Assessment Report

Sault Ste. Marie Region

Source Protection Area

APPENDIX 1 -
CHAPTER 4
GROS CAP INTAKE PROTECTION ZONE

STUDY PHASE - 1

February 5, 2015

The Assessment Report was initially approved on November 25, 2011.
Amendments were made in 2014 to include Chapter 2c.

Surface Water Vulnerability Anlysis

The following chapter of the Assessment Report is presented as per *Technical Rules Clean Water Act, 2006*. The chapter is comprised of three consultants reports completed as part of the Ministry of the Environment's Technical Studies funding to achieve the requirements of the *Clean Water Act, 2006.*

Baird

oceans

engineering

lakes

design

rivers

science

watersheds

construction

Gros Cap Intake Protection Zone Study
FINAL PHASE 1 REPORT

January 22, 2008
11125.000




Gros Cap Intake Protection Zone Study
FINAL PHASE 1 REPORT

Prepared for

Sault Ste. Marie Region Conservation Authority

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Baird

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In association with
Conestoga-Rovers & Associates

EXECUTIVE SUMMARY

The Clean Water Act received Royal Assent on October 19, 2006 and it ensures communities are able to protect their municipal drinking water supplies. The Act is based on a local collaborative approach driven by good technical information for decision making. Since the geographic framework for source water protection in Ontario are the individual watersheds, the existing Conservation Authorities have been designated as source protection regions. This report summarizes the results of a **Phase 1** protection zone study for the Gros Cap intake coordinated by a partnership including the Sault Ste. Marie Region Conservation Authority, The Corporation of the City of Sault Ste. Marie and the Public Utilities Commission Services Inc. The technical work was completed by Baird & Associates, and our partners Conestoga-Rovers & Associates.

The Gros Cap pumping station is located at the western extent of Highway 550, also known as Second Line within the limits of the City of Sault Ste. Marie. The shoreline within 5 km of the intake consists of residential homes and one marina. The mouth of the intake is located approximately 830 m from shore and consists of a circular fibreglass structure in a depth of approximately 15 m. Refer to Figure I for a location map. The intake screen openings are approximately 2.0 m above the lake bottom. The intake diameter is 1.2 metres and has a hydraulic capacity of 150,000 cubic metres per day.

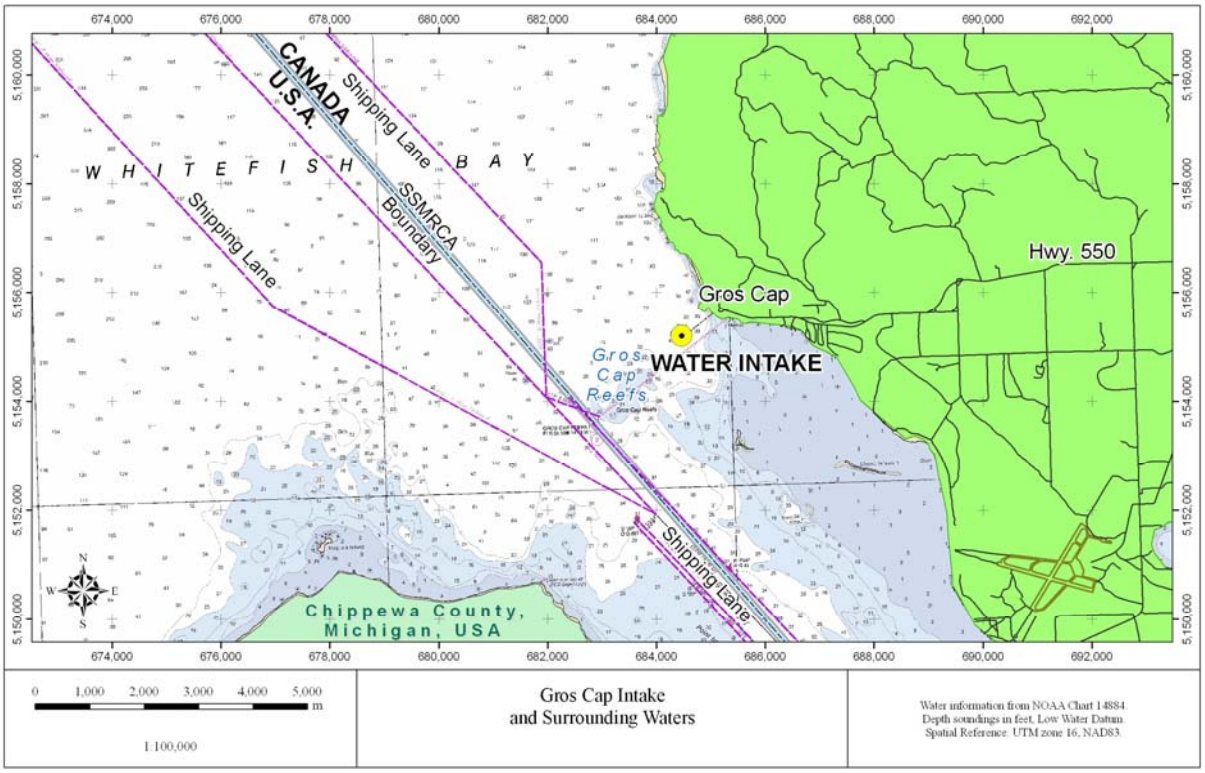

Figure I Study Area and Gros Cap Intake

The scope of the **Phase 1** study included data collection, intake characterization, ADCP current data collection and analysis, water and sediment sampling and analysis, preliminary IPZ delineations and reporting. The **Phase 2** study, which is not complete, will include 3D hydrodynamic modeling to investigate currents in the vicinity of the intake and refine the IPZ-2 boundaries presented in this report.

The following existing data was assembled for this investigation: lakebed depths (bathymetry), recorded and modeled wind data, modeled currents, tributary flows, water quality information, sediment samples, turbidity information, and shipping records for the St. Marys River and Lake Superior. In addition, the following datasets were collected specifically by the study team: current measurements throughout the water column adjacent to the intake, surface and composite water samples, sediment samples from the lakebed and local tributaries, and stream flow measurements from five local tributaries.

The Gros Cap intake is located at the south-eastern limits of Whitefish Bay, where the Canadian and US shorelines converge to form the St. Marys River. The lakebed substrate is predominately boulders, cobbles and gravel. Due to the absences of consolidated glacial sediments in this region, measured turbidity at the intake is very low, especially when compared to common readings at intakes on the lower Great Lakes.

Since the St. Marys River is the outlet of Lake Superior, the predominate flow direction is from the west to the east. However, the ADCP current data collected at the intake identified complex flow patterns that cannot be easily generalized. Wind generated waves and currents from both the northwest and southeast have the potential to impact the intake. These currents and the potential impacts on the IPZ-2 delineation will be investigated in **Phase 2**.

Raw water quality at the intake was characterized with data from a variety of sources, including: 1) information from the water treatment plant, 2) four composite surface water samples, and 3) three surface water grab samples from the tributaries flowing into the preliminary IPZ-2. The raw source water samples (untreated) met most of the Ontario Drinking Water Standards, which are intended for treated drinking water. These results suggest the raw source water is very high quality. The only health related exceedance for the untreated samples was for microbiological parameters, which are addressed in the treatment process.

Sediment quality within the preliminary IPZ-2 was compared to the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life and the Ontario Sediment Quality Guidelines. With the exception of one sample collected along the shoreline at Gros Cap, no parameters were detected at concentrations that exceeded the Canadian or Ontario guidelines. The shoreline sample at Gros Cap was approximately 830 m from the intake structure.

An IPZ-1 with a 1 km radius was delineated around the Gros Cap intake. Refer to Figure II. Given the close proximity of this region to the actual water intake, it is considered the most vulnerable region for contaminants to negatively impact the source water. The IPZ-2 acts as a secondary protective zone around the intake and the geographic limits of this zone are related to the plant operators ability to respond to an adverse spill, and travel time for contaminants in the lake and local tributaries. A 3-hour response time was selected based on the operators survey (Appendix B). Since the computer modeling of local currents is not yet complete, a preliminary IPZ-2 with a 5 km radius has been established around the intake. This preliminary IPZ-2 will be refined in **Phase 2** of the study.

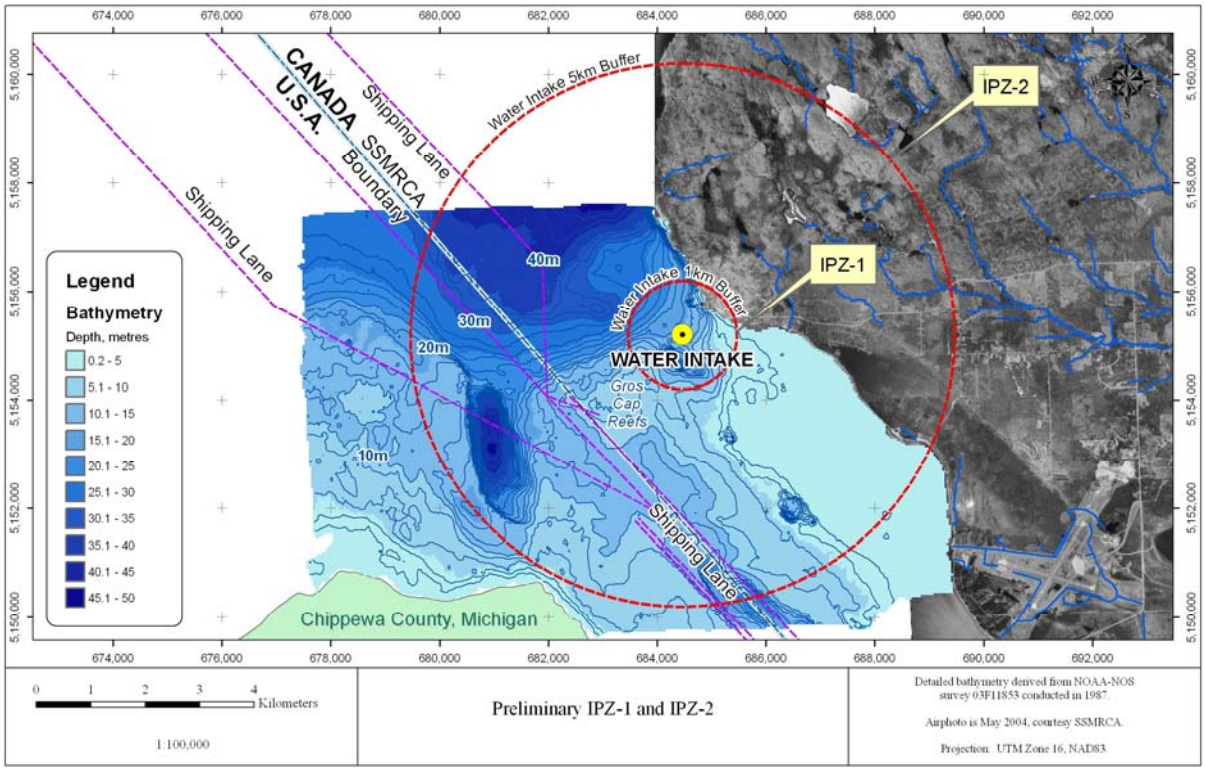

Figure II IPZ-1 and Preliminary IPZ-2

The suggested MOE methodology to assess intake vulnerability to contaminants was applied at Gros Cap. The vulnerability score is the product of two variables: 1) zone vulnerability factor and 2) source vulnerability modifying factor. A score is assigned to each IPZ. The IPZ-1 received a score of 5, while the IPZ-2 was assigned a score of 4, indicating this is a low vulnerability intake.

The level of uncertainty associated with the delineation of the intake protect zones and developing the vulnerability score was also assessed. For the 1 km IPZ-1, the level of uncertainty is low for the IPZ delineation and high for the vulnerability score, resulting in an overall uncertainty rating of high. For the preliminary IPZ-2, the uncertainty in the delineation of the zone is high, since the numerical modeling has not yet been completed. The level of uncertainty in the vulnerability score is also high as input from the client is required before this can be finalized. The overall uncertainty rating is high.

The following data and knowledge gaps have been identified at the completion of the Phase 1 study:

- Additional sediment and water testing at/near the shoreline of the intake for SVOC and microbial contaminants;
- Stream discharge data in close proximity to the intake is not available for the assessment of factors causing turbidity, however, existing turbidity levels are very low; and
- 3D hydrodynamic modeling to define local currents and IPZ-2 (planned for Phase 2).

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1.0 INTRODUCTION

1.1 Background

The Clean Water Act received Royal Assent on October 19, 2006. It ensures communities are able to protect their municipal drinking water supplies through developing collaborative, locally driven, science-based protection plans. The Act establishes a framework for the development and implementation of source protection plans across Ontario.

Source protection is a locally driven program that uses scientifically sound methods for assessing risks to drinking water and is an approach to decision-making that emphasizes information sharing, consultation and involvement by interested members in the watershed communities. Under the Act, source protection plans are to be developed on a watershed basis. To facilitate efficient use of resources and coordination of source water protection planning, regulations under the Act classify individual Conservation Authorities into source protection regions. The Act mandates that source protection plans be developed to address threats to all municipal residential drinking-water systems within these source protection regions.

The framework for source protection, as set out in the Act, requires the development of a watershed based assessment report. This assessment report includes a watershed characterization, a water budget, municipal long term water supply strategies (aligned with municipal residential systems), a groundwater and surface water vulnerability analysis, a threats assessment and issues evaluation, and a risk assessment for water quality and quantity. Once the assessment reports are complete and risks to drinking water have been identified, source protection will focus on the development of the source protection plan. This plan is to set out locally based management measures to reduce or eliminate significant risks to drinking-water supplies, and set out a strategy to implement these measures.

The Sault Ste. Marie Region Conservation Authority (SSMRCA) in partnership with The Corporation of the City of Sault Ste. Marie (CSSM) and Public Utilities Commission (PUC) selected Baird & Associates (Baird) and our partners Conestoga Rogers and Associates (CRA) to undertake source water protection studies for the municipal intake at Gros Cap. Refer to Figure 1.1 for a map of the region noting the intake location.

1.2 Scope of Work

The primary purpose of the vulnerability analysis is to delineate the Intake Protection Zones (IPZ) around the drinking water intake and assign vulnerability scores that reflect the comparative likelihood of a contaminant reaching the intake. This information will ultimately feed into the Assessment Report –Vulnerability: Surface Water Intake Protection Zones, where vulnerable areas will be ranked based on the threat to drinking water.

The general approach used on this project is based on the methodology outlined below with specific tasks included:

- Data collection and analysis;
- Intake classification including characterization;
- Definition of current regime;
- ADCP current data collection;
- Water quality sampling and analysis;
- Sediment sampling and analysis;
- Calculation of flow velocities and travel times for water courses;
- Preliminary delineation of IPZ; and
- Reporting.

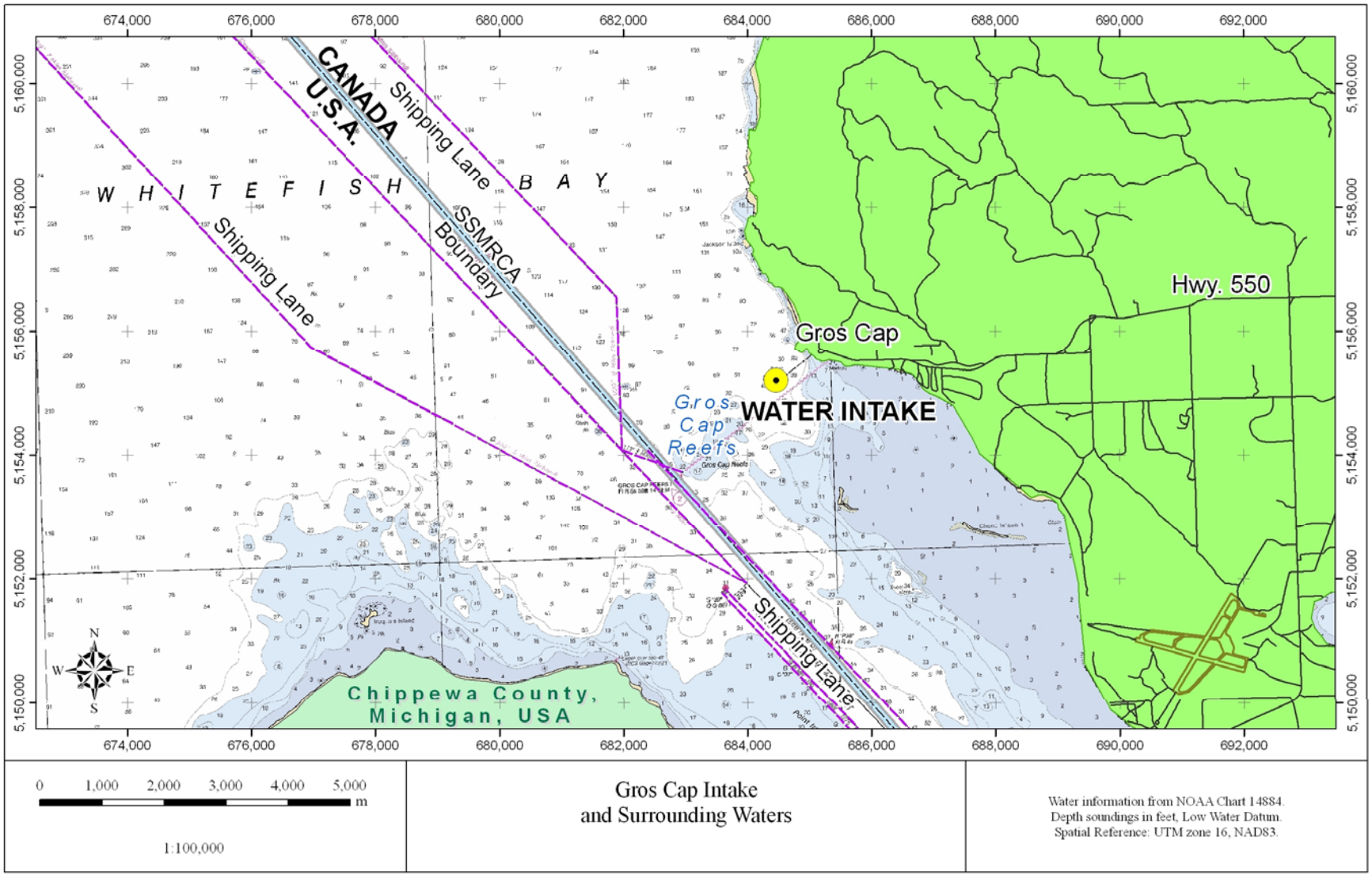

Figure 1.1 Gros Cap Intake and Surrounding Waters

2.0 DATA COLLECTION AND ANALYSIS

2.1 Bathymetry

Canadian and US sources for bathymetric data covering the study area were reviewed. The only Canadian data available was a 1987 field sheet at 1:50,000 scale. A total of four surveys were available from the US National Ocean Service. Three were selected for use in this study, as summarized in Table 2.1 below.

Table 2.1
Summary of Bathymetry Data in Study Area

Title	Field Sheet/ Survey ID	NGDC ID	Year	# Data Points
Whitefish Bay	L2028	03L11141	1958	2,788
St. Mary's River (upper)	H10246	03F11853	1987	26,235
St. Mary's River (lower)	H10194	03F11780	1985	20,985
NOAA Nautical Chart	14844	N/a	Unknown	62

A total of 62 additional soundings were extracted from the NOAA nautical chart to provide data in two areas without coverage. Figure 2.1 provides an overview map of the various bathymetry data sets used in the study.

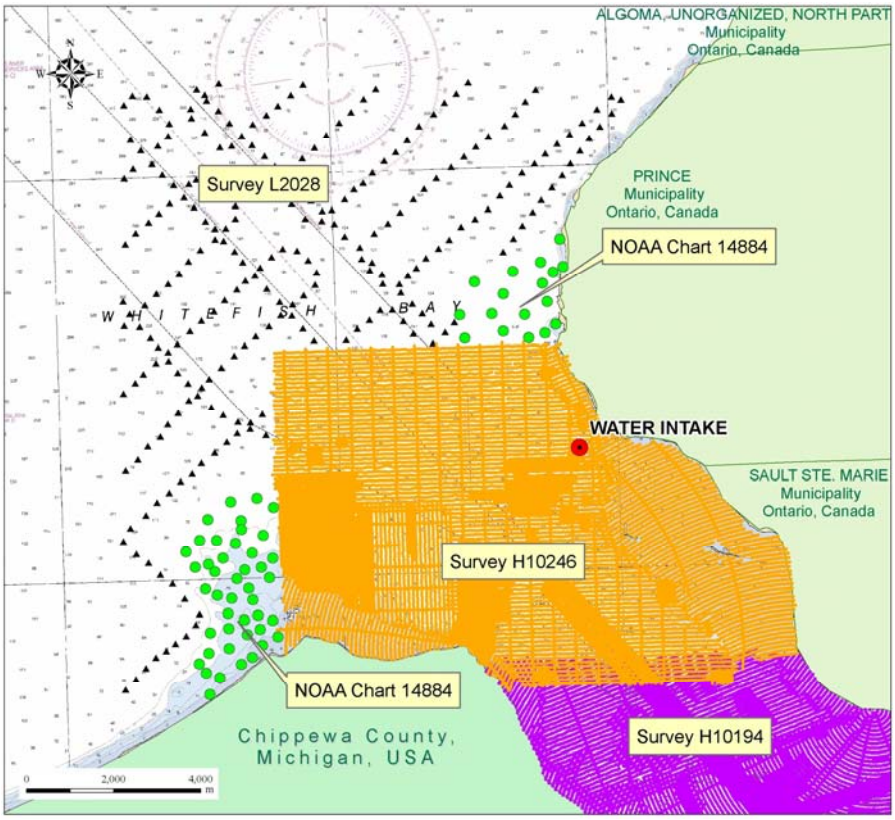

Figure 2.1 Bathymetric Survey Data used in the Study

2.2 Wind

Wind data were obtained from the Lake Superior Operational Forecast System (LSOFS), which utilizes the Princeton Ocean Model (POM) to generate nowcast and forecast winds for Lake Superior and the St. Marys River. LSOFS was developed and is maintained by the U.S. National Oceanic and Atmospheric Administration (NOAA).

The POM wind data is generated from many meteorological stations located around the lake, in Canada and the United States. Values are interpolated for the model domain; secondary influences such as water temperature are also included. Output from the LSOFS showing wind velocity vectors for a sample time step is provided in Figure 2.2. Hourly data were used as input to the model for the Phase 2 work.

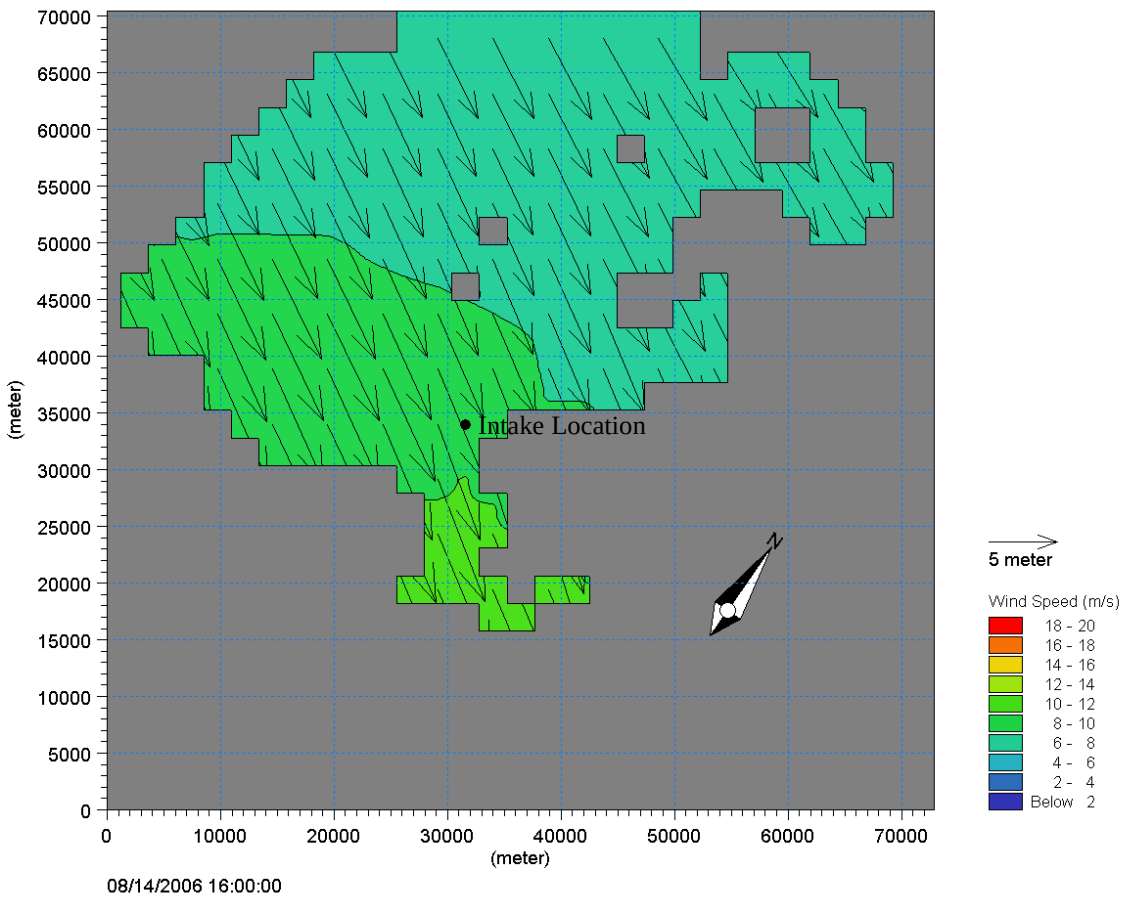

Figure 2.2 Example of Wind Vectors on Lake Superior from LSOFS Model

Wind data in the immediate vicinity of the intake were extracted from the LSOFS for the numerical modeling undertaken in Phase 2.

Wind data were also collected from the Sault Ste. Marie Airport for the period 1971 to 2007 to confirm the POM wind vectors (speed and direction) are suitable for the study. Figure 2.3 summarizes a time series comparison between the LSOFS wind speeds and the recorded data at the Sault Ste. Marie Airport for the period August 8 to 20, 2006. In general, the POM winds compare

well to the recorded data at the Sault Ste. Marie Airport, as the wind speeds are similar for the two datasets and the overall trend is reproduced (highs and lows).

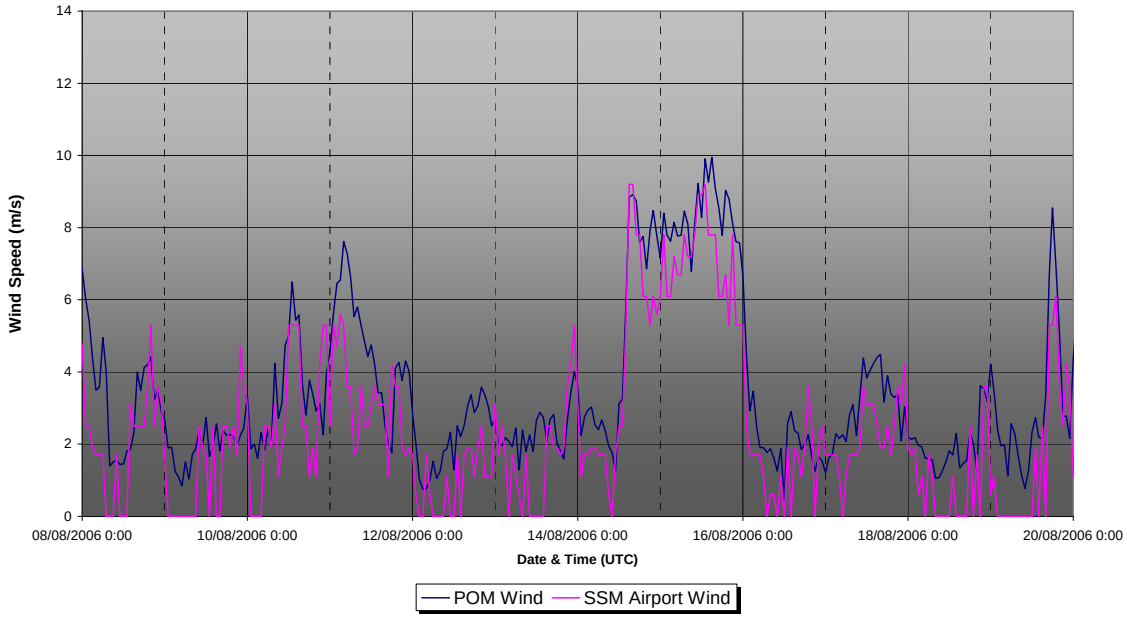

Figure 2.3 Time Series Comparison of Wind Speed for the LSOFS/POM (blue) and SSM Airport (pink)

The POM wind direction is compared to the airport winds for the same temporal period in Figure 2.4. In general, the comparison is reasonable, especially considering the lakewide POM will have difficulty reproducing the exact wind fields at the airport due to the local topographic effects and the overall geometry of the lake in this region.

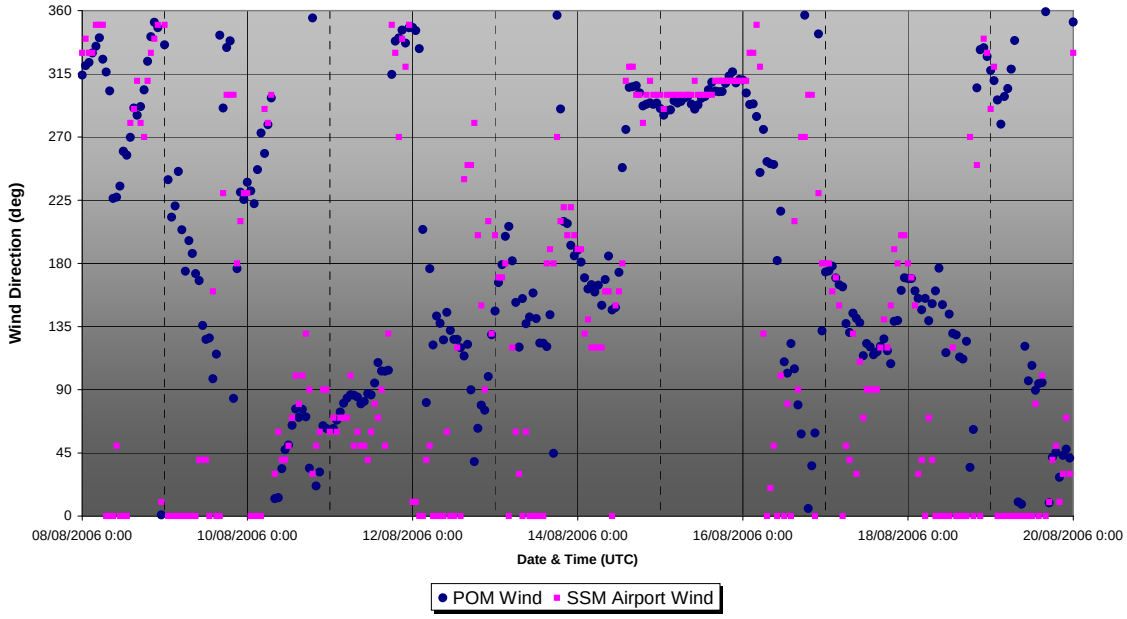

Figure 2.4 Time Series Comparison of Wind Direction for the LSOFS/POM (blue) and SSM Airport (pink)

2.3 Currents

Modeled time series current data were obtained from the LSOFS model. These data were used to define the boundary conditions for the modeling undertaken in Phase 2. The LSOFS model includes the entire Lake Superior. The model grid is too coarse to define the currents in the vicinity of the intake, and the model does not extend to shore.

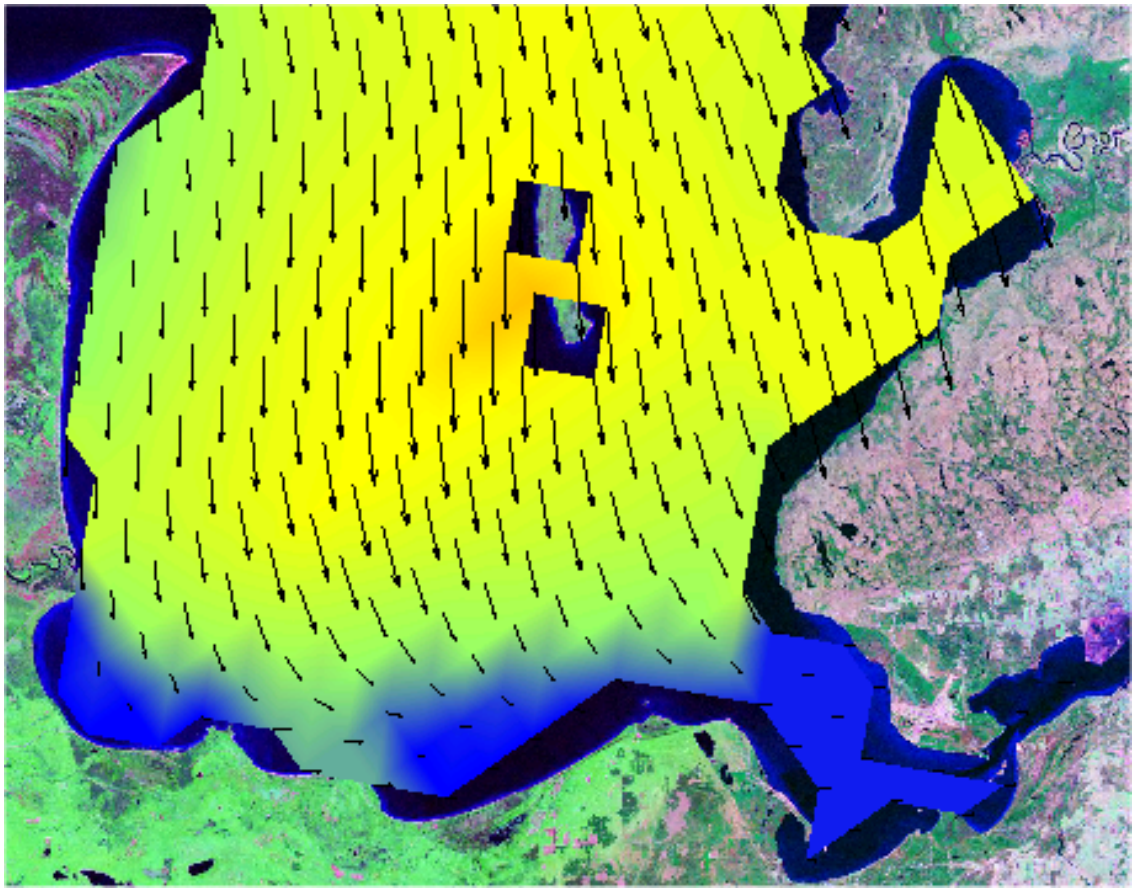

Figure 2.5 Current Data from the LSOFS Model (arrow size relative to velocity)

2.4 Tributary Flow

The closest gauged river to Gros Cap is the Goulais River, which is located approximately 20 km north of the intake (see Figure 2.6). The river drains into Goulais Bay, which is connected to Whitefish Bay. The actual river gauge is approximately 30 km upstream of the river mouth. Unfortunately, the smaller local tributaries, such as the Prince or Jackson Creek, are not presently gauged.

Figure 2.6 Location of the Goulais River and Gauge Relative to Gros Cap Intake

A sample of the flow data from the Goulais River gauge is plotted in Figure 2.7. Winter and summer flows are generally less than 10 m^3/s. The peak in May 2006 is related to the spring melt, while the peaks in the fall of 2006 are related to higher precipitation levels.

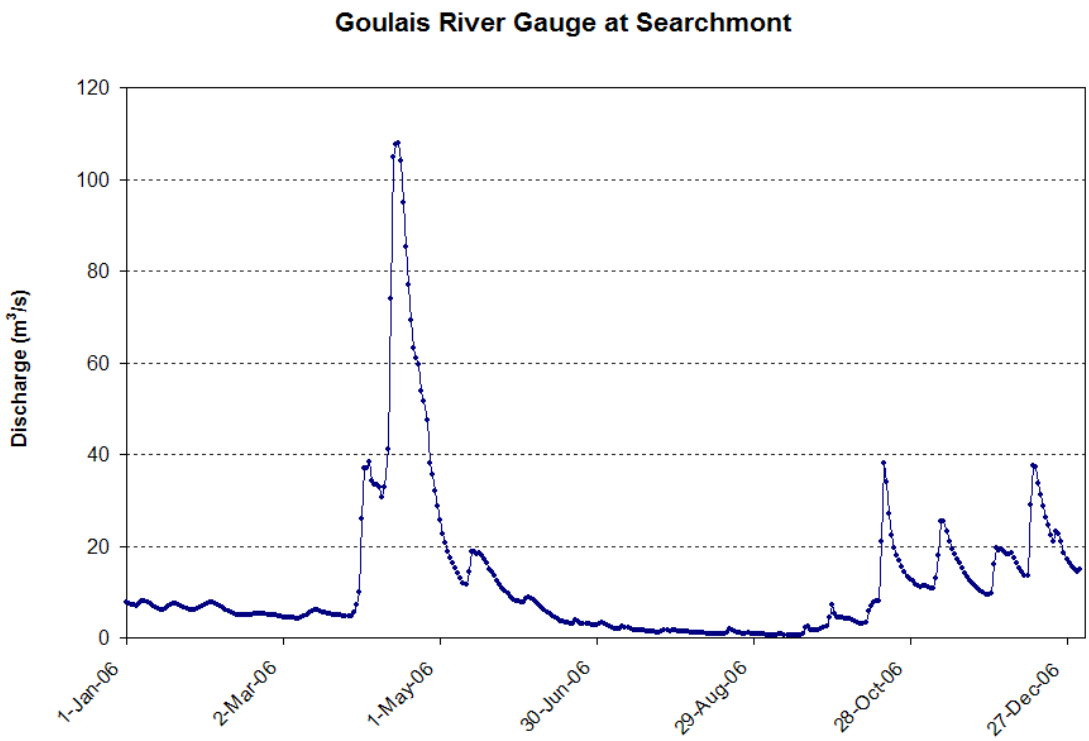

Figure 2.7 Sample of Flow Data from the Goulais River Gauge

2.5 Water Quality Data

Existing raw water quality data collected in the vicinity of the water intake was reviewed. Data sets from Lake Superior were reviewed for the presence of trends and potential drinking water threats. The following data sets were reviewed:

1. Ontario Drinking Water Surveillance Program – Collected at the Water Treatment Plant Intake
2. Gros Cap Water Treatment Plant Raw Water Quality – Monitored every 15 minutes at the Gros Cap Pumping Station
3. R/V Lake Guardian – Collects spring and summer surface water samples at various depths at locations throughout Lake Superior. The R/V Lake Guardian is the United States Environmental Protection Agency's (EPA's) self contained research ship. Operated by EPA's Great Lakes National Program Office (GLNPO), the R/V Lake Guardian is used to conduct bi-annual (spring and summer) monitoring surveys throughout the Great Lakes. The vessel is used to collect samples including air, water, sediment, and aquatic plants and animals. Surface water samples are collected at various depths and locations throughout Lake Superior. The closest surface water sampling station is located approximately 65 km northwest of the Gros Cap Intake.

Table 2.2 summarizes the data available from each source including parameters that were reviewed, sample frequency, and years of record. An analysis of the data and discussion is provided in Section 4.6.

Table 2.2
Water Quality Data Overview

Source of Information	Year of Record	Parameters Available (# of parameters)
Ontario Drinking Water Surveillance program	1990 to 2005	• Alkalinity, Turbidity, Temperature • Chlorides, Nitrates, Phosphorus, Sodium • General Chemistry (17) • Bacteriological (2) • Metals (26) • Volatile Organics (26) • Chloromatics (14) • Chlorophenols (6) • Herbicides and Pesticides (48) • Phenolics (1) • Polynuclear Aromatic Hydrocarbons (PAHs) (17) • Radionucliedes (7)
Gros Cap Raw Water Quality Monitoring	2006	• Temperature • Turbidity
R/V Lake Guardian	1999 to 2005	• Temperature, Turbidity, pH, Alkalinity, Conductivity, TKN • Chlorophyll a, Chlorophyll fluorescence • Ammonia, Nitrate +Nitrite • Chloride • Dissolved Oxygen • Silica, Phosphorus (total and dissolved)

2.6 Sediment Sampling

Existing sediment quality data for the St. Marys River, available within the St. Marys River Remedial Action Plan (MOE, DNR, 1992, 2003) were reviewed. Table 2.3 summarizes the sediment data available within the Remedial Action Plan (RAP).

Limited sediment quality information was obtained from the RAP. The data contained within the RAP Stage 1 is over 20 years old and the reproduction quality of the tables is very poor and difficult to read. The RAP Stage 2 does not include data, but references a sediment survey conducted by the Ontario Ministry of the Environment (1992) and contains a narrative description of various sites where sediment analytical results exceeded the Provincial Sediment Quality Guidelines (PSQGs).

The RAP Stages 1 and 2 list various Sites identified as sources of contaminated sediments within the St. Marys River including:

- Point aux Pins Bay;
- Algoma Steel Slip and Slag Dump;
- Bellevue Park Marina;
- Cannelton Industries (Michigan);
- East End Pollution Control Plant;
- Bells Point;
- Lake George;
- Little Lake George;
- Squirrel Island;
- Ojibway Trailer Park Beach;
- Lake Nicolet (Michigan); and
- Sault Ste. Marie (Michigan).

All of the above noted sites are located at least 5 km downstream of the Gros Cap intake. No data was provided for sediment within the vicinity or upstream of the Gros Cap intake.

Table 2.3
Sediment Quality Data Overview

Source of Information	Year of Record	Parameters Available (# of parameters)
St. Marys River RAP Stage 1	1985	• Grain Size • Metals (8-10) • PCBs, Oils, Phenol, Cyanide • Ammonia, TKN, Phosphorus • Volatile Solids • Silica, Phosphorus (total and dissolved)
St. Marys River RAP Stage 2	1992	• Narrative description of prioritized contaminated sites

2.7 Turbidity Data

Turbidity is used as an indicator to identify elevated levels of suspended sediment and potential sources of contaminants at the intake. It is our experience that high turbidity at intakes in the Great Lakes can generally be explained by a combination of one or more of the following factors:

- Local re-suspension and or lakebed erosion of sediment by wave generated orbital velocities, breaking waves, and to a lesser extent longshore currents;
- Lake water with high turbidity levels can result when regional re-suspension of sediment occurs and transported to the intake through large scale circulation patterns; and
- Suspended sediment transported to the littoral zone in river plumes, particularly during peak flow events.

A preliminary analysis was undertaken to better understand the turbidity levels at Gros Cap and the conditions that may lead to elevated concentrations. Daily turbidity data were obtained for the Gros Cap water treatment plant (WTP) intake covering 2006 and part of 2007.

The turbidity data were analyzed with the wind data described in Section 2.2 and the flow data described in Section 2.4, to determine if there was correlation between wind events, river flow and turbidity at the intake. The results of the analysis are discussed below.

Daily raw turbidity data for the Gros Cap intake were provided for the period July 2006 to August 2007. The maximum turbidity recorded during that period was only 3.14 NTU with an average turbidity level of 0.54 NTU over the 14 month record. The peak recorded level of 3.14 NTU is much lower than typical conditions for Great Lakes intakes, particularly those located on the lower lakes that feature a much higher percentage of consolidated glacial sediment, such as lacustrine clay or glacial till.

As discussed in Section 2.4, the closest gauged river to Gros Cap is the Goulais River, which is located approximately 20 km north of the intake. Based on typical rivers in the Great Lakes Watershed, this is generally too far for river discharge to have a significant effect on the turbidity levels at the intake. However, since the Goulais River is the closet gauged river, the flow was used to evaluate how local tributary flows closer to the intake may impact turbidity levels. Wind data from the nearby Sault St. Marie Airport for the period January 2006 to September 2007 was also used for the analysis.

Figure 2.8 shows a typical two-week period at the intake in the month of August 2006. Turbidity remains low over a range of wind speeds. Even when the wind speed peaks at 9 m/s from the west northwest, the turbidity levels appear to be unaffected when compared with the levels during the calm periods before and after this event. Clearly wind speeds of this magnitude do not generate local currents sufficient to transport sediment to the intake. The lakebed is gravel and rock, so re-suspension of lakebed sediments at the intake is not an issue. The deep water at the intake may also protect it from events that only generate high turbidity near the surface of the water column.

On October 29th and 30th, 2006 wind speeds spiked near 12 m/s for a twelve hour period. The wind direction was from the west-northwest for close to 36 hours. Based on the elevated turbidity levels at the intake, it appears that wind events which feature these speed and direction components can result in elevated levels of turbidity at the intake (see Figure 2.9). However, turbidity levels were still very low compared with typical values at other intakes in the Province. Earlier in the month (October 18th), discharge on the Goulais River peaked at close to 40 m^3/s. If local tributaries also exhibited peak flows at this time, it appears these flows did not affect intake turbidity. It is also possible that the local tributaries at Gros Cap were not affected by the same climatic conditions as the Goulais River and thus did not peak during this same period.

Figure 2.10 plots the time series data for a second elevated flow on Thursday December 14th, 2006. Discharge at the Goulais River was again close to 40 m^3/s and no significant increase in recorded

turbidity at the Gros Cap intake was documented. Again, either peak flows in the local tributaries doesn't affect turbidity levels or the local tributaries didn't peak.

Figure 2.11 plots the January 2007 turbidity data along with recorded wind speed and direction. On January 19, 2007 wind speeds peaked near 12 m/s, which is a similar order of magnitude to the conditions observed in August 2006. The antecedent wind direction prior to the January 19th storm, however, was quite different. Over a 36 hour period, the wind direction swung from south to west and then north. Therefore, the potential for this storm to suspect bottom sediments and transport them alongshore towards the intake would be significantly less than the August 2006 event. Consequently, the January 19th wind event had no measurable impact on the measured levels of turbidity at the intake. It is also possible that Whitefish Bay and the St. Marys River were ice covered during this period and thus the flows and currents were not impacted by wind speed.

In conclusion, the overall turbidity levels are generally very low at Gros Cap when compared to other water intakes in the Great Lakes Region. From the data analyzed, it is possible that sustained strong winds from the west to north-west direction can cause a slight increase in turbidity levels at the intake (e.g. 2.5 NTU for the Oct. 29, 2006 event). Based on the assumption that the flows from the Goulais River can be used as a proxy for the local tributaries, such as Prince or Jackson Creek, higher than normal discharge from nearby tributaries does not appear to have any visible effect on the turbidity levels, likely due to the small size of these watersheds. Locally, the stony composition of the lake bottom minimizes the potential for particle re-suspension by local currents and thus elevated turbidity levels at the intake.

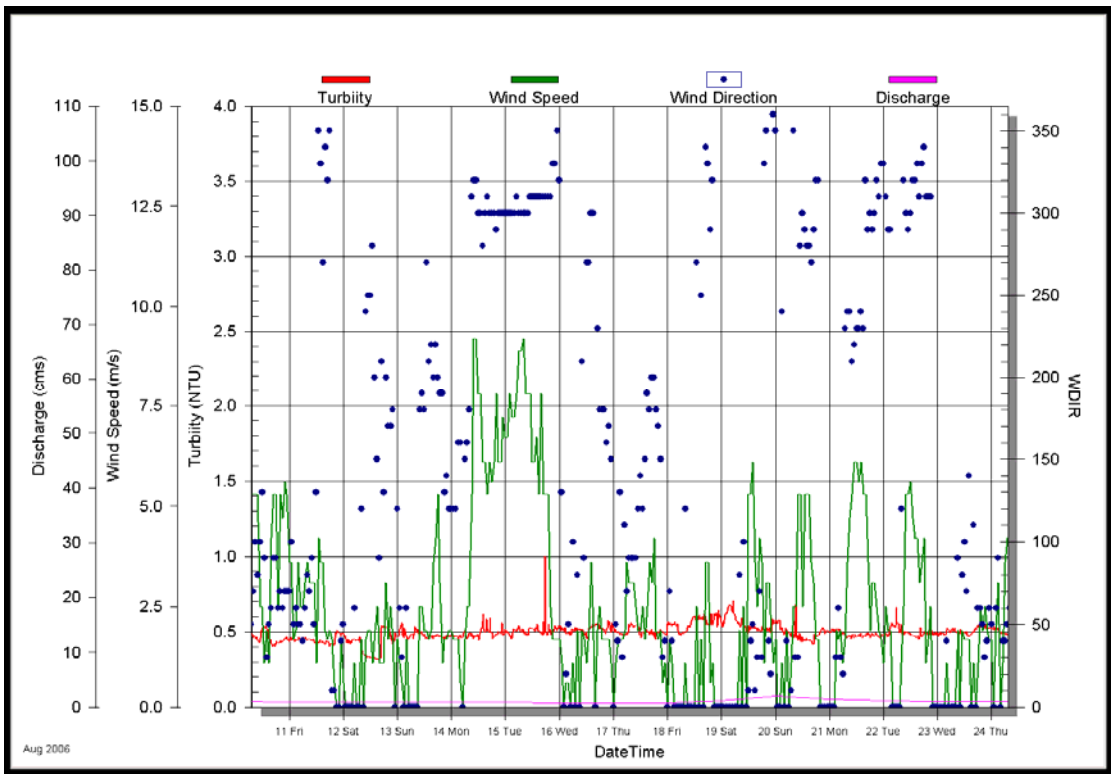

Figure 2.8 Time Series Turbidity, Wind Data and River Discharge for August 2006

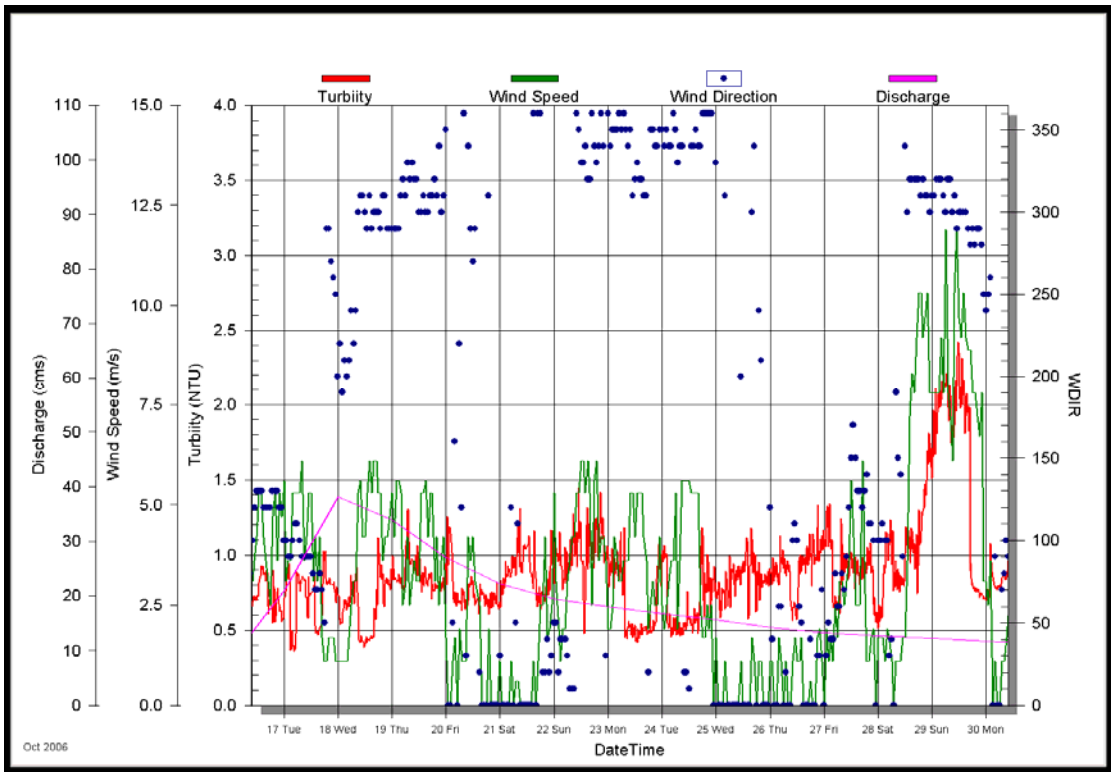

Figure 2.9 Time Series Turbidity, Wind Data and River Discharge for October 2006

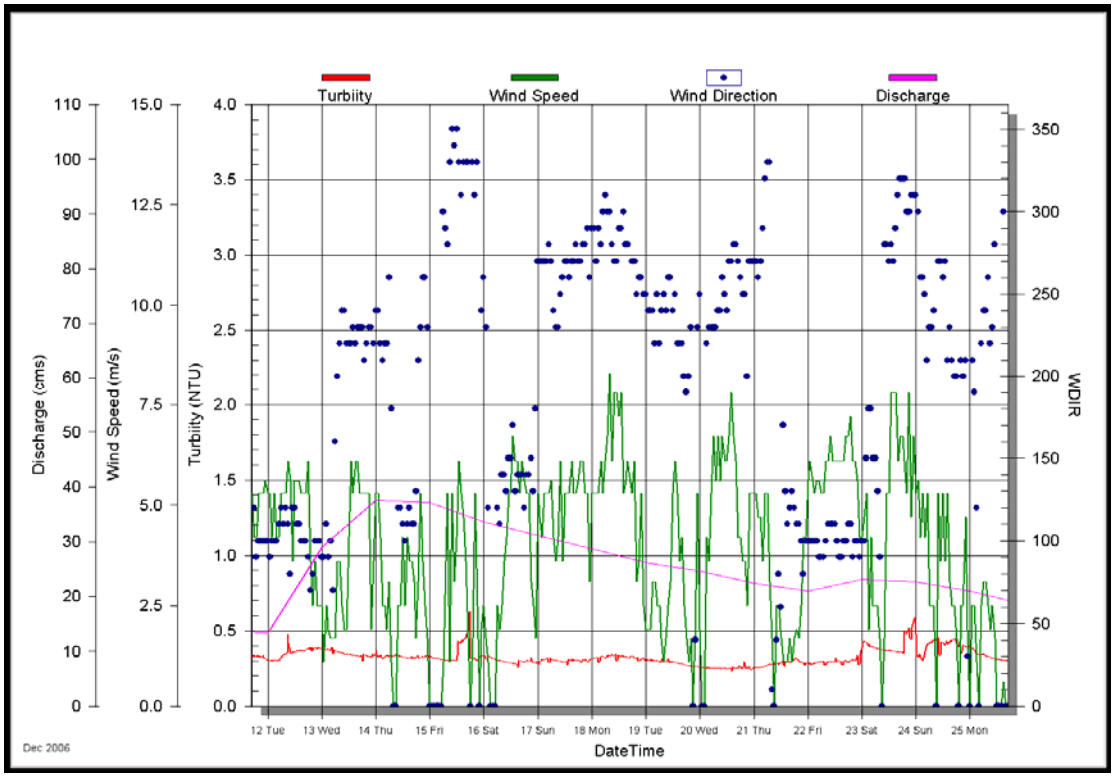

Figure 2.10 Time Series Turbidity, Wind Data and River Discharge for December 2006

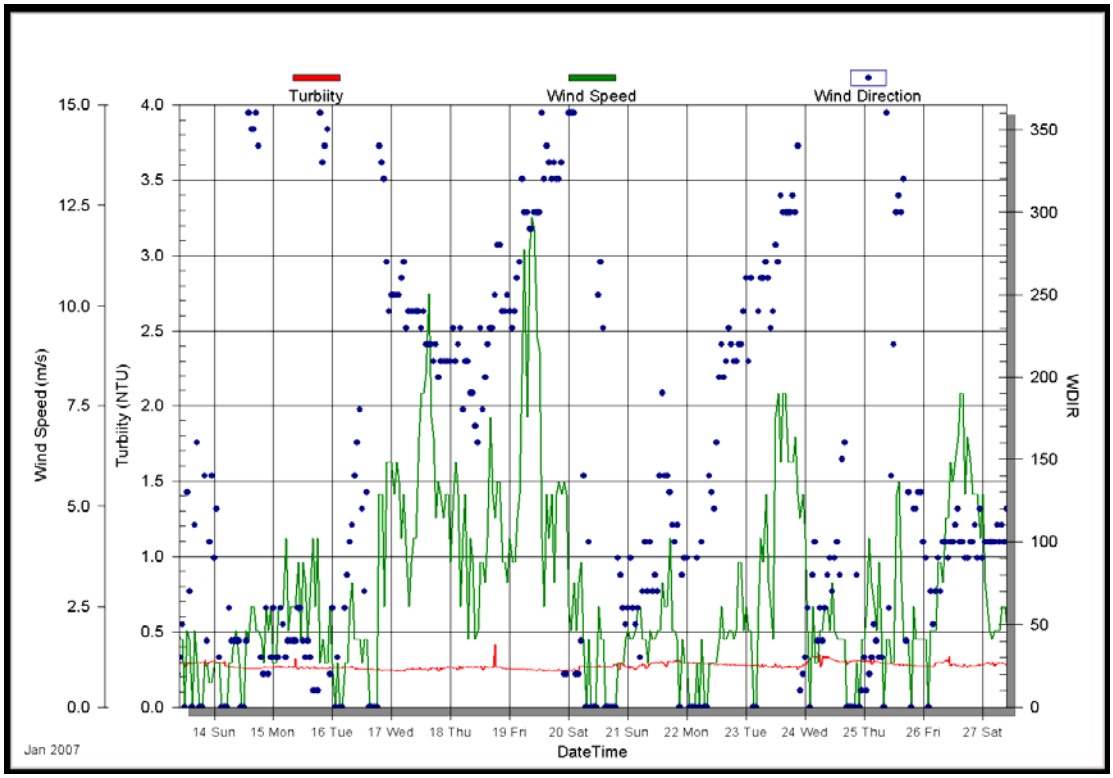

Figure 2.11 Time Series Turbidity, Wind Data and River Discharge for January 2007

2.8 Shipping Data

The St. Marys River is a key link for transport in the Great Lakes. The shipping channel, shown on Figure 1.1, is located within IPZ -2 passing approximately two kilometres southwest of the Gros Cap intake at its closest point and three kilometres northwest (upstream) of the intake.

Cargo moved through the shipping channel includes coal, petroleum products (crude, gasoline, fuel oil, etc.), metals and metal ores (iron, steel, manganese), chemicals (fertilizers and sodium hydroxide), grain and other food products, dredge spoils and others.

Based on information provided by the U.S. Army Corps of Engineers, a total of 70 million tons of cargo moved through the American locks in 2006, over half of which was iron ore. Another quarter of the shipping volume was coal/coke. A total volume of 170 thousand tons of petroleum product was shipped through the locks in 2006.

Ship traffic passing to and from the St. Marys River represents a significant potential source of contamination for drinking water at the Gros Cap Intake in the event of a cargo spill or fuel leak. In addition, the wake of passing ships may stir up contaminated sediments

2.9 Sea Lamprey Control Program

Sea lamprey control is carried out to maintain populations of the parasitic fish at a minimum within the Great Lakes. Streams that contain larval sea lamprey are treated on a four to six year frequency to reduce larval population before metamorphosis into the parasitic adult form and migration into the lakes. Lampricide is applied to approximately 175 Great Lakes tributaries.

CRA contacted Mr. Robert Young of the Sea Lamprey Control Centre, based in Sault Ste. Marie, Ontario. According to Mr. Young, in the Sault Ste. Marie area lampricide is applied to the following tributaries that flow into Lake Superior:

- East and West Davignon Creeks;
- Little and Big Carp Rivers;
- Cranberry Creek; and
- Goulais River.

The East and West Davignon Creeks and the Little and Big Carp Rivers all discharge to the St. Marys River downstream of the preliminary IPZ-2. Cranberry Creek and Goulais River are located approximately 20 km upstream of the intake. Mr. Young reported that the lampricide used is non-persistent (half life of 4 days) and degrades under microbial action and sunlight. As such, the application of lampricide in the above tributaries is not considered a potential impact to drinking water quality at the Gros Cap intake.

3.0 FIELD DATA COLLECTION PROGRAM

3.1 Acoustic Doppler Current Profiler

An Acoustic Doppler Current Profiler (ADCP) was deployed to provide data on the local current patterns in the water column near the intake. The data can also be used to calibrate numerical models. A 1 MHz Nortek Aquadopp (with a 90°) ADCP was selected to meet the specified objectives. The Nortek Aquadopp, ready for deployment at Gros Cap, can be seen in Figure 3.1. The Aquadopp uses Acoustic Doppler technology in order to measure current velocity (both magnitude and direction) at various depths throughout the water column.

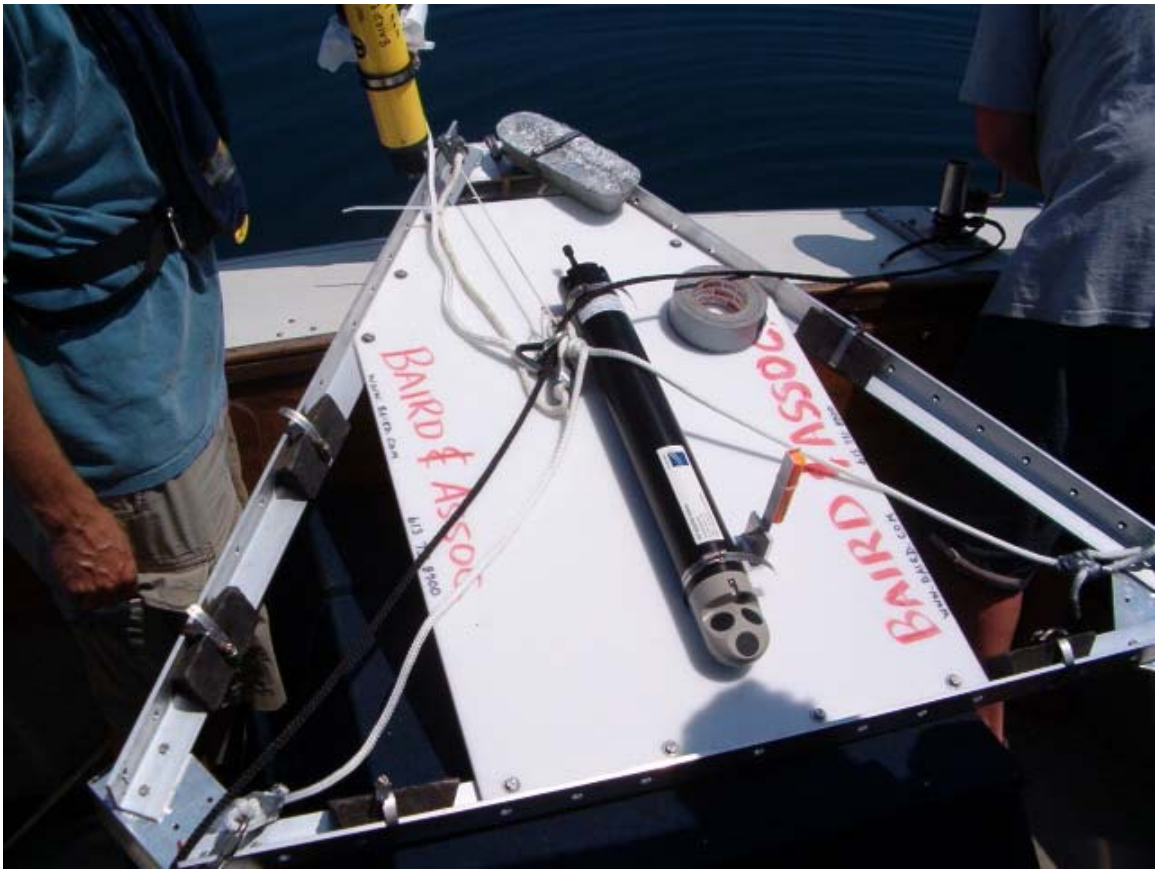

Figure 3.1 ADCP Prior to Deployment

The Aquadopp was mounted on an aluminium frame with a plastic base and attached with hose clamps. Lead weights (approximately 23 kg) were used to increase the overall mass of the deployment. Lead was used in lieu of steel because ferric metals interfere with the compass orientation of the instrument. It is also more dense (heavy) than steel.

A 73 kHz Sonotronics tilt pinger, (the small orange cylinder visible in Figure 3.1), was used to ensure the frame was resting flat on the lakebed. A hydrophone was then used to listen to the pings emitted from the Sonotronics unit. A vertical unit pings at an interval of 1200 ms (every 1.2

seconds), and for every 5° off vertical, the rate of ping drops by 10ms (0.01 seconds). A pinger attached to a perfectly flat base would emit 50 pings in 60 seconds. When tested, the deployed pinger emitted 50 pings in 59.5 seconds, confirming that the base was lying almost perfectly flat. This pinger could also be used to locate the instrument during retrieval.

For retrieval, an InterOcean 111 Acoustic Release, seen in Figure 3.2, was connected to one corner of the frame with a tagline canister containing 75 ft of rope. When signaled remotely from the surface, a buoy attached to the frame by rope, was released to the surface. The rope was then pulled up and the instrument was retrieved.

Figure 3.2 InterOcean 111 Acoustic Release

A string of HOBO temperature gauges was also deployed in order to locate a possible thermocline in the water column. The gauges were fastened to a length of rope, attached to concrete blocks and a Danforth anchor to prevent movement during operation.

The Aquadopp was deployed on July 13, 2006 in the early afternoon. The weather conditions were perfect for a deployment; warm, still water, and very little wind. The location of the Aquadopp deployment is shown in Figure 3.3. The UTM coordinates of the deployment were (684407,5155289), and were determined with a Garmin GPSmap76 unit. The Aquadopp was set to record currents at 1m depth intervals, every 15 minutes.

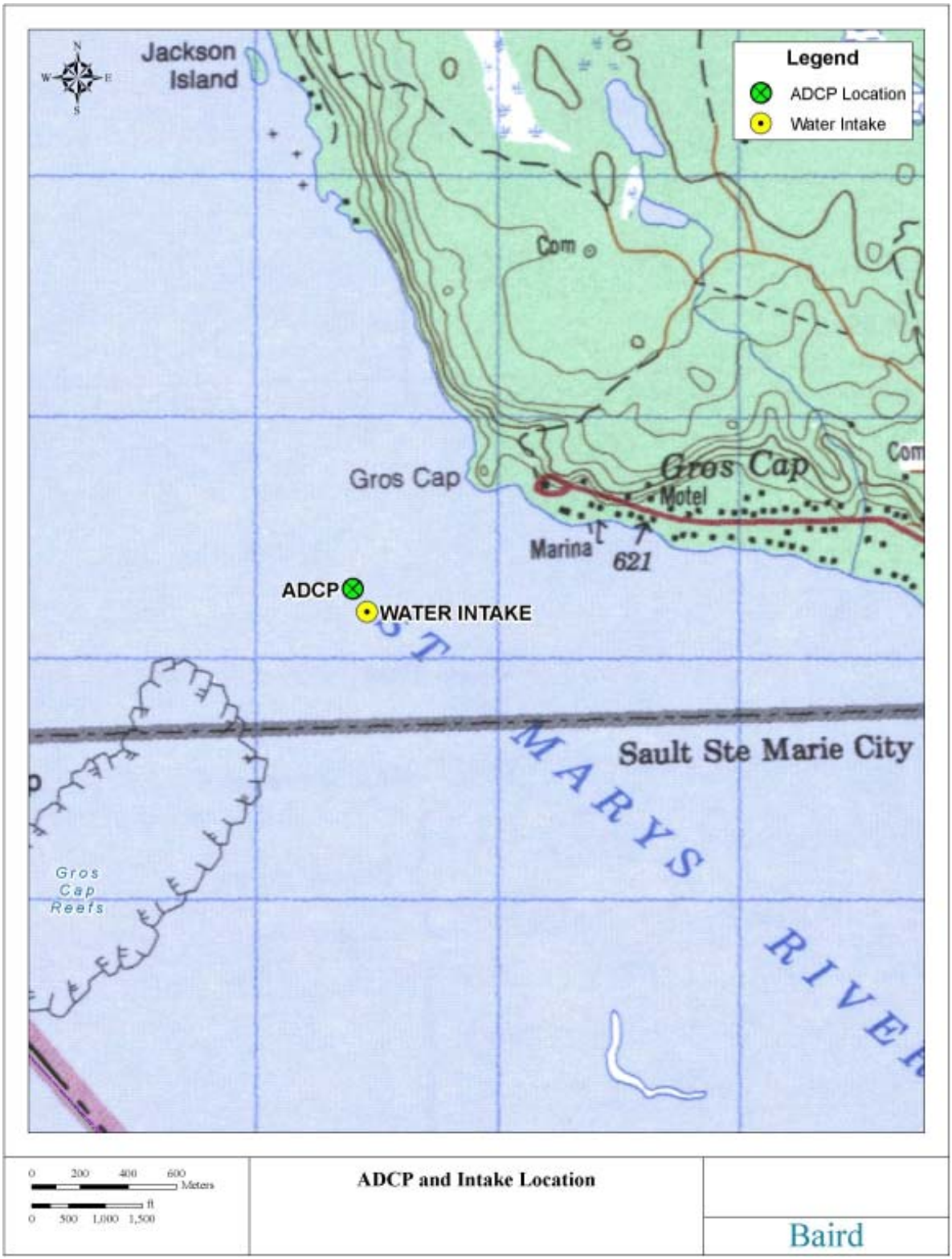

Figure 3.3 Gros Cap Intake Location and ADCP Deployment

The Aquadopp was retrieved on Oct. 15, 2006 at approximately 3:30 P.M. The data were downloaded from the instrument and processed with Nortek Storm 1.06b and Baird in-house software (X-Wave).

A series of rose diagrams summarize the currents at four depths above the lake bottom in Figure 3.4. The rose bins plot the direction the current is moving towards (e.g. north bin indicates the current is moving from the south towards the north). These roses are broken up into both directional and velocity magnitude bins, graphically displaying the percentage of time that currents occur in each bin. It is clear from the results that there is considerable variability in current direction and speed at the various depths. In addition, there is considerable variability in the currents with depth, as represented by the rose diagram for 0.4 m above the lakebed versus the conditions at 11.4 m above the lakebed (near the surface).

It is interesting to note that the rose diagram close to the lakebed (0.4 m) shows currents moving towards the north and south directions, whereas the currents closer to the surface flow from the north to south (rose diagram for 11.4 m from the bottom). These results highlight the value of the ADCP data in capturing the complex local current conditions and the 3D numerical modeling to evaluate the intake protection zones.

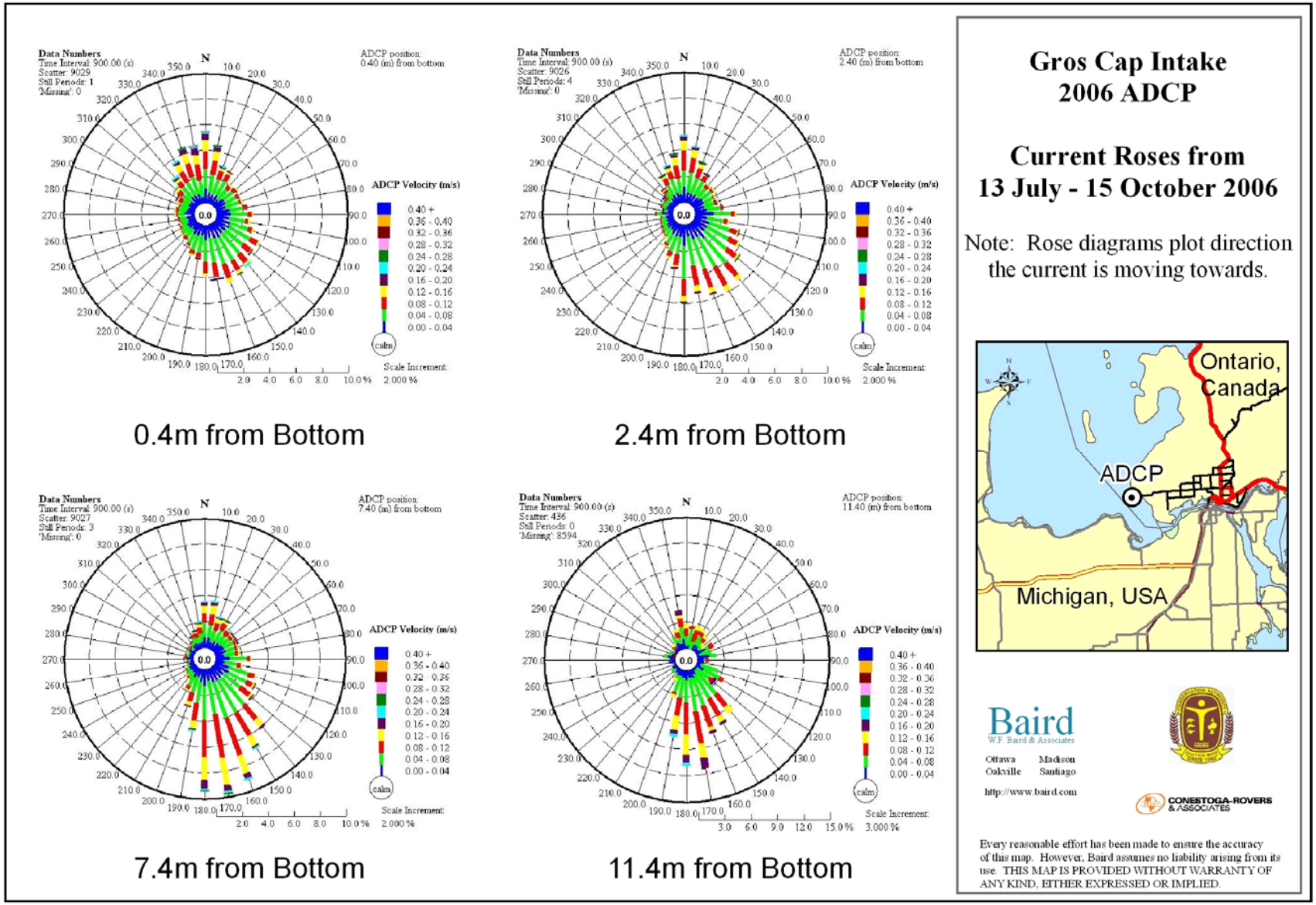

Figure 3.4 Current Roses Summarizing ADCP Data at Four Depths Above the Lakebed (diagrams plot direction current is moving towards)

The current velocities range from 0 to 0.3 m/s. The current directions are generally bi-directional, alternating between North and South. As expected, there is a slight increase in velocity towards the surface of the water column. This is most likely caused by wind shear stress, creating wind-driven currents.

The Aquadopp results will be used to verify the numerical model to be used in Phase 2 of the study. They clearly demonstrates the variability in currents through the water column in the lake and the need for a three dimensional hydrodynamic model to evaluate the IPZ, since two dimensional models use one depth averaged velocity (and direction) to represent currents through the water column.

The data from the HOBO temperature gauges is presented in Figure 3.5. The top gauge, shown in red, was attached to a buoy roughly 2m below the water surface during deployment. The water column shows periods of isothermal activity through the water column for most of the summer. However, the temperature shows signs of stratification towards the end of August and into September. The signal may also represents decreasing temperature with depth for this period.

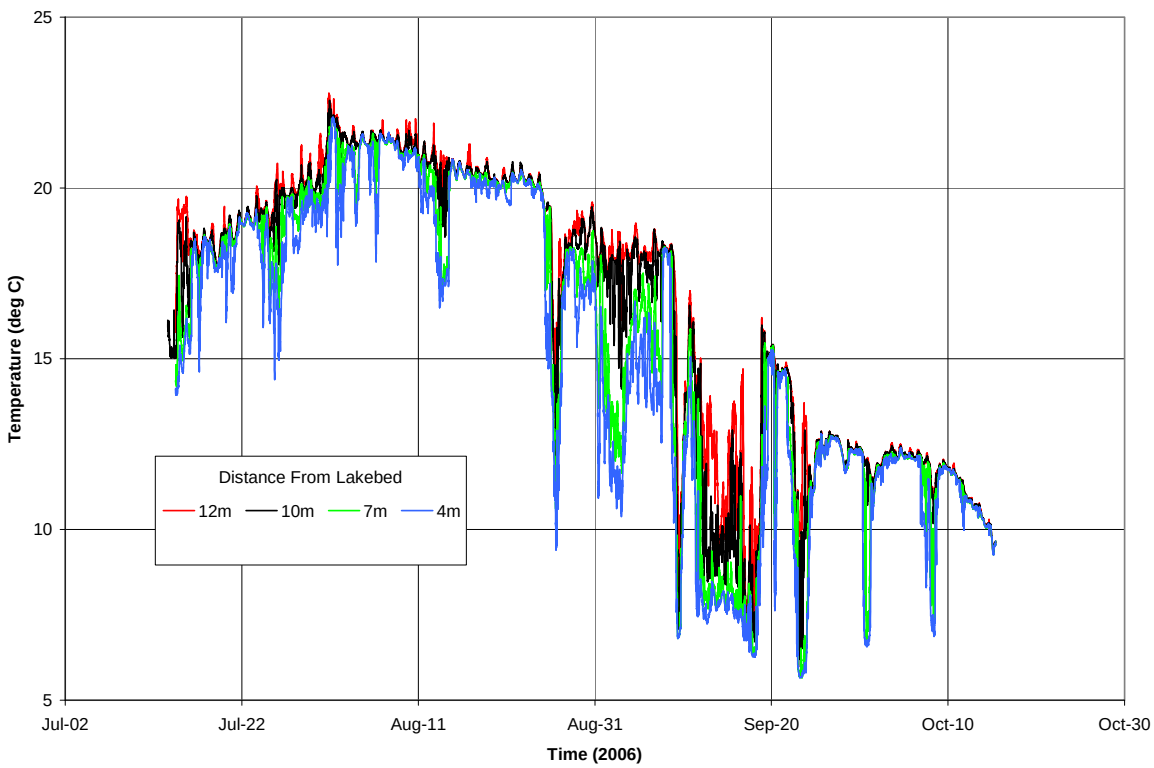

Figure 3.5 Recorded Temperature at Various Depths in the Water Column

A CD-ROM with the raw and processed ADCP time series data is provided in Appendix C.

3.2 Water Quality Sampling

Surface water and composite water column samples were collected in the area surrounding the Gros Cap intake to facilitate raw water characterization. Figure 3.6 a) identifies all sample locations. GPS coordinates for all sampling locations are provided on Table A-1 of Appendix A. The following sections describe the sampling program for Lake Superior and the perennial streams.

3.2.1 Lake Superior

Four surface water sample locations were selected in Lake Superior. Two samples were located at the one kilometre (km) radius surrounding the intake, along the predominant flow path (A04, A06). A third sample (A02) was located 400 m from the intake half-way between the Gros Cap intake and the shore. The fourth sample location (A05) was collected at the one kilometre radius from the intake directly opposite A02. A sample was not collected at the intake location as raw water characterization for the intake is readily available from the Sault Ste. Marie Public Utilities Commission Inc. All sample locations are shown on Figure 3.6a.

On April 28, 2007, composite (integrated) samples were collected from the water column at each of the above mentioned locations. Discrete aliquots of equal volume were collected at depths of 1 m (surface), 5 m, 10 m, and one metre above the sediments using Kemmerer and Van Dorn style sampling devices. Each water volume was added to a large, clean glass bottle, previously rinsed with surface water from that sample location. Following sample collection, the surface water was transferred into laboratory supplied sample bottles. Volatile Organic Compounds (VOCs) samples were collected directly into laboratory supplied sample bottles from the mid depth at each sample location.

Three additional vertical water profiles were collected: one at the Gros Cap intake (A01) and two at locations southeast of the intake along the predominant flow path (A07 and A08). Refer to Figure 3.6a.

Samples were placed in pre-cleaned, laboratory-supplied bottles, and shipped via overnight courier under chain-of-custody to ALS Laboratory Group (ALS) in Waterloo, Ontario for analysis of physical, chemical, and microbial parameters summarized in Tables 1, 2, and 4 of the Ontario Drinking-water Standards (OMNR, 2006). The results of the surface water analysis are summarized in Table A-2 of Appendix A.

GPS co-ordinates were recorded at each sample location as well as the total depth of the water column. Water temperature, pH, conductivity, dissolved oxygen (DO), and turbidity were also recorded at discrete intervals along the vertical water column at each sample station to obtain a vertical water profile consistent with procedures implemented during the St. Marys River Remedial Action Plan (KEC, 2004). Water column characterization results are provided in Table A-3 of Appendix A.

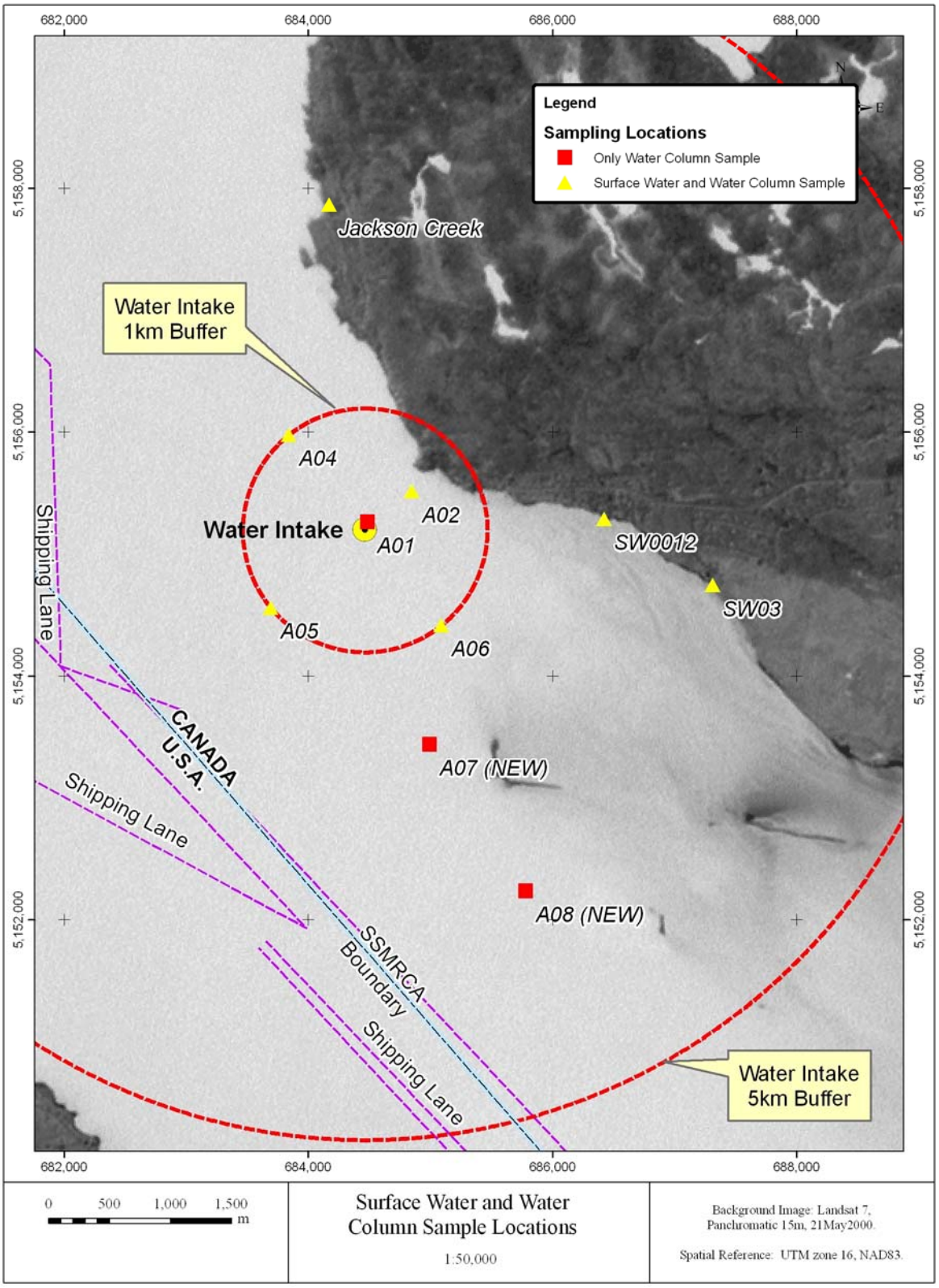

Figure 3.6a Surface Water and Water Column Samples

3.2.2 Perennial Streams

Surface water and water column samples were also retrieved from Jackson Creek, and two of the ephemeral streams (SW0012 and SW03) located within the preliminary IPZ-2 (defined as a 5 km radius around the intake as shown in Figure 3.6a), to determine possible source(s) of contamination. The samples were collected during a 'peak flow' event (collected within 24 hours of a rainfall) on June 9, 2007 to enable the sampling during runoff conditions. Where surface water and sediment were collected at the same location, the water sample was collected first to ensure suspended sediments were not introduced into the water sample. Refer to Figure 3.6a for a map of the sample locations.

Samples were collected directly into pre-cleaned, laboratory-supplied bottles, and shipped via overnight courier under chain-of-custody to ALS in Waterloo, Ontario for analysis of physical, chemical, and microbial parameters included in Tables 1, 2, and 4 of the ODWS (OMNR, 2006), and phenols (excluding dioxins and furans). The results of the laboratory analysis are presented in Tables A-2 and A-3 of Appendix A.

GPS co-ordinates were recorded at each sample location as well as water temperature, pH, conductivity, dissolved oxygen (DO), and turbidity.

3.3 Sediment Sampling

Sediment and substrate characterization on the local lakebed within the probable zone of influence was undertaken as part of this study. To assess the level of sediment contamination within the preliminary IPZ-2, a total of eleven sediment samples were planned for the lakebed and along the shoreline at key areas of potential contamination to the intake (stream tributaries and eroding shoreline). GPS coordinates for all sampling locations are provided on Table A-1 of Appendix A. Refer to Figure 3.6b for a location map.

Based on CRA's experience in the area, and according to the St. Marys River Remedial Action Plan (MOE and DNR, 1992; MOE and DNR, 2003), the majority of the lakebed sediment within five km of the Gros Cap intake consists primarily of gravel or rock. The presence of boulders prohibited the extraction of sediment samples at all but two of the planned lakebed sediment sampling locations. Therefore, the remaining lakebed sediment samples were collected at alternate, strategic locations along the shoreline. The samples were extracted from a region that featured an exposed lakebed due to recent dry weather conditions. These sediments have the greatest potential for re-suspension when water levels rise. The alternate locations are further discussed in Section 3.3.2.

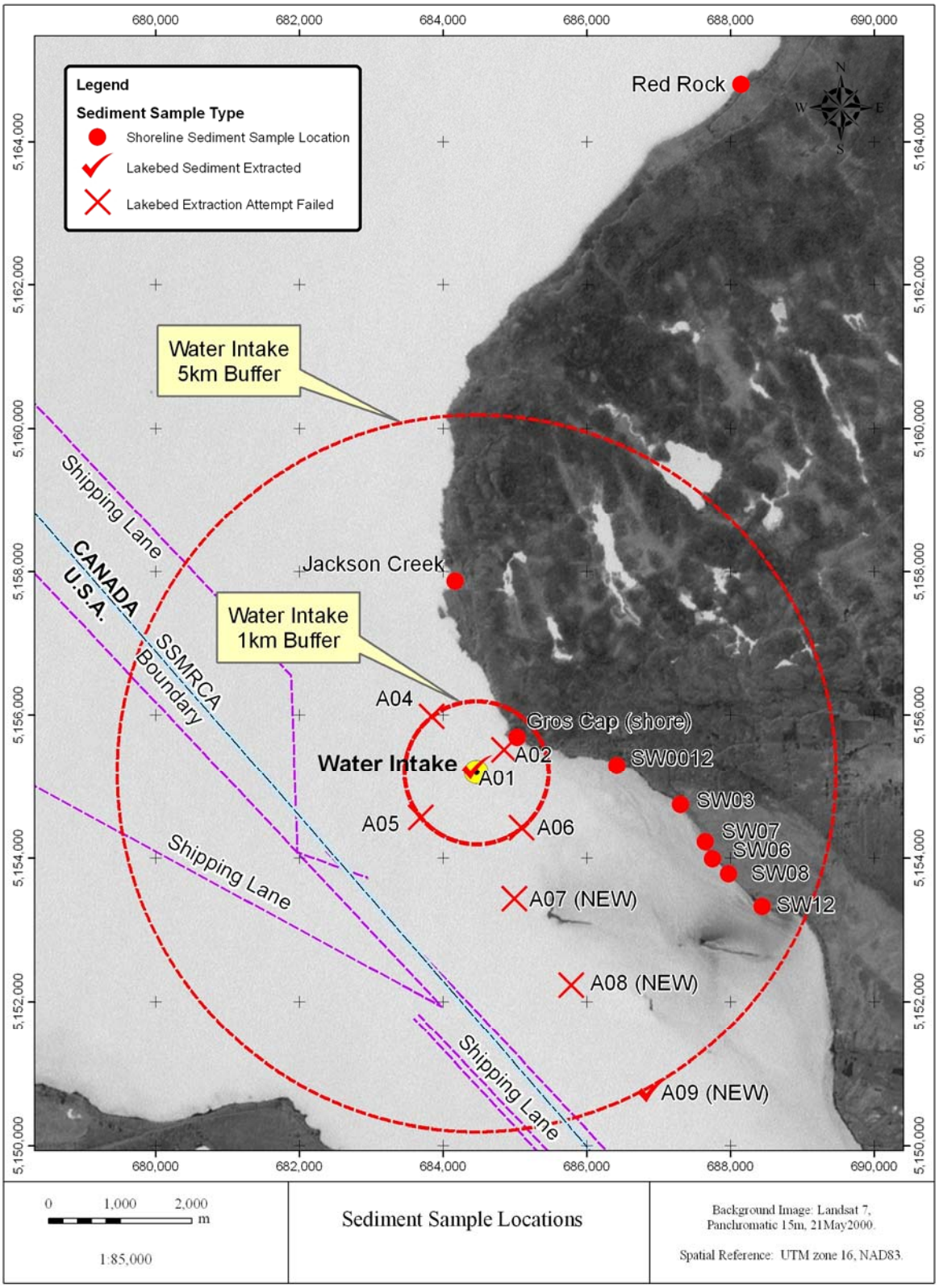

Figure 3.6b Sediment Sample Locations

3.3.1 Lakebed Sediment

On April 28, 2007, two lake bed sediment samples were collected in the area around the Gros Cap intake. One sample was collected approximately one kilometre northwest of the intake (A04). The second sample was collected approximately five kilometres southeast of the intake along the predominant flow path (A09). Attempts were made to collect sediment samples at six other locations around the intake (A01, A02, A05, A06, A07, and A08); however the nature of the bottom sediments (cobbles and boulders) at these locations prevented sample collection. As such, sediment samples were collected at additional locations along the shoreline (Red Rock, Gros Cap shoreline, SW07, SW08, and SW12). Refer to Figure 3.6b for the failed sample locations.

A Ponar sampling device was used to collect the sediment samples from the lakebed surface to approximately 0.15 metres deep. Individual samples were placed in a stainless steel bowl and blended as thoroughly as possible to obtain consistency throughout. Sediments were then transferred into pre-cleaned laboratory supplied sample bottles. Volatile organic compounds (VOC) samples were collected directly into laboratory supplied sample bottles. The samples were shipped under chain-of-custody protocol via overnight courier to ALS in Waterloo, Ontario for analyses of grain size, redox potential, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), total organic content (TOC), Total Kjeldahl Nitrogen(TKN), phosphorus, oil and grease, ammonia, phenols, and metals. Chemical oxygen demand (COD) was not analyzed due to samples being received at the laboratory beyond the recommended holding time. The sampling results are summarized in Tables A-3 and A-4 of Appendix A.

3.3.2 Shoreline Sediment

On June 9, 2007, nine sediment samples were collected along the shoreline within the preliminary IPZ-2, including samples collected at the mouths of the four tributary streams including one perennial stream (Jackson Creek) and three intermittent/ephemeral streams (SW0012, SW03, and SW06). Five additional samples were collected along the shore of Lake Superior (Red Rock, Gros Cap shoreline, SW07, SW08, and SW12). Refer to Figure 3.6b for the locations.

Stainless steel sample spoons were used to collect sediment samples from the shoreline. Individual samples were placed in a stainless steel bowl and blended as thoroughly as possible to obtain consistency throughout. Sediments were then transferred into laboratory supplied sample bottles. VOCs samples were collected directly into laboratory supplied sample bottles.

The samples were shipped under chain-of-custody protocol via overnight courier to ALS in Waterloo, Ontario for analyses of grain size, redox potential, PCBs, PAHs, TOC, TKN, phosphorus, oil and grease, ammonia, phenols, and metals. Chemical oxygen demand (COD) was not analyzed due to samples being received at the laboratory beyond the recommended holding time. The laboratory results are summarized in Table A-4 of Appendix A.

3.4 Water Course Survey

The Gros Cap preliminary intake protection zone (IPZ-2) incorporates all perennial streams that are directly impacting or have the potential to impact the intake. Five streams were identified within the preliminary IPZ-2 discharging into Lake Superior: two perennial (Prince and Jackson Creeks) and three intermittent/ephemeral streams (SW0012, SW03, and SW05). Various drainage ditches

were also identified, which discharge to the preliminary IPZ-2. Locations of these streams are shown on Figure 3.7.

Flow conditions within the identified streams and drainage ditches were assessed on two occasions: one base flow event (Fall 2006) and one 'peak flow' or storm runoff event (Spring 2007). All locations were surveyed during the Fall 2006 event and select locations were re-surveyed during the Spring 2007 event.

Inland watercourse stream flow measurements were performed in accordance with CRA's Standard Operating Procedure (SOP) for surface water flow measurements. Stream flow measurements were taken at various points along each stream.

Flow rates were calculated by determining the flow velocity through a cross-section and then multiplying by the flow area. For shallow cross-sections, the (vertical) average velocity was calculated by the selection of an appropriate grid governed by the stream width and depth. The six-tenths depth method consists of measuring the velocity of 0.6 of the depth from the water surface. It is generally used for shallow flows where the two-point method is not applicable (depths of 0.1 to 0.8 meters or 0.3 to 2.5 feet).

Many of the drainage ditches and both the perennial streams were dry or stagnant during the Summer 2006 event. Calculated base flows ranged from 0.09 to 0.27 m^3/s. Calculated peak flows ranged from 0.04 to 1.98 m^3/s. Calculated flow rates are shown in Appendix A, Table A-6.

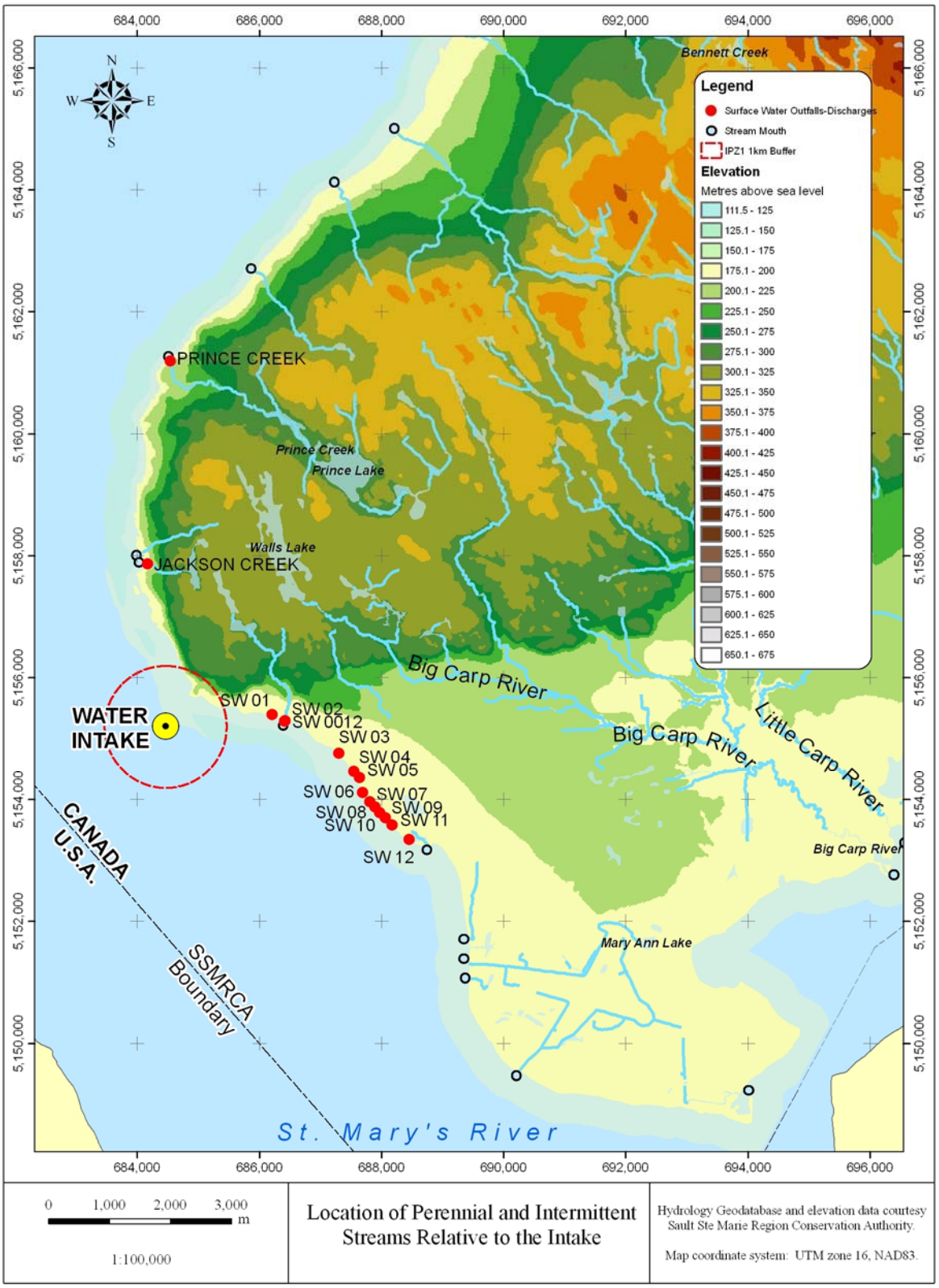

Figure 3.7 Location of Perennial and Intermittent Streams Relative to Intake

4.0 INTAKE CHARACTERIZATION

This section includes the characterization of the Gros Cap intake. Discussed in this section are the intake technical characteristics, information provided by the water treatment plant operator(s), potential contaminant sources within the watershed, hydrologic conditions and hydrodynamics, sediment processes, sediment and substrate characterization, raw water quality, and shoreline development. Bathymetry, regional currents, wind patterns, tributary flow and shipping data are discussed in Section 2.0. Local currents are discussed in Section 3.0.

Local watershed influences in the IPZ are expected to be minimal due to small or non-existent stream flows within the area. The effect of long term and seasonal weather patterns on wave generation within the IPZ-2 will be addressed in the next version of this report.

4.1 Technical Characteristics

The Gros Cap intake is located at the western extent of Highway 550 (known as Second Line within the limits of the City of Sault Ste. Marie). Refer to Figure 1.1 for a study area map. The intake is located in Lake Superior northwest of the inlet to the St. Marys River. Local industry and wastewater treatment plants are located downstream of the intake along the St. Marys River.

The intake is a circular, fibreglass structure that extends approximately 830 metres from the shoreline to a depth of 15 metres below the water surface. The intake's bellmouth is supported by a crib structure with the intake screen openings approximately 1.8 metres above the lakebed. The intake has a diameter of 1.2 metres and a hydraulic capacity of 150,000 cubic metres per day (m^3/d).

According to an inspection of the intake structure performed by Watech Services Inc. in August 2006 (WSI, 2006), the intake structure was in good condition at that time. Watech's report did not recommend any immediate remedial actions over and above the existing annual inspection program.

The raw water pumping station, located on shore, houses twin raw water traveling screens, intake wet wells, and four raw water, fixed speed, vertical, turbine pumps. Station capacity is 695 litres per second (L/s) against a total dynamic head (TDH) of 72 to 90 metres. The facility is equipped with a backup diesel generator.

The raw water transmission main is a buried 0.75 metre diameter main with a maximum hydraulic design capacity of 80,000 m^3/d. The main is in two sections, pumped flow and gravity flow. The pumped flow section is located along Highway 550 between the raw water pumping station and the hydraulic control tanks located approximately 2.5 kilometres east of the pumping station near the intersection of Highway 550 and Marshall Drive. The gravity flow section is located between the control tanks and the water filtration plant located on the south side of Highway 550 (Second Line) and east of Town Line.

The twin hydraulic control tanks (standpipes) consist of two, 14 metre diameter by 14 metre high steel tanks with a maximum water elevation of 236 metres and a base elevation of 225 metres. Together the tanks have a maximum storage volume of 3,393 cubic metres.

4.2 Operator Interview

The PUC is responsible for the operation and maintenance of all aspects of the water treatment and distribution within the municipality of Sault Ste. Marie, including the Gros Cap Surface Water Intake and the associated water filtration plant. On behalf of the Commission, PUC Services Inc. operates the A.S. Boniferro Water Filtration Plant (WTP) located at 2059 Second Line West in Sault Ste. Marie, Ontario.

On November 8, 2006, CRA interviewed Mr. Dan Tonan, Manager Water Treatment Operations for PUC Services Inc. Mr. Tonan provided historical records of raw water quality (chemical and bacteriological) as well as raw water pumping rates, temperature and turbidity measured every 15 minutes on a daily basis in 2006/2007.

In 2006 and 2007 turbidity in raw water ranged from 0 to 3.15 NTU, with an average value of 0.54 NTU. Higher turbidity values are generally observed in October/November on an annual basis, due to build up of debris in the water following defoliation. Raw water temperature ranged from 0.3^{o}C in early spring to 22.6 ^{o}C in mid summer.

Mr. Tonan indicated a low level of concern related to various contaminant groups within raw water including:

- Microbial (coliforms, cryptosporidium, etc.);
- Inorganics (metals, nitrates, etc.);
- VOCs (benzene, TCE, etc.);
- Synthetic organics (PCBs, etc.);
- Pesticides; and
- Radioactive substances.

No taste or odour issues were reported associated with the raw water source (Lake Superior). Wind, ice and/or current are not the cause any issues with respect to the intake or raw water quality.

According to Mr. Tonan, and CRA's assessment, potential contaminant sources within the preliminary IPZ-2 include:

- Urban, highway, and construction runoff;
- Sediment dredging at the Gros Cap Marina and Tannery Bay;
- Residential heating oil spills and septic systems;
- Shipping within the St. Marys River; and
- Discharges from various streams.

Mining, landfilling, and salt storage operations are also located north of the IPZ-2.

The estimated reaction time for the treatment plant to respond to a spill event, from notification to shut down, is approximately two hours. An additional maximum 1 hour is allowed for the MOE Spills Action Centre (SAC) to inform the PUC operator if a spill is called into their centre. A shut-down time of 3 hours is therefore recommended for calculation of the IPZ-2. The operator survey is included in Appendix B.

4.3 Hydrologic Conditions and Hydrodynamics

The bedrock that forms the escarpment north and east of Gros Cap is Precambrian in age (~600 million years old) and is capped with a thin layer of gravel, followed by several metres of coarse sand. This region is known as the Prince Landscape. The southern limit is marked by exposed rock bluffs (PRL, 1982).

Below the Precambrian bluffs the bedrock is sedimentary in origin, consisting of sandstone and limestone deposits (PRL, 1982). The bedrock between the bluffs and shoreline is blanketed in silty/sandy loams for the Algonquin Terrance (which is adjacent to Gros Cap) and fine textured silt soils for the Nipissing Terrace further to the east. At Gros Cap, the surficial rock is quartz-feldspar porphyry (PRL, 1982).

Several streams traverse the Prince Landscape and then bisect the Precambrian bluffs, resulting in very steep gradients until they reach the Algonquin and Nipissing Terraces (e.g. Gros Cap Stream and Big Carp River). These tributaries eventually drain into the lake or river.

The Gros Cap intake is exposed to waves from Whitefish Bay and Lake Superior further to the northwest. As such, during storms from the northwest, large waves from Lake Superior would propagate through Whitefish Bay towards the St. Marys River. Smaller waves could also impact the intake from the southeast. As such, the site can be exposed to very large wave generated currents, especially during storm conditions from the northwest. Smaller events from the southeast are also possible.

Since the St. Marys River is the outlet for Lake Superior, the predominant flow direction in the vicinity of the intake is thought to be from west to east.

4.4 Lakebed and Sediment Processes

The sediment in Whitefish Bay is generally described as fine-grained sand, with the exception of the deep depositional basins, where silts and clays will dominate (PRL, 1982). The lakebed in the vicinity of Gros Cap consists of large rubble and cobble, and gravel deposits. In depths greater than 12 m, a sand-gravel substrate is more common (PRL, 1982).

The intake is located at the transition of a deep basin in Whitefish Bay to more shallow conditions as the Canadian and American shorelines converge at the St. Marys River.

Locations of shoreline erosion were observed during the field work for this investigation. These regions have the potential to contribute new sediment to the littoral zone and further offshore, depending on grain size.

4.5 Shoreline Development

Shoreline development within the preliminary IPZ-2 was determined based on review of aerial photography and mapping, general knowledge of the area and field reconnaissance.

Development documented within 5 km of the Gros Cap intake includes approximately 80 residential homes (camps, cottages) and a marina, which does not include a re-fuelling station. The marina and four of the residences are located within one km of the intake. Many of these

residences are serviced with fuel oil tanks, septic beds and water supply wells (sand point or drilled/dug wells). Given the recent low water levels, very few residences use water lines to supply drinking water directly from Lake Superior.

Shoreline development currently taking place within the preliminary IPZ-2 includes the construction of residential homes and cottages located southeast of the intake along Sunnyside Beach Road. Approximately 40 residential lots are currently under development.

4.6 Raw Water Quality

Raw water quality at the Gros Cap intake was characterized using information available from the water treatment plant as well as four composite surface water samples collected at different circumference intervals around the intake and three surface water grab samples collected from tributaries flowing into IPZ-2. Table 4.1 shows the water analytical results in comparison to the ODWS. The full surface water analytical results are provided in Appendix A (Table A-2).

The ODWS are provided in the *"Technical Support Document for Ontario Drinking-water Standards, objectives, and Guidelines"* Ontario Ministry of the Environment, (2006) made under Ontario Regulation 169/03 (O.Reg. 169/03) of Ontario's Safe Drinking Water Act. The ODWS include Table 1 – Microbiological Standards, Table 2 – Chemical Standards (health related), Table 3 – Radionuclide Standards, and Table 4 – Objectives and Guidelines. These standards, objectives and guidelines are the minimum expected concentrations for treated drinking water.

ODWS Tables 1 through 3 provides concentrations of various parameters for the protection of human health. The aesthetic objectives (AOs) provided in ODWS Table 4 are intended to provide drinking water that is free from objectionable tastes, odours, and colours. Some parameters have an aesthetic objective as well as a health related standard. Operational guidelines (OGs) provide values or ranges of various parameters, which if not maintained will prevent the efficient and effective treatment and distribution of drinking water.

As presented in Table 4.1 of this report, seven raw water samples were characterized and the results compared to the ODWS criteria. Table 4.1 also presents average historical concentrations of various parameters from raw water samples collected at the Water Filtration Plant. Historical raw water quality data was provided by the PUC Services Inc.

For 2,4-dichlorophenol the laboratory method detection limit (MDL) was marginally above the ODWS AO, but below the health related standard for all samples.

Table 4.1
Surface Water Analytical Results Summary – April/June 2007
for the Gros Cap Intake Zone

Sample Location	*Units*	*MOE*	*Historical*	*A06*	*A02*	*A04*	*A05*	*Jackson Creek*	*SW0012*	*SW03*
Sample Name		*Standard* (1)	*Average*	*SW-46442-070428-RE-001*	*SW-46442-070428-RE-002*	*SW-46442-070428-RE-003*	*SW-46442-070428-RE-004*	*SW-46442-070609-KM-01*	*SW-46442-070609-KM-02*	*SW-46442-070609-KM-03*
Sample Date				*4/28/2007*	*4/28/2007*	*4/28/2007*	*4/28/2007*	*6/9/2007*	*6/9/2007*	*6/9/2007*
Iron	ug/L	300 AO	10.47	50 U	50 U	50 U	50 U	50 U	100	**980**
Manganese	ug/L	50 AO	0.93	1 U	2	5	1	3	11	**52**
Alkalinity, Total (as CaCO3)	mg/L	30 - 500 OG	44.2	40	43	39	41	**20**	**25**	**24**
Color (Apparent)	TCU	5 AO	1.5	1 U	1 U	1 U	1 U	**38**	**25**	**60**
Hardness	mg/L	80 - 100 OG	**44.6**	**40**	**40**	**50**	**40**	**30**	**30**	**40**
Microcystin	ug/L	15	-	0.1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nitrogen, Organic	mg/L	0.15 OG	-	**0.3**	**0.2**	**0.3**	**0.3**	**0.7**	0.15 U	**0.8**
Taste	NONE	inoffensive AO	-	INOFF	INOFF	INOFF	INOFF	**OFF**	INOFF	**OFF**
Escherichia coli	cfu/100mL	ND	0	0	0	**1**	0	0	**39**	**19**
Total Coliform Bacteria	cfu/100mL	ND	**2**	**24**	**52**	**18**	**2**	**870**	**360**	**650**
Total Coliform Bacteria Background	cfu/100mL	200 (2)	-	**> 200**	**> 200**	**> 200**	**> 200**	**> 2000**	**> 2000**	**> 2000**
Dissolved Organic Carbon (DOC)	mg/L	5 AO	1.4	2	2	2	2	**8**	5	**8**

NOTES:

(1)	*"Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines"*, June 2003, Revised June 2006
(2)	There is no current ODWS for Background Colony Count. The former Ontario Drinking Water Standards (January 2001) provided a standard of 200 colonies on a total coliform membrane filter.
AO	Aesthetic Objective - Not Health Related
ND	Not detectable
OG	Treatment Operational Guideline - Not Health Related
U	Not detected above method detection limit shown
100/1 AO	Table 2 ODWS/Table 4 Aesthetic Objective
-	No criteria
	Measured concentration exceeds applicable groundwater quality criterion.
--	Data not available

Based on a review of the analytical data, several exceedances of the ODWS were noted for samples collected from Lake Superior. The results are summarized in Table 4.2.

Table 4.2
ODWS Exceedances for Lake Superior Samples

Location	Parameter	ODWS (mg/L)	Type	Concentration (mg/L)
WTP Historical Average	Hardness	80 – 100	OG	44.6
	Total Coliforms	0 cfu/100mL	Health	2 cfu/100mL
A06	Hardness	80 – 100	OG	40
	Organic Nitrogen	0.15	OG	0.3
	Total Coliforms	0 cfu/100mL	Health	24
	Background Coliforms	200 cfu/100mL	Health	> 200
A02	Hardness	80 – 100	OG	40
	Organic Nitrogen	0.15	OG	0.2
	Total Coliforms	0 cfu/100mL	Health	52
	Background Coliforms	200 cfu/100mL	Health	> 200
A04	Hardness	80 – 100	OG	50
	Organic Nitrogen	0.15	OG	0.3
	Total Coliforms	0 cfu/100mL	Health	18
	E.Coli	0 cfu/100mL	Health	1
	Background Coliforms	200 cfu/100mL	Health	> 200
A05	Hardness	80 – 100	OG	40
	Organic Nitrogen	0.15	OG	0.3
	Total Coliforms	0 cfu/100mL	Health	2
	Background Coliforms	200 cfu/100mL	Health	> 200

Based on a review of the analytical data, the following exceedances of the ODWS were noted for samples collected from the tributaries discharging to Lake Superior within the IPZ-2. The results are summarized in Table 4.3.

Table 4.3
ODWS Exceedances for Tributary Samples

Location	Parameter	ODWS (mg/L)	Type	Concentration (mg/L)
Jackson Creek	Alkalinity	30 - 500	OG	20
	Colour	5 TCU	AO	38
	Hardness	80 – 100	OG	30
	Organic Nitrogen	0.15	OG	0.7
	Taste	Inoffensive	AO	Offensive
	Total Coliforms	0 cfu/100mL	Health	870 cfu/100mL
	Background Coliforms	200 cfu/100mL	Health	> 2,000
`	DOC	5	AO	8
SW0012	Alkalinity	30 - 500	OG	25
	Colour	5 TCU	AO	25
	Hardness	80 – 100	OG	30
	E.Coli	0 cfu/100mL	Health	39 cfu/100mL
	Total Coliforms	0 cfu/100mL	Health	360 cfu/100mL
	Background Coliforms	200 cfu/100mL	Health	> 2,000
SW03	Iron	300	AO	980
	Manganese	50	AO	52
	Alkalinity	30 - 500	OG	24
	Colour	5 TCU	AO	60
	Hardness	80 – 100	OG	40
	Organic Nitrogen	0.15	OG	0.8
	Taste	Inoffensive	AO	Offensive
	E.Coli	0 cfu/100mL	Health	19
	Total Coliforms	0 cfu/100mL	Health	650 cfu/100mL
	Background Coliforms	200 cfu/100mL	Health	> 2,000
	DOC	5	AO	8

None of the above noted exceedances are unexpected for a surface water source. The presence of organic nitrogen, DOC, colour, and offensive taste result from the natural decomposition of organic matter. Higher bacteriological results for the tributary samples are most likely due to the proximity of these water courses to residential septic systems.

The PUC describes the surface water source for the WTP as "very high quality". Considering that samples from the raw source water and the tributaries meet most of the ODWSs, which are intended for comparison with drinking water analytical results, the results of this study support that claim. In addition, the only health related exceedances are for microbiological parameters, which the treatment system can easily handle. Exceedances in the samples collected from tributaries to Lake Superior are sufficiently diluted so that they result in little impact to the source water quality.

Based on the historical raw water quality data that was provided by the PUC Services Inc., pH, colour, alkalinity, and total coliforms show slight decreasing trends from 1990 to 2005. Turbidity showed a slight decreasing trend from 1995 to 1998 and a slight increasing trend from 1999 to 2005. In 2006, average turbidity increased slightly from 2005 due to a period of significantly increased turbidity in the fall of that year. In 2007, average turbidity decreased from the 2006 concentration. The chloride concentration has remained stable since 2000. The *E.Coli* concentration remained relatively stable at 0 cfu/mL from 2003 to 2006 with occasional peaks of 1 or 2 cfu/mL. Graphical illustrations of historical source water quality trends for select parameters are included in Appendix A.

It should be noted that all samples were received at the laboratory beyond the recommended holding time for analysis of bacteria, turbidity, colour, chlorine and chloramines. Although analysis beyond the holding time would be expected to result in lower concentrations for these parameters, the concentrations are in line with the historical average raw water quality. Detectable concentrations of chloride and chloramines are generally due to chlorination and are not expected in untreated water.

4.7 Sediment Quality

Sediment quality was characterized based on the lakebed and shoreline samples collected throughout the preliminary IPZ-2. Sediment analytical results in comparison to Canadian and Ontario Sediment Quality Guidelines are included in Appendix A. A summary of the grain size analysis is also included in Appendix A.

Based on grain size analysis, sediments within the IPZ-2 consist of sand with gravel and traces of silt and clay. Field observations note the presence of boulders and bedrock at locations north of the intake. Boulders were also noted on the lakebed surrounding the intake and at some locations further south of the intake as well. Stream/Lakebed descriptions and grain size analysis results are presented in Appendix A.

The Canadian Sediment Quality Guidelines for the Protection of Aquatic Life are provided in the *"Canadian Environmental Quality Guidelines"*, Canadian Council of Ministers of the Environment (CCME), 2002. The CCME Guidelines include the interim freshwater sediment quality guidelines (ISQGs) below which adverse impacts are not usually associated with a given chemical, and the probable effect levels (PELs). Chemical concentrations above the PELs are likely to result in

adverse effects on aquatic life. Concentrations that fall between the ISQG and PEL have an increased risk of adverse biological impact.

The Ontario Sediment Quality Guidelines are provided in the *"Guideline for the Protection and Management of Aquatic Sediment Quality in Ontario"*, Ministry of the Environment (MOE), 1993. The MOE Guidelines are applied for protection of aquatic organisms that have direct contact with sediment (benthic organisms). They include lowest effect levels (LELs) and severe effect levels (SELs). Sediment concentrations at or below the LEL will have no effect on the majority of the benthic community. Sediment concentrations above the SEL are considered to be heavily polluted and may be acutely toxic.

The MOE LEL Guidelines have been adopted as Standards in the *"Soil, Groundwater and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act"*, MOE, (2004) under O.Reg 153/04 of Ontario's Environmental Protection Act. The MOE LELs were developed based on the health and viability of benthic organisms rather than human health. As such, sediment analytical results were also compared to the MOE *"Table 1: Full Depth Background Site Condition Standards for Soil"* presented in *"Soil, Groundwater and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act"*, MOE, (2004).

With the exception of the sample collected along the shoreline at Gros Cap, no parameters were detected at concentrations that exceeded any of the criteria. For some parameters however, the laboratory method detection limit (MDL) exceeded some of the criteria. For cadmium, the laboratory MDL was marginally above the MOE LEL. The laboratory MDL for total PCBs exceeded the MOE LEL for samples collected at the Gros Cap shoreline, SW03, SW06, and SW07. The MDL for oil and grease was significantly above the MOE LEL for the shoreline samples. It is unknown if sediments at the sampled locations exceed the criteria for the above parameters.

The sediment sample collected along the shoreline at Gros Cap, approximately 830 metres from the intake structure, exhibited the exceedances summarized in Table 4.4, all of which are higher than the CCME PEL and/or the MOE LEL for the particular parameter:

Table 4.4 Exceedances

Parameter	*CCME ISWG (mg/kg)*	*CCME PEL (mg/kg)*	*MOE LEL (mg/kg)*	*MOE Table 1 (mg/kg)*	*Gros Cap Shoreline (mg/kg)*
Acenaphthene	0.00671	0.0889	-	0.05	0.12
Anthracene	0.0469	0.245	0.22	0.05	0.80
Benzo(a)anthracene	0.0317	0.385	0.32	0.1	3.40
Benzo(a)pyrene	0.0319	0.782	0.37	0.1	2.64
Benzo(g,h,i)perylene	-	-	0.17	0.2	1.62
Benzo(k)fluoranthene	-	-	0.24	0.05	2.17
Chrysene	0.0571	0.862	0.34	0.18	3.24
Dibenz(a,h)anthracene	0.00622	0.135	0.06	0.15	0.23
Fluoranthene	0.111	2.355	0.75	0.24	8.10

Fluorene	0.0212	0.144	0.19	0.05	0.19
Indeno(1,2,3-cd)pyrene	-	-	0.2	0.11	1.82
Phenanthrene	0.0419	0.515	0.56	0.19	1.75
Pyrene	0.053	0.875	0.49	0.19	6.18

The above chemical concentrations are elevated 1.5 to 43 times the Ontario background soil concentrations. These concentrations are likely to result in adverse, but not severe effects on the health of some benthic organisms.

The extent and source of the semi-volatile organic compounds (SVOC) impact at the Gros Cap shoreline is unknown. Based on the distance from the intake and the predominant flow direction, the above SVOC impact is not expected to adversely affect water quality at the intake. In addition, SVOCs are generally found bound to sediments rather than within the water column. With the exception of Benzo(a)pyrene, SVOCs were not analyzed as part of the raw water characterization. Benzo(a)pyrene was not detected in any of the surface water samples. Historically, concentrations of Benzo(a)pyrene in raw water samples collected at the Gros Cap Intake are well below the ODWS (see Appendix A for graphical illustration of historical Benzo(a)pyrene concentrations in raw water at the Intake).

5.0 PRELIMINARY DELINEATION OF INTAKE PROTECTION ZONES

The Gros Cap intake is classified as a Great Lakes intake. The purpose of delineating zones around the Great Lakes intakes is to protect them from immediate contaminants of concern that might enter from nearby areas or known sources. Drinking water intakes on the Great Lakes may be influenced by several environmental factors including: winds, waves and currents. For Phase 1 of this study, computer modeling to simulate wind driven currents and currents generated by tributaries flowing into the lake was not completed. This modeling will be completed in Phase 2 to further evaluate and delineate the IPZ-2.

For Great Lakes intakes, two zones are to be delineated: IPZ-1 is a fixed radius around the intake crib; and IPZ-2 takes into account areas outside the IPZ-1 that have the potential to directly impact the intake such as streams, rivers or shoreline features. Preliminary delineation of the IPZ is described below and shown on Figure 5.1. It is intended that the IPZ-2 be refined during Phase 2 of the project, following the computer modeling of currents.

5.1 Delineation of IPZ-1

The IPZ-1 is the area immediately around the intake crib. Due to its close proximity to the intake, this area is considered the most vulnerable to any contaminant of concern that may be released in this zone. Any contaminants released in this zone will have the highest potential to impact water quality.

The IPZ-1 shown in Figure 5.1 includes the following local threats:

- Four residential homes that may feature heating oil tanks, private septic tanks and water supply wells;
- Recreational boat marina (no fuelling station);
- Non-point source threats, such as spills from commercial vessels or recreational boats on Lake Superior.

5.2 Delineation of IPZ-2

The IPZ-2 acts as a secondary protective zone around the IPZ-1. In the event of a spill or acute situation, the treatment facility will have minimal time to respond. Contaminants released in this zone through spills have a high chance of reaching the intake quickly and will not have sufficient time to be diluted or filtered prior to reaching the intake.

The IPZ-2 is defined based on the response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributaries. A 3-hour response time has been used on this project based on the operator survey described in Section 3.2. The operator indicated a 1 hour maximum time for the MOE Spills Action Centre (SAC) to inform the PUC operator if a spill is called into their centre, plus an allowance of 2 hours to shut the WTP down upon notification of a spill. The preliminary IPZ-2 is presented in Figure 5.1.

Since the computer modeling of local currents will be completed in Phase 2, the preliminary IPZ-2 is currently defined by a 5 km radius around the intake. Following Phase 2 of the study, the IPZ-2 will be modified based on the current velocities in the lake, the inland extent and to consider the travel times in tributaries flowing into the IPZ-2.

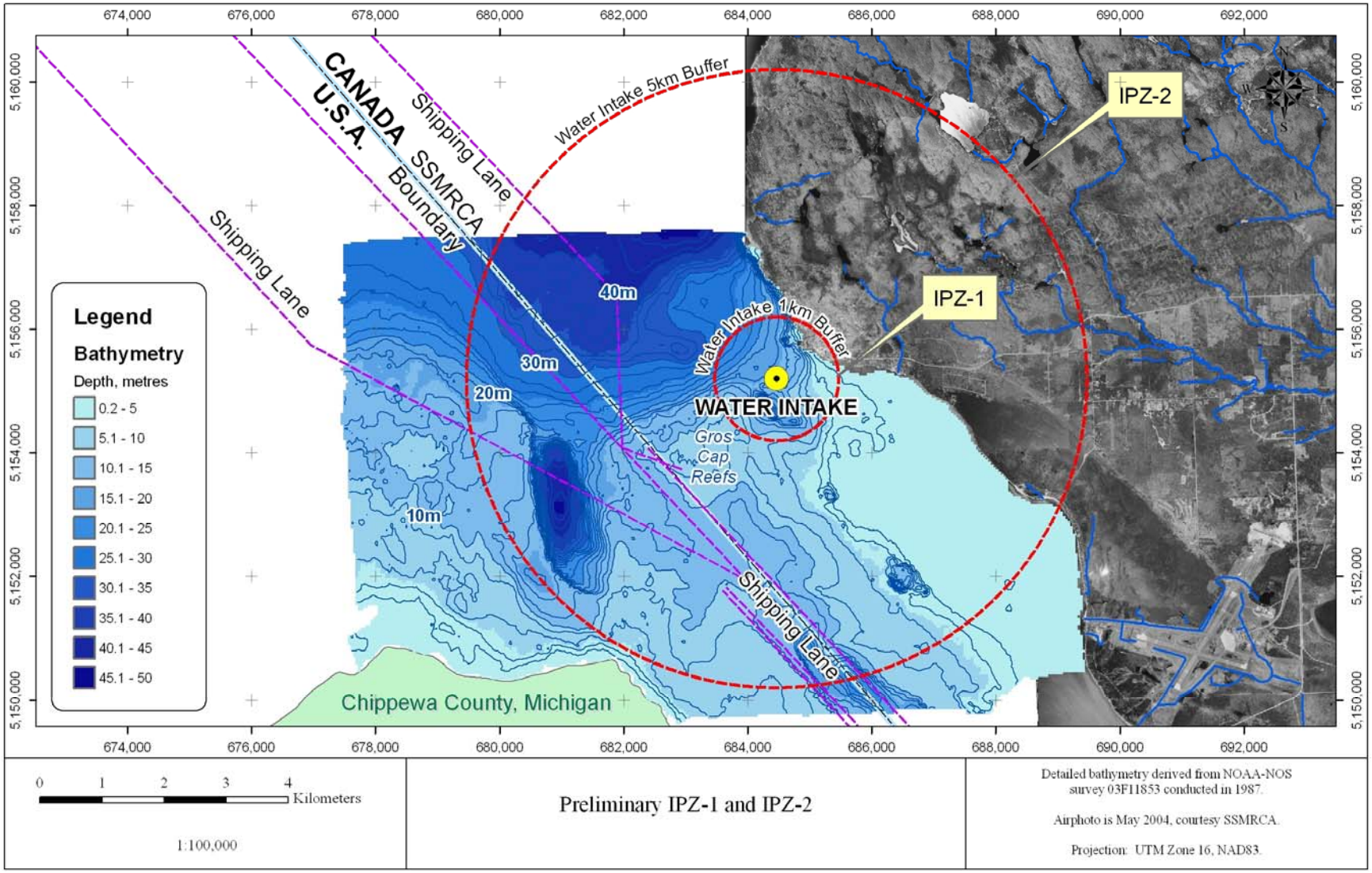

Figure 5.1 Preliminary IPZ-1 and IPZ-2

6.0 VULNERABILITY SCORES AND LEVEL OF UNCERTAINTY

6.1 Vulnerability Scores

The vulnerability score quantifies the vulnerability of the intake to contaminants. Different types of surface waters (e.g. Great Lakes, Great Lakes connecting channels, inland rivers/streams and inland lakes) have different degrees of vulnerability resulting from inherent hydrological and environmental characteristics. The water source will affect the water quality at the intake. In addition to the source vulnerability, there is also vulnerability associated with each zone (IPZ-1 and IPZ-2). A formula was developed by MOE to assess the overall vulnerability for surface water intakes. The vulnerability score (V) is defined as:

$$V = Vf_z \times Vf_s$$

where V = vulnerability score

Vf_z = zone vulnerability factor; and

Vf_s = source vulnerability modifying factor

MOE has defined acceptable ranges for the vulnerability factors for the different surface water sources as listed in Table 6.1 (Gros Cap is a Great Lakes intake). Vulnerability scores were assigned to each IPZ as described below. The vulnerability scores will be used in future chapters including the Water Quality Risk Assessment. Vulnerability scores are to be developed with input from the client and operator. Proposed values are presented in this section.

Table 6.1
Vulnerability Score Ranges for Drinking Water Intakes Using Surface Water Sources

Intake Type	Zone Vulnerability Factor (Vf_Z)			Source Vulnerability Factor (Vf_s)	Range of vulnerability score (V)		
	IPZ-1	IPZ-2			IPZ-1	IPZ-2	
Great Lakes	10	7 to 9		0.5 to 0.7	5 to 7	3.5 to 6.3	
Great Lakes connecting channels	10	7 to 9		0.7 to 0.9	7 to 9	4.9 to 8.1	
Inland lakes	10	7 to 9		0.8 to 1	8 to 10	5.6 to 9	
Inland rivers/ streams	10	7 to 9		0.9 to 1	9 to 10	6.3 to 9	

Ranking of vulnerability score: Low ($V \leq 5$)
Medium ($5 < V \leq 6$)
High ($V > 6$)

6.1.1 Zone Vulnerability Factor

Each of the intake protection zones is assigned a vulnerability factor (Vf_z) with the zones closest to the intake having the highest Vf_z. The specified Vf_z ranges are listed in Table 6.1. The following factors are considered in selecting the Vf_z :

- Runoff generation potential based on rainfall, land cover, soil permeability, slope (more runoff – higher Vfz);
- Transport pathways in the zone including natural and anthropogenic pathways: urban or rural drainage, open drains, small streams/ditches (faster or more transport pathways - higher Vfz);
- Distance of threat source to the watercourse and along the watercourse (longer distance – lower Vfz).

For IPZ-1, the Vf_z is set at 10 due to its close proximity to the intake. This value is fixed and cannot be altered.

For IPZ-2, the Vf_z is between 7 and 9, reflecting the moderately high vulnerability of this zone resulting from its proximity to the intake. Runoff potential is moderate. A limited number of very small tributaries lie within the preliminary IPZ-2 and there are no significant rivers. The proximity to the international shipping channel is a consideration. A mid range Vf_z of 8 is recommended.

6.1.2 Source Vulnerability Modifying Factor

The source vulnerability modifying factor (Vf_s) applies to the location of the intake on a particular water body. Intakes located on inland lakes are generally more vulnerable to contamination than intakes situated on the Great Lakes, for example. For intakes on the Great Lakes, a value of 0.5 to 0.7 is specified (see Table 6.1). A lower value within this range is appropriate for intakes located in deeper water, further from shore, and/or where historical water records indicate few or no incidences exceeding the water quality guidance/standards. The Gros Cap intake is located approximately 830 m from shore, in 15 m water depth. The operator did not report any conditions that have required the plant to be shut down and the PUC describes the surface water source for the WTP as "very high quality". A value of 0.5 has therefore been assigned. This is subject to review and input from the client.

6.1.3 Vulnerability Score

The vulnerability factors and scores for IPZ-1 and IPZ-2 are summarized in Table 6.2.

Table 6.2
Summary of Vulnerability Scores at Gros Cap Intake

IPZ	Vf_z	Vf_s	$V = Vf_z \times Vf_s$
IPZ-1	10	0.5	5
IPZ-2	8	0.5	4

Vulnerability scores of 5 (IPZ-1) and 4 (IPZ-2) classify this intake as a low vulnerability intake (see Table 6.1).

6.2 Level of Uncertainty

The level of uncertainty associated with the intake protection zone delineation and assessment is a requirement of Assessment Report. The level of uncertainty accounts for management decisions related to natural systems and the infinite number of data required to achieve complete certainty about a system. The possible sources of uncertainty may be related to the completeness of information, model application and site-specific knowledge related to natural variation (MOE, 2005). The final uncertainty score is based on a combination of the delineation and vulnerability score. A qualitative uncertainty analysis was used to determine the combined uncertainty.

6.2.1 Uncertainty for Delineation of Intake Protection Zones

During this first planning cycle, sufficient data was not available to quantify the level of uncertainty for delineation of the IPZ using a formal analysis such as defining specific levels of confidence. A qualitative uncertainty analysis has therefore been provided.

The IPZ-1 was delineated based on defined distances from the intake (IPZ-1) and recognized threats. The level of uncertainty for the IPZ-1 is low.

During this phase of the project, no numerical modeling was undertaken to define the current velocities as required for delineation of the IPZ-2. The level of uncertainty for the IPZ-2 is high.

6.2.2 Uncertainty for Vulnerability Scoring

The vulnerability scores assigned to each vulnerable area (Vf_z and Vf_s) are not physical parameters that can be directly measured in the field, and it is therefore more difficult to evaluate the level of uncertainty. The level of uncertainty for the vulnerability scoring for the IPZ is high at this time, as input from the client is required. Once Phase 2 is completed, the level of uncertainty will be re-evaluated.

6.2.3 Overall Uncertainty Rating

The overall uncertainty ratings for each of the vulnerable areas are summarized in Table 6.3. The uncertainty for each vulnerable area is a combination of the uncertainty in the delineated IPZ and in the vulnerability scoring. Where either category was assigned a high vulnerability, the overall vulnerability is high. Once the numerical modeling is completed in Phase 2, the level of uncertainty will be re-evaluated.

Table 6.3
Summary of Uncertainty Ratings for Vulnerable Areas

IPZ	Uncertainty for IPZ Delineation	Uncertainty for Vulnerability Scores	Overall Uncertainty
IPZ-1	Low	High	High
IPZ-2	High	High	High

7.0 DATA AND KNOWLEDGE GAP ANALYSIS

The following list summarize the data and knowledge gaps at the completion of the Phase 1 study:

1. Given there were SVOC impacts along the shoreline near the pumping station, additional sediment and/or surface water analyses in this region would help to better define this potential threat, since the sediments within the immediate vicinity of the intake are generally gravel/cobbles and are not thought to pose a risk to water quality. Furthermore, the microbial detections within the raw water intake may necessitate a better understanding of the seasonal and/or local influences;
2. The ADCP data demonstrates the three-dimensional characteristics of the current patterns in the vicinity of the intake. Numerical modeling is required to delineate the IPZ-2, based on currents, which vary spatially, temporally, and with depth. Numerical modeling will be undertaken in Phase 2;
3. The closes gauged tributary was the Goulais River, which isn't even located in the SSMRCA watershed boundary. The absence of a gauged river within the IPZ-1 or IPZ-2 boundary was a limitation of the turbidity analysis;
4. The St. Marys River Remedial Action Plan provided historical sediment quality information, however, it was allocated at least 5 km downstream of the Gros Cap intake; and
5. Data defining the frequency and type of shipping traffic within the area, and historical spills, should be analyzed in the Threat Inventory Study in future phases of the work.

8.0 SUMMARY AND RECOMMENDATIONS

Section 8.0 provides a summary of the key study findings and recommendations for additional technical investigation:

1. The Gros Cap WTP intake is located in Lake Superior northwest of the St. Marys River inlet. The intake extends approximately 830 metres from the shoreline to a depth of 15 metres below the water surface. The intake's bellmouth is supported by a crib structure with the intake screen openings approximately 1.8 metres above the lakebed;
2. The WTP Operator indicated a low level of concern related to various contaminant groups within raw water including: microbial (coliforms, cryptosporidium, etc.); inorganics (metals, nitrates, etc.); VOCs (benzene, TCE, etc.); synthetic organics (PCBs, etc.); pesticides; and radioactive substances;
3. The Operator identified the following potential contaminant sources: urban, highway, and construction runoff; sediment dredging at the Gros Cap Marina and Tannery Bay; residential heating oil spills and septic systems; shipping within the St. Marys River; and discharges from various streams. Mining, landfilling, and salt storage operations are also located north of the IPZ-2;
4. The Operator provided a shut-down time of 2 hours. An additional maximum 1 hour is allowed for the MOE Spills Action Centre (SAC) to inform the PUC operator if a spill is called into their centre. A shut-down time of 3 hours is therefore recommended for calculation of the IPZ-2;
5. Data required for the Source Water Studies has been collected and reviewed. Data was also collected and processed for use in the Phase 2 numerical modeling. The data sets reviewed included: bathymetry, winds, currents, tributary flow, water quality, sediment quality, turbidity and shipping data;
6. Raw turbidity data from the Gros Cap WTP for the period July 2006 to August 2007 were analyzed with wind and flow data to identify potential causes of high turbidity and contaminants related to flow from tributaries and or wind events. The maximum turbidity recorded during that period was only 3.14 NTU with an average turbidity level of 0.54 NTU over the 14 month record. This is low when compared with other WTPs on the Great Lakes;
7. Existing sediment quality data for the St. Marys River, available within the St. Marys River Remedial Action Plan (MOE and DNR, 1992; MNR and DNR, 2003) were reviewed. In several cases, the data indicated that sediment analytical results exceeded the Provincial Sediment Quality Guidelines (PSQGs), however all samples exceeding the PSQGs were located more than 5 km downstream of the intake. No data were available from the RAP for sediment within the vicinity or upstream of the Gros Cap intake;
8. Ship traffic passing to and from the St. Marys River represents a significant potential source of contamination for drinking water at the Gros Cap Intake in the event of a cargo spill or fuel leak. In addition, the wake of passing ships may stir up contaminated sediments. This threat should be assessed in the Threats Chapter of the Assessment Report;

9. An Acoustic Doppler Current Profiler and temperature gauges were deployed near the intake from July 13, 2006 to October 15, 2006, to collect data for definition of the currents in the area. For the period of record, the data confirm that the currents vary significantly through the water column, with flows near the bed moving in both a north and south direction, while the surface flows were predominantly towards the south;

10. Four locations within 1 km of the intake were selected for water sampling. These locations were selected with input from the client. Composite (integrated) samples were collected from the water column at each of the four locations. Vertical water profiles were recorded at a total of seven locations: one at each of the four water sample locations, one at the Gros Cap intake, as well as at two additional locations downstream of the intake along the predominant flow path. Surface water samples were also collected from Jackson Creek, and two of the ephemeral streams located within the preliminary IPZ-2 to determine possible source(s) of contamination. The raw water samples were analyzed and characterized and the results compared to the ODWS criteria. For 2,4-dichlorophenol the laboratory method detection limit (MDL) was marginally above the ODWS AO, but below the health related standard for all samples. Although there were several exceedances of the ODWS, these are not unexpected for untreated water. The only health related exceedances were for microbiological parameters which are treated for at the WTP. This limited sampling supports the operator's opinion that the water is "very high quality";
11. Eleven sediment samples were collected from the lakebed and along the shoreline at key areas of potential contamination to the intake (stream tributaries and eroding shoreline) to assess the level of sediment contamination within the preliminary IPZ-2. With the exception of the sample collected along the shoreline at Gros Cap, no parameters were detected at concentrations that exceeded any of the criteria. For some parameters however, the laboratory MDL exceeded one or more of the criteria. For cadmium, the MDL was marginally above the MOE LEL. The MDL for total PCBs exceeded the MOE LEL for samples collected at the Gros Cap shoreline, SW03, SW06, and SW07. For oil and grease, in the shoreline samples the MDL was significantly above the MOE LEL. It is unknown if sediments at the sampled locations exceed the criteria for the above parameters;
12. The sediment sample collected at the Gros Cap Shoreline, exhibited concentrations of various SVOCs that exceeded the MOE LEL and the CCME PEL. These chemical concentrations are likely to result in adverse, but not severe effects on the health of some benthic organisms. Based on the distance from the intake and the predominant flow direction, the SVOCs impact is not expected to adversely affect the health of some benthic organisms water quality at the intake. However, shoreline sediments should be characterized further prior to any future dredging activities to ensure the water quality within the IPZ remains protective of the environment and drinking water quality;
13. Though the treatment plant is capable of treating low level microbial action, additional microbial surface water assessment may be considered to better understand its source;
14. Tributaries flowing into the preliminary IPZ-2 were surveyed and flow measurements were taken. Five streams were identified within the preliminary IPZ-2 discharging into Lake Superior: two perennial (Prince and Jackson Creeks) and three intermittent/ephemeral streams. Various drainage ditches were also identified, which discharge to the IPZ-2;
15. Preliminary IPZ delineation has been undertaken. The IPZ-2 will be revised in Phase 2 based on numerical modeling that will be used to define current velocities in the vicinity of the intake;
16. A preliminary vulnerability score of 5 has been assigned to the IPZ-1 and a value of 4 has been assigned to the IPZ-2. These scores indicate low vulnerability. This is to be reviewed by SSMRCA and the PUC as required. The overall uncertainty ratings for both IPZ is high at

this stage of the work. These scores will be re-evaluated after the Phase 2 modeling is complete; and

17. Data gaps are listed in Section 7. Data defining the frequency and type of shipping traffic within the area and historical spills should be analyzed in the Threat Inventory Study in the next Phase of the work.

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APPENDIX A
FIELD DATA

TABLE A-1
SAMPLING/MONITORING LOCATIONS
GROS CAP INTAKE PROTECTION ZONE

Sampling/Monitoring Location Name	GPS Coordinates		Analysis				
	Northing	Easting	Water Column Characterization	Raw Water Sample	Sediment Sample	Grain Size	Stream Measurments
North of 5 km Radius							
RED ROCK	5164312	687721			X	X	
North of Intake							
JACKSON CREEK	5157864	684160	X	X	X	X	X
A04	5155977	683845	X	X	X	X	
A02	5155513	684852	X	X			
At Intake							
A01	5155259	684485	X				
Gros Cap Shoreline	5155696	685023			X	X	
South of Intake							
SW 0012	5155286	686424	X	X	X	X	X
SW01	5155390.123	686217.251					X
SW02	5155284.271	686422					X
SW 03	5154753.681	687311.06	X	X	X	X	X
SW 04	5154459.611	687551.46					X
SW 05	5154359.82	687641.46					X
SW 06	5154114.876	687698.904			X	X	X
SW 07	5153961.285	687819.021			X	X	X
SW 08	5153874.772	687902.501			X	X	X
SW 09	5153784.998	687979.351					X
SW 10	5153693.512	688065.011					X
SW 11	5153581.825	688183.062					X
SW 12	5153340.661	688459.587			X	X	X
A05	5154559	683695	X	X			
A06	5154415	685094	X	X			
A07 (NEW)	5153435	684995	X				
A08 (NEW)	5152232	685782	X				
A09 (NEW)	5150763	686927			X	X	

TABLE A-2
SURFACE WATER ANALYTICAL RESULTS SUMMARY - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Sample Location	*Units*	*MOE Standard* [1]	*Historical Average*	*A06*	*A02*	*A04*	*A05*	*Jackson Creek*	*SW0012*	*SW03*
Sample Name				*SW-46442-070428-RB-001*	*SW-46442-070428-RB-002*	*SW-46442-070428-RB-003*	*SW-46442-070428-RB-004*	*SW-46442-070609-KM-01*	*SW-46442-070609-KM-02*	*SW-46442-070609-KM-03*
Sample Date				*4/28/2007*	*4/28/2007*	*4/28/2007*	*4/28/2007*	*6/9/2007*	*6/9/2007*	*6/9/2007*
Volatiles										
1,1,1,2-Tetrachloroethane	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	ug/L	-	0.04	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	ug/L	-	0.11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	ug/L	-	0.09	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	ug/L	-	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	ug/L	14	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromoethane (Ethylene Dibromide)	ug/L	-	0.09	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	ug/L	200/3 AO	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	ug/L	5	0.08	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	ug/L	-	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	ug/L	-	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	ug/L	5/1 AO	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone (Methyl Ethyl Ketone)	ug/L	-	-	20 U	20 U	20 U	20 U	20 U	20 U	20 U
2-Hexanone	ug/L	-	-	20 U	20 U	20 U	20 U	20 U	20 U	20 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	ug/L	-	-	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Acetone	ug/L	-	-	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Benzene	ug/L	5	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane (Methyl Bromide)	ug/L	-	-	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon tetrachloride	ug/L	5	0.2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	ug/L	80/30 AO	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	ug/L	-	-	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform (Trichloromethane)	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloromethane (Methyl Chloride)	ug/L	-	-	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	ug/L	-	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dichlorodifluoromethane (CFC-12)	ug/L	-	-	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	ug/L	2.4 AO	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
m&p-Xylene	ug/L	-	0.08	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methane	ug/L	3 L/m^3	-	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Methyl Tert Butyl Ether	ug/L	-	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	ug/L	-	0.44	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	ug/L	-	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Styrene	ug/L	-	0.11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	ug/L	30	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	ug/L	24 AO	0.05	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	ug/L	-	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,3-Dichloropropene	ug/L	-	-	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	ug/L	5	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane (CFC-11)	ug/L	-	-	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trihalomethanes	ug/L	100	-	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Vinyl chloride	ug/L	2	0.06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylene (total)	ug/L	300 AO	0.13	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U

TABLE A-2
SURFACE WATER ANALYTICAL RESULTS SUMMARY - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Sample Location	*Units*	*MOE*	*Historical*	*A06*	*A02*	*A04*	*A05*	*Jackson Creek*	*SW0012*	*SW03*
Sample Name		*Standard* [1]	*Average*	*SW-46442-070428-RB-001*	*SW-46442-070428-RB-002*	*SW-46442-070428-RB-003*	*SW-46442-070428-RB-004*	*SW-46442-070609-KM-01*	*SW-46442-070609-KM-02*	*SW-46442-070609-KM-03*
Sample Date				*4/28/2007*	*4/28/2007*	*4/28/2007*	*4/28/2007*	*6/9/2007*	*6/9/2007*	*6/9/2007*
O.Reg 170/03 Pesticies - List 1										
2,3,4,6-Tetrachlorophenol	ug/L	100/1 AO	0.01	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2,4,6-Trichlorophenol	ug/L	5/2 AO	0.02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2,4-Dichlorophenol	ug/L	900/0.3 AO	-	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Alachlor	ug/L	5	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Atrazine	ug/L	-	0.05	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Atrazine and metabolites	ug/L	5	0.4	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Azinphos-methyl	ug/L	20	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Bendiocarb	ug/L	40	1.5	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Benzo(a)pyrene	ug/L	0.01	0.005	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Bladex (Cyanazine)	ug/L	10	0.1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Carbaryl	ug/L	90	0.2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Carbofuran	ug/L	90	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chlorpyrifos	ug/L	90	0.08	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Desethyl Atrazine	ug/L	-	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Diazinon	ug/L	20	0.13	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Diclofop-methyl	ug/L	9	-	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Dimethoate	ug/L	20	0.5	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Ethyl Parathion	ug/L	50	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Malathion	ug/L	190	0.259	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Metolachlor	ug/L	50	0.5	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Metribuzin	ug/L	80	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Pentachlorophenol	ug/L	60 / 30 AO	0.01	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Phorate	ug/L	2	0.07	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Prometryn	ug/L	1	0.05	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Simazine	ug/L	10	0.05	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Tempephos	ug/L	280	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Terbufos	ug/L	1	-	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Triallate	ug/L	230	0.6	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Trifluralin	ug/L	45	0.005	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
O.Reg 170/03 Pesticies - List 2										
2,4,5-T	ug/L	280/20 AO	0.05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2,4-Dichlorophenoxyacetic acid (2,4-D	ug/L	100	0.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
4,4'-DDD	ug/L	-	0.005	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDE	ug/L	-	0.00136	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDT	ug/L	-	0.005	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4-Amino-3,5,6-trichloropicolinic acid (Picloram	ug/L	190	5	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Aldrin	ug/L	-	0.001	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Aldrin & Dieldrin	ug/L	0.7	0.003	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
alpha-Chlordane	ug/L	-	0.002	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Bromoxynil	ug/L	5	-	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chlordane (Total)	ug/L	7	0.14	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
DDT and Metabolites	ug/L	30	0.017	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Dicamba	ug/L	120	0.31	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Dieldrin	ug/L	-	0.002	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Dinoseb	ug/L	10	-	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
gamma-BHC (Lindane)	ug/L	4	0.001	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Heptachlor	ug/L	-	0.001	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Heptachlor epoxide	ug/L	-	1.36	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Heptachlor/Heptachlor Epoxide	ug/L	3	0.003	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Methoxychlor	ug/L	900	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
o,p'-DDT	ug/L	-	0.005	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Oxychlordane	ug/L	-	0.002	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U

TABLE A-2
SURFACE WATER ANALYTICAL RESULTS SUMMARY - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Sample Location	*Units*	*MOE*	*Historical*	*A06*	*A02*	*A04*	*A05*	*Jackson Creek*	*SW0012*	*SW03*
Sample Name		*Standard* [1]	*Average*	*SW-46442-070428-RB-001*	*SW-46442-070428-RB-002*	*SW-46442-070428-RB-003*	*SW-46442-070428-RB-004*	*SW-46442-070609-KM-01*	*SW-46442-070609-KM-02*	*SW-46442-070609-KM-03*
Sample Date				*4/28/2007*	*4/28/2007*	*4/28/2007*	*4/28/2007*	*6/9/2007*	*6/9/2007*	*6/9/2007*
Metals										
Aluminum	ug/L	100 OG	8.65	10 U	10	20	10 U	80	60	100
Antimony	ug/L	6	0.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Arsenic	ug/L	25	0.45	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Barium	ug/L	1000	9.53	10 U	10 U	10 U	10 U	20	20	20
Boron	ug/L	5000	7.36	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Cadmium	ug/L	5	0.05	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Calcium	mg/L	-	13.35	10.7	12.4	15	11.2	8.9	9.9	11.6
Calcium (Dissolved)	mg/L	-	-	11	12	15	11	9	10	12
Chromium Total	ug/L	50	1.05	1 U	1 U	1	1 U	1 U	1 U	2
Copper	ug/L	1000 AO	3.3	1 U	1 U	1 U	1 U	2	1 U	2
Iron	ug/L	300 AO	10.47	50 U	50 U	50 U	50 U	50 U	100	**980**
Lead	ug/L	10	0.16	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Magnesium	mg/L	-	2.75	2.4	2.4	2.5	2.4	1.6	2.2	2.6
Manganese	ug/L	50 AO	0.93	1 U	2	5	1	3	11	**52**
Mercury	ug/L	1	0.02	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Selenium	ug/L	10	0.87	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Sodium	mg/L	200 AO	1.45	1.3	1.3	1.3	1.3	2.3	2.0	14.2
Uranium-238	ug/L	20	0.07	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Zinc	ug/L	5000 AO	1.55	3 U	24	62	8	4	18	18
General Chemistry										
Alkalinity, Total (as CaCO3)	mg/L	30 - 500 OG	44.2	40	43	39	41	**20**	**25**	**24**
Ammonia-n	mg/L	-	0.01	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.06	0.05 U
Bromate	mg/L	0.01	-	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.02	0.01 U
Chloride	mg/L	250 AO	1.44	2 U	2 U	2 U	2 U	7	2 U	25
Chlorine	mg/L	-	-	0.01 U	0.01 U	0.01 U	0.01 U	0.03	0.01	0.01
Chlorine, residual (free)	mg/L	-	-	0.01 U	0.01 U	0.01 U	0.01 U	0.01	0.01	0.01
Color (Apparent)	TCU	5 AO	1.5	1 U	1 U	1 U	1 U	**38**	**25**	**60**
Cyanide (Dissolved)	mg/L	200	0.001	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Fluoride	mg/L	1.5	0.04	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Hardness	mg/L	80 - 100 OG	**44.6**	**40**	**40**	**50**	**40**	**30**	**30**	**40**
Microcystin	ug/L	15	-	0.1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Chloramines	mg/L	3000	-	0.01 U	0.01 U	0.01 U	0.01 U	0.02	0.01 U	0.01 U
Nitrate (as N)	mg/L	10.0	0.33	0.4	0.4	0.4	0.4	0.3	0.3	1.1
Nitrilotriacetic acid	mg/L	0.4	0.01	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.12	0.05 U
Nitrite (as N)	mg/L	1.0	0.003	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nitrite/Nitrate	mg/L	10.0	0.333	0.4	0.4	0.4	0.4	0.3	0.3	1.1
Nitrogen, Organic	mg/L	0.15 OG	-	**0.3**	**0.2**	**0.3**	**0.3**	**0.7**	0.15 U	**0.8**
Odor	NONE	inoffensive AO	-	INOFF	INOFF	INOFF	INOFF	INOFF	INOFF	INOFF
pH (lab)	S.U.	6.5 - 8.5 OG	7.94	7.87	7.82	7.90	7.78	7.22	7.31	7.08
Phenol	mg/L	-	0.0003	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Sulfate	mg/L	500	3.57	4	4	4	4	5	6	10
Sulfide	mg/L	0.05	-	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Taste	NONE	inoffensive AO	-	INOFF	INOFF	INOFF	INOFF	**OFF**	INOFF	**OFF**
Total Dissolved Solids (TDS)	mg/L	500 AO	50.675	70	60	50	70	60	60	130
Total Kjeldahl Nitrogen (TKN)	mg/L	-	0.1	0.3	0.2	0.3	0.3	0.7	0.2	0.8
Turbidity	NTU	5 AO	0.4	0.30	0.25	0.25	0.30	0.14	0.16	2.2

TABLE A-2
SURFACE WATER ANALYTICAL RESULTS SUMMARY - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Sample Location	*Units*	*MOE Standard* [1]	*Historical Average*	*A06*	*A02*	*A04*	*A05*	*Jackson Creek*	*SW0012*	*SW03*
Sample Name				*SW-46442-070428-RB-001*	*SW-46442-070428-RB-002*	*SW-46442-070428-RB-003*	*SW-46442-070428-RB-004*	*SW-46442-070609-KM-01*	*SW-46442-070609-KM-02*	*SW-46442-070609-KM-03*
Sample Date				*4/28/2007*	*4/28/2007*	*4/28/2007*	*4/28/2007*	*6/9/2007*	*6/9/2007*	*6/9/2007*
PCBs										
Aroclor-1242 (PCB-1242)	ug/L	-	-	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Aroclor-1254 (PCB-1254)	ug/L	-	-	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Aroclor-1260 (PCB-1260)	ug/L	-	-	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Total PCBs	ug/L	3	0.02	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Biological										
Escherichia coli	cfu/100mL	ND	0	0	0	**1**	0	0	**39**	**19**
Fecal Coliform Bacteria	cfu/100mL	-	1.5	0	1	1	0	0	40	19
Heterotrophic plate coun	CFU/mL	-	-	163	69	64	37	500 >	138	284
Total Coliform Bacteria	cfu/100mL	ND	**2**	**24**	**52**	**18**	**2**	**870**	**360**	**650**
Total Coliform Bacteria Background	cfu/100mL	200 [2]	-	**> 200**	**> 200**	**> 200**	**> 200**	**> 2000**	**> 2000**	**> 2000**
Herbicides										
Aldicarb	ug/L	9	-	9 U	9 U	9 U	9 U	9 U	9 U	9 U
Diquat	ug/L	70	-	7 U	7 U	7 U	7 U	7 U	7 U	7 U
Diuron	ug/L	150	1.5	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Glyphosate	ug/L	280	2	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Paraquat	ug/L	10	0.37	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Miscellaneous										
Dissolved Organic Carbon (DOC)	mg/L	5 AO	1.4	2	2	2	2	**8**	5	**8**

NOTES:

(1)	*"Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines"* , June 2003, Revised June 2006
(2)	There is no current ODWS for Background Colony Count. The former Ontario Drinking Water Standards (January 2001) provided a standard of 200 colonies on a total coliform membrane filter.
AO	Aesthetic Objective - Not Health Related
ND	Not detectable
OG	Treatment Operational Guideline - Not Health Related
U	Not detected above method detection limit shown
100/1 AO	Table 2 ODWS/Table 4 Aesthetic Objective
-	No criteria
Bold	Measured concentration exceeds applicable groundwater quality criterion.
--	Data not available

TABLE A-3
WATER COLUMN CHARACTERIZATION - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Location	*Depth (m)*	*pH (Units)*	*Conductivity (mS/cm)*	*Turbidity (NTU)*	*DO (mg/L)*	*Temperature (^oC)*
A01	1	7.94	0.139	0	13.13	1.5
	3	7.44	0.136	0	13.08	1.4
	5	7.34	0.136	0	13.1	1.4
	7	7.32	0.138	0	13.12	1.4
A02	1	5.95	0.001	147	13.88	3
	3	6.88	0	146	17.21	1.9
	4	7	0.001	146	17.8	1.7
A04	1	7.3	0.137	0	13.17	1.3
	3	7.2	0.136	0	13.18	1.3
	5	7.14	0.136	0	13.08	1.2
	7	7.18	0.135	0	13.12	1.2
	10	7.18	0.135	0	13.16	1.2
	13	7.21	0.135	0	13.08	1.2
	15	7.21	0.135	0	13.07	1.3
	16	7.19	0.135	0	13.06	1.3
A05	1	7.93	0.148	0	13.15	1.4
	3	7.63	0.134	0	13.17	1.4
	5	7.35	0.135	0	13.06	1.4
	7	7.21	0.135	0	13.05	1.4
A06	1	7.7	0.155	8.1	13.8	1.4
	3	7.31	0.14	0	13.45	1.3
	5	7.2	0.137	0	13.26	1.8
A07	1	7.89	0.146	0	13.18	1.8
	3	7.37	0.136	0	13.11	1.8
	5	7.27	0.135	0	13.12	1.9
A08	1	8.01	0.141	0	13.11	2.1
	3	7.45	0.135	0	13.08	2
Jackson Creek	0.2	7.23	0.230	0	7.0	10.6
SW0012	0.5	6.88	0.73	0	4.83	13.8
SW03	0.5	7.59	0.166	123	5.66	11.3

TABLE A-4
SEDIMENT ANALYTICAL RESULTS SUMMARY - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Sample Location	*Units*	*CCME*	*CCME*	*MOE*	*MOE*	*MOE*	*AO4*	*AO9*	*Red Rock*	*Jackson Creek*	*Gros Cap Shoreline*	*SW0012*
Sample Name		*ISWG*	*PEL*	*LEL*	*SEL*	*Soil*	*SS-46442-070428-RB-001*	*SS-46442-070428-RB-003*	*SS-46442-070609-KM-01*	*SS-46442-070609-KM-02*	*SS-46442-070609-KM-03*	*SS-46442-070609-KM-04*
Sample Date		*Criteria [(a)]*	*Criteria [(b)]*	*Criteria [(c)]*	*Criteria [(d)]*	*Criteria [(e)]*	*4/28/2007*	*4/28/2007*	*6/9/2007*	*6/9/2007*	*6/9/2007*	*6/9/2007*
Semi-Volatiles												
1-Methylnaphthalene	mg/kg	-	-	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
2-Methylnaphthalene	mg/kg	0.0202	0.201	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Acenaphthene	mg/kg	0.00671	0.0889	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	**0.12**[abe]	0.05 U
Acenaphthylene	mg/kg	0.00587	0.128	-	-	0.08	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Acridine	mg/kg	-	-	-	-	-	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Anthracene	mg/kg	0.0469	0.245	0.22	370	0.05	0.05 U	0.05 U	0.05 U	0.05 U	**0.80**[abce]	0.05 U
Benzo(a)anthracene	mg/kg	0.0317	0.385	0.32	1,480	0.1	0.05 U	0.05 U	0.05 U	0.05 U	**3.40**[abce]	0.05 U
Benzo(a)pyrene	mg/kg	0.0319	0.782	0.37	1,440	0.1	0.02 U	0.02 U	0.02 U	0.02 U	**2.64**[abce]	0.02 U
Benzo(b)fluoranthene	mg/kg	-	-	-	-	0.3	0.05 U	0.05 U	0.05 U	0.05 U	2.72	0.05 U
Benzo(b)pyridine (Quinoline)	mg/kg	-	-	-	-	-	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzo(g,h,i)perylene	mg/kg	-	-	0.17	320	0.2	0.05 U	0.05 U	0.05 U	0.05 U	**1.62**[ce]	0.05 U
Benzo(k)fluoranthene	mg/kg	-	-	0.24	1340	0.05	0.05 U	0.05 U	0.05 U	0.05 U	**2.17**[ce]	0.05 U
Chrysene	mg/kg	0.0571	0.862	0.34	460	0.18	0.05 U	0.05 U	0.05 U	0.05 U	**3.24**[abce]	0.05 U
Dibenz(a,h)anthracene	mg/kg	0.00622	0.135	0.06	130	0.15	0.05 U	0.05 U	0.05 U	0.05 U	**0.23**[abce]	0.05 U
Fluoranthene	mg/kg	0.111	2.355	0.75	1,020	0.24	0.05 U	0.05 U	0.05 U	0.05 U	**8.10**[abce]	0.05
Fluorene	mg/kg	0.0212	0.144	0.19	160	0.05	0.05 U	0.05 U	0.05 U	0.05 U	**0.19**[abe]	0.05 U
Fluorine	mg/kg	-	-	-	-	-	0.05 U	0.05 U	0.05 U	0.05 U	0.19	0.05 U
Indeno(1,2,3-cd)pyrene	mg/kg	-	-	0.2	320	0.11	0.05 U	0.05 U	0.05 U	0.05 U	**1.82**[ce]	0.05 U
Naphthalene	mg/kg	0.0346	0.391	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Phenanthrene	mg/kg	0.0419	0.515	0.56	950	0.19	0.05 U	0.05 U	0.05 U	0.05 U	**1.75**[abce]	0.05 U
Pyrene	mg/kg	0.053	0.875	0.49	850	0.19	0.05 U	0.05 U	0.05 U	0.05 U	**6.18**[abce]	0.05 U
Metals												
Arsenic	mg/kg	5.9	17	6	33	14	1	2	2	1 U	1	1 U
Cadmium	mg/kg	0.6	3.5	0.6	10	1	1 U	1 U	1 U	1 U	1 U	1 U
Chromium Total	mg/kg	37.3	90	26	110	7	3	5	12	9	14	5
Cobalt	mg/kg	-	-	50	-	19	1 U	2	4	4	6	2
Copper	mg/kg	35.7	197	16	110	26	1	4	5	4	5	3
Iron	mg/kg	-	-	20,000	40,000	-	2,210	6,090	13,700	8,710	11,600	5,390
Lead	mg/kg	35	91.3	31	250	55	1 U	4	4	3	5	2
Manganese	mg/kg	-	-	460	1,100	-	23	80	120	226	118	144
Mercury	ug/g	0.17	0.486	0.2	2	0.16	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nickel	mg/kg	-	-	16	75	43	2	3	6	6	14	3
Silver	mg/kg	-	-	0.5	-	0.35	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	mg/kg	123	315	120	820	150	6	13	19	17	22	11
PCBs												
Total PCBs	mg/kg	0.0341	0.277	0.07	530	0.3	0.04 U	0.04 U	0.04 U	0.04 U	0.2 U	0.04 U
General Chemistry												
Ammonia-n	mg/kg	-	-	100	-	-	10	19	9	10	26	24
Cyanide (total)	mg/kg	-	-	0.1	-	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Fraction Organic Carbon (FOC)	NONE	-	-	-	-	-	0.001 U	0.001 U	0.003	0.003	0.002	0.002
Moisture	%	-	-	-	-	-	20.1	15.3	17.2	15.3	22.5	26.4
Oil and Grease	mg/kg	-	-	1500	-	-	100 U	200	10,000 U	10,000 U	10,000 U	10,000 U
Phenol	mg/kg	-	-	-	-	0.1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Phosphorus	mg/kg	-	-	600	2,000	-	55	113	126	159	279	122
Redox	millivolts	-	-	-	-	-	160	260	225	250	260	270
Total Kjeldahl Nitrogen (TKN)	mg/kg	-	-	550	4,800	-	305	406	155	295	361	516
Total Organic Carbon (TOC)	%	-	-	1	10	-	0.1 U	0.1 U	0.3	0.3	0.2	0.2

NOTES:

(a) *"Canadian Sediment Quality Guideline for the Proection of Aquatic Life"*, CCME, 2002. Interim Sediment Quality Guideline
(b) *"Canadian Sediment Quality Guideline for the Proection of Aquatic Life"*, CCME, 2002. Probable Effect Level
(c) *"Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines"*, MOE, 2006. Lowest Effect Level
(d) *"Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines"*, 2006. Severe Effect Level
"Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario" (MOE, 1993).
(e) *"Soil, Ground Water and Sediment Standards for use Under Part XV.1 of the Environmental Protection Act", MOE, 2004*
Table 1 - Full Depth Backgroud Site Condition Standards. Agricultural or other property use

U Not detected above method detection limit shown
\- No criteria
Bold Measured concentration exceeds applicable groundwater quality criterion.

TABLE A-4
SEDIMENT ANALYTICAL RESULTS SUMMARY - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Sample Location	*Units*	*CCME*	*CCME*	*MOE*	*MOE*	*MOE*	*SW03*	*SW07*	*SW06*	*SW08*	*SW12*
Sample Name		*ISWG*	*PEL*	*LEL*	*SEL*	*Soil*	*SS-46442-070609-KM-05*	*SS-46442-070609-KM-06*	*SS-46442-070609-KM-07*	*SS-46442-070609-KM-08*	*SS-46442-070609-KM-09*
Sample Date		*Criteria [a]*	*Criteria [b]*	*Criteria [c]*	*Criteria [d]*	*Criteria [e]*	*6/9/2007*	*6/9/2007*	*6/9/2006*	*6/9/2006*	*6/9/2006*
Semi-Volatiles											
1-Methylnaphthalene	mg/kg	-	-	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
2-Methylnaphthalene	mg/kg	0.0202	0.201	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Acenaphthene	mg/kg	0.00671	0.0889	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Acenaphthylene	mg/kg	0.00587	0.128	-	-	0.08	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Acridine	mg/kg	-	-	-	-	-	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Anthracene	mg/kg	0.0469	0.245	0.22	370	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzo(a)anthracene	mg/kg	0.0317	0.385	0.32	1,480	0.1	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzo(a)pyrene	mg/kg	0.0319	0.782	0.37	1,440	0.1	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Benzo(b)fluoranthene	mg/kg	-	-	-	-	0.3	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzo(b)pyridine (Quinoline)	mg/kg	-	-	-	-	-	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzo(g,h,i)perylene	mg/kg	-	-	0.17	320	0.2	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Benzo(k)fluoranthene	mg/kg	-	-	0.24	1340	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Chrysene	mg/kg	0.0571	0.862	0.34	460	0.18	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Dibenz(a,h)anthracene	mg/kg	0.00622	0.135	0.06	130	0.15	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Fluoranthene	mg/kg	0.111	2.355	0.75	1,020	0.24	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Fluorene	mg/kg	0.0212	0.144	0.19	160	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Fluorine	mg/kg	-	-	-	-	-	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Indeno(1,2,3-cd)pyrene	mg/kg	-	-	0.2	320	0.11	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Naphthalene	mg/kg	0.0346	0.391	-	-	0.05	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Phenanthrene	mg/kg	0.0419	0.515	0.56	950	0.19	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Pyrene	mg/kg	0.053	0.875	0.49	850	0.19	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Metals											
Arsenic	mg/kg	5.9	17	6	33	14	1	1 U	1	1	1 U
Cadmium	mg/kg	0.6	3.5	0.6	10	1	1 U	1 U	1 U	1 U	1 U
Chromium Total	mg/kg	37.3	90	26	110	7	4	4	5	7	5
Cobalt	mg/kg	-	-	50	-	19	2	2	2	2	2
Copper	mg/kg	35.7	197	16	110	26	3	3	3	3	3
Iron	mg/kg	-	-	20,000	40,000	-	4,360	3,760	3,620	6,650	4,680
Lead	mg/kg	35	91.3	31	250	55	2	2	2	2	3
Manganese	mg/kg	-	-	460	1,100	-	60	42	41	50	46
Mercury	ug/g	0.17	0.486	0.2	2	0.16	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nickel	mg/kg	-	-	16	75	43	2	2	2	3	3
Silver	mg/kg	-	-	0.5	-	0.35	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	mg/kg	123	315	120	820	150	12	6	8	6	11
PCBs											
Total PCBs	mg/kg	0.0341	0.277	0.07	530	0.3	0.2 U	0.2 U	0.2 U	0.04 U	0.04 U
General Chemistry											
Ammonia-n	mg/kg	-	-	100	-	-	26	16	15	10	20
Cyanide (total)	mg/kg	-	-	0.1	-	-	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Fraction Organic Carbon (FOC)	NONE	-	-	-	-	-	0.002	0.001 U	0.003	0.002	0.001
Moisture	%	-	-	-	-	-	25.9	17.5	26.2	21.7	23.2
Oil and Grease	mg/kg	-	-	1500	-	-	10,000 U	10,000 U	10,000 U	10,000 U	10,000 U
Phenol	mg/kg	-	-	-	-	0.1	0.1 U	0.1 U	0.1 U	0.1 U	0.1
Phosphorus	mg/kg	-	-	600	2,000	-	101	48	129	102	115
Redox	millivolts	-	-	-	-	-	265	285	285	295	295
Total Kjeldahl Nitrogen (TKN)	mg/kg	-	-	550	4,800	-	297	194	399	262	193
Total Organic Carbon (TOC)	%	-	-	1	10	-	0.2	0.1 U	0.3	0.2	0.1

NOTES:

(a) *"Canadian Sediment Quality Guideline for the Proection of Aquatic Life"* , CCME, 2002. Interim Sediment Quality Guideline
(b) *"Canadian Sediment Quality Guideline for the Proection of Aquatic Life"* , CCME, 2002. Probable Effect Level
(c) *"Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines"* , MOE, 2006. Lowest Effect Level
(d) *"Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines"* , 2006. Severe Effect Level
"Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario" (MOE, 1993).
(e) *"Soil, Ground Water and Sediment Standards for use Under Part XV.1 of the Environmental Protection Act", MOE, 2004*
Table 1 - Full Depth Backgroud Site Condition Standards. Agricultural or other property use

U Not detected above method detection limit shown
\- No criteria
Bold Measured concentration exceeds applicable groundwater quality criterion.

TABLE A-5
SEDIMENT GRAIN SIZE ANALYSIS SUMMARY - APRIL/JUNE 2007
GROS CAP INTAKE PROTECTION ZONE

Sample Location	*Sample Name*	*Field Observations*	*Laboratory Description*	*Gravel*	*Sand*			*Silt + Clay*
					Coarse	*Medium*	*Fine*	
				%	*%*	*%*	*%*	*%*
AO4	SS-46442-070428-RB-001	-	Sand with Gravel, Trace Silt + Clay	12	1.57	12.76	72.9	1
AO9	SS-46442-070428-RB-003	-	Sand with Gravel, Trace Silt + Clay	13.21	4.54	27.81	49.9	4.54
Red Rock	SS-46442-070609-KM-01	Gravel and Boulders	Gravelly Sand	32.8	18.8	42.8	5.6	0
Jackson Creek	SS-46442-070609-KM-02	Sand, Gravel and Boulders	Sand and Gravel	42	15.6	27.6	14.8	0
Gros Cap Shoreline	SS-46442-070609-KM-03	Sand, Gravel and Boulders	Gravelly Sand, Trace Silt + Clay	35.2	6.8	27.2	30	0.8
SW0012	SS-46442-070609-KM-04	Sand	Sand, Trace Silt + Clay	0	0	14.8	83.6	1.6
SW03	SS-46442-070609-KM-05	Sand, some Gravel	Sand, Trace Silt + Clay, Trace Gravel	1.6	0.4	37.6	58.4	2.0
SW07	SS-46442-070609-KM-06	Sand	Sand, Trace Silt + Clay	0.4	0.4	21.2	76.4	1.6
SW06	SS-46442-070609-KM-07	Sand, some Gravel	Gravelly Sand, Trace Silt + Clay	29.6	5.2	4.4	60	0.8
SW08	SS-46442-070609-KM-08	Sand, some Gravel	Sand with Gravel, Trace Silt + Clay	19.6	10.8	15.20	52.8	1.6
SW12	SS-46442-070609-KM-09	Sand, some Gravel	Sand with Gravel, Trace Silt + Clay	11.6	2.4	10.4	71.2	4.4

TABLE A-6
SURFACE WATER OUTFALLS/DISCHARGES
GROS CAP INTAKE PROTECTION ZONE
SAULT STE. MARIE, ONTARIO

Discharge	*Tributary*	*Slope*	*Soil Type*	*Stream Cross-Section*			*Discharge Calculation Fall 2006*							*Comments*
				Width (m)	*Height (m)*	*Area (m^2)*	*Water Depth (m)*	*Wetted Area (m2)*	*Wetted Perimeter (m)*	*Hydraulic Radius (Rh) (m)*	*Approx. Discharge Flow (m^3/sec)*	*Coefficient*	*Actual Discharge (1) (2) Flow (m^3/sec)*	
North of 5 km Radius														
0	PRINCE CREEK	1:20	Sand, Boulder	10	0.5	5	0	0	10	0	DRY	0.04	0.00	
North of Intake														
1	JACKSON CREEK	1:20	Sand, Boulder, Bedrock	4	1	4	0	0	4	0	DRY	0.04	0.00	
South of Intake														
2	SW 0012	1:30	Sand, Gravel, Boulder	1	0.75	0.75	0.102	0.102	1.204	0.08	0.00001	0.037	0.09	
3	SW 01	1:20	Sand, Scattered Boulder with Sand Bags	2	1.5	3	0	0	2	0.00	DRY	0.037	DRY	DRY
4	SW 02	1:25	Sand, Scattered Boulders	2.5	0.5	1.25	0.06	0.15	2.62	0.06	0.001	0.037	0.12	
5	SW 03	1:30	Sand, Fine Gravel	1.4	0.5	0.7	0.16	0.224	1.72	0.13	0.003	0.037	0.27	
6	SW 04	1:25	Sand, Cobbles	3	1	3	0.06	0.18	3.12	0.06	0.008	0.037	0.15	
7	SW 05	1:25	Sand, Rip Rap at Mouth	4	1.5	6	0.04	0.16	4.08	0.04	0.003	0.037	0.10	
8	SW 06	1:25	Sand, Rip Rap at Mouth	2.5	1	2.5	0.04	0.1	2.58	0.04	STAGNANT	0.037	STAGNANT	STAGNANT
9	SW 07	1:25	Sand, Rip Rap at Mouth	1.5	0.5	0.75	0	0	1.5	0.00	DRY	0.037	0.00	DRY
10	SW 08	1:25	Sand, Rip Rap at Mouth	2	0.5	1	0	0	2	0.00	DRY	0.037	0.00	DRY
11	SW 09	1:25	Sand, Rip Rap at Mouth	1.5	0.5	0.75	0	0	1.5	0.00	DRY	0.037	0.00	DRY
12	SW 10	1:25	Sand, Rip Rap at Mouth	2.5	1	2.5	0	0	2.5	0.00	DRY	0.037	0.00	DRY
13	SW 11	1:25	Sand, Rip Rap at Mouth	3	1.2	3.6	0	0	3	0.00	DRY	0.037	0.00	DRY
14	SW 12	1:30	Sand	1	0.25	0.25	0.17	0.17	1.34	0.13	STAGNANT	0.037	STAGNANT	STAGNANT

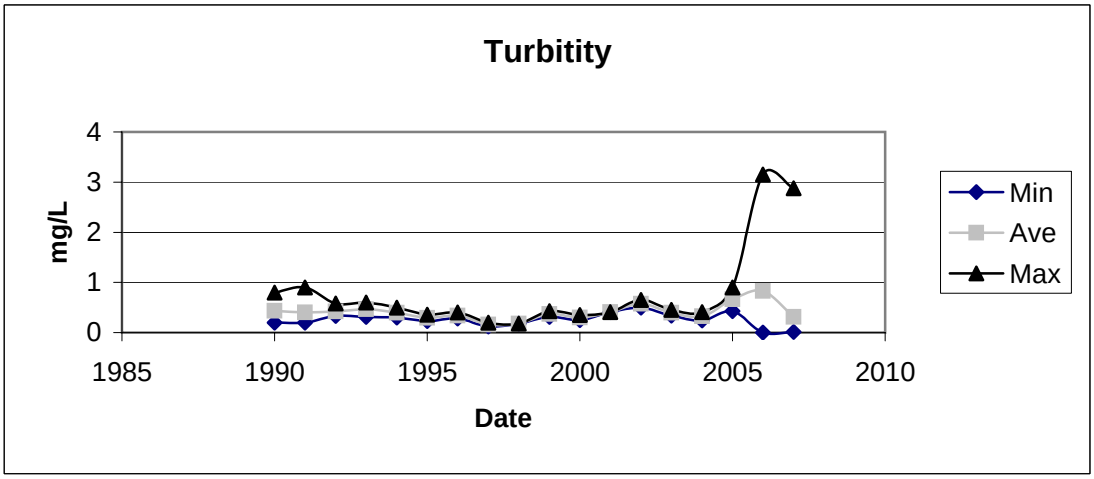
NOTES:
1) Coefficient for Prince and Jackson Creeks based on Natural Channels with Fairly Regular Sections (0.40) and all others based on Excavated Rock Streams (0.037)
2) Flow calculated using on Manning's Equation

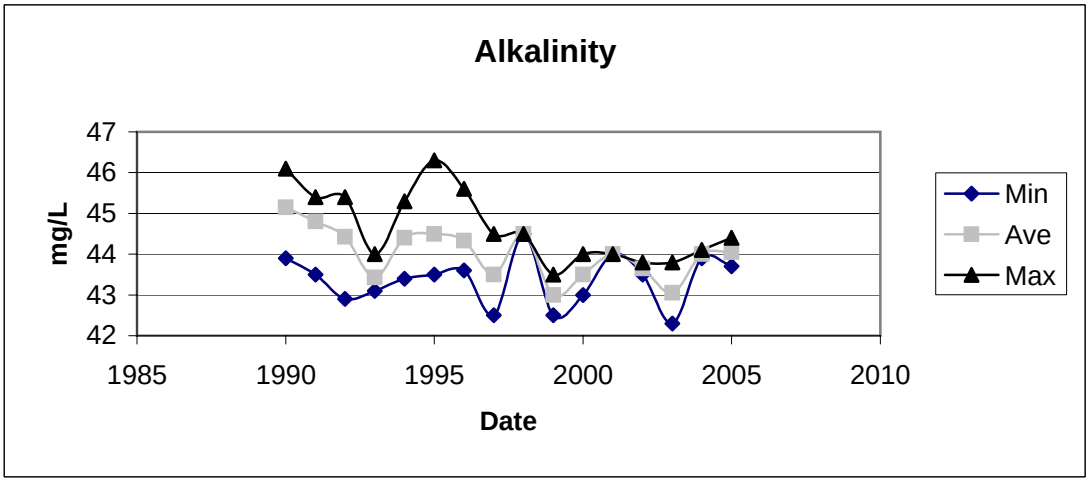
TABLE A-6
SURFACE WATER OUTFALLS/DISCHARGES
GROS CAP INTAKE PROTECTION ZONE
SAULT STE. MARIE, ONTARIO

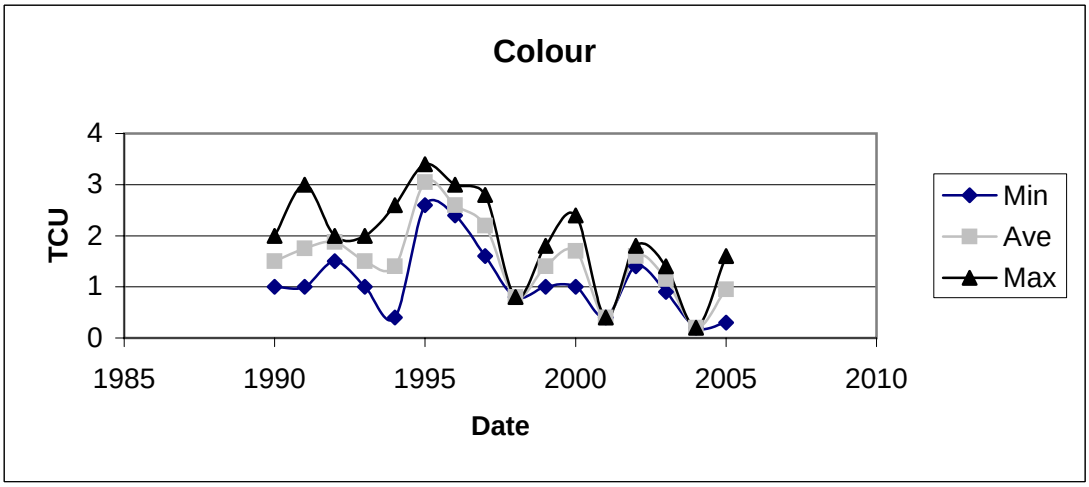
Discharge	*Tributary*	*Slope*	*Soil Type*	*Stream Cross-Section*			*Discharge Calculation Spring 2007*							*Comments*
				Width (m)	*Height (m)*	*Area (m^2)*	*Water Depth (m)*	*Wetted Area (m2)*	*Wetted Perimeter (m)*	*Hydraulic Radius (Rh) (m)*	*Approx. Discharge Flow (m^3/sec)*	*Coefficient*	*Actual Discharge (1) (Manning Formula)*	
North of 5 km Radius														
0	PRINCE CREEK	1:20	Sand, Boulder	10	0.5	5								NOT SURVEYED
North of Intake														
1	JACKSON CREEK	1:20	Sand, Boulder, Bedrock	4	1	4	0.1	0.4	4.2	0.095	0.0017	0.04	0.47	
South of Intake														
2	SW 0012	1:30	Sand, Gravel, Boulder	1	0.75	0.75	0.9	0.9	2.8	0.321	0.00025	0.04	1.98	
3	SW 01	1:20	Sand, Scattered Boulder with Sand Bags	2	1.5	3								NOT SURVEYED
4	SW 02	1:25	Sand, Scattered Boulders	2.5	0.5	1.25								NOT SURVEYED
5	SW 03	1:30	Sand, Fine Gravel	1.4	0.5	0.7	0.05	0.07	1.5	0.047	0.0045	0.04	0.04	
6	SW 04	1:25	Sand, Cobbles	3	1	3								NOT SURVEYED
7	SW 05	1:25	Sand, Rip Rap at Mouth	4	1.5	6								NOT SURVEYED
8	SW 06	1:25	Sand, Rip Rap at Mouth	2.5	1	2.5	0.05	0.125	2.6	0.0481	0.003	0.04	0.09	
9	SW 07	1:25	Sand, Rip Rap at Mouth	1.5	0.5	0.75	0	0	1.5	0	STAGNANT	0.04	STAGNANT	STAGNANT
10	SW 08	1:25	Sand, Rip Rap at Mouth	2	0.5	1	0	0	2	0	DRY	0.04	DRY	DRY
11	SW 09	1:25	Sand, Rip Rap at Mouth	1.5	0.5	0.75								NOT SURVEYED
12	SW 10	1:25	Sand, Rip Rap at Mouth	2.5	1	2.5								NOT SURVEYED
13	SW 11	1:25	Sand, Rip Rap at Mouth	3	1.2	3.6								NOT SURVEYED
14	SW 12	1:30	Sand	1	0.25	0.25	0.1	0.1	1.2	0.083	STAGNANT	0.04	0.00	STAGNANT

NOTES:
1) Coefficient for Prince and Jackson Creeks based on Natural Channels with Fairly Regular Sections (0.40) and all others based on Excavated Rock Streams (0.037)

GRAPHICAL TRENDS IN RAW WATER QUALITY PARAMETERS
GROS CAP INTAKE
SAULT STE. MARIE, ONTARIO

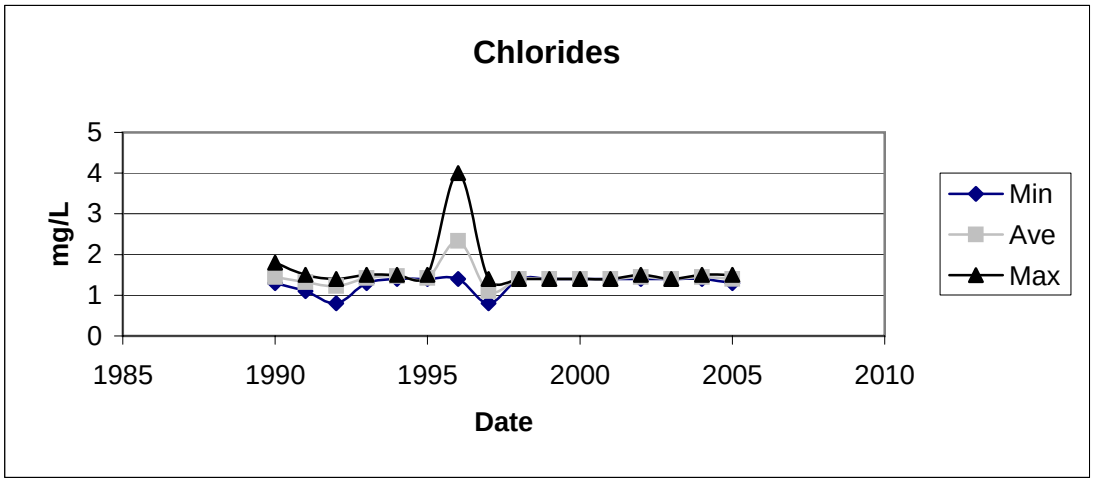


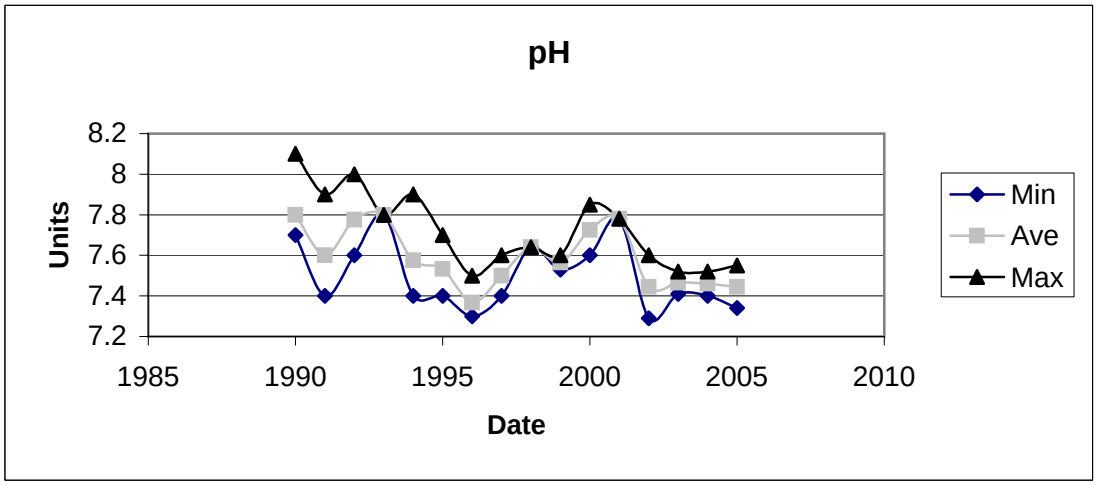


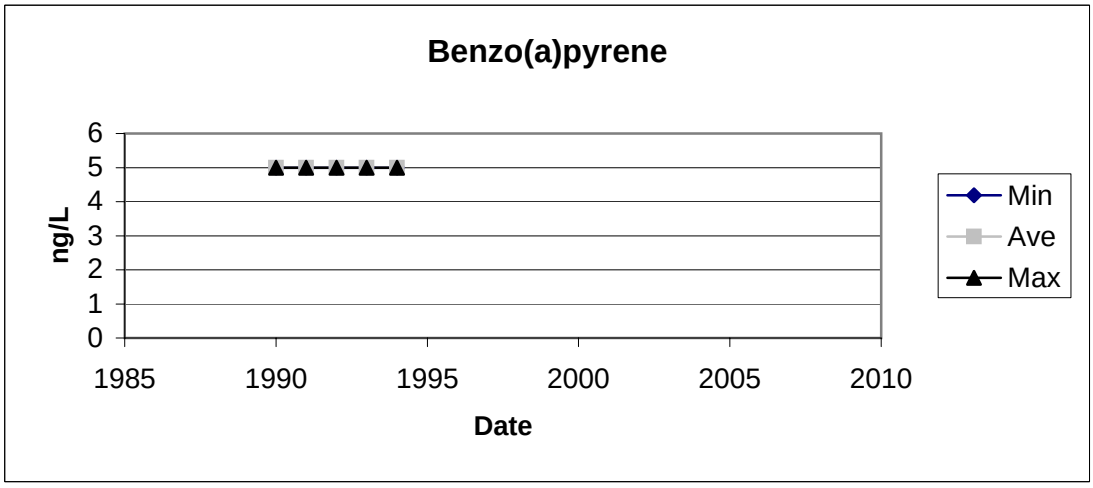


Data from PUC Services Inc.

GRAPHICAL TRENDS IN RAW WATER QUALITY PARAMETERS
GROS CAP INTAKE
SAULT STE. MARIE, ONTARIO

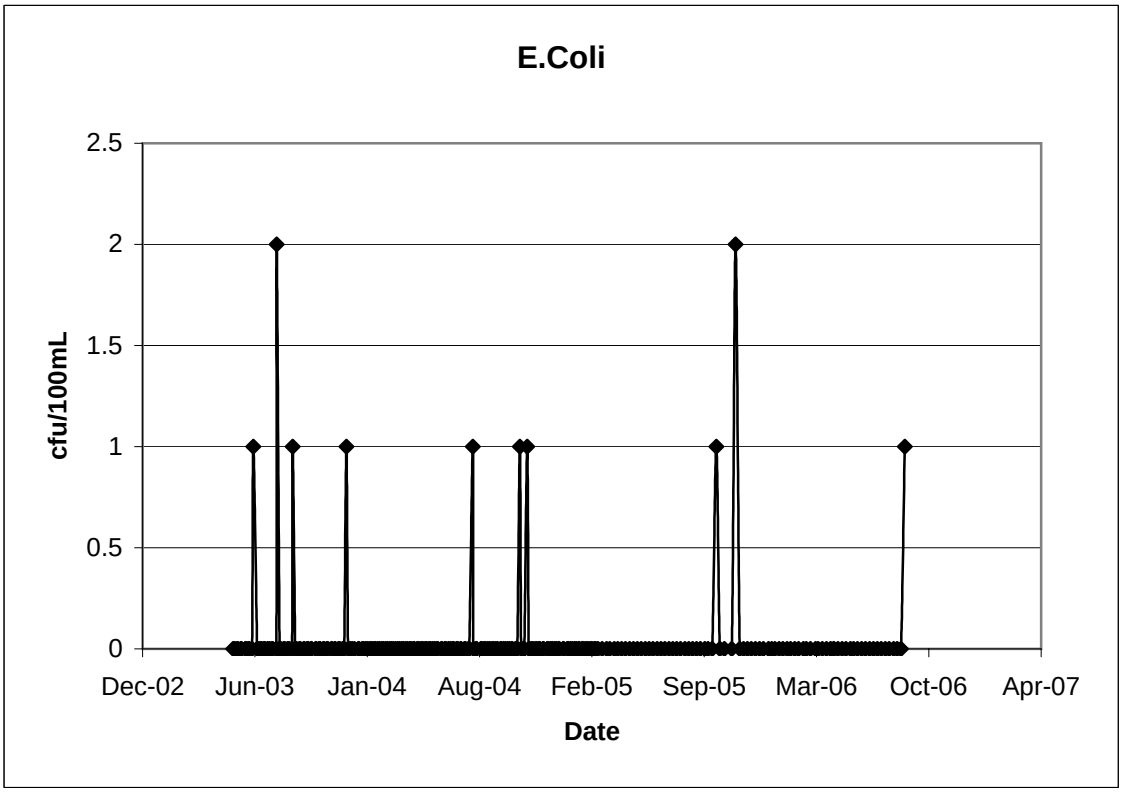


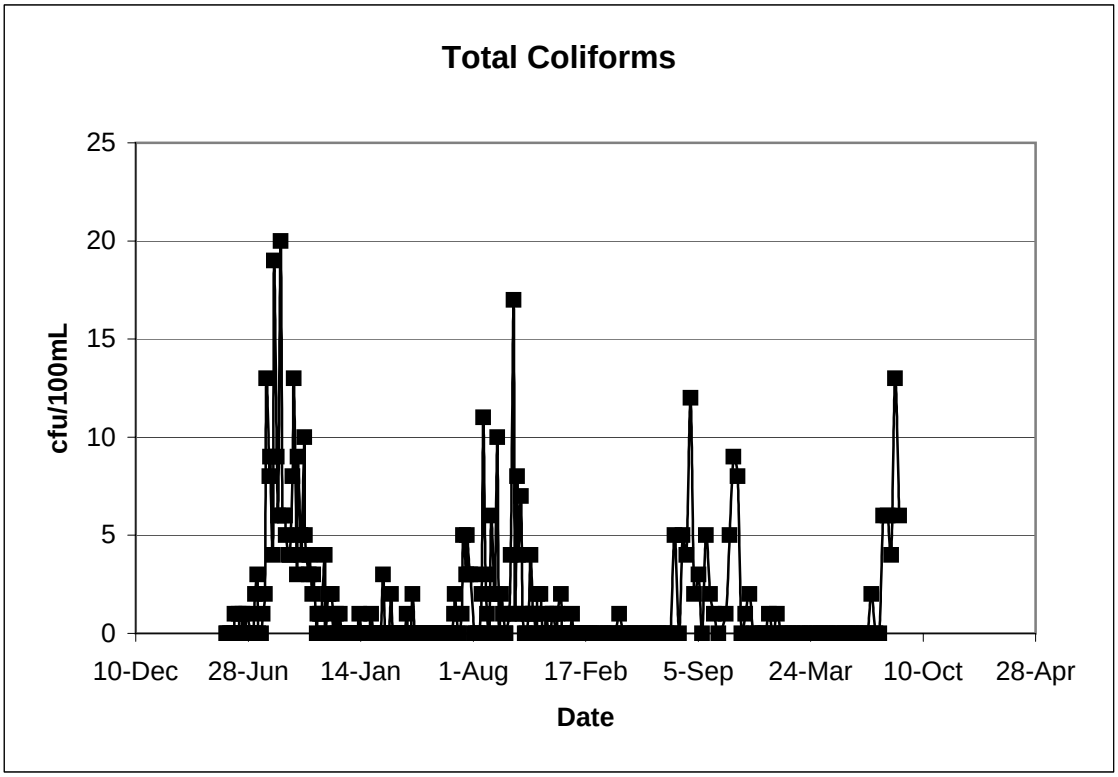




Data from PUC Services Inc.

GRAPHICAL TRENDS IN RAW WATER QUALITY PARAMETERS
GROS CAP INTAKE
SAULT STE. MARIE, ONTARIO





Data from PUC Services Inc.

APPENDIX B
OPERATORS SURVEY

Source Water Assessment Program

Water Supply Name:	**Municipality:**
Lake Superior (Gros Cap)	Sault Ste. Marie
Intake Eastings (NAD 83/WGS 84):	**Intake Northings (NAD 83/WGS 84):**
84°32' 34.09225"W	46°36' 37.5"N
Pipe diameter (mm):	**As-built attached (y/n):**
1200mm	No

Intake description (where is water being drawn from?):

The intake extends 830 metres from the shore of Lake Superior to a depth of 15 metres below water surface.

Operational details

Water Treatment Plant Design:
Please submit the existing treatment plant design parameters/limitations for the various chemicals of concern (i.e., VOCs, coliforms, etc.).

See attached flowchart

Pumping record:
Please submit a digital record of extraction at the smallest interval possible

Attached

Intake water temperature:
Please submit a digital record of temperature at the smallest interval possible

Attached

Raw water quality:
Please submit a digital record of historical raw water quality

Attached

Typical/estimated notification time from MOE for local spill events:

1 hour

Anticipated reaction time to respond to a spill event (shut-down time):

2 hours, Note: There is approximately 5.5 hrs retention time from intake to WTP based on design flow rate of 40,000 m^3/day.

Historical operational issues
Please summarize taste, odour, and turbidity issues experienced at the intake including timing, recurrence, and potential causes (e.g., after heavy rainfall). Also list issues associated with wind, ice or current conditions (e.g., winds above X km/h from direction Y result in high turbidity, we get frazil ice accumulating under X conditions).

- No taste or odour issues;
- No wind, ice or current issues; and
- Turbidity ranges from 0.27 to 1.5 NTU with higher values observed in October/November on an annual basis, due to build up of debris in the water following defoliation.

Past Raw Water Qualities (5 Years)	*Average*	*Minimum*	*Maximum*	*Comments*
Turbidity:	0.38	0.12	0.9	1990-2005
Total Coliform:	2	0	20	2003-2006
E.coli:	0	0	2	2003-2006
HPC:		not available		
Chlorides:	1.4	0.8	4	
PH:	7.59	7.29	8.1	1990-2005
Color:	1.5	0.2	3.4	1990-2005
Alkalinity:	44.0	42.5	46.3	1990-2005

Please indicate your level of concern (Very, Somewhat, Low, Don't Know) for each of the following Contaminant Groups and Contaminant Sources with comments where appropriate.

Contaminants of Concern	
Microbial (Coliform, Cryptosporidium, etc.):	Low
Inorganics (Metals, Nitrates, etc.):	Low
Volatile Organics (Benzene, TCE, Etc.):	Low
Synthetic Organics (PCB's, Dioxin, etc.):	Low
Pesticides (Atrazine, etc.):	Low
Radioactivity (Radium, etc.):	Low
Other:	

Potential Sources of Contaminant Sources of Concern – Complete only those that apply to intake.	
Crop Related Agriculture:	N/A
Grazing Related Agriculture:	N/A
Animal Feeding Operations:	N/A
Municipal Wastewater Discharges:	N/A
Industrial Wastewater Discharges:	N/A
Wastewater Treatment Bypasses:	N/A
Combined Sewer Overflows:	N/A
Urban Runoff/Storm Sewers: Drainage ditches in Prince Township.	
Construction Runoff: Sunnyside Beach (located downstream) has residential lots under development.	
Contaminated Sediments: Tannery Bay (located approximately 1 kilometre downstream on St. Mary's River) has heavy metals and SVOCs impacted sediments.	
Bank or Shoreline Modifications: Residential properties have gabions and shore walls to prevent errosion	
Drainage/Filling of Wetlands:	N/A
Highway Runoff: Intake located at the end of Highway 558	
Stream Channelization:	N/A
Dredging: Access Dredging occurs occasionally at the Gros Cap Marina and within the shipping channel (St Marys R.). Currently, Tannery Bay sediments are being dredged for disposal.	
Dam Construction:	N/A
Upstream Impoundments: Mine tailings ponds located along Lake Superior's north shore (at a distance).	

Land Disposal of Sludge/Wastewater: N/A
Landfills: North of Sault Ste. Marie, small MNR Landfills may discharge to watercourses that join Lake Superior.
Leaky Underground Storage Tanks: Not aware of any
Marinas -Gros Cap Marina is located adjacent to Intake. No fuel storage at this location.
Wildlife -N/A
Mining Activities: - At distance, north of Sault Ste. Marie.
Salt Storage: -Located 1 km from Goulais River and operated by Ministry of Transportation of Ontario.
Logging Activities: Potential in the long-term.
Spills: Residential heating oil from aboveground storage tanks.
Shipping: Major shipping channel located in the St. Mary's River. Commodity Codes are attached to this document.
River/Creek Influences: Jackson Creek and other minor, intermittent discharges
County Drain Influences: Drainage Ditches from shoreline roads
Others: Potential forest fire fallout over Lake Superior
Data Sources/Reports: Please list the information available and the format (digital, hard copy, can come to plant and scan)
Engineering design / Assessment reports: Underwater Inspection of Water Intake Structure (Watech Services Inc., August 2006) Water Intake Inspection Video (October 2004), Engineers' Report for Water Works (Delcan May 2001) Sault Ste. Marie P.U.C. Reprot – New Water Supply (The Proctor & Redfern Group, July 1982)
Sediment and substrate characteristics at the intakes and in the local lakebed: NA
Shoreline modifications/engineering works: NA
Bathymetry around intake and flood mapping: NA
Local and regional current/flow and drift patterns by currents, waves and ice: NA
Local recreational uses: NA
Municipal land use plans (.shp file where possible): Available at Sault Ste. Marie's GIS Portal http://portal.ssmic.com/
Meteorological data (municipal): NA
Others: NA
Survey Completed by: DAN TONON — Title: MANAGER, WATER TREATMENT
Municipality: SAULT STE. MARIE — Date: AUG. 16/07 — Telephone: (705) 759-6518 — email: dan.tonon@ssmpuc.com
Plant(s) managed: SAULT STE. MARIE A.C. BONIFERRO WATER TREATMENT PLANT

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Sault Ste. Marie
Ontario P6B 4J8

APPENDIX C
RAW AND PROCESSED ADCP DATA

(DATA CD TO BE ENCLOSED WITH FINAL REPORT)

APPENDIX - D

ISSUES EVALUATION AND THREATS INVENTORY

GROS CAP INTAKE
SAULT STE. MARIE, ONTARIO

Prepared For:
SAULT STE. MARIE REGION CONSERVATION AUTHORITY

JULY 2009
REF. NO. 046442 (3)

This report is printed on recycled paper.

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1.0 INTRODUCTION

This Issues Evaluation and Threats Inventory was prepared on behalf of the Sault Ste. Marie Conservation Authority (SSMRCA) to identify drinking water issues and concerns associated with the drinking water intake located within Lake Superior at Gros Cap, Ontario (Gros Cap Intake) and to create an inventory of threats (past and present) that may adversely affect the drinking water source. The Issues Evaluation and Threats Inventory, prepared in accordance with the Technical Rules (MOE, 2008), will be included as part of the Technical Assessment Report for the Sault Ste. Marie source water protection area.

1.1 SCOPE OF WORK

This report includes the required threats assessment and issues evaluation as well as the risk assessment relating to water quality for the Gros Cap Intake.

1.2 DATA SOURCES

Various data sources were utilized in compiling the Issues Evaluation and Threats Inventory, including the following:

Data Sources Utilized – Gros Cap Issues Evaluation and Threats Inventory

Data Source Referenced	Purpose
Traffic Statement 2006 Navigation Season, St. Marys Falls Canal	Identification of Materials Transported Through the Shipping Channel
Lock Commodities Report – Sault Locks 2007	Identification of Materials Transported Through the Shipping Channel
ERIS Report - Multiple Databases Searched	Identification of Historical Issues/Threats
ODWSP Data	Historical Raw Water Quality
Property Owner/Tenant Questionnaire	Property Use and Potential Threats

Data Source Referenced	Purpose
Interviews with PUC personnel and Prince Township Staff	Property Use and Potential Threats
Field Reconnaissance	Property Use and Potential Threats
Ontario Base Mapping	Area features and IPZ Overlay
Township of Prince Office Consolidation of Zoning By-law 77-7	Property Use
MPAC Data	Property UTM Coordinates
PIN Maps Obtained from the Sault Ste. Marie Land Registry Office	Property PIN numbers
Aerial Photography (Google Earth)	Property Development
Assessment Report: Draft Guidance Module 5 – Issues Evaluation and Threats Inventory	Original MOE Guidance for Inventory Preparation
Technical Rules: Assessment Report, Clean Water Act, 2006 (December 2008)	Current Technical Rules for Describing Issues, Listing Threats and Assessing Risk
Sault Ste. Marie Region Conservation Authority Watershed Characterization, Draft Report, 2008	Initial Issues and Threats Evaluation
Gros Cap Intake Protection Zone Study, 2008	Raw Water Characterization and WTP Operator Interview
Gros Cap Intake Protection Zone Study Addendum, 2008	IPZ delineation, Vulnerability Scores and Uncertainty Analysis

2.0 BACKGROUND

2.1 THE CLEAN WATER ACT

The Clean Water Act (Act) of Ontario was passed into law in 2006 for the purpose of protecting past and future drinking water resources within the province. The Act establishes areas within the jurisdiction of Ontario Conservation Authorities as drinking water source protection areas and mandates the development and implementation of source protection plans for municipal residential drinking water sources within these areas. Under the Act, source water protection is presented as a locally driven, science-based, multi-stakeholder process. The local source water protection committee (SPC), established for each source water protection area, is required to develop a terms of reference, an assessment report and a source protection plan for the source protection area.

The assessment report is a locally developed, science-based report, which will include a watershed characterization, a water budget, delineation of vulnerable areas, groundwater and surface water vulnerability analysis, a threats assessment and issues evaluation, and a risk assessment for water quality and quantity. The assessment reports will be used as a basis for the development of source protection plans.

2.2 PREVIOUS STUDIES

Previous work conducted in support of the assessment report and source protection plan for the Gros Cap Intake include the preparation of a groundwater management and protection study and vulnerability analysis (Burnside, 2003 and 2005), and a draft *Watershed Characterization Report* (SSMRCA, 2008) for the source protection area as well as the delineation of the surface water intake protection zones (IPZs) around the Gros Cap Intake, the determination of the associated vulnerability scores, and an analysis of the uncertainty associated with the intake protection zone delineation (Baird, 2008). Water Budgets and associated enumeration of threats to water quantity within the source protection area were also conducted by others.

2.2.1 WATERSHED CHARACTERIZATION

The draft Watershed Characterization Report prepared for the source protection area (SSMRCA, 2008) notes that approximately 50 percent of the City of Sault Ste. Marie's drinking water is sourced from Lake Superior, drawn from the Gros Cap Intake. The

surface water quality analysis provided in the report indicates that based on a review of available water quality analysis data (1990 to 2005), parameter concentrations detected within raw water at the Gros Cap Intake did not exceed the Ontario Drinking Water Standards (ODWS).

The draft Watershed Characterization Report provides a general assessment of existing drinking water threats mainly associated with groundwater resources within the source protection area. Identified point source threats included fuel storage and handling facilities, waste disposal facilities, septic systems, contaminated sites, PCB storage sites, waste generators and haulers, salt storage facilities, cemeteries and abandoned wells. Non-point source threats identified within the source protection area, which may also apply to surface water, included pesticide, herbicide and fertilizer application for agricultural purposes or for lawn/garden maintenance, organic soil conditioning and septage spreading, as well as road salt application. Threats related to these activities were associated with improper chemical use and spills.

2.2.2 INTAKE PROTECTION ZONE STUDY

The Intake Protection Zone Study (Baird, 2008) was conducted to delineate the intake protection zones IPZ-1 and IPZ-2 around the Gros Cap Intake. The Study included assigning vulnerability scores for each of these areas, which reflect the probability that a contaminant released within the area will reach the intake.

An addendum to the Intake Protection Zone Study was released in October 2008. The IPZ-1 was updated to conform to the Draft Technical Rules (MOE, 2008) in place at the time (Baird, 2008). The IPZ-2 was also updated using a computer model that simulated hydrodynamic processes within the IPZ (Baird, 2008). The updated IPZ-2 included the upstream reaches of two tributaries (Jackson Creek and SW0012) that discharge into Lake Superior within IPZ-2. The updated IPZ-1 and IPZ-2 are shown on Figure 1.

The vulnerability scores assigned to each IPZ-1 and IPZ-2 were calculated in accordance with the following formula:

$$\text{Vulnerability Score} = B \times C$$

Where:

B = the area vulnerability factor of the surface water intake protection zone
C = the source vulnerability factor of the surface water intake protection zone

The assigned vulnerability scores are shown below.

Summary of Vulnerability Scores - Gros Cap Intake

IPZ	Area Vulnerability Factor	Source Vulnerability Factor	Vulnerability Score
IPZ-1	10	0.5	5
IPZ-2	8	0.5	4

2.3 RAW WATER QUALITY

The Intake Protection Zone Study (Baird, 2008) included a review of the historical concentrations of various parameters from raw water samples collected at the Water Filtration Plant (Plant). Historical raw water quality data was provided for 1990 to 2005 by PUC Services Inc (PUC), the Plant operators. The PUC raw water quality data for the intake was documented as part of the Ontario Drinking Water Surveillance Program (ODWSP). Sample parameters included general chemistry parameters (temperature, harness, alkalinity, etc.) ions, nutrients, bacteria, metals, volatile organic compounds (VOCs), herbicides and pesticides, phenolics, polynuclear aromatic hydrocarbons (PAHs), radionuclides and other chemicals included the Technical Support Document for Ontario Drinking-Water Standards, Objectives, and Guidelines (MOE, 2006) (ODWS).

Based on the historical ODWSP data, average pH, colour, alkalinity, turbidity, and total coliforms showed relatively stable or slight decreasing trends from the mid 1990s to 2005 with a slight increase in 2006. The chloride concentration remains stable since 2000 and the *E.Coli* concentration remained relatively stable at 0 cfu/mL from 2003 to 2007, with occasional peaks of 1 or 2 cfu/mL.

The Intake Protection Zone Study (Baird, 2008) also included the collection of four surface water samples from locations in the area surrounding the Gros Cap Intake. Samples were collected at locations ranging from 400 meters to one kilometre from the intake structure. With the exception of volatile organic compounds (VOCs), samples were composites of water volumes collected throughout the water column. The samples were analyzed for physical, chemical, and microbial parameters included in Tables 1, 2, and 4 of the ODWS, and for phenols. Based on a review of the analytical data, several parameter concentrations exceeded the ODWS including *E.coli*, total coliform bacteria, and organic nitrogen. In addition, the water hardness consistently fell below the

operational guideline range. These parameter concentrations are summarized on Table 1.

None of the noted exceedances are unexpected for a surface water source. The only health related exceedances were for microbiological parameters, which the treatment system can easily handle.

During the operator interview conducted as part of the Intake Protection Zone Study (Baird 2008), the PUC plant operator described the surface water source for the WTP as "very high quality". Considering that samples from the raw source water meet most of the ODWS, which are intended for comparison with treated drinking water analytical results, the results historical and recent source water sampling support that claim.

2.4 SEDIMENT QUALITY

The Intake Protection Zone Study (Baird, 2008) included the collection of sediment samples at Jackson Creek, tributary SW0012 and at the Gros Cap shoreline as well as a sample collected from the lake bed at the Intake structure. Sediment samples were analyzed for semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, and general chemistry parameters.

With the exception of the sediment sample collected at the Gros Cap shoreline no parameters were detected at concentrations that exceeded any of the provincial or federal sediment criteria. The Gros Cap shoreline sample, collected within IPZ-1, approximately 830 metres from the Intake structure, exhibited concentrations of 13 polyaromatic hydrocarbons (PAHs) that exceeded the MOE lowest effect level (LEL). The MOE LELs were adopted as Standards in "Soil, Groundwater and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act" (MOE, 2004) (Soil, Groundwater and Sediment Standards). These parameter concentrations are summarized on Table 2.

With the exception of Benzo(a)pyrene, PAHs are not analyzed as part of the raw water characterization for the Gros Cap Intake. Benzo(a)pyrene was not detected in any of the surface water samples collected during the Intake Protection Zone Study and concentrations of Benzo(a)pyrene provided in the ODWSP data were well below the ODWS.

The extent and source of the PAH impact at the Gros Cap shoreline was not determined during the Intake Protection Zone Study.

In addition, the laboratory method detection limit (MDL) marginally exceeded the MOE LEL for cadmium for all samples. The laboratory MDL for total PCBs exceeded the MOE LEL for the sample collected at the Gros Cap Shoreline. As such, it is not known if these contaminant concentrations exceed the criteria at these locations.

2.5 ENVIRONMENTAL DATABASES SEARCH

CRA contracted EcoLog Environmental Risk Information Services Ltd. (ERIS) to conduct a search of available federal, provincial and private environmental databases. The database searches were completed to assist in the identification of environmental conditions within the IPZ. A summary of the pertinent findings from the database search is provided below. The numbers of records identified for the IPZ are identified in the following table. The complete database search report, which describes the database contents and limitations associated with this information, is included in Appendix A.

Database	*Number of Records*
FEDERAL DATABASES	
Environmental Effects Monitoring (**EEM**)	None
Environmental Issues Inventory System (**EIIS**)	None
Federal Convictions (**FCON**)	None
Federal Contaminated Sites (**FCS**)	5
Five Records were listed in the FCS database for two Sites. A site at the southwest section of the Gros Cap Reefs, located within IPZ -2, was identified within the database. No contaminants of concern were identified. The record indicated that no samples were taken to confirm contamination. Four additional records were included for sites located in the area of the Gros Cap Marina. Based on a historical review, heavy metals were a suspected contaminant within sediment. An initial testing program identified petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and heavy metals in soil in the vicinity of the access area. The sample results were not included with the record.	
Fisheries & Oceans Fuel Tanks (**FOFT**)	None
Indian & Northern Affairs Fuel Tanks (**IAFT**)	None
National Analysis of Trends in Emergencies System (**NATE**)	None
National Defense & Canadian Forces Fuel Tanks (**NDFT**)	None
National Defence & Canadian Forces Spills (**NDSP**)	None
National Defence & Canadian Forces Waste Disposal Sites (**NDWD**)	None
National Environmental Emergencies System (**NEES**)	None
National PCB Inventory (**NPCB**)	None

Database	*Number of Records*
National Pollutant Release Inventory (**NPRI**)	None
Parks Canada Fuel Storage Tanks (**PCFT**)	None
Transport Canada Fuel Storage Tanks (**TCFT**)	None
PROVINCIAL DATABASES	
Abandoned Aggregate Inventory (**AAGR**)	None
Aggregate Inventory (**AGR**)	None
Abandoned Mines Information System (**AMIS**)	None
Certificates of Approval (**CA**)	None
Coal Gasification Plants (**COAL**)	None
Compliance and Convictions (**CONV**)	None
Drill Holes (**DRL**)	None
Environmental Registry (**EBR**)	None
Ontario Regulation 347 Waste Generators Summary (**GEN**)	None
Mineral Occurrences (**MNR**)	None
Non-Compliance Reports (**NCPL**)	None
Ontario Inventory of PCB Storage Sites (**OPCB**)	None
Ontario Oil and Gas Wells (**OOGW**)	None
Pesticide Register (**PES**)	None
Private and Retail Fuel Storage Tanks (**PRT**)	None
Ontario Regulation 347 Waste Receivers Summary (**REC**)	None
Record of Site Condition (**RSC**)	None
Wastewater Discharger Registration Database (**SRDS**)	None
Ontario Spills **(SPL)**	None
Waste Disposal Sites – MOE CA Inventory (**WDS**)	None
Waste Disposal Sites – MOE 1991 Historical Approval Inventory (**WDSH)**	None
Water Well Information System (**WWIS**)	37
The majority of the wells are domestic supply wells. One well was for public supply. A listing of the water wells located within the IPZ identified within the WWIS database is included on Table 3. The water well locations are shown on Figures 2 through 7.	
PRIVATE DATABASES	
Anderson's Waste Disposal Inventory (**ANDR**)	None
Automobile Wrecking & Supplies (**AUWR**)	None
Commercial Fuel Oil Tanks (**CFOT**)	None
Chemical Register (**CHEM**)	None
ERIS Historical Searches (**EHS**)	None
Fuel Storage Tanks (**FST**)	None
Canadian Mine Locations (**MINE**)	None
Oil and Gas Wells (**OGW**)	None
Canadian Pulp and Paper (**PAP**)	None
Retail Fuel Storage Tanks (**RST**)	None
Scott's Manufacturing Directory (**SCT**)	None
Anderson's Storage Tanks (**TANK**)	None

Based on the environmental database search conducted, the only identified potential threat is the presence of contaminated soils in the area of the Gros Cap marina and suspected contaminated sediments in the area of the Gros Cap Reefs. No information was provided detailing the specific chemicals of concern, concentrations or the extent of any contamination in soil or sediment.

3.0 FIELD RECONNAISSANCE

In fall 2008 and spring 2009 CRA conducted a field program to gather/verify information regarding property uses and potential land based threats within IPZ-1 and IPZ-2. The field reconnaissance consisted of a site by site inspection. Questionnaires were delivered to each home and business and where possible, owners/residents were interviewed. A drop box was placed at the Prince Township office for owners/residents to return questionnaires. Examples of the introductory letter and accompanying questionnaire distributed within the area are included in Appendix B.

During the field reconnaissance properties were inspected to determine activities conducted at each site, identify the locations of above ground storage tanks (ASTs) and underground storage tanks (USTs), septic systems, outhouses, and drinking water wells. Locations of these features were recorded in UTM coordinates (Zone 16) using a Leica model DF500 GPS unit with sub-metre (m) accuracy. Features identified during the field reconnaissance are shown on Figures 2 to 7.

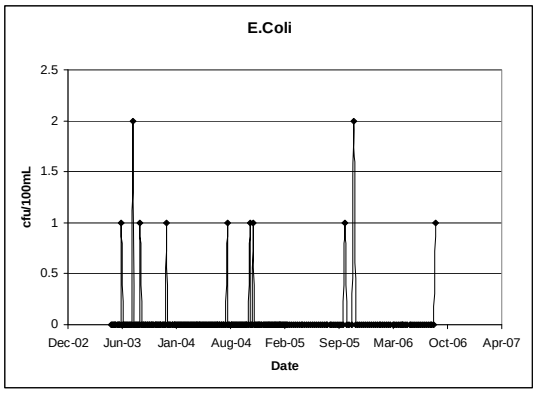
4.0 ISSUES EVALUATION

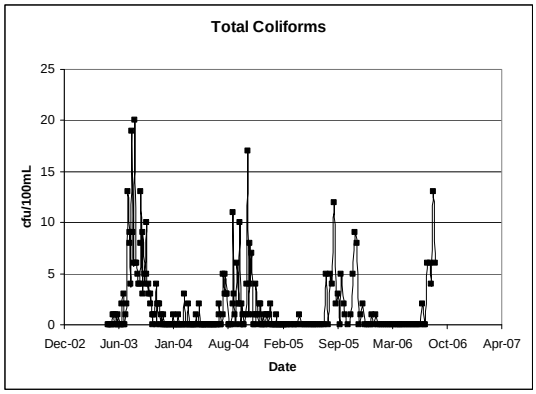
In accordance with Technical Rules, a drinking water issue is defined as the presence of a parameter in water at a surface water intake or in a well related to a drinking water system if the parameter is listed in Schedule 1, 2, 3 or 4 of the ODWS (MOE, 2006) and the parameter is present at a concentration that may result in the deterioration of the source water quality, or a trend of increasing concentrations is observed for such a parameter that would result in a deterioration of source water quality.

Drinking water issues for the Gros Cap Intake were evaluated based on the ODWSP historical raw water quality data, surface water sampling results from the Intake Protection Zone Study (Baird, 2008) and in consultation with the WTP operator.

As discussed in Section 2.3 the water quality at the Gros Cap Intake is described by the WTP operator as "very high quality". The operator did not identify any drinking water issues related to the source water for the Gros Cap Intake. Based on the historical analytical data, with the exception total coliform bacteria and occasional *E.coli* concentrations, none of the analyzed parameters within the raw water exceeded the ODWS since 1990. Water hardness was consistently lower than the operational guideline range. Generally parameter concentrations are stable however the total coliform bacteria concentration exhibits a decreasing trend.

Graphical representations of the E.coli and total coliform bacteria concentrations over time are illustrated below. The ODWS for both *E.Coli* and total coliform bacteria is 0 colony forming units per 100 milliliters (CFU/100mL)





Samples collected in the vicinity of the Gros Cap Intake during the Intake Protection Zone Study (Baird, 2008) exhibited *E.coli*, total coliform bacteria, and organic nitrogen concentrations that exceeded the ODWS and water hardness consistently fell below the operational guideline range.

As discussed in Section 2.3, none of the noted exceedances are unexpected for a surface water source. The source water's hardness is typical of that throughout Lake Superior. Based on discussions with the WTP operator, the hardness, nitrogen and bacteria concentrations observed in raw water at and around the Gros Cap Intake do not represent Issues as these concentrations are easily handled by the WTP.

Based on the above, no Issues were identified for the Gros Cap Intake.

5.0 THREATS INVENTORY

In accordance with the Act, a drinking water threat is defined as an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, and included an activity or condition that is prescribed by the regulations as a drinking water threat (MOE, 2008)

Drinking water threats for the Gros Cap IPZs were assessed based on the Technical Rules: Assessment Report (MOE, 2008) (Technical Rules). Threats are divided into two categories, chemical and pathogen. The Technical Rules provide three methods for identifying threats and quantifying the associated risks.

Method 1: Prescribed Threats based on Activities

Method 2: Calculation of Hazard Ratings and Risk Scores based on Other Activities

Method 3: Calculation of Risk Scores based on Conditions resulting from Past Activities

These methods and how they apply to the Gros Cap IPZs are described below.

5.1 PRESCRIBED THREATS

Activities prescribed as drinking water threats are those activities included in paragraphs 1 through 18 and paragraph 21 of subsection 1.1 (1) of O.Reg. 287/07, which are as follows:

- The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act
- The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage
- The application of agricultural source material to land
- The storage of agricultural source material
- The management of agricultural source material
- The application of non-agricultural source material to land
- The handling and storage of non-agricultural source material
- The application of commercial fertilizer to land
- The handling and storage of commercial fertilizer
- The application of pesticide to land

- The handling and storage of pesticide
- The application of road salt
- The handling and storage of road salt
- The storage of snow
- The handling and storage of fuel
- The handling and storage of a dense non-aqueous phase liquid (DNAPL)
- The handling and storage of an organic solvent
- The management of runoff that contains chemicals used in the de-icing of aircraft
- The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard

5.1.1 IDENTIFIED LAND USE ACTIVITIES

Land use activities were determined for the IPZs based on field reconnaissance and on a review of Prince Township's zoning By-Law. Properties within IPZ-1 include residential homes, a former hotel (now a residential property), a marina, the Gros Cap municipal water supply pump station, Second Line West, which is a paved roadway, and vacant/undeveloped lands. The majority of the properties located within the IPZ-2 are comprised of residential homes along Second Line East and Pinder Drive, summer cottages at the northern extent of North Gros Cap Road and vacant lands. Other property uses within IPZ-2 include roadways (paved and gravel surfaced), a church and associated cemetery, a taxidermist, and an ice manufacturing facility. The majority of the area within IPZ-2 is comprised of open water. The International Shipping Channel crosses through IPZ-2 at its western extent.

For vacant/undeveloped lands, potential property use was considered based on the land use zoning for the property as well as the surrounding property uses. Given the current development and zoning within the IPZs, vacant/undeveloped lands were assessed as though they were residential properties.

5.1.2 PRESCRIBED DRINKING WATER THREATS

Property uses were categorized in accordance with the North American Industry Classification System (NAICS). The NAICS codes for identified property uses within the IPZs are as follows:

NAICS Codes Associated with Property Uses

Observed Property Use	NAICS Code	Land Use Activity Name
Residential	814110/-9999	Private Households/ Residential Homes
Vacant/Undeveloped	NA	NA
Church	813110	Religious Organizations
Cemetery	81222	Funeral Services
Taxidermy	711511	Independent Artists, Writers and Performers
Ice Production	312110	Soft Drink and Ice Manufacturing
Former Hotel	721111	Traveler Accommodation
PUC Pumping Station	221310	Water, Sewage and Other Systems
Marina	71393	Marinas
Roadway	-9999	Transportation Corridor
Shipping Channel	-9999	Transportation Corridor

The MOE prescribed threats based on the above NAICS codes are listed in Table 4. Additional threats associated with specific activities observed during the field reconnaissance were also assessed.

For sites with combined property uses (e.g. a business with an attached residence), all threats prescribed for with each property use were assessed.

5.1.3 ASSESSMENT OF THREAT SIGNIFICANCE

Whether particular threats were significant or not was assessed using the Tables of Drinking Water Threats (MOE, 2008) (Threat Tables). The drinking water threat tables identify numerous individual circumstances associated with a prescribed threat. Circumstances include information such as a particular chemical of concern, its storage location (above or below ground), the quantity of chemical stored or used and so on.

The appropriate circumstances and associated reference numbers were determined based on the information gathered from the field reconnaissance, interviews, and questionnaires, etc. Multiple reference numbers were considered in cases where the particular contaminant of concern, volume of chemical stored, etc. was not known. The items considered and assumptions made during the selection of appropriate circumstances for each prescribed threat are further explained below.

Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste

This threat refers to incidental wastes that contain hazardous constituents and their empty/discarded containers. This threat was prescribed for all residential properties and thus was also applied to vacant properties as discussed previously in Section 5.1.1. The average household stores small quantities of various chemicals, depending on the activities of the residents. As such, circumstances were considered for storage of all the chemicals of concern listed in the Chemical Threat Table, above and/or below grade. For the cemetery, the burial of human bodies was treated as below grade storage.

The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage

Since there is no municipal or other centralized sewage collection and treatment system within the area of Prince Township that intersects the IPZs, all properties within the IPZs that have a building large enough for occupancy were assumed to have an associated septic system or outhouse. It was also assumed that should any vacant property be developed a septic system or outhouse would be installed. Circumstances were considered for discharge of all chemicals of concern listed in the Chemical Threat Table as well as discharges of pathogens.

Application of a Commercial Fertilizer to Land

It was assumed that fertilizer could be applied at all residential properties, properties that might be developed as residential and other non-residential properties with landscaping. No farming (crop or livestock) was observed within the IPZs during the field reconnaissance or on aerial photographs of that area. As such, the managed land percentage and livestock density were assumed to be the minimum for the IPZs.

Handling and Storage of Commercial Fertilizer

It was assumed that small retail size quantities of fertilizer could be stored and handled at all residential properties, properties that might be developed as residential and other non-residential properties with landscaping.

Application of a Pesticide to Land

It was assumed that small quantities of pesticide could be applied at residential properties, properties that might be developed as residential and other non-residential properties with landscaping. Developed properties within the IPZs are generally less than one hectare in size. It was not anticipated that pesticide would be applied over areas larger than one hectare.

Handling and Storage of a Pesticide

It was assumed that small retail size quantities of pesticide could be stored and handled at all residential properties, properties that might be developed as residential and other non-residential properties with landscaping.

Application of Road Salt

Road Salt application was assumed for all paved roads, but not for seasonal gravel surfaced roads. Total impervious surface area maps were not available for Prince Township. The impervious surface area was estimated to be between 1 and 8 percent.

Storage of Road Salt

There are no permanent salt storage facilities within the IPZs, however large quantities of salt are transported as cargo within the international shipping channel. This was considered to be temporary storage of road salt.

Handling and Storage of Fuel

All residential properties and other properties with a building large enough for occupancy were assumed to be storing fuel for heating purposes. Based on the field

reconnaissance not USTs were noted within the IPZ. Residential heating oil tanks are ASTs would typically fall within the range of 250 to 2,500 litres. Larger fuel quantities (>2,500 L) are transported along roadways to make fuel deliveries and even larger quantities of gasoline and fuel oil are transported as cargo within the international shipping channel. Transportation of fuel within the shipping channel and along roadways was considered to be temporary fuel storage.

Handling and Storage of a DNAPL

This threat was prescribed for the Marina and for the PUC Pump Station. Circumstances were considered where DNAPLs were stored above and/or below grade.

Handling and Storage of an Organic Solvent

Although a prescribed threat for a Site where funeral services are conducted, the Cemetery was never an embalming facility and it is unlikely that organic solvents were used there although they may have been present in small quantities in the embalmed bodies that are buried at the property.

Circumstances including below grade chemical or other storage were considered only for properties where storage containers were buried, not in the case where containers such as ASTs were situated within basements.

5.1.4 LOW, MODERATE AND SIGNIFICANT THREATS

The threat level for each particular circumstance was assessed as significant, moderate or low based on the vulnerability score for the IPZ-1 or 2.

Based on the current and potential future property uses within the IPZ-1, none of the prescribed or identified threats were significant or moderate. Low level threats were identified for 11 properties within IPZ-1, which are listed on Table 5. No threats were identified for IPZ-2.

Considering any potential future development, without restriction, review of the entire list of chemical and pathogen threats provided in the Tables of Drinking Water Threats (MOE, 2008) reveals that there are 599 circumstances (558 Chemical and 41 Pathogen) that represent a low threat level within IPZ-1. Due to the low vulnerability scores this assessment did not reveal any significant or moderate threats for IPZ-1. No threats were identified for IPZ-2. For any threats listed within the Tables of Drinking Water

Threats to be classified as moderate or significant the required minimum vulnerability scores are 6 and 9 respectively.

5.2 OTHER ACTIVITES

In accordance with the Technical Rules, where an activity is identified by the Source Protection Committee as a potential drinking water threat, with the approval of the Director the Risk Score is calculated as follows:

$$\text{Risk Score} = A \times B$$

Where:

A = The Chemical or Pathogen Hazard Rating
B = The Vulnerability Score of the Area in which the activity is taking place

Chemical Hazard Ratings are calculated considering:

- Toxicity Score of the parameter
- Environmental Fate Score of the parameter
- Quantity Score
- Method of Release (Direct vs. Indirect)
- The Type of Vulnerable Area in which the activity is located

Pathogen Hazard Ratings are calculated considering:

- The frequency of the presence of pathogens that may be associated with the activity
- Method of Release to the natural environment

Risk Scores that are greater than 80 denote a significant threat, Risk Scores between 60 and 80 denote a moderate threat level, and Risk Scores below 60 denote a low threat level.

5.2.1 THE INTERNATIONAL SHIPPING CHANNEL

Based on discussions with the SSMRCA personnel, the International Shipping Channel that passes through the IPZ-2 is approved by the Director as an activity that represents sufficient threat potential for additional consideration.

Based on the Traffic Statement for the St. Marys Falls Canal (US Army Corps., 2006) 70 million tons of cargo moved through the American locks in 2006. Half of the material was iron ore and another quarter of the shipping volume was coal/coke. In addition to these, other materials including asphalt, tar and pitch, petroleum products (crude, gasoline, fuel oil, etc.), metal ores, salt, fertilizers, sodium hydroxide, dredge spoils, etc. are transported through the locks on a regular basis. A total volume of 170 thousand tons of petroleum product was shipped through the locks in 2006.

Various chemical compounds are associated with the materials transported in the Shipping Channel, which if released have the potential to degrade water quality. Due to the number of possible contaminants and contaminants associated with unknown materials transported in the shipping channel, a worst case chemical hazard rating and risk score was initially calculated for the Shipping Channel according to the procedure outlined in the Technical Bulletin: Addressing Transportation Threats (MOE, 2009). For the purpose of considering the worst case scenario, maximum scores of 10 were assigned for the toxicity, environmental fate, quantity and method of release resulting in a Chemical Hazard Rating of 10. The resulting Risk Score and associated risk level for the IPZs is presented below.

Worst Case Risk Score – Shipping Channel - Gros Cap Intake

IPZ	Vulnerability Score	Chemical Hazard Score	Risk Score	Risk Level
IPZ-1	5	10	50	Low
IPZ-2	4	10	40	Low

Based on the above, further calculations for individual chemicals of concern were not conducted.

5.2.2 TAXIDERMIST

Based on information gathered during the field reconnaissance a taxidermist business located within IPZ-2 at 4703 Second Line West. This business uses an underground storage tank (UST) to hold spent chemicals including sulphuric acid, bleach, and formaldehyde. A business representative indicated that the tank is approximately 5,600 litres in size and is pumped out three times a year.

Based on the worst case scenario calculation completed in the previous section, given the low vulnerability score for IPZ-2, risk levels for chemicals of concern at this property would be low.

5.3 CONDITIONS RESULTING FROM PAST ACTIVITIES

In accordance with Technical Rules, condition includes one of the following:

- The presence of a non-aqueous phase liquid in groundwater within a highly vulnerable aquifer, a significant groundwater recharge area, or a wellhead protection area
- The presence of a single mass greater than 100 litres of one or more DNAPLs in surface water within an IPZ
- The presence of a contaminant in groundwater within a highly vulnerable aquifer, a significant groundwater recharge area or a wellhead protection area, where the contaminant concentration exceeds the MOE generic standard presented in *"Table 2 - Full Depth Generic Site Condition Standards in a Potable Ground Water Condition"* of the Soil, Ground Water and Sediment Standards (MOE, 2004)
- The presence of a contaminant in surface soil in an IPZ where the contaminant concentration exceeds the MOE generic standards presented in *"Table 4 - Stratified Site Condition Standards in a Potable Ground Water Condition."* of the Soil, Ground Water and Sediment Standards (MOE, 2004), for industrial/ commercial/community property use
- The presence of a contaminant in sediment, if the contaminant concentration exceeds the generic standards presented in *"Table 1 - Full Depth Background Site Condition Standards"* of the Soil, Groundwater and Sediment Standards (MOE 2004)

Based on the above, the PAH levels detected in sediment at the Gros Cap Shore Line during the Intake Protection Zone Study (Baird, 2008) at concentrations that exceeded the *"Table 1 - Full Depth Background Site Condition Standards"* of the Soil, Groundwater and Sediment Standards (MOE 2004) is a condition that is a drinking water threat.

In accordance with the Technical Rules, the Risk Score of an area where a condition is identified is calculated as follows:

$$\text{Risk Score} = A \times B$$

Where:

A = The Hazard Rating of the Condition = 10
B = The Vulnerability Score of the Area in which the Condition is identified (5 for IPZ-1 and 4 for IPZ-2)

As such, the Risk Scores for IPZ-1 and IPZ-2 are 50 and 40 respectively. Risk Scores that are below 60 denote a low threat level.

6.0 SUMMARY AND CONCLUSIONS

1. A sediment sample collected at the Gros Cap shoreline during the Intake Protection Zone Study exhibited concentrations of 13 PAHs that exceeded the MOE sediment standard in Soil Groundwater and Sediment Standards (MOE, 2004).
2. Based on the environmental database search conducted, the only identified potential threat is the presence of contaminated soils in the area of the Gros Cap marina and suspected contaminated sediments in the area of the Gros Cap Reefs. No information was provided detailing the specific chemicals of concern, concentrations or the extent of any contamination in soil or sediment.
3. A field reconnaissance program was conducted to gather information regarding potential land based threats within the IPZs. The program included a site by site inspection and interviews with available property owners/residents. Questionnaires were delivered to each home and business.
4. During the field reconnaissance program the locations of ASTs, USTs, septic systems and drinking water wells were recorded in UTM coordinates using a GPS unit.
5. Drinking water issues for the Gros Cap Intake were evaluated in consultation with the WTP operator, based on historical raw water quality data for the intake and surface water sampling results from the area around the intake.
6. No drinking water issues were identified for the Gros Cap IPZs.
7. Drinking water threats were assessed for the Gros Cap IPZs based on the Technical Rules: through the identification of activities and associated prescribed threats, the calculation of hazard and risk scores for other activities that do not have associated prescribed threats, and the calculation of hazard and risk scores for conditions resulting from past activities.
8. No significant or moderate drinking water threats were identified for the Gros Cap IPZ-1.
9. No threats were identified for the Gros Cap IPZ-2.