

**January 2018**



**HAMMOND REEF GOLD PROJECT**

**Water and Sediment Quality  
Technical Support Document**

**VERSION 3**

**Submitted to:**  
Canadian Malartic Corporation  
2140 St Mathieu St.  
Montreal, QC H3H 2J4

**Project Number:** 1656263

**Distribution:**  
Sandra Pouliot, Environmental Project Leader

*Note: This Version 3 Technical Supporting Document is identical to the Version 2 Technical Supporting Document as provided herein.*

December 2013



# HAMMOND REEF GOLD PROJECT Water and Sediment Quality Technical Support Document

VERSION 2

**Submitted to:**

Osisko Hammond Reef Gold Ltd.  
155 University Avenue, Suite 1440  
Toronto, Ontario M5H 3B7

**Project Number:** 13-1118-0010

**Document Number:** DOC024

**Distribution:**

Alexandra Drapack, Director Sustainable Development  
Cathryn Moffett, Project Manager Sustainable Development



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**WATER AND SEDIMENT QUALITY  
TECHNICAL SUPPORT DOCUMENT  
VERSION 2**

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## **TABLE OF CONTENTS**

- Part A: Introduction**
- Part B: Supplemental Information Package**
- Part C: Water and Sediment Quality Technical Support Document, Version 1**

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**WATER AND SEDIMENT QUALITY  
TECHNICAL SUPPORT DOCUMENT  
VERSION 2**

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# **PART A**

## **Introduction**



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**WATER AND SEDIMENT QUALITY TECHNICAL SUPPORT DOCUMENT  
VERSION 2  
PART A: INTRODUCTION**

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In support of the Osisko Hammond Reef Gold's (OHRG) Draft Environmental Impact Statement/Environmental Assessment (EIS/EA) Report, technical information related to water quality was provided in the following Technical Support Documents (TSD):

- **Water and Sediment Quality TSD** – provides a description of baseline water and sediment quality conditions within the Project site and surrounding waterbodies. This information is summarized in Section 3.0 of the EIS/EA Report.
- **Site Water Quality TSD** – provides predictions of potential changes to water quality within the mine study area as a result of the Project and information on site discharge volumes and water quality. The information and findings of this TSD are considered in other TSDs including the Lake Water Quality TSD and are summarized in Section 6.0 of the EIS/EA Report.
- **Lake Water Quality TSD** – provides a description of the predicted water quality conditions in the receiving water bodies, including Upper Marmion Reservoir, Lizard Lake and the discharge from Raft Lake Dam. The water quality analysis presented in this TSD considers site discharge water quality predictions presented in the Site Water Quality TSD, environmental processes such as hydrologic variability and hydrodynamic mixing within the receiving waters, and water level management activities at the Raft Lake Dam. The information presented in this TSD is summarized in Section 6.0 of the EIS/EA Report.

Version 1 of the Water and Sediment Quality TSD was published on February 15, 2013 as part of the Draft EIS/EA Report.

The Draft EIS/EA Report underwent a seven week public review comment period after which, on April 5, 2013 OHRG received comments from the public, Aboriginal groups and the Government Review Team (GRT) seeking clarification and requesting new information.

Approximately four comments regarding the Water and Sediment Quality TSD and the baseline water and sediment quality component of the EIS/EA Report were received from the GRT. Written responses were prepared for each comment and are provided in Appendix 1.IV of the EIS/EA Report.

Version 1 of the Water and Sediment Quality TSD has not been revised and no significant changes have been made to the baseline water and sediment quality component of the EIS/EA Report.

Version 2 of the Water and Sediment Quality TSD is comprised of the following:

- Part A: Introduction
- Part B: Supplemental Information Package. No supplemental information has been prepared for this Version 2 of the Water and Sediment Quality TSD. This Part B is included in Version 2 of the Water and Sediment Quality TSD for consistency in format with other TSDs.
- Part C: Version 1 of the Water and Sediment Quality TSD. Part C was issued in February 2013, and is available online on OHRG's website; it has not been re-printed as part of this Version 2 of the Water and Sediment Quality TSD. The Version 1 document should be reviewed within the context of this Version 2 document, and associated updated information as presented in Part A or Part B should be considered as correct should it differ from the information presented in Version 1.



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**WATER AND SEDIMENT QUALITY TECHNICAL SUPPORT DOCUMENT**  
**VERSION 2**  
**PART A: INTRODUCTION**

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Throughout the EIS/EA Report, unless otherwise noted, all references made to the Water and Sediment Quality TSD are to Part C.

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**WATER AND SEDIMENT QUALITY  
TECHNICAL SUPPORT DOCUMENT  
VERSION 2**

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# **PART B**

## **Supplemental Information Package**

**(No supplemental information has been prepared for this Version 2 of the Water and Sediment Quality TSD)**



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**WATER AND SEDIMENT QUALITY  
TECHNICAL SUPPORT DOCUMENT  
VERSION 2**

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# **PART C**

## **Water and Sediment Quality Technical Support Document, Version 1**

February 2013



# HAMMOND REEF GOLD PROJECT Water and Sediment Quality Technical Support Document

## VERSION 1

**Submitted to:**  
Osisko Hammond Reef Gold Ltd.  
155 University Avenue, Suite 1440  
Toronto, Ontario M5H 3B7

**Project Number:** 10-1118-0020

**Document Number:** 2012-079

**Distribution:**

Alexandra Drapack, Director Sustainable Development  
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## **Hammond Reef Gold Project Water and Sediment Quality Technical Support Document**

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<Original signed by>

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Principal, Project Director  
Golder Associates Ltd. Date: February 15, 2013

# WATER AND SEDIMENT QUALITY TSD VERSION 1



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## **WATER AND SEDIMENT QUALITY TSD VERSION 1**



### **1.0 INTRODUCTION**

Osisko Hammond Reef Gold Ltd. (OHRG) proposes the development of an open pit gold mine in north-western Ontario, herein referred to as the Hammond Reef Gold Project (Project). This Technical Support Document (TSD) is one of a series of reports in support of the Project's Environmental Impact Statement/Environmental Assessment Report (EIS/EA Report).

The following reports have been prepared to support the EIS/EA Report:

- Atmospheric Environment TSD.
- Geochemistry, Geology and Soil TSD.
- Hydrogeology TSD.
- Hydrology TSD.
- Water and Sediment Quality TSD.
- Site Water Quality TSD.
- Lake Water Quality TSD.
- Aquatic Environment TSD.
- Terrestrial Ecology TSD.
- Aboriginal Interests TSD.
- Cultural Heritage Resources TSD.
- Human Health and Ecological Risk Assessment TSD.
- Socio-economic Environment TSD.
- Alternatives Assessment Report.
- Conceptual Closure and Rehabilitation Plan.

The EIS/EA Report will summarize the findings of this TSD and of the above-listed supporting reports.

### **1.1 Purpose and Scope**

The purpose of this TSD is to fulfill the assessment scope outlined in the Project's Terms of Reference (ToR) approved by the Ontario Minister of the Environment (July 2012), and in the Environmental Impact Statement Guidelines (EIS Guidelines) published by the Canadian Environmental Assessment Agency (CEA Agency) (December 2011).

As part of the requirements a water and sediment quality baseline program related to the Project Site was developed based on feedback from regulatory agencies, Aboriginal engagement, a review of existing data

## WATER AND SEDIMENT QUALITY TSD VERSION 1



sources, and sampling programs. Specifically, the water and sediment quality baseline study focuses on the defined study areas, and within these areas provides:

- A description of water quality and sediment sampling protocols and analytical methods and the quality assurance/quality control program followed.
- A summary of the collected surface water quality data compared to the relevant guidelines.
- An assessment of variation relative to historical data.

Due to seasonal variability, monitoring was conducted throughout the year, to determine annual trends and seasonal changes. To date, sampling has occurred from September 2010 to June 2011. This TSD provides description of the baseline water quality of the existing surface water quality. In addition to presentation of data for all defined sampling locations, the data is reported for the following main locations:

- Lizard Lake Water Quality.
- Marmion Reservoir Water Quality.
- Raft Lake Dam Discharge Water Quality.

These water bodies may collectively be referred to herein as "lake" or "lake water".

The overall objective of the programs completed and described in this TSD is to provide specific information at a level sufficient for inclusion in the EIS/EA Report in order to guide decision making regarding the potential for environmental effects of the Project, or to allow for further analyses as part of other TSDs or work related to the environmental assessment. The information and findings developed from this assessment of baseline lake water quality will be considered in other TSDs including the Lake Water Quality TSD and the Aquatic Environment TSD. This TSD provides the baseline information on surface water quality only. The assessment of environmental effects, the determination of significance of these effects, and the proposed mitigation measures will be addressed in the EIS/EA Report and the Human Health and Ecological Risk Assessment TSD. An explanation of this approach is provided in Section 1.4 of this report.

### 1.1.1 Study Objectives

Baseline data was collected to meet the requirements of the EIS Guidelines and to be consistent with provincial and federal requirements (CEA Agency 2011).

## 1.2 Report Organization

This TSD is structured as follows:

- Section 1 presents the purpose and scope of the TSD, an overview of the Project, the general assessment approach, incorporation of traditional knowledge, Valued Ecosystem Components and assessment boundaries of the TSD.
- Section 2 describes the methods used to identify baseline water sampling locations; collection and analyses water samples.



## WATER AND SEDIMENT QUALITY TSD VERSION 1



- Section 3 provides the baseline water quality results for all sample locations
- Section 4 summarizes the findings of this report.

### 1.3 Project Overview

The Project overview and Project description is provided in Chapter 5 of the EIS/EA Report. Project aspects that influence the lake water quality baseline data collection and evaluation are described in Sections 1.3 to 1.8.

#### 1.3.1 Project Location

The Project is located within the Thunder Bay Mining District in north-western Ontario, approximately 170 kilometres (km) west of Thunder Bay and 23 km northeast of the town of Atikokan (Figure 1-1).

Access to the Hammond Reef property is presently via two routes: the Premier Lake Road, a gravel road that intersects Highway 623 near Sapawe and the Hardtack-Sawbill Road, a gravel road that intersects Highway 622 northwest of the Town of Atikokan. The Hammond Reef property is also accessible by water from the southwest end of the Marmion Reservoir at its access point from Highway 622. The existing Hardtack-Sawbill road located to the north of Finlayson Lake has been upgraded to provide an improved and more direct linkage to the Project Site in support of the expanded exploration program.

The Hammond Reef deposit is located mainly on a peninsula of land extending into the north end of the Upper Marmion Reservoir. The peninsula containing the deposit is surrounded by the Marmion Reservoir on three sides with Sawbill Bay to the northwest and Lynxhead Bay to the southeast. The Hammond Reef property also contains a number of smaller lakes. Mitta Lake is a small, steep-sided waterbody located atop mineralized zones of the deposit. Due to its location, the open pit mining activities require the draining of Mitta Lake. Lizard Lake is located immediately to the east of the proposed Project Site and drains into Marmion Reservoir.

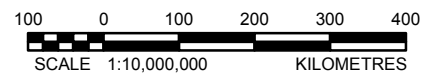
#### 1.3.2 Climate

The Project is located in a typical boreal climate region, which is characterized by long, usually very cold winters, and short, cool to mild summers. The annual temperature average is 1.6 degrees Celsius (°C) for Atikokan with a seasonal maximum of 16.2°C (average) for summer and a minimum of minus 15.4°C (average) for winter. Temperatures lower than minus 37°C have been recorded during the fall and winter. The annual normal total for precipitation is 788 millimetres (mm) (568 mm of rainfall and 220 mm of snowfall) for Atikokan with a seasonal maximum of 299 mm for the summer period.



**REFERENCE**

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.;  
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N



DATE	February, 2013
DESIGN	CGE
GIS	JO
CHECK	REJ
REVIEW	KJD

TITLE	<b>PROJECT LOCATION</b>	
PROJECT	HAMMOND REEF GOLD PROJECT ATIKOKAN, ONTARIO, CANADA	<b>FIGURE: 1-1</b>

PROJECT No. 10-1118-0020

SCALE AS SHOWN

VERSION 1

## WATER AND SEDIMENT QUALITY TSD VERSION 1



### 1.3.3 Project Phases

The Project comprises four phases: construction, operations, closure and post-closure. Additional details regarding activities expected to take place in each phase of the Project are provided in Chapter 5 of the EIS/EA Report. With regards to understanding baseline surface water quality the data needs to be collected prior to construction.

### 1.3.4 Project Components

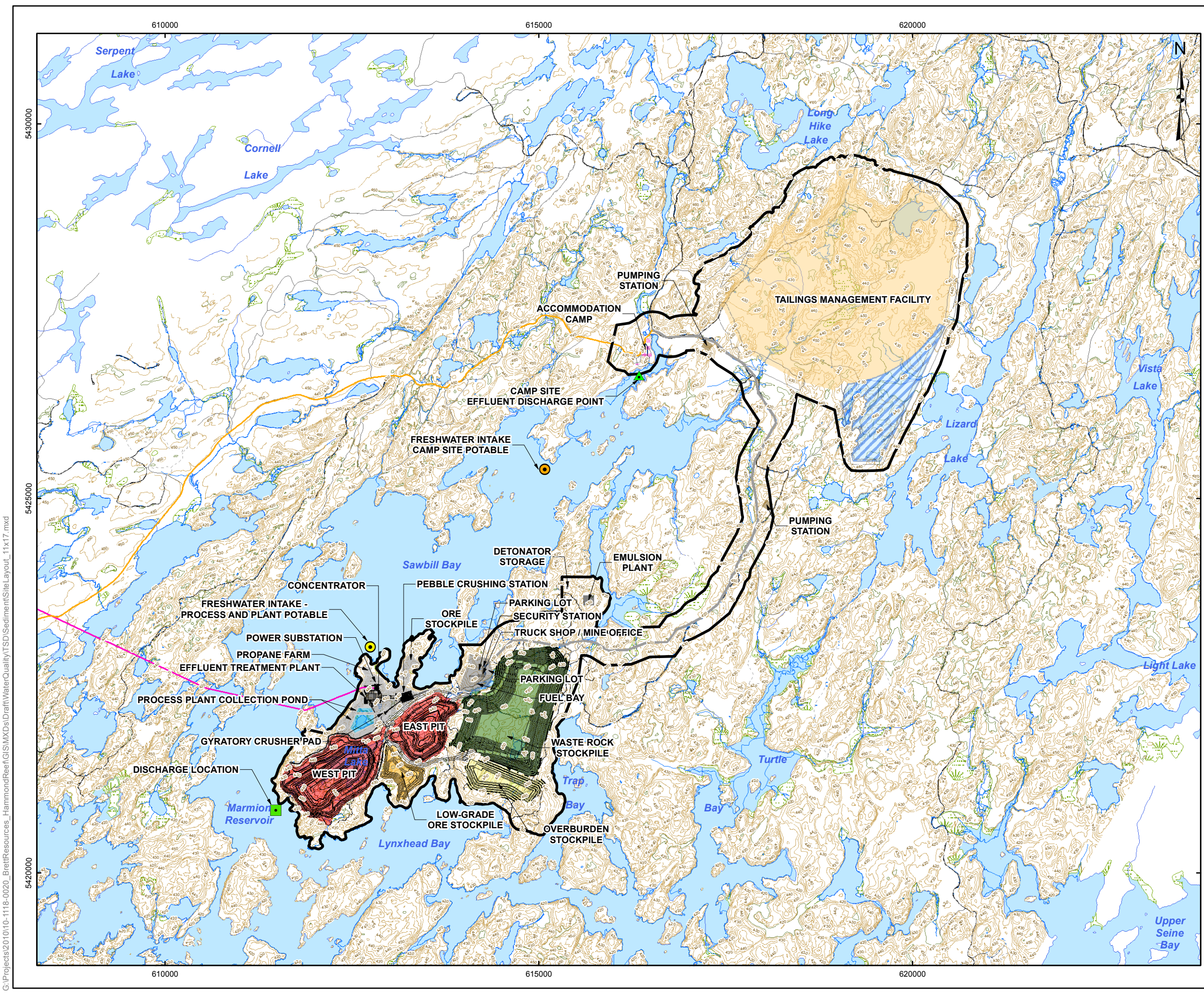
The existing pre-construction conditions need to be understood when collecting baseline information collected including:

- Existing road access.
- Existing exploration camp and previous exploration activities.

An understanding of the project components and proposed locations is also necessary to ensure adequate spatial coverage of baseline information is obtained. The Project consists of eight main components:

- Mine, including two open pits (east pit and west pit).
- Waste Rock Management Facility (WRMF).
- Ore Processing Facility.
- Tailings Management Facility (TMF).
- Support and Ancillary Infrastructure.
- Water Management System.
- Linear Infrastructure.
- Borrow Sites.

Proposed Project components are shown in Figure 1-2. A detailed description of Project components is provided in Chapter 5 of the EIS/EA Report.

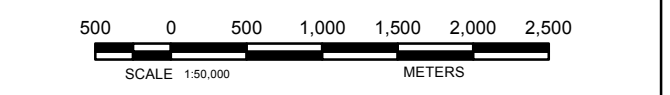



**LEGEND**

- Index Contour (5m interval)
- Road
- - - Trail
- Marsh/Swamp
- - - Ditch
- River/Stream
- Lake
- Wetland
- Discharge Location
- ▲ Effluent Discharge Point
- Freshwater Intake - Process and Plant Potable
- Freshwater Intake - Camp Site Potable
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Accommodation Camp
- Laydown Area
- Office and Truck Shop, Explosives Storage and Processing Plant
- Open Pits
- Ore Stockpile
- Overburden Stockpile
- Process Plant Collection Pond
- Pump Station
- Tailings Management Facility
- Tailings Management Facility Reclaim Pond
- Waste Rock Stockpile
- Project Boundary

**REFERENCE**

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.  
 Base Data - MNR NRVIS, obtained 2004  
 Produced by Golder Associates Ltd under licence from  
 Ontario Ministry of Natural Resources, © Queens Printer 2008  
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N



PROJECT	HAMMOND REEF GOLD PROJECT ATIKOKAN, ONTARIO, CANADA		
TITLE	SITE LAYOUT		
 Golder Associates Mississauga, Ontario	PROJECT NO.	10-1118-0020	SCALE AS SHOWN
	DESIGN	CGE 14 Nov. 2008	VERSION 1
	GIS	JO 6 Feb. 2013	
	CHECK	REJ 6 Feb. 2013	
	REVIEW	KJD 31 Jan. 2013	<b>FIGURE: 1-2</b>

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## WATER AND SEDIMENT QUALITY TSD VERSION 1



### 1.4 General Assessment Approach

The Project has the potential to affect the lake water environment. The approach for this TSD follows the first four of six key steps provided below:

- Step 1: Screening of Project activities to determine which activities have the potential to produce changes to the lake water environment.
- Step 2: Identify temporal and spatial boundaries within which potential changes to lake water quality may occur.
- Step 3: Identify parameters used to characterize these potential changes.
- Step 4: Design and carry out field studies and/or background research to characterize the existing lake water quality, and to support the prediction of changes to lake water.
- Step 5: Carry out predictive modelling of potential changes to the lake water environment during Project phases identified as bounding scenarios (Site Water TSD and Lake Water Quality TSD).
- Step 6: Outline the monitoring requirements for each Project phase to confirm predicted changes to the environment and to ensure that requirements are being met for identified parameters.

This TSD is intended to support the EIS/EA Report and as such does not assess the significance of potential effects on lake water quality, nor does it identify mitigation measures. These topics are addressed in the EIS/EA Report and in other TSDs.

### 1.5 Incorporation of Traditional Knowledge

First Nations monitors participated in the collection of water and sediment quality samples in the June 2011 sampling campaign. Traditional knowledge in combination with other information sources is valuable in achieving a better understanding of the Project's potential effects on the biophysical and socio-economic environment. It also contributes to the description of the existing biophysical and human environment, natural cycles, resource distribution and abundance, and the use of land and water resources. Those aspects of traditional knowledge related to water quantity and water quality are important when considering the results of the lake water quality assessment, in particularly as it relates to use of the resources as defined in the Aquatic Environment TSD, Terrestrial Ecology TSD, Human Health and Ecological Risk Assessment TSD. A detailed discussion on traditional knowledge is included in the Aboriginal Interests TSD.

### 1.6 Selection of Valued Ecosystem Components

The Valued Ecosystem Component (VEC) selected for this TSD is Lake Water Quality. Table 1-1, provides the rationale for selection of the VEC along with proposed indicators and measures.

## WATER AND SEDIMENT QUALITY TSD VERSION 1



**Table 1-1: Valued Ecosystem Components Selected for the Surface Water Quality Environment**

Valued Ecosystem Component	Rationale for Selection	Indicators	Measures
Lake Water Quality	Potential for change to overall lake water quality as result of Project activities	Changes in concentrations of key parameters at key locations	Analytical data for key parameters at key locations

### 1.7 Effects Assessment

Changes to lake water quality may lead to or influence the assessment of effects of the Project, but are not in and of themselves the endpoints of the assessment. Therefore, potential effects of the Project on the VECs selected for water quality are not discussed in this TSD. The assessment of effects on the endpoints of changes to water quality is presented in the EIS/EA Report and in the following TSDs:

- Aquatic Environment TSD.
- Terrestrial Ecology TSD.
- Human Health and Ecological Risk Assessment TSD.
- Socio-economic Environment TSD.

### 1.8 Temporal and Spatial Boundaries

#### 1.8.1 Temporal Boundaries

The temporal boundary to determine baseline conditions is pre-construction. Temporal boundaries for Project phases and the duration of these phases are:

- Construction phase: 30 months.
- Operations phase: 11 years.
- Closure phase: 2 years.
- Post-closure phase: duration of pit flooding (78 years) and release plus >10 years.

This TSD presents the pre-construction baseline water quality. The Site Water TSD and Lake Water Quality TSD address the Project's implications on water quality for the identified temporal boundaries.

#### 1.8.2 Spatial Boundaries

Spatial boundaries define the geographical extents within which potential environmental changes may occur. As such, spatial boundaries become the Project's study area for the purposes of baseline water quality collection and evaluation. The study areas for the collection of lake water quality information were selected based on the following factors:

## WATER AND SEDIMENT QUALITY TSD VERSION 1



- The Project footprint.
- The proposed locations for water intakes and effluent discharges.
- The location of water users (Socio-economic Environment TSD).
- Location of major lakes, streams and watershed divides.

This TSD has three study areas, as described in the following sections.

### **1.8.2.1 Regional Study Area**

The lake water and sediment quality Regional Study Area (RSA) is delineated in Figure 1-3. The Project Site is located in Ontario at approximately 150 km west of Thunder Bay and 23 km northeast of the Town of Atikokan. The RSA includes Upper and Lower Marmion Reservoir and the upstream catchment of the Seine River. The RSA extends south to Highway 622.

Upper Marmion Reservoir is separated from Lower Marmion Reservoir by a series of dams constructed in the early 1950s (Boileau 2004). Flow between the Upper and Lower Marmion Reservoir is regulated by the Marmion Sluiceway also constructed in the early 1950s. The Seine River is regulated by the Raft Dam located approximately 30 km from the site. The inflow from the Seine River into Upper Marmion Reservoir is also regulated by the Lac Des Mille Lacs Dam (built in 1952) located approximately 80 km upstream of the site (as described in the Hydrology TSD).

### **1.8.2.2 Local Study Area**

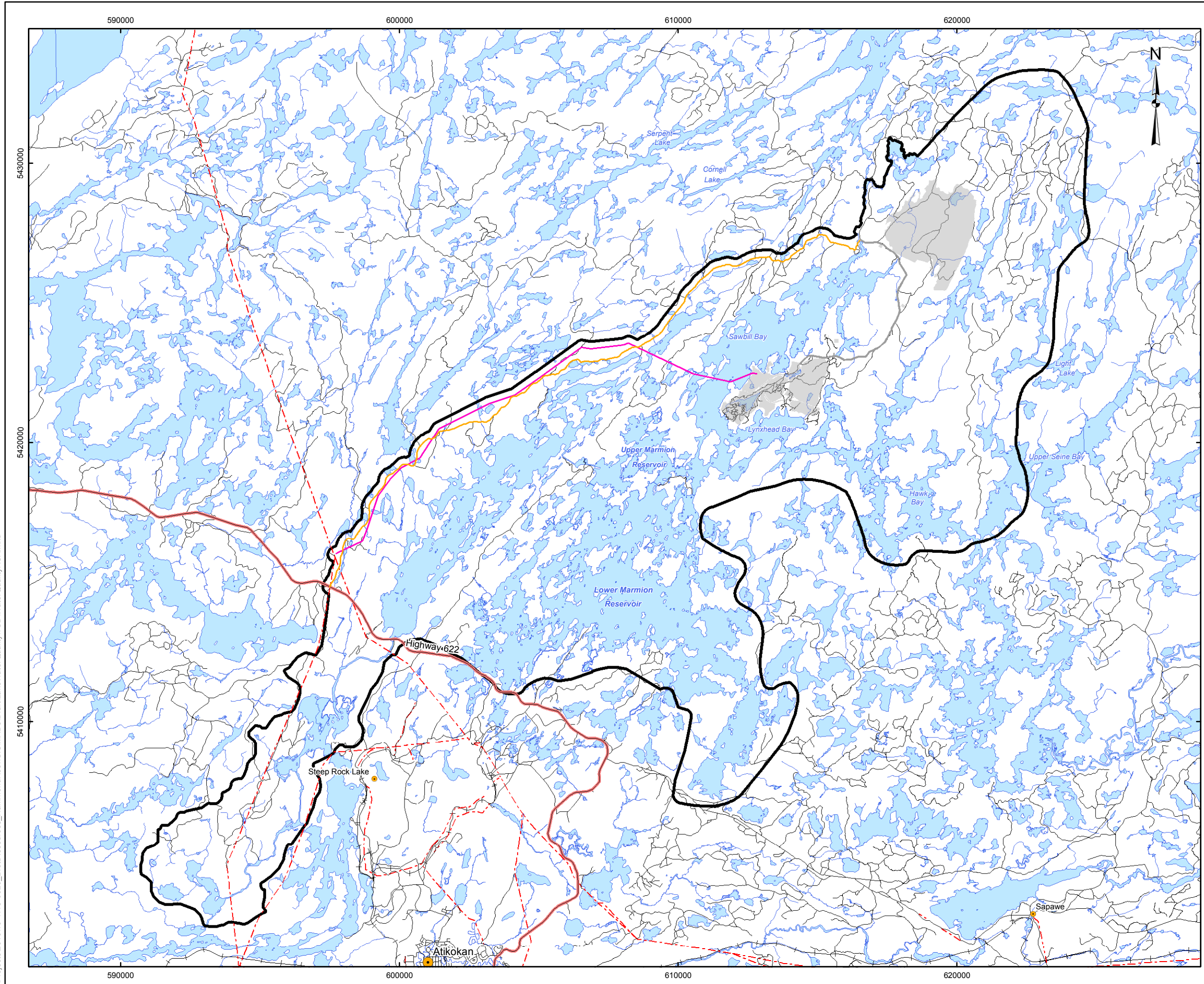
The lake water and sediment quality Local Study Area (LSA) is delineated in Figure 1-4. The Project Site is located on the south-west corner of Sawbill Bay. The Mine is surrounded by Sawbill Bay on the north side and Seine River on the south side. The Seine River forms a series of basins separated by shallow areas collectively called Upper Marmion Reservoir as shown on Figure 1-3.

The LSA extends generally to the middle of Sawbill and Lynxhead Bays of Marmion Reservoir on the west and south sides respectively, the Lizard Lake catchment area to the east is also included.

### **1.8.2.3 Mine Study Area**

The Mine Study Area encompasses the footprints of the Mine, the Waste Rock Management Facility, the Processing Plant, the Tailings Management Facility, and the Support and Ancillary Infrastructure (Figure 1-2). Borrow Pits are not included, as they are subject to a separate permitting process.

The components of the Project Site are relevant to the site water balance and water quality model and are described in detail in the Site Water Quality TSD. With respect to the Lake Water Quality TSD, the key components are the intake and discharge of water from the Project.



**LEGEND**

- City/Town
- Small Community
- Provincial Highway
- Road
- + Existing Railway
- - - Power Transmission Line
- River/Stream
- █ Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- █ Project Facilities
- Water Quality Regional Study Area

**REFERENCE**

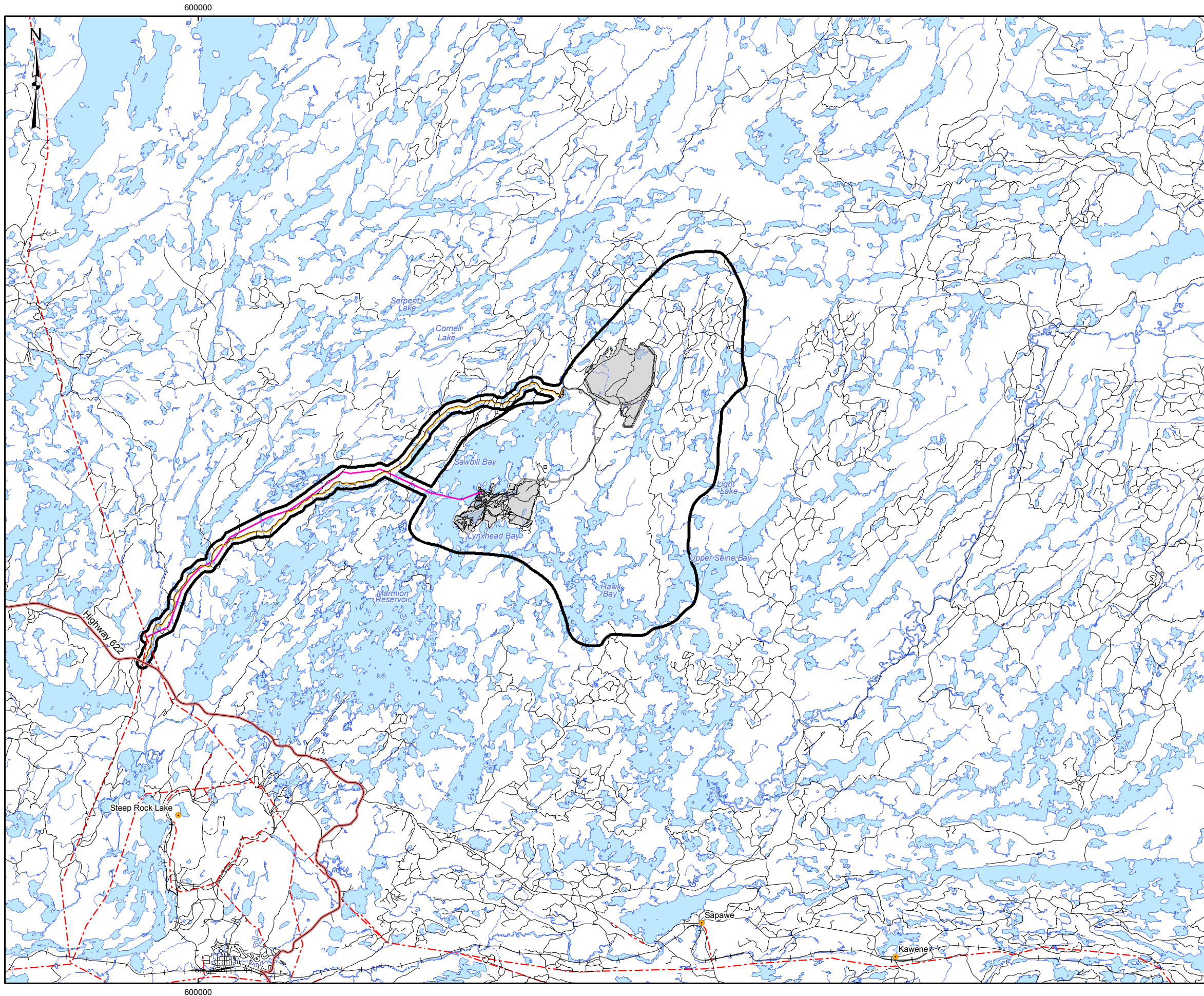
Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd  
 Base Data - MNR NRVIS, obtained 2004  
 Produced by Golder Associates Ltd under licence from  
 Ontario Ministry of Natural Resources, © Queens Printer 2008  
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N



<b>PROJECT</b>	<b>HAMMOND REEF GOLD PROJECT ATIKOKAN, ONTARIO, CANADA</b>		
<b>TITLE</b>	<b>WATER QUALITY REGIONAL STUDY AREA</b>		
 Golder Associates Mississauga, Ontario	PROJECT NO. 10-1118-0020	SCALE AS SHOWN	VERSION 1
	DESIGN CGE 14 Nov. 2008		
	GIS JO 5 Feb. 2013		
	CHECK REJ 5 Feb. 2013		
	REVIEW KJD 5 Feb. 2013	FIGURE: 1-3	

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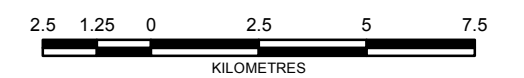


**LEGEND**

- Small Community
- Provincial Highway
- Road
- + Existing Railway
- River/Stream
- Lake
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities
- Water Quality Local Study Area

**REFERENCE**

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd  
 Base Data - MNR NRVIS, obtained 2004  
 Produced by Golder Associates Ltd under licence from  
 Ontario Ministry of Natural Resources, © Queens Printer 2008  
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N



<b>PROJECT</b>	<b>HAMMOND REEF GOLD PROJECT ATIKOKAN, ONTARIO, CANADA</b>		
<b>TITLE</b>	<b>WATER QUALITY LOCAL STUDY AREA</b>		
 Golder Associates Mississauga, Ontario	PROJECT NO. 10-1118-0020	SCALE AS SHOWN	VERSION 1
	DESIGN CGE 27 Jun. 2012		
	GIS JO 5 Feb. 2013	<b>FIGURE: 1-4</b>	
	CHECK REJ 5 Feb. 2013 REVIEW KJD 5 Feb. 2013		

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## 2.0 METHODS

### 2.1 Secondary Data Review

Aside from one study of Mitta Lake, located directly above the ore body, no historical water or sediment quality information prior to baseline data collection was found. Water quality and an assessment of fish communities in Mitta Lake were provided in a report prepared by TBT Engineering Ltd. (TBT 2009). A summary of the water quality is as follows:

- Water quality was measured in June and July of 2009.
- Temperature, pH, dissolved oxygen (DO) and conductivity were measured at one metre (m) intervals throughout the water column at the deepest part of the lake (approximately 17 m):
  - The surface temperature was 23.2°C with a thermocline occurring at approximately 5 m in depth where the temperature dropped 5°C over a distance of one metre.
  - DO measured 7.5 parts per million (ppm) near the surface decreasing to 1.6 ppm at a depth of 6 m. A maximum of 11.3 ppm was recorded at a depth of 4 m. Readings in all depth strata below 6 m indicated an absence of oxygen.
  - pH values decreased from slightly alkaline near the surface (8.4) to mildly acidic in the lower depths of the lake (6.5 at lake bottom).
  - Conductivity increased with depth from approximately 37 to 62 microSiemens per centimetre ( $\mu\text{S}/\text{cm}$ ).
- Water samples were taken at depths of 1.5 m and 12 m below surface. All measured parameter values were below Ontario Provincial Water Quality Objectives (PWQO) (PWQO 1999) with the exception of total phosphorus and iron the deepest sample.

### 2.2 Primary Data Collection

Water and sediment quality sampling for the Project has been conducted on a seasonal basis in order to monitor temporal changes in water and sediment quality. Sampling has also included assessment of limnological conditions through water column profiling. The baseline study was designed to capture the seasonality of the area and to include low- and high-flow periods. To date, the sampling has been performed during:

- September 2010 – Low flow conditions, summer.
- November 2010 – Prior to freeze-up.
- March 2011 – Low flow conditions, minimum temperature.
- June 2011 – Spring freshet.
- April 2012 – Spring freshet.

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- August 2012 – Low flow conditions, summer.

The proposed suite of analytes, method detection limits and applicable receiving water guidelines for water and sediment quality are provided in Appendix 2.II.

### 2.2.1 Sampling Locations

Sample locations were chosen to characterize the existing environment at locations upstream and downstream of the Project. Specific locations reflect individual Project components such as the open pits, waste rock stockpile, exploration camp, previously proposed alternative tailings management facilities, downstream receptors and other infrastructure. Figure 2-1 shows all sampling locations.

Surface water samples were collected from 30 locations for the first four sampling campaigns. While an effort was made to collect sediment at each of the same 30 surface water locations, rocky substrate prevented sediment collection at some locations. Hence, a total of 19 sediment samples were collected. Eight additional locations (Mitta Lake, Sawbill Bay, Lizard Lake, Light Bay, Hawk Bay, Turtle Bay, Lynxhead Bay and Premier Lake) were sampled to provide a water column profile including both water and sediment quality and limnology.

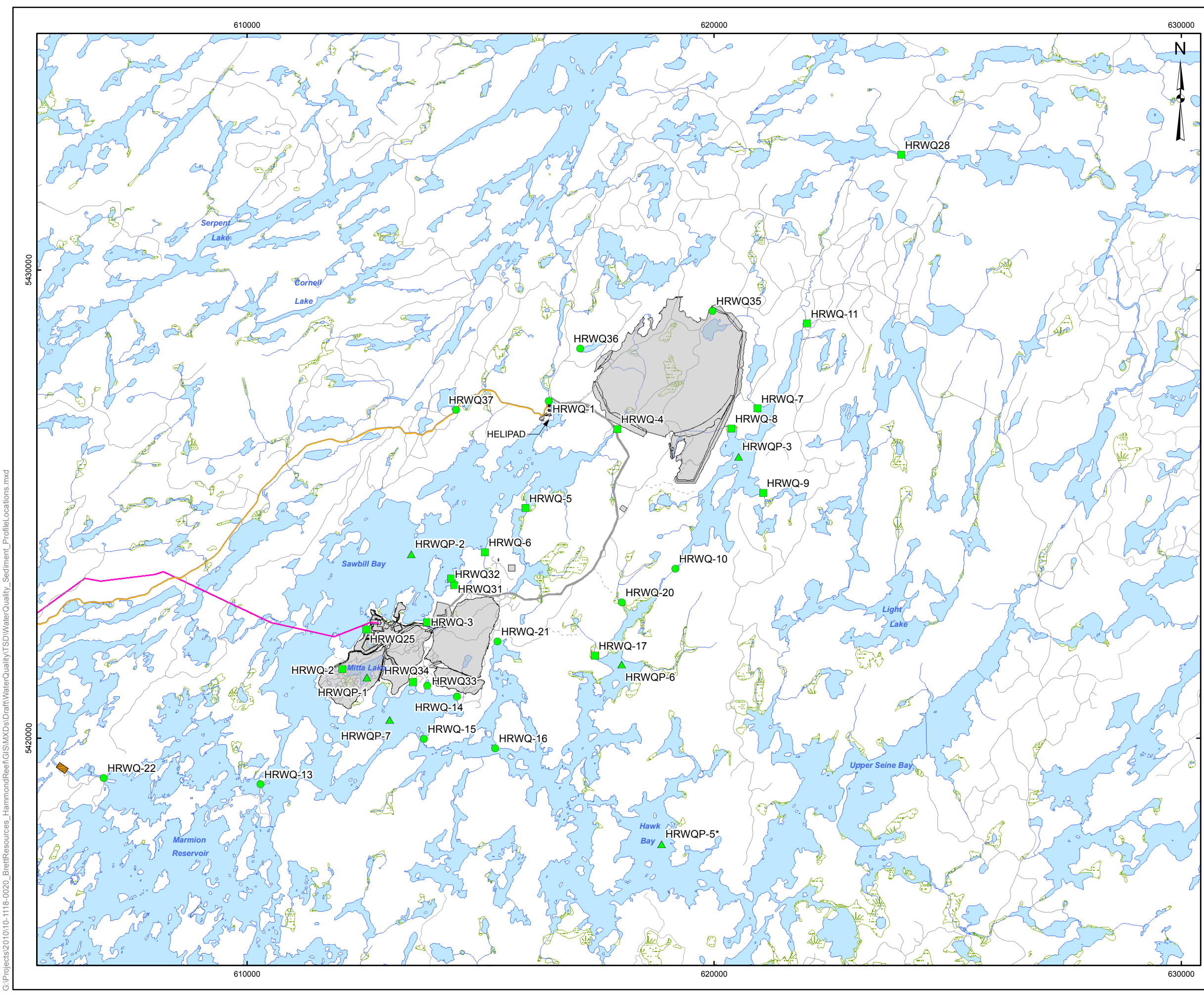
Sampling at water column profile stations involved the collection of two water samples at each location (one near the top of the water column and one near the bottom of the water column). It was possible to collect sediment samples at each column profile location.

In March 2012 some of the strategic water sample locations were modified to address changes to the location of Project components. This included the removal of some existing and the addition of new surface water/sediment stations as follows:

- Nine surface water/sediment stations (HRWQ) previously monitored were removed from the baseline monitoring program (HRWQ-12, HRWQ-18, HRWQ-19, HRWQ-23, HRWQ-24, HRWQ-26, HRWQ-27, HRWQ-29, HRWQ-30).
- Two water column profile stations (HRWQP) previously monitored were removed from the baseline monitoring program (HRWQP-4, HRWQP-8).
- Nine new surface water/sediment stations were added to the baseline monitoring program (HRWQ-31 through HRWQ-39).

The modified sampling program (carried out in the April and August 2012 campaigns) included a total of 30 surface water stations and six water column profile stations (Mitta Lake, Sawbill Bay, Lizard Lake, Hawk Bay, Turtle Bay and Lynxhead Bay). Although it was not possible to collect sediment at all stations due to rocky substrate, sediment was collected at 18 surface water stations and at all six water column profile stations.

Field parameters (temperature, depth, pH, dissolved oxygen, oxygen-reduction potential, and conductivity) were measured at each surface water grab station, as well as throughout the entire depth of water column profile stations in one-metre intervals. It should be noted that the YSI multiparameter meter malfunctioned during some field events, resulting in reported values that were outside of an acceptable range of results from a quality assurance perspective. These results were removed from the complete data set and have been noted (Appendix 2.III).

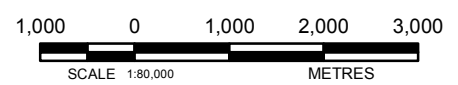


**LEGEND**

- Surface Water Sample Location
- Surface Water and Sediment Sample Location
- ▲ Profile Sample Location (Surface Water and Sediment)
- Raft Lake Cut Location
- Road
- - - Trail
- River/Stream
- Lake
- Wetland
- Mine Site Road
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Project Facilities

**REFERENCE**

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.  
 Base Data - MNR NRVIS, obtained 2004  
 Produced by Golder Associates Ltd under licence from  
 Ontario Ministry of Natural Resources, © Queens Printer 2008  
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N



<b>PROJECT</b>	<b>HAMMOND REEF GOLD PROJECT ATIKOKAN, ONTARIO, CANADA</b>		
<b>TITLE</b>	<b>WATER QUALITY, SEDIMENT AND PROFILE SAMPLE LOCATIONS</b>		
 Golder Associates Mississauga, Ontario	PROJECT NO. 10-1118-0020	SCALE AS SHOWN	VERSION 1
	DESIGN CGE 14 Nov. 2008		
	GIS JO 6 Feb. 2013		
	CHECK REJ 6 Feb. 2013		
	REVIEW KJD 6 Feb. 2013	<b>FIGURE: 2-1</b>	

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The coordinates for sampling locations and the number of times each location was sampled are summarized in Table 2-1. It should be noted that due to safety concerns, fewer locations were sampled in the winter (March 2011).

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**Table 2-1: Water and Sediment Sampling Summary**

Locations <sup>(a,b)</sup>	UTM <sup>(c)</sup>		2010		2011		2012	
	Easting	Northing	September	November	March	June	April	August
<b>Surface Water</b>								
HRWQ-1	15616458	5427206	X	X	X	X	X	X
HRWQ-2	15612038	5421474	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-3	15613852	5422474	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-4	15617930	5426603	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-5	15615961	5424918	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-6	15615094	5423969	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-7	15620926	5427042	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-8	15620369	5426612	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-9	15621047	5425242	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-10	15619170	5423620	X	X	—	X	X	X
HRWQ-11	15621990	5428860	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-12	15624198	5428901	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	—	—
HRWQ-13	15610287	5419015	X	X	—	X	X	X
HRWQ-14	15614495	5420889	X	X	—	X	X	X
HRWQ-15	15613786	5419985	X	X	—	X	X	X
HRWQ-16	15615313	5419786	X	X	—	X	X	X
HRWQ-17	15617448	5421763	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>

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**Table 2-1: Water and Sediment Sampling Summary (Continued)**

Locations <sup>(a,b)</sup>	UTM <sup>(c)</sup>		2010		2011		2012	
	Easting	Northing	September	November	March	June	April	August
HRWQ-18	15618559	5421551	X <sup>(S)</sup>	X	—	X <sup>(S)</sup>	—	—
HRWQ-19	15618476	5422456	X <sup>(S)</sup>	X	—	X <sup>(S)</sup>	—	—
HRWQ-20	15618024	5422899	X	X	—	X	X <sup>(S)</sup>	X
HRWQ-21	15615362	5422066	X	X	—	X	X	X
HRWQ-22	15606933	5419151	X	X	—	X	X	X
HRWQ-23	15621428	5421111	X <sup>(S)</sup>	X	—	X <sup>(S)</sup>	—	—
HRWQ-24	15621388	5420146	X	X	—	X	—	—
HRWQ-25	15612550	5422322	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-26	15627322	5424365	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	—	—
HRWQ-27	15626330	5427612	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	—	—
HRWQ-28	15624004	5432463	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ-29	15628983	5428731	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	—	—
HRWQ-30	15623070	5424168	X	X	—	X	—	—
HRWQ31	15614433	5423268	—	—	—	—	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ32	15614371	5423406	—	—	—	—	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ33	15613855	5421119	—	—	—	—	X	X
HRWQ34	15613552	5421195	—	—	—	—	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ35	15619965	5429130	—	—	—	—	X	X

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**Table 2-1: Water and Sediment Sampling Summary (Continued)**

Locations <sup>(a,b)</sup>	UTM <sup>(c)</sup>		2010		2011		2012	
	Easting	Northing	September	November	March	June	April	August
HRWQ36	15617133	5428323	—	—	—	—	X	X
HRWQ37	15614479	5427014	—	—	—	—	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ38	15602922	5420754	—	—	—	—	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQ39	15601274	5413433	—	—	—	—	X <sup>(S)</sup>	X <sup>(S)</sup>

**Water Column Profile**

HRWQP-1	15612566	5421293	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQP-2	15613517	5423932	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQP-3	15620522	5426008	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQP-4	15622211	5418963	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	—	—
HRWQP-5	15618879	5417736	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQP-6	15618020	5421576	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQP-7	15613056	5420391	X <sup>(S)</sup>	X <sup>(S)</sup>	—	X <sup>(S)</sup>	X <sup>(S)</sup>	X <sup>(S)</sup>
HRWQP-8	15624206	5427828	X <sup>(S)</sup>	X <sup>(S)</sup>	X	X	—	—

Notes:

- <sup>(a)</sup> HRWQ: Hammond Reef water and sediment quality sample location.
- <sup>(b)</sup> HRWQP: Hammond Reef water and sediment quality profile sample location.
- <sup>(c)</sup> Universal Transverse Mercator (UTM).
- <sup>(S)</sup> Denotes sediment sample was collected at this location.
- No sample was collected.



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### 2.2.2 Sample Collection Methods

Sampling was performed in accordance with recognized standard methods (ASTM 2006), (MOEE 1996) and (U.S. EPA 1992). The following sections discuss the surface water and sediment sample collection field methods.

#### 2.2.2.1 Surface Water Samples

Sterile gloves were worn during sample collection. Sample bottles were provided by the contract analytical laboratory and were pre-charged with preservatives at the analytical laboratory as required. Samples were stored in a cooler with ice packs and maintained in a cool state until shipped to the laboratories.

Surface water samples were collected both from boat and along the shores of rivers/streams. River and stream samples were collected as far from the bank as safely possible, carefully wading out to avoid disturbing the bottom sediment. Sampling was conducted facing upstream of the flow. Sample bottles were submerged below the water surface and facing upstream to avoid introducing any disturbed bottom sediment into the sample. The cap was removed under water and the bottle was let to fill. The bottle was recapped before lifting it out of the water. Bottles pre-charged with preservatives were filled by pouring off the contents of the General Parameters bottle.

Measurements of pH, oxygen-reduction potential (ORP), temperature, electrical conductivity and dissolved oxygen (DO) were collected in the field at the time of sampling using a YSI multiparameter meter (YSI). The YSI meter was calibrated by the supplier and in the field with calibration solutions provided by the supplier. Calibration for pH (two points: 4 and 7), electrical conductivity and ORP was carried out daily before sampling and documented in field notes. The YSI was placed downstream to equilibrate during the sampling procedure before measured parameters were recorded.

Water was collected approximately one metre below surface and one metre above lakebed using an eight-litre capacity plastic Van Dorn water sampler, tripped by a messenger weight. Limnology data (field parameter measurements) were collected using the YSI in one-metre intervals from the surface of the water column to the lakebed. All sample and data were collected from an anchored boat near the middle of the water body.

Water samples not requiring filtration (general parameter, major ions, nutrients, organics, microorganisms, total metals and total organic carbon) were decanted to individual sample bottles from a clean 500 millilitre (mL) sample bottle (rinsed three times with sample water). Samples requiring filtration (dissolved metals, dissolved organic carbon and dissolved inorganic carbon) were collected with a sterile syringe and passed through a 0.45 micrometre ( $\mu\text{m}$ ) sterile filter into individual sample bottles.

#### 2.2.2.2 Column Profile Samples

Water was collected approximately one metre below surface and one metre above lakebed using an 8 litres (L) capacity plastic Van Dorn water sampler, tripped by a messenger weight. Limnology data (field parameter measurements) were collected using the YSI in one-metre intervals from the surface of the water column to the lakebed. All sample and data were collected from an anchored boat near the middle of the water body.

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### 2.2.2.3 Sediment Samples

Sediment at surface water stations was collected from the river/stream bed either by hand (gloved) or by scooping sediment using laboratory-provided glass sediment jars. Sediment at column profile stations was collected at the lakebed using a stainless steel Petit Ponar dredge sampler. Organics (detritus, rootlets, etc.) and large grain-sized sediment (gravel, pebbles, etc.) were removed by hand, and excess water was decanted from the sample jar.

### 2.2.2.4 Documentation

Field staff labelled samples with unique sample numbers and documented observations. Observations include:

- Field conditions: weather, surrounding vegetation, and substrate.
- Sediment observation: colour, odour, grain size and organic content.
- Water observation: colour, clarity and odour.

### 2.2.3 Laboratory Analysis

Water and sediment samples were analyzed at ALS Thunder Bay for all sampling events. Surface water quality samples were submitted for the following analysis:

- **Physical parameters:** pH, acidity, alkalinity, conductivity, hardness, temperature, total dissolved solids, total suspended solids, total organic carbon (TOC) and dissolved organic carbon (DOC).
- **Major ions:** calcium, magnesium, potassium, sodium, sulphate, chloride, fluoride and cyanide (free and total).
- **Nutrients:** nitrate, nitrite, ammonia (total and un-ionized), total phosphorus and orthophosphate.
- **Organics:** oil and grease and phenols.
- **Microorganisms:** E coli and total coliform.
- **Metals:** total and dissolved metals (milligrams per litre (mg/L)) including aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, tungsten, uranium, vanadium, zinc, and zirconium.

The following parameters were added to the surface water analytical suite as follows: carbonate, bicarbonate, orthophosphate (April and August 2012), and acidity (March 2011, June 2011, April 2012 and August 2012).

Due to consistently non detectable concentrations, the following parameters were removed from the surface water analytical suite: free cyanide, total cyanide, e-coli and total coliforms (April and August 2012) and oil and greases (August 2012). Also due to consistently non-detectable concentrations, polycyclic aromatic

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hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) were removed from the sediment analytical suite (April and August 2012).

Sediment quality samples were submitted for the following analysis:

- **Metals** – total metals (milligrams per kilogram (mg/kg)) including aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, uranium, vanadium, zinc, and zirconium.
- **Polycyclic aromatic hydrocarbons (PAHs)** (mg/kg) including 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Acridine, Anthracene, Benz(a)anthracene, Benzo(b&j)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Benzo(a)pyrene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene, Phenanthrene, Pyrene, and Quinoline.
- **Polychlorinated biphenyls (PCBs)** (mg/kg) including Aroclor 1254, Total PCBs, 2-Fluorobiphenyl, p-Terphenyl d14, Aroclor 1242, Aroclor 1248, Aroclor 1260, d14-Terphenyl, and Silicon.

Analytes were chosen to be consistent with the applicable guidelines (Section 2.3). In general, the analytical detection limits were selected to be less than the applicable guidelines. Exceptions to this, for which analytical detection limits exceeded guidelines, are as follows:

- Cadmium detection limits of 0.00009 mg/L and 0.00002 mg/L in surface water samples were greater than the Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines (CCME CWQG) (0.000017 mg/L) observed in September 2010 and November 2010, respectively.
- Mercury detection limit of 0.0001 mg/L in surface water samples as observed in September 2010 was greater than the CCME CWQG (0.000026 mg/L).
- Silver detection limit of 0.0002 mg/L in surface water samples as observed in November 2010 was greater than the CCME CWQG and PWQO guidelines (0.0001 mg/L).
- Selenium detection limit of 0.002 mg/L in surface water samples as observed in June 2011 was greater than the CCME CWQG (0.001 mg/L). Some samples collected in September 2010 also had a detection limit (0.005 mg/L) that was greater than the CCME CWQG.
- All PAHs in sediment quality samples had detection limits that were greater than the guidelines.

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### 2.2.4 Quality Assurance and Quality Control

Quality Assurance/Quality Control (QA/QC) samples were collected during each sampling campaign. Duplicate samples were collected for approximately 10% of samples collected during each sampling campaign. In addition to the duplicate samples, the laboratory provided a field blank (de-ionized water decanted into sample bottles at the Project Site). These QA/QC procedures are in addition to the internal QA/QC requirements and programs of the analytical laboratory.

As part of data review, the following were considered with respect to Quality Assurance/Quality Control (QA/QC) issues:

- Lab, field and/or trip blank(s) showed contamination.
- Dissolved metal concentrations were substantially greater than the total concentrations.
- Total metal concentrations were greater than total suspended solids.
- Uncharacteristically high, anomalous concentrations.

Results reported by ALS Thunder Bay prior to January 2012 reported some detection limits that were lower for total metals than dissolved metals. Statistical calculations of data which assign a value equal to the detection limit to those values below detection resulted in an overestimation of the concentration of dissolved species. This was a reporting error that has since been corrected by the analytical laboratory. A letter from ALS Thunder Bay that qualifies and explains the reason for this occurrence (reportedly due to ultra low detections) is attached in Appendix 2.I.

The surface water laboratory, field and/or trip blank(s) that had detectable parameters, and/or values that were not within acceptable CCME CWQG and PWQO ranges are as follows:

- Aluminum concentration (0.027 mg/L) greater than both the CCME CWQG (0.005 mg/L) and PWQO (0.015 mg/L) guidelines observed in field blank in September 2010.
- Lead concentration (0.0019 mg/L) greater than both the CCME CWQG (0.001 mg/L) and PWQO (0.001 mg/L) guidelines observed in field blank in September 2010.
- Mercury concentration 0.00004 mg/L greater than the CCME CWQG (0.000026 mg/L) observed in trip blank in March 2011.

This indicates that sampling or analytical error may have occurred for these sampling periods. As such, the verification and evaluation of data with respect to regulatory guidelines was taken into consideration for aluminum, lead and mercury for results reported in this time period.

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### 2.3 Guidelines and Indicators

The following describes the guidelines used to compare the water and sediment quality results.

The results of the baseline water quality program were compared to:

- Ontario Provincial Water Quality Objectives (PWQO) (PWQO 1999).
- Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines (CCME CWQG) for the protection of aquatic life (CCME, 2007). Only total concentrations were compared to the guidelines.
- Ontario Drinking Water Standards (ODWS) Maximum Acceptable Concentration (MAC), Interim Maximum Acceptable Concentration (IMAC), Aesthetic Objective (AO) and Operational Guidelines (OG) (ODWS 2006). The most conservative (lowest) values were used from this list of four guidelines in the screening of results.

The results of the baseline sediment quality program were compared to:

- Canadian Council of Environment Ministers (CCME) sediment quality guidelines for the protection of aquatic life Probable Effect Level (PEL) and Interim Sediment Quality Guideline (ISQG) (CCME 2002).
- Ontario Provincial Sediment Quality Guidelines (PSQG) Lowest Effect Level (LEL) and Severe Effect Level (SEL) (MOEE 1993).

The complete analyte list and guidelines for surface water quality are provided in Appendix 2.II. The complete analyte list and guidelines for sediment quality are provided in Appendix 2.IV.

It should be noted that these are guidelines used for the baseline results and are not related to the impact assessment. Guidelines used to assess the magnitude and significance of impact will be developed as part of the effects assessment and provided in Chapter 6 of the EIS/EA Report. They may include the guidelines listed above for the baseline program as well as the actual baseline results. Similarly, indicators will also be developed as the impact assessment proceeds.



## **3.0 BASELINE RESULTS (EXISTING CONDITIONS)**

### **3.1 General Conditions and Comparison to Receiving Water Guidelines (CCME CWQG and PWQO)**

#### **3.1.1 Surface Water Samples**

A total of 173 surface water grab samples including 14 duplicate samples were collected from 39 locations during six sampling campaigns. In general, the surface water quality can be characterized by the following:

- Slightly acidic to slightly alkaline pH values.
- 28% and 34% of total aluminum concentrations greater than the CCME CWQG and PWQO guidelines, respectively.
- 36% of total iron concentrations greater than both the CCME CWQG and PWQO guidelines.
- Sporadic concentrations of total arsenic, cadmium, cobalt, copper, and lead greater than the CCME CWQG and/or PWQO guidelines.
- Only one total mercury concentration greater than the CCME CWQG.
- 14% and 10% of phenol concentrations greater than the CCME CWQG and PWQO guidelines, respectively.

The summary of results with percentages greater than the guidelines can be found in Table 3-1. Full water quality results including a statistical summary for count, minimum, maximum, average, median and 95<sup>th</sup> percentile are presented in Appendix 2.III.

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**Table 3-1: Summary of CCME CWQG and PWQO Screening of Results for Surface Water Grab Sample**

Parameters	Guidelines		Total Number	Values not meeting guidelines				Locations	
	CCME CWQG	PWQO		CCME CWQG		PWQO		CCME CWQG	PWQO
				Number	Percent	Number	Percent		
pH	6.5-9	6.5-8.5	172	32	19%	32	19%	HRWQ-1, 2, 6, 7 <sup>(b)</sup> , 8 <sup>(b)</sup> , 9 <sup>(b)</sup> , 10, 11 <sup>(b)</sup> , 13, 14 <sup>(b)</sup> , 16, 17 <sup>(b)</sup> , 18 <sup>(b)</sup> , 19, 20, 23, 26, 27 <sup>(b)</sup> , 28, 30, 35 <sup>(b)</sup>	HRWQ-1, 2, 6, 7 <sup>(b)</sup> , 8 <sup>(b)</sup> , 9 <sup>(b)</sup> , 10, 11 <sup>(b)</sup> , 13, 14 <sup>(b)</sup> , 16, 17 <sup>(b)</sup> , 18 <sup>(b)</sup> , 19, 20, 23, 26, 27 <sup>(b)</sup> , 28, 35 <sup>(b)</sup>
Dissolved Oxygen	5.5-9.5	4-8	138	9	7%	5	4%	HRWQ-6, 7, 8, 11 <sup>(b)</sup> , 17, 27, 36, 35	HRWQ-7, 11 <sup>(b)</sup> , 27, 35
Phosphorus	—	0.02	173	—	—	15	9%	—	HRWQ-3, 7, 11 <sup>(b)</sup> , 15 <sup>(b)</sup> , 17 <sup>(b)</sup> , 18, 19, 20 <sup>(b)</sup> , 25, 27
Phenols	0.004	0.005	173	24	14%	17	10%	HRWQ-3, 4, 5, 8, 9, 11, 12, 13, 15, 17, 18, 19, 20, 21, 22 <sup>(b)</sup> , 25, 26, 27, 28, 29 <sup>(b)</sup> , 30	HRWQ-4, 8, 11, 12, 13, 15, 18, 19, 21, 22 <sup>(b)</sup> , 26, 27, 28, 29 <sup>(b)</sup>
Aluminum (total)	0.005-0.1	0.015-0.075	172	48	28%	58	34%	HRWQ-1, 2 <sup>(b)</sup> , 3, 4, 6 <sup>(b)</sup> , 7 <sup>(b)</sup> , 8 <sup>(b)</sup> , 9 <sup>(b)</sup> , 10, 11 <sup>(b)</sup> , 13, 14 <sup>(b)</sup> , 16, 17 <sup>(b)</sup> , 18 <sup>(b)</sup> , 19 <sup>(b)</sup> , 20 <sup>(b)</sup> , 23, 25 <sup>(b)</sup> , 26, 27 <sup>(b)</sup> , 28, 35 <sup>(b)</sup>	HRWQ-1, 2 <sup>(b)</sup> , 3, 4 <sup>(b)</sup> , 6 <sup>(b)</sup> , 7 <sup>(b)</sup> , 8 <sup>(b)</sup> , 9 <sup>(b)</sup> , 10, 11 <sup>(b)</sup> , 13, 14 <sup>(b)</sup> , 16, 17 <sup>(b)</sup> , 18 <sup>(b)</sup> , 19 <sup>(b)</sup> , 20 <sup>(b)</sup> , 23, 25 <sup>(b)</sup> , 26 <sup>(b)</sup> , 27 <sup>(b)</sup> , 28, 35 <sup>(b)</sup> , 38
Arsenic (total)	0.005	0.1	172	1	1%	0	0%	HRWQ-31	—
Cadmium (total)	0.0000041-0.000042	0.0001-0.0005	172	18	10%	1	1%	HRWQ-1	HRWQ-3
Cobalt (total)	—	0.0009	172	—	—	5	3%	—	HRWQ-3 <sup>(b)</sup> , 7, 11 <sup>(b)</sup>
Copper (total)	0.002-0.004	0.001-0.005	172	5	3%	11	6%	HRWQ-3, 22, 27, 31 <sup>(b)</sup>	HRWQ-3, 11, 13, 22 <sup>(b)</sup> , 23, 27 <sup>(b)</sup> , 31, 33
Iron (total)	0.3	0.3	171	62	36%	62	36%	HRWQ-3 <sup>(b)</sup> , 4 <sup>(b)</sup> , 6, 7 <sup>(b)</sup> , 8 <sup>(b)</sup> , 9 <sup>(b)</sup> , 11 <sup>(b)</sup> , 13 <sup>(b)</sup> , 15 <sup>(b)</sup> , 16 <sup>(b)</sup> , 17 <sup>(b)</sup> , 18 <sup>(b)</sup> , 19, 20, 21 <sup>(b)</sup> , 22 <sup>(b)</sup> , 24, 25 <sup>(b)</sup> , 27 <sup>(b)</sup> , 31, 33 <sup>(b)</sup> , 34 <sup>(b)</sup>	HRWQ-3 <sup>(b)</sup> , 4 <sup>(b)</sup> , 6, 7 <sup>(b)</sup> , 8 <sup>(b)</sup> , 9 <sup>(b)</sup> , 11 <sup>(b)</sup> , 13 <sup>(b)</sup> , 15 <sup>(b)</sup> , 16 <sup>(b)</sup> , 17 <sup>(b)</sup> , 18 <sup>(b)</sup> , 19, 20, 21 <sup>(b)</sup> , 22 <sup>(b)</sup> , 24, 25 <sup>(b)</sup> , 27 <sup>(b)</sup> , 31, 33 <sup>(b)</sup> , 34 <sup>(b)</sup>
Lead (total)	0.001-0.007	0.001-0.005	172	1	1%	0	0%	HRWQ-3	—
Mercury (total)	0.000026	0.0002	173	1	1%	0	0%	HRWQ-1	—

Notes:

- <sup>(a)</sup> Refer to Appendix 2.III for the time period details.
- <sup>(b)</sup> Surface water quality locations that had concentrations greater than the guideline in at least two occurrences during the baseline investigation.
- <sup>(c)</sup> Parameters were greater than the guidelines for all seasons of the baseline investigation.
- Site water quality data was not modelled for this parameter

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The following parameters did not meet the CCME CWQG and/or the PWQO guidelines:

- pH values ranged from 5.6 to 8.3, ranging from slightly acidic to slightly alkaline. Thirty-two values were below the lower values range of both the CCME CWQG and PWQO guidelines (6.5).
- Total aluminum concentrations ranged from 0.0048 to 3.0 mg/L. Fifty-eight concentrations were greater than the PWQO guideline (0.015-0.075 mg/L, pH dependent), of which 48 were also greater than the CCME CWQG (0.005-0.1 mg/L, pH dependent). The maximum was observed at HRWQ-3 in March 2011.
- Total arsenic concentrations ranged from 0.000199 to 0.00553 mg/L. One concentration was greater than the CCME CWQG (0.005 mg/L). The maximum was observed at HRWQ-31 in August 2012.
- Total iron concentrations ranged from 0.00007 to 18.0 mg/L. Sixty-two concentrations were greater than both the CCME CWQG and PWQO (both values are 0.3 mg/L) guidelines. The maximum was observed at HRWQ-3 in March 2011.
- Total copper concentrations ranged from 0.00015 to 0.006 mg/L. Eleven concentrations were greater than the PWQO guideline (0.001-0.005 mg/L, hardness dependent), of which five were also greater than the CCME CWQG (0.002-0.004 mg/L, hardness dependent). The maximum was observed at HRWQ-3 in March 2011.
- Total cadmium concentrations ranged from 0.000002 to 0.00022 mg/L. Eighteen concentrations were greater than the CCME CWQG (0.0000041-0.000042 mg/L, hardness dependent), of which one was also greater than the PWQO guideline (0.0001-0.0005 mg/L, hardness dependent). The maximum was observed at HRWQ-3 in November 2010.
- Total cobalt concentrations ranged from 0.000012 to 0.0063 mg/L. Five concentrations were greater than the PWQO guidelines (0.0009 mg/L). The maximum was observed at HRWQ-3 in March 2011.
- Total lead concentrations ranged from 0.00002 to 0.0032 mg/L. One concentration was greater than the CCME CWQG (0.001-0.007 mg/L, hardness dependent) observed at HRWQ-3 in March 2011.
- Total mercury concentrations ranged from < 0.00001 to 0.00004 mg/L. One sample was greater than the CCME CWQG (0.000026 mg/L) observed at HRWQ-1 in March 2011.
- All other total metal concentrations were below CCME CWQG and PWQO guidelines.
- Dissolved oxygen concentrations ranged from 1.3 to 14.0 mg/L. Nine concentrations were below the accepted CCME CWQG (5.5 mg/L), of which five were also below the accepted PWQO guideline (4 mg/L). The minimum was observed at HRWQ7 in August 2012.
- Phenol concentrations ranged from < 0.001 to 0.024 mg/L. Twenty-four concentrations were above the CCME CWQG (0.004 mg/L), of which seventeen were also greater than the PWQO guideline (0.005 mg/L).
- Phosphorus concentrations ranged from < 0.005 to 0.31 mg/L with 15 samples having values greater than the PWQO guideline (0.02 mg/L).



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### 3.1.2 Water Column Profiles

Field parameters were measured throughout the water column in eight locations (Mitta Lake, Sawbill Bay, Lizard Lake, Light Bay, Hawk Bay, Turtle Bay, Lynxhead Bay and Premier Lake) during the first four sampling campaigns and in six locations (Mitta Lake, Sawbill Bay, Lizard Lake, Hawk Bay, Turtle Bay, and Lynxhead Bay) during the last two sampling campaigns. The results for each water column profile are presented in Appendix 3.I.

Due to unsafe ice conditions, sampling in March 2011 was not possible at stations HRWQP-2 to HRWQP-7 (Sawbill Bay, Lizard Lake, Light Bay, Hawk Bay, Turtle Bay and Lynxhead Bay).

A total of 84 water samples including eight samples for QA/QC were collected from top and bottom of the eight bodies of water. The summary of results and number of samples greater than the guidelines can be found in Table 3-2. Detailed profile water quality results including a statistical summary for count, minimum, maximum, average, median and 95<sup>th</sup> percentile are presented in Appendix 2.III.

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**Table 3-2: Summary of CCME CWQG and PWQO Screening of Results for Water Samples collected from Profile Stations**

Parameters	Guidelines		Total Number	Values not meeting guidelines				Location <sup>(a)</sup>	
	CCME CWQG	PWQO		CCME CWQG		PWQO		CCME CWQG	PWQO
				Number	Percent	Number	Percent		
pH	6.5-9	6.5-8.5	84	20	24%	20	24%	HRWQP-1A, 1B <sup>(b)</sup> , 2A, 2B <sup>(b)</sup> , 3A <sup>(b)</sup> , 4B, 5B <sup>(b)</sup> , 6A, 6B, 7A <sup>(b)</sup> , 7B <sup>(b)</sup> , 8B	HRWQP-1A, 1B <sup>(b)</sup> , 2A, 2B <sup>(b)</sup> , 3A <sup>(b)</sup> , 4B, 5B <sup>(b)</sup> , 6A, 6B, 7A <sup>(b)</sup> , 7B <sup>(b)</sup> , 8B
Dissolved Oxygen	5.5-9.5	4-8	72	9	13%	7	10%	HRWQP-1B <sup>(b)</sup> , 2B, 5B <sup>(b)</sup> , 7B	HRWQP-1B <sup>(b)</sup> , 5B <sup>(b)</sup>
Phosphorus	—	0.02	84	—	—	12	14%	—	HRWQP-1B <sup>(b)</sup> , 4B, 5B <sup>(b)</sup> , 6A, 7B, 8A
Phenols	0.004	0.005	84	12	14%	6	7%	HRWQP-1A <sup>(b)</sup> , 1B, 4A, 4B, 6B, 7A, 7B <sup>(b)</sup> , 8A, 8B	HRWQP-1B, 4B, 7A, 7B, 8A, 8B
Aluminum (total)	0.005-0.1	0.015-0.075	84	30	36%	29	35%	HRWQP-1A <sup>(b)</sup> , 1B <sup>(b)</sup> , 2A <sup>(b)</sup> , 2B <sup>(b)</sup> , 3A <sup>(b)</sup> , 4B <sup>(b)</sup> , 5B <sup>(b)</sup> , 6A <sup>(b)</sup> , 6B, 7A <sup>(b)</sup> , 7B <sup>(b)</sup> , 8B	HRWQP-1A <sup>(b)</sup> , 1B <sup>(b)</sup> , 2A <sup>(b)</sup> , 2B <sup>(b)</sup> , 3A <sup>(b)</sup> , 4B <sup>(b)</sup> , 5B <sup>(b)</sup> , 6A <sup>(b)</sup> , 6B, 7A, 7B <sup>(b)</sup> , 8B
Cadmium (total)	0.0000041-0.000042	0.0001-0.0005	84	4	5%	0	0%	HRWQP-5B, 6A, 7B, 8B	—
Cobalt (total)	—	0.0009	84	—	—	1	1%	—	HRWQP-7B
Copper (total)	0.002-0.004	0.001-0.005	84	1	1%	3	4%	HRWQP-1B	HRWQP-5B, 7A, 7B
Iron (total)	0.3	0.3	84	32	38%	32	38%	HRWQP-1B <sup>(b)</sup> , 2B <sup>(b)</sup> , 4A, 4B <sup>(b)</sup> , 5A <sup>(b)</sup> , 5B <sup>(b)</sup> , 6A, 7A <sup>(b)</sup> , 7B <sup>(b)</sup>	HRWQP-1B <sup>(b)</sup> , 2B <sup>(b)</sup> , 4A, 4B <sup>(b)</sup> , 5A <sup>(b)</sup> , 5B <sup>(b)</sup> , 6A, 7A <sup>(b)</sup> , 7B <sup>(b)</sup>
Mercury (total)	0.000026	0.0002	84	1	1%	0	0%	HRWQP-1A	—
Zinc (total)	0.03	0.02	84	0	0%	1	1%	—	HRWQP-1A

Notes:

- <sup>(a)</sup> Refer to Appendix 3.1 for the time period details.
- <sup>(b)</sup> Indicates concentrations greater than the guideline in at least 2 occurrences during the baseline investigation.
- Site water quality data was not modelled for this parameter

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### 3.1.2.1 Mitta Lake

The limnology trends for Mitta Lake are summarized below and detailed results of limnology are presented in Appendix 3.I, Figure 1:

- Mitta Lake is a small (about 17 Ha) lake and is generally steep-sided with a limited catchment area of approximately 82 hectares (ha) indicating minimal inputs from surface runoff. Some portion of water inputs may be provided by groundwater recharge.
- A distinct thermocline was recorded at a depth of between 4 and 7 m in both September 2010 and August 2012, where the temperature decreased by greater than 5°C over a 1 m interval.
- A less distinct thermocline was recorded at a depth of approximately 2 m in June 2011 where the temperature decreased by nearly 2°C over a 1 m interval.
- As observed from the temperature profile, Mitta Lake was stratified in September 2010, June 2011 and August 2012. Stratification was not observed in November 2010 or March 2011.
- In general a gradual decrease of dissolved oxygen with depth was observed (corresponding to temperature in all seasons but March 2011).
  - Dissolved oxygen was outside of the acceptable guidelines range in 75% of observations based on the CCME CWQG range (5.5 to 9.5 mg/L), and 91.6% of observations based on the PWQO guideline range (4 to 8 mg/L).
- The lake was depleted of dissolved oxygen below a depth of 6 m (to a total depth of 12 m) in September 2010. Similarly, the concentration of dissolved oxygen rapidly decreased below a depth of 6 m to a concentration of approximately 2 mg/L in March 2011, June 2011, and August 2012.
- The pH trended from a slightly acidic pH of 6.0 (August 2012, at bottom) to a slightly alkaline pH of 8.0 (August 2012, at surface).
  - The pH generally increased with depth in June 2011, and conversely, decreased with depth in the other five seasons.
- Conductivity readings increased with depth ranging from the lowest concentration (measured in September 2010) of 46 µS/cm at one-metre depth, to the highest concentration (measured in April 2012) of 91 µS/cm at 12 m.

### 3.1.2.2 Lizard Lake

The limnology trends for Lizard Lake are summarized below and detailed results of limnology are presented in Figure 2 of Appendix 3.I:

- Lizard Lake has a surface length that is approximately 5 times greater than the surface width (indicating a large fetch, i.e. potential for significant impact from wind action), in a northeast to southwest orientation (top to bottom), with a surface area of approximately 2.04 square kilometres (km<sup>2</sup>).

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- The lake is well-mixed with a maximum depth of approximately 7 meters.
- The temperature ranged from 5.1°C (observed at surface in November 2011) to 22.1°C (observed at surface in August 2012).
- Dissolved oxygen ranged from 7.6 mg/L (observed at bottom in August 2012) to 12.3 mg/L (observed at surface in November 2012).
  - Dissolved oxygen was greater than the acceptable guidelines range in 50% of observations based on the CCME CWQG (9.5 mg/L), and 90% of observations based on the PWQO guideline (8 mg/L).
- pH ranged from 6.28 (observed at 2m depth in June 2011) to 7.57 (observed at surface in August 2012).
  - pH values were below both the CCME CWQG and PWQO guidelines in the entire 5 meters of the water column in June 2011. All other pH results were within the CCME CWQG and PWQO guidelines except for one surface value in September 2010.
- Conductivity ranged from 59 µS/cm (observed throughout the majority of the water column in April 2012) to 76 µS/cm (observed at meter 5 in June 2011).

### 3.1.2.3 *Sawbill Bay, Lizard Lake, Light Bay, Hawk Bay, Turtle Bay, Lynxhead Bay and Premier Lake*

The remaining seven water bodies can be categorized as either stratified or non-stratified with general trends as described below. Detailed results of limnology are presented in Figures 3 through 8 of Appendices 3.I.

- Thermal stratification was observed in Sawbill Bay, Light Bay, Hawk Bay and Premier Lake (approximate depths of 24 m, 10 m, 14 m, and 8 m, respectively), with similar trends to Mitta Lake as follows:
  - Distinct thermoclines observed in September 2010, June 2011 and August 2012 were observed for these locations, with the exception of Light Bay (only stratified in June 2011) and Hawk Bay (only stratified in September 2010 and June 2011).
  - When stratified, there is a general decrease in temperature and dissolved oxygen with depth.
  - Generally a circumneutral pH.
- Lizard Lake, Turtle Bay and Lynxhead Bay (approximate depths of 5 m, 2 m, and 12 m, respectively) are well-mixed (non-stratified), and present similar values for conductivity, dissolved oxygen and pH with depth throughout the water column. However it should be noted that stratification of Lynxhead Bay waters was observed at the deepest measurement (12 m) in September 2010.

### 3.1.2.4 *Profile Water Quality*

A total of 84 water samples of surface and bottom water were taken during six sampling events, including eight duplicate samples collected for QA/QC. The following parameters did not meet the CCME CWQG and/or the PWQO guidelines:

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- pH values ranged from 5.2 (bottom) to 8.0 (surface), and can be considered acidic to slightly alkaline. Twenty values were below the lowest accepted range for both the CCME CWQG and PWQO guidelines (6.5).
- Total aluminum concentrations ranged from 0.014 to 1.2 mg/L. Thirty concentrations were greater than the CCME CWQG (0.005-0.1 mg/L, pH dependent), of which 29 were also greater than the PWQO guideline (0.015-0.075 mg/L, pH dependent). The maximum concentration was observed in Mitta Lake bottom sample in April 2012.
- Total iron concentrations ranged from 0.02 to 4.0 mg/L. Thirty-two concentrations were greater than both the CCME CWQG and PWQO guidelines (both values are 0.3 mg/L). The maximum concentration was observed in Lynxhead Bay bottom sample in August 2012.
- Total mercury concentration was 0.0074 mg/L. One concentration was greater than the CCME CWQG (0.000026 mg/L), and less than the PWQO guideline (0.0002 mg/L). The maximum was observed in Mitta Lake top in April 2012.
- Total copper concentrations ranged from 0.0004 to 0.0025 mg/L. Three concentrations were greater than the PWQO guidelines (0.001-0.005 mg/L, hardness dependent), of which one concentration was also greater than the CCME CWQG (0.002-0.004 mg/L, hardness dependent). The maximum was observed in Mitta Lake bottom samples in April 2012.
- Total zinc concentrations ranged from 0.00025 to 0.024 mg/L. One concentration was greater than the PWQO (0.02 mg/L), observed in Mitta Lake top sample in September 2010.
- Dissolved oxygen concentrations ranged from 0.47 to 14 mg/L. Nine concentrations were below accepted oxygen level defined by CCME CWQG (5.5 mg/L), of which seven were also below PWQO (4 mg/L) accepted level.
- Phenol concentrations ranged from < 0.001 to 0.018 mg/L. Twelve concentrations were greater than the CCME CWQG (0.004 mg/L), of which six were also greater than the PWQO guideline (0.005 mg/L). The maximum was observed in Premier lake top sample in March 2011.
- Phosphorus concentrations ranged from 0.0055 to 0.072 mg/L. Twelve concentrations were greater than the PWQO guideline (0.02 mg/L). The maximum was observed in Lynxhead Bay bottom sample in August 2012.

### 3.1.3 Marmion Reservoir

Sampling locations chosen to represent Marmion Reservoir water quality include the following surface water and column profile stations: HRWQ-13, HRWQ-15, HRWQ-16, HRWQ-22, HRWQ-24, HRWQP-2A/2B (Sawbill Bay top and bottom), HRWQP-4A/B (Light Bay top and bottom), HRWQP-5A/B (Hawk Bay top and bottom), and HRWQP-6A/B (Turtle Bay top and bottom) and HRWQP-7A/B (Lynxhead Bay top and bottom).

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The summary of results and number of samples greater than the guidelines can be found in Table 3-3. The statistical summary for count, minimum, maximum, average, median and 95<sup>th</sup> percentile is presented in Appendix 2.III:

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**Table 3-3: Summary of CCME CWQG and PWQO Screening of Results for Water Samples collected from Marmion Reservoir**

Parameters	Guidelines		Total Number	Values not meeting guidelines				Location <sup>(a)</sup>
	CCME CWQG	PWQO		CCME CWQG		PWQO		
				Number	Percent	Number	Percent	
pH	6.5-9	6.5-8.5	77	16	21%	16	21%	HRWQ-7,13,16 and HRWQP-2A,2B,4B,5B,6A,6B
Dissolved Oxygen	5.5-9.5	4-8	64	4	6%	2	3%	HRWQP-2B, 5B,7B
Phosphorus	—	0.02	77	—	—	7	9%	HRWQ-7,15 and HRWQP-4B,5B,6A
Phenols	0.004	0.005	77	12	16%	8	10%	HRWQ-13,15,22 and HRWQP-4A,4B,6B
Aluminum (total)	0.005-0.1	0.015-0.075	77	8	10%	9	12%	HRWQ-7,13,16 and HRWQP-2A,2B,4B,5B,6A,6B
Cadmium (total)	0.0000041-0.000042	0.0001-0.0005	77	4	5%	0	0%	HRWQ-16 and HRWQP-5B,6A,7B
Chromium (total)	0.001	0.001	77	2	3%	2	3%	HRWQP- 6A,7B
Cobalt (total)	—	0.0009	77	—	—	1	1%	HRWQP-7
Copper (total)	0.002-0.004	0.001-0.005	77	1	1%	7	9%	HRWQ-13,22 and HRWQP-5B,7A,7B
Iron (total)	0.3	0.3	76	45	59%	45	59%	HRWQ-13,15,16,22,24 and HRWQP-2B,4A,4B,5A,5B,6A,7A,7B

Notes:

— Site water quality data was not modelled for this parameter

<sup>(a)</sup> Refer to Appendix 2.III for the time period details.

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The following parameters within Marmion Reservoir did not meet the CCME CWQG and/or PWQO guidelines:

- pH values ranged from 5.2 to 7.7, ranging from slightly acidic to circumneutral. Sixteen values were below the lower values range of both the CCME CWQG and PWQO guidelines (6.5).
- Total iron concentrations ranged from 0.112 to 4 mg/L. Forty-five concentrations were greater than both the CCME CWQG and PWQO (both values are 0.3 mg/L) guidelines. The maximum was observed at HRWQP-7 in August 2012.
- Total aluminum concentrations ranged from 0.026 to 0.8 mg/L. Eight concentrations were greater than the CCME CWQG (0.005-0.1 mg/L, pH dependent) and nine concentrations were also greater than the PWQO guideline (0.015-0.075 mg/L, pH dependent). The maximum was observed at HRWQP-6A in August 2012.
- Total cadmium concentrations ranged from <0.00001 to 0.00005 mg/L. Four concentrations were greater than the CCME CWQG (0.0000041-0.000042 mg/L, hardness dependent). The maximum was observed at HRWQP-7 in August 2012.
- Total copper concentrations ranged from <0.0007 to 0.0021 mg/L. Seven concentrations were greater than the PWQO guideline (0.001-0.005 mg/L, hardness dependent), of which one was also greater than the CCME CWQG (0.002-0.004 mg/L, hardness dependent). The maximum was observed at HRWQ-22 in November 2010.
- Total chromium concentrations ranged from <0.00005 to 0.0014 mg/L. Two concentrations were greater than both the PWQO and CCME CWQG (0.001 mg/L) guideline. The maximum was observed at HRWQP-7B in August 2012.
- Total cobalt concentrations ranged from < 0.00005 to 0.0014 mg/L. One concentration was greater than the PWQO guidelines (0.0009 mg/L). The maximum was observed at HRWQ-7 in August 2012.
- All other total metal concentrations were below CCME CWQG and PWQO guidelines.
- Dissolved oxygen concentrations ranged from 0.47 to 14.0 mg/L. Four concentrations were below the accepted CCME CWQG (5.5 mg/L), of which two were also below the accepted PWQO guideline (4 mg/L). The minimum was observed in a Hawk Bay bottom sample in August 2012.
- Phenol concentrations ranged from < 0.001 to 0.012 mg/L. Twelve concentrations were above the CCME CWQG (0.004 mg/L), of which eight were also greater than the PWQO guideline (0.005 mg/L). The maximum was observed at a Light Bay bottom sample in June 2011.
- Phosphorus concentrations ranged from 0.0065 to 0.072 mg/L with seven samples having values greater than the PWQO guideline (0.02 mg/L). The maximum was observed at a Turtle Bay surface sample in August 2012.



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### 3.2 Sediment Quality

A total of 134 samples including seven duplicate samples were collected during six sampling campaigns. The summary of results with values and percentages greater than the most conservative guidelines can be found in Table 3-4. Full sediment quality results including a statistical summary for count, minimum, maximum, average, median and 95<sup>th</sup> percentile are presented in Appendix 2.IV. It should be noted that both the grab and Lake Profile sediment results are included in this discussion, Table 3-4 and Appendix 2.IV.

The following parameters did not meet the CCME and PSQG guidelines:

- Arsenic concentrations can be summarized as follows:
  - Concentrations ranged from < 1 to 60.9 mg/kg.
  - Thirty-four concentrations were greater than the CCME ISQG guideline (5.9 mg/kg).
  - Thirty-four samples were greater than the PSQG LEL (6 mg/kg).
  - Eleven samples were greater than the CCME PEL (17 mg/kg).
  - Two samples were greater than the PSQG SEL guideline (33 mg/kg).
  - The maximum was observed at HRWQ-25 in June 2011.
- Cadmium concentrations ranged from < 0.5 to 5.4 mg/kg. Thirty-six concentrations were greater than the PSQG LEL and CCME ISQG guidelines (0.6 mg/kg), of which two were also greater than the CCME PEL guideline (3.5 mg/kg). The maximum was observed at HRWQP-7B in September 2010.
- Chromium concentrations ranged from 3 to 216 mg/kg. Thirty-five concentrations were greater than the PSQG LEL guideline (26 mg/kg), of which 14 were also greater than the CCME ISQG guideline (37.3 mg/kg), and one was greater than both the CCME PEL guideline (90 mg/kg) and Ontario Ministry of the Environment and Energy (MOEE) SEL guideline (110 mg/kg). The maximum was observed at HRWQ-38 in August 2012.
- Cobalt concentrations ranged from 1.7 to 69.9 mg/kg. Two concentrations were greater than the MOEE SEL guideline (50 mg/kg). The maximum was observed at HRWQP-7B in September 2010.
- Copper concentrations ranged from < 1 to 67.9 mg/kg. Sixty-eight concentrations were greater than the PSQG LEL guideline (16 mg/kg), of which four were also greater than the CCME ISQG guideline (35.7 mg/kg). The maximum was observed at HRWQ-39 in August 2012.
- Iron concentrations ranged from 1,630 to 137,000 mg/kg. Thirty-three concentrations were greater than the PSQG LEL guideline (20,000 mg/kg), of which twenty-one were also greater than the PSQG SEL guideline (40,000 mg/kg). The maximum was observed at HRWQP-2B in June 2011.

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- Lead concentrations ranged from < 1 to 68.1 mg/kg. Fifteen concentrations were greater than the MOEE LEL guideline (31 mg/kg), of which nine were also greater than the CCME ISQG guideline (35 mg/kg). The maximum was observed at HRWQP-1B in September 2010.
- Manganese concentrations ranged from 0.061 to 80,900 mg/kg. Forty-four concentrations were greater than the PSQG LEL guideline (460 mg/kg), of which twenty-four were also greater than the PSQG SEL guideline (1100 mg/kg). The maximum was observed at HRWQP-7B in September 2010.
- Mercury concentrations ranged from 0.01 to 256 mg/kg. Eleven concentrations were greater than the CCME ISQG guideline (0.17 mg/kg), of which ten were also greater than the MOEE LEL guideline (0.2 mg/kg), nine were greater than the CCME PEL guideline (0.486 mg/kg) and five were greater than the MOEE SEL guideline (2 mg/kg). The maximum was observed at HRWQ-9 in November 2010.
- Nickel concentrations ranged from < 1 to 104 mg/kg. Forty-seven concentrations were greater than the PSQG LEL guideline (16 mg/kg), of which 37 were also greater than the CCME ISQG guideline (18 mg/kg), three were greater than CCME PEL guideline (36 mg/kg) and one was greater than the MOEE SEL guideline (75 mg/kg). The maximum was observed at HRWQ-38 in August 2012.
- Silver concentrations ranged from < 0.2 to 201 mg/kg. Six concentrations were greater than the MOEE SEL guideline (0.5 mg/kg). The maximum was observed at HRWQ-27 in November 2010.
- Zinc concentrations ranged from < 1 to 213 mg/kg. Seven concentrations were greater than the MOEE LEL guideline (120 mg/kg), of which six were also greater than the CCME ISQG guideline (123 mg/kg). The maximum was observed at HRWQP-7B in September 2010.
- PAHs concentration can be discussed as follows:
  - Four benzo(k)fluoranthene concentrations were greater than the PSQG LEL (0.00034 mg/kg), of which one was also greater than the CCME ISQG (0.0571 mg/kg).
  - Three benzo(a)pyrene concentrations were greater than the PSQG LEL (0.00006 mg/kg) and CCME ISQG (0.00622 mg/kg) guidelines, of which one was also greater than the PSQG SEL (0.13 mg/kg) and CCME PEL (0.135 mg/kg) guidelines.
  - Two 2-methylnaphthalene concentrations were greater than the CCME ISQG guideline (0.00587 mg/kg), of which one is also greater than the CCME PEL guideline (0.128 mg/kg).
  - One concentration of benzo(b&j)fluoranthene, fluoranthene, ideno(1,2,3-cd)pyrene, pyrene and 1-methylnaphthalene was greater than at least one of the guidelines.

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**Table 3-4: Summary of CCME and PSQG Screening of Sediment Quality Results (Grab and Lake Bottom Samples)**

Parameters	Lowest Receiving Guidelines <sup>(a)</sup>	Total Number	Values Not Meeting Guidelines		Location
			Number	Percent	
Arsenic	5.9	134	34	25%	HRWQP-1,2,4,5,7,8 and HRWQ-2,25,31,38,39 <sup>(b)</sup>
Cadmium	0.6	134	36	27%	HRWQP-1,2-5,7,8 and HRWQ-2,25,29,38,39 <sup>(b)</sup>
Chromium (total)	26	134	35	26%	HRWQP-2-8 and HRWQ-3,6,17,20,38 <sup>(b)</sup>
Cobalt	50	134	2	1%	HRWQP-7 (Sep 2010)
Copper	16	134	68	51%	HRWQP-1-8 and HRWQ-2,3,5,6,8,9,17,18,20,25,26,29,31,32,37-39 <sup>(b)</sup>
Iron (total)	20000	134	33	25%	HRWQP-1-5,7,8 and HRWQ-17,20,25,38,39 <sup>(b)</sup>
Lead	31	134	15	11%	HRWQP-1,2,5,7 and HRWQ-25,29,38 <sup>(b)</sup>
Manganese	460	134	44	33%	HRWQP-1-5,7,8 and HRWQ-2,3,5,6,11,20,25,26,34,38,39 <sup>(b)</sup>
Mercury	0.17	134	11	8%	HRWQ-3,6,9,27,31,32 <sup>(b)</sup>
Nickel	16	134	47	35%	HRWQP-1-8 and HRWQ-2,3,5,6,8,17,20,38,39 <sup>(b)</sup>
Silver	0.5	134	6	4%	HRWQP-1 (Nov. 2010), HRWQP-7 (Nov. 2010), HRWQ-2 (Aug. 2012), HRWQ-27 (Nov. 2010)
Zinc	120	134	7	5%	HRWQP-3,5,7 and HRWQ-8,38 <sup>(b)</sup>
1-Methylnaphthalene	0.00671	84	1	1%	HRWQ-27 (Nov. 2010)
2-Methylnaphthalene	0.00587	84	2	2%	HRWQ-11 (Nov. 2010), HRWQ-27 (Nov. 2010)
Benzo(k)fluoranthene	0.00034	84	4	5%	HRWQP-2 (Nov. 2010), HRWQ-4 (Nov. 2010), HRWQ-5 (Nov. 2010), HRWQ-11 (Nov. 2010)
Benzo(b&j)fluoranthene	0.00037	84	1	1%	HRWQP-5 (Nov. 2010)
Benzo(a)pyrene	0.00006	84	3	4%	HRWQP-2 (June 2011), HRWQP-4 (Nov. 2010), HRWQP-5 (Nov. 2010)
Fluoranthene	0.0002	84	1	1%	HRWQP-5 (Nov. 2010)
Indeno(1,2,3-cd)pyrene	0.0202	84	1	1%	HRWQP-5 (Nov. 2010)
Pyrene	0.00049	84	1	1%	HRWQP-5 (Nov. 2010)

Notes:

<sup>(a)</sup> The most conservative value was taken from four guidelines: CCME PEL, CCME ISQG, PSQG LEL and PSQG SEL.

<sup>(b)</sup> Refer to Appendix 2.IV for the time period details.

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### 3.3 Comparison to Ontario Drinking Water Standards

Screening of surface water quality with respect to the Ontario Drinking Water Standards (ODWS) was carried out to evaluate the baseline water quality of surface water that may currently be used for human consumption.

The summary of surface water quality results with number and percentages of values greater than the guidelines can be found in Table 3-5. Full surface water quality results with respect to ODWS including a statistical summary for count, minimum, maximum, average, median and 95th percentile are presented in Appendix 2.III.

**Table 3-5: Summary of ODWS Screening of Results for Surface Water Samples**

Parameters	Guidelines	Total Number	Values not meeting guidelines		Location (ODWS) <sup>(b)</sup>
	ODWS <sup>(a)</sup>		ODWS		
			Number	Percent	
pH	6.5–8.5	172	32	19%	HRWQ-1,2,6,7,8,9,10,11,13,14,16,17,18,19,20,23,26,27,28,30,35
DOC	5	173	167	97%	All stations
Alkalinity	30–500	173	144	83%	HRWQ-1,2,4,5,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,25,26,27,28,29,30,32,33,34,35,36,37,38,39
Hardness	80–100	170	169	99%	All stations
Aluminum	0.1	172	28	16%	HRWQ-2,3,4,6,7,9,11,17,18,19,20,25,27
Iron (total)	0.3	172	62	36%	HRWQ-3,4,6,7,8,9,11,13,15,16,17,18,19,20,21,22,24,25,27,31,33,34
Manganese	0.05	172	31	18%	HRWQ-3,4,6,7,11,12,14,15,16,17,21,25,27,31,33,34,35,37,39

Notes:

- (a) The most conservative value was taken from four guidelines: ODWS MAC: Maximum Acceptable Concentration; IMAC: Interim Maximum Acceptable Concentration; AO: Aesthetic Objective; OG: Operational Guideline.
- (b) Values do not meet guidelines for more than one time period. See Appendix 2.III for details.

The surface water quality with respect to ODWS guidelines can be summarized as:

- Slightly acidic to slightly alkaline pH values with 19% of measured values lower than the ODWS guidelines (6.5) at several sample locations.
- 97% of DOC values were greater than the ODWS guidelines (5 weight percent solution (wt %)) at all sample locations.
- 83% of alkalinity concentrations were below the lower bound ODWS guidelines (30 milligrams per litre as calcium carbonate (mg CaCO<sub>3</sub>/L)) at several sample locations.

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- 99% of hardness concentrations were outside of the ODWS optimum range (80 to 100 mg CaCO<sub>3</sub>/L) at all sample locations.
- 16% of aluminum concentrations were greater than the ODWS guidelines (0.1 mg/L) at several sample locations.
- 36% of iron concentrations were greater than the ODWS guidelines (0.3 mg/L) at several sample locations.
- 18% of manganese concentrations were greater than the ODWS guidelines (0.05 mg/L) at several sample locations.

The summary of profile water quality results with number and percentage of values greater than the ODWS guidelines can be found in Table 3-6. Full profile water quality results with respect to ODWS including a statistical summary for count, minimum, maximum, average, median and 95th percentile are presented in Appendix 2.III.

**Table 3-6: Summary of ODWS Screening of Results for Profile Water Samples**

Parameters	Guidelines	Total Number	Values not meeting guidelines		Location (ODWS) <sup>(b)</sup>
	ODWS <sup>(a)</sup>		ODWS		
			Number	Percent	
pH	6.5–8.5	84	20	24%	HRWQP-1A,1B <sup>(c)</sup> ,2A,2B <sup>(c)</sup> ,3A <sup>(c)</sup> ,4B,5B <sup>(c)</sup> ,6A,6B,7A <sup>(c)</sup> ,7B <sup>(c)</sup> ,8B
DOC	5	84	84	100%	All stations
Alkalinity	30–500	84	80	95%	All stations
Hardness	80–100	79	79	100%	All stations
Aluminum	0.1	84	12	14%	HRWQP-1A,1B <sup>(c)</sup> ,2A,4B,5B,6A,7B
Iron (total)	0.3	84	32	38%	HRWQP-1B <sup>(c)</sup> ,2B <sup>(c)</sup> ,4A,4B <sup>(c)</sup> ,5A <sup>(c)</sup> ,5B <sup>(c)</sup> ,6A,7A <sup>(c)</sup> ,7B <sup>(c)</sup>
Manganese	0.05	84	15	18%	HRWQP-1A,1B <sup>(c)</sup> ,4A,4B,5A,5B <sup>(c)</sup> ,7A,7B

Notes:

- (a) The most conservative value was taken from four guidelines: ODWS MAC: Maximum Acceptable Concentration; IMAC: Interim Maximum Acceptable Concentration; AO: Aesthetic Objective; OG: Operational Guideline.
- (b) See appendix 2.III for the time period details.
- (c) Indicates parameters greater than the guidelines more than one occurrence during baseline investigation

The profile water quality with respect to ODWS guidelines can be summarized as:

- Slightly acidic to circumneutral pH values with 24% of measured values lower than the ODWS guidelines (6.5) at several sample locations.
- 100% of DOC values were greater than the ODWS guidelines (5 wt %) at all sample locations.

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- 95% of alkalinity concentrations were below the lower bound ODWS guidelines (30 mg CaCO<sub>3</sub>/L) at all sample locations.
- 100% of hardness concentrations were outside of the ODWS optimum range (80 to 100 mg CaCO<sub>3</sub>/L) at all sample locations.
- 14% of aluminum concentrations were greater than the ODWS guidelines (0.1 mg/L) at several sample locations.
- 38% of iron concentrations were greater than the ODWS guidelines (0.3 mg/L) at several sample locations.
- 18% of manganese concentrations were greater than the ODWS guidelines (0.05 mg/L) at several sample locations.

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### 4.0 SUMMARY OF EXISTING CONDITIONS

As discussed in Section 1, this TSD provides information on the existing or baseline conditions only. The application of this information, predicted changes, and final lake water concentrations for the project under the various project stages are provided in the Site Water TSD and the Lake Water Quality TSD.

#### **CCME CWQG and PWQO**

Baseline water quality was collected six times between September 2010 and August 2012, from 39 surface water locations and eight water profile locations. The results were compared to CCME CWQG and PWQO guidelines.

In general, the baseline surface water samples can be characterized with respect to CCME CWQG and PWQO guidelines as follows:

- Slightly acidic to slightly alkaline values with approximately 19% of measured values lower than the CCME CWQG and PWQO guidelines (6.5).
- 28% and 34% of total aluminum concentrations were greater than the CCME CWQG and PWQO guidelines, respectively, at all sample locations.
- 36% of total iron concentrations were greater than both the CCME CWQG and PWQO guidelines.
- Sporadic concentrations of total arsenic, cadmium, cobalt, copper, lead greater than the CCME CWQG and/or PWQO guidelines.
- Only one total mercury concentration was greater than the CCME CWQG.
- 14% and 10% of phenol concentrations were greater than the CCME CWQG and PWQO guidelines, respectively.
- 9% of phosphorus concentrations were greater than the PWQO guidelines.

The results of the baseline lake profile measurements indicated:

- Stratification in Mitta Lake, Sawbill Bay, Light Bay, Hawk Bay and Premier Lake was observed for some portion of the year, with the strongest stratification observed in September 2010, June 2011 and August 2012. In general decreasing temperature, pH and dissolved oxygen concentrations at depth, with increasing conductivity were observed.
- Weak to no stratification was observed in Lizard Lake, Turtle Bay and Lynxhead Bay with near constant temperature, conductivity pH and dissolved oxygen values throughout the profile.

The baseline column profile samples can be characterized with respect to CCME CWQG and PWQO guidelines as follows:

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- pH values range from slightly acidic to slightly alkaline with 24% of the observed values below the lowest range for both the CCME CWQG and PWQO guidelines (6.5).
- 36% and 35% of total aluminum concentrations were greater than the CCME CWQG and PWQO guidelines, respectively.
- 38% of total iron concentrations were greater than the CCME CWQG and PWQO guidelines.
- One total mercury concentration measured in top samples from Mitta Lake was greater than the CCME CWQG guideline.
- Sporadic concentrations of total cadmium, total cobalt, total copper, total zinc and dissolved oxygen did not meet CCME CWQG and/or PWQO guidelines.
- Up to 14% of measured phenol concentrations were greater than the CCME CWQG and/or PWQO guidelines.

Sediment concentrations were compared to CCME PEL ISQG and PSQG LEL/SEL guidelines. The baseline concentration of arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc were greater than one or more of the sediment guidelines. In addition, some PAH concentrations in sediments were also greater than the sediment guidelines.

### ODWS

In general, the baseline surface water samples can be characterized with respect to ODWS guidelines as follows:

- Several DOC, alkalinity and hardness values were greater than the ODWS guidelines at several sample locations.
- Some iron, aluminum and manganese concentrations were greater than the ODWS guidelines at several sample locations.

The baseline column profile water samples can be characterized with respect to ODWS guidelines as follows:

- All DOC and hardness values were greater than the ODWS guidelines.
- Several alkalinity concentrations were below the lower bound ODWS guidelines at all sample locations.
- Some iron, aluminum and manganese concentrations were greater than the ODWS guidelines at several sample locations.



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### 5.0 LIST OF REFERENCES

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### 6.0 GLOSSARY OF TERMS

**Table 6-1: Glossary of Terms**

Term	Definition
Alkaline	Having a pH of 7.0 or above. The condition of water or soil which contains a sufficient amount of alkali substances to raise the pH above 7.0. The quality of being bitter due to alkaline content. (U.S. Department of the Interior 2012)
Catchment	An area having a common outlet for its surface runoff (NOAA 2012)
Coliform	Organisms common to the intestinal tract of humans and animals; the organisms' presence in waste water is an indicator of pollution. (U.S. Department of the Interior 2012)
Discharge	The release or extraction of water from an aquifer. Typical mechanisms of natural discharge are evapotranspiration by phreatophytes, springs, and drains to surface water bodies. Pumping is a man-caused discharge. (University of Idaho 2012)
Effluent	Partially or completely treated wastewater flowing out of a treatment facility, reservoir, or basin. (U.S. Department of the Interior 2012)
Limnology	Scientific study of the physical characteristics and biology of lakes, ponds, and streams. (U.S. Department of the Interior 2012)
Mineralization	The conversion of organic compounds into inorganic, plant-available compounds such as ammonium. This is accomplished by soil organisms as they consume organic matter and excrete wastes. (USDA 2012)
Recharge	Mechanisms of inflow to the aquifer. Typical sources of recharge are precipitation, applied irrigation water, underflow from tributary basins and seepage from surface water bodies. (University of Idaho 2012)
Sluiceway	An opening in a diversion dam used to discharge heavy floating debris safely past the dam. (U.S. Department of the Interior 2012)
Stratification	Thermal layering of water in lakes and streams. Lakes usually have three zones of varying temperature, the epilimnion, the metalimnion, and the hypolimnion. The formation of separate layers (of temperature, plant, or animal life) in a lake or reservoir. (U.S. Department of the Interior 2012)
Substrate	Surface on which a plant or animal grows or is attached. The base on which an organism lives; a substance acted upon. (U.S. Department of the Interior 2012)
Thermocline	The middle layer of a lake, separating the upper, warmer portion (epilimnion) from the lower, colder portion (hypolimnion). The middle layer in a thermally stratified lake or reservoir. In this layer there is a rapid decrease in temperature with depth. (U.S. Department of the Interior 2012)

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### 7.0 ABBREVIATIONS, ACRONYMS AND INITIALISMS

**Table 7-1: List of Abbreviations, Acronyms and Initialisms**

Acronym	Definition
ALS	ALS Environmental
ASTM	American Society for Testing and Materials
CCME CWQG	Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines
CEA Agency	Canadian Environmental Assessment Agency
DO	Dissolved oxygen
DOC	Dissolved organic carbon
EA	Environmental Assessment
EIS	Environmental Impact Statement
U.S. EPA	United States Environmental Protection Agency
Golder	Golder Associates Ltd.
HRWQ	Hammond Reef Gold Project surface water/sediment stations
HRWQP	Hammond Reef Gold Project water column profile stations
IMAC	Interim Maximum Acceptable Concentration
ISQG	Interim Sediment Quality Guideline
LEL	Lowest Effect Level
LSA	Local study area
MAC	Maximum Acceptable Concentration
MOE	Ontario Ministry of the Environment
MOEE	Ontario Ministry of the Environment and Energy
NOAA	National Oceanic and Atmospheric Administration
ODWS	Ontario Drinking Water Standards
OG	Operational Guideline

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**Table 7-1: List of Abbreviations, Acronyms and Initialisms (Continued)**

Acronym	Definition
OHRG	Osisko Hammond Reef Gold Ltd.
ORP	Oxygen-reduction potential
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PEL	Probable effect level
PSQG	Ontario Provincial Sediment Quality Guidelines
PWQO	Ontario Provincial Water Quality Objectives
QA/QC	Quality assurance/Quality control
RSA	Regional study area
SEL	Severe effect level
TBT	TBT Engineering Ltd.
TMF	Tailings Management Facility
TOC	Total organic carbon
ToR	Terms of Reference
TSD	Technical Support Document
USDA	United States Department of Agriculture
UTM	Universal Transverse Mercator (coordinate system)
VEC	Valued Ecosystem Component
WRMF	Waste Rock Management Facility

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### 8.0 UNITS

**Table 8-1: List of Units**

Abbreviation	Unit
%	percent
<	less than
°C	degrees Celsius
µm	micrometre
µS/cm	microSiemens per centimetre
ha	hectare
km	kilometre
km <sup>2</sup>	square kilometres
L	litre
m	metre
mg CaCO <sub>3</sub> /L	milligrams per litre as calcium carbonate
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mL	millilitre
mm	millimetre
ppm	parts per million
wt %	weight percent solution

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**APPENDIX 2.I**  
**ALS Thunder Bay Letter**



February 1, 2013

Rachel James  
Golder Associates Ltd.  
Mississauga, ON L5N 7K2

**RE: Metal Detection Limits**

Dear Ms. James

In response to your request for an explanation for detection limit variations between total and dissolved metals detection limits for the 10-1118-0020 8000 Campaign, ALS Limits of Reporting (LORs) are established using rigorous experimental and statistical procedures that begin with the determination of the Method Detection Limit (MDL) at 99% confidence. The MDL takes into account several factors, including long term Method Blanks, low level Sample Duplicates, and low-level Spiked Samples. However, the MDL is based on "typical" sample types in the absence of sample-specific problems, and doesn't apply in all circumstances.

Prior to January 2012, ALS Thunder Bay provided Golder Associates with low level metal detection limits. The low level detection limits were the absolute lowest detection limit that the instrument could achieve. These limits were well below any guideline. Due to the fact that the absolute lowest limits were provided in the 10-1118-0020 8000 campaign, there are some parameters that have Dissolved Detection limits that are higher than the total metal Detection limits.

After January 2012, ALS took a conservative approach to detection limits. All detection limits for low level metals for both total and dissolved metals are now equal.

Yours sincerely  
<Original signed by>

Tricia Sampson  
Client Services Supervisor



## **APPENDIX 2.II**

### **Water Quality – Proposed Suite of Analytes, Method Detection Limits and Applicable Receiving Water Guidelines**



**TABLE 1**  
**Proposed Suite of Analytes,**  
**Method Detection Limits and**  
**Applicable Receiving Water Guidelines**

Parameter <sup>(a)</sup>	Unit	Receiving WQ Guidelines					
		ONTARIO DRINKING WATER STANDARDS <sup>(b)(c)</sup>				CCME Water Guidelines <sup>(d)</sup>	PWQO <sup>(e)</sup>
		MAC	IMAC	AO	OG		
<b>Field Parameters</b>							
Temperature	°C	—	—	—	—	—	±10 <sup>(f)</sup>
pH	—	—	—	—	6.5-8.5	6.5-9	6.5-8.5
Conductivity	uS/cm	—	—	—	—	—	—
Dissolved Oxygen	mg/L	—	—	—	—	5.5-9.5 <sup>(g)</sup>	4-8 <sup>(h)</sup>
ORP	mV	—	—	—	—	—	—
<b>Physical-Chemical</b>							
pH	—	—	—	—	—	6.5-9	6.5-8.5
DOC	% wt	—	—	5	—	—	—
TOC	% wt	—	—	—	—	—	—
Acidity	mg(CaCO <sub>3</sub> )/L	—	—	—	—	—	—
Alkalinity	mg(CaCO <sub>3</sub> )/L	—	—	—	30-500	—	-25% <sup>(f)</sup>
Conductivity	µS/cm	—	—	—	—	—	—
Total Suspended Solids	mg/L	—	—	—	—	+5-25 <sup>(f)(i)</sup>	—
Total Dissolved Solids	mg/L	—	—	500	—	—	—
<b>Major Ions</b>							
Calcium	mg/L	—	—	—	—	—	—
Chloride	mg/L	—	—	250	—	120-640	—
Fluoride	mg/L	1.5 <sup>(i)</sup>	—	—	—	—	—
Magnesium	mg/L	—	—	—	—	—	—
Potassium	mg/L	—	—	—	—	—	—
Sodium	mg/L	—	—	200 <sup>(k)</sup>	—	—	—
Sulphate	mg/L	—	—	500 <sup>(l)</sup>	—	—	—
Carbonate (CO <sub>3</sub> <sup>2-</sup> )	mg/L	—	—	—	—	—	—
Bicarbonate (H(CO <sub>3</sub> ) <sup>-</sup> )	mg/L	—	—	—	—	—	—
Hardness	mg(CaCO <sub>3</sub> )/L	—	—	—	80-100	—	—
Cyanide (free)	mg/L	0.2	—	—	—	0.005	0.005
Cyanide (total)	mg/L	—	—	—	—	—	—
<b>Nutrients</b>							
Nitrate-N	mg/L	10 <sup>(m)</sup>	—	—	—	13 <sup>(n)(o)</sup> -550	—
Nitrite-N	mg/L	1 <sup>(m)</sup>	—	—	—	0.06 <sup>(p)</sup>	—
Ammonia-N	mg/L	—	—	—	—	0.019 <sup>(q)</sup>	0.02 <sup>(r)</sup>
Un-ionized ammonia	mg/L	—	—	—	—	— <sup>(q)</sup>	— <sup>(r)</sup>
Phosphate	mg/L	—	—	—	—	—	—
ortho-Phosphate	mg/L	—	—	—	—	—	—
Phosphorus	mg/L	—	—	—	—	0.004-0.1 <sup>(s)</sup>	0.02 <sup>(n)</sup>
<b>Organics</b>							
Oil and Greases	mg/L	—	—	—	—	—	physically non-detect
Phenols	mg/L	—	—	—	—	0.004	0.005 <sup>(n)</sup>
<b>Micro-organisms<sup>(t)</sup></b>							
Escherichia coli	per 100 mL	—	—	—	—	—	100 <sup>(u)</sup>
Total coliforms	per 100 mL	—	—	—	—	—	—

**TABLE 1**  
**Proposed Suite of Analytes,**  
**Method Detection Limits and**  
**Applicable Receiving Water Guidelines**

Parameter <sup>(a)</sup>	Unit	Receiving WQ Guidelines					
		ONTARIO DRINKING WATER STANDARDS <sup>(b)(c)</sup>				CCME Water Guidelines <sup>(d)</sup>	PWQO <sup>(e)</sup>
		MAC	IMAC	AO	OG		
<b>Metals<sup>(v)</sup></b>							
Aluminum	mg/L	—	—	—	0.1	0.005-0.1 <sup>(w)</sup>	0.015-0.075 <sup>(n)(x)</sup>
Antimony	mg/L	—	0.006	—	—	—	0.02 <sup>(n)</sup>
Arsenic	mg/L	—	0.025	—	—	0.005	0.1
Barium	mg/L	1	—	—	—	—	—
Beryllium	mg/L	—	—	—	—	—	0.011-1.1 <sup>(y)</sup>
Bismuth	mg/L	—	—	—	—	—	—
Boron	mg/L	—	5	—	—	1.5-29 <sup>(z)</sup>	0.2 <sup>(n)</sup>
Cadmium	mg/L	—	0.005	—	—	0.000017 <sup>(n)(aa)</sup>	0.0001-0.0005 <sup>(n)(ab)</sup>
Chromium (VI)	mg/L	—	—	—	—	0.001	0.001
Chromium (III)	mg/L	—	—	—	—	0.0089	0.0089
Chromium (total)	mg/L	0.05	—	—	—	—	—
Cobalt	mg/L	—	—	—	—	—	0.0009
Copper	mg/L	—	—	1	—	0.002-0.004 <sup>(ac)</sup>	0.001-0.005 <sup>(n)(ad)</sup>
Iron (total)	mg/L	—	—	0.3	—	0.3	0.3
Lead	mg/L	0.01 <sup>(ae)</sup>	—	—	—	0.001-0.007 <sup>(af)</sup>	0.001-0.005 <sup>(n)(ag)</sup>
Manganese	mg/L	—	—	0.05	—	—	—
Mercury	mg/L	0.001	—	—	—	0.000026	0.0002
Methyl mercury	mg/L	—	—	—	—	0.000004 <sup>(n)</sup>	—
Molybdenum	mg/L	—	—	—	—	0.073 <sup>(n)</sup>	0.04 <sup>(n)</sup>
Nickel	mg/L	—	—	—	—	0.025-0.15 <sup>(ah)</sup>	0.025
Selenium	mg/L	0.01	—	—	—	0.001	0.1
Silicon	mg/L	—	—	—	—	—	—
Silver	mg/L	—	—	—	—	0.0001	0.0001
Strontium	mg/L	—	—	—	—	—	—
Thallium	mg/L	—	—	—	—	0.0008	0.0003 <sup>(n)</sup>
Tin	mg/L	—	—	—	—	—	—
Titanium	mg/L	—	—	—	—	—	—
Tungsten	mg/L	—	—	—	—	—	0.03 <sup>(n)</sup>
Uranium	mg/L	0.02	—	—	—	0.015-0.033	0.005 <sup>(n)</sup>
Vanadium	mg/L	—	—	—	—	—	0.006 <sup>(n)</sup>
Zinc	mg/L	—	—	5	—	0.03	0.02 <sup>(n)</sup>
Zirconium	mg/L	—	—	—	—	—	0.004 <sup>(n)</sup>
Strontium	mg/L	—	—	—	—	—	—
Thallium	mg/L	—	—	—	—	—	—
Tin	mg/L	—	—	—	—	—	—
Titanium	mg/L	—	—	—	—	—	—
Tungsten	mg/L	—	—	—	—	—	—
Uranium	mg/L	—	—	—	—	—	—
Vanadium	mg/L	—	—	—	—	—	—
Zinc	mg/L	—	—	—	—	—	—
Zirconium	mg/L	—	—	—	—	—	—

**Proposed Suite of Analytes, Method Detection Limits  
and Applicable Receiving Water Guidelines (Notes)**

## Notes:

— = A dash indicates that guidelines do not apply for this parameter.

**Applicable guideline:**

(a) Total concentrations are assumed, unless stated otherwise.

(b) Ontario Regulation (O.Reg.) 169/03: Ontario Drinking Water Standards (ODWS). Last amendment: O.Reg. 327/08.

[http://www.e-laws.gov.on.ca/html/regs/english/elaws\\_regs\\_030169\\_e.htm](http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm).

(c) MAC: Maximum Acceptable Concentration; IMAC: Interim Maximum Acceptable Concentration; AO: Aesthetic Objective; OG: Operational Guideline. The lowest values of the four sub-guideline for Ontario Drinking Water Standards were used in the results appendix (1.II) to simplify the screening of values.

(d) - Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update 7.1 (December 2007). Updated publications at [www.http://ceqg-rcqe.ccme.ca/](http://www.ceqg-rcqe.ccme.ca/), visited 17 January 2013.

(e) Provincial Water Quality Objectives, Ministry of Environment and Energy (February 1999).

(f) Compared to baseline conditions.

(g) Dissolved oxygen for warm-water biota: early life stages = 6000 µg·L<sup>-1</sup>; other life stages = 5500 µg·L<sup>-1</sup>  
for cold-water biota: early life stages = 9500 µg·L<sup>-1</sup>; other life stages = 6500 µg·L<sup>-1</sup>

(h)

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

(i) Under clear flow: + 25 mg·L<sup>-1</sup> from background levels for any short-term exposure (e.g., 24-h period).  
average + 5 mg·L<sup>-1</sup> from background levels for longer term exposures (24 h < discharge < 30 d).  
Under high flow: + 25 mg·L<sup>-1</sup> from background levels at any time when background levels between 25 and 250 mg·L<sup>-1</sup>.  
+ 10% of background levels when background is >250 mg·L<sup>-1</sup>.

(j) Where Fluoride is added to drinking water, it is recommended that the concentration be adjusted to 0.5-0.8 mg/L the optimum level for control of tooth decay. contain naturally occurring fluoride at levels higher than 1.5 mg/L but less than 2.4 mg/L the Ministry of Health and Long Term Care recommends an approach through boards of health to raise public and professional awareness to control excessive exposure to fluoride from other sources.

(k) The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds this information may be communicated to local physicians for their use with patients on sodium restricted diets.

(l) When sulphate levels exceed 500 mg/L, water may have a laxative effect on some people.

(m) Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen).

(n) Interim Guideline

(o) Guidelines are expressed in µg nitrate·L<sup>-1</sup>. These values are equivalent to 2900 µg nitrate-nitrogen·L<sup>-1</sup>, and 3600 µg nitrate-nitrogen·L<sup>-1</sup>, for freshwater and marine respectively.

(p) Guideline is expressed as µg nitrite-nitrogen·L<sup>-1</sup>. This value is equivalent to 197 µg nitrite·L<sup>-1</sup>.

WATER AND SEDIMENT QUALITY TSD  
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**TABLE 1**

Osisko Hammond Reef Gold Ltd.

**Proposed Suite of Analytes, Method Detection Limits  
and Applicable Receiving Water Guidelines (Notes)**

(q) Un-ionized ammonia. Total ammonia:

Temp (°C)	pH							
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	10
0	231	73.0	23.1	7.32	2.33	0.749	0.250	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.50	2.39	0.767	0.256	0.094	0.043	0.021

(r)  $f = 1/(10^{pK_a - pH} + 1)$ , where  $f$  is the fraction of  $NH_3$ ;  $pK_a = 0.09018 + 2729.92/T$ ;  $T$  = ambient water temperature in Kelvin ( $K = °C + 273.16$ )

(s) Ultra-oligotrophic <4  $\mu\text{g}\cdot\text{L}^{-1}$ ; oligotrophic 4-10  $\mu\text{g}\cdot\text{L}^{-1}$ ; mesotrophic 10-20  $\mu\text{g}\cdot\text{L}^{-1}$ ; meso-eutrophic 20-35  $\mu\text{g}\cdot\text{L}^{-1}$ ; eutrophic 35-100  $\mu\text{g}\cdot\text{L}^{-1}$ ; hyper-eutrophic >100  $\mu\text{g}\cdot\text{L}^{-1}$

(t) Not applicable to groundwater quality samples.

(u) Based on a geometric mean of at least 5 samples; based on a recreational water quality guideline.

(v) Guidelines apply to total metal concentrations, however, application of guidelines to dissolved metal concentrations can be employed as a screening tool.

(w) Aluminium guideline = 5  $\mu\text{g}\cdot\text{L}^{-1}$  at  $\text{pH} < 6.5$   
= 100  $\mu\text{g}\cdot\text{L}^{-1}$  at  $\text{pH} \geq 6.5$

(x) Aluminium guideline = 15  $\mu\text{g}\cdot\text{L}^{-1}$  at  $4.5 < \text{pH} < 5.5$   
= +10% of background at  $5.5 < \text{pH} < 6.5$   
= 75  $\mu\text{g}\cdot\text{L}^{-1}$  at  $6.5 < \text{pH} < 9$

(y) Beryllium guideline = 11  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness < 75  $\text{mgCaCO}_3/\text{L}$   
= 1100  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness > 75  $\text{mgCaCO}_3/\text{L}$

(z) Respectively for long term and short term exposure.

(aa) Guideline based on  $Cd = 10^{0.86[\log(\text{hardness})] - 3.2}$

(ab) Cadmium guideline = 0.1  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness < 100  $\text{mgCaCO}_3/\text{L}$   
= 0.5  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness > 100  $\text{mgCaCO}_3/\text{L}$

(ac) Copper guideline = 2  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 0–120  $\text{mg}\cdot\text{L}^{-1}$  (soft to medium) as  $\text{CaCO}_3$   
= 3  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 120–180  $\text{mg}\cdot\text{L}^{-1}$  (hard) as  $\text{CaCO}_3$   
= 4  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness > 180  $\text{mg}\cdot\text{L}^{-1}$  (very hard) as  $\text{CaCO}_3$

(ad) Copper guideline = 1  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness < 20  $\text{mgCaCO}_3/\text{L}$   
= 5  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness > 20  $\text{mgCaCO}_3/\text{L}$

(ae) This standard applies to water at the point of consumption. Since lead is a component in some plumbing systems, first flush water may contain higher concentrations of lead than water that has been flushed for five minutes.

(af) Lead guideline = 1  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 0–60  $\text{mg}\cdot\text{L}^{-1}$  (soft) as  $\text{CaCO}_3$   
= 2  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 60–120  $\text{mg}\cdot\text{L}^{-1}$  (medium) as  $\text{CaCO}_3$   
= 4  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 120–180  $\text{mg}\cdot\text{L}^{-1}$  (hard) as  $\text{CaCO}_3$   
= 7  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness > 180  $\text{mg}\cdot\text{L}^{-1}$  (very hard) as  $\text{CaCO}_3$

(ag) Lead guideline = 1  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness < 30  $\text{mgCaCO}_3/\text{L}$   
= 3  $\mu\text{g}\cdot\text{L}^{-1}$  at  $30 < \text{hardness} < 80 \text{ mgCaCO}_3/\text{L}$   
= 5  $\mu\text{g}\cdot\text{L}^{-1}$  at hardness > 80  $\text{mgCaCO}_3/\text{L}$

(ah) Nickel guideline = 25  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 0–60  $\text{mg}\cdot\text{L}^{-1}$  (soft) as  $\text{CaCO}_3$   
= 65  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 60–120  $\text{mg}\cdot\text{L}^{-1}$  (medium) as  $\text{CaCO}_3$   
= 110  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness of 120–180  $\text{mg}\cdot\text{L}^{-1}$  (hard) as  $\text{CaCO}_3$   
= 150  $\mu\text{g}\cdot\text{L}^{-1}$  at a water hardness > 180  $\text{mg}\cdot\text{L}^{-1}$  (very hard) as  $\text{CaCO}_3$



# **APPENDIX 2.III**

## **Surface Water Quality Results**



WATER AND SEDIMENT QUALITY TSD  
APPENDIX 2.III  
VERSION 1

TABLE 1  
Surface Water Quality Results

Table with columns for Parameter, Unit, and Receiving WQ Guidelines (ODWS, CCME, PWQO). It contains data for various water quality parameters such as Temperature, pH, Conductivity, Dissolved Oxygen, and a wide array of metals and nutrients. Values are provided for multiple sampling events across different months and years.

Notes:  
(a) See Appendix 1.1 for detailed notes for water quality guidelines.  
(b) CCME and PWQO receiving water quality guidelines for aluminum have been calculated based on pH. See Appendix 1.1 for details.  
(c) CCME and/or PWQO receiving water quality guidelines for these parameters have been calculated based on hardness. See Appendix 1.1 for details.  
1.0 Values highlighted in yellow greater than the Ontario Drinking Water Standards (ODWS), Ontario Regulation (O. Reg.) 169/03, Ontario Drinking Water Standards (ODWS) (Revised June 2006).  
1.0 Values greater than the Canadian Council of Ministers of the Environment (CCME), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update 7.1 (December 2007).  
1.0 Values greater than the Provincial Water Quality Objectives (PWQO), Ministry of Environment and Energy.  
Where cells are blank, data has been removed, or was not recorded due to field instrument error.  
Where cells are blank, analysis was not performed during this time period. Some parameters were added to the sampling program later in the campaign, while others were removed from the sampling campaign due to non detection.  
"–" A dash indicates that guideline criteria are not available for this parameter.  
"D" A "D" next to the station name indicates that this is a duplicate sample.

TABLE 1 Surface Water Quality Results

Table with columns for Parameter, Unit, ODWS, CCMF, PWQO, and 30 HRWQ sampling dates from Jun-11 to Apr-16. The table contains numerous rows for various parameters like Temperature, pH, Conductivity, Dissolved Oxygen, and various metals.

Notes: (a) See Appendix 1.1 for detailed notes for water quality guidelines. (b) CCMF and PWQO receiving water quality guidelines for aluminum have been calculated based on pH. (c) CCMF and PWQO receiving water quality guidelines for these parameters have been calculated based on hardness. (d) Values highlighted in yellow greater than the Ontario Drinking Water Standards (ODWS), Ontario Regulation (O.Reg.) 169/03: Ontario Drinking Water Standards (ODWS) (Revised June 2006). (e) Values greater than the Canadian Council of Ministers of the Environment (CCME), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update 7.1 (December 2007). (f) Values greater than the Provincial Water Quality Objectives (PWQO), Ministry of Environment and Energy. (g) Where cells are blank, data has been removed, or was not recorded due to field instrument error. (h) Where cells are blank, analysis was not performed during this time period. (i) Some parameters were added to the sampling program later in the campaign, while others were removed from the sampling campaign due to non detection. (j) A dash indicates that guideline criteria are not available for this parameter. (k) "D" = A "D" next to the station name indicates that this is a duplicate sample.



WATER AND SEDIMENT QUALITY TSD APPENDIX 2.III VERSION 1

TABLE 1 Surface Water Quality Results

Osisko Hammond Reef Gold Ltd.

Table with columns for Parameter, Unit, ODWS, CCME, PWQO, and 33 sampling dates (Aug-12 to Aug-22). Rows include Field Parameters (Temperature, pH, Conductivity, etc.), Physical-Chemical (pH, DOC, TOC, etc.), Major Ions (Calcium, Chloride, etc.), Nutrients (Nitrate-N, Ammonia-N, etc.), Micro-organisms (Escherichia coli), Total Metals (Aluminum, Antimony, etc.), and Dissolved Metals (Aluminum, Antimony, etc.).

Notes: (a) See Appendix 1.1 for detailed notes for water quality guidelines. (b) CCME and PWQO receiving water quality guidelines for aluminum have been calculated based on pH. See Appendix 1.1 for details. (c) CCME and/or PWQO receiving water quality guidelines for these parameters have been calculated based on hardness. See Appendix 1.1 for details. Values highlighted in yellow greater than the Ontario Drinking Water Standards (ODWS), Ontario Regulation (O.Reg.) 169/03, Ontario Drinking Water Standards (ODWS) (Revised June 2006). Values greater than the Canadian Council of Ministers of the Environment (CCME), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update 7.1 (December 2007). Values greater than the Provincial Water Quality Objectives (PWQO), Ministry of Environment and Energy. Where cells are blank, data has been removed, or was not recorded due to field instrument error. Where cells are blank, analysis was not performed during this time period. Some parameters were added to the sampling program later in the campaign, while others were removed from the sampling campaign due to non detection. -- = A dash indicates that guideline criteria are not available for this parameter. \*D\* = A "D" next to the station name indicates that this is a duplicate sample.

WATER AND SEDIMENT QUALITY TSD  
APPENDIX 2.III  
VERSION 1

TABLE 1  
Surface Water Quality Results

Osisko Hammond Reef Gold Ltd.

Table with columns for Parameter, Unit, ODWS, CCME, PWQO, and sampling dates (HRWQ-22D to HRWQ-29). Rows include Field Parameters (Temperature, pH, Conductivity), Physical-Chemical (pH, DOC, TOC), Major Ions (Calcium, Chloride), Nutrients (Nitrate, Ammonia), Organics (Phenols), Micro-organisms (Escherichia coli), Total Metals (Aluminum, Antimony), and Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Bismuth, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silicon, Silver, Strontium, Thallium, Tin, Titanium, Tungsten, Uranium, Vanadium, Zinc, Zirconium).

Notes:  
(a) See Appendix 1.1 for detailed notes for water quality guidelines.  
(b) CCME and PWQO receiving water quality guidelines for aluminum have been calculated based on pH. See Appendix 1.1 for details.  
(c) CCME and/or PWQO receiving water quality guidelines for these parameters have been calculated based on hardness. See Appendix 1.1 for details.  
Values highlighted in yellow greater than the Ontario Drinking Water Standards (ODWS), Ontario Regulation (O.Reg.) 169/03, Ontario Drinking Water Standards (ODWS) (Revised June 2006).  
1.0 Values greater than the Canadian Council of Ministers of the Environment (CCME), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update 7.1 (December 2007).  
1.0 Values greater than the Provincial Water Quality Objectives (PWQO), Ministry of Environment and Energy.  
Where cells are blank, data has been removed, or was not recorded due to field instrument error.  
Where cells are blank, analysis was not performed during this time period. Some parameters were added to the sampling program later in the campaign, while others were removed from the sampling campaign due to non-detection.  
— A dash indicates that guideline criteria are not available for this parameter.  
"D" = A "D" next to the station name indicates that this is a duplicate sample.









WATER AND SEDIMENT QUALITY TSD APPENDIX 2.III VERSION 1

TABLE 1 Surface Water Quality Results

Table with 38 columns: Parameter, Unit, ODWS, CCME, PWQO, Light Bay - Top (HRWQP-4A, HRWQP-4A, HRWQP-4A, HRWQP-4B, HRWQP-4B, HRWQP-4B), Light Bay - Bottom (Sep-10, Nov-10, Jun-11), Hawk Bay - Top (HRWQP-5A, HRWQP-5A, HRWQP-5A, HRWQP-5A, HRWQP-5A, HRWQP-5A), Hawk Bay - Bottom (Sep-10, Nov-10, Jun-11, Apr-12, Aug-12), Count, ODWS, CCME, PWQO, Min, Max, Average, Median, 95th %ile, and 95th %ile. Rows include Field Parameters (Temperature, pH, Conductivity, Dissolved Oxygen, ORP), Physical-Chemical (pH, DOC, TOC, Acidity, Alkalinity, Conductivity, Total Suspended Solids, Total Dissolved Solids), Major Ions (Calcium, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulphate, Bicarbonate, Hardness, Cyanide), Nutrients (Nitrate, Ammonia, Un-ionized ammonia, ortho-Phosphate, Phosphorus), Organics (Oil and Greases, Phenols), Micro-organisms (Escherichia coli, Total coliforms), Total Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silicon, Silver, Strontium, Thallium, Tin, Titanium, Tungsten, Uranium, Vanadium, Zinc, Zirconium), and Dissolved Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silicon, Silver, Strontium, Thallium, Tin, Titanium, Tungsten, Uranium, Vanadium, Zinc, Zirconium).

Notes: (a) See Appendix 1.1 for detailed notes for water quality guidelines. (b) CCME and PWQO receiving water quality guidelines for aluminum have been calculated based on pH. See Appendix 1.1 for details. (c) CCME and/or PWQO receiving water quality guidelines for these parameters have been calculated based on hardness. See Appendix 1.1 for details. 1.0 Values highlighted in yellow greater than the Ontario Drinking Water Standards (ODWS), Ontario Regulation (O.Reg.) 169/03; Ontario Drinking Water Standards Values greater than the Canadian Council of Ministers of the Environment (CCME), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update Values greater than the Provincial Water Quality Objectives (PWQO), Ministry of Environment and Energy. Where cells are blank, data has been removed, or was not recorded due to field instrument error. Where cells are blank, analysis was not performed during this time period. Some parameters were added to the sampling program later in the campaign, while others were removed from the sampling campaign due to non detection. A dash indicates that guideline criteria are not available for this parameter. \*D\* = A "D" next to the station name indicates that this is a duplicate sample.





WATER AND SEDIMENT QUALITY TSD  
APPENDIX 2.II  
VERSION 1

TABLE 1  
Surface Water Quality Results

Osisko Hammond Reef Gold Ltd.

Table with columns: Parameter, Unit, ODWS, CCME, PWQO, Lynthead Bay - Top (HRWQP-7A to HRWQP-7A), Lynthead Bay - Bottom (HRWQP-7B to HRWQP-7B), Count, ODWS, CCME, PWQO, Min, Max, Average, Median, 95th %ile. Rows include Field Parameters (Temperature, pH, Conductivity, etc.), Physical-Chemical (pH, DOC, TOC, etc.), Major Ions (Calcium, Chloride, etc.), Nutrients (Nitrate-N, Ammonia-N, etc.), Organics (Oil and Greases, Phenols, etc.), Micro-organisms (Escherichia coli, Total coliforms), and Total Metals (Aluminum, Antimony, Arsenic, etc.).

Notes:  
(a) See Appendix 1.1 for detailed notes for water quality guidelines.  
(b) CCME and PWQO receiving water quality guidelines for aluminum have been calculated based on pH. See Appendix 1.1 for details.  
(c) CCME and PWQO receiving water quality guidelines for these parameters have been calculated based on hardness. See Appendix 1.1 for details.  
1.0 Values highlighted in yellow greater than the Ontario Drinking Water Standards (ODWS), Ontario Regulation (O.Reg.) 169/03, Ontario Drinking Water Standards (ODWS) (Revised June 2006).  
1.0 Values greater than the Canadian Council of Ministers of the Environment (CCME), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update 7.1 (December 2007).  
1.0 Values greater than the Provincial Water Quality Objectives (PWQO), Ministry of Environment and Energy  
Where cells are blank, data has been removed, or was not recorded due to field instrument error.  
Where cells are blank, analysis was not performed during this time period. Some parameters were added to the sampling program later in the campaign, while others were removed from the sampling campaign due to non detection.  
-- A dash indicates that guideline criteria are not available for this parameter.  
\*D\* = A "D" next to the station name indicates that this is a duplicate sample.





# **APPENDIX 2.IV**

## **Sediment Quality Results**

WATER AND SEDIMENT QUALITY TSD
APPENDIX 2.IV
VERSION 1

TABLE 1
Sediment Quality Results

Osisko Hammond Reef Gold Ltd.

Table with columns: Parameter, Unit, CCME (Freshwater PEL, Freshwater ISQG), MOE (LEL, SEL), and 28 HRWQ sampling dates. Rows include Metals (Aluminum, Arsenic, etc.), Polycyclic Aromatic Hydrocarbons (PAHs), and Polychlorinated Biphenyls (PCBs).

- Notes:
(a) Canadian Council of Environment Ministers (CCME)
(b) Ontario Ministry of Environment and Energy (MOEE)
(c) CCME Sediment quality guidelines for the protection of aquatic life: Probable Effect Level (PEL), Freshwater, 2002
(d) CCME Sediment quality guidelines for the protection of aquatic life: Interim Sediment Quality Guideline (ISQG), Freshwater, 2003
(e) MOEE Provincial Sediment Quality Guidelines (PSQG): Lowest Effect Level (LEL), 1993
(f) MOEE Provincial Sediment Quality Guidelines (PSQG): Severe Effect Level (SEL), 1994
(g) Blank cells indicate parameters that were not analyzed either due to non detection in previous campaigns, or were missing from the laboratory analytical suite.

Legend table for values:
1.0 Value greater than the Freshwater PEL (CCME) guideline
1.0 Value greater than the Freshwater ISQG (CCME) guideline
1.0 Value greater than the LEL (MOEE) guideline
1.0 Value greater than the SEL (MOEE) guideline
-- Where cells are blank, analysis was not performed during this time period.

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TABLE 1  
Sediment Quality Results

Table with columns for Parameter, Unit, CCME (Freshwater PEL, Freshwater ISQG), MOEE (LEL, SEL), and 25 sampling events (HRWQ-8 to HRWQ-25). Rows include Metals (Aluminum to Zirconium), Polycyclic Aromatic Hydrocarbons (PAHs), and Polychlorinated Biphenyls (PCBs).

- (a) Canadian Council of Environment Ministers (CCME)
- (b) Ontario Ministry of Environment and Energy (MOEE)
- (c) CCME Sediment quality guidelines for the protection of aquatic life: Probable Effect Level (PEL), Freshwater, 2002
- (d) CCME Sediment quality guidelines for the protection of aquatic life: Interim Sediment Quality Guideline (ISQG), Freshwater, 2003
- (e) MOEE Provincial Sediment Quality Guidelines (PSQG): Lowest Effect Level (LEL), 1993
- (f) MOEE Provincial Sediment Quality Guidelines (PSQG): Severe Effect Level (SEL), 1994
- (g) Blank cells indicate parameters that were not analyzed either due to non detection in previous campaigns, or were missing from the laboratory analytical suite.

Legend for values in the table: 1.0 Value greater the Freshwater PEL (CCME) guideline; 1.0 Value greater the Freshwater ISQG (CCME) guideline; 1.0 Value greater than the LEL (MOEE) guideline; 1.0 Value greater than the SEL (MOEE) guideline; - Where cells are blank, analysis was not performed during this time period.

TABLE 1  
Sediment Quality Results

Table with columns: Parameter, Unit, CCME (Freshwater PEL, Freshwater ISQG), MOEE (LEL, SEL), and 34 sampling locations (HRWQ-25, HRWQ-26, HRWQ-27, HRWQ-28, HRWQ-29, HRWQ-30, HRWQ-31, HRWQ-32, HRWQ-33, HRWQ-34, HRWQ-37, HRWQ-38, HRWQ-39). Rows include Metals, Polycyclic Aromatic Hydrocarbons (PAHs), and Polychlorinated Biphenyls (PCBs).

Notes:  
(a) Canadian Council of Environment Ministers (CCME)  
(b) Ontario Ministry of Environment and Energy (MOEE)  
(c) CCME Sediment quality guidelines for the protection of aquatic life: Probable Effect Level (PEL), Freshwater, 2002  
(d) CCME Sediment quality guidelines for the protection of aquatic life: Interim Sediment Quality Guideline (ISQG), Freshwater, 2003  
(e) MOEE Provincial Sediment Quality Guidelines (PSQG): Lowest Effect Level (LEL), 1993  
(f) MOEE Provincial Sediment Quality Guidelines (PSQG): Severe Effect Level (SEL), 1994  
(g) Blank cells indicate parameters that were not analyzed either due to non-detection in previous campaigns, or were missing from the laboratory analytical suite.  
- = A dash indicates that guideline criteria are not available for this parameter.

Legend table with columns: Value (1.0) and Description (Value greater than the Freshwater PEL (CCME) guideline, Value greater than the Freshwater ISQG (CCME) guideline, Value greater than the LEL (MOEE) guideline, Value greater than the SEL (MOEE) guideline, Where cells are blank, analysis was not performed during this time period).



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TABLE 1  
Sediment Quality Results

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Table with columns for Parameter, Unit, CCME (Freshwater PEL and ISQG), MOEE (LEL and SEL), 18 sampling dates (Sep-10 to Nov-10, Jun-11, Aug-12, Apr-12), 18 sampling dates (Sep-10 to Nov-10, Jun-11, Aug-12, Apr-12), and 18 sampling dates (Sep-10 to Nov-10, Jun-11, Aug-12, Apr-12). Rows include Metals (Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silver, Sodium, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc, Zirconium), Polycyclic Aromatic Hydrocarbons (PAHs), and Polychlorinated Biphenyls (PCBs).

Notes:  
(a) Canadian Council of Environment Ministers (CCME)  
(b) Ontario Ministry of Environment and Energy (MOEE)  
(c) CCME Sediment quality guidelines for the protection of aquatic life: Probable Effect Level (PEL), Freshwater, 2002  
(d) CCME Sediment quality guidelines for the protection of aquatic life: Interim Sediment Quality Guideline (ISQG), Freshwater, 2003  
(e) MOEE Provincial Sediment Quality Guidelines (PSQG): Lowest Effect Level (LEL), 1993  
(f) MOEE Provincial Sediment Quality Guidelines (PSQG): Severe Effect Level (SEL), 1994  
(g) Blank cells indicate parameters that were not analyzed either due to non detection in previous campaigns, or were missing from the laboratory analytical suite.  
-- = A dash indicates that guideline criteria are not available for this parameter.

Legend table with columns for Value and Description: Value greater than the Freshwater PEL (CCME) guideline, Value greater than the Freshwater ISQG (CCME) guideline, Value greater than the LEL (MOEE) guideline, Value greater than the SEL (MOEE) guideline, Where cells are blank, analysis was not performed during this time period.

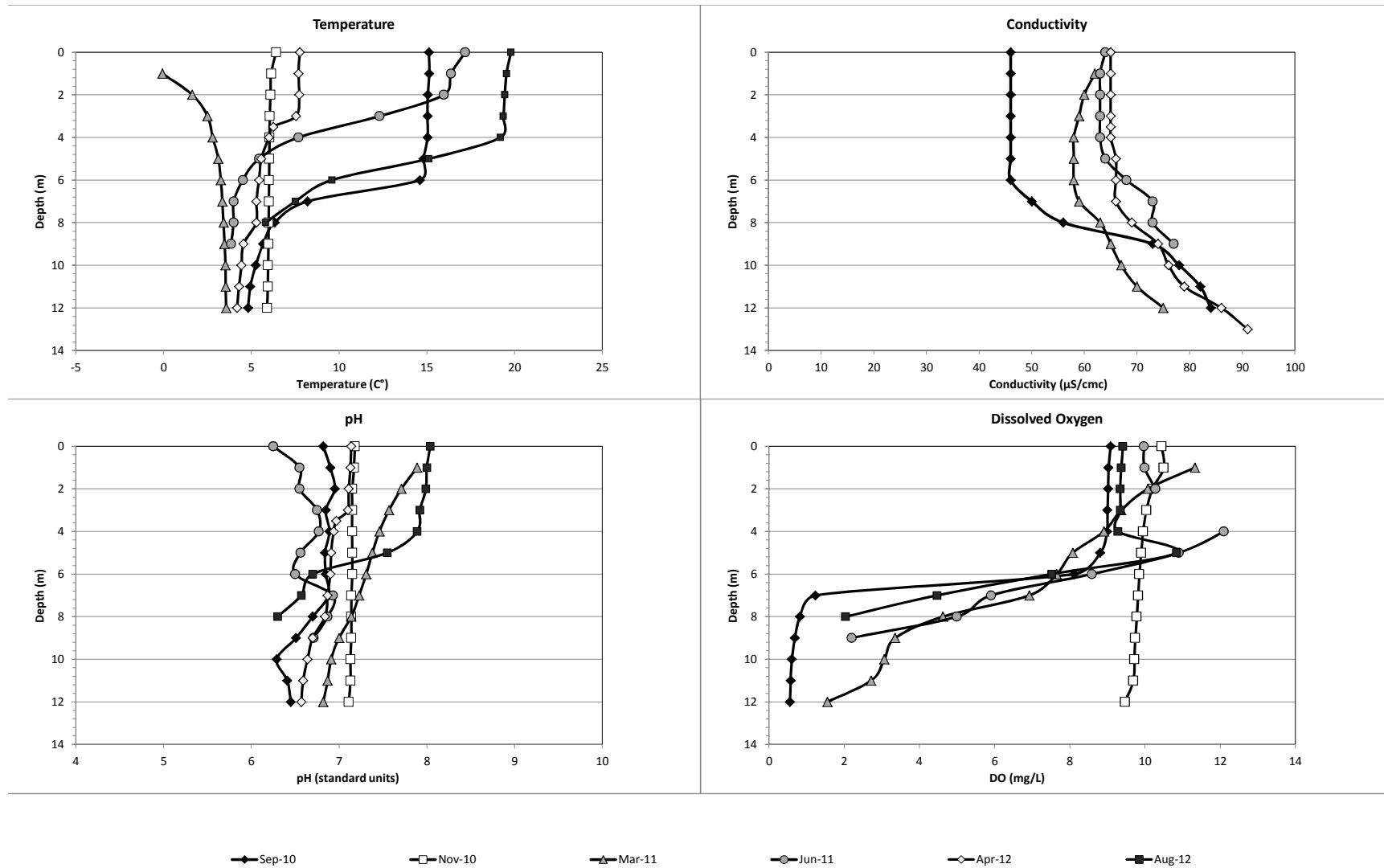




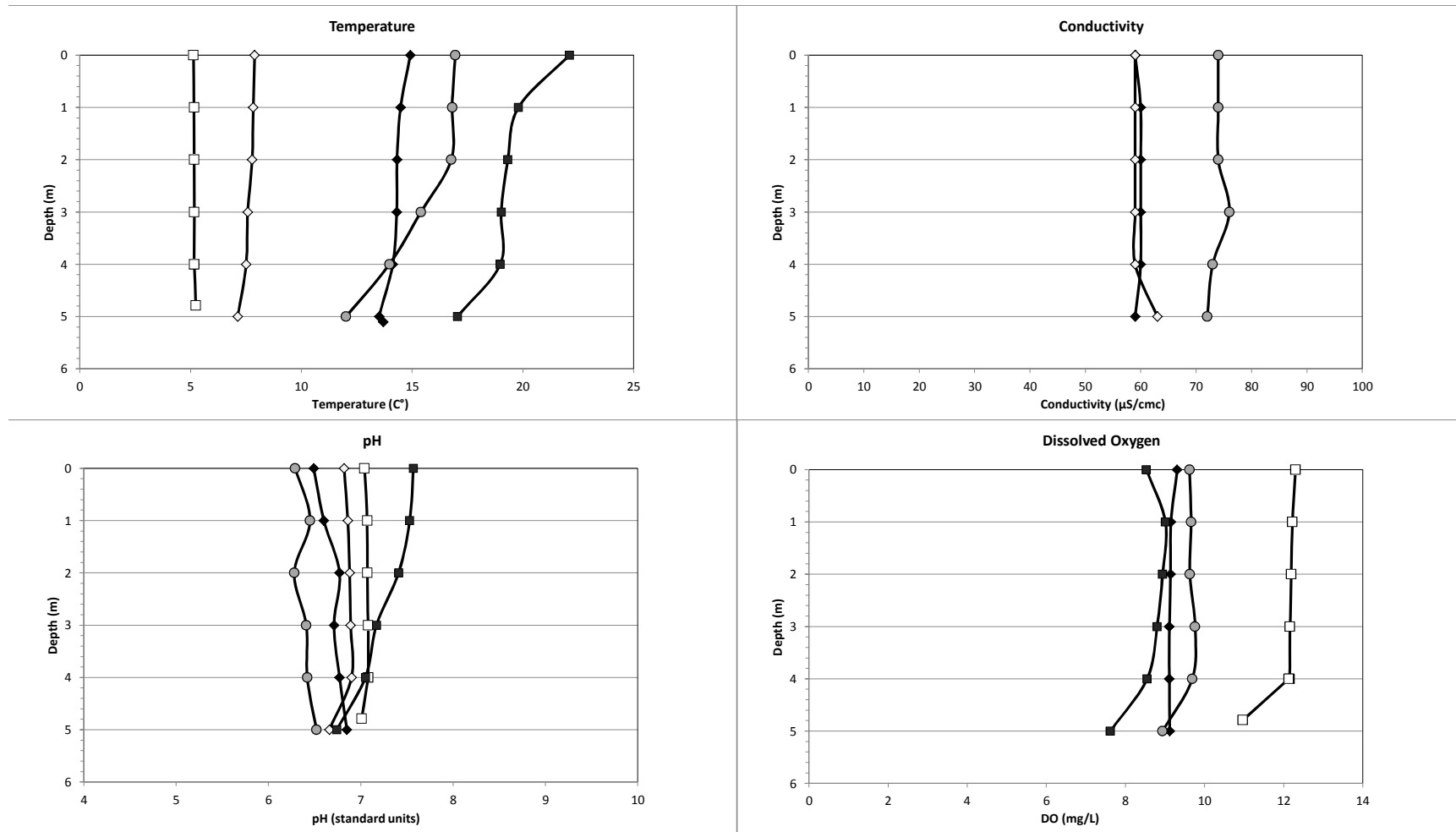
# **APPENDIX 3.I**

## **Field Parameters Results for Water Column Profiles**

**FIGURE 1**  
**Field Parameter Results for Mitta Lake Water Column Profile**

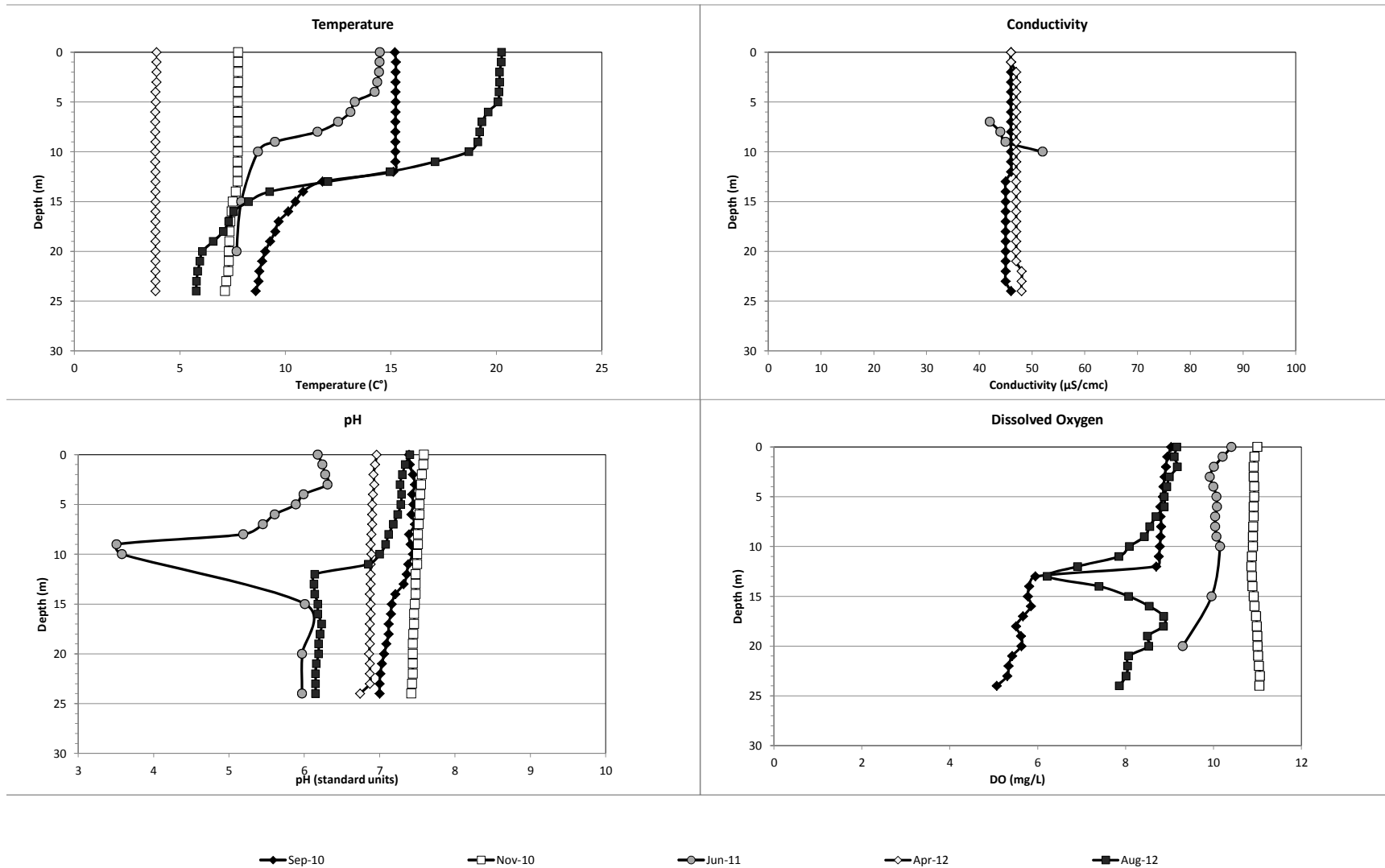


**FIGURE 2**  
**Field Parameter Results for Lizard Lake Water Column Profile**

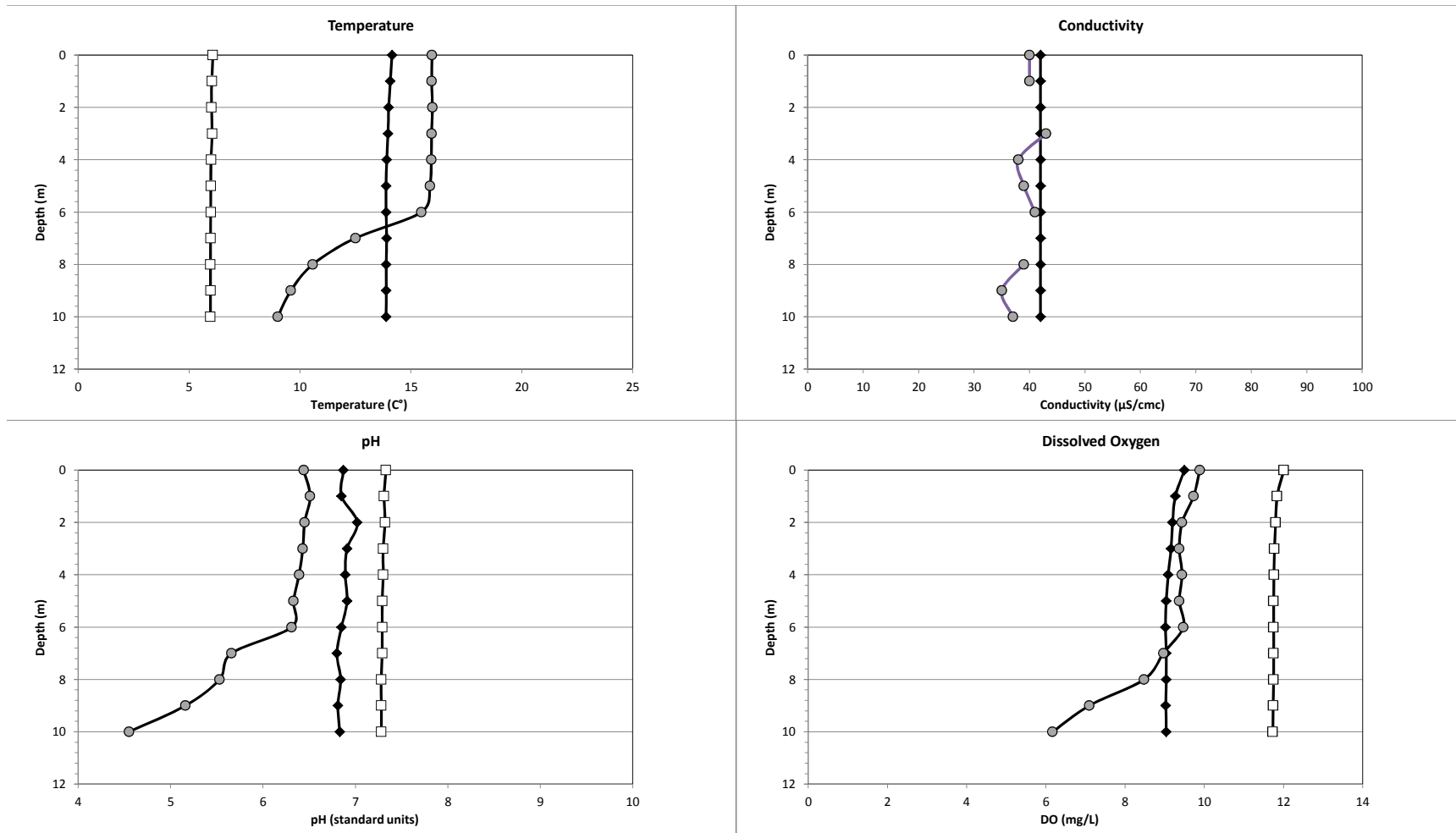


Sep-10     
  Nov-10     
  Jun-11     
  Apr-12     
  Aug-12

**FIGURE 3**  
**Field Parameter Results for Sawbill Bay Water Column Profile**

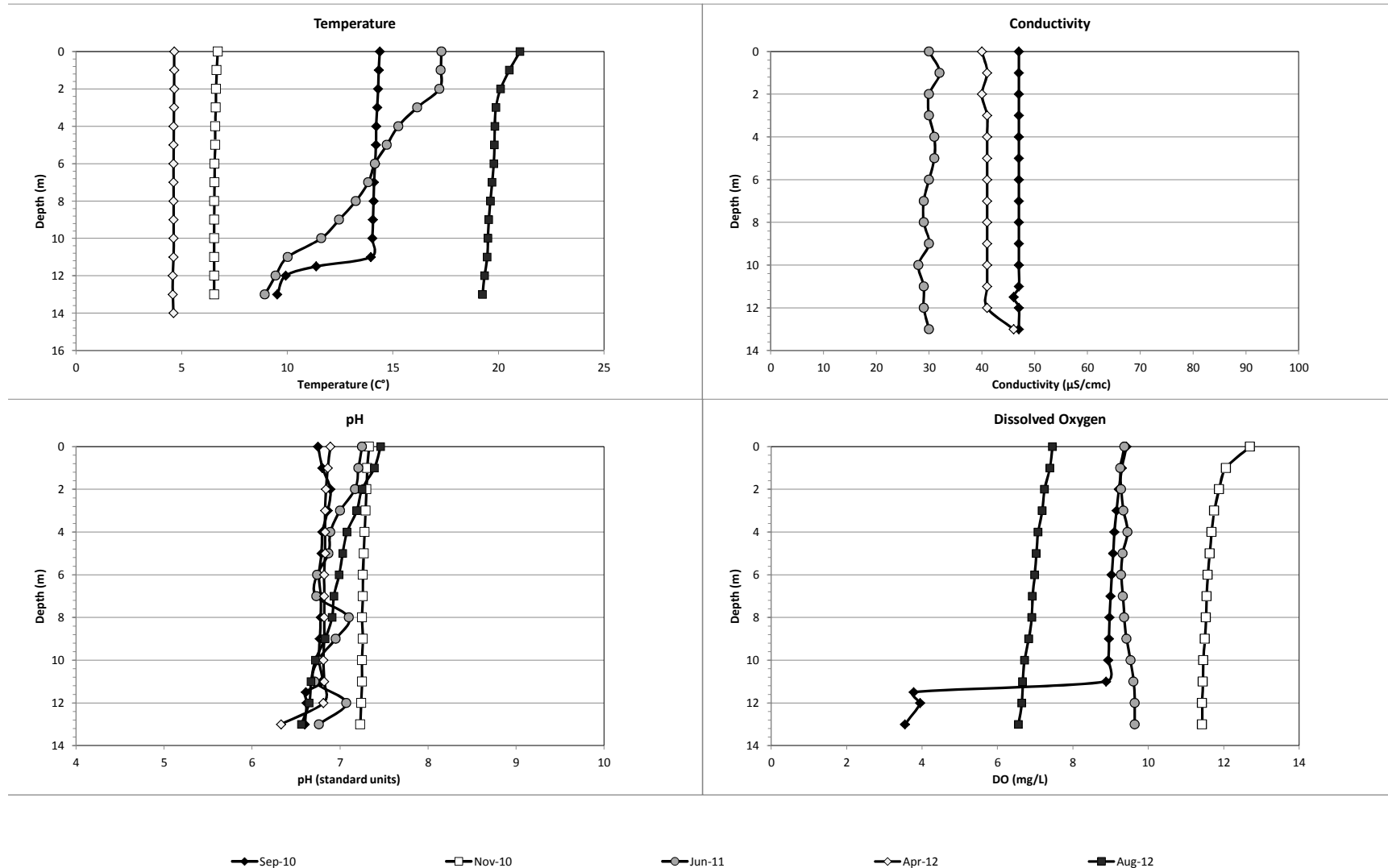


**FIGURE 4**  
**Field Parameter Results for Light Bay Water Column Profile**

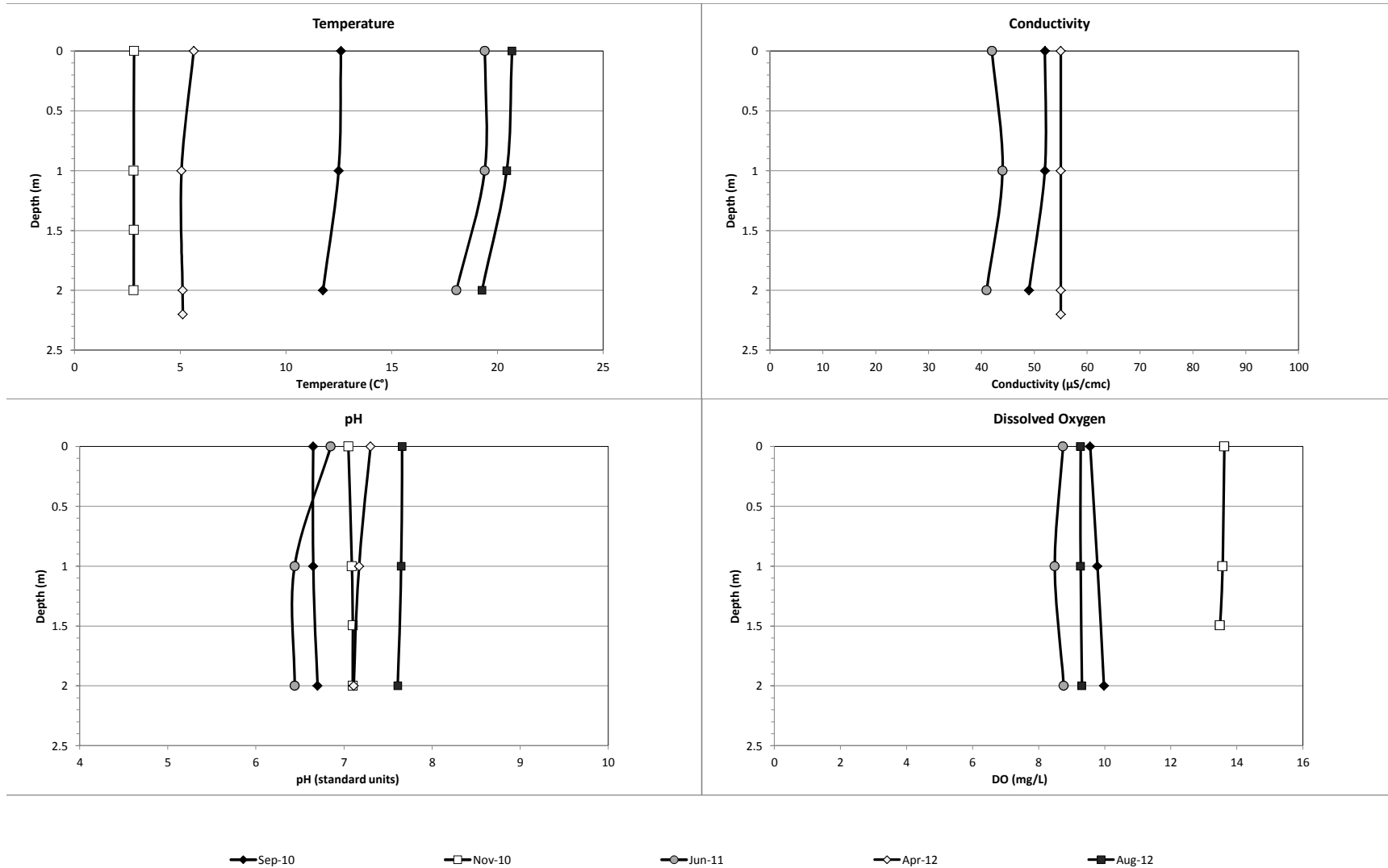


Sep-10     
  Nov-10     
  Jun-11

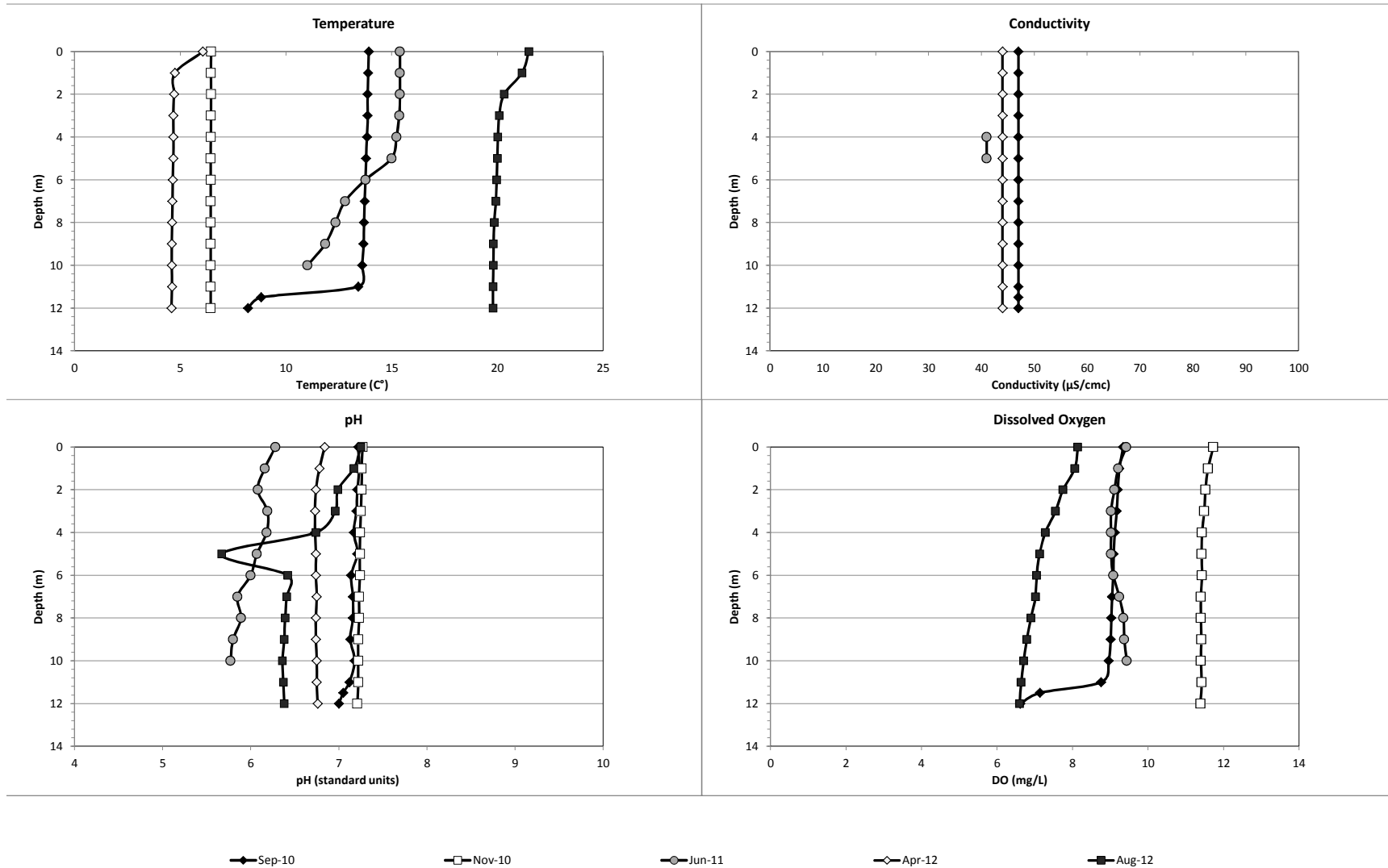
**FIGURE 5**  
**Field Parameter Results for Hawk Bay Water Column Profile**



**FIGURE 6**  
**Field Parameter Results for Turtle Bay Water Column Profile**



**FIGURE 7**  
**Field Parameter Results for Lynxhead Bay Water Column Profile**





**FIGURE 8**

**Field Parameter Results for Premier Lake Water Column Profile**

