Biophysical Inventory

Includes:
Final Report

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Department: Biology
Course Code: BIOL 491H
Course Name: Reading Course
Term: Fall/Winter 2006
Date of Project Submission: December 2006

Project ID: 759

Executive Summary

The Whitfield Wetland Biophysical Assessment was completed for the Otonabee Conservation Foundation by the Otonabee Region Conservation Authority in 2007. This project was initiated as a result of the identified need for a scientific evaluation of the property and adjacent lands to assist in the creation of a management plan for the property.

The Whitfield Wetland covers an area of approximately 37 hectares (91 acres) and is part of the Provincially Significant Peterborough Airport Wetland Complex. It is located at the southern border of the City of Peterborough in the vicinity of Airport Road and Highway 115 (Part Lots 8 and 9, Concession 10, North Monaghan Ward, Peterborough County). The Whitfield Wetland was donated to the Otonabee Conservation Foundation in 2003, and the adjacent abandoned railway line was later purchased with the assistance of the City of Peterborough.

The Whitfield Wetland Biophysical Assessment is comprised of several components and includes a physical description of the property and natural heritage features, an evaluation of water quality conditions, an inventory of flora and fauna species an assessment of habitat, and recommendations for future activities.

Wetlands play an integral role in the ecology of the watershed. The combination of shallow water, high levels of nutrients, and primary productivity is ideal for the development of organisms that form the base of the food web and feed many species of fish, amphibians, invertebrates, and insects. Many species of birds and mammals rely on wetlands for food, water, and shelter, especially during migration and breeding. Wetlands have important filtering capabilities for intercepting surface water runoff from higher dry land before the run off reaches open water. As the runoff water passes through, the wetlands retain excess nutrients and some pollutants, and reduce sediment that would clog waterways and affect fish and amphibian egg development.

The Whitfield Wetland supports a diverse community of flora and fauna, which is surprising due to its small size and location in close proximity to Highway 115. Ecologically, the wetland is in fairly good condition, and is providing habitat for many species of flora and fauna. The quality of the water entering the wetland could be improved, and water quality monitoring showed that the wetland is actively filtering out many contaminants, as the quality of the water exiting the wetland is significantly better than upon entry. Many opportunities exist for increased public access, education, restoration and further study and are described in the recommendations section of this report.

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Acknowledgements

The Otonabee Region Conservation Authority would like to acknowledge the following people and organizations for their support and contributions to this report: The Otonabee Conservation Foundation Board of Directors, Sarah Hogg and the Trent Centre for Community Based Education, HRSDC Job Creation Partnership Program, The Ontario Ministry of Natural Resources Summer Experience Program, Marla Williams, Amanda Harkins, Brett Tregunno, Ash Walker, Gerry Sullivan, Rebecca Scobie, Kim Johns, Meredith Carter, and The City of Peterborough.

1.0 Introduction

The Whitfield Wetland covers an area of approximately 37 hectares (91 acres) and is part of the Provincially Significant Peterborough Airport Wetland Complex. The Whitfield Wetland is located at the southern border of the City of Peterborough in the vicinity of Airport Road and Highway 115 - Part Lots 8 and 9, Concession 10, North Monaghan Ward, Peterborough County (Map 1). The Whitfield Wetland was donated to the Otonabee Conservation Foundation (OCF) in 2003, and the adjacent abandoned railway line was later purchased by the OCF with the assistance of the City of Peterborough.

A wetland is defined as “lands that are seasonally or permanently flooded by shallow water, as well as lands where the water table is close to the surface. In either case, the presence of abundant water has caused the formation of hydric soils and has favored the dominance of either hydrophytic or water tolerant plants; periodically saturated lands used for agricultural purposes, which no longer exhibit wetland characteristics, are not considered to be wetlands” (Ontario Ministry of Natural Resources, 1993). Wetlands have many important ecological functions including attenuating peak flows, delaying flood peaks, recharging and discharging of groundwater, maintaining baseflow, and sustaining water quality (Greenland, 2001).

The Whitfield Wetland Biophysical Assessment was completed for the Otonabee Conservation Foundation by the Otonabee Region Conservation Authority (ORCA) in 2007. This project was initiated as a result of the identified need for a scientific evaluation of the property and adjacent lands to assist in the creation of a management plan for the property.

The Whitfield Wetland Biophysical Assessment is comprised of several components and includes a physical description of the property and natural heritage features, an evaluation of water quality conditions, an inventory of flora and fauna species an assessment of habitat, and recommendations for future activities.

Map 1: Site Location

1.1. Wetland Characteristics

The Whitfield Wetland can be classified as a riverine wetland with both marsh and swamp wetland areas. Wetlands play an integral role in the ecology of the watershed. The combination of shallow water, high levels of nutrients, and primary productivity is ideal for the development of organisms that form the base of the food web and feed many species of fish, amphibians, invertebrates, and insects. Many species of birds and mammals rely on wetlands for food, water, and shelter, especially during migration and breeding. Wetlands have important water filtering capabilities and can intercept surface water run off from higher dry land before the run off reaches open water. As the run off water passes through a wetland, excess nutrients, and some pollutants are retained. Sediments may also be retained by wetlands which reduce the movement of sediment that may impede flow in waterways and negatively impact fish and amphibian egg development.

The three broad categories used to describe the relationship between wetlands and other surface waters are:

- Lacustrine wetlands are associated with lakes.
- Riverine wetlands are found along shores of rivers and streams.
- Palustrine wetlands are not associated with lakes, rivers or streams.

There are several different types of wetlands including marshes, swamps, bogs and fens:

Marsh

A type of wetland ecosystem characterized by poorly drained mineral soils and by plant life dominated by grasses (Figure 1). Marshes are common at the mouths of rivers, especially where extensive deltas have been built. The marsh plants slow down the flow of water and allow for the nutrient enriched sediments to be deposited, thus providing conditions for the further development of the marsh.

Figure 1: Photograph of a Typical Marsh

Swamp

A wetland ecosystem characterized by mineral soils with poor drainage and by plant life dominated by trees (Figure 2). Swamps are found throughout the world, most often in low-lying regions (with poor drainage) next to rivers, which supply the swamp with water. Some swamps develop from marshes that slowly fill in, allowing trees and woody shrubs to grow. The dominant vegetation, therefore, distinguishes the two major types of mineral soil wetlands: grasses dominate marshes, while trees dominate swamps. Both marshes and swamps may be freshwater or saltwater.

Figure 2: Photograph of a Typical Swamp

Bog

A type of wetland ecosystem characterized by wet, spongy, poorly drained peaty soil, dominated by the growth of bog mosses, *Sphagnum,* and heaths, particularly *Chamaedaphne* (Figure 3). Bogs are usually acid areas, frequently surrounding a body of open water. Bogs receive water exclusively from rainfall.

Figure 3: Photograph of a Typical Bog

Fen

A type of wetland ecosystem characterized by peaty soil, dominated by grasses, grass-like plants, sedges, and reeds (Figure 4). Fens are alkaline rather than acidic areas, receiving water mostly from surface and groundwater sources.

Figure 4: Photograph of Typical Fen

1.2. Study Purpose

The Whitfield Wetland Biophysical Assessment was completed by ORCA for the OCF in 2006. This project was undertaken to enable the OCF to develop a management plan for the Whitfield Wetland property based on a scientific inventory and evaluation of the property and adjacent lands. The information collected as part of this project will also ensure that restoration activities are undertaken strategically, and that enhancement projects have significant positive environmental benefits to the wetland and adjacent lands.

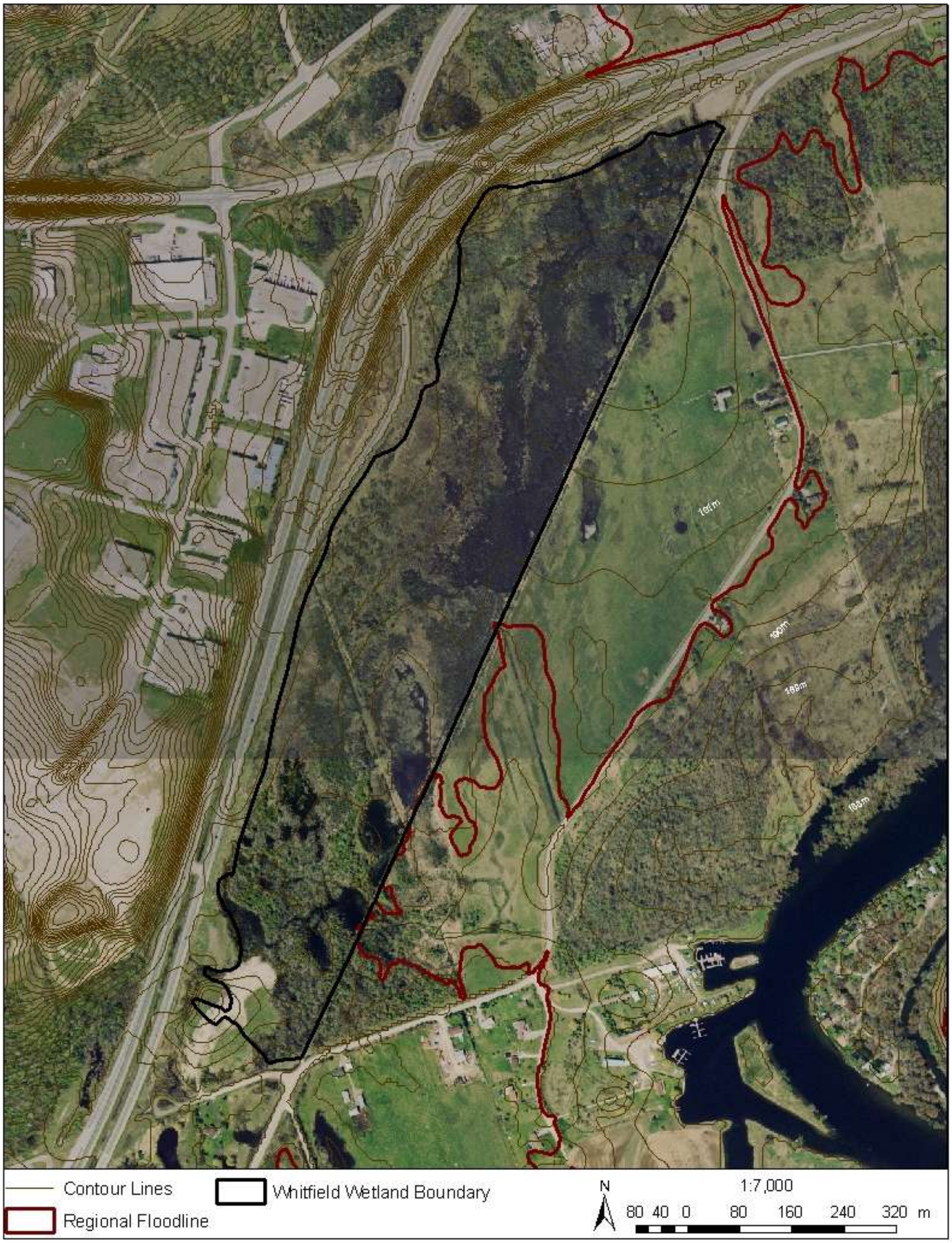
The Whitfield Wetland Biophysical Assessment is comprised of several components and includes a physical description of the property and natural heritage features, an evaluation of water quality conditions, an inventory of flora and fauna species an assessment of habitat, and recommendations for future activities and studies.

1.3. Study Area, Location and Description

The Whitfield Wetland covers an area of approximately 37 hectares (91 acres) and is part of the Provincially Significant Peterborough Airport Wetland Complex. It is located at the southern border of the City of Peterborough in the vicinity of Airport Road and Highway 115 (Part Lots 8 and 9, Concession 10, North Monaghan Ward, Peterborough County). The Whitfield Wetland was donated to the OCF in 2003, and the adjacent abandoned railway line was later purchased with the assistance of the City of Peterborough. Refer to Map 1 for a Map of the Site Location and Map 2 for a Map of the Study Area.

The property occupies the land between Hwy 115 and the abandoned railway line. The access point to the property is located on Worboy Court, just west of Airport Road at the abandoned railway line. The property is enclosed by roadways to the north, south, and west, and the abandoned railway line to the east. This development, along with a healthy population of beavers (*castor canadensis*) has created the current high water levels on the property. The property contains both swamp and marsh wetland types and some areas of open water.

The City of Peterborough has expressed interest in maintaining and enhancing the Whitfield Wetland property so it can act as a “green entrance” to the City due to its highly visible location from Hwy 115.



Map 2: Study Area

1.4. Study Program

The Whitfield Wetland Biophysical Assessment was undertaken in 2006 to document the current conditions of the Whitfield Wetland. The study components included a water quality assessment using water chemistry, benthic macroinvertebrates and amphibians, a vegetation assessment using a modified version of the Ecological Land Classification (ELC), confirmation of the wetland boundary, inventories of flora, fauna and fish species, a physical description and assessment of the property and interviews with former property owners. Site conditions were documented through photographs, which are included in Appendix F. Refer to Map 3 for sampling locations.

ORCA staff documented the current conditions of the Whitfield Wetland through the collection of data including; water quality using chemical and biological indicators, amphibians, boundary and vegetation assessments, and an inventory of flora, fauna and fish species. This section of the report is divided into these areas and includes the methodology and results for each data set. Refer to Appendix A for Species Lists, Appendices B and C for the water chemistry data and Appendix D for the benthic macroinvertebrate data.

1.4.1. Physical Description

- A summary of the physical characteristics of the property was completed based on observations during site visits.
- Digital photographs were taken and are included in the final report and as Appendix F.

1.4.2. Water Quality Assessment

- An assessment of water quality conditions was undertaken using a combination of chemical, physical, bacteriological and biological indicators.

Chemical, Physical and Bacteriological Indicators

- Water Chemistry: 6 samples were taken monthly from May through to October and analysed for the following parameters: Dissolved Oxygen, Conductivity, Salinity, Total Suspended Solids, Temperature, Biochemical Oxygen Demand (BOD), Total Phosphorus, Nitrate, Nitrite, Sodium, Chloride, Metals, Total Coliforms, E. coli, Total Dissolved Solids, and pH.

Biological Indicators

- Benthic Macroinvertebrates are excellent biological indicators of water quality and are sensitive to changes in water chemistry and habitat. Samples of the benthic macroinvertebrate populations were taken at four locations in May 2006 (inlets and outlets of Cells A and B (Map 3).
- Amphibians are excellent indicators of environmental change, particularly water quality. Amphibians surveys were completed three (3) times (May, June, July) to

provide a qualitative assessment of the adult male population of frogs and toads.

1.4.3. Vegetation Assessment

- The vegetation communities were assessed using a modified version of the ELC. The property was divided into ecological units and mapped to provide a description of the vegetation and habitat types present on the property. The surveys were undertaken in August 2006.

1.4.4. Wetland Boundary Confirmation

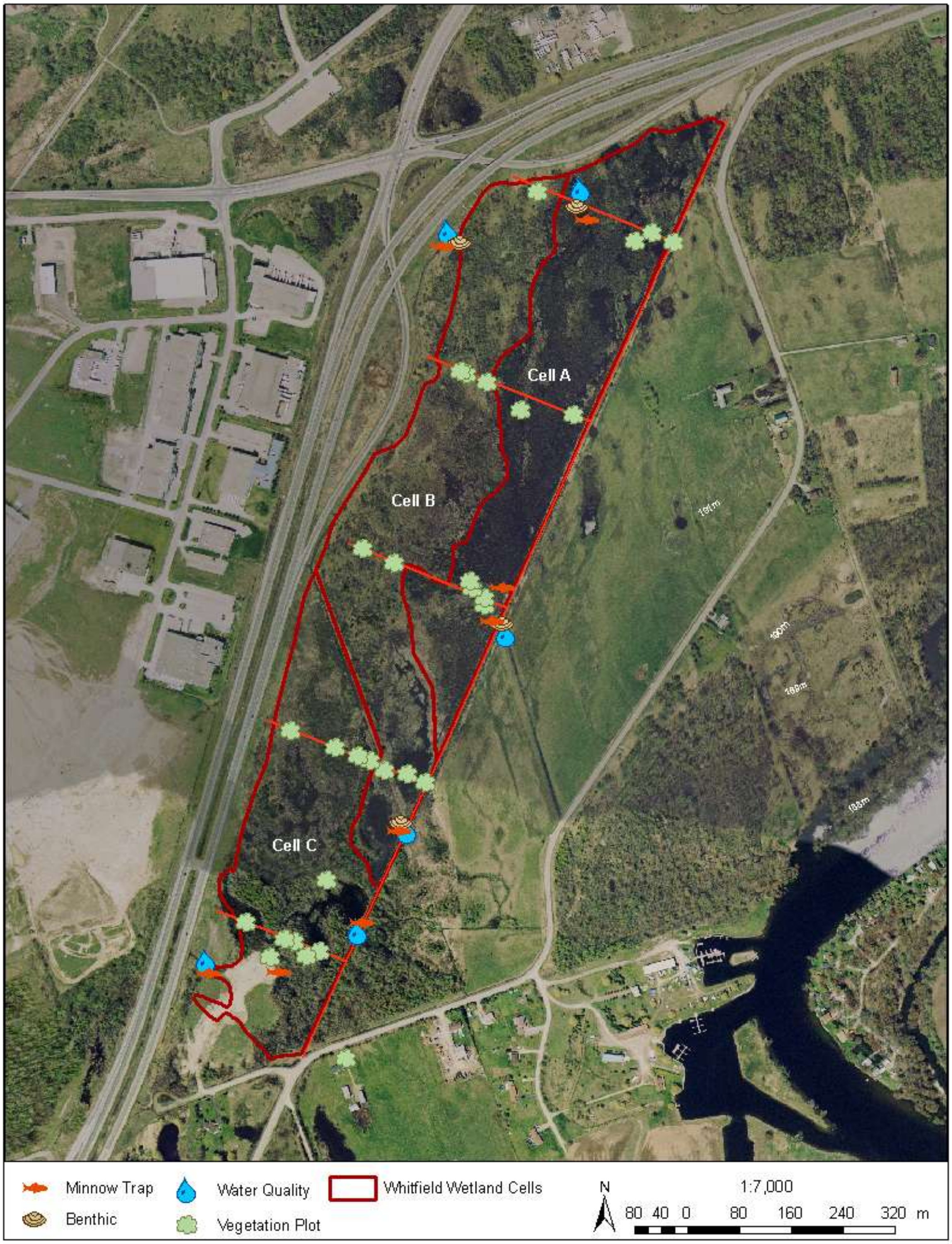
- Whitfield Wetland is part of the Provincially Significant Peterborough Airport Wetland Complex that was last evaluated in 1995, so a new evaluation is not needed at this time. However, a confirmation of the wetland boundary was undertaken.

1.4.5. Inventory of Vegetation Species

- An inventory of vegetation species was completed
- Species identified were compared to previous inventories to confirm existing species and recognize new ones.

1.4.6. Inventory of Wildlife Species

- An inventory of fauna species (mammals, birds, fish, and amphibians) was completed to determine which species currently inhabit or use the property for food, shelter or breeding.
- Fish populations were assessed using minnow traps.



Map 3: Sampling Locations.

2.0 Physical Description

The Whitfield Wetland covers an area of 91 acres (38 hectares) and is part of the provincially significant Peterborough Airport Wetland Complex. The Whitfield Wetland is bordered to the north, west and south by roadways and to the east by an abandoned railway line. The construction of these roadways and the rail line, as well as beaver activity, has created the current wetland conditions. Prior to the construction of these roadways, the Whitfield Wetland was a low-lying wet area used as a pasture for livestock.

Several wetland types are present on the site including marsh, swamp and open aquatic areas. Willow thickets dominate the northern half of the complex with the exception of a small meadow marsh area to the east (Map 7). The southern half of the wetland is a mix of shallow open aquatic, swamp and some upland forest and marsh. Most of these ecotypes can be viewed from the abandoned railway line that runs on a north-easterly course from the southeast corner of the property. The eastern portion of the property is easily accessed via the abandoned railway line. However, the northern and western portions of the property are visible from Highway 115, but are difficult to access due to fencing and high traffic volume.

For the purposes of this study, the Whitfield Wetland has been divided into three cells (A, B, C). Cell A begins at the most northerly end of the wetland and drains the upper portion of the wetland (comprised mostly of willow thickets). It exits the wetland in approximately the middle of the railway line where it creates a small stream (water flows through beaver dam above this point). Cell B begins at a concrete box culvert where a cold water stream flows into the wetland, it continues alongside Highway 115 before traveling across the wetland alongside a raised area (possibly former railway line). Cell C comprises the southern portion of Whitfield Wetland. It is bordered to the west by Highway 115, to the east by the abandoned railway line and to the south by Beardsmore Road.

There are three locations where water enters Whitfield Wetland (inlets) on the north and west property boundaries. These inlets enable stormwater run off from the Highway 115 to enter Cells B and C. The outlets of Cells A and B are characterized by still, standing water due to damming activity by beavers. The outlet of Cell B is characterized by moving water that flows through a breach in the abandoned railway line. Water flowing from the outlets of Cells A, B, and C converge downstream of Whitfield Wetland before their confluence with the Otonabee River. Refer to Map 4 for locations of inlets and outlets within the Whitfield Wetland.

Map 4: Whitfield Wetland water flow and cell delineation.

Figure 5: **Photos**

Willow thicket at Cell B outlet.

Swamp at southern end of wetland, viewed from rail line.

Area of open water at outlet of Cell C.

Cattail marsh area near Cell A.

Looking south on rail line in Cell C.

Farm to east – viewed from rail line.

Cell A outlet through farm field.

Cell B outlet through farm field.

First crossing on rail line crossing, showing beaver dam across trail.

Whitfield Wetland Outlet at Otonabee River.

Beaver dam between open aquatic areas.

Willow thicket in northern end of wetland (Cell A).

Corridor from second water crossing.

Inlet at Cell C facing Highway 115.

Whitfield Wetland viewed from Highway 115 off ramp.

Harper Creek tributary before crossing under Highway 115.

Cell A outlet – stream at rail line.

Harper Creek tributary above Whitfield Wetland.

Runoff from Hwy 115 at Cell A.

3.0 Water Quality Assessment

Experts agree that due to the linkages between land, water and air, the status of aquatic resources can be considered representative of overall ecosystem health. Water quality monitoring identifies the presence of contaminants that affect the health of a watershed. Water quality data also provides insight to the potential causes of degraded watershed health, as well as the sources of contaminants in a watershed. It is important to compare water chemistry data with biological data such as benthic macroinvertebrate populations when assessing wetlands as water chemistry data alone can be misleading when attempting to characterize the overall health of the wetland.

For this reason, the water quality monitoring component of this study included the investigation of the chemical, physical, and biological components of water. Surface water samples were collected at six (6) sites and analyzed for a variety of chemical, physical and biological parameters. Four (4) samples of the benthic invertebrate population were also taken to assess water quality conditions and compare with water chemistry results.

The following section includes a summary of the data collected (physical, chemical, bacteriological and biological parameters), and an evaluation of water quality.

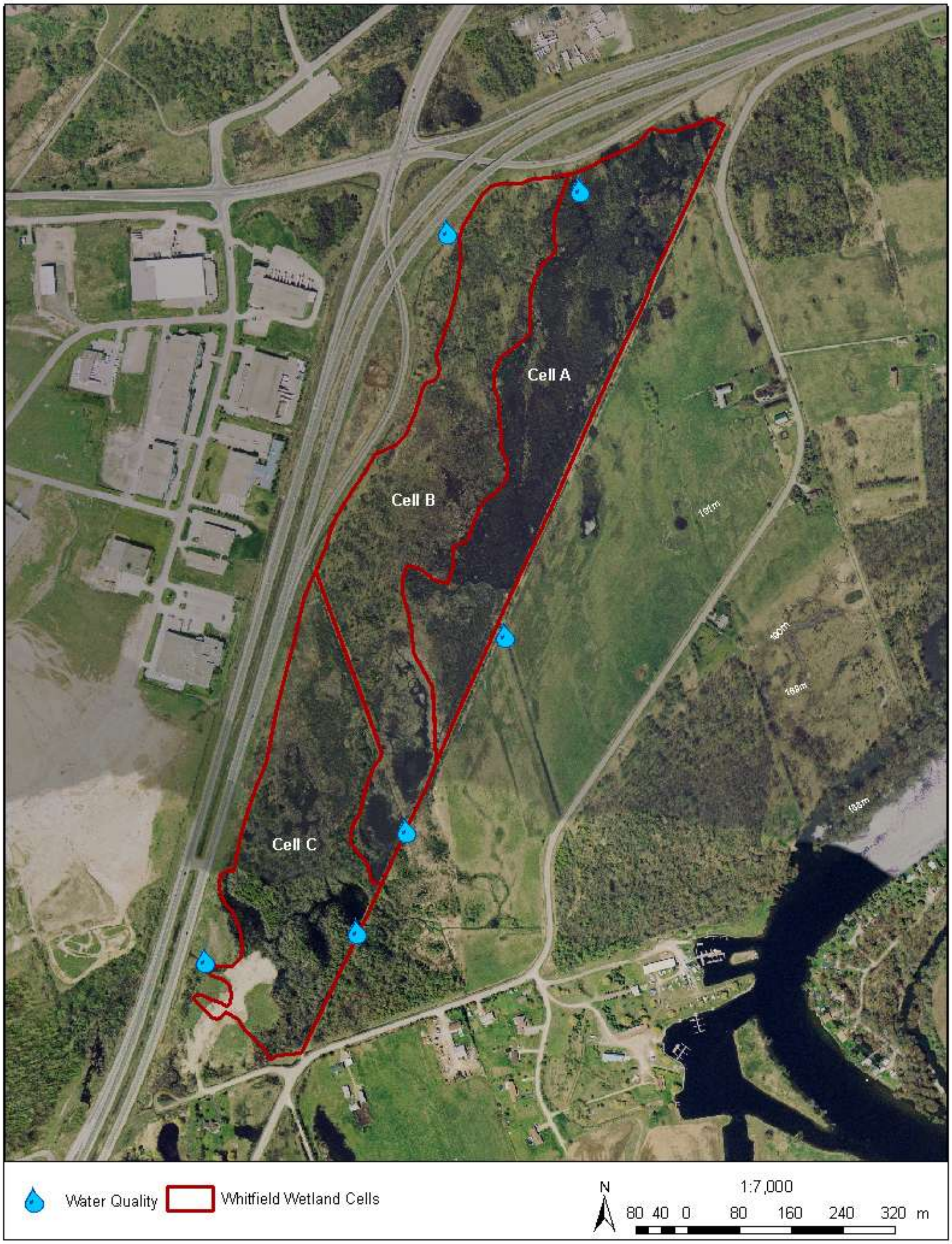
3.1. Water Chemistry

The monitoring of surface water quality using water chemistry is used to identify and track the presence of contaminants that can impact the health of the aquatic ecosystem. The water chemistry parameters used in the Whitfield Wetland water quality monitoring can be used to give an indication of the overall health of the wetland and identify potential problems.

3.1.1. Water Chemistry Methodology

Surface water samples were taken at six (6) sites (Map 5), which are the inlets and outlets to Cells A, B, and C. Sampling was conducted from May to October 2006 using standard Ontario Ministry of the Environment Surface Water Quality Sampling Protocols. Sampling locations were documented using a handheld Garmin Etrex Venture Global Positioning System.

Surface water quality was evaluated both in the field and by a laboratory using a total of sixteen (16) physical, chemical, and biological parameters. Together, these parameters provide an indication of overall stream health, and can assist in the identification of potential impacts from stormwater inputs.



Map 5: Surface water sampling locations.

Surface water samples were analyzed in the field using an YSI 650 MDS Multi-Meter. This meter was calibrated before sampling according to Ministry of the Environment Protocol and the manufacturers recommended procedures for the following parameters:

- Temperature
- Dissolved oxygen
- Conductivity
- Salinity
- pH
- Total dissolved solids

Surface water samples were also sent to SGS Lakefield Research, a local CAEAL (Canadian Association for Environmental Analytical Laboratories) accredited facility to be analysed for:

- Total suspended solids
- Biochemical oxygen demand (BOD)
- Total phosphorus
- Nitrate
- Nitrite
- Sodium
- Chloride
- Metals
- Total coliforms
- *E coli*.

Evaluation of the surface water quality was undertaken by comparing the analytical results of the samples collected each month with the limit or recommended guideline set by the provincial or federal governments for each parameter. Please refer to Table 22, Appendix C for a summary of Federal, Provincial, and local Water Quality Criteria.

3.1.2. Water Chemistry Results

3.1.2.1.Physical Parameters

Total Suspended Solids

Total suspended solids (TSS) are a measure of the particulate matter that is suspended within the water column. A high concentration of suspended solids (non-filterable residue) increases turbidity, thereby restricting light penetration and hindering photosynthesis of aquatic vegetation. Suspended material can result in damage to fish gills, while settling suspended solids can cause impairment to spawning habitat by smothering fish eggs. Suspended solids interfere with water treatment processes. Although there are no Provincial guidelines for total suspended solids, levels above 5 mg/L are considered elevated for this watershed. This value will be used as a local guideline.

Total suspended solids were elevated at all monitoring sites with the exception of the outlet of Cell C (Figure 6). Overall results for the wetland ranged from 2 mg/L (Cell B – inlet and Cell C - outlet) to 160 mg/L (Cell A - inlet) with an average of 22.83 mg/L. TSS were consistently higher at the inlet sample sites indicating that as the water passes through the wetland suspended sediments are settling out of the water.

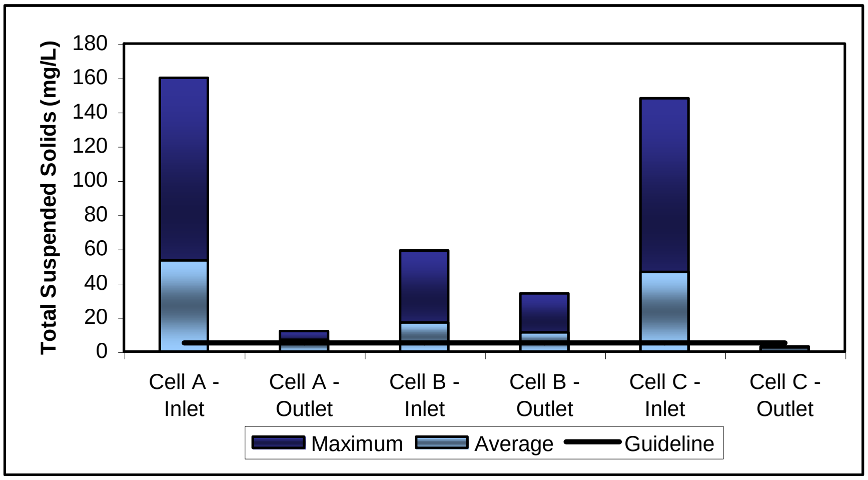


Figure 6: **Maximum and average total suspended solid values for Whitfield Wetland in 2006 compared to the guideline.**

Results showed that Cells A and C have considerably higher levels of TSS than Cell B. This is likely due to the fact that Cells A and C receive inputs from rain events and run off from Highway 115, while Cell B is stream-fed. This illustrates the impact of the highway on levels of TSS in the Whitfield Wetland.

Total Dissolved Solids

Total dissolved solids (TDS) are a measure of the amount of dissolved solids in the water column. High concentrations of TDS limit the suitability of water as a drinking source and irrigation supply. High TDS waters may interfere with the clarity, colour and taste of manufactured products. Although there are no provincial guidelines for total dissolved solids, levels above 300 mg/L are considered elevated for this watershed. This value will be used as a local guideline.

Total dissolved solids were elevated at all monitoring sites (Figure 7). Overall levels of TDS within the wetland ranged from 314 mg/L (Cell A - outlet) to 2039 mg/L (Cell C - inlet) with an average of 689 mg/L (Appendix B and C). TDS levels were generally found to be higher at the monitoring sites located at the inlets to the wetland indicating that as the water passes through the wetland, dissolved solids are being absorbed by aquatic plants.

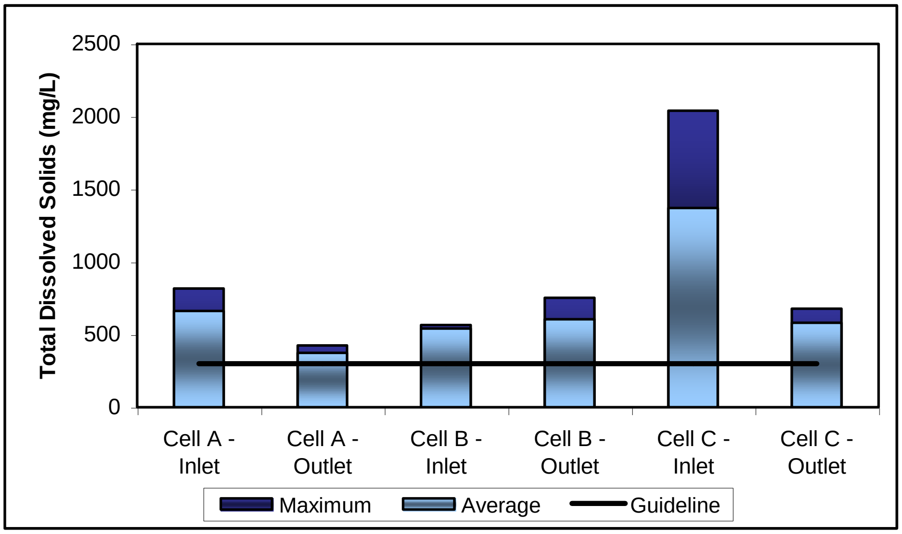


Figure 7: Maximum and average total dissolved solid values for Whitfield Wetland in 2006 compared to the guideline.

Elevated concentrations of TDS are likely the result of run off from Highway 115 which runs along the northwest border of the wetland. Results illustrate the impact of the highway on levels of total dissolved solids within Whitfield Wetland as both Cells A and C have considerably higher levels than the stream-fed Cell B. Another possible source of contamination is through agricultural run off from the adjacent property on the southeast border of Whitfield Wetland. Water from flooded agricultural fields is mixing with the wetland water in this area of Whitfield Wetland.

Water Temperature

The temperature of water affects the solubility of many chemical compounds and can therefore influence the effect of pollutants on aquatic life. Increased temperatures elevate the metabolic oxygen demand, which in conjunction with reduced oxygen solubility, impacts many species. Temperature can be affected by development, agricultural use, industrial discharges and the alteration of flow patterns. Water temperature and air temperature data can be used to classify fish habitat and assess the habitat suitability of an area to support specific aquatic species. Water temperature was monitored at Whitfield Wetland to ensure that existing water temperatures were documented as a basis for comparison in the future.

Temperatures ranged from 11.29 ^{o}C (Cell B Inlet) to 28.48 ^{o}C (Cell A Outlet) with an average of 19.83 ^{o}C (Appendices B and C). Overall, the wetland can be classified as warm water as all sites had temperatures exceeding 22^{o}C (Figure 8). However, it should be noted that the inlet of Cell B was consistently cooler than the rest of the wetland, which is expected as it is fed by a cold water stream.

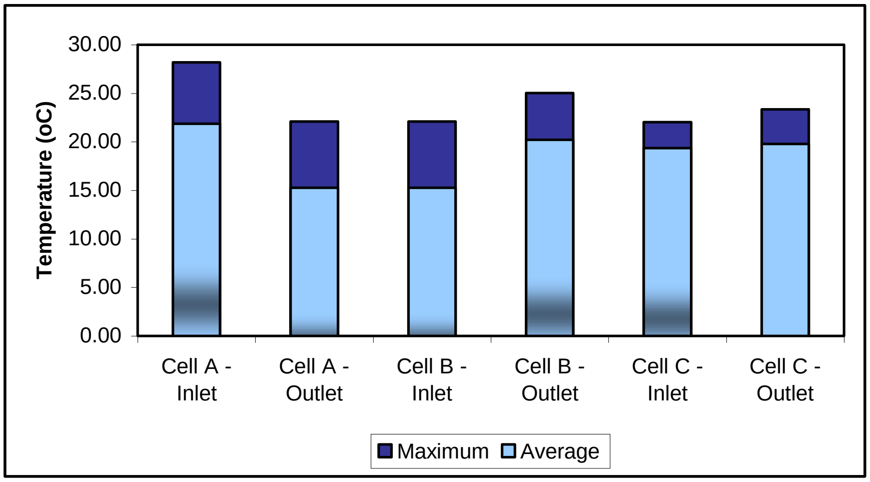


Figure 8: Maximum and average water temperatures for Whitfield Wetland in 2006.

Biological Oxygen Demand (BOD)

Biological oxygen demand (BOD) is a measure of the amount of oxygen consumed by micro-organisms which break down organic matter within the water. High BOD is indicative of high levels of organic pollution, and results in less oxygen being available for aquatic plants and animals (Cook, 2004). High BOD also results in decreased dissolved oxygen levels as the oxygen that is available in the water is being consumed by micro-organisms. This decreased availability of dissolved oxygen within the water can lead to increased stress that, in severe cases, can increase mortality rates of fish and other aquatic life (CIESE 2006). BOD guidelines are available in Table 1.

Table 1: Explanation of BOD guidelines and how they relate to water quality and degree of organic pollution (CIESE 2006).

BOD (mg/L)	Water Quality
1-3	**Very Good** Little to no organic waste present in the water
3-6	**Fair: Moderately Clean** Slight organic contamination
6-9	**Poor: Somewhat Polluted** Organic matter and micro-organism activity present
100 or greater	**Very Poor: Very Polluted** Organic matter present and micro-organism activity high

Biological oxygen demand was elevated at all sample sites within Whitfield Wetland (Figure 9). Overall results for Whitfield wetland ranged from 1 mg/L (Cell C Outlet) to 63 mg/L (Cell A Inlet) with an average of 8.67 mg/L (Appendices B and C). Wetland ecosystems will generally have higher organic content than stream or river systems as they have little to no water flow and thus slightly elevated levels of BOD should be expected. However, at the inlets of Cells A and Cell C BOD levels were above 60 mg/L suggesting the presence of organic pollution.

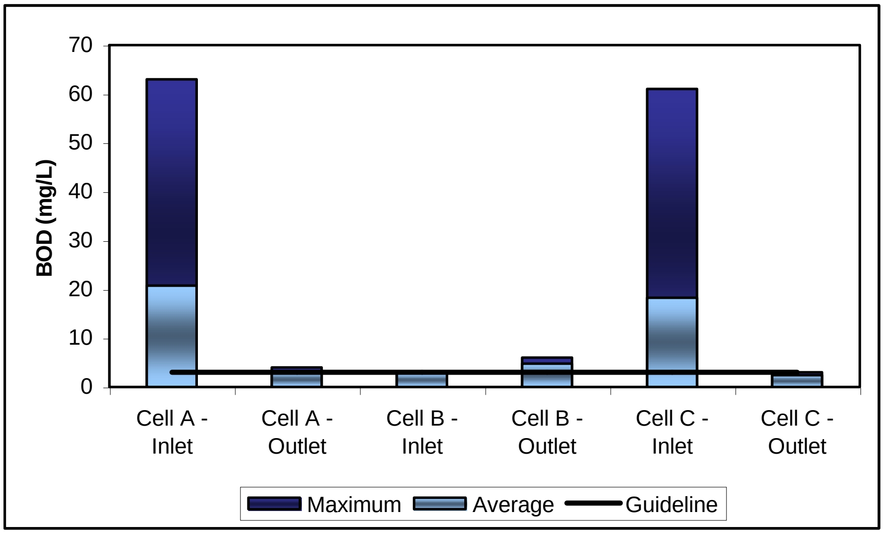


Figure 9: Maximum and average biological oxygen demand for Whitfield Wetland in 2006 compared to the guideline.

Dissolved Oxygen (DO)

Dissolved Oxygen (DO) is essential to the respiratory metabolism of aquatic organisms and is an essential element of good water quality. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As DO levels in water drop below 5.0 mg/L, aquatic life is put under stress. The lower the dissolved oxygen concentration is, the greater the stress to aquatic organisms. Oxygen levels that remain below 2 mg/L for a few hours can result in large fish kills.

Levels of DO affect the solubility and availability of nutrients, and therefore the productivity of aquatic ecosystems. The amount of oxygen is perhaps the most widely used indicator of water quality. Many factors may impact the level of oxygen in surface water. For example, it is strongly affected by the presence of micro-organisms that use oxygen as they decompose organic matter. The dissolved oxygen saturation level is inversely proportional to the temperature.

The Canadian Water Quality Guideline (CWQG) minimum requirement of DO for warm water biota is 5.5 mg/L and coldwater biota is 6.5 mg/L. Generally, wetlands have high levels of nutrients, warmer temperatures, and standing water which usually results in lower DO levels than creeks and streams. The DO requirements for warm water biota (5.5 mg/L) were used to evaluate the conditions in Whitfield Wetland.

Dissolved oxygen levels within the Whitfield Wetland were found to be below 5.5 mg/L at five (5) of the six (6) sample sites (Figure 10). DO levels ranged from 0.2 mg/L (Cell A Inlet) to 12.71 mg/L (Cell B Inlet) with an average of 5.21 mg/L (Appendices B and C). The outlet of Cell A and the inlet of Cell B were the only sample sites that had average DO levels above 5.5 mg/L.

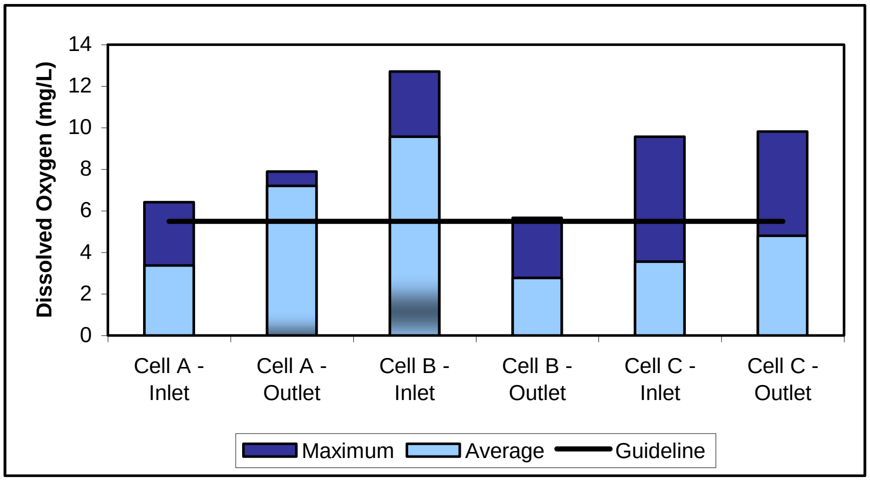


Figure 10: Maximum and average DO values in 2006 compared to the guideline.

DO is higher in cooler, fast moving waters. This explains why Cell B, which is fed by a cold water stream, and Cell A which outlets into a stream that flows into the Otonabee River, both averaged higher DO levels than the other stagnant water sites within the wetland. Warmer water temperatures and the abundance of organic matter and the micro-organisms that decompose it are likely affecting the DO levels within the Whitfield Wetland.

3.1.2.2.Chemical Parameters

Phosphorus
Phosphorus is generally considered to be the most limiting nutrient in aquatic systems, due to the fact that its input to fresh water systems can cause extreme proliferations of algal growth. Inputs of phosphorus are the prime contributing factors to eutrophication in most fresh water systems.

Wetlands cycle phosphorus, and therefore accumulate it in the soil, roots and surrounding water. This can result in wetlands exhibiting higher levels of phosphorus than those found in healthy creeks and streams. It is important to recognize that wetlands can also be a source of phosphorus to the receiving watercourse, especially during the spring freshet or periods of high precipitation.

Total phosphorous has a negative impact on water quality due to the fact that it stimulates plant and algal growth. Increased plant growth results in increased plant death and results in increased biological oxygen demand as micro-organism populations thrive on dead plant matter.

The Provincial Water Quality Objective (PWQO) for total phosphorus is 0.02 mg/L for lakes and 0.03 mg/L for streams. In the Great Lakes Basin, 0.03mg/L is used as an indicator level of phosphorus for coastal wetlands. Sources of phosphorus include decomposition of organic matter, detergents, treated or untreated sewage, industrial waste, urban and rural run off, erosion, and fertilizer.

Total phosphorous concentrations were elevated at all six (6) samples sites within the Whitfield Wetland (Figure 11). Overall results for the wetland ranged from 0.02 mg/L (Cell B and Cell C - outlet) to 1.21 mg/L (Cell A - inlet) with an average of 0.16 mg/L (Appendices B and C). The average total phosphorous concentrations for all sites were either at or above the provincial objective of 0.03 mg/L. Total phosphorous concentrations at the inlets of both Cells A and C were considerably higher than outlet concentrations, while results for Cell B were highest at the outlet. Differences between Cells A and C, Cell B are likely due to the fact that Cells A and C are fed through rain events and the resulting stormwater runoff from Highway 115, while Cell B is fed by a small cold water stream.

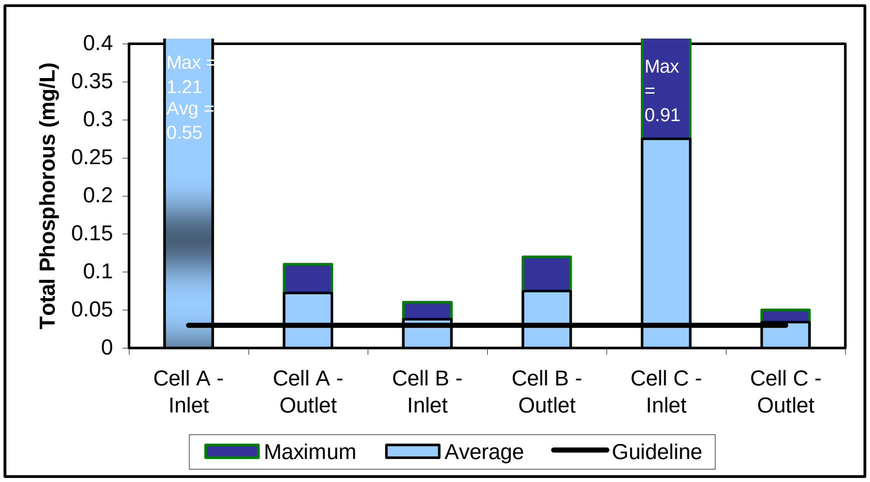


Figure 11: Maximum and average total phosphorous values for Whitfield Wetland in 2006 compared to the guideline.

Nitrate

Nitrate (NO_3) is the primary form of nitrogen utilized by plants as a nutrient to stimulate growth. Excessive amounts of nitrogen may result in phytoplankton or macrophyte proliferations. At high levels it is toxic to infants. Elevations in nitrate concentrations are important because they indicate the presence of pollution from non-point sources. Elevated levels of NO_3 are commonly found in locations downstream of urban, agricultural, and other developed areas therefore. High levels of nitrate can occur from run off from manure storage facilities, faulty septic systems, sewage treatment plants and to a lesser extent, fertilized areas such as lawns, golf courses, and agricultural activities.

The Ontario Drinking Water Standard (ODWS) for nitrate is 10 mg/L to protect aquatic life from the potential toxicological effects of elevated nitrate levels. In the Great Lakes Basin, 0.5 mg/L is used as an indicator level for nitrate in coastal wetlands.

Nitrate concentrations were well below the ODWS of 10 mg/L at all six (6) sample sites within Whitfield Wetland (Figure 12). Overall results for the wetland ranged from 0.05 mg/L (Cell A, Cell C, and Cell B Outlet) to 0.87 mg/L (Cell B - inlet) with an average of 0.18 mg/L (Appendices B and C). Although nitrate levels are below the ODWS, they are elevated for this area which has an average nitrate concentration of 0.05 mg/L. Sources of nitrates near the Whitfield Wetland may include run off from adjacent properties and run off from Highway 115.

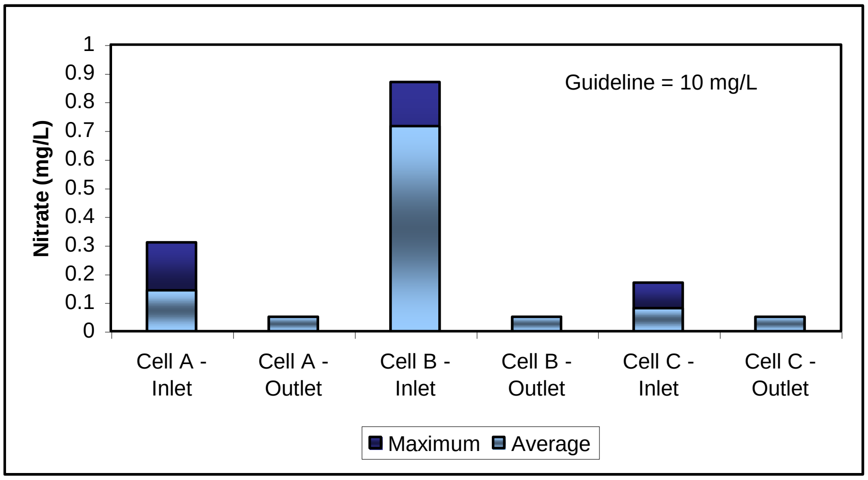


Figure 12: Maximum and average nitrate values for Whitfield Wetland in 2006 compared to the guideline.

pH

High pH values tend to facilitate the solubility of ammonia, heavy metals, and salts. The precipitation of carbonate salts (marl) is encouraged when pH levels are high. Low pH levels tend to increase carbon dioxide and carbonic acid concentrations. Lethal effects of pH on aquatic life occur below pH 4.5 and above pH 9.5. Acid precipitation and industrial discharges are the main causes of extreme pH levels**.** The acceptable pH range under the Provincial Water Quality Objectives (PWQO) for surface waters is 6.5 to 8.5, and the acceptable pH range for wetlands is 5.1 – 7.0. However, it is not uncommon to observe pH values as high as 9.0 in Peterborough County due to the limestone bedrock geology.

pH levels were well within the acceptable range of 6.5 to 8.5 for all six (6) sample sites within Whitfield Wetland (Figure 13). Overall pH results for the wetland ranged from 6.74 (Cell C – Inlet) to 8.4 (Cell B - inlet) with an average of 7.67 (Appendix B and C). pH fluctuations within the Whitfield Wetland may be attributed to inputs from non point source contaminants such as run off from the highway, industrial, or agricultural activities. During rain events contaminants are washed into the wetland resulting in greater variation of pH levels.

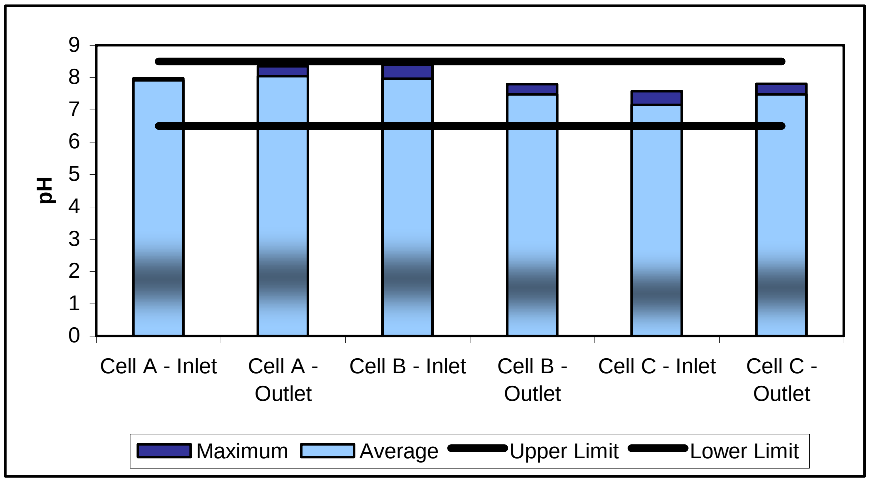


Figure 13: **Maximum and average pH values for Whitfield Wetland in 2006 compared to the acceptable range.**

Conductivity

Conductivity may be used to estimate the total ion concentration of the water, and is often used as an alternative measure of dissolved solids. High levels of conductivity can indicate water quality impairment, but further investigation of other parameters is necessary to determine causes. In this report, levels of conductivity greater than 400 μs/cm are considered elevated.

Conductivity levels within Whitfield Wetland were elevated at all six (6) sample sites (Figure 14). Conductivity levels ranged from 483 μs/cm (Cell A – outlet) to 3136 μs/cm (Cell C - inlet) with an average of 1060 μs/cm (Appendices B and C). Conductivity levels within Whitfield Wetland clearly illustrate that water quality is impaired.

Elevated conductivity concentrations are likely the result of run off from Highway 115 which runs along the northwest border of the wetland. Results illustrate the impact of the highway on conductivity levels within the Whitfield Wetland as both Cells A and C have considerably higher levels than the stream-fed Cell B. Other potential sources of contamination include run-off from the adjacent agricultural property on the southeast border of the Whitfield Wetland.

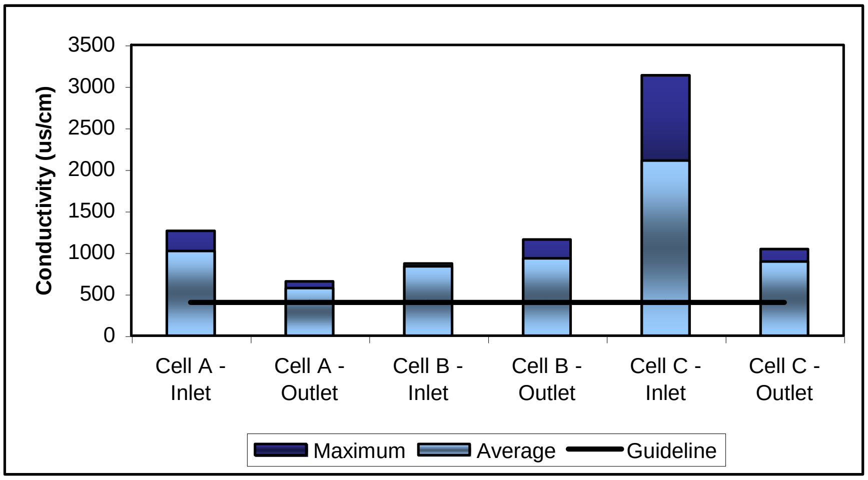


Figure 14: Maximum and average conductivity values for Whitfield Wetland in 2006 compared to the guideline.

Salinity

Salinity is the measurement of the amount (%) of dissolved salt compounds that are found in the water. Salinity encompasses numerous chemicals including silica, iron, calcium, magnesium, sodium, potassium, bicarbonate, sulphate, chloride, nitrate and bromide. Salinity levels of more than 0.4% may be cause for concern in this watershed, as they may have a negative impact on aquatic biota. Typical sources of salinity include road salt and naturally occurring salts. Levels of salinity between 0.1% and 0.25% are typical for surface waters in this watershed while levels greater than 0.4% are considered elevated. This value of 0.4% is used as a guideline for salinity in this report.

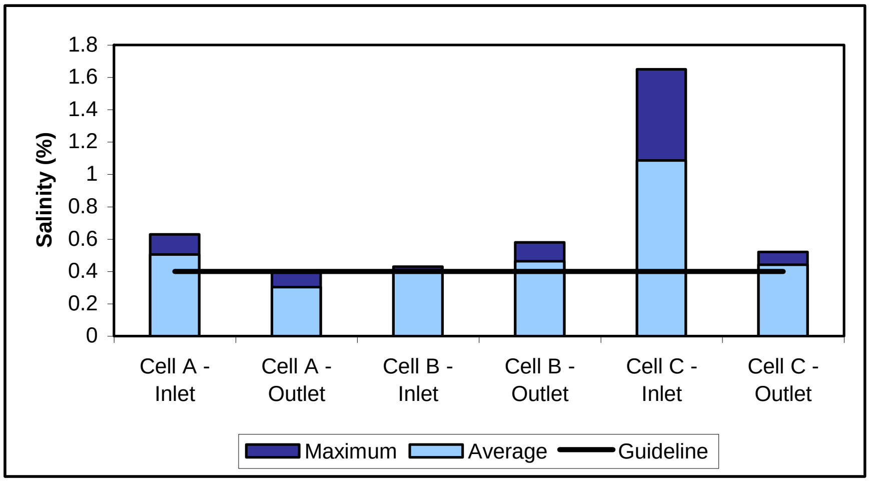


Figure 15: Maximum and average salinity values for Whitfield Wetland in 2006 compared to the guideline.

Salinity levels within Whitfield Wetland were found to be above the guideline of 0.4% at five (5) of the six (6) sample sites (Figure 15). Salinity levels ranged from 0.23% (Cell A – outlet) to 1.65% (Cell C - inlet) with an average of 0.54% (Appendices B and C). High salinity levels are likely the result of run off from Highway 115.

Sodium

Sodium is a natural chemical element that is a component of minerals found within the earth. Sodium is often strongly correlated with chloride as they bind together naturally to form sodium chloride salts. Sodium is used in the production of glass, soap, metal, and various industrial activities. Sodium salts are found in seawater (1.05%), salty lakes, alkaline lakes and mineral spring water. The most common sources of elevated sodium levels in surface water are erosion of salt deposits, rocks and minerals, road salt, irrigation, precipitation, sewage effluent, landfills, and industrial sites. High levels of sodium can result in increased alkalinity which could have negative impacts on both the aquatic habitat as well as the organisms within it. The ODWS for sodium is 200 mg/L.

Sodium concentrations were below the guideline for all sample sites except the inlet of Cell C (Figure 16). Overall results for the wetland ranged from 40.8 mg/L (Cell B - inlet) to 498 mg/L (Cell C - inlet) with an average of 124 mg/L (Appendices B and C). Elevated sodium levels are likely a direct result of heavy road salt applications during the winter months on Highway 115.

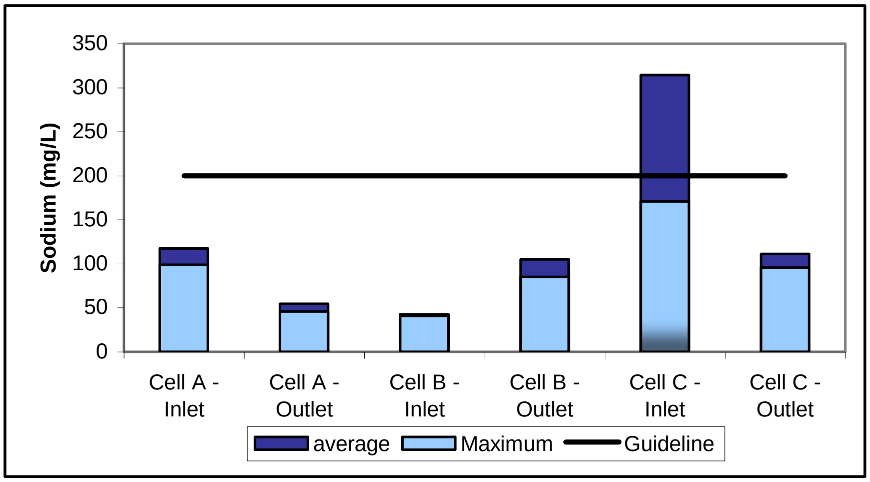


Figure 16: Maximum and average sodium values for Whitfield Wetland in 2006 compared to the guideline.

Chloride

Chloride is an ion that can be readily found in the aquatic environment as natural mineral deposits and also from human-related sources such as municipal storm drainage, sewer discharges, irrigation drainage, road salts, oil well operations, and industrial wastes. Chloride can be toxic to aquatic organisms at high concentrations and chronic effects on growth and reproduction have been observed at low concentrations. Chloride ions behave conservatively in the aquatic environment and therefore move with the water without being lost. As a result, almost all chloride ions entering both the soil and groundwater will be expected to eventually reach the surface water. Chloride is used extensively in the form of sodium chloride for road salting in the winter months, as well as in the form of calcium chloride in the wastewater treatment industry, and as potassium chloride in potash used for fertilizer. Surface water in urban areas tends to have the highest chloride contamination due to road salt application (ODWS, 2005). The ODWS and CWQG for chloride is 250 mg/L.

Chloride concentrations were below the guideline for all sample sites except the inlet of Cells A and C (Figure 17). Overall results for the wetland ranged from 78 mg/L (Cell B - inlet) to 740 mg/L (Cell C - inlet) with an average of 203 mg/L. Elevated chloride levels are likely a direct result of heavy road salt applications during the winter months on Highway 115. The inlets of Cells A and C both had results that exceeded the guideline of 250 mg/L. This supports the theory that Highway 115 is the main source of chloride contamination within Whitfield Wetland as both inlets are fed solely from rainfall and run off from the Highway. The effects of increasing chloride concentrations on aquatic life is not fully understood, and further examination of this issue within Whitfield Wetland is recommended.

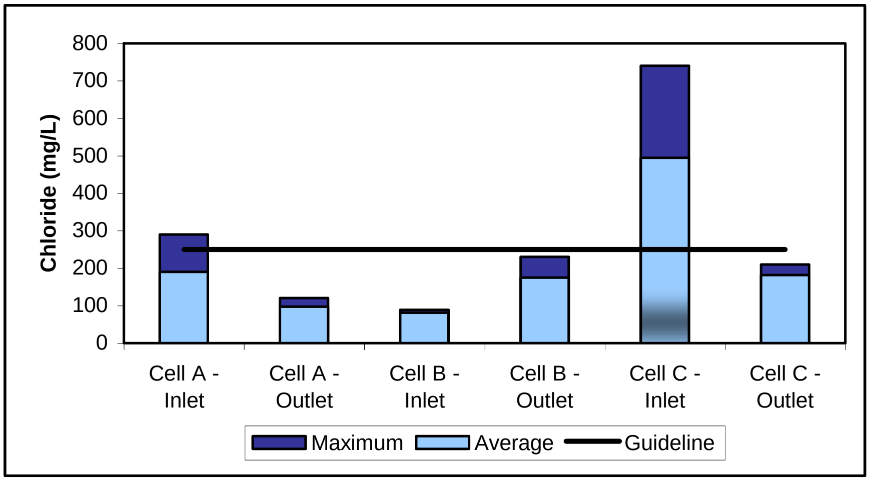


Figure 17: Maximum and average chloride values for Whitfield Wetland in 2006 compared to the guideline.

3.1.2.3. Metal Parameters

An analysis of thirty (30) metal parameters was performed for all six (6) sample sites in August 2006. Table 2 lists all of the parameters that were examined for the Whitfield Wetland along with corresponding guidelines. Results indicated that chromium, aluminum, iron, and manganese were elevated at most of the sampling locations within Whitfield Wetland.

Table 2: Average concentrations of metals within Whitfield Wetland

Parameter	Guideline	Average Concentration
Silver (mg/L)	0.0001	0.00003
Aluminum (mg/L)	0.075	0.117
Arsenic (mg/L)	0.005	0.001
Barium (mg/L)	1	0.131
Beryllium (mg/L)	1.1	0.00004
Boron (mg/L)	0.2	0.041
Bismuth (mg/L)		0.00002
Calcium (mg/L)		70.43
Cadmium (mg/L)	0.0002	0.00006
Cobalt (mg/L)	0.0009	0.0003
Chromium (mg/L)	0.001	0.0011
Copper (mg/L)	0.005	0.0012
Iron (mg/L)	0.3	2.06
Potassium (mg/L)		6.17
Lithium (mg/L)		0.002
Magnesium (mg/L)		12.55
Manganese (mg/L)	0.05	0.460
Molybdenum (mg/L)	0.04	0.0007
Nickel (mg/L)	0.025	0.0008
Lead (mg/L)	0.025	0.00053
Antimony (mg/L)	0.02	0.0003
Selenium (mg/L)	0.1	0.003
Silica (mg/L)		3.44
Tin (mg/L)		0.0003
Strontium (mg/L)		0.221
Titanium (mg/L)		0.005
Thallium (mg/L)	0.0003	0.0001
Uranium (mg/L)	0.005	0.0016
Vanadium (mg/L)	0.006	0.001
Zinc (mg/L)	0.02	0.005

Note: Highlighted rows indicate exceedences of the guideline.

Chromium

Chromium is found in the natural environment in ore deposits containing other elements. Chromium is used in metal alloys such as stainless steel; protective coatings on metal; magnetic tapes; and pigments for paints, cement, paper, rubber, composition floor covering and other materials and its soluble forms are used in wood preservatives. Short-term health effects of chromium exposure include skin irritation or ulceration, while more serious health effects such as damage to the liver, kidney circulatory and nerve tissues can occur as a result of long-term exposure (EPA 2006).

Chromium compounds bind to soil and are not likely to migrate to ground water. However, they are very persistent in water as sediments and there is a high potential for accumulation of chromium in aquatic life. The PWQO is 0.001 mg/L for hexavalent chromium and 0.0089 mg/L for trivalent chromium.

Chromium concentrations exceeded the Provincial objective at all three (3) inlet sample sites within Whitfield Wetland (Figure 18). Overall results for the wetland ranged from 0.0007 mg/L (Cell A - outlet) to 0.0017 mg/L (Cell C - inlet) with an average of 0.0011 mg/L (Appendix B and C). Chromium exceedences only occurred at the inlets of the wetland which indicates that the contaminant source is coming from the area of inlet and could possibly be Highway 115. Chromium concentrations were lower at the outlets and thus it is likely that chromium is settling out with sediments as it passes through the wetland.

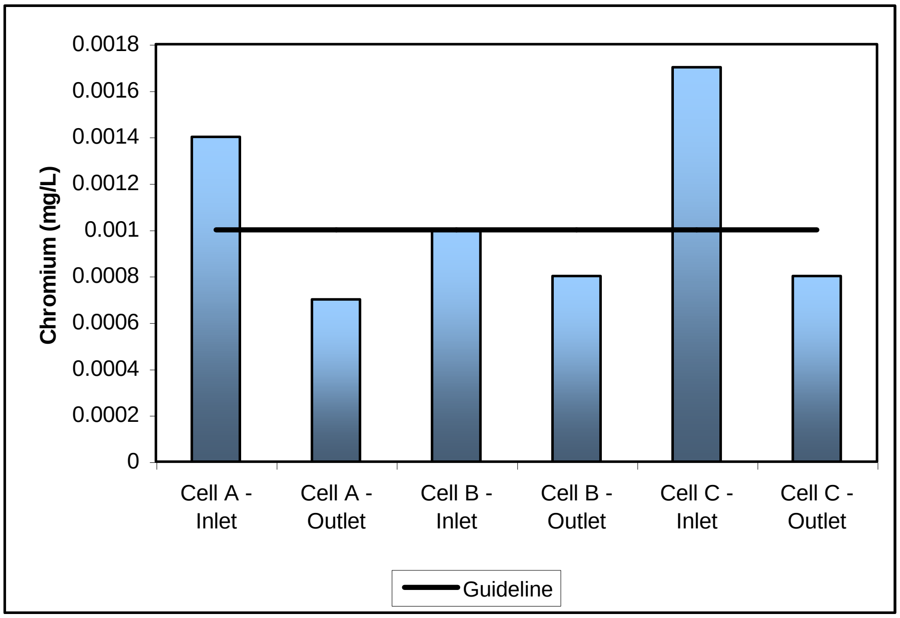


Figure 18: **Chromium values for Whitfield Wetland in 2006 compared to the guideline.**

Aluminum

Aluminum is one of the most abundant elements in the earth's crust and occurs in many rocks and ores, but never as a pure metal. The most common sources of aluminum in surface water include industrial wastes and effluents from drinking water treatment plants. High concentrations of aluminum in surface water can be toxic to aquatic life if the pH is lowered (RAMP 1997). The PQWO for aluminium is 0.075 mg/L given that the pH is between 6.5 and 8.5.

Aluminum concentrations exceeded the PWQO at all three (3) inlet sample sites within Whitfield Wetland (Figure 19). Overall results for the wetland ranged from 0.022 mg/L (Cell C - outlet) to 0.344 mg/L (Cell C - inlet) with an average of 0.112 mg/L (Appendix B and C). Aluminum exceedences only occurred at the inlets of the wetland which indicates that the contaminant source is coming from the area of inlet and could possibly be Highway 115. Aluminum concentrations were lower at the outlets and thus it is likely that Aluminum is settling out with sediments as it passes through the wetland.

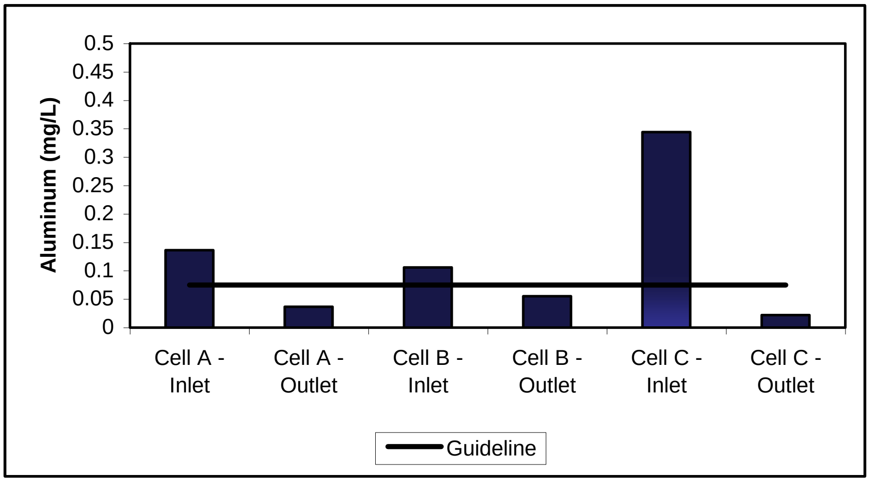


Figure 19: Aluminum values for Whitfield Wetland in 2006 compared to the guideline.

Iron

Iron makes up 95 % of all the metal tonnage produced worldwide. Anthropogenic sources of iron in surface water include industrial effluent, acid-mine drainage, and sewage and landfill leachate. Its applications range from staples to cars and ships. Iron is the most abundant (by mass, 34.6%) element making up the Earth. World production of new iron is over 500 million tonnes a year, and recycled iron adds another 300 million tonnes (OMOE, 2002). The PWQO for iron 0.3 mg/L.

Iron concentrations exceeded the PWQO at all sample sites within Whitfield Wetland except for the outlet of Cell A (Figure 20). Overall results for the wetland ranged from 0.29 mg/L (Cell A - outlet) to 7.41 mg/L (Cell C - inlet) with an average of 2.06 mg/L

(Appendix B and C). Iron concentrations were significantly higher at the inlets of Cells A and Cell C which indicates that contamination is likely due to run-off from Highway 115.

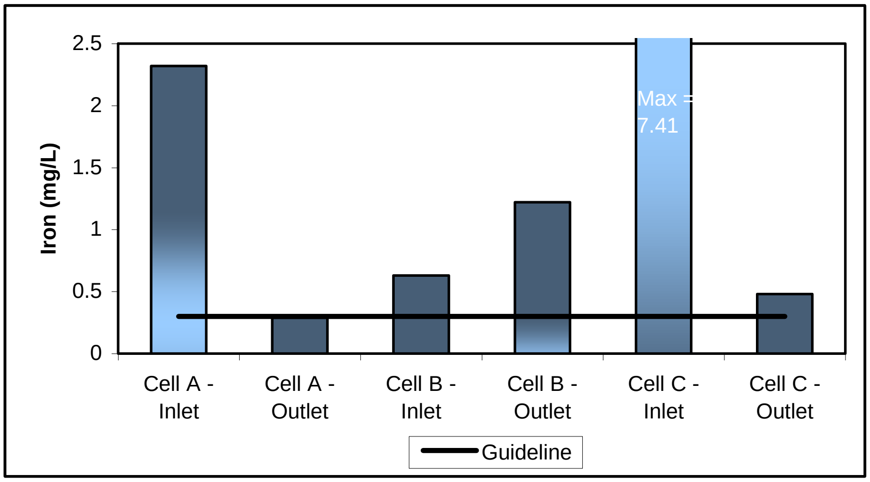


Figure 20: Iron values for Whitfield Wetland in 2006 compared to the guideline.

Manganese

Manganese is essential to iron and steel production that accounts for 85% to 90% of the total manganese demand. Anthropogenic sources of manganese include industrial effluent, acid-mine drainage, sewage and landfill leachate and fertilizers. Manganese is one of the most abundant metals in soils and more than 25 million tonnes are mined every year. Manganese is an essential element for all species, including diatoms, molluscs and sponges, which accumulate manganese through the food chain. Fish and mammals can have up to 5 ppm and 3 ppm in their tissue respectively. Manganese is a toxic essential trace element, and thus it is not only necessary for humans to survive, but it can be toxic at high concentrations within the human body. Symptoms of manganese poisoning are hallucinations, forgetfulness and nerve damage (OMOE, 2002). The CWQG and ODWS for manganese is 0.05 mg/L.

Manganese concentrations exceeded the guideline at all sample sites within Whitfield Wetland except for the inlet of Cell B (Figure 21). Overall results for the wetland ranged from 0.039 mg/L (Cell B - inlet) to 1.070 mg/L (Cell C Inlet) with an average of 0.46 mg/L (Appendices B and C). Manganese exceedences were significantly higher within Cell C than at the other sampling locations indicating the source of manganese contamination is likely coming from the southwest area of the wetland. Possible sources of manganese contamination within Whitfield Wetland include run off from Highway 115 and the fill placement that is located on the western border of the wetland.

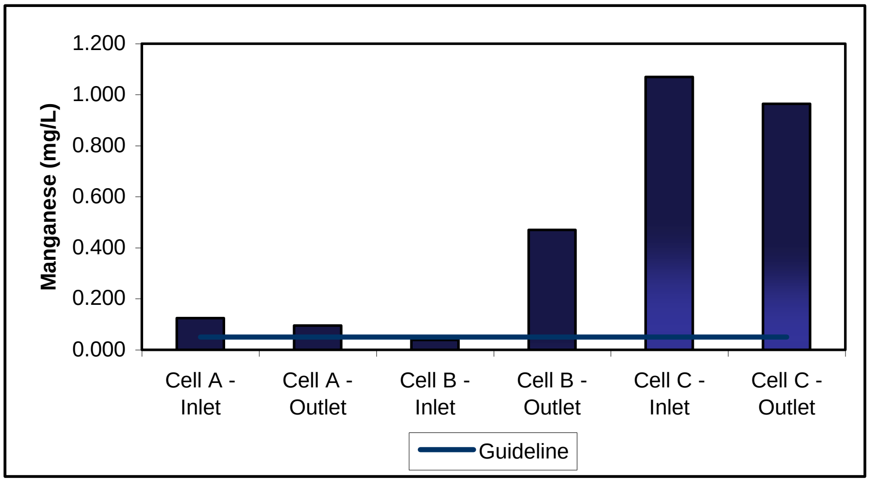


Figure 21: Manganese values for Whitfield Wetland in 2006 compared to the guideline.

3.1.2.4. Biological Parameters

Escherichia coliform (*E. Coli*), Total coliform bacteria

Many types of bacteria occur naturally in the environment and it is important to understand that only certain bacteria pose a health risk to people and livestock. Bacteria are used as indicators of water quality impairment, specifically *E. coli* that is found in the intestines of warm-blooded mammals and total coliforms that include all types of bacteria usually associated with fecal waste.

The current PWQO for bacteria levels in recreational water is 1000 total coliforms per 100 mL of water, and 100 *E. coli* per 100mL of water. Possible sources of bacteria include unrestricted livestock access to streams, milk house wastes, faulty septic systems, surface run off, sewage treatment plant discharges and waste from warm-blooded animals such as geese, pets and other wildlife.

Total coliform levels exceeded the PWQO at all sample sites within Whitfield Wetland with the exception of the outlet of Cell C (Figure 22). Overall results for the wetland ranged from 58 cfu/100mL (Cell B - outlet) to 72,000 cfu/100mL (Cell A - inlet) with an average of 7,950 cfu/100mL. Total coliform levels were consistently higher at the inlets of the wetland which indicates that the contaminant source is coming from the area of inlet and could possibly be attributed to the proximity to Highway 115 or the industrial area that is located on the northwest side of the highway. Cell A also showed significantly higher total coliform concentrations than the rest of the wetland. This may be due to the large water fowl population that predominantly resides within this open-water area of the wetland and run-off from the agricultural land that is located on the Eastern border of Cell A.

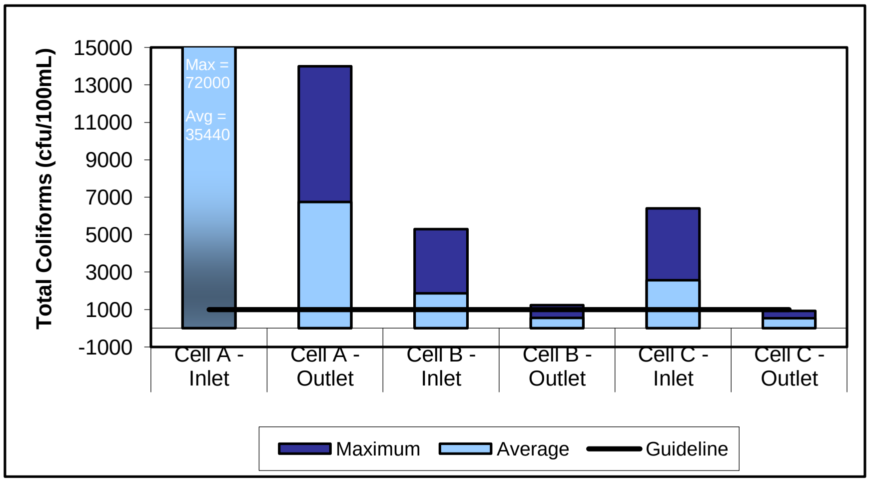


Figure 22: Maximum and average total coliform values for Whitfield Wetland in 2006 compared to the guideline.

E. coli levels exceeded the PWQO at all sample sites within Whitfield Wetland except for the outlet of Cell C (Figure 23). Overall results for the wetland ranged from 4 cfu/100mL (Cell C - outlet) to 72000 cfu/100mL (Cell A - inlet) with an average of 3983 cfu/100mL (Appendices B and C). Cell A showed significantly higher E. coli concentrations than the rest of the wetland. This could be due to the large water fowl population that predominantly resides within this open-water area of the wetland and also the agricultural land that is located on the Eastern border of Cell A.

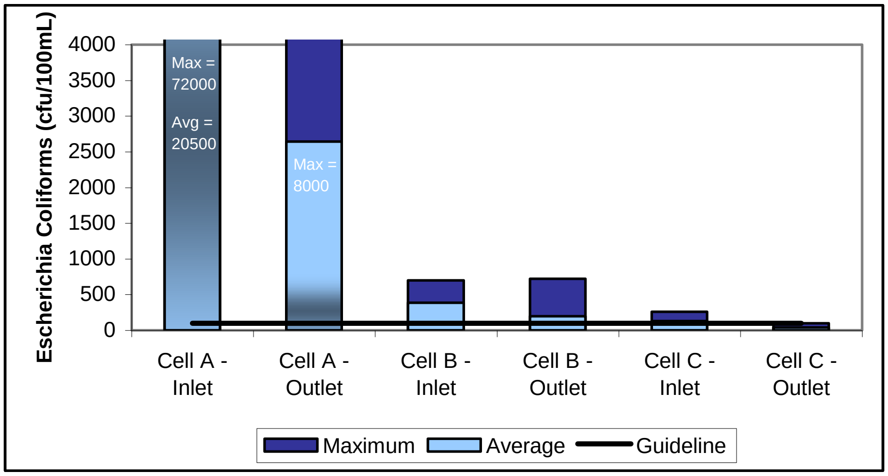


Figure 23: Maximum and average Escherichia Coliform values for Whitfield Wetland in 2006 compared to the guideline.

3.2. Benthic Macroinvertebrates

Benthic macroinvertebrates or the “bugs” that live in the bottom of watercourses are frequently used as indicators of stream health because their distribution in an aquatic system is completely dependant on environmental conditions. Benthic macroinvertebrates are present in all aquatic ecosystems and their ability to escape unfavourable conditions, such as depleted oxygen levels, is limited because they are frequently sedentary. For this reason, the presence and abundance of benthic macroinvertebrates at a point location is an excellent measure of the health of an aquatic ecosystem.

The types of benthic macroinvertebrates found in local watercourses include: insects, true water mites (*Hydrachnidia*), molluscs, worms (*Oligochaetes*), leeches (*Hirundinea*), bloodworms (*Chironomidae*), crustaceans, and others. In most bodies of freshwater, larval insects dominate the macroinvertebrate community.

Different species of benthic macroinvertebrates have different levels of tolerance to pollution, making them an excellent water quality assessment tool. For example, worms and leeches are much more tolerant of pollution than stonefly larvae. Therefore, the presence or absence, and relative abundance of benthic macroinvertebrates at a point location will reveal the quality of the water and therefore provide an excellent measure of the health of the aquatic ecosystem. Benthics are often considered to be a better representation of aquatic health than fish, primarily due to the ability of fish to quickly relocate to a more tolerable habitat. When using benthic macroinvertebrates as indicators of water quality it is important to take into account the affect habitat type has on the benthic community. Different benthic species are associated with different habitat types and thus the composition of the benthic community within a particular stream may be related more to the habitat availability than the quality of the water. Wetland habitats are generally less suitable for pollution sensitive benthic macroinvertebrate species as they do not have fast flowing water, riffles, or a rocky substrate.

3.2.1. Benthic Macroinvertebrate Methodology

Benthic macroinvertebrate samples were collected at the inlets and outlets of Cells A and B of the Whitfield Wetland in May 2006. The site was permanently covered with water, submerged and emergent vegetation was observed, and the substrate was organic detritus. Refer to Map 6 for benthic macroinvertebrate sampling locations.

Benthic Macroinvertebrate Sample Collection

Benthic macroinvertebrate sampling was carried out using the Ontario Benthos Biomonitoring Network (OBBN) traveling kick and sweep protocol designed for wetland habitats (Jones et al. 2005). Three representative wetland segments were chosen for each sampling area of Whitfield Wetland in which transects were sampled (Figure 24). The traveling kick and sweep method was applied by wading (1-person) along transects and vigorously kicking the substrate to dislodge benthos. Dislodged benthos were collected by sweeping a hand-held D-net (2nd-person) up and down and back and forth (figure 8 motion) through the water to collect the benthos (Jones et al. 2005). The D-net had a mesh size of 500 micron as per the specifications of the OBBN. Samples were collected for approximately 10 minutes per wetland segment or until it was certain that over 100 bugs were collected, and one full transect was completed. Samples were then rinsed in the net (carefully so as not to loose any benthos) and transferred to a bucket containing lake water. Large rocks and debris were removed making sure that any benthos attached to them were removed and returned to the sample bucket. Habitat information and water chemistry were also recorded on the OBBN Wetland Field Sheet for each site (Appendix E).

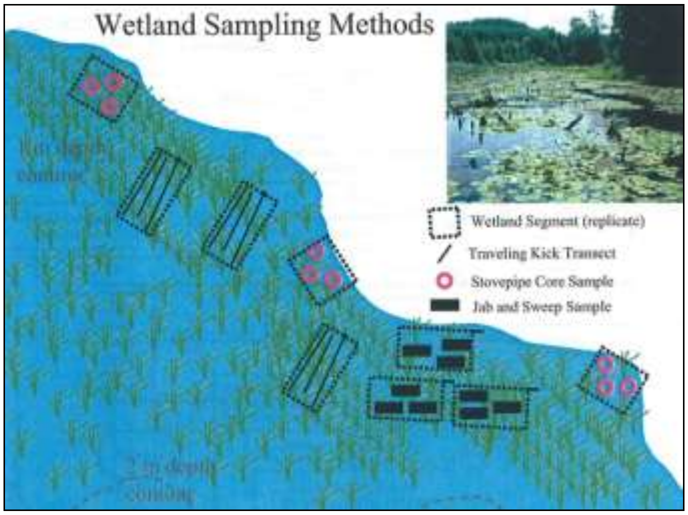


Figure 24: Illustration of benthic macroinvertebrate sampling methods for wetlands.

Identification

Samples were then brought back to the lab where they were identified with the aid of a microscope. Sub-samples of each replicate were taken using the teaspoon method. The teaspoon method involves taking a ladle of sample and identifying everything within this sub-sample and repeating this until 100 individuals were found. Every sub sample must be picked until no more individuals are present even the count has reached 100 individuals. Benthic macroinvertebrates were identified to the Coarse 27 OBBN group as specified in the OBBN protocol.

Analysis

Analysis of the benthic macroinvertebrate data was performed using the Hilsenhoff Index, Simpson’s Diversity Index, and community structure ratios.

3.2.2.The Hilsenhoff Index

The Hilsenhoff Index was used to analyze the benthic macroinvertebrate results. The Hilsenhoff Index indicates the quality of water and the likelihood of organic pollution based on the abundance and diversity of pollution tolerant and pollution sensitive species found (Table 3). The Hilsenhoff Index is calculated as follows:

$$H = \frac{\text{sum}[(Tv)(n)]}{N}$$

Where:
n =the percent of an individual species in the sample
TV = tolerance value for each species
N = the total number of individuals in the collection

Table 3: Interpretation of Hilsenhoff Index Results

Degree of Organic Pollution	Water Quality	Index
Organic Pollution Unilikely	Excellent	0.00-3.75
Possible Slight Organic Pollution	Very Good	3.76-4.25
Some Organic Pollution Probable	Good	4.26-5.00
Fairly Substantial Organic Pollution Likely	Fair	5.01-5.75
Substantial Organic Pollution Likely	Fairly Poor	5.75-6.50
Very Substantial Organic Pollution Likely	Poor	6.51-7.25
Severe Organic Pollution Likely	Very Poor	7.26-10.00

It is important to separate the influence of habitat on water quality when interpreting the results. Low gradient, soft bottom stream segments will contain higher numbers of tolerant species and their presence likely reflects the substrate as opposed to the quality of the water.

3.2.3.The Simpson’s Diversity Index

The Simpson’s Diversity Index was also used to determine the diversity of the benthic community. This index represents the probability that two individuals randomly selected from a sample will belong to different species or in this case taxonomic groups. Species diversity is correlated with species richness, and evenness, and thus as richness and evenness increase so does overall diversity.

The Simpson's Diversity Index is calculated as follows:

$$D = 1 - (\Sigma(n(n-1))/N(N-1))$$

Where:
N = the total number of organisms in the sample
n = the total number of organisms of a particular species

The results range between 0.0 –(low species diversity) and 1.0 (high species diversity). As with the Hilsenhoff index, the influence of habitat should be noted.

Community Structure

Benthic macroinvertebrate results were also analyzed by examining the composition of the community. Community composition illustrates what species dominate the community and is also an excellent way to determine changes over time within a community. Benthic species were divided into seven (7) categories, based on genus, order, or phylum. Table 4 illustrates how the benthic species were divided in order to assess community structure.

Table 4: Community Structure Classes

Class	Benthic Species
% EPT	Ephemeroptera, Plecoptera, Trichoptera
%Odonata	Anisoptera, Zygoptera
% Malacostraca	Amphipoda, Isopoda, Decapoda
% Mollusca	Gastropoda, Pelecypoda,
% Worms	Oligochaeta, Nematoda, Hirudinea
% Diptera	Chironomidae, Simuliidae, Tipulidae, Tabanidae, Culicidae, Ceratopogonidae, Other Diptera
% Other	Acarina, Hemiptera, Coleoptera, Megaloptera, Lepidoptera, Ostracoda, Hydra, Platyhelminthes

Map 6: Benthic macroinvertebrate sampling locations.

3.2.4. Benthic Macroinvertebrate Results

Benthic Macroinvertebrates in Cell A

Cell A of the Whitfield Wetland has moderate benthic diversity with an average Simpson's Diversity Index of 0.59 and an average Hilsenhoff Index of 6.51 indicating poor water quality and the presence of substantial organic pollution (Appendix D).

The benthic community composition within Cell A of the Whitfield Wetland is indicative of a significantly polluted water system. Pollution sensitive species such as Ephemeroptera, Plecoptera, and Trichoptera (EPT) make up only 15% of the entire community, while pollution tolerant species such as Malacostraca, Mollusca and Diptera accounted for 20%, 15% and 40% of the community respectively (Figure 25). Benthic macroinvertebrate results differed between the inlet and the outlet of Cell A. Chironomidae was the most dominant benthic species found at the inlet of Cell A making up on average 66.30% of the benthic community. The most dominant benthic species at the outlet of Cell A were Isopoda and Ephemeroptera making up on average 32.44% and 29.13% of the benthic community, respectively.

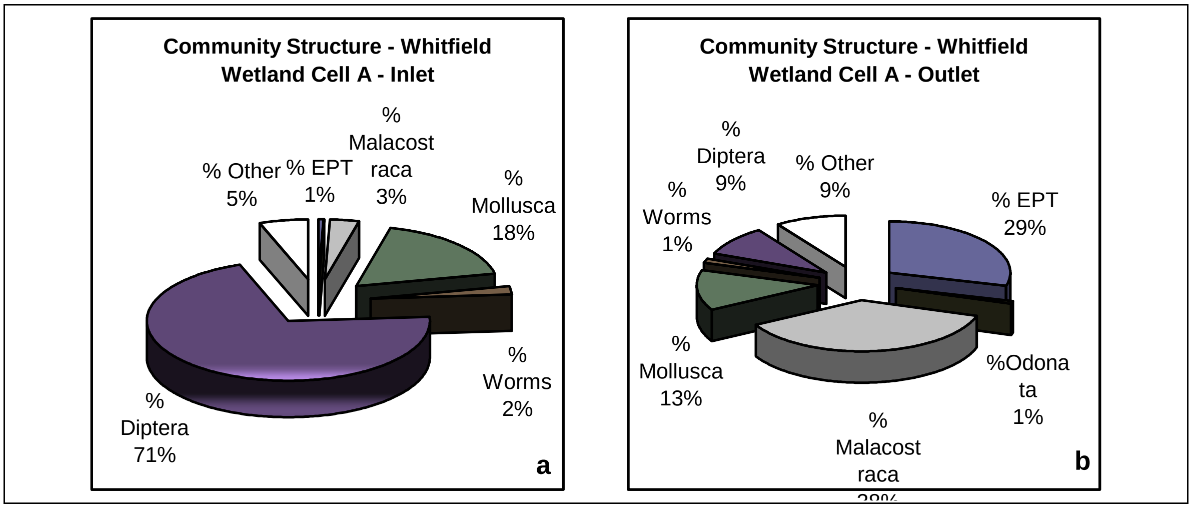


Figure 25: Benthic Macroinvertebrate community structure in Cell A inlet (a) and outlet (b).

The benthic community in Cell A is likely being impacted by both habitat availability and water quality. Habitat in Cell A can be classified as a stagnant willow/open water swamp. The substrate consists of heavy organic build up and silt. Habitat within Cell A is not suitable for pollution sensitive species such as stoneflies due to its low oxygen content, warmer temperatures, and organic substrate; instead it is preferable to more tolerant species such as midges and clams. Habitat at the outlet of Cell A is slightly more suitable for pollution sensitive species as it is a shallow, flowing stream with higher oxygen levels. Benthic species such as Ephemeroptera were more abundant at the outlet as a result of this change in habitat.

Whitfield Wetland is surrounded by a variety of land uses. The northwest border of the wetland is adjacent to Highway 115 which appears to be a major pollution source for the wetland, and the southeast border of the wetland is surrounded by agricultural land. The major inlet of the wetland flows from the north through an industrial area and under Highway 115. Water chemistry analysis revealed that pollution from these possible sources is affecting the water quality of Whitfield Wetland and thus it is likely that the composition of the benthic community is affected by both the habitat and water quality.

Benthic Macroinvertebrates in Cell B

Cell B has moderate benthic diversity with an average Simpson's Diversity Index of 0.57 and an average Hilsenhoff Index of 6.45 indicating poor water quality and the presence of substantial organic pollution (Appendix D).

The benthic community composition within Cell B of the Whitfield Wetland is indicative of a significantly polluted water system. Pollution sensitive species such as Ephemeroptera, Plecoptera, and Trichoptera (EPT) make up only 3% of the entire community, while pollution tolerant species such as Malacostraca, Mollusca, and Diptera accounted for 8%, 30%, and 43% of the community, respectively (Figure 26). Benthic macroinvertebrate results were similar for both the inlet and the outlet of Cell B. Chironomidae was the most dominant benthic species found at the inlet of Cell B making up on average 67.67% of the benthic community. The most dominant benthic species at the outlet of Cell B were Pelecypoda and Hemiptera making up on average 40.70% and 13.85% of the benthic community, respectively.

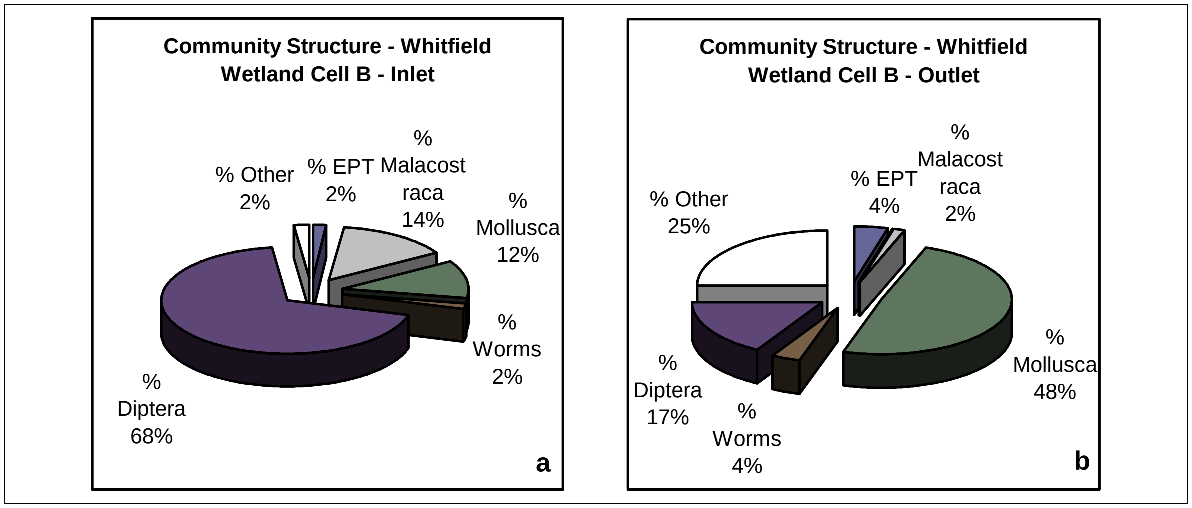


Figure 26: Benthic Macroinvertebrate community structure in Cell B inlet (a) and outlet (b).

The benthic community in Cell B is likely being impacted by both habitat availability and water quality. Habitat in Cell B can be classified as a stagnant willow/open water swamp with a stream channel at the inlet area. The substrate consists of heavy organic build up, silt and some gravel near the inlet area. Habitat within Cell B is not suitable for pollution sensitive species such as stoneflies mainly due to its minimal flow, and organic/silty substrate, instead it is preferable to more tolerant species such as midges and clams. Habitat at the inlet of Cell B is slightly more suitable for pollution sensitive species as it is a flowing stream with higher oxygen levels and cooler temperatures. However pollution sensitive benthic species were still not common in this area. The absence of pollution sensitive species at the inlet sampling site is likely the result of water quality impairment, and the predominance of sandy/silty substrate.

3.3. Water Quality Discussion

Water quality monitoring within the Whitfield Wetland revealed that this system is being significantly affected by surrounding land uses. The main water quality issues identified were sedimentation, high nutrient levels, bacterial contamination, and high levels of some metals. Analysis of the benthic macroinvertebrate community supports the results of the water chemistry analysis, as the benthic community was dominated by pollution tolerant species at all four (4) sampling sites. The benthic macroinvertebrate results also suggest that water quality is improving slightly as it passes through the wetland. For both Cells A and C, outlets had higher diversity and lower degrees of organic pollution than the inlets. This supports the evidence provided by the water chemistry data that suggests the wetland is filtering out sediment, nutrient, and metal related contaminants as the water moves from the inlets to the outlets.

Possible sources of pollution for Whitfield Wetland include Highway 115 that runs along the northwest border of the wetland. Stormwater run off from the highway is the primary source of water for the inlets of both Cells A and C of Whitfield Wetland, making this a significant contaminant source. Oil, gas, and other fluids from cars, dirt, salts and debris from the road structure and maintenance, and any garbage that is discarded along the highway corridor, can easily enter the wetland via these two inlets.

The southeast border of the wetland is adjacent to seasonally or permanently wet agricultural land that may enable the transport of contaminants into the wetland. Livestock are also present in these wet areas, a factor that may be causing the elevated levels of bacteria observed in Cell A.

The main tributary that feeds Cell B of Whitfield Wetland originates near the Harper Park compost facility. It passes through the composting facility and developed industrial area, on the north side of Highway 115 before entering the wetland. These upstream land uses may also be contributing to the impaired water quality conditions in this wetland.

Results of the water quality monitoring of Whitfield Wetland have identified several water quality issues. Further study will need to be undertaken to identify the sources of contamination and determine a strategy for remediation.

4.0 Vegetation Assessment

The vegetation communities present within a wetland are an indicator of the wetland type, permanence and overall health. The abundance and diversity of vegetation is dependant on a number of factors including soil quality, site disturbance, and adjacent land vegetation. The presence or absence of some species can be used as an indicator of soils, hydrology, wetland type and significance.

Wetland vegetation provides habitat for a variety of wildlife species, making it an important component of the wetland ecosystem. A description of each vegetation community is included in this section. As expected, the vegetation communities observed during the field visits are indicative of marsh and swamp conditions.

4.1. Methodology

The inventory of vegetation in Whitfield Wetland was completed by ORCA staff in May and June of 2006. The methodology was based on a modified version of the Ecological Land Classification System (ELC) and also included portions of the method outlined in the Handbook for Wetlands Conservation and Sustainability produced by the Izaak Walton League of America. The methodology involved establishing a baseline through the wetland and then establishing regularly spaced transects at 90 degree angles from which vegetation samples would then be taken. The abandoned railway line was used as the baseline and five transects located 300m apart were established along it. Map 8 identifies the baseline and transects locations.

The baseline and transects were established using ESRI ArcMap 9.1 and 2002 digital orthophotography of the area. Vegetation plots were established along each transect where the vegetation community appeared to change. These locations were determined using aerial photos of the area and were verified on the ground. A Garmin 12 XL Global Positioning System was used to locate the plots by walking or by canoe.

Each species within a specific distance of the central plot was recorded and the abundance estimated (A=abundant, P=present, R=rare). For trees, every species within a 9m radius circular plot was recorded. For shrubs and saplings, a 4.5m radius was used and, for herbaceous vegetation and woody vines, a 1.5m radius was used. General notes about any species observed along the transect but not encountered in the vegetation plots was recorded on a "general" transect sheet to ensure all species within the wetland were recorded.

Vegetation was identified in the field using the following field guides: Wetland Plants of Ontario, Forest Plants of Central Ontario, Trees of Ontario and Peterson's Guide to Wildflowers. Plants that could not be identified in the field were taken back to the lab in plastic Ziploc bags for identification using An Illustrated Flora of the Northern United States and Canada or Shrubs of Ontario. Any remaining unidentified plants were refrigerated in labelled Ziploc bags and brought to Michael Oldham, Botanist for the Natural Heritage Information Centre, for identification.

A record of vegetation along the baseline (abandoned railway line) was also completed as the area has an abundance of weed and/or invasive species. Sampling in this location involved walking the entire portion of the abandoned railway line within the boundaries of the property owned by the OCF and noting any species present. Data collected was compared to historic data for the entire Peterborough Airport Wetland Complex as well as documentation of vegetation species known to occur in the Whitfield Wetland area.

4.2. Ecological Land Classification (ELC)

ELC is a tool that was established to create a comprehensive and consistent approach to describing and inventorying ecosystems across the province (Lee et al, 1998). It is flexible and designed to be used at varying scales, from the Site Region (largest scale) to Vegetation Type (smallest scale).

Series scale is the lowest level that can be identified without comprehensive field visits. These are the units that are normally visible and recognizable on aerial photography (Lee et. al, 1998). For the purpose of this summary, the property was classified according to the community series level. This was completed using ESRI ArcMap 9.1, 2002 Orthophotography of the area and the Ecological Land Classification for Southern Ontario Field Guide. Vegetation inventories and the knowledge of field staff were also used when identifying polygons (areas with a similar vegetation community).

Classification of the wetland complex yielded a total of six (6) different community series levels (Map 7). These include: Thicket Swamp (SWT), Meadow Marsh (MAM), Deciduous Swamp (SWD), Mixed Shallow Aquatic (SAM), Shallow Marsh (MAS) and Coniferous Swamp (SWC). It should be noted that the Coniferous Swamp community series is not identified on Map 7 as it is not large enough to warrant its own polygon and is instead included as a part of the Deciduous Swamp. Areas of upland forest are present on the property but their ELC data was not compiled, as they are not included as part of the wetland complex. A brief description of each ELC type is included below. . For further information on the ELC please refer to the aforementioned Guide.

4.2.1. Thicket Swamp

A thicket swamp is described as a wetland with greater than 25% shrub cover. Vegetation present is dominated by continuous or patchy shrub cover with variable emergent herbaceous cover (Lee et al, 1998). In the Whitfield Wetland, these areas consist primarily of willow thickets (*Salix spp.*) with Purple Loosestrife (*Lythrum salicaria*), Water Horehound (*Lycopus americanus*), and Bulbiferous Water Hemlock

(*Cicuta bulbifera*).

4.2.2. Meadow Marsh

Meadow Marsh community types are wetland areas which have less than 25% shrub cover and are dominated by emergent herbaceous species. In the Whitfield Wetland, these areas are characterized by various Boldenrod (*Solidago sp*.), edge (*Carex sp.*) and bedstraw (*Galium sp.)* species.

4.2.3. Mixed Shallow Aquatic

A mixed shallow aquatic community is comprised of floating-leaved and submergent vegetation (greater than 25% cover each) and less than or equal to 25% emergent species. In the wetland, these areas consist of various Pondweeds (*Potamogeton sp.*), Burreeds, Duckweeds, and several other aquatic species.

4.2.4. Shallow Marsh

Shallow marsh community types contain less than or equal to 25% shrub cover and are dominated by emergent herbaceous species. In the Whitfield Wetland, these areas are dominated by Common and Narrow Leaved Cattails (*Typha sp*.) and Reed Canary Grass (*Phalaris arundinacea*).

4.2.5. Deciduous Swamp

A deciduous swamp is a wetland type containing greater than 25% tree cover. In order to be classified as a deciduous swamp, greater than 75 % of the tree species present must be deciduous. Deciduous trees include a Red/Silver Maple hybrid (*Acer saccharinum X. Acer rubrum*), White Birch (*Betula papyrifera*) and American Elm (*Ulmus americana*).

4.2.6. Coniferous Swamp

A coniferous swamp is a wetland type containing greater than 25% tree cover. In order to be classified as a coniferous swamp, greater than 75% of the tree species present must be coniferous species. The dominant coniferous species found on the Whitfield Wetland Property is White Cedar (*Thuja occidentalis*) conifers.

Map 7: Ecological Land Classification of the Whitfield Wetland.

4.3. Vegetation Inventory

After completing a vegetation inventory in the Whitfield Wetland, ORCA staff found a total of 204 species on the property, the majority of which were native wetland plants. Of these 204 species, 48 are considered to be weeds or invasive in Ontario. Most of these were found along the abandoned railway line and are likely to have been introduced by the railway and/or people traveling along the trail. Purple Loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*) are invasive, non-native species that may be a cause for concern as they were found within the wetland and are known to spread rapidly and choke out native vegetation. The purple loosestrife observed within the wetland appeared to have been eaten by leaf cutter insects, possibly aiding in its control.

Several poisonous plants were also found within the wetland, these are: Bulbiferous Water Hemlock (*Cicuta bulbifera*), Spotted Water Hemlock (*Cicuta maculata*) and Virgin's Bower (*Clematis virginiana*). Additionally, Poison Ivy (*Rhus radicans*) is abundant along the abandoned railway line. Care should be taken by anyone using and/or monitoring the area to avoid these plants.

A number of new species (not previously recorded in the Peterborough Airport Complex) were identified by field staff with the assistance of Micheal Oldham. Many of these are weed/invasive or forest species that were not wholly contained within the wetland.. The majority of the remaining new species are submerged aquatic plants, sedges, or grasses.

These include Common Bladderwort (*Utricularia vulgaris*), Northern Water Milfoil (*Myriophyllum sibiricum*), coontail (*Ceratophyllum demersum*), muskgrass (*Chara sp.*), Limestone Meadow Sedge (*Carex granularis*), Troublesome Sedge (*Carex molesta*), Woolly Sedge (*Carex pellita*), Deflexed Bottle-brush Sedge (*Carex retrorsa*), Woolly Panic Grass (*Panicum implicatum*), and Slender Wedge Grass (*Sphenopholis intermedia*).

No rare, uncommon, or species at risk were found on the property. For more information on vegetation inventory results see plant list in Appendix A.

Map 8: Vegetation transects and plot locations.

5.0 Wildlife Inventory and Habitat Assessment

Wetlands support a wide variety of wildlife species many of which are considered to be at risk or have other special management considerations. Many mammal species are valued for their hunting or trapping value in addition to their aesthetic value. Wildlife can also be indicators of habitat quality as they are sensitive to disturbance, noise, etc.

Any wildlife or evidence of wildlife observed within the wetland during monitoring (May to July 2006) was documented. Evidence included tracks, beaver dams/lodges, evidence of browsing etc. Data was compared to past observations of wildlife in the entire Peterborough Airport Wetland Complex. Any amphibian species observed and/or heard within that wetland during sampling of vegetation, water quality, benthos, etc., were documented. Reptile species observed in the wetland during site visits were also documented.

5.1. Birds

Different bird species have very different requirements for food, shelter and breeding habitat. Wetlands can be used as a breeding area for waterfowl, shorebirds, and many other types of birds as well as a staging area (an area for birds to stop and rest during migration). Some species of bird are sensitive to high noise levels and disruption by people, machinery, etc., while others are very versatile and will live in a wide variety of conditions. Species of exotic or non-native birds also exist such as the European Starling and House Sparrows. Diversity is important as the presence or absence of particular species can indicate the health of an ecosystem even if the number of birds observed is low (Firehock et al., 1998).

5.1.1. Methodology

All birds observed or heard within the wetland during monitoring (May to July 2006) were documented along with any associated breeding evidence (Appendix A). Data collected was compared to historical data for the Peterborough Airport Wetland Complex to determine if there were any changes to species composition.

Birding effort focused on the number of species and therefore, diversity of birds in the wetland rather than the population of each species itself. An effort was also made to identify the likelihood that each species was using the wetland as a breeding area.

A one-time survey of birds within the wetland was also completed on Friday, July 31, 2006. This survey was conducted from 6AM to 9AM following the standard point count methodologies as per the Ontario Breeding Bird Atlas and the Marsh Monitoring Program. The latter involves playing a tape of five elusive bird species to solicit a response. These species are the Virginia Rail, Common moorhen, Sora, Least bittern and Pied-billed-grebe. The surveys also followed standard minimum weather protocols. Stations surveyed were approximately spaced at 200m intervals along the abandoned railway line.

5.1.2. Results

A total of 48 bird species were recorded and included woodland, marsh, swamp, and field species. Wetland specific species included the Virginia Rail, Common Moorhen, Sora, Common Snipe, Belted Kingfisher (Ceryle alcyon), Willow Flycatcher (Empidonax trailii), Alder Flycatcher, Great-blue Heron (Agelaius phoeniceus), Green Heron, Swamp Sparrow (Melospiza georgiana), and several species of ducks (Wood, Mallard, Blue-winged Teal).

Of the 48 species identified, none are considered nationally, provincially, or regionally rare. Four species are known as area sensitive. These are species that require a minimum area of contiguous suitable habitat to breed. Area sensitive species found in the Whitfield Wetland include the Pileated Woodpecker (Dryocopus pileatus), Whitebreasted Nuthatch (Sitta carolinensis), Veery (Catharus fuscescens), and Ovenbird (Seirus aurocapillus).

Pileated woodpeckers have become more numerous in the City due to the large number of mature and over mature trees, and scattered woodlands. Nuthatches are also fairly common in the urban area due to mature trees and scattered stands of poplar. Veery are common in any swamp or thicket swamp and were found within the Whitfield Wetland areas. The Ovenbird was found in the adjacent woodlands where it finds interior habitat for breeding.

The wetland also acts as a staging and moulting area for waterfowl with dozens of Wood Ducks, Mallards and Teal observed. Most observed were young birds that were not yet able to fly, and adult birds in moult. Overall the wetland provides a good mix of open water, swamp, marsh, and upland forested habitat that, together, contribute to a diversity of bird species.

5.1.3. Breeding

The Whitfield Wetland is the known breeding habitat of several waterfowl species, songbirds, and other bird species. The breeding habitat within the wetland is quite diverse, providing both the grassy areas preferred by mallards and teal species, as well as the cavity trees preferred by ducks such as Wood Duck, Golden-eye, Merganser(s) and Bufflehead (OMNR, 2000).

The young of several songbird and waterfowl species were observed including young

Mallards and Red-winged Blackbirds. In the Peterborough Airport Wetland, eight (8) bird species are confirmed as breeding within the complex. Of these, five were confirmed breeders at Whitfield according to evidence codes of the Ontario Breeding Bird Atlas. This includes observing the fledged young of Red-winged Blackbirds (*Agelaius phoeniceus*), Canada Geese (*Branta canadensis*) and Mallards (*Anas platyrhynchos*). A juvenile Hairy Woodpecker (*Picoides villosus*) was also observed in the southern portion of the wetland and a Baltimore Oriole (*Icterus galbula*) was observed carrying food during the breeding season (a confirmation of breeding status).

Several other bird species have probable breeding status within the wetland including the Belted Kingfisher (*Megaceryle alcyon*), Common Moorhen (*Gallinula chloropus*), Killdeer (*Charadrius vociferous*), and Green Heron (*Butorides virescens*), all of which exhibited a territorial behaviour and/or the establishment of a permanent territory. A pair of Blue-winged Teal (*Anas discors*) was also observed on site in the breeding season (appropriate nesting habitat is present within the wetland and in the farm field next to the property). Large cavities are present in the southern portion of the wetland and may indicate nesting habitat for both Pileated Woodpeckers (*Dryocopus pileatus*) (listed by the OMNR as area sensitive) and Wood Ducks (*Aix sponsa*).

Surveys were conducted late in the breeding season, but still within the accepted window for breeding bird surveys. Due to this, several migrant species of shorebirds which breed in the Arctic were observed, including the solitary sandpiper (*Tringa solitaria*), lesser yellowlegs (*Tringa flavipes)* and least sandpiper (*Calidris minutilla*). Shorebirds migrate south beginning in early July and peak in early August. The presence of flooded fields and mud flats within the marsh and swamp communities provided ideal habitat for these species. The extent of mudflat and abundance of insect larvae are the main attractants in this wetland. While the Whitfield Wetland is not locally or regionally significant, it does provide valuable habitat for these species of migrant shorebirds.

5.1.4. Habitat

A wide variety of foraging habitat is available on the property, particularly for water birds such as mallards, blue-winged teal and the great blue heron (*Ardea herodias*). Fish species, a variety of benthic invertebrates, and aquatic and terrestrial vegetation are available on site for consumption by birds. Mallards and great blue herons have been observed foraging in the wetland on multiple visits.

Adult insects including a variety of dragonflies, moths, and butterflies were also observed throughout the property and these are likely providing food for many songbirds and other bird species.

The Peterborough Airport Wetland Complex is listed as a staging area for waterfowl.

This also appears to be true for the Whitfield Wetland as large flocks of waterfowl were observed in early spring/late fall. Migrants were also observed in late August including the Solitary Sandpiper (*Tringa solataria*), Spotted Sandpiper (*Actitis macularia*), White-rumped Sandpiper (*Calidris fuscicollis*), Least Sandpiper (*Calidris minutilla*), and Lesser Yellowlegs (*Tringa flavipes*). Redhead Ducks (*Aytha americana*) were observed in early May and a pair of Great Egrets (*Ardea alba*) were observed in the wetland in late July. The Redhead ducks and Great Egrets are both likely to be migrants through the area although Redheads are listed as an occasional breeder in the area (Bezener, 2000). Future research is necessary to determine the extent to which the Whitfield Wetlands serve as a stop-over location for shorebirds and waterfowl (may be significant wildlife habitat) (OMNR, 2000).

5.2. Mammals

Eight species of mammals were observed or evidence identified within the Whitfield Wetland by ORCA staff. These species include Beaver (Castor canadensis), Muskrat (*Ondatra zibethicus),* Racoon (*Procyon lotor),* Mink *(Mustela vison),* Striped Skunk *(Mephitis mephitis),* White-tailed Deer *(Odocoileus virginianus),* Eastern Chipmunk (*Tamias striatus),* and River Otter *(Lutra canadensis).*

Five other species of mammals including the Star-nosed Mole (*Condylura cristata)*, Porcupine (*Erethizon dorsatum*), Meadow Vole (*Microtus pennsylvanicus*), Eastern Gray Squirrel (*Sciurus carolinensis*), and Meadow Jumping Mouse *(Zapus hudsonius*) were identified in the 1995 Wetland Evaluation but were not observed by ORCA staff. Please refer to Appendix A for a complete list of species.

5.2.1. Breeding

The Whitfield Wetland provides appropriate breeding habitat for several species of mammal including minks, squirrels and chipmunks. Cavity trees present in the southern end of the property (swamp) and beside the railway line and these provide adequate nesting habitat for small rodents such as squirrels and the occasional chipmunk (*Tamias striatus*). A pair of Mink (*Mustela vison*) was also observed and may be breeding on the property as they are known to den in areas close to water and make use of old Muskrat (*Ondatra zibethicus*) or Beaver (*Castor Canadensis*) homes (Eder, 2002; OMNR, 2000).

Due to the abundance of beaver lodges and dams observed within the wetland and the fact that their preferred breeding habitat is within a wetland environment, it is likely that beaver are breeding on site. Evidence of the presence of Muskrat and River Otter was also observed. These mammals may be breeding in the wetland as it provides suitable habitat (OMNR, 2000).

5.2.2. Habitat

There is evidence that several mammal species use the Whitfield Wetland for feeding.

Tracks of White-tailed Deer (*Odocoileus virginianus*) and evidence of deer browsing was observed on many young trees during site visits. Beaver dams and muskrat houses were also observed throughout the wetland indicating that the area is being used for both food and shelter. Raccoon (*Procyon lotor*) tracks were observed in the wetland, indicating that they too may be using the area for foraging. Many of the identified species identified in the marsh include frogs, fish, eggs, and young birds, all of which are known food sources for raccoons. Striped Skunk (*Mephitis mephitis*) has also been observed within the Peterborough Airport Wetland complex and the observance of predated bees' nests suggests they may forage in this area.

Both River Otter (*Lutra canadensis*) and mink have been observed on the property and a variety of food is available for them on site including amphibians, reptiles, snakes and invertebrates. Mink are also known to prey on muskrats, as species previously noted as present on the property (Eder, 2002).

The wetland provided adequate shelter for all species listed above as breeding or foraging within the wetland. Specifically, there is evidence of the wetland being used fairly extensively by deer with tracks, runways, and obvious resting locations present throughout the area. Beaver and muskrat houses can also be viewed throughout the wetland and obviously provide a significant habitat for them. As both mink and otter inhabit old beaver lodges and muskrat homes, this also leaves adequate area for them to create their homes.

5.3. Reptiles

Reptiles form a class of vertebrates (other classes include fish, amphibians, birds and mammals) with over 6,600 species worldwide. Reptiles can be distinguished from other animals because of their scaly skin and, except for snakes, true claws. Another common characteristic that all living reptiles share are ectotherms (a trait commonly referred to as cold-blooded). This means that reptiles do not hold their body temperature constant like mammals, but their internal temperature depends upon that of the surrounding environment.

As herbivores, carnivores, and scavengers, turtles play an important role in aquatic ecosystems. Loss of wetland habitat, road mortalities, pollution, collection for the pet trade and for food, and predation threaten Ontario's turtles. Turtle populations cannot sustain this threat. Six (6) of eight (8) turtle species in Ontario are listed with the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

5.3.1. Results

Three species of reptiles were observed in the wetland during site visits conducted by ORCA staff in 2006. These species are the Common Snapping Turtle (*Chelydra serpentina*), Midland Painted Turtle (*Chrysemys picta marginata*), and Eastern Garter Snake (Thamnophis sirtalis sirtalis).

5.3.2. Breeding

Both Snapping Turtles (*Chelydra serpentine*) and Painted Turtles (*Chrysemys picta marginata*) have been observed within the Whitfield Wetland. Suitable breeding habitat was also observed for both species. Additionally, an abundance of turtle nests and hatched eggs were observed in the southwest portion of the wetland where a large volume of Fill is present. This area is a prime nesting location due to its close proximity to water and distance from the nearest roadway. It also provides a soft gravel substrate for ease of nest creation, and sufficient sunlight to enhance egg development (OMNR, 2000). Finding such an abundance of nests in one location is a rare occurrence and such a location may be significant wildlife habitat as determined by the Ontario OMNR (2000). Snapping Turtle young have been observed in the northwest portion of the wetland near the inlet of Cell B.

No evaluation of snake breeding habitat was completed, however, Garter Snakes (*Thamnophis sirtalis sirtalis*) were observed on site on multiple occasions and it is likely that breeding and rearing habitat exists on site.

5.3.3. Habitat

Reptiles observed on site are almost certainly feeding within the area as benthic invertebrates, terrestrial insects, and small fish have all been documented within the wetland and are the required food of these animals.

5.4. Amphibians

Frogs and toads spend part of their life cycle in the water and part on land so they are sensitive to changes in either habitat, with water quality being an inherent component of each. Amphibians can absorb toxic chemicals through their skin, and an entire local population can be eliminated if one breeding area is disrupted. These characteristics make them an excellent indicator of environmental quality. The marsh provides a variety of habitat including open water, temporary pools, swamp, marsh, and wooded areas. Impacts to water quality or habitat will have affects on frog populations.

5.4.1. Amphibian Monitoring Methodology

The ideal time to undertake amphibian population assessments is during the breeding season in the spring and early summer months (April to July). ORCA Staff conducted amphibian population assessments during May, June, July, and August 2006 using the

Marsh Monitoring Protocol as recommended by Bird Studies Canada. This protocol involves going to the site between dusk and midnight and listening for three (3) minutes from a specific location. To capture as many species as possible, this is undertaken a minimum of three (3) times during the breeding season, more specifically, when the temperature range is below 10 °C, between 10-20 °C, and above 20 °C.

5.4.2. Results

Five (5) species of frogs were identified; Striped Chorus Frog (*Pseudacris triserata*), Wood Frog (*Rana sylvatica*), Green Frog (*Rana clamitans*), Leopard Frog (Rana pipiens). and bullfrog (*Rana catesbiana*). All species that have been identified in the wetland are common to the area according to the Natural Heritage Information Centre of the Ontario OMNR, 2003. The Northern Spring Peeper (*Pseudacris c. crucifer*) and the Wood Frog are less tolerant of disturbance than the other species documented in the marsh, making them an important indicator. It is recommended that amphibian surveys be continued to determine if species composition has changed or if species were not heard due to the timing of the survey or weather.

The 1995 Airport Wetland Evaluation identified two other species as being present that were not heard in 2006. These species are the Gray Treefrog (*Hyla versicolor)* and the American Toad (*Bufo americanus***)**. This could be a result of different survey sites or changes in habitat and breeding times. Further monitoring is recommended to determine if these species are present in the wetland.

Northern Leopard Frog (*Rana pipiens)*

A green or brown frog with large, light-edged spots. Leopard Frogs also have prominent light-coloured dorsolateral ridges and a white belly. They can grow to over 10 cm body length but this is quite rare. Adults are usually 5-8 cm.

Green Frog (*Rana clamitans*)

The Green Frog is a large, true frog with large, distinct tympanum and prominent dorsolateral ridges. It may be green, bronze or brown, or a combination but is typically green on the upper lip. The belly is white with darker lines or spots. There may be some irregular spotting on the back. It is distinguished from other frogs in that the dorsolateral ridges run only partway down the back and do not reach the groin. The hind legs have dark bars. Males have a bright yellow throat. Maximum adult size is 10 cm.

Wood Frog (*Rana sylvatica*)

This is a moderate sized, true frog with prominent dorsolateral ridges. It may be reddish, tan or dark brown with a dark mask that ends abruptly behind the tympanum. Some individuals have a light line down the middle of the back. There is a dark blotch on the chest near each front leg. The belly is white and there may be some dark mottling. The toes are not fully webbed. Adults may reach up to 8cm.

Western/Striped Chorus Frog (*Pseudacris triserata)*

The Striped Chorus Frog is a small, smooth skinned treefrog. Colour varies from green-grey to brown. There is a dark stripe through the eye and a white stripe along the upper lip. It is distinguished from most other treefrogs by the three dark stripes down the back. In some individuals the stripes are broken. Maximum adult size about 4 cm.

Bullfrog (*Rana catesbiana)*

The Bullfrog is the largest frog found in North America. Their tadpoles also grow larger than other species. The colour varies from pale green to dark greenish/brown above and is creamy white below with variable dark mottling on the back or underside. It is distinguished by its very large tympanum that is always larger than the eye, and by the lack of dorsolateral ridges. Adult males have pale to bright yellow chins during the breeding season. Adults may reach up to 17 cm in length.

5.4.3. Breeding

Five (5) species of frog have been observed within the wetland, including Bullfrog (*Rana catesbeiana*), Green Frog (*Rana clamitans*) and Leopard Frogs (*Rana pipiens*) wood frog (Rana sylvatica) and western/striped chorus frog (pseudacris triserata). As the wetland incorporates many wetland types (i.e. swamp, marsh, open water), suitable breeding and rearing habitat is available for all of these species. Tadpoles have been observed throughout the wetland although these were not identified to specific species with the exception of the bullfrog. This is especially important as areas with large bullfrog populations may be considered significant wildlife habitat depending on the availability of similar habitat in the local area (OMNR, 2000).

Northern Leopard Frog Breeding occurs in mid-late spring in relatively permanent ponds without fish. Egg masses are attached to submerged vegetation. A female can lay up to 7000 eggs although half this number is more typical. The eggs are approximately 1.5 mm in diameter and hatch in one to three weeks depending upon the temperature. Tadpoles transform in mid to late summer.

Green Frogs begin calling in late spring to mid-summer and may breed as late as August. Three or four small clutches of eggs are draped over submerged vegetation in permanent water. Tadpoles overwinter in water before transforming the following summer. Because of the extended breeding season and long larval period, tadpoles of various sizes and newly transformed frogs can be found during most of the spring and summer.

Wood Frogs are the earliest breeders in most of their range, often beginning to call when there is still ice on the ponds in spring. The egg mass of up to 2,000 eggs is attached to submerged vegetation. Most of the egg masses in a population will be laid within a few days and clustered together so their combined dark colouration warms them and speeds hatching. The tadpoles transform after 44-85 days

Western or Striped Chorus Frogs breed very early in the spring and may begin as early as March and continue until May. They may be heard calling as a chorus during the day as well as at night. A series of small egg masses are laid and attached to vegetation. Eggs hatch within a few weeks and tadpoles finish transforming by early summer. They are usually mature in one year and rarely live beyond three.

Bullfrog breeding is later than in most other frogs and usually occurs from mid-June to late July on warm, humid or rainy nights. Egg masses may contain up to 20,000 eggs and spread out over the surface of the water when they are first laid. Tadpoles grow for up to three years before transforming into frogs.

5.4.4. Habitat

Amphibian species, including those observed in 2006 in the Whitfield Wetland have specific breeding habitat requirements. The presence of each of the afore-noted species indicates that their habitat requirements are being met in the Whitfield Wetland.

Leopard Frogs occupy a wide range of habitats from prairie to woodland to tundra. They are often found a considerable distance from open water. Green Frogs can be found at the edge of lakes, ponds, streams and ditches. They usually stay close to water but occasionally may be encountered several hundred metres away from water in forests and fields. Green Frogs are most commonly found in or near shallow, permanent water such as springs, swamps, brooks and pond and lake edges. Although found in tundra to the north and occasionally in grasslands in the west, the Wood Frog is most commonly associated with moist woodlands and vernal woodland pools. The Striped Chorus Frog's preferred habitat is forest openings around woodland ponds. They will breed in almost any fishless pond with at least 10cm of water, including roadside ditches, gravel pits, flooded fields, beaver ponds, marshes, swamps or shallow lakes. Bullfrogs require large permanent water bodies to breed but may spend part of the summer in smaller ponds. They are usually found in water along a well vegetated shoreline.

Note: A salamander monitoring program was not undertaken as part of this project but is recommended for future study as salamander species have been observed by local residents. No comprehensive evaluation of the salamander population has been undertaken but suitable breeding habitat is available on site, making it possible for a healthy population to exist within the Whitfield Wetland.

5.5. Fisheries

Several fish species were observed within the Whitfield Wetland and many young of the year fish were both observed and caught (Appendix A). Many of these were cyprinid species such as Pearl Dace (*Semotilus margarita*) and Northern Red Belly Dace (*Phoxinus eos*). Young of the year Largemouth Bass (*Micropterus salmoides*), young brown bullhead (*Ictalurus punctatus*) and Brook Sticklebacks (*Culaea inconstans)* were also observed. This indicates that Whitfield is an important spawning and/or rearing habitat for several fish species.

5.5.1. Methodology

Sampling took place at the six (6) major inlets and outlets of the wetland (Map 9). Fisheries data was collected using minnow traps placed in the water at each location over night. Traps were baited and visited the next day. Any fish caught were identified and the number of each species was recorded. Fish were then released live directly back into the wetland. Field staff used The Baitfish Primer (DFO, 2005) to aid in the identification of baitfish and the Audubon Society's Fish Guide to identify larger sport fish. Specimens that could not be identified were brought to the lab for identification by Gerry Sullivan, ORCA Fisheries Biologist, before being released live at the location they were caught. Fisheries data collection took place during June and July 2006. Any fish observed during site visits or other monitoring activities were also recorded as being present in the wetland.

Seine nets were not used to collect fisheries data due to the lack of access to open water from the edges of the wetland, and the abundance of woody debris and aquatic vegetation. To supplement the use of minnow traps, a dip-net was used to sample any cyprinids or other fish observed during vegetation monitoring.

Map 9: Minnow trap locations.

5.5.2. Results

Fisheries data collected in June 2006 indicated that eleven species of fish were present in the Whitfield Wetland. These species include Brook stickleback (*Culaea inconstans),* Finescale Dace *(Phoxinus neogaeus),* Pearl Dace *(Semotilus margarita),* Northern Redbelly Dace *(Phoxinus eos),* Longnose Dace *(Rhinichthys cataractae),* Central Mudminnow *(Umbra limi),* Creek Chub *(Semotilus atromaculatus),* Brassy Minnow *(Ictiobus cyprinellus),* Fathead Minnow *(Pimephales promelas),* Brown Bullhead *(Ictalurus punctatus), and* Largemouth Bass (Young of the year - YOY) *(Micropterus salmoides).*

Of these, two (2) are species considered to be sport fish: Brown Bullhead *(Ictalurus punctatus), and* Largemouth Bass (YOY) *(Micropterus salmoides).* The other nine species are used as baitfish. An additional species, Banded Killifish (*Fundulus diaphanous*) was observed by Trent University students completing a benthic invertebrate study in September 2006. This species is listed as uncommon but is not at risk according to both the OMNR and COSEWIC.

5.5.3. Habitat

Wetlands provide habitat for many species of fish, including cyprinids (minnow family) and larger sport fish (ie: perch and bass). They provide habitat for young fish to mature in where they can avoid larger fish and still find a diversity of invertebrate life to feed upon. Small minnows breed in wetland pools and may travel between the wetland and other water bodies providing food for larger commercial fish. Fish are also sensitive to aquatic contaminants (i.e. Chloride) and temperature changes and can therefore help to indicate the health of wetland.

Both Largemouth Bass (*Micropterus salmoides*) and Brown Bullhead (*Ictalurus punctatus*) were caught in minnow traps placed at the outlet of Cell B. This watercourse is not connected directly to the Otonabee River as the beaver dams at the wetland outlets act as a barrier to fish passage. All Largemouth Bass caught were less than three inches in length and appeared to be young-of-the-year. The brown bullhead caught was approximately four inches in length, which suggested a young-of-the-year or yearling fish. This indicates that the wetland and upstream areas are providing important habitat and feeding area for juvenile sport fish.

All fish found in the Whitfield Wetland complex are common to the area and are listed as moderately tolerant to tolerant of human disturbance and warm water temperatures (Credit Valley Conservation, 2002). Several species, such as the Fathead Minnow (*Pimephales promelas*), Brown Bullhead, and Brook Stickleback (*Culaea inconstans*) are listed as being tolerant of high temperature, high salinity levels, and pollution (Credit Valley Conservation, 2002).

It should be noted that minnow trapping did not appear to be effective for some fish species. For instance, brook stickleback were caught with a dip-net in several locations but were not observed in minnow traps. Minnow trapping also appeared to cause fatalities in central Mudminnows (*Umbra limi*). It was observed in traps only when few other fish were caught.

6.0 Conclusions

- Water quality data indicates impairment, with elevated levels of phosphorus, nutrients, salinity and sediment, particularly at the upstream end of the wetland. Some water quality improvement was observed at the downstream end of the wetland, and the wetland is still able to support diverse communities of both flora and fauna.

- The main water quality issues identified within the Whitfield Wetland appear to be sedimentation, and elevated levels of nutrients, bacteria, metals, and salinity.

- Water quality should continue to be monitored to determine if the identified impairments are a result of disturbance, or the normal range for this particular wetland as water quality was consistently poorer in Cell A than Cell C. Many of the exceedences of water quality guidelines occurred during June, and may be a result of runoff and/or precipitation.

- Water quality data suggests that the wetland is filtering out sediment, nutrients, metals and bacteria as the water moves through the wetland.

- Evidence of stressors on the system are present along the boundary of the wetland (i.e.: fill, high traffic volume), however, due to the fact that minimal human disturbance or development has occurred in the interior of the property, the vegetation communities remain intact.

- No rare plant or animal species were observed on the property however additional monitoring should be undertaken to confirm this.

- Invasive and exotic species of vegetation were observed primarily around the perimeter of the wetland, and along the abandoned railway line where the greatest disturbance has occurred.

- The property appears to be used by a wide variety of species for many different needs including for breeding, foraging, and shelter at this time.

- The abandoned railway line provides a safe and easy travel route for animals such as deer, raccoons, and skunks from the north end of the property (Highway 115 area) to the south end. Evidence of wildlife is limited on the side of the wetland closest to Highway 115, and most species appear to be using the areas adjacent to the abandoned railway line.

- The value of the property as a wildlife corridor is limited, due to the proximity of

Highway 115 on the northwest side of the Whitfield Wetland. However, the property does provide a linkage to the Airport Wetland Complex to the south and west.

- The close proximity of the wetland to a major highway and the amount of stormwater entering the wetland cause some concerns about the ability of the Whitfield Wetland to continue to provide good quality wildlife habitat. The main concerns are light and noise levels from traffic interfering with amphibian breeding, water contamination from run-off, introduction of invasive species, and the increase of vehicle/animal collisions due to the close proximity of the roadway.

- The breaches in the abandoned railway line and the beaver dams act as barriers to fish passage preventing fish from the Otonabee River from entering the Whitfield Wetland.

- This property is an appropriate location for a passive use trail, and has potential for limited development including a viewing tower, interpretive signage and boardwalk.

- The Whitfield wetland currently supports five (5) species of amphibians, two (two) species of reptiles, and a variety of birds and mammals, indicating a higher level of diversity than anticipated as the wetland is quite small, and in very close proximity to many disturbances including Highway 115.

7.0 Recommendations

7.1. Flora

7.1.1. Invasive

- Many invasive species are present along the edge of Highway 115 including Common Reed *(Phragmites)* and Purple Loosestrife *(Lythrum salicaria).* Removal, control and monitoring should be considered.

- The abandoned railway line provides habitat for a variety of invasive and weed species that could be a cause for concern if they begin to invade the wetland. Care should be taken to minimize the spread of these species and eradicate those that pose a particularly serious threat.

- Adjacent landowners should be informed and educated about the most effective methods to prevent the spread of the invasive species and appropriate methods of control or removal.

7.1.2. Vegetation Inventories

- Detailed inventories should be undertaken every five years to document the health and diversity of the wetland.
- As the water quality impairment is likely a result of adjacent land uses including agricultural activities and runoff from Highway 115, the planting of a vegetated buffer around the wetland may have a positive impact on water quality. Native species of trees and shrubs should be planted around the wetland, particularly along the west and northern boundaries which are closest to Highway 115.

7.2. Fauna

7.2.1. Bird Species

- Due to the number and variety of waterfowl species observed in the wetland, it may be beneficial to explore partnerships with other agencies such as Ducks Unlimited Canada (DU) to undertake wetland enhancement projects.
- Wood Ducks have been observed in the wetland and the installation of nesting boxes would provide additional habitat.
- The installation of a noise barrier, such as a row of conifer trees on the north side of the wetland, may benefit breeding birds by reducing disturbance from the highway.
- Continuation of bird surveys to gather additional data for species of interest in the wetland that include redhead, great egret, and least bittern. Local groups

such as the Peterborough Field Naturalists may be able to assist with this and partnerships should be investigated.
- Further monitoring programs should include migration periods to determine the importance of the wetland as a staging area as well as confirm breeding status for birds already observed.

7.2.2. Fisheries

- The wetland is currently inaccessible to fish from the Otonabee River due to barriers to fish passage which include conditions on adjacent properties and the beaver dams at the breaches in the abandoned railway line. Opportunities for restoration of connectivity for fish passage could be investigated with adjacent landowners.
- Beaver dams at outlets of the wetland do not currently allow fish passage. An engineered fish-way could be constructed to allow fish passage to the wetland that is currently blocked by the beaver dams.
- If beaver activity is causing flooding issues on adjacent lands, the possibility of installing ‘beaver bafflers’ in the beaver dams at the outlets to Cells B and C should be considered.

7.2.3. Wildlife

- Observation and documentation of wildlife species including amphibians, reptiles and mammals, should continue.
- Cover boards for salamanders and reptiles should be installed to gain an understanding of the local populations.
- Amphibian and reptile surveying should be continued annually as amphibian populations in particular can be impacted by water quality impairment. The continued collection of data would enable OCF to identify changes in the composition and abundance of amphibian populations within the Whitfield Wetland.

7.3. Water Quality

- Further investigation of the sources of contaminants entering the wetland should be undertaken through a continued, comprehensive water quality monitoring program.
- Further study and investigation of upstream sources of contaminants on the Harper Creek Tributary entering Cell B should be investigated.
- Water quality improvement projects on adjacent lands, including fencing and the

planting of vegetative buffers on the downstream channel, could be investigated in partnership with neighbouring property owners.

7.4. Public Access and Potential for Development

- The abandoned railway line on the eastern border of the property is an excellent location for a trail that would provide convenient access to the wetland and excellent opportunities for wildlife viewing.
- Crossings should be installed at the three breaches in the railway line in order to make the trail accessible by foot. Potential to make the trail barrier free (accessible to those who use wheelchairs, or other assistance could also be investigated).
- Plants such as Poison Ivy and Water Hemlock are present on the railway line, and are concentrated at the southern end. Eradication may be necessary in order for the trail to be used by the public.
- Pet access to the trail should be discouraged so that pets do not disturb breeding birds and other wildlife. Pets should be leashed and owners should be encouraged to pick up after their pets.
- The availability of parking should be investigated with the City, as current parking availability is minimal and visitors currently must park on Johnston Drive.
- As water quality does not meet recreational standards, the OCF may want to consider posting signs to inform users of the potential risks, and to discourage contact with the water.
- Bee's nests were identified in the ground on the edge of the trail, so the public should be informed about their presence and cautioned not to leave the trail.
- A viewing platform could be constructed to provide enhanced opportunities for wildlife viewing without encroachment. An excellent potential location for this would be adjacent to the open water area in Cell A.
- Trees and shrubs along the trail should be pruned annually.
- The opportunity to install a boardwalk on the raised area (looks like a former road bed) between Cells B and C should be investigated. This would provide access to the western portion of the property.

7.5. Educational Opportunities

- The variety of wildlife species present, and the existing trail on the abandoned railway line could provide excellent environmental educational opportunities for students, members of the public, youth groups etc. to learn about the importance of wetlands, local species and the activities of the OCF and ORCA.
- The installation of interpretive signage would provide an educational component

and serve to inform visitors of the many different types of ecosystems and communities found on the property.

- The abundance of both songbirds and waterfowl within the wetland make it especially attractive for birdwatchers, and enhancements could be made to provide viewing opportunities.
- A guide to the flora and fauna of the Whitfield Wetland could be produced to further educate visitors about the property.

7.6. Restoration/Stewardship Opportunities

- Adjacent landowners could be contacted to inform them of development plans and the potential for restoration work on their own properties
- Garbage in the southern portion of the property should be removed and future dumping prevented through the installation of barriers, signage, and public education.
- Establishment of a vegetative buffer zone should be established along the northwest boundary. A noise barrier and vegetation buffer could be established by planting coniferous trees and shrub to both deflect noise and encourage infiltration of runoff into the ground rather than flowing directly in to the wetland.
- The installation of nest boxes in appropriate areas of the property would also provide further educational value. As a variety of waterfowl species have been observed in the wetland, it may be beneficial to explore partnerships with other agencies such as Ducks Unlimited Canada.
- Opportunities for funding from partners should be investigated to assist with the stewardship, monitoring and educational activities identified in this report.

8.0 Future Study/Monitoring Programs

- Further investigation of the water quality of the wetland and tributaries should be undertaken through a comprehensive water quality monitoring program.

- Benthic sampling at or near all six (6) of the major inlets/outlets should be undertaken on a five year basis, especially due to the high salinity values in Cell C.

- Monitoring of vegetation communities, wildlife observed, and water quality should be completed annually.

- Bird surveys should be undertaken annually during breeding and migration.

- Observation of wildlife species including amphibians/turtles and mammals should be also recorded.

- Monitoring of invasive species should be ongoing in order to make management decisions about their eradication if necessary.

- Partnerships with other organizations should be investigated to assist in the monitoring and protection of this wetland.

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Glossary

Anthropogenic: human induced or caused.

Bankfull: the discharge which just fills the channel without overflowing onto the floodplain.

Biological Indicators: A living organism or group of organisms that represent or demonstrate a specific environmental condition (e.g. the presence/absence of certain fish species suggests specific water quality status and conditions).

Canadian Water Quality Guidelines: Guidelines for the protection of freshwater life, agricultural water uses for irrigation and livestock, drinking water supplies, recreational water quality and aesthetics, and industrial water supplies.

Channel: natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks that serve to confine water.

Channel Width: the horizontal distance along a transect line from bank to bank at the high water marks, measured at right angles to the direction of flow. Multiple channel widths are summed to represent total channel width.

Cold Water Species: Species with narrow thermal tolerance levels that are usually restricted to cold, highly oxygenated water. The temperature range for these species is from 10ºC to 18ºC.

Cold Water Stream: temperature of 5 - 18 degrees Celsius; fish species indicators include sculpins and trout, benthic indicators include stoneflies.

Community: An assemblage of interacting populations living in a particular locale.

Confluence: The location where one stream flows into another.

Contaminant: An undesirable chemical or biological substance that is not normally present in groundwater, or a naturally occurring substance present in unusually high concentrations. Common contaminants include bacteria and viruses, petroleum products, chlorinated substances, pesticides, nitrates and salt.

Cool Water Species: Cool water habitat includes waters with temperatures between 19°C and 25°C. Cool water species can tolerate these temperatures.

Cool Water Stream: temperature of 18 - 25 degrees Celsius, combinations of warm and cold water fish species and benthic indicators.

Conductivity: the conductivity test provides a measure of the electrolytic properties of water. The presence of dissolved ions (in solution) such as chlorides, sulphates and calcium, renders water conductive. Conductance, the reciprocal of resistance, is recorded in the unit mho and, in order to avoid inconvenient decimals, data is reported in micromhos per cubic centimetre. In many waters there is a direct linear relationship between dissolved solids concentration and conductivity. Conductivity serves as a control parameter and is an excellent indicator of water quality changes since it is relatively sensitive to variations in dissolved solids concentrations.

Debris: includes foreign material which does not improve the quality of the stream such as litter, as well as natural debris including stumps, logs, and detritus which can provide habitat.

Discharge: The volume of water that passes a given location within a given period of time.

Dissolved Oxygen: Dissolved oxygen in water originates directly from the atmosphere or through photosynthesis in aquatic plants. Dissolved oxygen is necessary to maintain satisfactory conditions for fish and other biological life in water. Organic wastes and some inorganic materials exert, upon decomposition, an oxygen demand which may deplete the dissolved oxygen below levels required by aquatic life.

Diversity: A numerical expression of the evenness and distribution of organisms.

E coli: *E coli* is generally found in the alimentary tract of warm-blooded animals. It is indicative of sanitary waste intrusion and/or faecal contamination from warm-blooded animals. Possible sources of contamination include unrestricted livestock access to streams, milk house wastes, faulty septic systems, surface run off and sewage treatment plant discharges.

Fill Line: a line drawn on a map and described in a written schedule which indicates the area of over which the conservation Authority has jurisdiction for the placement of fill for the purpose of the Fill, Construction and Alteration to Waterways Regulation.

Flood Plain: the area, usually low lands, adjoining a watercourse which has been or may be covered by flood water from the regulatory flood.

GIS (Geographic Information System): A map based database management system, which uses spatial reference system for analysis and mapping purposes.

Gravel: Rock particles between 4 mm and 76 mm in diameter.

Groundwater flow: The movement of water through the pore spaces of overburden material or through faults and fractures in bedrock.

Groundwater: Water occurring in the zone of saturation in an aquifer or soil.

Hardness: A measure of the concentration of divalent cations in water, (mainly calcium and magnesium).

Hydrologic cycle: The circulation of water in and on the earth and through the atmosphere through evaporation, condensation, precipitation, run off, groundwater storage and seepage, and re-evaporation into the atmosphere.

Infiltration: The flow of water from the land surface into the subsurface.

In water work: any activity that occurs within the bankfull channel.

Marsh: a type of wetland that is almost always flooded, dominated by emergent, floating and submergent vegetation such as reeds, sedges, pondweeds and water lilies.

Macroinvertebrate: organisms with no backbone that are greater than 2mm in size. Generally refers to Benthic organisms such as insects and molluscs.

Manure: The fecal and urinary matter produced by livestock and poultry.

Milligrams per litre: A unit of the concentration of a dissolved constituent in water. Equivalent to ppm at low concentrations.

Nitrate: the end product of the stabilization of organic nitrogen. Nitrate is usually found in polluted waters that have undergone some degree of eutrophication and can also occur in watercourses which intercept drainage from fertilized agricultural areas. Nitrogen in the form of nitrate is readily utilized by aquatic plants and algae. In unpolluted rivers, the nitrate concentration is generally less than 0.5 mg/L.

Non-point source contaminant: Contamination, which originates over large areas.

Ontario Drinking Water Objectives: (ODWO): A set of regulations and guidelines developed by the Ontario government to help protect drinking water sources.

Provincial Water Quality Objectives (PWQO): numerical criteria that act as chemical and physical indicators for a satisfactory level of surface water quality to protect all forms of aquatic life.

PPM (parts per million): A common basis for reporting water analysis. One ppm equals one unit of measurement per million units of the same measurement.

Rare: Species are recognized as rare by the Natural Heritage Information Centre (NHIC), which tracks the status and distribution of species and communities. A G-rank, N-rank or S-rank is assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global, national or sub-national level, respectively.

Revegetate: to cause (eroded land, for example) to bear a new cover of vegetation.

Riparian Area: the land adjacent to a watercourse that is not normally submerged, which provides an area for vegetation to grown as a buffer to the land use alongside to the stream. It acts as a transitional area between aquatic and terrestrial environments, and is directly affected is affected by that body of water.

River basin: The area drained by a river and its tributaries.

Run off: Water that reaches surface watercourses via overland flow.

Sand: Sedimentary particles ranging from 0.074 mm to 4 mm in diameter.

Silt: Sedimentary particles ranging from 0.054 mm to 0.002 mm in diameter.

Solids: total, suspended and dissolved solids are presented as separate parameters in this report. The solids analyses are gross measurements of the amounts of particulate matter and dissolved materials found in water. Solids enter the watercourse from virtually every source, the most familiar being sewage treatment plant effluents, municipal storm drainage, industrial discharges and erosion.

Subwatershed: A geographical area defining a single drainage zone within the watershed.

Surface run off: Water flowing over the land surface in streams, ponds or marshes.

Surface Water: Includes water bodies (lakes, wetlands, ponds, etc.), watercourses (rivers and streams), infiltration trenches and temporary ponds.

Swamp: wetland dominated by trees or shrubs, with periodic standing water, often with neutral or slightly acidic organic soils.

Time of Travel: The length of time it takes groundwater to travel a specified horizontal distance.

Turbidity: The amount of solid particles that are suspended in water and produce a cloudy appearance.

Warm Water Stream: a stream with a maximum temperature of 25+ degrees Celsius; characterized by an abundance of plant life; warm water fish species such as bass, and sunfish; and insects including dragonflies.

Watercourse: a channel that carries water from an area to a receiving water body. These watercourses may be either perennial or intermittent in nature. Roadside ditches that receive run off only from adjacent road and sheet flow from adjacent land are not considered to be watercourse.

Watershed: The area of land drained by a watercourse or water body.

Wetland or Wetland area: "any low lying area land which may serve a reservoir function and be, for hydrological purposes, a wetland." (L. Kamerman, Mining and Lands Commissioner, Donald Bye vs Otonabee Region Conservation Authority, November 19, 1993 - unreported) The areas may or may not be identified wetlands by the Ontario Ministry of Natural Resources (OMNR). Where a wetland is identified by the OMNR that fact will be considered in decision making.

APPENDIX A: Species Lists

Table 5: Fish species found within the Whitfield Wetland by ORCA in 2006.

Latin Name	Common Name	ORCA 2006
Culaea inconstans	Brook Stickleback	X
Ictalurus punctatus	Brown Bullhead	X
Ictiobus cyprinellus	Brassy Minnow	X
Micropterus salmoides	Largemouth Bass (YOY)	X
Phoxinus eos	Northern Redbelly Dace	X
Phoxinus neogaeus	Finescale Dace	X
Pimephales promelas	Fathead Minnow	X
Rhinichthys cataractae	Longnose Dace	X
Semotilus atromaculatus	Creek Chub	X
Semotilus margarita	Pearl Dace	X
Umbra limi	Central Mudminnow	X

Table 6: Mammal species found within the Whitfield Wetland.

Latin Name	Common Name	Airport 1995	ORCA 2006	Evidence
Castor canadensis	Beaver	X	X	dams, cut down trees, beaver obs. Cell B Inlet
Condylura cristata	Star-nosed Mole	X		
Erethizon dorsatum	Porcupine	X		
Lutra canadensis	River Otter		X	along west side of tracks, open water
Mephitis mephitis	Striped Skunk	X	X	bees nests dug up along trail, landowner comments
Microtus pennsylvanicus	Meadow Vole	X		
Mustela vison	Mink	X	X	pair observed
Odocoileus virginianus	White-tailed Deer	X	X	lay down spot, tracks, browsed twigs
Ondatra zibethicus	Muskrat	X	X	many seen and houses observed
Procyon lotor	Raccoon	X	X	tracks @ Cell C
Sciurus carolinensis	Eastern Gray Squirrel	X		
Tamias striatus	Eastern Chipmunk		X	along east side of tracks
Zapus hudsonius	Meadow Jumping Mouse	X		

Table 7: **Amphibian and Reptile species found within the Whitfield Wetland.**

Latin Name	Common Name	Airport 1995	ORCA 2006
Bufo americanus	American Toad	X	
Hyla versicolor	Gray Treefrog	X	
Pseudacris maculata	Striped Chorus Frog		X
Rana catesbeiana	Bullfrog	X	X
Rana clamitans	Green Frog	X	X
Rana pipiens	Northern Leopard Frog	X	X
Rana syvestris	Wood Frog	X	X

Table 8: **Reptile species found within the Whitfield Wetland.**

Latin Name	Common Name	Airport 1995	ORCA 2006
Chelydra serpentina	Common Snapping Turtle	X	X
Chrysemys picta marginat	Midland Painted Turtle	X	X
Thamnophis sirtalis sirtalis	Eastern Garter Snake	X	X

Table 9: **Butterflies, dragonflies, and moths found within the Whitfield Wetland.**

Type	Latin Name	Common Name	Airport 1995	ORCA 2006
Butterfly	*Ancyloxypha numitor*	Least Skipper	X	X
Butterfly	*Boloria bellona*	Meadow Fritillary	X	X
Butterfly	*Coenonympha tullia*	Inornate Ringlet	X	
Butterfly	*Colias philodice*	Common Sulphur	X	
Butterfly	*Danaus plexippus*	Monarch	X	X
Butterfly	*Limenitis archippus*	Viceroy	X	
Butterfly	*Nymphalis antiopa*	Mourning Cloak	X	
Butterfly	*Phyciodes selenis*	Northern Pearl Crescent	X	
Butterfly	*Pieris rapae*	Cabbage White	X	X
Butterfly	*Satyrodes eurydice*	Eyed Brown	X	
Damselfly	*Xanthagrion erythroneuru*	Blue Damselfly		X
Moth	*Alypia octomaculata*	Eight Spotted Forester		X

Table 10: **Bird species found within the Whitfield Wetland.**

Latin Name	Common Name	Airport 1986 Breeding Status	Additions from Whitfield Report	2006 ORCA Observations
Accipiter striatus	Sharp-shinned Hawk	poss		
Actitis macularia	Spotted Sandpiper	prob		X
Agelaius phoeniceus	Red-winged Blackbird	prob		X
Aix sponsa	Wood Duck	conf		X
Anas discors	Blue-winged Teal			X
Anas platyrhynchos	Mallard	conf		X
Anas rubripes	Black Duck			X
Ardea alba	Great Egret			X
Ardea herodias	Great Blue Heron	obs		X
Aytha americana	Redhead			X
Bombycilla cedrorum	Cedar Waxwing	poss		
Branta canadensis	Canada Goose	conf		X
Buteo jamaicensis	Red-tailed Hawk	prob		X
Buteo platypterus	Broad-winged Hawk	conf		
Butorides virescens	Green Heron			X
Calidris fuscicollis	White-rumped Sandpiper			X
Cardinalis cardinalis	Northern Cardinal	poss		
Carduelis tristis	American Goldfinch	poss		X
Cathartes aura	Turkey Vulture			X
Catharus fuscescens	Veery	prob		
Certhia americana	Brown Creeper	poss		
Charadrius vociferous	Killdeer	prob (edge)		X
Circus cyaneus	Norther Harrier	conf		
Coccyzus erythropthalmus	Black-billed Cuckoo	poss		
Colaptes auratus	Northern Flicker	obs		
Columba livia	Rock Dove	obs		
Contopus virens	Eastern Wood-Pewee	obs		
Corvus brachyrhyncos	American Crow	poss		X
Cyanocitta cristata	Blue Jay	poss		X
Dendroica magnolia	Magnolia Warbler	poss		
Dendroica pensylvanica	Chestnut Sided Warbler	poss		
Dendroica petechia	Yellow Warbler	prob		X
Dolichonyx oryzivorus	Bobolink	poss		
Dryocopus pileatus	Pileated Woodpecker	obs		
Dumetella carolinensis	Gray Catbird	prob		
Empidonax alnorum	Alder Flycatcher	prob		X
Empidonax traillii	Willow Flycatcher	prob		
Empidonex minimus	Least Flycatcher	poss		
Gallinago delicata	Common Snipe	poss		
Gallinula chloropus	Common Moorhen		X	X
Geothlypis trichas	Common Yellowthroat	prob		X

Latin Name	Common Name	Airport 1986 Breeding Status	Additions from Whitfield Report	2006 ORCA Observations
Hirundo rustica	Barn Swallow	poss		X
Hylocichla mustelina	Wood Thrush	poss		
Icterus galbula	Northern/Baltimore Oriole	poss		X
Ixobrychus exilis	Least Bittern		X	
Larus delawarensis	Ring-billed Gull	obs		X
Megaceryle alcyon	Belted Kingfisher	prob		X
Melospiza georgiana	Swamp Sparrow	prob		X
Melospiza melodia	Song Sparrow	prob		
Mniotilta varia	Black-and-White Warbler	poss		
Molothrus ater	Brown-headed Cowbird	prob		X
Mycoplasma gallisepticum	House Finch	poss		
Myiarchus crinitus	Great Crested Flycatcher	poss		
Pandion haliaetus	Osprey	obs		
Parus atricapillus	Black-capped Chickadee	prob		X
Passer domesticus	House Sparrow	obs		
Passerculus sandwichensis	Savannah Sparrow	poss (edge)		X
Pheucticus ludovicianus	Rose-breasted Grosbeak	poss		
Picoides pubescens	Downy Woodpecker	obs		
Picoides villosus	Hairy Woodpecker	obs		X
Porzana carolina	Sora	poss		X
Quiscalus quiscala	Common Grackle	prob		X
Rallus limicola	Virginia Rail	poss		X
Scolopax minor	American Woodcock	poss		
Seiurus aurocapillus	Ovenbird	poss		
Seiurus noveboracensis	Northern Waterthrush	poss		
Setophaga ruticilla	American Redstart	poss		
Sitta canadensis	Red-breasted Nuthatch	poss		
Sphyrapicus varius	Yellow-bellied Sapsucker	obs		
Spizella passerina	Chipping Sparrow	poss (edge)		
Sturnella magna	Eastern Meadowlark	poss (edge)		
Sturnus vulgaris	European Starling	poss		X
Tachycineta bicolor	Tree Swallow	conf		X
Tringa solataria	Solitary Sandpiper			X
Troglodytes aedon	House Wren	poss		
Turdus migratorius	American Robin	conf		X
Tyrannus tyrannus	Eastern Kingbird	poss		
Vermivora ruficapilla	Nashville Warbler	poss		
Vireo gilvus	Warbling Vireo	prob		
Vireo olivaceus	Red-eyed Vireo	poss		
Wilsonia canadensis	Canada Warbler	prob		X
Zenaida macroura	Mourning Dove	conf		X
Zonotrichia albicollis	White-throated Sparrow	prob		

Table 11: Vegetation species found within the Whitfield Wetland.

Latin Name	Common Name	Airport 1995	Whitfield 1995	ORCA 2006
Abies balsamea (L.) Mill	Balsam Fir	1		
Acer negundo L.	Manitoba Maple			1
Acer rubrum L.	Red Maple	1		
Acer saccharinum L.	Silver Maple	1		
Acer saccharinum 1. Acer rubrum	Red/Silver Hybrid		1	1
Achillea millefolium	Common Yarrow	1		1
Actea rubra	Red Baneberry			1
Alisma plantago-aquatica L.	Water Plantain	1		1
Alnus incana (L.) Moench	Speckled Alder	1	1	1
Amphicarpaea bracteata (L.) Fern.	Hog Peanut	1		
Anemone canadensis	Canada Anemone			1
Anemone quinquefolia	Wood Anemone			1
Apocynum cannabinum	Indian Hemp			1
Apocynum androsaemifolium	Spreading Dogbane			1
Aralia nudicaulis L.	Wild Sarparilla	1		1
Arisaema triphyllum (L.) Schott	Jack in the Pulpit	1		
Artemisia biennis Willd.	Biennial Wormwood			1
Asclepias syriaca	Common Milkweed			1
Asclepias incarnata L.	Swamp Milkweed	1		1
Asparagus officinalis	Wild Asparagus			1
Aster lateriflorus L.	Calico Aster	1		
Aster novae-angliae	New England Aster	1		
Aster puniceus	Purple Stemmed Aster			1
Aster sagittifolius	Lance leaved Aster			1
Aster spp.	Aster spp.			1
Astragalus canadensis L.	Canadian Milk Vetch	1		
Betula alleghaniensis	Yellow Birch	1		
Betula papyrifera Marsh.	Paper Birch	1		1
Bidens cernua L.	Nodding Beggarticks	1	1	
Bidens frondosa L.	Devil's Beggarticks	1		
Boehmeria cylindrica (L.) Sw.	False Nettle	X		
Bromus ciliatus	Fringed Brome			X
Bromus inermis Leyss.	Smooth Brome			X
Calamagrostis canadensis (Mich1.) Beauv.	Canada Blue-joint	X		X
Caltha palustris L.	Marsh Marigold	X		X
Carex annectens(E. Bickn)	Sedge	X		
Carex arctata Boott	Compressed Sedge	X		
Carex aurea Nutt.	Golden Sedge	X		
Carex Bebbii	Bebbs Sedge	X		X
Carex crinita	Fringed Sedge	X		X

Latin Name	Common Name	Airport 1995	Whitfield 1995	ORCA 2006
Carex diandra Schrank	Two stammened Sedge	X		
Carex flava L.	Yellow Sedge	X		
Carex gracillima Schw.	Filiform Sedge	X		X
Carex granularis	Limestone Meadow Sedge			X
Carex hysterina Muhl	Porcupine Sedge	X	X	X
Carex interior Bailey	Inland Sedge	X		
Carex intumescens Rudge	Bladder Sedge	X		X
Carex lasiocarpa Ehrh.	Wooly Sedge	X		
Carex lurida	Sallow Sedge			X
Carex lupulina Muhl.	Hop Sedge	X		X
Carex molesta	Troublesome Sedge			X
Carex olligosperma	Few Seeded Sedge			X
Carex pellita	Woolly Sedge			X
Carex projecta Mack.	Cyperus Like Sedge	X		X
Carex pseudo-cyperus	Spreading Sedge	X		
Carex retrorsa	Deflexed Bottle-brush Sedge		X	X
Carex scoparia Schk	Broom Sedge	X		
Carex stipata Muhl. E1 Willd.	Awl-Fruited Sedge	X	X	X
Carex stricta Lam.	Stiff Sedge	X		
Carex tuckermanii Boott	Tuckerman's Sedge	X		X
Carex utriculata Boott	Beaked Sedge	X		X
Carex vesicara L.	Sedge	X		
Carex vulpinoidea Mich1.	Fox Tail Sedge	X		
Carpinus caroliniana Walt.	Blue Beech	X		
Cephalanthus occidentalis L.	Buttonbush	X		X
Ceratophyllum demersum	Coontail			X
Chara spp.	Muskgrass		X	X
Chrysanthemun leucanthemum	Ox-eye Daisy			X
Cicuta bulbifera	Bulbiferous Water Hemlock	X		X
Cicuta maculata	Spotted Water Hemlock			X
Circaea alpina L.	Small Enchanter's Nightshade	X		
Cirsium arvense L.	Canada Thistle			X
Cirsium muticum	Swamp Thistle			X
Clematis virginiana L.	Virgin's Bower	X		X
Cornus alternifolia L.	Alternate Leaved Dogwood	X		X
Cornus racearosa	Bunchberry	X		
Cornus rugosa	Grey Dogwood	X		X
Cornus stolonifera Mich1.	Round Leaved Dogwood	X	X	X
Corus canadensis L.	Red Osier Dogwood	X		X
Cypridedium calceolus L.	Yellow Lady's Slipper	X		
Cypridedium reginae Walt.	Showy Lady's Slipper	X		
Cystoperis bulbifera (L.) Bernhardi	Bulbet Fern	X		
Daucus carota	Queen Anne's Lace			X

Latin Name	Common Name	Airport 1995	Whitfield 1995	ORCA 2006
Desmidium canadense L. DC	Showy Tick Trefoil	X		X
Dryopteris carthusiana	Spinulose Wood Fern			X
Echinocystis lobata (Mich1.) T&B	Wild Cucumber	X		
Echium vulgare	Blueweed			X
Erigeron philadelphicus	Common Fleabane			X
Erigeron speciosus	Daisy Fleabane			X
Eleocharis acicularis (L.) R..& S.	Needle Spike-rush	X		
Eleocharis intermedia (Muhl.) Scult.	Intermediate Spike-rush	X		
Eleocharis obtusa (Willd.) Schult	Spike-rush	X		
Eleocharis palustris (L.) R. & S.	Marsh Spike-rush	X	X	
Eleocharis tenuis (Willd.) Schult.	Elliptic Spike-rush	X		
Elodea canadensis	Canada Waterweed			X
Epipactus helleborine (L.) Crantz	Helleborine	X		
Equisetum arvense	Field Horsetail	X		X
Equisetum fluviatile	Water Horseail	X		
Equisetum spp. - horsetail	Horsetail			X
Equisetum hymale L	Common Scouring Rush	X		
Equisetum palustre	Marsh Horsetail			X
Equisetum pratense	Meadow Horsetail			X
Equisetum scirpoides Mich.	Dwarf Scouring Rush	X		X
Equisetum varigatum	Varigated Scouring Rush		X	
Erysimum cheiranthoides L.	Wormseed Mustard			X
Eupatorium maculatum L.	Spotted Joe-Pye Weed	X	X	X
Eupatorium perfoliatum L.	Boneset	X		
Eupatorium rugosum Houtt.	White Snakeroot	X		
Euphorbia cyparissias L.	Cypress Spurge			X
Fragaria virginiana	Wild Strawberries	X		X
Fra1inus americana	White Ash			X
Fra1inus nigra Marsh.	Black Ash	X	X	X
Fra1inus pennsylvannica Marsh.	Red Ash	X	X	X
Galium palustre L.	Marsh Bedstraw	X		X
Galium trifidium L.	Small Bedstraw	X		X
Geum aleppicum Jacq.	Yellow Avens	X		X
Glechoma dederaceae L.	Ground Ivy	X		
Glyceria canadensis (Mich1) Trin	Canada Manna Grass	X		X
Glyceria grandis S. Wats.	Tall Manna Grass	X		X
Glyceria striata(Lam.) A. Hitchc.	Fowl Manna Grass	X		
Hieracium aurantiacum L	Orange Hawkweed			X
Hieracium caespitosum	Yellow Hawkweed			X
Hydrocotyle americana L.	Marsh Pennywort	X		
Hypericum perforatum	Common St. John's Wort			X
Impatiens capensis Merb.	Spotted Touch-me-not (Jewelweed)	X		X
Iris versicolor	Northern Blueflag	X		X
Juncus nodosus L.	Rush	X		

Latin Name	Common Name	Airport 1995	Whitfield 1995	ORCA 2006
Juncus articulatus	Rush	X		
Juncus dudleyi Wieg.	Dudley's Rush	X		X
Juncus effusus L.	Knotted Rush	X		
Laportea canadensis (L.) Wedd.	Wood Nettle	X		
Lari1 laricina (Durai) K. Koch	Tamarack	X		X
Leersia oryzoides	Rice Cut Grass	X		X
Lemna minor	Common Duckweed	X	X	X
Lemna trisulca	Star Duckweed	X		X
Linaria vulgaris L.	Yellow Toadflax			X
Liparis loeselii(L.) Rich.	Loesel's Twayblade	X		
Lobelia inflata L.	Indian Tobacco	X		
Lobelia kalmii L.	Kalm's Lobelia	X		
Lobelia spicata Lam.	Pale Spike Lobelia	X		X
Lonicera canadensis	Fly Honeysuckle			X
Lonicera hirsuta	Hairy Honeysuckle			X
Lonicera oblongifolia	Swamp Fly Honeysuckle			X
Lotus conriculatus	Bird's Foot Trefoil			X
Lycopodium digitatum	Southern Ground Cedar			X
Lycopodium spp. (lucidulum?)	Clubmoss (shining?)			X
Lycopus americanus Muhl.	American Water-horehound	X	X	X
Lycopus uniflorus Mich1.	Northern Bugleweed	X		X
Lysimachia ciliata L.	Fringed Loosestrife	X		
Lysimachia terrestris L.	Swamp Candles	X		
Lysimachia spp.	Lysimachia Species			X
Lythrum salicaria L.	Purple Loosestrife	X	X	X
Maianthemum canadense Desf.	Wild Lily of the Valley/Canada Mayflo	X		X
Mattucia struthiopeteris (L.) todero	Ostrich Fern	X		X
Medicago lupulina	Black Meddick			X
Megalondonta beckii	Water Marigold			X
Melilotus officinalis	White Sweet Clover			X
Memispermum canadense L.	Moonseed Vine	X		
Mentha arvensis L.	Wild Mint	X		X
Myriophyllum sibiricum	Northern Watermilfoil			X
Mirabilis nyctaginea	Wild Four O'Clock			X
Mitella diphylla L.	Bishop's Cap	X		
Mitella nuda L.	Maked Mitrewort	X		
Myrica gale L.	Sweet Gale			X
Nuphar variegatum	Yellow Pond Lily			X
Onoclea sensibillis L.	Sensitive Fern	X		X
Osmunda regalis L.	Royal Fern	X		
Panicum implicatum	Woolly Panic Grass			X
Parthenocissus inserta	Virginia Creeper	X		X
Petasites palmatus	Sweet Coltsfoot			X
Penstemon digitalis	Foxglove Beardtongue			X

Latin Name	Common Name	Airport 1995	Whitfield 1995	ORCA 2006
Phleum pratense	Timothy			X
Phalaris arundinacea	Reed Canary Grass	X	X	X
Phragmites australis Cav.	Common Reed			X
Picea glauca (Moench) Voss	White Spruce	X		X
Pilea pumila (L.) Gray	Clearweed	X		
Plantago major	Common Plantain			X
Poa annua	Annual Bluegrass			X
Poa compressa	Canada Bluegrass			X
Poa palustris	Fowl Meadow Grass	X		X
Polygonum amphibium L.	Water Smartweed	X		X
Polygonum hydropiperoides Mich1.	False Water Pepper	X		
Polygonum pensylanicum L.	Pennsylvania Knotweed	X		X
Polygonum persicaria	Lady's Thumb			X
Populus alba	White Poplar			X
Populus balsamifera L.	Balsam Poplar	X	X	X
Populus tremuloides Mich1.	Trembling Aspen	X		X
Potamogeton epihydrus Raf.	Emersed Pondweed	X		
Potamogeton folisus Raf.	Leafy Pondweed	X		
Potamogeton gramineus L.	Grass-leafed Pondweed	X		
Potamogeton Natans	Floating Leaved Pondweed	X		
Potamogeton pectinatus	Sago Pondweed	X		X
Potamogeton pusillus	Slender Pondweed			X
Potentilla norvegica	Rough Cinquefoil			X
Potentilla simplex	Common Cinquefoil			X
Proserpinaca palustris L. var. crebra Fern. & Griscom	Mermaid Weed	X	X	
Prunella vulgaris L.	Selfheal (heal-all)	X		X
Prunella vulgars ssp. Lanceolata	Heal-All			X
Prunus virginia	Chokecherry			X
Pyrola asarifolia Mich1.	Pink Pyrola	X		
Pyrola elliptica	Shinleaf			X
Pteridium aquilinum	Bracken Fern			X
Quercus macrocarpa Mich1.	Bur Oak	X		X
Ranunculus abortivus	Kidney leaved Buttercup/Crowsfoot			X
Ranunculus acris	Common Buttercup			X
Ranunculus hispidus Mich1.	Swamp Buttercup	X		
Rhamnus arnifolia L. Her.	Alder Leaved Buckthorn	X		
Rhamnus cathartica	Common Buckthorn	X		X
Rhamnus frangula L.	Glossy Buckthorn	X		X
Rhus tyhina	Staghorn Sumac			X
Rhus radicans	Poison Ivy	X		X
Rhynchospora spp.	Beakrush spp.			X
Ribes americanum Mill.	Wild Black Currant	X		X

Latin Name	Common Name	Airport 1995	Whitfield 1995	ORCA 2006
Rubus ideus	Wild Red Raspberry			X
Ribes cynosbati L.	Prickly Gooseberry	X		X
Robinia pseudoacacia	Black Locust			X
Rorippa palustris (L.) Besser	Marsh Yellow Cress	X		X
Rosa blanda	Smooth Wild Rose			X
Rubus odoratus	Flowering Raspberry			X
Rubus purbescens Raf.	Dwarf Raspberry	X		X
Rudbeckia hirta	Black Eyed Susan			X
Rumex verticillatus L.	Water Dock	X		
Sagittaria cuneata	Floating-leaved Arrowhead			X
Sagittaria latifolia Willd.	Broad-leaved Arrowhead	X		X
Sagittaria rigida	Stiff Arrowhead			X
Salix bebbiana sarg	Bebb's Willow	X		X
Salix discolor Muhl.	Pussy Willow	X	X	X
Salix eriocephala	Heartleaf Willow	X		X
Salix fragilis L.	Crack Willow	X	X	X
Salix humilis	Upland Willow			X
Salix lucida Muhl.	Shining Willow	X		X
Salix petiolaris	Slender Willow	X	X	X
Salix purpurea	Basket Willow	X		
Sambucus canadensis L.	Common Elder	X		
Sambucus racemnosa L. ssp pubens L.	Red-berried Elder	X		
Scirpus acutus Muhl.	Great Bulrush	X		
Scirpus atrovirens Willd.	Black Bulrush	X		
Scripus cespitosum	Tufted Clubrush			X
Scirpus cyperinus	Wool Grass	X		X
Scirpus validus	Soft Stem Bulrush	X		X
Scutellaria lateriflora	Mad Dog Skullcap	X		X
Setaria viridis	Green Foxtail			X
Silene cucubalus	Bladder Campion			X
Silene latifolia	Evening Lychnis			X
Sisyrinchium montanum	Common Blue-eyed Grass			X
Sium suave Walt.	Water Parsnip	X	X	X
Smilacina racemosa	False Solomon's Seal			X
Smilax hispida Muhl.	Prickly Greenbriar	X		
Solanum dulcamara L.	Bittersweet Night Shade	X		X
Solidago canadensis L.	Canada Goldenrod	X		X
Solidago giantea	Late Goldenrod			X
Solidago rugosa	Rough Stemmed Goldenrod			X
Solidago spp.	Goldenrod Species			X
Sphenopholis intermedia	Slender Wedge Grass			X
Stellaria longipes	Long-stalked Stitchwort			X

Latin Name	Common Name	Airport 1995	Whitfield 1995	ORCA 2006
Sparganium eurycarpum Engelm.	Giant Bur-reed	X		
Spiraea alba DuRoi	Narrow Leaved Meadowsweet	X		
Spirodela polyrhiza	Greater Duckweed			X
Tara1acum officinale	Common Dandelion			X
Thalictrum polygamum	Tall Meadow Rue			X
Thelypteris palustris (Salisb.) Schott	Marsh Fern	X	X	X
Thuja occidentalis	Eastern White Cedar	X	X	X
Tilia americana	Basswood	X		X
Tragopogon dubius	Yellow Goat's beard			X
Trifolia pratense	Red Clover			X
Trifolium repens	White Clover			X
Typha angustifolia	Narrow Leaved Cattail	X	X	X
Typha latifolia	Common Cattail	X	X	X
Ulmus americana	American Elm	X	X	X
Ulmus rubra Muhl.	Red Elm	X		
Urticularia vulgaris L.	Common Bladderwort	X		X
Valisneria americana	Tape Grass			X
Verbascum thapsus L.	Common Mullein			X
Verbena hastata L.	Blue Vervain	X		X
Veronica anagallis-aquatica.	Water Speedwell			X
Veronica scutellata L.	Marsh Speedwell	X		
Viburnum acerifolium	Maple Leaved Viburnum			X
Viburnum lentago L.	Nannyberry	X		
Viburnum opulus var. americanum	Highbush Cranberry			X
Vicia cracca	Cow Vetch	X		X
Viola canadensis	Canada Violet			X
Vinceto1icum nigrum	Dog Strangling Vine			X
Vitis riparia	Riverbank Grape	X		X
Wolffia borealis (Engelm.) Landolt	Water-meal	X		
Wolffia columbiana Karst.	Water-meal	X		

APPENDIX B: Raw Water Quality Data

Table 12: Raw Water Quality Data Cell A inlet to Whitfield Wetland.

Parameter	Objectives	Date				Average	Maximum	Minimum
		26-Jun-06	26-Jul-06	########	25-Sep-06			
Temperature (deg C)		28.2	23.99	21.3	13.92	21.85	28.2	13.92
pH	6.5-8.5	7.97	7.76	7.97	7.96	7.915	7.97	7.76
Dissolved Oxygen (mg/L)	5.5	0.44	6.42	0.2	6.4	3.37	6.42	0.2
Total Dissolved Solids (mg/L)	<300	776	817	586	470	662	817	470
Conductivity (uS/cm^2)	<400	1195	1263	902	723	1021	1263	723
Salinity (%)	0.40	0.59	0.63	0.44	0.36	0.51	0.63	0.36
BOD (mg/L)	3	8	9	63	3	21	63	3
Total Suspended Solids (mg/L)	5	18	22	160	13	53	160	13
Sodium (mg/L)	<200	154	113	104	98.8	117	154	98.8
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Nitrate (mg/L)	10	0.11	0.31	0.05	0.1	0.143	0.31	0.05
Total Phosphorus (mg/L)	0.03	0.3	0.15	1.21	0.09	0.438	1.21	0.09
Chlorides (mg/L)	250	290	180	160	130	190	290	130
Total coliform (CFU/100mL)	1000	1160	63000	72000	5600	35440	72000	1160
E coli (CFU/100mL)	100	1100	8500	72000	400	20500	72000	400
Hardness (mg/L CaCO3)	80-100	---	---	231	---	---	---	---
Silver (mg/L)	0.0001	---	---	0.00003	---	---	---	---
Aluminum (mg/L)	0.075	---	---	0.136	---	---	---	---
Arsenic (mg/L)	0.005	---	---	0.00021	---	---	---	---
Barium (mg/L)	1	---	---	0.164	---	---	---	---
Beryllium (mg/L)	1.1	---	---	0.00004	---	---	---	---
Boron (mg/L)	0.2	---	---	0.054	---	---	---	---
Bismuth (mg/L)		---	---	0.00002	---	---	---	---
Calcium (mg/L)		---	---	75.8	---	---	---	---
Cadmium (mg/L)	0.0002	---	---	0.00007	---	---	---	---
Cobalt (mg/L)	0.0009	---	---	0.000309	---	---	---	---
Chromium (mg/L)	0.0001	---	---	0.0014	---	---	---	---
Copper (mg/L)	0.005	---	---	0.003	---	---	---	---
Iron (mg/L)	0.3	---	---	2.32	---	---	---	---
Potassium (mg/L)		---	---	6.76	---	---	---	---
Lithium (mg/L)		---	---	0.002	---	---	---	---
Magnesium (mg/L)		---	---	10.1	---	---	---	---
Manganese (mg/L)	0.05	---	---	0.124	---	---	---	---
Molybdenum (mg/L)	0.04	---	---	0.00173	---	---	---	---
Nickel (mg/L)	0.025	---	---	0.001	---	---	---	---
Lead (mg/L)	0.025	---	---	0.0013	---	---	---	---
Antimony (mg/L)	0.02	---	---	0.0007	---	---	---	---
Selenium (mg/L)	0.1	---	---	0.003	---	---	---	---
Silica (mg/L)		---	---	9.06	---	---	---	---
Tin (mg/L)		---	---	0.0004	---	---	---	---
Strontium (mg/L)		---	---	0.222	---	---	---	---
Titanium (mg/L)		---	---	0.0057	---	---	---	---
Thallium (mg/L)	0.0003	---	---	0.0001	---	---	---	---
Uranium (mg/L)	0.005	---	---	0.00455	---	---	---	---
Vanadium (mg/L)	0.006	---	---	0.00359	---	---	---	---
Zinc (mg/L)	0.02	---	---	0.0079	---	---	---	---

Table 13: Raw Water Quality Data Cell A Outlet from Whitfield Wetland.

Parameter	Objectives	Date Sampled				Average	Maximum	Minimum
		26-Jun-06	26-Jul-06	########	25-Sep-06			
Temperature (deg C)		28.36	28.48	18.4	14.93	22.54	28.48	14.93
pH	6.5-8.5	7.54	8	8.26	8.35	8.04	8.35	7.54
Dissolved Oxygen (mg/L)	5.5	7.01	7.89	7.2	6.73	7	7.89	6.73
Total Dissolved Solids (mg/L)	<300	400	358	314	424	374	424	314
Conductivity (uS/cm^2)	<400	614	551	483	652	575	652	483
Salinity (%)	0.40	0.4	0.26	0.23	0.32	0	0.40	0.23
BOD (mg/L)	3	3	3	4	2	3	4.00	2.00
Total Suspended Solids (mg/L)	5	12	4	8	4	7	12.00	4.00
Sodium (mg/L)	<200	62.1	48.5	62.2	45.9	54.68	62.20	45.90
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.060	0.06	0.06
Nitrate (mg/L)	10	0.05	0.05	0.05	0.05	0.050	0.05	0.05
Total Phosphorus (mg/L)	0.03	0.11	0.04	0.08	0.06	0.07	0.11	0.04
Chlorides (mg/L)	250	120	83	100	87	98	120.00	83.00
Total coliform (CFU/100mL)	1000	14000	3200	6000	3800	6750	14000	3200
E coli (CFU/100mL)	100	8000	1900	280	400	2645	8000	280
Hardness (mg/L CaCO3)	80-100	---	---	205	---	---	---	---
Silver (mg/L)	0.0001	---	---	0.00003	---	---	---	---
Aluminum (mg/L)	0.075	---	---	0.0366	---	---	---	---
Arsenic (mg/L)	0.005	---	---	0.0006	---	---	---	---
Barium (mg/L)	1	---	---	0.129	---	---	---	---
Beryllium (mg/L)	1.1	---	---	0.00004	---	---	---	---
Boron (mg/L)	0.2	---	---	0.049	---	---	---	---
Bismuth (mg/L)		---	---	0.00002	---	---	---	---
Calcium (mg/L)		---	---	57.5	---	---	---	---
Cadmium (mg/L)	0.0002	---	---	0.00006	---	---	---	---
Cobalt (mg/L)	0.0009	---	---	0.000104	---	---	---	---
Chromium (mg/L)	0.0001	---	---	0.0007	---	---	---	---
Copper (mg/L)	0.005	---	---	0.0005	---	---	---	---
Iron (mg/L)	0.3	---	---	0.29	---	---	---	---
Potassium (mg/L)		---	---	2.71	---	---	---	---
Lithium (mg/L)		---	---	0.002	---	---	---	---
Magnesium (mg/L)		---	---	14.8	---	---	---	---
Manganese (mg/L)	0.05	---	---	0.0954	---	---	---	---
Molybdenum (mg/L)	0.04	---	---	0.00009	---	---	---	---
Nickel (mg/L)	0.025	---	---	0.0007	---	---	---	---
Lead (mg/L)	0.025	---	---	0.00002	---	---	---	---
Antimony (mg/L)	0.02	---	---	0.0002	---	---	---	---
Selenium (mg/L)	0.1	---	---	0.003	---	---	---	---
Silica (mg/L)	---	---	---	1.34	---	---	---	---
Tin (mg/L)	---	---	---	0.0003	---	---	---	---
Strontium (mg/L)	---	---	---	0.205	---	---	---	---
Titanium (mg/L)	---	---	---	0.0018	---	---	---	---
Thallium (mg/L)	0.0003	---	---	0.0001	---	---	---	---
Uranium (mg/L)	0.005	---	---	0.00058	---	---	---	---
Vanadium (mg/L)	0.006	---	---	0.00041	---	---	---	---
Zinc (mg/L)	0.02	---	---	0.0012	---	---	---	---

Table 14: Raw Water Quality Data for Cell B Inlet to Whitfield Wetland.

Parameter	Objectives	Date Sampled					Average	Maximum
		########	26-Jun-06	26-Jul-06	24-Aug-06	25-Sep-06		
Temperature (deg C)		11.29	18.1	22.08	13.5	11.33	15.26	22.08
pH	6.5-8.5	8.04	7.62	7.61	8.16	8.4	7.97	8.4
Dissolved Oxygen (mg/L)	5.5	11.49	7.82	4.73	11.08	12.71	9.57	12.71
Total Dissolved Solids (mg/L)	<300	556	565	549	512	528	542	565
Conductivity (uS/cm^2)	<400	855	871	845	788	812	834	871
Salinity (%)	0.40	0.42	0.43	0.41	0.39	0.4	0.41	0.43
BOD (mg/L)	3	2	3	3	3	3	2.80	3
Total Suspended Solids (mg/L)	5	2	9	9	59	6	17.00	59
Sodium (mg/L)	<200	46.2	40.8	40.9	41.7	42.4	42.40	46.2
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Nitrate (mg/L)	10	0.86	0.79	0.24	0.87	0.82	0.72	0.87
Total Phosphorus (mg/L)	0.03	0.02	0.06	0.05	0.02	0.04	0.04	0.06
Chlorides (mg/L)	250	89	79	78	78	81	81.00	89
Total coliform (CFU/100mL)	1000	580	760	5300	1340	1300	1856	5300
E coli (CFU/100mL)	100	224	300	700	560	140	385	700
Hardness (mg/L CaCO3)	80-100	---	---	---	382	---	---	---
Silver (mg/L)	0.0001	---	---	---	0.00003	---	---	---
Aluminum (mg/L)	0.075	---	---	---	0.106	---	---	---
Arsenic (mg/L)	0.005	---	---	---	0.0006	---	---	---
Barium (mg/L)	1	---	---	---	0.211	---	---	---
Beryllium (mg/L)	1.1	---	---	---	0.00004	---	---	---
Boron (mg/L)	0.2	---	---	---	0.018	---	---	---
Bismuth (mg/L)		---	---	---	0.00002	---	---	---
Calcium (mg/L)		---	---	---	121	---	---	---
Cadmium (mg/L)	0.0002	---	---	---	0.00006	---	---	---
Cobalt (mg/L)	0.0009	---	---	---	0.00016	---	---	---
Chromium (mg/L)	0.0001	---	---	---	0.001	---	---	---
Copper (mg/L)	0.005	---	---	---	0.0012	---	---	---
Iron (mg/L)	0.3	---	---	---	0.63	---	---	---
Potassium (mg/L)		---	---	---	1.98	---	---	---
Lithium (mg/L)		---	---	---	0.002	---	---	---
Magnesium (mg/L)		---	---	---	19.3	---	---	---
Manganese (mg/L)	0.05	---	---	---	0.0391	---	---	---
Molybdenum (mg/L)	0.04	---	---	---	0.00038	---	---	---
Nickel (mg/L)	0.025	---	---	---	0.0007	---	---	---
Lead (mg/L)	0.025	---	---	---	0.00075	---	---	---
Antimony (mg/L)	0.02	---	---	---	0.0002	---	---	---
Selenium (mg/L)	0.1	---	---	---	0.003	---	---	---
Silica (mg/L)	---	---	---	---	6.74	---	---	---
Tin (mg/L)	---	---	---	---	0.0003	---	---	---
Strontium (mg/L)	---	---	---	---	0.287	---	---	---
Titanium (mg/L)	---	---	---	---	0.005	---	---	---
Thallium (mg/L)	0.0003	---	---	---	0.0001	---	---	---
Uranium (mg/L)	0.005	---	---	---	0.0015	---	---	---
Vanadium (mg/L)	0.006	---	---	---	0.00063	---	---	---
Zinc (mg/L)	0.02	---	---	---	0.0064	---	---	---

Table 15: Raw Water Quality Data for Cell B Outlet from Whitfield Wetland.

Parameter	Objectives	Date Sampled				Average	Maximum	Minimum
		26-Jun-06	26-Jul-06	Aug 24 06	25-Sep-06			
Temperature (deg C)		23.37	25.02	18.56	13.85	20.20	25.02	13.85
pH	6.5-8.5	7.1	7.47	7.54	7.79	7.48	7.79	7.10
Dissolved Oxygen (mg/L)	5.5	1.62	5.66	0.9	2.92	3	5.66	0.90
	<300	552	540	753	575	605	753	540
Conductivity (uS/cm^2)	<400	849	831	1158	885	931	1158	831
Salinity (%)	0.40	0.42	0.41	0.58	0.44	0	0.58	0.41
BOD (mg/L)	3	5	3	6	5	5	6.00	3.00
Total Suspended Solids (mg/L)	5	4	3	34	4	11	34.00	3.00
Sodium (mg/L)	<200	93	103	139	84.9	104.98	139.00	84.90
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.060	0.06	0.06
Nitrate (mg/L)	10	0.05	0.05	0.05	0.05	0.050	0.05	0.05
Total Phosphorus (mg/L)	0.03	0.08	0.02	0.12	0.08	0.08	0.12	0.02
Chlorides (mg/L)	250	180	170	230	120	175	230.00	120.00
Total coliform (CFU/100mL)	1000	58	360	1240	540	550	1240	58
E coli (CFU/100mL)	100	36	20	720	20	199	720	20
Hardness (mg/L CaCO3)	80-100	---	---	250	---	---	---	---
Silver (mg/L)	0.0001	---	---	0.00003	---	---	---	---
Aluminum (mg/L)	0.075	---	---	0.055	---	---	---	---
Arsenic (mg/L)	0.005	---	---	0.0021	---	---	---	---
Barium (mg/L)	1	---	---	0.143	---	---	---	---
Beryllium (mg/L)	1.1	---	---	0.00004	---	---	---	---
Boron (mg/L)	0.2	---	---	0.067	---	---	---	---
Bismuth (mg/L)		---	---	0.00002	---	---	---	---
Calcium (mg/L)		---	---	77.5	---	---	---	---
Cadmium (mg/L)	0.0002	---	---	0.00006	---	---	---	---
Cobalt (mg/L)	0.0009	---	---	0.000203	---	---	---	---
Chromium (mg/L)	0.0001	---	---	0.0008	---	---	---	---
Copper (mg/L)	0.005	---	---	0.0005	---	---	---	---
Iron (mg/L)	0.3	---	---	1.22	---	---	---	---
Potassium (mg/L)		---	---	10.2	---	---	---	---
Lithium (mg/L)		---	---	0.002	---	---	---	---
Magnesium (mg/L)		---	---	13.8	---	---	---	---
Manganese (mg/L)	0.05	---	---	0.47	---	---	---	---
Molybdenum (mg/L)	0.04	---	---	0.00077	---	---	---	---
Nickel (mg/L)	0.025	---	---	0.0008	---	---	---	---
Lead (mg/L)	0.025	---	---	0.00032	---	---	---	---
Antimony (mg/L)	0.02	---	---	0.0002	---	---	---	---
Selenium (mg/L)	0.1	---	---	0.003	---	---	---	---
Silica (mg/L)	---	---	---	0.98	---	---	---	---
Tin (mg/L)	---	---	---	0.0003	---	---	---	---
Strontium (mg/L)	---	---	---	0.247	---	---	---	---
Titanium (mg/L)	---	---	---	0.003	---	---	---	---
Thallium (mg/L)	0.0003	---	---	0.0001	---	---	---	---
Uranium (mg/L)	0.005	---	---	0.00179	---	---	---	---
Vanadium (mg/L)	0.006	---	---	0.0013	---	---	---	---
Zinc (mg/L)	0.02	---	---	0.0007	---	---	---	---

Table 16: Raw Water Quality Data for Cell C Inlet to Whitfield Wetland.

Parameter	Objectives	Date Sampled				Average	Maximum	Minimum
		26-Jun-06	26-Jul-06	########	25-Sep-06			
Temperature (deg C)		22.03	21.35	18.71	15.28	19.34	22.03	15.28
pH	6.5-8.5	7.23	6.74	7.06	7.58	7.15	7.58	6.74
Dissolved Oxygen (mg/L)	5.5	1.94	1.82	0.87	9.57	4	9.57	0.87
Total Dissolved Solids (mg/L)	<300	851	1237	1355	2039	1371	2039	851
Conductivity (uS/cm^2)	<400	1310	1903	2085	3136	2109	3136	1310
Salinity (%)	0.40	0.65	0.97	1.07	1.65	1	1.65	0.65
BOD (mg/L)	3	6	2	61	4	18	61.00	2.00
Total Suspended Solids (mg/L)	5	11	23	148	4	47	148.00	4.00
Sodium (mg/L)	<200	171	253	335	498	314.25	498.00	171.00
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.060	0.06	0.06
Nitrate (mg/L)	10	0.17	0.05	0.05	0.05	0.080	0.17	0.05
Total Phosphorus (mg/L)	0.03	0.08	0.04	0.91	0.07	0.28	0.91	0.04
Chlorides (mg/L)	250	280	450	510	740	495	740.00	280.00
Total coliform (CFU/100mL)	1000	700	1660	6400	1520	2570	6400	700
E coli (CFU/100mL)	100	134	60	60	260	129	260	60
Hardness (mg/L CaCO3)	80-100	---	---	174	---	---	---	---
Silver (mg/L)	0.0001	---	---	0.00003	---	---	---	---
Aluminum (mg/L)	0.075	---	---	0.344	---	---	---	---
Arsenic (mg/L)	0.005	---	---	0.0023	---	---	---	---
Barium (mg/L)	1	---	---	0.0909	---	---	---	---
Beryllium (mg/L)	1.1	---	---	0.00004	---	---	---	---
Boron (mg/L)	0.2	---	---	0.033	---	---	---	---
Bismuth (mg/L)		---	---	0.00002	---	---	---	---
Calcium (mg/L)		---	---	56.1	---	---	---	---
Cadmium (mg/L)	0.0002	---	---	0.00006	---	---	---	---
Cobalt (mg/L)	0.0009	---	---	0.000725	---	---	---	---
Chromium (mg/L)	0.0001	---	---	0.0017	---	---	---	---
Copper (mg/L)	0.005	---	---	0.0016	---	---	---	---
Iron (mg/L)	0.3	---	---	7.41	---	---	---	---
Potassium (mg/L)		---	---	13.5	---	---	---	---
Lithium (mg/L)		---	---	0.002	---	---	---	---
Magnesium (mg/L)		---	---	8.28	---	---	---	---
Manganese (mg/L)	0.05	---	---	1.07	---	---	---	---
Molybdenum (mg/L)	0.04	---	---	0.00101	---	---	---	---
Nickel (mg/L)	0.025	---	---	0.0009	---	---	---	---
Lead (mg/L)	0.025	---	---	0.00075	---	---	---	---
Antimony (mg/L)	0.02	---	---	0.0003	---	---	---	---
Selenium (mg/L)	0.1	---	---	0.003	---	---	---	---
Silica (mg/L)	---	---	---	1.88	---	---	---	---
Tin (mg/L)	---	---	---	0.0003	---	---	---	---
Strontium (mg/L)	---	---	---	0.21	---	---	---	---
Titanium (mg/L)	---	---	---	0.0146	---	---	---	---
Thallium (mg/L)	0.0003	---	---	0.0001	---	---	---	---
Uranium (mg/L)	0.005	---	---	0.00112	---	---	---	---
Vanadium (mg/L)	0.006	---	---	0.00151	---	---	---	---
Zinc (mg/L)	0.02	---	---	0.0125	---	---	---	---

Table 17: Raw Water Quality Data for Cell C Outlet from Whitfield Wetland.

Parameter	Objectives	Date Sampled					Average	Maximum	Minimum
		########	26-Jun-06	26-Jul-06	24-Aug-06	25-Sep-06			
Temperature (^{o}C)		18.7	23.34	22.13	19.04	15.73	19.79	23.34	15.73
pH	6.5-8.5	7.69	7.05	7.2	7.8	7.62	7.47	7.8	7.05
Dissolved Oxygen (mg/L)	5.5	9.81	2.56	2.46	3.74	5.46	4.81	9.81	2.46
Total Dissolved Solids (mg/L)	<300	678	563	482	564	613	580	678	482
Conductivity (uS/cm^2)	<400	1041	866	742	868	943	892	1041	742
Salinity (%)	0.40	0.52	0.43	0.36	0.43	0.47	0.44	0.52	0.36
BOD (mg/L)	3	2	3	1	3	3	2.40	3	1
Total Suspended Solids (mg/L)	5	2	2	3	3	2	2.40	3	2
Sodium (mg/L)	<200	122	110	95.6	125	104	111	125	96
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Nitrate (mg/L)	10	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Phosphorus (mg/L)	0.03	0.02	0.04	0.03	0.03	0.05	0.03	0.05	0.02
Chlorides (mg/L)	250	210	200	150	190	160	182	210	150
Total coliform (CFU/100mL)	1000	700	146	260	660	920	537	920	146
E coli (CFU/100mL)	100	14	4	20	60	100	40	100	4
Hardness (mg/L CaCO3)	80-100	---	---	---	124	---	---	---	---
Silver (mg/L)	0.0001	---	---	---	0.00003	---	---	---	---
Aluminum (mg/L)	0.075	---	---	---	0.0218	---	---	---	---
Arsenic (mg/L)	0.005	---	---	---	0.0007	---	---	---	---
Barium (mg/L)	1	---	---	---	0.0503	---	---	---	---
Beryllium (mg/L)	1.1	---	---	---	0.00004	---	---	---	---
Boron (mg/L)	0.2	---	---	---	0.025	---	---	---	---
Bismuth (mg/L)		---	---	---	0.00002	---	---	---	---
Calcium (mg/L)		---	---	---	34.7	---	---	---	---
Cadmium (mg/L)	0.0002	---	---	---	0.00006	---	---	---	---
Cobalt (mg/L)	0.0009	---	---	---	0.00006	---	---	---	---
Chromium (mg/L)	0.0001	---	---	---	0.0008	---	---	---	---
Copper (mg/L)	0.005	---	---	---	0.0006	---	---	---	---
Iron (mg/L)	0.3	---	---	---	0.48	---	---	---	---
Potassium (mg/L)		---	---	---	1.84	---	---	---	---
Lithium (mg/L)		---	---	---	0.002	---	---	---	---
Magnesium (mg/L)		---	---	---	9.02	---	---	---	---
Manganese (mg/L)	0.05	---	---	---	0.964	---	---	---	---
Molybdenum (mg/L)	0.04	---	---	---	0.00005	---	---	---	---
Nickel (mg/L)	0.025	---	---	---	0.0007	---	---	---	---
Lead (mg/L)	0.025	---	---	---	0.00004	---	---	---	---
Antimony (mg/L)	0.02	---	---	---	0.0002	---	---	---	---
Selenium (mg/L)	0.1	---	---	---	0.003	---	---	---	---
Silica (mg/L)	---	---	---	---	0.62	---	---	---	---
Tin (mg/L)	---	---	---	---	0.0003	---	---	---	---
Strontium (mg/L)	---	---	---	---	0.154	---	---	---	---
Titanium (mg/L)	---	---	---	---	0.0012	---	---	---	---
Thallium (mg/L)	0.0003	---	---	---	0.0001	---	---	---	---
Uranium (mg/L)	0.005	---	---	---	0.00035	---	---	---	---
Vanadium (mg/L)	0.006	---	---	---	0.00019	---	---	---	---
Zinc (mg/L)	0.02	---	---	---	0.0003	---	---	---	---

APPENDIX C: Summary of Water Quality Calculations

Table 18: Average values for water quality parameters tested within the Whitfield Wetland.

Average							
Parameter	**Objectives**	**Cell A - Inlet**	**Cell A - Outlet**	**Cell B - Inlet**	**Cell B - Outlet**	**Cell C - Inlet**	**Cell C - Outlet**
Dissolved Oxygen (mg/L)	*5.5*	3.37	7.2075	9.57	2.78	3.55	4.81
Total Dissolved Solids (mg/L)	*<300*	662	374	542	605	1371	580
Conductivity (uS/cm2)	*<400*	1020.75	575	834	931	2109	892
Salinity (%)	*0.40*	0.51	0.30	0.41	0.46	1.09	0.44
BOD (mg/L)	*3*	21	3	3	5	18	2
Total Suspended Solids (mg/L)	*5*	53	7	17	11	47	2
Sodium (mg/L)	*<200*	117	54.675	42.4	104.975	314	111.32
Total Phosphorus (mg/L)	*0.03*	0.438	0.07	0.04	0.08	0.28	0.03
Chlorides (mg/L)	*250*	190	97.5	81	175	495	182
Total coliform (CFU/100mL)	*1000*	35440	6750	1856	550	2570	537.2
E coli (CFU/100mL)	*100*	20500	2645	385	199	129	39.6
Aluminum (mg/L)	*0.075*	0.136	0.037	0.106	0.055	0.344	0.0218
Chromium (mg/L)	*0.001*	0.0014	0.0007	0.0010	0.0008	0.0017	0.0008
Iron (mg/L)	*0.3*	2.32	0.29	0.63	1.22	7.41	0.48
Manganese (mg/L)	*0.05*	0.124	0.095	0.039	0.470	1.070	0.964

Table 19: Maximum values for water quality parameters tested the within Whitfield Wetland.

Maximum							
Parameter	**Objectives**	**Cell A - Inlet**	**Cell A - Outlet**	**Cell B - Inlet**	**Cell B - Outlet**	**Cell C - Inlet**	**Cell C - Outlet**
Dissolved Oxygen (mg/L)	*5.5*	6.42	7.89	12.71	5.66	9.57	9.81
Total Dissolved Solids (mg/L)	*<300*	817	424	565	753	2039	678
Conductivity (uS/cm^2)	*<400*	1263	652	871	1158	3136	1041
Salinity (%)	*0.40*	0.63	0.4	0.43	0.58	1.65	0.52
BOD (mg/L)	*3*	63	4	3	6	61	3
Total Suspended Solids (mg/L)	*5*	160	12	59	34	148	3
Sodium (mg/L)	*<200*	154	62.2	46.2	139	498	125
Total Phosphorus (mg/L)	*0.03*	1.21	0.11	0.06	0.12	0.91	0.05
Chlorides (mg/L)	*250*	290	120	89	230	740	210
Total coliform (CFU/100mL)	*1000*	72000	14000	5300	1240	6400	920
E coli (CFU/100mL)	*100*	72000	8000	700	720	260	100

Table 20: **Minimum values for water quality parameters tested within the Whitfield Wetland.**

Minimum							
Parameter	Objectives	Cell A - Inlet	Cell A - Outlet	Cell B - Inlet	Cell B - Outlet	Cell C - Inlet	Cell C - Outlet
Dissolved Oxygen (mg/L)	5.5	0.2	6.73	4.73	0.9	0.87	2.46
Total Dissolved Solids (mg/L)	<300	470	314	512	540	851	482
Conductivity (uS/cm^2)	<400	723	483	788	831	1310	742
Salinity (%)	0.40	0.36	0.23	0.39	0.41	0.65	0.36
BOD (mg/L)	3	3	2	2	3	2	1
Total Suspended Solids (mg/L)	5	13	4	2	3	4	2
Sodium (mg/L)	<200	98.8	45.9	40.8	84.9	171	95.6
Total Phosphorus (mg/L)	0.03	0.09	0.04	0.02	0.02	0.04	0.02
Chlorides (mg/L)	250	130	83	78	120	280	150
Total coliform (CFU/100mL)	1000	1160	3200	580	58	700	146
E coli (CFU/100mL)	100	400	280	140	20	60	4

Table 21: **Proportion of exceedences for water quality parameters tested within the Whitfield Wetland.**

Proportion of Exceedences							
Parameter	Objectives	Cell A - Inlet	Cell A - Outlet	Cell B - Inlet	Cell B - Outlet	Cell C - Inlet	Cell C - Outlet
Dissolved Oxygen (mg/L)	5.5	2./3		1./4	2./3	1./3	3./4
Total Dissolved Solids (mg/L)	<300	3./3	3./3	4./4	3./3	3./3	4./4
Conductivity (uS/cm^2)	<400	3./3	3./3	4./4	3./3	3./3	4./4
Salinity (%)	0.40	3./3		3./4	3./3	3./3	3./4
BOD (mg/L)	3	3./3	3./3	3./4	3./3	2./3	2./4
Total Suspended Solids (mg/L)	5	3./3	2./3	3./4	1./3	3./3	
Sodium (mg/L)	<200					2./3	
Total Phosphorus (mg/L)	0.03	3./3	3./3	2./4	2./3	3./3	3./4
Chlorides (mg/L)	250	1./3				3./3	
Total coliform (CFU/100mL)	1000	3./3	3./3	2./4	1./3	2./3	
E coli (CFU/100mL)	100	3./3	3./3	4./4	1./3	1./3	
Aluminum (mg/L)	0.075	1./1		1./1		1./1	
Chromium (mg/L)	0.001	1./1		1./1		1./1	
Iron (mg/L)	0.3	1./1	1./1	1./1	1./1	1./1	1./1
Manganese (mg/L)	0.05	1./1	1./1		1./1	1./1	1./1

Table 22: Federal, and Provincial Water Quality Standards.

Parameter	Units	Objective					
		PWQO	**Condition**	**ODWS**	**Condition**	**CWQG**	**Condition**
Aluminum	mg/L	0.075	pH = 6.5-9.0			0.2	OG
Antimony	mg/L	0.02		0.006	IMAC	0.006	HBG
Arsenic	mg/L	0.005*		0.025	IMAC	0.025	HBG
Barium	mg/L			1	MAC	1	HBG
Beryllium	mg/L	11	CaCO3<75				
		1100	CaCO3>75				
Boron	mg/L	0.2*		5	IMAC	5	HBG
Cadmium	mg/L	0.0001*	CaCO3 =0-100	0.005	MAC	0.005	HBG
		0.0005*	CaCO3>100				
Chromium	mg/L	0.001	Hexavalent Chromium	0.05	MAC	0.05	HBG
		0.0089	Trivalent Chromium				
Cobalt	mg/L	0.0009					
Copper	mg/L	0.005		1	AO	1	AO
		0.001*	CaCO3<20				
		0.005*	CaCO3>20				
Iron	mg/L	0.3		3	AO	0.3	AO
Lead	mg/L	0.001*	CaCO3<30	0.01	MAC	0.01	HBG
		0.003*	30<CaCO3<80				
		0.005*	CaCO3>80				
Magnesium	mg/L	No guideline Available (2006)					
Manganese	mg/L			0.05	AO	0.05	AO
Molybdenum	mg/L	0.04*					
Nickel	mg/L	0.025					
Potassium	mg/L	No guideline Available (2006)					
Silicates		No guideline Available (2006)					

Parameter	Units	Objective					
		PWQO	Condition	ODWS	Condition	CWQG	Condition
Selenium	mg/L	0.1		0.01	MAC	0.01	HBG
Silver	mg/L	0.0001					
Strontium	mg/L	No guideline Available (2006)					
Sulphate	mg/L			500	AO	500	AO
Titanium		No guideline Available (2006)					
Uranium	mg/L	0.005		0.02	MAC	0.02	HBG
Vanadium	mg/L	0.006					
Zinc	mg/L	0.03		5	AO	5	AO
		0.02*					
BOD	mg/L	3 mg/L (refer to chart)					
Chloride	mg/L			250	AO	250	AO
Coliform, Total	counts	1000/100mL aquatic health				0	MAC
Conductivity	us/cm	400 local maximum range					
Dissolved Oxygen	mg/L	4.5					
E. Coli	CFU	100/100mL					
Nitrate	mg/L			10	Nitrate as nitrogen		
Nitrite	mg/L			1			
pH		6.5-8.5				6.5-8.5	
Total Phosphorous	mg/L	0.03	Rivers/Streams				
		0.02	Lakes				
Sodium	mg/L			200	AO	200	AO
TDS	mg/L	300 local guideline		500	AO	500	AO
TSS	mg/L	5 (local guideline)					
Salinity	%	0.4 local guideline					
Calcium	mg/L	No guideline Available (2006)					

PWQO = Provincial Water Quality Objectives
ODWS = Ontario Drinking Water Objectives
CWQG = Canadian Water Quality Guidelines

APPENDIX D: Benthic Macroinvertebrate Data

Table 23: Benthic macroinvertebrate data for the outlet of Cell A of the Whitfield Wetland Replicate One.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711865
From SAPSO			Northing	4904200
	Whitfield Wetland Cell A - Outlet			
	Replicate:	1		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)		0.00		6	0.00	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)	3	3.00		5	0.15	6
Hirudinea (Leeches)	1	1.00		8	0.08	0
Amphipoda (Scuds)	7	7.00		6	0.42	42
Isopoda (Aquatic Sowbugs)	24	24.00		8	1.92	552
Chironomidae (Blood Worms)	5	5.00		7	0.35	20
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)		0.00		6	0.00	0
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)	24	24.00		5	1.20	552
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	12	12.00		5	0.60	132
Coleoptera (Beetles)		0.00		4	0.00	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	10	10.00		8	0.80	90
Pelecypoda (Clams)	14	14.00		6	0.84	182
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	100
Hilsenhoff Index	6.36
Simpson's Diversity Index	0.840808

% Diptera	5.00	**% EPT**	24.00	**%Odonata**	0.00
% Malacostraca	31.00	**% Other**	12.00	**% Worms**	4.00
% Mollusca	24.00			**Total**	100.00

Table 24: Benthic macroinvertebrate data for the outlet of Cell A of the Whitfield Wetland Replicate Two.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711865
From SAPSO			Northing	4904200
	Whitfield Wetland Cell A - Outlet			
	Replicate:	1		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)		0.00		6	0.00	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)		0.00		5	0.00	0
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)	21	5.92		6	0.35	420
Isopoda (Aquatic Sowbugs)	257	72.39		8	5.79	65792
Chironomidae (Blood Worms)	4	1.13		7	0.08	12
Simuliidae (Black Flies)	1	0.28		6	0.02	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	1	0.28		6	0.02	0
Other Diptera	3	0.85		5	0.04	6
Ephemeroptera (Mayflies)	51	14.37		5	0.72	2550
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)		0.00		5	0.00	0
Coleoptera (Beetles)	5	1.41		4	0.06	20
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	8	2.25		8	0.18	56
Pelecypoda (Clams)	4	1.13		6	0.07	12
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	355
Hilsenhoff Index	7.32
Simpson's Diversity Index	0.451993

% Diptera	2.54	**% EPT**	14.37	**%Odonata**	0.00
% Malacostraca	78.31	**% Other**	1.41	**% Worms**	0.00
% Mollusca	3.38			**Total**	100.00

Table 25: Benthic macroinvertebrate data for the outlet of Cell A of the Whitfield Wetland Replicate Three.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711865
From SAPSO			Northing	4904200
	Whitfield Wetland Cell A - Outlet			
	Replicate:	3		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)	1	0.93		6	0.06	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)		0.00		5	0.00	0
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)	1	0.93		6	0.06	0
Isopoda (Aquatic Sowbugs)	1	0.93		8	0.07	0
Chironomidae (Blood Worms)	7	6.54		7	0.46	42
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	15	14.02		6	0.84	210
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)	53	49.53		5	2.48	2756
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	14	13.08		5	0.65	182
Coleoptera (Beetles)	1	0.93		4	0.04	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)	1	0.93		5	0.05	0
Zygoptera (Damselflies)	1	0.93		7	0.07	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	4	3.74		8	0.30	12
Pelecypoda (Clams)	8	7.48		6	0.45	56
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	107
Hilsenhoff Index	5.51
Simpson's Diversity Index	0.712749

% Diptera	20.56	**% EPT**	49.53	**%Odonata**	1.87
% Malacostraca	1.87	**% Other**	14.95	**% Worms**	0.00
% Mollusca	11.21			**Total**	100.00

Table 26: Benthic macroinvertebrate data for the outlet of Cell B of the Whitfield Wetland Replicate One.

Water Quality Report	**Date:**	18/05/2006			Grid	17
Hilsenhoff Index	**Sample Location:**				Easting	711717
From SAPSO					Northing	4903894
	Whitfield Wetland Cell B - Outlet					
	Replicate:	1				

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)		0.00		6	0.00	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)		0.00		5	0.00	0
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)		0.00		6	0.00	0
Isopoda (Aquatic Sowbugs)	1	0.99		8	0.08	0
Chironomidae (Blood Worms)	4	3.96		7	0.28	12
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	2	1.98		6	0.12	2
Other Diptera	1	0.99		5	0.05	0
Ephemeroptera (Mayflies)	4	3.96		5	0.20	12
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	5	4.95		5	0.25	20
Coleoptera (Beetles)		0.00		4	0.00	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	4	3.96		8	0.32	12
Pelecypoda (Clams)	80	79.21		6	4.75	6320
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	101
Hilsenhoff Index	6.04
Simpson's Diversity Index	0.368515

% Diptera	6.93	**% EPT**	3.96	**%Odonata**	0.00
% Malacostraca	0.99	**% Other**	4.95	**% Worms**	0.00
% Mollusca	83.17			**Total**	100.00

Table 27: Benthic macroinvertebrate data for the outlet of Cell B of the Whitfield Wetland Replicate Two.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711717
From SAPSO			Northing	4903894
	Whitfield Wetland Cell B - Outlet			
	Replicate:	2		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)	23	18.55		6	1.11	506
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)	2	1.61		5	0.08	2
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)	2	1.61		6	0.10	2
Isopoda (Aquatic Sowbugs)		0.00		8	0.00	0
Chironomidae (Blood Worms)	5	4.03		7	0.28	20
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)	1	0.81		8	0.06	0
Ceratopogonidae (No-See-Ums)	28	22.58		6	1.35	756
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)	4	3.23		5	0.16	12
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	11	8.87		5	0.44	110
Coleoptera (Beetles)	4	3.23		4	0.13	12
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	8	6.45		8	0.52	56
Pelecypoda (Clams)	36	29.03		6	1.74	1260
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	124
Hilsenhoff Index	5.98
Simpson's Diversity Index	0.820614

% Diptera	27.42	**% EPT**	3.23	**%Odonata**	0.00
% Malacostraca	1.61	**% Other**	30.65	**% Worms**	1.61
% Mollusca	35.48			**Total**	100.00

Table 28: Benthic macroinvertebrate data for the outlet of Cell B of the Whitfield Wetland Replicate Three.

Water Quality Report	**Date:**	18/05/2006		Grid	17
Hilsenhoff Index	**Sample Location:**			Easting	711717
From SAPSO				Northing	4903894
	Whitfield Wetland Cell B - Outlet				
	Replicate:	3			

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)	8	7.92		6	0.48	56
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)	7	6.93		5	0.35	42
Hirudinea (Leeches)	2	1.98		8	0.16	2
Amphipoda (Scuds)	2	1.98		6	0.12	2
Isopoda (Aquatic Sowbugs)		0.00		8	0.00	0
Chironomidae (Blood Worms)	6	5.94		7	0.42	30
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	10	9.90		6	0.59	90
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)	5	4.95		5	0.25	20
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	28	27.72		5	1.39	756
Coleoptera (Beetles)	4	3.96		4	0.16	12
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	15	14.85		8	1.19	210
Pelecypoda (Clams)	14	13.86		6	0.83	182
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	101				
Hilsenhoff Index	5.92				
Simpson's Diversity Index	0.861188				
% Diptera	15.84	**% EPT**	4.95	**%Odonata**	0.00
% Malacostraca	1.98	**% Other**	39.60	**% Worms**	8.91
% Mollusca	28.71			**Total**	100.00

Table 29: Benthic macroinvertebrate data for the inlet of Cell A of the Whitfield Wetland Replicate One.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711986
From SAPSO			Northing	4904869
	Whitfield Wetland Cell A - Inlet		Accuracy	6m
	Replicate:	1		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)		0.00		6	0.00	0
Oligochaeta (Segmented Worms)	1	0.96		8	0.08	0
Nematoda (Roundworms)		0.00		5	0.00	0
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)		0.00		6	0.00	0
Isopoda (Aquatic Sowbugs)		0.00		8	0.00	0
Chironomidae (Blood Worms)	75	72.12		7	5.05	5550
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)		0.00		6	0.00	0
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)		0.00		5	0.00	0
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	5	4.81		5	0.24	20
Coleoptera (Beetles)		0.00		4	0.00	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	1	0.96		8	0.08	0
Pelecypoda (Clams)	22	21.15		6	1.27	462
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	104
Hilsenhoff Index	6.71
Simpson's Diversity Index	0.436893

% Diptera	72.12	**% EPT**	0.00	**%Odonata**	0.00
% Malacostraca	0.00	**% Other**	4.81	**% Worms**	0.96
% Mollusca	22.12			**Total**	100.00

Table 30: Benthic macroinvertebrate data for the inlet of Cell A of the Whitfield Wetland Replicate Two.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711986
From SAPSO			Northing	4904869
	Whitfield Wetland Cell A - Inlet		Accuracy	6m
	Replicate:	2		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)	1	0.89		6	0.05	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)	5	4.46		5	0.22	20
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)	4	3.57		6	0.21	12
Isopoda (Aquatic Sowbugs)		0.00		8	0.00	0
Chironomidae (Blood Worms)	85	75.89		7	5.31	7140
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	8	7.14		6	0.43	56
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)		0.00		5	0.00	0
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	2	1.79		5	0.09	2
Coleoptera (Beetles)		0.00		4	0.00	0
Megaloptera (Helgrammites)	2	1.79		4	0.07	2
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	2	1.79		8	0.14	2
Pelecypoda (Clams)	3	2.68		6	0.16	6
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	112
Hilsenhoff Index	6.70
Simpson's Diversity Index	0.417632

% Diptera	83.04	**% EPT**	0.00	**%Odonata**	0.00
% Malacostraca	3.57	**% Other**	4.46	**% Worms**	4.46
% Mollusca	4.46			**Total**	100.00

Table 31: Benthic macroinvertebrate data for the inlet of Cell A of the Whitfield Wetland Replicate Three.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711986
From SAPSO			Northing	4904869
	Whitfield Wetland Cell A - Inlet		Accuracy	6m
	Replicate:	3		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)	1	0.88		6	0.05	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)		0.00		5	0.00	0
Hirudinea (Leeches)	1	0.88		8	0.07	0
Amphipoda (Scuds)	7	6.14		6	0.37	42
Isopoda (Aquatic Sowbugs)		0.00		8	0.00	0
Chironomidae (Blood Worms)	58	50.88		7	3.56	3306
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	6	5.26		6	0.32	30
Other Diptera	1	0.88		5	0.04	0
Ephemeroptera (Mayflies)	1	0.88		5	0.04	0
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	7	6.14		5	0.31	42
Coleoptera (Beetles)		0.00		4	0.00	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)	1	0.88		4	0.04	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	3	2.63		8	0.21	6
Pelecypoda (Clams)	28	24.56		6	1.47	756
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	114				
Hilsenhoff Index	6.48				
Simpson's Diversity Index	0.675361				
% Diptera	57.02	**% EPT**	1.75	**%Odonata**	0.00
% Malacostraca	6.14	**% Other**	7.02	**% Worms**	0.88
% Mollusca	27.19			**Total**	100.00

Table 32: Benthic macroinvertebrate data for the inlet of Cell B of the Whitfield Wetland Replicate One.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711803
From SAPSO			Northing	4904798
	Whitfield Wetland Cell B - Inlet			
	Replicate:	1		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)		0.00		6	0.00	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)		0.00		5	0.00	0
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)	9	7.14		6	0.43	72
Isopoda (Aquatic Sowbugs)	1	0.79		8	0.06	0
Chironomidae (Blood Worms)	115	91.27		7	6.39	13110
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)		0.00		6	0.00	0
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)		0.00		5	0.00	0
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)		0.00		5	0.00	0
Coleoptera (Beetles)		0.00		4	0.00	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	1	0.79		8	0.06	0
Pelecypoda (Clams)		0.00		6	0.00	0
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	126				
Hilsenhoff Index	6.94				
Simpson's Diversity Index	0.163048				
% Diptera	91.27	**% EPT**	0.00	**%Odonata**	0.00
% Malacostraca	7.94	**% Other**	0.00	**% Worms**	0.00
% Mollusca	0.79			**Total**	100.00

Table 33: Benthic macroinvertebrate data for the inlet of Cell B of the Whitfield Wetland Replicate Two.

Water Quality Report	**Date:**	18/05/2006			Grid	17
Hilsenhoff Index	**Sample Location:**				Easting	711803
From SAPSO					Northing	4904798
	Whitfield Wetland Cell B - Inlet					
	Replicate:	2				
Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)	1	0.95		6	0.06	0
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)		0.00		5	0.00	0
Hirudinea (Leeches)		0.00		8	0.00	0
Amphipoda (Scuds)	26	24.76		6	1.49	650
Isopoda (Aquatic Sowbugs)		0.00		8	0.00	0
Chironomidae (Blood Worms)	48	45.71		7	3.20	2256
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)	1	0.95		5	0.05	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	1	0.95		6	0.06	0
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)	2	1.90		5	0.10	2
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)	2	1.90		5	0.10	2
Coleoptera (Beetles)		0.00		4	0.00	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)		0.00		5	0.00	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	24	22.86		8	1.83	552
Pelecypoda (Clams)		0.00		6	0.00	0
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0
Total Number of Organisms	105					
Hilsenhoff Index	6.87					
Simpson's Diversity Index	0.682967					
% Diptera	47.62	**% EPT**	1.90	**%Odonata**		0.00
% Malacostraca	24.76	**% Other**	2.86	**% Worms**		0.00
% Mollusca	22.86			**Total**		100.00

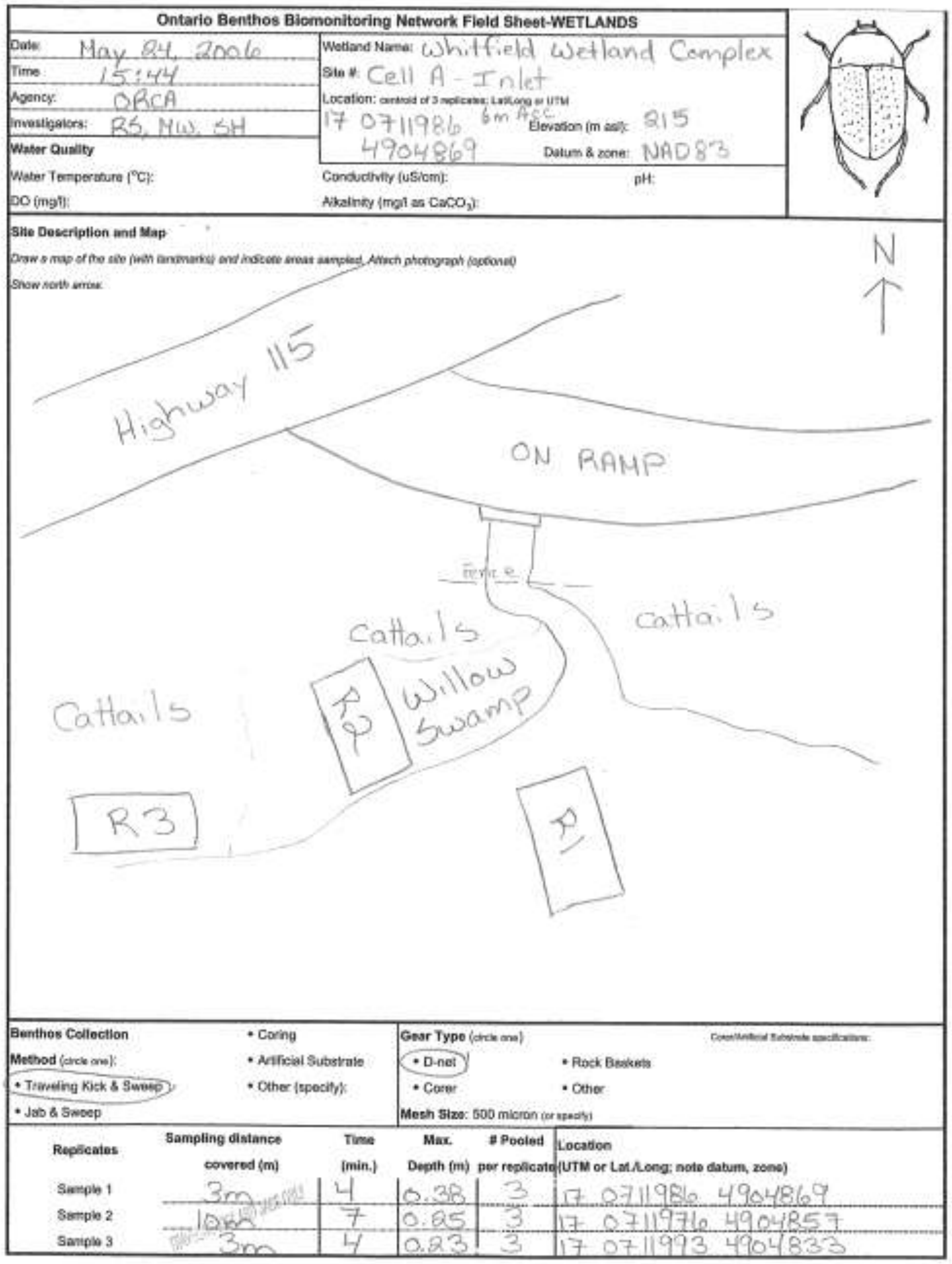
Table 34: Benthic macroinvertebrate data for the inlet of Cell B of the Whitfield Wetland Replicate Three.

Water Quality Report	**Date:**	18/05/2006	Grid	17
Hilsenhoff Index	**Sample Location:**		Easting	711803
From SAPSO			Northing	4904798
	Whitfield Wetland Cell B - Inlet			
	Replicate:	3		

Invertebrate Taxon	**Number**	**Percentage**		**Index**	**Score**	**n(n-1)**
Acarina (Water Mites)	2	1.89		6	0.11	2
Oligochaeta (Segmented Worms)		0.00		8	0.00	0
Nematoda (Roundworms)	2	1.89		5	0.09	2
Hirudinea (Leeches)	3	2.83		8	0.23	6
Amphipoda (Scuds)	4	3.77		6	0.23	12
Isopoda (Aquatic Sowbugs)	7	6.60		8	0.53	42
Chironomidae (Blood Worms)	70	66.04		7	4.62	4830
Simuliidae (Black Flies)		0.00		6	0.00	0
Tipulidae (Craneflies)		0.00		3	0.00	0
Tabanidae (Horse and Deer Flies)		0.00		5	0.00	0
Culicidae (Mosquitos)		0.00		8	0.00	0
Ceratopogonidae (No-See-Ums)	1	0.94		6	0.06	0
Other Diptera		0.00		5	0.00	0
Ephemeroptera (Mayflies)	3	2.83		5	0.14	6
Plecoptera (Stoneflies)		0.00		1	0.00	0
Hemiptera (True Bugs)		0.00		5	0.00	0
Coleoptera (Beetles)	1	0.94		4	0.04	0
Megaloptera (Helgrammites)		0.00		4	0.00	0
Anisoptera (Dragonflies)	1	0.94		5	0.05	0
Zygoptera (Damselflies)		0.00		7	0.00	0
Trichoptera (Caddisflies)		0.00		4	0.00	0
Lepidoptera (Aquatic Moths)		0.00		5	0.00	0
Gastropoda (Snails)	10	9.43		8	0.75	90
Pelecypoda (Clams)	2	1.89		6	0.11	2
Ostracoda (Seed Shrimp)		0.00		7	0.00	0
Decapoda (Crayfish)		0.00		0	0.00	0
Hydra		0.00		5	0.00	0
Platyhelminthes (Flatworms)		0.00		6	0.00	0

Total Number of Organisms	106				
Hilsenhoff Index	6.96				
Simpson's Diversity Index	0.551482				
% Diptera	66.98	**% EPT**	2.83	**%Odonata**	0.94
% Malacostraca	10.38	**% Other**	2.83	**% Worms**	4.72
% Mollusca	11.32			**Total**	100.00

APPENDIX E: Benthic Macroinvertebrate Field Sheets



Ontario Benthos Biomonitoring Network Field Sheet-WETLANDS

Date: May 24, 2006
Time: 15:44
Agency: ORCA
Investigators: RS, MW, SH

Wetland Name: Whitfield Wetland Complex
Site #: Cell A - Inlet
Location: centroid of 3 replicates; Lat/Long or UTM
17 0711986 6m Acc
4904869
Elevation (m asl): 215
Datum & zone: NAD83

Water Quality
Water Temperature (°C):
DO (mg/l):
Conductivity (uS/cm):
Alkalinity (mg/l as $CaCO_3$):
pH:

Site Description and Map
Draw a map of the site (with landmarks) and indicate areas sampled. Attach photograph (optional)
Show north arrow.

Benthos Collection Method (circle one):
- [✓ Traveling Kick & Sweep]
- Jab & Sweep
- Coring
- Artificial Substrate
- Other (specify):

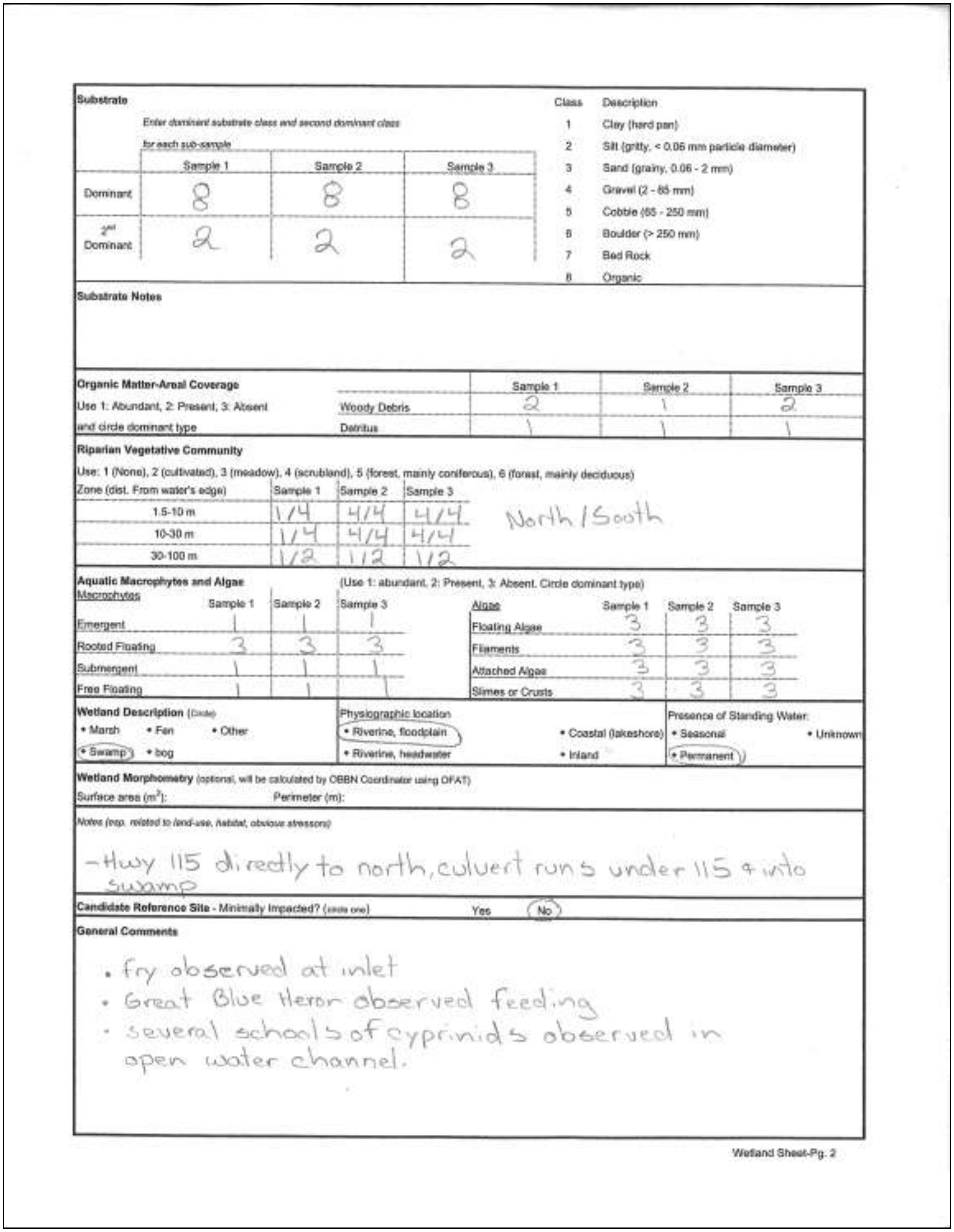
Gear Type (circle one)
- [✓ D-net]
- Corer
- Rock Baskets
- Other

Core/Artificial Substrate specifications:

Mesh Size: 500 micron (or specify)

Replicates	Sampling distance covered (m)	Time (min.)	Max. Depth (m)	# Pooled per replicate	Location (UTM or Lat./Long; note datum, zone)
Sample 1	3m	4	0.38	3	17 0711986 4904869
Sample 2	10m	7	0.85	3	17 0711976 4904857
Sample 3	3m	4	0.23	3	17 0711993 4904833

Figure 12: Front page of benthic field sheet for Cell A – Inlet



Substrate

Enter dominant substrate class and second dominant class for each sub-sample

	Sample 1	Sample 2	Sample 3
Dominant	8	8	8
2nd Dominant	2	2	2

Class	Description
1	Clay (hard pan)
2	Silt (gritty, < 0.06 mm particle diameter)
3	Sand (grainy, 0.06 - 2 mm)
4	Gravel (2 - 65 mm)
5	Cobble (65 - 250 mm)
6	Boulder (> 250 mm)
7	Bed Rock
8	Organic

Substrate Notes

Organic Matter-Areal Coverage
Use 1: Abundant, 2: Present, 3: Absent
and circle dominant type

	Sample 1	Sample 2	Sample 3
Woody Debris	2	1	2
Detritus	1	1	1

Riparian Vegetative Community
Use: 1 (None), 2 (cultivated), 3 (meadow), 4 (scrubland), 5 (forest, mainly coniferous), 6 (forest, mainly deciduous)

Zone (dist. From water's edge)	Sample 1	Sample 2	Sample 3
1.5-10 m	1/4	4/4	4/4
10-30 m	1/4	4/4	4/4
30-100 m	1/2	1/2	1/2

North / South

Aquatic Macrophytes and Algae (Use 1: abundant, 2: Present, 3: Absent. Circle dominant type)

Macrophytes	Sample 1	Sample 2	Sample 3
Emergent	1	1	1
Rooted Floating	3	3	3
Submergent	1	1	1
Free Floating	1	1	1

Algae	Sample 1	Sample 2	Sample 3
Floating Algae	3	3	3
Filaments	3	3	3
Attached Algae	3	3	3
Slimes or Crusts	3	3	3

Wetland Description (Circle)
• Marsh • Fen • Other [✓ • Swamp] • bog

Physiographic location
[✓ • Riverine, floodplain] • Riverine, headwater • Coastal (lakeshore) • Inland

Presence of Standing Water:
• Seasonal [✓ • Permanent] • Unknown

Wetland Morphometry (optional, will be calculated by OBBN Coordinator using OFAT)
Surface area (m^2):
Perimeter (m):

Notes (esp. related to land-use, habitat, obvious stressors)

- Hwy 115 directly to north, culvert runs under 115 + into swamp

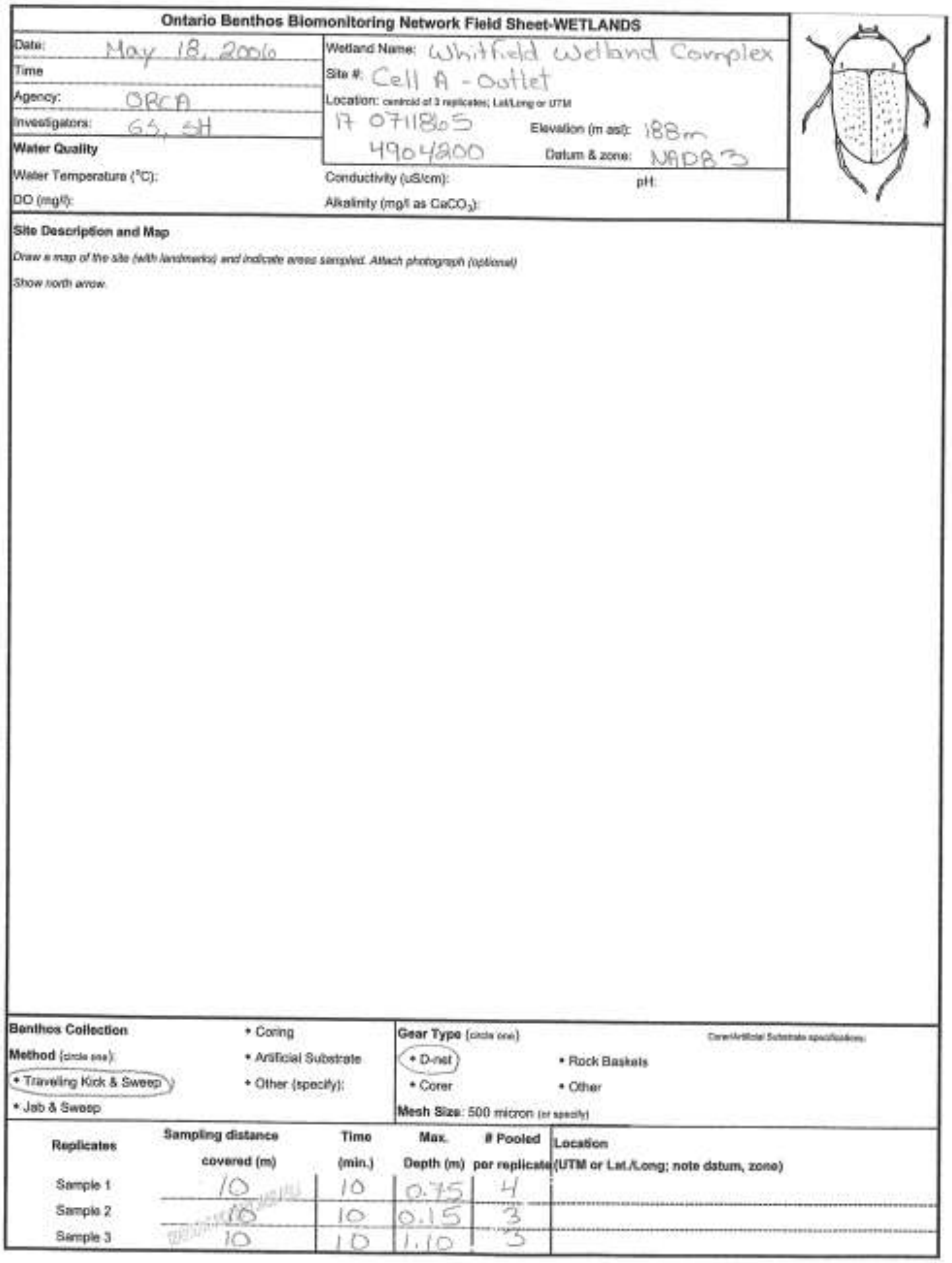
Candidate Reference Site - Minimally Impacted? (circle one) Yes [✓ No]

General Comments

- fry observed at inlet
- Great Blue Heron observed feeding
- several schools of cyprinids observed in open water channel.

Wetland Sheet-Pg. 2

Figure 27: Back page of benthic field sheet for Cell A – Inlet.



Ontario Benthos Biomonitoring Network Field Sheet-WETLANDS

Date: May 18, 2006
Time
Agency: ORCA
Investigators: GS, SH

Wetland Name: Whitfield Wetland Complex
Site #: Cell A - Outlet
Location: centroid of 3 replicates; Lat/Long or UTM
17 0711805
4904200
Elevation (m asl): 188m
Datum & zone: NAD83

Water Quality
Water Temperature (°C):
Conductivity (uS/cm):
pH:
DO (mg/l):
Alkalinity (mg/l as $CaCO_3$):

Site Description and Map

Draw a map of the site (with landmarks) and indicate areas sampled. Attach photograph (optional)

Show north arrow.

Benthos Collection Method (circle one):
- [✓ Traveling Kick & Sweep]
- Jab & Sweep
- Coring
- Artificial Substrate
- Other (specify):

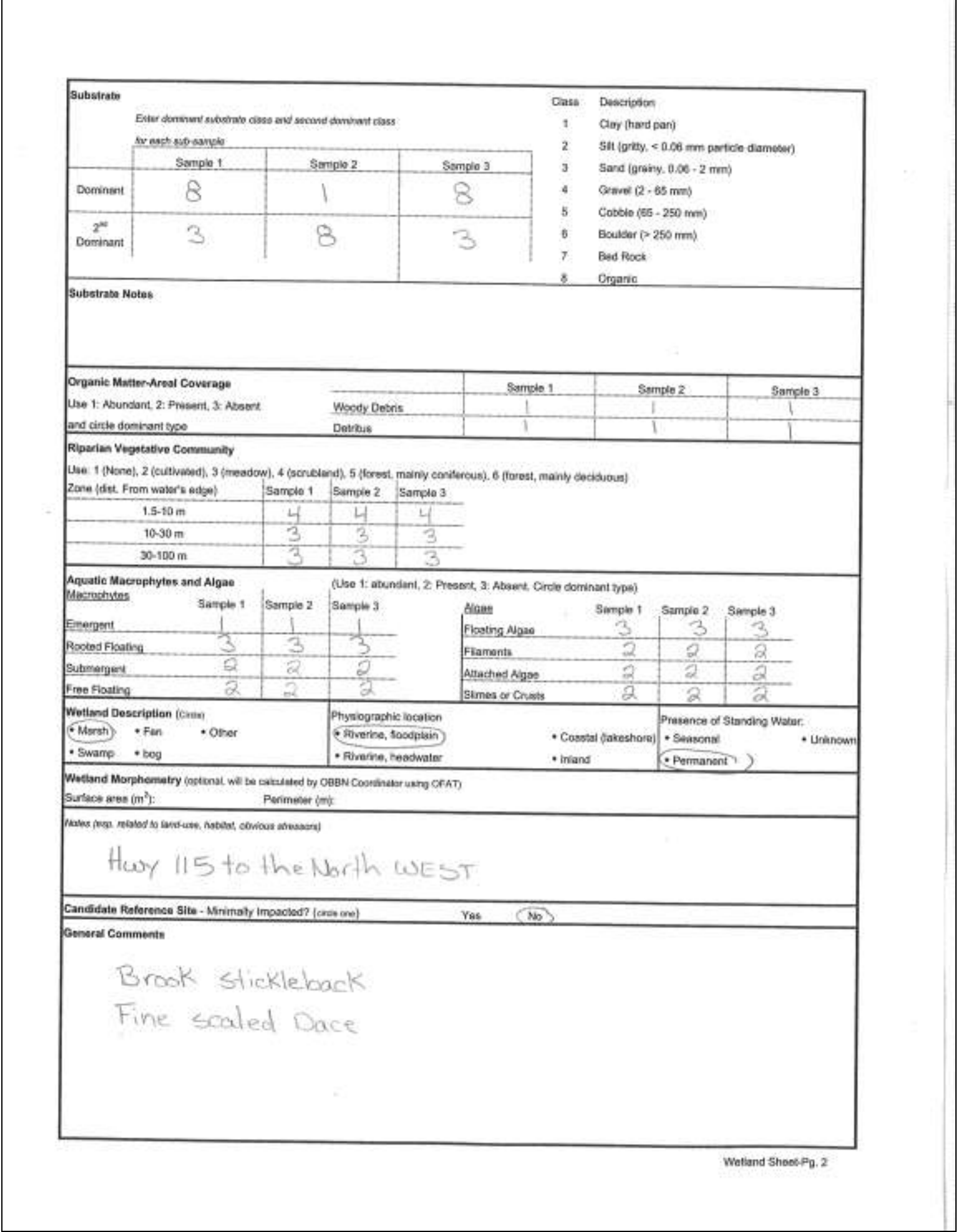
Gear Type (circle one)
- [✓ D-net]
- Corer
- Rock Baskets
- Other

Core/Artificial Substrate specifications:

Mesh Size: 500 micron (or specify)

Replicates	Sampling distance covered (m)	Time (min.)	Max. Depth (m)	# Pooled per replicate	Location (UTM or Lat./Long; note datum, zone)
Sample 1	10	10	0.75	4	
Sample 2	10	10	0.15	3	
Sample 3	10	10	1.10	3	

Figure 28: Front page of benthic field sheet for Cell A – Outlet.



Substrate

Enter dominant substrate class and second dominant class for each sub-sample

	Sample 1	Sample 2	Sample 3
Dominant	8	1	8
2nd Dominant	3	8	3

Class	Description
1	Clay (hard pan)
2	Silt (gritty, < 0.06 mm particle diameter)
3	Sand (grainy, 0.06 - 2 mm)
4	Gravel (2 - 65 mm)
5	Cobble (65 - 250 mm)
6	Boulder (> 250 mm)
7	Bed Rock
8	Organic

Substrate Notes

Organic Matter-Areal Coverage

Use 1: Abundant, 2: Present, 3: Absent and circle dominant type

	Sample 1	Sample 2	Sample 3
Woody Debris	1	1	1
Detritus	1	1	1

Riparian Vegetative Community

Use: 1 (None), 2 (cultivated), 3 (meadow), 4 (scrubland), 5 (forest, mainly coniferous), 6 (forest, mainly deciduous)

Zone (dist. From water's edge)	Sample 1	Sample 2	Sample 3
1.5-10 m	4	4	4
10-30 m	3	3	3
30-100 m	3	3	3

Aquatic Macrophytes and Algae (Use 1: abundant, 2: Present, 3: Absent. Circle dominant type)

Macrophytes	Sample 1	Sample 2	Sample 3
Emergent	1	1	1
Rooted Floating	3	3	3
Submergent	2	2	2
Free Floating	2	2	2

Algae	Sample 1	Sample 2	Sample 3
Floating Algae	3	3	3
Filaments	2	2	2
Attached Algae	2	2	2
Slimes or Crusts	2	2	2

Wetland Description (Circle)
[✓ • Marsh] • Fen • Other
• Swamp • bog

Physiographic location
[✓ • Riverine, floodplain] • Coastal (lakeshore)
• Riverine, headwater • Inland

Presence of Standing Water:
• Seasonal • Unknown
[✓ • Permanent]

Wetland Morphometry (optional, will be calculated by OBBN Coordinator using OFAT)
Surface area (m^2): Perimeter (m):

Notes (esp. related to land-use, habitat, obvious stressors)

Hwy 115 to the North WEST

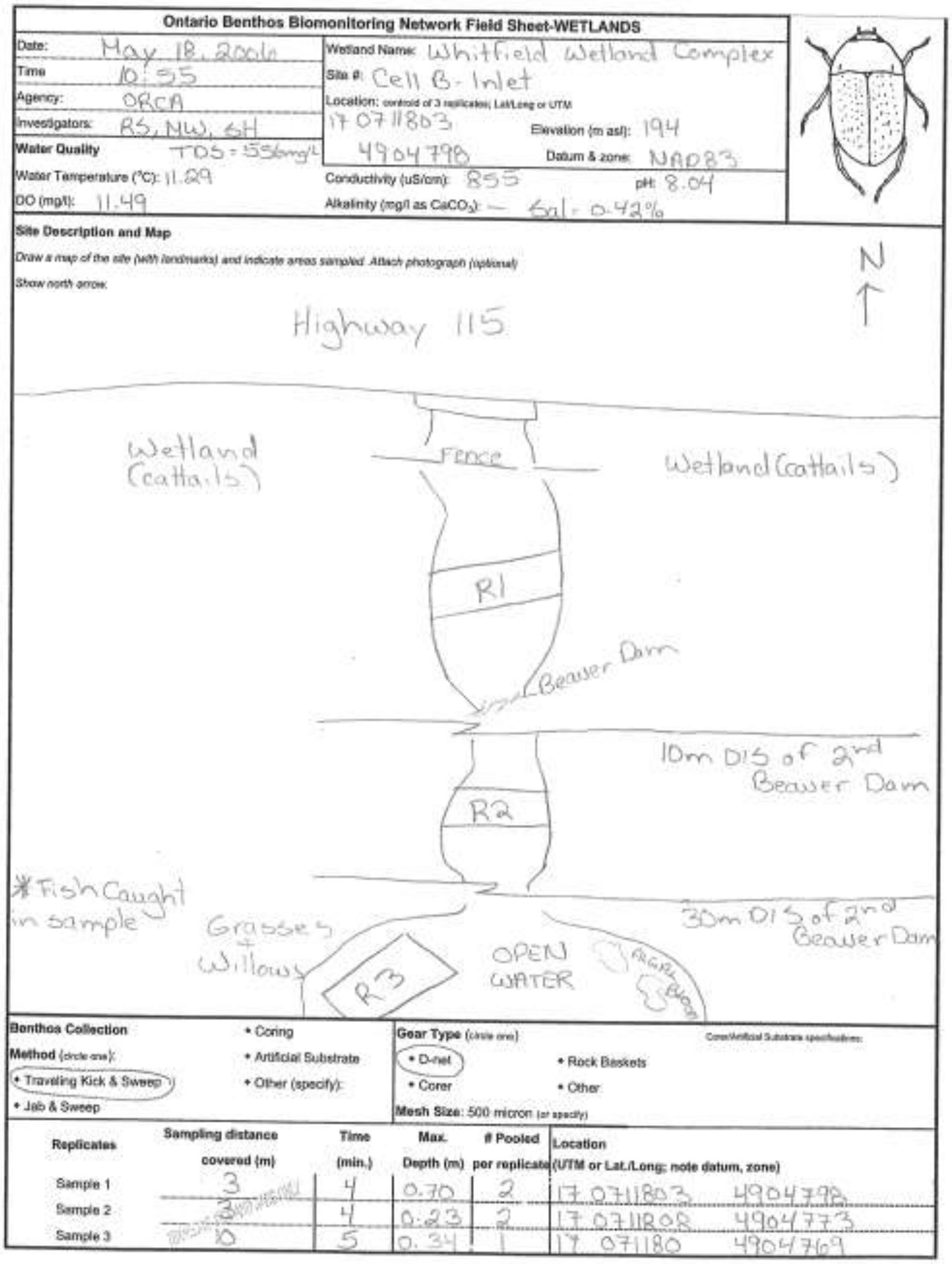
Candidate Reference Site - Minimally Impacted? (circle one) Yes [✓ No]

General Comments

Brook Stickleback
Fine scaled Dace

Wetland Sheet-Pg. 2

Figure 29: Back page of benthic field sheet for Cell A – Outlet.



Ontario Benthos Biomonitoring Network Field Sheet-WETLANDS

Date: May 18, 2006
Time 10:55
Agency: ORCA
Investigators: RS, NW, GH
Water Quality TDS = 556mg/L
Water Temperature (°C): 11.29
DO (mg/l): 11.49

Wetland Name: Whitfield Wetland Complex
Site #: Cell B - Inlet
Location: centroid of 3 replicates; Lat/Long or UTM
17 0711803
4904798
Elevation (m asl): 194
Datum & zone: NAD83
Conductivity (uS/cm): 855
pH: 8.04
Alkalinity (mg/l as $CaCO_3$): — Sal = 0.42%

Site Description and Map

Draw a map of the site (with landmarks) and indicate areas sampled. Attach photograph (optional)

Show north arrow.

Benthos Collection Method (circle one):
- Coring
- Artificial Substrate
- Other (specify):
- [✓ Traveling Kick & Sweep]
- Jab & Sweep

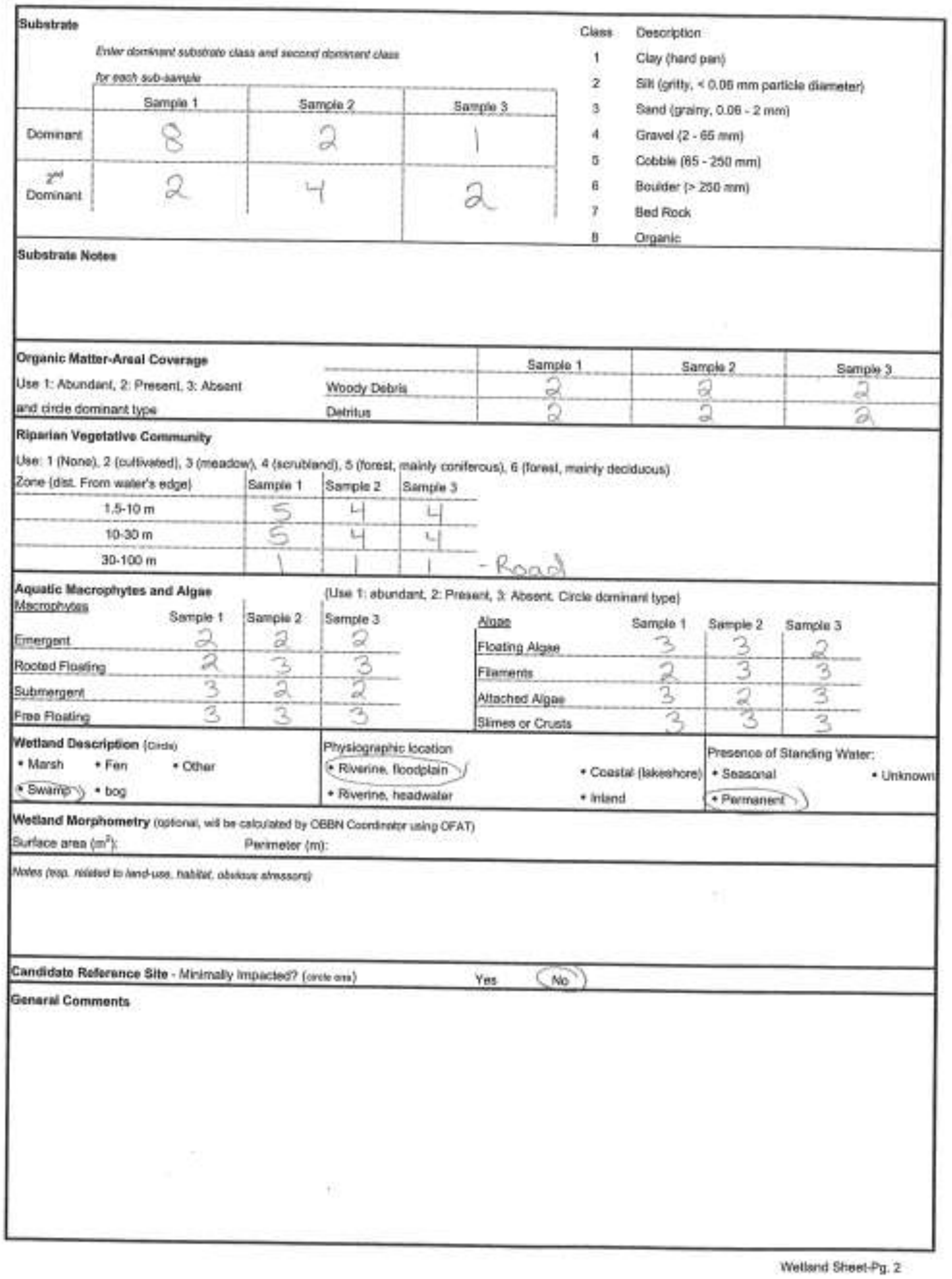
Gear Type (circle one)
- [✓ D-net]
- Rock Baskets
- Corer
- Other

Core/Artificial Substrate specifications:

Mesh Size: 500 micron (or specify)

Replicates	**Sampling distance covered (m)**	**Time (min.)**	**Max. Depth (m)**	**# Pooled per replicate**	**Location (UTM or Lat./Long; note datum, zone)**
Sample 1	3	4	0.70	2	17 0711803 4904798
Sample 2	3	4	0.23	2	17 0711808 4904773
Sample 3	10	5	0.34	1	17 071180 4904769

Figure 30: Front page of benthic field sheet for Cell B – Inlet.



Substrate

Enter dominant substrate class and second dominant class for each sub-sample

	Sample 1	Sample 2	Sample 3
Dominant	8	2	1
2nd Dominant	2	4	2

Class	Description
1	Clay (hard pan)
2	Silt (gritty, < 0.06 mm particle diameter)
3	Sand (grainy, 0.06 - 2 mm)
4	Gravel (2 - 65 mm)
5	Cobble (65 - 250 mm)
6	Boulder (> 250 mm)
7	Bed Rock
8	Organic

Substrate Notes

Organic Matter-Areal Coverage

Use 1: Abundant, 2: Present, 3: Absent and circle dominant type

	Sample 1	Sample 2	Sample 3
Woody Debris	2	2	2
Detritus	2	2	2

Riparian Vegetative Community

Use: 1 (None), 2 (cultivated), 3 (meadow), 4 (scrubland), 5 (forest, mainly coniferous), 6 (forest, mainly deciduous)

Zone (dist. From water's edge)	Sample 1	Sample 2	Sample 3	
1.5-10 m	5	4	4	
10-30 m	5	4	4	
30-100 m	1	1	1	- Road

Aquatic Macrophytes and Algae (Use 1: abundant, 2: Present, 3: Absent. Circle dominant type)

Macrophytes	Sample 1	Sample 2	Sample 3
Emergent	2	2	2
Rooted Floating	2	3	3
Submergent	3	2	2
Free Floating	3	3	3

Algae	Sample 1	Sample 2	Sample 3
Floating Algae	3	3	2
Filaments	2	3	3
Attached Algae	3	2	3
Slimes or Crusts	3	3	3

Wetland Description (Circle)
- Marsh
- Fen
- Other
- [✓ Swamp]
- bog

Physiographic location
- [✓ Riverine, floodplain]
- Riverine, headwater
- Coastal (lakeshore)
- Inland

Presence of Standing Water:
- Seasonal
- Unknown
- [✓ Permanent]

Wetland Morphometry (optional, will be calculated by OBBN Coordinator using OFAT)

Surface area (m^2):

Perimeter (m):

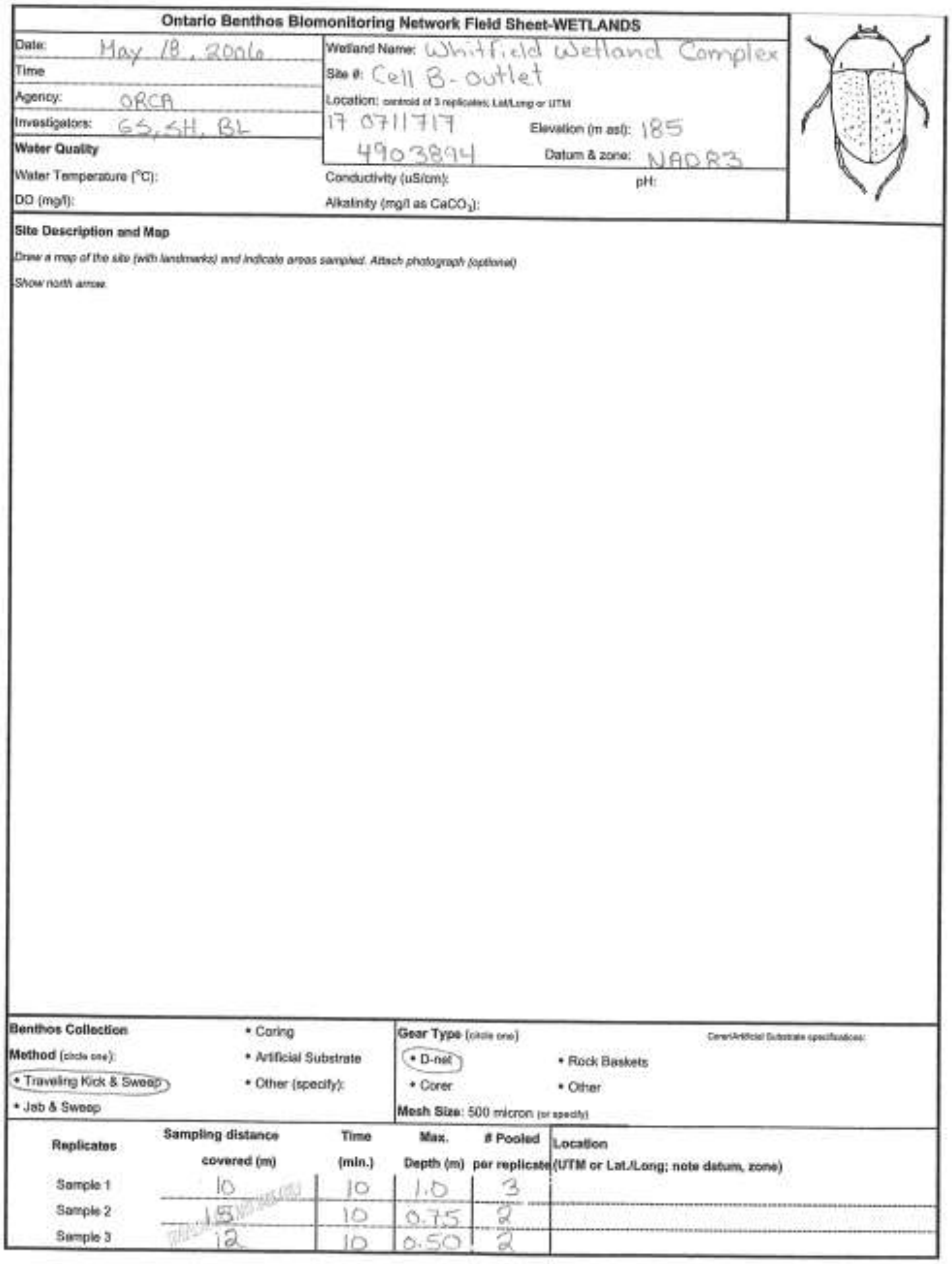
Notes (esp. related to land-use, habitat, obvious stressors)

Candidate Reference Site - Minimally Impacted? (circle one) Yes [✓ No]

General Comments

Wetland Sheet-Pg. 2

Figure 31: Back page of benthic field sheet for Cell B – Inlet.



Ontario Benthos Biomonitoring Network Field Sheet-WETLANDS

Date: May 18, 2006
Time
Agency: ORCA
Investigators: GS, SH, BL

Wetland Name: Whitfield Wetland Complex
Site #: Cell B - outlet
Location: centroid of 3 replicates; Lat/Long or UTM
17 0711717
4903894
Elevation (m asl): 185
Datum & zone: NAD83

Water Quality
Water Temperature (°C):
DO (mg/l):
Conductivity (uS/cm):
pH:
Alkalinity (mg/l as $CaCO_3$):

Site Description and Map

Draw a map of the site (with landmarks) and indicate areas sampled. Attach photograph (optional)
Show north arrow.

Benthos Collection Method (circle one):
- [✓ Traveling Kick & Sweep]
- Jab & Sweep
- Coring
- Artificial Substrate
- Other (specify):

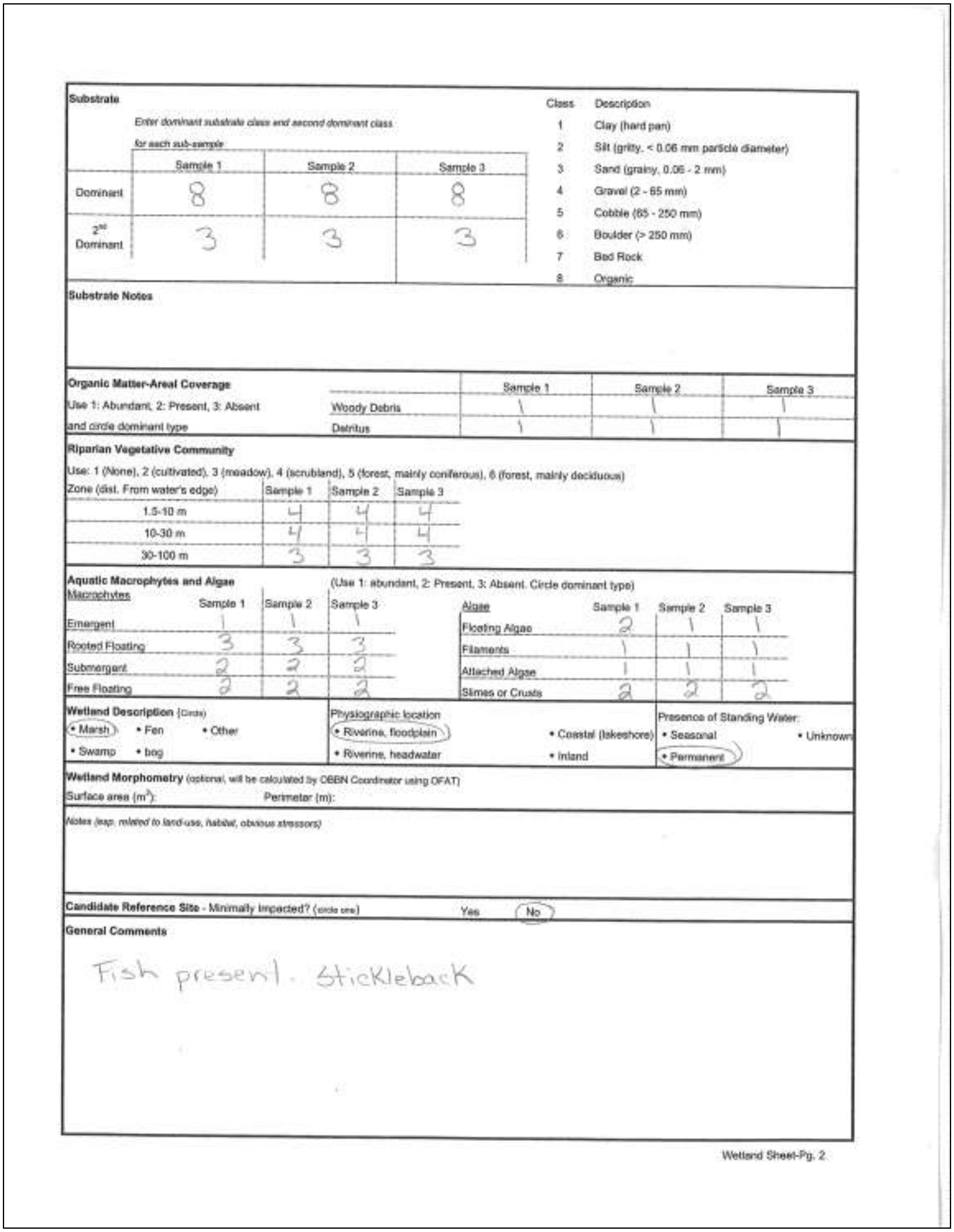
Gear Type (circle one)
- [✓ D-net]
- Corer
- Rock Baskets
- Other

Mesh Size: 500 micron (or specify)

Corer/Artificial Substrate specifications:

Replicates	Sampling distance covered (m)	Time (min.)	Max. Depth (m)	# Pooled per replicate	Location (UTM or Lat./Long; note datum, zone)
Sample 1	10	10	1.0	3	
Sample 2	15	10	0.75	2	
Sample 3	12	10	0.50	2	

Figure 32: Front page of benthic field sheet for Cell B – outlet.



Substrate

Enter dominant substrate class and second dominant class for each sub-sample

	Sample 1	Sample 2	Sample 3
Dominant	8	8	8
2nd Dominant	3	3	3

Class	Description
1	Clay (hard pan)
2	Silt (gritty, < 0.06 mm particle diameter)
3	Sand (grainy, 0.06 - 2 mm)
4	Gravel (2 - 65 mm)
5	Cobble (65 - 250 mm)
6	Boulder (> 250 mm)
7	Bed Rock
8	Organic

Substrate Notes

Organic Matter-Areal Coverage
Use 1: Abundant, 2: Present, 3: Absent and circle dominant type

	Sample 1	Sample 2	Sample 3
Woody Debris	1	1	1
Detritus	1	1	1

Riparian Vegetative Community
Use: 1 (None), 2 (cultivated), 3 (meadow), 4 (scrubland), 5 (forest, mainly coniferous), 6 (forest, mainly deciduous)

Zone (dist. From water's edge)	Sample 1	Sample 2	Sample 3
1.5-10 m	4	4	4
10-30 m	4	4	4
30-100 m	3	3	3

Aquatic Macrophytes and Algae (Use 1: abundant, 2: Present, 3: Absent. Circle dominant type)

Macrophytes	Sample 1	Sample 2	Sample 3
Emergent	1	1	1
Rooted Floating	3	3	3
Submergent	2	2	2
Free Floating	2	2	2

Algae	Sample 1	Sample 2	Sample 3
Floating Algae	2	1	1
Filaments	1	1	1
Attached Algae	1	1	1
Slimes or Crusts	2	2	2

Wetland Description (Circle)
[✓ • Marsh] • Fen • Other
• Swamp • bog

Physiographic location
[✓ • Riverine, floodplain] • Coastal (lakeshore)
• Riverine, headwater • Inland

Presence of Standing Water:
• Seasonal • Unknown
[✓ • Permanent]

Wetland Morphometry (optional, will be calculated by OBBN Coordinator using OFAT)
Surface area (m^2):
Perimeter (m):

Notes (esp. related to land-use, habitat, obvious stressors)

Candidate Reference Site - Minimally Impacted? (circle one) Yes [✓ No]

General Comments

Fish present. Stickleback

Wetland Sheet-Pg. 2

Figure 33: Back page of benthic field sheet for Cell B – outlet.

APPENDIX F: Whitfield Wetland Photo Catalogue

Figure 34: Vegetation.


Canada Blue Joint


Canada Anemone


Arrowhead


Buttercups


Daisy Fleabane


Small Bedstraw


Hawkweed


Spreading Dogbane

Figure 35: Wildlife

Animal Den

Monarch Butterfly

Bees nest dug up by skunk

Bullfrog

Black-capped Chickadee

Canada Geese in Flight

Deer Lay

Deer Tracks

Female Red-wing Blackbird

Pair of Great Egret

Blue heron in flight

Pair of Morning Doves

Killdeer

Pileated Woodpecker Holes

Sandpiper

Red-winged Blackbird

Dragonfly

Moth

Green Frog

Northern Leopard Frog

Raccoon Tracks

Turtle Eggs

Spider

Figure 36: Scenery

Cell A open water area

Inlet of Cell A off Hwy 115

Cell A willow thicket

Cell A near inlet

Cell A outlet stream

Corridor marking SW border of Cell B

Cell B outlet

Cell B open water area

Cell C inlet

Cell C open water area

Cell C swamp area

Fill on the Southern border of Cell C

Path on old railway line

Farm East of Cell A

Lot for sale near inlet of Cell C

Garbage within Whitfield

Figure 37: Inlet Stream

Headwaters

Potential Spring

Headwaters of Inlet to Cell B

Waterfall

Beaver pond

Compost facility near headwaters.

Figure 38: Outlet Stream

Whitfield outlet stream

Outlet stream at Johnston Drive

Whitfield outlet stream

Outlet stream at Otonabee River