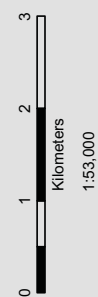
**Legend:**

- Study Area (Watershed Boundary)
- Study Area (Riverine and Road Boundary)
- Proposed Open Pit

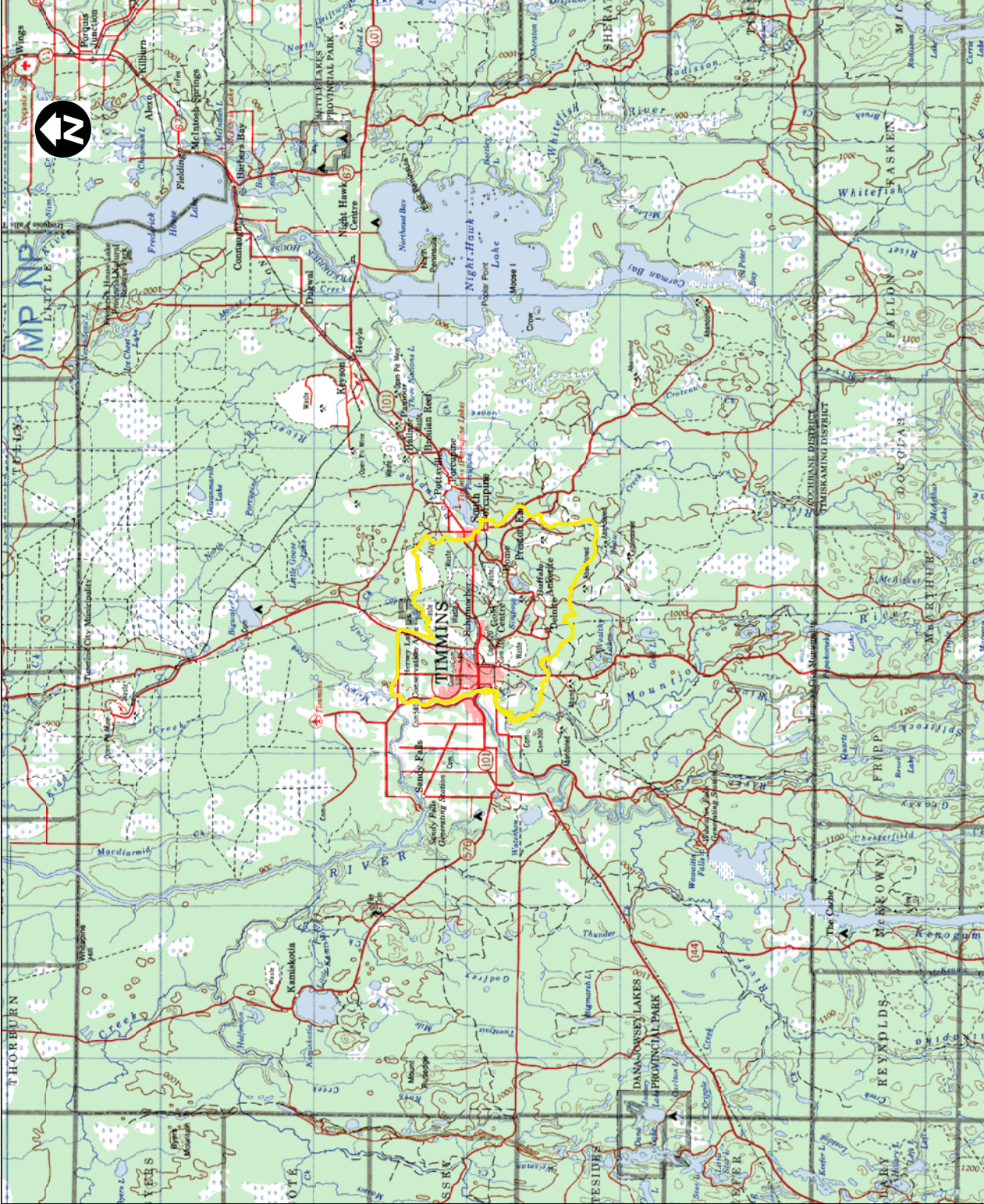
**Surficial Geology Types**

- 1, RR - Rock ridge
- 2, RR(GM) - Rock ridge (ground moraine) (subordinate landform types are shown in brackets)
- 3, RN(LFc) - Rock knob (lacustrine plain - clay/silt)
- 4, RR(LP<sub>s</sub>) - Rock ridge (lacustrine plain - sand)
- 5, LFc(RR, OT) - Lacustrine plain - clay/silt (rock ridge/organic terrain)
- 6, LFc(RN) - Lacustrine plain - clay/silt (rock knob)
- 7, LFc(RP) - Lacustrine plain - clay/silt (rock plain)
- 8, LP<sub>s</sub>(RP) - Lacustrine plain - sand (rock plain)
- 9, LP<sub>s</sub> - Lacustrine plain - sand
- 10, LFc(OT) - Lacustrine plain - clay/silt (organic terrain)
- 11, GFe - Glacial-fluvial outwash - sand
- 12, GFe - Glacial-fluvial esker - sand
- 13, ED - Dunes - sand
- 14, AP - Alluvial plain
- 15, OT - Organic terrain
- 16, T - Tailings
- 17, WR - Waste rock

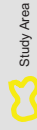
SOURCE: Northern Ontario Engineering Geology Terrain Study Base Maps - Timmins (Map 5025) and parmour (Map 5026)



<b>HOLLINGER BASELINE STUDIES</b>	
TIMMINS ONTARIO	
<b>Surficial Geology</b>	
SCALE: 1:53,000	DATE: October 2007
PROJECT No: TC71507	FIGURE: 1.2 REV: 2



**Legend:**



Study Area

NOTE: Base map supplied by Geomatics Canada,  
Department of Natural Resource



<b>amec</b>	
HOLLINGER BASELINE STUDIES	
TIMMINS ONTARIO	
<b>Study Area and City of Timmins Municipal Boundary</b>	
SCALE: 1:250,000	DATE: October 2007
PROJECT No: TC71507	FIGURE: 1.3
	REV: 2

## **2.0 METHODOLOGY**

### **2.1 Secondary Source Information Review**

Available secondary source information relevant to the aquatics biophysical inventory of the LSA was identified and reviewed at the start of the study. These reports, while providing detailed information regarding several aquatic environments, did not encompass the entire LSA. Accordingly, a comprehensive field program was designed and implemented to fill data gaps in addition to address any changes or evolution of those systems' conditions since the historic studies were completed.

A summary and delineation of sampling locations undertaken in relevant historic aquatic inventory or monitoring programs is provided in Figures 2.1, 2.2, and 2.3.

### **2.2 Site Characterization Program**

#### **2.2.1 Surface Water Quality**

To support the early phases of project planning, the characterization of baseline water quality applies both recent instantaneous water sampling undertaken in 2006 to 2007, as well as secondary source historical information that dates as far back as 1989. The historical data includes the results from a variety of compliance based monitoring studies that have been undertaken with respect to the Dome and adjacent mine properties. As a component of the 2007 baseline update study program, instantaneous surface water samples were collected from various stations located in watercourses, lakes and ponds in and around the LSA as outlined in Figure 2.1. The sampling was completed in the river/creek and lake/pond systems within the LSA that fall within drainages that may potentially be influenced by some component of project development. Some of these samples also support characterization of particular habitat conditions largely in association with biophysical sample collection.

Water samples were collected as grab samples from 10 cm below the water surface prior to any other station activities (such as sediment sampling) in appropriately preserved nalgene bottles. Water samples were stored in a cool environment until they were analyzed at Goldcorp Canada Ltd. PGM – DOME Mine Analytical and Environmental Services Laboratory. Instantaneous field measurements were also undertaken with portable analytical equipment and included dissolved oxygen, conductivity and temperature. This sampling effort provided additional data with respect to site specific microhabitat conditions associated with other biophysical sampling and is reported in the context of habitat descriptions within this document.

Analytical results were compared to the Provincial Water Quality Objectives (PWQO) for the protection of aquatic life.

### 2.2.2 Sediment Quality

Sediment samples were collected from representative river, creek, lake and pond systems within the LSA (Figure 2.2). The sediment sampling stations were coordinated with the benthic invertebrate sampling program to assist with benthic habitat descriptions. Samples were collected from the top 0 to 10 cm sediment horizon using a grab sampler (petite Ponar) from depositional environments. Each sediment sample consisted of three sub-field grabs, pooled and homogenized into a representative sample. These samples were stored in clean, sealed and labeled plastic containers in a cool environment until analyzed.

Sediment analytical results were assessed according to the Provincial Sediment Quality Guidelines (PSQG; MOE, 1993), as well as to the Canadian Sediment Quality Guidelines (CSQG) for the protection of aquatic life (Canadian Council of Ministers of the Environment, 2002).

Under the PSQG, three levels of effects are prescribed that reflect potential chronic and longterm effects of contaminants on benthic invertebrates. The three levels are:

- 1) No effect: no toxic effects are observed on aquatic organisms (concentrations are less than the method detection limits);
- 2) Lowest effect level (LEL): level of sediment contamination that can be tolerated by the majority of the sediment-dwelling benthic invertebrates, for which the sediment is considered to be clean to marginally contaminated; and,
- 3) Severe effect level (SEL): level of sediment contamination at which pronounced disturbance of the sediment-dwelling community can be expected, for which the sediment is considered heavily contaminated.

The CSQG prescribe one level of contamination at which there are probable effects (PEL).

### 2.2.3 Benthic Invertebrates

Benthic invertebrates were sampled from lake/pond and river/creek environments to provide a baseline taxonomic reference for the local watercourses relative to the onset of project planning (Figure 2.2). Sampling was completed during the fall of 2007 and results were not available at the time this baseline report was prepared. Accordingly, secondary source information was reviewed and documented to provide an aquatic system condition characterization for project planning, reference and completeness of the aquatic ecosystem description in this report. Further documentation of recent 2007 detailed baseline conditions with respect to the benthic invertebrate community will be prepared under separate report cover.

#### **2.2.4 Aquatic Habitat**

Detailed aquatic habitat field investigations were conducted during the period of August through October 2007. Habitat inventories included rivers, creeks, lakes and ponds within the LSA. The lengths of creek and river channels within the LSA were observed from a channel morphological perspective. The objectives of channel morphological inventories are to:

- Characterize habitat in terms of channel/floodplain dimensions and gradient, substrate composition and vegetation communities;
- Establish classification of channel reaches based on these characteristics: and,
- Provide information to assist with the selection of appropriate sampling locations to characterize water, sediment and benthic macroinvertebrates.

Preliminary delineation of reach type classifications were prepared using remote sensing (aerial photographs and satellite imagery) and available mapping. These initial delineations were adjusted as needed after field review and detailed by means of defining specific coordinates. Field work was undertaken during 2007 reviewed watercourses within the LSA with the exception of the Porcupine River system. This system was reviewed based on secondary source information available from historic baseline and monitoring studies and familiarity of the system to the study team. Based on available information, the watercourse reach classification was also applied for baseline condition reporting consistency. Given that this effort is interpretive and for planning purposes, any site specific work activities intended within this watercourse system should include a detailed site assessment to confirm localized aquatic conditions.

A similar habitat classification system was applied to delineate the shoreline areas along lake and major pond margins. Shoreline habitat was differentiated on the basis of substrate composition, shoreline gradients, depth, riparian and aquatic vegetation, and cover opportunities.

#### **River and Creek Classification System**

The preliminary assessment of river/creek characteristics was completed through classification in terms of generalized reach types exhibiting relatively uniform or common biophysical and habitat characteristics. The morphological and biophysical criteria included: typical channel section, gradient, chainage (measured in kilometers starting from 0 km at downstream limits), substrate composition, riparian vegetation structure, overhead cover (shading) and in-stream cover. Minor variation within a reach type and typical transitions within and between reach types were not detailed as they represented only a small proportion of the overall creek length. The general reach classification is developed through an ongoing system established by AMEC, demonstrating generally common morphological and biophysical characteristics.

Based on the general reach type classification system, a total of nine reach types were found to apply within the LSA. The basic characteristics of each reach types are outlined in Appendix A.

Supporting schematic cross-sections providing key channel diagnostic features for each reach type were prepared and reach distribution delineated on Lidar based mapping. The reach types were described for each of the watercourse systems considered of potential relevance with respect to proposed project activities within the LSA.

## **Lake and Pond Classification System**

Preliminary evaluations of shoreline characteristics were carried out through field observations and photo documentation. Information was later compiled and assessed to classify shoreline types based on common biophysical habitat characteristics as summarized in Appendix B. Shoreline types, vegetative communities (aquatic, riparian/eulittoral, and supralittoral) and substrates for lakes and ponds were summarized in tabular format.

### **2.2.5 Fisheries**

Fish sampling was conducted on riverine and lacustrine systems throughout the LSA during the summer and fall of 2007 to confirm fish species community distribution. Fish were collected using a variety of capture techniques including electrofishing (boat and backpack) (Figure 2.3) and baited minnow traps (Figure 2.4). A summary of capture methods utilized for each respective waterbody is provided in Table 2.1.

Electrofishing was conducted where habitat and access allowed utilizing either a Haltec Backpack Electrofisher (Model Number HT2000B) or a Smith-Root boat electrofishing unit (Model No. 2.55 GPP Electrofisher System). Backpack electrofishing was completed in representative watercourse reaches in an upstream fashion. Electrofishing was typically conducted where defined channels were less than 1 m in depth and bed condition permitted safe wading and collection activity.

Electrofishing was completed using the boat unit generally in shallow (less than 3 m deep) near-shore areas on lakes/ponds and larger watercourse sections that did not permit safe or effective backpack electrofishing. Electrofishing was conducted on the smaller generally shallow water bodies throughout much of the basin in a random transect fashion and along the perimeter shorelines where cover opportunities were characteristically most well represented. In larger waterbodies, electrofishing effort focused on sampling representative shoreline habitat types.

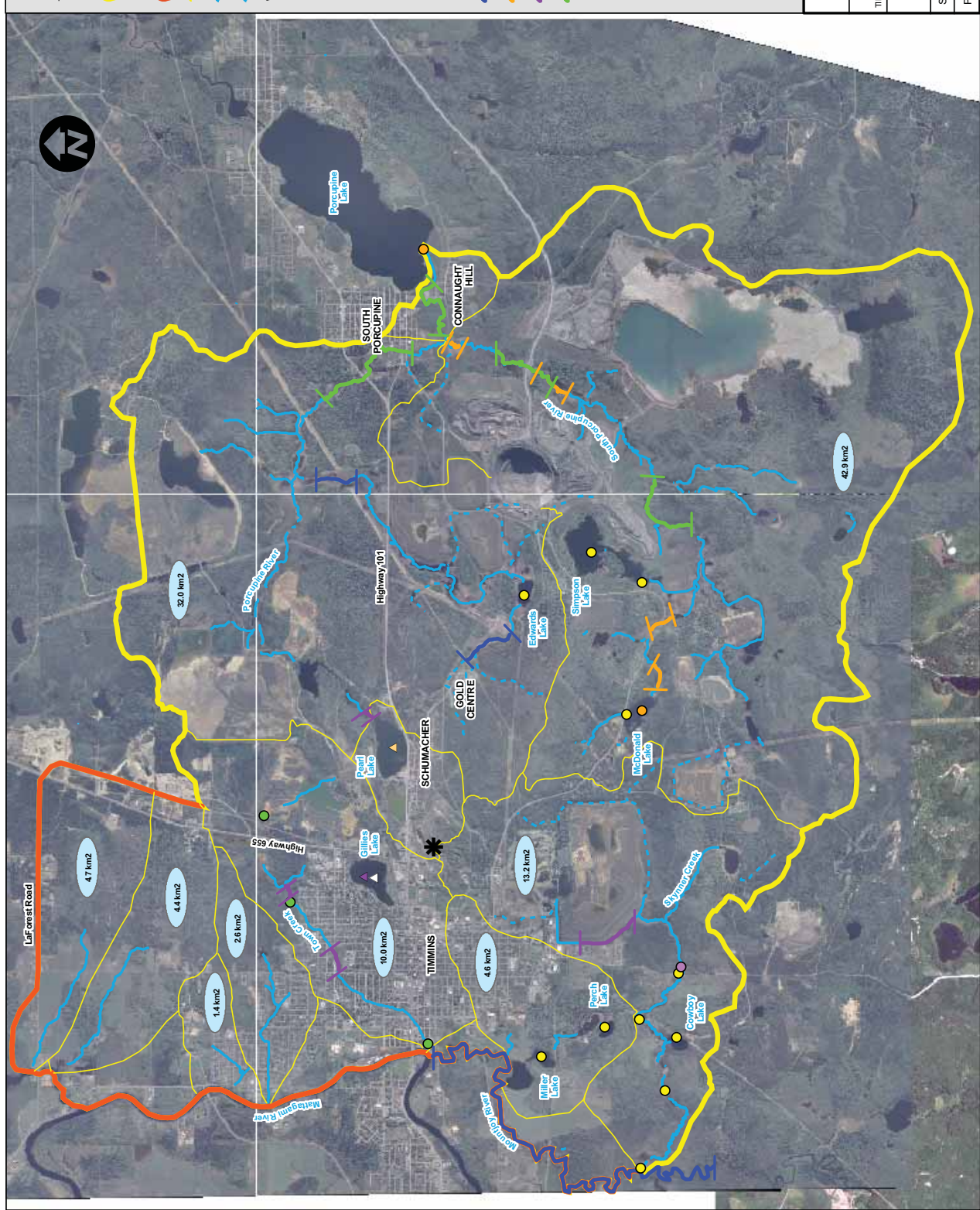
Other fish sampling methodology was used in areas where electrofishing effort was not appropriate. Minnow traps were applied in smaller isolated watercourse reaches and pond shorelines. Secured traps were baited with cat food and bread and checked at least once daily for the duration of the effort.

Individual specimen lengths were taken to the millimeter for large bodied fish using a standard metric ruler in a sampling board. Associated specimen weights were taken via digital calibrating weigh scale to the gram. Appropriate aging structures were taken from sacrificed fish or incidental mortalities intended for flesh metals analysis. Destructive sampling was in accordance with the sample size allocated in the scientific collection permit issued by OMNR, and sampling mortality

was maintained at less than 5% during the inventory program. All captured fish that were not required for destructive sampling, were released unharmed in areas immediately adjacent to collection locations. Visual observations were also made of all fish for obvious tumors and lesions.

**Table 2.1 - Hollinger Baseline Studies Fisheries Community Assessment Collection Methods and Utilization within the Local Study Area**

Sample Location	Smith-Root Boat Electrofishing unit		Haitec Electro Backpack Electro Fisher Unit		Minnow Traps	
	Usage	Time (Seconds)	Usage	Time (Seconds)	Usage	Time (Hours)
Simpson Lake	X	5050				
Mountjoy River	X	2548				
MacDonald Lake	X	1257				
Cowboy Lake	X	1208				
Perch Lake	X	1006				
Miller Lake	X	1108				
Peroli Lake	X	1495				
Miller Pond	X	1913				
Fuller Mine Pond	X	1860				
Edwards Creek						
ED2					X	402
ED1					X	156
Skynner Creek						
SK1			X	785	X	42
SK2			X	1740	X	64
SK3					X	61
SK4					X	30
SK5			X	300		
Simpson Outflow					X	57
<b>Total Usage</b>		<b>17445</b>		<b>2825</b>		<b>812</b>



**Legend:**

- Proposed Hollinger Pt. Centroid
- Study Area (Watershed Boundary)
- Waste Rock Stockpile (Maximum Footprint Under Consideration)
- Study Area (Riverine and Road Boundary)
- Watersheds
- River or Creek
- Intermittent River or Creek
- Water Quality Sampling Location
- AMEC (2007)
- Aquifer Beach (2000)
- Beak (1999)
- Goldcorp
- Minnow (2001)
- Minnow (2002)
- Senes (2007)
- AMEC (2007)
- Beak (1999)
- Minnow (2001)
- Minnow (2005)



**amec**

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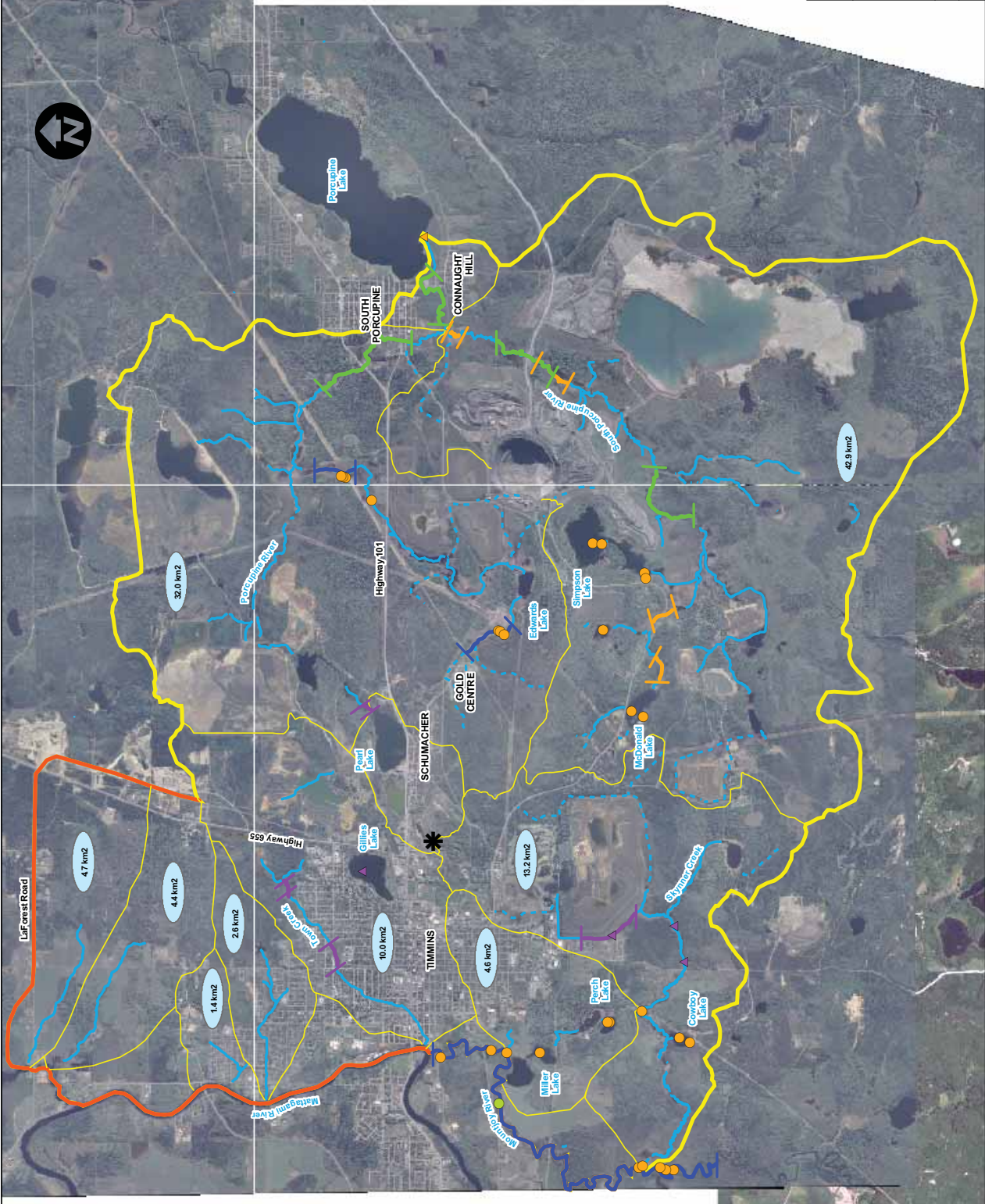
**HOLLINGER BASELINE STUDIES**  
TIMMINS ONTARIO

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**Historical and AMEC 2007  
Water Quality Sampling Locations**

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SCALE: 1:53,000	DATE: MARCH 2008
PROJECT No: TC71507	FIGURE: 2.1
REV: 1	



**Legend:**

- Proposed Hollinger Pit Centroid
- Study Area (Watershed Boundary)
- Study Area (Riverine and Road Boundary)
- Watersheds
- River or Creek
- Intermittent River or Creek
- Sediment Sampling Location**
- Beak (1999)
- Minnow (2002)
- AMEC (2007)
- Beak (1999)
- Minnow (2002)
- Minnow (2005)
- Benthic & Sediment Sample Location (AMEC 2007)
- Sediment Sample Location (1 site only, AMEC 2007)

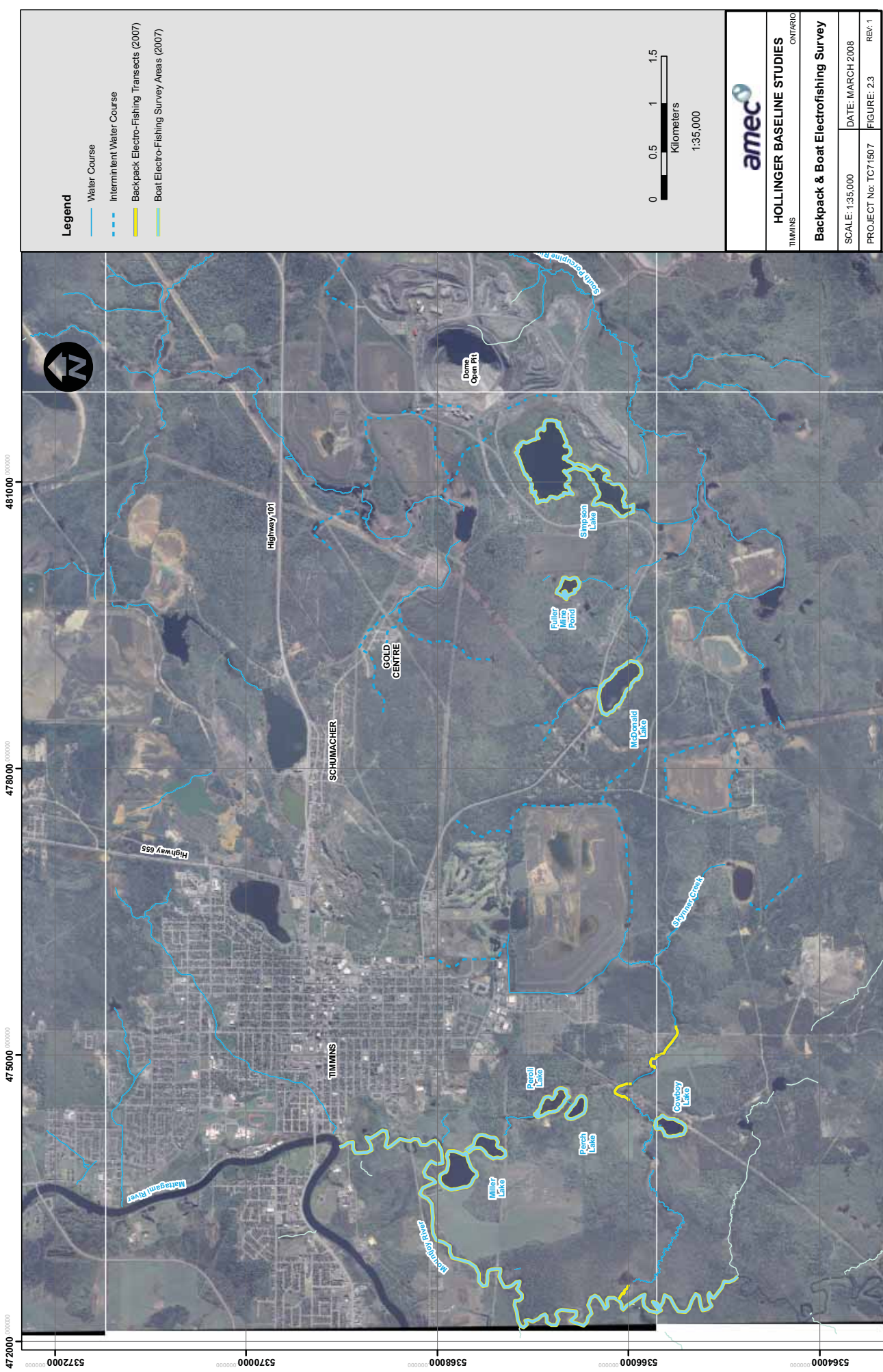


**amec**

**HOLLINGER BASELINE STUDIES**  
TIMMINS ONTARIO

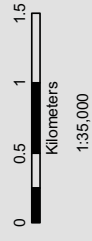
**Historical and AMEC 2007**  
**Sediment and Benthic Sampling Locations**

SCALE: 1:53,000	DATE: MARCH 2008
PROJECT No: TC71507	FIGURE: 2.2
	REV: 1



**Legend**

- Water Course
- - - Intermitent Water Course
- Backpack Electro-Fishing Transects (2007)
- Boat Electro-Fishing Survey Areas (2007)

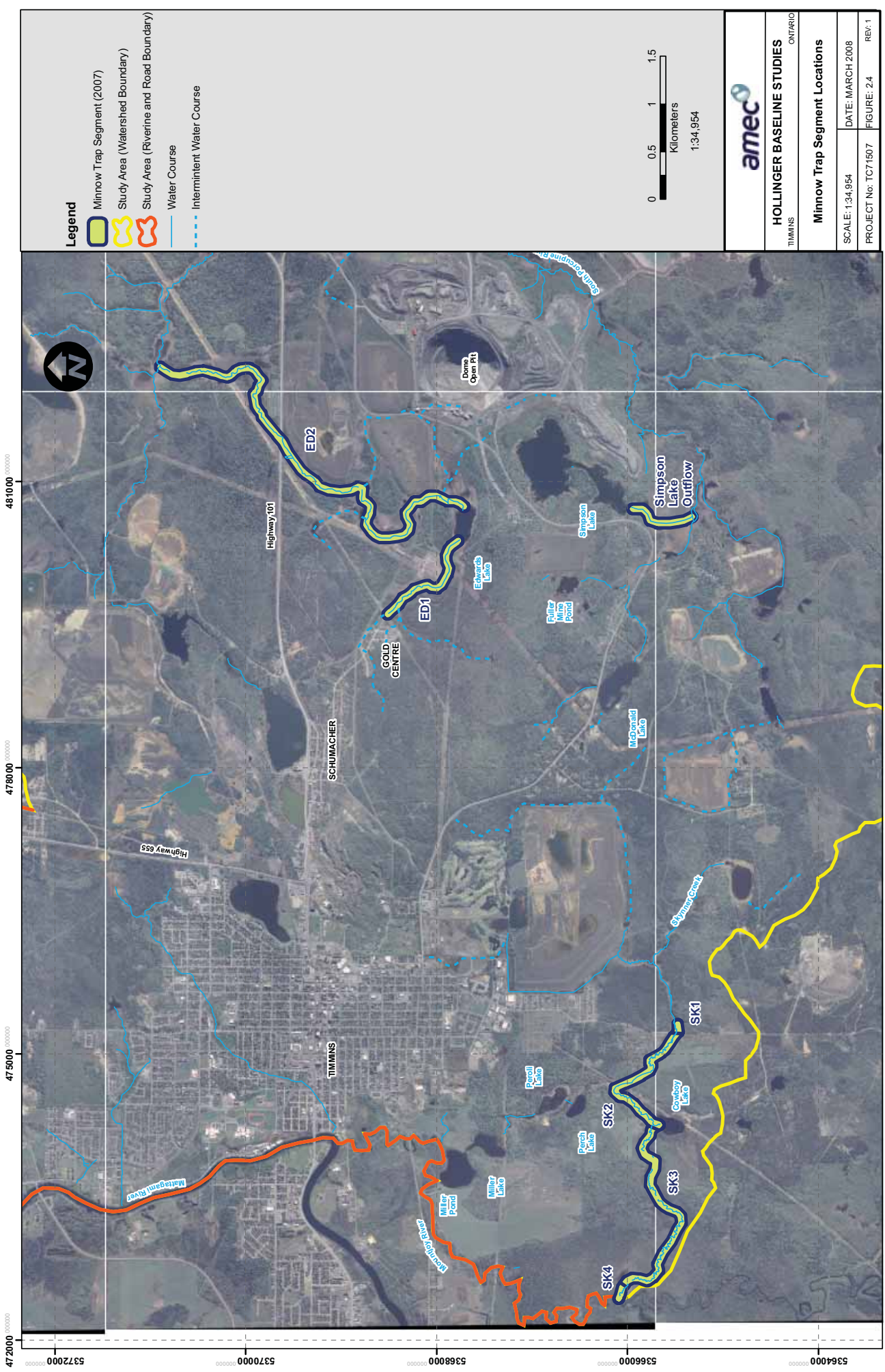


**HOLLINGER BASELINE STUDIES**  
TIMMINS ONTARIO






**Backpack & Boat Electrofishing Survey**

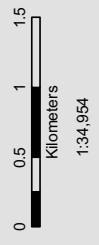
SCALE: 1:35,000	DATE: MARCH 2008
PROJECT No: TC71507	FIGURE: 2.3
	REV: 1

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**Legend**

-  Minnow Trap Segment (2007)
-  Study Area (Watershed Boundary)
-  Study Area (Riverine and Road Boundary)
-  Water Course
-  Intermittent Water Course



<b>HOLLINGER BASELINE STUDIES</b>	
TIMMINS ONTARIO	
<b>Minnow Trap Segment Locations</b>	
SCALE: 1:34,954	DATE: MARCH 2008
PROJECT No: TC71507	FIGURE: 24
	REV: 1

### **3.0 RESULTS**

In addition to the historic secondary source information that was available for aquatic features in the LSA, a supplemental field program was undertaken in 2007 to in-fill data gaps. The comprehensive aquatic habitat characterization and fish sampling effort was conducted during August to October 2007, the results of which are presented herein. The sections that follow describe the river/creek and lake/pond systems and the fisheries resources within the LSA applying a combination of the historic and updated 2007 data.

#### **3.1 Regional Setting**

The region consists of generally low-lying topography with a distribution of exposed rock knobs. Falling within the limits of the City of Timmins, much of the area is urbanized or has been altered as a component of mine infrastructure development including open pits, waste rock piles, tailings areas, power lines and access roads. In the natural areas interspersed beyond developed areas, moderate-size forest blocks dominate and are characterized by varying mixtures of black spruce and poplar (Trembling aspen and Balsam poplar), with white spruce, Jack Pine, balsam fir, tamarack and white birch as common associates. The area contains both riverine and lacustrine systems ranging from intermittent creeks to river systems, as well as largely small and relatively shallow lakes and ponds. The watercourses are typically slow flowing and exhibit extensive flat gradient reaches controlled by the surrounding low-lying topography and beaver activity.

Fish communities in the region are generally diverse, with larger lakes and river systems hosting sport species such as walleye, northern pike and smallmouth bass, coarse fish such as yellow perch and white sucker as well as a variety of small bodied species. Smaller creek and pond systems typically contain only a forage and coarse fish community due to habitat limitations. Recreational species of interest include walleye, and to a lesser extent northern pike and smallmouth bass. Brook trout are also reported to occur in the region, typically in headwater areas where groundwater influence provides suitable thermal regimes, elevated dissolved oxygen, and spawning opportunities. The majority of the lakes are governed by provincial fisheries and management initiatives such as “put, grow, take” which provides angling opportunities.

#### **3.2 Porcupine River Watershed**

The Porcupine River watershed, to the point of its confluence with the South Porcupine River just west of Porcupine Lake, measures 32.0 km<sup>2</sup> (Figure 3.1). Beyond this confluence, the Porcupine River flows into the southwest end of Porcupine Lake, and on leaving Porcupine Lake, flows in a north-north-easterly direction, meandering to the north before orienting south to drain into Night Hawk Lake, and the Frederick House River system. Near where the Porcupine River crosses Highway 101, at Hoyle, just upstream of its confluence with Night Hawk Lake, Environment Canada formerly maintained the Porcupine River WSC flow gauging station (04MD004). This station was operated from January 1977 to September 1994 (AMEC 2007a).

Headwaters of the Porcupine River drain Little Pearl Tailings Pond, Pearl Lake, Clearwater Lake, and the southern portion of the ERG tailings area. Current underground dewatering through pumping at the McIntyre headframe, results in a supplemental discharges to Little Pearl Tailings Pond, and hence to the Porcupine River. This pumping is carried out to control groundwater levels in the Hollinger mine site area. Underground workings of the former Hollinger, McIntyre and Coniaurum mines are all interconnected resulting in a considerable reservoir. Water quality and quantity within the Porcupine River is influenced by past mining activities within its drainage basin.

The Porcupine River is a low gradient system, with the river mainstem, downstream of Pearl Lake exhibiting a gradient of 0.44% (i.e., a drop of 4.4 m vertical per 1,000 m horizontal). The river flow and that of its tributaries is interrupted by numerous beaver dams, both active and historic. The western portion of the watershed is characterized by rock knob terrain, with secondary expression of low-lying glacio-lacustrine clay and silt plain terrain (Figure 1.3). At a point directly north of the historic tailings bordering the south side of Highway 101, the terrain transitions to one dominated by glacio-lacustrine clay and silt plain terrain, with secondary inclusions of rock ridge and organic terrain.

### **3.2.1 Water Quality**

Water quality data for the Porcupine River system are available from EAG (1989), Beak (1999), Minnow (2001, 2005), Goldcorp Canada Ltd. data files, and from data collected as part of this 2007 baseline study (Table 3.1). From upstream to downstream, water quality data are available for Pearl Lake (Goldcorp data files), the Porcupine River just downstream of Pearl Lake (Minnow 2001), Clearwater Lake (EAG 1987), Edwards Creek upstream (this study), Edwards Creek downstream (this study), Porcupine River at Highway 101 (Minnow 2005), and Porcupine River outlet to Porcupine Lake (Beak 1999 and Minnow 2005). Sample locations are shown in Figure 2.1.

The general watershed shows signs of water quality degradation for a number of parameters along its main stem from the Pearl Lake headwater area to Porcupine Lake and beyond. Edwards Creek, on the other hand, shows little if any signs of water quality degradation; and where apparent degradation of Edwards Creek is suggested, the reason for this is the use of laboratory detection limits which are in excess of guideline values (i.e., for total phosphorus, cadmium, and lead).

Headwater areas of the Porcupine River are influenced by (1) mine water pumped from the McIntyre #11 shaft headframe to Little Pearl Tailings Pond, which drains to Pearl Lake, and (2) seepage and runoff from the McIntyre and Coniaurum above grade tailings deposits (Figure 2.1). Mid channel reaches are affected by drainage from the ERG tailings facility, and the lower reach is affected by treated effluent discharge from the Dome tailings facility. Of these various contaminant sources, only the McIntyre #11 shaft discharge and the Dome tailings discharge are actively managed. The other sources are passive inputs originating from historic mining infrastructure.



Parameters which exceed, or potentially, exceed provincial and/or federal protection of aquatic life guidelines in the Porcupine River mainstem include: nitrate, nitrite, total phosphorus, aluminium, arsenic, cadmium, chromium, cobalt, copper, iron, lead, mercury, nickel, and zinc. In a number of instances, potential exceedences are due mainly to the use of laboratory detection limits which are in excess of applicable provincial or federal guidelines; hence it can not be confirmed that existing water quality is consistent with these guidelines.

In the case of nutrients (nitrate, nitrite and total phosphorus) exceedences of nitrate/nitrite guidelines are minor and very infrequent, and therefore not of concern. Phosphorus, however, occurs in modest to slight excess of the provincial interim guideline value of 0.03 mg/L throughout the system, with maximum recorded values in the range of 0.10 to 0.12 mg/L. The source of the added phosphorus is sewage from historic and active septic systems, and from past spills of untreated sewage (Minnow 2005).

Among the metals and metalloids, exceedences of aluminium concentrations are infrequent, marginal and not of concern; and arsenic was only observed to be in excess of provincial federal guidelines (and the interim provincial guideline) at the downstream most station, downstream of the confluence with the South Porcupine River, which shows elevated arsenic concentrations throughout much of its length (Table 3.1).

Cadmium concentration detection limits have generally been sufficient to allow comparison with provincial water quality guidelines, set at 0.0002 mg/L, but not with federal guidelines set at a more stringent 0.000017 mg/L. There is only one instance where cadmium exceeded the provincial guideline, and that was for the upper range of samples collected from the Porcupine River just upstream of Porcupine Lake, where the guideline was only marginally exceeded. Detection limits are not sufficiently rigorous to allow meaningful comparisons with the more stringent federal guideline value of 0.000017 mg/L, but at least some measured cadmium values were above the 0.0001 mg/L laboratory detection threshold frequently used, such that the federal guideline is likely to be commonly exceeded in the present condition.

Chromium concentrations were generally either below the provincial/federal guideline, or below the applicable laboratory detection limit. The high upper range chromium concentration of 0.366 mg/L recorded for Pearl Lake is not consistent with other values from this site, and is considered anomalous (Table 3.1). Where more stringent detection limits were used, chromium concentrations were well below protection of aquatic life guideline values, such that chromium does not appear to be of concern.

Cobalt concentrations were elevated with respect to provincial water quality guidelines in the Porcupine River downstream of its confluence with the South Porcupine River (Table 3.1). Cobalt concentrations at the Highway 101 crossing were inconclusive due to restricted laboratory detection limits. Upstream Porcupine River sites (effectively Pearl Lake) showed cobalt concentrations below the provincial guidelines.

Copper is elevated throughout the Porcupine River mainstem, downstream of the McIntyre and Coniaurum tailings areas. Copper is a frequent associate of gold mineralization, and the presence of elevated copper in the Porcupine River system is directly attributable to past and current mining activities. Average copper concentrations are approximately twice the provincial and federal guideline values in the middle sections of the Porcupine River, and higher still in the lowest river reaches below the confluence with the South Porcupine River, where copper is the contaminant of primary concern. Higher copper concentrations shown for Clearwater Lake in the EAG 1989 data are potentially unreliable relative to dated analytical technology and feasible detection limits, and are provided for historical reference only. The EAG data are not considered indicative of current conditions.

Iron concentrations are typically consistent with provincial and federal protection of aquatic life guidelines, except where total suspended solids (TSS) are elevated, in which case the iron is associated with particulate materials and is not of concern. The very high upper range value of 1.23 mg/L for samples from Pearl Lake was associated with an extremely elevated TSS value of 133 mg/L.

Lead concentrations in Porcupine River samples were generally low, with the exception of the older EAG data that are considered unreliable and dated. Where potential exceedences of the more stringent federal protection of aquatic life guidelines are indicated, the problem is likely with the laboratory detection limits. Where more stringent detection limits were used, lead levels were generally quite low. The elevated 0.0666 mg/L upper range lead value shown for Pearl Lake was associated with a high TSS value of 35.9 mg/L, which is not indicative of the general data set.

Mercury concentrations were generally below the provincial water quality guideline value of 0.0002 mg/L, but potentially above the far more stringent federal guideline of 0.000026 mg/L guideline. The upper end ranges of samples from the Porcupine River at Highway 101 and at the outlet to Porcupine Lake showed mercury concentrations slightly above the provincial guideline (Table 3.1). Mercury was used historically for gold recovery (amalgamation) in the Porcupine camp, and therefore is still likely to be in the system at some level.

Nickel concentrations were generally consistent with provincial and federal guidelines, with the exception of the earlier EAG data, and are not of concern. Zinc concentrations were similarly consistent for the most part with provincial and federal guidelines, and are not of concern. Except for the EAG data, where exceedences of guidelines did occur for zinc, the exceedences were minor and infrequent.

Taking all of the above into consideration, the principal contaminants of potential concern are (1) cadmium and mercury relative to the more stringent federal guidelines, (2) cobalt in downstream portions of the system below the confluence with the South Porcupine River, and possibly at the Highway 101 crossing, and (3) copper throughout the system. Compared with historic conditions, overall metal concentrations in the Porcupine River system appear to be improving (Minnow 2005), which is a function of both reduced active mining activity, and the application of improved wastewater treatment technologies in the case of the Dome Mine. The Dome Mine currently uses a

combination of natural degradation and chemical oxidation (INCO SO<sub>2</sub>Air process) to destroy cyanide; and lime, ferric sulphate and Ethylenediaminetetraacetic acid(EDTA) addition to manage metal concentrations and toxicity (Minnow 2002). Results with this combined effluent treatment system have been effective at meeting provincial requirements.

### 3.2.2 Sediment Quality

Sediment quality data for the Porcupine River system are available from Beak (1999), Minnow (2001, 2005), and from data collected as part of this baseline study (Table 3.2). From upstream to downstream, sediment quality data are available for Pearl Lake (Minnow 2001), the Porcupine River just downstream of Pearl Lake (Minnow 2001), Edwards Creek (this study), Porcupine River at Highway 101 (Minnow 2005), and Porcupine River outlet to Porcupine Lake (Beak 1999 and Minnow 2005). Sample locations are shown in Figure 2.2.

As with water quality data, the general watershed shows signs of sediment quality degradation for a number of parameters along the river mainstem from Pearl Lake to Porcupine Lake. Also, similar to the water quality data for this system, Edwards Creek for the most part shows limited degradation of sediment quality, with the exception of one sample (sample S2007-13659), which showed elevated concentrations of a number of parameters. The high copper, nickel and zinc values for this single sample suggest that the sample may contain tailings solids associated with the historic Dome tailings, which have long since been rehabilitated. Some release of tailings to this watercourse occurred in 2003 as a result of tailings dam erosion, which has subsequently been repaired. This sample also contains notably elevated levels of organic materials, which can sequester heavy metals and therefore account in part for the elevated metals concentrations.

Parameters which exceed provincial sediment quality guidelines in the Porcupine River mainstem include: total Kjeldahl nitrogen (TKN), total organic carbon (TOC % solids), arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc. Essentially all parameters, for which there are provincial sediment quality guidelines, are in exceedence of the guidelines at some level, with the exception of the guideline for total phosphorus, for which there are fewer measurements. In the majority of instances, the exceedences are for lowest effect level (LEL) thresholds. However, for TKN, TOC, arsenic, copper, nickel and zinc, there are a number of instances where contaminant concentrations exceed the severe effect level (SEL). LEL levels are defined such that the threshold “level of contamination which has no effect on the majority of the sediment-dwelling organisms. The sediment is clean to marginally polluted. (Persaud et al. 1992). The SEL is defined as sediment which is “considered heavily polluted and likely to affect the health of sediment-dwelling organisms.” (Persaud et al. 1992).

TKN is a measure of that portion of nitrogen associated with ammonia and organics (mainly amines), and is therefore related to the amount of organic matter present in the sediments. Hence, there is a strong relationship between the two measures. For example, a regression analysis of TKN and TOC values shown in Table 3.2 yields an “R<sup>2</sup>” coefficient of 0.93. Where elevated TKN and TOC values are due to human influences, the sources of contamination are typically sewage and agricultural runoff. However, TKN and TOC are also high in wetland environments and in lakes



and pond sediments which contain naturally high organic sediment content. The Perch Lake deep basin data provide a good example of a local instance where there is little suggested influence of water quality deterioration due to anthropogenic influences, but where TKN and TOC are both at levels well above SEL guidelines. It is consequently suspected that the majority of elevated TKN and TOC values shown for the Porcupine River system are due to natural causes, and not to anthropogenic influences.

Elevated concentrations of arsenic, copper, nickel and zinc, on the other hand, are undoubtedly associated with local mining activities, past and present, although even here some local enrichment would be expected in the natural background condition due to regional mineralization. Pearl Lake, in the Porcupine River headwaters, shows marked elevations of all four parameters, with particularly high concentrations of arsenic, copper and zinc. Pearl Lake is a historic recipient of mine water discharges and may also have received some direct tailings input in the past. Further downstream, at the Highway 101 crossing and above Porcupine Lake, zinc and copper appear to diminish (although copper concentrations are still well above the SEL concentration guideline); whereas arsenic concentrations remain strongly elevated, and there is an increase in the concentration of nickel.

Descriptions above provide comparisons with provincial sediment guidelines, only. Federal guidelines are shown in Table 3.2 for comparison, but are not discussed. Generally, the federal guideline values (Canadian Environmental Quality Guidelines – Probable Effect Level – CEQG PEL) are all intermediate between the provincial LEL and SEL values, with the exception of copper, where the federal guideline is above the provincial SEL value.

### **3.2.3 Benthic Invertebrates**

The earliest records of the benthic macroinvertebrate community were available from mine effluent monitoring studies conducted by EAG (1989). This investigation identified a chironomid dominated invertebrate community that was considered consistent with the soft textured organic and clay substrates common to both the Porcupine and South Porcupine River. The Porcupine River immediately downstream of the ERG tailings discharge was characterized as exhibiting no crustaceans, very few molluscs, and many more tubificids and chironomids than the South Porcupine.

According to sampling undertaken by Beak (1999), the lower reach of the Porcupine River immediately upstream of Porcupine Lake showed similar or greater (69 taxa) diversity than a reference reach in the South Porcupine River near McDonald Lake, as well as representation by suggested indicator species such as Ephemeroptera, Plecoptera and Trichoptera (EPT) species, amphipods and clams (*Pisidium*). Chironomids represented the most abundant organism with over 20% proportional representation.

Environmental effects monitoring undertaken by Minnow (2004) focused on the areas of the South Porcupine River, relative to the Dome tailings effluent discharge, the area below the confluence of the Porcupine and South Porcupine River, and the Porcupine River through the town of South

Porcupine. Consistent with previous inventories, chironomids were the most abundant organism in the Porcupine River in the range of 20 to 30% of relative abundance. Tubificids ranged from 10 to 20% of relative abundance, also characterizing the fine soft sediments in this system. Other groups were noted to largely be expressed at less than 10% of the representative community, and were distributed in a patchy manner with localized abundance. EPT species were rare in all areas, including in those upstream of mine effluent related discharges, thereby suggesting general habitat limitations. In the reaches below the confluence of the two watercourses and above Porcupine Lake, the benthic community was notably different from the individual watercourse reaches upstream, suggesting higher habitat complexity, moderate enrichment and/or recovery from stress.

The upper watershed areas including Pearl Lake (Porcupine River) were reported by Minnow (2001). A total of 21 taxa were identified within Peal Lake and with the exception of seed shrimp, which dominated the macroinvertebrate community at one sampling station (67.0% of the total taxa), the predominate taxa was represented by chironomids consistent with other watershed areas of similar fine soft substrates. The low observed diversity was considered consistent with elevated metals levels in the sediments. Data collected in October 2001 (Minnow 2001) determined that the invertebrate community in the Peal Lake Outlet had low density and diversity, but was similar to the lake with 20 taxa observed. Chironomids (44%) and Ostracods (27%) dominated the community. A high proportion of annelid worms within the samples were attributed to low dissolved oxygen levels and fine sediment substrates.

Although no historic sampling records were available for Clearwater and Edwards Lake, given the similarity of habitat conditions amongst the waterbodies, a similar macroinvertebrate community composition as observed in the most proximate sampling locations reported in the above noted reports is anticipated.

### **3.2.4 Aquatic Habitat**

During the 2007 field program, approximately 6,566 m of Edwards Creek and the perimeter of Edwards Lake and Pearl Lake were evaluated for biophysical characteristics. Additionally, secondary source reference material and Lidar satellite imagery were utilized to classify the Porcupine River, Pearl Lake Outflow Channel, Clearwater Lake and the Clearwater Lake Outflow Channel. Detailed channel diagnostic features are outlined in Table 3.3 and their distribution is shown in Figure 3.2.

TABLE 3.3 HOLLINGER BASELINE STUDIES KEY BIOPHYSICAL PARAMETERS AND CHANNEL DIAGNOSTICS WITHIN LOCAL STUDY ARE.

Watercourse	Reach Type	Proportional Reach Length (%)	Total Length of Reach Type (m)	Watershed	Gradient	Channel Morphology (% composition)	Mean Bank Width (m)	Mean Bank Depth (m)	Mean Bed Depth (m)	Floodplain Width (m)	Left Upstream Bank Stability	Right Upstream Bank Stability	Substrate Composition (%)	In-stream Cover (% of surface area)	Aquatic Vegetation Type (based on overall 100% distribution)			Overbank Vegetation (stream adjacent)	Riparian Vegetation	Migratory Obstructions / Potential Habitat	Summer Water Chemistry Parameters	
															Emergent	Flloating	Submergent					
Mountjoy River	Type 1	100%	9842.98	Mountjoy Watershed	Low	100% Flat	22.6	4.28	3.13	30	Stable	Stable	60% Clay, 20% Sand, 15% Silt, 5% Detritus	20% 150k Large Woody Debris, 10% Overhanging Vegetation, 5% Aquatic Vegetation, 20% Upland Water	30% (60% Grasses, 10% Arrowweed)	0	70% (80% Pondweed, 10% Grasses)	5% Overhanging Vegetation	Sedge, Grasses, Willow, Red Cedar, Dogwood, Black Spruce, White Birch, Trembling Aspen, Balsam Fir	Woody Debris, Jam	pH: 8.39 Conductivity: 28.28 us DO: 8.39 mg/L Water Temp: 16.79°C	
	Type 3A	3.18%	282.09	Mountjoy Watershed	Low	80% Run, 20% Flat	1.47	0.69	0.43	40-70	Stable	Stable	30% Muck, 30% Sand, 15% Clay, 10% Silt, 5% Detritus, 5% Cobble, 5% Gravel	20% 50k Overhanging Vegetation, 5% Aquatic Vegetation, 5% Upland Water, 10% Woody Debris, 10% Upland Water	0	100% (100% Grasses)	30% Overhanging Vegetation	Sedge, Grasses, Willow, Herbaceous species, Red Cedar Dogwood, Black Spruce, Trembling Aspen, Spruce, Balsam Fir	Urban Debris, Jam, Woody Debris, Jam	pH: 8.40 Conductivity: 132.0 us DO: 8.39 mg/L Water Temp: 16.13°C		
	Type 4	62.50%	554.87		Low	-	-	-	1.15	10x15, 30x30, 150x200, 300x60, 150x250	Stable	Stable	60% Muck, 20% Detritus, 10% Gravel, 10% Clay Silt, 10% Cray	20% 20k Woody Debris, 10% Overhanging Vegetation, 40% Aquatic Vegetation	60% (60% Reed, 50% Cattail, 10% Arrowweed)	10% (100% Pondweed)	50% (50% Milkfoil, 40% Stonewort, 10% Grasses)	Cattail, Sedge, Bulrush, Alder, Willow, Red Cedar Dogwood, Tamarac, Cedar, Black Spruce, Trembling Aspen, White Birch	Beaver Dams, Woody Debris, Puddle in stream vegetation	pH: 8.39 Conductivity: 640 us DO: 7.78 mg/L Water Temp: 13.59°C		
	Type 6A	12.08%	1071.00		Low	40% Run, 20% Pool, 20% Rifle	1.72	0.78	0.23	6-20	Unstable	Unstable	40% Sand, 20% Gravel, 10% Detritus, 10% Silt	15% 100k Aquatic Vegetation, 15% Undercut Bank, 10% Upland Water, 10% Urban Debris	10% (50% Stonewort, 50% Grasses)	15% Overhanging Vegetation	50% (50% Milkfoil, 40% Stonewort, 10% Grasses)	Sedge, Grasses, Bulrush, Cattail, Choccherry, Trembling White Birch, Raspberry	Woody Urban Debris, ATV Trail Crossing, Low flow Conditions	pH: 7.27 Conductivity: 101.5 us DO: 8.39 mg/L Water Temp: 13.5°C		
Smymer Creek	Type EB	6.83%	606.98		Low	90% No Morphology, 5% Rifle, 5% Run	-	-	6.03 - >1.5	20-150	Slightly Unstable	Slightly Unstable	40% Muck, 20% Detritus, 20% Sand, 10% Silt, 5% Gravel, 5% Clay, 5% Cobble	20% 50k Organic Debris, 10% Overhanging Vegetation, 30% Aquatic Vegetation	50% (60% Reed, 10% Sedge)	0	50% (60% Milkfoil, 20% Stonewort)	5% Overhanging Vegetation	Sedge, Grasses, Bulrush, Willow, Herbaceous species, Alder, White Birch, Trembling Aspen, Spruce, Balsam Fir, Raspberry	Beaver Dams	pH: 8.40 Conductivity: 126 us DO: 7.05 mg/L Water Temp: 17.52°C	
	Type 8A	3.46%	306.96		Moderate	40% Run, 40% Pool, 20% Rifle	2.12	0.79	0.39	10-20	Moderately Unstable	Moderately Unstable	40% Sand, 20% Gravel, 20% Detritus, 5% Clay, 10% Silt, 5% Cobble	20% 40k Aquatic Vegetation, 5% Upland Water, 5% Boulder, 10% Cobble, 10% Urban Debris, 10% Overhanging Woody Debris, 10% Aquatic Vegetation	45% (60% Grasses, 40% Arrowweed)	50% (100% Stonewort)	50% (100% Pondweed)	50% (60% Milkfoil, 20% Stonewort)	Herbaceous species, Red Cedar Dogwood, Trembling Aspen, Black Spruce, Balsam Fir, White Birch	Large Urban Debris, Unfinished Culvert at Pipe Street, Low Flow Conditions at Rifle Areas	pH: 7.97 Conductivity: 426 us DO: 8.39 mg/L Water Temp: 16.21°C	
	Type 8B	1.48%	130.97		Moderate	40% Pool, 30% Run, 30% Rifle	1.75	0.68	0.26	2-3.5	Unstable	Unstable	50% Sand, 30% Detritus, 10% Silt, 10% Gravel	40% 60k Large Woody Debris, 5% Debris, 25% Overhanging Vegetation	0	0	10% (100% Stonewort)	10% Overhanging Vegetation	Herbaceous species, Balsam Fir, Red Cedar Dogwood, Alder, Cattail, Spruce	Woody Debris, Beaver Dam, Gradient	pH: 9.01 Conductivity: 104 us DO: 9.81 mg/L Water Temp: 12.89°C	
	Type 12	10.43%	925.29		Low	-	-	-	0.66	200-300	Stable	Stable	60% Muck, 40% Detritus	50% (60% Overhanging Vegetation, 20% Woody Debris, 20% Organic Debris)	0	0	50% (100% Overhanging Vegetation, 10% Woody Debris)	50% Overhanging Vegetation	Sedge, Grasses, Cattail, Willow, Herbaceous species, Ferns, Red Cedar Dogwood, Black Spruce, Trembling Aspen, Black Spruce, White Birch, White Moss	No Defined Channel Passage, Low flow Conditions, Woody and Organic Debris	pH: 7.47 Conductivity: 714 us DO: 7.74 mg/L Water Temp: 12.89°C	
Edwards Creek	Type 3A	5.88%	386.58	Percupine Watershed	Low	70% Run, 30% Flat	1.24	0.73	0.27	30-50	Unstable	Unstable	30% Muck, 30% Sand, 20% Detritus, 10% Silt, 10% Gravel	30% 45k Overhanging Vegetation, 15% Aquatic Vegetation, 15% Woody Debris, 5% Undercut Bank, 15% Undercut Bank	100% (20% Herbaceous Cattail, 75% Sedge)	0	0	30% (50% Milkfoil, 40% Stonewort, 10% Grasses)	30% Overhanging Vegetation	Willow, Herbaceous species, Red Cedar Dogwood, Alder, White Birch, Spruce, Balsam Fir	Beaver Dams, Woody Debris, Puddle in stream vegetation	pH: 7.90 Conductivity: 482 us DO: 1.04 mg/L Water Temp: 17.41°C
	Type 4	74.55%	4895.40		Low	-	-	-	1.01 - >1.5	50-400	Stable	Stable	60% Muck, 20% Detritus, 10% Silt, 10% Clay	25% 30k Organic Debris, 60% Aquatic Debris, 10% Woody Debris	60% (10% Reed, 80% Cattail, 10% Sedge)	10% (50% Pondweed, 50% Duckweed)	30% (40% Milkfoil, 60% Stonewort)	10% (100% Overhanging Vegetation)	Cattail, Sedge, Bulrush, Alder, Willow, Red Cedar Dogwood, Tamarac, Cedar, Black Spruce, Balsam Fir, Trembling Aspen, White Birch	Beaver Dams, Woody Debris, Puddle in stream vegetation	pH: 8.17 Conductivity: 1562 us DO: 8.30 mg/L Water Temp: 18.19°C	
	Type 6B	10.36%	680.26		Low	-	-	-	>1.75	50-65	Stable	Stable	50% Muck, 30% Detritus, 15% Sand, 5% Clay, 5% Cobble	20% 100k Woody Debris, 10% Overhanging Vegetation, 40% Aquatic Vegetation	70% (10% Herbaceous Cattail, 60% Sedge)	10% (100% Pondweed)	20% (50% Milkfoil, 40% Stonewort, 10% Grasses)	5% Overhanging Vegetation	Cattail, Sedge, Bulrush, Alder Dogwood, Herbaceous species, Cedar, Black Spruce, Balsam Fir, Trembling Aspen, White Birch	Beaver Dams, Woody Debris, Industrial Landuse	pH: 8.39 Conductivity: 126 us DO: 1.25 mg/L Water Temp: 17.68°C	
	Type 8B	6.45%	423.34		Moderate	60% Run, 30% Pool, 10% Rifle	1.45	0.65	0.33	8-15	Unstable	Unstable	30% Silt, 25% Detritus, 10% Sand, 5% Gravel, 5% Clay, 5% Cobble	30% 140k Woody Debris, 10% Undercut Bank, 25% Overhanging Vegetation, 20% Organic Debris, 5% Aquatic Debris	100% (100% Arrowweed)	0	10% (100% Pondweed)	10% (100% Overhanging Vegetation)	Sedge, Grasses, Herbaceous species, Alder Dogwood, Myrtle sylvatica, Red Cedar Dogwood, Alder, Balsam Fir	Woody Debris, Residential Landuse	pH: 8.07 Conductivity: 1113 us DO: 7.03 mg/L Water Temp: 14.89°C	

TABLE 3.3 HOLLINGER BASELINE STUDIES KEY BIOPHYSICAL PARAMETERS AND CHANNEL DIAGNOSTICS WITHIN LOCAL STUDY AREA.

Watercourse	Reach Type	Proportional Representation of Total Length (%)	Total Length of Reach Type (m)	Watershed	Gradient	Channel Morphology (% composition)	Mean Wetted Width (m)	Mean Bankfull Depth (m)	Mean Wetted Depth (m)	Mean Bankfull Width (m)	Pond Dimensions	Floodplain Width (m)	Left Upstream Bank Stability	Right Upstream Bank Stability	Substrate Composition (%)	In-stream Cover (% of surface area)	Aquatic Vegetation Type Based on overall 100% distribution!	Emergent	Flloating	Stemmergent	Overhead Coverage (% stream studied)	Riparian Vegetation	Migratory Obstructions / Potential Critical Habitat	Summer Water Chemistry Parameters
	Type 12	2.75%	180.77		Low		-	0.63		-	-	50 - 70	Stable	Stable	60% Muck, 40% Detritus	60% (60% Overhanging Vegetation, 20% Overhanging Woody Debris, 20% Organic Debris)	0	0	0	70% Overhanging Vegetation, 5% Overhanging Woody Debris	Sedge, Grasses, Cattail, Willow, Herbaceous species, Myrica sp. ssp., Fens, Red Oak Dogwood, Alder, White Birch, Black Spruce, Balsam Fr, Sphagnum Moss	No Defined Channel Passage, Low flow Conditions, Woody and Organic Debris	pH: 7.34 Conductivity: 86.6 us DO: - Water Temp: 19.1	
Pearl Lake Outflow Channel	Type 4	100%	1113.00	Porcupine Watershed	Low		5-10	1.5-2.0		15X17, 75X175	20 - 170	Stable	Stable	Stable	60% Muck, 20% Detritus, 20% silt / sand	20% (40% Aquatic Vegetation, 30% Woody Debris, 30% Overhanging Vegetation)	40% (45% Reed, 20% Grasses, 10% Sedge)	10% (30% Potamogeton, 70% Duckweed)	50% (30% Storewort, 70% Storewort)	5% Overhanging Vegetation	Cattail, Bulrush, Grasses, Sedges, Alder, Willow, Red Pine, Balsam Fr, Red Oak Dogwood, Meadow Sweet, Trembling Aspen	Beaver Dams, Road / Culvert Crossing Obstructions, Low Flow Conditions	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a	
Clewer Lake Outflow Channel	Type 4	100%	1035.30	Porcupine Watershed	Low		-	0.4		35X100	70 - 150	Stable	Stable	Stable	60% Muck, 20% Detritus, 20% silt / sand	50% (50% Aquatic Vegetation, 30% Woody Debris, 20% Organic Debris)	30% (Horsetail, Cattail)	0	0	5% Overhanging Vegetation	Cattail, Bulrush, Alder, Willow, Red Pine, Balsam Fr, Red Oak Dogwood, Trembling Aspen	Beaver Dams, Road / Culvert Crossing Obstructions, Low Flow Conditions	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a	
Stimpson Lake Outflow Channel	Type 4	100%	892.89	South Porcupine Watershed	Low		-	0.65 - >1		12X14, 30X50, 60X100, 50X150	20 - 150	Stable	Stable	Stable	80% Muck, 20% Detritus	20% (40% Aquatic Vegetation, 20% Woody Debris, 10% Organic Debris)	45% (45% Cattail, 25% Reed, 15% Grasses, 15% Sedge, 5% Arrowweed)	5% (50% Potamogeton, 50% Duckweed)	50% (30% Miffoil, 70% Storewort)	5% Overhanging Vegetation	Cattail, Sedge, Bulrush, Alder, Willow, Red Pine, Balsam Fr, Red Oak Dogwood, Trembling Aspen, White Birch	Beaver Dams, Potlase In stream Vegetation	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a	
McDonald Lake Outflow Channel	Type 4	71%	645.45	South Porcupine Watershed	Low		-	-		30X36, 55X200	50 - 70	Stable	Stable	Stable	Combination of Muck and Detritus	Combination of Aquatic Vegetation, Overhanging Vegetation, and Organic Debris	Combination of Cattail, Sedges, Grasses	-	-	Combination of Storewort and Miffoil	Combination of Overhanging Vegetation	Trembling Aspen, Black Spruce, Alder, Grasses, Sedges	Combination of Beaver Dams, Potlase in Stream Vegetation	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a
	Type 6A	22%	200.00		Low		1 - 1.5	-		-	50 - 70	Stable	Stable	Stable	Combination of Muck and Detritus	Combination of Aquatic Vegetation, Overhanging Vegetation, and Organic Debris	Combination of Cattail, Sedges, Grasses	-	-	Combination of Storewort and Miffoil	Combination of Overhanging Vegetation	Trembling Aspen, Black Spruce, Alder, Grasses, Sedges	Combination of Beaver Dams, Potlase in Stream Vegetation	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a
	Type 12	7%	63.60		Low		-	-		-	50 - 70	Stable	Stable	Stable	Combination of Muck and Detritus	Combination of Overhanging Vegetation, Overhanging Woody Debris, and Organic Debris	Combination of Cattail, Sedges, Grasses	-	-	0	Combination of Overhanging Vegetation, Overhanging Woody Debris	Sedge, Grasses, Cattail, Herbaceous species, Myrica, Woodruff, Sphagnum, Alder, Red Pine, Balsam Fr, Red Oak Dogwood, Alder, White Birch, Trembling Aspen, Black Spruce, Balsam Fr, Sphagnum Moss	No Defined Channel Passage, Low flow Conditions, Woody and Organic Debris	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a
Fuller Mine Pond Outflow Channel	Type 4	100%	535.50	South Porcupine Watershed	Low		-	-		13X30, 16X50, 63X60, 84X60	70 - 200	Stable	Stable	Stable	Combination of Muck and Detritus	Combination of Overhanging Vegetation, Overhanging Woody Debris, and Organic Debris	Combination of Cattail, Sedges, Grasses	-	-	Combination of Storewort and Miffoil	Combination of Overhanging Vegetation and Woody Debris	Sedge, Grasses, Cattail, Herbaceous species, Red Oak Dogwood, Alder, White Birch, Trembling Aspen, Black Spruce, Balsam Fr	No Defined Channel Passage, Low flow Conditions, Woody and Organic Debris	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a
Pond Lake Outflow Channel	Type 4	100%	566.76	Mount Joy Watershed	Low		-	>1.5		50x200, 50x45	50 - 80	Stable	Stable	Stable	80% Muck, 20% Detritus	20% (40% Aquatic Vegetation, 30% Overhanging Vegetation, 20% Overhanging Woody Debris, 10% Organic Debris)	50% (45% Cattail, 25% Reed, 20% Grasses, 10% Sedge)	0	50% (30% Miffoil, 70% Storewort)	5% Overhanging Vegetation	Cattail, Bulrush, Alder, Willow, Red Pine, Balsam Fr, Red Oak Dogwood, Meadow Sweet, Trembling Aspen, Serviceberry, Honey Suckle	Beaver Dams, Hydro Culvert Crossing Obstructions, Low Flow Conditions	pH: n/a Conductivity: n/a DO: n/a Water Temp: n/a	

## **Porcupine River System**

The Porcupine River System, for the purpose of this report, is defined as those reaches that extend from the spillway outlet channel of the Coniaurum tailings area to the Porcupine River inflow to Porcupine Lake immediately south of the community of South Porcupine. It is recognized that the headwater drainages for this watershed originate in Pearl and Clearwater Lake, however, they have been described separately in this document. Based on the Reach Type classifications as presented in Appendix A, five reach types were identified to characterize this 8 km segment of the Porcupine River and included Type 3A, 4, 5, and 6A. The reach types identified in the Porcupine River system are identified in Figure 3.2.

The majority of this watercourse is characterized by open water riverine wetland reaches consistent with Reach Type 4. These areas reflect the flat topography, clay soils and extensive beaver activity that results in the ponded and flooded areas. In various areas, the channel narrows and is more confined. To some extent dense shrub growth along the channel margin contributes to stabilization of the channel banks and thereby maintaining a defined cross section and planform. These areas met the Reach Type 3A classification. With low representative flows and a wide floodplain, certain areas the channel have become choked with cattails, and a defined channel no longer exists (Reach Type 5). This feature tends to fragment the aquatic corridor function as do the numerous beaver dams. In the vicinity of South Porcupine, urban infrastructure related development activities have resulted in the channelization of approximately 600 m of the creek channel (Reach Type 6A). In the vicinity of the Evans Street crossing, rock substrate placement was undertaken in the late 1980s in an attempt to improve spawning opportunities for Porcupine Lake walleye.

The surrounding terrain is well buffered by forested terrain that extends beyond 100 m of the floodplain over much of the watercourse. Intrusion in the floodplain occurs in association with tailings management areas in the upstream reaches near the Coniaurum and McIntyre Tailings, and downstream in the more urbanized area. The final 600 m of channel that discharge to Porcupine Lake, pass through a wide (200 m) floodplain densely overgrown with alder (Reach Type 3B).

Typical channel widths in non-impounded areas of less than 5 m and depths below 1 m have been reported for reaches inventoried during historic studies (EAG 1989; Minnow 2005). Riparian vegetation included overhanging alder, Red-osier dogwood, balsam fir, sedges, grasses, and cattails. Muck, sand and detritus dominated the channel bed materials with marginal amount of silt and exposed clay, as well as a few pockets of gravel exposure were also observed.

## **Edwards Creek System**

Based on the Reach Type characteristics outlined in Appendix A, five reach types were identified to characterize this watercourse system including: Type 3; Type 4; Type 6B; Type 9B; and Type 12. Detailed channel diagnostic features of each reach type are outlined in Table 3.3 and their distribution is shown in Figure 3.2. Additional typical section details depicting biophysical diagnostic features are provided in Appendix C.

Edwards Creek originates in a forested block south of Highway 101 and east of the residential areas of Schumacher and Gold Center (chainage 6.89 to 6.43 km). Surrounding land use was generally natural consisting of forested or well vegetated areas. Including approximately 10% of the overall watercourse morphology of this headwater reach was characterized by Reach Type 9B and extended over 423 m in length. Channel morphology consisted primarily of runs and pools with occasional embedded riffle sequences. Exhibiting a moderate drainage slope, the average wetted width and depth was 1.45 m and 0.33 m, respectively. Erosion of the exposed channel banks result in 20% of the reach length exhibiting unstable conditions, with the scour and redeposition of clay/sand fines largely confined within the reach. Substrates consisted of finer bed materials combined with a larger distribution of organics. Riparian vegetation included overhanging alder, Red-osier dogwood, balsam fir, sedges, grasses, cattails, and clusters of Forget-me-Not. Aquatic vegetation, overhanging shrubs, organic debris, and undercut banks provided approximately 30% of in-stream cover, with the adjacent thicket forest providing 10% overhead cover.

Reach Type 3 extends 389 m downstream of the Edwards Creek headwater reach and represents approximately 5.8% of the overall watercourse reach characterization (chainage 6.43 to 6.05 km). Consisting of 70% runs and 30% pools, this channel configuration was well defined and contained within a 30 to 50 m floodplain area. Flat bed gradient with an approximate slope of less than 0.5% was observed and resulted in relatively low to moderate flow velocity. The channel had a mean width of 1.24 m and a corresponding mean depth of 0.27 m, with a u shaped cross section and largely vertical banks. Muck, sand and detritus dominated the channel bed materials with marginal amount of silt and gravel also observed. Riparian vegetation predominantly consisted of herbaceous species and meadow grasses, cattails, and occasional shrub species of Red-osier dogwood, willow, and alder. Valley vegetation along the floodplain margin featured dense alder combined with white birch, spruce, and balsam fir. Undercut banks, organic and woody debris, aquatic vegetation and overhanging grasses provided some overhead cover.

Reach Type 6B represents approximately 680 m, 10% of overall watercourse reach representation in Edwards Creek. This reach is located adjacent to a power transmission substation, the development of which appears to have required the realignment of the watercourse and corresponding floodplain as well as some infilling (Chainage 6.05 to 5.37 km). Unlike the upstream reaches where a defined channel was noted, extensive beaver activity and consequent long-term inundation of the flood plain by two beaver ponds, has converted this channel segment into an open water impoundment, with ponds ranging in size between 20 m by 80 m to 20 m by 200 m. Cross-sectional features are relatively uniform with wetted depths at 1 m to greater than 1.5 m throughout. Riparian vegetation was comprised of dense cattails, bulrush, reed, and herbaceous and sedge species. Floating pondweed and submergent macrophytes such as northern water milfoil and stonewort were common throughout the open water areas. Beyond the vegetated perimeter, various shrub species including alder, willow, spruce, trembling aspen, and white birch line a developing marsh margin. Substrate materials were predominately organic muck and detritus, with variable depositional areas of sand, gravel, cobble, clay and silt. In-stream cover was dominated by aquatic vegetation and equal distributions of woody and organic debris, and overhanging vegetation.

Approximately 180 m upstream of Edwards Lake, a dense alder thicket and hummocky floodplain separates the channelized and beaver impounded area from the open waterbody (Chainage 5.37 to 5.19 km). This section represented the smallest reach type (Type 12) in the Edwards Creek system, demonstrating only 2.75% of its overall reach composition. Characterized by a poorly defined and intermittently appearing channel, flow conveyance largely occurs in a diffused manner through emergent vegetation. Floodplain widths ranged between 50 m to 70 m wide and small areas of pooling water had an average depth of 0.63 m. Substrate in the thicket area was largely composed of organic sediments and detritus. Understory species consisted of sedge, grass, cattail, marsh marigold (*Caltha palustris*), Forget-Me-Not clusters, and ferns. Alder, Red-osier dogwood, willow, and dead woody debris contributed approximately 70% of overhead cover in the minor open water channel areas. The floodplain perimeter was characterized by a mixed forest community, consistent with the general area.

Reach Type 4 dominates the downstream segments leading into the Porcupine River and represents 4,895 m (74%) of the creek reach composition (Chainage 4.89 to 0 km). One road crossing (Highway 101), a trail crossing and much of the eastern floodplain margin is contacted by the revegetated Dome Mine tailings area, represent development intrusions into this system. Since these intrusions are generally minor and, in terms of the tailings area, well separated from the creek mainstem, the creek channel through these areas was classified as being largely natural as opposed to physically altered. A combination of flat channel gradients and long-term beaver activity has created wide open-water impoundments, associated riverine marsh, and extensive floodplain widths. Open water areas are substantial in size, varying approximately 80 to 600 m in length and 50 to 100 m in width. Wetted depths were relatively uniform ranging between 1 to 1.5 m. Low to no discernable flow velocity was observed, which reflects the deposition of finer bed material and organics throughout. Generally, bed material was comprised of a muck, detritus and silt combination with an underlain layer of unconsolidated clay. Cover opportunities within the open water area consisted mostly of aquatic vegetation such as northern water milfoil, duckweed, floating pondweed, and stonewort. The wetland vegetation forming the margin of the open water area was dominated by cattails and also included sedges, grasses, and reeds. Additionally, extensive areas of this reach were overgrown entirely with marsh vegetation and no open water was present (Reach Type 5). The area surrounding the wetland margins was largely natural and composed of a mixed forest, with riparian vegetation consisting of grasses, dogwood, cedar, alder and willow.

## **Edwards Lake**

Edwards Lake is a small on-line waterbody formed as a result of a low point in the topography, the low channel gradient at the outlet, and extensive beaver activities throughout the area that cause a backwater that maintains lake open water conditions. The general land use that surrounds Edwards Lake is natural mixed forested community. Both active and historic mine and power transmission infrastructure are located beyond this forest buffer. Bathymetry data was not completed on Edwards Lake during the AMEC 2007 assessment. The lake was characterized by only one shoreline habitat type: wetland-type shoreline (Type 2A) which was uniformly distributed around the open water margin forming a lacustrine marsh. Shoreline habitat distribution is provided in Figure 3.3, with

details with respect to shoreline types provided in Tables 3.4 to 3.6 and photographs in Appendix D. The site-specific shoreline types are further described as follows:

### Shoreline Habitat Type 2A

The entire shoreline of Edwards Lake was dominated by Type 2A shoreline habitat. The area was characterized by conditions typical of dense marsh wetland conditions and covered approximately 1,236 m of the lake perimeter. Dominant emergent aquatic vegetation consisted of cattails interspersed with bulrush species, while the dominant submergent species was stonewort. Many dead standing trees and stumps were observed, contributing approximately 20% of habitat cover opportunities. Riparian vegetation lining the lake margin was narrow and consisted of a variety of sedges, grasses, alder and Red-osier dogwood with a peripheral growth of white birch, alder, and black spruce. The supralittoral zone was equally composed of deciduous (aspen and white birch) and coniferous trees (black spruce). Bottom substrates lacked diversity and consisted of mostly organic materials and detritus.

### Field Water Chemistry

Several field water quality parameters were measured in Edwards Lake, during the site visit on October 19, 2007. The measurements included dissolved oxygen (8.03 mg/L), pH (8.07), conductivity (617  $\mu$ s), and water temperature 7.98°C at an air temperature of -1°C. Water was clear but distinctly colored by tannins during the October 2007 inventory.

## **Pearl/Clearwater Lake System**

### Pearl Lake

Located approximately 1.1 km upstream from Clearwater Lake and immediately lateral to Highway 101 on the north side, this small waterbody is a headwater basin to the Porcupine River. Its overall surface area was 30 ha with a maximum depth of 12.3 m and mean depth of 5.16 m (Figure 3.4). Land use surrounding Pearl Lake consists of mining operations to the north; mixed forest block to the northeast; and urbanized development to the south and west associated with the community of Schumacher. A few residential properties border the eastern shoreline of the lake, however, the vegetation has been maintained in a forested state. The outflow channel linking to Clearwater Lake and ultimately draining to the Porcupine River is located on the north-eastern shoreline. This lake was characterized by three shoreline habitat types: rocky substrate with moderate gradients and overhanging vegetative shoreline (Type 1A), dense cattail shoreline with soft bed substrate (Type 2A), and an anthropogenically altered shoreline (constructed road) (Type 3). Shoreline habitat distribution is provided in Figure 3.4, with details with respect to shoreline types provided in Tables 3.4 to 3.6 and photographs in Appendix D. The site-specific shoreline types are further described as follows:



Table 3.5 - Hollinger Baseline Studies Summary of Supralittoral and Eulittoral Vegetation in Lake and Pond Systems within the Local Study Area

Waterbody	Littoral Zone	Eulittoral			Supralittoral		
		Graminoid	Ericaceous	Trees and Shrubs	Average Width of Zone (m)	% Coniferous	% Deciduous
Cowboy Lake	Type 1A	40% (Grasses 40%, Sedges 40%, 20% herbaceous species)	0	60% (Alder 50%, Red-osier Dogwood, 30%, Willow 20%)	1.5	30% (Jack Pine 60%, White Spruce 30%, Black Spruce 10%)	70% (Trembling aspen 50%, White Birch 40%, White Ash 10%)
Cowboy Lake	Type 2	30% (Sedges 30%, herbaceous species 70%)	0	70% (Black Spruce 40%, Trembling Aspen 20%, White Spruce 20%, White Birch 10%, Alder 10%)	2	90% (Black Spruce 60%, Jack Pine 30%, White Spruce 10%)	10% (Trembling Aspen 60%, White Birch 40%)
Cowboy Lake	Type 2A	10% (Grasses 100%)	0	90% (Alder 70%, Willow 20%, Red-osier Dogwood 10%)	5	20% (Black Spruce 100%)	80% (Trembling Aspen 80%, White Birch 20%)
McDonald Lake	Type 1A	20% (Grasses 50%, Sedges 50%)	40% (Sweet gale 100%)	40% (Alder 60%, Red-osier Dogwood 20%, Willow 10%, Cedar 10%)	1.5	75% (Jack Pine 30%, Black Spruce 30%, White Spruce 10%, Balsam Fir 10%, Cedar 20%)	25% (Trembling Aspen 50%, White Birch 30%, Tamarack 10%, White Ash 10%)
McDonald Lake	Type 2A	20% (Grasses 40%, Sedges 40%, Cattail 20%)	0	80% (Alder 90%, Red-osier Dogwood 10%)	2	80% (Black Spruce 70%, Cedar 30%)	20% (Trembling Aspen 60%, White Birch 40%)
McDonald Lake	Type 3	70% (Grasses 70%, Sedges 30%)	0	30% (Alder 100%)	2	No supralittoral vegetation present	No supralittoral vegetation present
McDonald Lake	Type 3A	40% (Grasses 30% Sedges 50%)	20% (Sweet gale 100%)	40% (Alder 90%, Trembling Aspen 10%)	1.5	25% (Balsam Fir 50%, Black Spruce 20%, Jack Pine 20%, Cedar 10%)	75% (Trembling Aspen 80%, White Birch 15%, Tamarack 5%)
Perch Lake	Type 1A	40% (Grasses 50%, Sedges 50%)	20% (Fris 100%)	40% (Alder 50%, Red-osier Dogwood 30%, Willow 20%)	3.5	10% (White Spruce 30%, Black Spruce 30%, 20% Jack Pine, Balsam Fir 20%)	90% (Trembling Aspen 50%, White Birch 40%, Tamarack 10%)
Perch Lake	Type 2C	40% (herbaceous species 50%, Grasses 20%, Sedges 20%, Cattail 10%)	50% (Sphagnum Moss 60%, Sweet gale 30%, Fris 10%)	10% (Alder 40%, Tamarack 40%, Trembling Aspen 20%)	17.5	80% (Black Spruce 80%, White Spruce 10%, Jack Pine 10%)	20% (Tamarack 40%, Trembling Aspen 40%, White Birch 20%)
Perch Lake	Type 2A	20% (Sedges 50%, Grasses 50%)	0	80% (Alder 80%, dogwood 30%, Willow 20%)	6	75% (Black Spruce 100%)	25% (Trembling Aspen 40%, Tamarack 30%, White Birch 30%)
Perch Lake	Type 3	20% (herbaceous species 60%, Grasses 40%)	0	80% (Alder 40%, Red-osier Dogwood 40%, Tamarack 20%)	2.5	No supralittoral vegetation present	No supralittoral vegetation present
Perch Lake	Type 2A	20% (Sedges 50%, Grasses 50%)	5% (Rush 100%)	75% (Alder 70%, Red-osier Dogwood 30%)	5	50% (Black Spruce 60%, Cedar 20%)	50% (White Birch 100%)
Miller Lake	Type 2A	75% (Grasses 60%, Sedges 30%, herbaceous species 10%)	0	25% (Red-osier Dogwood 100%)	4	No supralittoral vegetation present	No supralittoral vegetation present
Miller Lake	Type 3A	30% (Sedges 100%)	0	70% (Alder 70%, Red-osier Dogwood 15%, Willow 15%)	7.5	20% (White Spruce 50%, Black Spruce 30%, Balsam Fir 20%)	80% (Trembling Aspen 60%, Alder 30%, White Ash 10%)
Miller Pond	Type 2A	10% (Grasses 50%, Sedges 50%)	30% (Sweet gale 100%)	60% (Alder 30%, Red-osier Dogwood 30%, Willow 10%, Trembling Aspen 15%, Cedar 10%, White Birch 5%)	0.5	50% (Jack Pine 30%, Black Spruce 30%, Cedar 20%, White Spruce 20%)	50% (Trembling Aspen 70%, White Birch 30%)
Simpson Lake	Type 1	10% (Grasses 50%, Sedges 50%)	0	90% (Alder 70%, Red-osier Dogwood 20%, White Birch 5%, Trembling Aspen 5%)	5	40% (Jack Pine 40%, Black Spruce 40%, White Spruce 20%)	60% (Trembling Aspen 70%, White Birch 30%)
Simpson Lake	Type 2	10% (Grasses 100%)	0	70% (Alder 50%, Red-osier Dogwood 20%, Willow 20%, Trembling Aspen 10%)	4.5	40% (Jack Pine 40%, Black Spruce 40%, White Spruce 20%)	60% (Trembling Aspen 70%, White Birch 30%)
Simpson Lake	Type 2A	20% (Grasses 20%, herbaceous species 80%)	10% (Sweet gale 100%)	50% (Alder 60%, Trembling Aspen 20%, Red-osier Dogwood 20%)	1	No supralittoral vegetation present	No supralittoral vegetation present
Simpson Lake	Type 3	60% (Grasses 50%, Sedges 50%)	20% (Sweet gale 100%)	40% (Alder 50%, Red-osier Dogwood 30%, Willow 20%)	5	40% (Black Spruce 50%, Cedar 30%, White Spruce 10%, Balsam Fir 10%)	60% (Trembling Aspen 40%, White Birch 20%, Tamarack 20%, Willow 10%, maple 10%)
Pearl Lake	Type 1A	20% (Grasses 50%, Sedges 50%)	0	80% (Alder 60%, Red-osier Dogwood 30%, White Birch 10%)	4	60% (Black Spruce 50%, Cedar 30%, White Spruce 10%, Balsam Fir 10%)	40% (Trembling Aspen 50%, White Birch 40% and Tamarack 10%)
Pearl Lake	Type 2A	60% (Grasses 50%, Sedges 50%)	0	40% (Alder 60%, Red-osier Dogwood 30%, Trembling Aspen 5%)	1.5	No supralittoral vegetation present	No supralittoral vegetation present
Pearl Lake	Type 3	(Cattail, Grasses, Sedges)	n/a	(Alder, Red-osier Dogwood)	n/a	Mixed forest community	
Slymer Lake	Type 2A	40% (Grasses 20%, Sedges 80%)	0	60% (Alder 60%, Red-osier Dogwood 30%, White Birch 15%, Black Spruce 15%)	3	50% (Black Spruce 100%)	50% (Trembling Aspen 60% and White Birch 40%)
Edwards Lake	Type 2A	30% (Grasses 50%, Sedges 50%)	0	70% (Alder 50%, Tamarack 20%, Red-osier Dogwood 15%, White Birch 5%, Trembling Aspen 3%, Black Spruce 5%)	4.5	50% (Black Spruce 100%)	50% (Trembling Aspen 60% and White Birch 40%)
Fuller Mine Pond	Type 2A	100% (Grasses 50%, Sedges 50%)	0	0	0.5	No supralittoral vegetation present	No supralittoral vegetation present
Fuller Mine Pond	Type 3	(Cattail, Grasses, Sedges)	n/a	n/a	n/a	50% (Black Spruce 100%)	50% (Trembling Aspen 60% and White Birch 40%)
Gilles Lake	Type 2	(Cattail, Grasses, Sedges)	n/a	n/a	n/a	50% (Black Spruce 100%)	50% (Trembling Aspen 60% and White Birch 40%)
Gilles Lake	Type 2A	(Cattail, Grasses, Sedges)	n/a	n/a	n/a	50% (Black Spruce 100%)	50% (Trembling Aspen 60% and White Birch 40%)
Gilles Lake	Type 3A	(Grasses, Sedges)	n/a	n/a	n/a	50% (Black Spruce 100%)	50% (Trembling Aspen 60% and White Birch 40%)
Clearwater Lake	Type 2A	50% (Grasses 50%, Sedges 50%)	0	50% (Alder 50%, Red-osier Dogwood 50%)	5	50% (Black Spruce 100%)	50% (Trembling Aspen 60% and White Birch 40%)



### Shoreline Type 1A Habitat

Type 1A shoreline habitat was identified in several areas of Pearl Lake totalling 637 m. Much of the southeastern shoreline and sporadic segments along the north were characterized by moderate bank and bed gradients, rocky substrate materials, and limited aquatic vegetation. Generally, littoral and eulittoral areas were narrow with sparse cover opportunity with the exception of the south-eastern perimeter which consisted of a mature forest vegetation unit that provided a canopy overhanging the shoreline. Emergent and submergent vegetation was not present throughout the near shore areas. At depths greater than 1 m, prolific and extensive mounds of submergent stonewort were distributed across the lake bed. Riparian vegetation, predominantly grasses and sedges, lined the lake perimeter and the outer eulittoral area consisted of alder, Red-osier dogwood, and willow. The upland valley vegetation along the northern shoreline was greatly diminished and consisted of mostly deciduous species where as the south-eastern shore contained a mixed, dense, forest community. Bed substrate composition included an assortment of boulders, and medium to smaller cobble materials combined with a sublayer of sands. Deeper lake samples consist of muck with detritus and sand materials

### Shoreline Type 2A Habitat

Type 2A shoreline habitat is interspersed with Type 1A habitat along the north and eastern shoreline of Pearl Lake, covering approximately 890 m. The littoral zone was dominated by dense cattails, bulrush species and profuse mats of submergent stonewort. The eulittoral zone was narrow consisting of mostly shrubs such as alder and Red-osier dogwood. Mixed forests, with variable density, lined the outer perimeter of the eulittoral zone in this shoreline type. Tree species such as black spruce, tamarack, white birch, and trembling aspen were identified throughout. Finer substrate sediments such as silt and sand were observed in areas of exposed lake bed. At areas of dense submergent vegetation, bed materials consisted of organics and detritus with a marginal underlayer of sand.

### Shoreline Type 3 Habitat

Approximately 956 m of the south and western shoreline of Pearl Lake have been altered to accommodate a previous Highway 101 widening and the Schumacher (McIntyre) Arena building and parking lot. Large granular riprap fill materials line this portion of the lake perimeter. Only a small distribution of emergent vegetation was observed within the narrow littoral zone, mostly consisting of cattail and bulrush species. Similar to the remainder of this waterbody, dense areas of submergent stonewort were noted specifically within the wide littoral shelf along the western perimeter. Shrub and sapling tree species such as alder, Red-osier dogwood, and trembling aspen combined with grasses, sedges and herbaceous groundcover occupy voids within the granular fill materials. The highway embankment forming the southern lake margin was largely vegetated by grasses and herbaceous groundcover species. This habitat type did not include a supralittoral area due to the nature of the surrounding land use. Near shore substrates were dominated by fragmented boulder, cobble, gravel and sand while in deeper areas, samples consisted of sand and silt coupled with a thick layer of muck. Urban debris was also abundant in this habitat area.

## Field Water Chemistry

Field water quality parameters were measured in Pearl Lake during the site visit conducted by Minnow Environmental Ltd. October 4 to 5, 2001. Dissolved oxygen, pH, conductivity and water temperature at surface were 9.16 mg/L, 8.08, 1981  $\mu$ s, and 12.3°C, respectively. Dissolved oxygen profiling indicated that levels were above 8.5 mg/L until a depth of 5 m where conditions become more limiting and DO concentrations rapidly decrease to 1.17 mg/L. No secchi depth reading was recorded during the 2007 field program however the lake water was noted as being very clear. Dissolved oxygen profiling for Pearl Lake is available in Appendix F.

## **Pearl Lake Outflow Channel**

The Pearl Lake Outflow Channel was not classified during the 2007 field program conducted by AMEC, and a review of secondary sources and detailed Lidar satellite imagery provided information regarding the biophysical habitat and channel diagnostic features of this conveyance system. Reach Type 4 was the only reach classification identified. Some transitional reach areas are also present, but minor in relative representation. Detailed channel diagnostic features are outlined in Table 3.3 and the reach distribution is shown Figure 3.2.

Pearl Lake Outflow Channel flows in a northeasterly pattern approximately 1.1 km downstream before draining into Clearwater Lake. Largely characterized by variable floodplain widths (20 to 170 m), flat channel gradients, and slow moving and densely vegetated impounded waters, only a few areas exhibit a defined channel. Water depths measured between 1.5 to 2 m (Minnow 2001) and in areas with channel definition, wetted widths ranged from 5 to 10 m wide. In ponded areas, dimensions ranged from 17 to 175 m in length and 15 to 75 m in width. Dense aquatic vegetation such as cattails, sedges, duckweed, and pondweed occupy open water areas (Minnow 2001). Local beaver activities frequently restrict water flow while contributing significant quantities of woody debris. Similar to comparable habitats found in the LSA, riparian and valley vegetation consists of dense shrub and tree species such as spruce, trembling aspen, and alder. Sparse residential development was identified on the eastern boundary. Laboratory results detail bed materials to be predominantly silt and moderate to fine sands (Minnow 2001). With the closure of the McIntyre Mine, an access road crossing was removed within this reach, providing an uninterrupted aquatic corridor.

## **Clearwater Lake**

Clearwater Lake was not characterized during the 2007 field program conducted by AMEC. Alternatively, a review of secondary sources and detailed Lidar satellite imagery provided sufficient information to classify the shoreline habitat features of this waterbody.

Clearwater Lake is a small waterbody with an overall surface area of 11.26 ha, a maximum depth of 6 m and mean depth of 2 m (EAG 1989). Land use surrounding Clearwater Lake consists of historic tailing management areas to the north and east; sporadic mixed forest communities to the west and

southwest; and low density residential development along the inlet channel to the south. The outflow channel draining to the Porcupine River was located on the northeastern shoreline. A constructed tailings dam (stop-log structure) was also identified at the outflow channel which regulated lake water levels and flow (EAG 1989), but it is unconfirmed at this time which grade control presently maintains the lake water levels. This lake was generally characterized by one shoreline habitat type: cattail shoreline with soft bed substrate (Type 2A). The northern margin may have been previously influenced by the Hollinger tailings area dam development, but the shoreline appears to have become naturalized. An aerial image of Clearwater Lake and the associated shoreline habitat distribution is shown in Figure 3.5.

### Shoreline Type 2A Habitat

The majority of the 2,083 m lake margin was dominated by typical aquatic vegetation such as cattails, and submergent milfoil and stonewort species. Riparian condition was variable throughout as a result of the existing land uses. Some areas contained dense and typically shrub dominated communities while other areas were confined to grasses, sedges, and herbaceous understory. Upland vegetation around the lake consisted of black spruce, trembling aspen, and white birch (EAG 1989). Bed materials were characterized by fine organic matter overlying a clay base (EAG 1989).

### Field Water Chemistry

Results from the EAG report (1989) measured dissolved oxygen at 7.9 mg/L at surface water temperature of 24.0°C in July 1988. Dissolved oxygen levels are above 3.5 mg/L until a depth of 4 m, where conditions become more limiting (DO measurement at 2.4 mg/L). Dissolved oxygen profiling for Clearwater Lake is available in Appendix F.

### **Clearwater Lake Outflow Channel**

The Clearwater Lake Outflow Channel was not characterized during the 2007 field program conducted by AMEC. Alternatively, a review of secondary sources and detailed Lidar satellite imagery was applied to evaluate the biophysical habitat and channel diagnostic features of this conveyance system. This descriptive channel segment was delineated to extend from the lake outlet, through the access road crossing at the Coniaurum tailings area and downstream to the confluence with the Coniaurum spillway discharge channel. Reach Type 4, was identified between the lake and the culvert crossing, and essentially reflects the conditions of the lake effect. A second reach type, Reach Type 9B, extends to the end of the delineated reach. Details of the reach type distribution are shown in Figure 3.2.

The Clearwater Lake Outflow Channel is bordered by two major tailings areas, however, the small valley and channel have remained in a relatively naturalized state such that aquatic corridor function is maintained. This reach was largely characterized by a small channel, often completely overgrown with alder, sedges, and grasses (EAG 1989). The average width and depth measured was 1.0 m

and 0.4 m, respectively. The valley's mixed forest community was typical of the surrounding area which included black spruce, trembling aspen, alder, grasses, and sedges.

### **3.2.5 Fisheries Resources**

#### **Porcupine River**

The Porcupine River was not sampled during the AMEC field program in 2007. Alternatively, a review of secondary sources, specifically the EAG 1989 report, was utilized for the purpose of this description. The main branch of the Porcupine River was sampled within the vicinity of Highway 101 and approximately 1 km upstream, as well as the reach immediately downstream of the confluence with the South Porcupine River. In the beaver ponds and deeper channel areas of the area north of Highway 101, a variety of coarse and forage fish were encountered including brook stickleback, mottled sculpin, pearl dace, yellow perch and white sucker. Yellow perch was the dominant species at 65%.

The lower reaches of the river above Porcupine Lake exhibited a fish community of northern pike, white sucker and yellow perch. The species diversity was similar to the Highway 101 sampling station, however, the species abundance was generally much lower as there was only seven fish caught in total, with the dominant species being white sucker. This was a reflection of sampling bias, as the shallower reaches near Highway 101 were sampled with electrofishing gear, and the other site involved more selective techniques such as gill netting.

#### **Edwards Creek**

Edwards Creek, for the purpose of describing the fisheries resource, was organized into two sampling areas: Edward Creek Area 1 (ED1), located upstream of Edwards Lake to the headwaters adjacent to the residential subdivision at Gold Centre, and Edwards Creek Area 2 (ED2), encompassing the downstream mainstem from Edwards Lake to the confluence with the Porcupine River.

Six baited minnow traps were set throughout ED1 on September 11 and 12, 2007 for a total duration of 23 hours each. A combined catch of 112 fish was obtained, consisting of brook stickleback, creek chub, fathead minnows, finescale dace, northern redbelly dace and pearl dace, with pearl dace being the most dominate species at 71% of the catch. ED1 CPUE was marginally greater than the mean study CPUE. ED1 also had higher than average species diversity than the studies mean.

The ED1 fisheries habitat area consisted of four reach types over the course of the upstream study area. Numerous barriers to fish migration, generally in the form of beaver dams were common, fragmenting the fish community and temporarily isolating them to some extent in reaches between dams. The communities between the dams are all very similar in species composition.

Six baited minnow traps were set throughout the lower portion of Edwards Creek (ED2) on September 7, 8, and 9, 2007 for an average duration of 29 hours. A combined catch of 25 fish was obtained, consisting of brook stickleback, creek chub, fathead minnows, finescale dace, northern redbelly dace and pearl dace, with northern redbelly dace being the most dominate species at 32% of the catch. ED2 CPUE was far lower than the mean study CPUE, yet the species diversity was equal to ED1 and marginally higher than the mean diversity of the sites sampled within the LSA. A summary of fish collection data is provided in Table 3.7.

## **Pearl/Clearwater Lake System**

### Pearl Lake

Pearl Lake was not sampled during the AMEC 2007 field program. Alternatively, a review secondary sources, specifically the Minnow 2001 report, was utilized for the purpose of this description. Pearl Lake basin is influenced by surrounding land use and hosts an abundance of large bodied benthivorous/planktivorous species. Application of standard index trap nets and minnow traps resulted in catches of both yellow perch and rock bass. Other forage and course fish specie included brook stickleback, fathead minnow, lake chub (*Couesius plumbeus*), and white sucker.

Although detailed sampling records for the Pearl Lake outflow are not available, the contiguous nature of the aquatic corridor downstream to Clearwater Lake, suggest that the communities found in both lakes have access to suitable habitat opportunities that may be available.

### **Clearwater Lake**

Fish sampling records for Clearwater Lake relate to work undertaken by EAG (1989). Summer netting and minnow trapping efforts revealed a coarse and forage based community consisting of yellow perch, white sucker and brook stickleback. Yellow perch were the predominant species in the catch records representing 75% of the total reported.

The outlet channels from Clearwater Lake exhibits notably different habitat conditions than the creek reach between Pearl and Clearwater Lake. With a small channel, this reach is more suitable for the forage based species that have been reported throughout the system.

## **3.3 South Porcupine River Watershed**

The South Porcupine River watershed, to the point of its confluence with the Porcupine River just west of Porcupine Lake, measures 42.7 km<sup>2</sup> (Figure 3.1). The headwaters originate in McDonald and Simpson Lakes. Much of the upper drainage basin is influenced by past and present mining activity including flows reporting from the existing Dome tailings containment facility and waste rock storage areas, the historic Aunor, Buffalo Ankerite, Paymaster and Preston East mine facilities (Figure 2.1). South Porcupine River characteristics are generally similar to those of the Porcupine River, with a mainstem gradient of 0.33% (3.3 m vertical drop per 1,000 m horizontal), and a system

**Table 3.7 - Hollinger Baseline Studies Total Fish Species Abundance in Creek Systems within Local Study Area**

Species	Edwards Creek		Skynner Creek					Simpson Lake Outflow Channel	Total Catch By Species
	ED2	ED1	SK1	SK2	SK3	SK4	SK5		
Creek Chub	1	1	30	5				13	50
Fathead Minnow	2	9							11
Finescale Dace	6	18				9		4	37
Northern Red Belly Dace	8	8	2			25		30	73
Pearl Dace	6	80	8					5	99
Brook Stickleback	4	4							8
<b>Total Catch by Stream</b>	<b>27</b>	<b>120</b>	<b>40</b>	<b>5</b>	<b>0</b>	<b>34</b>	<b>0</b>	<b>52</b>	<b>278</b>

heavily fragmented by numerous beaver dams. For the purpose of this study, the South Porcupine River initiates at the point where tributaries from the McDonald Lake/Simpson Lake headwaters merge with flows from the Buffalo Ankerite mine site to form a third order watercourse.

Terrain conditions are similar to, but more varied than those described above for the Porcupine River watershed, consisting of a mosaic of glacio-lacustrine sand and clay/silt plains, with secondary inclusions of rock plain and rock knob terrain; together with dominant expression of rock ridge terrain and secondary expression of ground moraine in the area north of McDonald Lake (Figure 1.3).

### **3.3.1 Water Quality**

Water quality data for the South Porcupine River system are available from Beak (1999), Minnow (2005), and from data collected as part of this baseline study (Table 3.1). From upstream to downstream, water quality data are available for McDonald Lake (Beak 1999, and this study), the area downstream of McDonald Lake (Beak 1999), Simpson Lake (this study), South Porcupine River upstream of the Dome tailings discharge (Beak 1999, Minnow 2005), and the area downstream of the Dome tailings discharge (Minnow 2005). Sample locations are shown in Figure 2.1.

Water quality conditions in the South Porcupine River are generally similar to those discussed above for the Porcupine River, with many of the same parameters being of potential concern.

McDonald Lake is positioned at the headwaters of the South Porcupine River, and based on its general location and associated water quality profile, is outside of the zone of influence of current and past mining activities (Table 3.1). Where possible exceedences of provincial and federal water quality guidelines are indicated (i.e., for phosphorus, cadmium and mercury), this is due to the use of laboratory detection limits which are in excess of guideline values. The very low levels of key indicator parameters such as sulphate (6.65 to 8 mg/L) and copper (0.0008 to 0.0011 mg/L) demonstrate a lack of any mine related influences on McDonald Lake water quality.

Water quality data reported by Beak (1999) for the first South Porcupine River station downstream of McDonald Lake (300 m downstream of McDonald Lake, Table 3.1) are difficult to interpret because of the apparent, slightly elevated arsenic values, averaging 0.017 mg/L. The presence of elevated arsenic suggests mine-related drainage influences, but all other parameters, including sulphate (mean of 4.3 mg/L) and copper (mean of 0.00053 mg/L) are strongly suggestive of natural background conditions. The arsenic values here should be considered suspect, as there is no other indication of a potential source of contamination.

At the next furthest downstream station from McDonald Lake (1,000 m DS of McDonald Lake) drainage inputs from the inactive Paymaster, Aunor, Delnite and Buffalo Ankerite sites are likely. At this location, there is a notable, but still modest by mining standards, increase in sulphate concentrations (mean of 52.7 mg/L), along with higher concentrations of arsenic, copper and iron. Copper although slightly elevated compared with upstream stations is still within provincial and

federal guideline concentrations. Iron is slightly above the guideline value of 0.3 mg/L, but dissolved concentration data from Beak (1999) show that the majority of the iron present (approximately 83%) occurs in particulate form despite the very low TSS values.

Simpson Lake forms a small sub-drainage basin to the South Porcupine River. This lake is bounded on its proximal east side by waste rock piles associated with the Dome open pit, and derives drainage from these rock piles. Evidence of water quality effects from this drainage is shown by elevated concentrations of sulphate (273 to 283 mg/L) and copper (0.0049 to 0.019 mg/L), with copper concentrations, especially in the north lake basin, being in excess of provincial and federal guidelines (Table 3.1). Other parameters that may or may not exceed provincial and/or federal protection of aquatic life guidelines include total phosphorus, arsenic, and cadmium. Mercury was not measured. Phosphorus and cadmium laboratory detection limits were in excess of the guidelines, so no conclusions can be drawn from the data other than consistency with the guidelines has not been demonstrated.

In the South Porcupine River upstream and downstream of the Dome tailings effluent inflow, there are a number of parameters which exceed, or potentially exceed, provincial and/or federal protection of aquatic life guidelines inclusive of: nitrite (downstream), total phosphorus (upstream/downstream), arsenic (upstream/downstream), cadmium (potentially upstream/downstream, inconclusive laboratory detection limits), chromium (potentially upstream/downstream, inconclusive laboratory detection limits), cobalt (downstream, inconclusive upstream), copper (downstream, inconclusive upstream), iron (occasional exceedences upstream and downstream, most likely due to particulate phases), lead (upstream and downstream inconclusive), mercury (upstream and downstream inconclusive), nickel (downstream), and zinc (mainly upstream).

As for other areas discussed above, many of the potential exceedences (denoted above as inclusive) are a function of laboratory detection limits being in excess of guidelines. The only parameters for which there are provincial and/or federal guidelines, and where there appears to be definite enrichment due most likely to discharges associated with the Dome tailings effluent are for nitrite, cobalt and copper. Copper has been recognized as a parameter of concern in the Dome tailings effluent, and EDTA has been added to this effluent to mitigate the potential toxic effects of copper on aquatic life.

EDTA is a strong ligand that binds with the copper ion to form a stable complex with limited biological availability (i.e., it makes the copper difficult for aquatic organisms to assimilate). The EDTA-copper complex is quite stable in the natural environment (Hering and Morel 1988). EDTA also binds with other metals in a preferential series defined as  $Cr^{3+} \ll Fe^{3+} < Ni^{2+} < Co^{2+} \sim Fe^{2+} < Zn^{2+} < Mn^{2+} < Cd^{2+} < Cu^{2+} < Hg^{2+} < Pb^{2+}$  (Hering and Morel 1988). In its mode of function, EDTA is like naturally occurring organic acid ligands derived from the breakdown of plant materials, such as humic and fulvic acids, but is a much stronger ligand.

### **3.3.2 Sediment Quality**

Sediment quality data for the South Porcupine River are similar to those described above for the Porcupine River, with virtually all parameters where provincial sediment guideline values showing exceedences at some level. Arsenic, copper and nickel are again the parameters which most consistently exceed the SEL guideline thresholds, along with iron. TKN, TOC, and chromium exceed the SEL guideline values less frequently.

The “River US Dome Discharge” and “River DS Dome Discharge” values provided by Minnow (2005) are particularly interesting, because these values relate to the only remaining active tailings system in the local study area (LSA). A review of these data show that there is generally little difference between upstream (US) and downstream (DS) concentrations, with some parameters being higher upstream and some higher downstream. There, however, a few parameters which are suggestive of possible effects, most notably copper, nickel, manganese and cobalt – there are no sediment quality guidelines for cobalt. Copper, nickel and cobalt were also notably elevated in water samples collected from downstream of the Dome tailings effluent inflow (Table 3.1). Manganese concentrations measured in Porcupine River waters were actually lower in the area downstream of the Dome effluent discharge, compared with the upstream discharge.

A cursory inspection of the data presented in Table 3.2 also suggests that portion of South Porcupine River metal loadings to sediment could potentially derive from Dome waste rock stockpile drainages, as evidenced by the very high copper concentrations found in Simpson Lake sediments. However, the water quality data for Simpson Lake show only a very slight enrichment of copper (Table 3.1), and hence do not support this conclusion. Historically, there has been extensive mining activity throughout the South Porcupine River watershed downstream of McDonald Lake, such that it is difficult to draw conclusions about individual loading sources without carrying out more detailed studies, and even with such studies it would be difficult to distinguish between more recent effects and those related to the early years of mining.

McDonald Lake shows virtually no effect of sediment metals enrichment, but elevated concentrations of arsenic, copper, nickel, zinc and other parameters are in evidence a short distance downstream from the discharge of McDonald Lake, showing the likely influence of drainage from historic tailings in the area.

### **3.3.3 Benthic Macroinvertebrates**

Historic records of the benthic macroinvertebrate community were available from mine effluent monitoring studies conducted by EAG (1989). This investigation identified a chironomid dominated invertebrate community that was considered consistent with the soft textured organic and clay substrates common in the flat gradient South Porcupine River. Observations derived from this study included that the upper South Porcupine sampling stations exhibited both amphipods and fingernail clams, considered as indicator taxa, while areas downstream of the Dome Tailings discharge did not.

South Porcupine River sampling by Beak (1999) almost a decade later showed a continued predominance of chironomids at all stations, particularly in the organically based substrates of the upper watershed where these taxa represented 50 to 90% of the samples. Similarly, amphipods and clams were absent in near-field sampling stations located adjacent to the recent Pamour Mine haul road crossing, but present in reference and far-field stations. The lower reach of the Porcupine River immediately upstream of Porcupine Lake showed similar or greater diversity than the reference reach near McDonald Lake, as well as representation by Ephemeroptera, Plecoptera and Trichoptera (EPT) species and clams (*Pisidium*). Conclusions of the study suggested some mine related stress is evident in the near field stations based on lower density, taxon richness, and number/presence of indicator taxa. No mine related effects were suggested in the far-field stations located downstream of the Porcupine River confluence.

Environmental effects monitoring undertaken by Minnow (2004) focussed on the areas of the South Porcupine River, relative to the Dome tailings effluent discharge, and the area below the confluence of the Porcupine and South Porcupine Rivers. Consistent with previous inventories, chironomids were the most abundant organism in the South Porcupine River ranging from about 30 to 65% of relative abundance in the two sampling reaches. Oligochetes were also well represented with relative abundance range of about 20 to 30%, again reflective of the fine organic sediments. In comparison to previous studies, crustaceans such as amphipods and ostracods were observed in the South Porcupine immediately downstream of tailings effluent discharge exhibiting 27% of relative abundance. Other groups were noted to be expressed as less than 10% of the relative abundance, and were distributed in a patchy manner with localized abundance. EPT species were rare in all areas, including those upstream of mine related effluent discharges, thereby suggesting general habitat limitations. Low diversity and density was characteristic of the South Porcupine River relative to other areas of the system sampled. This was considered to reflect low flow conditions, habitat limitations, nutrients, and possibly mine related influences from the numerous historic facilities in the watershed.

#### **3.3.4 Aquatic Habitat**

Three waterbodies associated with the South Porcupine River watershed were assessed during the 2007 field program; McDonald Lake, Simpson Lake, and the Fuller Mine Pond. Additionally, South Porcupine River, McDonald Lake Outflow Channel, Fuller Mine Pond Outflow Channel, and the Simpson Lake Outflow Channel were evaluated and described on the basis of direct observations or through review of secondary source information (EAG 1989; Minnow 2005). Delineation of the watercourses was undertaken based on secondary source information.

##### **South Porcupine River Mainstem**

From the point of confluence of the McDonald Lake Outflow channel and drainage emanating from the south at the former Buffalo Ankerite mine site, the South Porcupine River flows 6.7 km to the Porcupine River confluence. The watercourse valley is bordered by extensive mining activity that, during its development, has maintained a buffer of natural vegetation beyond the floodplain area. The Dome mine and associated pit and waste rock piles are located to the west of the valley, and

the Tailings 6 dam and additional waste rock piles are located to the east. The valley is crossed by a mine access road to the tailings area, and the Pamour Mine Haul Road. The community of Connaught Hill is located to the east of the valley near the Porcupine River confluence. Consistent with the flat gradient valley system and inundated conditions due to beaver activity, habitat conditions are relatively homogeneous throughout the watercourse length. Only two reach types were designated and included Reach Type 4 and Reach Type 3A. Reach type distribution is outlined in Figure 3.2.

The majority of the South Porcupine river channel was classified as Type 4. The 200 to 300 m wide floodplain is predominated by cattail marsh, with intermittent open water pond areas being generated by beaver dams. A channel meanders through the flat gradient marsh, and is characteristically 3 to 5 m in width. Depths were typically recorded at 1 to 1.3 m, and maximum depths were on the order of 1.8 m near the beaver dams. Several sections of the channel were also bordered by dense alder growth contributing to channel definition. In addition to the cattail marsh community, the open water channel areas contain a dense aquatic vegetation community that includes pondweeds, yellow water lily, and smart weed. The depositional environment results in a substrate consisting of organic sediments, and detritus over a clay pavement.

Much of the remainder of the watercourse consists of Reach Type 3, representing 1.7 km of the South Porcupine River length. This reach type has largely similar channel section characteristics as the cattail marsh areas of Reach Type 4. Differentiating features consist of a higher density of alder shrub thicket that borders the channel and contributes to a greater shrub distribution across the adjacent floodplain and assists in stabilizing/defining the channel location and section.

## **McDonald/Simpson Lake/Fuller Mine Pond System**

### **McDonald Lake**

McDonald Lake has a surface area of 12.52 ha, and was considerably deep relative to surface area with a maximum depth of 29 m and mean depth of approximately 10.6 m (Figure 3.6). This waterbody represents a headwater basin in the South Porcupine River system. The outlet was identified on the eastern shoreline and conveys flow in a south-easterly direction until it meets the Simpson Lake Outflow Channel forming the South Porcupine River mainstem. The general land use surrounding McDonald Lake includes a mixed forested community to the south, west, and east; and sparse residential development along Gold Mine Road to the north. The lake was characterized by four shoreline habitat types: variable smaller rock bed materials, overhanging shrub and tree riparian vegetation, steep to moderate bank and bed gradients (Type 1A), wetland-type shoreline (Type 2A), constructed shoreline (Gold Mine Road) (Type 3), and other altered shoreline with finer bed materials and flat shoreline/bed gradient (Type 3A). Shoreline habitat distribution is provided in Figure 3.6 and summarized in Tables 3.4 to 3.6. Additional site specific data is provided in the following discussion:

### Shoreline Habitat Type 1A

Type 1A shoreline habitat represented the highest proportion of the habitats found in this waterbody. A total length of 948 m along the north and south perimeters are characterized by moderate topography, variable substrate materials, and an abundance of woody debris along the lake margin. The northern shoreline demonstrates moderate bank and bed gradients while the southern perimeter was dominated by steep banks and moderate bed gradients. Vertical banks and shallow topsoils appear to contribute to a considerably higher occurrence of large woody debris along the southern shoreline perimeter. In water vegetation was sparse within the littoral zone and consisted predominantly of submergent stonewort and sporadic areas of yellow water lily and pondweed. No aquatic vegetation was observed at depths greater than 1.5 m. Similarly, both shorelines possess dense overhanging riparian vegetation consisting largely of overhanging sweet gale, willow, cedar, Red-osier dogwood, and sedge species. The supralittoral zone was dominated by coniferous species (75% distribution) such as Jack pine, black and white spruce, balsam fir, and cedar with the remaining 25% composed of white ash, trembling aspen, white birch, and tamarack. Four residential properties were located within this shoreline habitat type however the riparian buffer area was not disturbed. Substrate collection consisted of a combination of cobble, gravel, silt/sand with sporadic boulders overlain by a thin layer of organic detritus. Bed material composition was observed to remain similar within deeper water depths however an increased proportion of muck was observed. Substrates at deeper depths through the entire water body were a combination of muck, silt, and sand.

### Shoreline Habitat Type 2A

This shoreline habitat type occupies four small areas, totaling approximately 295 m in length. Pockets of dense cattails combined with rush species, yellow water lily and pondweed cover much of the shoreline perimeter. Profuse and uniform distributions of submergent stonewort and Northern Water Milfoil, an abundance of large woody debris, and remnant dead standing trees contribute to aquatic habitat in this area. Dense alder, cattails, grasses and sedges separate the shoreline margin from the supralittoral zone. Upland shoreline vegetative communities consisted of 80% coniferous species (black spruce and cedar) and 20% deciduous (trembling aspen and white birch). Substrate material, predominantly composed of muck and detritus combined with an underlain deposition of silty sand, remained consistent throughout this habitat type.

### Shoreline Type 3 Habitat

Approximately 118 m of the north shoreline of McDonald Lake has been historically modified to support the Gold Mine Road crossing. Materials associated with this shoreline type include granular fill and scour protection in the form of various grades of riprap. A narrow distribution of aquatic vegetation such as cattails and large patches of pondweed combined with sporadic submergent stonewort, were observed throughout. Bank vegetation consisted of grass and sedge species with a smaller distribution of alder saplings. This habitat type did not include a supralittoral area. As a result of fill placement in this area, substrates consisted of cobble, boulder, gravel and sand with a

marginal amount of detritus located within the voids of the larger bed material. Substrates within the deeper lake areas were represented by a combination of muck, silt, and sand.

### Shoreline Habitat Type 3A

Representing the smallest proportion of shoreline habitat, Type 3A was confined to two areas along the south-eastern and south-western shoreline, totaling approximately 249 m in length. These areas were characterized by altered habitat a result of historical mining activities and current land uses. Bed gradients throughout the areas were generally flat due to fills and extend several metres into the basin before gradients lead into deeper water. Limited to no productive biophysical features were observed within the altered/disturbed areas. Aquatic vegetation consists largely of patchy submergent stonewort with occasional distributions of floating pondweed. Eulittoral and supralittoral zones are poorly defined and consist of limited juvenile tree and shrub species and/or manicured lawn with no protective riparian buffer. Near shore substrate materials are dominated by fine sands and a small distribution of cobble, gravel, and overlying detritus. Currently, the south-eastern shoreline is occupied by the maintained pumphouse property.

### Field Water Chemistry

Field water quality parameters measured in McDonald Lake, during the site visit on August 31, 2007, included dissolved oxygen (8.84 mg/L), pH (7.60), conductivity (286  $\mu$ s), and a water temperature of 19.48°C at an air temperature of 27°C. Dissolved oxygen concentrations at surface were observed to be in the range of 9.5 to 9.7 mg/L at typical observed temperatures under 28°C. Dissolved oxygen profiling indicated that levels are above 5 mg/L until a depth of 9 m where DO drops and conditions become more limiting. Dissolved oxygen profiling for McDonald Lake is available in Appendix F. Average secchi depth readings of 3.56 m were recorded and water clarity was noted as very clear.

### **McDonald Lake Outflow Channel**

The McDonald Lake Outflow Channel was not characterized during the 2007 field program conducted by AMEC. A review of Lidar satellite imagery was applied relative to adjacent habitat features to delineate habitat distribution. Three reach type; Type 6A, Type 4 and Type 12 were identified in the 2.2 km first order section of watercourse, prior to entering the South Porcupine River. Available detailed channel diagnostic features are outlined in Table 3.3 and reach type distribution is shown Figure 3.2.

The McDonald Lake Outflow Channel is a first order system that is characterized by low-lying topography, beaver activities, and associated inundated and marsh conditions. Surrounding land uses associated with mining and residential development has also influenced the nature of this tributary with crossings realignment and some floodplain infilling. The watercourse receives drainage from the Fuller Mine Pond and the Simpson Lake subwatersheds before discharging to the mainstem of the South Porcupine River. Surrounding land uses consisted of sparse residential development including and watercourse crossings by Gold Mine Road in the north and west; mixed

forest community to the south, west and north; tailing management areas (Paymaster and Buffalo Ankerite tailings) in the downstream corridor; and an active pumping station located at the outlet of McDonald Lake.

The conveyance system, specifically downstream of McDonald Lake, was largely dominated by Reach Type 4. Areas of relatively wide floodplain widths (50 to 70 m) in relation to the watercourse flows, flat channel gradients, and slow moving, impounded waters were identified in segments between McDonald Lake and Gold Mine Road and between the easterly crossing of Gold Mine Road to the confluence with the South Porcupine River. Small areas of alder thicket (Type 12) with limited open water areas were also observed and commonly located downstream from beaver dam structures. In areas with defined channel form, wetted channel widths ranged between 1 to 1.5 m (EAG, 1989). Poned areas measured 36 to 200 m in length and 30 to 55 m in width. Dense aquatic vegetation such as cattails, sedges, and grasses line the channel corridor. Riparian and valley vegetation consisted of shrub and tree species such as black spruce, trembling aspen, with alder, grasses, and sedges noted along the floodplain area. Along the north lateral embankment of Gold Mine Road, a small section of the watercourse has been channelized apparently to accommodate the road alignment and the residential road crossing (Reach Type 6A). The channel flows in a northerly direction and confluences with an intermittent watercourse that drains the Fuller Mine Pond.

### **Fuller Mine Pond**

The Fuller Mine Pond located north of Gold Mine Road was assessed on October 14, 2007. It is a small headwater basin contributing flow to the South Porcupine River, approximately 2 km downstream. Surrounding land use includes a tailing management area to the east (Paymaster tailings); a relatively young reforested block to the north; remnants of the former mine site and a few industrial buildings to the west; and natural forest uplands to the south and a marshy valley corridor to the immediate south. This relatively small and shallow pond has a surface area of 3.3 ha, a maximum depth of 1.22 m and mean depth of approximately 0.55 m. (Figure 3.7). A poorly defined outlet was noted along the southern shoreline. The pond was characterized by two shoreline habitat types: wetland-type shoreline (Type 2A) and constructed shoreline (Type 3). Shoreline habitat distribution is provided in Figure 3.7 and features are summarized in Tables 3.4 to 3.6. Additional habitat features are described as follows:

#### Shoreline Habitat Type 2A

This waterbody was largely dominated by Type 2A shoreline habitat. The area was characterized by dense marsh wetland conditions that extended along 832 m of the pond perimeter. Dominant emergent aquatic vegetation consisted of cattails interspersed with bulrush, and the dominant submergent species was stonewort. The riparian zone beyond the emergent vegetation and lining the pond margin was narrow and consisted of a variety of sedges, grasses, alder, tamarack, and Red-osier dogwood with an outer layer of white birch, trembling aspen, alder, and black spruce. The supralittoral zone was equally composed of deciduous (aspen and white birch) and coniferous

(black spruce) trees. Bottom substrates lacked diversity and consisted of mostly organic materials and detritus.

### Shoreline Type 3 Habitat

Approximately 165 m of the western shoreline has been modified as a result of pond infilling and the construction of a rock pad. Materials associated with this shoreline type include granular fill and scour protection in the form of riprap. Emergent aquatic vegetation was not present however beds were dominated by stonewort. Extremely limited bank vegetation consisting of grass and sedge species were documented however the area did not contain a supralittoral zone. As a result of fill placement in this area, substrates consisted of cobble, boulder, gravel and sand with a marginal amount of detritus located within the voids of the larger rock material. Substrates within the deeper lake areas were represented by a combination of muck, silt, and sand.

### Field Water Chemistry

Field water quality parameters were not measured during the AMEC 2007 field program.

### **Fuller Mine Pond Outflow**

The Fuller Mine Pond outflow extended from the pond to the McDonald Lake outflow channel near Gold Mine Road. This small channel appears to be intermittent in nature and relatively poorly defined, passing through sections of shrub thickets and dense cattail marsh, the Reach Types vary from impounded wetland areas (Type 4), dense cattail marsh with undefined watercourse channel (Type 5) to a small defined channel (Type 3A). The system is susceptible to beaver activity which can facilitate ponding of the flat gradient and 100 m wide floodprone valley. Open water area observed in Lidar images was between 70 to 140 m in length and 40 to 70 m in width. The watercourse is crossed by the access to the former Fuller Mine site. Detailed channel diagnostic features are outlined in Table 3.3 and its distribution is shown Figure 3.2.

### **Simpson Lake**

Simpson Lake forms a headwater basin that contributes flows to the South Porcupine River. This waterbody consists of two distinct basins separated by a 200 m narrow. Historic records suggest that the original lake consisted of a single basin (northern basin), and it is likely that intervention associated with land development, such as the constriction along the northern boundary of the Paymaster tailings area, has resulted in a grade change allowing the valley drainage to inundate the floodprone area upstream and form a larger lake. The combined basins have a surface area of 36.73 ha, a maximum depth of 9.52 m and a mean depth of 3.03 m (Figure 3.8). The outflow channel, located along the southern perimeter, conveys flow in a southern direction and drains to the McDonald Lake Outflow channel. The general land use that surrounds Simpson Lake includes the Dome Mine (open pit and waste rock piles) to the east and tailings (Paymaster tailings) to the south; as well as small, narrow forest blocks that separate the waterbody from the Gold Mine Road along the north and west. The lake was characterized by four shoreline habitat types: bedrock

outcropping, rocky substrate with steeper gradients and riparian vegetated shoreline (Type 1); open littoral wetland dominated shoreline (Type 2); wetland-type shoreline (Type 2A); and constructed shoreline (causeway/crossing/road) (Type 3). Shoreline habitat distribution is provided in Figure 3.8 with diagnostic details summarized in Tables 3.4 to 3.6. Additional site specific habitat type descriptions are as follows:

### Shoreline Habitat Type 1

Shoreline Habitat Type 1 was interspersed along the perimeter of the lake basin, reflecting the steeper surrounding rock ridge topography located northeast extending to the base of the valley. A total of 1,049 m of shoreline displays bedrock outcropping, rocky substrates and steeper bed and bank gradients. Emergent aquatic vegetation was very limited and only a narrow near shore perimeter of organic substrates supported clusters of yellow water lily, cattails, sedges, and grasses. Submergent stonewort was observed in profuse, however patchy quantities throughout the littoral areas, and continued to extend into deeper waters until no visual identification could be made. A narrow eulittoral zone was dominated by shrubs and included sweet gale, Red-osier dogwood, willow, alder and an outer layer of trembling aspen, cedar, and white birch. The supralittoral zone largely represented a rock barren forest of white and black spruce, Jack pine, cedar, trembling aspen, and white birch. With the proximity of the forested area to the water's edge and the prevalence of shallow soils on bedrock, wind throws and other large woody debris are commonly documented. These structural features provide additional cover opportunities. Substrates consisted of a combination of fragmented bedrock, boulder, cobble, gravel, and sand coupled with a thin overlying layer of muck and detritus. Bed material composition was similar in deeper areas however an increased amount of cobble, gravel and fine materials including muck was observed. At deeper depths, the bed composition reflects historical tailing deposition, muck, silt and fine sand.

### Shoreline Type 2 Habitat

Type 2 shoreline habitat representation, totaling 856 m, was characterized by sparse wetland conditions typical in shallow water depths with bare softer substrate materials. Near shore vegetation was dominated by a dense however narrow cattail, Reed and bulrush perimeter with small pockets of submergent stonewort, providing a marginal value of overall protective coverage. Floating vegetation consisting of yellow water lily was sparsely distributed and provided only 5% of overall cover. Aquatic vegetation was not evident at water depths greater than 2 m during the June 2007 observations. Prolific amounts of submergent woody debris and tree stumps, resulting from extensive beaver activities and long-term flooding, contribute the most significant portion of aquatic habitat coverage. The eulittoral zone consisted mainly of grasses, Red-osier dogwood, and alder with an outer layer encompassed by white birch and trembling aspen. The supralittoral vegetation included trembling aspen, white birch, Jack pine, and white and black spruce. Bed material consisted of muck, detritus and occasional embedded sand, cobble and boulders. Substrates at depth throughout most of the basin were a combination of muck and detritus with a thin layer of silt/sand, specifically in the small lake basin.

### Shoreline Type 2A Habitat

Shoreline Type 2A represented 3,799 m of the Simpson Lake perimeter. Several embayments provided extended littoral widths before leading into deeper water. Pockets of dense cattails combined with bulrush/cattail hummocks exhibited the dominant shoreline cover opportunity throughout. Consistent with associated shoreline types, dense mats of submergent stonewort were observed along the near shore and extend to deeper water depths. Several dead standing trees and woody debris were present as a result of extensive flooding and surrounding beaver activities. Dense alder, willow, Red-osier dogwood, sweet gale, trembling aspen, and grasses separate the shoreline margin from the supralittoral zone. Upland shoreline vegetation consisted of 60% deciduous species (trembling aspen and white birch) and 40% coniferous (white spruce, black spruce and Jack Pine). Substrates along the perimeter of this habitat type consisted of soft unconsolidated materials such as muck and organics. A small distribution of underlain silty sand was also present. At deeper depths (1 to 2 m) bed materials remained consistent with the general composition of the overall waterbody and tailing surroundings.

### Shoreline Type 3 Habitat

Two areas exhibit altered open water margins consistent with Shoreline Type 3 habitat. This habitat type does not include a supralittoral area. Approximately 256 m of the smaller basin shoreline has been historically altered due to construction of a causeway that provides access to the southern quadrant of the Dome site. Additionally, the remnants of a pumphouse platform exist along the eastern shoreline of the larger basin. Both areas are composed of granular fill and scour protection in the form of riprap. As a result of fill materials lake margin substrates consisted of cobble, boulders, and gravel with lesser distributions of muck and organic materials.

A dense aquatic vegetation community has established along the causeway shoreline including submergent coontail, northern water milfoil and floating watershield. Milfoil extends into deeper areas of open water, however, coverage decreased considerably. No floating vegetation was noted at deeper water depths. Overhanging riparian shrub and herbaceous groundcover such as alder, Red-osier dogwood, and goldenrod (*Solidago* spp.) occupy the granular bank material.

No emergent or submergent vegetation was document along the pumphouse area. Furthermore, riparian vegetation was limited and consisted of sedges, grasses, and small shrubs.

### Field Water Chemistry

During the site visit on August 29, 2007, field water quality parameters measured in both basins of Simpson Lake included secchi disk, dissolved oxygen, pH, conductivity, water temperature, and air temperature. The results of this sampling for both the north and south lake basins are summarized in Appendix E. Dissolved oxygen profiling for both Simpson Lake basins are available in Appendix F.

Water clarity was noted as very clear in both basins. Given the shallow nature of the smaller lake basin, the bed was generally readily visible in all areas. Dissolved oxygen profiling was only carried out in the larger basin. Dissolved oxygen indicated that levels are above 5 mg/L until a depth of 6.5 m where conditions become more limiting. Prolific algae blooms were also recorded during the 2007 field program, indicating higher concentrations of key water quality parameters.

### **Simpson Lake Outflow Channel**

Approximately 893 m of Simpson Lake Outflow Channel was assessed during the AMEC 2007 field program. This drainage system was characterized by one reach type; Type 4. Detailed channel diagnostic features are outlined in Table 3.3. Additional schematics depicting visual features are provided in Appendix C.

The Simpson Lake Outflow channel is located along the southern perimeter of the Simpson Lake basin. This area was characterized by Reach Type 4 containing flat channel gradients, sporadic defined channel form, and long-term beaver activity creating wide open water impoundments, associated riverine marsh, and moderate floodplain widths. Ponded areas range in size from 12 m to 150 m in length and 14 m to 100 m in width. The outlet channel varied in wetted depth from approximately 0.65 m to greater than 1 m. The channel exhibited low to no discernable flow velocity with resultant depositional environment permitting bed material of deep, dense muck and detritus to accumulate. In water aquatic cover opportunities consisted mostly of macrophytes such as stonewort, northern water milfoil, and floating pondweed. Overhead coverage was minimal, consisting only of 5% overhanging vegetation. Wetland margin area contained dense distributions of cattails, grasses, bulrush, reed, and arrowhead species. Riparian vegetation consisted of Red-osier dogwood, sedges, grasses, alder, tamarack, and willow with valley vegetation representing a mixed tree community.

### **3.3.5 Fisheries Resources**

#### **South Porcupine River**

The South Porcupine River was not sampled during the AMEC 2007 field program as a simultaneous detailed investigation was being undertaken to assess biophysical conditions as a component of Environmental Effects Monitoring. These results will be published under separate cover by Goldcorp. Since these results were not available at the time of this report preparation, secondary sources information including EAG (1989) and Beak International (1999) were utilized for the purpose of providing an aquatic resource description. The South Porcupine River hosts a diverse community consisting of eight fish species. Catches of both yellow perch and brook stickleback suggest an abundance of these species. Other species noted included fathead minnow, mottled sculpin, northern redbelly dace, northern pike, pearl dace and white sucker.

Areas of greater fish concentration included; under road bridges, overhanging terrestrial vegetation and slower moving pools. Capture methods included Electrofishing minnow trapping and overnight gill netting.

## **McDonald Lake**

On September 9, 2007, fish were collected from McDonald Lake using a boat electrofishing unit. Sampling effort consisted of a total of 1,257 seconds of effort. The fish population included species representing several trophic guilds: brook stickleback, rock bass (*Ambloplites rupestris*), slimy sculpin (*Cottus cognatus*), smallmouth bass (*Micropterus dolomieu*), white sucker and yellow perch. The catch was dominated by rock bass.

Electrofishing efforts were divided into the four available classified shoreline habitat types. The majority of the sampled fish was captured within the wetland/vegetated shorelines, with the exception being rock bass which were documented throughout all habitats associated with this lake. The CPUE for the lake was marginally lower than the mean CPUE for other waterbodies within the LSA, yet the total diversity was greater than the 2007 sampling mean. A summary of fish collections is provided in Table 3.8.

Historically, McDonald Lake was a source water reservoir for the surrounding residential development. Additionally, previous fisheries enhancement initiatives, such as the introduction of salmonids were attempted but evidently were not successful given the results of the 2007 sampling program.

## **Fuller Mine Pond**

Fish capture effort in the Fuller Mine Pond was carried out October 14, 2007 and consisted of 1,880 seconds of electrofishing. A forage fish population with the absence of predator species was identified and consisted of brook stickleback, fathead minnow, and finescale dace.

Two distinct shoreline habitat types characterize this waterbody including wetland with dense emergent aquatic vegetation and infilled shoreline. The CPUE for the lake was marginally greater than the mean CPUE for the 2007 LSA sampling effort, but the total diversity was lower than the overall mean diversity.

## **McDonald Creek Outflow Channel**

The creek reaches represented by the McDonald Lake Outflow were not sampled during the AMEC 2007 field program as a simultaneous detailed investigation was being undertaken to assess biophysical conditions as a component of Environmental Effects Monitoring. These results will be published under separate cover by PJV. Results from this study were not available at the time of this report preparation.

**Table 3.8 - Hollinger Baseline Studies Total Fish Species Abundance in Lake and Pond Systems within Local Study Area**

Species	Simpson Lake	Mountjoy River	McDonald Lake	Cowboy Lake	Perch Lake	Miller Pond	Peroli Lake	Miller Lake	Fuller Mine Pond	Total Catch By Species
Creek Chub										
Fathead Minnow					81				67	148
Finescale Dace					30				3	33
Northern Red Belly Dace					32			115		147
Pearl Dace		1								1
Log Perch		2								2
Unk Dace Sp.									26	26
Spottail Shiner	1									1
Common White Sucker		5	1	5		10	2	1		24
Long Nose Sucker										
Brown Bullhead	24					37		2		63
Brook Stickleback			2		95				39	136
Iowa Darter							2			2
Blacknose Shiner	162			3			24			189
Johnny Darter					7	1				8
Slimy Sculpin	3	4	1							8
Rock Bass		1	50							51
Yellow Perch	5	3	1	1		11	9	8		38
Walleye		1								1
Northern Pike	8	1		6		1	1	1		18
Smallmouth Bass			2							2
<b>Total Catch by Lake</b>	<b>203</b>	<b>18</b>	<b>57</b>	<b>15</b>	<b>245</b>	<b>60</b>	<b>38</b>	<b>127</b>	<b>135</b>	<b>898</b>

## **Simpson Lake**

Fish capture effort in Simpson Lake was carried out September 8, 2007 and consisted of 5,050 electrofishing seconds. A community consisting of both forage and predatory species was recorded and included: blacknose shiner, brown bullhead, northern pike, spottail shiner, slimy sculpin and yellow perch. The catch was dominated by spottail shiner (Table 3.8).

Simpson Lake was characterized by four shoreline habitat types which included; bedrock outcropping with rocky substrates, open littoral wetland with organic bed material, wetland/vegetated areas and altered shoreline areas. The CPUE for the lake was marginally lower than the mean CPUE for the other water bodies sampled in the LSA in 2007. The species diversity was greater than the mean.

Predatory fish were typically captured along the fringe areas between the wetland habitat and the bedrock outcropping and rocky substrate areas. Forage species were notably abundant along the windward side of the rocky points. The brown bullheads were localized along a 60 m causeway on the southwest basin of the lake among dense submergent aquatic vegetation.

## **Simpson Lake Outflow Channel**

Three minnow traps were set in the Simpson Lake Outflow Channel on September 13 and 14, 2007, one trap was set near the upstream area of the wetland immediately downstream of Simpson Lake, and another was set in a small scour pool above an un-maintained culvert crossing under the Model Airplane Club Road. The last trap was set in the marshy wetland area south west of the model airplane club. The minnow traps were set in narrow channel sections to effectively intercept any small bodied fish moving up or down the limited and intermittent channel. Fish were captured in all three traps set at these locations. Species captured included creek chub, finescale dace, northern redbelly dace, and pearl dace. The dominant species was northern redbelly dace.

## **3.4 Skynner Creek Watershed**

Skynner Creek originates at Skynner Lake in the southeast corner of the 13.4 km<sup>2</sup> watershed, but also drains the southern portion of the City of Timmins, the golf course, and Kayorum tailings areas (Figure 3.1). This area has included considerable watershed alteration to accommodate these varying land uses. Skynner Creek drains in a south westerly direction to the Mountjoy River, which flows north into the Mattagami River. The creek is a generally low gradient system, being characterized by a mainstem valley slope of 0.54% (5.4 m vertical drop per 1,000 m horizontal), and numerous beaver dams.

Much of the Skynner Creek drainage system passes through terrain dominated by glaciofluvial sand deposits (Figure 1.3). Hence, there is the potential for stronger surface water/groundwater interconnections in this area than other clay controlled watercourses in the LSA.

### **3.4.1 Water Quality**

Headwater creek drainage from the City of Timmins and Kayorum tailings area shows elevated concentrations of cadmium, cobalt, copper and iron, relative provincial and federal guidelines for the protection of aquatic life (Table 3.9 - West Watersheds). Also, as a general observation there is a tendency for the concentrations of these metals, as well as sulphate, to improve with location further downstream. All other parameters meet provincial and federal guidelines with the possible exception of total phosphorus, where laboratory detection limits were above the guideline; hence the results are inconclusive.

Data were not obtained for the immediate Skynner Lake drainage area, but it is likely that these waters are more indicative of regional background values given the basins separation distance from the predominant former mine related features to the immediate north and east.

Given the presence of sandy terrain associated with much of the Skynner Creek drainage basin, there is a high potential for increased groundwater-derived baseflow to the system. Such drainages are typically associated with elevated values for a number of indicator parameters such as hardness, conductivity, calcium, and chloride, relative to systems with reduced groundwater influences. However, because of headwater drainages derived from formerly active tailings areas, which also show elevated readings for these same indicator parameters, and the absence of samples from Skynner Lake and its immediate downstream drainage, it is not possible to make any definitive interpretations relative to groundwater influences on Skynner Creek water quality.

### **3.4.2 Sediment Quality**

As with water quality, the sediment quality data for Skynner Creek show the influence of drainage from past mining operations, including drainage associated with the Kayorum Tailings stack and drainage from at-grade historic tailings to the direct north of the Kayorum site (i.e., the Crown Mine tailings). As a result of these drainages, concentrations of arsenic, copper and nickel show values that occasionally above the SEL threshold, and frequently above the LEL threshold.

Further downstream on Skynner Creek, at the pipeline crossing, there is little evidence of current sediment metals enrichment, with the exception of copper which shows a modest enrichment above the LEL guideline of 41 µg/g (Table 3.10 – West Watersheds).

Concentrations of TOC and TKN are particularly elevated in the deep water portion of Cowboy Lake, and these organic materials enhance the metal retaining capacity of the sediments, as evidenced by elevated concentrations of arsenic, copper, nickel and other metals in these deep water sediments. The shallow water sediments of Cowboy Lake in contrast contain comparatively low concentrations of organic substrates and metals. A comparison between the deep water sediments of Cowboy Lake and Perch Lake (see below), which show more or less equivalent elevated concentrations of TKN and TOC, suggests that the elevated concentrations of arsenic,



TABLE 3.10 - HOLLINGER PROJECT BASELINE SEDIMENT QUALITY DATA - WEST WATERSHEDS

Parameters	Units	PSQG LEL <sup>a</sup>	PSQG SEL <sup>b</sup>	CEQG PEL <sup>c</sup>	Symner Creek System				Perch Lake System				Mountjoy River								Towne Creek System							
					Skyrner Cr. Tailings	Skyrner Cr. Pipeline Crossing	Cowboy Lake Shallow	Cowboy Lake Deep	Perch Lake Shallow	Perch Lake Deep	Miller Lake	Mountjoy River US (Area 1)	Mountjoy River US (Area 1)	Mountjoy River US (Area 1)	Mountjoy River MS (Area 4)	Mountjoy River DS (Area 2)	Mountjoy River DS (Area 2)	Mountjoy River DS (Area 2)	Mountjoy River DS (Area 2)	Gillies Lake	Town Cr. at Murray St.	Town Cr. at McLean Dr.						
Source →					Minnow 2002	Minnow 2002	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	AMEC 2007	Minnow 2001	Minnow 2001	
Time Interval →					May 01	May 01	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	Sep 07	May 01	Oct 01	Oct 01	
Statistic →					Mean n = 3	Mean n = 3	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	Mean n = 3	Mean n = 3	Mean n = 3	
Sediment ID																												
Predominant Substrate																												
Loss on Ignition (LOI)	%																											
pH	units																											
Total Kjeldahl Nitrogen	µg/g	550																										
Total Organic Carbon	% solids	1																										
Total Phosphorus	µg/g	600																										
Aluminum	µg/g																											
Antimony	µg/g																											
Arsenic	µg/g	6	33	17																								
Barium	µg/g																											
Beryllium	µg/g																											
Bismuth	µg/g																											
Cadmium	µg/g	0.6	10	3.5																								
Calcium	µg/g																											
Chromium	µg/g	26	110	90																								
Cobalt	µg/g																											
Copper	µg/g	16	110	197																								
Iron	µg/g	20,000	40,000	64,300																								
Lead	µg/g	31	250	91.3																								
Magnesium	µg/g																											
Manganese	µg/g	460	1,100																									
Mercury	µg/g	0.2	2	0.4																								
Methylbenzene	µg/g																											
Nickel	µg/g	16	75																									
Phosphorus	µg/g																											
Potassium	µg/g																											
Selenium	µg/g																											
Silver	µg/g																											
Sodium	µg/g																											
Sulphur	µg/g																											
Vanadium	µg/g																											
Zinc	µg/g	120	820	315																								

Individual sample or sample mean exceeds PSQG LEL  
Upper end of observed range exceeds PSQG LEL  
Individual sample or sample mean exceeds PSQG SEL  
Upper end of observed range exceeds PSQG SEL  
Anomalous value

copper, nickel, zinc and other metals in Cowboy Lake are linked to contaminated drainage associated with Skykker Creek (Table 3.10 – West Watersheds). There is also the possibility of contamination linked with past disturbance on the southeast shore of Cowboy Lake which is evident in historic photos of the area (Figure 1.1).

### 3.4.3 Benthic Macroinvertebrates

The Skykker Creek watershed was inventoried and documented by Minnow (2002). This program involved sampling in the defined drainage channel originating in the Hollinger Golf Club, and was accordingly referred to as the Hollinger Golf Club Drainage. For the purpose of this baseline study, this tributary is considered a channel reach of Skykker Creek. Largely consisting of channelized reaches, the 2001 sampling effort was undertaken in representative more natural flat gradient sections with finer sediments. Forty taxa were identified, and consistent with the habitat conditions, chironomids (52%) were predominant. Other taxa were represented to a much lesser extent including pea clams (*Pisidium*) (10%), nematodes (5.4 %) and seed shrimp (*Ostracods*) (3.9%). Indicator species such as the EPT taxa had a relatively low representation (2.6%). It was concluded that the diversity, through application of the Brillouin diversity index, was similar to that reported for other Ontario reference systems of similar habitat.

The main branch of Skykker Creek also exhibited variable habitat which resulted in a combination of sampling techniques that included fine substrates as well as granular substrates of a riffle section near the Pine Street crossing. In the finer substrates, a total of 41 taxa were reported. Unlike historic results from other watercourses within the LSA, chironomids did not predominate the samples and had a relative abundance of 17%. The most abundant taxa was the Nematode (32%). Tubificid oligochaetes (8.96%), seed shrimp (7.9%) beetles (5.45%), biting midges (6.94%), and pea clams (7.38%) were also relatively abundant. Unionid mussels (*Pyganodon*) were present in one of the three sub-samples, representing only 0.08% of taxa sampled but as a large organism they represented a high proportion of the overall biomass. Similar to the tributary reaches draining from the north Minnow (2002) reported diversity that was within the normal range for reference offsite areas. EPT indicator taxa had a relatively low representation at 2.6% of the community, which was similar to the upstream tributary reaches.

In the more erosion prone reach of Skykker Creek that contained granular substrate materials had a similar density of organisms than those collected in depositional environments, however, the diversity was lower with 24 taxa reported. Consistent with the more dynamic flow and diverse substrate conditions, EPT taxa dominated the samples resulting in a relative abundance of 55%. Caddisflies (*trichoptera*) were the most abundant (51%) of the EPT taxa encountered. Chironomids (14%) were less abundant than in the finer substrates, largely a reflection of habitat conditions. Other common inverts included Coleoptera of the family Elmidae (8.57%), midges of the family (*Simuliidae*) (15.71%) and pea clams (3.08%).

No historic inventories were available for the lower reaches of Skykker Creek and the Cowboy Lake basin.

### **3.4.4 Aquatic Habitat**

During the 2007 field program, approximately 5,842 m of Skynner Creek, commencing upstream of Pine Street, was assessed. This included a channelized portion adjacent to a trailer park development and west of the Kayorum Tailings Management Area. Skynner Lake was not assessed during the 2007 field program however a general description has been provided. The entire perimeter of Cowboy Lake, which drains to Skynner Creek, was evaluated for biophysical and habitat characteristics.

#### **Skyner Creek**

Seven reach types characterize this watercourse system including: Type 3; Type 4; Type 6A; Type 6B; Type 9A; Type 9B; and Type 12. Detailed channel diagnostic features of each reach type are outlined in Table 3.3 and their distribution is shown in Figure 3.2. Additional channel section schematics and photographic records are provided in Appendix C.

The northern channel corridor of Skynner Creek drains the Hollinger Golf Course and flows adjacent to the Sheridan Mobile Home Park and the Kayorum Tailings Management Area. This section was characterized by Reach Type 6A. Approximately 1.1 km (12%) has been channelized resultant of surrounding residential development and tailing facility. This has resulted in a straight channel with no sinuosity. Demonstrating a riffle/run/flat channel configuration, the watercourse traversed a narrow floodplain, approximately 6 to 20 m wide, before outflowing to a natural wetland area downstream (Type 4). The channel and valley gradient was observed to be low, and resulted in low to moderate flow velocity. Mean width was 1.72 m and a corresponding depth at 0.23 m was observed throughout. Substrate composition was predominantly sand with gravel, cobble, and equal distributions of silt and detritus. Undercutting and general bank instability was high as a result of run-off from surrounding impervious surface. Urban debris was also frequently observed within the channel as a result of uncontrolled dumping of refuse. Riffle areas exhibited embedded substrate conditions and siltation was present in the run and pool sections. In water vegetation consisted of cattail, grasses, and arrowhead. A narrow boundary of riparian vegetation contained cattail, bulrush, grasses, and the occasional Red-osier dogwood, willow, and alder. Valley vegetation was also limited due to the surrounding land use and consisted of chokecherry, trembling aspen, willow, white birch, and raspberry. Undercut banks, urban debris, aquatic vegetation and bed materials provided 15% overhead cover opportunity.

Several sections of Skynner Creek, approximately 5545 m or 63%, represent Reach Type 4, specifically identified in southern headwater segments and three distinct sections downstream of Pine Street (Chainage 3.6 to 3.2 km, 2.6 to 1.39 km, and 0.4 to 0.13 km). This channel reach type was the most common documented in the overall LSA, a reflection of the typically flat terrain. Impounded open waters and riverine marsh conditions are a result of local beaver activity, flat channel gradients, and general topographic features. Floodplain widths, extensive in many areas, ranged between 30 to 350 m. Poned areas vary in size, approximately 10 to 150 m in length and 15 to 200 m in width. Wetted depths were relatively uniform and averaged 1.15 m, however, deeper depths are observed in open water sections. During the August 2007 survey, low to no discernable

flow velocity was observed. Such flows contribute to a depositional environment resulting in finer bed material (silt), overlaying a thick layer of muck, detritus and unconsolidated clay. Cover opportunities within the open water area consisted mostly of aquatic vegetation such as northern water milfoil, floating pondweed, and stonewort. Wetland vegetation was dominated by cattails combined with sedges, grasses, bulrush, and reed species. Similarly, extensive areas of this reach type were overgrown entirely and no open water was present. The upland valley vegetation combined a mixed forested stand while riparian vegetation consisted of grasses, dogwood, cedar, alder and willow. As a result of the fragmented open water and lack of defined channel, often limited useable fish habitat was available in this reach type.

The section of the creek, located at Pine Street, represented Reach Type 9A (Chainage 3.8 to 4.18 km). Representing approximately 3.5% of the overall watercourse morphology, this reach type occupies 306.96 m of the total creek length. Before flowing into a mixed forested stand, a small straightened section funnels through a 1.42 m CSP culvert that accommodates a 12 m wide municipal road (Pine Street South). Characterized by a well defined channel exhibiting erosional features and granular bed materials, general morphology consisted of an equal distribution of run and pool areas with occasional riffle sections. Substrates consisted of courser materials combined with a larger distribution of sand. Exhibiting a moderate channel slope, the average wetted width and depth was 2.12 and 0.39 m, respectively. Undercut banks affect approximately 20% of the reach length causing moderate bank instability. Large woody and urban debris observed downstream of the culvert results in a planimetric adjustment to compensate the obstruction; however the channel regains its form immediately downstream. Riparian vegetation included overhanging alder, Red-osier dogwood, white ash, sedges, grasses, cattails surrounded by spruce, white birch, trembling aspen and balsam fir. Aquatic vegetation, overhanging shrubs, organic and urban debris, and undercut banks provided approximately 20% of in stream cover, with the adjacent thicket forest providing 15% overhead cover opportunity.

Reach Type 3, located downstream of Type 9A, spans 282.09 m, a total of 3.18% of the overall channel reach type (chainage 3.5 to 3.8 km). Surrounding land use was agricultural to the south and sporadic residential/forested blocks occupy the north. Dominated by run/flat channel configuration, the watercourse flows through a dense meadow floodplain, approximately 40 to 70 m wide. Flat drainage slopes of <0.5% were observed and resulted in low to moderate flow velocity. Mean width was 1.47 m and a corresponding depth at 0.43 m was observed throughout. Substrate composition was variable with muck and sand representing the largest component. Meadow grasses, cattails, and occasional shrub species including Red-osier dogwood, willow, and alder create a dense riparian perimeter. Valley vegetation along the floodplain margin featured alder combined with white birch, spruce, and balsam fir. Undercut banks, organic and woody debris, aquatic vegetation and overhanging grasses provided 20% overhead cover opportunity.

Downstream of Reach Type 3, Skynner Creek (chainage 2.6 to 3.2 km) was characterized by Reach Type 6B. Approximately 605.98 m (6.83%) was historically channelized as a component of aggregate extraction activities through the valley and adjacent areas. Presently, the area is utilized by locals for various purposes such as ATV activities, and unauthorized refuse disposal. A power transmission corridor also crosses the valley, and is accompanied by an access road. Vehicular

crossings, artificial landform depressions, and proximity to the water table contribute to substantial ponded areas and irregular flow patterns (planimetric adjustment). Little to no evidence of a meandering pattern was present throughout this area. Additionally, segments of the watercourse are over grown with aquatic vegetation in association with extensive beaver activities and long-term inundation of the flood plain. Impounded open water areas ranged in size between 10 to 50 m in width and 25 to 150 m in length. Wetted depths are relatively uniform between 1 m to greater than 1.5 m throughout. Substrate materials are predominately organic muck and detritus, with variable depositions of sand, gravel, cobble, clay and silt presumably from the surrounding land uses. The ponded areas are lined with a dense perimeter of cattails, herbaceous species, grasses, and sedges. Open water areas are dominated by submergent northern water milfoil and stonewort with marginal distributions of floating pondweed. Beyond the cattail perimeter, various shrub species partition the upper valley vegetation. At a shallow road crossing leading towards Cowboy Lake, a small defined channel becomes apparent. This confined section demonstrates a riffle/pool/run sequence with mean wetted widths of 3.25 m and depths between 0.03 and 0.47 m. Unlike the surrounding area, the bed substrate consisted of a gravel, cobble, pebble, and sand matrix. Small schools of minnow and dace were observed within this area.

Approximately 465 m upstream from the Mountjoy River confluence, at chainage 0.464 to 1.39 km, Skynner Creek flows through a dense alder thicket and hummocky floodplain and is classified as Reach Type 12. This section represents 10.43% of the overall channel morphology of this system. Characterized by a poorly defined and intermittent watercourse segments, water flows in a diffuse manner before reaching the open water impoundments characteristic of Reach Type 4 further downstream towards the Mountjoy River. Floodplain width ranged between 200 to 300 m wide and small areas of pooling water had an average depth of 0.56 m. Substrates in the thicket area are largely composed of organic sediments and detritus. Understory groundcover consisted of dense herbaceous species, sedges, grasses, cattails, and ferns. Alder, Red-osier dogwood, willow, and dead woody debris contributed approximately 60% of overhead coverage. The floodplain perimeter consisted of a mixed forest community, which was consistent with the general area.

Reach Type 9B represents the smallest proportion of channel morphology found in the Skynner Creek system (approximately 1.48%). A small segment of this reach type was located at the furthest downstream section (Chainage 0 to 0.13 km) adjacent to the Mountjoy River and extended 130 m upstream to the Reach Type 4 extent identified above. This section is dynamic and possesses unstable, and erosive and entrenched conditions. Channel gradient was moderate to steep with rapid flow throughout the reach. The channel morphology was dominated by pools and an equal distribution of riffle and run areas. Average wetted widths and depths are 1.75 m and 0.26 m, respectively. The riparian vegetation consisted of grasses, herbaceous and shrub species that contribute to the overall channel form. Overhead and in stream vegetation provided over 50% protective coverage. Bed substrate materials consist of predominantly sand, coupled with silt and fine sand bed and bank materials.

## **Cowboy Lake**

Cowboy Lake, located approximately 2.3 km upstream from the Mountjoy River, is one of two waterbodies identified within the Skynner Creek system. This small, and somewhat on-line lake, has a surface area of 4.43 ha with a maximum depth of 6.32 m and mean depth of 2.53 m (Figure 3.9). Land use surrounding Cowboy Lake consists of rural residential zoning (hobby farm) to the north; power transmission corridor/unmaintained roadway/former aggregate pit to the east and south east; and a predominantly coniferous forest block to the west. Aerial imagery depicts previous logging activities upland of the western lake perimeter. Inflow and outflow from this waterbody is difficult to differentiate due to diffuse flow paths through an undefined channel and dense cattail marsh located along the northern shoreline. This lake was characterized by three shoreline habitat types: the open littoral wetland dominated shoreline (Type 2), dense cattail shoreline with soft bed substrate (Type 2A), and rocky substrate with moderate gradients and overhanging vegetative shoreline (Type 1A). Shoreline habitat distribution is provided in Figure 3.9 and additional details are provided in Tables 3.4 to 3.6. Images of the shoreline habitat types are provided in Appendix D.

### Shoreline Type 1A Habitat

Hydro transmission towers were installed adjacent to Cowboy Lake. Furthermore, previous shoreline modification resulted in an unmaintained right-of-way road and a former aggregate pit which is currently used for recreational purposes. Naturalization process and revegetation has transformed the constructed area into a Type 1A habitat and covers 326 m of the eastern shoreline. Little to no emergent aquatic vegetation was recorded however uniform areas of submergent stonewort were observed. Overhanging grasses, sedges, Red-osier dogwood, willow, and alder provide a diverse and dense shoreline riparian community. Upland vegetation was very limited consisting of a narrow boundary of mixed forest tree saplings. Shoreline bank and bed gradients are moderate and substrate materials consist of small rocky materials and sand. Woody and urban debris, in water and overhanging, was often observed throughout.

### Shoreline Type 2 Habitat

Representing the largest shoreline habitat type identified in Cowboy Lake, much of the south and western shoreline features Type 2 characteristics. This area was characterized by an extended littoral zone, shallow water depths, and sporadic aquatic vegetation distribution. Sparse wetland condition occupies a total length of 425 m of the lake's perimeter and boasts a narrow strip of dense cattails and patchy mats of submergent stonewort and milfoil areas. Riparian condition, narrowly defined, consisted of overhanging shrub, mature coniferous and juvenile deciduous trees, and an herbaceous understory. Exposed lake substrate represented by a thick muck and organic matrix was often observed throughout this habitat type. Several dead standing trees line the lake perimeter and an abundance of woody debris was noted in the open water. Marginal amounts of white water lily was sparsely distributed and provided only 5% of overall cover. At depths greater than 1 m, emergent aquatic vegetation was not evident, however, an increased amount of submergent stonewort was documented. The supralittoral zone was dominated by large coniferous species combined with marginal proportions of deciduous trees.

### Shoreline Type 2A Habitat

Type 2A shoreline habitat was characterized by typical wetland conditions and a wide littoral zone. One area, approximately 163 m located along the northern shoreline, consists of dense emergent cattails spanning several metres in width. A prolific and uniform distribution of submergent milfoil and stonewort provides ideal fish habitat along this shoreline. Dead standing trees, stumps, and in water woody debris was abundant throughout. Cowboy Lake is connected to the Skynner Creek system and as a result, the eutlittoral zone, consisting of overhanging shrub species, is located along the distant northern shoreline. A residential/farm located along the upland north shoreline and the associated maintained meadows/pasture overlooks the waterbody and restricts natural valley vegetation growth or recolonization. Bed substrates are composed of substantial organic detritus underlain layers of gravel, sand, and silt.

General substrate composition in deeper areas of both habitat types consisted of predominantly muck and organic material.

### Field Water Chemistry

Field water quality parameters measured in Cowboy Lake during the site visit on September 9, 2007 included dissolved oxygen (10.03 mg/L), pH (8.69), conductivity (791  $\mu$ s), and a water temperature of 19.93°C at an air temperature of 25°C. Dissolved oxygen profiling indicated that levels are above 7 mg/L until a depth of 3.5 m where conditions become more limiting and DO concentrations decrease to 2.07 mg/L. One secchi depth reading of 4.60 m was recorded with water clarity noted as very clear. . Dissolved oxygen profiling for Cowboy Lake is available in Appendix F.

### **Skyenner Lake**

Due to the location of Skyenner Lake and its lack of anticipated interaction with the proposed project activities, it was not assessed during the AMEC 2007 field program. A review of Lidar satellite imagery was utilized to provide a general description for the purpose of this report. This lake was characterized by one shoreline habitat type: dense cattail shoreline with organic bed substrates (Type 2A) (Figure 3.10). It has a surface area of 6.3 ha and represents a headwater basin in the Skynner Creek Watershed. The outlet along the northern shoreline conveys flow in a northwesterly direction where it ultimately reports to the Mountjoy River, approximately 6.5 km downstream. The general land use surrounding Skyenner Lake is natural to the north, south, west, and east. The shoreline perimeter consisted of dense cattail, grasses, and sedge species. The surrounding riparian vegetative area was generally wide, spanning between 30 to 60 m to the terrestrial boundary area. Valley vegetation surrounding Skyenner Lake consisted of a mixed forest community.

### **3.4.5 Fisheries Resources**

#### **Skyunner Creek**

Skyunner Creek, for the component of this fisheries discussion has been subdivided into five sample areas; Skyunner Creek Area 1 (SK1) encompasses the upstream areas of Pine Street to the headwaters area located adjacent to the Hollinger Golf and Country Club, Skyunner Creek; Area 2 (SK2) includes the reach downstream of Pine Street into the identified aggregate area off of Sunset Boulevard, Skyunner Creek; Area 3 (SK3) consists of the portion from the confluence of Cowboy Lake to approximately 1500 meters downstream where Skyunner Creek dissipates into the poorly define alder thicket (Reach Type 12); and Skyunner Creek Area 4 (SK4) which includes the confluence of the Mountjoy River upstream to the poorly define alder thicket.

The area of SK1, throughout the upper portion of Skyunner Creek was not surveyed during the 2007 AMEC field program. Alternatively, a review secondary sources, specifically the Minnow 2002 report, was utilized for the purpose of this description. Species identified consisted of brook stickleback, creek chub, fathead minnows, finescale dace, northern redbelly dace and pearl dace (Table 3.7), with pearl dace being the most dominate species at 71% of the catch. The downstream portion of SK1 was sampled using minnow traps placed in areas closer to Pine Street.

Four baited minnow traps were set throughout the SK2 sample area on September 12 and 13, 2007 for a total duration of 23 hours each. A combined catch of 5 fish was obtained, consisting entirely of creek chub. Electro backpack shocking was also carried out and yielded a much greater result, contributing a higher than average species diversity than the study mean. The area was shocked for a total of 750 electro seconds. The most abundant species was creek chub, which comprised 68% of the total catch in this area. Other species noted in this area included brook stickleback, fathead minnow, Johnny darter, northern redbelly dace and white sucker.

Three baited minnow traps were set throughout the SK3 sample area on September 12 and 13, 2007 for a total duration of 23 hours each. No catch was yielded from the three traps. Backpacking shocking was also carried out for a total of 955 electro seconds and yielded a higher than average species diversity than the study mean. The predominant species in the catch was creek chub, which comprised 33% of the total sample in this area. Similar to SK1 and SK2, other species noted in this area included brook stickleback, Johnny darter, northern redbelly dace and white sucker.

Three baited minnow traps were set throughout SK3 sample area of Skyunner Creek on September 12 and 13, 2007 for a total duration of 23 hours each. No catch was yielded from the three traps. Backpack electro shocking was also carried out for a total of 955 electro seconds. Higher than average species diversity was yielded relative to the studies mean. Similarly, the most abundant species was creek chub, which comprised 33% of the total catch in this area. Other species noted in this area included brook stickleback, Johnny darter, northern redbelly dace and white sucker.

Two baited minnow traps were set throughout SK5 sample area on September 13 and 14, 2007 for a total duration of 23 hours each. A combined catch of 5 fish was obtained, consisting entirely of creek chub. Backpack shocking was also carried out and yielded a much greater abundance in addition to a higher than average species diversity than the study mean. The area was shocked for a total of 750 electro seconds and the sample was dominated by creek chub, which comprised 68% of the total catch in this area. Other species noted included brook stickleback, fathead minnow, Johnny darter northern redbelly dace and white sucker consistent with other sampling stations in the creek.

### **Cowboy Lake**

Fish capture effort in Cowboy Lake was carried out September 10, 2007 and consisted of 1,260 seconds of boat electrofishing time. Cowboy Lake species consisted of blacknose shiner, northern pike, yellow perch and white sucker. Northern pike was the dominant species, representing 40% of the total catch (Table 3.8).

Three distinct habitat types were present in Cowboy Lake. These habitats consisted of a wetland composition with dense emergent aquatic vegetation, woody debris with sparse open littoral flats and barren organic areas, and rock/sand substrates with overhanging vegetation. The CPUE for this waterbody was much lower than that for other locations sampled by electroshocking within the LSA. Total species diversity was the lowest of all assessed areas within the LSA. The majorities of species captured in the lake were found in areas of abundant macrophyte growth and associated cover opportunities.

## **3.5 Perch Lake Watershed**

The Perch Lake system is a smaller drainage system, located adjacent to the Skynner Creek watershed, which also flows to the Mountjoy River. Similar to the Skynner Creek system, much of the Perch Lake watershed is founded on glaciofluvial sand deposits, and therefore potentially exhibits a strong surface water/groundwater interconnection.

### **3.5.1 Water Quality**

A single water sample from this system was collected by AMEC in September 2007, from Perch Lake itself. This sample showed no evidence of any form of water quality impairment, with all parameters being consistent with provincial and federal guidelines for the protection of aquatic life, with inconclusive results for total phosphorus and cadmium because of laboratory detection limits.

Also, despite the association of the Perch Lake watershed with glaciofluvial sand deposits, there was nothing in the chemical profile of the lake to suggest meaningful groundwater discharge to the system (i.e., concentrations of indicator parameters such as hardness, conductivity, calcium, and chloride are all comparatively). These data suggest that, if anything, the Perch Lake system may recharge the groundwater system.

### **3.5.2 Sediment Quality**

Sediment quality data for Perch Lake are also indicative of background conditions with low concentrations of all parameters except for TKN and TOC for the deeper portion of the basin (Table 3.10 – West Watersheds). In this portion of the basin a number of metals show concentrations which are slightly above provincial LEL values, but these slightly elevated metal concentrations are most likely a function of the natural metal sequestering properties of the organic materials themselves, and not a reflection of anthropogenic contamination linked to past mining activities.

The comparison between Perch Lake and Cowboy Lake is instructive in this regard, where the deep basin of Cowboy Lake with equivalent, or lower TKN and TOC values, shows much higher concentrations of key metalloids and metals such as arsenic, cobalt, copper, iron, nickel and zinc, with the difference in copper being particularly striking.

### **3.5.3 Benthic Macroinvertebrates**

No historic benthic macroinvertebrate inventory data was available for the shallow lake systems associated with the Perch Lake drainage. Given the generally shallow nature of the basins and the organic substrates that are prevalent, invertebrate communities are anticipated to be consistent with other similar habitats in the LSA. Recent information regarding 2007 sampling will be reported under separate cover to provide a characterization of baseline benthic macroinvertebrate communities for the lakes in this system.

### **3.5.4 Aquatic Habitat**

Four waterbodies associated with the Perch Lake Watershed were assessed during the 2007 field program; Perch Lake, Peroli Lake, Miller Lake, and Miller Pond which outflows to the Mountjoy River. Additionally, a small section of the Peroli Lake Outflow Channel was also evaluated.

#### **Perch Lake**

Perch Lake represents the headwater basin of the Perch Lake Watershed and is located approximately 1.5 km upstream from the Mountjoy River. The smallest of the on-line waterbodies, its surface area is 2.81 ha with a maximum depth of 3.72 m and mean depth of 1.88 m (Figure 3.11). General land use consists of natural mixed forest stands encompassing the entire perimeter of the waterbody. Water flow is diffuse through an undefined and marshy outlet located on the north-eastern shoreline leading into a low-lying area linked to Peroli Lake. The lake was characterized by two shoreline habitat types: characteristically bog-like shoreline with shallow water depths (Type 2C) and rocky substrate with moderate gradients and vegetated shoreline (Type 1A). Shoreline habitat distribution is provided in Figure 3.11 and features are summarized in Tables 3.4 to 3.6. Shoreline habitat type photos are provided in Appendix D.

### Shoreline Type 1A Habitat

Type 1A shoreline habitat represented the smallest proportion of the habitats identified in this waterbody. A total length of 250 m along the north-eastern lake perimeter consisted of moderate bank and bed gradients, variable substrate materials, increased canopy shading, and sporadic areas of woody debris along the lake margin. Littoral and eulittoral zones were significantly narrow compared to those observed in Habitat Type 2C. Near shore vegetation was comprised of pockets of broad-leaf arrowhead, iris, grasses, sedges, and cattails. Submergent vegetation was consistent throughout with a large representation of milfoil and stonewort. The outer eulittoral area consisted of overhanging alder, Red-osier dogwood, and willow with the nearby supralittoral zone dominated by deciduous tree species. Bed substrate comprised of an assortment of medium to smaller rockier materials combined with a sublayer of sands. Some areas of bed were overlain with silt, detritus, and organics matter. Deeper lake samples consisted of muck with small amounts of detritus and sand particles.

### Shoreline Type 2C Habitat

A total of 452 m of the lake perimeter was dominated by Type 2C habitat. Shorelines were characterized by flat lake margin, shallow water depths and an extended bog-like boundary ranging 5 to 30 m from the open water area to the surrounding terrestrial forest. The near shore margin was limited, containing small distributions of emergent grasses, arrowhead, sedges, and cattails. Denser submergent vegetation was observed consisting predominantly of northern water milfoil and stonewort. The eulittoral zone contained a characteristic bog vegetation community supported by a fully saturated and floating mat of vegetated organic material. Typical vegetation included various grasses, sedges, alder, tamarack, iris, sweet gale, sphagnum mosses, and herbaceous species with an outer boundary community consisting of trembling aspen, alder and cattails. The supralittoral area consisted of a predominantly coniferous forest including black spruce, Jack pine, white spruce and tamarack. Substrate materials consisted of a soft muck and organic detritus matrix consistent with the shallow and bog-like characteristics of this shoreline type.

Small patches of yellow water lily were noted in both habitat types as well as at deeper depths.

### Field Water Chemistry

Field water quality parameters measured in Perch Lake during the site visit on September 10, 2007 included dissolved oxygen (9.07 mg/L), pH (8.70), conductivity (45  $\mu$ s), and water temperature (16.37°C) at an air temperature of 21°C. Dissolved oxygen profiling indicated consistent levels ranging between 9.07 mg/L and 8.31 mg /L until a depth of 2.5 m where conditions become more limiting. Dissolved oxygen profiling for Perch Lake is available in Appendix F. One secchi depth reading of 2.4 m was recorded and water clarity was noted as clear.

## **Peroli Lake**

Historic aerial imagery (1969) exhibits Peroli Lake once as a shallow waterbody that contained dense cattail hummocks and limited open water area. Recent developments (identified along the north-western shoreline) have resulted in long-term flooded conditions and significantly increased water levels. Although water depth remained relatively shallow, the current open water area is much greater and aquatic vegetation is confined to near shore areas. General land use includes a natural mixed forest community and a former aggregate pit located upland from the western shoreline. Overall surface area is approximately 4.91 ha with a maximum depth of 3.32 m and mean depth of 1.09 m (Figure 3.11). Peroli Lake was characterized by two shoreline habitat types: wetland-type shoreline (Type 2A) and an anthropogenic alteration, constructed causeway/crossing/road (Type 3). Shoreline habitat distribution is provided in Figure 3.11 and a summary of features is provided in Tables 3.4 to 3.6.

### Shoreline Type 2A Habitat

The majority of Peroli Lake was dominated by Type 2A shoreline habitat. This area, covering a total of 1029 m, was characterized by typical features identified in wetland environments. The emergent aquatic vegetation was dominated by a dense cattail perimeter combined with lower representations of sedge and grass species, while floating vegetation consisted of yellow water lily and pondweed. A uniform distribution of submergent stonewort dominates much of the visible lake bed. Riparian vegetation included a mix of sedges, willows, dogwood and speckled alder while the supralittoral zone was composed of white birch, trembling aspen, black spruce and tamarack. Bottom substrates were largely composed of organic materials and detritus. Marginal amounts of woody debris were observed throughout this shoreline type. Sporadic remnants of historical habitat condition such as cattail hummocks and original channel definition were observed in some areas.

### Shoreline Type 3 Habitat

Approximately 127 m of the northwest shoreline of Peroli Lake consists of a constructed causeway, newly built beaver dam, and a gravel road leading into a former aggregate pit. Granular fill and scour bank protection in the form of medium to large riprap material line this portion of the lake perimeter. A marginal distribution of aquatic vegetation, including floating pondweed and submergent stonewort were observed in areas with suitable bed substrates. Shrub and tree saplings including alder, Red-osier dogwood, and tamarack combined with grasses and herbaceous groundcover occupy areas within the granular bank material. This habitat type did not include a supralittoral area due to the nature of the surrounding land use. Bottom substrates were dominated by boulder, cobble, gravel and sand with overlying organic detritus and woody debris.

### Field Water Chemistry

Field water quality parameters measured in Peroli Lake during the site visit on October 16, 2007 included dissolved oxygen (7.44 mg/L), pH (8.41), conductivity (513  $\mu$ s), and water temperature (7.96°C) at an air temperature of 13°C. Dissolved oxygen profiling indicated consistent levels

ranging between 7.44 and 7.91 mg/L to lake bottom (2.5 m). Dissolved oxygen profiling for Peroli Lake is available in Appendix F. One secchi depth reading of 2.15 m was recorded and water clarity was noted as very clear.

### **Peroli Lake Outflow Channel**

The Peroli Lake Outflow Channel is the only channel segment identified within the Perch/Miller Lake system. Approximately 567 m is characterized as Reach Type 4 and the channel links Peroli Lake to Miller Lake. Detailed channel diagnostic features are outlined in Table 3.3 and its distribution is shown in Figure 3.2. Additional channel sections and photographs for this reach type are provided in Appendix C.

Influenced by local beaver activities, general land use, and natural topography, this flat gradient channel segment consists of impounded conditions, dense aquatic vegetation, and evidence of planimetric form adjustment. Moderate floodplain widths ranging between 50 to 80 m are combined with open water areas approximately 45 to 200 m in length and 25 to 50 m in width. Several beaver dams were documented and result in areas of overgrown channel, specifically approaching Miller Lake. Low-lying topography surrounding the hydro transmission towers contribute to the overall planimetric form adjustment occurring upstream. Wetted depths were typically greater than 1.5 m. Low to no discernable flow velocity was observed, permitting deposition of finer bed material and organics throughout. Cover opportunities within the open water area consisted mostly of aquatic vegetation such as northern water milfoil, woody debris, and stonewort. The wetland vegetation forming the margin of the open water area was dominated by cattails coupled with sedge, grasses, reed, and bulrush species. The area surrounding the wetland was natural and composed of a mixed forest coupled with grasses, dogwood, raspberry, alder and willow.

### **Miller Lake**

Miller Lake is a small on-line waterbody formed as a result of the low topographical gradients and extensive beaver activities in the area. The general land use that surrounds Miller Lake includes a mixed forest community to the east and west; a power transmission corridor to the south; and a small portion of the northern shoreline borders on agricultural land. Miller Lake has a surface area of approximately 4.77 ha with a maximum depth of 3.32 m and mean depth of 1.76 m (Figure 3.12). The lake was characterized by two shoreline habitat types: wetland-type shoreline (Type 2A) and anthropogenically influenced environments, finer bed materials, and gradual shoreline and bed gradient (Type 3A). Shoreline habitat distribution is provided in Figure 3.12 with details summarized in Tables 3.4 to 3.6.

#### Shoreline Type 2A Habitat

Miller Lake was largely dominated by Shoreline Habitat Type 2A. Approximately 1,030 m of the lake perimeter was characterized by typical marshy and bog-like wetland conditions. The emergent aquatic vegetation that surrounds the perimeter was dominant by cattails coupled with sporadic patches of dense sedges, broad-leaf arrowhead, and grasses. Various submergent and floating

species are present along the southern shoreline including northern water milfoil, yellow water lily, Sago and floating pondweed, and duckweed. Riparian vegetation lining the lake margin consisted of sedges, rushes, and grasses. The eulittoral zone consists mainly of speckled alder and Red-osier dogwood while the supralittoral zone was composed of black spruce and white birch trees with small inclusions of eastern white cedar. Bottom substrates lacked diversity and consisted mostly of organic materials and detritus.

### Shoreline Type 3A Habitat

A small portion, approximately 114 m located on the northern shoreline, represents an altered habitat resultant of the surrounding agricultural land use. The riparian vegetation was dominated by grasses including meadow Timothy, Canada bluejoint, common reed and fowl bluegrass in addition to early growth of Red-osier dogwood. No shrub and tree species were identified in the eulittoral or the supralittoral vegetative zones leading into the upland agricultural plot. Bank and bed gradients were moderate and no in-water aquatic vegetation was observed. Bed substrates remain consistent throughout this area and were similar to those identified in Shoreline Habitat Type 2A.

Significant evidence of recent beaver activity was observed within this habitat type.

### Field Water Chemistry

Several field water quality parameters were measured in Miller Lake during the site visit on October 13, 2007. Measurement parameters included dissolved oxygen (9.22 mg/L), pH (7.53), conductivity (459  $\mu$ s), and water temperature (7.77°C) at an air temperature of -2°C. Water clarity was noted as a tannic during the inventory. No dissolved oxygen profile was documented during the AMEC 2007 field program.

### **Miller Pond**

Miller Pond is the final on-line waterbody that links the upstream conveyance system to the Mountjoy River. One inlet was identified along the south-eastern shoreline however water flow was significantly impeded as a result of a beaver dam and dense cattails that divides Miller Pond from Miller Lake. A shallow outlet with a 2 m width flows into the Mountjoy River and was located on the northeastern shoreline. A deciduous forest surrounded much of the southern perimeter while the northern shoreline was composed of a mixed forest block, through which the Mountjoy River meanders in close proximity. Both the eastern and western shorelines encompass a narrow forested belt that separates the outer agricultural land use. Miller Pond has a surface area of approximately 8.68 ha with a maximum depth of 5.92 m and mean depth of 3.19 m (Figure 3.12). The lake was characterized by only one shoreline habitat type: wetland-type shoreline (Type 2A).

### Shoreline Type 2A Habitat

Approximately 1,340 m of the lake perimeter was dominated by Type 2A shoreline habitat. The littoral zone was characterized by dense emergent species typical of marshy wetland conditions.

Gradual shoreline bank and bed gradients were observed throughout, permitting areas of extended littoral widths before leading into deeper waters. Emergent vegetation was dominated by a dense growth of sedges combined with a sparse distribution of burr reed, cattails, broad-leaf arrowhead, and grasses. Floating aquatic species were represented in small patches of yellow water lily, mostly observed at 1 – 2 m water depths. Compact and uniform mats of submergent stonewort were observed throughout providing ideal refuge for several fish species. At depths greater than 2 m, small pockets of submergent Richardson's pondweed were documented. Riparian vegetation consisted of sedges and speckled alder with Red-osier dogwood and willow also present. The supralittoral zone varied from predominantly deciduous on the south shoreline to a coniferous dominated mix along the north shoreline. Species included in the valley vegetation were poplar, white ash, white spruce, black spruce and balsam fir. The bottom substrates consisted of mostly dense organics underlain with soft silty sand materials. Minimal woody debris and logs were observed along the shoreline. One residential property was identified on the western perimeter resulting in very small portion of shoreline consisting purely of maintained lawn.

### Field Water Chemistry

Several field water quality parameters were measured in Miller Pond during the site visit on August 28, 2007. Dissolved oxygen concentrations at surface level ranged between 9 mg/L to 10 mg/L at observed water temperatures under 20°C. Dissolved oxygen profiling indicated that levels are above 6.5 mg/L until a depth of 3.5 m where conditions become more limiting and DO concentrations decrease to 3.51 mg/L. Dissolved oxygen profiling for Miller Pond is available in Appendix F. Additional measurements of surface water parameters included pH (8.53) and conductivity (367 µs). Water clarity was noted as clear during the inventory with average secchi depth readings of 2.85 m.

### **3.5.5 Fisheries Resources**

#### **Perch Lake**

Fish capture effort in Perch Lake was carried out September 10, 2007 and consisted of 1,006 seconds of boat electrofishing. An abundant forage fish population with an absence of predator species was identified within this waterbody. Perch Lake species consisted of brook stickleback fathead minnow, finescale dace Johnny darter and northern redbelly dace. The catch was predominantly brook stickleback and fathead minnow (Table 3.8).

Perch Lake consisted of two distinct shoreline habitat types; a natural shoreline consisting of floating mats of aquatic vegetation, and the other consisting of a barren sand and gravel bed with a thin layer of detritus material. The CPUE for the lake was greater than the mean for 2007 sampling within the LSA, however, the total diversity was generally lower. The total catch for the lake was the highest throughout the LSA and was twice the study mean. This is likely due to the lack of primary order predators within this waterbody and has resulted in a robust cyprinid population that is bound solely by the lake carrying capacity as a limiting factor.

### **Peroli Lake**

Fish capture effort in Peroli Lake was carried out October 16, 2007 and consisted of 1,485 seconds of boat electrofishing. A healthy forage and predator fish population was present including northern pike and many adult yellow perch. Peroli Lake species consisted of black nose shiner, Iowa darter (*Etheostoma exile*), northern pike, white sucker and yellow perch. The catch was dominated by black nose shiner (Table 3.8).

Peroli Lake consists of two shoreline habitat types. The lake perimeter is largely dominated by a wetland-type shoreline with soft organic bed and dense macrophytes while the remaining area consisted of an anthropogenically altered shoreline. Fish were relatively well distributed throughout the various habitat types. The CPUE for the lake was much lower than the mean CPUE for the LSA sampling. Additionally, the total diversity was marginally lower than for the overall LSA sampling. Total catch for the lake was significantly below the LSA sampling mean however the species diversity was average.

### **Miller Lake**

Fish capture effort in Miller Lake was carried out October 13, 2007 and consisted of 1,913 seconds of electrofishing time. A balanced ratio of sportfish to forage fish species was identified in this waterbody. Miller Lake species consisted of brown bullhead northern redbelly dace, northern pike and yellow perch. The catch was dominated by northern redbelly dace (Table 3.8).

Miller Lake was characterized by two shoreline habitat types and fish were well distributed in both. The CPUE for the lake was marginally greater than the mean CPUE for the LSA sampling program, yet the total diversity was lower than the overall mean. The total catch for the lake was much greater than the LSA sampling mean and this may be attributed to the larger presence of forage fish that were absent in Miller Pond basin.

### **Miller Pond**

Fish capture effort in Miller Pond was carried out September 9, 2007 and consisted of 1,018 seconds of electrofishing time. Miller Pond species consisted of white sucker, brown bullhead, Johnny darter, northern pike and yellow perch. The catch was predominantly brown bullhead (Table 3.8).

The CPUE for the lake was marginally lower than the mean CPUE for the LSA waterbody sampling as was the total diversity. Although the species captured throughout the lake were found in areas of abundant macrophytes concentrations, it was evident that the brown bullheads were in greater abundance in the shallower warm water areas.

Miller Pond is a back water area influenced by the adjacent Mountjoy River. No evidence was identified through the comprehensive sampling program that supports the existence of walleye in

Miller Pond, despite anecdotal reports of a, small seasonally migrant population located in the Mountjoy River system.

### **3.6 Mountjoy River Watershed**

Both the Skynner Creek system and the Perch Lake system drain to the Mountjoy River, which in turn drains to the Mattagami River a short distance downstream of the Perch Lake system inflow. The Mountjoy River drains an area of approximately 540 km<sup>2</sup>, and passes through terrain characterized mainly by forested area.

#### **3.6.1 Water Quality**

Water quality data for the Mountjoy River indicate the provincial and federal water quality objectives for the protection of aquatic life are met for all parameters, with the possible exception of inconclusive results for total phosphorus and cadmium because of laboratory detection limits, and for iron mostly likely because of TSS effects (Table 3.9 - West Watersheds). Most iron in such water is associated with particulate materials.

#### **3.6.2 Sediment Quality**

Sediment quality data for the Mountjoy River, like the water quality data, are unremarkable, being indicative of uncontaminated background conditions (Table 3.10 – West Watersheds). The only parameter which is above any of the provincial sediment guidelines is TKN which shows values only slightly above the LEL threshold, and these concentrations are mostly indicative of natural background values, possibly with some minor influence from associated agricultural lands.

#### **3.6.3 Benthic Macroinvertebrates**

No historic benthic macroinvertebrate inventory data was available for this moderate sized and clay bottomed riverine system. Recent information regarding 2007 benthos sampling will be reported under separate cover to provide a characterization of the baseline benthic macroinvertebrate communities.

#### **3.6.4 Aquatic Habitat**

Approximately 9,843 m of the Mountjoy River was assessed during the AMEC 2007 field program. This watercourse was characterized by one reach type; Type 1. Detailed channel diagnostic features are outlined in Table 3.3 and their distribution is shown in Figure 3.2. Additional section details and photographs are provided in Appendix C.

Reach Type 1 dominates the entire study segment to the Mattagami River confluence, west of the City of Timmins. Surrounding land use was natural with areas of agriculture and sporadic residential homes sparsely distributed along the lower reaches. This watercourse possesses a uniform, u-shape cross-sectional profile with an average width and depth of 22.6 and 3.13 m, respectively.

Overall gradient was extremely low with a flat channel morphology throughout. The slow moving water generates areas of fine depositional substrates (silt, sand) overlying a compacted clay bed. In-water habitat opportunities consisted predominantly of large and displaced logs, deeper/turbid water, and marginal aquatic vegetation such as Richardson's pondweed, arrowhead, and burr reed. The channel was lined with a dense yet narrow riparian zone of overhanging Red-osier dogwood, willow, grasses, sedges, and alder shrubs. Overhead coverage was minimal consisting only of 5%, however, in flooded conditions the existing, dense riparian zone can potentially provide an additional 5% of shade. Valley vegetation was dominated by large Eastern white cedar and black spruce intermingled with trembling aspen, balsam fir, and white birch.

Generally, the Mountjoy River represents a stable fluvial system with some evidence of channel widening and degradation observed, which is not uncommon for watercourses of this size and gradient. Fluctuating water levels influence 95% of the bank toe, consequentially removing topsoil, exposing underlying compacted clay material, and then rendering the bank to increased instability. As a result, only marginal amounts of aquatic and terrestrial vegetation have established along the near shore perimeter. With the lack of rooted bank support, leaning valley vegetation and exposed roots are common, indicating evidence of widening.

### **3.6.5 Fisheries Resources**

The Mountjoy River was sampled using a boat electrofishing unit throughout three defined sampling areas which included the area immediately upstream of the Skynner Creek confluence, downstream of the confluence of Skynner Creek to Miller Pond outflow channel, and the downstream channel segment draining to the Mattagami River. A total effort of 2548 seconds was carried out on September 9, 2007. Fish captured consisted of blacknose shiner, log perch (*Percina caprodes*), northern pike (*Esox lucius*), rock bass, slimy sculpin walleye (*Sander vitreus*), white sucker and yellow perch. The catch was dominated by blacknose shiner (Table 3.8).

This area had the greatest diversity (eight species) encountered within the LSA sampling program. However, abundance was low and lowest catch per unit effort was encountered relative to the remainder of the LSA.

### **3.7 Town Creek Watershed**

The Town Creek system drains Gillies Lake, low gradient tailings areas to the east of Highway 655, and significant portions of the City of Timmins property (Figure 3.1). The connection between Gillies Lake and Town Creek is subsurface, by way of a buried pipeline that exits to the Town Creek drainage system to the north of the city. The low gradient tailings to the east of Highway 655 (the Hollinger tailings) were reportedly deposited in the former northeastward extension of Gillies Lake during the 1920's and 1930's (Kees Pols per. comm., Mattagami Region Conservation Authority, October 5, 2007). These tailings are sulphide concentrate tailings and are therefore potentially acid generating.

The upper Town Creek watershed drains the Gillies Lake tailings area on the east side of Highway 655, as well as adjacent glacio-fluvial esker terrain (Figure 1.2). The lower portion of the watershed is characterized by urban development sited on lacustrine clay plain terrain with associated secondary bedrock outcropping.

### **3.7.1 Water Quality**

The water quality of both headwater drainages to Town Creek, namely Gillies Lake and the Hollinger/McIntyre tailings deposits on the east side of Highway 655, show the influence of past mining activity. Gillies Lake shows very modest exceedences of provincial and/or federal protection of aquatic life guidelines for arsenic, copper, and occasionally iron, lead and zinc (Table 3.9 - West Watersheds). This modest contamination appears to derive from a combination of (1) mine water inflows from the former Hollinger Mine, when water levels rose following the cessation of mining at both the Hollinger and McIntyre mines, and (2) tailings deposited directly into the former eastward extension of Gillies Lake, east of Highway 655, which was completely infilled with gold concentrate (i.e., elevated sulphide) tailings.

Direct drainage from Gillies Pond and the associated concentrate tailings that flows northwest to the Town Creek Highway 655 crossing is much more problematic than drainage from Gillies Lake, itself. This drainage is the most contaminated drainage found within the LSA. The source of this contamination is the Hollinger concentrate tailings which were previously deposited within the former eastward extension of Gillies Lake (Senes 2007). Drainage from this area is acidic (average pH 3.69, Table 3.9 - West Watersheds) and contains moderately high average concentrations of sulphate (1,433 mg/L), copper (0.51 mg/L), iron (67 mg/L), nickel (0.26 mg/L) and zinc (1.56 mg/L). The major portion of the elevated metals values at this location appears to be attributable to elevated levels of suspended solids (mean concentration 37.1 mg/L), as minimum metals values reported by Senes (2007) for the key metals are only marginally above guidelines (copper and iron), or below the guidelines (nickel and zinc). Nevertheless, acidic drainage and metals loadings from this area are of concern and are being addressed through the current closure plan (Senes 2007), with further plan development by AMEC (in preparation).

With flow downstream from Highway 655, there is a marked improvement in the water quality of Town Creek (Table 3.9 - West Watersheds), as evidenced by parameters such as sulphate, which is not influenced by TSS loadings. The data for indicator metals/metalloids such as arsenic, copper, nickel and zinc are confounded by variable TSS readings, with which there is an obvious correlation (Table 3.9 - West Watersheds).

### **3.7.2 Sediment Quality**

Sediment quality data for Gillies Lake and Town Creek are similar those of the Porcupine River and other local drainages that have been influenced by past mining activities, as evidenced by elevated concentrations of metalloids (arsenic) and a number of metals (copper, iron, manganese, nickel and zinc). Town Creek and Gillies Lake sediment quality data is shown in Table 3.10. Metal

concentrations in Gillies Lake are undoubtedly influenced, at least in part, by the elevated organic content of these sediments.

### **3.7.3 Benthic Macroinvertebrates**

An assessment of the Town Creek system was undertaken and reported by Minnow (2001). A total of 32 taxa were observed in Upper Town Creek and 34 taxa in Lower Town Creek. Roundworms consistently dominated the communities collected in each site with a relative abundance of 27% and 79% in Upper and Lower Town Creek, respectively. Within Upper Town Creek, nematoda (segmented worms) (22%) and ostracoda (seed shrimp) (10%) were also relatively abundant. Density of benthic invertebrates varied considerably in both upstream and downstream reaches, apparently attributable to a patchy distribution of the relatively abundant roundworms. Indicator species of the EPT taxa were slightly higher in representation in the upstream reaches, however, overall they comprised a minor proportion of the community. The study concluded that low diversity, predominance of tolerant species and poor representation of more sensitive indicator species suggests a system that is stressed. Limited by the available of precedent or reference data, interpretation into the cause of stress was inconclusive and poor habitat availability was considered as likely as contamination to generate limiting conditions.

The Gillies Lake benthic macroinvertebrate community was inventoried as part of a biological assessment in support of mine water management study for the Hollinger, McIntyre and Coniaurum Mines (Minnow 2002). In sampling 3 stations within the lake basin, a total of 22 macroinvertebrate taxa were reported with chironomids predominating at 89% of relative taxa representation. EPT taxa only represented 4.4% of the community and were considered sparsely distributed. The relatively homogeneous nature of the lake bed habitat is reflected in the taxa representation predominated by a relatively high abundance of a limited number of taxa.

### **3.7.4 Aquatic Habitat**

Town Creek was not characterized during the 2007 field program conducted by AMEC. Alternatively, a review of secondary sources and detailed Lidar satellite imagery provided the basis for a summary of Reach Type designation.

Originating in the northern quadrant of the LSA and east of Highway 655, the existing upper Town Creek system collects drainage from the McIntyre Concentrate Dump and then flows northerly until it merges with the outflow channel from Gillies Pond, thus creating the headwaters of Town Creek (AMEC 2007b). The system continues to flow north-westerly through a low gradient area that has historically experienced tailings deposition resulting in heavy sedimentation and limited natural morphology observed (AMEC 2007b). Channel braiding, slow moving water, and ponding in the overbank area were also documented within this area. Flow increases when the system merges with the drainage from the Hollinger Tailings Area and continues to flow northwest, passing through a wooden box culvert under Sand Claim Road. The channel system travels pass Highway 655 through two culverts with flow capacity greatly diminished by heavy sedimentation. Approximately 330 m downstream, this channel combines with another small tributary, creating the mainstem of

Town Creek. The downstream limits have been significantly influenced by several land use activities such as urban development. Several small segments are slow moving and flow through riverine marsh and alder thickets, bounded by generally early successional mix forest communities such as poplar, maple, and alder (Minnow 2001). The mainstem channel varies in available habitat as it flows into the Mattagami River. Intermittent channelized sections, specifically throughout residential areas, are frequently lined with wire riprap bank support as well as reinforced riprap channel beds (Minnow 2001). Water flow was fast moving in areas of modified channel form, limiting depositional bed materials. In areas that are not channelized, confined forest blocks permit Town Creek to exist in a relatively natural morphology (Minnow 2001). Slower moving water contributed to the increased depositional features of these areas. Aquatic vegetation was sparse throughout, consisting of predominantly tapegrass (*Vallisneria americana*) however, overhead canopy and riparian conditions were abundant with sedges, grasses, small alders, and larger trees noted. Woody debris was documented in variable densities throughout. Bed materials identified in Town Creek were largely a sand matrix overlain with black muck material and organic/woody debris.

### **Gillies Lake**

Gillies Lake was not characterized during the 2007 field program conducted by AMEC. Alternatively, a review of secondary resources and detailed Lidar satellite imagery provided sufficient information regarding the shoreline habitat features of this waterbody. Gillies Lake was characterized by three shoreline habitat types: sparse wetland-type shoreline (Type 2), flat shoreline and bed gradient (Type 3A) and dense cattail shoreline with soft bed substrate (Type 2A).

Surrounded by residential zoning, Gillies Lake is a small waterbody, approximately 20.5 ha, with a maximum depth of 5 m and mean depth of 2 m (Minnow 2002). It has been significantly influenced by surrounding mining activities as well as recreational purposes. The biophysical features are generally low as a result of limited riparian protection and a disturbed littoral zone (Type 2). Where habitat was present, the area was dominated by cattails and sedges coupled with alder and willow species (Type 2A) (Minnow 2002). Coontail milfoil and a variety of sedges and rushes were sparsely distributed throughout (Minnow 2002). Lake bed materials, known to contain historic tailings, are composed of finer sediments (clay and silt) with moderately high contents of decaying organics material, woody debris, and overlying fine muck.

A small shoreline section consisting of a municipal beach and boardwalk line the north lake perimeter (Type 3A). Along the eastern shoreline, approximately 160 m of maintained lawn acts as a buffer separating the lake from Highway 655. The west and north-west perimeter consists of residential homes situated on moderate sloped hillsides that border the basin. The lake basin and shoreline features are shown in Figure 3.13.

### Field Water Chemistry

Several field water quality parameters were documented by Minnow Environmental Ltd. in 2002. Dissolved oxygen concentrations at surface level averaged 9.59 mg/L at observed water

temperatures under 15°C. Additional measurements of surface water parameters included pH (8.30) and conductivity (1141 µs).

### **3.7.5 Fisheries Resources**

#### **Town Creek**

Town Creek was not sampled during the AMEC 2007 field program and secondary sources information (Minnow 2001) was utilized for the purpose of this description. Town Creek was delineated into two sampling areas; upstream of Murray Street and downstream of Ross Avenue East. Results indicated low abundances of one species (brook stickleback) that was captured throughout the entire watercourse. The upstream sample area generated a higher CPUE than the overall Town Creek study mean. Conversely, the downstream area resulted in a lower value compared to the study mean. The lower CPUE in the downstream area can be attributed to the lack of suitable aquatic habitat resulting from extensive urban influence such as channelization and water quality degradation.

#### **Gillies Lake**

Gillies Lake was not sampled during the AMEC field program in 2007. Secondary source information, Minnow Environmental (2002) was utilized for the purpose of this description. The Gillies Lake fish community consisted of warm water species that include lake chub, pearl dace, pumpkinseed, white sucker and yellow perch. Yellow perch was the dominant species with very high capture rates observed. Pearl dace and lake chub abundance was low throughout the basin.

Methods utilized included minnow traps, Casselman traps and trap nets.

### **3.8 Northwest Watersheds**

In addition to Town Creek, there are four other smaller watersheds that drain the area west of Highway 655 and north of the Town Creek system. All of these smaller watersheds drain directly or indirectly (through Craft Creek) to the Mattagami River. The upper reaches of the larger three watersheds drain glacio-lacustrine sand plain terrain, and associated rock outcropping areas. The lower reaches of the three larger watersheds and the entire portion of the smaller watershed drain glacio-lustrine clay plain terrain, portions of which are urbanized (Figures 1.2 and 3.1).

These smaller watersheds are included in the LSA for the sole reason that consideration was given to stockpiling waste rock in the area west of Highway 655 and north of the Timmins hospital. However, further considerations argued against using this area for waste rock storage (discussed separately in AMEC 2007b), hence no specific efforts have been directed at detailing these smaller watersheds.

### **3.8.1 Water Quality**

Water quality data were not collected from the smaller northwest watersheds. These watersheds do not drain mining lands, so there is little reason to suspect metals or sulphate enrichment. The southernmost of the northwest watersheds receives urban drainage from Timmins, and may therefore be expected to show some effects from this drainage. The remaining drainages receive runoff from undeveloped lands and agricultural lands. Drainages associated with agricultural lands may be expected to show some evidence nutrient enrichment (nitrates, nitrites, and phosphorous and phosphates), but in the absence of hard data, this conclusion is speculative.

### **3.8.2 Sediment Quality**

Similar to the above, no sediment data was collected from the smaller northwest watersheds, but based on their location and surrounding land uses there is little reason to suspect any meaningful metals enrichment. Sediment parameters linked to agricultural uses, such as TKN and TOC, could potentially show some enrichment above natural background values.

### **3.8.3 Benthic Macroinvertebrates**

No historic benthic macroinvertebrate inventory data was available for the relatively small sized drainage swales and intermittent watercourses observed in these watersheds. Qualitative observations of the watercourses, for general planning scale objectives within the LSA, did not require benthic macroinvertebrate sampling during the 2007 inventory. It is anticipated that the Northwest Watersheds drainages will host a similar invertebrate community relative to similar, fine bedded and clay controlled channel beds reported elsewhere in the LSA where some level of watershed disturbance has occurred.

### **3.8.4 Aquatic Habitat**

A general assessment of the Northwest Watersheds was completed on October 24, 2007. In the effort to obtain an overall understanding of the area, several road crossings were visited, with watercourse features, vegetation composition, and field water chemistry values documented at each site.

Since names have not been established for these watercourses/watersheds, the areas were subdivided into four sections; Area A, a direct tributary of the Mattagami River, located immediately north of Town Creek; Area B, located immediately north of Area A; Craft Creek Tributary C (or Area C), located immediately north of Area B; and Craft Creek Tributary (Area D), located immediately south of Laforest Road (See Figure 3.2). All of these smaller watersheds drain directly or indirectly (through Craft Creek) to the Mattagami River. Only one conveyance system, Area A, was described in this report given the subwatershed position proximate to the northeast quadrant of Timmins, and other drainage systems did not exhibit significant habitat features relative to future mining activity or support infrastructure. Water quality field parameters for all tributaries are available in Appendix E.

## **Area A (Mattagami River Tributary)**

Located within the Melrose Garden residential development area and north of the downtown core, Area A is the largest conveyance system of the Northwest Watersheds. Area A watershed, to the point of its confluence with the Mattagami River 1.5 km downstream, drains an area of approximately 2.6 km<sup>2</sup> (Figure 3.1). Originating east of McLean Drive, a small, marshy open water area, influenced by beaver activities, contributes flow and develops into its headwater channel. Mean channel wetted width and depth at this location were 1.27 m and 0.40 m, respectfully. The watercourse passes through twin culverts at McLean Drive, and flows into an open scrubland consisting of overhanging alders, red osier dogwood, balsam fir, white spruce and dense herbaceous and grass groundcover before flowing into a natural hardwood forest stand lined with residential homes. Flow is in a generally westerly direction and the channel reflects a natural riffle / run / pool morphology with a somewhat sinuous meander pattern. Areas of undercutting banks and deposition on the overbank zone were observed indicating flashy conditions during high flow periods indicative of runoff from the adjacent open farm fields. Channel substrates consisted of various small rocks, pebbles, sand materials and organic debris.

At the College Road crossing and downstream, the channel flows from a natural forested block through a large box culvert into recreational park areas. The channel shows evidence of modification such as valley slope re-grading, channelization, bank armouring, and reduced riparian vegetation resulting from adjacent land use activities. Channel morphology consisted of mostly runs with sporadic riffles and pool areas. Wetted widths range between 0.57 to 2 m and depths measured at 0.23 to 0.63 m. Bank erosion and undercutting combined with entrenched conditions are indicative of active degradation and unstable conditions. In addition, siltation in pools and embedded riffles were also noted and suggest channel aggradation. Approximately 50 m downstream of the College Road crossing, an additional stormwater drainage culvert contributes flow to this system during rain events. Riparian vegetation consisted of dense herbaceous and grass groundcover with sporadic trembling aspen, willow, red osier dogwood and raspberry shrubs.

The downstream segments leading into the Mattagami River have been channelized and the general aquatic condition has been extensively influenced by surrounding development. Riparian vegetation was limited and consisted predominantly of grasses and herbaceous species. Several areas of channel have been completely colonized by dense cattail and bulrush vegetation with flow significantly impeded. Channel morphology consisted predominantly of run features with sporadic riffles located downstream of culvert / road crossings. Wetted widths and depths were generally uniform ranging 1.5 to 2.5 m wide and 0.5 to greater than 1 m deep. Urban debris accumulation was noted upstream of several culvert / road crossings and result in significant bank erosion, large scour pools, and culvert undermining. Bed materials were dominated by silt and sand coupled with embedded cobble underlain with unconsolidated clay. At riffle locations bed material was coarser and consisted of boulders, cobble, pebbles, and sand.

Immediately upstream of the Mattagami River confluence, the channel reflects a natural morphology with the surrounding biophysical habitat generally intact. Riparian vegetation consisted of dense

overhanging shrubs, and herbaceous ground cover lined with deciduous tree species. Surrounding land uses shift from residential to agricultural (greenhouses) west of Airport Road.

## **4.0 EVALUATION AND DISCUSSION**

The Porcupine River, South Porcupine River, Skynner Creek, Perch Lake system, Mountjoy Creek and Town Creek are the principal watercourse systems found within the local study area. A total of 13 lakes and major ponds are also distributed within these watersheds. General watercourse channel morphology was characterized by flat channel gradients and associated slow flows. Beaver activity is common in all the watercourses resulting in fragmented aquatic corridors and substantial areas of ponding. Marsh habitat dominated by cattail/sedge shoreline vegetation was common to creek, pond and lake systems.

The watershed of the overall Porcupine/South Porcupine River system represents the majority of drainage within the LSA at 75 km<sup>2</sup>. Areas of defined mainstem channels and un-impounded conditions are relatively small (<5 m width) and shallow (<1 m), with tributary reaches that extend into headwater areas becoming poorly defined and intermittent. The exception is the Mountjoy River which drains an area of 540 km<sup>2</sup> including regional drainage well beyond the LSA. Generally, the lakes in the LSA are small in size on the order of 5 ha, with the exception of Gillies, Pearl and Simpson Lake which ranged in size from 20 to 40 ha. Ponds were shallow (<2 m), and lakes moderate in depth (<7 m) with the exception of McDonald Lake (29 m) which appears to be a kettle lake.

Land use within the LSA represents a mix of natural, urban and mining related land use. With historic and/or active mine facilities within most of the watersheds, review of water quality and sediment chemistry data shows some degree of contaminant loading, with a number of parameters in these systems showing exceedences of provincial and federal water and sediment quality guidelines. In each case, biotic communities continue to persist. With a predominant fine organic sediment substrate in most of the systems, benthic invertebrates are predominated by the characteristically tolerant chironomids. Typical indicator taxa such as ephemeroptera, plecoptera and trichoptera, generally exhibited a low relative abundance. Effects assessment either suggests some functional habitat impairment, or difficulty in differentiating biophysical habitat limitations from mine related effects.

Fish communities were observed in each of the sampled watercourses with small bodied forage fish predominating. The relatively larger watercourses or lakes in the LSA also contained coarse and sport fish species.

### **4.1 Environmental Constraints and Sensitivities**

Several watercourses, lakes and ponds within the study area represent environmental sensitivity issues to be considered during future phases of the proposed development of the Hollinger Mine and related infrastructure requirements, as well as mine closure. Issues are principally related to the potential alteration of the ecological form and function of the aquatic habitat. Key areas with potential habitat issues include the following:

- **Porcupine River from Pearl Lake to the inlet to Porcupine Lake:** Confirmed small bodied and coarse fish community throughout the system, with presence of sport fish occurring in the lower reaches close to Porcupine Lake. A distribution of both general and critical habitat is available to sustain the observed fish community. Both Pearl Lake and Clearwater Lake are included in this fish habitat categorization.
- **South Porcupine River (mainstem):** Confirmed small bodied and coarse fish community throughout the system, with presence of sport fish occurring in the lower reaches close to Porcupine Lake.
- **McDonald Lake:** Confirmed small bodied and coarse fish community as well as presence of game fish (smallmouth bass) likely introduced through stocking. A distribution of both general and critical habitat is available to sustain the observed fish community.
- **Simpson Lake:** Confirmed small bodied, coarse and game fish (northern pike) community. A distribution of both general and critical habitat is available to sustain the observed fish community.
- **Fuller Mine Pond:** Confirmed small bodied and coarse fish community in this generally isolated pond. A distribution of both general and critical habitat is available to sustain the observed fish community.
- **Skyenner Creek (mainstem):** Confirmed small bodied and coarse fish community in a generally isolated creek system. Creek does not represent a continuous aquatic corridor to the Mountjoy River due to poorly defined reaches downstream of Cowboy Lake. A distribution of both general and critical habitat is available to sustain the observed fish community within the isolated reach.
- **Cowboy Lake:** Confirmed small bodied, coarse and game fish (northern pike) community. A distribution of both general and critical habitat is available to sustain the observed fish community.
- **Perch Lake:** Confirmed small bodied and coarse fish community. A distribution of both general and critical habitat is available to sustain the observed fish community.
- **Peroli and Miller Lake:** Confirmed small bodied, coarse and game fish (northern pike) community. A distribution of both general and critical habitat is available to sustain the observed fish community. Isolated from Miller Pond and Mountjoy River by beaver dam fragmentation.
- **Miller Pond:** Confirmed small bodied, coarse and game fish (northern pike) community and seasonal/continuous aquatic corridor to Mountjoy River. Miller Pond may provide additional critical fish habitat in terms of spawning and rearing for fish residing in the Mountjoy River.

- **Mountjoy River:** Confirmed small bodied, coarse and game fish (northern pike, walleye) community and exhibited greatest fish species diversity (8 species) in the LSA. A distribution of both general and critical habitat is available to sustain the observed fish community. Part of a contiguous and unimpeded aquatic corridor to the larger Mattagami River system downstream.
- **Town Creek:** Confirmed small bodied fish community consisting of one tolerant species. System is limited in fish habitat conditions and influenced by mining and urban land use.
- **Gillies Lake:** Confirmed small bodied and coarse fish community. System physically altered by historic mining activity and in state of long term restoration. Naturalized basin no contains a distribution of both general and critical habitat is available to sustain the observed fish community. Isolated lake basin, with no contiguous aquatic corridor to downstream reaches of Town Creek (piped outlet system).
- **Northwestern Watersheds:** Small permanent to intermittent watercourses with unconfirmed distribution of fish community. Potential for small bodied and coarse fish presence.

In terms of sensitivity, the availability of habitat provided by the majority of the watercourses, lakes and ponds, is common within the LSA. With tolerant fish species communities predominating, the systems are considered of medium sensitivity. Waterbodies that provide potential critical habitat opportunities by linkage to larger systems through contiguous aquatic corridors; or contain a more diverse fish community that includes a range of forage, coarse and sportfish; may be considered to have a heightened sensitivity to alteration and potential project effects.

With fish species present in the noted waterbodies, any planned Project developments must consider the potential for Harmful Alteration, Disruption or Destruction (HADD) of fish habitat under the policies of the Federal *Fisheries Act*. Aquatic habitat encroachment in watercourses containing fish would require some form of mitigative consideration during the planning and design phases of the operational and closure phases of the project, and is also a potential trigger for application of the *Canadian Environmental Assessment Act*.

In terms of future mine operation, federal Metal Mining Effluent Regulations (MMER) will require effluent monitoring, acute lethality testing and Environmental Effects Monitoring (EEM) with any discharges to the noted potential receiving waters. Similarly, under provincial Certificates of Approval for sewage works, impact assessments or biological monitoring programs on such receiving waters are required. These effects assessment and monitoring programs are intended to determine whether a mine effluent is affecting aquatic habitat, fish, benthic macroinvertebrates and/or fish resource use. Such studies are presently being undertaken by Goldcorp within the LSA. With advancement of Project plans and determination of requirements for future effluent discharges to the above noted waterbodies, consideration for monitoring requirements should be included in Project planning.

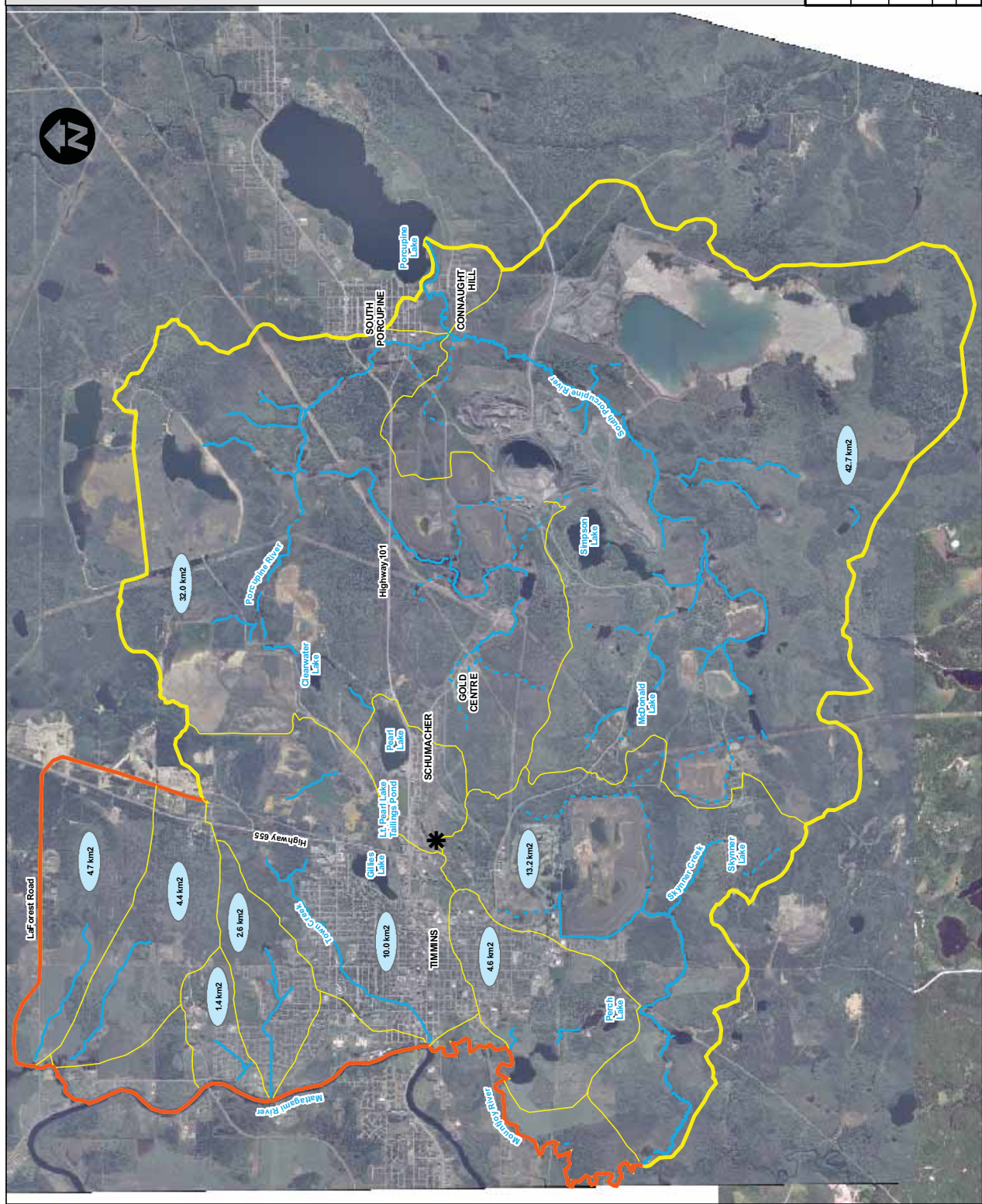
## **4.2 Recommendations**

With the extensive compliance and effects monitoring presently ongoing in the LSA, it is not recommended that additional aquatic ecosystem studies be completed at this time. Once more detailed Project plans become available, and potential implications to the above noted watercourses, lakes and ponds becomes more apparent, some further follow-up studies could potentially be required to assist planning and design decisions.







## 5.0 REFERENCES

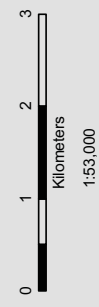
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**Legend:**

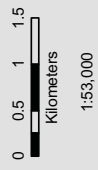
-  Proposed Hollinger Pit Centroid
-  Study Area (Watershed Boundary)
-  Study Area (Riverine and Road Boundary)
-  Option for Possible New Hollinger Waste Rock Stockpile (Maximum Footprint Under Consideration)
-  Watersheds
-  River or Creek



	
<b>HOLLINGER BASELINE STUDIES</b>	
TIMMINS ONTARIO	
<b>Watersheds</b>	
SCALE: 1:53,000	DATE: MARCH 2008
PROJECT No: TC71507	FIGURE: 3.1
	REV: 1

**Legend**

- Study Area (Watershed Boundary)
- Study Area (Riverine and Road Boundary)
- Water Course
- Intermittent Water Course
- Reach Type**
- Type 1
- Type 3A
- Type 3B
- Type 4
- Type 5
- Type 6A
- Type 6B
- Type 9A
- Type 9B
- Type 12
- Unclassified

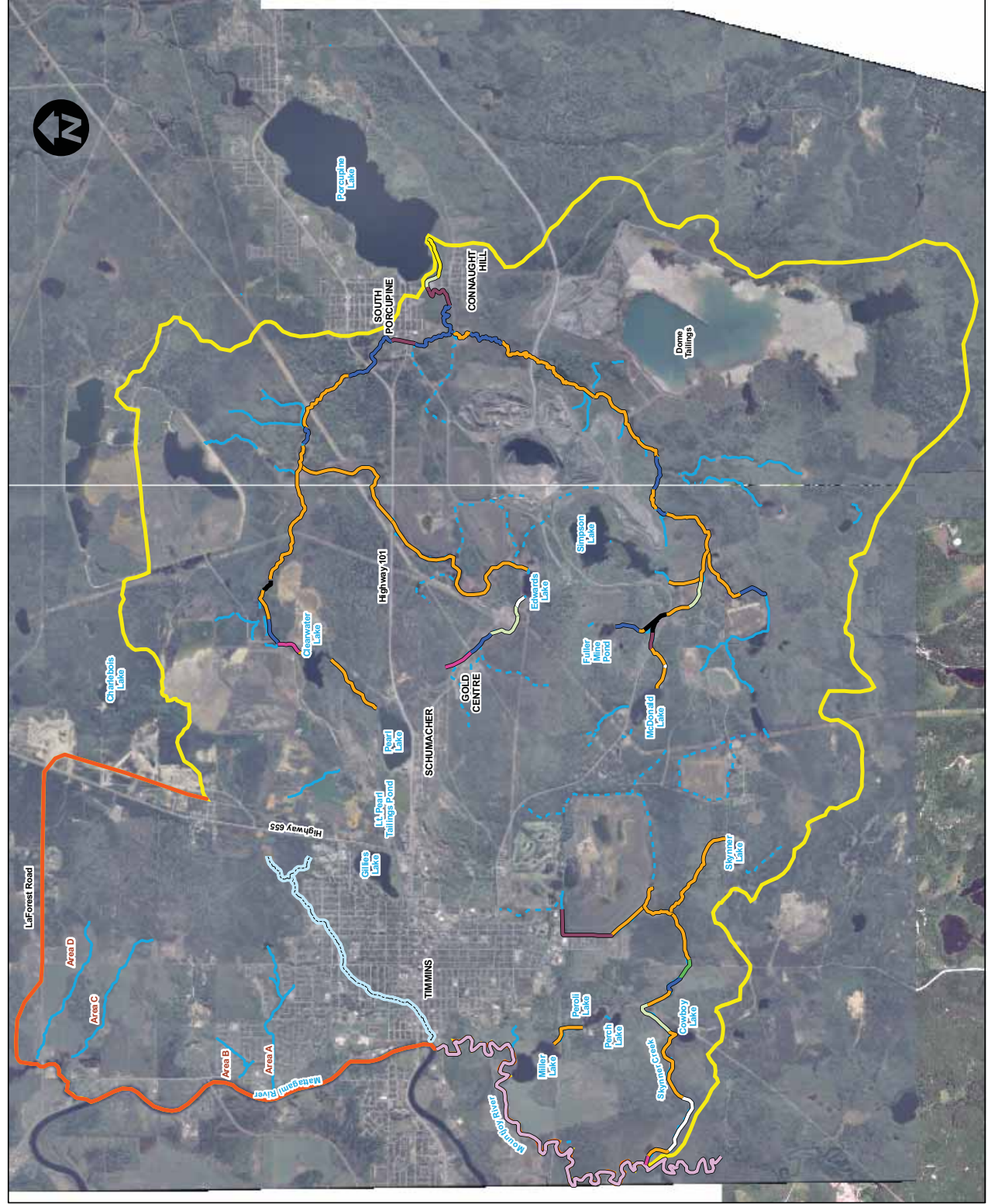


**amec**

**HOLLINGER BASELINE STUDIES**  
TIMMINS ONTARIO

**Watercourse Reach  
Type Characterization**

SCALE: 1:53,000 DATE: MARCH 2008  
PROJECT No: TC71507 FIGURE: 3.2 REV: 1






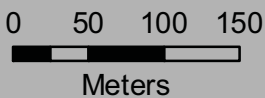


**Legend**

 Bathymetry Contours - 1.0 metre intervals

**Shoreline Habitat Types**

-  Type 1A
-  Type 2A
-  Type 3



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Pearl Lake  
Bathymetry and Shoreline Habitat Types**

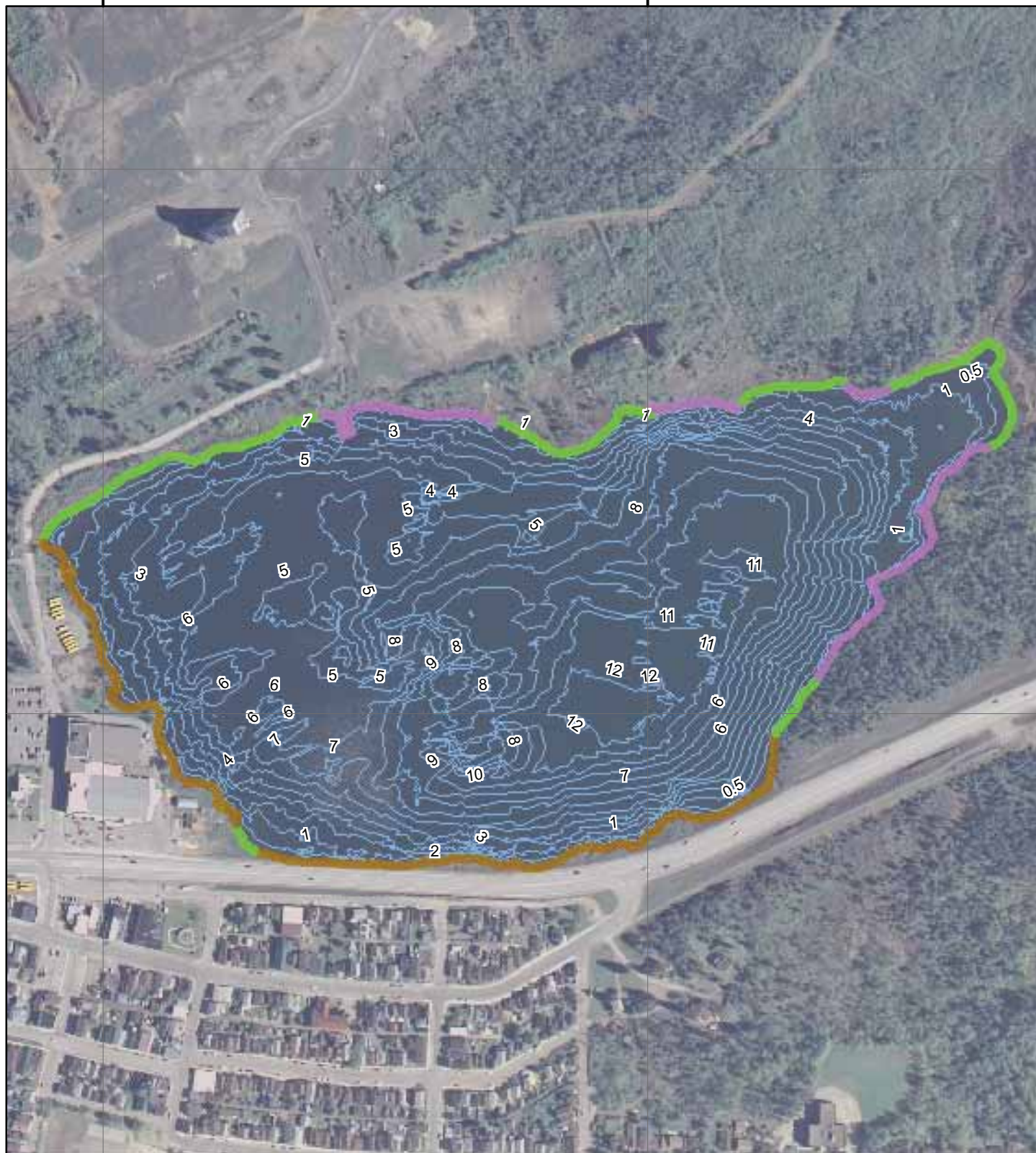
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DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.4




REV: 1

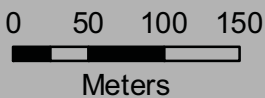


**Legend**

 Bathymetry Contours - 1.0 metre intervals

**Shoreline Habitat Types**

-  Type 1A
-  Type 2A
-  Type 3



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Pearl Lake  
Bathymetry and Shoreline Habitat Types**

SCALE: 1:5,000

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.4

REV: 1

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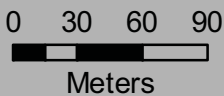


**Legend**

**Shoreline Habitat Types**

 Type 2A

NOTE: No bathymetry data collected during AMEC 2007 field program



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Clearwater Lake  
Shoreline Habitat Type**

SCALE: 1:3,500

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.5

REV: 1

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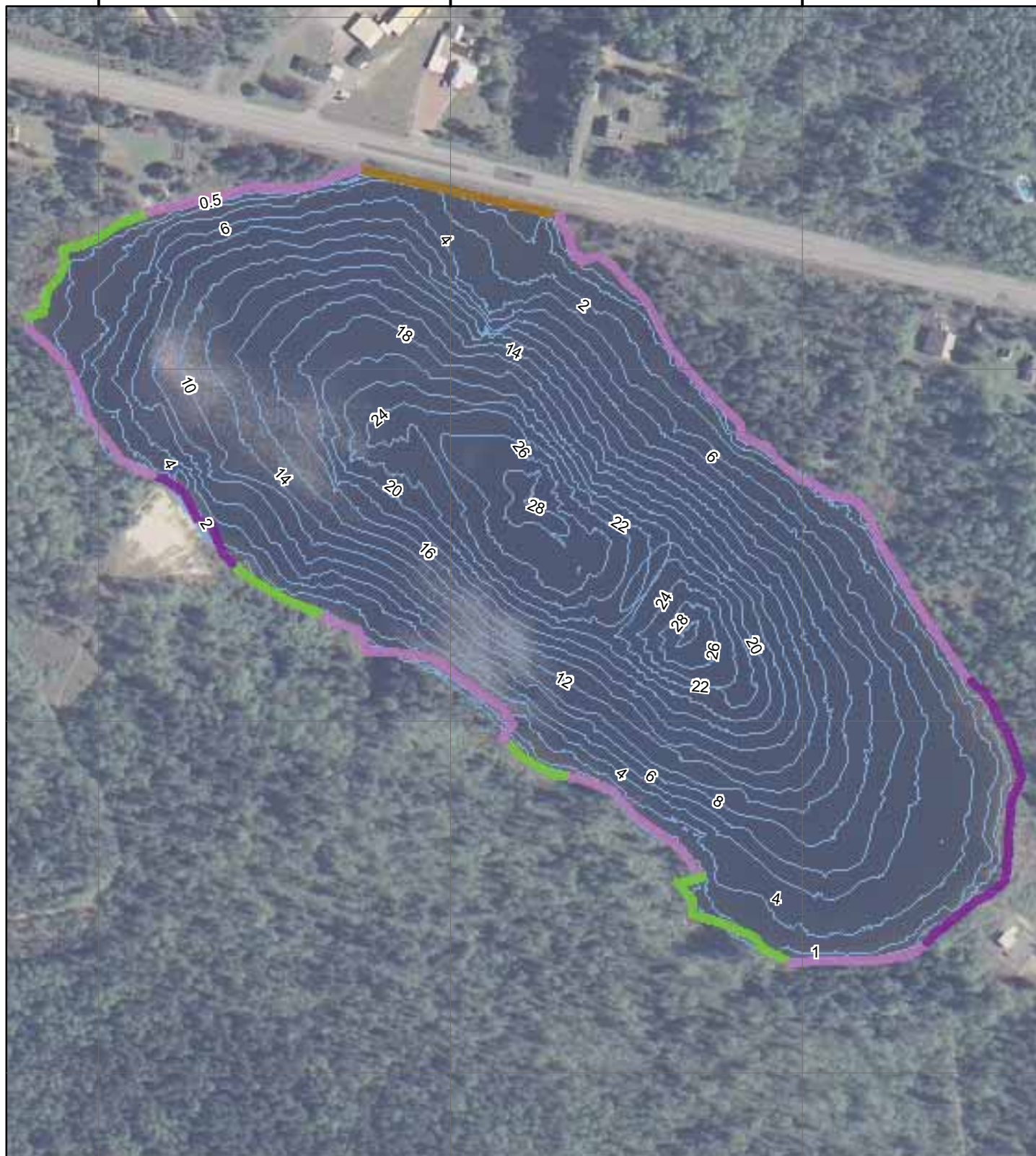
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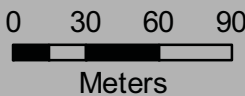


**Legend**

 Bathymetry Contours - 2.0 metre intervals

**Shoreline Habitat Types**

-  Type 1A
-  Type 2A
-  Type 3
-  Type 3A



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**McDonald Lake  
Bathymetry and Shoreline Habitat Types**

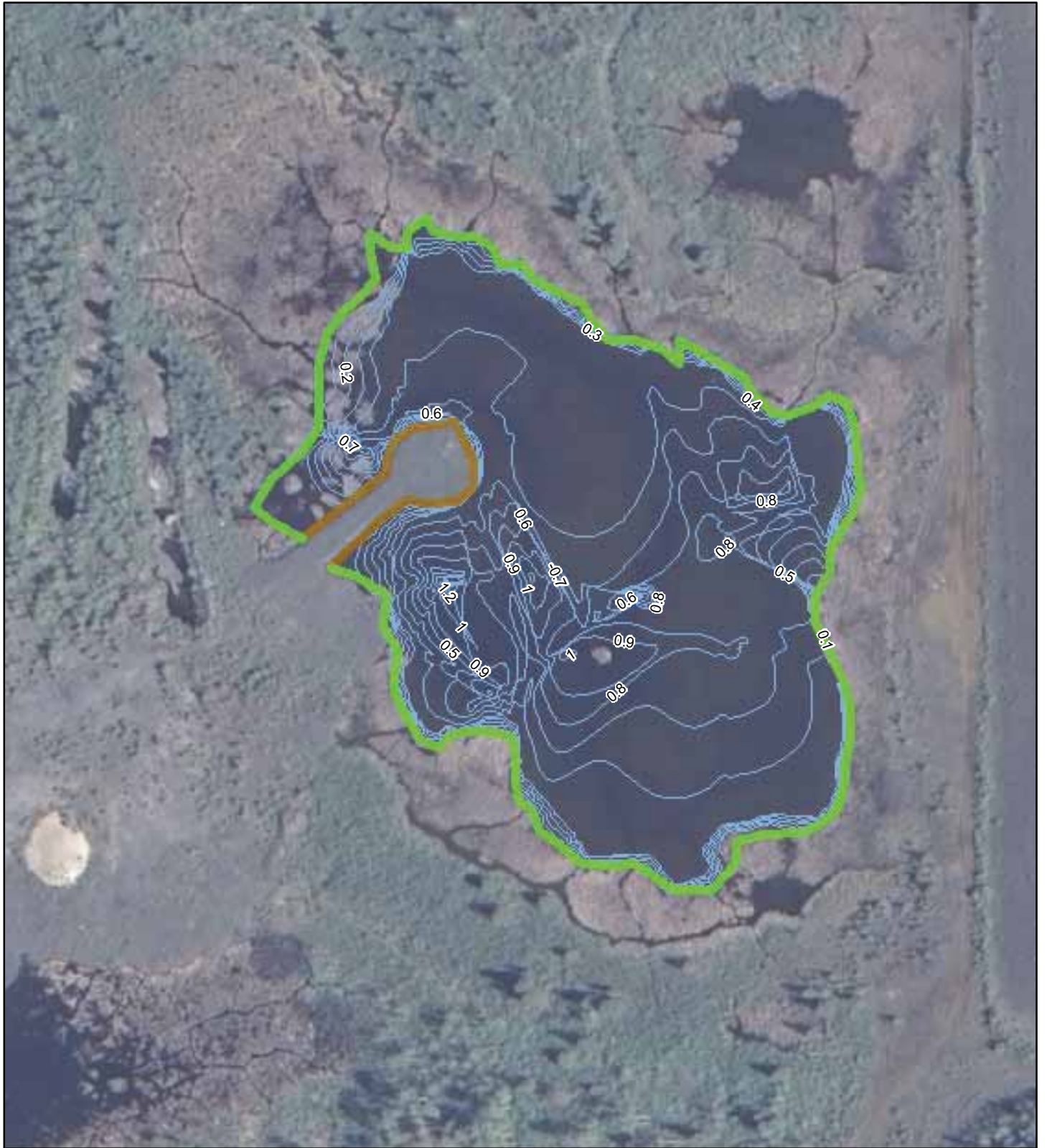
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DATE: MARCH 2008


PROJECT No: TC71507

FIGURE: 3.6

REV: 1



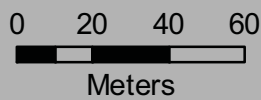
**Legend**

 Bathymetry Contours - 0.1 metre intervals

**Shoreline Habitat Types**

 Type 2A

 Type 3



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Fuller Mine Pond  
Bathymetry and Shoreline Habitat Types**

SCALE: 1:2,000

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.7

REV: 1

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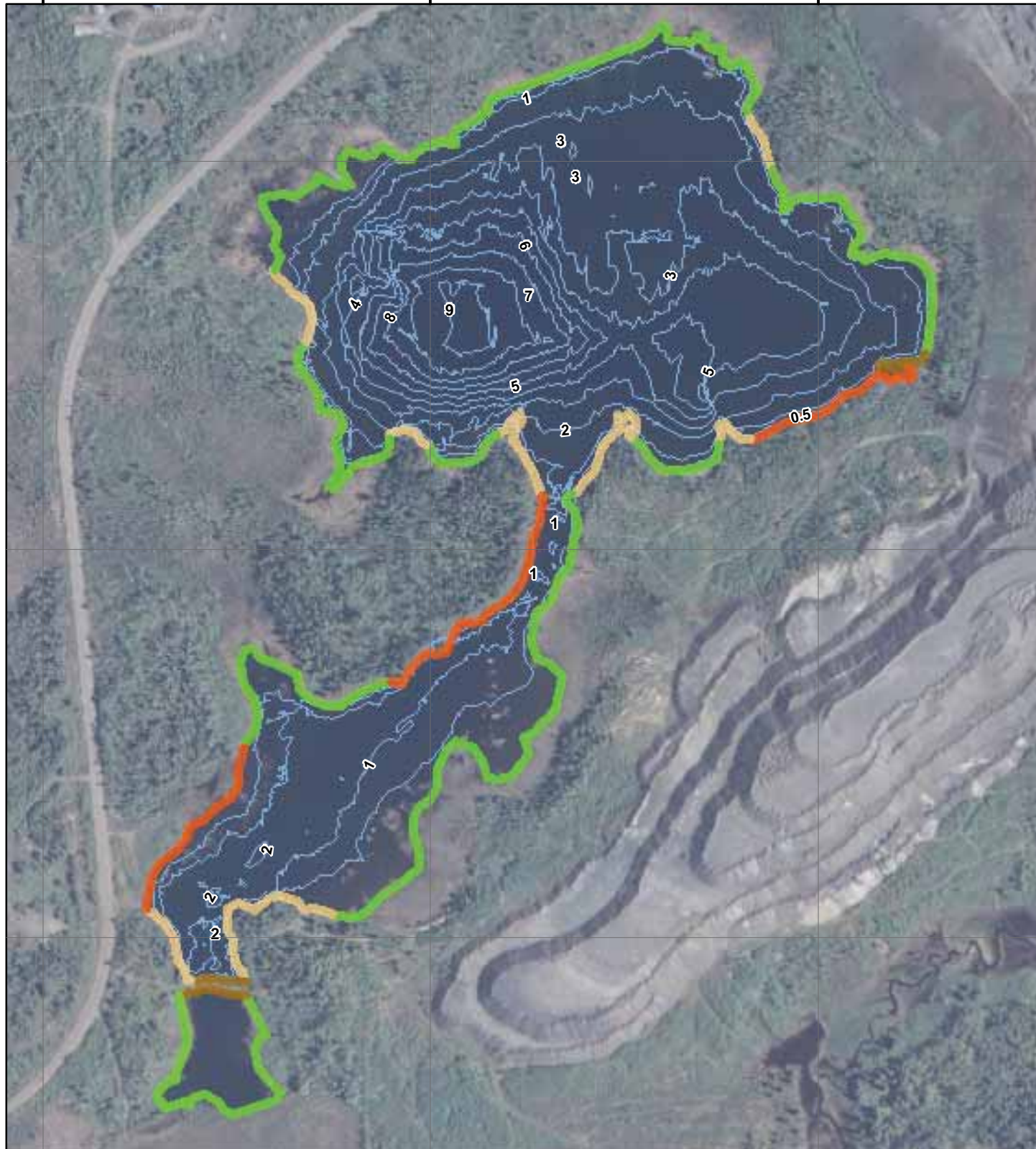
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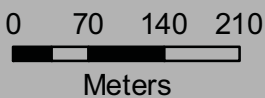


**Legend**

 Bathymetry Contours - 1.0 metre intervals

**Shoreline Habitat Types**

-  Type 1
-  Type 2
-  Type 2A
-  Type 3



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Simpson Lake  
Bathymetry and Shoreline Habitat Types**

SCALE: 1:7,000

DATE: MARCH 2008

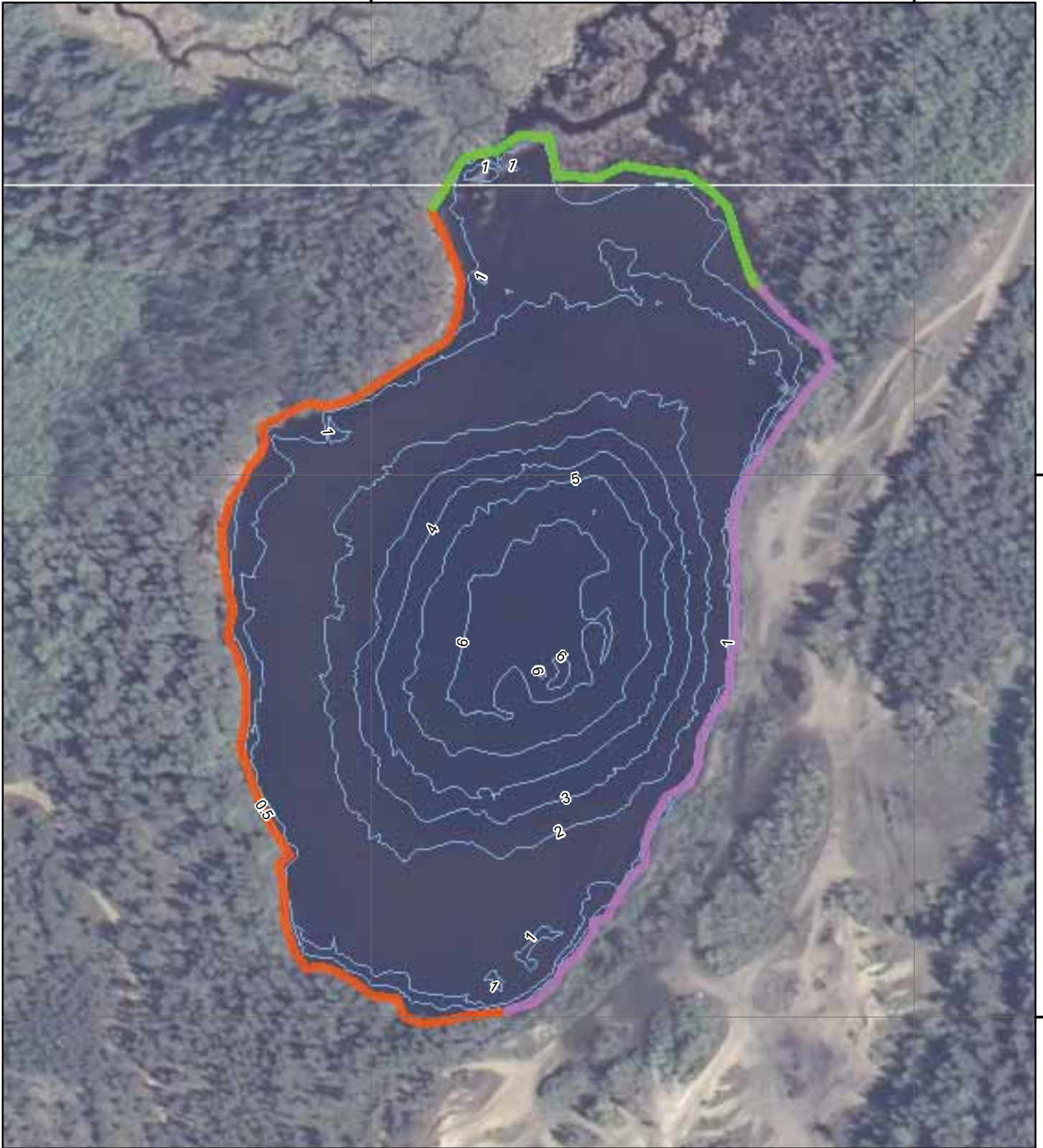
PROJECT No: TC71507

FIGURE: 3.8

REV: 1

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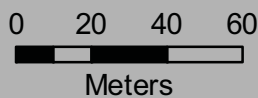
P:\EMP\Projects\2007\TC71507\_Hollinger Baseline Studies\GIS\data\Aquatics Mapping\Literal\_Cowboy.mxd

**Legend**

 Bathymetry Contours - 1.0 metre intervals

**Shoreline Habitat Types**

-  Type 1A
-  Type 2
-  Type 2A



**HOLLINGER BASELINE STUDIES**  
TIMMINS ONTARIO

**Cowboy Lake  
Bathymetry and Shoreline Habitat Types**

SCALE: 1:2,000

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.9

REV: 1

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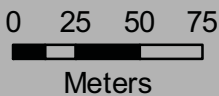


**Legend**

**Shoreline Habitat Types**

 Type 2A

NOTE: No bathymetry data collected during AMEC 2007 field program



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Skyenner Lake  
Shoreline Habitat Type**

SCALE: 1:3,000

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.10

REV: 1

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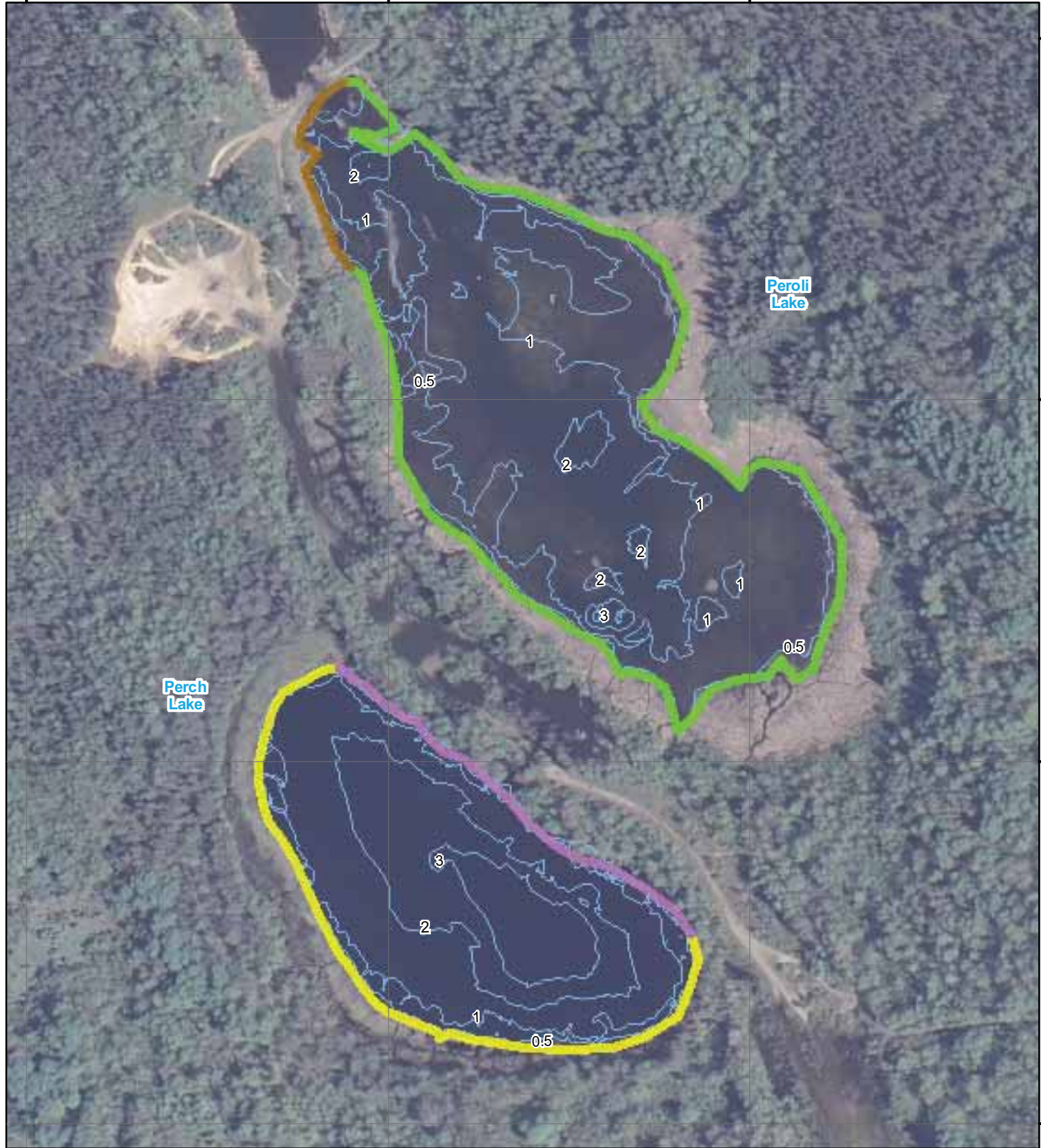
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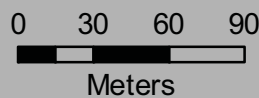


**Legend**

 Bathymetry Contours - 1.0 metre intervals

**Shoreline Habitat Types**

-  Type 1A
-  Type 2A
-  Type 2B
-  Type 3



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Perch and Peroli Lake  
Bathymetry and Shoreline Habitat Types**

SCALE: 1:3,000

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.11

REV: 1

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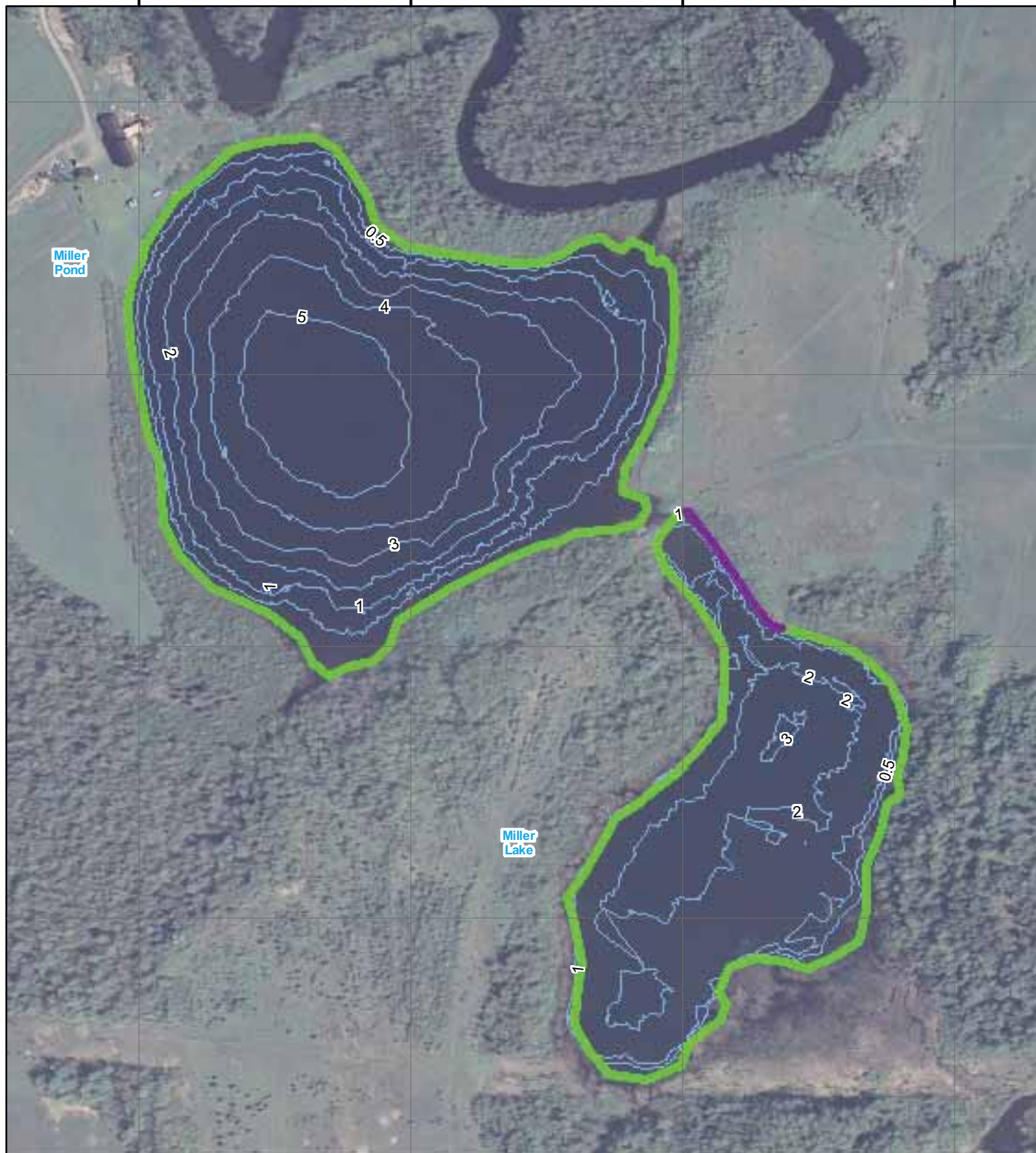
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Miller Pond

Miller Lake

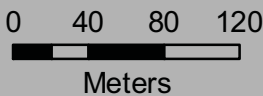
**Legend**

 Bathymetry Contours - 1.0 metre intervals

**Shoreline Habitat Types**

 Type 2A

 Type 2



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Miller Lake and Miller Pond  
Bathymetry and Shoreline Habitat Types**

SCALE: 1:4,000

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.12

REV: 1

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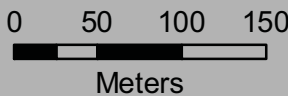
**Legend**

**Shoreline Habitat Types**

-  Type 2
-  Type 2A
-  Type 3A



NOTE: No bathymetry data collected during AMEC 2007 field program



**HOLLINGER BASELINE STUDIES**

TIMMINS

ONTARIO

**Gillies Lake  
Shoreline Habitat Types**

SCALE: 1:4,500

DATE: MARCH 2008

PROJECT No: TC71507

FIGURE: 3.13

REV: 1

**APPENDIX A**

**HOLLINGER BASELINE STUDIES  
REACH TYPE CLASSIFICATION SUMMARY  
FOR WATERCOURSES IDENTIFIED  
WITHIN THE LOCAL STUDY AREA**

**HOLLINGER BASELINE STUDIES REACH TYPE CLASSIFICATION SUMMARY FOR  
WATERCOURSES WITHIN THE LOCAL STUDY AREA**

Reach Type	Common Characteristics
1	<ul style="list-style-type: none"> <li>- Flat gradient</li> <li>- Flat morphology</li> <li>- Low flow velocity</li> <li>- Depositional environment with variable substrates</li> <li>- Riparian margin forested or dominated by shrubs</li> <li>- Width greater than 5 m</li> </ul>
3	<ul style="list-style-type: none"> <li>- Flat gradient</li> <li>- Well defined channel linked to functional floodplain</li> <li>- Flat and run morphology</li> <li>- Low to moderate velocity</li> <li>- Stable bedload environment</li> <li>- Riparian margin dominated by shrubs and meadow vegetation</li> <li>- Width less than 5 m</li> </ul>
4	<ul style="list-style-type: none"> <li>- Flat gradient area impounded by beaver dams and topography</li> <li>- Large open water ponded area</li> <li>- Poorly defined channel</li> <li>- Low to no discernable flow velocity</li> <li>- Depositional environment</li> <li>- Uniform open water depths (1 to 1.5 m)</li> <li>- Riverine marsh vegetation borders impounded area</li> <li>- Width greater than 20 m</li> </ul>
5	<ul style="list-style-type: none"> <li>- Flat gradient</li> <li>- No to minor areas of poorly define channel and very limited open water</li> <li>- Low to no discernable flow velocity</li> <li>- Expansive and dense areas of emergent aquatic vegetation</li> <li>- Depositional environment</li> <li>- Uniform open water depths (1 to 1.5 m)</li> <li>- Dense riverine marsh vegetation community throughout watercourse</li> <li>- Floodplain width varies depending on surrounding valley corridor</li> </ul>
6B	<ul style="list-style-type: none"> <li>- Anthropogenically influenced</li> <li>- Combination of channelized watercourse, beaver impounded area characterized by marsh vegetation</li> <li>- Depositional environment</li> <li>- Width greater than 5 m</li> </ul>
9A	<ul style="list-style-type: none"> <li>- Moderate gradient</li> <li>- Well defined meandering channel</li> <li>- Riffle/run/pool morphology</li> <li>- Moderate flow velocity</li> <li>- Erosive environment in granular bed and bank materials</li> <li>- Riparian vegetation forest and shrubs contributing to channel form</li> <li>- Width less than 5 m</li> </ul>
9B	<ul style="list-style-type: none"> <li>- Moderate gradient</li> <li>- Defined meandering channel</li> <li>- Riffle/run/pool morphology</li> <li>- Moderate flow velocity</li> <li>- Erosive environment in silt and fine sand bed and bank materials</li> <li>- Riparian vegetation forest and shrubs contributing to channel form</li> <li>- Width less than 5 m</li> </ul>
12	<ul style="list-style-type: none"> <li>- Flat gradient</li> <li>- No to poorly define channel and sporadic pooling water</li> <li>- Low to no discernable flow velocity</li> <li>- Dense alder thicket, herbaceous groundcover, and marsh vegetation community throughout</li> <li>- Width greater than 20 m</li> </ul>

## **HOLLINGER BASELINE STUDIES DESCRIPTION OF REACH TYPES CLASSIFICATION SUMMARY IDENTIFIED WITHIN THE LOCAL STUDIES AREA**

### **Reach Type 1**

Reach Type 1 characteristically exhibits low gradients (<1.0%) and flat channel morphology. Channel diagnostic features are commonly uniform throughout with only minor variation in wetted depths and widths. Typically, wetted widths are greater than 5 m and flow velocities are low. These combined conditions permit deposition of variable sediment materials such as silt, fine sand, and organic detritus. Riparian margins are generally dominated by shrub species such as Red-osier dogwood and willow in association with an outer overbank assemblage of mixed forest species.

### **Reach Type 3**

Reaches are characterized by well defined channels that are generally less than 5 m wide and functionally linked to a floodplain. Channel morphology consists of 70% to 80% flats and 20% to 30% runs with low gradients and slightly meandering channel planform. Flow velocities are generally low to moderate and substrate materials predominantly consist of a sand and muck matrix coupled with variable percentages of gravel, cobble, and silty clay which are well or sparsely distributed. Riparian vegetation is often dominated by dense shrubs, herbaceous and meadow species, combined with deciduous trees such as tamarack.

### **Reach Type 4**

This reach type is characterized by flat gradients and open water impoundment areas with an associated riverine marsh community, largely resulting from long-term beaver activity or other fixed grade control feature. Open water areas can be substantial in size, with pond dimensions ranging from 100 m to 1 km in length and 15 to several hundred metres in width. Pond cross sections are comparatively uniform with depths approximately 1 to 1.5 m throughout. Substrate materials are predominately organic muck and detritus, with sparsely distributed concentrations of material ranging from clay and silt to bedrock depending on underlying surficial materials. The open water pond areas are typically surrounded by dense emergent vegetation such as cattails and submergent macrophytes such as northern water milfoil and stonewort. Beyond the cattail perimeter, vegetation distribution consists of various shrub and tree species such as alder, willow, cedar, tamarack and spruce (coniferous to mixed forest).

### **Reach Type 5**

Reaches are characterized by conditions reflecting wetland environments with poor representation of open water area. Typically, areas are overgrown with dense emergent vegetation and only minor isolated or non-discernable sections of defined channel or open water habitat are present. Floodplain widths vary depending of the watercourse morphology and surrounding valley corridor. Pond cross sections are comparatively uniform with depths approximately 1 to 1.5 m throughout. Substrate materials are predominately organic muck and detritus, with sparsely distributed concentrations of material ranging from clay and silt to bedrock depending on underlying surficial materials. Aquatic vegetation is typically composed of cattail/sedge areas, grassy hummocks with

occasional patches of floating vegetation where minor and fragmented open water pockets are observed.

## **Reach Type 6**

Reach Type 6 characterizes areas that have been subject to significant anthropogenic watercourse modifications. Modifications can include those from historical mining or other resource based activities, infrastructure development, channelization or other intrusive in-water works for various purposes in support of surrounding land uses such as land clearing, agriculture, or urbanization (e.g., infilling, scour protection, retaining walls, marinas).

### **Reach Type 6A**

Reach Type 6A generally consists of channelized watercourses that have had conveyance confined as a result of surrounding land use. Resulting channel/floodplain linkage and associated function is typically compromised. Channel morphology can include runs, riffles and pools depending on the resulting gradient and bed grade changes. Bed substrate materials primarily consist of typical underlying surficial materials or some form of placed armouring. Due to the surrounding development in these areas, riparian vegetation is either absent or generally limited to a small area fringe immediately adjacent to the water margin.

### **Reach Type 6B**

Similar to Reach Type 6A, this reach type is also characterized by channelized watercourses however, extensive beaver activities and a resulting long-term inundation of the flood plain create impounded open water areas. Ponds may vary in size from small (e.g., 10 x 25 m) to moderate (200 x 350 m) in size, with lengths largely determined by the gradient of the overall valley system and height of beaver dams. Cross sections are relatively uniform with depths ranging from approximately 1 to greater than 1.5 m throughout. General substrate materials are predominately organic muck and detritus, with variable depositional areas of sand, gravel, cobble, clay and silt. These types of ponds are typically surrounded by a dense perimeter of emergent vegetation such as cattails, and submergent macrophytes are common throughout the open water areas. Beyond the cattail perimeter various shrub species including alder, willow, spruce, and birch typically line the marsh margin.

### **Reach Type 9A and Reach Type 9B**

Reach Type 9A and 9B are both characterized by moderate gradients and flow velocities, as well as defined meandering channels. General channel morphology consists primarily of pool and run sequences with occasional riffle areas. Wetted widths are normally less than 5 m throughout. Additionally, erosive features such as undercut banks, indicating several fluvial geomorphic processes, are commonly associated with this reach type. The riparian vegetation consists of forest and shrub species that contribute to the overall channel form.

Variations in bed substrate material differentiate Reach Type 9A and Reach Type 9B. Reach Type 9A consists of granular particle size and Reach Type 9B consists of silt and fine sand bed and bank materials.

### **Reach Type 12**

This reach type is characterized by only an intermittently appearing defined channel that passes through muskeg, alder thicket or densely vegetated cattail marsh dominated floodplain. Otherwise the channel is undefined and passes through extensive areas of dense vegetation in a diffuse manner. Linkage to the floodplain is high with potential floodprone areas being unlimited relative to channel size (greater than 20 m wide). Due to nature of the characteristic flat vegetated and/or hummocky terrain, depressions that intercept the channel form sporadic pools with shallow water depths typically below 1 m. Substrates through the floodplain largely consist of organic sediments and detritus. Low to no discernable flow velocity is observed in the short defined channel sections.



**APPENDIX B**

**HOLLINGER BASELINE STUDIES  
SHORELINE HABITAT CLASSIFICATION SUMMARY  
IDENTIFIED IN LAKES AND PONDS WITHIN THE LOCAL STUDY AREA**

**HOLLINGER BASELINE STUDIES SHORELINE HABITAT TYPE CLASSIFICATION  
SUMMARY IDENTIFIED IN LAKES AND POND WITHIN THE LOCAL STUDIES AREA**

<b>Shoreline Habitat Type</b>	<b>Common Characteristics</b>
1	<ul style="list-style-type: none"> <li>- Bedrock controlled</li> <li>- Moderate to steep bank and bed gradient</li> <li>- Overhanging shrub and tree vegetation</li> <li>- Fragmented bedrock, boulder, cobble and sand substrates</li> <li>- Barren rock eulittoral and supralittoral zones</li> </ul>
1A	<ul style="list-style-type: none"> <li>- Variable small rock to sand substrates</li> <li>- Moderate bank and bed gradient</li> <li>- Overhanging shrub and tree riparian vegetation</li> <li>- Sparse emergent and submergent macrophytes</li> </ul>
2	<ul style="list-style-type: none"> <li>- Sparse emergent aquatic vegetation composition</li> <li>- Soft bed materials mostly organics and muck</li> <li>- Clumped submergent macrophytes</li> <li>- Gradual bed gradient</li> </ul>
2A	<ul style="list-style-type: none"> <li>- Dense cattails, grass, sedge, bulrush, and reed vegetation</li> <li>- Organic and muck bed materials</li> <li>- Uniform and dense submergent macrophytes</li> <li>- Gradual bank and bed gradient</li> </ul>
2C	<ul style="list-style-type: none"> <li>- Waterlogged, and often floating muskeg area dominated by sphagnum mosses and herbaceous species</li> <li>- Wide muskeg boundary that extends from the waterbody perimeter to the surrounding terrestrial forests</li> <li>- Organic bed materials</li> <li>- Dense submergent macrophytes</li> <li>- Flat near shore margin</li> </ul>
3	<ul style="list-style-type: none"> <li>- Anthropogenically influenced</li> <li>- Granular fill and/or bank and bed scour protection in the form of riprap above and below shoreline water level.</li> <li>- Causeway/road embankment/shoreline modification</li> <li>- Rock substrates can be overlain with organics and muck</li> <li>- Successional vegetative distribution</li> <li>- Little to no supralittoral zone</li> </ul>
3A	<ul style="list-style-type: none"> <li>- Anthropogenically influenced</li> <li>- Flat or gradual bank and bed gradients</li> <li>- Fine bed materials such as sands or tailings</li> <li>- Little to no riparian vegetation community</li> <li>- Limited biophysical composition</li> <li>- Little to no supralittoral zone</li> </ul>



## **HOLLINGER BASELINE STUDIES DESCRIPTION OF SHORELINE HABITAT TYPES FOR LAKES AND PONDS IDENTIFIED WITHIN LOCAL STUDY AREA**

### **Shoreline Habitat Type 1**

This shoreline habitat type is typically characterized by bedrock outcropping, rocky substrates, narrow littoral zones, and moderate to steep bank and bed gradients trending into deeper water depths. Bed materials are often composed of fragmented bedrock, boulder, cobble, and an assortment of granular to sand sized particles. Aquatic vegetation is generally sparse (<20% coverage) due to the lack of suitable near shore substrates capable of supporting plant growth. Riparian vegetation densities can vary as a result of the typically steep and often rock barren dominated landscape. Vegetation types commonly include tree and shrub species such as alder, Red-osier dogwood, cedar, spruce, Jack Pine, and Trembling aspen. Due to the prevalence of shallow soils and lack of supporting root structure, windblown large woody debris overhanging and in the water along the shoreline is common.

### **Shoreline Habitat Type 1A**

This shoreline habitat type features variable smaller rock based bed materials consisting of cobble, gravel, pebble, and coarse to fine sand material. Large woody debris is often abundant providing protective cover opportunities for aquatic biota. Emergent and submergent aquatic vegetation is limited and located in suitable bed materials conducive to support plant growth that are distributed in a patchy manner. This habitat type exhibits dense riparian vegetation consisting largely of overhanging shrubs, herbaceous species, grasses, and sedges.

### **Shoreline Habitat Type 2**

Shoreline Habitat Type 2 is characterized by sparse wetland conditions typically in shallow water depths (<1 m) with soft organic substrate materials. Near shore emergent species consisting of grasses, sedges, and/or cattails are typical in low densities. Isolated distributions of submergent macrophytes, commonly stonewort, are generally interspersed throughout. Sporadic areas of floating vegetation are common such as yellow water lily, floating pondweed, or watershield. Beyond the typically flooded wetland margin, shrub and sapling species prevail. Overbank areas can exhibit a coniferous, mixed, or deciduous forest depending on adjacent terrain and soil conditions.

### **Shoreline Habitat Type 2A**

Type 2A shoreline habitat exhibits conditions that are typical of marsh wetland environments. Fully saturated shorelines and bed substrate composition consists of predominantly organic muck combined with detritus and is generally thick (>0.5 m). Vegetation distributions in these areas are relatively diverse, primarily consisting of emergent species such as grasses, arrowhead, sedges and cattails. Floating vegetation, such as water lilies, occasionally occur in areas of softer organic substrate materials. Dense submergent aquatic vegetation such as northern water milfoil and/or stonewort is also often associated with this habitat type. Beyond the typically flooded wetland

margin, shrub and sapling species prevail. Overbank areas can exhibit a coniferous, mixed, or deciduous forest depending on adjacent terrain and soil conditions.

### **Shoreline Habitat Type 2C**

This shoreline habitat type is characterized by flat near shore margins, shallow water depths and an extensive, fully saturated, floating mat eulittoral zone that extends from the waterbody perimeter to the surrounding terrestrial forests. Portions of the open water zone can be dominated by colonies of floating vegetation including water lily, pondweed, or floating watershield. Near shore vegetation generally consists of emergent aquatic species with common submergent macrophytes such as milfoil and stonewort. Typical eulittoral zone vegetation includes various herbaceous species, sweet gale, willow, alder, tamarack, sphagnum mosses, and leatherleaf. Substrate materials are generally composed of a soft muck and organic detritus matrix, indicative of the surrounding biophysical structure.

### **Shoreline Habitat Type 3**

This shoreline habitat type represents areas that have been historically altered for various purposes such as roadway access, shoreline protection, or infilling for infrastructure installation (e.g., causeways, road embankments, pumphouse infills). Materials associated with this shoreline type include granular fill and bank and bed scour protection in the form of riprap. Generally, shorelines are devoid of vegetation due to nature of rocky fill, or riparian overhanging shrub and groundcover vegetation colonize the open voids within the fill material providing sporadic areas of coverage. Additionally, this habitat type does not normally include a supralittoral area due to the nature of the structure's usage. Aquatic vegetative community diversity and density can vary and is largely dependant on the age of the existing structure and deposition of sediments on placed substrates that permit recolonization.

### **Shoreline Habitat Type 3A**

Shoreline Habitat Type 3A is characterized by anthropogenically influenced environments resulting from various purposes such as historical mining/tailing management areas, public beaches, agricultural activities, or other remnant land use function. Typically, bed materials near shore are dominated by fine sand/silt particle size and small proportions of cobble, gravel, and overlying detritus. Shoreline gradients are flat and vegetation communities are in the process of colonizing/naturalizing the altered area. Aquatic vegetation generally consists of cattails and submergent stonewort with occasional distribution of floating vegetation. Eulittoral and supralittoral zones are limited and consist of juvenile tree and shrub species or regularly maintained lawn with no protective riparian buffer.

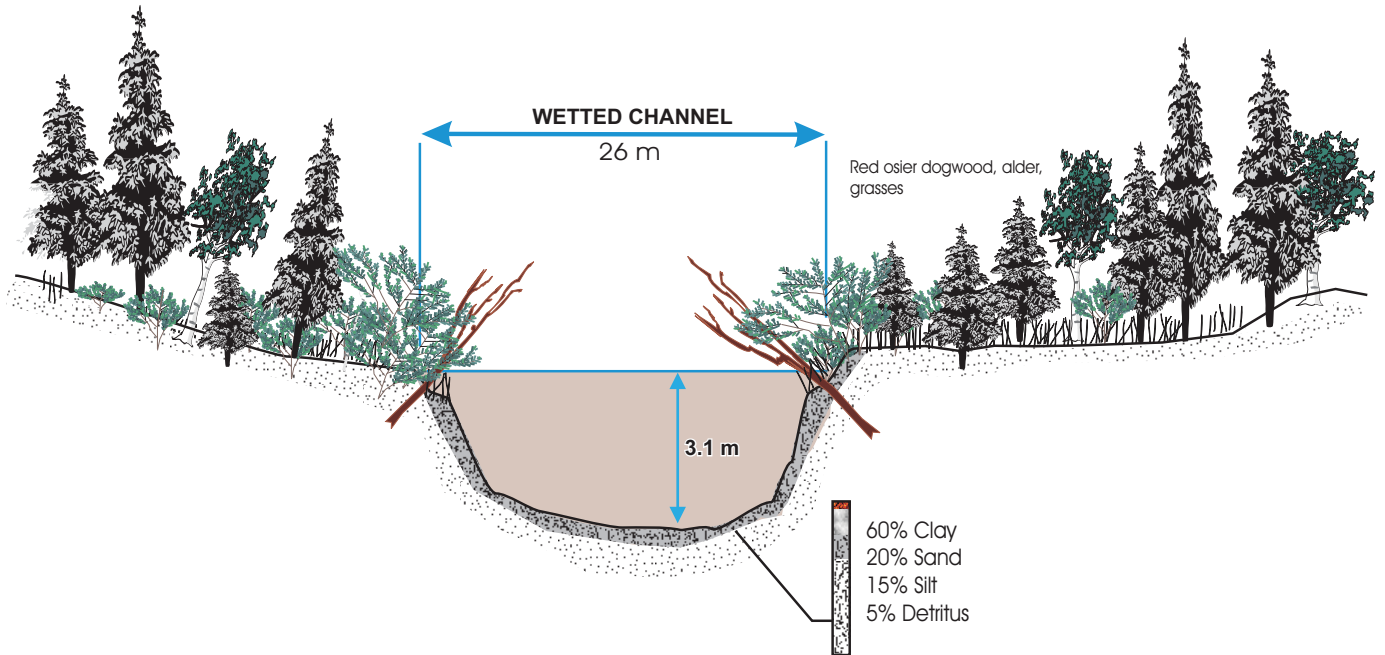


**APPENDIX C**

**HOLLINGER BASELINE STUDIES  
WATERCOURSE REACH TYPE SCHEMATICS IDENTIFIED  
WITHIN LOCAL STUDY AREA**

AVERAGE WIDTH = 26 m  
AVERAGE DEPTH = 3.13 m  
OVERHEAD COVER = 20%  
INSTREAM COVER = 20% - wood / vegetation / turbid water

white birch,  
black spruce,  
balsam fir, trembling  
aspens



Mountjoy River



Mountjoy River

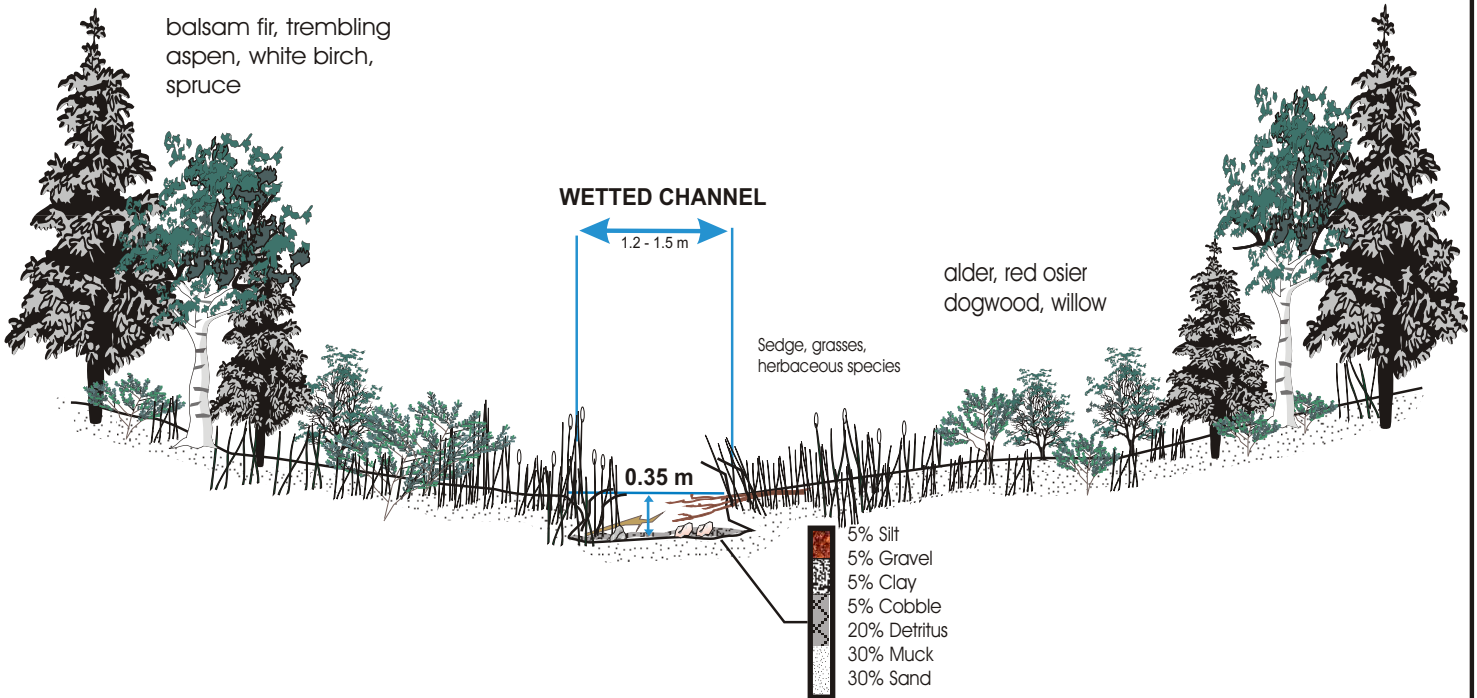


Mountjoy River (Upstream)



Mountjoy River (Upstream)

**AVERAGE WIDTH = 1.2 - 1.5 m**  
**AVERAGE DEPTH = 0.35 m**  
**OVERHEAD COVER = 30%**  
**INSTREAM COVER = 25% wood / vegetation / organics / undercut banks**



Edwards Creek



Edwards Creek



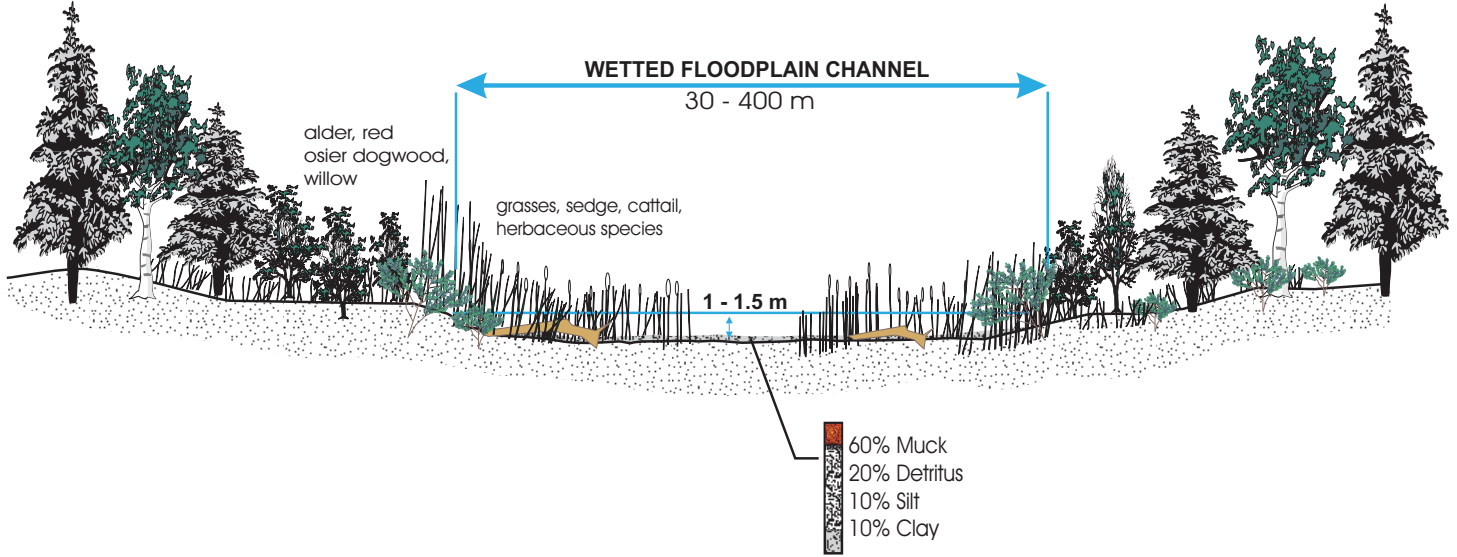
Skyner Creek



Skyner Creek

FLOODPLAIN WIDTH = 30 - 400 m  
 AVERAGE DEPTH = 1 - 1.5 m  
 OVERHEAD COVER = 5%  
 INSTREAM COVER = 20% - wood / organics / vegetation

spruce, tamarack,  
 white birch, trembling  
 aspen, balsam fir



Edwards Creek



Edwards Creek



Perch Miller Lake System



Simpson Lake Outlet Flow



Skynner Creek



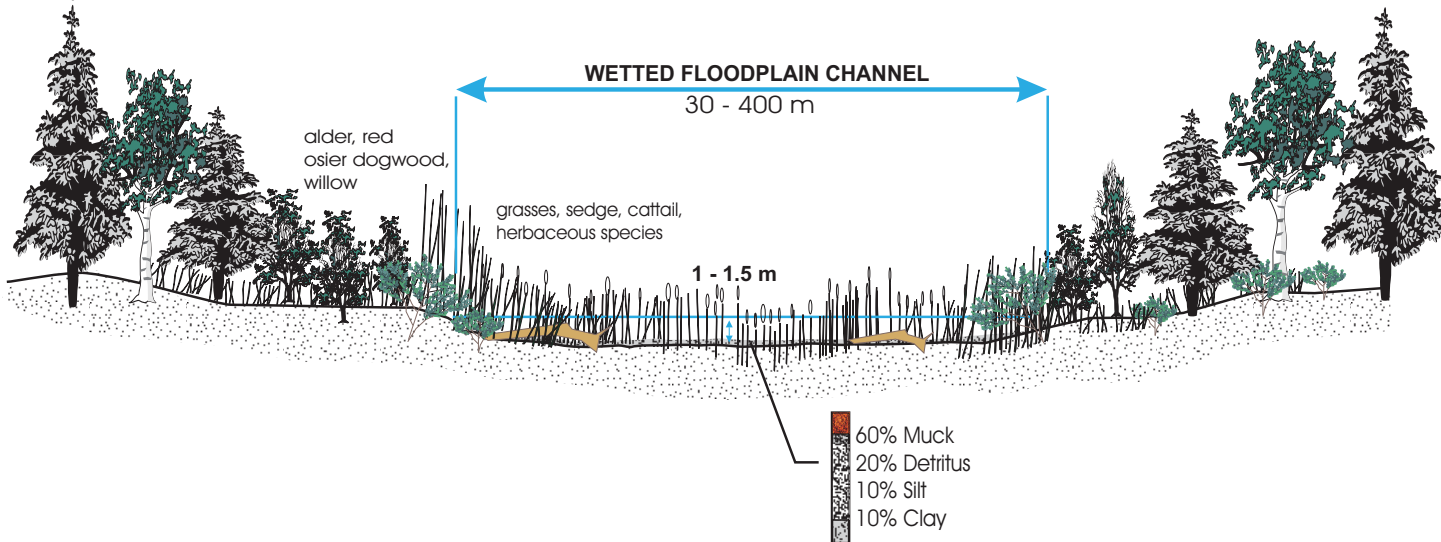
Skynner Creek



Skynner Creek

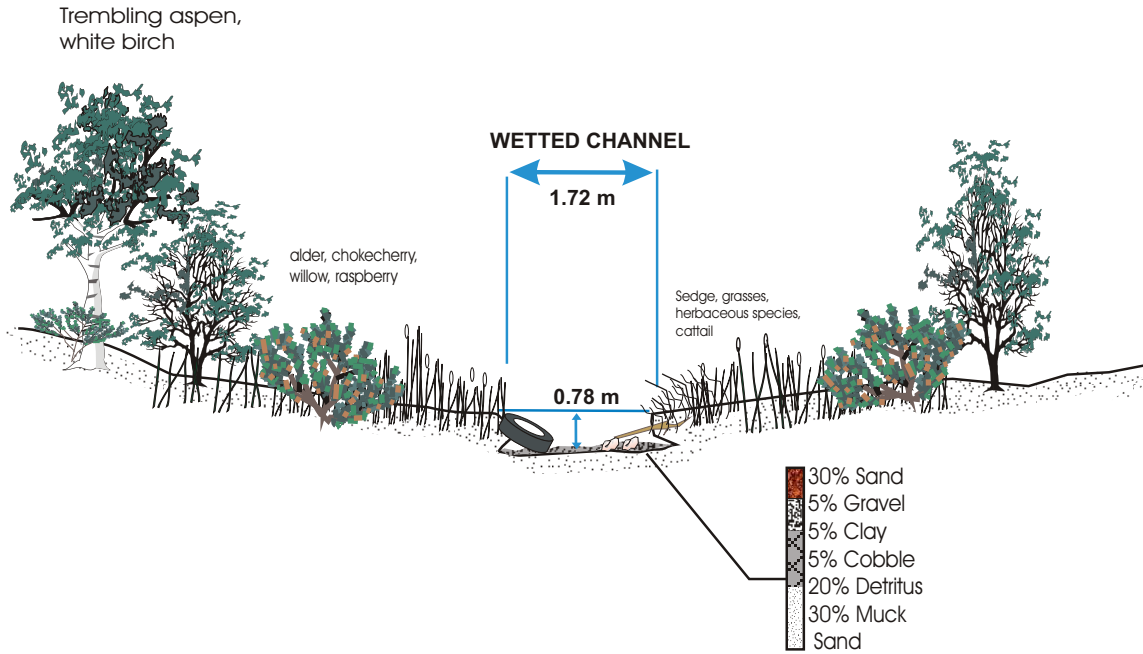
FLOODPLAIN WIDTH = 30 - 400 m  
AVERAGE DEPTH = 1 - 1.5 m  
OVERHEAD COVER = 20%  
INSTREAM COVER = 70% - wood / organics / vegetation

spruce, tamarack,  
white birch, trembling  
aspen, balsam fir



Edwards Creek South of Hwy. 101

**AVERAGE WIDTH = 1.72 m**  
**AVERAGE DEPTH = 0.78 m**  
**OVERHEAD COVER = 15%**  
**INSTREAM COVER = 15% wood / vegetation / urban debris / undercut banks**



**Skyenner Creek**



**Skyenner Creek**

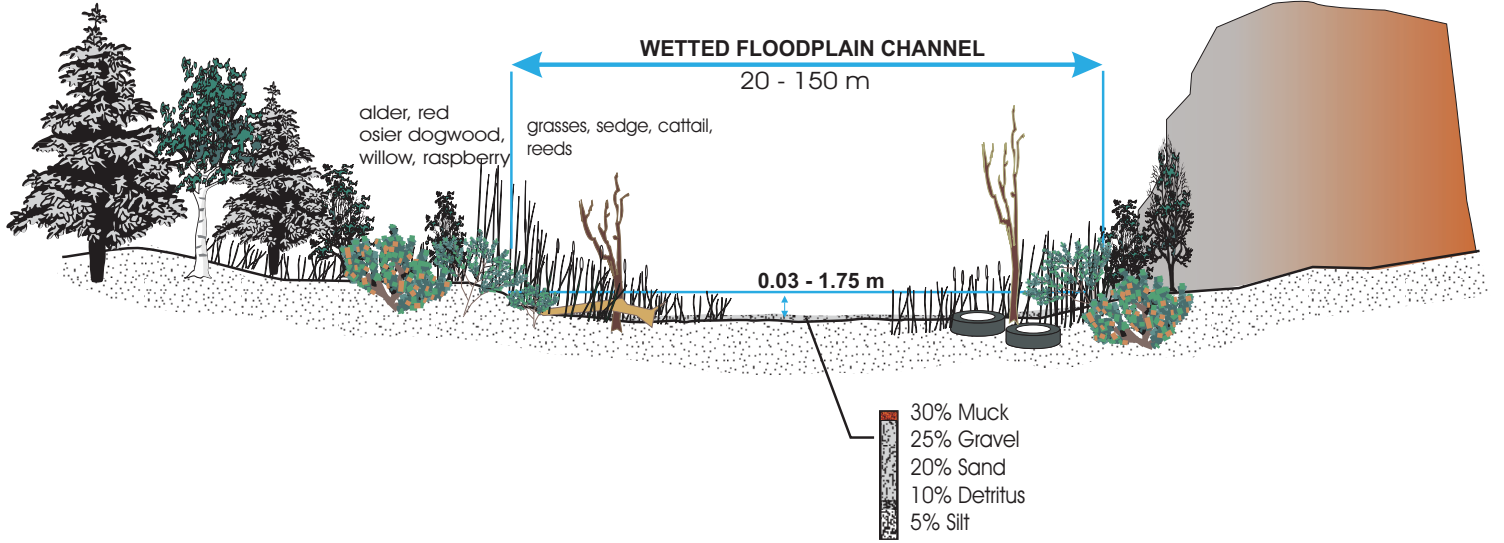


**Skyenner Creek**  
**Residential development**  
**adjacent to channel**

**FLOODPLAIN WIDTH = 20 - 150 m**  
**AVERAGE DEPTH = 0.03 - 1.75 m**  
**OVERHEAD COVER = 5%**  
**INSTREAM COVER = 20% - wood / organics / vegetation**

spruce, white birch  
trembling aspen, balsam fir

Industrial Land Uses  
(Hydro subtransmission station and aggregate pit)



**Skynner Creek**



**Skynner Creek**



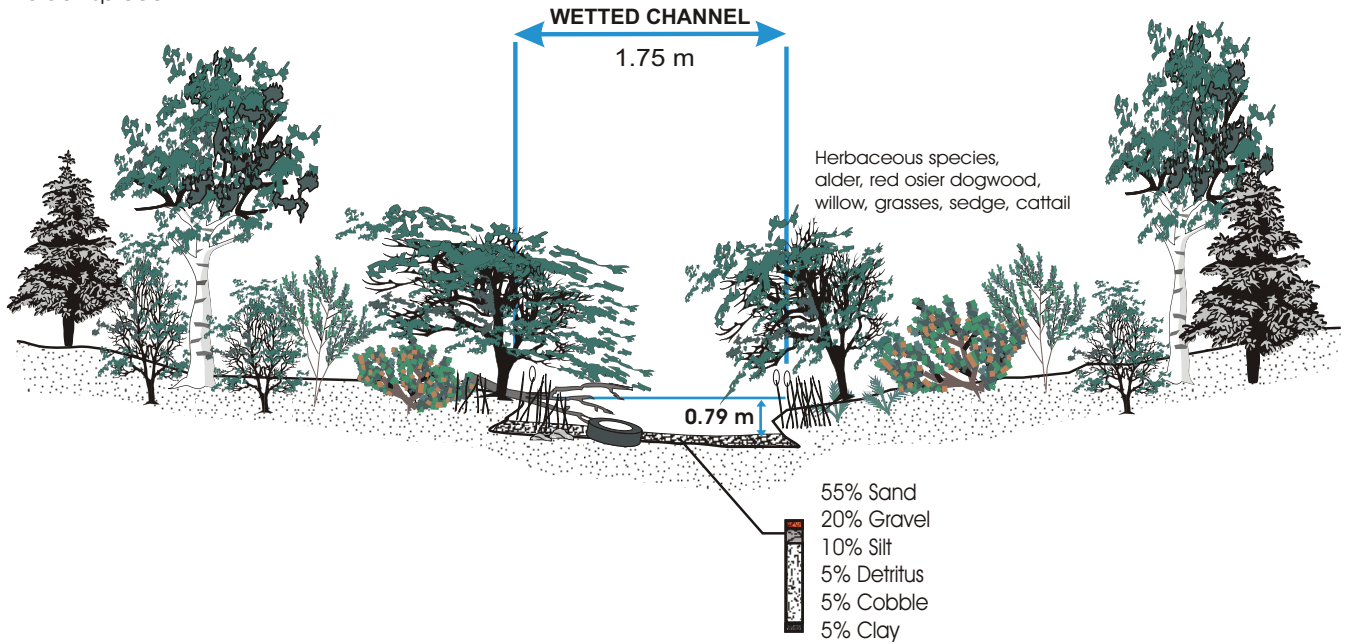
**Edwards Creek**



**Edwards Creek**

AVERAGE WIDTH = 1.75 m  
AVERAGE DEPTH = 0.79 m  
OVERHEAD COVER = 30%  
INSTREAM COVER = 20% - rock / wood / organics / undercut banks/  
urban debris / vegetation

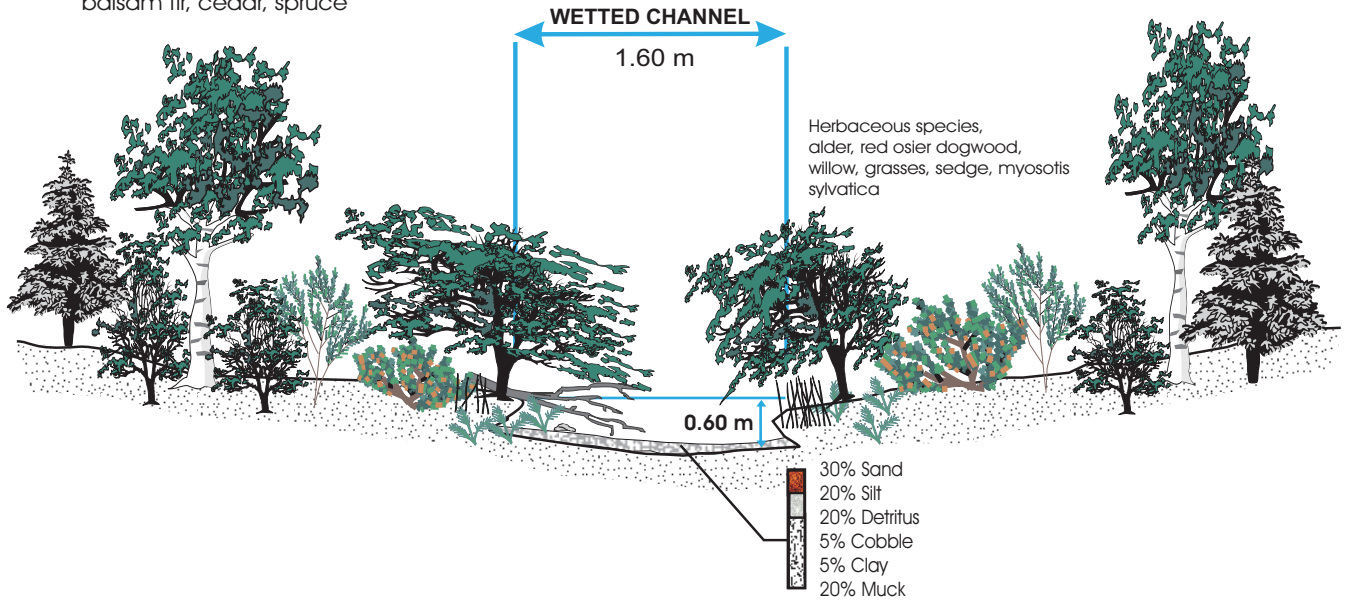
white birch, white ash,  
trembling aspen, balsam fir,  
black spruce



Skynner Creek at Pine Street

**AVERAGE WIDTH** = 1.60 m  
**AVERAGE DEPTH** = 0.60 m  
**OVERHEAD COVER** = 10%  
**INSTREAM COVER** = 35% - rock / wood / organics / undercut banks/ vegetation

white birch, trembling aspen,  
balsam fir, cedar, spruce



Skynner Creek (Confluence with the Mountjoy River)



Skynner Creek (Confluence with the Mountjoy River)



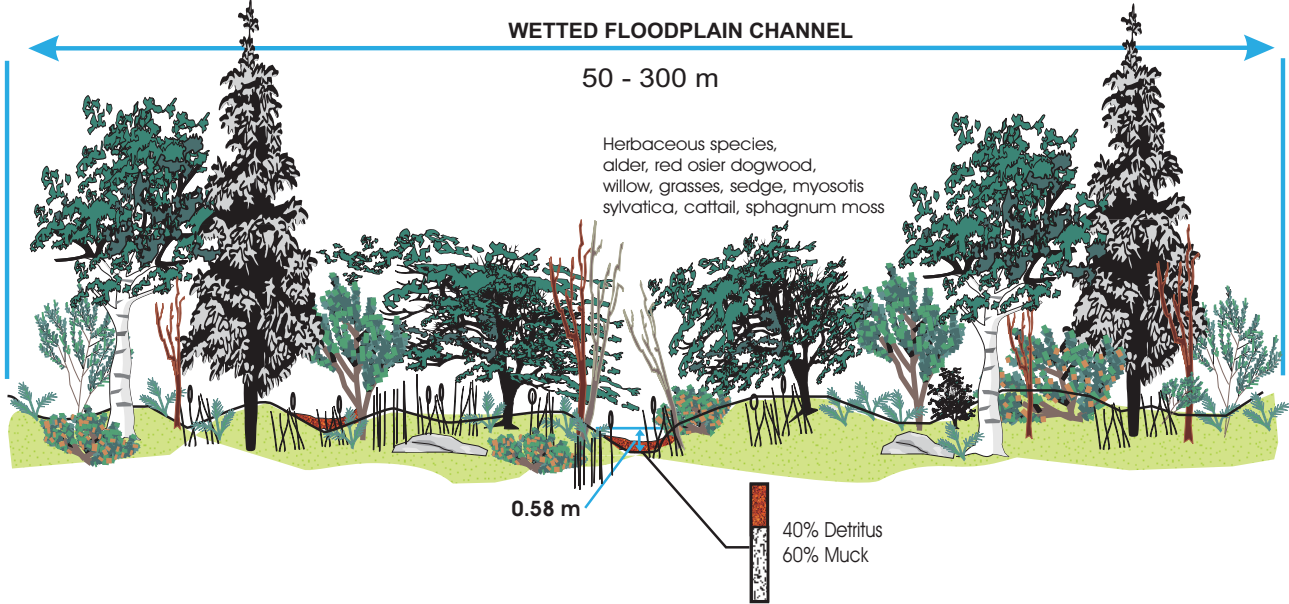
Edwards Creek (Upstream headwater)



Edwards Creek (Upstream headwater)

FLOODPLAIN WIDTH = 50 - 300 m  
 AVERAGE DEPTH = 0.58 m  
 OVERHEAD COVER = 60%  
 INSTREAM COVER = 50% - wood / organics / vegetation

white birch, trembling aspen,  
 balsam fir, cedar, black spruce



Edwards Creek (Upstream of Edwards Lake)



Edwards Creek (Upstream of Edwards Lake)



Skynner Creek (Upstream of Mountjoy River)



Skynner Creek (Upstream of Mountjoy River)



**APPENDIX D**

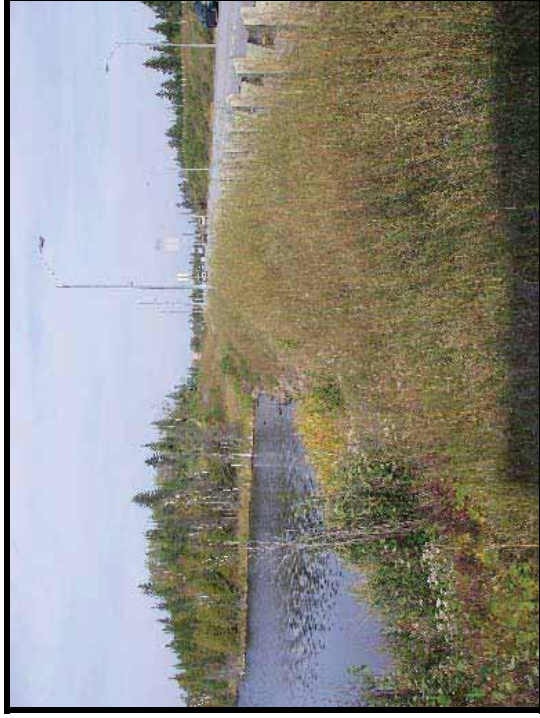
**HOLLINGER BASELINE STUDIES  
SHORELINE HABITAT PHOTOGRAPHS FOR LAKES AND PONDS WITHIN  
LOCAL STUDY AREA**



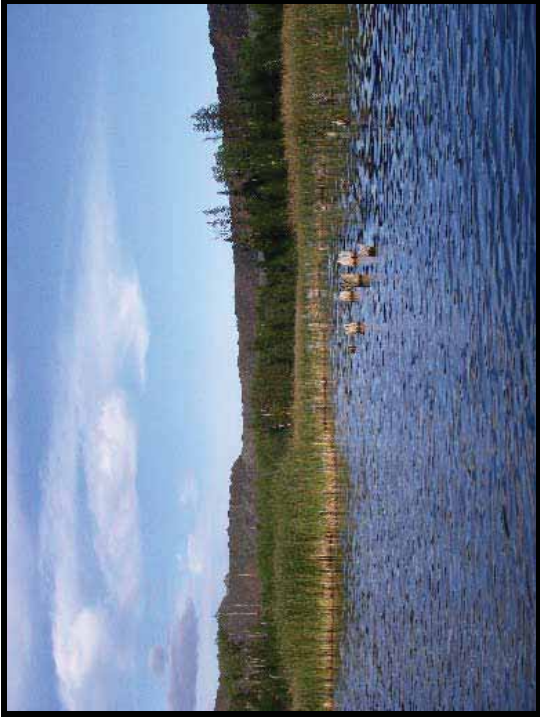
Pearl Lake – Shoreline Type 1A



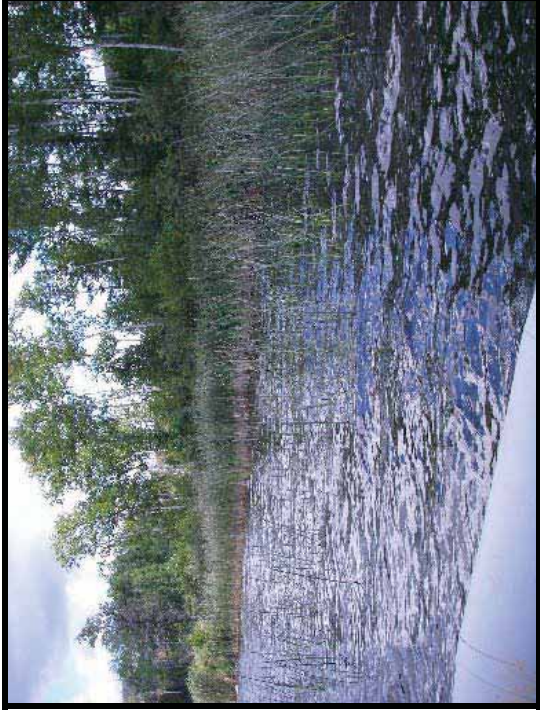
Pearl Lake – Shoreline Type 2A



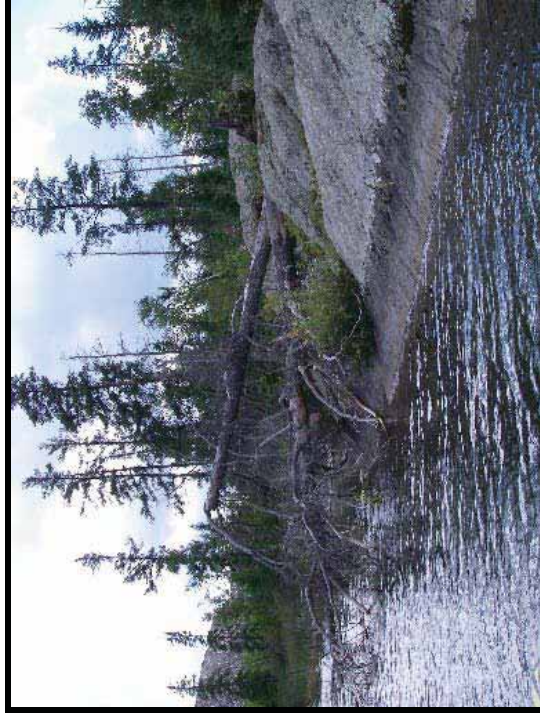
Pearl Lake – Shoreline Type 3A



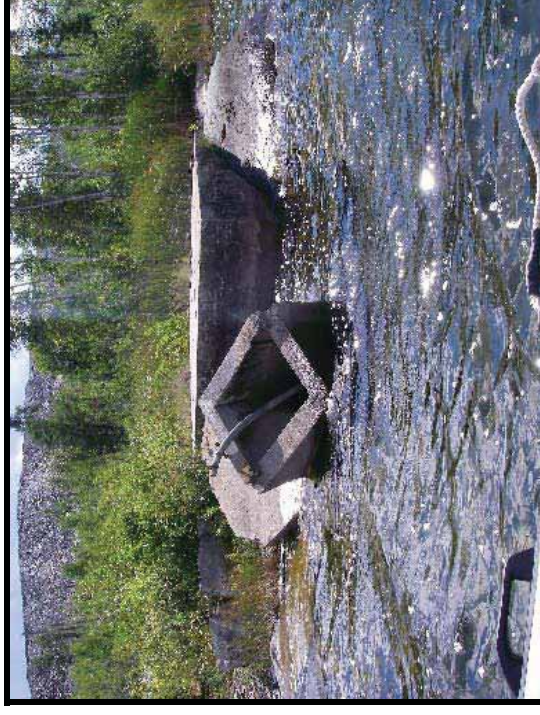
Simpson Lake – Shoreline Type 2A



Simpson Lake – Shoreline Type 2



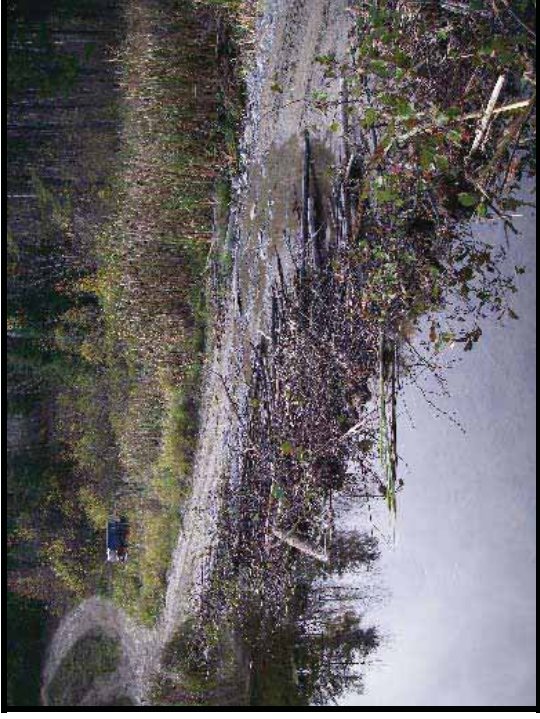
Simpson Lake – Shoreline Type 1



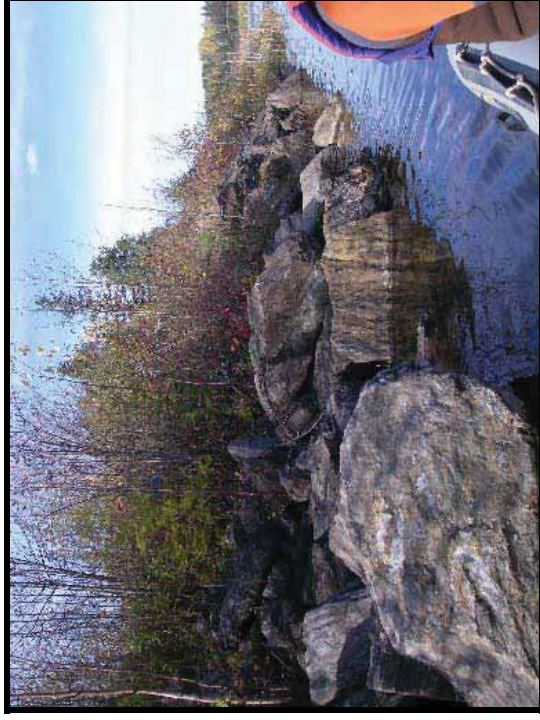
Simpson Lake – Shoreline Type 3



Perroi Lake – Shoreline Type 2A



Perroi Lake – Shoreline Type 3



Perroi Lake – Shoreline Type 3



McDonald Lake – Shoreline Type 3A



McDonald Lake – Shoreline Type 2A



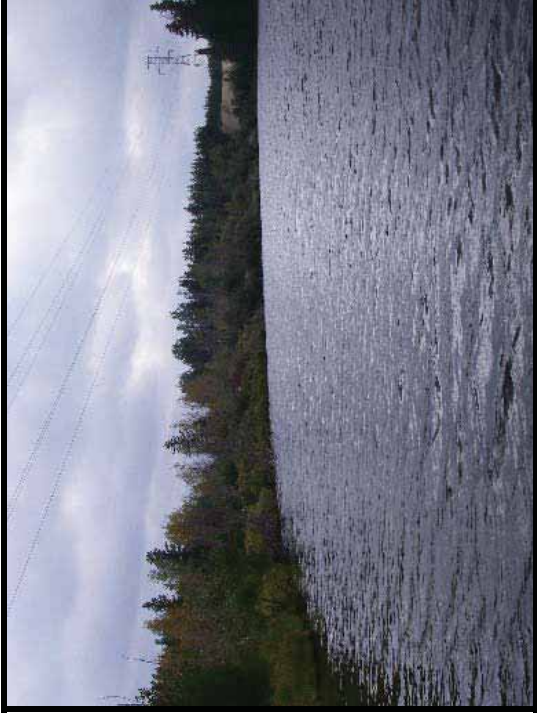
McDonald Lake – Shoreline Type 1A



McDonald Lake – Shoreline Type 3



Cowboy Lake – Shoreline Type 2A



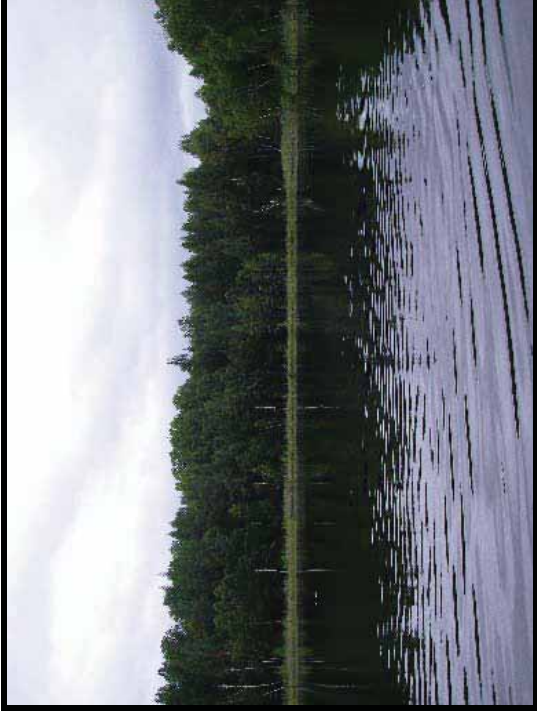
Cowboy Lake – Shoreline Type 1A



Cowboy Lake – Shoreline Type 2



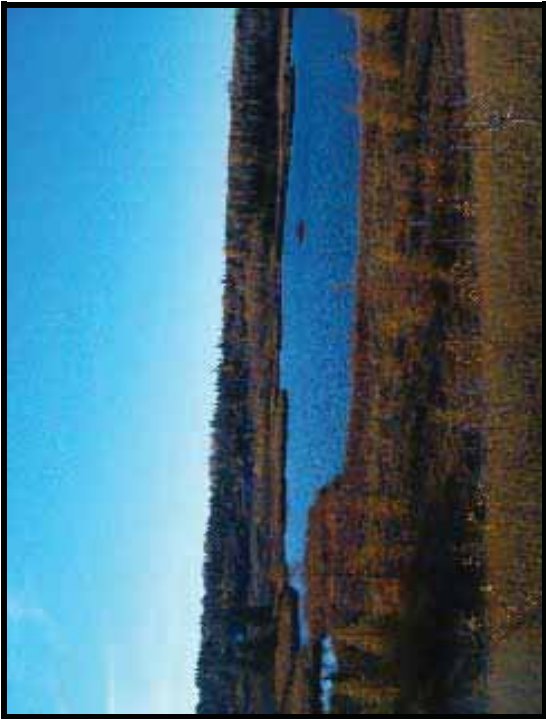
Perch Lake – Shoreline Type 2C – Vegetation



Perch Lake – Shoreline Type 2C



Perch Lake – Shoreline Type 1A

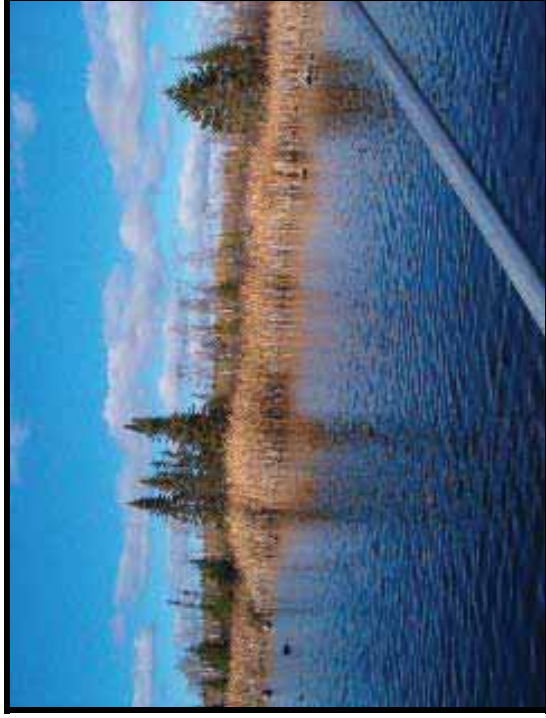


Fuller Mine Pond



Fuller Mine Pond

Shoreline Type 2A Foreground- Shoreline Type 3 in Background



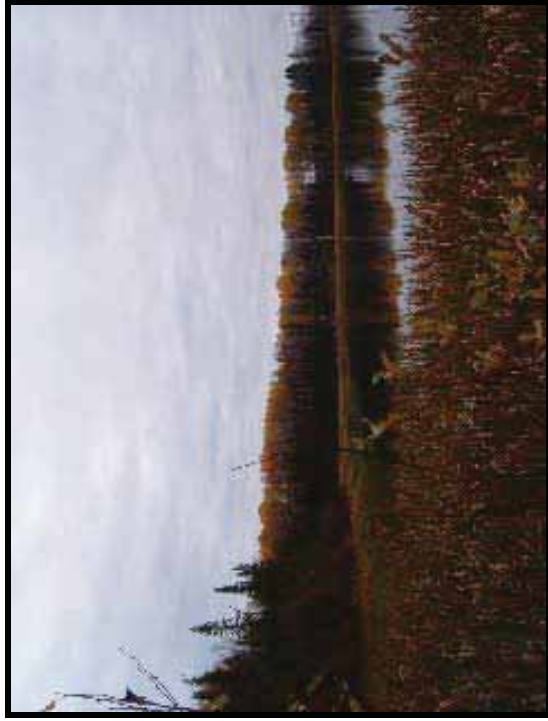
Fuller Mine Pond – Shoreline Type 2A



Beaver Dam Separating Miller Lake and Miller Pond



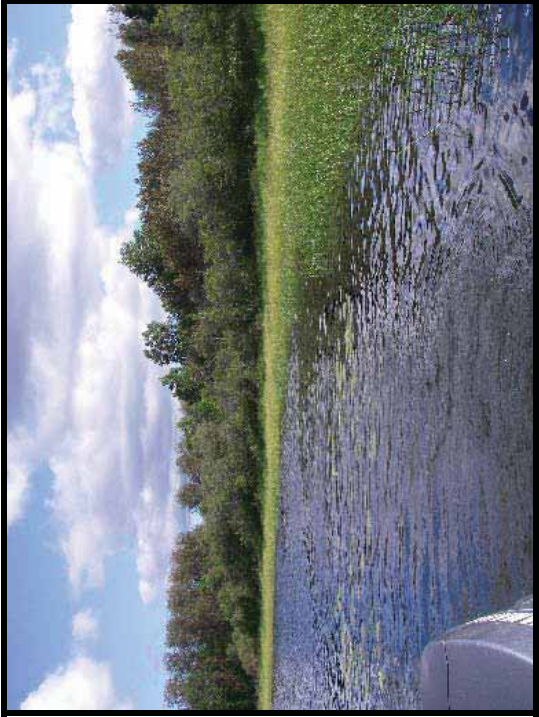
Miller Lake – Shoreline Type 3A



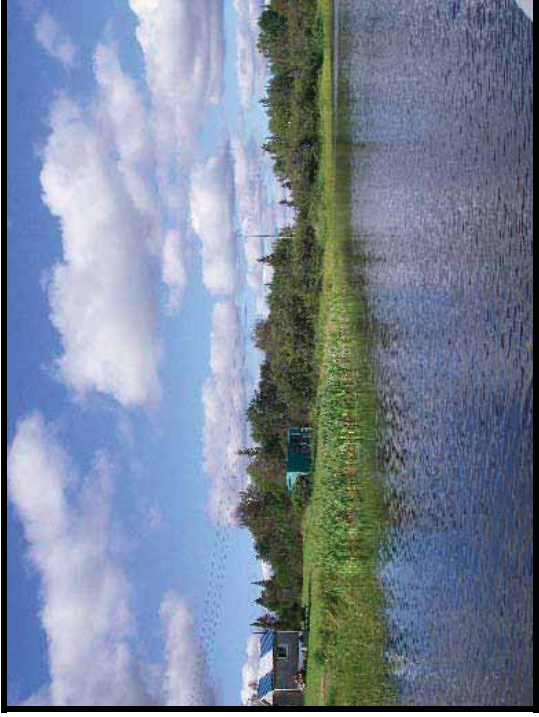
Miller Lake – Shoreline Type 2A



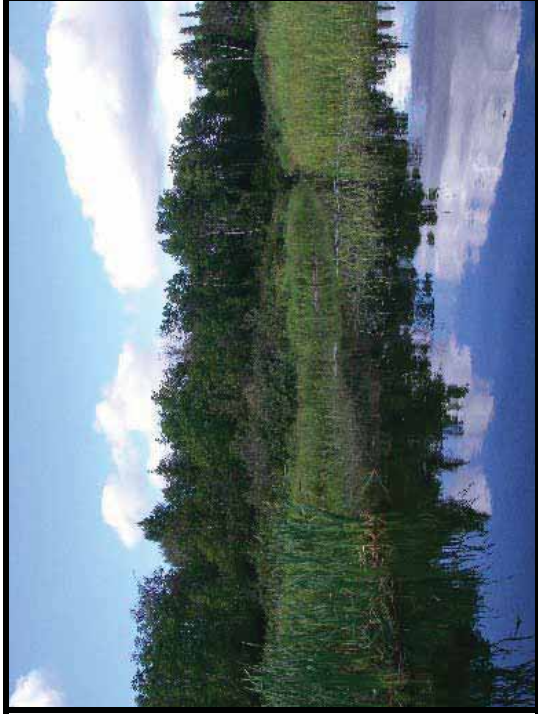
Miller Lake – Shoreline Type 3A



Miller Pond – Shoreline Type 2A



Miller Pond – Small segment of manicured lawn



Miller Pond – Outflow to Mountjoy River



**APPENDIX E**

**HOLLINGER BASELINE STUDIES  
WATER QUALITY FIELD PARAMETERS MEASURED AT SIMPSON LAKE,  
AREA A TRIBUTARY, AREA B TRIBUTARY, AREA C TRIBUTARY,  
AND AREA D TRIBUTARY WITHIN LOCAL STUDY AREA**

**Hollinger Baseline Studies Water Quality Field Parameters measured at Simpson Lake, Area A Tributary, Area B Tributary, Area C Tributary, and Area D Tributary**

<b>Sample Site</b>	<b>Water Temperature (°C)</b>	<b>DO (mg/L)</b>	<b>Conductivity (µs)</b>	<b>Ambient Temperature (°C)</b>	<b>pH</b>	<b>Secchi Disk (m)</b>
Simpson Lake (Northern, larger basin)	19.45	9.52	568	27	9.04	4.57
Simpson Lake (Southern, smaller basin)	19.14	8.83	595	24	8.71	1.8
Area A Tributary (Denise Street Crossing)	7.38	10.72	197	20	8.63	-
Area A Tributary (College Street Crossing)	7.81	11.36	159	20	8.6	-
Area A Tributary (McLean Dr. Crossing)	8.17	10.43	151	20	8.51	-
Area A Tributary (Airport Road Crossing)	10.31	13.14	234	20	9.12	-
Area B Tributary (Loneragan Blvd. Crossing)	10.77	7.13	526	20	8.16	-
Area C Tributary (McLean Dr. Crossing)	6.79	9.37	94	19	8.47	-
Area D Tributary (McLean Dr. Crossing)	6.64	11.4	132	19	8.62	-



## **APPENDIX F**

### **HOLLINGER BASELINE STUDIES DISSOLVED OXYGEN PROFILES IN LAKE AND POND SYSTEMS WITHIN THE LOCAL STUDY AREA (AMEC 2007 FIELD PROGRAM)**

**Hollinger Baseline Studies Dissolved Oxygen Profiles in Lake and Pond Systems in the Local Study Area (AMEC 2007 Field Program)**

Waterbody in Local Study Area	Depth (m)	Temperature in Celsius	DO (mg/L)	Conductivity (uS/cm)	pH
Simpson Lake (Northern, larger basin)	0.5	19.45	9.52	569	9.04
	1	19.44	9.54	569	9.01
	1.5	19.43	9.57	568	8.98
	2	19.4	9.6	567	8.93
	2.5	19.13	9.53	564	8.86
	3	18.76	9.37	561	8.85
	3.5	18.7	9.39	560	8.8
	4	18.65	9.35	559	8.77
	4.5	18.52	9.24	558	8.71
	5	18.4	9.12	558	8.64
	5.5	18.11	8.72	554	8.57
	6	17.47	8.22	550	8.51
	6.5	16.62	5.57	548	8.5
	7	16.18	4.84	566	8.51
	Simpson Lake (Southern, smaller basin)	0.5	19.78	8.83	593
1		19.76	8.96	585	8.7
1.5		19.75	8.84	598	8.79
MacDonald Lake	2	19.14	8.89	583	8.82
	0.5	16.94	9.74	271	8.91
	1	16.94	9.57	270	8.89
	1.5	16.95	9.54	270	8.88
	2	16.94	9.49	270	8.87
	2.5	16.91	9.45	268	8.85
	3	16.93	9.43	270	8.83
	3.5	16.93	9.47	270	8.77
	4	16.91	9.44	268	8.68
	4.5	16.8	9.3	270	8.62
	5	15.6	10.13	261	8.64
	5.5	12.36	9.85	246	8.75
	6	10.37	8.08	234	8.62
	6.5	8.87	5.78	231	8.65
	7	7.64	4.7	226	8.67
7.5	6.8	3.82	224	8.69	
8	6.36	3.09	223	8.71	
8.5	5.62	1.99	221	8.75	
9	5.18	1.7	221	8.76	
9.5	4.83	1.14	222	8.76	
10	4.64	0.38	223	8.79	
10.5	4.45	0.25	224	8.8	
11	4.35	0.27	224	8.83	
11.5	4.22	0.28	225	8.85	
12	4.13	0.33	227	8.84	
12.5	4.13	0.33	228	8.8	
13	4	0.29	229	8.79	
13.5	3.94	0.28	229	8.71	
14	3.92	0.3	230	8.74	
14.5	3.91	0.41	231	8.71	
15	3.6	0.47	235	8.63	

Waterbody in Local Study Area	Depth (m)	Temperature in Celsius	DO (mg/L)	Conductivity (uS/cm)	pH
Cowboy Lake	0.5	19.93	10.03	791	8.69
	1	19.87	9.96	789	8.63
	1.5	19.75	9.73	787	8.55
	2	18.3	9.28	768	8.49
	2.5	18.07	9.23	764	8.42
	3	17.95	8.76	773	8.36
	3.5	17.86	7.4	851	8.28
	4	17.8	2.07	1065	8.19
	4.5	17.24	0.55	1135	8.15
	5	15.48	0.41	1133	8.13
	5.5	13.96	0.29	1178	8.12
	6	11.33	0.23	1158	8.08
	6.5	9.65	0.21	1159	8.04
	9.2	19.15	9.2	367	8.53
	Miller Pond	1	19.03	9	362
1.5		18.94	10.17	358	8.41
2		18.94	10.17	358	8.37
2.5		18.89	10.17	357	8.37
3		18.47	8.49	365	8.22
3.5		17.26	6.83	361	8.22
4		16.29	3.51	358	8.06
4.5		14.04	2.06	383	7.99
5		11.42	0.43	460	7.93
5.5		11.08	0.49	466	7.96
Pearl Lake October 4-5/01 Reference: Minnow Environmental Ltd. (2001)		0	12.3	9.16	1981
	1	12.3	9.69	1981	8.07
	2	12.2	10.08	1981	8.07
	3	12.1	9.62	1981	8.02
	4	12.1	9.73	1981	8.01
	5	12.1	8.76	1979	7.95
	6	12.1	1.17	1985	7.41
	0.5	7.96	7.44	513	8.41
	1	7.95	7.59	513	8.41
	1.5	7.95	7.61	513	8.43
	2	7.73	7.63	510	8.45
2.5	7.54	7.91	506	8.49	
Perch Lake	0.5	16.37	9.07	45	8.7
	1	16.37	8.87	46	8.72
	1.5	16.35	8.67	45	8.75
	2	16.23	8.31	45	8.72
	2.5	16.23	5.83	46	8.61
3	16.22	2.64	51	8.54	
Clearwater Lake July 28/88 Reference: The Environmental Applications Group Limited (1989)	0	24	7.9	-	-
	1	24	6.2	-	-
	2	23	5.7	-	-
	3	19.5	4.85	-	-
	4	17	3.5	-	-
	5	15	2.5	-	-
6	13	2.4	-	-	