WATERSHED CHARACTERIZATION REPORT

Saugeen, Grey Sauble, Northern Bruce Peninsula

Source Protection Region

DRAFT version 5I - - April 18, 2008

EXECUTIVE SUMMARY

The Watershed Characterization Report (WCR) was prepared to serve as the foundational document of the Assessment Report for the Saugeen, Grey Sauble, Northern Bruce Peninsula Source Protection Region (SPR). The SPR was created as a result of regulations made pursuant to the Ontario Clean Water Act (2006). The WCR outlines both the natural and human characteristics of the SPR and serves to aid in protecting drinking water at the source.

The SPR represents approximately 8400 sq. km and has approximately 160,000 residents. The area is very diverse with two Conservation Authorities, two First Nations groups, and 21 municipalities. Activities by provincial, federal, and non-governmental organizations are prevalent within the region as well. The physical characteristics of the region are equally as varied. The climate is greatly influenced by Lake Huron and Georgian Bay. Prominent features include the Niagara Escarpment, karst topography, various types of wetlands (Greenock Swamp), and the Saugeen River system, to name a few.

A variety of land use activities occur throughout the region. Agricultural activities are the most prevalent across the SPR. Various types of livestock and crop farming exist in the SPR, but cattle farming represents the most common type. Forestry activities, quarries and aggregate extraction, and recreational areas are also prominent in the SPR.

Assessing the quality of surface and ground water sources was a main task of the WCR. Available data sources were used to evaluate drinking water sources. Limited data exists for the Provincial Groundwater Monitoring Network and, therefore, provides difficulty in producing assessments on trends. The main source of water chemistry information was from the Ontario Ministry of Environment, which operates several monitoring programs. The largest and most comprehensive source of data for streams in the SPR is from the Provincial Water Quality Monitoring Network (PWQMN). Eight water chemistry parameters were chosen to characterize water quality conditions. Overall, water quality in streams does not appear to exhibit substantial stress from land use activities in this region. Most parameters are below selected Ontario Drinking Water Quality Standards/guidelines and/or Ontario Provincial Water Quality Objectives. Exceedences are mostly noted in metals and total phosphorus concentrations. Although below drinking water standards, chloride concentrations appear to be exhibiting an upward trend based on data from the last 30 years.

Stream water quality is also being assessed by use of macroinvertebrate indices. Data collected by Grey Sauble Conservation illustrate that most locations sampled show that “good” or “excellent” water quality conditions predominate. Saugeen Valley Conservation was still in the developmental phase of the macroinvertebrate program and has not released results at this time.

Microbial data is collected under the Drinking Water Systems regulation (O.Reg. 170/030) of the Safe Drinking Water Act (2002). The data that was analyzed spans from 2003 to 2006. Results show that the Chesley, Ripley, and Teeswater well supplies had no presence of coliforms. The Lakeshore, Mildmay, Mount Forest, Neustadt, and Tiverton well supplies had isolated coliform events. The Chatsworth, Clifford, Durham, Kimberly, Markdale, Shallow Lake, and Tara well supplies experienced more persistent occurrences of coliforms.

Water quantity, or more specifically the flux of water that flows between components of the water cycle in the region, and understanding its availability are also important. Regional shortages for drinking water are not expected, but specific locations (i.e. overburden aquifers) may be susceptible because of the differences associated with water storage between reservoirs. The WCR briefly deals with water sources and its' uses. The Saugeen, Grey Sauble, Northern Bruce Peninsula Planning Region Draft Conceptual Water Budget (2007) is another document of the Assessment Report and provides more detail on this topic.

The vulnerability of drinking water sources can be determined by various methods depending on the availability and amount of information for a given area. Being able to establish or delineate vulnerable areas and the associated limitations is critical for source protection planning and is related to natural features of the landscape.

A preliminary threats database for the region was compiled using existing sources of information. Issues and concerns were also inventoried where information was available. Threats are any contaminants (chemical or pathogen) from land use activities or natural sources that have the potential, by direct or indirect means, to adversely impact or interfere with the use or availability of drinking water sources. Threats that manifest into an actual known problem become an issue. Concerns are perceived issues that are not supported by scientific evidence. Typical threats in the region include airborne, agricultural, cemeteries, septic beds, industrial and manufacturing, marinas, municipal infrastructure, and wildlife.

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INTRODUCTION

1.0 INTRODUCTION

In the "Report of the Walkerton Inquiry" (Ontario, 2002), Justice O'Connor made 121 recommendations, 22 of which related to Source Water Protection. The Walkerton Report stressed the need for planning to fit the functioning of ecosystems and recommended the protection and enhancement of natural systems as one of the effective means of protecting the safety of drinking water. Watersheds are areas of land drained by a river or stream into a common body of water (for our purposes Lake Huron or Georgian Bay) and it is these watersheds which constitute natural functioning units.

Ontario is unique in having a network of 36 Conservation Authorities (CAs) structured on a watershed basis to facilitate cooperation among municipalities. While the impetus to establish the Authorities over half a century ago was primarily flood control, their program has widened to encompass a range of environmental management initiatives. Each has a mandate to establish and undertake, in the area over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals (Conservation Authorities Act R.S.O. 1990 C.27, Section 20).

Conservation Authorities are, therefore, well-positioned to coordinate Drinking Water Source Protection planning. Following advice provided in "Watershed Based Source Protection: Implementation Committee Report to the Minister of the Environment" (Ontario, 2004), the provincial government decided that Conservation Authorities with related geography and issues would be grouped into planning regions so as to permit efficient use of new planning resources. In some instances, areas adjacent to CA jurisdictions are also incorporated into the planning regions for purposes of Source Protection planning. These areas are listed and described in O. Reg. 284/07.

As part of their Source Protection coordinating role, Conservation Authorities worked with local stakeholders to form Source Protection Committees. The Source Protection Committee consists of representatives from municipalities, agricultural organizations, industry, business, interest groups and the general public. There are also two places for First Nations communities on the committee. The local committees will oversee the development of science-based watershed Assessment Reports and watershed level Source Protection Plans within the Source Protection Region (SPR).

The Assessment Report will analyze the vulnerability of groundwater and surface water sources to contamination and over use. It will then evaluate issues related to the specific sources of water within the region as well as inventory the threats to those drinking water sources. Finally the Assessment Report will complete a water quality and quantity risk assessment which will identify and categorize the risks to our drinking water sources.

The Source Protection Committee will continue their work and develop Source Protection Plans that will set out how risks identified in the Assessment Reports are to be addressed. The plans will establish policies, outline responsibilities and establish timelines on how drinking water risks are to be reduced or eliminated. Through a process of broad public consultation, the Source Protection Committee will work to develop a series of tools ranging from regulatory requirements and land use planning control to voluntary initiatives in order to address the risks.

The “Watershed Characterization Report” is the first in a series of documents that make up the Assessment Report. The major components of the Assessment process include:

- Watershed Characterization
- Municipal Water Supply Strategy
- Groundwater Vulnerability Analysis
- Surface Water Vulnerability Analysis
- Issues Evaluation and Threats Inventory
- Water Quality Risk Assessment
- Water Budget and Water Quantity Risk Assessment

The “Watershed Characterization Report” is an introduction to the Drinking Water Source Protection program in this watershed region and forms the foundation for all future work to be undertaken. It generally describes the physical and human qualities of the watershed region by providing a compilation of existing information. It contains an overview of water use, as well as water quality conditions and trends for both groundwater and surface water. Furthermore, the report generally describes vulnerable areas, inventories threats and identifies potential issues. The document has been prepared with the assistance of guidance documents provided by the Ontario Ministry of the Environment

The “Watershed Characterization Report” is intended for any agency, group or individual interested in being involved in the protection of our sources of drinking water. It will be actively used by the Source Protection Committee and Source Protection working groups as a source of information as these groups work towards developing the remainder of the Assessment Report and the Source Protection Plan. It will be a valuable document for agencies, such as municipalities and Conservation Authorities, who have responsibilities with respect to water quality and water management programs. Landowner organizations and individuals may find it useful as they work toward protecting water within their own sectors or on their own properties. The process of developing the various documents related to the Source Protection program will be an open and public process with many opportunities for the involvement of interested groups and individuals.

1.1 Data Sources

A list of references is included in this Report between Chapter 7 and the Appendices. As well, several databases were essential for analysis of water quality and wells, including the Drinking Water Information System.

Spatial information was supplied by various sources, including: Ministry of Natural Resources (MNR); Land Information Ontario (LIO); Southern Ontario Land Resource Information System (SOLRIS); Ontario Geospatial Data Exchange (OGDE); and Conservation Authorities.

1.2 Knowledge and Data Gaps

Due to unavailable, incomplete, inadequate or inaccurate data, it may be difficult to draw conclusions regarding a watershed's vulnerability, potential threats, and risk. For example, a data gap arises when data are not populated, are partially populated, are out of date, are too sparse, or are poorly georeferenced (spatial data). It is important to keep in mind future needs for source protection activities at the specific scale for which they will be completed. For example, activities that are examined at a sub-watershed scale should have data gaps assessed at this scale.

Knowledge gaps occur when there is a lack of referenced material or expertise to assess certain characteristics of a specific watershed. For example, water managers may suspect water shortages due to a reduced storage capacity of degraded wetlands, but have little or no direct evidence or studies to which they can refer.

The following summarizes data gaps that are identified in other sections of the "Watershed Characterization Report".

Data and Knowledge Gaps for Watershed Description

There is sparse information on fish species and a lack of thermal and fish population studies. Benthic data collection is too sparse and there are gaps in the time series. Little information is available on the extent of invasive species within the SPR. Much of the forestry information is older; however, new aerial photography is now available that could help to fill this gap. The MOE wells data set is partially populated and contains spatial inaccuracies.

Map 6 on Quaternary Geology currently shows a gap in information for the Northern Bruce Peninsula SPA. The Ontario Geological Survey is presently undertaking a project that will map the quaternary geology for the Bruce Peninsula and should fill this data gap in the near future.

Data and Knowledge Gaps for Water Quality

Assessment of the aquatic health of stream systems is not possible due to limited benthic data. Water chemistry is not available for all drinking water systems in the SPR, as it is a voluntary program. The Provincial Groundwater Monitoring Network has gathered insufficient data to identify trends. As well, the Provincial Water Quality Monitoring Network does not collect stream discharge data at monitoring locations and there are no monitoring locations in the Northern Bruce Peninsula SPA.

Data and Knowledge Gaps for Vulnerable Areas

Knowledge gaps exist for private wells, cluster or village wells, and communal wells. Wellhead protection areas for these areas have not been completed. At this point, the study of these systems is outside the scope of the Report.

Chapter 2

WATERSHED DESCRIPTION

2.0 WATERSHED DESCRIPTION

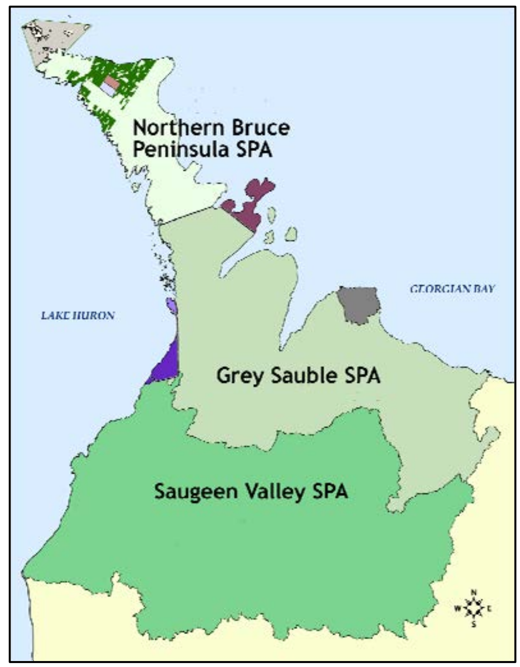
The watershed description is a general assessment of the SPR's fundamental natural and man-made characteristics, including current status and trends. Available background studies and documents were used in compiling the report and any major gaps requiring future research were identified. The watershed description gives a broad understanding of water quantity and quality conditions that are discussed in subsequent sections of the "Watershed Characterization Report". The intent is to provide a general context and support future public consultations.

The format employed here follows a template developed by the MOE. Minor reorganization has been incorporated where appropriate to accommodate additional detail and to tailor the description to better suit its local application.

2.1 Source Protection Region

The Saugeen, Grey Sauble, Northern Bruce Peninsula Source Protection Region (SPR or planning region) has been established as an SPR under the Clean Water Act regulations, O. Reg. 284/07. The SPR consists of three Source Protection Areas (SPA) established under the regulations: Saugeen Valley SPA; Grey Sauble SPA; and Northern Bruce Peninsula SPA.

A partnership among Saugeen Valley Conservation Authority (SC) (also known as Saugeen Conservation), Grey Sauble Conservation Authority (GSC) (also known as Grey Sauble Conservation), and the Municipality of Northern Bruce Peninsula (MNBP) forms the SPR. Saugeen Conservation's jurisdiction and Grey Sauble Conservation's jurisdiction share a common watershed boundary. The MNBP, while not a member of the authority, abuts GSC to the south and is otherwise surrounded by water. (Map 1A)



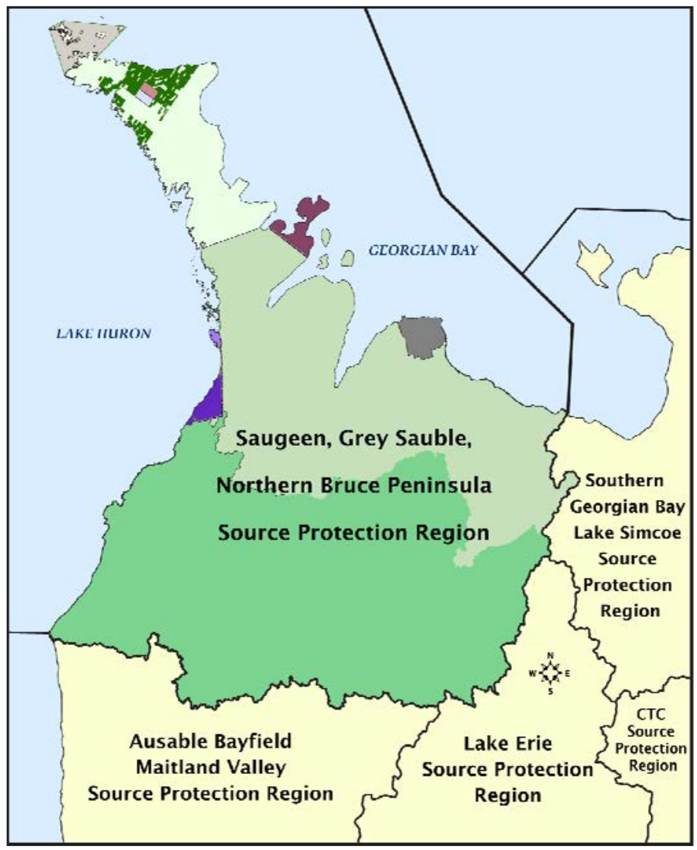
Source Protection Region

2.1.1 Source Protection Areas

The Saugeen Valley SPA encompasses the jurisdiction of Saugeen Conservation. About 90,000 people (Census, 2001) live in this area, which covers approximately 4675 sq km (1805 sq mi). The major watershed is the Saugeen River with its major sub-watersheds: North Saugeen; Rocky Saugeen; Beatty Saugeen; South Saugeen; and Teeswater. The Saugeen River is the third largest watershed in Southern Ontario, draining 4052 sq km (1565 sq mi) into Lake Huron. The Penetangore River, Pine River and smaller lake fringe watersheds that also drain into Lake Huron are part of the Saugeen Valley SPA. (Maps 2A and 2B)

The Grey Sauble SPA comprises approximately 3146 sq km (1214 sq mi) and corresponds with the jurisdiction of Grey Sauble Conservation. The population is about 63,000 people (Census, 2001). The Sauble River, with the largest catchment area in the Grey Sauble SPA, drains into Lake Huron. Four large watersheds drain into Georgian Bay, namely the Beaver, Bighead, Sydenham and Pottawatomi Rivers. In addition, there are a number of fairly significant creeks draining into Georgian Bay, including Indian Brook, Little Beaver Creek, Centreville Creek, Sucker Creek (Meaford), Johnston Creek, Kiefer Creek, Bothwell Creek, Indian Creek, Big Bay Creek and Gleason Brook. The significant creeks draining into Lake Huron are Sucker Creek (South Bruce Pen.) and Stoney Creek. Finally, there are long stretches of lake fringe that drain directly into Georgian Bay or Lake Huron (Maps 2A and 2B).

Northern Bruce Peninsula SPA encompasses the Municipality of Northern Bruce Peninsula, with an area of 761 sq km (294 sq mi) and a population of 4,048 residents (Census, 2001). It contains a large number of smaller catchments with complex hydrologic regimes related to extensive karst features (see section 2.2.1). In the late 1880's and early 1900's, extensive logging occurred on the peninsula. This boom period was followed by a decline in the population through to the middle of the 20th century. Population increases in the last few decades can be attributed in part to employment opportunities in the tourism sector and servicing of growing cottage developments, as well as the conversion of cottage properties to full-time residences. The Municipality of Northern Bruce Peninsula was created in 1999 by an amalgamation of the Village of Lion's Head, Township of St. Edmunds, Township of Lindsay and Township of Eastnor. The islands and waters off the northern tip of the Bruce Peninsula are part of Fathom Five National Marine Park. Extensive portions of MNBP near Tobermory (in the former St. Edmunds Township) are designated Bruce Peninsula National Park. The two parks were established in 1987.



Neighbouring Source Protection Regions

Three other Source Protection Regions share a boundary with the Saugeen, Grey Sauble, Northern Bruce Peninsula SPR. To the south is the Ausable Bayfield Maitalnd Valley SPR, while to the east are the Lake Erie SPR and the Southern Georgian Bay Lake Simcoe SPR.

2.1.2 Stakeholders and Partners

Source Protection will use a broad scale, interdisciplinary approach to managing and protecting sources of drinking water. This implies bringing together a wide range of technical expertise, along with organizations and individuals with differing mandates and interests, in order to build a process that can incorporate analyses and values from the purely technical to the socio-political. The level of stakeholder involvement may range from invitations to contribute and the receipt of information/documentation up to extensive participation in plan development through committees and working groups. The two CAs have long-term experience in working with partners and have extensive networks of interested and committed individuals and organizations. A comprehensive contact list of current and potential partners will be maintained throughout the course of the project. Some of the key partners and stakeholders are outlined in the following subsections.

2.1.2.1 Conservation Authorities

Conservation Authorities (CAs) are local environmental agencies that undertake a broad range of programs for watershed management. For more than 50 years, CAs have protected and restored resources in their watersheds using a science-based approach. CAs work in partnership with all levels of government, agricultural and rural organizations, environmental groups, landowners, buisnesses and residents to ensure the proper management of land and water resources. Areas of expertise and service include: watershed management; water quality and water quantity management; flooding and erosion; afforestation; natural heritage; recreation; environmental education; and agriculture and rural landowner assistance.

Durham Conservation Area

Saugeen Conservation was established in 1950 as a result of increased flooding problems in and around the communities that had developed along the Saugeen River. From its start in the Saugeen River watershed, the SC's jurisdiction has expanded over the years to include the Pine River, Penetangore River and several smaller watersheds draining into Lake Huron. Significant flooding events on the Saugeen River occurred in 1947, 1948, 1970, 1977, 1981, 1986 and 1997. Efforts to control flooding include dyke systems at Walkerton, Paisley and Pinkerton, as well as channelization at Durham and Neustadt. An extensive flood forecasting system has been developed. Large-scale erosion control projects have been completed at Southampton and Kincardine (SC, 2000).

The SC's vision is "a watershed where human needs are met in balance with the needs of the natural environment." In addition, its mission is "to provide leadership through co-ordination of watershed planning, implementation of resource management programs and promotion of conservation awareness, in co-operation with others" (SC, 2000). A Watershed Plan was developed in 1983 and a Strategic Plan was completed in 1993. Resource management activities include forestry work and extensive land holdings.

Grey Sauble Conservation was established in 1985 through the amalgamation of the North Grey Region Conservation Authority (est. 1957) and the Sauble Valley Conservation Authority (est. 1958). Significant flooding events occurred in 1947, 1948, 1967 and 1977.

Flood damage prevention involves ensuring that new development is placed outside the floodplain. Flood protection is implemented through capital projects and maintenance of channels to alleviate the effects of flooding on existing structures. GSC operates several water control structures as part of its comprehensive water management program, including a flood forecasting network. In addition to its two flood control structures, Clendenan Dam and Taylor Street Detention Pond, the Authority owns and operates eight other water control structures, such as the Mill Dam in Owen Sound. These dams serve a variety of functions including recreation, waterfowl habitat, fisheries management and flow augmentation. Several have local historical significance.

Six major erosion control projects have been constructed by GSC, along with numerous smaller ones, at various locations across the watershed. The Authority continues to monitor and maintain these projects on an annual basis.

Shallow Lake

The GSC's vision is "a healthy watershed environment in balance with the needs of society" and its mission "in partnership with stakeholders of the watershed, to promote and undertake sustainable management of renewable natural resources and to provide responsible leadership to enhance biodiversity and environmental awareness" (GSC, 2005).

The Maitland Valley Conservation Authority lies to the south of the SC jurisdiction. Along SC's eastern boundary is the Grand River Conservation Authority. The Nottawasaga Valley Conservation Authority borders the eastern edge of the GSC and a small section of the SC jurisdiction. The jurisdictional boundaries mark the height of land that separates one watershed from another.

There is a history of cooperative activities with adjacent Conservation Authorities and this approach will be important to Source Protection. Examples of collaborative projects between neighbouring CAs include: the My Land, Our Water website from SC and MVCA; Healthy Futures from SC and GSC; and the Grey-Bruce Forestry Services program of SC and GSC. Due to shared issues in water sources, it is expected that CAs will work collaboratively in Source Protection.

Conservation Ontario is the provincial association of Conservation Authorities and plays a coordinating and administrative role regarding Source Protection. Regular meetings and workshop and working group activities are important in setting standards and sharing experience and approaches.

2.1.2.2 Municipalities

The partnerships between municipalities and Conservation Authorities will be crucial to describing and assessing watersheds for purposes of Source Protection planning. The municipalities provide drinking water, many treat sewage, and all have a range of activities and mandates which affect water quantity and quality.

There are 21 municipalities in the planning region, all but one being a member municipality of a Conservation Authority. Of the 20, 15 are member municipalities of SC and eight are member municipalities of GSC, with three overlapping members. Some are also member municipalities of neighbouring CAs – four in Maitland Valley Conservation Authority (MVCA), two in Grand River Conservation Authority (GRCA), and two in Nottawasaga Valley Conservation Authority (NVCA). The planning region principally encompasses Grey and Bruce Counties, with eight municipalities in Bruce and nine in Grey, as well as two municipalities in each of Wellington and Huron (Table 2.1). In addition, there are two minor sections of the GSC jurisdiction in Simcoe County and a small area of the SC jurisdiction in Dufferin County. Map 1A shows jurisdictions and Map 1B shows municipal boundaries and the communities within those municipalities.

TABLE 2.1 - Municipalities within the Planning Region

Municipality	***County***	***Conservation Authority Membership***
Municipality of Arran-Elderslie	Bruce	SC/GSC
Municipality of Brockton	Bruce	SC
Township of Huron-Kinloss	Bruce	SC/MVCA
Municipality of Kincardine	Bruce	SC
Municipality of Northern Bruce Peninsula	Bruce	Not within CA
Town of Saugeen Shores	Bruce	SC
Municipality of South Bruce	Bruce	SC/MVCA
Town of South Bruce Peninsula	Bruce	GSC
Township of Chatsworth	Grey	SC/GSC
Township of Georgian Bluffs	Grey	GSC
Municipality of Grey Highlands	Grey	SC/GSC/NVCA
Town of Hanover	Grey	SC
Municipality of Meaford	Grey	GSC
City of Owen Sound	Grey	GSC
Township of Southgate	Grey	SC/GRCA
Town of The Blue Mountains	Grey	GSC/NVCA
Municipality of West Grey	Grey	SC
Township of Howick	Huron	SC/MVCA

Municipality	County	Conservation Authority Membership
Municipality of Morris-Turnberry	Huron	SC/MVCA
Township of Minto	Wellington	SC/MVCA
Township of Wellington North	Wellington	SC/GRCA/MVCA

2.1.2.3 Provincial Ministries

The Ministry of the Environment (MOE) is the lead provincial Ministry for Drinking Water Source Protection. MOE is responsible for legislation and regulations, such as the Clean Water Act, 2006 (Bill 43), and Safe Drinking Water Act, 2002. A regional office is located in London, with an area office located in Owen Sound that houses both drinking water inspectors and environmental officers. The Ministry works to provide all Ontarians with safe and clean air, land and water. MOE provides funding and guidance for wellhead protection area and intake protection zone delineation and drinking water systems. The Ministry is a source of information about municipal water systems and water well records.

An area office for the Ministry of Natural Resources (MNR) is located in Owen Sound, with the district office in Midhurst and the regional office in Peterborough. MNR has a long working relationship with CAs in resource management, such as forestry and flood warning. The Ministry has a Conservation Authorities branch that oversees transfer payment allocation and guidance to CAs.

The Ministry of Municipal Affairs and Housing (MMAH) is responsible for the policies and programs of the Government of Ontario in relation to municipal affairs, including: coordination of programs of financial assistance to municipalities; community planning; community development; maintenance and improvement of the built environment and land development; and housing and related matters. The Southwestern Municipal Services Office is located in London. MMAH's role in Source Protection will likely be in guidance on integrating recommendations of source protection plans into municipal by-laws and official plans.

The Ministry of Agriculture, Food and Rural Affairs (OMAFRA) provides services to rural communities, farmers and the agri-food industries. Among its roles are assisting farmers to responsibly manage chemical inputs and animal waste to protect the environment, as well as administrating and enforcing the Nutrient Management Act. There is an office in Owen Sound for the Rural Programs Branch - Regional West Economic Development. A resource centre is located in Clinton.

The Ministry of Northern Development and Mines (MNDM) develops and administers the Mining Act and provides valuable information about the province's geology. Quaternary and bedrock geology data from the Ministry will assist in delineation of wellhead protection zones, aquifers and other groundwater features relevant to Source Protection. The nearest MNDM office is located in Sudbury.

2.1.2.4 Federal Government

A number of federal lands exist in the planning region, as shown on Map 1A. The Department of National Defence runs the Land Force Central Area Training Centre Meaford. The site is locally known as the Meaford Tank Range for its former role in armoured vehicle training. The current key task is as a general armed forces training centre. Covering 6800 ha just north of the town of Meaford, the Training Centre includes limestone cliffs, rolling open ground, dense forest, swamp, a small lake and 22 kilometres of Georgian Bay shoreline.

Parks Canada operates two parks in the region. The islands and waters off the northern tip of the Bruce Peninsula are part of Fathom Five National Marine Park, which was Canada's first national marine park. One of the significant features is the pillars of limestone that jut from the blue waters, such as at Flowerpot Island. The area is known for its numerous islands, lighthouses, 22 shipwrecks and recreational activities, such as scuba diving. A visitor's centre is located at the edge of Tobermory.

Extensive portions of the Municipality of Northern Bruce Peninsula near Tobermory (in the former St. Edmunds Township) are designated Bruce Peninsula National Park. The primary visitor facilities are focussed around Cyprus Lake. The area is famous for its scenic landscape with clifftop views over Georgian Bay and an incredible diversity of plants, including over 40 species of orchids and more than 20 species of ferns.

Fisheries and Oceans Canada has signed an agreement with both Saugeen Conservation and Grey Sauble Conservation to review proposed projects under section 35 of the Fisheries Act. Section 35 of the Fisheries Act deals with the management and protection of fish habitat. The Conservation Authority conducts the initial review of the project to identify any impacts to fish and fish habitat. As well, the Conservation Authority determines how the proponent can mitigate any potential impacts to fish and fish habitat. If impacts to fish and fish habitat can be mitigated, then the Conservation Authority issues a letter of advice. If impacts to fish and fish habitat cannot be fully mitigated, the project is forwarded to the local DFO office for further review.

These agreements were developed to streamline day-to-day referrals in Ontario for projects that may have a shared regulatory interest between DFO and the Conservation Authorities. These agreements were put in place to improve client service with a one window approach. Therefore, Conservation Authorities are the first point of contact for the majority of projects in and around water in Ontario (DFO, 2005).

Environment Canada has been an important partner in several wildlife management initiatives in the region. Perhaps the best known function of Environment Canada is weather forecasting. CA staff utilise weather data from Environment Canada to determine the likelihood of precipitation or snowmelt as part of the CA's flood forecasting program. As well, many of the streamflow gauges on local watercourses are operated by the Canadian Hydrographic Service of Environment Canada. The gauges provide real-time data on the water level and flows, which can then be used to assess when levels will peak and whether they may reach flood stage. Over the long-term, streamflow data can be used to model the behaviour of the river and improve flood forecasting abilities.

2.1.2.5 First Nations

The Chippewas of Nawash First Nation 27 reserve is at Cape Croker (Neyaashiinigmiing) near Wiarton and its related Hunting Ground 60B abuts the Bruce Peninsula National Park. The Chippewas of Saugeen First Nation 28 and 29 reserves are on the Lake Huron shoreline near Southampton and Sauble Beach, and its related Hunting Ground 60A also abuts Bruce Peninsula National Park. The Chippewas of Saugeen FN and the Chippewas of Nawash FN, together known as the Saugeen Ojibway Nations, meet in joint council and share land claims. They passed a resolution in joint council in September 2003 relating to Ontario's then proposed Source Protection framework. The resolution advocates for the use of the precautionary principle and traditional environmental knowledge in developing Source Protection Plans.

2.1.2.6 Non-Governmental Organizations and the Public

Many non-governmental organizations (NGOs) have mandates and program activities that are relevant to Source Protection. Some will be significant stakeholders in the Source Protection planning process. A representative listing of NGOs in the planning region is shown in Table 2.2. This list is not exhaustive, but is intended to show the range of groups interested in water and land related issues. The information about each organization was derived from their own websites wherever possible.

A contact database will be maintained and enhanced throughout the project to support engagement of NGOs and the public at large. There are many members of the public who have taken part in watershed-related activities and many possess extensive technical or local knowledge.

TABLE 2.2 - Non-Governmental Organizations in the Planning Region.

Name of Organization	***Main Interests and Activities***
Arboretum Alliance	- implementation of expansion of Arboretum at GSC office - trail development, tree planting, fundraising
Blue Mountain Watershed Trust	- coordinated Beaver River Water Quality Improvement Project - participate in tree planting initiatives - promote conservation of natural heritage features, such as Silver Creek Wetlands - promote landowner and public education - promote practical, efficient and ecological solutions to environmental concerns
Bruce County Federation of Agriculture	- promote best management practices - encourage stewardship
Bruce County Woodlot Association	- encourage sustainable management of the forests in Bruce County - promote sustainable forest management by increasing awareness of the social, economic and environmental values - support community involvement in forest protection/ conservation and sustainability - provide and support community workshops/activities and educational opportunities about the forest ecosystem and sustainable forestry

Name of Organization	***Main Interests and Activities***
Bruce Peninsula Environment Group	- preserve the unique ecology of the Bruce Peninsula - promote a greater awareness of the diverse flora, fauna, geology, and cultural history of the Bruce Peninsula - encourage sustainable development - build partnerships with other groups, agencies, and individuals in seeking cooperative community based solutions to present and future environmental challenges and concerns - utilize education, presentations and open dialogue to communicate the importance of and the means to maintaining a healthy natural environment
Bruce Resource Stewardship Network	- support sustainable harvesting of forest, agriculture, and natural resource products of Bruce County - offer educational opportunities that promote resource sustainability to all residents and visitors to the community - provide demonstrations on sound forestry ecosystem management practices - support the maintenance and enhancement of fish and wildlife habitat of Bruce County
Bruce Trail Conservancy (Bruce Trail Association)	- public access to Niagara Escarpment - conservation corridor containing a public footpath along the Niagara Escarpment
Christian Farmers Federation of Ontario	- public policy development - enabling farmers to work out their Christian faith in their vocation as citizens - agricultural programs
Concerned Walkerton Citizens	- advocate for compensation to people affected by Walkerton water tragedy - support holistic stewardship of Ontario's drinking water
Ducks Unlimited Canada	- wetland enhancement projects, such as Bognor Marsh - assist landowners with habitat improvement projects
East Grey Anglers and Hunters	- wildlife management - habitat enhancement
Escarpment Biosphere Conservancy	- established to preserve the landscape, ecology and wildlife of the Niagara Escarpment - develop and manage a system of nature reserves on which only ecologically sustainable recreational activities are permitted - secure significant habitat features through land purchase, donation or negotiation of conservation agreements
Friends of MacGregor Point	- enhance public awareness, education and understanding of MacGregor Point Provincial Park - supplement interpretive and education programs
Girl Guides	- environmental education - community service
Grey Association for Better Planning	- encourage better land use planning and policy in Grey County - identify and take action on land use that are unwise or illegal - inform the public on planning issues

Name of Organization	*Main Interests and Activities*
Grey Bruce Children's Water Festival	- annual festival educates 2,000 Grade four students about water issues and the physical properties of water - promote maintenance of ground and surface water quality and quantity
Grey County Federation of Agriculture	- promote best management practices - encourage stewardship
Grey County Forest Stewardship Network	- wetland restoration and stream rehabilitation - education about woodlot management and wetlands
Grey County Woodlot Association	- promote sustainable forest management by increasing awareness of the forest's inherent social, economic, and environmental values - provide technical advice about forest management and marketing
Grey Sauble Conservation Foundation	- cultivate and enhance natural resource conservation - assist with purchase of environmentally sensitive, geologically unique and special natural areas - encourage research, public education and awareness of conservation related topics in Grey and Bruce Counties - trail development, interpretive signage and displays - wildlife habitat improvement - Wild Water (spring water and ice safety) Program for students - conservation area improvements
Huron Fringe Field Naturalists	- preserve wildlife and natural habitat - natural history education
Kincardine Fishing Club	- stream rehabilitation - fisheries management
Lake Huron Centre for Coastal Conservation	- protect and restore Lake Huron's coastal environment - promote a healthy coastal ecosystem lake-wide - help local groups with environmental issues in their own communities
Nature Conservancy of Canada	- protect areas of biological diversity for their intrinsic value and for the benefit of future generations. - lead, innovate and use creativity in the conservation of Canada's natural heritage - secure ecologically significant natural areas through purchases, donations, conservation agreements or other mechanisms - achieve long-term stewardship through management plans and monitoring arrangements
Ontario Nature (Federation of Ontario Naturalists)	- conservation and restoration of natural habitats - education and advocacy - nature reserves - environmental projects, research
Owen Sound Field Naturalists	- natural history education - naturalization project - assist in purchase of environmentally sensitive lands - record local flora and fauna

Name of Organization	Main Interests and Activities
Pine River Watershed Initiative Network	- promote dialogue and education about watershed processes in the Pine River watershed - promote programs that can improve the Pine R. watershed - raise awareness of the needs of the Pine R. watershed and coordinate activities
Sauble Anglers and Hunters	- wildlife management - habitat enhancement
Saugeen Conservation Foundation	- trail development at Greenock Swamp and improvements at Conservation Areas - support conservation education program - support wetland and fish habitat projects
Saugeen Field Naturalists	- develop an appreciation and understanding of all aspects of nature - promote wise use and conservation of natural resources - encourage preservation of wild species and natural areas, especially in Grey and Bruce counties
Scouts Canada	- involve youth throughout their formative years in a non-formal educational process - assisting youth to establish a value system based upon spiritual, social and personal principles as expressed in the Promise and Law - environmental awareness, social responsibility, tree planting
Sydenham Sportsmen Association	- fish ladder and artificial spawning channels on Sydenham River - fish hatchery - stream enhancement projects, including cattle fencing - wildlife management

2.2 Physical Description

A broad overview of the physical character of the planning region is provided in this section. The topics include geology, topography and soils. More in-depth analysis can be found in the Conceptual Water Budget Report for the SPR. Two excellent information sources are the Grey and Bruce Counties Groundwater Study (Waterloo Hydrogeologic, 2003) and "Geology and Landforms of Grey and Bruce Counties" (Owen Sound Field Naturalists, 2004).

2.2.1 Bedrock Geology

Knowledge of bedrock geology is necessary for understanding bedrock aquifers and regional groundwater movement. Descriptions of the bedrock units, and an awareness of groundwater quality parameters like hardness and salinity, help to identify regional aquifers and aquitards. Information on bedrock geology in the planning region includes mapping from the Ontario Geological Survey (OGS), reports on Paleozoic geology from various authors and well records in the Water Well Information System (WWIS).

Three boreholes were drilled by the OGS in the spring of 2006 near Hanover and Walkerton. The cores collected at these sites will help to increase the knowledge and understanding of geological units in the area. The boreholes extend more than 125 metres below the surface.

2.2.1.1 Stratigraphy

General bedrock stratigraphy (that is, the character, thickness and sequence of rock units) in the planning region is summarized in Table 2.3 (Stratigraphy) and illustrated in Map 3. Bedrock consists mainly of carbonate (limestone and dolostone) rocks, as well as some shale units that are interbedded with the limestone and dolostone. Dolostone is a hard, resistant rock and differs from limestone in that some of the calcium ions have been replaced by magnesium. The presence of dolostone promotes the formation of vertical cliffs and waterfalls as it acts to shield softer, underlying layers of rock from erosion.

Stratigraphy as seen in exposed rock layers at Indian Falls Conservation Area.

The bedrock dips to the southwest at a regional slope of 5 to 7 m/km and there is a general thinning of the overburden from west to east, resulting in bedrock exposure along the Niagara Escarpment. An indication of the depth to bedrock is also shown in the distribution of historical quarry operations. With the exception of a few around Walkerton and Kincardine, all quarry operations are located in the area of Owen Sound and north on the Bruce Peninsula.

TABLE 2.3 - Stratigraphy of Bedrock in the Planning Region. (Waterloo Hydrogeologic, 2003)

Period	Group	Formation	Material Type
Quaternary	Overburden (glacially-derived gravel, sand, silt and clay)		
Middle Devonian		Dundee	Brown limestone
	Detroit River	Lucas	Grey-brown limestone and dolostone
		Amherstburg	Tan to grey-brown bituminous limestone, dolostone
Lower Devonian		Bois Blanc	Grey-green to grey-brown limestone, dolostone
Upper Silurian		Bass Island	Dark-brown to buff dolostone
		Salina	Interbedded grey-brown limestone and bituminous shale
Middle Silurian		Guelph	Buff to brown medium-bedded dolostone
		Amabel	Blue-grey thick-bedded dolostone

Period	Group	Formation	Material Type
		Fossil Hill	Buff to grey-brown fossiliferous dolostone
		St. Edmund	Cream-buff thin-bedded dolostone
		Wingfield	Olive-green argillaceous dolostone and shale
		Dyer Bay	Grey-brown dolostone
Lower Silurian	Cataract	Cabot Head	Maroon to green-grey non-calcareous shale
		Manitoulin	Grey fossiliferous dolostone
Upper Ordivician		Queenston	Maroon shale, interbeds of limestone and calcareous siltstone
		Georgian Bay	Blue-grey shale, interbeds of siltstone and limestone
		Blue Mountain	Blue-grey non-calcareous shale
Middle Ordivician	Simcoe	Lindsay	Limestone, argillaceous limestone, calcareous shale

Most of the limestone and dolostone units have the potential to supply adequate quantities of water. However, the water has elevated hardness due to the carbonate composition of the bedrock. The Guelph and Amabel Formations are important bedrock aquifers that occupy a band, up to 30 km wide, which extends northwest of Shelburne to Sauble Beach and up the western side of the Bruce Peninsula. Poor, natural water quantity and quality characterize the shale of the Queenston Formation, and poor, natural water quality characterizes the Salina Formation, which has elevated hardness, sulphate and chloride.

2.2.1.2 Bedrock Topography

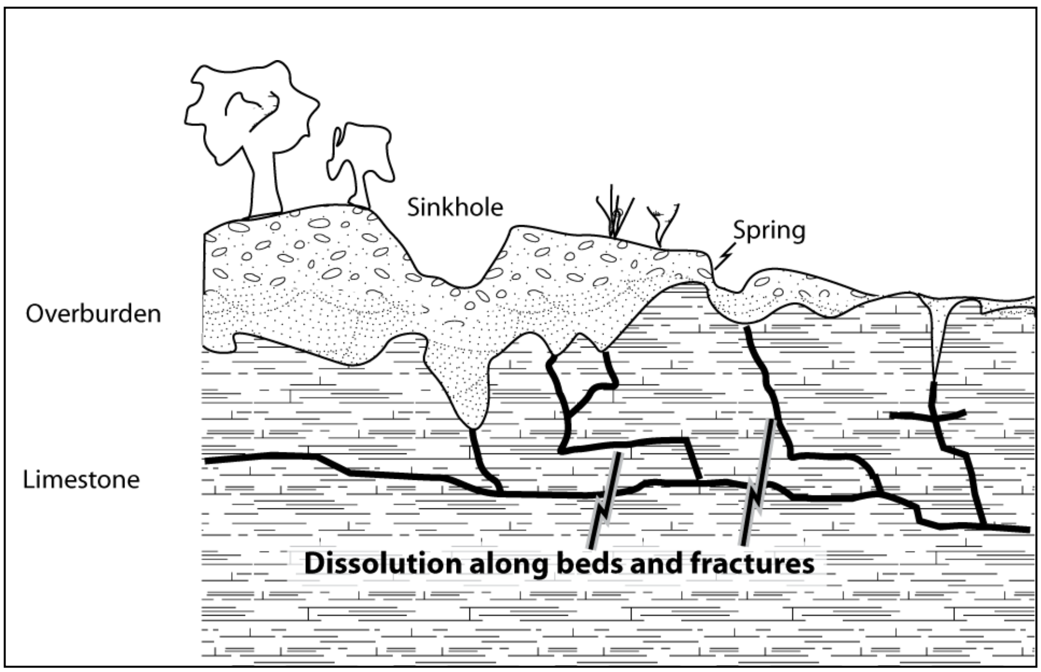
Bedrock surface elevation mapping serves to identify bedrock valleys where useful overburden aquifers may be located and to define bedrock highs and lows, which could control groundwater occurrence and movement. A high degree of present-day drainage and topography appear to be somewhat related to pre-existing patterns in the bedrock. A map of the bedrock surface elevations is presented in Map 4.

The bedrock surface elevation reaches its highest point at 515 m above-mean-sea-level (masl) in the southeast portion of the planning region. The lowest elevations are south of Kincardine at 130 masl. In general, the bedrock surface controls, and is parallel to, the overlying ground surface, as shown in Map 5. Prominent bedrock depressions or valleys are associated with the Beaver and Bighead Valleys, which are re-entrant valleys (embayments) in the Niagara Escarpment adjacent to Georgian Bay. A broad bedrock valley is also evident from Hanover to the Lake Huron shore at Southampton, and underlies parts of the Saugeen River Valley. This bedrock valley follows the contact between the Salina and Bass Island formation and is likely the result of differential erosion between the two formations. Parallel to the bedrock valley that underlies the Saugeen River is a less prominent bedrock valley that begins just northwest of Wingham, which may be an extension of the well-documented Dundas Valley.

2.2.1.3 Karst Features

Karst is a distinctive type of topography, formed primarily by the dissolution of carbonate rocks, such as limestone and dolostone. These rocks are dissolved by the action of weak carbonic acid which is formed when carbon dioxide from the atmosphere or from within the soil environment dissolves in water (Owen Sound Field Naturalists, 2004). The chemical action pits the surface of rocks and enlarges vertical cracks and horizontal bedding planes. Over time, groundwater flow conduits increase in size and aquifers with large conduits are created, thereby lowering the water table below the level of surface streams. These surface streams and drains may begin to lose water to developing cave systems underground. As more surface drainage is diverted underground, streams may disappear and become replaced by closed basins called sinkholes. Sinkholes vary from small cylindrical pits to large conical or parabolic basins that collect and funnel runoff into karst aquifers (Ford and Williams, 1989).

Groundwater flow in karst areas is significantly different from that of other aquifers because of the solutionally enlarged conduits. In conventional carbonate (limestone, dolostone) aquifers, groundwater moves very slowly. In karst aquifers, groundwater flowing in enlarged conduits can have velocities approaching those of surface streams. The nature of this flow system makes karst areas highly susceptible to groundwater contamination (Ford and Williams, 1989).



Karst formation (after USDI, 2006)

Shallow karst aquifers are vulnerable to contamination because they can receive recharge in two ways. They can receive surficial recharge through the soil profile, and concentrated recharge from surface streams and drains that flow directly into the aquifer at sinkholes.

Karst areas are common along the Bruce Peninsula as a result of thinning overburden and exposed bedrock. A study was conducted for the Canadian Parks Service in the northern Bruce Peninsula to map karst areas along the Niagara Escarpment. This study completed a survey of the geomorphological features of the Peninsula within the former Township of St. Edmunds including karst, glacial, aeolian and fluvial features (Canadian Parks Service, 1994). A follow-up study on karst in the planning region was completed by Waterloo Hydrogeologic (2005), which contains a GIS database of karst areas that will aid in the assessment of groundwater vulnerability. For a good description of karst landforms see the Guide to the Geology and Landforms of Grey and Bruce Counties (Owen Sound Field Naturalists, 2004).

The Grey County Official Plan states: "A Special Policy Area is applied to those lands, which possess or are expected to possess shallow overburden with karst topography. The combination of the two features have the potential of being extremely sensitive, thus requiring further in-depth study through an Environmental Impact Study prior to any development being permitted" (Grey County Official Plan, 2.8.4).

2.2.2 Surficial Geology

Glacial deposits remaining after the last glaciation determine the current physiography of the region, the nature and distribution of surficial aquifers, groundwater discharge and recharge areas, and the sand and gravel deposits. Much of the planning region is covered by till, which typically transmits water slowly (i.e. has a low hydraulic conductivity) because of its fine-textured character. In contrast, there are also sand plains and glaciofluvial sand deposits (spillways), which have higher hydraulic conductivities because of their coarse-textured character (Waterloo Hydrogeologic, 2003). A summary of the Quaternary deposits in the planning region is presented in Table 2.4.

The surficial geology left by the glaciers is highly varied over the planning region, as illustrated in Map 6. The physical features of the land surface are illustrated in Map 7, Physiography.

The Catfish Creek Till is the oldest till in the planning region and outcrops in a small area of the planning region between Dundalk and Flesherton. The Elma Till and the Dunkeld Till, which are carbonate-derived silty to sandy tills, occur extensively in the Saugeen River watershed and the Grey Sauble SPA. The Elma Till occurs as ground moraine and in the drumlins of the Teeswater drumlin field, and is associated with the Singhampton Moraine. The Dunkeld Till occurs as ground moraine within the Saugeen River watershed and is the core of the Walkerton Moraine.

The St. Joseph Till is a glaciolacustrine-derived till that occurs over most of the southwestern part of the Saugeen Valley SPA and is found in the Wyoming Moraine running south from Ripley, the Williscroft Moraine north of Chesley and the Banks Moraine south of Craigleith. Glaciolacustrine shoreline deposits occupy a large part of the western half of the Saugeen Valley SPA, as well as by the Lake Huron shore from MacGregor Point to north of Oliphant and near Georgian Bay at Meaford and Thornbury. These are largely well-sorted glaciolacustrine sand deposits that host a fairly significant shallow aquifer.

TABLE 2.4 - Summary of Quaternary Deposits and Events in the Planning Region (Waterloo Hydrogeologic, 2003; after Karrow, 1993; 1977)

Deposit or Event	Lithology	Morphologic Expression
Modern alluvium and organic deposits	Silt, sand, gravel, peat, muck, marl	Present day rivers and flood plains
Lacustrine deposits	Silt and clay	Flat-lying surficial deposits
Outwash	Sand, gravel, some silt	Mainly buried (end moraine)
Ice Contact	Sand, gravel	Kames and eskers
St. Joseph Till	Calcareous, silt to silty clay till	Surficial till
Elma till	Silt till	Lower stony till
Dunkeld Till	Calcareous silt till	Surficial till
Elma Till	Calcareous, silt, sandy silt and clayey silt till	Surficial till, ground moraine, Teeswater Drumlins, Singhampton Moraine
Lacustrine deposits	Silts	Wildwood Silt deposits
Catfish Creek Till	Stoney, sandy silt to silt till	Buried

Glaciofluvial ice-contact and outwash deposits are represented in the middle and upper parts of the Saugeen River watershed, the upper parts of the Sauble River, Sydenham River and Beaver River watersheds. These are generally composed of sand and gravel deposits that host numerous small, shallow aquifers. As well, these aquifers are the source for a large portion of the base flow in the Saugeen River.

A bedrock-drift complex occurs over large areas in the north of the Grey Sauble jurisdiction and the MNBP where the bedrock is covered by a thin veneer of till. Modern alluvial deposits are found in the floodplains of many rivers in the planning region, while organic deposits are associated with wetlands

2.2.3 Topography

The topography of the planning region exhibits diversity from flat to rolling to vertical, as shown on Map 5. Overall, elevations trend from high ground in the east to low in the west. The lowest surface elevation in the planning region is Lake Huron and Georgian Bay with a low water datum level of 176.0 masl (Canadian Hydrographic Service, 2007). The maximum elevations in the planning region occur along the watershed boundary between the GSC and Nottawasaga Valley Conservation Authority where the land rises to over 540 masl near Singhampton (Digital Elevation Model, 2007).

One of the dominant natural features of the planning region is the Niagara Escarpment. Steep hills rise more than 200 m at the Blue Mountains, while other sections have sheer cliffs up to 60 m high that make for spectacular lookouts. The land on the lee side of the escarpment has a much gentler slope. The escarpment stays fairly close to the Georgian Bay shoreline as it winds its way through the region from Collingwood to Tobermory. Exceptions are the deep re-entrant valleys of the Beaver, Bighead and Sydenham Rivers that extend southward for several kilometres.

The coastal fringe along Lake Huron is relatively flat and generally less than 220 masl. Central and eastern parts of the Saugeen Valley SPA and Grey Sauble SPA have lightly to heavily rolling terrain. The Bruce Peninsula consists of a rugged, bedrock plain dominated by the stark cliffs of the Niagara Escarpment along the Georgian Bay side. On the west side of the Peninsula, the land slopes very gradually toward Lake Huron. The coast is highly indented and numerous small islands and shoals are located offshore.

2.2.3.1 Overburden Thickness

Overburden thickness, as shown in Map 8, is essentially the thickness of the unconsolidated glacial sediments over top of bedrock. The thickness can be calculated by finding the difference between the surface elevation (Map 5) and the bedrock elevation (Map 4). Overburden thickness is an important hydrogeologic parameter to review, because it is one of the major parameters that control the amount of protection for underlying surficial and bedrock aquifers. Overburden thickness and grain size distribution control the infiltration rate, and the rate of movement of surface contamination, into these aquifers.

Areas of minimal overburden and exposed bedrock occur mainly along the Bruce Peninsula. Elsewhere, a maximum thickness of up to 80 metres is associated chiefly with bedrock depressions. Two such bedrock depressions underlie the Beaver and Bighead Valleys, with a maximum overburden thickness of 60 m and 80 m, respectively. Although the overburden is less than 30 m thick under the current Beaver Valley, a swath of slightly thicker overburden extends past the tip of the valley as far southwest as Mount Forest, indicating a possible bedrock depression in this area not identified in the bedrock elevation data. Another area of thick overburden is associated with the bedrock valley underlying the Saugeen River, from Hanover to the Lake Huron shore at Southampton. Overburden thickness of up to 80 m occurring at the Lake Huron shore indicates that the underlying bedrock valley likely extends farther to the northwest, under the lake. Two additional areas of thick overburden occur in the region. One is between Walkerton and Kincardine, and is reflected in an area of higher ground surface elevations. The other is along the Lake Huron shore south of Kincardine. Neither area is associated with a bedrock depression.

Sand and gravel thickness throughout the study area is presented in Map 9. The thickness was calculated by summing the total thickness of sand and/or gravel logged in the MOE water well records. The map is used to identify areas of thicker permeable material, identifying areas of potentially significant aquifers within overburden material. The map does not differentiate between sands and gravels above the water table and saturated material below the water table, and so it over-estimates potential aquifer thickness. The major bedrock valleys are not directly associated with thicker intervals of sand and gravel (see Map 9). A lack of data may be caused by the ‘push effect’, which is a result of domestic wells not typically being drilled deeper than the first suitable aquifer. The prevalence of suitable overburden aquifers in these bedrock depressions results in the full thickness of sand and gravel likely not being represented.

The data indicates that most of the study area is underlain by less than 10 metres of sand and gravel. Nearly all the Northern Bruce Peninsula SPA has less than 10 metres. Much of the Grey Sauble SPA has a similarly thin cover of sand and gravel, except for pockets that exceed 20 metres near Chatsworth, in the Beaver Valley and from Arran Lake to Sauble Beach. There are extensive areas of sand and gravel thicker than 20 metres in the Saugeen Valley SPA, the highest values being near Hanover, Durham, Mount Forest and the Greenock Swamp.

2.2.4 Physiography

The dominant surficial features of the planning region are shown on Map 7, and are based on the Physiography of Southern Ontario (Chapman and Putnam, 1984).

The Bruce Peninsula consists largely of exposed dolostone plains, with thin overburden throughout. The irregular topography of the bedrock surface results in many small lakes and swamps on the Peninsula.

Coarse-textured glaciolacustrine deposits make up the sand plains of the Huron Fringe. This area comprises wave-cut terraces of glacial Lakes Algonquin and Nippissing along the Lake Huron shore, with minor sand plains also occurring along the Georgian Bay shoreline.

Shale plains, known as the Cape Rich Steps, are located between Owen Sound and Nottawasaga Bay. This area consists of Paleozoic bedrock overlain by shallow overburden, with the plain being incised by the Beaver Valley (in the Thornbury area) and the Bighead Valley (in the Meaford area).

The Port Huron Moraine system, consisting of glaciofluvial and ice-contact stratified deposits (kames), extends southwest from the head of the Beaver and Bighead Valleys covering the southcentral part of the planning region. Meltwater stream deposits and spillways also occur throughout this physiographic region, as do drumlins in the vicinity of Dornoch.

The southeast part of Grey County, extending to the southern tip of Beaver Valley and east to the Niagara Escarpment, consists mainly of drumlinized till plains, with a small drumlin field in the area of Dundalk. The till is a stone-poor, carbonate-derived silty to sandy deposit.

A similar area located at the base of the Bruce Peninsula is known as the Arran drumlin field. The ground moraine is thin with many of the drumlins located directly on bedrock. Another drumlin field is located near Teeswater.

Immediately south of the Arran drumlin field is an area of fine-textured, glaciolacustrine deposits of the Saugeen Clay Plain. It is underlain by deep stratified clay. The Saugeen River, Teeswater River and Deer Creek have cut valleys through the clay up to 38 m deep.

West of the Saugeen Clay Plain, and extending south along the Lake Huron shore, is an area of silty to clayey till of the Huron Slope. The till is generally up to 3 m thick, and overlies stratified clay. The clay matrix of the till is likely reworked material from the underlying clay beds.

2.2.5 Soil Characteristics

Soil conditions in the planning region are illustrated in Map 10A - Soil Texture and Map 10B - Soil Drainage. Texture refers to the size of the particles making up the soil, such as clay, silt and sand. Drainage describes the relative rate at which water will pass through the soil horizon. Soil type refers to the named categories of soil based upon texture, parent material, drainage and other characteristics.

The northern portions of the planning region are dominated mainly by the Brown Forest Great Soil Group. The combination of climate, soil materials, and age has resulted in reduced weathering and therefore, a much more shallow profile. These types of soils are typically well drained and leaching of soluble materials is not very marked.

The Northern Bruce Peninsula SPA has slightly varying soil characteristics due to a high degree of bedrock exposure. This area is dominated by the Breypen land type, which does not consist of any particular soil type but is largely exposed bedrock with small pockets of soil materials and muck. Drainage in this area is variable.

The Breypen series extends down into northern sections of the Grey Sauble SPA and along the Georgian Bay shore into Owen Sound. Southwestern areas of the Grey Sauble SPA are predominantly covered by the Harkaway series, which are well drained, loamy soils that are susceptible to erosion. They are associated with drumlinized land and usually have a smooth, moderately sloping topography, but steep slopes occur where land has been dissected by streams. Southeastern portions are covered by the Osprey series, which is developed on stony till and is generally well drained. The topography consists of steep irregular slopes that are very susceptible to erosion. Areas extending along the Beaver and Bighead Rivers are predominantly covered by the Vincent series of soils. These soils are characterized by well drained till with moderate to steep slopes (Hoffman & Richards, 1954).

The soils in the southern portions of the planning region, stretching mainly through the Saugeen Valley SPA, have developed under a more temperate climate. These soils, which are part of the Grey-Brown Podzolic Soil Group, are well drained and generally form under a layer of mixed hardwood and deciduous vegetation. Harriston silt loam is the predominant soil type of the Grey-Brown Podzolic group. This type of soil has developed in medium textured, moderately stony materials and tends to appear in drumlinized areas.

Southwest areas of the Saugeen Valley SPA are composed mainly of the Perth series, while the northwest region is composed of the Elderslie series of soils. These series are characterized by soils with imperfect drainage, smooth gentle slopes, and slow internal and external drainage. (Gillespie & Richards, 1954). Huron clay loam is a common soil type on the moraine ridges of the Port Huron Moraine System.

2.3 Hydrology

The hydrological and climatic character is discussed through a description of the significant watercourses and aquifers in the planning region, the climatic normals and climatic trends. The Water Budget Report gives a more thorough treatment of these parameters.

2.3.1 Surface Water Hydrology

Surface water hydrology refers to the way water flows over the land surface. Maps 2A and 2B illustrate the watersheds in the planning region. Map 2C identifies the main rivers in the region. Table 2.5 summarizes statistics about watercourses in the planning region.

The Saugeen Valley SPA is dominated by the Saugeen River. The land is characterized by undulating topography, except for flatter terrain near Lake Huron and near Dundalk. Lakes are rare here due to the permeable nature of underlying glacial deposits. Close to Lake Huron, the Pine River, Penetangore River and other small watercourses cut deeply into the soft materials as they flow westwards into Lake Huron.

The Saugeen River is one of the major river systems in southern Ontario. The main branch of the Saugeen River flows for 195 km from near Dundalk (520 masl) to Lake Huron at Southampton (176 masl). Its main tributaries are the North Saugeen, the Rocky Saugeen, the South Saugeen, the Beatty Saugeen and the Teeswater Rivers.

The North Saugeen River runs from the east side of the Township of Chatsworth through Chesley and connects with the main river at Paisley. The Rocky Saugeen River begins south of Markdale and flows west to join the Saugeen River east of Hanover. The South Saugeen River extends from Dundalk and through Mount Forest before connecting with the main river on the west side of Hanover. The Beatty Saugeen River has a relatively short run from its source east of Durham until it meets the South Saugeen River just south of Hanover. The Teeswater River begins south of Mildmay and meanders its way through Teeswater and Cargill before entering the main Saugeen River at Paisley. From Paisley northward the Saugeen River occupies a fairly broad valley through to its mouth at Southampton.

TABLE 2.5 - River Systems in the Planning Region (Digital Elevation Model, MNR)

Subwatershed	***Area of Sub-watershed (km^2)***	***Elevation at Headwaters (masl)***	***Elevation at Mouth (masl)****	***Change in Elevation (m)***	***Length of Stream (km)***	***Slope of Stream (m/km)***
Saugeen Valley SPA						
Beatty Saugeen River	272.8	451.4	260.9	190.5	52.1	3.7
Main Saugeen River	1695.3	519.8	176.0	343.8	209.3	1.6
North Saugeen River	269.2	374.5	212.0	162.5	69.9	2.3
Penetangore River	181.7	281.9	176.0	105.9	37.3	2.8
Pine River	160.1	285.4	176.0	109.4	34.4	3.2
Rocky Saugeen River	281.7	424.5	304.4	120.1	46.8	2.6
South Saugeen River	795.0	494.2	259.8	234.4	115.7	2.0
Teeswater River	682.1	348.5	213.2	135.3	89.5	1.5

Subwatershed	Area of Sub-watershed (km^2)	Elevation at Headwaters (masl)	Elevation at Mouth (masl)*	Change in Elevation (m)	Length of Stream (km)	Slope of Stream (m/km)
Grey Sauble SPA						
Beaver River	617.5	510.1	176.0	334.1	76.1	4.4
Big Bay Creek	9.3	230.0	176.0	54.0	3.7	14.7
Bighead River	350.9	321.0	176.0	145.0	52.6	2.8
Bothwell's Creek	63.1	265.0	176.0	89.0	14.2	6.3
Gleason Brook	44.9	242.2	176.0	66.2	21.3	3.1
Indian Brook	34.0	473.4	176.0	297.4	16.5	18.0
Indian Creek	81.1	230.0	176.0	54.0	14.2	3.8
Johnson Creek	19.0	298.1	176.0	122.1	12.0	10.2
Keefer Creek	38.8	287.5	176.0	111.5	13.7	8.1
Little Beaver River	14.4	356.5	176.0	180.5	6.5	27.7
Orchard Creek	14.1	324.9	176.0	148.9	10.1	14.8
Pottawatomi River	113.2	244.3	176.0	68.3	18.4	3.7
Rankin River	221.8	205.1	180.1	25.1	21.7	1.2
Sauble River	692.8	244.5	176.0	68.5	86.1	0.8
Stoney Creek	31.2	218.5	176.0	42.5	15.1	2.8
Sucker Creek (S. Bruce Peninsula)	46.4	205.5	176.0	29.5	15.5	1.9
Sucker Creek (Meaford)	36.7	304.1	176.0	128.1	14.5	8.9
Sydenham River	198.7	322.7	176.0	146.7	40.9	3.6
Waterton Creek	57.1	352.8	176.0	176.8	20.8	8.5
Northern Bruce Peninsula SPA						
Black Creek	10.8	196.4	176.0	20.4	7.0	2.9
Brinkman's Creek	32.0	200.8	176.0	24.8	9.4	2.6
Crane River	83.4	225.8	176.0	49.8	22.2	2.2
Judges Creek	85.8	194.0	181.8	12.2	12.0	1.0
Old Woman's River	29.2	189.7	176.0	13.7	7.6	1.8
Sadler Creek	17.9	206.2	176.0	30.2	9.6	3.2
Sideroad Creek	45.3	212.2	176.0	36.2	10.4	3.5
Spring Creek	53.8	210.9	176.0	34.9	22.6	1.5
Stokes River	77.1	200.0	176.0	24.0	18.0	1.3
Willow Creek	18.7	198.4	176.0	22.4	40.5	0.6

* Chart Datum for Lake Huron and Georgian Bay is 176.0 m based on IGLD 1985 (Canadian Hyrdographic Service, 2007)

The Grey Sauble SPA is drained by five major river systems and numerous smaller streams. The Sauble River is the largest of these watercourses. The main branch begins near Desboro within the Arran Drumlin Field and flows in a northwesterly direction to enter Lake Huron north of Sauble Beach. Several lakes are within the Sauble River's watershed, including Gould, Chesley and Arran Lakes. The main tributary is the Rankin River, which drains Berford, Sky, Issac and Boat Lakes, and joins the main Sauble River just upstream of Sauble Falls.

Other notable rivers within the Grey Sauble SPA are the Pottawatomi, Sydenham, Bighead, and Beaver Rivers. The Pottawatomi River flows from the southern parts of the Township of Georgian Bluffs in a northeasterly direction into the west side of Owen Sound and out to the harbour. The Sydenham River rises in the central part of the Township of Chatsworth and flows in a northerly direction. It plunges over Inglis Falls and flows through downtown Owen Sound before ending at the harbour. The Bighead and Beaver Rivers collect numerous small creeks, headland swamps and spring-fed streams. The Bighead River begins in the northeastern part of the Township of Chatsworth. It travels north and then east through rolling terrain and enters Georgian Bay at Meaford. Finally, the Beaver River travels from its source east of Feversham westward into Eugenia Lake. It then descends over Eugenia Falls into a broad, deep valley on a northerly course to Georgian Bay at Thornbury.

Much of the Northern Bruce Peninsula SPA consists of rugged bedrock dominated by sharp cliffs of the Niagara Escarpment along its east side. From the brow of the escarpment, the surface of the Bruce Peninsula slopes very gradually in a south-westerly direction. This allows the numerous small creeks of the Bruce Peninsula to drain into Lake Huron. The loss of surface water and rain into the bedrock greatly limits the size of streams on the Bruce Peninsula. Some watercourses are captured underground by sinkholes and directed underground. Karst in the Northern Bruce Peninsula is evidenced by disappearing streams, bedrock outcrops, grykes (fissures) and caves. Understanding the hydrology of a karst system is extremely difficult.

Large watercourses are more rare in the north part of the Bruce Peninsula consistent with the karst-dominated terrain of this area. Due to its impermeable dolostone bed, the peninsula is home to over 30 lakes, including Cameron, Gillies and Miller in the north. Most of the lakes are shallow and underlain by amorphous glacial deposits, such as marl. However, Lake Gillies is one of the deepest inland waterbodies in southern Ontario, with a depth of over 35 m near its eastern end.

2.3.2 Hydrogeology

The two major ground sources of water are the well-protected, regional scale, bedrock aquifers and the smaller, less-protected, overburden aquifers. There are 11 regional bedrock aquifers in the planning region. The bedrock potentiometric surface of the major deep aquifers shows a flow tendency from southeast to northwest.

Comprehensive groundwater studies have been completed for each county represented in the planning region. The studies focussed on characterization of the regional groundwater resources and well head protection area modeling. One subsequent and more task specific study was the Grey Bruce Counties Municipal Groundwater Supply Vulnerability Pilot Study (Waterloo Hydrogeologic, July 2005), which further delineated and characterized ground water sources focusing on detailed evaluations within the vicinity of the municipal water extraction wells. Further discussion is provided in Section 5.0 of this document and in the Water Budget Report.

2.3.3 Surface-Groundwater Interactions

Two key processes in surface-groundwater interaction are recharge and discharge. Recharge is the process by which water infiltrates into the ground and ultimately joins the aquifers. In discharge, the water in confined aquifers is released to the land surface or to a shallow unconfined aquifer.

Water enters and leaves groundwater through recharge and discharge. Surface and ground water systems are in continuous dynamic interaction. In order to properly understand these systems, the important features in each system must be examined. These features are grouped into components referred to as the surface component, the unsaturated zone component, and the groundwater (saturated) component.

Groundwater is an important element in the hydrologic cycle for its role as a large storage reservoir. It accepts and releases water both to and from the surface. Near the ground surface of a recharge area flow is directed downward, while a discharge area will have an upward flow near the surface.

Usually the primary recharge area for the principal aquifer is the uplands surrounding the watershed, as well as overburden not containing thick clay layers. Groundwater flow in primary recharge areas has a downward component, if present. Secondary recharge areas are where the potentiometric surface in the principal aquifer is below the ground surface. Recharge areas serve to replenish the groundwater supplies, but may also allow for introduction of contaminants into the upper most unconfined aquifer.

Groundwater discharge areas are at lower elevations than recharge areas. For a discharge to happen, the hydraulic head in the principal aquifer must be higher than the water table in the shallow unconfined aquifer. Wells with potentiometric surfaces above the top of the confining layer can be identified from well logs.

Surface water, springs, or phreatophytic plants (ones that obtain much of their water needs from the zone of saturation) can be other indicators of groundwater discharge. Surface water features, such as wetlands and streams, are fed by overburden aquifers in areas with an elevated water table.

A common way of mapping recharge and discharge areas is using water levels (piezometric patterns). Map 11 shows the groundwater recharge and discharge areas of the planning region. In nature, groundwater not only moves laterally through aquifers, but also moves vertically, in response to differences in hydraulic head between aquifers, called vertical gradients. These differences can be determined by comparing the water table elevations of the shallow aquifers with the potentiometric surface (theoretical level to which water in an aquifer would rise in a well due to natural pressure) of the deeper bedrock aquifers. Where the potentiometric surface elevation is higher than the water table elevation, groundwater flow is upward, and deeper groundwater will recharge the shallow aquifers from below.

Local overburden shallow aquifers may be influenced by surface water. The surface water features that may be recharging aquifers are lakes, wetlands, streams, hummocky terrain (see Section 5.2.6.3) and karst features. Water infiltrates from the surface through the unsaturated zone by direct precipitation and overland flow, as well as from leakage through streambeds, lakes, wetlands, fractured exposed confining layers and springs. Poorly permeable strata (e.g. clay layer) can create barriers to downward flow that can limit the amount of water reaching the underlying zone. Areas of lesser overburden thickness are usually the zones for surface-groundwater interaction. In addition, the type and thickness of surficial geology influences the rate and direction of movement.

Most local rivers show strong flows in the fall and spring, which are due to rainfall and snow melting respectively. During the rest of the year, the rivers and small creeks are subjected to groundwater base flow.

2.3.4 Climate

The climate of the planning region is influenced by its proximity to large bodies of water, namely Georgian Bay and Lake Huron. This influence is reflected in precipitation patterns and a general lack of temperature extremes. Map 12 shows annual average precipitation amounts, while Map 13 shows average temperature by season.

According to Environment Canada, there are five Ecodistricts that cover the planning region as shown on Map 14 and described in Table 2.6. The Northern Bruce Peninsula SPA is in Ecodisrtict 550; much of the Grey Sauble SPA is in Ecodistrict 551; the eastern part of the Saugeen Valley SPA is in Ecodistrict 556; and the western part of the Saugeen Valley SPA is in Ecodistricts 557 and 558. Based on the Canadian normals for the period from 1961-1990, the mean annual precipitation in the planning area is approximately 980 mm, of which approximately 25% is snowfall (as water). Precipitation is evenly distributed across the region, with a slight increase in average precipitation toward the south (Environment Canada, 1997).

TABLE 2.6 – Characteristics of Ecodistricts in the Planning Region (Canadian Ecodistrict Climate Normals 1961-1990. December, 1997 (revised) http://sis.agr.gc.ca/cansis/nsdb/ecostrat/district/climate.html)

Parameter	***Ecodistrict 550***	***Ecodistrict 551***	***Ecodistrict 556***	***Ecodistrict 557***	***Ecodistrict 558***
Elevation Minimum (m)	176	170	243	176	221
Elevation Maximum (m)	341	518	541	426	480
Elevation Mean (area based mean) (m)	183.9	237.3	455.0	243.6	346.4
Effective growing degree-days	1609.2	1844.1	1667.4	1894.7	1826.3
Precipitation surplus/deficit (mm) Penman method	323.74	377.48	418.75	425.45	413.39
Total precipitation (mm)	870.4	990.5	988.5	1053.0	1022.9
Total snowfall (cm)	247.4	284.4	272.6	280.6	258.4
Total rainfall (mm)	653.5	705.4	726.3	777.0	769.3
Average daily mean air temperature (^{o} C)	5.7	6.4	5.4	6.7	6.3
Average daily minimum air temperature (^{o} C)	1.2	1.7	0.5	1.8	1.4
Average daily maximum air temperature (^{o} C)	10.0	11.1	10.1	11.6	11.0

In the winter, cold, dry Arctic air flows from the northwest, but increases in temperature and moisture as it crosses over the comparatively warmer Great Lakes. When it reaches the land, the moisture condenses as snow, creating heavy snowfalls on the lee side of the lakes in areas frequently referred to as snowbelts. As well, weak, Pacific air masses from the west and warmer, more humid air masses from the Gulf of Mexico affect the Great Lakes basin.

By early spring, the warmer air and increased sunshine begin to melt the snow and lake ice. The lakes are slower to warm than the land and tend to keep adjacent land areas cool, thus prolonging cool conditions sometimes well into April. In summer, shoreline areas tend to be cooler than inland sections of the planning region due to the moderating effect of the Lake's relatively cool waters. In the autumn, the rapid movement and occasional clash of warm and cold air masses through the region produce strong winds (US EPA and Environment Canada, 1995).

Precipitation data for the SPR is available from the Environment Canada National Climate Archive (http://climate.weatheroffice.ec.gc.ca/). More than 40 stations have been used across the planning region to record precipitation and other weather information. The period of record in some instances, though, may be as little as one year. Only a handful of stations that are currently active have greater than 30 years of data collection, which is the length of time commonly used for calculating averages.

Precipitation amounts vary from approximately 746 to 1138 mm per year, and are highest in the areas that are in the lee of Lake Huron, largely as a result of lake-effect precipitation during the winter months. Based on the available data, there is a large amount of precipitation that falls over the region from November through January. Snowfall may represent as much as 40-50% of the annual precipitation, highlighting the importance of the spring freshet to runoff conditions in the region.

In addition, total precipitation is larger in the winter months (i.e. November-March), although this trend is more pronounced in the northern portion of the region. Monthly precipitation amounts typically decrease from January to April and gradually increase from May to December. These trends are typical at the four stations. The highest mean annual precipitation amounts were found at the Wiarton station (1169 mm), followed by the Chatsworth (1054 mm), Hanover (1044 mm) and Kincardine (941 mm) climate stations.

At present, no snowfall records are available for the study area. Snow depth measurements are recorded bi-weekly in the winter months. The lack of snowfall data is considered a data gap for the area.

2.3.5 Climatic and Meteorological Trends

A study by Hamilton and Whitelaw (1999) looked at past trends from select weather stations along the Niagara Escarpment, including Wiarton, Owen Sound and Chatsworth. Overall, the trends show a recent increase in mean and minimum temperatures and in total precipitation and rainfall. The most significant changes are winter and spring warming and increased rainfall in the fall season. Cooling conditions existed in the early 1900s, warming into the early 1950s, cooling to the late 1970s, and then subsequently warming. At Wiarton, the mean annual temperature showed an overall increase of 0.7 ^{O}C with winter and spring having the greatest increase. Significant increases of 1.4 ^{O}C were detected in annual minimum temperatures with summer showing the greatest increase. Annual maximum temperature showed little change, while the daily temperature range declined by 1.5^{O}C.

There was an increasing trend in annual precipitation, such as the 16% increase experienced at Owen Sound. All stations showed increasing trends in annual and fall rainfall. Owen Sound was up by 27% in annual total rainfall and 71% greater winter rainfall. Most stations showed declining trends in annual, fall and spring snowfall, although Owen Sound had increasing annual and winter snowfall.

The latest, most reliable projections of future climate change combine 100 years of historical data for Southern Ontario with the most up-to-date general circulation models of the Earth's climate system. "Confronting Climate Change in the Great Lakes Region" utilized the results from two general circulation models in their projections on climate: the Parallel Climate Model (PCM) and the HadCM3 model (Union of Concerned Scientists and The Ecological Society of America, 2003). In general, the climate of Southern Ontario will grow considerably warmer and probably drier during this century, especially in the summer. A 3 to 7°C rise in winter temperatures and a 4 to 8°C rise in summer temperatures by the end of the century are projected. Overall, extreme heat will be more common and the growing season in southern Ontario could be four to seven weeks longer. As a result of these changes, it is predicted that, by the 2030 summer in southern Ontario, it may feel more like present-day summer in upstate New York. Changes by 2095 are expected to be much more drastic, however, with summers feeling like those in northern Virginia today.

Annual average precipitation may slightly increase, with precipitation increasing in winter by 15–40% and possibly changing in summer by +20% to –5% in the southern part of the province. In summer, Ontario may well see drier soils and perhaps more droughts. Extreme events: The frequency of heavy rainstorms, both 24-hour and multiday, will continue to increase. Although average annual precipitation may not change much, an overall drier climate is expected because rainfall cannot compensate for the increase in evaporation resulting from greater temperatures. Thus, Ontario may see drier soils and more droughts. Seasonally, winter precipitation is expected to increase by 10-30% while summer precipitation is expected to remain the same and the frequency of heavy rainstorms will increase. Declines in ice cover on the Great Lakes and inland lakes have been recorded over the past 100-150 years and this trend is expected to continue. The trend is moderated somewhat in areas of lake-effect snow. The water level of Lake Huron could, by 2030, decrease by 1.3 to 4.6 m.

2.4 Naturally Vegetated Areas

Wetlands, wooded areas and vegetated buffers are part of a healthy watershed. The natural capacity to filter or alter contaminants, as well as trap sediments and soil, can help protect drinking water sources.

2.4.1 Wetlands

The planning region has a diverse mix of wetland types that cover approximately 530 sq km (6.15% of the planning region). Table 2.7 lists the percentage of land area that wetlands occupy in the subwatersheds of the planning region. There are several sites that have been classified as provincially significant and are highly regarded for their natural features.

Four types of wetlands are recognized under the Ontario Wetland Classification System: bog, fen, marsh and swamp. Swamps are wooded wetlands with 25% cover or more of trees or tall shrubs. Standing to gently flowing water occurs seasonally or persists for long periods on the surface. Marshes are wet areas periodically inundated with standing or slowly moving water, and/or permanently inundated areas characterized by robust emergents, and to a lesser extent, anchored floating plants and submergents. Fens are peatlands characterized by surface layers of poorly to moderately decomposed peat, often with well-decomposed peat near the base. The waters and peat in fens are less acid than in bogs. Bogs are peat-covered areas or peat-filled depressions with a high water table and a surface carpet of mosses, chiefly Sphagnum. The water table is at or near the surface in the spring, and slightly below during the remainder of the year.

Only about half of the wetland areas shown on Map 15A are classed by the four types, while the remainder have not been delineated under the classification system. Map 15B identifies wetlands as provincially significant or locally significant. Table D1 in Appendix D contains a listing of the features of evaluated wetlands in the planning region.

There are few coastal marshes in the planning region. With the exception of bays along the Lake Huron shoreline of the Bruce Peninsula, the coast is exposed to wave action and does not afford the shallow and sheltered waters that promote marsh development. Neither are riverine marshes very common. The largest marshlands in the planning region are the Bognor Marsh, the headwaters of Wodehouse Creek, along Hepworth Creek and the shores of Arran, Boat and Isaac Lakes.

Swamp is the most abundant wetland type and is a component of the majority of wetland complexes in the planning region. Pockets of swamp can be observed in low-lying areas near watercourses where they provide storage capacity and alleviate downstream flooding in times of high water. The Greenock Swamp, located in the western parts of the Municipality of Brockton and Municipality of South Bruce, covers nearly 9000 hectares and is the largest forested wetland in Southern Ontario. Other notable sites are in the headwaters of the Saugeen, Sydenham and Pottawatomi Rivers. (see Map 15A)

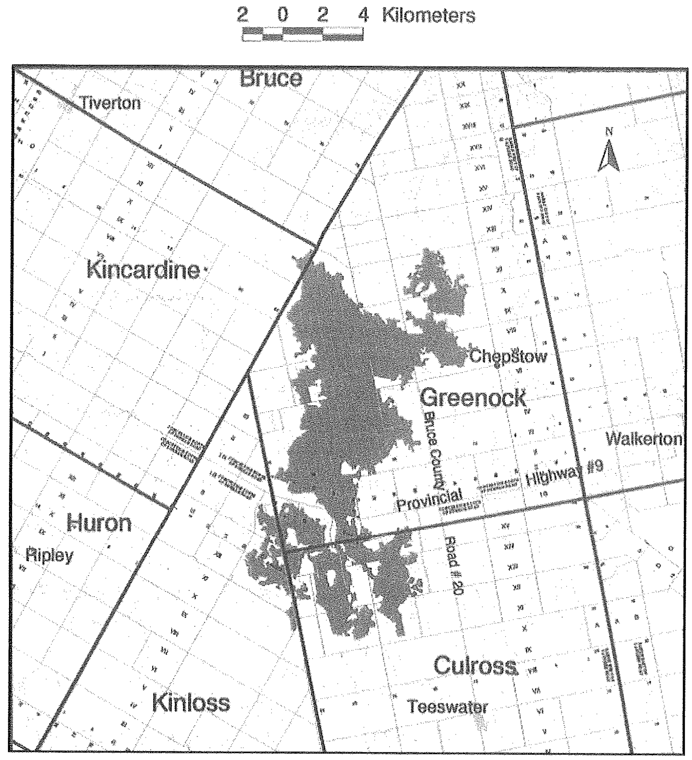
The Greenock Swamp has a long history of logging, which contributed significantly to the local economy from 1879 to 1920. Every year for 25 years, over 5,000,000 board feet of white pine was extracted from the swamp.

In 1982, the MNR selected the Greenock Swamp as a life science Candidate Nature Reserve (CNR). In 1983, the swamp was identified as a provincially significant Area of Natural and Scientific Interest (ANSI). In 1989, the swamp was classified as a Class 1 wetland, the highest provincial ranking of a wetland system.

There are many biological highlights in the Greenock Swamp. A number of ferns, four trillium species, and 22 different species of orchids reside in the swamp. There are eight provincially rare plant species in the Greenock, six are nationally rare and two of which are threatened.

The Greenock Swamp is home to over 25 species of mammals, 17 species of amphibians and reptiles and at least 100 bird species. The Barred Owl (Boreal species), and the Red-Shouldered Hawk are two provincially rare species both located in the Greenock Swamp. Two other provincially rare birds live in the swamp: the American Coot and the Cerulean Warbler (SVCA, 2003).

Local Setting of the Greenock Swamp



(Copied from the "Greenock Swamp, Area of Natural & Scientific Interest (A.N.S.I.), a Life Science Inventory", J. Johnson 1994, Ministry of Natural Resources.)

A small number of bogs are located throughout the planning region. They are typically found in the company of swamp and marsh habitats, with the bog comprising less than a third of the wetland complex area. Two of the largest bogs are found in the Beaverdale Bog Wetland and the Turner-Gillies-Wilcox Lakes Complex that hosts such interesting species as pitcher plant, black spruce, buckbean, cranberry and goldthread. Other notable bogs are the Glammis Bog and Letterbreen Bog. The Tobermory Bog includes a 20 hectare parcel with acid-tolerant species, such as leatherleaf, round-leaved sundew and Labrador tea.

TABLE 2.7 – Wetlands as a Percentage of Land Area in Subwatersheds in the Planning Region
(Derived from data in MNR's Natural Resources Values Information System (NRVIS))

Subwatershed	***Area of Subwatershed (km^2)***	***Total Area of Wetlands (km^2)***	***% of Subwatershed Covered by Wetlands***
Saugeen Valley SPA			
Beatty Saugeen River	272.81	22.07	8.09
Main Saugeen River	1695.26	81.96	4.83
North Saugeen River	269.19	18.65	6.93
Penetangore River	181.69	1.82	1.00
Pine River	160.14	0.89	0.56
Rocky Saugeen River	281.75	19.45	6.90
South Saugeen River	795.00	66.48	8.36
Teeswater River	682.07	120.20	17.62
TOTAL	4337.9	331.5	7.64

Subwatershed	Area of Subwatershed (km^2)	Total Area of Wetlands (km^2)	% of Subwatershed Covered by Wetlands
Grey Sauble SPA			
Beaver River	617.51	52.01	8.42
Big Bay Creek	9.33	1.61	17.26
Bighead River	350.89	15.24	4.34
Bothwell's Creek	63.10	0.49	0.78
Gleason Brook	44.92	4.41	9.83
Indian Brook	33.96	0.10	0.30
Indian Creek	81.07	8.73	10.77
Johnson Creek	19.03	0.08	0.44
Keefer Creek	38.82	1.97	5.06
Little Beaver River	14.36	0.00	0.00
Orchard Creek	14.08	0.02	0.16
Pottawatomi River	113.22	21.72	19.18
Rankin River	221.76	29.08	13.11
Sauble River	692.80	59.73	8.62
Stoney Creek	31.22	4.89	15.67
Sucker Creek (S. Bruce Peninsula)	46.39	4.28	9.23
Sucker Creek (Meaford)	36.73	0.12	0.34
Sydenham River	198.72	15.76	7.93
Waterton Creek	57.10	0.11	0.20
TOTAL	2685.0	220.3	8.21
Northern Bruce Peninsula SPA			
Black Creek	10.77	1.85	17.14
Brinkman's Creek	31.98	1.69	5.27
Crane River	83.44	4.82	5.78
Judges Creek	85.85	5.03	5.86
Old Woman's River	29.15	1.62	5.57
Sadler Creek	17.93	1.52	8.48
Sideroad Creek	45.28	3.07	6.78
Spring Creek	53.83	6.68	12.40
Stokes River	77.09	7.95	10.31
Willow Creek	18.68	0.87	4.65
TOTAL	454.0	35.1	7.73

Fens are fairly widespread in the planning region, with about 20 being greater than 10 ha in size. Howdenvale and Harrison Lake are the only two wetland complexes in the planning region where fen is the dominant wetland type. Generally fen habitat occurs in conjunction with swamp or marsh dominated sites. Dorcas Bay features a large fen inland from the coastal dunes and is home to orchid species, including ram's head, yellow lady's slipper and fringed polygala. Also on the Bruce Peninsula, Howdenvale Bay Wetland is a coastal wetland covering 36 ha, of which two-thirds is fen. At Baie du Dore, adjacent to the Bruce Nuclear Power Development, the 45 ha fen is dominated by grasses and sedges, as is typical of fen habitat.

2.4.2 Woodlands and Vegetated Riparian Areas

Woodlands can increase infiltration to shallow groundwater areas and decrease the speed of overland flow. The riparian zone is the land adjacent to rivers and streams. The riparian zone has no definite boundaries, but is the larger transitional area between the water surface and the upland (Ontario Cattlemen's Association, 2005). Vegetation contributes to the functions of the riparian zone and can vary greatly from lush forest or dense brush to grassy meadow or muddy bank. Riparian areas control the flow of water, sediments, nutrients and organisms between the upland and aquatic communities. They act as wildlife corridors, help in-stream water quality, serve as reservoirs for flood waters, control erosion and may contribute to groundwater recharge.

Map 16 shows the naturally vegetated areas in the planning region. No comprehensive data exists on the extent of riparian areas in the SPR, nor the composition of vegetation in those areas.

2.4.2.1 Woodlands

The planning region features hardwood forests characteristic of the Great Lakes - St. Lawrence Lowlands forest type, although a larger proportion of coniferous trees occur in northern areas. There is a marked decrease in the percentage of forested areas on the landscape from north to southwest.

Prior to, and at the time of settlement, extensive forests covered the planning region. Across a large portion of the watershed, forests were removed to make way for agricultural crops. As a result, by the early 1880's these once forested areas were reduced to the farm woodlots that can be observed today. In many places, the cleared land proved to be marginal farm land and was later abandoned or removed from farming. A small fraction of this land has since been returned to forest cover. Most of the Greenock Swamp, the Osprey Wetlands, and other smaller wetlands, were never cleared due to excessive soil moisture.

Large tracts form a relatively contiguous forest cover in the northern Bruce Peninsula. Significant sections of cedar scrub can be found where bedrock is very close to the surface. The southern half of the Bruce Peninsula retains about half of its land cover as forest. In eastern parts of the Grey Sauble SPA and Saugeen Valley SPA, land clearing has created a more fragmented set of woodlands. However, many of the rolling hillsides and swampy lowlands remain forested. The western half of the Saugeen Valley SPA has the lowest percentage of woodland in the planning region. Much of the land has been cleared for pasture and crops. The remaining pockets of forest tend to be isolated woodlots back in from roadways, sometimes referred to as "the back forty". These smaller blocks do not provide "interior" habitat that is preferred by certain wildlife and plant species; however, the woodlands still provide valuable ecological functions.

2.4.2.2 Vegetated Riparian Areas

As a general statement, most watercourses in the planning region have natural vegetation in the riparian zone along a high proportion of their length. The Northern Bruce Peninsula SPA and eastern parts of Grey Sauble SPA and Saugeen Valley SPA have the highest occurrence of forest in riparian areas. Parts of the Sauble River, Pine River and watercourses in the western Saugeen Valley SPA have the lowest proportion of vegetated riparian area. Extension programs and the promotion of best management practices have increased the occurrence of vegetated riparian buffers and reduced the number of farms where cattle are allowed to directly access watercourses and riparian areas.

A buffer strip is a strip of vegetation that has been planted or left beside a natural area to protect it from surrounding land uses. A buffer strip has many important functions and benefits. A properly function buffer strip acts as a living filter, trapping and treating sediments and other minerals. Buffer strips also help in stabilizing streambanks and preventing soil erosion. They also increase the soil's water holding capacity, reducing the impacts of flooding and droughts. A healthy riparian and buffer zone provides fish and wildlife habitat through added shade, cleaner and cooler water and superior plant variety (Ontario Cattlemen's Association, 2005).

2.5 Aquatic Ecology

Comprehensive Source Protection offers ancillary benefits beyond protecting water for drinking purposes. Maintaining high standards for drinking water also provides a necessary medium for healthy aquatic flora and fauna, terrestrial wildlife, and recreational opportunities. Aquatic plants and animals (fish, macroinvertebrates) serve as a feedback, or indicator, of present water quality characteristics. Having a good understanding of species richness and diversity provides information on water quality trends within streams over time based on the presence and/or absence of aquatic organisms. Aquatic organisms can be an initial indication of perturbations within a stream network.

Appendix B provides a comprehensive bibliography of studies and reports that have been completed by various agencies and have relevance to the planning region. Many of these studies are directly or indirectly related to fisheries, aquatic habitat, and water quality.

2.5.1 Fisheries

Neither CA in the planning region has a fisheries department. The fisheries studies completed in the SPR are done by the MNR, the DFO and other consultant companies. The region has a diverse amount of fish inhabiting the water. The headwaters of the Saugeen are home to brown trout and brook trout (Bruce County tourism). "You will find the Saugeen River one of Ontario's best trout and salmon runs" (SVCA website). Tables C1 and C2 in Appendix C summarize the various fish types and the year of last sighting or collection. Although the tables do not provide an indication of the amounts or health of the various populations, it does serve to provide a general overview of the types of fish species that can be expected within the watersheds.

There was a fish community study completed in 2005-2006, at 25 sites throughout the Saugeen watershed. The goal was to update the species list, and verify the presence/absence of fishes-at-risk. There were 1344 fish captured, representing 45 species; two of which are at risk, the black redhorse shiner, and the pugnosed shiner (D. Marson, N.E Mandrak and A. Drake). A Drain Classification study was carried out by SVCA 2000-2002, which was funded by the DFO. The purpose of the project was to produce fish habitat classifications for all the municipal drains within the SCVA's jurisdiction. Categorization (i.e. coldwater vs. warmwater) of streams in Grey and Bruce Counties is provided in the Owen Sound District Fisheries Management Plan, 1986-2000, Ontario Ministry of Natural Resources. This document serves as the primary tool for planning purposes in this region.

The thermal regime for streams in the planning region is illustrated in Map 17 and listed in Table 2.8. Most streams and inland lakes in the region would be categorized as coldwater from the significant input of groundwater in the region. Although coolwater and warmwater fish species are important from a management perspective, the most desirable and the highest level of management typically required in streams and inland lakes is for coldwater species. The Fisheries Management Plan strives for ideal conditions that support healthy fish stocks, which indirectly helps maintain stream water quality by providing essential forest cover, protection of recharge areas, wetlands, and other natural features. Many of the streams within the SPR do have excellent naturally sheltered segments (SVCA website). As the regime of the stream changes, most often the fish species will change, which may be an indicator of degradation in suitable aquatic and drinking water conditions.

TABLE 2.8 - Classification by Thermal Regime of Streams in the Planning Region (MNR, 2000)

Saugeen Valley SPA	
Subwatershed Name	***Thermal Regime: Streams***
Beatty Saugeen River	Cold: Beatty Saugeen River, McGillvary Creek, Norman Reeves Creek, Skunk Creek
Main Saugeen River	Cold: Allen's Creek, Bluewater Lakes Tributary, Brown's Creek, Bunessan Creek, Cameron Creek, Camp Creek, Deer Creek, Durham Creek, Habermehl Creek, Little Spring Creek, Louise Creek, McDonald Lake Tributary, McMillan Creek, Mountain Creek, Otter Creek, Ruhl Creek, Silver Creek, Snake Creek Tributary, Styx River, Varney Creek, Vesta Creek, Willow Creek Cold /Cool: Pearl Creek, Saugeen River Cool: Burgoyne Creek, Little Mill Creek, Mill Creek, Snake Creek
North Saugeen River	Cold: Hamilton Creek, Middleton Creek, Negro Creek Cold /Cool: North Saugeen River Cool: Walker Lake Tributary Warm: Stewart Lake Tributary
Penetangore River	Cold: Kincardine Creek, North Penetangore River, Penetangore River
Pine River	Cold: Clark Creek Cool: Pine River Warm: South Pine River
Rocky Saugeen River	Cold: Barhead Creek, Black's Creek, Markdale Creek, Rocky Saugeen River, Traverston Creek Cold /Cool: McKechnie Creek Cool: Bell's Lake Tributary
South Saugeen River	Cold: Bell's Creek, Carrick Creek, Cemetary Creek, Fairbanks Creek, Letterbreen Creek, South Saugeen River, Woodland Springs Creek Cold/Cool/Warm: Meux Creek Cold/Warm: Coon Creek Warm: South Saugeen River Tributary
Teeswater River	Cold: Allen's Creek, Alps Creek, Black Snake Creek, Formosa Creek, Muskrat Creek Cold/Cool: Greenock Creek, Teeswater River Cold/Warm: Belmore Creek Cool: Kinlough Creek, Plum Creek, Schmidt Creek, Snake Creek
Lake Fringe	Cold: Andrews Creek, Little Sauble River, Tiverton Creek, Underwood Creek

Grey Sauble SPA	
Subwatershed Name	**Thermal Regime: Streams**
Beaver River	Cold: Beaver River, Black's Creek, Blind Creek, Eugenia Falls, Flesherton Creek, Kolapore Creek, Little Beaver River, Mill Creek Cold/Cool: Boyne River, Wodehouse Creek Cool: Lake Eugenia Tributary, Wilcox Lake Tributary Cool/Warm: Duncan Lake Tributary
Big Bay Creek	Cool: Big Bay Creek
Bighead River	Cold: East Minniehill Creek, Minniehill Creek, Rocklyn Creek, Walter's Creek Cold/Cool: Bighead River
Bothwell's Creek	Cold: Bothwell's Creek
Gleason Brook	Cold: Gleason Brook
Indian Brook	No data
Indian Creek	No data
Johnson Creek	Cool: Johnson Creek
Keefer Creek	Cool: Keefer Creek
Little Beaver River	No data
Orchard Creek	Cold: Orchard Creek
Pottawatomi River	Cold: Davidson Creek, Maxwell Creek Cold/Cool: Pottawatomi River Cool: Kilsyth Creek
Rankin River	Cold: Albemarle Brook, Clavering Creek, Givens Creek Cool: Rankin River
Sauble River	Cold: Arkwright Creek, Cashore Creek, Desboro Creek, Grimston Creek, Keady Creek, Maryville Creek, Sauble River, Spring Creek, Tara Creek Cool: Hepworth Creek, Kirkland Creek, Parkhead Creek, Sauble River Tributary
Stoney Creek	Cold: Stoney Creek
Sucker Creek (S. Bruce Peninsula)	Cold: Sucker Creek
Sucker Creek (Meaford)	No data
Sydenham River	Cold: Armstrong Creek, Conger's Creek, Marshall's Lake Tributary, North Spey River, Spey River, Sydenham River
Waterton Creek	Cold: Waterton Creek
Lake Fringe	Cold: Colpoy's Creek, Mallard Creek, Sunnyside Beach Creek, Walser Creek

Northern Bruce Peninsula SPA	
Subwatershed Name	**Thermal Regime: Streams**
Black Creek	Cool: Black Creek
Brinkman's Creek	Cool: Brinkman's Creek
Crane River	Cold: Crane River
Judges Creek	Cold: Judges Creek
Old Woman's River	Cool: Old Woman's River
Sadler Creek	Cold: Sadler Creek
Sideroad Creek	Cool: Sideroad Creek
Spring Creek	Cold: Spring Creek
Stokes River	Cool: Stokes River Warm: Chin Creek
Willow Creek	Cold: Willow Creek
Lake Fringe	Cold: Dorcas Bay Creek

Limited thermal studies exist in the watershed region and few are recent. There are ongoing temperature studies being done by the two Conservation Authorizes, which commenced in 1999, however, they are not directly related to fisheries but do help indicate coldwater and warmwater streams. One such study was completed on the Bighead River, Grey County (Henderson, Paddon and Associates Ltd., 1999). The purpose of the study was to evaluate the thermal stability within the watershed. The study concluded that coldwater and coolwater fish habitat, typically first and second order streams, are few and are sensitive to external stresses such as human and beaver made dams, vegetative cover, and interference from livestock. The study identified varying rates of thermal change and classified the warming rates.

2.5.2 Aquatic Macroinvertebrates

Currently, the Ontario Benthos Biomonitoring Network (OBBN) has a database that can be used to compare sampled sites to benchmark sites (considered pristine) for a measure of aquatic integrity. Macroinvertebrates (MIs) are easy to study and serve as a good indicator of water quality conditions. MIs are readily available within the stream network, exhibit different responses among species, are not highly mobile, and can provide evidence of conditions over time. Biomonitoring of this sort is not without its problems. Although most problems can be overcome with the correct experimental design, MIs may not necessarily react to all stresses within the stream, and distribution and abundance can be affected seasonally and by multiple unknown perturbations.

Map 18 shows the location of biomonitoring sites in the planning region. A more complete discussion of macroinvertebrates can be found in Section 3.6.

2.5.3 Species and Habitats at Risk

Recovery and management of species population and conservation of vital habitat are essential to preventing the loss of biodiversity. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is responsible for assessing wild plants and animals, and then determining if the species are at some risk of disappearing from the wild in Canada. The various designations are: Endangered - Regulated; Endangered - Not Regulated; Threatened; Special Concern (formerly Vulnerable).

Sustainable development is necessary to prevent degradation and loss of habitat for the species at risk, and help to prevent extinction. The greatest stressors now facing the regions' natural communities and wildlife are those related to human activity. Development, water management conflicts, invasive species, agricultural runoff and climate change each have major consequences for species, ecosystems, and habitats throughout the region. No thorough study of the occurrence of these species has been compiled for the SPR. Range maps that are available from the Species at Risk/Royal Ontario Museum websites, indicate there are 18 species at risk whose ranges overlap within the SPR. These species include fish, amphibians, reptiles, and vascular plants. Many of the species dwell throughout the watersheds, and certain species have a particular area they occupy. See Table 2.9 Fish, Amphibians, Reptiles, and Vascular Plants at Risk in the SPR.

TABLE 2.9 Fish, Amphibians, Reptiles, and Vascular Plants at Risk in the Planning Region (Species at Risk, Environment Canada website)

Status	***Fish***	***Amphibians***	***Reptiles***	***Vascular Plants***
Extinct	• Deepwater Cisco			
Endangered	• Lake Sturgeon • Redside Dace • Shortnose Cisco • Pugnosed Shiner	• Jefferson Salamander	• Spotted Turtle	
Threatened	• Shortjaw Cisco • Black Redhorse Shiner		• Blanding's Turtle • Butler's Gartersnake • Massasauga • Queen Snake • Eastern Ribbonsnake • Milksnake • Northern Map Turtle	
Special Concern	• Deepwater Sculpin • Northern Brook Lamprey	• Hungerford's crawling water beetle*		• Hills Pondweed

* Not officially "at risk" in Ontario; endangered in USA

The redside dace is a species-at-risk in Ontario and inhabits streams within the Saugeen SPA. In 2004, the MNR and Ontario Streams, undertook a monitoring project for redside dace in the Saugeen SPA. The study consisted of 27 sites, 24 of which were based on historical evidence that the redside dace inhabited the site, and three of which were added due to the lack of historical data of the present of the dace. Results from the study demonstrate only three of the 27 sites still supported the redside dace. Maintaining adequate water quality and understanding quantity within areas that provide habitat for the redside dace is paramount in protecting the species.

The northern brook lamprey is a species of concern within the entire SPR. The decline in population could be attributed to the application of non-selective chemicals that have been introduced into streams to control the invasive sea lamprey (ROM, 2008.

While not officially designated as “at risk” in Ontario, the Hungerford’s Crawling Water Beetle is only found in Canada at sites in the Grey Sauble SPA and Saugeen SPA, such as in the North Saugeen River near Chesley. This beetle species is classified as endangered by the U.S. Fish and Wildlife Service. There are no noted changes in water quality since the first occurrence, not to say changes have not occurred, just that they have not been studied.

2.5.4 Invasive Species

Non-native, aquatic species have been introduced over the years into Ontario lake and stream systems. Typically, these species can negatively affect water quality; compete for food resources and damage vegetation and stream substrate that serves as habitat. The potential result is a decrease in the numbers of native species, which can upset the "natural" interaction amongst trophic levels.

More than 160 non-indigenous species have become established in the Great Lakes Basin, including species of plants, invertebrates, insects and fish. Little is known about the number of species or distribution in the planning region. This lack of knowledge can be considered a data gap and makes it difficult to identify potential areas that are subject to the indirect degradation of water quality.

Invasive species that have been identified in the planning region are listed in Table 2.10 (OFAH, MNR, 2007).

TABLE 2.10 Invasive Species in the Planning Region (OFAH, MNR, 2007)

Latin Name	***Common Name***
Gymnocephalus cernuus (fish)	Ruffe
Cyprinus carpio (fish)	Common Carp
Osmerus mordax (fish)	Smelt
Neogobius melanostomus (fish)	Round Goby
Petromyzon marinus (fish)	Sea Lamprey
Bythotrephes longimanus (planktonic crustacean)	Spiny Water Flea
Dreissena polymorpha (mollusk)	Zebra Mussels
Myriophyllum spicatum (plant)	Eurasian water-milfoil
Lythrum salicaria (plant)	Purple Loosestrife
Phragmites australis (plant)	Common Reed
Heracleum mantegazzianum (plant)	Giant Hogweed

2.6 Human Characterization

Land use and population are significant elements in Source Protection Planning. A spatial analysis of what human activities are occurring in relation to sources of drinking water will help reveal potential risks. As well, understanding the distribution of people will further show the reliance on particular water sources and potential impacts.

2.6.1 Population Distribution and Density

Approximately 160,000 people live in the Saugeen, Grey Sauble, Northern Bruce Peninsula SPR (Census, 2001). The population figures for each municipal jurisdiction, or portion falling within the planning region, are given in Table 2.11. Owen Sound is the most populous municipality in the planning region. Six others are in the order of 10,000 people in size. With the exception of Hanover and Owen Sound, each municipality is comprised of towns, villages, hamlets and rural areas.

Population density is illustrated in Map 19. The largest concentration in the planning region occurs in Owen Sound where density averages more than 1,000 people per square kilometre. Hanover has almost 700 people per sq km. Similar concentrations can be found in the larger urban centres, such as Port Elgin, Kincardine, Walkerton, Durham and Meaford. The vast majority of the planning region averages less than 20 people per sq km. The lowest population densities occur in the farmlands back in from Lake Huron and in the northern Bruce Peninsula.

TABLE 2.11 - Population and Densities for Municipalities in the Planning Region (2001 census)

Municipality	***Total Population*****	***Total Area (km^2)*** # +	***Population Density*** *(people per km^2)*
City of Owen Sound	25,587	23.4	1093.5
Clearview Township*	27	2.3	11.7
Municipality of Arran-Elderslie	6,577	466.4	14.1
Municipality of Brockton	9,658	570.0	16.9
Municipality of Grey Highlands*	8,520	793.4	10.7
Municipality of Kincardine	11,029	538.1	20.5
Municipality of Meaford	10,414	517.3	20.1
Municipality of Morris-Turnberry*	161	21.5	7.5
Municipality of Northern Bruce Peninsula	4,048	774.4	5.2
Municipality of South Bruce	6,766	482.9	14.0
Municipality of West Grey	11,741	884.3	13.3
Town of Collingwood*	122	1.4	85.8
Town of Hanover	6,869	9.9	693.8
Town of Minto*	1,815	97.3	18.7
Town of Saugeen Shores	11,388	173.2	65.8
Town of South Bruce Peninsula	8,456	552.7	15.3
Town of The Blue Mountains*	5,756	247.7	23.2
Township of Chatsworth	6,280	600.0	10.5
Township of Georgian Bluffs	10,518	604.3	17.4
Township of Howick*	282	20.8	13.6
Township of Huron-Kinloss*	3,851	251.8	15.3
Township of Melancthon*	61	10.6	5.8
Township of Southgate*	4,692	600.2	7.8
Township of Wellington North*	5,815	158.2	36.8
TOTAL	**160,433**	8402.1	19.1

Notes for Table 2.11

***** Approximated population figures. Only a portion of the Municipality is covered by the Source Protection Region. For these municipalities, new population values have been calculated based on the percentage of area covered by the SPR.

****** Population figures derived from the Statistics Canada 2001 Census of Population: Statistics Canada GeoSuite 2001 Census, Cat. No. 92F-0150-GIE © Queen's Printer for Ontario, 2005

\# Area of municipalities derived from the Statistics Canada 2001 Census of Population Dissemination Areas Cartographic Boundary File (Dissemination Areas represent the smallest unit of census measurement). Statistics Canada 2001 Cartographic Boundary Files (2nd Edition) Cat. No. 92F-0171-GIE © Minister of Industry, March 2002

\+ The cartographic boundary files provided with the census data are not intended for detailed and accurate mapping. Therefore, the reader is cautioned that values for municipal surface areas shown in the above table may differ from those used elsewhere in this document.

The role of topography, hydrology, soils, transportation and historic settlement are reflected in the present distribution of population. The importance of water-based transportation in the 1800's and 1900's resulted in the emergence of communities with good natural harbours and river links to inland areas. These natural features are uncommon on the Lake Huron shoreline, but can be found at Kincardine, Southampton, Owen Sound, Meaford and Thornbury. Water was also a significant source of power for industries, such as sawmills, grist mills and manufacturing plants. Many small and medium size communities in the SPR owe their beginnings to the water power afforded by their riverside setting.

The Niagara Escarpment has been both a barrier and an advantage to settlement. The sheltering influence of the Escarpment makes it an excellent site for fruit growing, as evidenced by the renown of the area for apple production. Population density remains fairly sparse on the more rugged sections of the Escarpment, although there is demand for residential lots. The towering slopes in Town of The Blue Mountains play host to a series of alpine resorts, which are diversifying into year-round attractions. There has been a recent surge in commercial and residential development.

The west half of the planning region is expected to grow in population by 10% over the next 20 years, whereas the eastern half is projected to have double that rate, or 20% growth. The City of Owen Sound is forecasted to have a growth pattern of 11.5% (Climans, 2002). The Ministry of Finance (2000) forecast projected growth from 1999-2021 at 7.5% in Bruce County and 8.3% in Grey County. "The County of Grey Development Charges Study" (Hemson, 2006) gives a projected increase in the number of housing units for Grey County. For the period 2006-2025, housing units would increase by 37% with more than half of this growth occurring in the Town of The Blue Mountains.

The proximity to the GTA (Greater Toronto Area) and in-migration of retirees, as well as residential and resort growth in Town of the Blue Mountains, will be a contributing factor to growth in the eastern area. Urban areas near the Bruce Nuclear Power Development are anticipating population growth in connection to construction and long-term employment prospects at the facility.

2.6.2 Land Use

Assessing the current and future land use needs of our society in general, and the needs of the Source Protection Region in particular, is a difficult task. When the different and conflicting values related to land use, including ecological values, are also taking into account, the task becomes even more daunting.

As this region is developed, and land use changes are made, they are followed by other changes on the landscape. Infrastructure must be improved and utility corridors upgraded and expanded. Development also means more demand on our resources. Not only will we require more water from our current sources, we may also need to find additional sources of water. Greater efforts will be required to protect these sources of water as we continue to generate waste requiring more landfill facilities and waste water treatment systems.

Land use in Ontario is guided by several pieces of legislation and accompanying regulations. The Planning Act and Provincial Policy Statement (PPS) are two significant components of the planning system and have application across Ontario. The Planning Act sets out the ground rules for land use planning in Ontario and describes how land uses may be controlled, and who may control them (MMAH, 2007).

The Provincial Policy Statement is issued under the authority of Section 3 of the Planning Act. It provides direction on matters of provincial interest related to land use planning and development, and promotes the provincial "policy-led" planning system. The Provincial Policy Statement recognizes the complex inter-relationships among economic, environmental and social factors in planning and embodies good planning principles. It includes enhanced policies on key issues that affect our communities, such as: the efficient use and management of land and infrastructure; protection of the environment and resources; and ensuring appropriate opportunities for employment and residential development, including support for a mix of uses (MMAH, 2007).

One of the most important tools available to us when making land use decisions is the Official Plan document. Official Plans are produced by upper and single-tier municipalities in Ontario and are used to guide development in the area over which the municipality has jurisdiction. They also guide future economic, social and land use changes within a municipality. They provide a broad policy framework for other planning documents such as bylaws.

It is important that Official Plans strive to consider and protect all interests in our society, including environmental, social, and economic, by integrating them into the decision making process. Respecting the natural environment, minimizing adverse impacts on the environment, and protecting significant features and water quality are goals of Official Plans in the SPR.

Official Plans also have as a stated objective, to establish policies that will protect groundwater recharge areas, coldwater streams, lakes and other surface waters for their habitat, recreational, ecological and drinking water benefits (Grey County Official Plan, 1997).

Numerous classes and sub-classes are designated, but can generally be divided into residential, commercial, industrial, institutional, agricultural, rural and environmental. Permitted uses and other development controls are described in the official plans. Map 20 and Map 21 illustrate land use in the western and eastern parts of the planning region, respectively.

2.6.2.1 Settlement Areas

Settlement areas are the built-up areas of urban and rural municipalities and the lands that have been designated for future development in an Official Plan. Rural lands separate the built-up pockets within the planning region. The urban areas enjoy the normal amenities of paved roads, sidewalks, street lighting, gas, cable, sewer and water. They also act as service centres for the rural areas.

Rural Areas

Rural areas are lands outside settlement areas. The planning region is predominantly rural. The population is widely dispersed in the rural areas, which is reflected by the low population densities discussed in Section 2.6.1 and shown in Map 19. In the official plans, the most productive agricultural land classes are distinguished on the maps and subject to more development constraints than the more generic ‘rural’ land use classification.

The historic settlement pattern was rectangular blocks of land with a farmhouse and barn at the end of the lane. In the last few decades, the trend has been to sever a parcel from the road frontage for residential construction and for homes to be built on previously undeveloped blocks of rural land. This has had the effect of distributing more people (and their wells) into agricultural areas.

Rural Residential

Dozens of hamlets with up to a few hundred people occur in the planning region. The typical configuration is a church, a few commercial establishments and several homes focussed near a crossroads. Alternatively, houses on estate-size lots line sections of the county roads, such as east of Rockford and the Balmy Beach - East Linton area. Nearly all of these rural residential sites are serviced by private wells and septic fields.

Significant growth is being experienced in the north-eastern part of the planning region. Subdivisions and resorts are being developed outside of established communities, but within urban designated areas or Escarpment Recreation designations.

Cottage and Camp Development

The wonderful recreational opportunities and scenic beauty of the area have attracted tourists and seasonal residents for many years. This brings a large influx of people during the warmer months, particularly to shoreline areas. In the winter, skiers and snowmobilers are drawn to the area. In many parts of the SPR, the population increases significantly seasonally. This presents different water protection challenges, especially since many of the users are not on municipal systems but are taking water directly from the surface. In addition, some areas planned for seasonal use now have year-round occupancy.

Cottage communities exist along Lake Huron and Georgian Bay, as well as the inland lakes. Some of the larger Lake Huron sites occur around Kincardine, Port Elgin, Southampton, Sauble Beach and the bays at Howdenvale, Red Bay and Oliphant. On Georgian Bay, cottage areas include Dyer’s Bay, Colpoys Bay and near Meaford and Craigleith. Boat, Isaac, Chesley, Arran, Rosalind and McCullough Lakes are among the popular inland lakes. Commercial campgrounds up to a few hundred sites in size also occur. Some of these have the benefit of municipal sewer and water.

Small lots serviced by wells and septic fields can create potential risks in these cottage areas for water quality in the lakes and for drinking water supplies. Proper maintenance and site selection, as well as appropriate sizing of septic fields, are crucial.

Some of the older wood-frame cottages are being torn down and replaced by larger, permanent homes. The change in use places substantial additional demands on water supply and increases the volume of septage needing treatment.

Urban Residential Development

Urban areas are characterized as having a high population to area ratio (density). They are distinguished by an increased percentage of impervious surfaces and a greater demand on water resources, although the density often means per capita water costs are lower and infrastructure is more efficient.

There are about 20 communities in the SPR with over a thousand residents and a similar number of smaller villages. Only a small percentage of the planning region is classed as 'urban residential'. Interspersed with the residential are the other urban land uses. Parks and amenities are located nearby for the enjoyment of the urban residents, as well as people in the outlying areas.

A diverse mix of residential housing stock occurs in the larger centres where turn-of-the-century brick homes, modern bungalows, townhouses, duplexes and apartment blocks are located.

Designated Growth Areas

Proposed growth areas are areas within the municipal boundary that are designated for future development but have not yet been developed. The proposed uses in these areas are important because they will add to water demand.

Growth can occur in vacant land parcels, through redevelopment, by conversion to denser uses or in adjoining municipalities. All municipal jurisdictions make provisions within their official plans for growth by designating land fringing the urban areas for future residential, commercial and industrial use. In some cases this is contentious because of neighbouring land uses or encroachment onto prime agricultural land. Owen Sound and Hanover have development of one kind or another over most of the land within their municipal boundaries, but are not yet "built out".

Industrial/Commercial Sectors Distribution

Major industrial sites include the Bruce Nuclear Power Development near Kincardine, manufacturing facilities in Owen Sound and wood products industries in Durham and Chesley. Other industries are widely scattered and are located in rural areas in some instances. Industrial parks have been developed in many of the larger centres. A cross-section of this sector would include: Transcontinental Printing (Owen Sound); Tenneco Automotive (Owen Sound); Bruce Power (Tiverton); Ontario Power Generation (Tiverton); Steelback Brewery (Tiverton); Commercial Alcohols (Tiverton); Pine River Cheese (Kincardine); Gay Lea Foods (Teeswater); Energizer (Walkerton); West Bros Furniture (Hanover); Durham Furniture (Durham, Hanover); Chapman's Ice Cream (Markdale); Terra Footwear (Markdale); Ice River Springs (Feversham); BTI (Thornbury); Neustadt Spring Brewery (Nesustadt); and Brick Brewing Company (Formosa). This list is by no means exhaustive, but serves to illustrate the diversity of firms operating in the SPR.

The traditional downtowns still thrive in the communities throughout the SPR. The big box stores, strip malls and shopping centres are limited in scope, with the exception of Owen Sound, Kincardine and Hanover.

2.6.2.2 Agricultural Resources

Agriculture across the planning region is highly prevalent and, for the most part, accounts for the largest percentage of total land use. Map 27 shows agricultural land use. Pasture and forage crops are the most common agricultural land uses in the planning region. The largest proportion of field crops occurs in the western portions of the Saugeen Valley SPA. This area is also characterized by a high degree of tile drainage, which assists in the drainage of excess water from the soil, thereby improving overall crop productivity. Approximately 20 percent of the total land area of the Saugeen Valley SPA is on a tile drainage system (OMAF – Tile Drainage dataset, 2005). These activities tend to diminish as you move to more northern portions of the region, particularly into the Northern Bruce Peninsula SPA where agricultural activities are less common. In general, agricultural land uses in the Northern Bruce Peninsula SPA occupy a much smaller percentage of the total land use than in the rest of the planning region.

Land capability for agriculture has been measured by the Canada Land Inventory, which is based on soil characteristics derived from various soil surveys. Map 28 illustrates the land capability for agriculture across the planning region. This data indicates that approximately 73% of the total area of the Northern Bruce Peninsula SPA has no capability for agriculture, which has been attributed to issues with surface stoniness and bedrock outcrops, topography, and excess water due to poor soil drainage. In comparison, thirteen percent of the Grey Sauble SPA has no capability for agriculture, while Saugeen Valley SPA has less than one percent of land classified as incapable of supporting agriculture.

Table 2.12 is a summary of the 2001 Census of Agriculture by Statistics Canada for Grey and Bruce Counties. According to this census, Bruce and Grey counties rank third and fifth in Ontario respectively in terms of total land area dedicated to agricultural purposes. The two counties together comprise 8.9 percent of the provincial total. In terms of farm production, both counties rank among the top producers of livestock in the province, with a population of just over 327,000 cattle and calves across the region. It is estimated that over 50 percent of all farms in the region are dedicated to the production of beef cattle alone. Dairy farms in Bruce County also directly support two major dairy processing companies in the region, Gay Lea Foods in Teeswater, and Pine River Cheese in the Township of Huron-Kinloss. Grey County is also known for its abundance of orchards, and makes up approximately 23 percent of the total provincial output of apple crops (Statistics Canada, 2001 Census of Agriculture).

TABLE 2.12 - Agriculture in the Planning Region (Statistics Canada, Census of Agriculture, 2001)

	BRUCE COUNTY		GREY COUNTY	
	Bruce	**% of Provincial Total**	**Grey**	**% of Provincial Total**
# of Farms				
Total	2,345	3.93	2,834	4.74
< 53 hectares	932	3.14	1,284	4.33
53 to 161 hectares	1,001	4.7	1,221	5.74
>=162 hectares	412	4.68	329	3.73

	BRUCE COUNTY		GREY COUNTY	
	Bruce	**% of Provincial Total**	**Grey**	**% of Provincial Total**
Land Use (Hectares)				
Cropland	149,693	4.09	128,339	3.51
Summerfallow	168	1.18	849	5.96
Tame or seeded pasture	34,326	10.96	30,694	9.80
Natural land for pasture	23,609	4.44	25,895	4.87
Other land	39,654	4.17	54,251	5.71
Total area of farms	247,449	4.53	240,028	4.39
Area owned	182,349	4.81	167,956	4.43
Area rented or crop shared	65,101	3.89	72,072	4.31
Number of Farms (with sales > $2,500) by Major Product Type				
Total with sales > $2,500	2,230	4.05	2,545	4.62
Dairy	247	3.85	206	3.21
Cattle (beef)	1,028	7.52	1,240	9.07
Hog	104	4.24	61	2.49
Poultry and egg	37	2.3	36	2.24
Wheat	14	3.54	6	1.52
Grain and oilseed	351	2.73	125	0.97
Other field crops	111	2.45	244	5.39
Fruit	9	0.52	101	5.83
Vegetable	17	1.38	14	1.14
Miscellaneous specialty	171	2.34	328	4.49
Livestock combination	93	5.75	114	7.05
Other combination	48	3.77	70	5.50
Major Field Crops (Hectares)				
Winter wheat	6,286	2.85	2,454	1.11
Oats for grain	1,537	3.74	1,685	4.10
Barley for grain	10,107	8.09	11,350	9.08
Mixed grains	8,218	9.3	11,335	12.83
Corn for grain	26,196	3.23	8,004	0.99
Corn for silage	8,173	6.32	5,302	4.10
Hay	52,635	5.19	71,292	7.04
Soybeans	29,039	3.19	8,879	0.98
Dry white beans	2,078	8.77	170	0.72
Flue-cured tobacco	0	0	0	0
Potatoes	262	1.49	29	0.17
Major Fruit Crops (Hectares)				
Apples	34	0.35	2,291	23.35
Peaches	x	-	x	-
Sour Cherries	x	-	2	0.17
Raspberries	12	2.23	14	2.69
Strawberries	25	1.24	30	1.46
Grapes	0	0	x	-
Total fruit crops	98	0.37	2,385	9.06

	BRUCE COUNTY		GREY COUNTY	
	Bruce	**% of Provincial Total**	**Grey**	**% of Provincial Total**
Major Vegetable Crops (Hectares)				
Sweet corn	38	0.19	30	0.15
Tomatoes	3	0.03	4	0.04
Green peas	14	0.15	x	-
Green or wax beans	32	0.6	2	0.05
Total vegetables	254	0.37	138	0.20
Livestock Inventories				
Dairy cows	12,980	3.57	9,543	2.62
Beef cows	29,346	7.8	32,950	8.76
Steers	45,064	13.56	30,817	9.28
Total cattle and calves	182,340	8.52	145,049	6.78
Total pigs	129,125	3.73	49,714	1.44
Total sheep and lambs	28,847	8.54	37,529	11.12
Poultry Inventories				
Total hens and chickens	829,199	1.9	1,306,747	3
Total turkeys	x	-	25,494	0.75

X = Data suppressed by Statistics Canada for privacy reasons due to small number of farms involved

2.6.2.3 Brownfields

Brownfields are abandoned, idle, or under-utilized industrial and commercial properties where the previous property use caused environmental contamination. The land may need to be cleaned up before it can be redeveloped (MOE, 2007). Brownfields are often in desirable locations, such as in communities, near downtown or along the waterfront. Some of the old tanneries, mills, and factory sites for furniture and other goods are to be found in most medium to large size communities across the planning region. Derelict gas stations and other places that are possibly contaminated with petroleum or chemical residues would also be classed as brownfields. The harbour lands of Owen Sound are prime examples of land with great development potential that would need to be assessed for remedial work before projects can proceed.

The provincial government encourages the redevelopment of brownfield sites as a way of putting the land back into productive use. As many brownfield sites are located on serviced, urban property, finding new uses reduces the need for municipalities to expand services. Additional benefits include new employment, increased economic development and, in some cases, greater retail, tourism or housing opportunities.

The Brownfields Environmental Site Registry was established under Ontario Regulation 153/04 and is administered by the MOE. Property owners may file a Record of Site Condition to show that a brownfield has been appropriately remediated and the required technical documents submitted. Once the Record is approved by the MOE, the property owner will get general protection from environmental cleanup orders for historic contamination.

The public can access information about brownfields that have been registered. As of June 2007, 10 such sites in the planning region were in the Registry. Seven former industrial sites were converted to residential use. One site was reused for commercial purposes after rehabilitation work. One site currently classified as community was converted to commercial use, while one commercial site changed to the community classification.

2.6.2.4 Landfills

Landfills are carefully designed sites used for the disposal of waste material, and have been utilized for many years. In 1998, the MOE passed a new regulation (O. Reg. 232/98), which requires Ontario landfills to offer state-of the-art environmental protection (MOE, 1998). The new standards include new and more specific requirements. For example, air emissions control and groundwater protection have become more regulated. Modern landfills are engineered to collect liquid leachate. Leachate is the liquid created from moisture and/or precipitation that filters through a landfill. The process of liquids leaching through the landfill material results in the addition of metals, minerals, organic chemicals, bacteria, viruses and other toxic materials.

In order to help prevent contamination into groundwater and surface water, a liner or membrane is installed during the construction process. This serves to collect and prevent the leachate from permeating into the ground. Site operation and maintenance is necessary to ensure that environmental controls work and monitoring facilities continue to function properly. When a landfill site has reached capacity, final closure must be completed in a method that ensures the long-term protection of the environment. The post-closure period may extend from many decades to several hundreds of years (MOE, 1998).

The locations of proposed, operational and closed landfills sites are shown in Map 22. It should be acknowledged that the database used to plot landfill positions has erroneous locations and missing locations for some landfills, which will need to be corrected.

In the past decade the amount of garbage being generated has been decreasing. This can be attributed to the 3R's, reduce, reuse and recycle. The Blue Box has kept more than 860,000 tonnes of useful materials out of landfills in 2005 (MOE, 2007). Composting has also helped to limit the amount of garbage being disposed of into our landfills. Hazardous waste days help to properly dispose of dangerous chemicals.

Municipalities keep a careful watch on how many more years their landfill site will be able to accept refuse before it reaches capacity. Long before that day, the process of identifying, getting approval and preparing a new site must begin. The site selection can be controversial because few people are eager to have that type of land use as a neighbour.

When landfills do reach capacity they are closed and referred to as 'abandoned'. Rehabilitation of the site is done and a monitoring program is prescribed. Examples of rehabilitations of closed landfill sites in the planning region have consisted of creating new public parks.

2.6.2.5 Quarries and Aggregate Extraction

Quarries and aggregate extraction locations are important to consider, as they can have potentially significant impacts on the surrounding natural and physical environment. In terms of Source Protection, it is necessary to have an understanding of the locations of these operations, as they have the potential to create adverse affects on local wetlands and can cause disturbances to the water table. Aggregate operations typically represent constructed preferential pathways to aquifers. Sand and gravel deposits, which make up the resources used for mining and aggregate extraction, also play a role in the formation of the aquifers for groundwater storage and recharge. Generally, there is a great deal of uncertainty about the overall effects of aggregate operations on groundwater flows (p. 7, Baker et al, 1995).

In addition to the affects that aggregate operations could have on groundwater sources, these types of operations can also require significant amounts of water taking for their day to day activities. Approximately 17 pit or quarry locations in the planning region currently have permits to take water for aggregate washing purposes. The majority of these operations are located in the Teeswater, Saugeen, and Beaver River watersheds and draw water from surrounding rivers, lakes, and ground water sources. Water takings for these types of operations are generally discharged back into groundwater and surface water systems after use. This recycled water has the potential to be high in suspended solids, which could have associated impacts on nearby streams and aquatic life.

Table 2.13 provides a summary of the total land area composed of pits and quarries for each subwatershed in the planning region. As can be seen in this table, a significant proportion of the total land area in the Sucker Creek, Old Woman's River, and Judges Creek subwatersheds is utilized for aggregate activities. Seven subwatershed areas, located mainly in the lower Northern Bruce Peninsula SPA and northern Grey Sauble SPA, report more than two percent of total land area for aggregates.

Map 23 illustrates the locations of pit and quarry activities in the planning region. As shown in this map, active quarry operations are concentrated in the Grey Sauble SPA and Northern Bruce Peninsula SPA, through areas characterized by the Guelph and Amabel bedrock formations of the middle and lower Silurian groups. These formations are primarily composed of dolostone, a high quality aggregate resource used primarily for construction, landscaping, and architectural purposes. Quarry operations in this area, particularly for Blue-Grey and Brown dolostone, have been conducted since the early 1900's. The region continues to be a major source of patio stone, flagstone, and polished marble (MNDM, 2003). Pit operations are more evenly distributed across the planning region, but there is evidence of higher concentrations of these activities, particularly in the central and western portions of the Grey Sauble SPA.

Current controls on pit and quarry development are covered in the Aggregate Resources Act, which was implemented in January 1990. This act controls pit development and rehabilitation through a licensing system that is administered by the Ontario Ministry of Natural Resources. Under the act, a Class "A" license is issued for extractions of aggregates in excess of 20,000 tonnes, while a Class "B" license is issued for extractions below this amount. Under the Bruce County and Grey County Official Plans, proposals for expansions or new operations are to be accompanied by the appropriate license, as well as a detailed report on the related impacts to adjacent land uses, to the physical and natural environment, to ground and surface water sources, as well as impacts to potential and existing municipal supply systems (Grey County Official Plan – Section 2.7; Bruce County Official Plan – Section 4.8).

TABLE 2.13 - Pits and Quarries by Subwatershed in the Planning Region.

Subwatershed	*Area of Subwatershed (km^2)*	*Area of Active Pits/Quarries (km^2)*	*% of Subwatershed Used for Pits/Quarries*
Saugeen Valley SPA			
Beatty Saugeen River	272.81	1.99	0.73
Main Saugeen River	1695.26	17.71	1.04
North Saugeen River	269.19	3.25	1.21
Penetangore River	181.69	0.28	0.16
Pine River	160.14	0.05	0.03
Rocky Saugeen River	281.75	1.84	0.65
South Saugeen River	795.00	2.03	0.26
Teeswater River	682.07	7.13	1.05
Lake Fringe	299.39	4.22	1.41
TOTAL and Average%	4637.30	38.50	0.83
Grey Sauble SPA			
Beaver River	617.51	3.97	0.64
Big Bay Creek	9.33	0.00	N/A
Bighead River	350.89	1.40	0.40
Bothwell's Creek	63.10	1.12	1.78
Centreville Creek	14.08	0.00	N/A
Gleason Brook	44.92	0.00	0.00
Indian Brook	33.96	0.80	2.35
Indian Creek	81.07	0.67	0.82
Johnson Creek	19.03	0.00	N/A
Keefer Creek	38.82	0.00	N/A
Little Beaver Creek	14.36	0.00	N/A
Centreville Creek	14.08	0.00	N/A
Pottawatomi River	113.22	3.68	3.25
Rankin River	221.76	4.61	2.08
Sauble River	692.80	7.49	1.08
Stoney Creek	31.22	0.18	0.56
Sucker Creek (S. Bruce Peninsula)	46.39	3.76	8.11
Sucker Creek (Meaford)	36.73	0.00	N/A
Sydenham River	198.72	4.96	2.49
Waterton Creek	57.10	0.32	0.55
Lake Fringe	472.76	4.23	0.89
TOTAL and Average%	3157.77	37.19	1.18
Northern Bruce Peninsula SPA			
Black Creek	10.77	0.00	N/A
Brinkman's Creek	31.98	0.00	N/A
Crane River	83.44	0.00	N/A

Subwatershed	Area of Subwatershed (km^2)	Area of Active Pits/Quarries (km^2)	% of Subwatershed Used for Pits/Quarries
Northern Bruce Peninsula SPA			
Judges Creek	85.85	3.85	4.48
Old Woman's River	29.15	1.30	4.45
Sadler Creek	17.93	0.00	N/A
Sideroad Creek	45.28	0.00	N/A
Spring Creek	53.83	0.00	N/A
Stokes River	77.09	0.29	0.37
Willow Creek	18.68	0.00	N/A
Lake Fringe	340.03	0.99	0.29
TOTAL and Average%	794.03	6.43	0.81

Notes for Table 2.13

Active Pit/Quarry Source: Ontario Ministry of Natural Resources "Pit or Quarry" data layer, 2005

Baker, Douglas and Darryl Shoemaker. Environmental Assessment and Aggregate Extraction in Southern Ontario: The Puslinch Case. University of Waterloo: Waterloo, Ontario, 1995. Document located at X:\SourceWater\Reports and Studies\AggregateExtractionSouthOnt.pdf

Ministry of Northern Development & Mines (MNDM). http://www.mndm.gov.on.ca/mndm/mines/mg/dimstone/intro_e.asp Last modified: 07/11/03. Last accessed: 08/05/06.

2.6.2.6 Oil, Gas and Salt Facilities

Boreholes that have been abandoned and wells with unknown status can be seen as potential areas of concern for groundwater contamination. Boreholes create a direct path into groundwater aquifers and are potentially high risk areas for contamination, particularly in the event that these wells were not properly sealed and capped. The locations of oil, gas and salt wells in the planning region are shown on Map 24.

The majority of oil, gas and salt wells in the planning region are found within the Grey Sauble SPA. They are located along the shores of Georgian Bay, with some heavier concentrations of wells in some inland areas. One such concentration can be found in the Hepworth area; the current status of most wells is unknown, but some are used for storage of natural gas underground.

The Saugeen Valley SPA has one known active private gas well located southwest of Robbtown in the Township of Southgate. The remaining 36 wells within the region have been abandoned. The Municipality of Kincardine, the Township of Huron-Kinloss, the Municipality of Brockton, and the Municipality of Southgate have the heaviest concentrations of abandoned and dry wells.

2.6.2.7 Forestry

Harvesting of forest resources has occurred since settlement times when wood was a primary source of heat and building materials. Numerous sawmills, operated by the abundant waterpower of the region, helped establish communities across the landscape. In the middle part of the twentieth century, many woodlots were 'highgraded' through the removal of large healthy trees. As a result, many of the remaining forests contain many poor quality trees. More recently, careful forest management has been undertaken in an attempt to improve forest health and residual tree quality.

Both Grey Sauble Conservation and Saugeen Conservation own thousands of hectares of forest parcels that are actively managed. As well, they have a long-standing partnership in Grey Bruce Forestry Services, which offers tree planting, managed forest plans, tending and pest control.

The County of Grey owns 3475 hectares of forest property in more than forty different tracts. These areas are managed for multiple purposes, including wildlife habitat, recreation, aesthetics, environmental protection, economics and sustainable timber supply. Bruce County owns 4850 hectares of land under its "Bruce County Forest" program, such as the Brant Tract near Paisley. Grey County has passed a Forest Management By-law, and Bruce County has a Forest Conservation By-law to encourage the use of good forestry practices.

The location of forested areas in the planning region is shown in Map 16.

2.6.2.8 Transportation

Map 25 illustrates the main transportation corridors across the planning region. Highways 6 and 10 are the main routes running north to south in the region, with the Highway 6 corridor extending up into the Northern Bruce Peninsula to Tobermory. Highway 26 provides access from the east and west along the shores of Georgian Bay, stretching from Owen Sound and through the Collingwood region. The Highway 21 corridor extends from Owen Sound westward towards Southampton where it extends to southern portions of the region along Lake Huron. The Highway 9 and 89 corridors in the southern portion of the Saugeen Valley SPA extend east and west from Lake Huron to the eastern most edge of the region. County roads provide vital links between communities, while municipal roads provide the access to businesses and properties across rural and urban areas.

Railway access across the planning region was fairly extensive at one time, but these routes have since been abandoned. Some of the former railway corridors have been converted to trail systems for recreational purposes.

Water transportation continues to play both a commercial and recreational role in the planning region. Owen Sound Harbour has commercial facilities for lake freighters and ocean-going vessels. Tobermory is host to the Chi-Cheemaun Ferry that links to Manitoulin Island. Fishing tugs operate from Port Elgin, Southampton and Tobermory, which also offers tour boats to Flowerpot Island and scubadiving sites. Marinas are located in Thornbury, Meaford, Owen Sound, Wiarton, Lion's Head, Tobermory, Sauble Beach, Port Elgin and Kincardine.

There are approximately 20 small airports scattered across the planning region. The majority of these are municipally funded airports, offering small charter and passenger flights, sightseeing tours, as well as flying schools. They are also available for storage and flights of privately owned planes.

2.6.2.9 Wastewater Treatment

Wastewater that is generated from toilets, showers, tubs, sinks and other uses generally requires treatment before it can be discharged. Urbanized areas tend to have wastewater treatment plants, whereas small communities and rural areas depend on septic systems.

Serviced and Non-Serviced Areas

In serviced areas, wastewater is discharged through a sanitary sewer system to municipal wastewater facilities, where it is undergoes a number of treatment processes. There are some two dozen treatment facilities in the SPR. The location of municipal water and wastewater treatment plants in the planning region is shown on Map 26.

In non-serviced areas, waste is typically discharged to private septic systems and holding tanks. The matter that is pumped from these systems is raw and untreated and is classified as hauled sewage. This septage may be land applied or disposed of at a sewage treatment plant, waste stabilization lagoon or landfill site (MOE, www.ene.gov.on.ca – Septage). Determining locations and conditions of these septic systems is of importance to Source Protection planning. Inadequate systems or improper treatment of sewage can lead to infiltration of pollutants and bacteria into ground and surface water sources, which may have adverse effects on overall water quality within the region.

Septic Systems & Wastewater Treatment

Various treatment technologies are used in municipal wastewater treatment facilities to achieve a significant reduction in the amount of organic matter, solids, nutrients, and pollutants prior to the effluent re-entering a body of water or being applied to the land. Sewage lagoons are used by several communities in the SPR, such as Tara, Ripley and Kincardine. Primary, secondary or tertiary treatment methods are used by other communities and may involve screening, filtering, biological digestion, settling, chemical treatment, UV treatment and other processes.

Septic systems are suitable for treating household septage provided that the system is properly constructed and maintained. In Ontario, septic systems are regulated by the Ministry of Municipal Affairs and Housing under the Building Code. Typical septic systems have a tank where solid materials settle to the bottom and lighter wastewater stays at the top. The liquid drains out of the tank and passes through a leaching bed made up of perforated pipes buried underground. Bacteria and other organisms help to digest the wastewater and the water slowly filters into the ground. Several other septic system designs are also available on the market.

A septic study was completed for Grey County in 2004 by the environmental engineering consulting firm Henderson Paddon & Associates Limited. The study entitled “Septage Management Plan for the Municipalities of Grey County” indicates that there are currently 12 municipal wastewater treatment plants servicing its nine municipalities. Each municipality has at least one treatment plant with the exception of the Township of Chatsworth. As of 2003, there were approximately 22,443 septic systems and 64 holding tanks across Grey County. This number may not be completely accurate due to the possible incompleteness of the database. The study also noted a high density of septic systems in the Grey Sauble SPA in the former Township of Sarawak (now the Township of Georgian Bluffs) near Owen Sound as well as in the Municipality of Grey Highlands near Eugenia Lake (Henderson Paddon, pp. 5-6).

Table 2.14 summarizes the number of septic systems and holding tanks by municipality for Grey County. A similar inventory of septic systems in other parts of the SPR has not been compiled.

TABLE 2.14 - Septic Systems and Holding Tanks for Municipalities in Grey County

Municipality	***No. of Septic Systems/ Holding Tanks***	***No. of Wastewater Treatment Plants***
Township of Georgian Bluffs	4,540	1
Municipality of West Grey	4,022	2
Municipality of Grey Highlands	3,838	3
Municipality of Meaford	3,048	1
Township of Chatsworth	2,792	0
Town of The Blue Mountains	2,286	2
Township of Southgate	1,870	1
Town of Hanover	99	1
City of Owen Sound	12	1
TOTAL	22,507	12

Source: Henderson Paddon, "Septage Management Plan for the Municipalities of Grey County"; 2004, p. 6
Note: Numbers may not be completely accurate due to assumptions made, incomplete records and likelihood of missing data. See discussion on p. 5-6 of "Septage Management Plan".

Stormwater Management

Another area of importance to Source Protection in terms of wastewater treatment is stormwater management policies and procedures across the planning region. Stormwater is the term used to describe the rainfall and other sources of water that are generated by urban runoff from areas such as streets, parking lots and roof drains on houses and other buildings. During storm events or floods, water flows across impervious surfaces, such as asphalt and concrete, and often comes into contact with several contaminants, such as oil, fertilizers, sediment and animal waste. Prior to discharging to a creek, wetland, pond, or lake, stormwater must be treated.

Stormwater management is the application of practices that are designed to protect downstream receiving waters from negative impacts of urban development, such as flooding, erosion, and degraded water quality (Ministry of Municipal Affairs and Housing). There are many benefits to stormwater pollution prevention including: minimizing or avoiding the creation of pollutants; using materials more efficiently; minimizing health risks; avoiding costly clean-ups; and enhancing the local environment (MOE).

Stormwater management practices in the planning region are much more prevalent in larger urban centres than in small rural locations. The City of Owen Sound, for example, has developed several initiatives and plans for surface water management. Official Plan documents stipulate that all new developments require drainage plans before construction may commence. Subdivisions may also require the installation of oil and grit inceptors in public streets, as well as the incorporation of stormwater management ponds and detention facilities into open space areas wherever possible (City of Owen Sound Official Plan, Sec. 6.2.4.6 and 6.2.4.10). The City has also been active in installing "stormceptor" units on major storm sewer outlets in order to further improve the quality of water running into the Sydenham and Pottawatomi Rivers, as well as Georgian Bay (City of Owen Sound Official Plan Background Study, Sec. 12.2.3).

2.6.2.10 Recreation

Recreation and tourism, as shown on Map 29, is very prevalent in the planning region as it offers a wealth of opportunity for outdoor activities year round. Located on the shores of Georgian Bay and Lake Huron, the region offers tourists numerous water activities during the summer months including swimming, sailing, boating, fishing, canoeing and cottaging. Innumerable beaches can be found along Lake Huron and the various inland lakes. Scubadiving is excellent in the crystal clear waters along the Bruce Peninsula, particularly at dive sites in and around Fathom Five National Marine Park. The Saugeen River is host to some of the best trout and fly fishing in Ontario and major fishing tournaments are hosted along Lake Huron and Georgian Bay, such as at Owen Sound and Kincardine.

The area is also particularly attractive to hikers as it is home to several large trail networks, including County Forest trails, Provincial Park trails, Conservation Authority trails, and over 600 km of Bruce Trail. High-quality mountain bike parks have been developed at the Brant Tract (south of Paisley), the Bruce Peninsula Mountain Bike Adventure Park (north of Wiarton) and the Carrick Tract (south of Mildmay). Spelunking can be enjoyed at numerous cave sites along the Niagara Escarpment, such as Bruce's Cave, Grieg's Caves, Scenic Caves and Duncan Caves.

An extensive network of dedicated snownmobile trails attracts enthusiastic sledders to the region. Some of the walking trails are also used during the winter months for cross-country skiing activities. Downhill skiing is a popular winter activity, particularly on the steep slopes surrounding the Beaver River Valley and Blue Mountain.

Camping is a popular pastime in the region. There are dozens of privately operated campgrounds, as well as five properties run by Saugeen Conservation, four Provincial Parks and Bruce Peninsula National Park.

While these activities offer both residents and tourists of the planning region a wide variety of recreational opportunities, it is important to note the effects that some of these activities have on water sources. Some recreational activities may have adverse effects on water quality, such as fuel, oil, and other pollutants entering water systems from boating or other water based activities.

Other activities may require large scale water takings for their operations. Downhill skiing facilities, for example, require large amounts of water for snowmaking operations. These types of facilities are concentrated mainly in the north eastern portion of the Grey Sauble SPA near the shores of Georgian Bay between Craigleith and Collingwood. There are also two downhill skiing facilities in the south end of the Beaver River watershed near Kimberley. Currently, there are six facilities in the Grey Sauble SPA with permits to take water for snowmaking operations.

The majority of these sites draw from surface sources, namely Nottawasaga Bay and the Beaver River.

Golf courses also require large water takings for irrigation of greens and fairways. There are approximately 23 golf courses spread across the planning region with permits to take water for irrigation purposes. Courses located along the shorelines tend to draw their water from surface sources including Georgian Bay, Lake Huron, and local rivers, while inland courses tend to draw from groundwater sources.

2.6.2.11 Protected Areas

Within the SPR, specific areas are protected and managed in order to deter development changes that could alter the natural character of the region. These protected sites are typically designated through national parks, provincial parks, crown lands, county forests and local conservation areas. Map 30 identifies the locations of parks and protected areas throughout the planning region.

Federally Owned Lands

Map 30 illustrates that a significant proportion of the Northern Bruce Peninsula is classified as protected area. These protected regions reflect the high degree of biological diversity as well as the number of rare species and ecosystems found in this area. The Bruce Peninsula National Park at the very northern tip of the peninsula encompasses an area of approximately 156 square kilometres; however, not all of this land is federally owned. As of 2003, approximately 22 percent is privately owned, 37 percent is owned by Parks Canada and 32 percent is provincially owned, but managed by Parks Canada under agreement with the Ontario Ministry of Natural Resources (Wildlands League, 2005). Further north at Tobermory, stretching into the waters of Lake Huron, is the Fathom Five National Marine Park of Canada. The park preserves a rich cultural heritage which includes 22 shipwrecks, several historical lighthouses, as well as the natural habitat and freshwater ecosystem.

Provincially Owned Lands

Provincial Parks are also scattered across the planning region. The Northern Bruce Peninsula SPA is home to approximately 76 sq. km of Provincial Park lands, the majority of which are classified as nature reserves. Within the Grey Sauble SPA are two nature reserves: Duncan Escarpment in the Beaver Valley; and Bayview Escarpment, just south of the Meaford Area Training Centre. Parks with this classification are generally established to represent and protect the natural habitat and land formations, and due to the fragility of the natural environment, are usually intended for education and research purposes, or passive recreational activities such as hiking or nature appreciation. Six other Provincial Parks in the planning region are designated as either Recreation Parks or Natural Environment Parks. These parks are mainly located on the shores of Lake Huron and Georgian Bay and offer visitors swimming and camping opportunities while still protecting the natural features of the area (Ontario Parks, 2002).

Other Provincially owned crown lands also occupy portions of land in the Grey Sauble SPA and more northern portions of the Saugeen Valley SPA. More than 4,400 hectares of crown lands exist in the planning region, the majority of which are located within the boundaries of the Grey

Sauble SPA. As can be seen in Map 30, there is a clustering of these lands in the Beaver River subwatershed of the Grey Sauble SPA, most of which comprise the Beaver Valley Lowlands and the Kolapore Uplands. These crown lands are managed by the Ontario Ministry of Natural Resources (MNR), who facilitates government control over land uses in these areas. The primary goals associated with these management policies are to protect terrestrial and aquatic ecosystems, preserve wildlife and habitat, ensure access by the public and resource based industries, and ensure the sustainable development of natural resources on crown lands (MNR, 1993).

A significant protected area in the planning region is the Niagara Escarpment, which is protected under the Greenbelt legislation. The escarpment is a provincially significant geological formation stretching from Niagara Falls to Tobermory at the tip of the Northern Bruce Peninsula. The Niagara Escarpment Planning and Development Act, passed in 1973, identifies seven land-use zones within the Niagara Escarpment planning region. These zones are intended to ensure that the natural features of the escarpment are maintained and that development practices within the area are compatible with the natural environment.

The Niagara Escarpment planning area covers approximately 866 square kilometres of the planning region, stretching the entire length of the Grey Sauble SPA and the Northern Bruce Peninsula SPA close to the shores of Georgian Bay. Approximately 26 percent of the total area is designated as Escarpment Natural Area, which is the most protective designation under the plan. This core area includes escarpment cliffs, forested lands, river and stream valleys, and significant ANSI's and allows for very limited types of development in these areas. As you move away from the cliff face, other land-use designations are identified, which are intended to minimize the impacts of certain land uses, while at the same time maintain the natural features of the area. Certain types of development and land uses are permitted within these zones, but are subject to some restrictions (Niagara Escarpment Commission, 2006).

County Forests

See discussion under 2.6.2.7.

Conservation Authority Properties

In addition to lands which are provincially or federally protected are those which are managed by the local Conservation Authorities. These properties provide a broad range of benefits including habitat, wetland conservation, flood control, education, recreation and forest management

Grey Sauble Conservation currently holds a total of approximately 10 812 hectares of land, of which 1055 hectares are classed as Conservation Areas, 9723 hectares are Management Lands and 84 hectares are nature preserves. Saugeen Conservation has total land holdings of 9058 hectares, with 8490 hectares being management lands and 568 hectares being Conservation Areas.

Conservation Areas are available to the public and provide outdoor recreational facilities, such as waterfalls, scenic look-outs, caves, and trails. All Conservation Areas operated by Grey Sauble Conservation are day-use sites, while Saugeen Conservation offers overnight camping facilities at Durham, Brucedale, Saugeen Bluffs, McBeath and Denny's Dam Conservation Areas.

Both authorities also own properties, which are designated for specific management and conservation purposes. Conservation Lands in the Saugeen include Conservation forests, management units, and significant wetlands and are designated as areas, which will be conserved, preserved, and managed in order to benefit future generations (Saugeen Conservation, 2003). Approximately 8 575 hectares of land in the Saugeen hold this designation and are intended for passive recreational uses such as hiking or cross-county skiing. Management Areas in the Grey Sauble, which consist of approximately 10 480 hectares, are properties that are managed for a variety of uses including forest management, fish and wildlife management, recreation, and watershed protection. Grey Sauble also holds five properties that are designated as nature preserves. Located mainly on the shores of Lake Huron and Georgian Bay, these lands have been left unmanaged in order to preserve them in a natural state, protect against further development, and to preserve sensitive natural features (Grey Sauble, 2006).

Non-Government Organization Protected Areas

Ontario Nature (Federation of Ontario Naturalists) is a non-government organization that is actively involved in the protection and restoration of natural habitats though research, education, and conservation. The organization currently owns and manages six nature reserve properties in the planning region, which they have acquired in order to protect the imperilled and vulnerable habitats in those areas. These properties are open to the public for activities such as hiking and snowshoeing on marked trails, photography, and scientific research. Activities such as hunting, use of motorized vehicles, camping, cycling, and trimming of vegetation are not permitted in these areas (Ontario Nature, 2002). The Bruce Alvar, Baptist Harbour, and Lyal Island properties in the Northern Bruce Peninsula are significant habitats for the provincially threatened eastern massassauga rattlesnake, and are characterized by unique alvars composed of dolostone bedrock formations. The Petrel Point, Malcolm Kirk, and Kinghurst Forest nature reserves in the Grey Sauble SPA and Saugeen Valley SPA serve to protect open bogs, fens, and forested wetlands with unique vegetation and wildflower communities (Ontario Nature, 2006).

Another non-profit organization with protected land holdings in the planning region is the Nature Conservancy of Canada (NCC). The agency is the largest private steward of lands conserving species at risk in Canada. The main goal of this organization is to protect threatened or ecologically rare sites through the application of conservation sciences on properties that have been donated by private land owners or purchased outright by the agency. The NCC also works with individual landowners to secure conservation easements, which limit or restrict certain types of development in order to protect the natural features of an area. Restrictions are tailored to fit the particular property, the interest of the landowner, and the natural features that are to be protected. This organization currently owns 590 hectares of land in the planning region, all of which is to remain as permanent nature preserve (Nature Conservancy of Canada, 2001).

2.6.2.12 Utilities

Utilities and the associated corridors and infrastructure extend across the SPR to supply electricity, gas, phone, cable and water to businesses and residents. The energy sector is a significant one in the SPR. The Bruce Nuclear Power Development, located between Port Elgin and Kincardine, was the first nuclear power facility in Canada. It contributes a considerable portion of Ontario's electrical capacity. Production will increase with the refurbishing of reactor units at the facility. Wind power is growing significantly with the development of several wind turbine projects near the Lake Huron shore, on the Bruce Peninsula and at other proposed sites.

2.6.2.13 Institutional Lands

Institutional properties occur in nearly every community in the form on churches, schools and community halls. As well, municipal and government offices form part of the institutional land use. These facilities are significant because of their public functions and role as a venue for community events. The buildings are often considerable in size and are also situated on large parcels of land. In rural portions of the SPR, institutional facilities may operate on their own well and septic system.

2.6.2.14 Hazard and Natural Environment Land Use

Planning policies contain a broad class of land use that encompasses hazard lands and natural features that pose a barrier to development or have significant environmental values worth protecting from development. The Grey County Official Plan states that Hazard Land includes "…floodplains, steep or erosion prone slopes, organic or unstable soils, poorly drained areas, and lands along the Georgian Bay shoreline impacted by flooding, erosion, and/or dynamic beach hazards" (Sec 2.8.1). Similar wording can be found in the Bruce County Official plan (Sec. 5.8). Use of the land may still occur, such as forestry or recreation, but the construction of buildings is generally not permitted. Provincially significant wetlands (class 1 to 3) and Areas of Natural and Scientific Interest are also included.

Conservation Authorities regulate development near watercourses, slopes and wetlands. Under the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation, permits may be required for works within or adjacent to rivers, streams, wetlands, and the shorelines of Lake Huron, Georgian Bay and inland lakes. The intent of the regulation is to ensure public safety with regard to natural hazards.

2.6.2.15 Other Land Use

Zoning maps and official plans can contain categories of land use other than those described in Section 2.6.2. Educational properties, such as Scout camps and church camps can be found near some of the lakes and rivers in the SPR.

2.7 Water Use

Water that enters the SPR is put to many uses, including human consumption, agriculture, industrial, commercial, recreational and ecological. The following discussion examines the various ways that water is used within each of these classifications. Further discussion and tables with statistics on water usage can be found in Chapter 4 of this report. For a detailed analysis of water use, refer to the Saugeen, Grey Sauble, Northern Bruce Peninsula Planning Region Draft Conceptual Water Budget (2007).

2.7.1 Data Sources

A number of sources of data for water usage are available for planning region. These data include: the Provincial Permit To Take Water (PTTW) database; the Water Well Information System; Agricultural water usage and census data; Municipal Well annual reports and Certificates of Approval; and existing groundwater studies. These data are useful for approximating the amount of water being extracted in the region. Takings from surface and groundwater sources are outlined in detail as part of the Saugeen, Grey Sauble, Northern Bruce Peninsula Planning Region Draft Conceptual Water Budget (2007). Map 26 shows water takings for municipal systems, Map 26A identifies the main types of water takings, and Map 31 plots the location of wells in the SPR.

2.7.2 Municipal Water Takings

Water takings for municipal drinking water supplies comprise a high volume of water takings within the SPR. Large portions of these takings are exploiting bedrock aquifers with no known supplies reliant on overburden aquifers. Surface water is exploited extensively along the Lake Huron and Georgian Bay Shorelines, as well as one inland lake, with no municipal water takings from rivers.

Municipal water systems are the focus of Source Protection at this time and, as a result, work is being concentrated on these systems. In general, those systems that are dependant on bedrock aquifers and Lake Huron/Georgian Bay are not likely to be considered as being under threat from a water quantity perspective either now or in the future. This is primarily the result of them exploiting a large, regionally and even internationally extensive reservoir.

Extensive studies have focused on municipal wells used for drinking water across Ontario. The various counties in the planning region have completed comprehensive groundwater studies: Grey and Bruce Counties in 2003 by Waterloo Hydrogeologic; Wellington County in 2006 by Golder Associates; Huron County in 2001 by Golder Associates, and the AEMOT Groundwater Management Study in 2001.

2.7.3 Agricultural Water Takings

Agriculture, including livestock feeding operations and irrigation, represents the largest land use within the SPR. As a result, it is also expected that the highest water takings will also be associated with these operations.

Agricultural operations rely heavily on the bedrock aquifers as a water supply, with relatively few takings from surface water. Livestock facilities are not required to obtain a PTTW and, as such, estimations of usage are best approximated from the distribution and estimated usage of different agricultural sectors.

Several previous studies have been completed in order to estimate the usage of water for the planning region that were summarized and estimated on a township scale in the Grey and Bruce Counties Groundwater Study (WHI, 2003). Water usage has also been estimated based on 2001 Statistics Canada agricultural census data using methodology developed by de Loe (2001). Takings for agricultural purposes are outlined in detail as part of the Saugeen, Grey Sauble, Northern Bruce Peninsula Planning Region Draft Conceptual Water Budget (2007).

2.7.4 Consumptive Industrial Water Takings

Consumptive water takings are those takings in which water is directly exported outside of the watershed, and includes such activities as water bottling, food processing and beer and beverage production. These takings are important as they represent the only net removal of water from the hydrologic system within the planning region. Consumptive water takings are confined to the bedrock aquifer system in the planning region, as there are no known consumptive surface water takings in the region.

These takings are regulated by the Ministry of Environment, which issues permits to the takers under the Permit to Take Water program. These takings are not known to have caused any water quantity issues in the watershed, but have been subject to public scrutiny and perceived as water quantity issues. A more detailed analysis of consumptive takings can be found as part of the Saugeen, Grey Sauble, Northern Bruce Peninsula Planning Region Draft Conceptual Water Budget (2007). Work will be targeted at areas of concentrated consumptive takings in order to evaluate the cumulative impact of these takings as part of a Tier I Water Budget, expected in the near future.

2.7.5 Non-consumptive Industrial Water Takings

Non-consumptive industrial water takings are those takings in which water is returned to the natural water system after use, and includes activities such as golf course irrigation, aggregate washing, quarry dewatering, aquaculture and takings for dams and reservoirs.

In the Saugeen, Grey Sauble, Northern Bruce Peninsula SPR these takings represent large, and important takings from the system, and commonly result in removal of water from one component of the hydrologic system (in this case, often the bedrock aquifer) and artificially directing it to another component (surface waters). This redistribution may have both positive impacts, such as augmenting stream flow in periods of drought, and negative impacts, such as releasing contaminated water, on the natural water system.

These takings are regulated by the Ministry of Environment, which issues permits to the takers under the Permit to Take Water program. These takings are not known to have caused any water quantity issues in the watershed, but have been subject to public scrutiny and perceived water quantity issues. A more detailed analysis of non-consumptive takings can be found as part of the Saugeen, Grey Sauble, Northern Bruce Peninsula Planning Region Draft Conceptual Water

Budget (2007). Work will be targeted at areas of concentrated non-consumptive takings in order to evaluate the cumulative impact of these takings as part of a Tier I water budget, expected in the near future.

2.7.6 Private Domestic Water Takings

Private consumption within the planning region almost exclusively exploits overburden and bedrock aquifers. The typical taking utilizes a drilled or, less commonly, bored well, which is then redirected into shallow overburden aquifers via a septic system. Smaller scale private takings, mostly related to recreational (cottage) properties, are also known to exploit the Lake Huron/Georgian Bay system as well as several other inland lakes.

Estimates of private usage of groundwater can be made on a municipality scale using population data, water well records and estimated usage per capita. Of particular interest to Source Protection is the amount of water that is transferred from deeper bedrock aquifers to shallower, overburden aquifers. This amount needs to be estimated properly in order to accurately represent the flow of groundwater in the area numerically.

In general, those systems that are dependant on bedrock aquifers and Lake Huron/Georgian Bay are not likely to be considered as being under threat from a water quantity perspective either now or in the future. This is primarily the result of them exploiting large, regionally and even internationally extensive reservoirs. Those systems exploiting overburden aquifers and smaller, inland lakes are more susceptible to shortages, due to the limited size of these reservoirs and their vulnerability during drought conditions.

Communal wells can be a source of drinking water for many individuals. Wells of this sort are known to occur in rural settings, campgrounds and trailer parks. As defined in Regulation 252 of the Ontario Safe Drinking Water Act, communal wells are categorized in a similar method as municipal wells. As mentioned previously, with the current data it is difficult to determine the number of wells that would meet the criteria for communal.

2.7.7 Recreational Water Usage

Recreational water use is a large economic driver within the planning region. These uses include outdoor recreation, hobby fishing, canoeing/kayaking and tourism and are focused on the major river systems, inland lakes, Lake Huron and Georgian Bay. Recreational usage of water within the planning region is generally non-consumptive and is not generally considered to impact the quantity of water in the system. However, adequate availability of water is required for the continued recreational use of these resources.

2.7.8 Ecological Water Use

The primary objective of the Source Protection program is to protect drinking water sources from contamination and over use. It is not just humans that depend on good quality and abundant water sources. Water is a necessity for all living things. Water of good quality is a prerequisite for healthy aquatic and terrestrial systems. When we work towards protecting source water, we also provide ecological protection through this widespread ecological dependence on water.

The extensive river systems of the planning region, and the lands adjacent to them, are home to a diverse and abundant variety of plant and animal species. The zones where water meets land, the riparian zone, is of particular importance, as these areas can be one of the richest and most productive ecological zones within a watershed. They protect our river by providing a buffer between the river and the intensively used urban and farm land on which much of our economy depends. They also protect people and property by keeping floodplain land intact.

Riparian zones are ecological water users. The health and extent of all the plant and animal components of these zones rely on the water. The better the quality of water available to the species within these zones, the healthier are the riparian zones.

Like the riparian zones along our shorelines, the wetland features throughout the watershed region are also important ecological features and an ecological water user. They too provide habitat for an array of plants and animal. Wetlands play a role in preventing floods and droughts and also improve the quality of water.

Our society has not always respected riparian zones and wetlands. Over the years, many of the wetlands and riparian zones have been cleared and farmed or built upon. It has been estimated that 70% of the wetlands within the region have been lost. In some cases, cultivated land extends to the very top of stream and river banks. This situation provides no natural erosion protection and provides an opportunity for direct runoff from agricultural land into rivers and streams. Many farm operations still provide cattle access to watercourses, which further accelerates erosion rates and degrades water quality. Many of our urban areas have also degraded our riparian zones by filling and developing these areas, thus making them prone to erosion and flooding from either the river or from storm water.

By working to protect, preserve, and rehabilitate these ecological features and users of water, and by providing them with exceptional water quality, we in turn will have a healthier watershed where sources of water are more easily protected.

2.7.9 Summary of Water Use

In general the SPR has ample water available for drinking water purposes. In particular, the Lake Huron/Georgian Bay system and the bedrock aquifer system are regional scale reservoirs. These reservoirs are not considered susceptible to shortages from short-term climate changes due to the high volume of water within them. Further, these systems are not likely to be impacted from anthropogenic activities given the existing land-use, water usage and projected population increases.

Smaller reservoirs, such as the overburden aquifer system and the inland surface water system, are inherently more vulnerable to shortages as a function of the relatively low volume of water stored in the system. These systems must be evaluated on an individual basis as the differences in water storage and volume can vary dramatically from one reservoir to another.

2.8 Data and Knowledge Gaps for Watershed Description

WC Deliverable	Data Set Name	Data Gap Problem	Comment
Fish Species		Too sparse	Lack of thermal and fish population studies
Benthic Species		Too sparse	GSCA and MNBP not active in Ontario Benthos Biomonitoring Network
Species-at-risk		Too sparse	Little to no info on spatial extent of species or habitats at risk
Invasive Species		Too sparse	Little to no info on spatial extent of invasive species or habitats at risk
Wells	MOE Wells	Spatially inaccurate; partially populated	Well type not classified (municipal, communal, etc.) per Regulations 170/03 and 252/05 of SDWA
Forestry		Dated information on forest cover	Lack of recent information on extent of forest cover and composition

Chapter 3

WATER QUALITY

3.0 WATER QUALITY

The purpose of the Water Quality chapter is to compile, organize, and present an anthology of significant sources of water quality data within the SPR. These sources represent sampling programs that have produced reliable and extensive water quality data. Although there is not a lot of accompanying information to provide insight for a particular day in time, the data does serve to identify potentially problematic areas that may be susceptible to less than desired water quality.

Understanding the quality of water within the study area is an essential part of Source Protection Planning. Water quality can be defined using a number of criteria, commonly related to the intended usage of the water itself. These criteria are based on the physical, chemical and biological properties of the water or water body, and can include factors such as appearance, aesthetic, taste, and odour, to more scientifically developed health-based criteria. For the purposes of defining water quality for Drinking Water Source Protection, the salient properties are chemical and biological.

The chemical properties of water are the most commonly used to develop an indication of the quality of a particular source. These chemical properties are most commonly measured as instantaneous concentrations of a given parameter, and guidelines for both human health and ecological functions are generally based on the effects of a given concentration on the suitability of the water for a chosen use. This approach for defining water quality has several limitations. Firstly, evaluating water quality and developing guidelines for water quality based on instantaneous concentrations does not take into account the effects of chronic, low concentration exposures to specific parameters. Secondly, by evaluating instantaneous concentrations large assumptions must be made in order to account for fluctuations in concentrations and, as a consequence, the potential loadings and accumulations of a certain parameter in receptors.

Acknowledging the limitations of using instantaneous concentrations for evaluating water quality, these are the most abundant, available and scientifically supported data. As a result, instantaneous concentrations are the primary measure of water quality for the study area.

Multiple sources of information were used to assess water quality conditions throughout the planning region. Data used in this chapter were collected through MOE programs (PGMN, PWQMN, DWIS, DWSP, and GLIS) following regulations outlined in the Safe Drinking Water Act (2002) that specify the water sampling procedures for public utilities (i.e. drinking water treatment plants), and from sampling programs of the partnering Conservation Authorities.

3.1 Indicator Parameters

Water chemistry parameters were selected based on the Conservation Ontario Discussion Paper: Recommendations for Monitoring Ontario's Water Quality (March, 2003) as a means of supporting watershed management. The recommended parameters are not prescriptive, but allow for a general overview of issues surrounding water quality and serve as an initial baseline for highlighting areas where site specific and more detailed monitoring and analyses may be required.

The indicator parameters are reflective of land use activities and serve to "indicate" problematic areas that may require further investigation. As mentioned, the indicator parameters are mainly used to indicate problematic areas resulting from various land use activities, but may also pose risks to human health (i.e. nitrates indicate excessive inputs from agricultural land, but also pose a risk to infants). To address the potential for human health issues associated with the chosen indicator parameters, the corresponding acceptable concentrations (for human health or aesthetic purposes) are given in Table 3.1. Aesthetic objectives are not considered to be health related, but can make drinking water undesirable for drinking and other domestic uses. The Canadian Drinking Water Quality Guidelines (DWQG) and the Ontario Drinking Water Standards (ODWS) are specific to human consumption while the Canadian Water Quality Guidelines and the Ontario Provincial Water Quality Objectives (PWQO), and the Cnadian Environmental Quality Guidelines (CEQG) are provided for the protection of aquatic life.

Guidelines and standards are developed on a generic basis for all waters. Due to the variability of the physical hydrology and geology of a given watershed, they may not be most aptly applied throughout the region. Some watersheds, due to their physical and geological properties, may not be able to meet some guidelines. Similarly, some watersheds may never exceed a given guideline. However, for the purposes of Drinking Water Source Protection, the guidelines and standards are accepted to be indicative of potential water quality issues, as defined in MOE Guidance (October, 2006).

The indicator parameters that will be reported on in this section are arsenic, fluoride, hardness, iron, sodium, total phosphorus, nitrate, copper, lead, suspended solids, and chloride. Background information will be provided for each parameter and existing provincial guidelines for drinking water standards and aesthetic objectives. Typical sources of the parameters are provided, but are not meant to be exhaustive. The indicator parameters are identified as being applied to surface water (SW) or groundwater (GW).

3.1.1 Arsenic (GW)

The interim maximum acceptable concentration (IMAC) for arsenic in drinking water is 0.025mg/L (ODWS). The source of arsenic in ground water is largely the result of minerals dissolving from weathered rocks and soils. Anthropogenic sources include industrial waste, phosphates, fertilizers and coal.

3.1.2 Chloride (SW and GW)

The aesthetic objective for chloride is 250 mg/L (ODWS) and will be used to assess any exceedences. The sources of the chloride ion include sodium chloride (salting of highways), potassium chloride (potash fertilizers), and calcium chloride (wastewater treatment). Other anthropogenic sources of chloride include oil well operations and sewage and irrigation drainage.

3.1.3 Copper (SW)

The aesthetic objective for copper is 1.0 mg/L (ODWS) and will be used to assess any exceedences. Typical sources of copper are from soil erosion, commercial activities (marine paints), agricultural and domestic activities (fungi pesticides, wood preservatives) and wastewaters.

TABLE 3.1 - Summary of objectives, standards, and guidelines for chosen indicators.

	Canadian DWQG		ODWS		PWQO
Parameter	***MAC (mg/L)***	***AO (mg/L)***	***MAC (mg/L)***	***AO (mg/L)***	***(mg/L)***
Arsenic			(Interim) ≤0.025		≤0.1
Chloride		≤250		≤250	
Copper				≤1.0	≤0.005
Fluoride	≤1.5		≤1.5		
Hardness				≤500	
Iron				0.3	≤0.3
Lead	≤0.01		≤0.01		Hardness as CaCO3 (mg/L) | Interim PWQO <30 | 0.001 30-80 | 0.003 > 80 | 0.005
Nitrate-N	≤10.0		≤10.0		
Sodium		≤200		≤200	
Total Phosphorus					≤0.03*
Total Suspended Solids		≤500		≤500	
Zinc		≤5.0		≤5.0	Interim PWQO ≤ 0.02

*Concentration provided to prevent aesthetic deterioration in lakes

3.1.4 Fluoride (GW)

The maximum acceptable concentration (MAC) for fluoride is 1.5mg/L (ODWS) and will be used to assess any exceedences. Where fluoride is added to drinking water it is recommended that the concentration be adjusted to 1.0 (+/- 0.2) mg/L, which is the optimum level to control tooth decay (ODWS). The sources of fluoride in groundwater include industrial processes, and phosphorus fertilizers.

3.1.5 Hardness ($CaCO_3$) (GW)

The chemical/physical objective for total hardness operational guideline is 80-100 mg/L (ODWS). This objective is not health related. Any value over 500 mg/L will be treated as an "exceedence" as it is considered unacceptable for most domestic purposes. Hardness is caused by dissolved calcium and magnesium, and is expressed as the equivalent quantity of calcium carbonate.

3.1.6 Iron (GW)

The aesthetic objective for iron is 0.30 mg/L (ODWS) and will be used to assess any exceedences. Iron may be present in groundwater as a result of chemically reducing underground conditions which cause mineral deposits. Iron can also leach into groundwater through industrial practices.

3.1.7 Lead (SW)

The maximum acceptable concentration for lead in drinking water is 0.01 mg/L (ODWS) and will be used to assess any exceedences. Typically; the sources of lead are from soil erosion or from industrial processes where lead is emitted into the air and is later deposited into water courses, from storm water runoff, or directly discharged into a stream.

3.1.8 Nitrate (SW and GW)

Elevated nitrates in drinking water can cause serious health issues with infants. Typically, high nitrate levels can be attributed to lawn fertilizers, leaking septic tanks, animal wastes, and landfills. The ODWS maximum acceptable concentration for nitrates in drinking water is 10 mg/L as NO_3-N and will be used to assess any exceedences. The Canadian Environmental Quality Guidelines have a limit of 2.9 mg/L NO_3-N and is used as a benchmark for aquatic health.

3.1.9 Sodium (GW)

The aesthetic objective for sodium in drinking water is 200 mg/L (ODWS). Sodium occurs naturally, and is slowly released from rocks and soils. When levels exceed 20 mg/L, the local Medical Officer of Health is required to be notified. Anthropogenic sources of sodium include road salt, runoff from fertilizers, and domestic water softeners.

3.1.10 Total Phosphorus (SW)

Total phosphorus represents all forms of phosphorus present in a water sample. Phosphorus is a required nutrient for all organisms and is naturally occurring in rocks, soils, and organic matter. Elevated total phosphorus relative to ambient levels can be indicative of excessive inputs of fertilizers, detergents, or animal wastes. High levels of phosphorus can be associated with algal blooms and subsequent decreases in dissolved oxygen and a degradation of suitable aquatic conditions.

The Ontario Provincial Surface Water Quality Objectives do not have a firm objective for total phosphorus because of insufficient scientific evidence, but general guidelines are provided. To prevent nuisance algae in lakes and excessive plant growth in streams, total phosphorus levels should remain below 0.02 mg/L, and 0.03 mg/L, respectively. To prevent aesthetic deterioration, levels should remain below 0.01 mg/L (PWQO). Any concentration greater than 0.03 mg/L will be treated as an exceedence.

3.1.11 Total Suspended Solids (SW)

There is no standard or guideline for total suspended solids, but there is an aesthetic objective for total dissolved solids being less than 500 mg/ L (ODWS). High values of TSS can make drinking water undesirable, affect other domestic uses, and be harmful to aquatic organisms. Suspended solids (silt, clay, organic/inorganic matter, plankton, and other microscopic particles) also allows for the transport of phosphorus, metals and other contaminants.

3.1.12 Zinc (SW)

To maintain the aesthetic objective for zinc, concentrations in drinking water should not exceed 5 mg/L (ODWS; Interim PWQO is 0.02 mg/L for aquatic life). Sources of zinc include corrosion of galvanized materials, electroplaters, domestic and industrial sewage, combustion of solid waste and fossil fuels, storm water runoff, and soil erosion.

3.2 Surface Water Quality Data Analysis and Reporting

3.2.1 Surface Water Quality - PWQMN

The Provincial Water Quality Monitoring Network (PWQMN) was established in 1964 to collect water chemistry data in streams of Ontario. Essentially, water quality data has been collected in different parts of the planning region with the exception of 1996-2002 when no water quality data was collected for the program. Monitoring stations have been added, moved, or retired based on specific needs or programs of the MOE. Currently, over 350 stations are used to collect water quality data that monitors specific land uses, pollutions sources or unique physiographical features. The PWQMN is structured to provide a spatially representative network that allows for determining ambient conditions and long term water quality trends.

Water quality parameters were examined for each of the SPA within the planning region. Each of these jurisdictions was examined on a subwatershed basis where water chemistry data exists from the Provincial Water Quality Monitoring Network (Map 32). The data analyses within the planning region spans from the early 1970s to 2005 depending on the number of years data was collected at each monitoring station on a particular stream.

Sites were chosen based on having data that is temporally relevant and closest to the mouth of the watershed. Other PWQMN sites exist that have data, but for the purpose of assessing water quality on a watershed basis the aforementioned criteria was used. The initial step in observing the water chemistry data involved a time series analysis. This allowed for identifying data gaps, ranges in results, and possible trends. Statistical analyses consisted of box-plots. Statistical outliers in the box-plots are identified with an asterisk (*). Data from a particular stream was grouped in five-year intervals where possible.

The density of data collected every year for the sites varied and presented problems in displaying the data graphically on the time series. The spacing of the time component (y-axis) of the graphs was not in equal increments, because the number of water samples collected was not consistent throughout the year. The spacing of years on the graphs was greater for years where more samples were collected and smaller when the number of samples were limited. To represent each year (365 days) graphically would not be practical for presentational purposes. To this end, only days where sampling had occurred were graphed.

Also, technological advancements in laboratory analytical capabilities and methods have further improved the detection capabilities of various water chemistry parameters. Thus, some laboratory results are reported at the detection limit, when the actual result is below the reported value. With some reported values, more specifically lead, there is a plus/minus of 11 ug/L for the reported value, which can skew results when the data are statistically analyzed. These problems with analyzing water chemistry are common.

Sampling Uncertainties

The reported values of copper, lead, and zinc in the 1970s and 1980s are often given as higher than the actual values, as concentrations were below detection limits of the laboratory equipment. In these instances, metal concentrations were reported at detection limits, when actual concentrations were less than the reported value. The reported values, therefore, may skew how the results are interpreted or used in identifying trends. For this report the concentrations provided were not modified and were used as provided.

This is also the case for more recent reporting of metals, but better laboratory methods/ equipment and the resulting lower detection limit have greatly reduced the margin of error. Even with these improvements caution must be exercised when assessing trends or identifying exceedences, as there is a +/-11 ug/L for lead concentrations, which can greatly influence the results. Any exceedences will be identified as such, but the reader must be cognizant that the discrepancy between reported and actual concentrations is unknown and analytical limitations must be understood.

3.2.1.1 Grey Sauble SPA

The Grey Sauble SPA was parsed into 19 subwatersheds based on sampling locations and drainage boundaries. Data exists for eight of the 19 subwatersheds within the Grey Sauble SPA. Data is absent from the Stoney Creek, Gleason Brook, Indian Creek, Johnson Creek, Sucker Creek (S. Bruce Penin.), Sucker Creek (Meaford), Centreville/Orchard Creek, Little Beaver Creek, and Indian Brook watersheds. For each subwatershed that has existing data, the station that is active and is closest to the mouth will be used to assess the overall water quality of the area and reflect current conditions.

Beaver River

Total phosphorus concentrations were near or above the target objective of 0.03 mg/L for the majority of the samples taken at the mouth (Figures 3.2.1 and 3.2.2), and midstream (Figures 3.2.3 and 3.2.4). The time series graph for chlorides from samples obtained at the mid-stream location shows a gradual increase in concentrations, but are substantially below aesthetic objectives. There were 26 exceedences observed for the data collected midstream and 23 for exceedences closer to the mouth (Table 3.2). Comparing the two monitoring stations for the years 2002-2005, there were 4 values that exceeded the target objective closer to the mouth of the river compared to 2 values midstream. Metals data for the midstream monitoring location was not available. Other indicator parameters were below established drinking water standards/guidelines. Overall, water chemistry concentrations appear to be stable and the available data does not show severe impacts from land use activities.

TABLE 3.2 - Summary of water chemistry exceedences for the Beaver River

Beaver River Midstream			
Year	***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed
1978-1982	64	10	15.6
1983-1987	53	8	15.1
1988-1992	54	4	7.4
1993-1996	34	2	5.9
2002-2005	28	2	7.1
TOTAL	233	26	11.2

Beaver River near mouth			
Year	**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed
2002-2005	28	4	14.3
TOTAL	28	4	14.3

Note: Limit for parameter - - Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Bighead River

Data has been collected from the Bighead River from 1975 to 1996 and from 2002 to 2005. No data exists between 1997 and 2001. The time series graph (Figure 3.2.5) shows that no metals data was collected prior to 1980. Also, no nitrate data exists prior to the samples that were collected in 2002. Table 3.3 summarizes water chemistry exceedences for the time period monitored. Copper and lead exceedences have decreased for the period monitored, while total phosphorus exceedences have remained constant. The box plots (Figure 3.2.6) show there is minimal change in the median values of the water chemistry parameters between the different groupings. The concentrations of the water chemistry parameters do not relect deteriorating water quality conditions from land use activities.

TABLE 3.3 - Summary of water chemistry exceedences for the Bighead River

Bighead River									
Year	***Copper***			***Lead***			***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1975-1979	0	0	N/A	0	0	N/A	52	9	17.3
1980-1984	40	1	2.5	39	2	5.1	73	20	27.4
1985-1989	111	0	0.0	111	4	3.6	113	32	28.3
1990-1996	126	1	0.8	128	3	2.3	128	21	16.4
2002-2005	27	0	0.0	10	0	0.0	28	5	17.9
TOTAL	304	2	0.7	288	9	3.1	394	87	22.1

Note: Limits for parameters - - Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Bothwell's Creek

Data for chloride, total suspended solids, and total phosphorus have been collected from 1972 to present. Copper, lead, and zinc data are sparse until the early 1980s. Water samples were not tested for nitrates until 2002 (Figure 3.2.7). Lead and total phosphorus were the only two parameters to exceed established limits (Table 3.4), but the occurrences have decreased for the period monitored. Chloride concentrations typically increased for the entire time period. Lead (reported) and total phosphorus levels are above drinking water standards/operational guidelines for all of the five-year groupings (Figure 3.2.8). The water chemistry data suggests that urban activities are influencing stream conditions.

TABLE 3.4 - Summary of water chemistry exceedences for Bothwell's Creek

Bothwell's Creek						
Year	***Lead***			***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1972-1974	2	1	50.0	40	15	37.5
1975-1979	1	1	100.0	62	14	22.6
1980-1984	46	9	19.6	59	7	11.9
1985-1989	50	3	6.0	52	10	19.2
1990-1996	66	0	0.0	67	5	7.5
2002-2005	14	0	0.0	28	2	7.1
TOTAL	179	14	7.8	308	53	17.2

Note: Limits for parameters - - Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Centreville Creek

Samples were collected from Centreville Creek from 1973 to 1978. Data for total suspended solids were absent from late 1975 to late 1977 (Figure 3.2.10). Total phosphorus concentrations were routinely above 0.03 mg/L (Table 3.5), while total suspended solids and chloride concentrations were within acceptable limits. The lack of data prevents any meaningful assessment of present day stream quality conditions.

TABLE 3.5 - Summary of water chemistry exceedences for Centreville Creek

Centreville Creek			
Year	***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed
1973-1978	75	13	17.3
TOTAL	75	13	17.3

Note: Limit for parameter - - Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Keefer Creek

Data collection from Keefer Creek was limited to 1995 and 1996 and exists for chloride, total suspended solids and total phosphorus (Figure 3.2.9 and Table 3.6). Chloride and total suspended solids were within acceptable limits while approximately 5% of total phosphorus values were above the operational objective of 0.03 mg/L. The lack of data prevents any meaningful assessment of stream quality conditions.

TABLE 3.6 -Summary of water chemistry exceedences for Keefer Creek

Keefer Creek			
Year	***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed
1995-1996	21	1	4.8
TOTAL	21	0	4.8

Note: Limit for parameter - - Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Pottawatomi River

Samples for chloride, suspended solids, and total phosphorus were collected from 1970 until the end of 1996, and from 2002 to 2005. Copper, lead, and zinc data are not available prior to 1983. Nitrate was sampled from 2002 to 2005. No samples were collected between 1996 and 2002 (Figure 3.2.11).

Lead and total phosphorus were above established limits within most year groupings (Table 3.7), but, comparatively, the number of exceedences has decreased in recent years. High values were noted in the 1970s and 1980s, but either limited data was collected, or are based on single samples, which make it difficult to assess stream conditions. Chloride values appear to be gradually rising, and are comparatively higher than levels in other subwatersheds of the Grey Sauble SPA, which is most likely from urban activities (Figure 3.2.12). Stream conditions appear to be more impacted on the Pottawatomi River relative to other watersheds, but the concentration of water chemistry parameters are below established limits.

TABLE 3.7 - Summary of water chemistry exceedences for the Pottawatomi River

Pottawatomi River						
Year	***Lead***			***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1970-1974	1	1	100.0	64	44	68.8
1975-1979	1	1	100.0	61	18	29.5
1980-1984	15	8	53.3	51	20	39.2
1985-1989	27	1	3.7	29	5	17.2
1990-1996	37	0	0.0	35	4	11.4
2002-2005	11	0	0.0	28	2	7.1
TOTAL	92	11	12.0	268	93	34.7

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Sauble River

Chloride, total suspended solids and total phosphorus data has been collected from 1970 to 2005. Copper, lead, and zinc data was sparsely collected until around 1985, at which time samples were tested regularly for metals. Nitrate data is only available from 2002 to present.

Exceedences were recorded for lead and total phosphorus (Table 3.8) and the frequency has decreased in recent years. There appears to be an upward trend in chloride concentrations beginning in the mid 1980s, while the concentrations of the other parameters appear to remain constant when comparing the different temporal groupings (Figures 3.2.13 and 3.2.14). Although most samples were below established limits, it appears that increased chloride concentrations may indicate the watershed is experiencing increased impacts from land use activities.

TABLE 3.8 - Summary of water chemistry exceedences for the Sauble River

Sauble River						
Year	***Lead***			***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1970-1974	3	2	66.7	63	10	15.9
1975-1979	12	9	75.0	65	9	13.8
1980-1984	20	7	35.0	54	4	7.4
1985-1989	53	1	1.9	54	6	11.1
1990-1996	67	0	0.0	66	6	9.1
2002-2005	8	0	0.0	29	1	3.4
TOTAL	163	19	11.7	331	36	10.9

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Sydenham River

Data for chloride, total suspended solids, and total phosphorus have been collected from 1975 to present. Metals data for lead is more sparse until the mid 1980s, while copper and zinc data are more readily available from the late 1970s. Water samples were not tested for nitrates until 2002 (Figure 3.2.15).

Chloride concentrations are below the aesthetic objective but increase for the entire time period, and more substantially from the mid 1980s to present. Total phosphorus levels were above drinking water standards/operational guidelines for all of the five year groupings (Figure 3.2.16), while observed exceedences for lead occurred in two of the five year groupings. Table 3.9 summarizes observed exceedences of lead and total phosphorus, which have decreased over recent years.

TABLE 3.9 - Summary of water chemistry exceedences for the Sydenham River

Sydenham River						
Year	***Lead***			***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1975-1979	1	0	0.0	55	10	18.2
1980-1984	46	12	26.1	49	7	14.3
1985-1989	28	0	0.0	32	3	9.4
1990-1996	37	0	0.0	41	1	2.4
2002-2005	13	0	0.0	27	3	11.1
TOTAL	125	12	9.6	204	24	11.8

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Waterton Creek

Data for Waterton Creek was collected from 1973 to early 1975. Chloride and total suspended solids were below objectives, while exceedences were noted for total phosphorus (Table 3.10). (Figure 3.2.17). The lack of data prevents any meaningful assessment of present day stream quality conditions.

TABLE 3.10 - Summary of water chemistry exceedences for Waterton Creek

Waterton Creek			
Year	***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed
1973-1975	30	9	30.0
TOTAL	30	9	30.0

Note: Limits for parameters - - Total Phosphorus: guideline of 0.03 mg/L (PWQO)

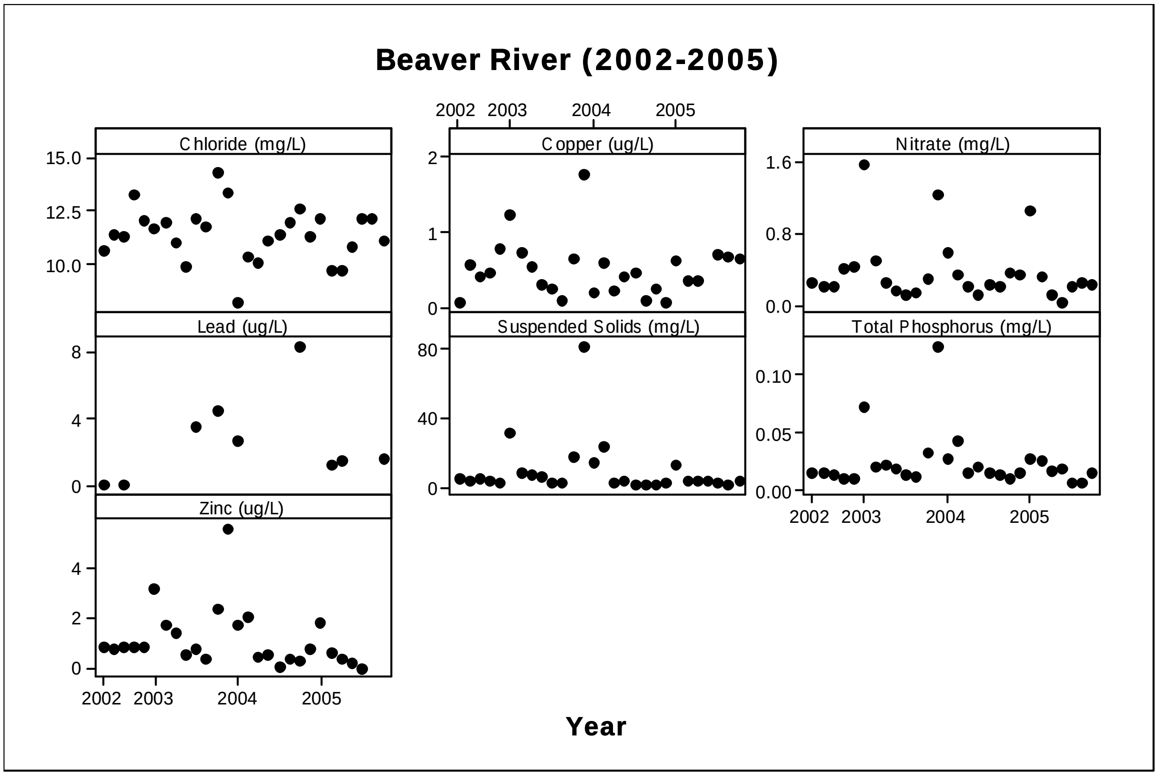


Figure 3.2.1 Time series graph of water chemistry parameters for the Beaver River

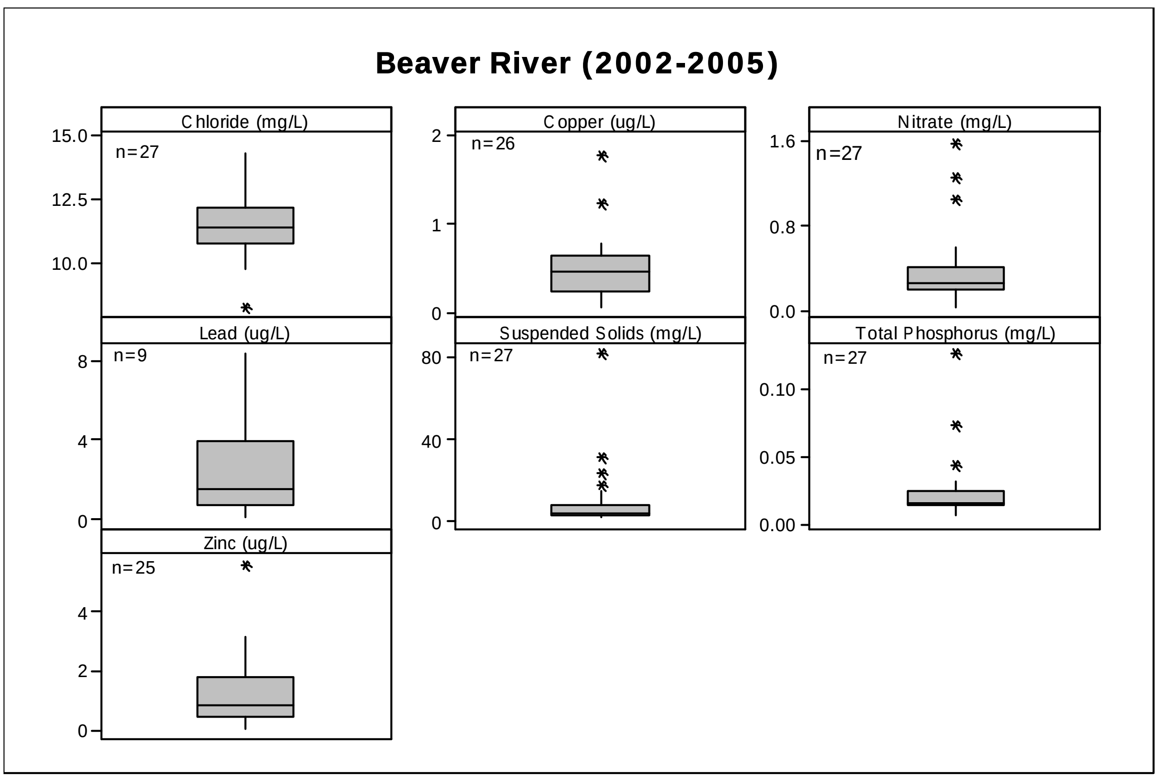


Figure 3.2.2 Box plot of water chemistry parameters for the Beaver River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

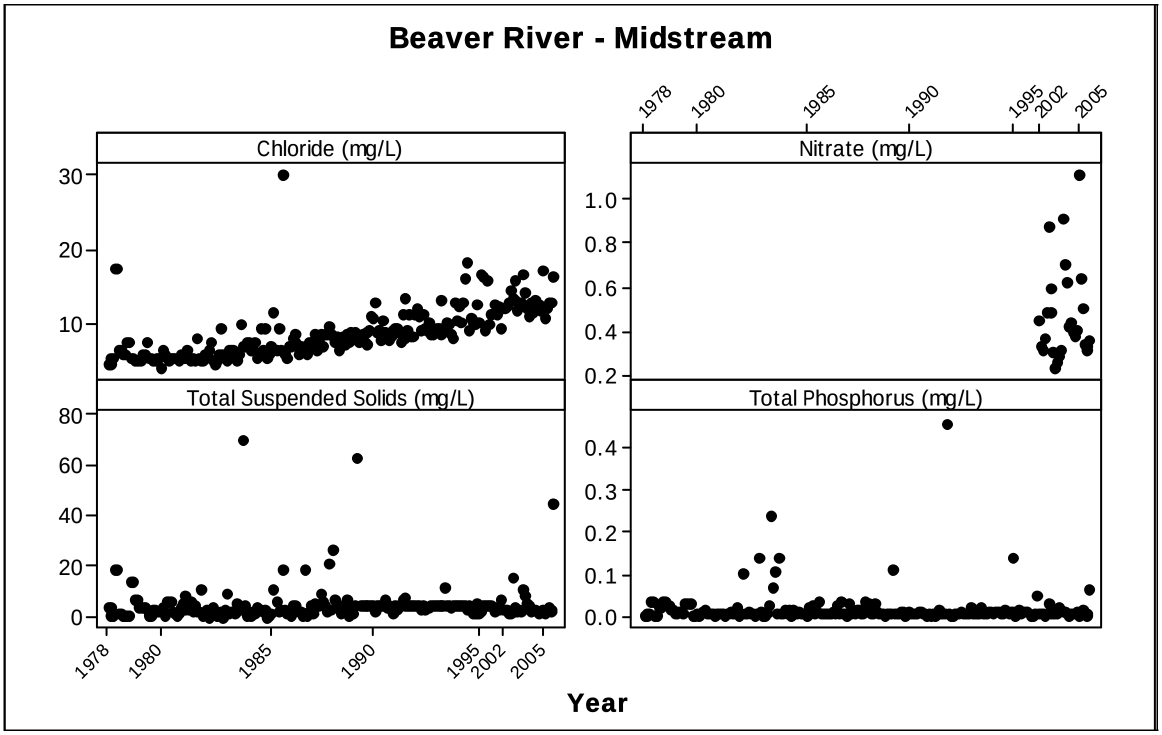


Figure 3.2.3 Time series of water chemistry parameters midstream for the Beaver River

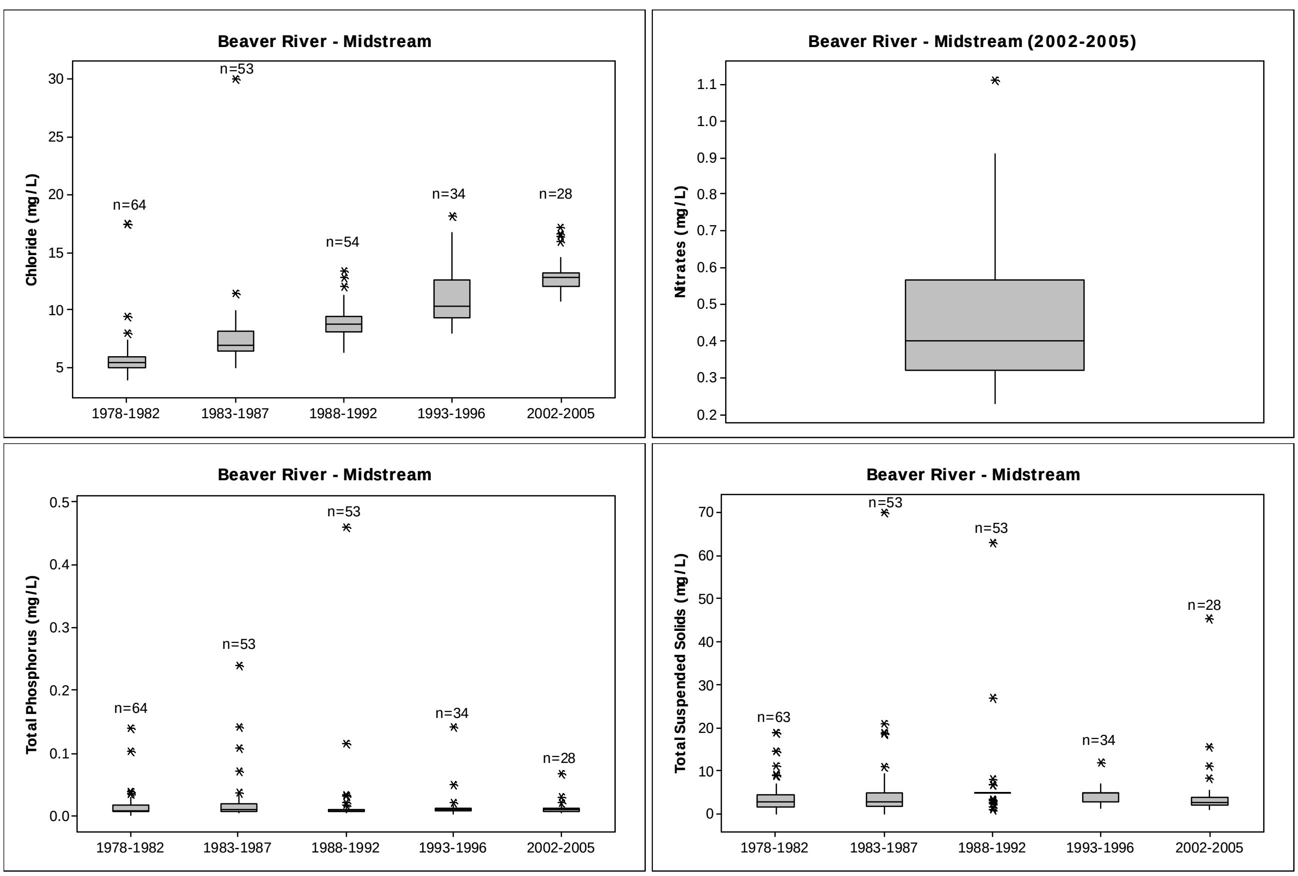


Figure 3.2.4 Box plots of water chemistry parameters midstream on the Beaver River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

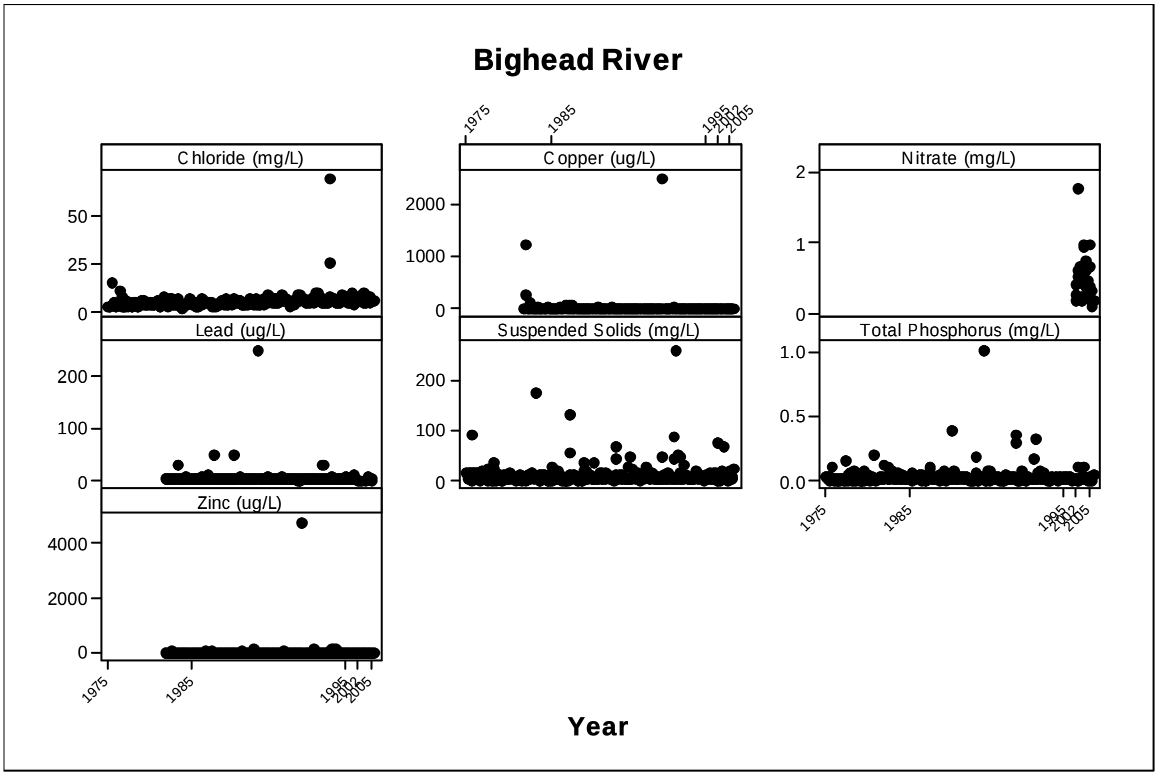
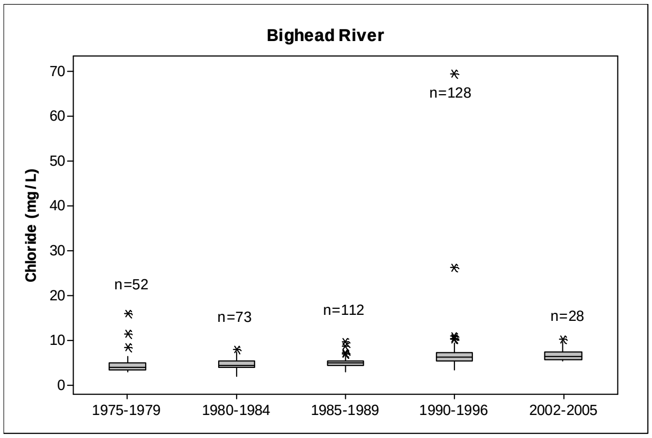
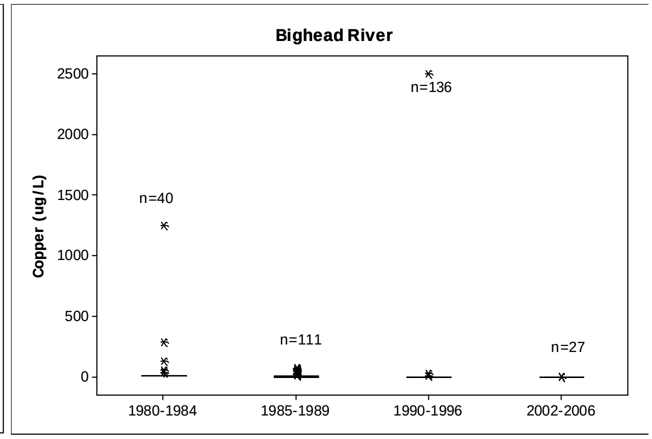
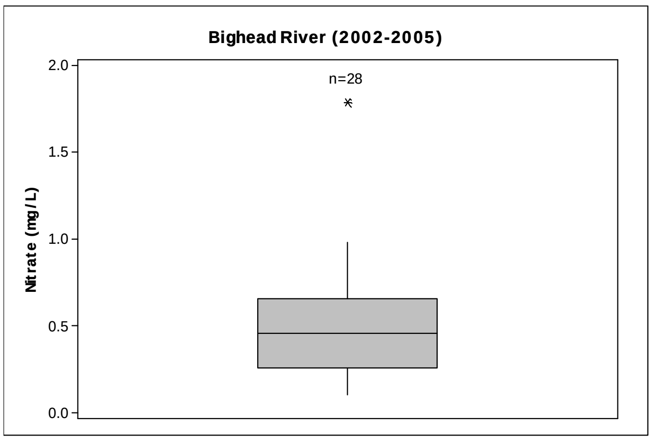
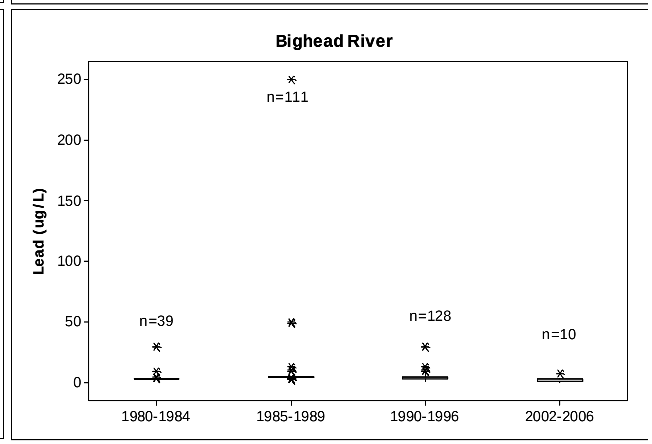


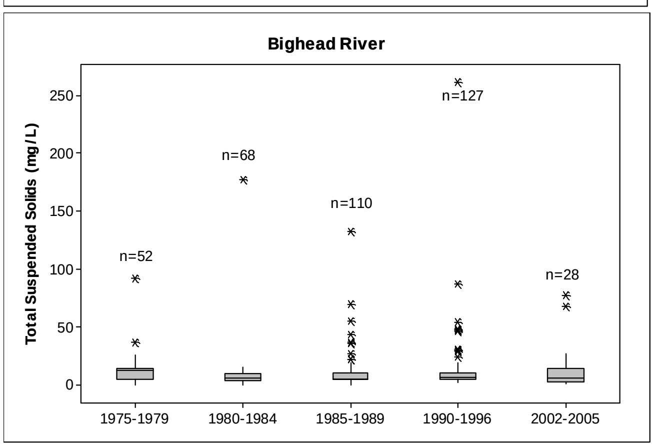
Figure 3.2.5 Time series of water chemistry parameters for the Bighead River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

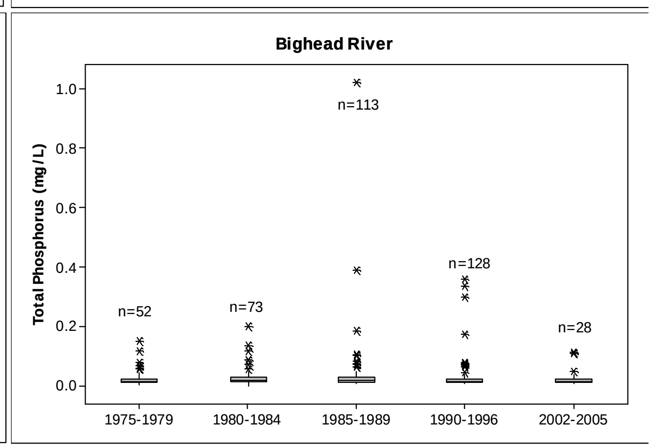












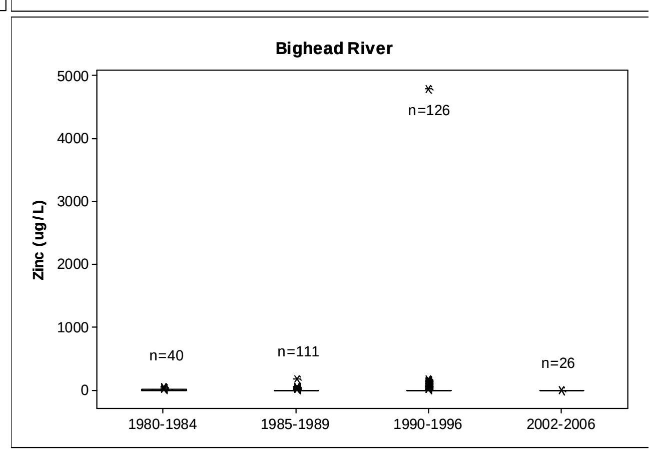


Figure 3.2.6 Box plots of water chemistry parameters for the Bighead River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

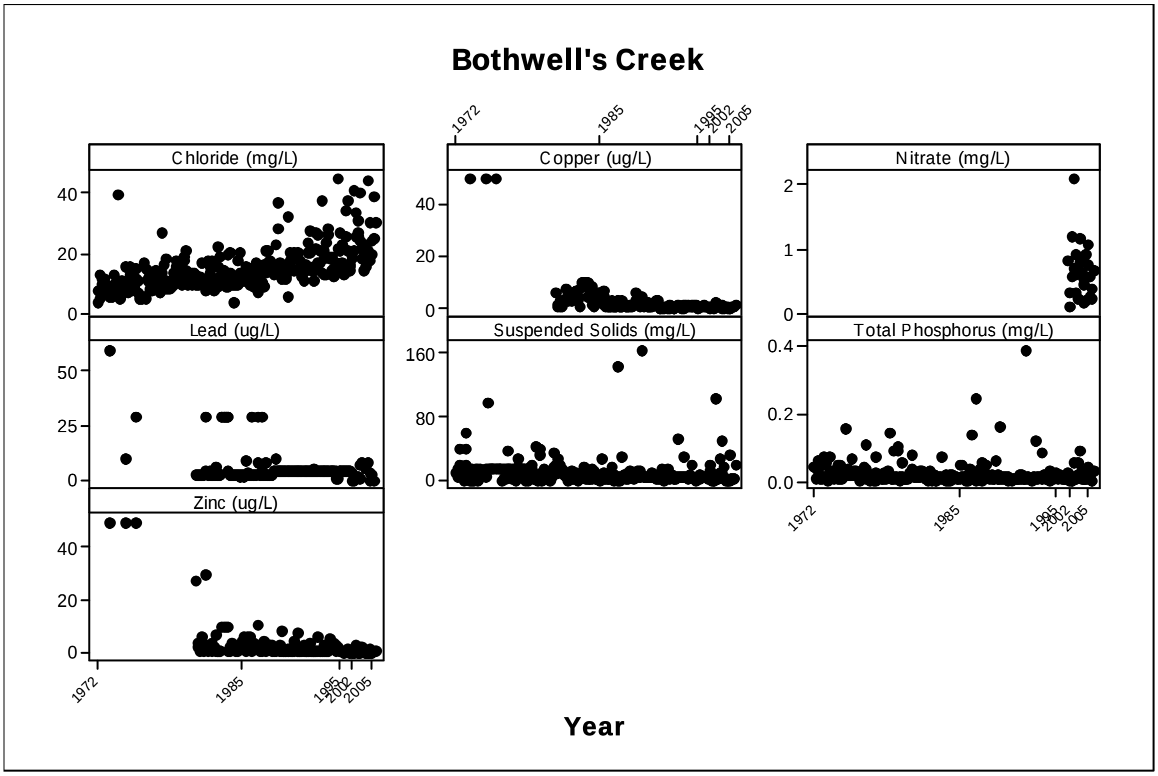
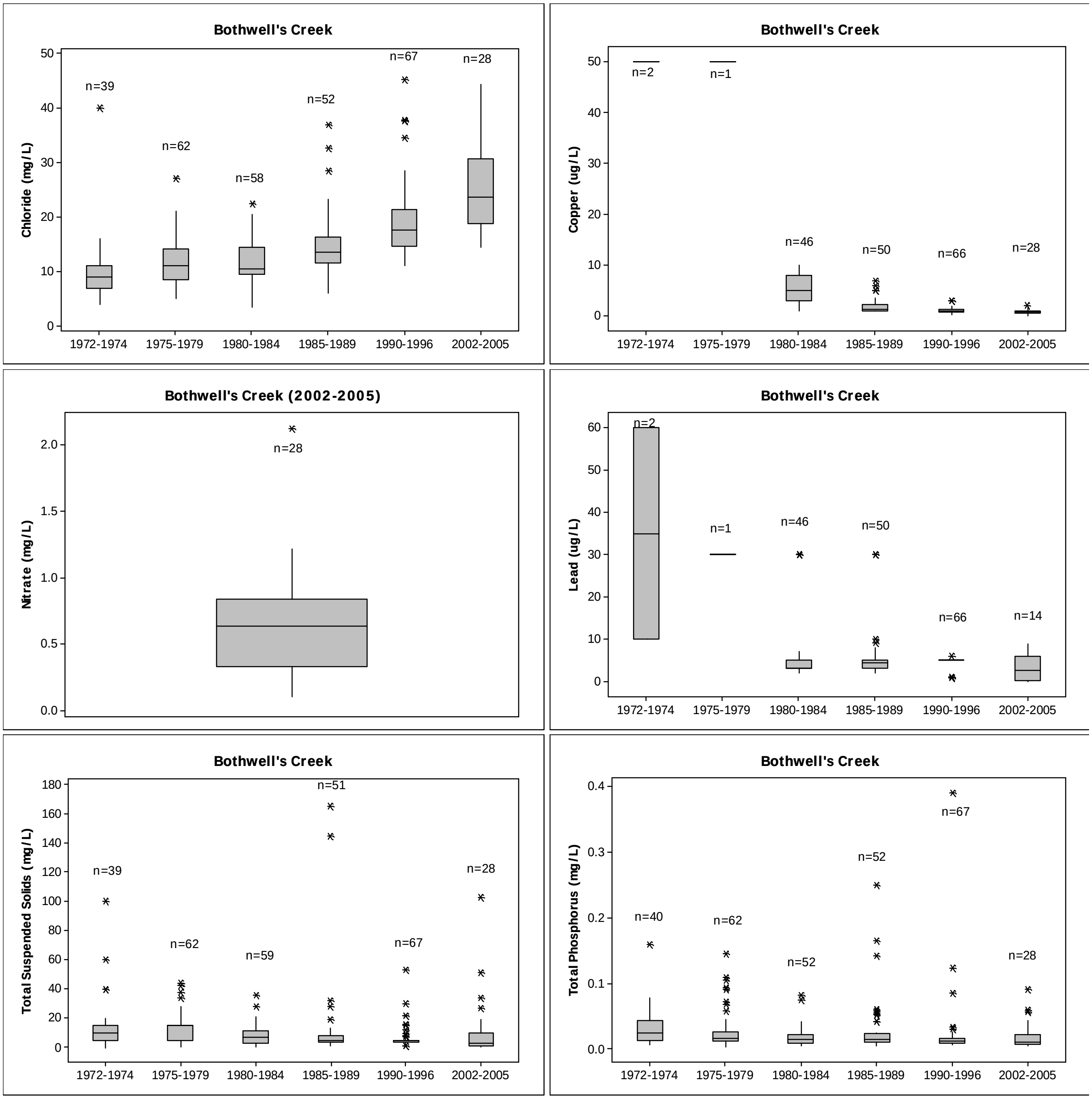


Figure 3.2.7 Time series of water chemistry parameters for the Bothwell's Creek
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



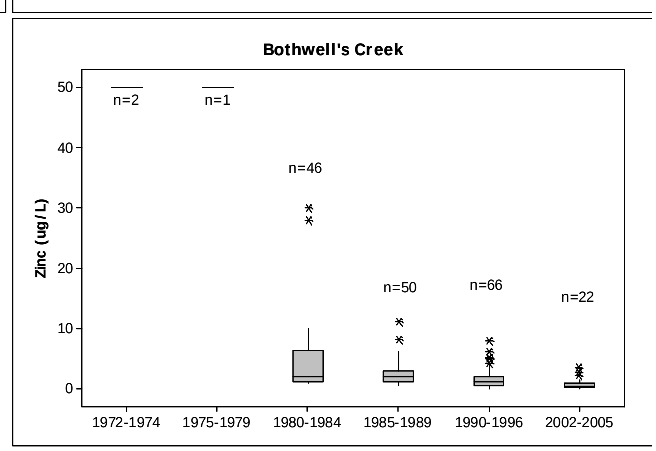
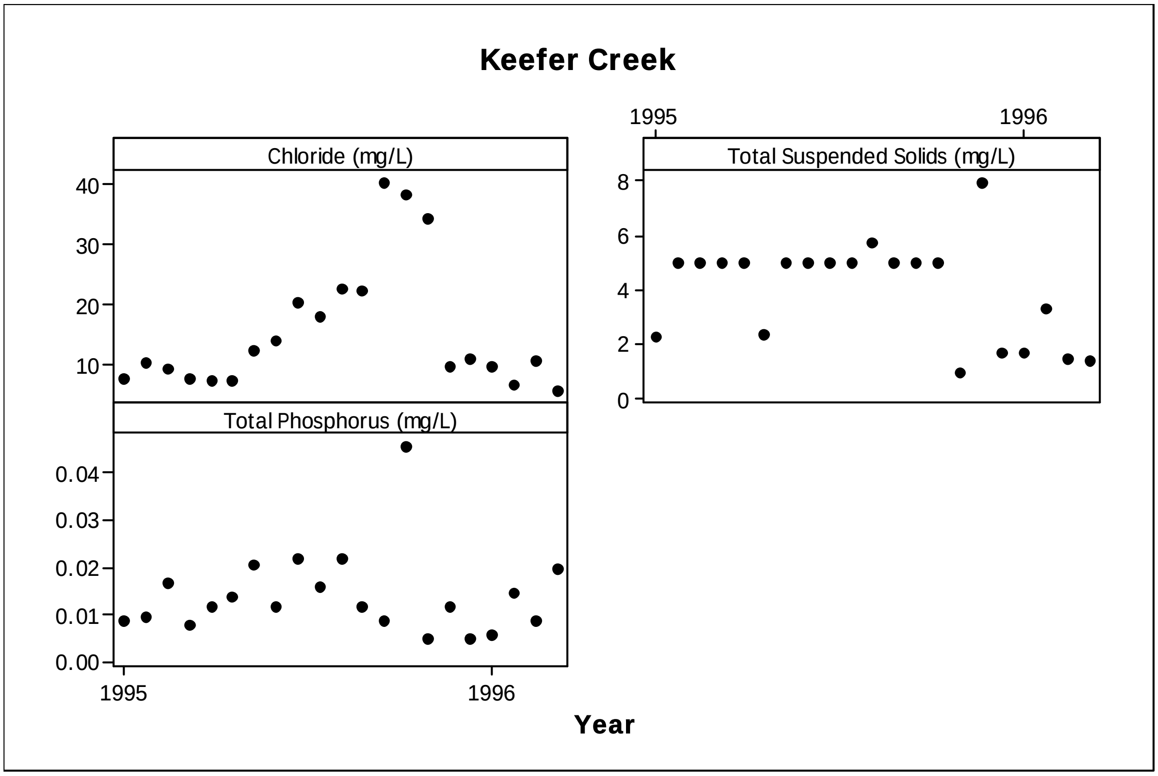
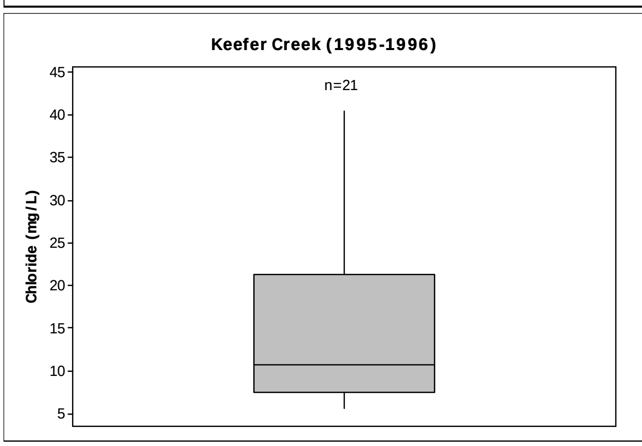
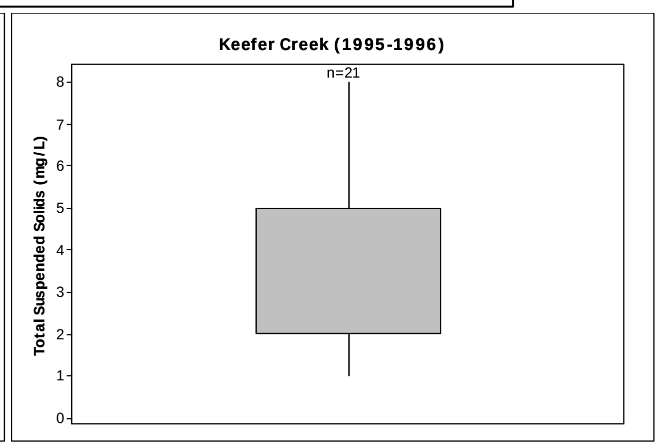


Figure 3.2.8 Box plots of water chemistry parameters for the Bothwell's Creek
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)







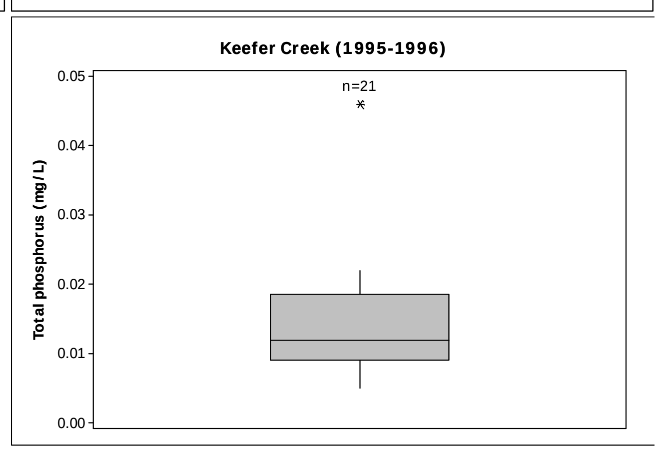


Figure 3.2.9 Graphs of water chemistry parameters for the Keefer Creek

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

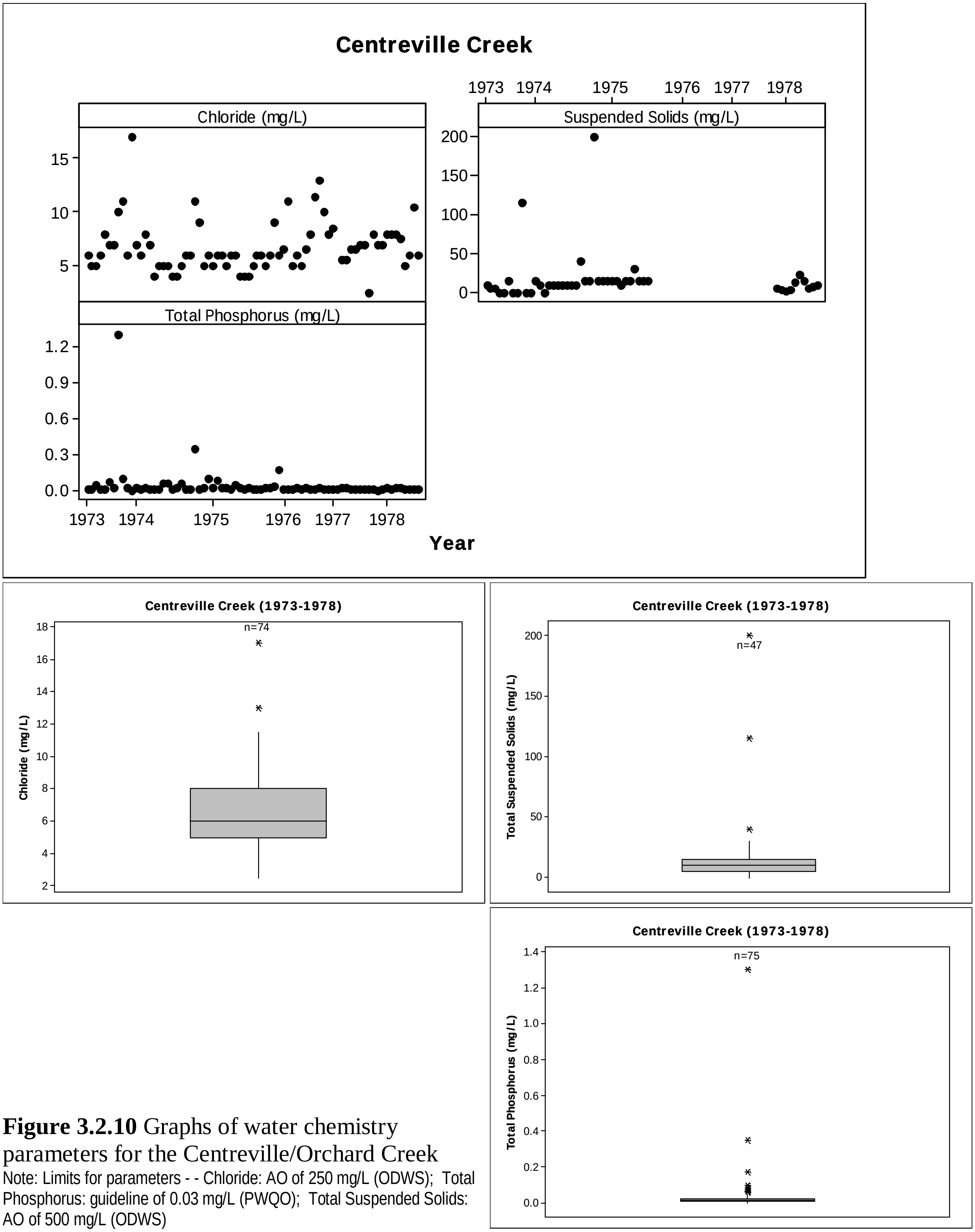


Figure 3.2.10 Graphs of water chemistry parameters for the Centreville/Orchard Creek

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

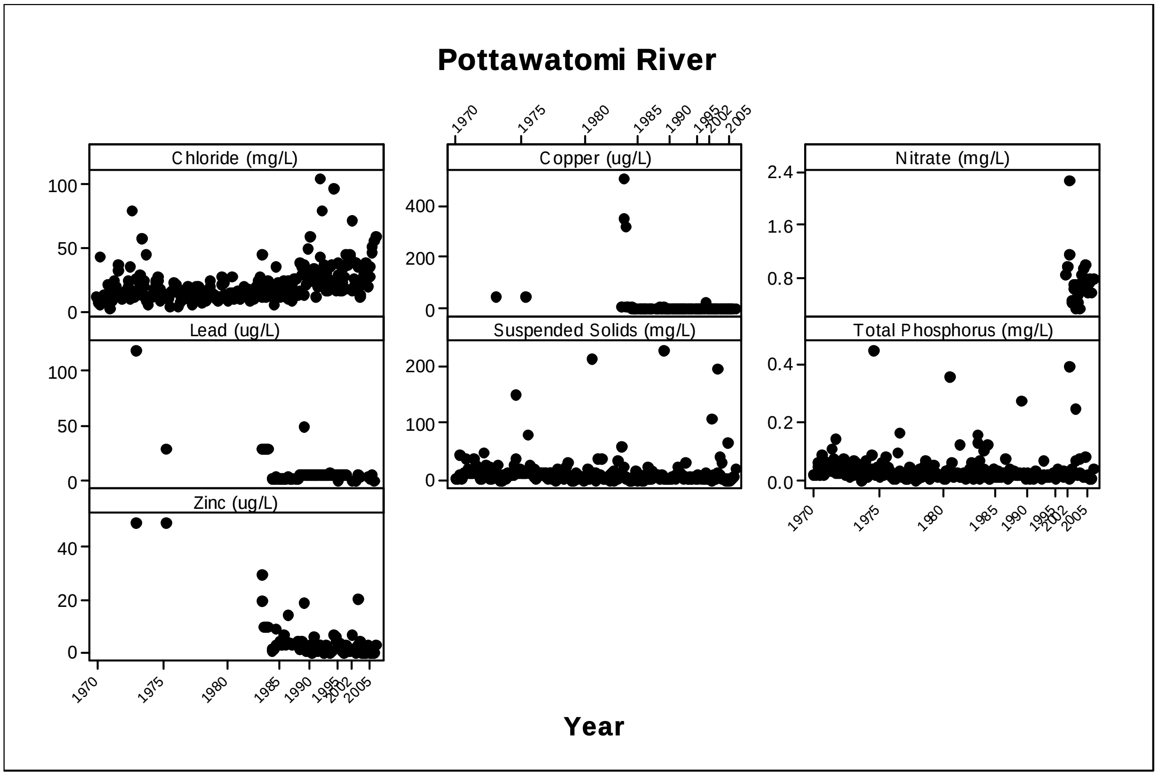
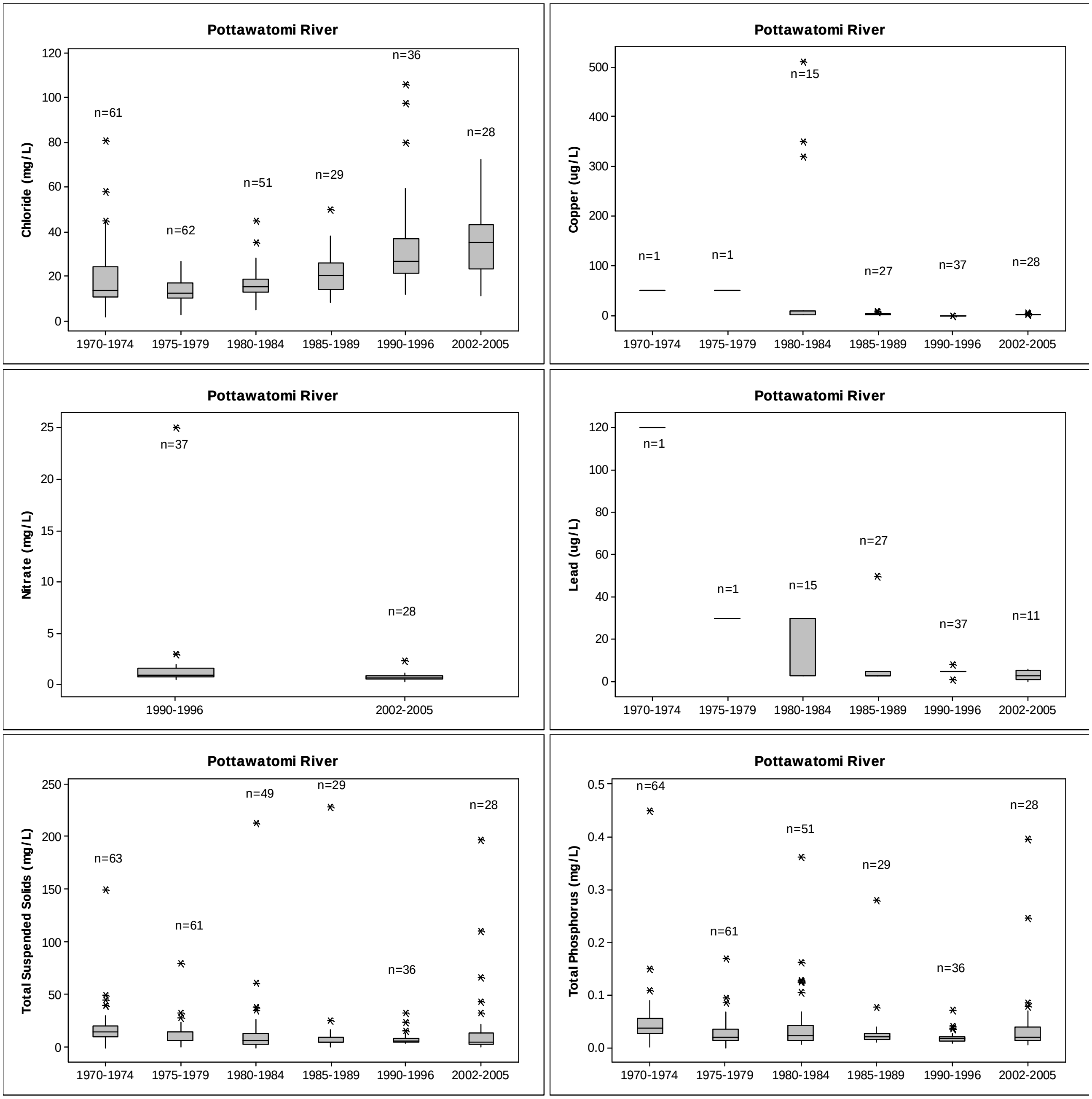


Figure 3.2.11 Time series of water chemistry parameters for the Pottawatomi River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



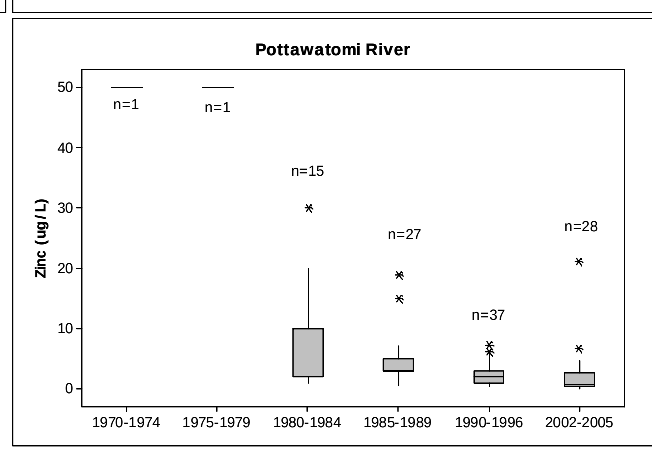


Figure 3.2.12 Box plots of water chemistry parameters for the Pottawatomi River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

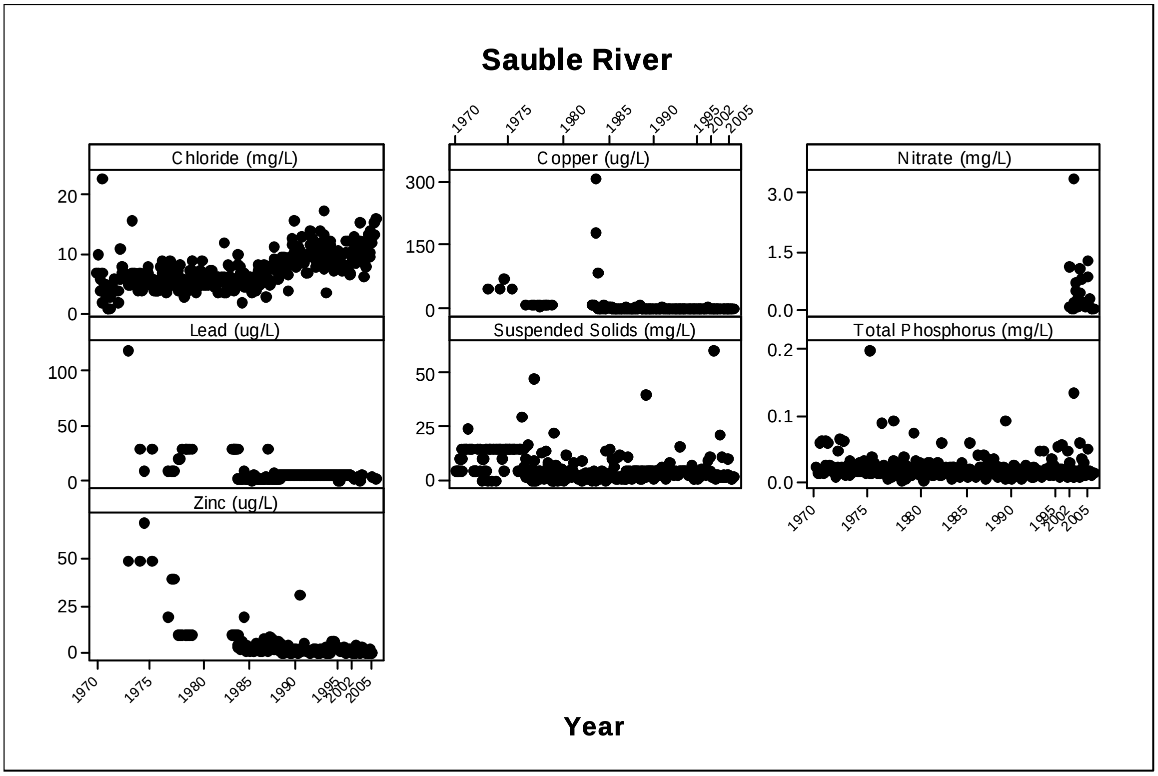
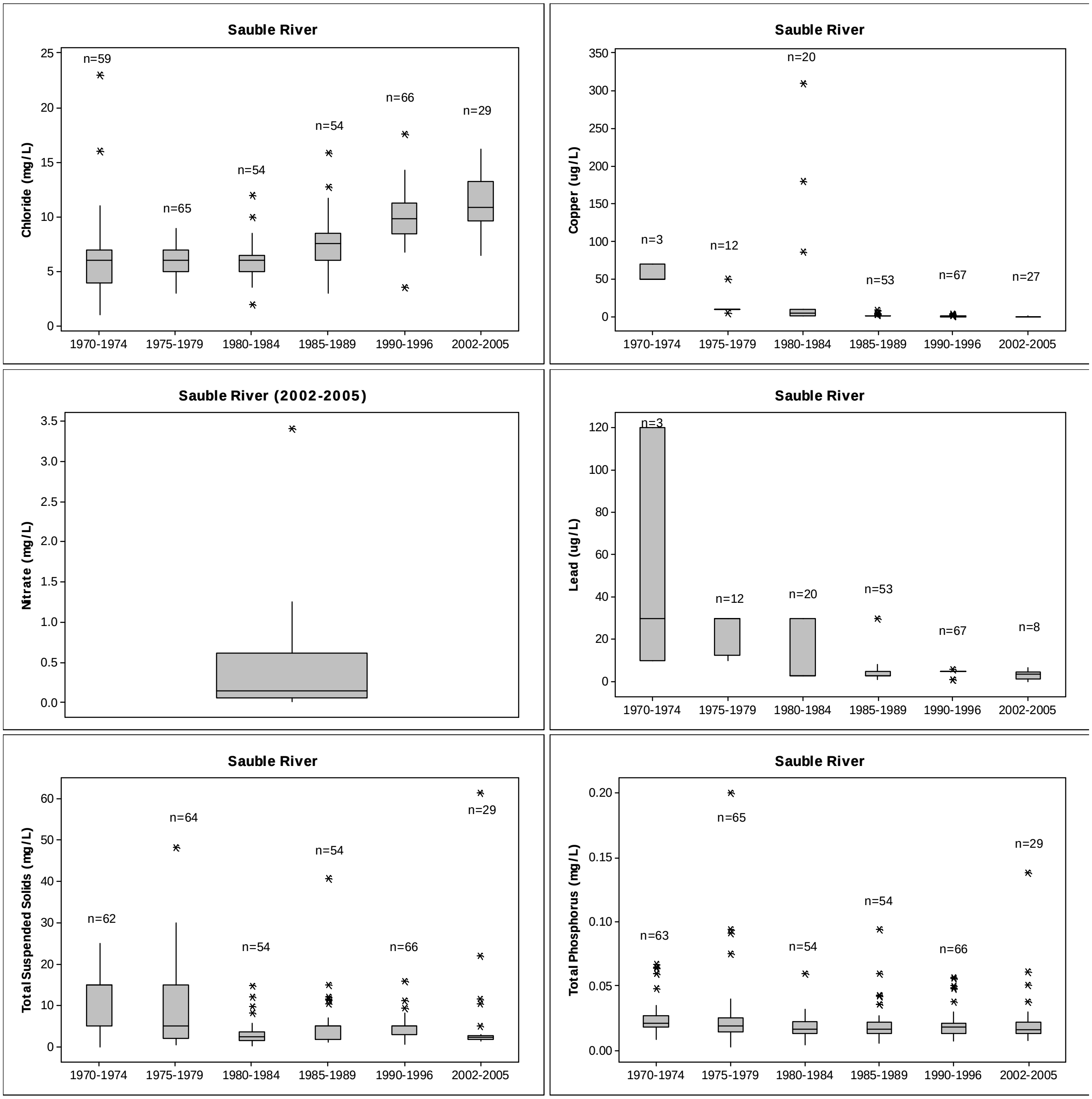


Figure 3.2.13 Time series of water chemistry parameters for the Sauble River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



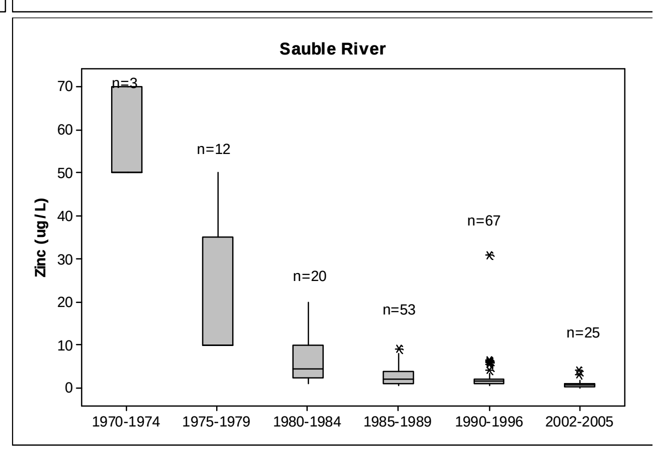


Figure 3.2.14 Box plots of water chemistry parameters for the Sauble River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

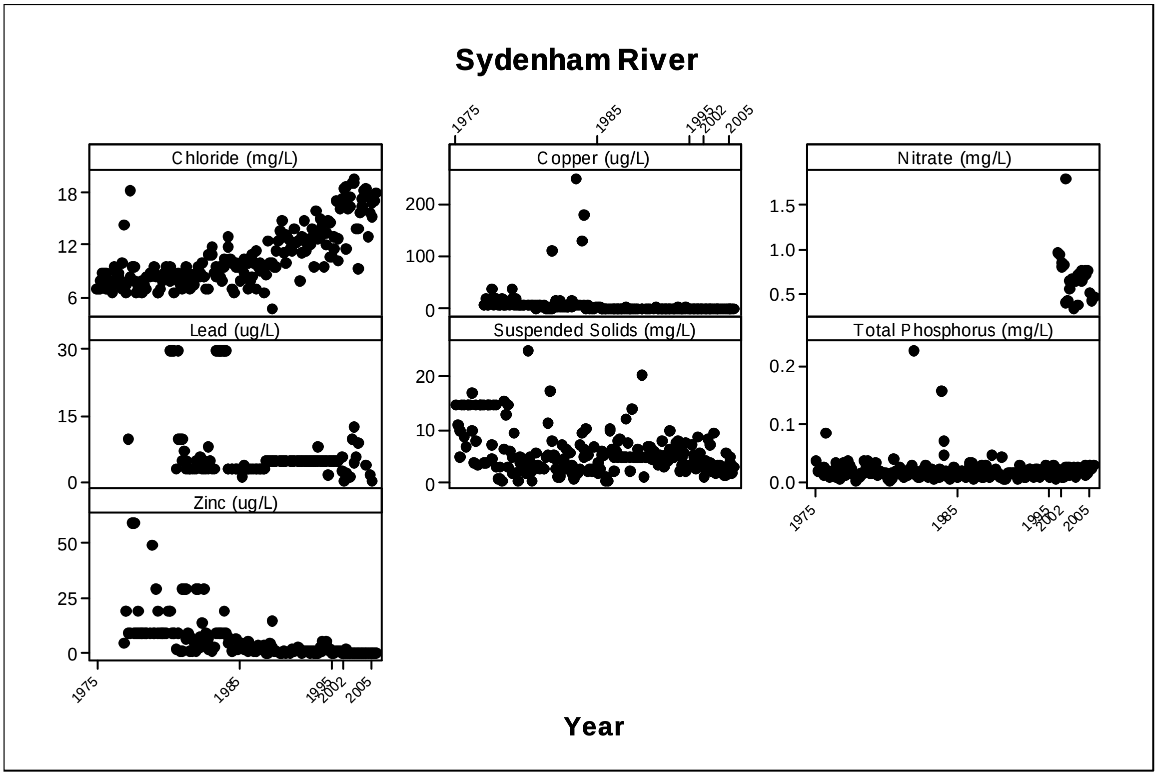
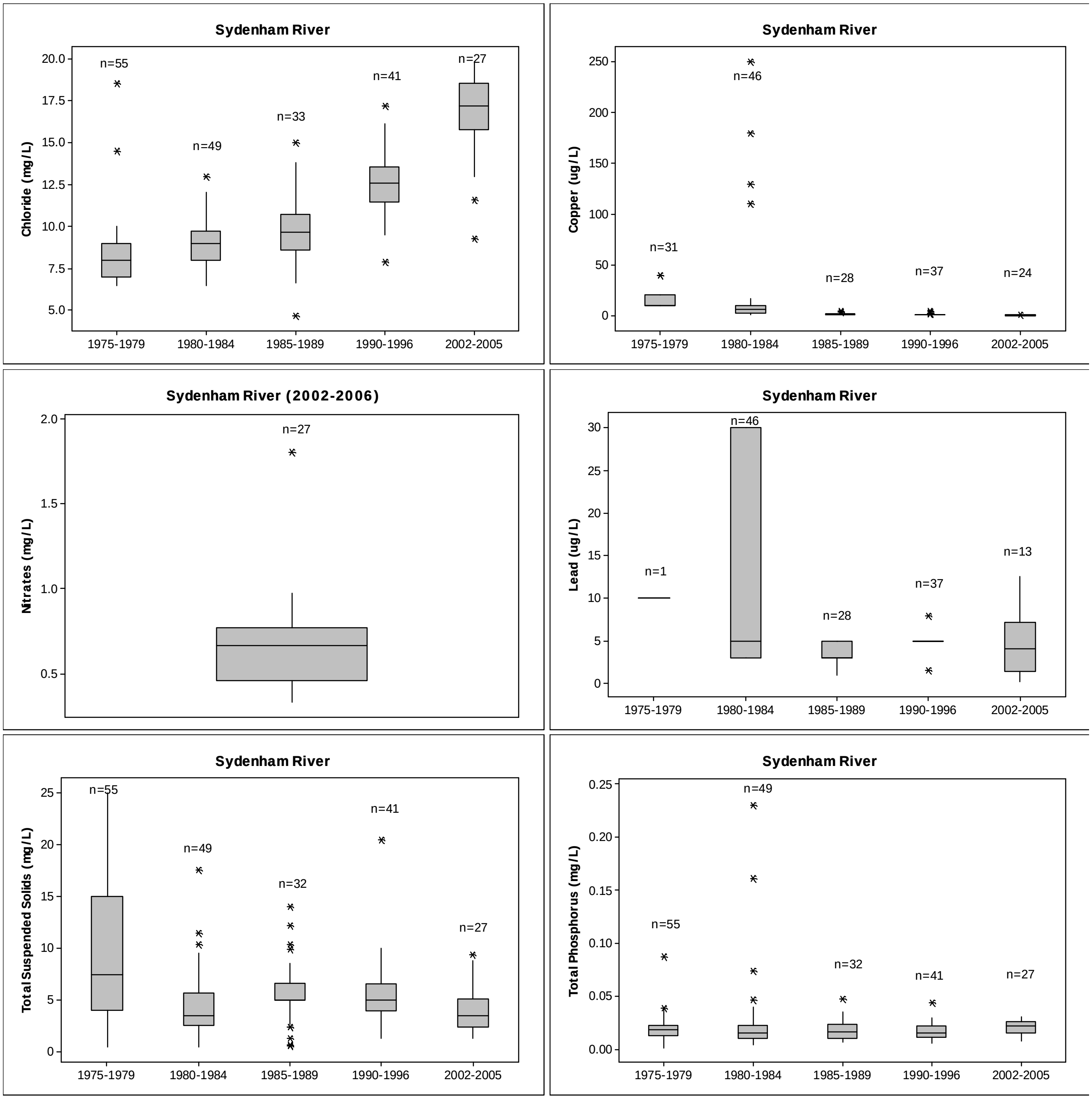


Figure 3.2.15 Time series of water chemistry parameters for the Sydenham River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



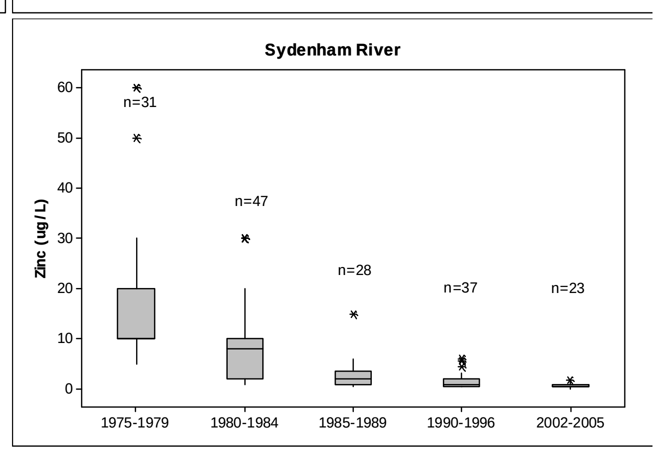


Figure 3.2.16 Box plots of water chemistry parameters for the Sydenham River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

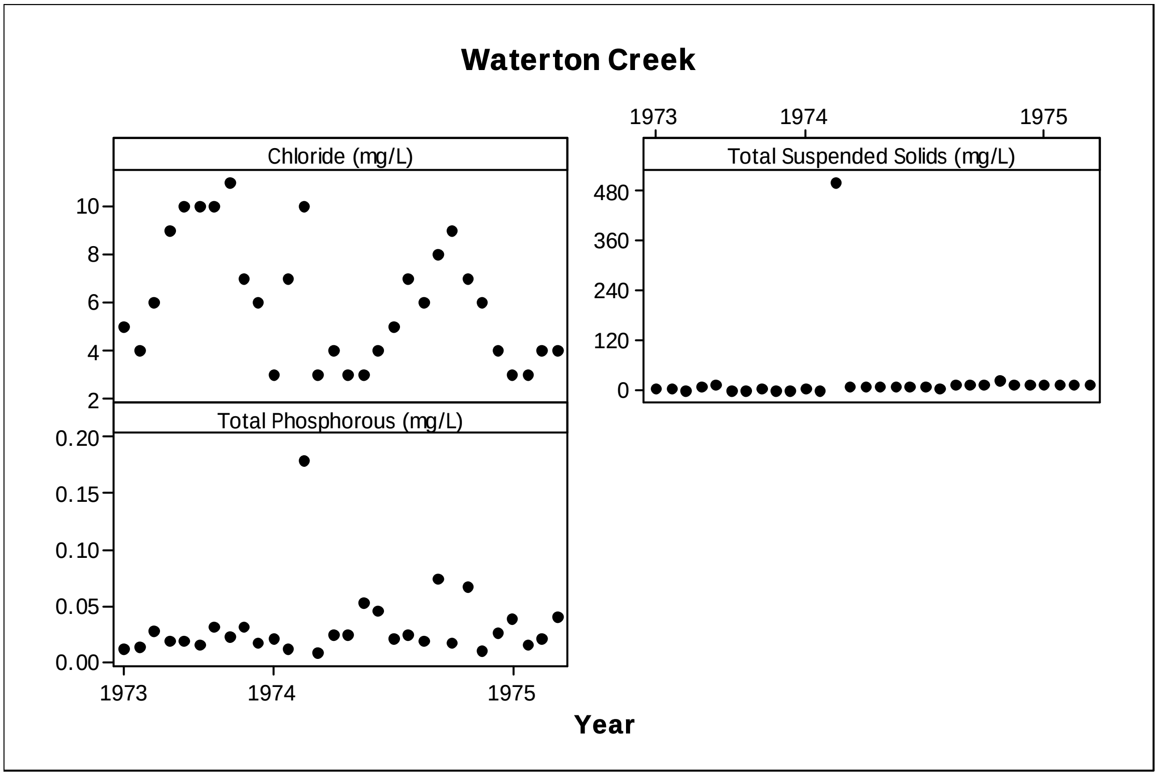


Figure 3.2.17 Time series of water chemistry parameters for the Waterton Creek
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

3.2.1.2 Saugeen Valley SPA

Stream water chemistry data exists for all eight subwatersheds in the Saugeen Valley SPA. With the exception of the Pine and Penetangore Rivers, the other six subwatersheds contribute to the water quality of the Saugeen River at various points within the reach.

Beatty Saugeen River

Water samples analyzed were collected from 2002 to 2005. Initial observations indicate that lead and total phosphorus concentrations were near or above recommended concentrations for most samples (Table 3.11 and Figure 3.2.18). The median concentration of lead values appears to be decreasing annually, while total phosphorus annual median values appear to remain constant (Figure 3.2.19).

TABLE 3.11 - Summary of water chemistry exceedences for the Beatty Saugeen River

Beatty Saugeen River			
Year	***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed
2002-2005	30	3	10
TOTAL	30	3	10

Note: Limit for parameter - - Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Main Saugeen River

The Saugeen River has been separated into three segments to deal with the size of the Saugeen River watershed. The segments were chosen to approximate three equal lengths of the stream channel and were based on the locations of sampling points. The segments represent: the headwaters of the Saugeen River to above Durham; above Durham to below Walkerton; and below Walkerton to the mouth of the Saugeen River. Water chemistry is also provided at the headwaters.

Water chemistry data for the headwaters was available from 2002-2005. For this time, there were three exceedences of phosphorus. The limited temporal availability of data at the headwaters prevents identifying any trends for the chemical parameters analyzed.

Data for the first segment (headwaters to above Durham) has chloride, total suspended solids, and total phosphorus data from 1973 to 1995 and 2002 to 2005. Copper, lead, and zinc data is available from approximately 1980 to 1995 and from 2002 to 2005. Nitrate data is only available from 2002 to 2005 (Figure 3.2.22). The middle segment (above Durham to below Walkerton) has chloride, total suspended solids, and total phosphorus data from 1970 to present. Metals data and nitrate data is only available from 2002 to 2005 (Figure 3.2.24). The third segment (below Walkerton to mouth) has chloride data from 2002 to present, while metals, total suspended solids and total phosphorus data has been collected from 1975 to present (Figure 3.2.26).

Table 3.12 identifies the exceedences for the data that was analyzed. There were exceedences in total phosphorus concentrations throughout the Saugeen River. In recent years (2002-2005), the frequency of total phosphorus concentrations has decreased from the headwaters to below Walkerton, but near the mouth of the river concentrations regularly exceed the PWQO of 0.03 mg/L. The frequency of lead concentration exceedences has increased for the same time period compared to previous year groupings. It appears the concentration of lead in the Saugeen River is most influenced from the Teeswater River, as the similar trend occurs there. At this point it is difficult to establish a causal relationship with the exceedences of lead and surrounding land use activities.

Concentrations typically increase for all indicator parameters from the headwaters to the mouth of the river, which is evident in the median concentrations spatially and temporally (Figures 3.2.23, 3.2.25, and 3.2.27). The increase in chloride concentrations is most notable in recent years.

TABLE 3.12 - Summary of water chemistry exceedences for the Main Saugeen River

Main Saugeen River- Headwaters			
Year	***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed
2002-2005	30	3	10.0
TOTAL	30	3	10.0

Main Saugeen River- Headwaters to above Durham						
Year	***Lead***			***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1973-1977	0	0	N/A	50	5	10.0
1978-1982	28	2	7.1	60	1	1.7
1983-1987	55	11	20.0	59	1	1.7
1988-1992	51	0	0.0	52	2	3.8
1993-1995	33	0	0.0	31	2	6.5
2002-2005	14	0	0.0	30	0	0.0
TOTAL	181	13	7.2	282	11	3.9

Main Saugeen River- Durham-Walkerton			
Year	***Total Phosphorus***		
	Total # Samples	# of Exceed	% Exceed
1970-1972	35	18	51.4
1973-1977	57	18	31.6
1978-1982	59	15	25.4
1983-1987	52	14	26.9
1988-1992	52	7	13.5
1993-1995	31	2	6.5
2002-2005	30	0	0.0
TOTAL	316	74	23.4

Main Saugeen River- Walkerton to Mouth									
Year	**Lead**			**Suspended Solids**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1975-1977	637	22	3.5	91	1	1.1	578	264	45.7
1978-1982	372	96	25.8	111	0	0.0	366	217	59.3
1983-1987	179	51	28.5	184	0	0.0	190	121	63.7
1988-1992	299	17	5.7	295	0	0.0	298	97	32.6
1993-1996	206	8	3.9	179	0	0.0	201	62	30.8
1997-2001	28	1	3.6	56	0	0.0	55	14	25.5
2002-2005	21	5	23.8	48	0	0.0	48	17	35.4
TOTAL	1742	200	11.5	964	1	0.1	1736	792	45.6

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

Mill Creek

Samples were collected between 2002 and 2005. With the exception of total phosphorus (Table 3.13), all indicator parameters were within acceptable concentrations for the dates sampled. Time series and box plots of the data are in Figures 3.2.28 and 3.2.29. Based on the data presented, it is difficult to establish trends, but there does not appear to be water quality issues or substantial impacts of land use activities in the watershed.

TABLE 3.13 - Summary of water chemistry exceedences for Mill Creek

Mill Creek			
Year	**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed
2002-2005	30	2	6.7
TOTAL	30	2	6.7

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

North Saugeen River

Water samples were collected midstream and near the mouth of the river between 2002 and 2005 (Figures 3.2.30 and 3.2.32). With the exception of lead and total phosphorus, concentrations of the other indicator parameters were within acceptable levels. Median concentrations of the indicator parameters are provided in Figures 3.2.31 and 3.2.33. The number of exceedences for each indicator parameter is provided in Table 3.14.

Midstream concentrations of lead and zinc are higher than concentrations near the mouth. This may be a result of dilution from increased discharge downstream. The data presented indicates minimal effects of land use activities within the watershed.

TABLE 3.14 - Summary of water chemistry exceedences for the North Saugeen River

North Saugeen River- Midstream			
Year	***Lead***		
	Total # Samples	# of Exceed	% Exceed
2002-2005	12	1	8.3
TOTAL	12	1	8.3

North Saugeen River Mouth						
Year	**Lead**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
2002-2005	18	1	5.6	30	4	13.3
TOTAL	18	1	5.6	30	4	13.3

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Penetangore River

Water chemistry data from 2002 to 2005 have been summarized. Exceedences were observed for lead and total phosphorus ((Table 3.15; Figure 3.2.34). Median concentrations of the indicator parameters are given in Figure 3.2.35. With the exception of lead concentrations, indicator parameters are within acceptable limits. It is evident that the Penetangore River is influenced by local soil and land use activities relative to other watersheds in the region.

TABLE 3.15 - Summary of water chemistry exceedences for the Penetangore River

Penetangore River			
Year	***Lead***		
	Total # Samples	# of Exceed	% Exceed
2002-2005	15	1	6.7
TOTAL	15	1	6.7

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS)

Pine River

Water chemistry data have been collected in two periods, 1970 to 1978 and 2002 to 2005. Chloride, total suspended solids, and total phosphorus data have been collected for both periods. Metals (a few data points from 1970 to 1978) and nitrates data are available from 2002 to 2005 (Figure 3.2.36). Nitrate, lead, and total phosphorus had at least one sample above drinking water standards/objectives for the 2002-2005 time periods (Figure 3.2.37). Annual exceedences are provided in Table 3.16. The temporal availability of samples makes it difficult to identify trends. The fine textured soils in the Pine River watershed does make it susceptible to erosional processes and to the transport of material into the reach.

TABLE 3.16 - Summary of water chemistry exceedences for the Pine River

Pine River									
Year	**Nitrate**			**Lead**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1970-1978	0	0	N/A	4	3	75.0	103	89	86.4
2002-2005	22	2	9.1	10	1	10.0	23	13	56.5
TOTAL	22	2	9.1	14	4	28.6	126	102	81.0

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

Rocky Saugeen River

Data have been collected from 1973 to 1975 and from 2002 to 2005. Results from 1973 to 1975 for chloride and total suspended solids data appears to be trace or at the detection limits, as most of the values are the same. Metals and nitrate data is available from 2002 to 2005 (Figure 3.2.38). With the exception of lead concentrations and total phosphorus, the concentrations of the other indicator parameters are well below recommended concentrations (Figure 3.2.39). Annual exceedences are provided in Table 3.17. The period of time analysed does not allow trends to be identified.

TABLE 3.17 - Summary of water chemistry exceedences for the Rocky Saugeen River

Rocky Saugeen River						
Year	**Lead**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1973-1975	0	0	N/A	20	4	20.0
2002-2005	14	1	7.1	30	0	0.0
TOTAL	14	1	7.1	50	4	8.0

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

South Saugeen River

Water chemistry data have been summarized from 1973 to 1995 and from 2002 to 2005. Chloride, total suspended solids and total phosphorus data are the most complete for these time periods. Metals data is sparse from the late 1970s to the mid 1980s. Nitrate data is only available from 2002 to 2005 (Figure 3.2.40). There were exceedences for total suspended solids (>500mg/L) in the first grouping, but statistically they are considered outliers (Figure 3.2.41). The numbers of annual exceedences are provided in Table 3.18. It appears the number of exceedences of lead concentrations have increased in the 2002-2005 time period.

TABLE 3.18 - Summary of water chemistry exceedences for the South Saugeen River

South Saugeen River									
Year	**Lead**			**Suspended Solids**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1973-1977	88	11	12.5	137	2	1.5	151	30	19.9
1978-1982	0	0	N/A	54	0	0.0	54	11	20.4
1983-1987	52	16	30.8	56	0	0.0	56	8	14.3
1988-1992	47	0	0.0	51	0	0.0	50	8	16.0
1993-1995	31	0	0.0	30	0	0.0	31	4	12.9
2002-2005	12	2	16.7	30	0	0.0	30	5	16.7
TOTAL	230	29	12.6	358	2	0.6	372	66	17.7

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

Teeswater River

Water chemistry data were summarized from two different stations. Data are from the headwaters and mouth of the Teeswater River.

No copper data was provided for the headwaters monitoring location (Figure 3.2.42) and data was collected from 2002-2005. Median concentrations for the four years that were sampled are in Figure 3.2.43. Chloride, total suspended solids, and total phosphorus data have been collected from 1977 to 1995 and from 2002 to 2005. Metals and nitrate data are available from 2002 to 2005 (Figure 3.2.44). The median values of lead and total phosphorus are above recommended concentrations for the various yearly groupings (Figure 3.2.45). Annual exceedences of water chemistry parameters are given in Table 3.19. The grouped data show that the number of total phosphorus exceedences has decreased.

TABLE 3.19 - Summary of water chemistry exceedences for the Teeswater River

Teeswater River- Headwaters						
Year	**Lead**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
2002-2005	12	2	16.7	30	2	6.7
TOTAL	12	2	16.7	30	2	6.7

Teeswater River- Mouth						
Year	**Lead**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1977-1981	0	0	N/A	52	27	51.9
1982-1986	0	0	N/A	59	31	52.5
1987-1991	0	0	N/A	53	18	34.0
1992-1995	0	0	N/A	41	15	36.6
2002-2005	16	3	18.8	30	9	30.0
TOTAL	16	3	18.8	235	100	42.6

Note: Limits for parameters - - Lead: MAC of 0.01 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO)

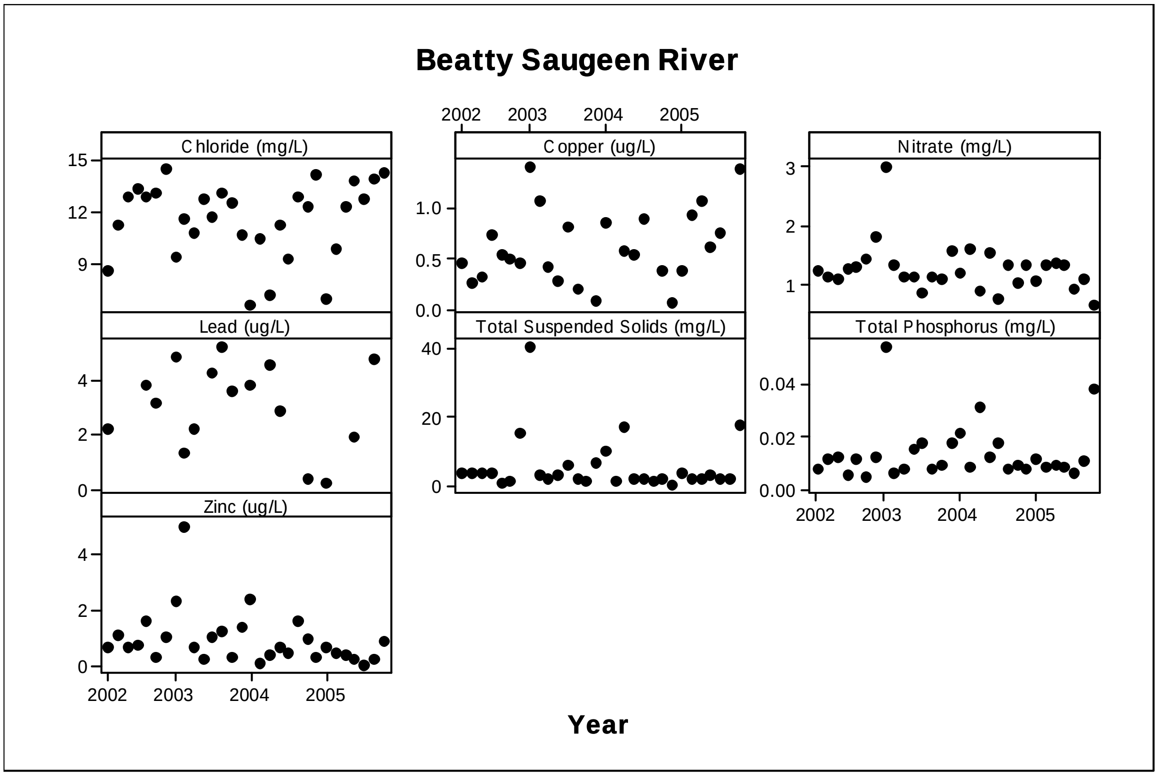
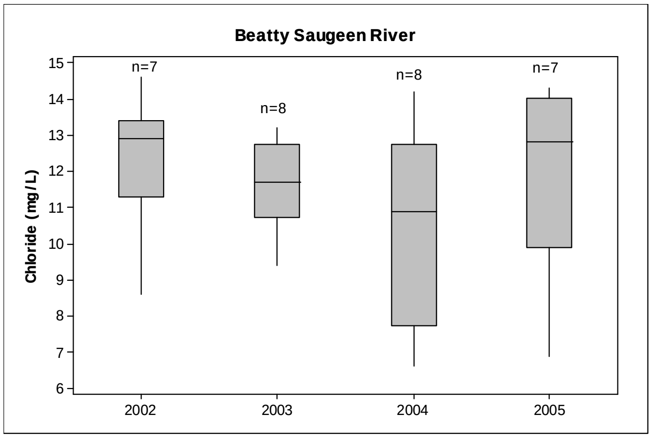
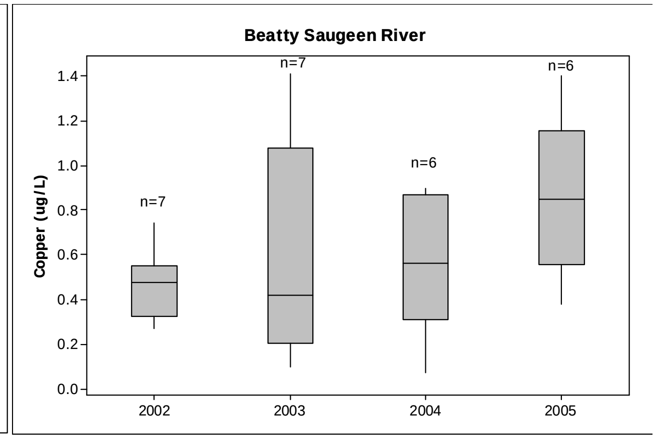
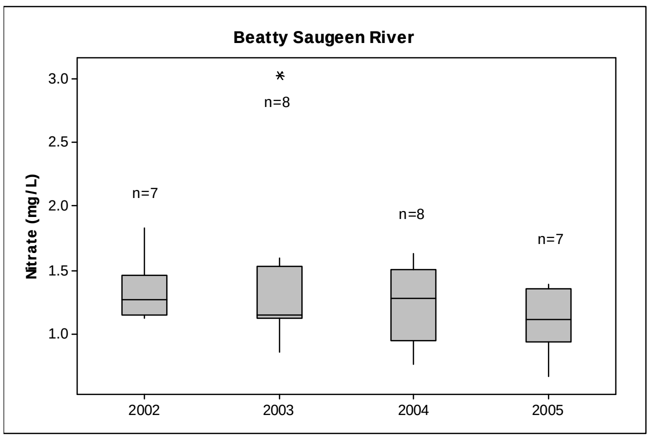
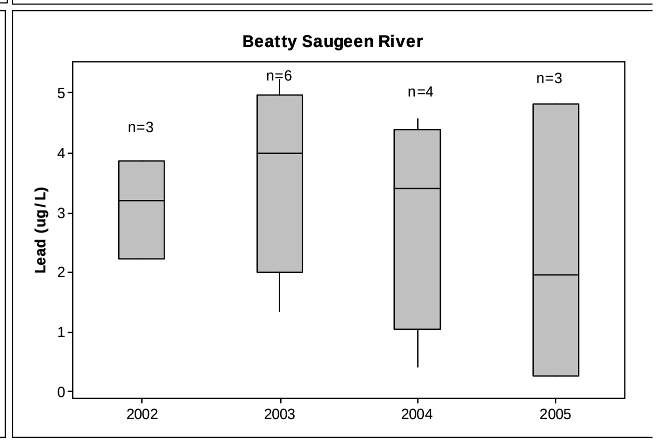


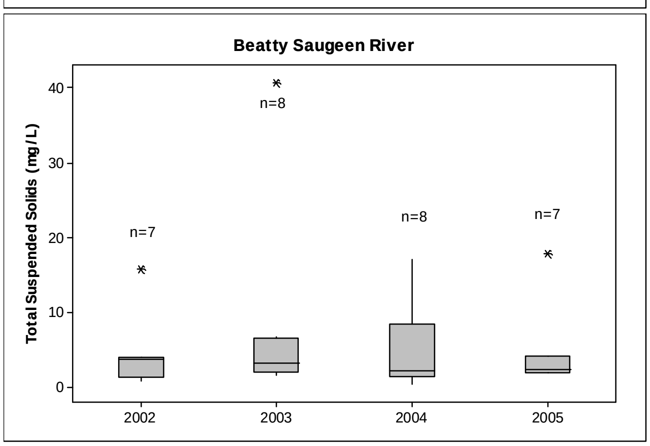
Figure 3.2.18 Time series of water chemistry parameters for the Beatty Saugeen River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)











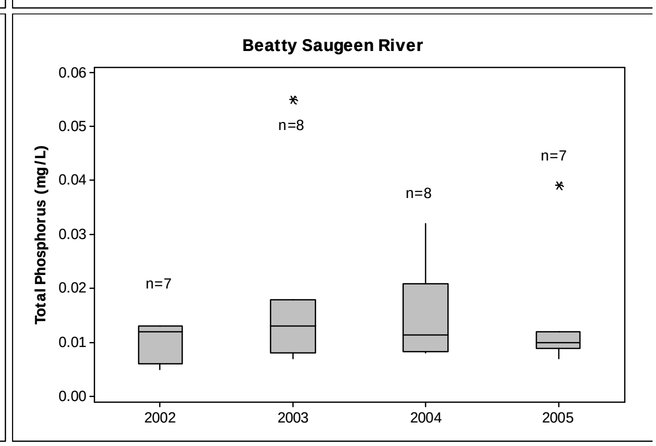
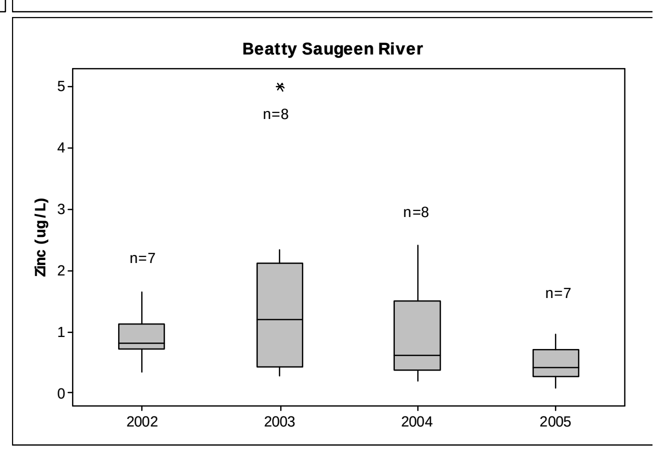


Figure 3.2.19 Box plots of water chemistry parameters for the Beatty Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



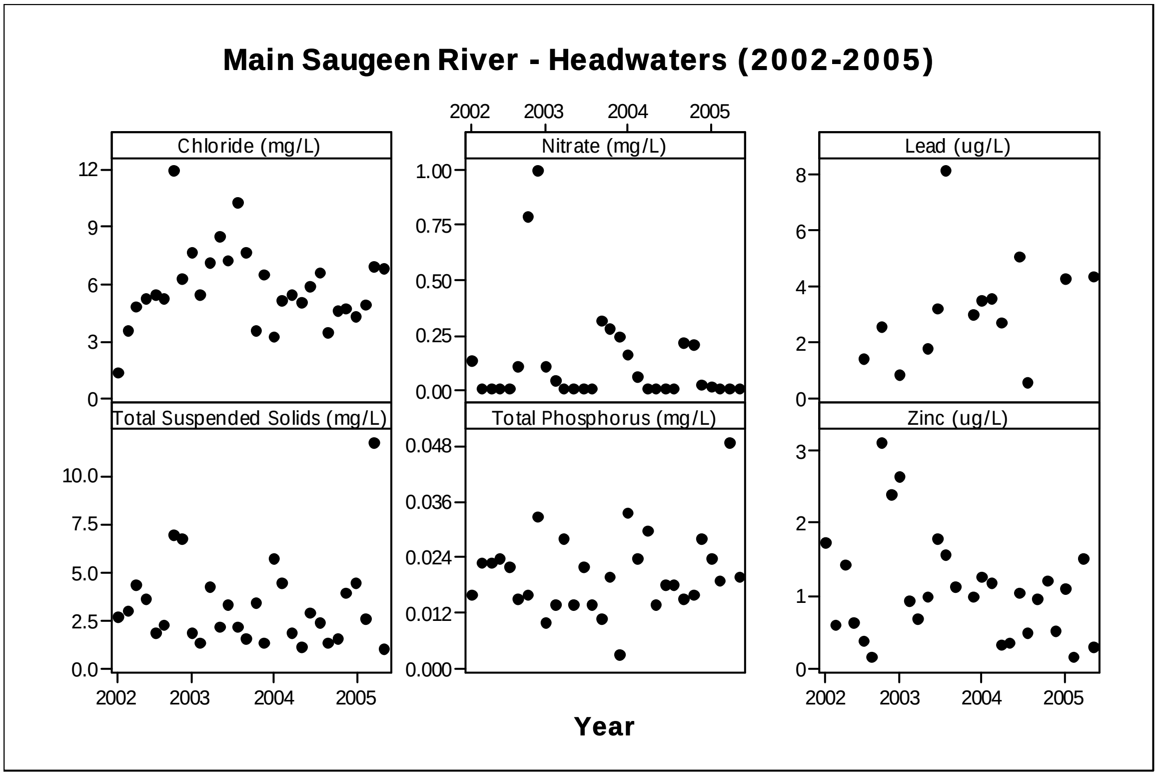


Figure 3.2.20 Time series of water chemistry parameters for the headwaters of the Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

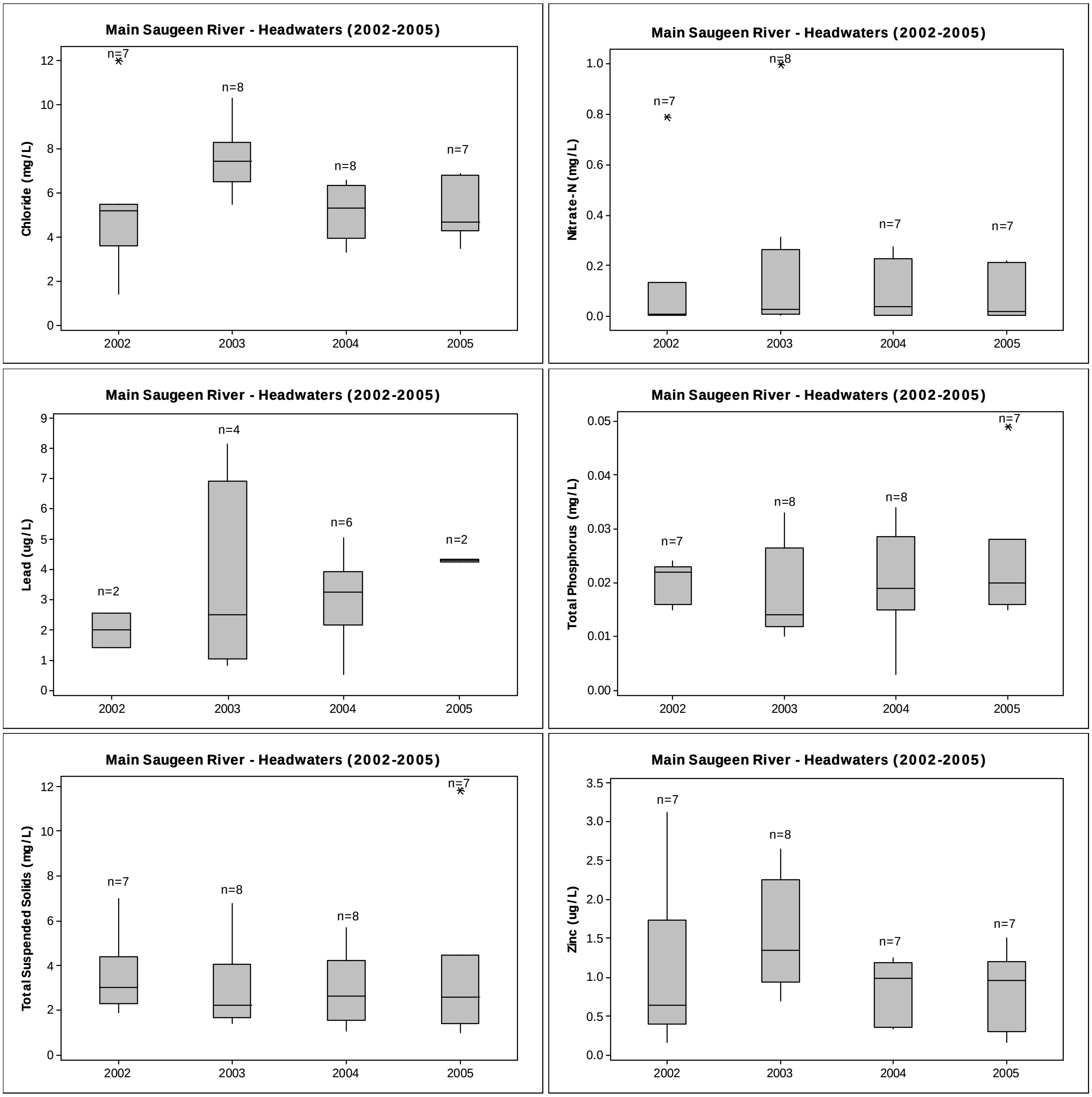


Figure 3.2.21 Box plots of water chemistry parameters for the headwaters of the Saugeen River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

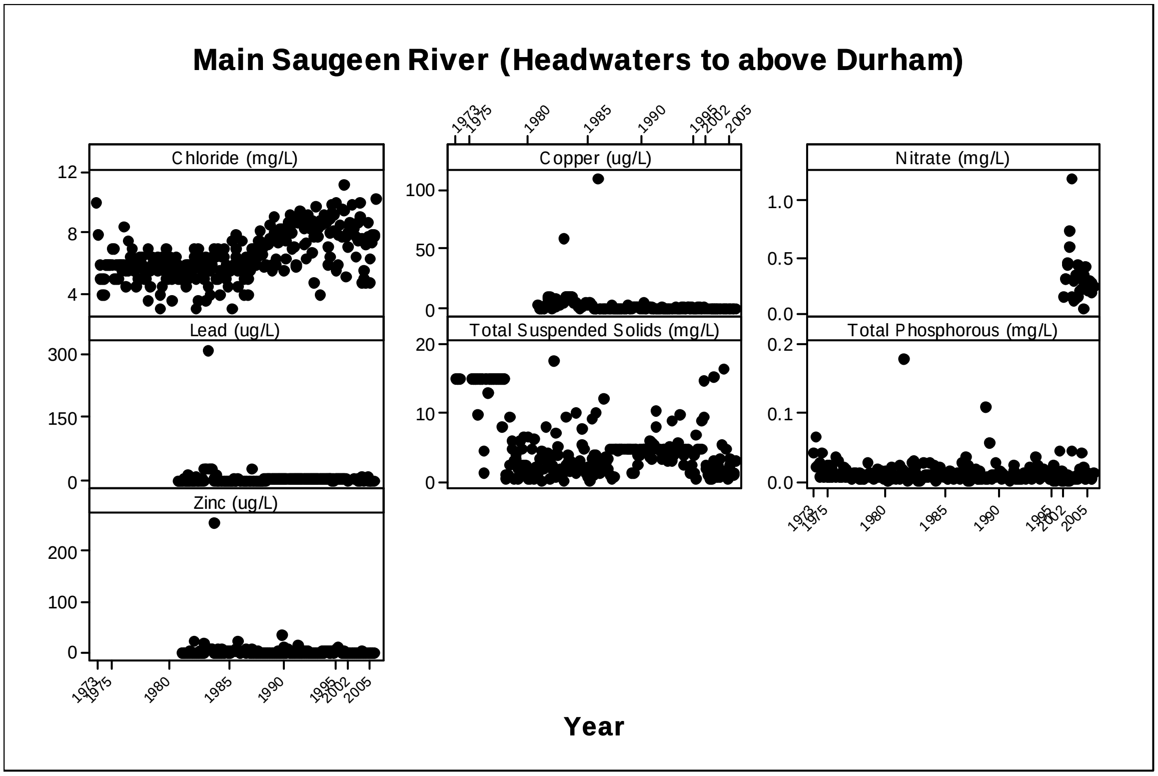
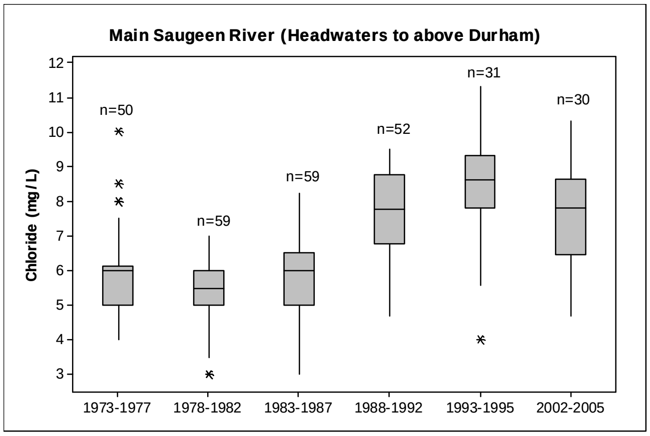
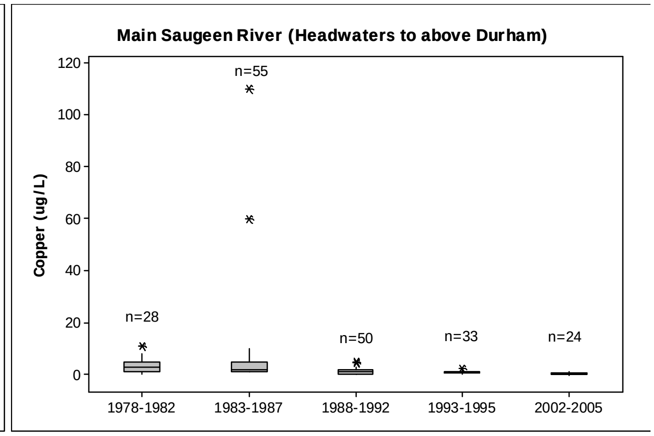
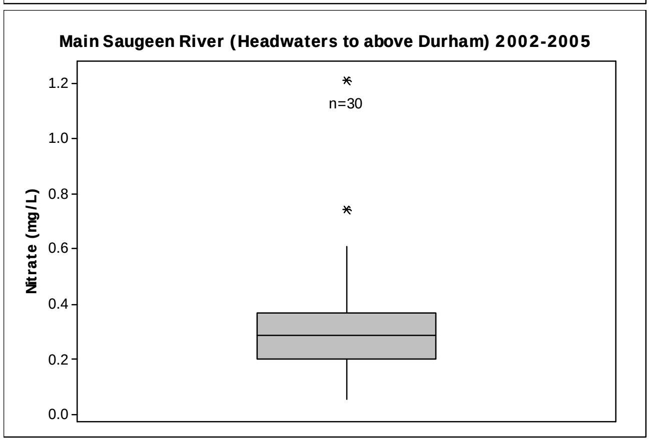


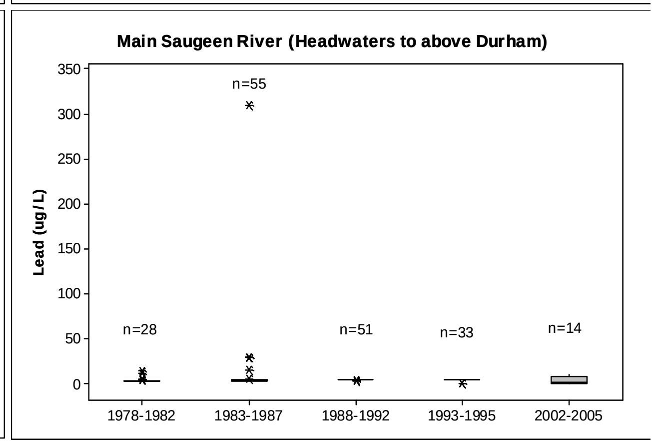
Figure 3.2.22 Time series of water chemistry parameters for the Saugeen River from the headwaters to above Durham

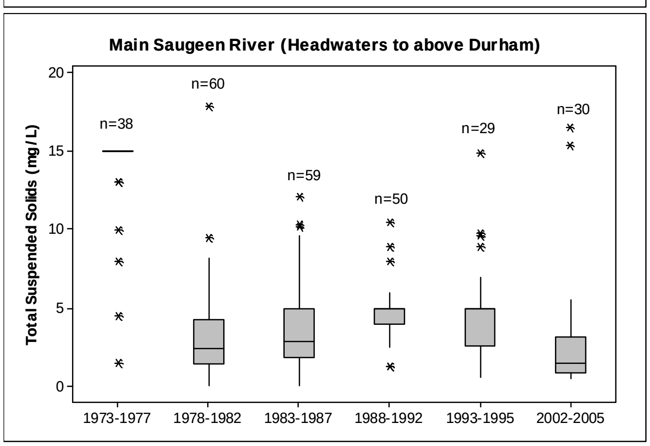
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

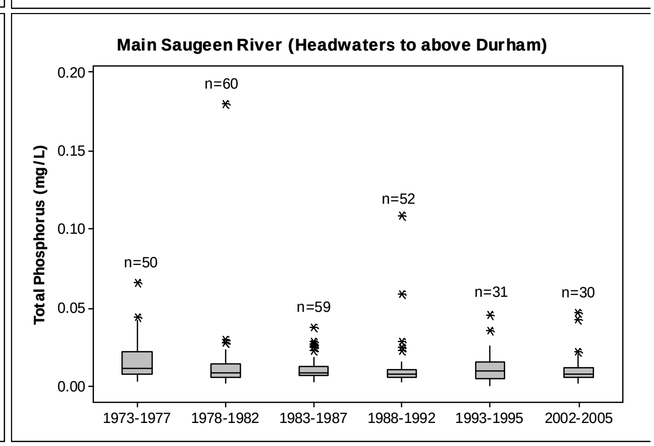












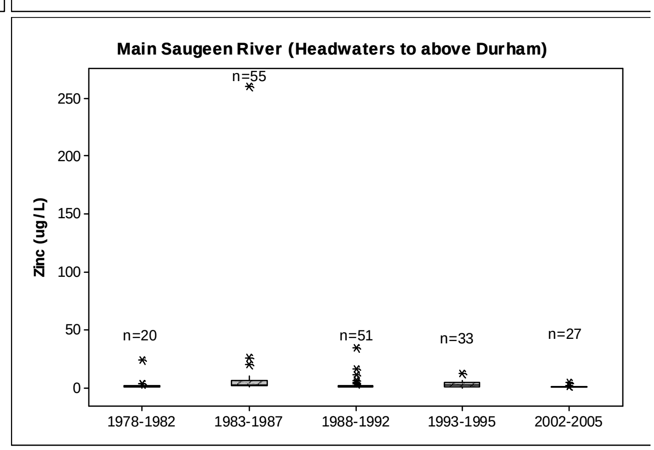


Figure 3.2.23 Box plots of water chemistry parameters for the Saugeen River from the headwaters to above Durham

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

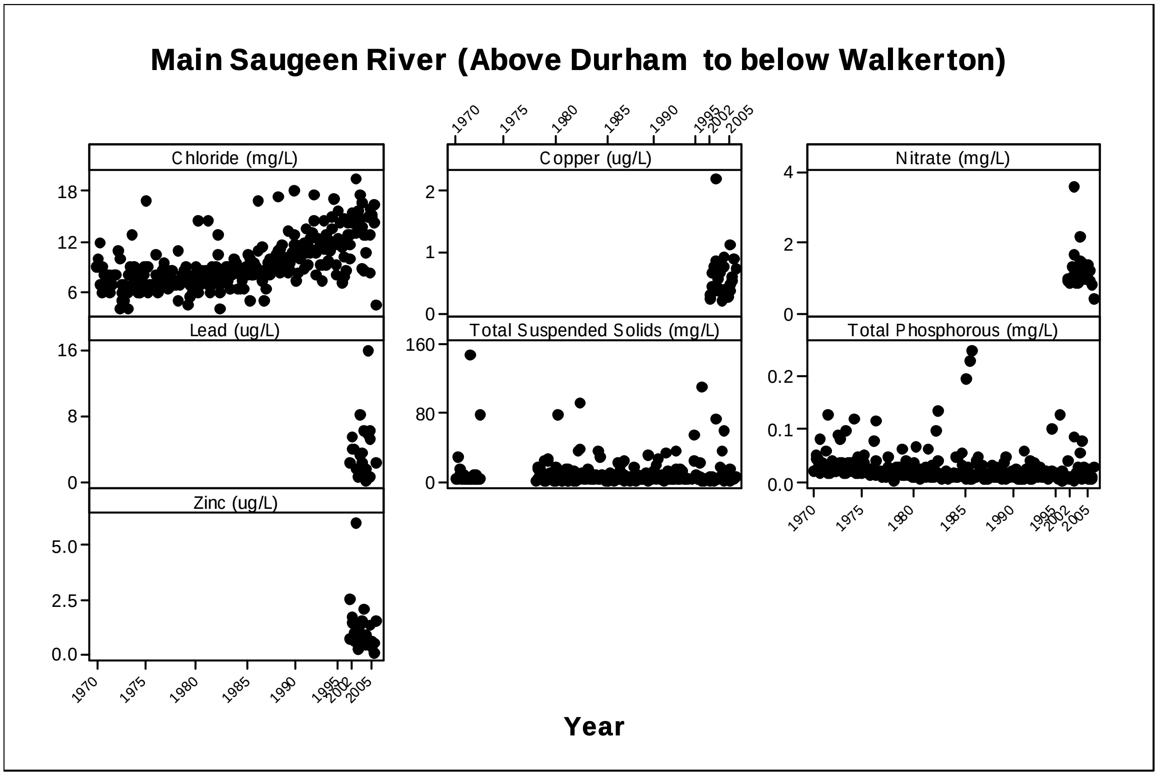


Figure 3.2.24 Time series of water chemistry parameters for the Saugeen River from above Durham to below Walkerton

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

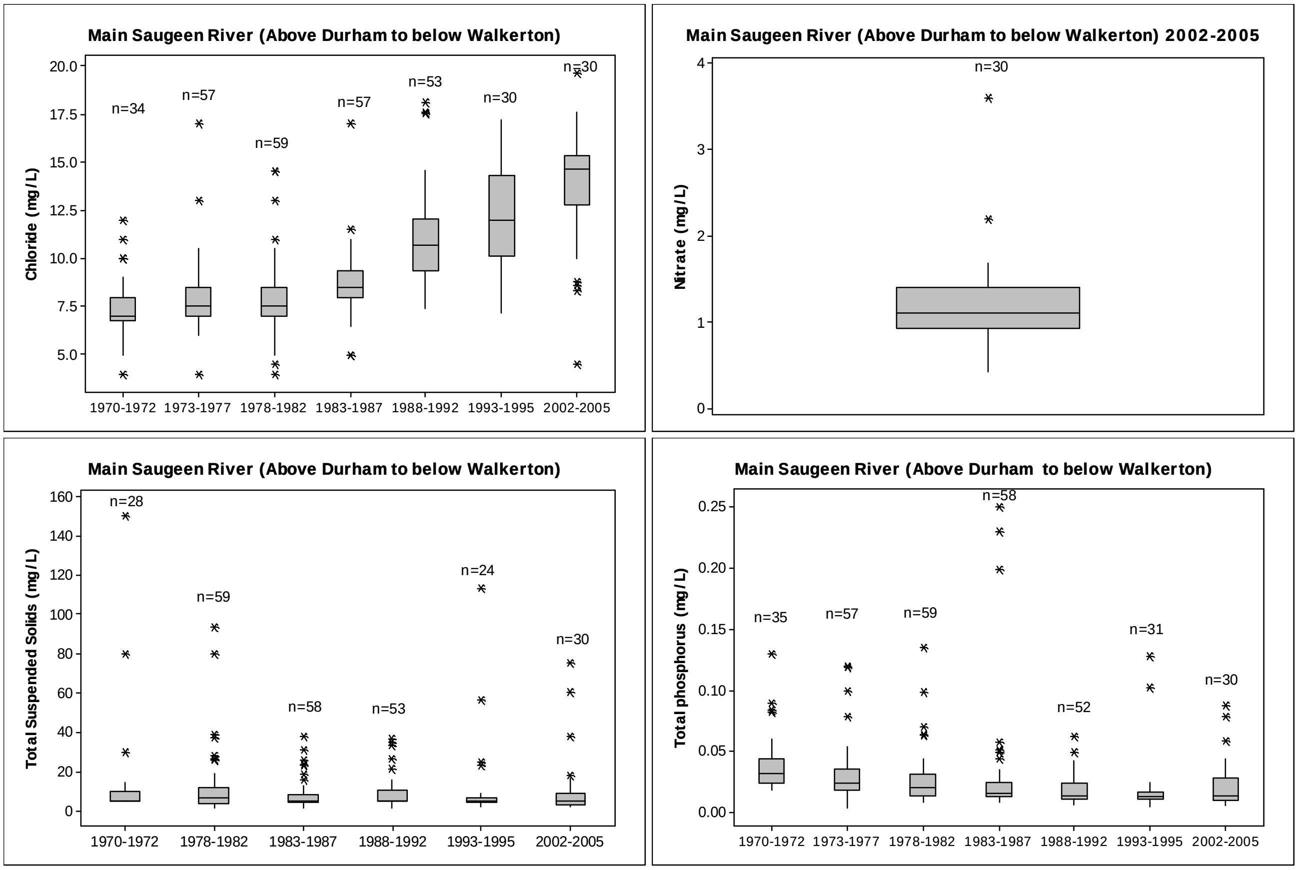


Figure 3.2.25 Box plots of water chemistry parameters for the Saugeen River from above Durham to below Walkerton

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

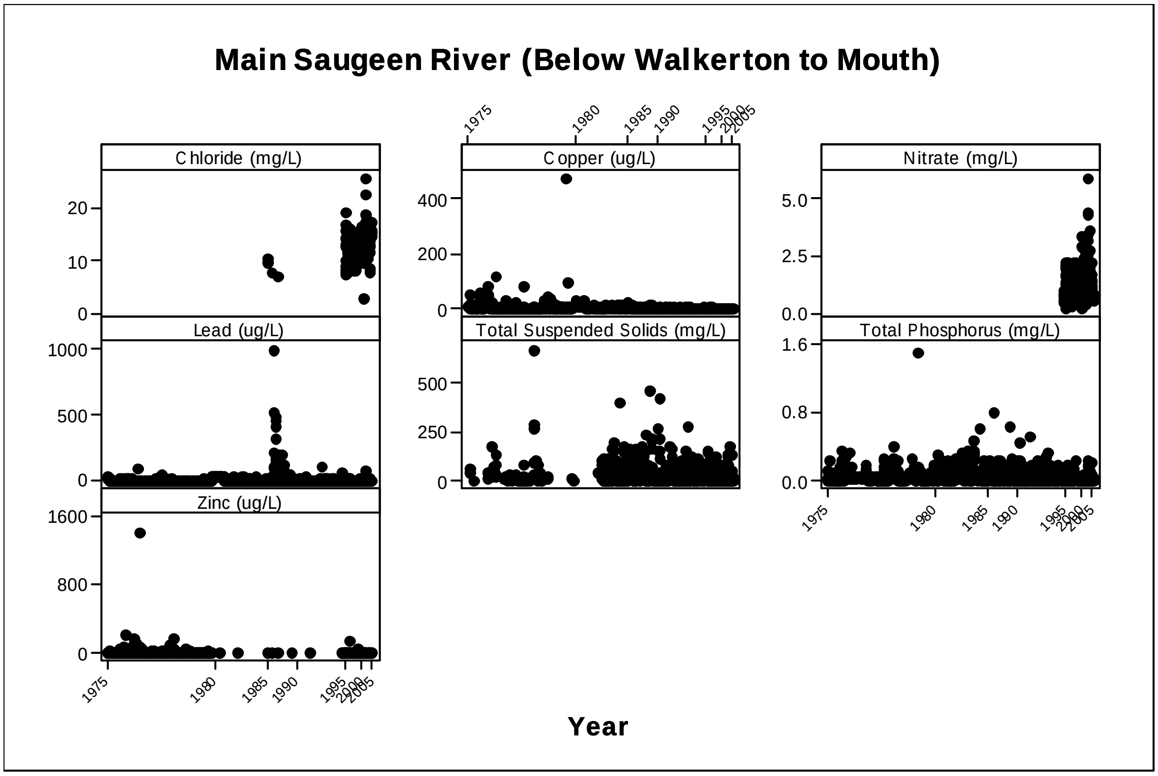
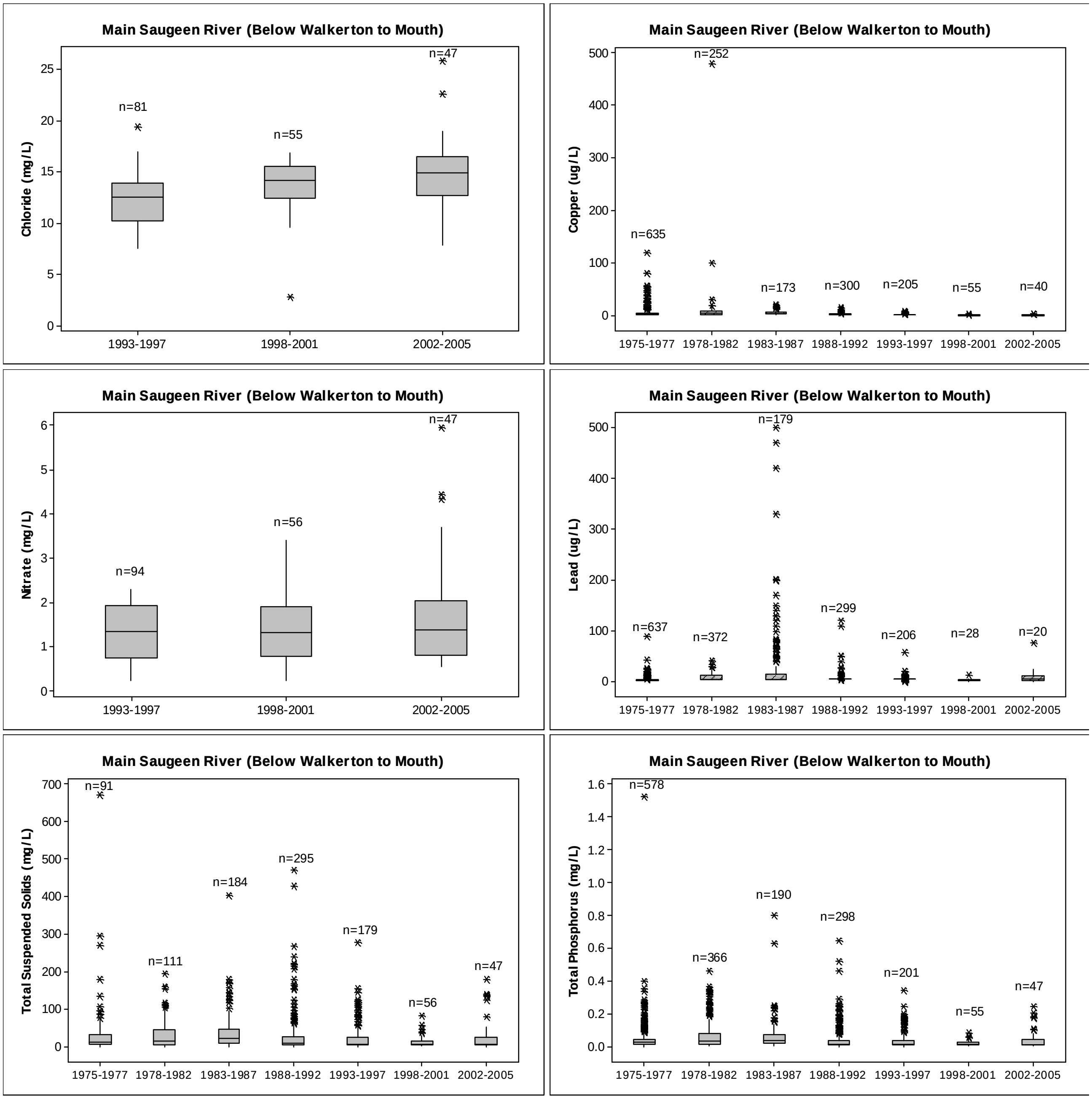


Figure 3.2.26 Time series of water chemistry parameters for the Saugeen River from below Walkerton to the mouth

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



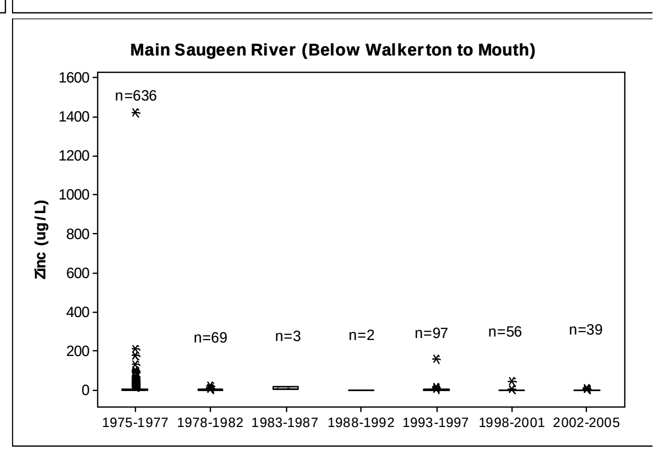


Figure 3.2.27 Box plots of water chemistry parameters for the Saugeen River from below Walkerton to the mouth

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

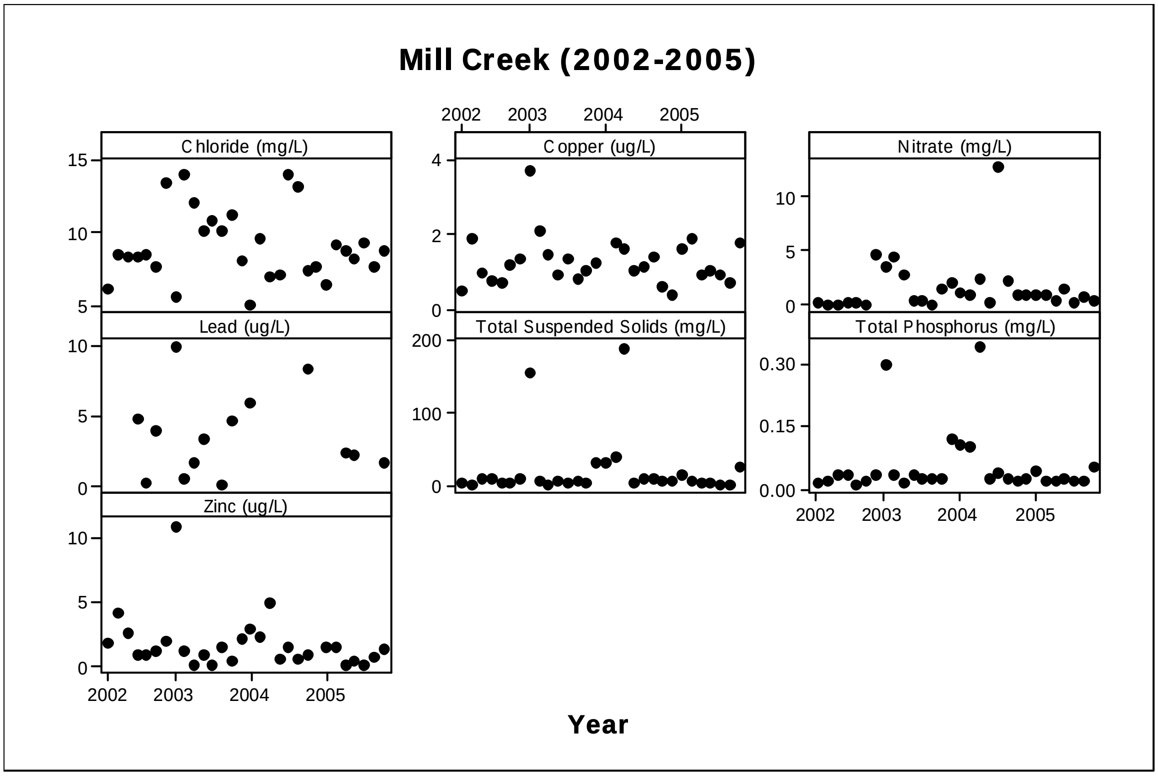
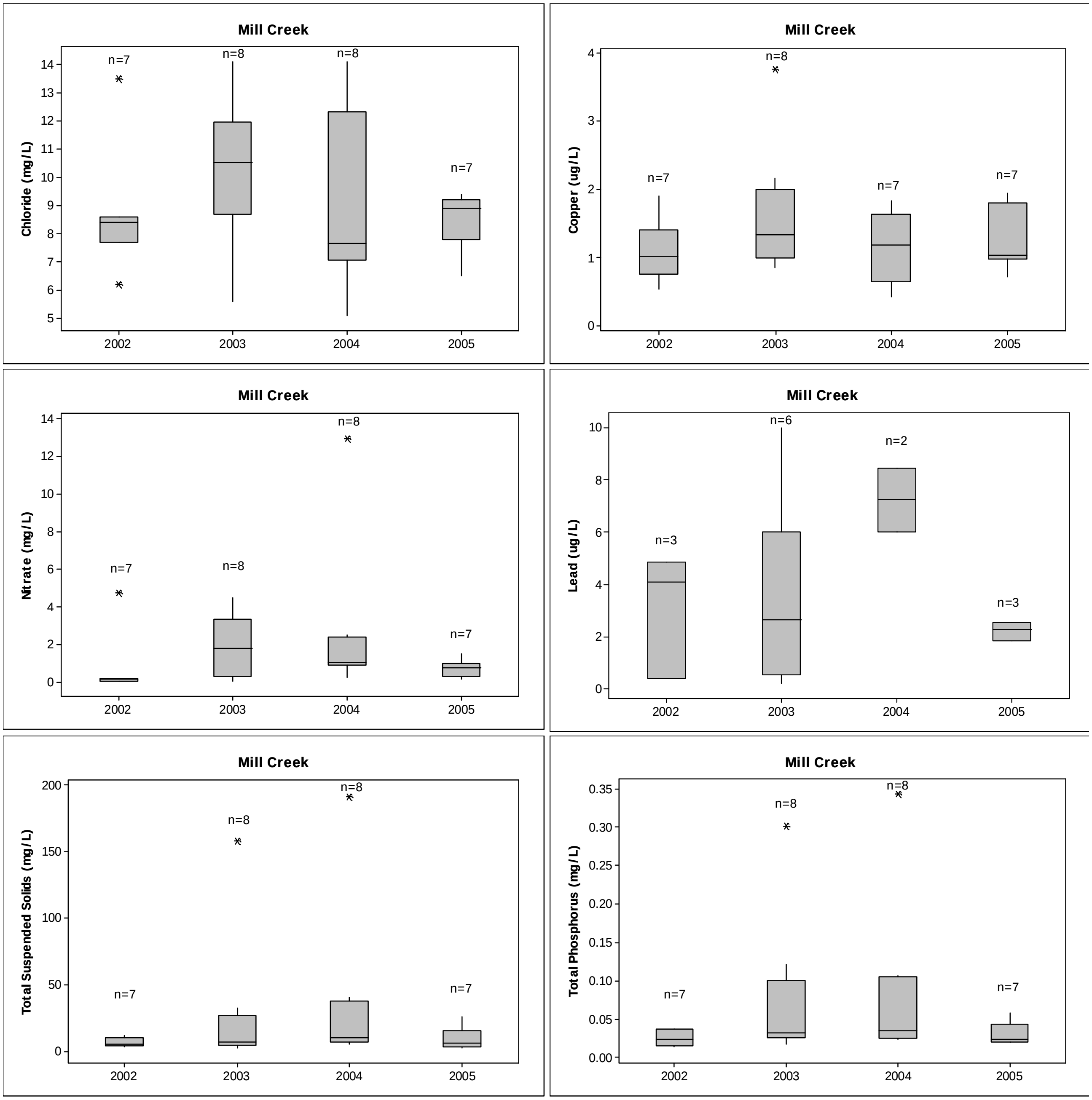


Figure 3.2.28 Time series of water chemistry parameters for Mill Creek

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



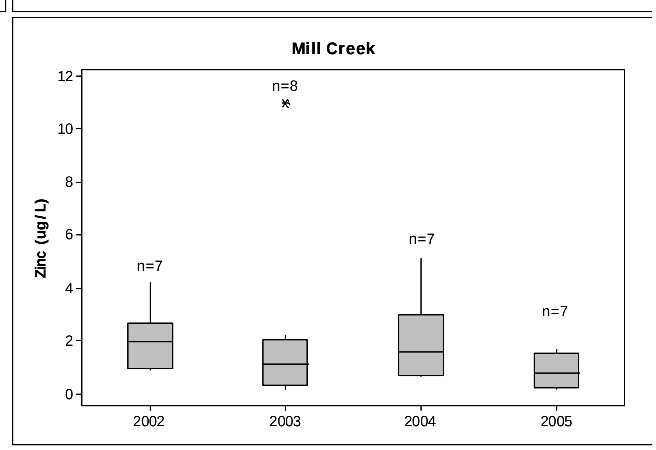


Figure 3.2.29 Box plots of water chemistry parameters for Mill Creek
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

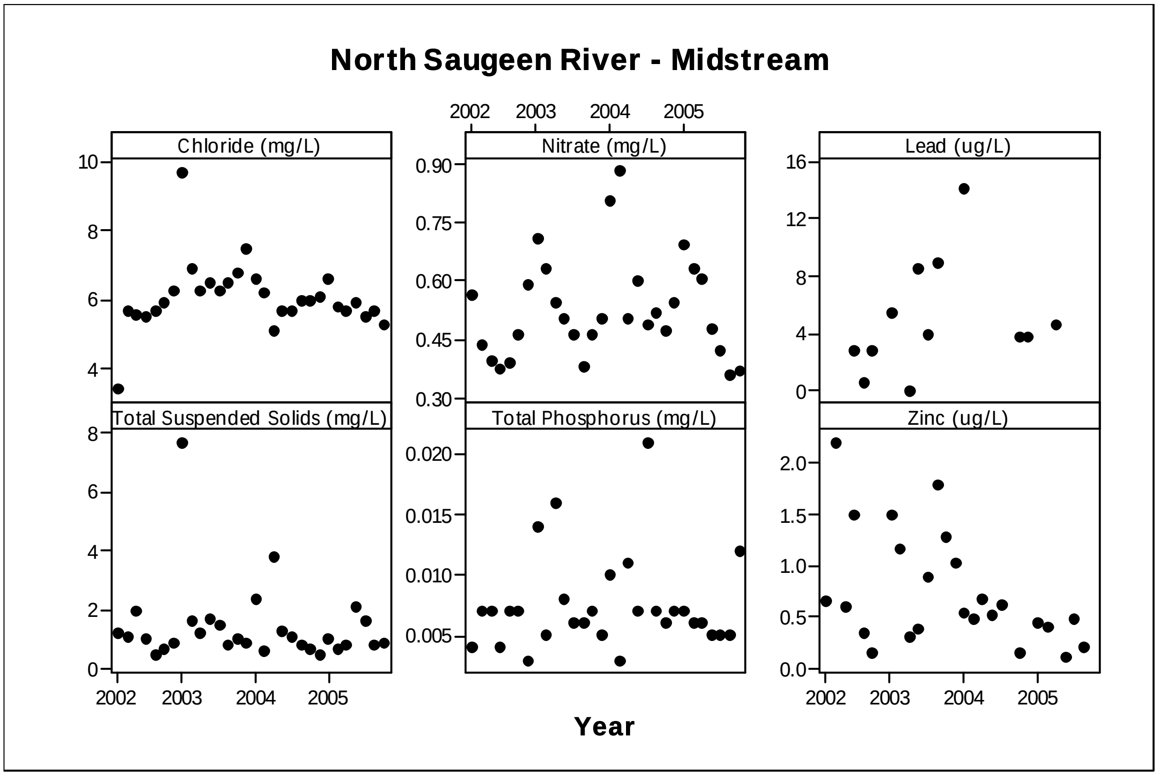


Figure 3.2.30 Time series of water chemistry parameters for the headwaters of the North Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

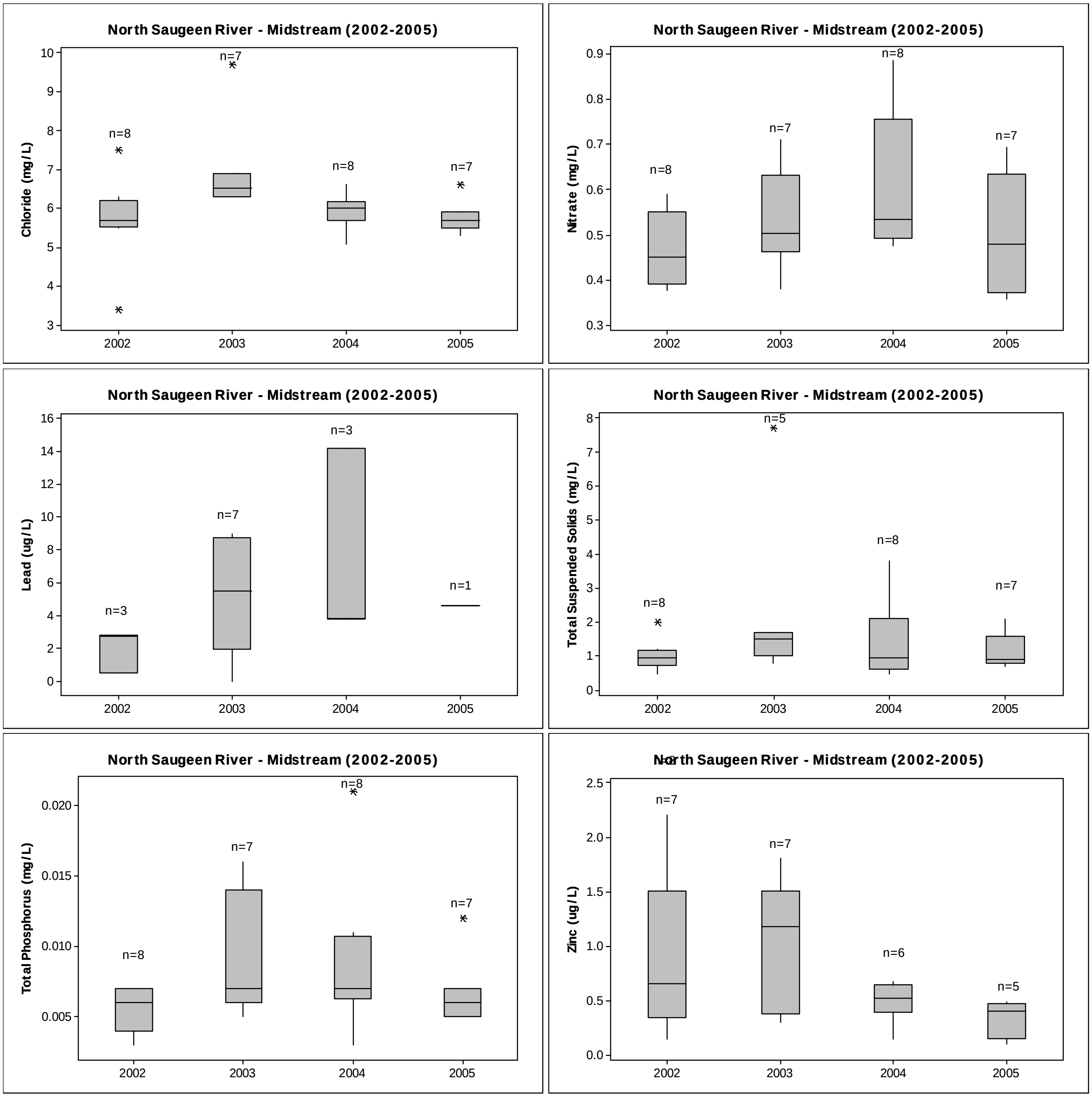


Figure 3.2.31 Box plots of water chemistry parameters for the headwaters of the North Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

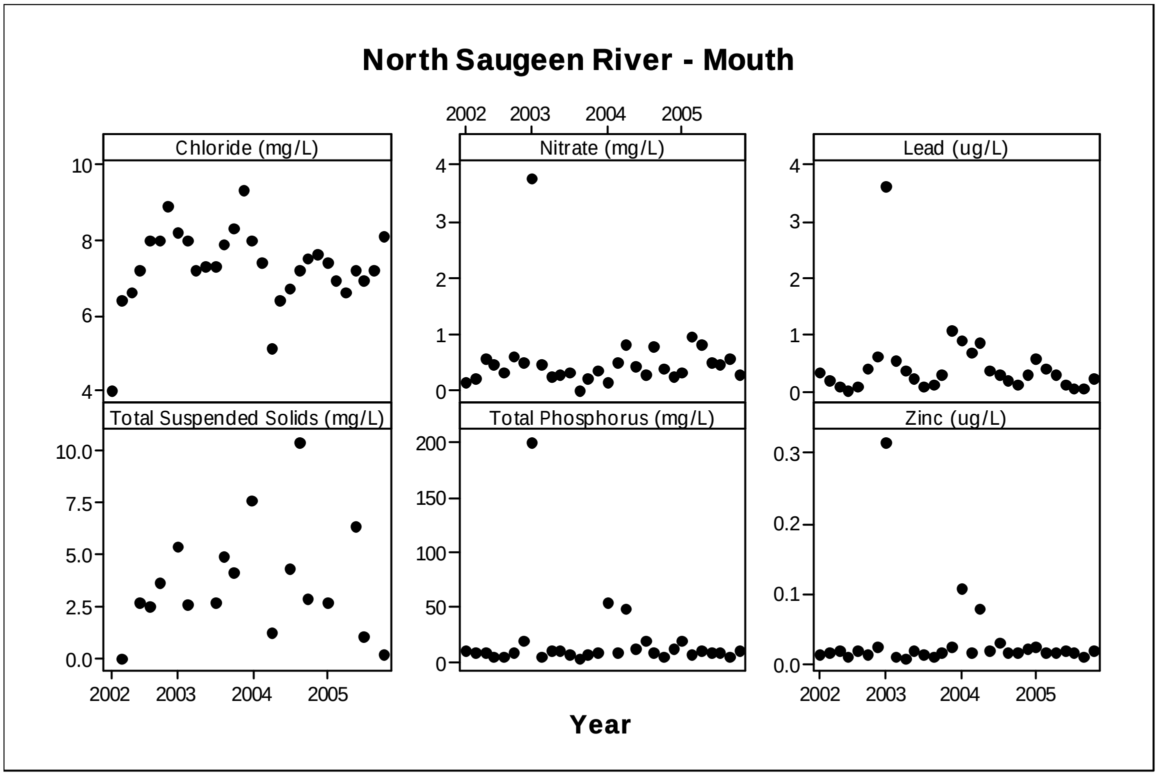


Figure 3.2.32 Time series of water chemistry parameters for the mouth of the North Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

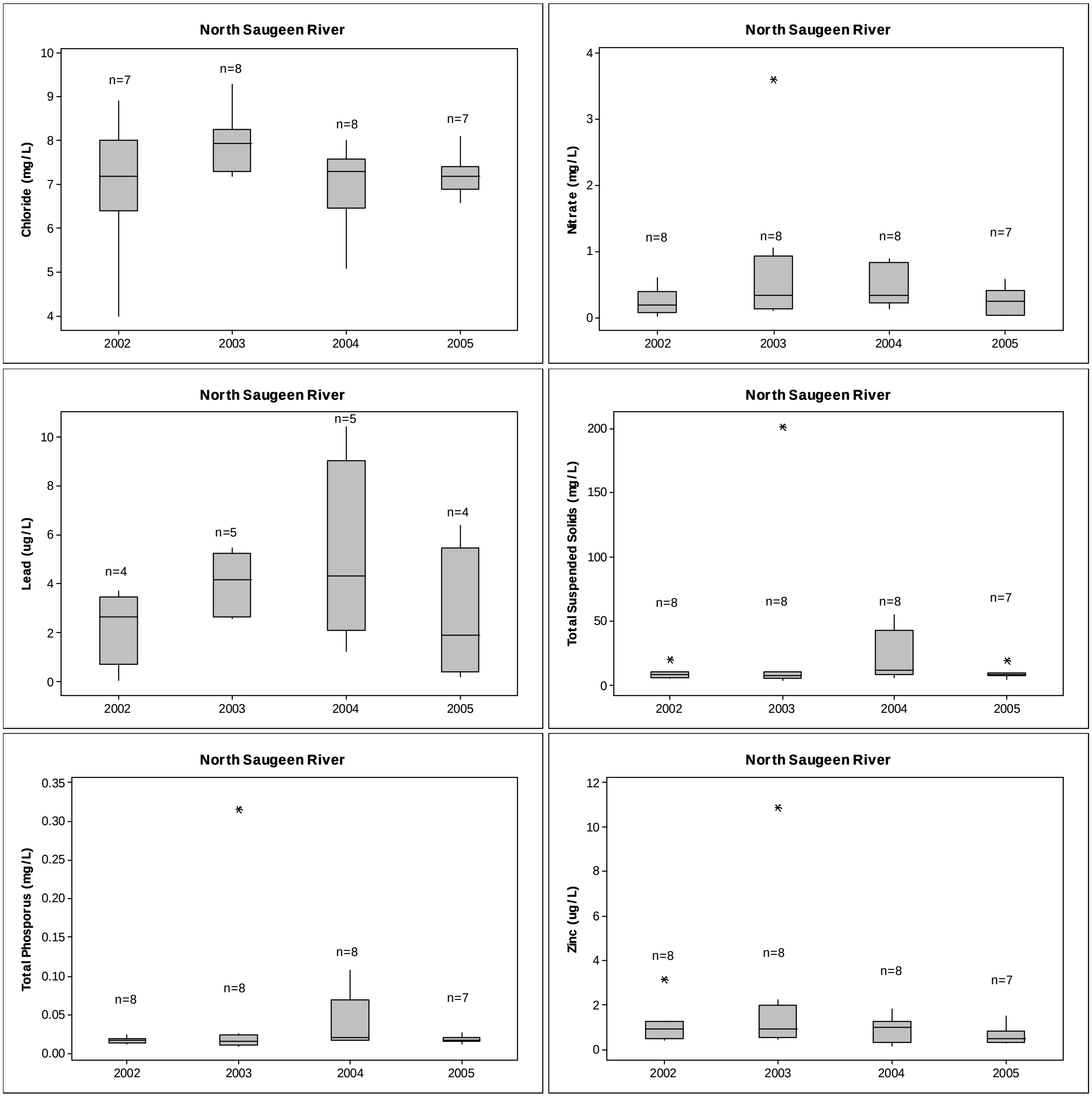


Figure 3.2.33 Box plots of water chemistry parameters for the mouth of the North Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

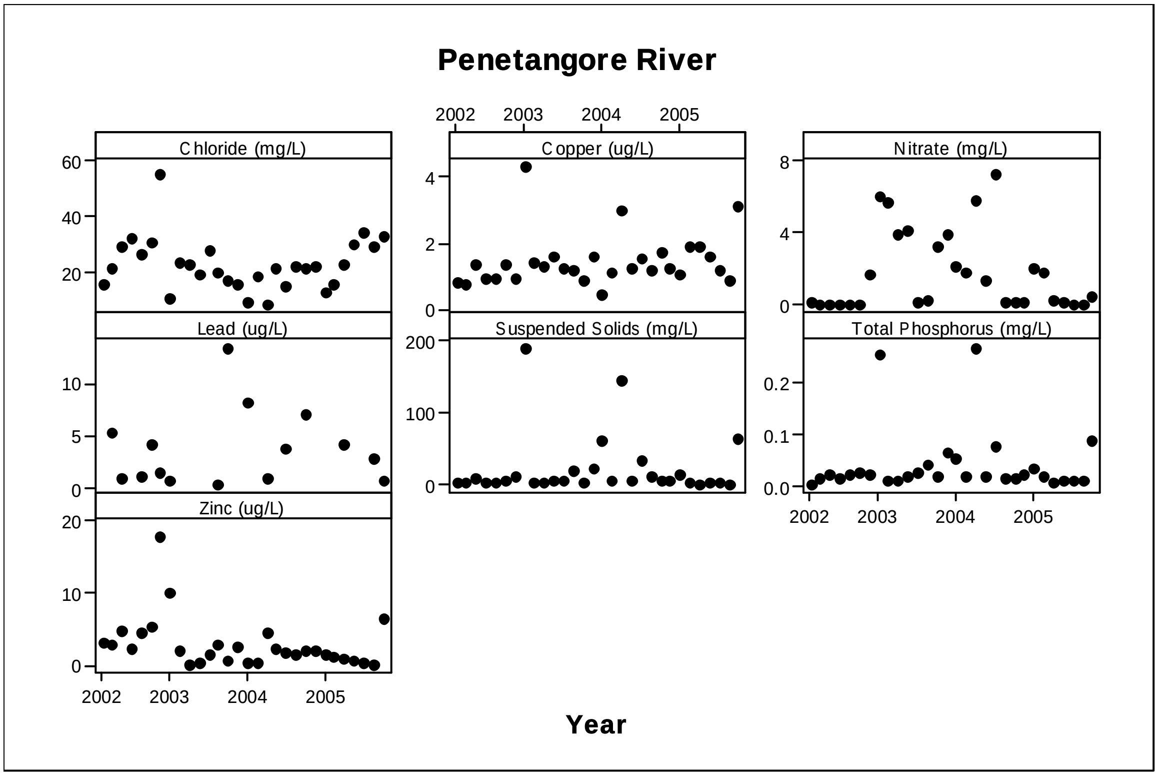
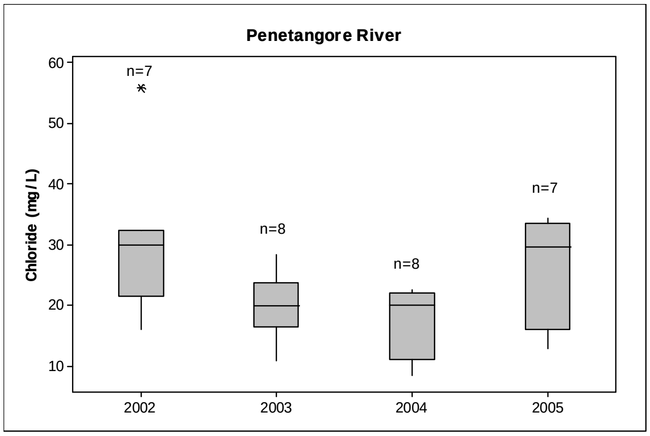
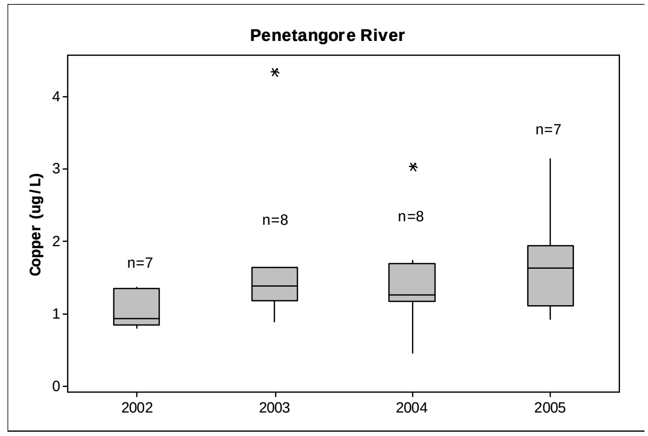
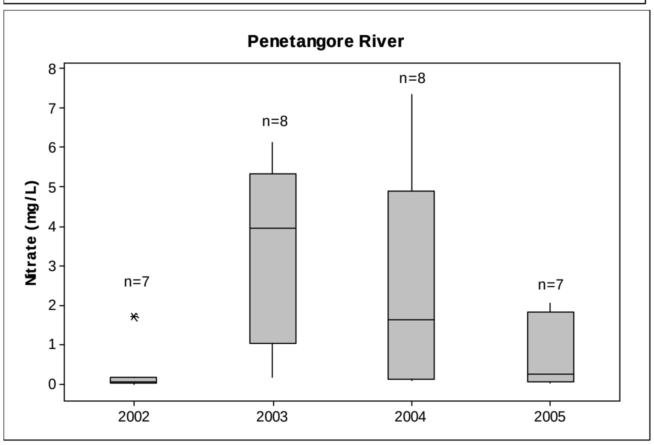
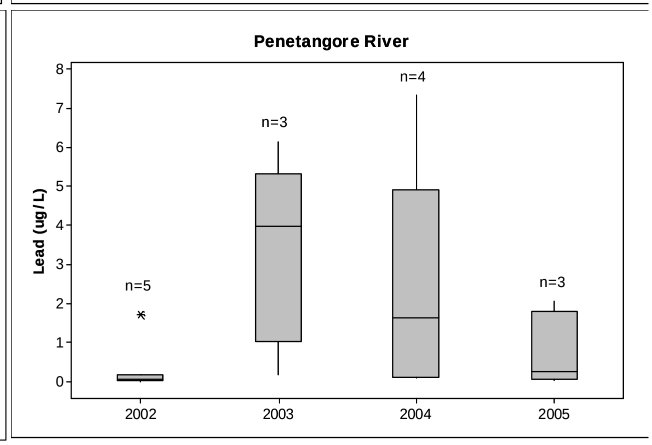


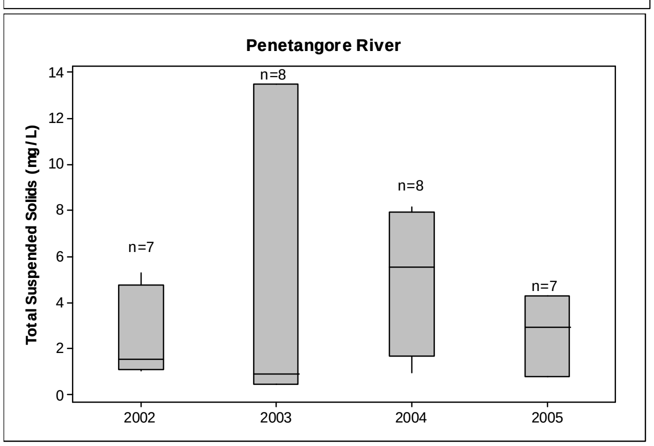
Figure 3.2.34 Time series of water chemistry parameters for the Penetangore River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

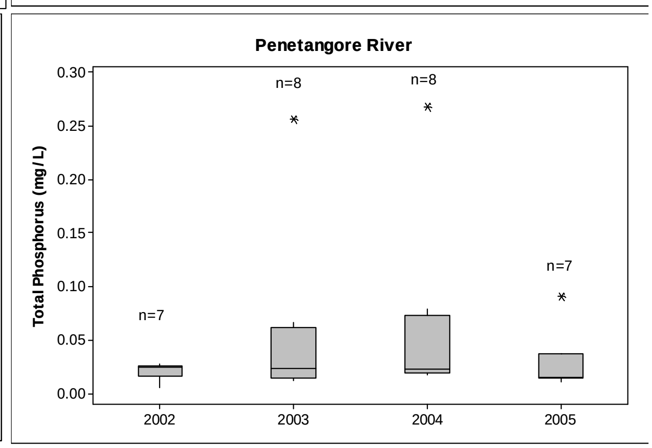












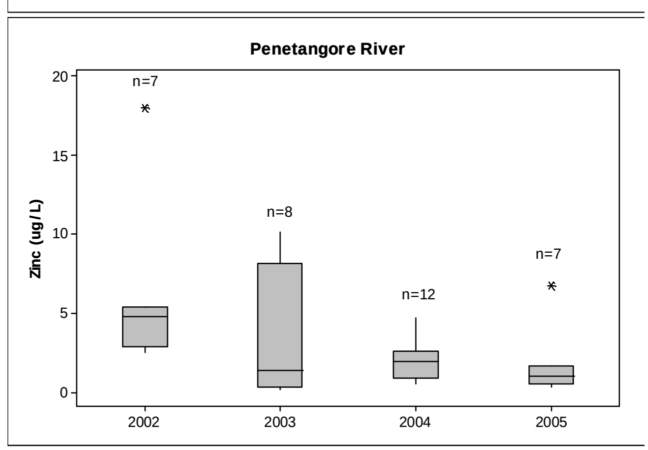


Figure 3.2.35 Box plots of water chemistry parameters for the Penetangore River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

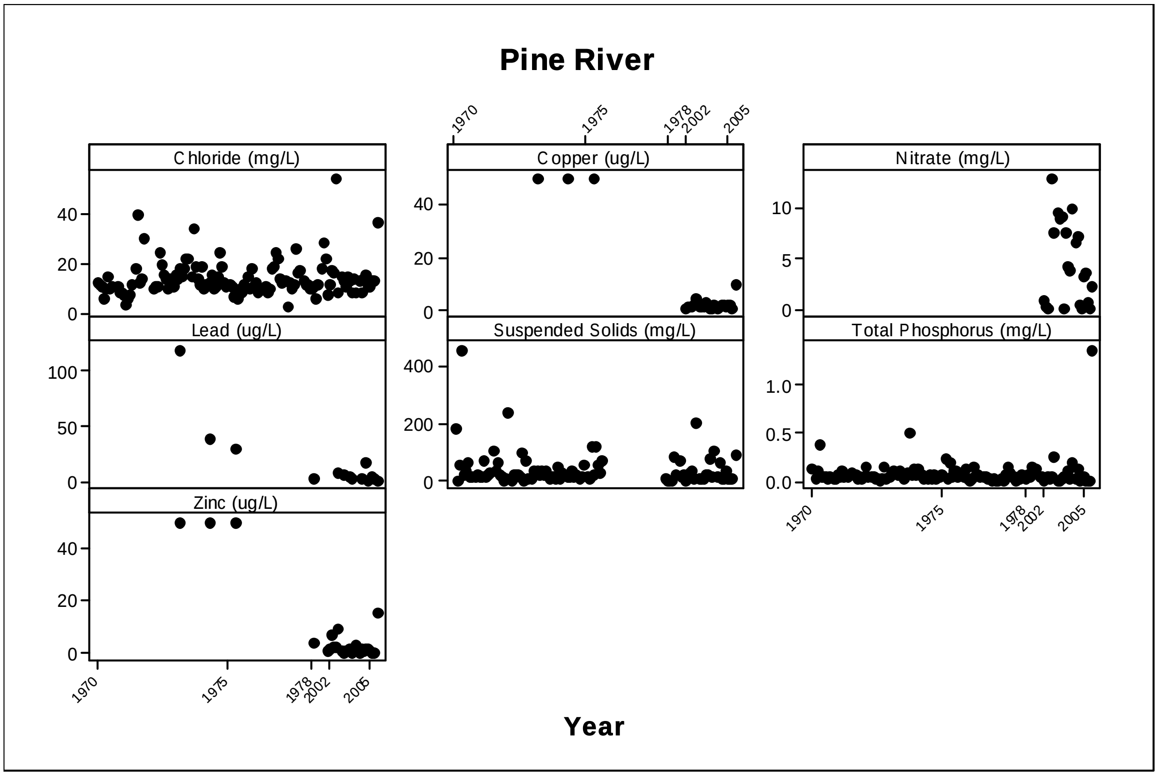
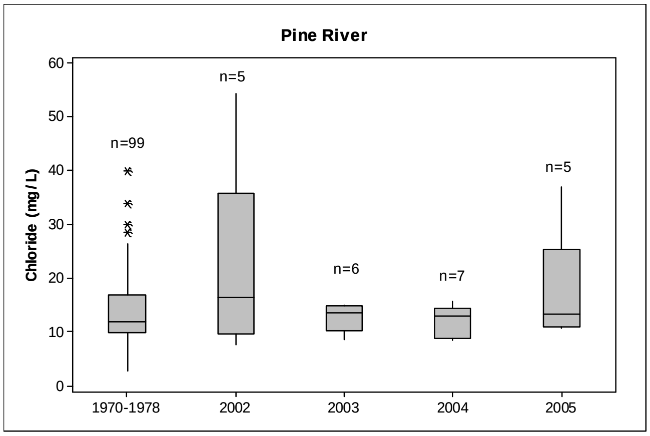
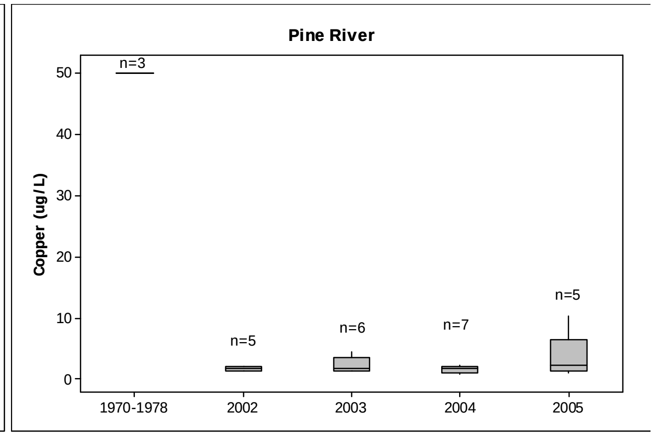
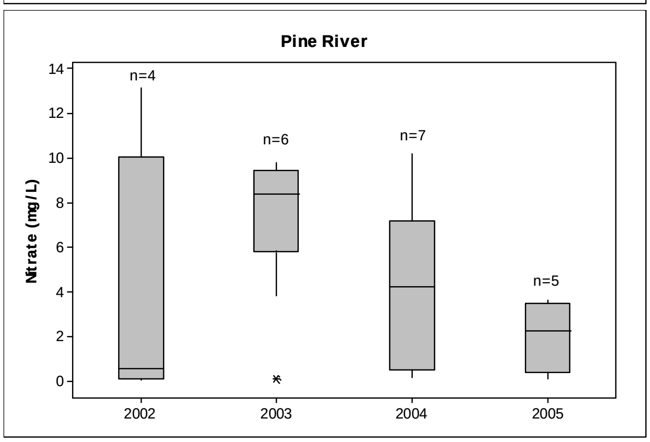
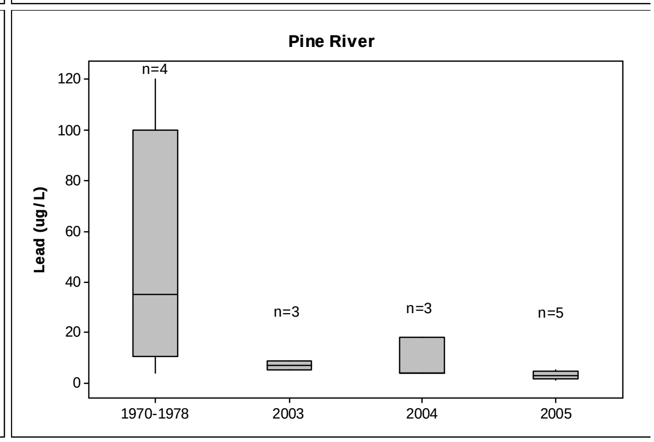


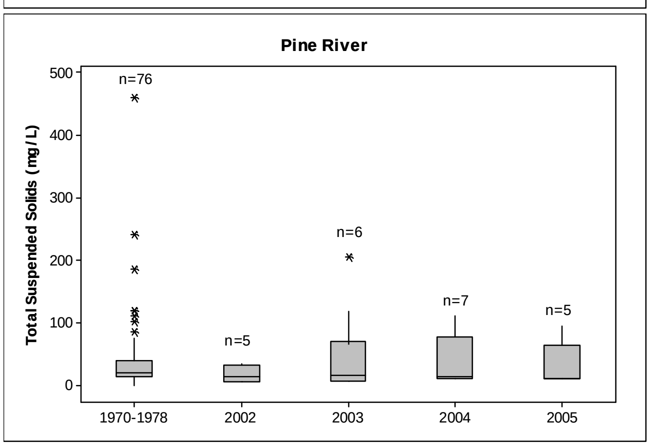
Figure 3.2.36 Time series of water chemistry parameters for the Pine River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

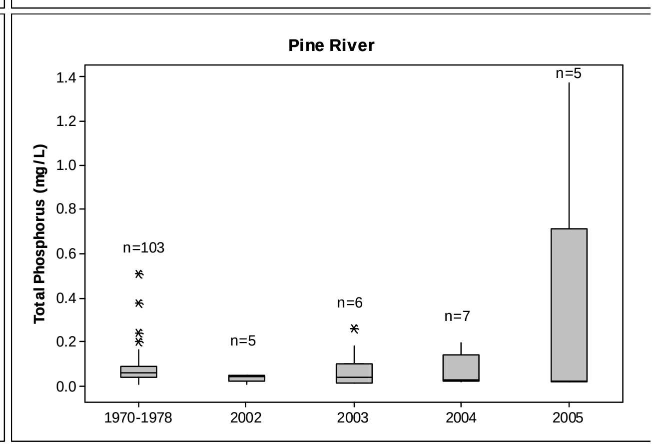












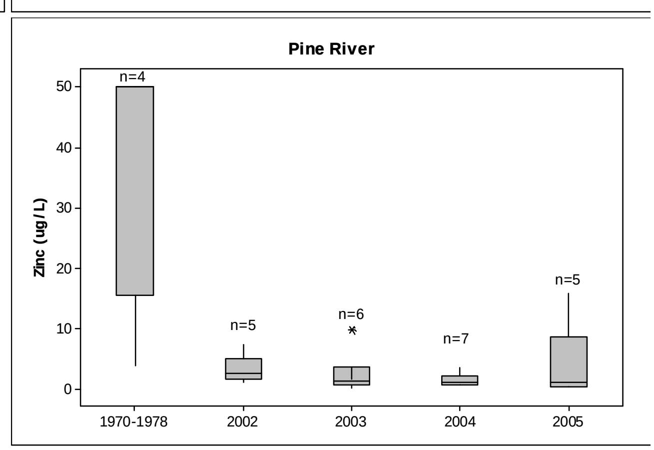


Figure 3.2.37 Box plots of water chemistry parameters for the Pine River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

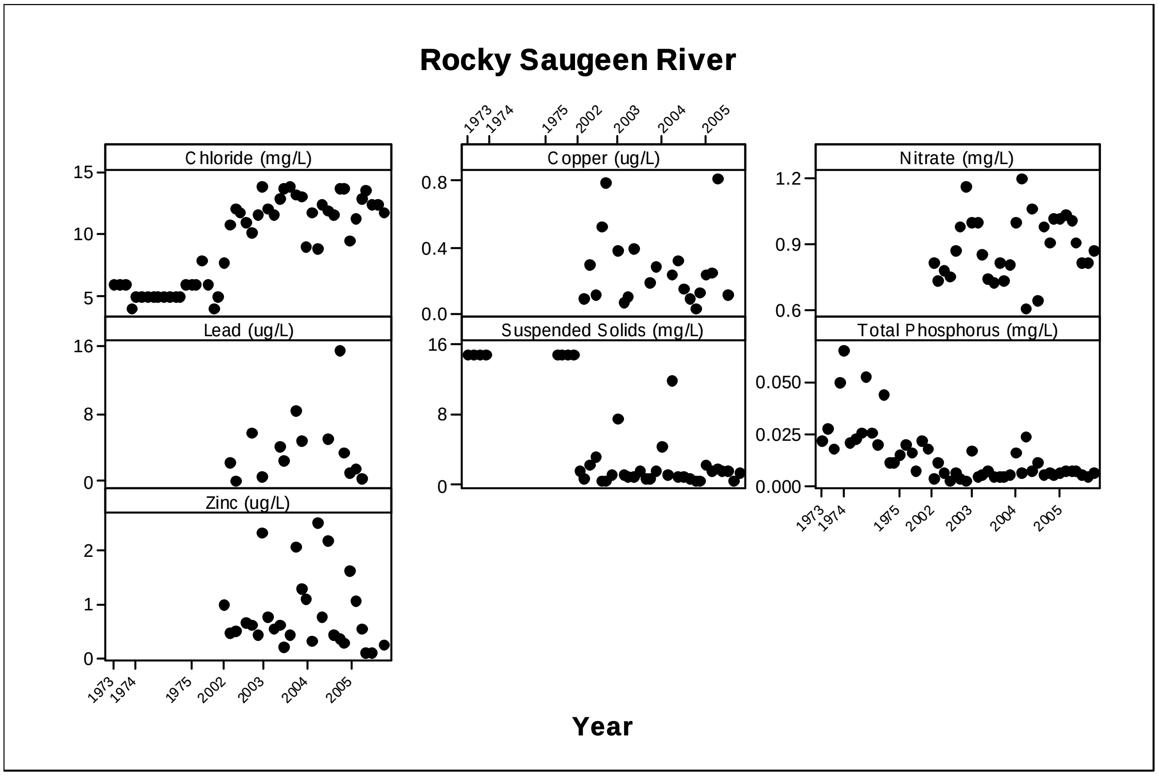
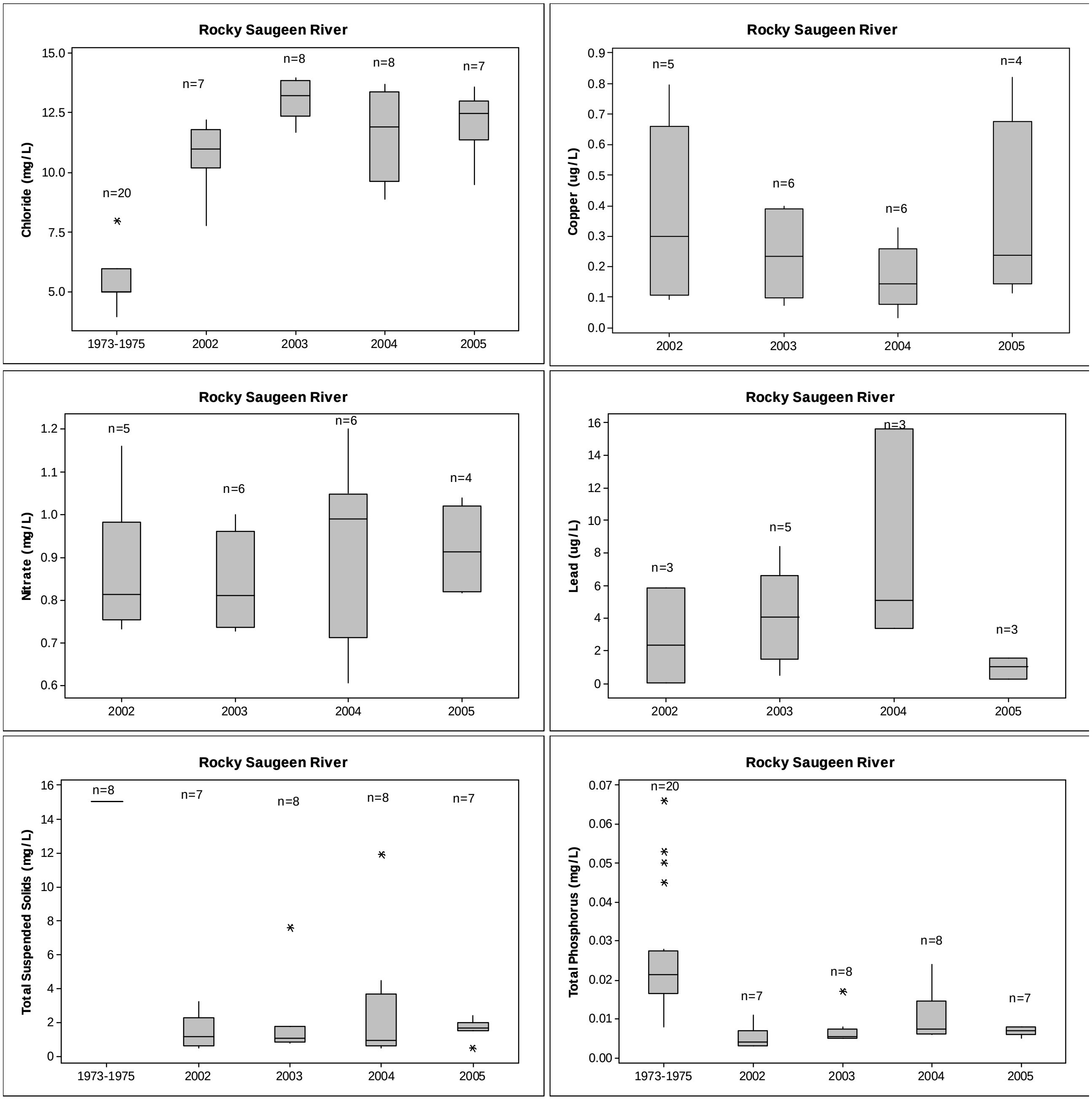


Figure 3.2.38 Time series of water chemistry parameters for the Rocky Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



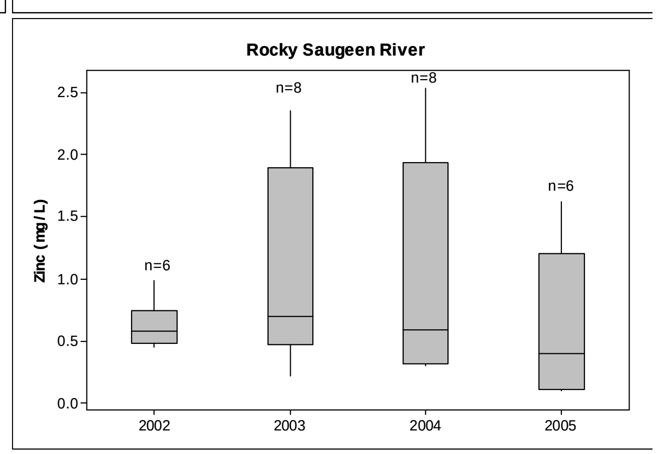


Figure 3.2.39 Box plots of water chemistry parameters for the Rocky Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

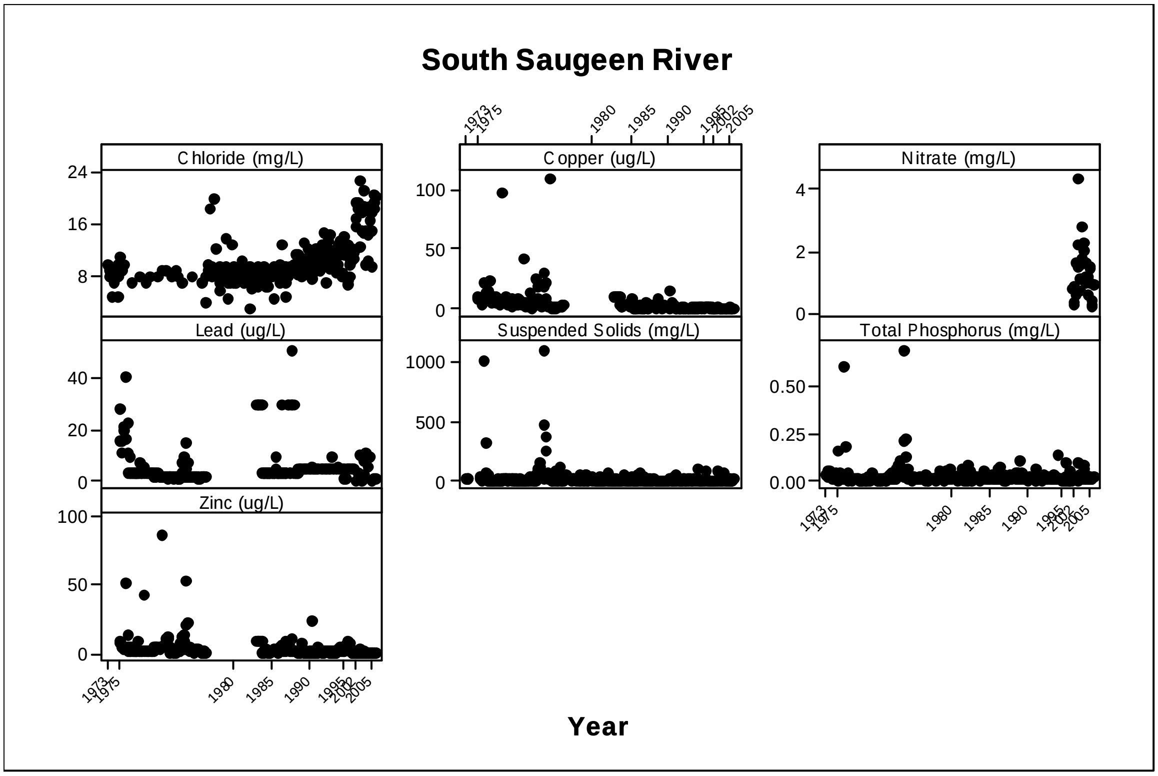
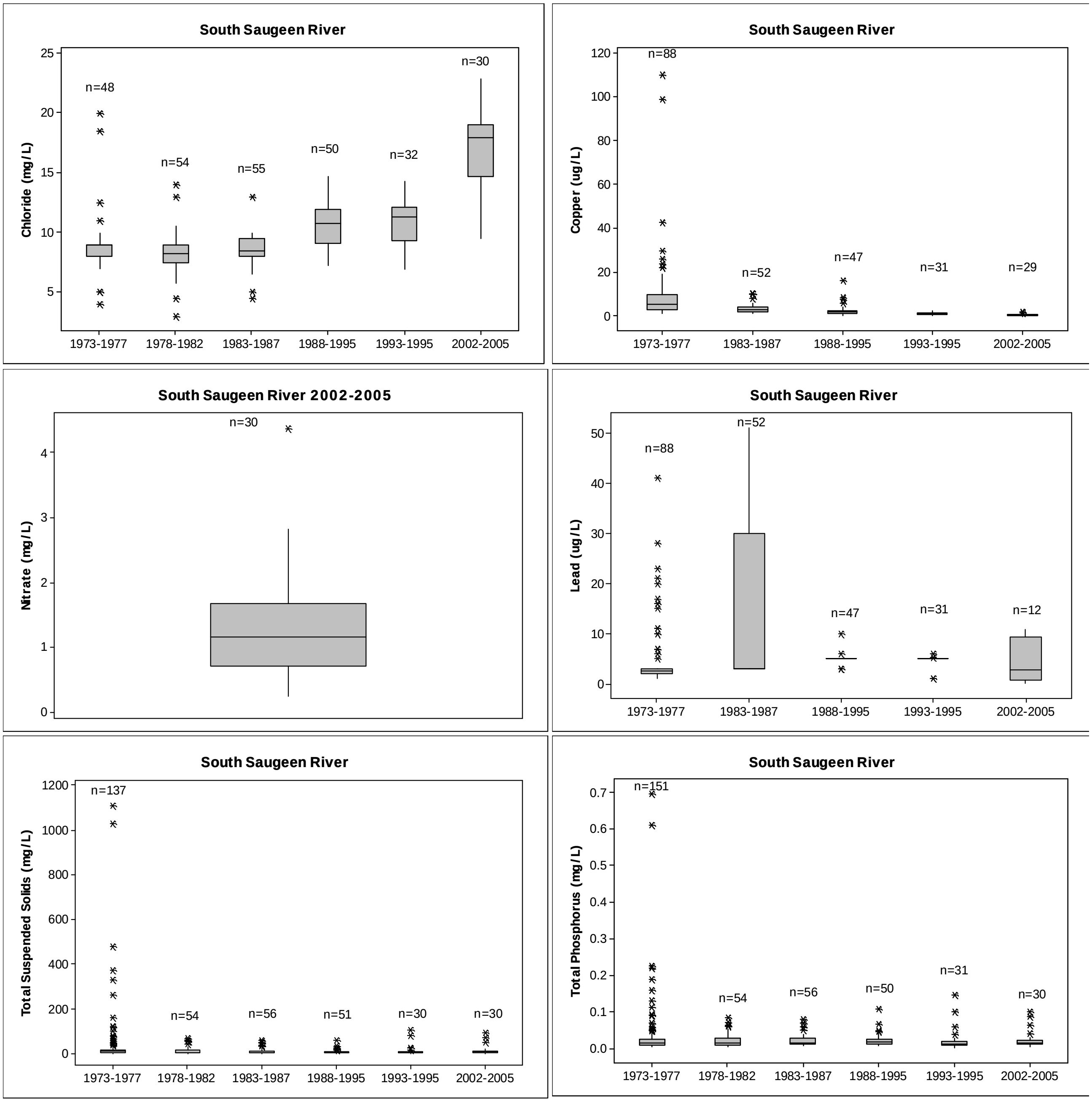


Figure 3.2.40 Time series of water chemistry parameters for the South Saugeen River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



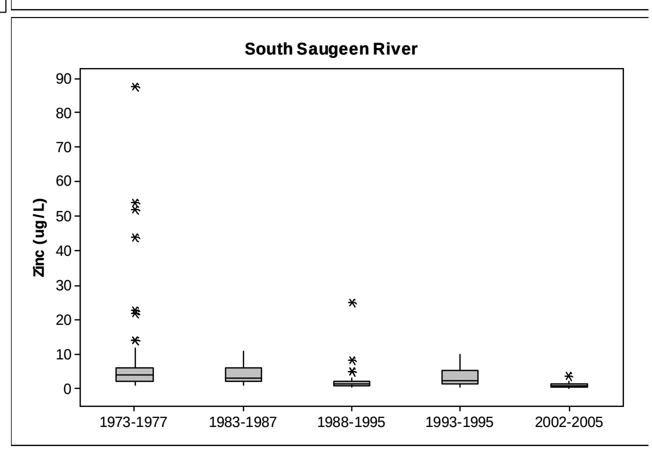


Figure 3.2.41 Box plots of water chemistry parameters for the South Saugeen River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

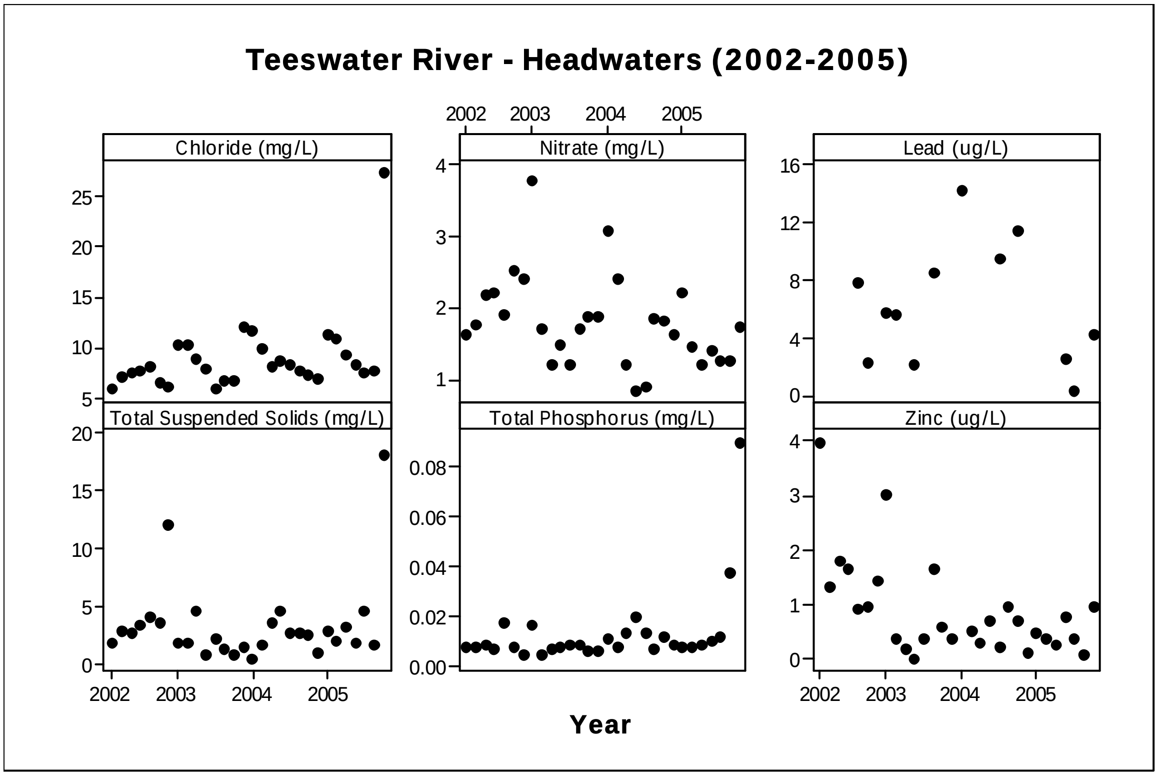


Figure 3.2.42 Time series of water chemistry parameters for the headwaters of Teeswater River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

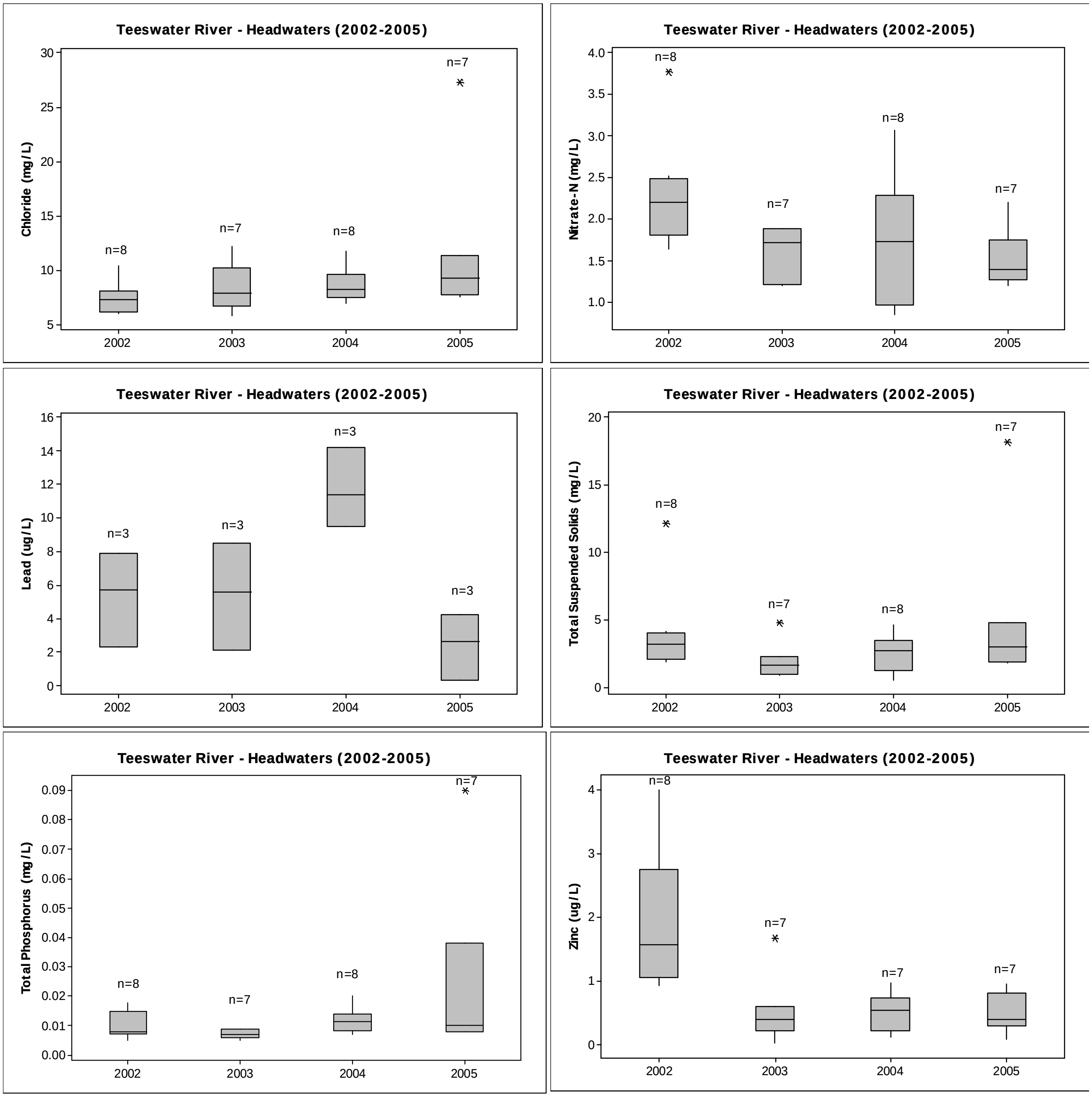


Figure 3.2.43 Box plots of water chemistry parameters for the headwaters of the Teeswater River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

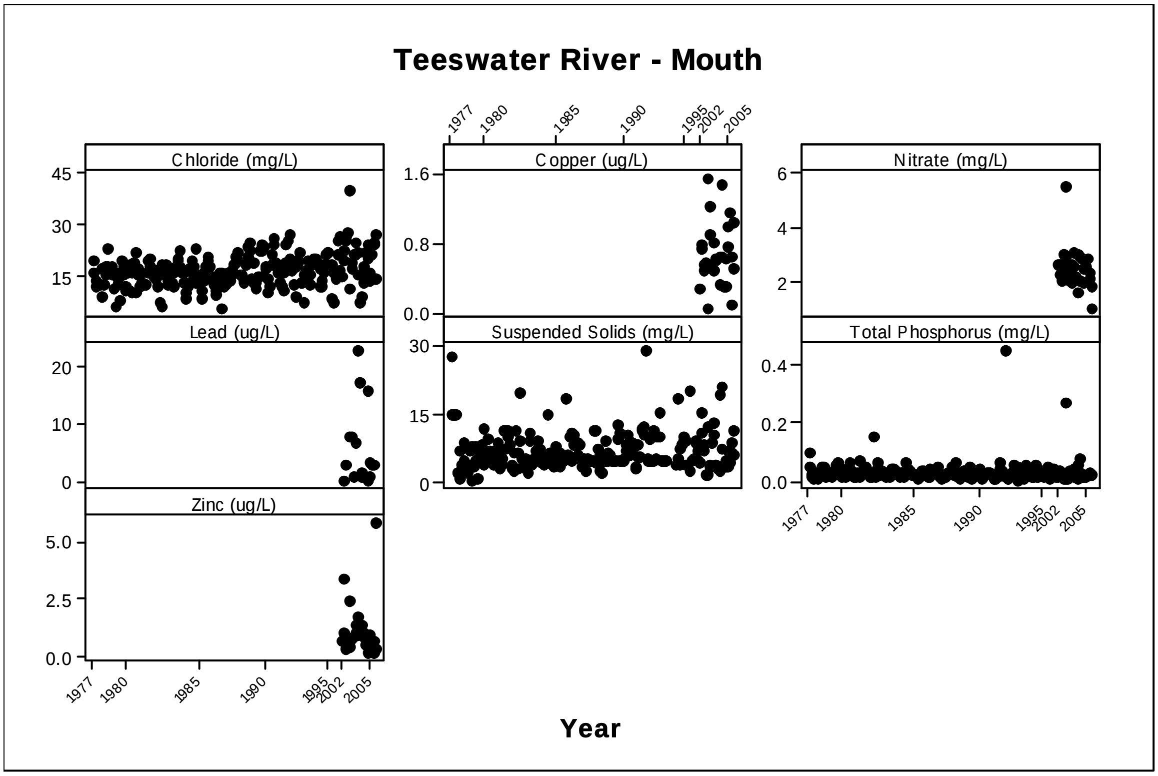
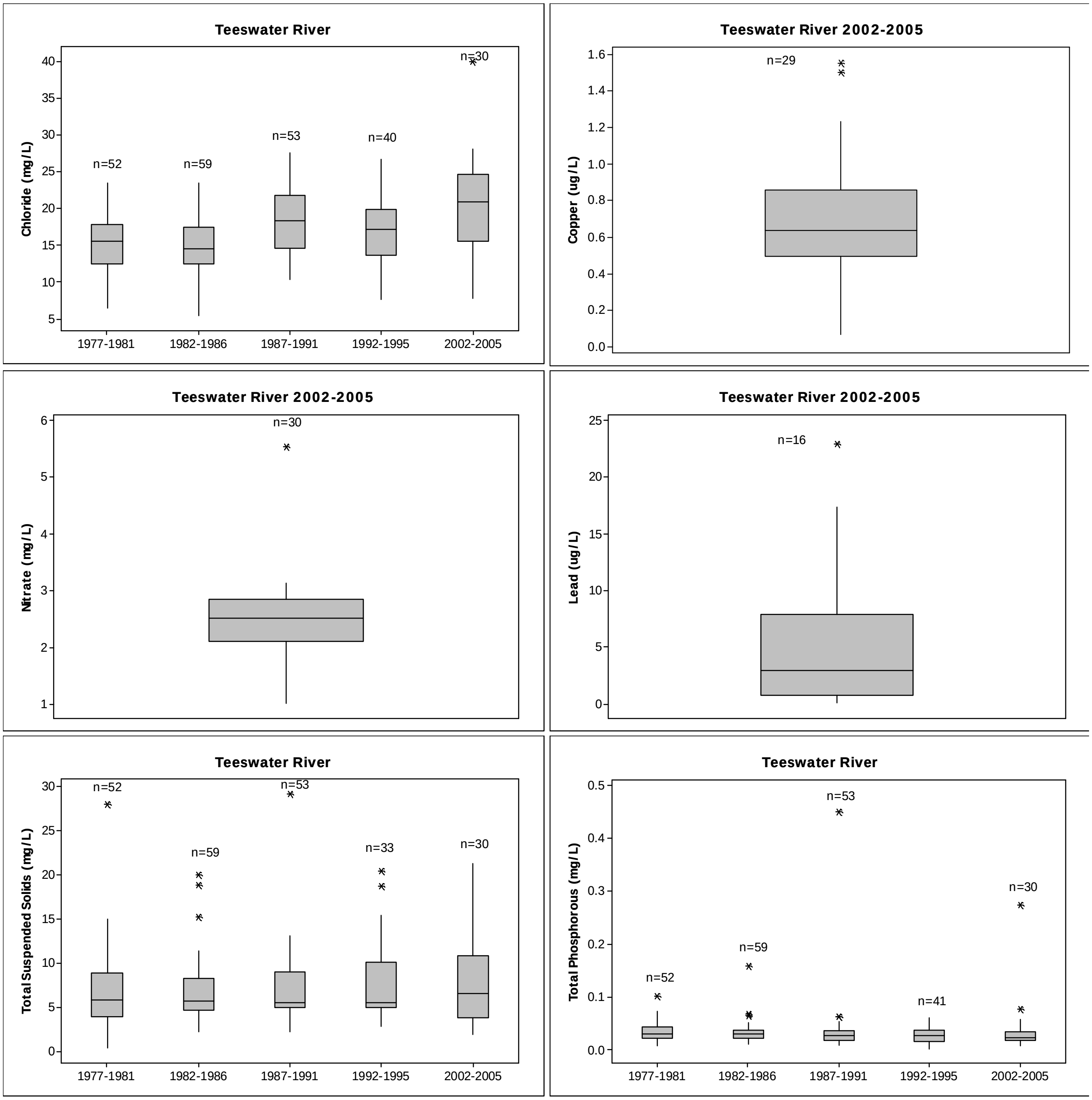


Figure 3.2.44 Time series of water chemistry parameters for the mouth of the Teeswater River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



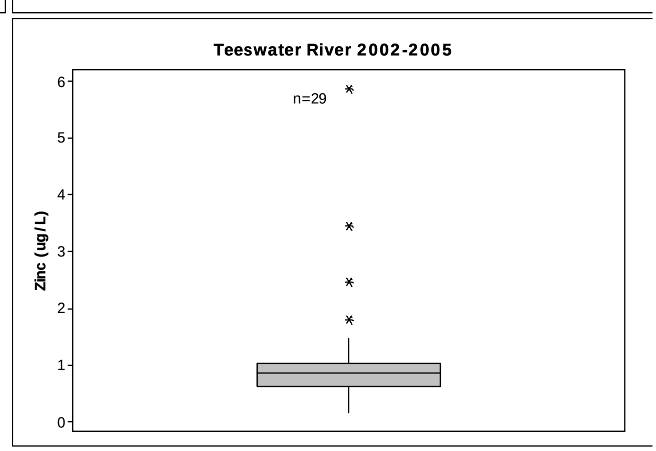


Figure 3.2.45 Box plots of water chemistry parameters for the mouth of the Teeswater River
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

3.2.1.3 Northern Bruce Peninsula SPA

Data collected from the PWQMN are limited for the Northern Bruce Peninsula SPA. Data exists for Spring Creek and the Stokes River, which account for two of the eleven subwatersheds mapped for the Northern Bruce Peninsula. These PWQMN stations are no longer active, with data collection for the Stokes River ending in 1995 and data collection for Spring Creek ending in 1979.

Spring Creek

Chloride, total suspended solids, and total phosphorus data was collected from 1975 to early 1979. Total phosphorus concentrations generally exceeded 30 ug/L for the samples that were collected (Figure 3.2.46).

TABLE 3.20 - Summary of water chemistry exceedences for Spring Creek

Spring Creek			
Year	**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed
1975-1979	36	2	5.6
TOTAL	36	2	5.6

Note: Limits for parameters - - Total Phosphorus: guideline of 0.03 mg/L (PWQO)

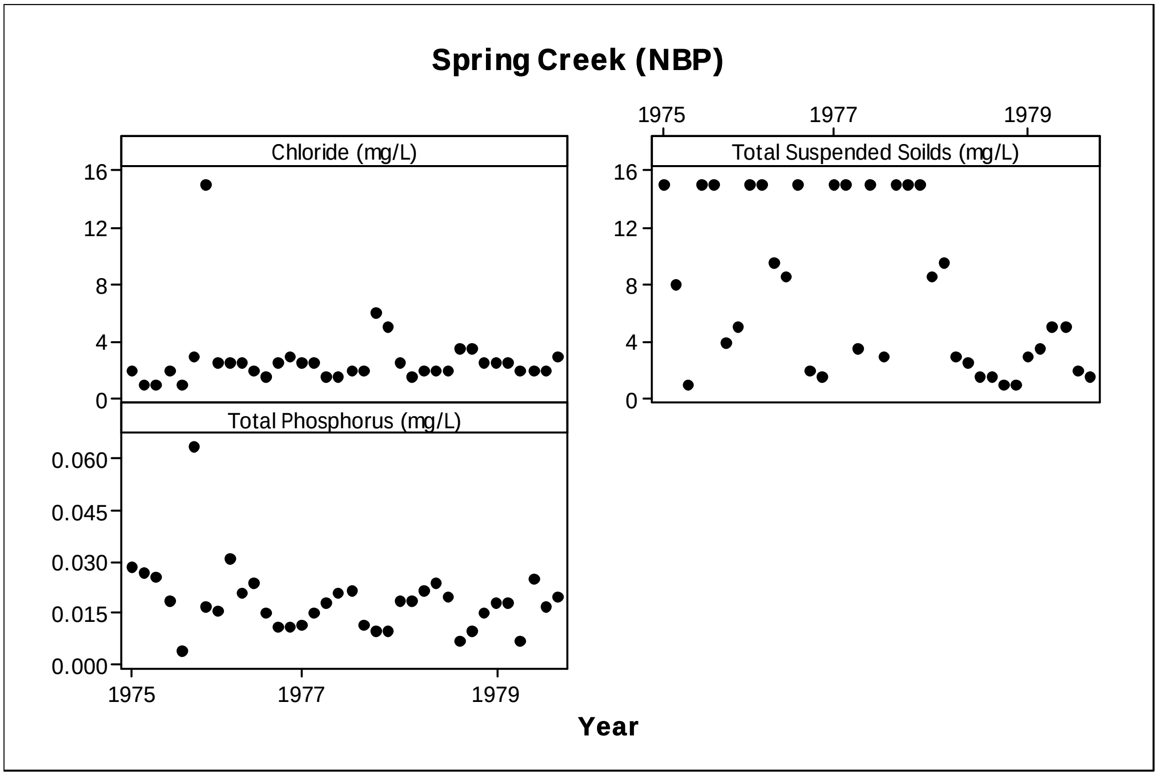
Stokes River

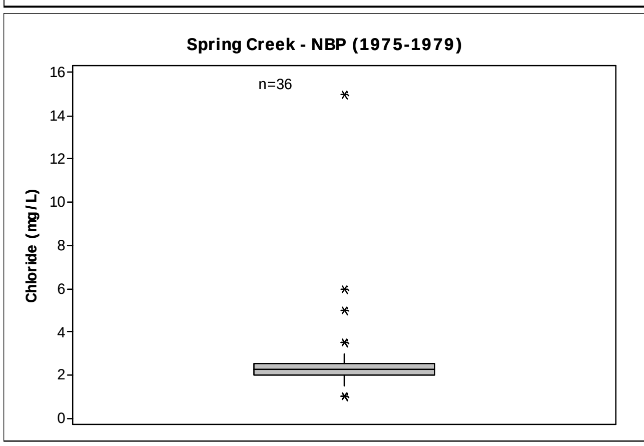
Chloride, total suspended solids, and total phosphorus data was collected from 1975 to 1979 and again from 1982 to 1996. Chloride and total suspended solids concentrations were within acceptable limits, but total phosphorus concentrations were typically above the operational objective of 30 ug/L (Figure 3.2.47).

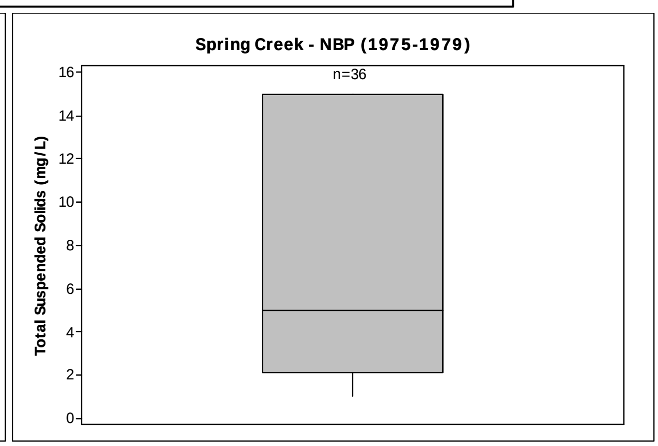
TABLE 3.21 - Summary of water chemistry exceedences for Stokes River

Stokes River Headwaters						
Year	**Suspended Solids**			**Total Phosphorus**		
	Total # Samples	# of Exceed	% Exceed	Total # Samples	# of Exceed	% Exceed
1975-1979	32	0	0.0	32	24	75.0
1982-1986	65	1	1.5	65	48	73.8
1987-1991	51	0	0.0	51	32	62.7
1992-1996	44	0	0.0	44	27	61.4
TOTAL	192	1	0.5	192	131	68.2

Note: Limits for parameters - - Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)







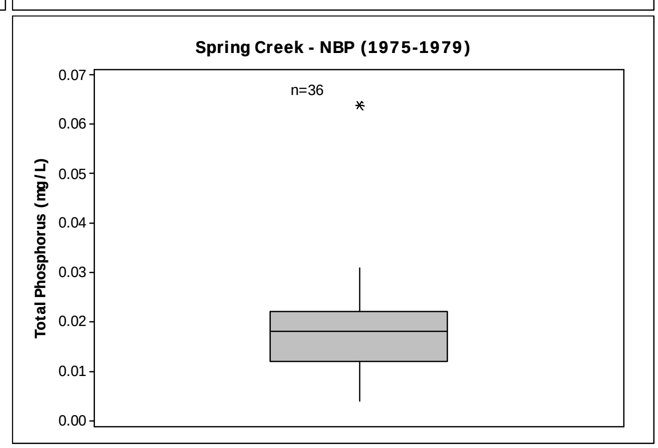
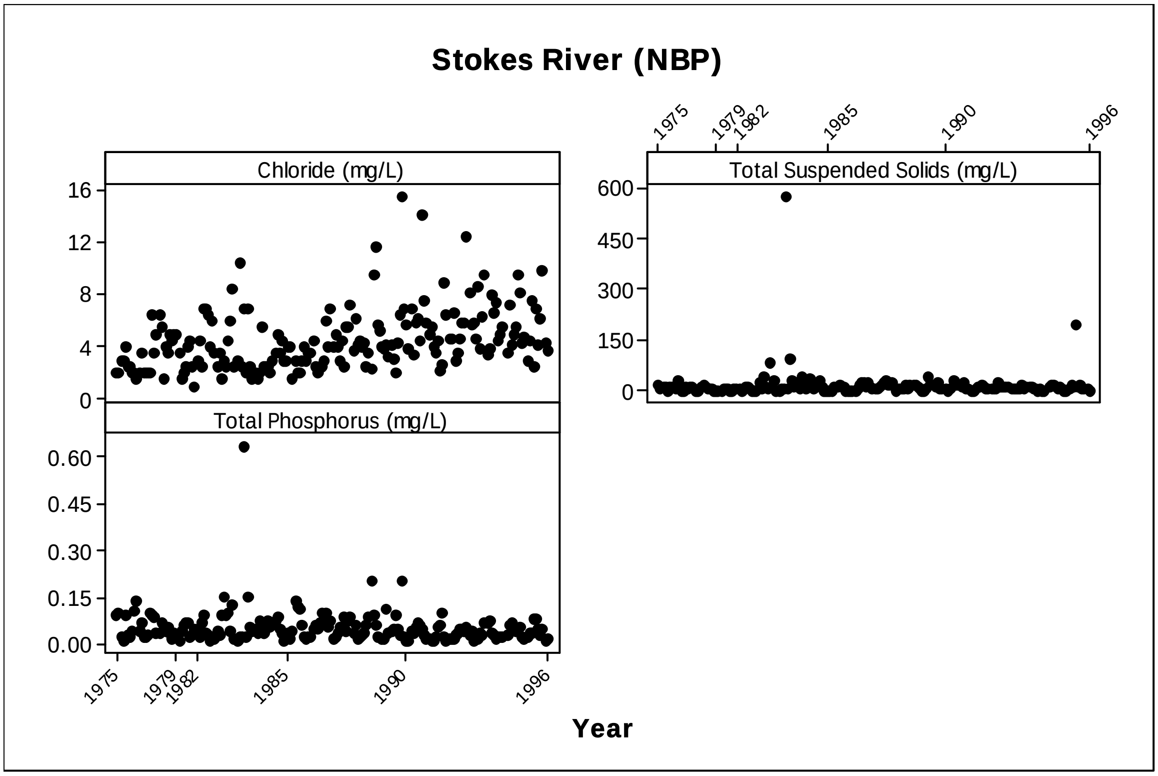
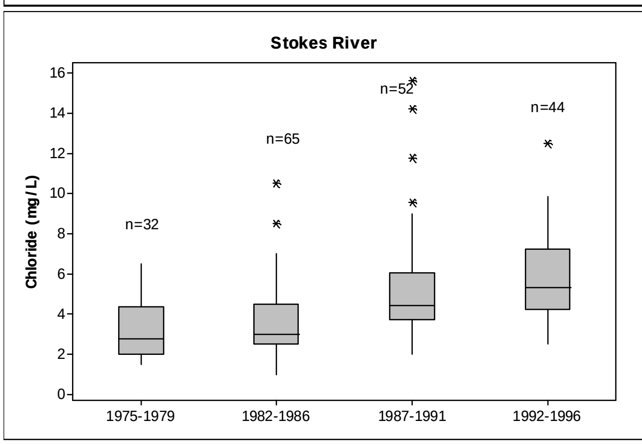
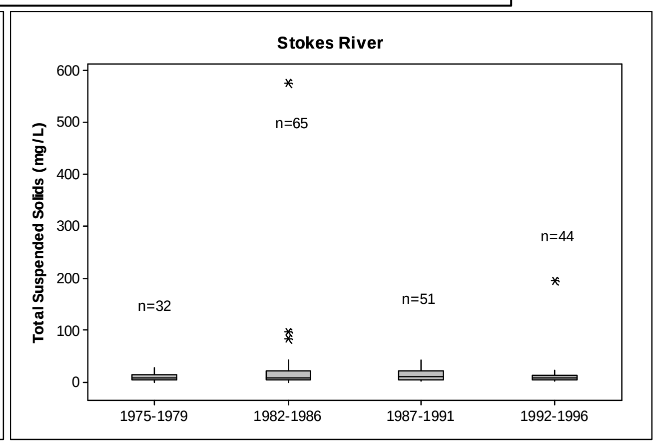


Figure 3.2.46 Graphs of water chemistry parameters for Spring Creek

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)







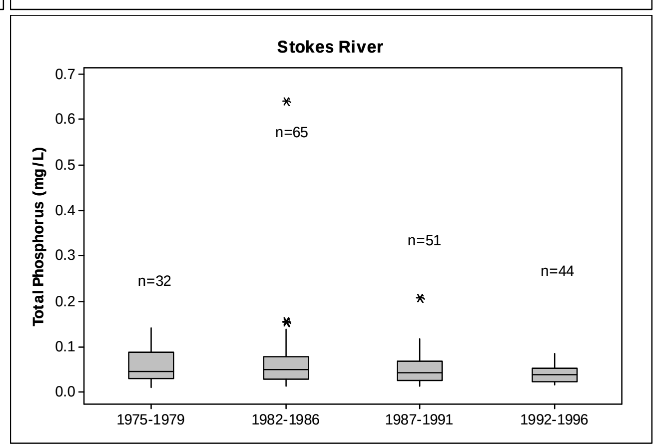


Figure 3.2.47 Graphs of water chemistry parameters for Stokes River

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS)

3.3 Groundwater Quality Data Analysis and Reporting

The Provincial Groundwater Monitoring Network (PGMN) was joined in 2000 by Saugeen Conservation and Grey Sauble Conservation, in partnership with the Ontario Ministry of Environment. Map 32A depicts the sampling locations within the region. Areas of interest were selected within each area based on the groundwater issues relevant to the times. Within these areas, where possible, existing wells were evaluated for long term monitoring. Where suitable existing wells were not available, new wells were drilled in these areas. Monitoring wells were then equipped with data loggers that record water levels and temperature on an hourly basis.

Initial sampling of wells for water quality was undertaken in 2003 throughout the region, with additional sampling preformed on an annual basis for wells operated by Saugeen Conservation. All wells were sampled according to protocols established by the MOE, and samples were analyzed at a common certified laboratory. Subsequent, more frequent samples were taken from wells with water quality objective exceedences.

The PGMN wells are a reliable source of water quality data for the planning region. These samples were all collected using a standard, rigorous protocol designed to minimize or eliminate any contamination of samples. In addition, the samples from these wells were all analyzed for a comprehensive suite of parameters at a single lab, using identical analytical methods, which make them ideal for comparing results between wells.

The major limitation of the PGMN data is the length of record for these analyses. The typical length of record for these samples is limited to the three years of the program's existence, and for the majority of these wells only four samples have been taken at the time of writing. Wells operated by GSC have only had an initial sample taken (2003) and have no additional sampling information.

Under the Provincial Groundwater Monitoring Network, there are 33 groundwater wells being tested once per year within the SPR: 23 sites in the Saugeen Valley SPA, 10 in the Grey Sauble SPA and no wells in the Northern Bruce Peninsula SPA. Table 3.22 identifies the various geological materials that the respective monitoring wells represent.

Additional information can be derived from other wells in the region, including Municipal wells. Municipal wells have legislated sampling protocols, including minimum wellhead standards and inspections that make them suitable sampling locations. Unfortunately, these legislative requirements were brought into place in 2001, and a majority of these wells have incomplete records prior to this date. In addition, the lack of digital data for these wells makes it impossible, in the timeframe provided, to incorporate the results in this report. It is anticipated that, in future iterations of this report, these wells will be included in the following analysis.

Other monitoring wells are available in the region, including those from various hydrogeological investigations, landfill monitoring programs and Health Unit sampling programs. At the time of writing, none of these data have been made available for incorporation into this document.

TABLE 3.22 - Attributing wells to formations

Formation/Aquifer	***Wells***
Amabel	GSCA66-1; GSCA77-1; GSCA98-1; GSCA69-1; GSCA190-1
Bass Islands	SVCA188-2; SVCA188-3; SVCA221-1
Bois Blanc	SVCA-2
Clinton	
Georgian Bay	
Guelph	SVCA314-1; SVCA177-1; SVCA177-2; SVCA177-3; GSCA70-1; GSCA78-1; GSCA79-1
Lake Warren Shoreline OB	SVCA302-2
Lucas	SVCA242-1; SVCA302-3
Nippissing Shoreline OB	SVCA240-1
Salina	SVCA301-1; SVCA176-1; SVCA246-1
Thornbury OB	GSCA68-1
Unknown Overburden Aquifer	SVCA303-2; SVCA303-3; SVCA305-1; SVCA304-1
Wyoming Moraine OB	SVCA299-1

3.3.1 Amabel Formation/Aquifer

Monitoring well 066-1 is located east of Kolapore on the edge of the Niagara Escarpment. A water quality sample was taken in 2003, and there was an exceedence in hardness.

Monitoring well 069-1 is located east of Wiarton near Lake Charles. The well is surrounded by the Niagara Escarpment. A water quality was taken in 2003, and there were exceedences in chloride, hardness, and iron.

Monitoring well 077-1 is located in the hamlet community of Rocklyn, which is surrounded by agricultural land. A water quality sample was taken in 2003, and there was an exceedence in hardness.

TABLE 3.23 – Monitoring Wells in the Amabel Formation/Aquifer

Amabel Formation/Aquifer	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	066-1	077-1	098-1	069-1	190-1
			2003	2003	2003	2003	2003
Arsenic (µg/L)	0.025		0.2	0.2	0.3	3	0.5
Chloride (mg/L)		250	2.5	3.5	1.3	266	4.8
Fluoride (mg/L)	1.5		0.04	0.05	0.09	0.75	1.21
Hardness (mg/L)		500	295	310	282	599	2243
Iron (µg/L)		0.3	5	4	20	614	16
Nitrate (mg/L)	10.0		2.285	3.25	0.045	0.045	0.045
Sodium (mg/L)		200	4.6	1.6	1	102	2.2

Monitoring well 098-1 is located in the hamlet community of Bognor. The area surrounding the well is largely marsh. A water quality sample was taken in 2003, and there was an exceedence in hardness.

Monitoring well 190-1 is located southwest of Hope Bay on the Bruce Peninsula. A water quality sample was taken in 2003, and there was an exceedence in hardness.

3.3.2 Bass Islands Formation/Aquifer

There are two monitoring stations west of Walkerton: 188-2 and 188-3. The land surrounding the wells is mainly used for agriculture. Water quality samples were taken in 2003 and twice in 2005 for both wells; during both years there were exceedences in hardness. In 2005, at well 188-2 there were two exceedences in nitrate.

Monitoring station 221-1 is located in Walkerton, which is a primary urban community. Water quality samples were taken once per year in 2003, 2005, and 2006. There were exceedences in fluoride and hardness in each sample. In 2005, there was an exceedence in iron.

TABLE 3.24 – Monitoring Wells in the Bass Islands Formation/Aquifer

Bass Islands Formation/Aquifer	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	188-2			188-3			221-1		
			2003	2005	2006	2003	2005	2006	2003	2005	2006
Arsenic (µg/L)	0.025		0.6	0.2	0.2	0.1	0.8	1	0.1	<3	<0.5
Chloride (mg/L)		250	2.9	21.4	23.6	23.8	2.9	3	0.9	2.39	1.3
Fluoride (mg/L)	1.5		0.83	0.02	0.05	0.08	0.75	0.78	1.66	1.57	2.05
Hardness (mg/L)		500	299	395	438	392	274	319	328	305	328
Iron (µg/L)		0.3	4	6	6	6	28	28	41	354	30
Nitrate (mg/L)	10.0		0.05	11.5	11.2	--	0.05	0.045	0.013	0.05	0.045
Sodium (mg/L)		200	1.6	8	8.8	9	1.6	1.4	1.6	1.67	1.80

3.3.3 Bois Blanc Formation/Aquifer

Monitoring station SVCA-2 is located south-west of Walkerton, and a sample was taken in 2007. The land surrounding the well is primarily farmland. There was an exceedence in hardness and sodium.

TABLE 3.25 – Monitoring Wells in the Bois Blanc Formation/Aquifer

Bois Blanc Formation/Aquifer	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	SVCA-2
			2007
Arsenic (µg/L)	0.025		ND
Chloride (mg/L)		250	5
Fluoride (mg/L)	1.5		0.2
Hardness (mg/L)		500	320
Iron (µg/L)		0.3	ND
Nitrate (mg/L)	10.0		3
Sodium (mg/L)		200	2200

3.3.4 Guelph Formation/Aquifer

Monitoring station 314-1 is located in Sullivan Township, south of Williamsford near McCullough Lake. The well is located in a rural forested area. A water quality sample was taken in 2003, which had an exceedence in hardness.

There are three monitoring sites 177-1, 177-2, and 177-3 located in Sullivan Township, south of Williamsford near McCullough Lake. The wells are located in a rural forested area. Water quality samples were taken once per year in 2002, 2003, 2005, and 2006. There were exceedences in hardness in each sample. There were five exceedences in iron within all wells and all years of sampling. At site 177-1 in 2003, there was an exceedence in arsenic, and at site 177-3 there was exceedence in fluoride in 2005.

TABLE 3.26 – Monitoring Wells in the Guelph Formation/Aquifer

Guelph Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	177-1				177-2			
			2002	2003	2005	2006	2002	2003	2005	2006
Arsenic (µg/L)	0.025		N/A	48.2	<3	1.9	2.60	N/A	2	1.7
Chloride (mg/L)		250	N/A	10.4	8.65	7.8	9.40	N/A	9.3	8.9
Fluoride (mg/L)	1.5		N/A	0.05	<0.05	0.05	0.03	N/A	0.07	0.06
Hardness (mg/L)		500	N/A	237	282	300	250	N/A	265	288
Iron (µg/L)		0.3	N/A	2100	630	450	1360	N/A	10	590
Nitrate (mg/L)	10.0		N/A	0.05	<0.05	<0.05	--	N/A	0.013	<0.05
Sodium (mg/L)		200	N/A	4.20	4.35	4.55	3.80	N/A	4.16	4.69

Guelph Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	177-3				314-1			
			2002	2003	2005	2006	2002	2003	2005	2006
Arsenic (µg/L)	0.025		0.00	N/A	2	<0.5	N/A	0.4	N/A	N/A
Chloride (mg/L)		250	10.5	N/A	0.07	12	N/A	0.69	N/A	N/A
Fluoride (mg/L)	1.5		0.06	N/A	14	0.06	N/A	0.03	N/A	N/A
Hardness (mg/L)		500	264	N/A	252	276	N/A	248	N/A	N/A
Iron (µg/L)		0.3	180	N/A	10	110	N/A	15	N/A	N/A
Nitrate (mg/L)	10.0		--	N/A	0.386	0.48	N/A	0.305	N/A	N/A
Sodium (mg/L)		200	5.60	N/A	5.55	6.86	N/A	1.4	N/A	N/A

Guelph Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	070-1				078-1			
			2002	2003	2005	2006	2002	2003	2005	2006
Arsenic (µg/L)	0.025		N/A	0.4	N/A	N/A	N/A	0.1	N/A	N/A
Chloride (mg/L)		250	N/A	113	N/A	N/A	N/A	47.9	N/A	N/A
Fluoride (mg/L)	1.5		N/A	0.16	N/A	N/A	N/A	1.74	N/A	N/A
Hardness (mg/L)		500	N/A	316	N/A	N/A	N/A	269	N/A	N/A
Iron (µg/L)		0.3	N/A	1	N/A	N/A	N/A	2460	N/A	N/A
Nitrate (mg/L)	10.0		N/A	4.25	N/A	N/A	N/A	0.045	N/A	N/A
Sodium (mg/L)		200	N/A	54.8	N/A	N/A	N/A	27.8	N/A	N/A

Guelph Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	079-1			
			2002	2003	2005	2006
Arsenic (µg/L)	0.025		N/A	0.6	N/A	N/A
Chloride (mg/L)		250	N/A	7.3	N/A	N/A
Fluoride (mg/L)	1.5		N/A	0.09	N/A	N/A
Hardness (mg/L)		500	N/A	310	N/A	N/A
Iron (µg/L)		0.3	N/A	26	N/A	N/A
Nitrate (mg/L)	10.0		N/A	0.045	N/A	N/A
Sodium (mg/L)		200	N/A	0.8	N/A	N/A

Monitoring station 070-1 is located in the hamlet community of Keady, which is a farming community. A water quality sample was taken in 2003, and there was an exceedence in hardness.

Monitoring station 078-1 is located north of Allenford. The well is located in a rural area. In 2003, there were exceedences in fluoride, hardness, and iron.

Monitoring station 079-1 is located west of Clavering, and is surrounded by forested land. A water quality sample was taken in 2003, and there was an exceedence in hardness.

3.3.5 Lake Warren Shoreline OB Formation/Aquifer

Monitoring station 302-2 is an overburden well located east of Ripley. The well is in a rural area surrounded by woodlots and farmland. Water quality samples were taken once per year in 2003 and 2005, having exceedences in hardness both years, and an exceedence in fluoride in 2003.

TABLE 3.27 – Monitoring Wells in the Lake Warren Shoreline OB Formation/Aquifer

Lake Warren Shoreline OB Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	302-2	
			2003	2005
Arsenic (µg/L)	0.025		1.8	<3
Chloride (mg/L)		250	7.1	11.3
Fluoride (mg/L)	1.5		1.71	1.27
Hardness (mg/L)		500	177	223
Iron (µg/L)		0.3	7	151
Nitrate (mg/L)	10.0		0.031	0.89
Sodium (mg/L)		200	6.66	6.09

3.3.6 Lucas Formation/Aquifer

Monitoring station 242-1 is a bedrock well, located in Tiverton, which is a primary urban community. Water quality samples were taken once per year in 2003, 2005, and 2006. In all three years there were exceedences in hardness and in iron. In 2003 and 2006 there were exceedences in fluoride.

Monitoring station 302-3 is in an overburden well located east of Ripley. The well is in a rural area surrounded by woodlots and farmland. Water quality samples were taken in 2003 and 2006, having exceedences in hardness both years, and an exceedence in fluoride in 2006.

TABLE 3.28 – Monitoring Wells in the Lucas Formation/Aquifer

Lucas Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	242-1			302-3		
			2003	2005	2006	2003	2005	2006
Arsenic (µg/L)	0.025		4.5	<3	3.89	0.4	N/A	<0.5
Chloride (mg/L)		250	9.2	8.39	8.1	11.3	N/A	10
Fluoride (mg/L)	1.5		1.65	1.01	1.59	1.34	N/A	1.60
Hardness (mg/L)		500	373	336	211	254	N/A	260
Iron (µg/L)		0.3	620	1150	710	1	N/A	<10
Nitrate (mg/L)	10.0		<0.05	<0.05	0.045	1.173	N/A	--
Sodium (mg/L)		200	58.2	71.3	57.7	6.4	N/A	6.45

3.3.7 Nippissing Shoreline OB Formation/Aquifer

Monitoring station 240-1 is an overburden well located in Port Elgin. Port Elgin is a primary urban community on the shore of Lake Huron. A water quality sample was taken in 2003, having an exceedence in hardness.

TABLE 3.29 – Monitoring Wells in the Nippissing Shoreline OB Formation/Aquifer

Nippissing Shoreline OB Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	240-1
Arsenic (µg/L)	0.025		1.1
Chloride (mg/L)		250	61
Fluoride (mg/L)	1.5		0.13
Hardness (mg/L)		500	274
Iron (µg/L)		0.3	122
Nitrate (mg/L)	10.0		0.245
Sodium (mg/L)		200	56.8

3.3.8 Salina

Monitoring station 301-1 is an overburden well located north-east of Paisley. The land surrounding the well is agricultural land. Water quality samples were taken once per year in 2003 and 2006, having exceedence in hardness.

Monitoring station 176-1 is a bedrock well, and is located at the Saugeen Conservation Headquarters, south of Hanover. The land surrounding this well is farmland and woodlots. Water quality samples were taken once per year in 2003, 2005, and 2006. There were exceedences in hardness in each sample and in iron in 2003 and 2006.

Monitoring station 246-1 is a bedrock well located in Allan Park, east of Hanover. Allan Park is a hamlet community, surrounded by woodlots and farmland. A water quality sample was taken in 2003 for well 246-1; iron and hardness were in exceedence.

TABLE 3.30 – Monitoring Wells in the Salina Formation/Aquifer

Salina Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	301-1			176-1			246-1		
			2003	2005	2006	2003	2005	2006	2003	2005	2006
Arsenic (µg/L)	0.025		0.4	N/A	<0.5	4.7	<2	0.60	0.1	N/A	N/A
Chloride (mg/L)		250	0.6	N/A	0.5	5.2	6.3	7.1	1.8	N/A	N/A
Fluoride (mg/L)	1.5		0.41	N/A	0.42	1.11	1.14	1.18	1.09	N/A	N/A
Hardness (mg/L)		500	115	N/A	117	1670	1560	--	223	N/A	N/A
Iron (µg/L)		0.3	45	N/A	19.9	3460	298	3280	313	N/A	N/A
Nitrate (mg/L)	10.0		0.105	N/A	<0.05	0.008	<0.05	0.05	0.242	N/A	N/A
Sodium (mg/L)		200	25.8	N/A	24.4	10.4	10.3	11.9	2.2	N/A	N/A

3.3.9 Thornbury OB Formation/Aquifer

Monitoring station 068-1 is located in the urban community of Thornbury. A water quality sample was taken in 2003, and there were exceedences in hardness and in iron.

TABLE 3.31 – Monitoring Wells in the Thornbury OB Formation/Aquifer

Thornbury OB Formation/Aquifer	ODWS *MAC* *(mg/L)*	ODWS OA *(mg/L)*	068-1
			2003
Arsenic (µg/L)	0.025		2.7
Chloride (mg/L)		250	12.8
Fluoride (mg/L)	1.5		0.09
Hardness (mg/L)		500	324
Iron (µg/L)		0.3	17900
Nitrate (mg/L)	10.0		0.032
Sodium (mg/L)		200	5.8

3.3.10 Unknown Overburden Aquifer

Monitoring stations 303-2 and 303-3 are located south of Hopeville. The land surrounding the wells is mostly wetlands and hazard lands. Water quality samples were taken once a year in 2003, 2005 and 2006. Hardness was only tested in 2003 and 2005 and there were exceedences in both wells for both years. In 2003 well 303-3 and in 2006 well 303-2 each had an exceedence in iron.

Monitoring station 305-1 is an overburden well in Osprey Township, south of Maxwell. The area surrounding the well is mainly wetlands. Water quality samples were taken once per year in 2003, 2005, and 2006, having exceedences in hardness when tested in 2003 and 2005.

Monitoring station 304-1 is located west of Walkerton. The land surrounding the well is mainly used for agricultural. Water quality samples were taken in 2003 and twice in 2005. In both years there were exceedences in hardness.

TABLE 3.32 – Monitoring Wells in Unknown OverburdenAquifer

Unknown OverburdenAquifer	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	303-2			303-3		
			2003	2005	2006	2003	2005	2006
Arsenic (µg/L)	0.025		4.8	4	6.09	6.4	4	4.2
Chloride (mg/L)		250	8.4	<2	1.1	1.6	7.4	7.4
Fluoride (mg/L)	1.5		0.81	0.08	0.10	0.1	0.77	0.78
Hardness (mg/L)		500	204	224	--	234	200	--
Iron (µg/L)		0.3	123	<10	320	302	<10	140
Nitrate (mg/L)	10.0		0.045	<0.013	<0.05	--	<0.013	<0.05
Sodium (mg/L)		200	12.6	4.09	4.31	3.8	12.4	11.8

Unknown OverburdenAquifer	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	305-1			304-1		
			2003	2005	2006	2003	2005	2006
Arsenic (µg/L)	0.025		0.1	<2	<0.5	0.2	0.2	0.3
Chloride (mg/L)		250	4.1	2.9	2.8	44.9	55.9	54.5
Fluoride (mg/L)	1.5		0.06	0.05	0.05	0.13	0.06	0.03
Hardness (mg/L)		500	284	323	--	420	350	--
Iron (µg/L)		0.3	0	<10	<10	3	6	6
Nitrate (mg/L)	10.0		9.55	5.92	4.65	8.45	7.12	7.14
Sodium (mg/L)		200	1.8	1.69	1.92	16.6	20	--

3.3.11 Wyoming Moraine OB Formation/Aquifer

Monitoring station 299-1 is an overburden well, located south of Kinloss. The land use surrounding the well is rural, agricultural land. Water quality samples were taken once per year in 2003, 2005, and 2006. There were exceedences in fluoride and hardness in each sample.

TABLE 3.33 – Monitoring Wells in the Wyoming Moraine OB Formation/Aquifer

Wyoming Moraine OB Formation/Aquifer	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	302-2		
			2003	2005	2006
Arsenic (µg/L)	0.025		5.5	10.0	4.4
Chloride (mg/L)		250	7.2	6.77	8.0
Fluoride (mg/L)	1.5		1.86	1.76	1.68
Hardness (mg/L)		500	194	227	123
Iron (µg/L)		0.3	154	210	210
Nitrate (mg/L)	10.0		0.045	<0.05	<0.05
Sodium (mg/L)		200	22.2	26.8	15.1

3.3.12 Unassigned Overburden Aquifers

Monitoring station 300-2 and 300-3 are both overburden wells located in Allan Park, east of Hanover. Allan Park is a hamlet community, surrounded by woodlots and farmland. Water quality samples were taken once per year in 2003, 2005, and 2006. There were exceedences in hardness in 2003 and 2005.

Monitoring stations 324-2 and 324-3 are overburden wells located south-east of Glammis on the edge on the Greenock Swamp. Water quality samples were taken once per year in 2003, 2005 and 2006, having exceedences in hardness. In 2003 each well had an exceedence in iron.

TABLE 3.34 – Monitoring Wells in Unassigned Overburden Aquifers

Unassigned Overburden Aquifers	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	300-2			300-3		
			2003	2005	2006	2003	2005	2006
Arsenic (µg/L)	0.025		0.1	<2	<0.5	0.7	<2	0.7
Chloride (mg/L)		250	3.9	<2	1.6	1.8	<2	1.9
Fluoride (mg/L)	1.5		0.06	0.06	0.06	0.55	0.46	0.42
Hardness (mg/L)		500	220	313	--	234	269	--
Iron (µg/L)		0.3	1	<10	<10	129	<10	210
Nitrate (mg/L)	10.0		0.495	0.321	0.33	--	<0.013	<0.05
Sodium (mg/L)		200	8.8	0.33	3.76	2.2	2.03	2.10

Unassigned Overburden Aquifers	ODWS *MAC (mg/L)*	ODWS OA *(mg/L)*	324-2			324-3		
			2003	2005	2006	2003	2005	2006
Arsenic (µg/L)	0.025		0.5	<2	0.5	8.9	18	10.2
Chloride (mg/L)		250	1.2	1.7	1.4	0.4	0.6	0.5
Fluoride (mg/L)	1.5		0.26	0.19	0.21	0.91	0.81	0.86
Hardness (mg/L)		500	233	247	--	163	160	--
Iron (µg/L)		0.3	427	153	240	338	120	180
Nitrate (mg/L)	10.0		0.045	0.045	<0.05	--	0.013	<0.05
Sodium (mg/L)		200	2.6	2.6	2.59	12.6	11.8	12

3.4 Raw Water Characterization for Drinking Water Intakes

The Drinking Water Surveillance Program (DWSP) is a voluntary program that municipalities can participate in by providing water samples that aid in gathering water quality data from municipal water systems. The program is operated by the MOE and analyses are provided by MOE and the Ministry of Labour. Chemical, physical, or radiological analyses are done on samples that are pre-treatment, or have been treated or are in a distribution system. All data for this report are from raw water samples. Microbiologicals are not tested under the DWSP, as each facility has a routine monitoring program. In total, 179 municipal drinking water systems participated in the program. In the Saugeen, Grey Sauble, Nortern Bruce Peninsula SPR, there are water chemistry data from eight sources (Map 33), of which four are derived from groundwater, and four are derived from surface water (http://www.ene.gov.on.ca/envision/ water/dwsp/0002/index.htm).

As mentioned, water chemistry/physical measurements are from raw samples. Turbidity measurements will also be included from surface water samples, as it serves as a useful indicator for potential problems with metals or microbiologicals and is monitored real-time at drinking water systems.

The Ontario Drinking Water Standard limit for turbidity is 1 NTU (1 NTU = 1 FTU, i.e. Formazine Turbidity Unit). Nephelometric Turbidity Units (NTUs) is the amount of diffuse light measured at a specific angle from a sample that has a beam of light passed through it. Different indicator parameters are used for raw water samples from groundwater to reflect different processes and influences that can affect water quality. No ambient climate/environmental conditions at the time of sampling are known that could influence the concentrations of various indicator parameters. Also, little information is known of the number of samples from each year that had exceedences.

3.4.1 Drinking Water Surveillance Program

3.4.1.1 Hanover Water Supply Plant

Groundwater is the source of the water samples that were tested. Samples were collected between 2000 and 2005 and ranged from four to 12 samples per year (Figure 3.4.1). The only exceedences occurred with iron and hardness levels. Iron levels were approximately 3 times the aesthetic objective of 300 ug/L from 2000 to 2002 and then significantly drop well below the objective in 2003. Although arsenic levels are well below the interm maximum acceptable concentration of 25 ug/L, the same drop is shown in 2003 from a maximum concentration of approximately 4 ug/L in 2002 to below 0.5 ug/L in 2003. The average hardness levels are well above the operational guideline of 80-100 mg/L (measured in mg $CaCO_3$/L) for the six years that were sampled. In 2004 and 2005, maximum hardness levels are close to 500 mg/L, which is the limit deemed to make water intolerable for drinking.

3.4.1.2 Owen Sound R.H. Neath Plant

The Owen Sound R. H. Neath Plant gets its water supply from Georgian Bay. Samples have been collected from 1990 to 2005 and range from one to 11 samples per year (Figure 3.4.2). Exceedences were observed for lead, total phosphorus, and turbidity. Lead values were near or above the maximum acceptable concentration (MAC) of 1 ug/L for 4 of the 16 years samples were collected. Total phosphorus concentrations exceeded the PWQO of 0.03 mg/L in 2 of 16 years that were sampled, and turbidity levels were near or above 1 FTU in 11 of the 16 years sampled.

3.4.1.3 Owen Sound Spring Supply Treatment Plant

This plant is no longer operated, but existing water quality data was examined. The water supply is from groundwater. Samples were collected for six years from 1990 to 1995. The number of samples collected ranged from 2 to 11 samples per year (Figure 3.4.3). Hardness was the only parameter that had values that exceeded the operational guideline of 80-100 mg/L of calcium carbonate every year sampling took place.

3.4.1.4 Port Elgin Water Treatment Plant

Drinking water was acquired from Lake Huron, but the plant has since been decommissioned. Samples were collected from 1990 to 2005. The number of samples ranged from one to nine per year over the 14-year period (Figure 3.4.4). Concentrations for lead, total phosphorus, and turbidity were near, or exceeded recommended levels for 1, 5, and 14 times respectively, for the period sampled. There also appears to be an overall upward trend in chloride concentrations, but they still remain well below aesthetic objectives.

3.4.1.5 Paisley Water Treatment Plant

Water for the Paisley Water Treatment Plant was provided from the Teeswater River. This facility has since ceased taking its water supply from the Teeswater River and now aquires water from Chesley via a pipeline. The results from the samples collected do serve utility for comparisons to be made to other sites where the water source is from Lake Huron. Water samples were collected for nine years from 1996 to 2005. The number of samples collected per year ranged from 3 to 12 (Figure 3.4.5). There were observed exceedences in the maximum concentrations of lead, total phosphorus, and turbidity. Essentially all samples for total phosphorus and turbidity were near or above guidelines/objectives for drinking for every year sampled, while there was only one year (1998) where lead concentrations surpassed drinking water standards.

3.4.1.6 Southampton Water Treatment Plant

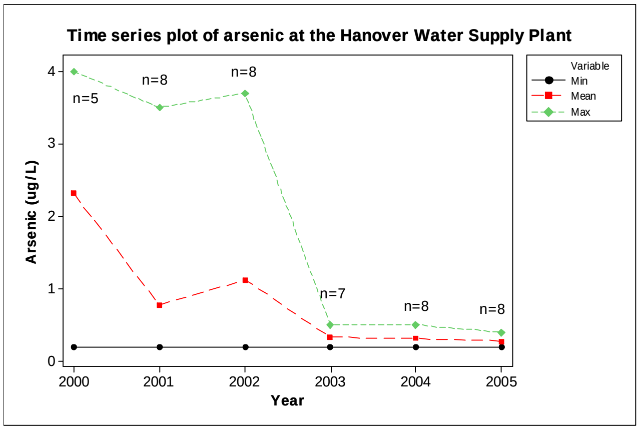
The Southampton Water Treatment Plant gets its water from Lake Huron and an additional intake has been constructed. Samples were collected for 14 years from 1992 to 2005 and the number of samples collected each year ranged from 1 to 9 (Figure 3.4.6). No data is available for metal (copper, lead, and zinc) concentrations. No values were recorded for total phosphorus. There were two years where samples exceeded acceptable lead concentrations and turbidity levels were near or above recommended levels every year.

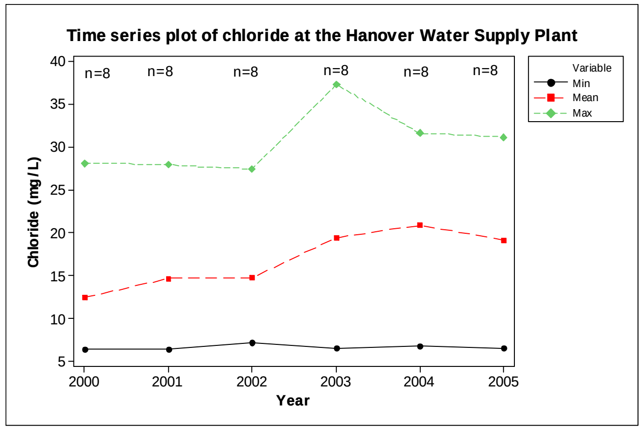
3.4.1.7 Walkerton Well Supply Plant

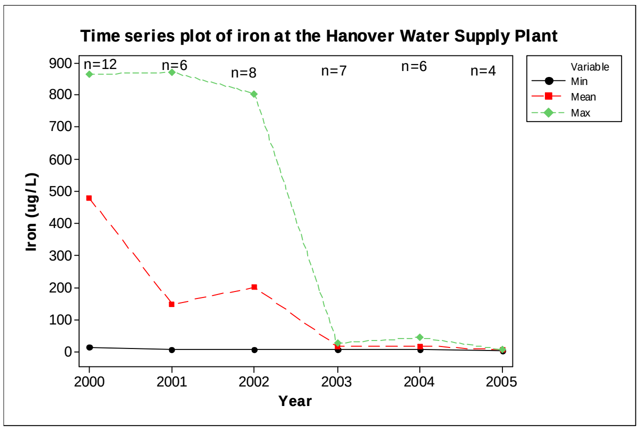
The water supply for the Walkerton Plant is from the groundwater. Samples have been collected for 5 years from 2001 to 2005 and the number of samples collected range from 5 to 12 samples per year (Figure 3.4.7). Hardness was the only indicator parameter with concentrations that exceeded the operational guideline (80-100 mg CaCO3/L) for drinking water. Maximum values were near 500 mg CaCO3/L (where water is considered to be unsuitable for drinking) for the five-year sampling period.

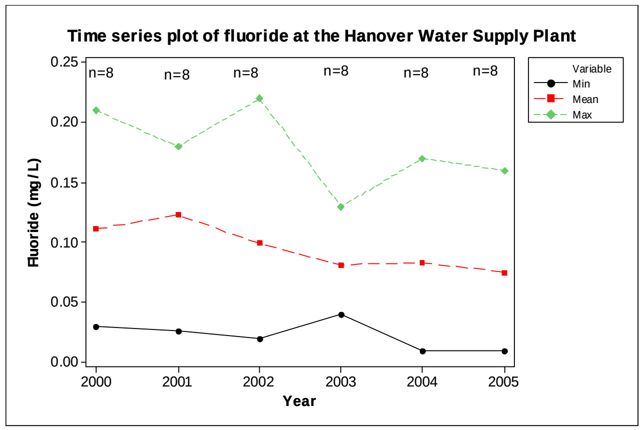
3.4.1.8 Point Clark/Lakeshore Well Supply

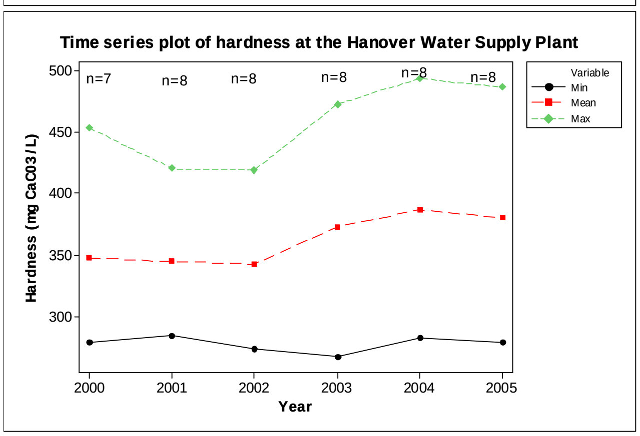
Data from the Point Clark/Lakeshore Well Supply was obtained for the year 2000 only (Figure 3.4.8). During that time, 5 five samples were collected. Fluoride, hardness, iron, and sodium concentrations were above established values for drinking water. All five samples had fluoride and hardness levels above 1.5 mg/L and 80-100 mg CaCO3/L respectively. At least one sample exceeded the aesthetic objective (300 ug/L) for iron as well. Although sodium concentrations did not exceed the aesthetic objective of 200 mg/L, samples were over 20 mg/L, which would require reporting to a public health officer.

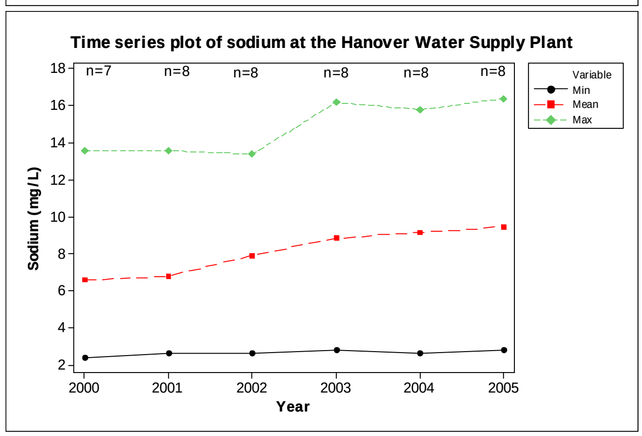












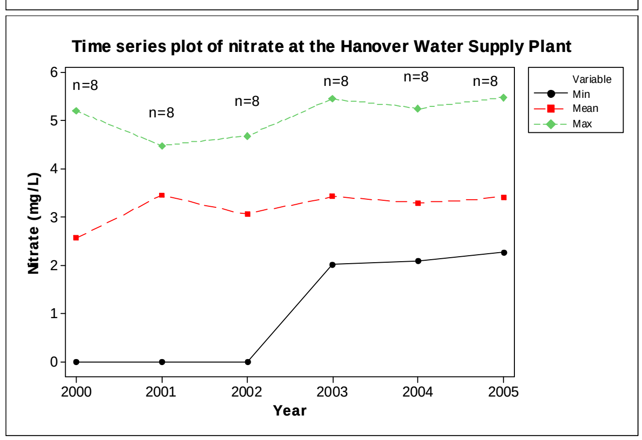


Figure 3.4.1 Summary of selected water Quality parameters from the Drinking Water Surveillance Program at the Hanover Water Supply Plant.

Note: Limits for parameters - - Arsenic: MAC of 0.025 mg/L (ODWS); Chloride: AO of 250 mg/L (ODWS); Fluoride: MAC of 1.5 mg/L (ODWS); Hardness: OG of 80-100 mg/L (ODWS); Iron: AO of 0.30 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Sodium: AO of 200 mg/L (ODWS)

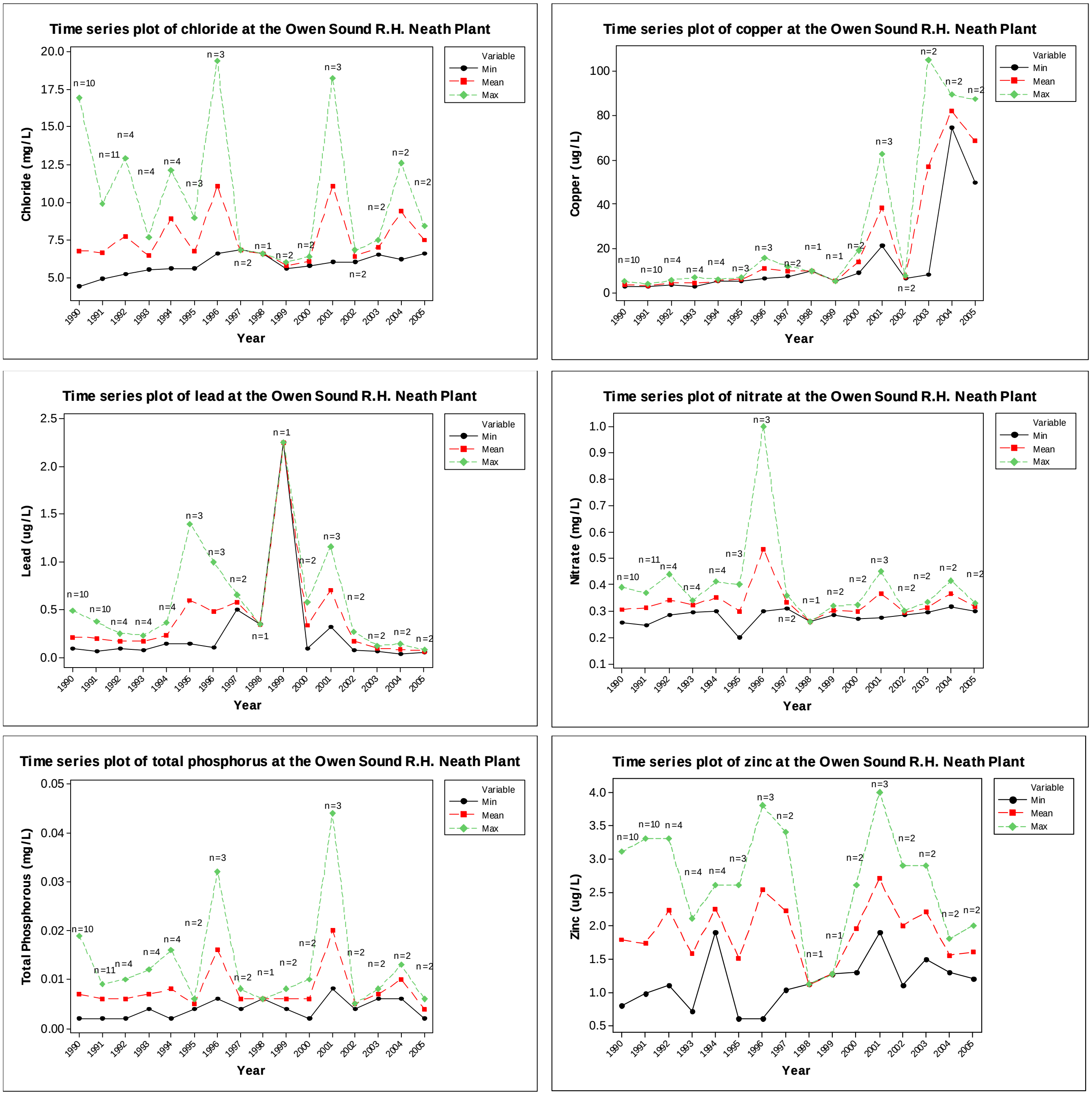
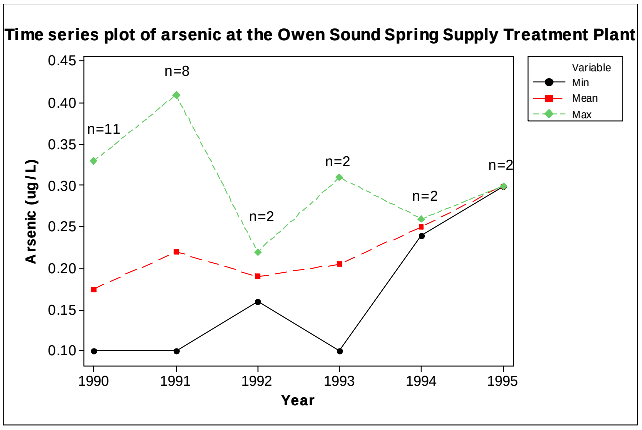
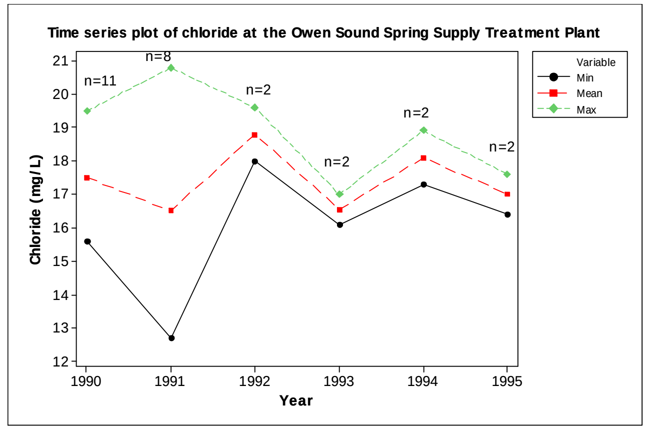
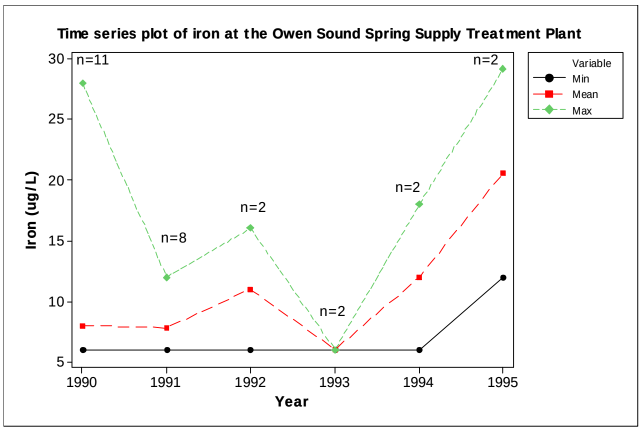


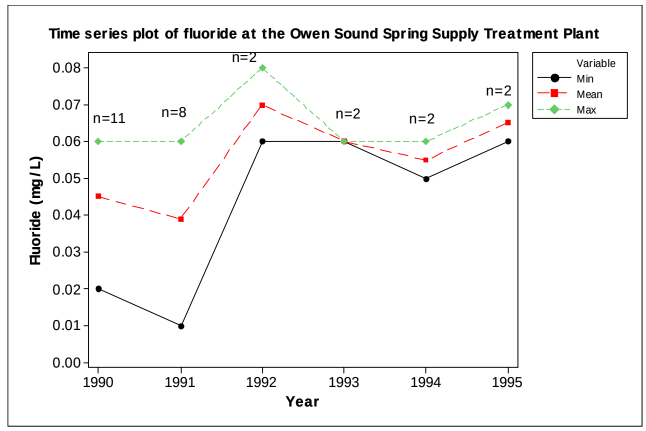
Figure 3.4.2 Summary of selected water quality parameters from the Drinking Water Surveillance Program at the Owen Sound Water Treatment Plant.

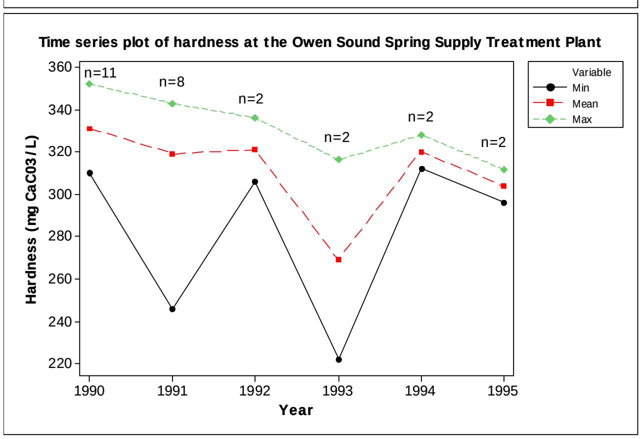
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Zinc: AO of 5.0 mg/L (ODWS)











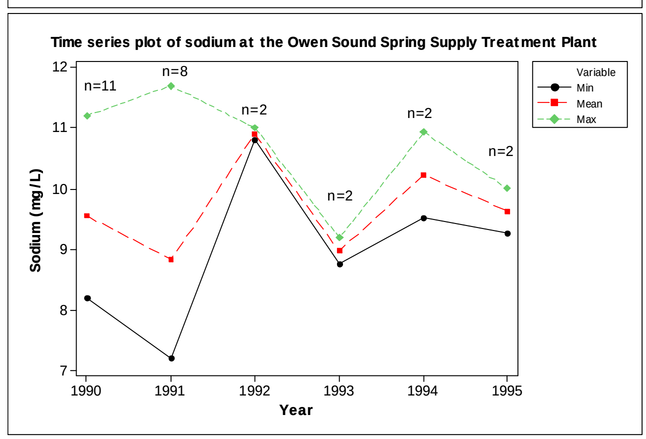
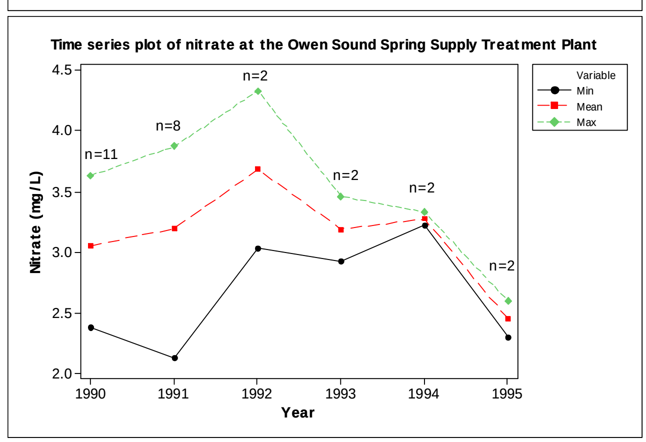


Figure 3.4.3 Summary of selected water quality parameters from the Drinking Water Surveillance Program at the Owen Sound Spring Supply Plant (no longer in use).
Note: Limits for parameters - - Arsenic: MAC of 0.025 mg/L (ODWS); Chloride: AO of 250 mg/L (ODWS); Fluoride: MAC of 1.5 mg/L (ODWS); Hardness: OG of 80-100 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Sodium: AO of 200 mg/L (ODWS)



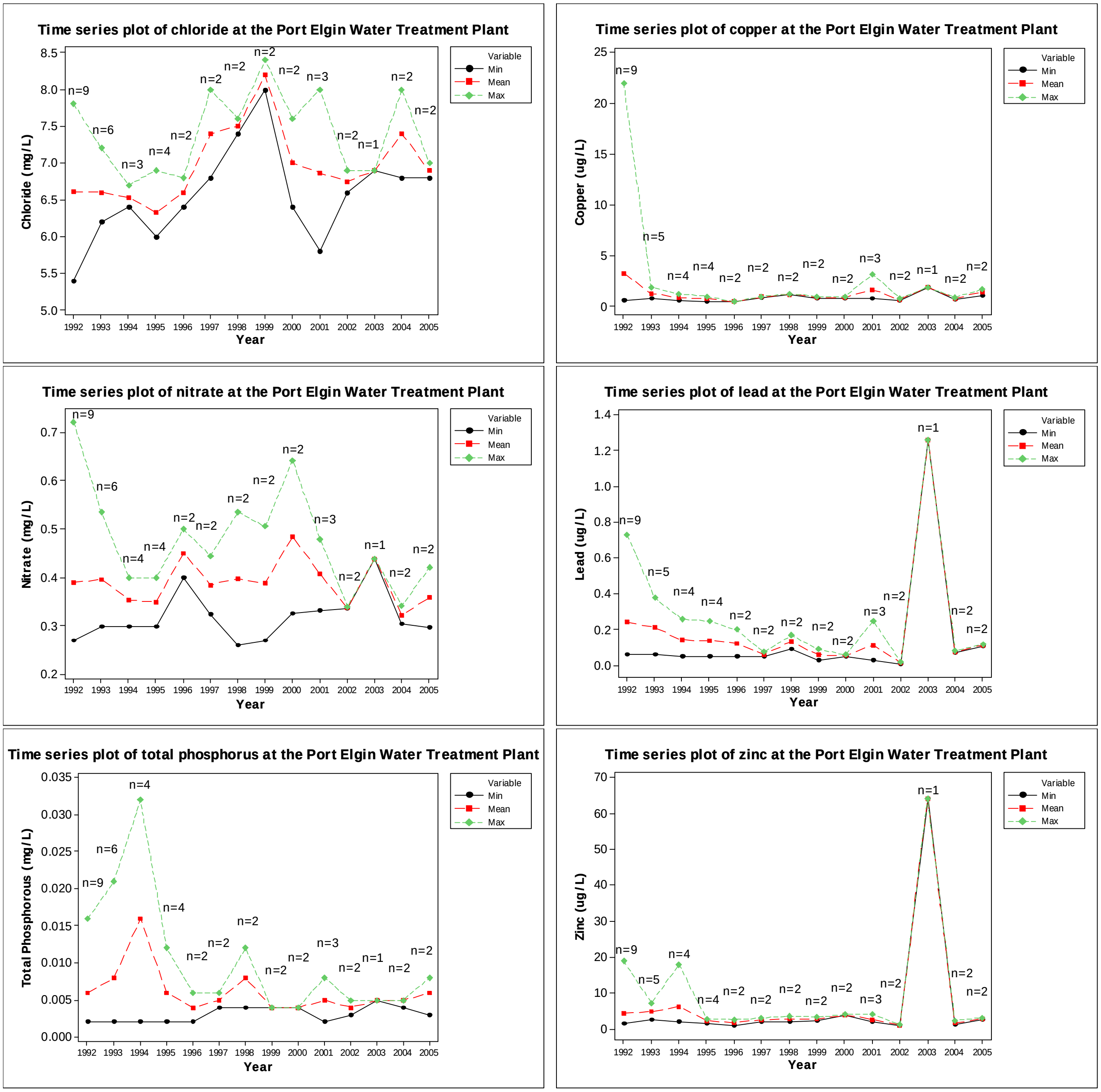


Figure 3.4.4 Summary of selected water quality parameters from the Drinking Water Surveillance Program at the Port Elgin Water Treatment Plant.

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Zinc: AO of 5.0 mg/L (ODWS)

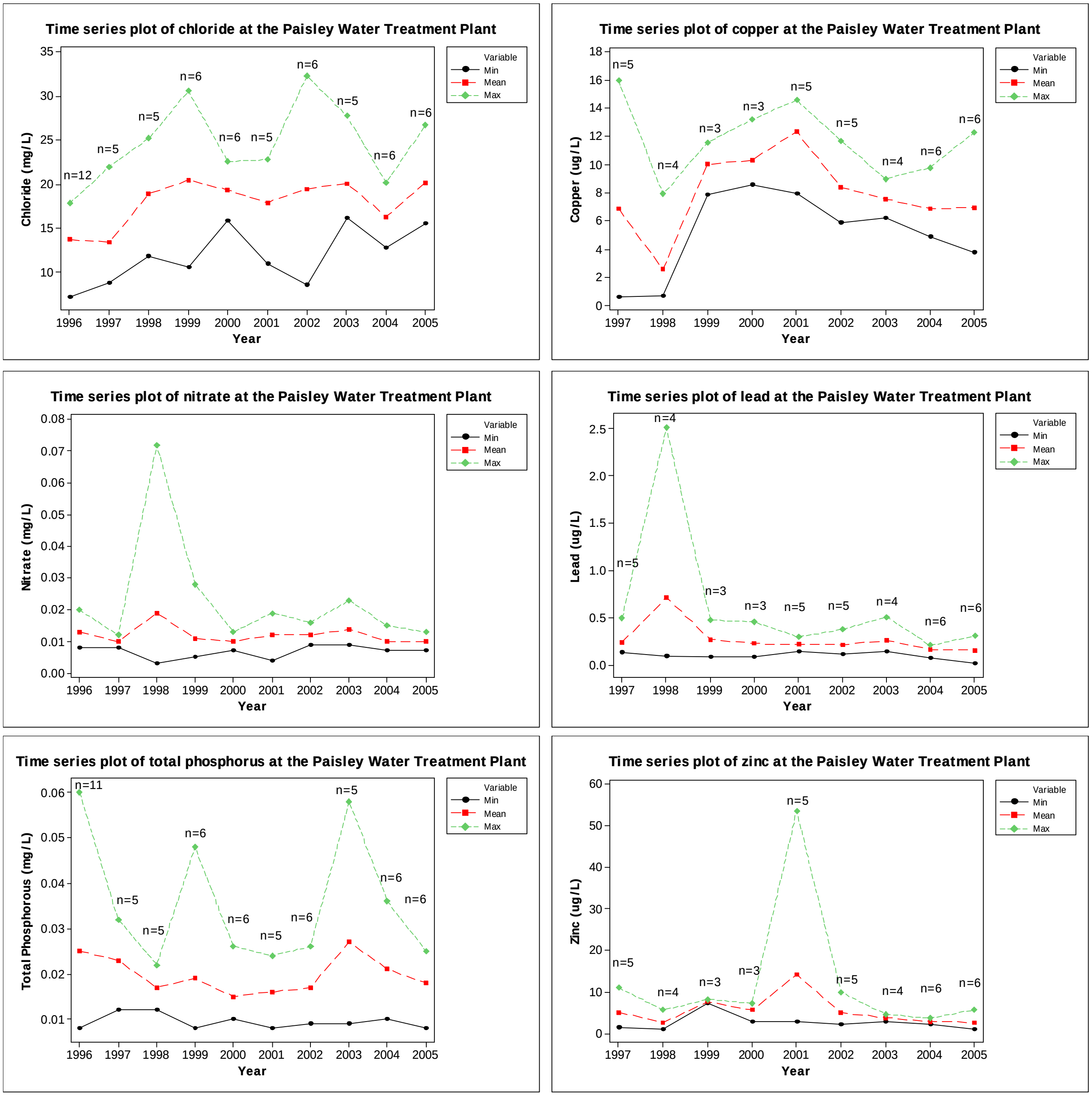


Figure 3.4.5 Summary of selected water quality parameters from the Drinking Water Surveillance Program at the Paisley Water Treatment Plant.
Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Zinc: AO of 5.0 mg/L (ODWS)

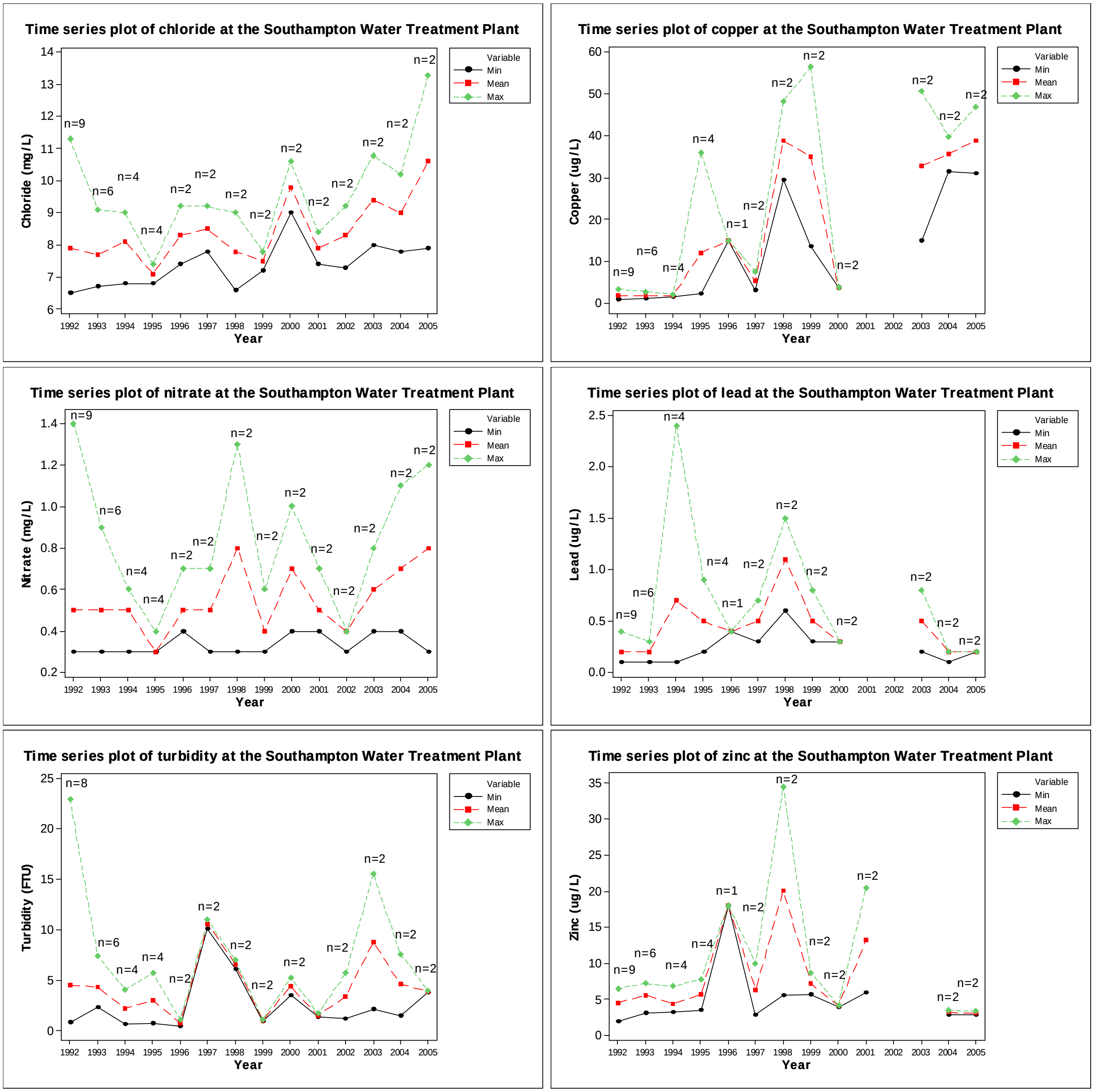
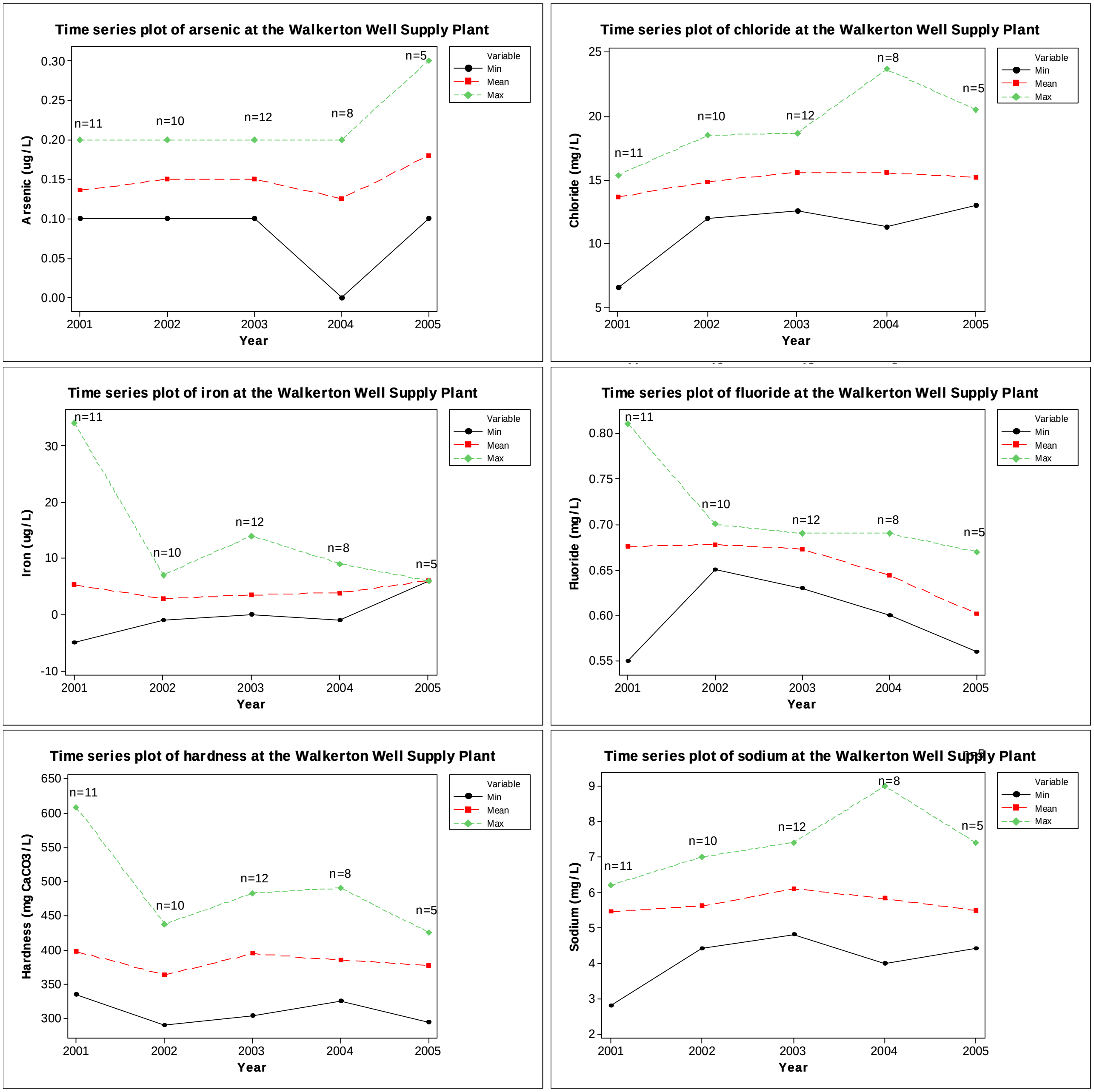


Figure 3.4.6 Summary of selected water quality parameters from the Drinking Water Surveillance Program at the Southampton Water Treatment Plant

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Lead: MAC of 0.01 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)



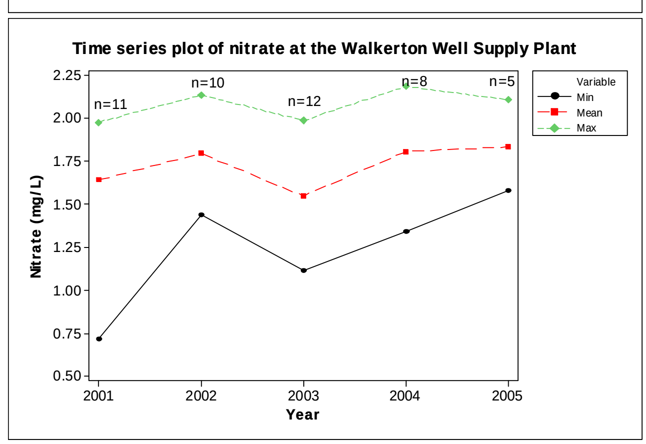


Figure 3.4.7 Summary of selected water quality parameters from the Drinking Water Surveillance Program at the Walkerton Well Supply

Note: Limits for parameters - - Arsenic: MAC of 0.025 mg/L (ODWS); Chloride: AO of 250 mg/L (ODWS); Fluoride: MAC of 1.5 mg/L (ODWS); Hardness: OG of 80-100 mg/L (ODWS); Iron: AO of 0.30 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Sodium: AO of 200 mg/L (ODWS)

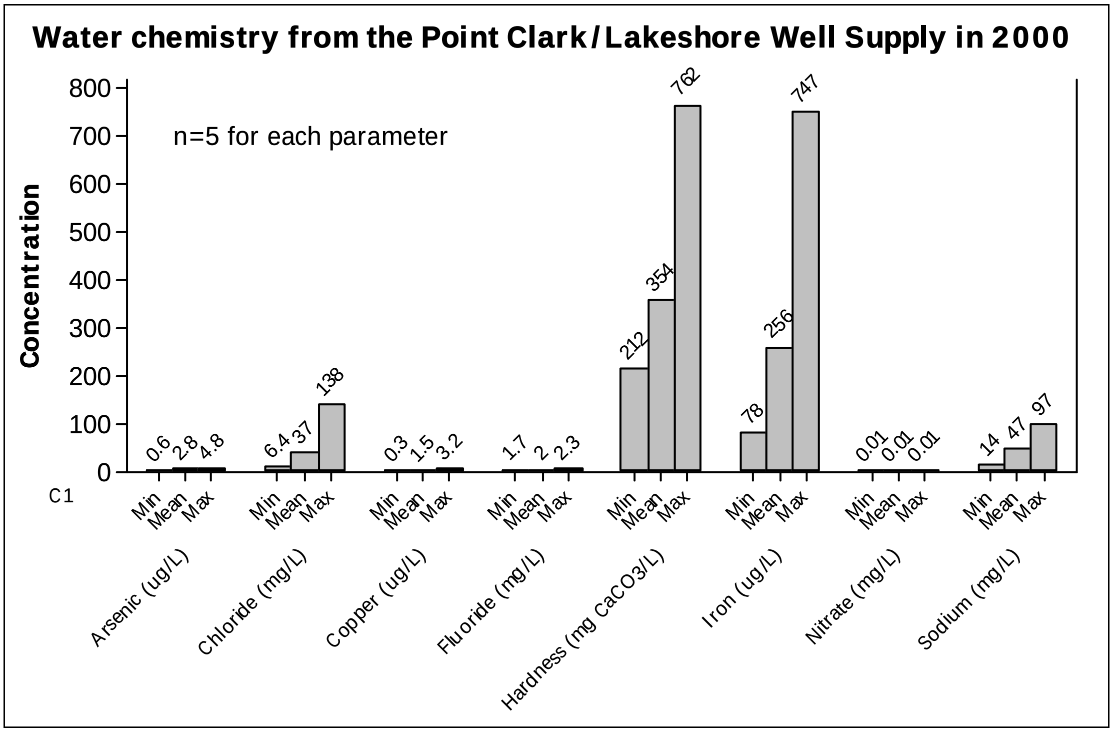


Figure 3.4.8 Summary of selected water quality parameters from the Drinking Water Surveillance Program at the Point Clark/Lakeshore Well Supply

Note: Limits for parameters - - Arsenic: MAC of 0.025 mg/L (ODWS); Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Fluoride: MAC of 1.5 mg/L (ODWS); Hardness: OG of 80-100 mg/L (ODWS); Iron: AO of 0.30 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Sodium: AO of 200 mg/L (ODWS)

3.4.2 Great Lakes Index Stations Monitoring (GLIS)

The GLIS monitor water quality in the Great Lakes. It is one of several programs by the Ontario Ministry of the Environment to monitor near shore water quality within the Great Lakes. There are 57 sites located in the Great Lakes and four of those are located in Lake Huron and two in Georgian Bay, which are proximate to the Source Protection Region (Map 1A). Samples are taken in the spring, summer, and fall months. The sites were selected to be representative of background conditions and areas where multiple stressors may exist.

The six Great Lakes stations are located near Kincardine, Southampton, Stokes Bay, Tobermory, Colpoys Bay, and Owen Sound (Map 34). There were five samples taken between 2002 and 2003. This was the first sampling session for the Lake Huron/Georgian Bay basin. The sampling design is to capture water quality conditions over time for the individual Great Lakes and the Great Lake system as a whole. Typically, samples were taken in June, August/September, and October. The chemical/physical parameters being discussed at each site and their respective upper limits, given in parantheses, are: chloride (250 mg/L, ODWS); total phosphorus (0.03 mg/L, PWQO); copper (1000 ug/L, ODWS); nitrate (10 mg/L, ODWS); total suspended solids (500 mg/L, ODWS); and zinc (5000 ug/L, ODWS).

Figures 3.4.9 to 3.4.14 summarizes the water chemistry/physical parameters for the relevant monitoring stations in Lake Huron/Georgian Bay. No exceedences were observed. These sampling sites would be useful for comparing future water chemistry data to make assessments on water quality trends in Lake Huron and Georgian Bay.

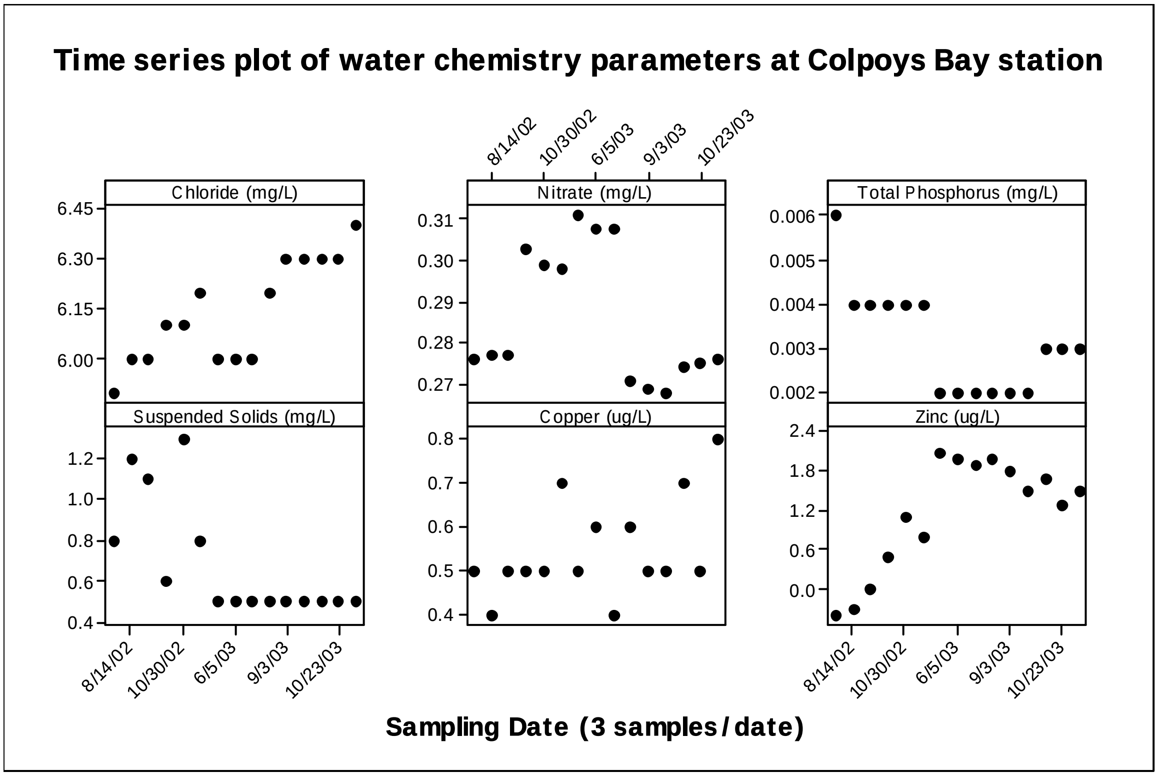


Figure 3.4.9 Summary of selected water quality parameters from the Great Lakes Index Station monitoring program at the Colpoys Bay (Georgian Bay) location

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

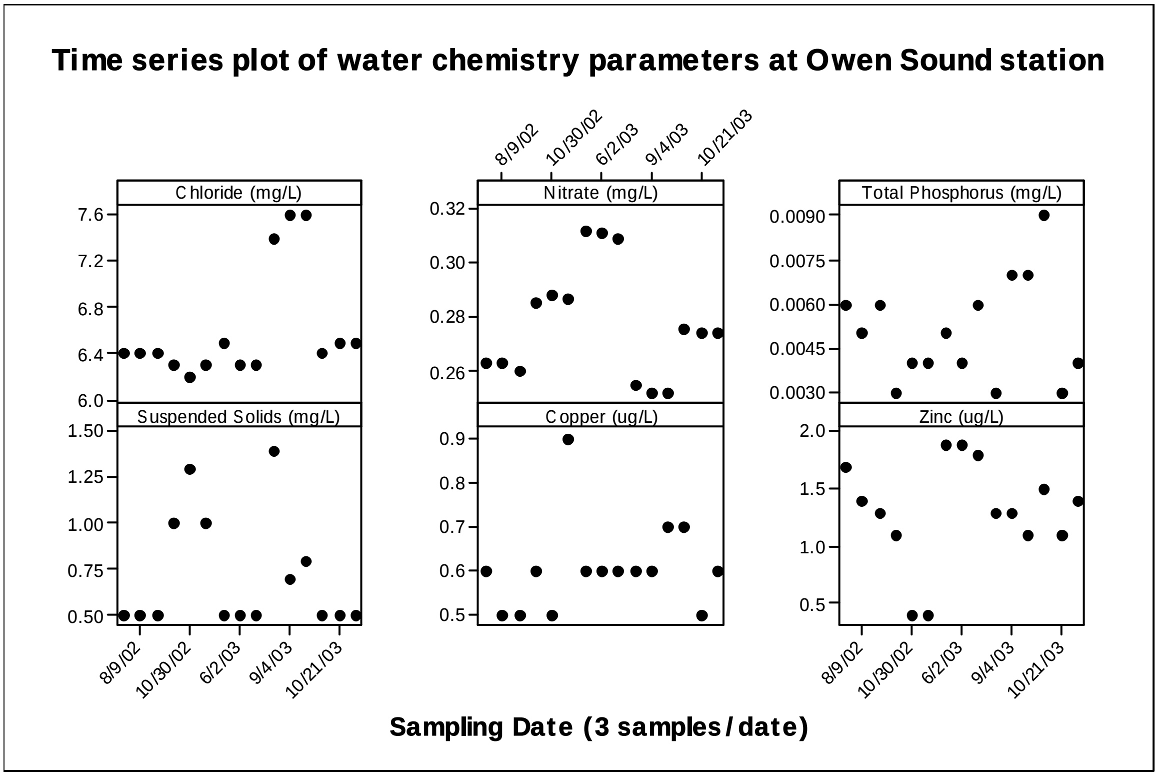


Figure 3.4.10 Summary of selected water quality parameters from the Great Lakes Index Station monitoring program at the Owen Sound (Georgian Bay) location.

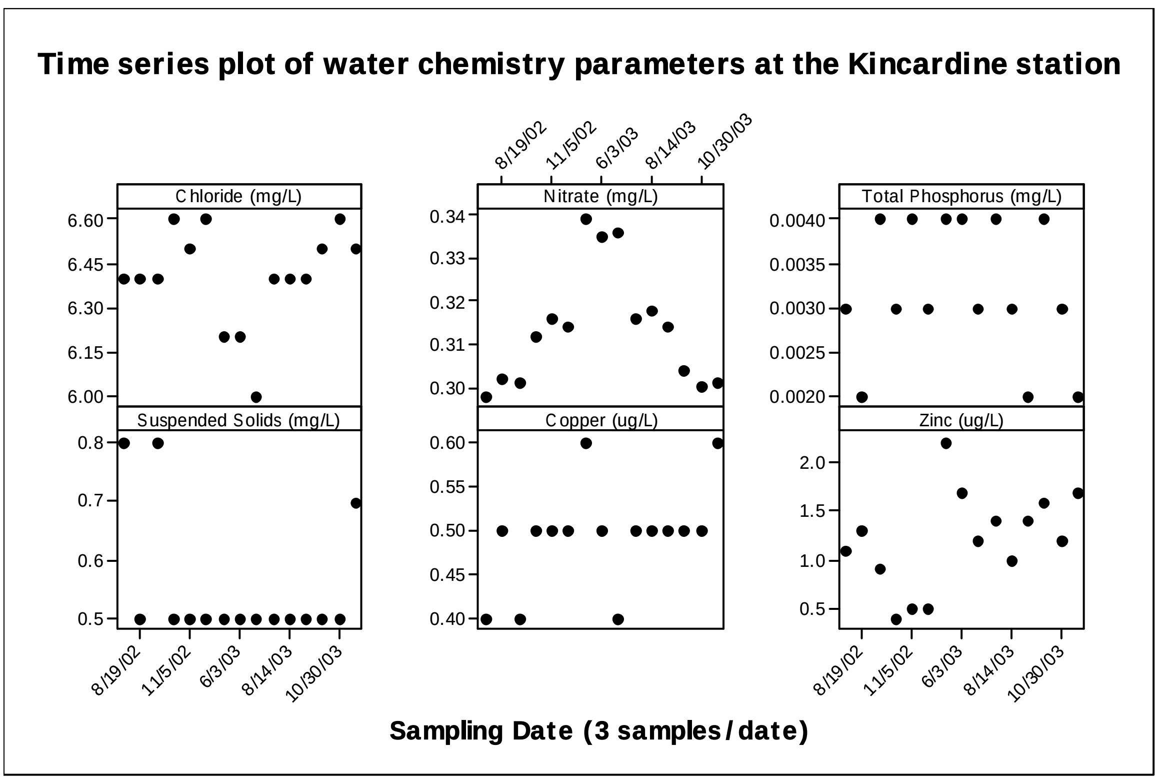


Figure 3.4.11 Summary of selected water quality parameters from the Great Lakes Index Station monitoring program at the Kincardine (Lake Huron) location.

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

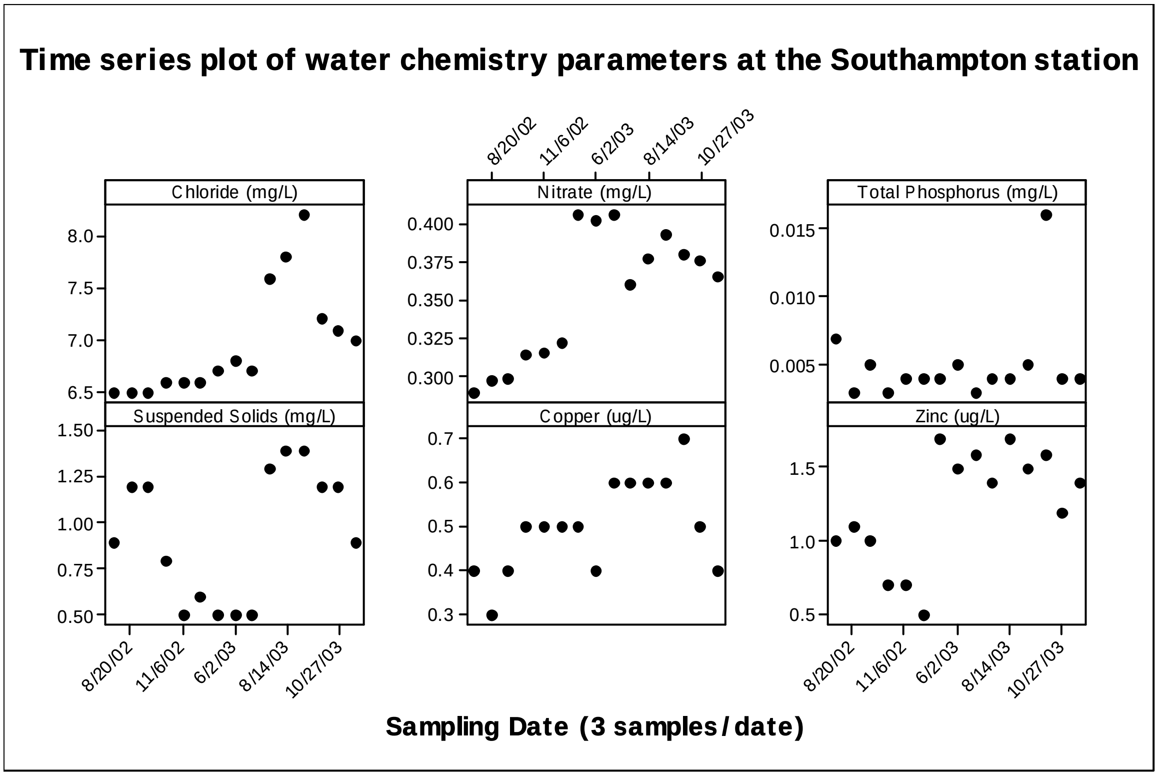


Figure 3.4.12 Summary of selected water quality parameters from the Great Lakes Index Station monitoring program at the Southampton (Lake Huron) location.

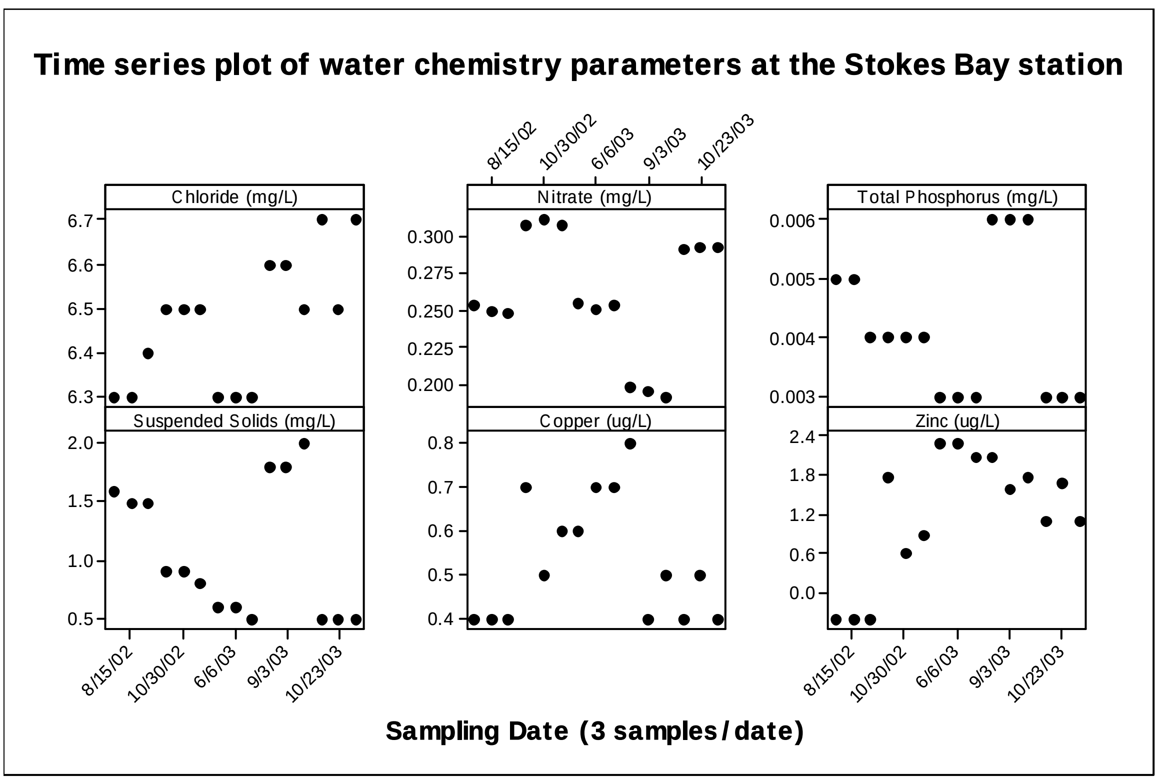


Figure 3.4.13 Summary of selected water quality parameters from the Great Lakes Index Station monitoring program at the Stokes Bay (Georgian Bay) location.

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

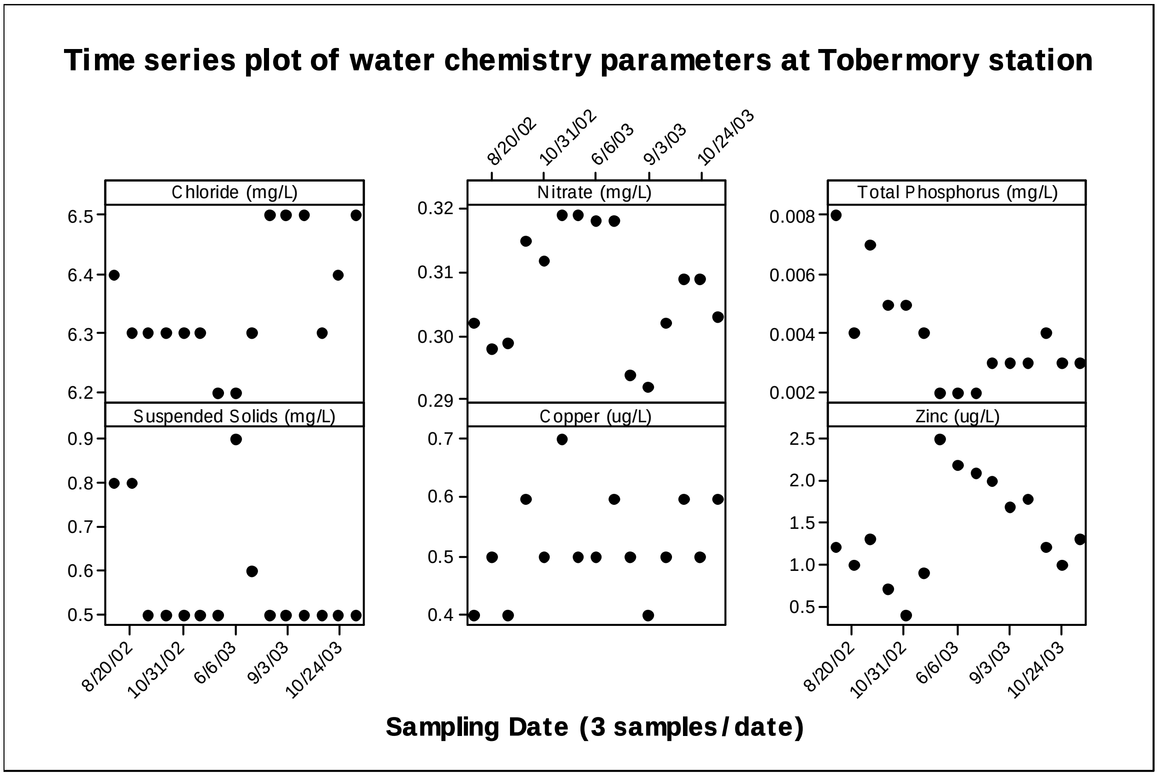


Figure 3.4.14 Summary of selected water quality parameters from the Great Lakes Index Station monitoring program at the Tobermory location.

Note: Limits for parameters - - Chloride: AO of 250 mg/L (ODWS); Copper: AO of 1.0 mg/L (ODWS); Nitrate: MAC of 10mg/L (ODWS); Total Phosphorus: guideline of 0.03 mg/L (PWQO); Total Suspended Solids: AO of 500 mg/L (ODWS); Zinc: AO of 5.0 mg/L (ODWS)

3.5 Microbial Source Water Characterization

3.5.1 Microbial Characterization for Large Municipal Residential Drinking Water Systems

A substantial amount of microbial indicator data for raw drinking water sources are collected under the Drinking Water Systems Regulation (O. Reg. 170/03) of the Safe Drinking Water Act (2002). Treated and distribution water is also tested, but are out of the scope for this document. The information gathered is stored in the Drinking Water Information System. The DWIS database serves as the main source for microbial data.

Under O. Reg. 170/03 raw water samples for large municipal residential systems (serves greater than 100 people) are required to be collected at a frequency of one per week. Micorbial data is collected within the SPR from large municipal residential drinking water systems, with 10 systems derived from surface water and 16 derived from groundwater (Table 3.35).

Raw water is tested for total coliforms and *E.coli*. These parameters are indicators of the amount of plant and animal life that has come into contact with the water supply. Total coliforms represent the cumulative concentration of composting plant material and animal excretions, while *E. coli* is specific to mammal and bird feces and is a unique type of fecal coliform. As mentioned, total coliforms and *E. coli* concentrations in themselves may not necessarily cause illness in humans, but it does indicate potential problems for pathogens that may induce illness. Although coliforms are naturally occurring, elevated concentrations can indicate inadequate nutrient management, livestock influence, excessive runoff from climate events, etc and necessitate a need to study the reason(s) for elevated concentrations.

Graphs (time series and histograms) were created for groundwater and surface water treatment systems. Some groundwater systems had too few data or no presence of total coliforms and *E. coli* for the time period that was sampled. In these cases, the treatment systems will be identified and the sample concentrations/date collected will be given. Typically data from water samples spans from May 2003 to September 2006.

The Chesley, Ripley, and Teeswater well supplies had no presence of coliforms. The Lakeshore, Mildmay, Mount Forest, Neustadt, Tiverton well supplies had isolated coliform events (Table 3.36).

The Chatsworth, Clifford, Durham, Kimberly, Markdale, Shallow Lake, and Tara well supplies experienced more persistent occurrences of coliforms. The results for both groundwater and surface water derived drinking water sources are summarized in Table 3.37. The data is also displayed graphically to show temporal variability (time series) and frequency of coliform concentrations (histograms) in Figures 3.5.1 through 3.5.17.

TABLE 3.35 - Summary of microbial raw water data from large municipal residential drinking water systems (MOE-DWIS).

Water System Name	DWS No.	GUDI Status	# Wells	Community	Municipality
Groundwater Sources					
Chatsworth WS	210003011	confirmed GUDI	2	Chatsworth	Chatsworth
Chesley WS	220002725	not GUDI	4	Arran-Elderslie	Arran-Elderslie
Clifford WS	220000031	not GUDI	4	Clifford	Minto
Durham WS	220001771	confirmed GUDI	2	Durham	West Grey
Kimberley-Amik-Talisman WS	220007070	confirmed GUDI	2	Grey Highlands	Grey Highlands
Lakeshore WS	220000425	not GUDI	5	Huron-Kinloss	Huron-Kinloss
Markdale WS	220001744	confirmed GUDI	3	Markdale	Grey Highlands
Mildmay WS	220002654	not GUDI	2	Mildmay	South Bruce
Mount Forest WS	220000068	not GUDI	4	Wellington North	Wellington North
Neustadt WS	210002147	confirmed GUDI	3	West Grey	West Grey
Ripley WS	220002636	not GUDI	2	Huron-Kinloss	Huron-Kinloss
Shallow Lake WS	220009096	confirmed GUDI	2		Georgian Bluffs
Tara WS	220002627	not GUDI	2	Arran-Elderslie	Arran-Elderslie
Teeswater WS	220002618	not GUDI	1	Teeswater	South Bruce
Tiverton WS	220002609	not GUDI	2	Kincardine	Kincardine
Walkerton WS	220002690	not GUDI	2	Brockton	Brockton
Surface Water Sources					
East Linton And Area WTP	220007659	not GUDI	0	Georgian Bluffs	Georgian Bluffs
Hanover WTP	210000167	confirmed SW+GUDI	2		Brockton
Kincardine WTP	220002716	not GUDI	0	Kincardine	Kincardine
Lion's Head WTP	220002672	not GUDI	0	Lion's Head	Northern Bruce Peninsula
Meaford PUC WTP	210000176	not GUDI	0	Meaford	Meaford
Owen Sound (R. H. Neath) WTP	220001799	not GUDI	0	Owen Sound	Owen Sound
Port Elgin WTP	220002707	not GUDI	0	Port Elgin	Saugeen Shores
Southampton WTP	210000078	not GUDI	0	Southampton	Saugeen Shores
Thornbury WTP	220001762	not GUDI	0	Thornbury	The Blue Mountains
Wiarton WTP	220002681	not GUDI	0		South Bruce Peninsula

TABLE 3.36 - Summary of total coliform data (MOE-DWIS)

Well Supply	***Well Description***	***Total Coliform (cfu/100 mL)***	***Date(s)***
Lakeshore Well Supply	Blairs Grove Well 2	2	7/11/06
	Huronville South Well 2	3	6/27/06
Mildmay Well Supply	Well 1	1	4/4/05
Mount Forest Well Supply	Well 4	200	5/26/03
		1	8/21/06
	Well 5	1	5/20/03, 10/27/03, 10/18/04
	Well 6	3	12/13/04
Neustadt Well Supply	Well 2	1	6/13/05
		2	10/21/03, 11/3/03
		3	10/28/03
	Well 3	2	11/3/03
Tiverton Well Supply	Dent Well	1	10/14/03, 8/3/04, 7/27/04, 2/13/06
		3	8/17/04
Walkerton Well Supply	Well 7	2	12/6/04, 1/17/05
		3	12/9/03
	Well 9	2	8/5/03, 9/5/06
		1	6/14/04, 1/17/05, 8/22/06

TABLE 3.37 - Geometric means of microbial concentrations for drinking water systems in the SPR.

DWS	***Total Coliform (TC) / E. coli***	***2003***	***2004***	***2005***	***2006***	***4 Yr. Avg.***	***Sample Size (n)***	***Days Sampled***
		(cfu/100mL)						
Groundwater Sources								
Chatsworth WS	Well 1 TC	7.1	3.2	3.6	1.7	3.4	82	180
	Well 1 E. coli	7.1	2.4	1.1	1.0	1.9	21	
	Well 2 TC	4.2	4.7	3.1	2.1	3.5	102	180
	Well 2 E. coli	2.7	4.3	1.6	1.4	2.4	19	
Clifford WS	TC	3.2	1.0				16	75
	E. coli	1.0	1.0				4	
Durham WS	Well 1B TC	1.6	2.3			2.0	19	86
	Well 2 TC		1.0			1.0	1	63
Kimberly WS	TC	118.0	138.4	130.2	116.6		173	173
	E. coli	23.7	15.3	16.3	11.5	16.0	160	

DWS	Total Coliform (TC) / E. coli	2003	2004	2005	2006	4 Yr. Avg.	Sample Size (n)	Days Sampled
		(cfu/100mL)						
Markdale WS	Well 1 TC		2.0	1.0	1.6	1.6	6	244
	Well 1 E. coli		1.0			1.0	1	
	Well 2 TC	2.1	3.7	1.8		2.7	60	114
	Well 2 E. coli	1.0	1.7	1.0		1.4	11	
	Well 3 TC		2.7	6.3	2.0	3.7	89	244
	Well 3 E. Coli		1.0	3.7	1.6	2.7	47	
	Well 4 TC		5.0	2.8	1.9	2.6	28	244
	Well 4 E. Coli			1.7	1.0	1.6	14	
Shallow Lake WS	PW2 TC	123.2	122.5	57.1	57.1		181	181
	PW2 E. Coli	8.0	3.8	4.7	5.7	5.2	154	
	PW3 TC	114.0	84.9	68.6	56.9	78.1	154	181
	PW3 E. Coli	9.0	3.9	4.1	3.3	4.6	125	
Tara WS	TC	2.8	4.3	2.9	1.0	2.6	28	161
	E. coli	1.8	4.7			2.9	6	
Surface Water Sources								
East Linton WTP	TC	15.5	17.2	27.7	164.7	42.2	115	175
	E. coli	2.5	2.4	5.9	11.9	5.6	65	
Hanover WTP	Ruhl Lake TC		177.5				35	37
	Ruhl Lake E. coli		3.4				37	
	Well 1 TC		3.1	1.2	1.0	2.6	6	118
	Well 1 E. coli		7.0			7.0	1	
Kincardine WTP	TC	33.9	39.5	31.8	26.2	33.4	131	169
	E. coli	3.5	4.9	4.0	3.4	4.0	67	
Lion's Head WTP	TC	21.7	12.8	18.2	6.0	14.0	144	176
	E. coli	4.9	3.1	7.1	4.8	4.7	70	
Meaford PUC WTP	TC	10.8	10.0	10.0	8.2	10.0	120	149
	E. coli	2.3	2.6	3.7	1.8	2.8	47	
Owen Sound WTP (R.H. Neath)	TC	44.9	66.6	53.8	30.5	47.1	172	182
	E. coli	4.1	3.8	6.3	4.4	4.5	127	
Port Elgin WTP	TC	29.7	9.9	24.9	38.2	27.7	148	178
	E. coli	3.6	2.9	2.6	7.2	3.8	89	
Southampton WTP	TC	33.4	141.0	148.7	84.2	110.4	101	176
	E. coli	8.2	29.4	18.8	10.4	16.8	81	
Thornbury WTP	TC	5.1	3.4	15.1	16.2	10.8	95	224
	E. coli		1.0	2.5	3.7	2.9	32	
Wiarton WTP	TC	10.9	6.3	5.6	8.1	7.4	118	190
	E. coli	1.5	2.2	1.7	1.9	1.9	35	

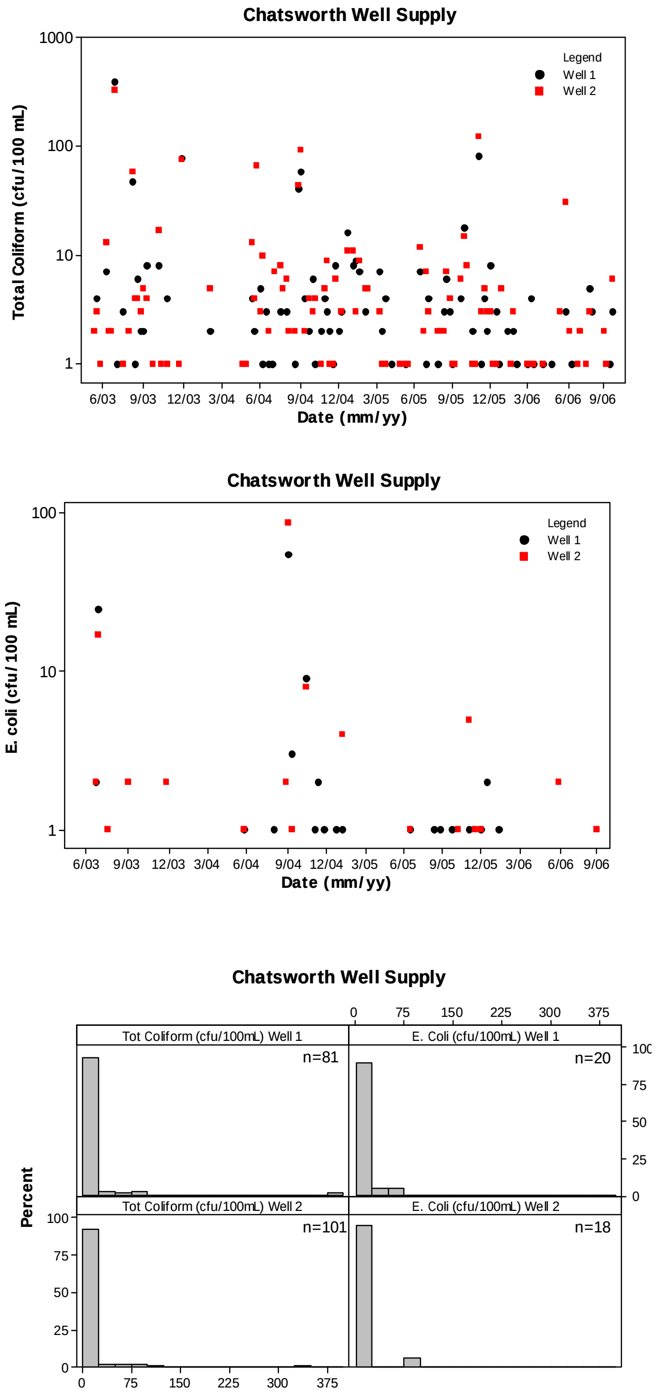


Figure 3.5.1 Microbial characterization of the Chatsworth Well Supply

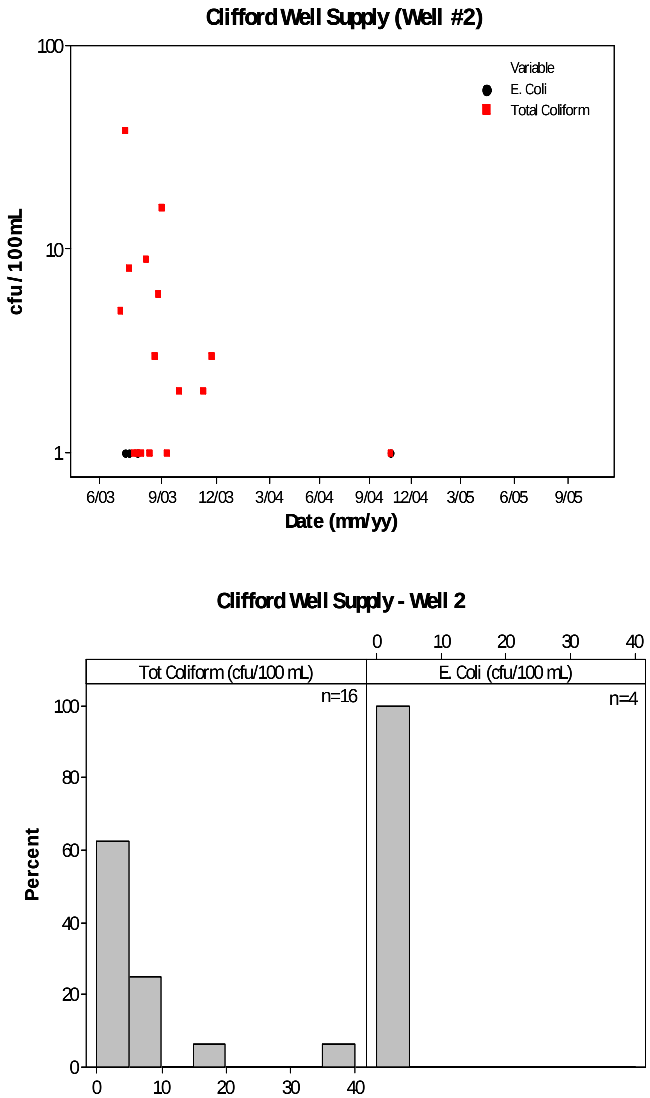
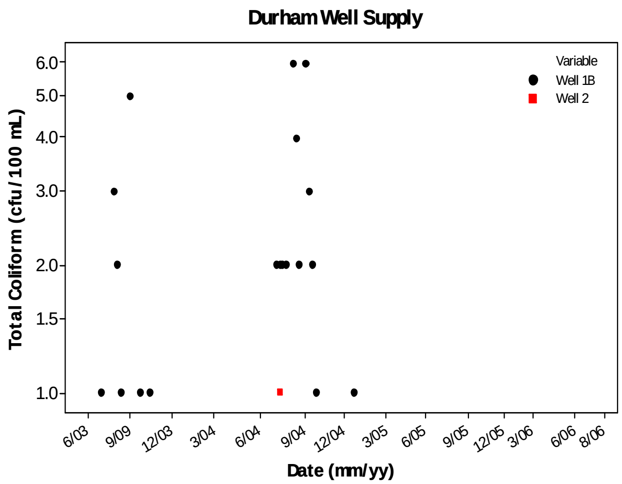


Figure 3.5.2 Microbial characterization of the Clifford Well Supply



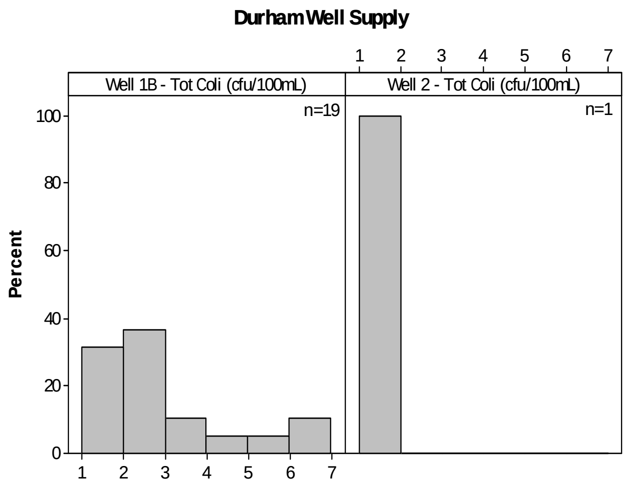
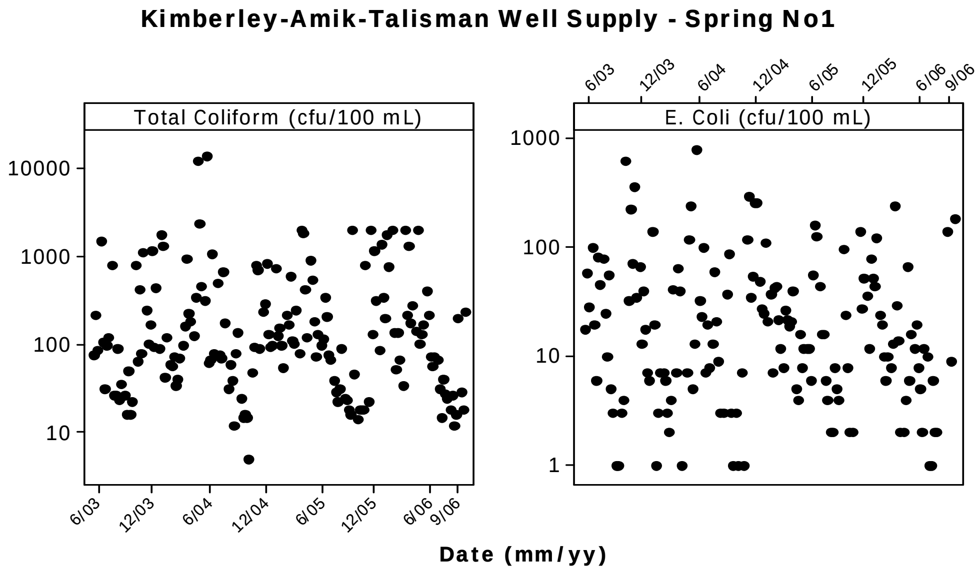


Figure 3.5.3 Microbial characterization of the Durham Well Supply



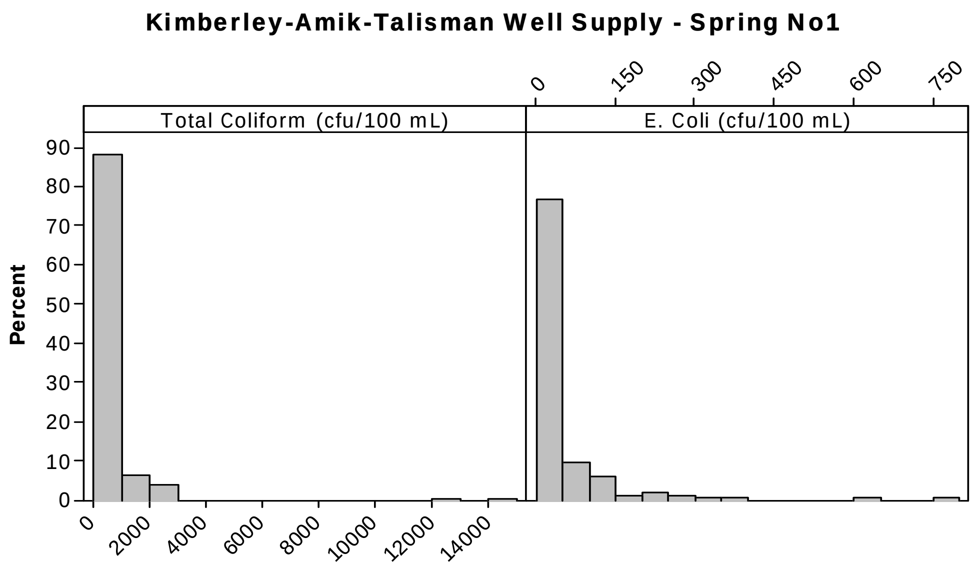


Figure 3.5.4 Microbial characterization of the Kimberly-Amik-Talisman Well Supply

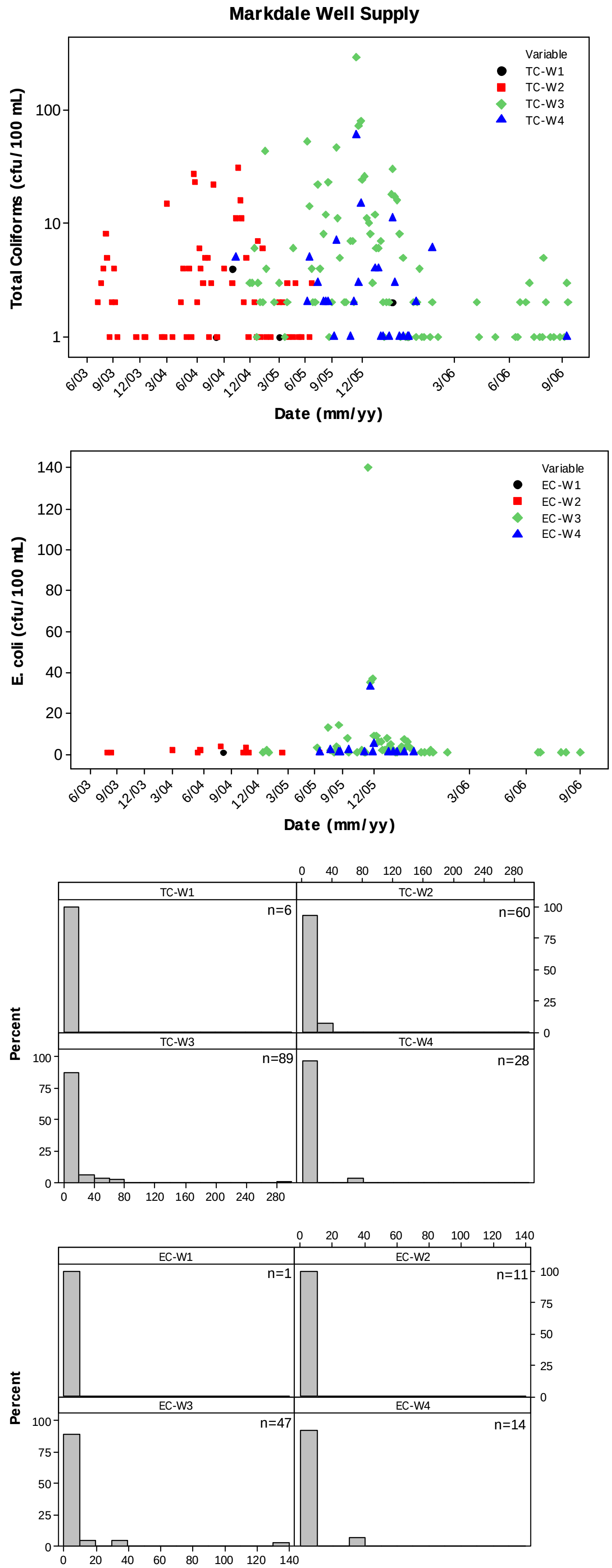


Figure 3.5.5 Microbial characterization of the Markdale Well Supply

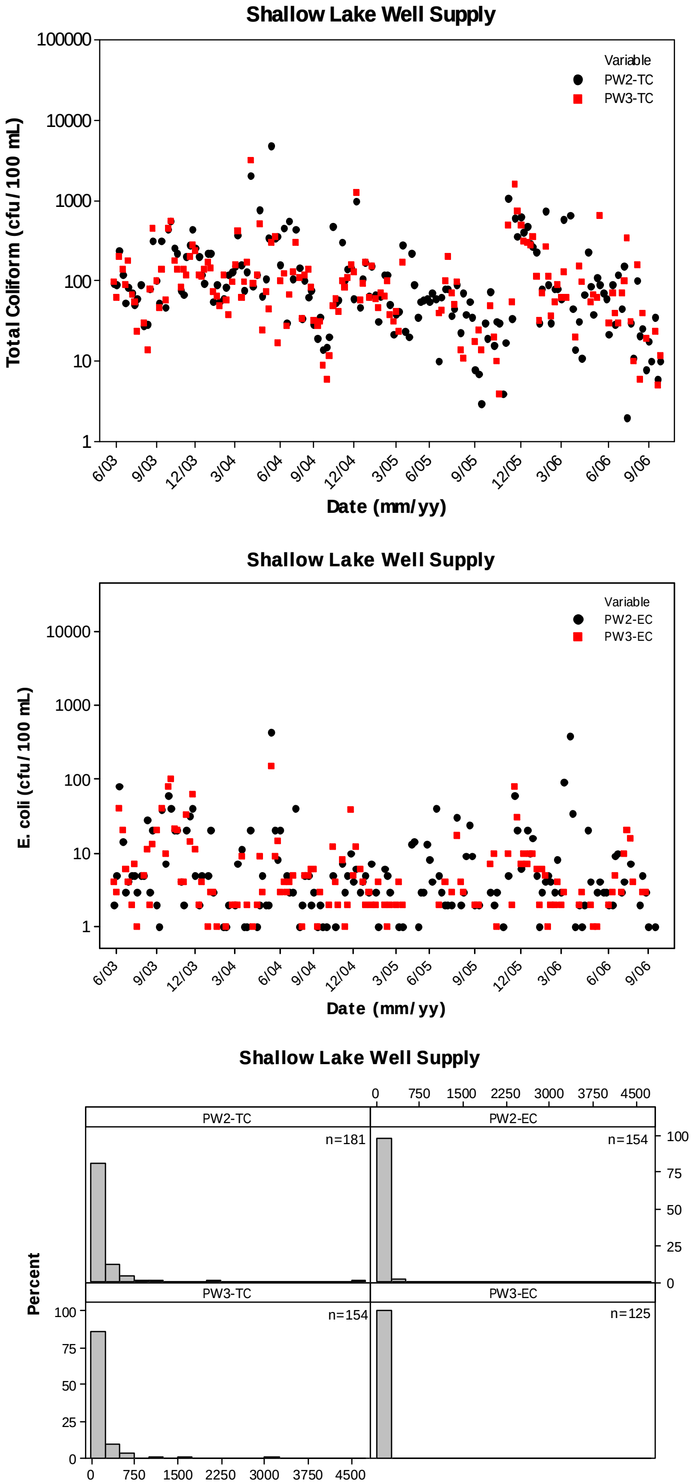


Figure 3.5.6 Microbial characterization of the Shallow Lake Well Supply

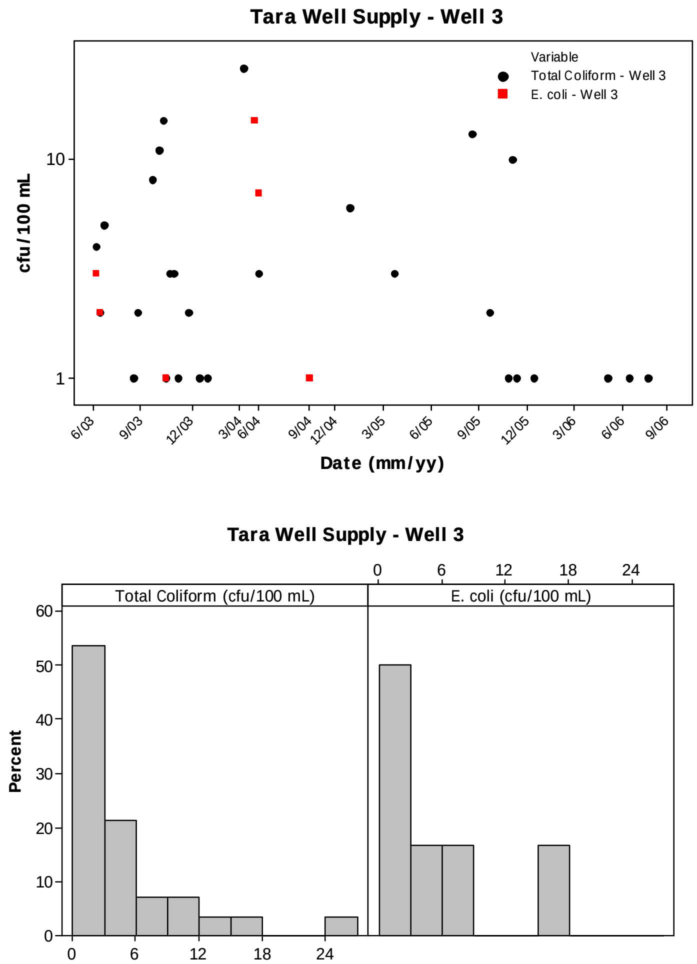


Figure 3.5.7 Microbial characterization of the Tara Well Supply

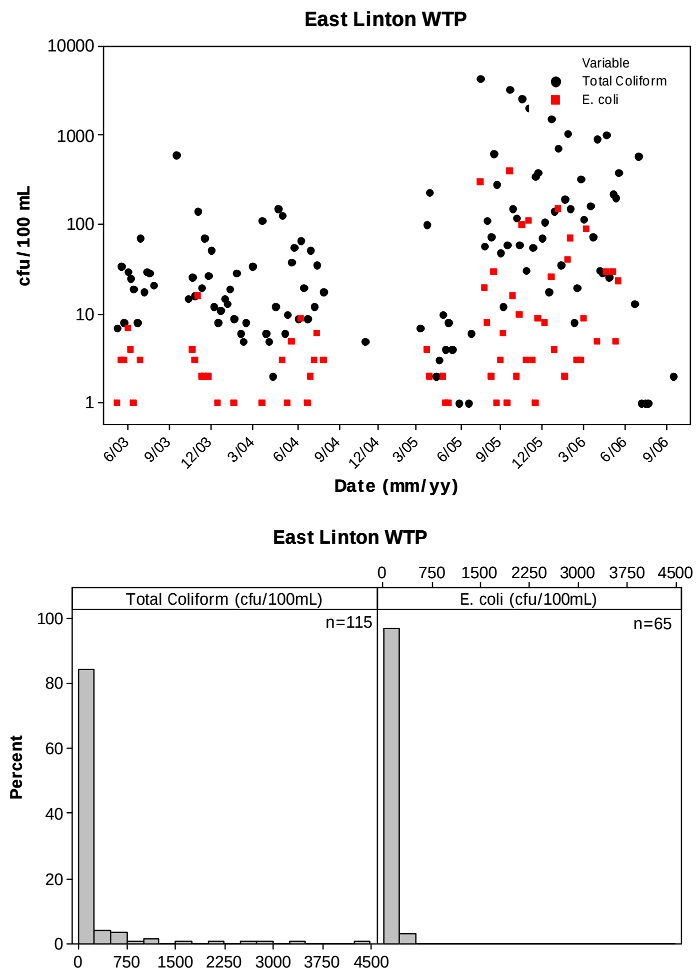


Figure 3.5.8 Microbial characterization of the East Linton WTP

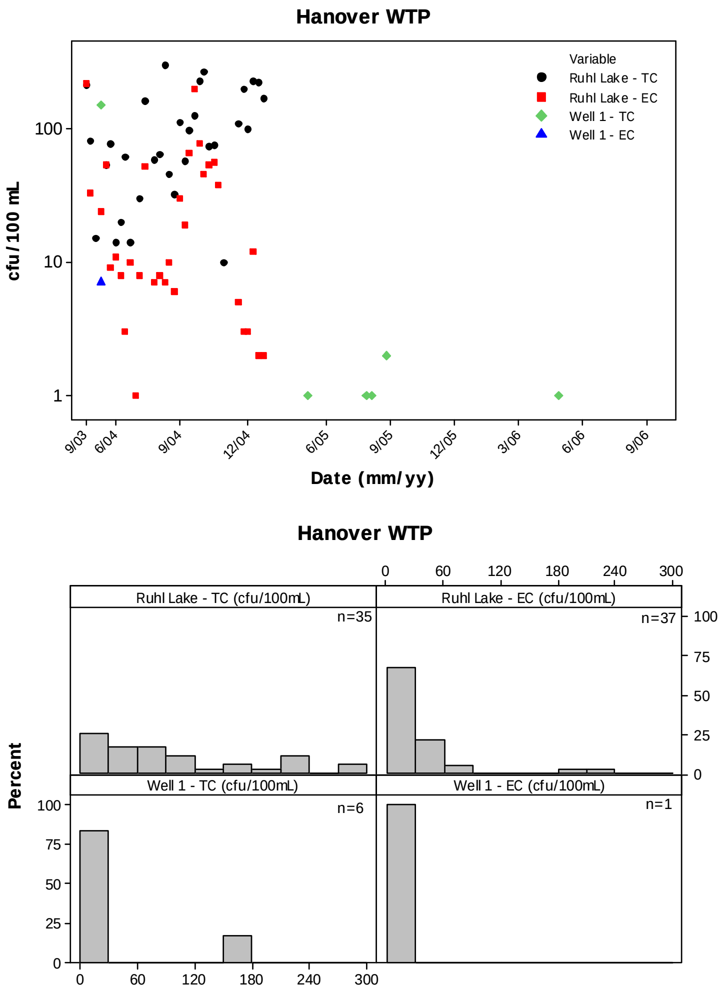
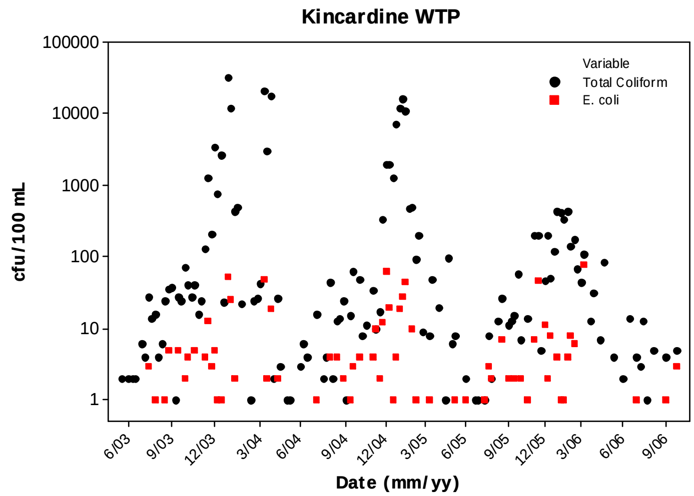


Figure 3.5.9 Microbial characterization of the Hanover WTP



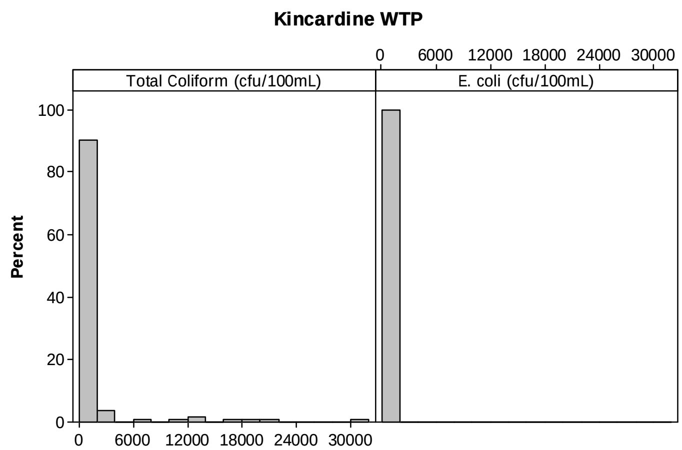


Figure 3.5.10 Microbial characterization of the Kincardine WTP

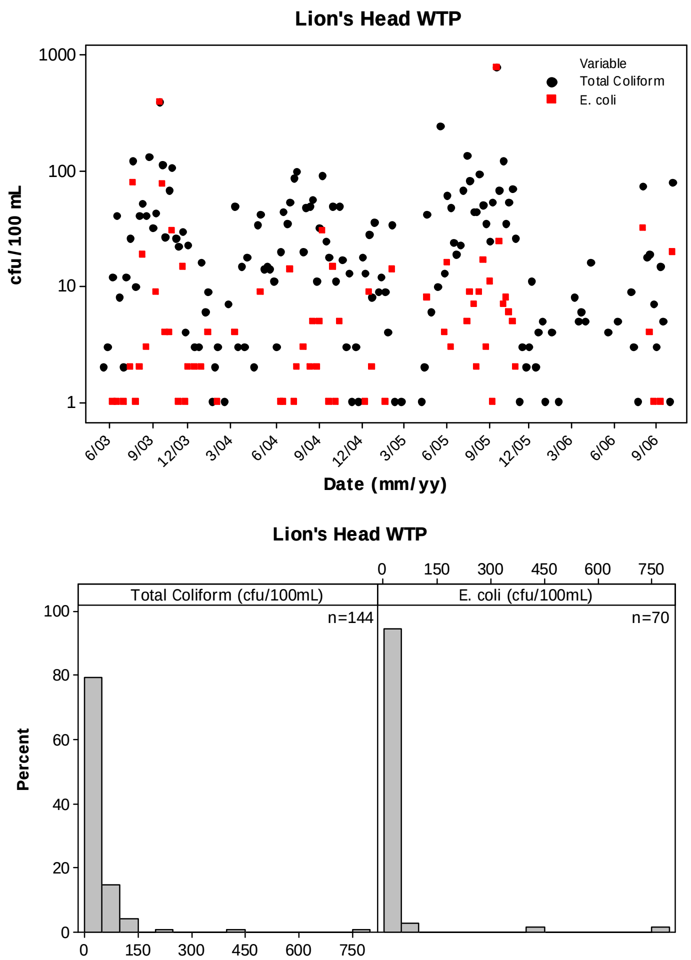


Figure 3.5.11 Microbial characterization of the Lion’s Head WTP

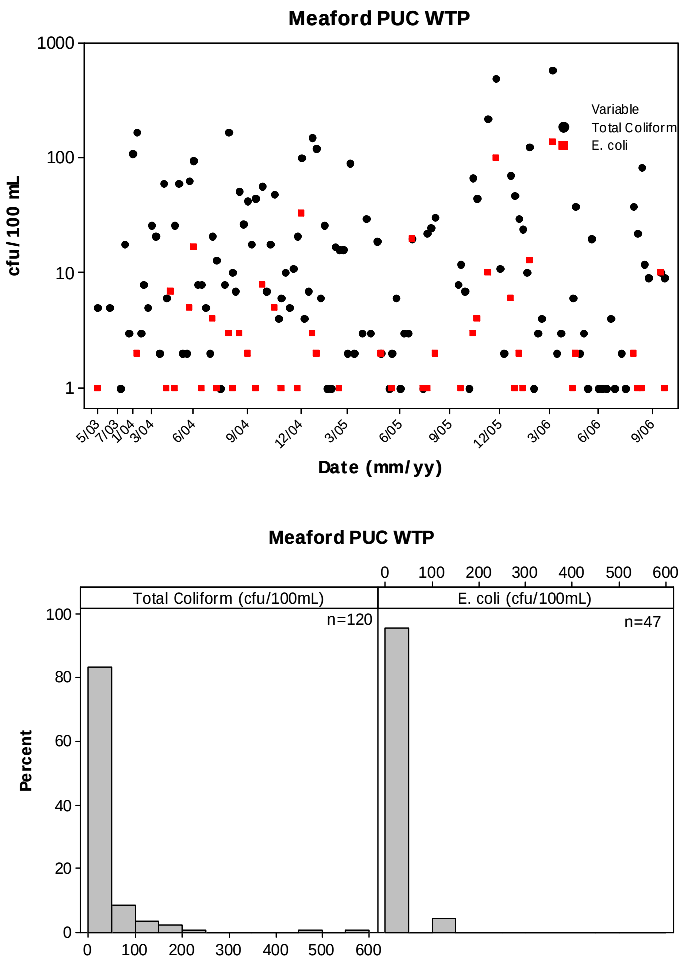


Figure 3.5.12 Microbial characterization of the Meaford PUC WTP

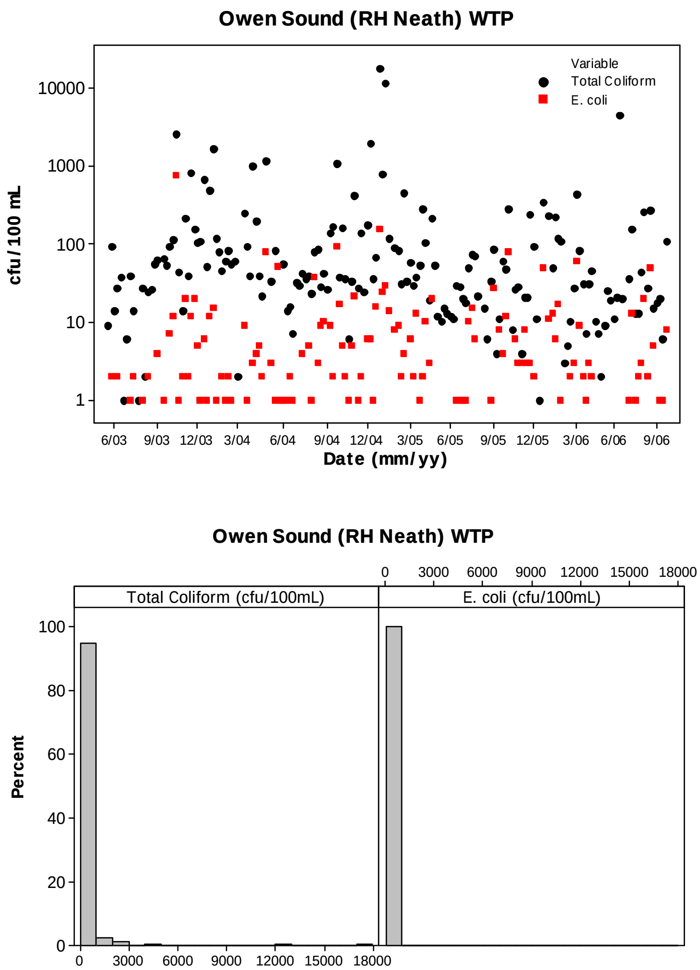


Figure 3.5.13 Microbial characterization of the Owen Sound WTP

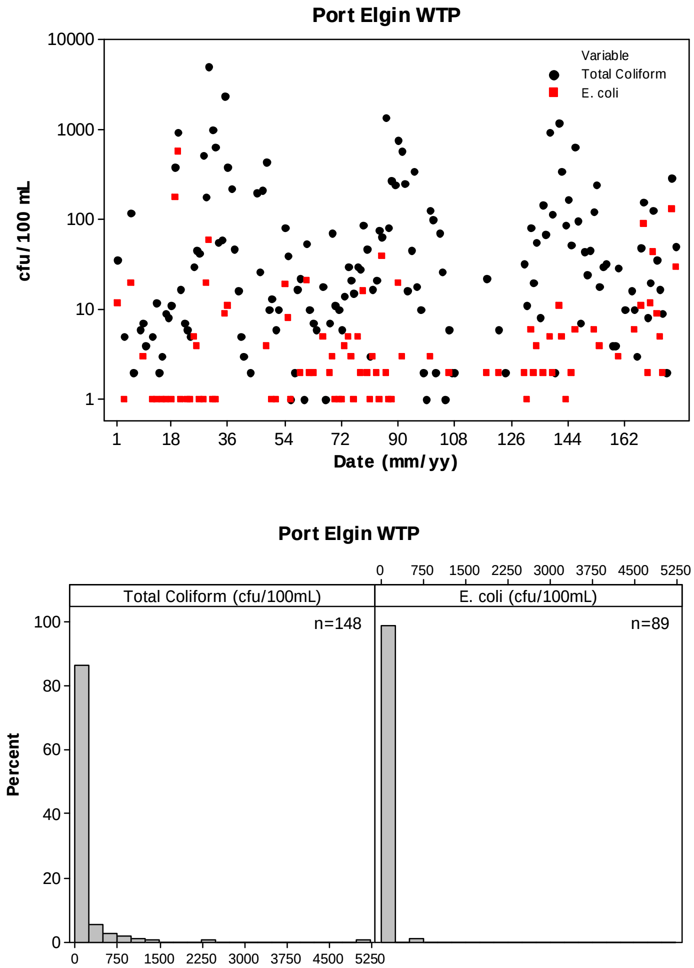


Figure 3.5.14 Microbial characterization of the Port Elgin WTP

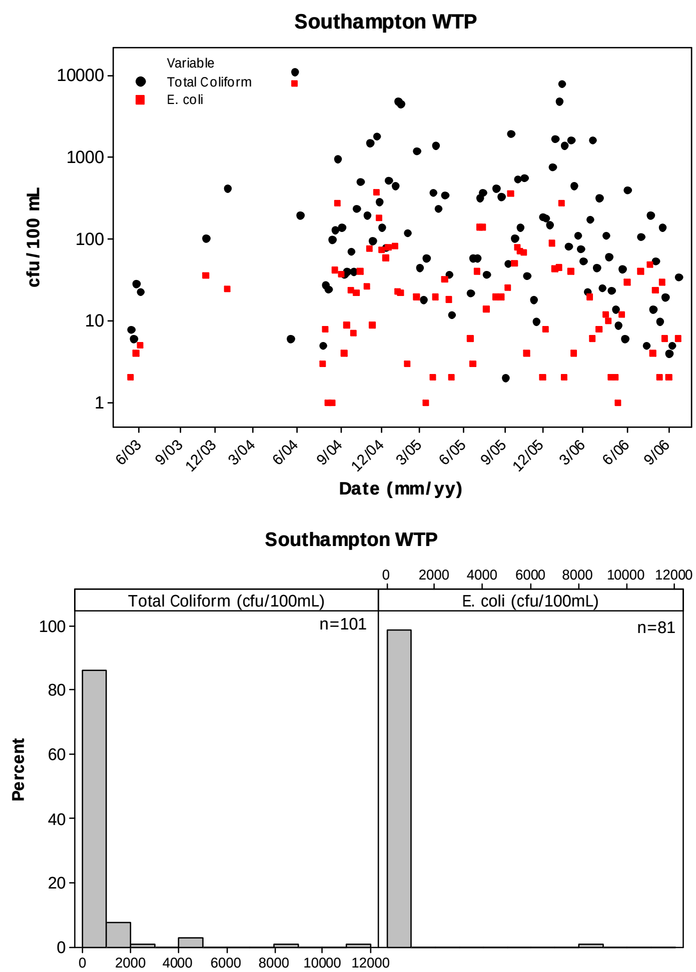
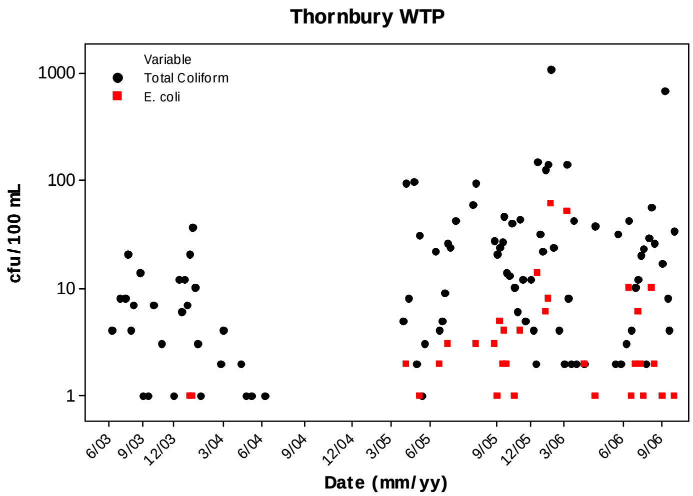


Figure 3.5.15 Microbial characterization of the Southampton WTP



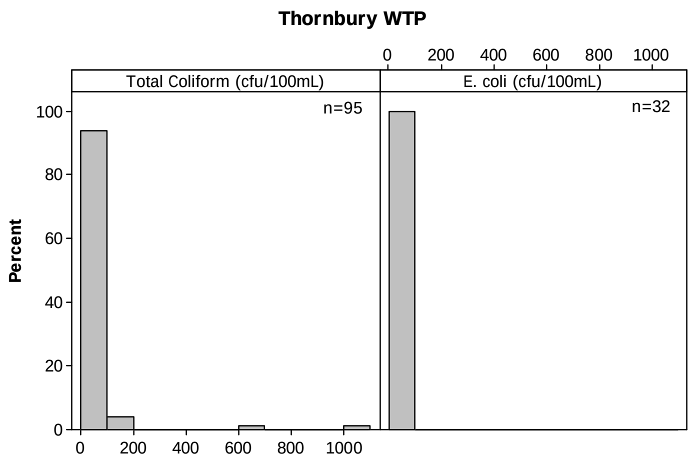


Figure 3.5.16 Microbial characterization of the Thornbury WTP

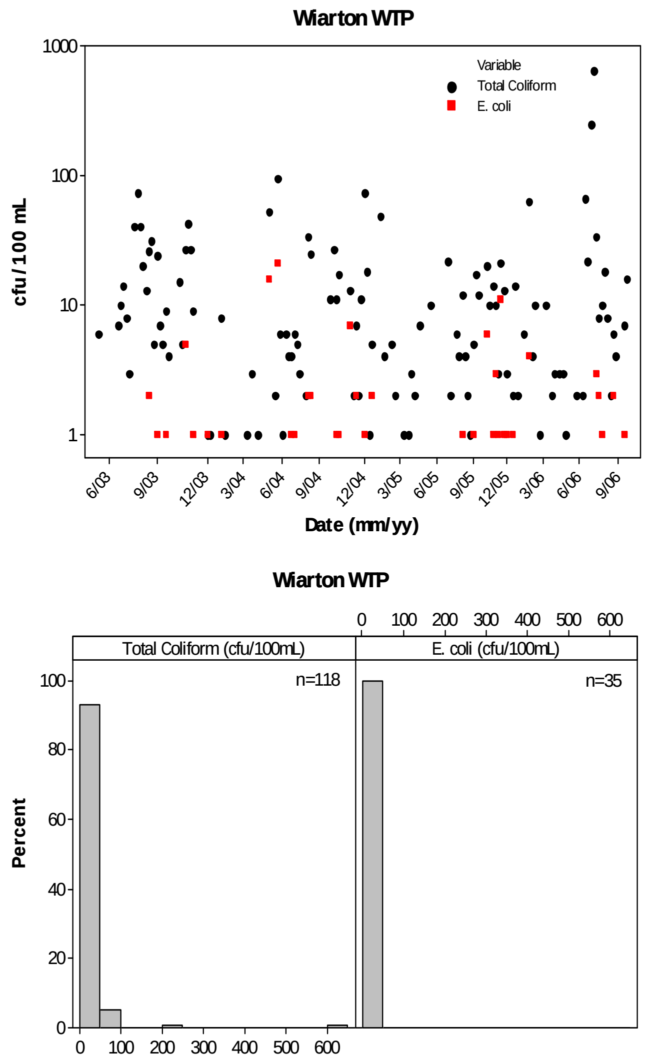


Figure 3.5.17 Microbial characterization of the Wiarton WTP

3.5.2 Microbial Characterization for Inland Streams

Microbial data has been collected in both the Saugeen Valley SPA and Grey Sauble SPA. The samples have been collected under the Provincial Water Quality Monitoring Network program operated by the MOE. General water chemistry testing has occurred more regularly than the testing for microbials in surface water. Also, not all of the same types of bacteriologicals have been consistently tested for the same time period. The types of organisms that water samples were tested for include total coliforms, fecal coliforms, fecal streptococci, *E. coli,* and *Pseudomonas aeruginosa*.

The cause of how total coliforms or E. coli become present in surface waters is addressed in section 3.5.1. Fecal coliforms and fecal streptococci are two different groups of bacteria. The presence of these directly may not be harmful, but may indicate the presence of, and are generally associated with, dangerous pathogenic organisms. Fecal coliforms are more fecal-specific than total coliforms and can represent contamination from sewage waste (*E. coli*), but can include non-fecal types associated with pulp and paper effluent (*Klebsiella*). Fecal streptococci are generally associated with waste from humans and other warm blooded animals and, therefore, are more specific to sewage contamination than the group of fecal coliforms. *Pseudomonas aeruginosa* is a dangerous and opportunistic pathogen that can cause serious health effects in individuals with weak immune systems. The organism is ubiquitous in the environment and can grow with minimal nutrients. Nutrient rich waters from sewage or other sources, therefore, can provide a medium that allows the organism to thrive and increases the probability of causing illness in humans.

Table 3.38 summarizes the years that water samples were tested for microbials and the individual years that each type or group of microbe(s) were monitored for the SPR. Microbial data has been collected throughout the reach of various subwatersheds. For this characterization, microbial data was assessed and analysed on a watershed basis and the same locations were used as in Section 3.5.2.1. Table 3.38 itemizes high counts of microbial concentrations that were omitted from the graphs (Figures 3.5.18 to 3.5.42) for presentational purposes.

3.5.2.1 Microbial Characterization for Streams in the Grey Sauble SPA

Microbials were tested in the surface waters of the Beaver River, Bighead River, Bothwell's Creek, Pottawatomi River, Sauble River, and Sydenham River from the early 1970s to mid 1990s. Data exists in Keefer Creek for 1995 and 1996 only. Data in the Centreville Creek and Waterton Creek is from the early to mid 1970s. The years sampled in each watershed are summarized in Table 3.38 and the data is presented graphically in Figures 3.5.18 through 3.5.26

3.5.2.2 Microbial Characterization for Streams in the Saugeen Valley SPA

Microbial data in the Saugeen Valley SPA is more recent and exists for all the main watersheds. Typically data exists from 2004 to 2006 and historical data exists back to the 1970s on parts of the Saugeen, Pine, and Teeswater Rivers. Table 3.38 summarizes the years that testing was completed for microbials and presents those data in Figures 3.5.27 to 3.5.40.

3.5.2.3 Microbial Characterization for Streams in the Northern Bruce Peninsula SPA

Microbial data only exists for the Stokes River and Spring Creek. Data for Stokes River exists from 1975 until 1995, while microbial data for Spring Creek is available from 1975 to 1979. Table 3.38 summarizes the years of sample collection for microbials, and Figures 3.5.41 and 3.5.42 depict the results for the microbial parameters tested.

TABLE 3.38 - Summary of testing for microbial characterization of inland streams

Subwatershed	Years Sampled	Total Coliform (CFU/100mL)	Fecal Coliform (CFU/100mL)	E-coli (CFU/100mL)	Fecal Streptococci (CFU/100mL)	Pseudo (CFU/100mL)
Grey Sauble SPA						
Beaver River	1978-1996	1978-1982	1978-1994	1994-1996	1978-1996	* 1978-1982 1984 & 1995
Bighead River	1975-1996	1975-1982 & 1984-1987	1975-1994	1994-1996	1975-1996	1975-1996
Centreville Creek	1973-1978	1973-1978	1973-1978		1973-1978	* 1973-1978
Keefer Creek	1995-1996			1995-1996	1995-1996	* 1995-1996
Pottawatomi River	1975-1996	1975-1983	1975-1994	1994-1996	1975-1996	1975-1983
Sauble River	1970-1996	1970-1982	1972-1994	1994-1996	1972-1996	1975-1996
Sydenham River	1975-1996	1975-1982	1975-1994	1994-1996	1975-1996	* 1975-1982
Telfer Creek	1972-1996	1975-1986	1972-1994	1994-1996	1972-1996	1975-1996
Waterton Creek	1973-1975	1973-1975	1973-1975		1973-1975	
Saugeen Valley SPA						
Beatty Saugeen River	2004-2006			2004 & 2006	2004	2004
North Saugeen River (Headwaters)	2004-2006			2004-2006	2004	2004
North Saugeen River (Mouth)	2004-2006			2004-2006	2004	2004
Mill Creek	2004-2006			2004-2006	2004	2004
Penetangore River	2004-2006			2004-2006	2004	2004
Pine River	1970-1978 & 2004-2006	1970-1978	1972-1978	2004-2006	1975-1978 & 2004	1975-1978 & 2004
Rocky Saugeen River (2)	2004-2006			2004-2006	2004	2004
Saugeen River (Headwaters)	2004-2006			2004-2006	2004	2004
Saugeen River (Above Durham)	2004-2006			2004-2006	2004	2004
Saugeen River (Below Walkerton)	1970-1995 & 2004-2006	1970-1982	1972-1994	1994-1995 & 2004-2006	1972-1995 & 2004	1975-1995 & 2004
Saugeen River (Mouth)	1975-1977 & 1979 & 2004-2006	1975-1977	1975-1977 & 1979	2004-2006	1975-1977 & 1979 & 2004	2004
South Saugeen River	2004-2006			2004-2006	2004	2004
Teeswater River (Headwaters)	2004-2006			2004-2006	2004	2004
Teeswater River (Mouth)	1977-1995 & 2004-2006	1977-1982	1994-1995	1994-1995 & 2004-2006	1994-1995 & 2004	1994-1995 & 2004
Northern Bruce Peninsula SPA						
Spring Creek	1975-1979	1975-1979	1975-1979		1975-1979	* 1975-1979
Stokes River	1975-1979 & 1982-1996	1975-1979 & 1982	1975-1979 & 1982-1994	1994-1996	1975-1979 & 1982-1996	1975-1979 & 1982-1996

* Actual values are less than reported values

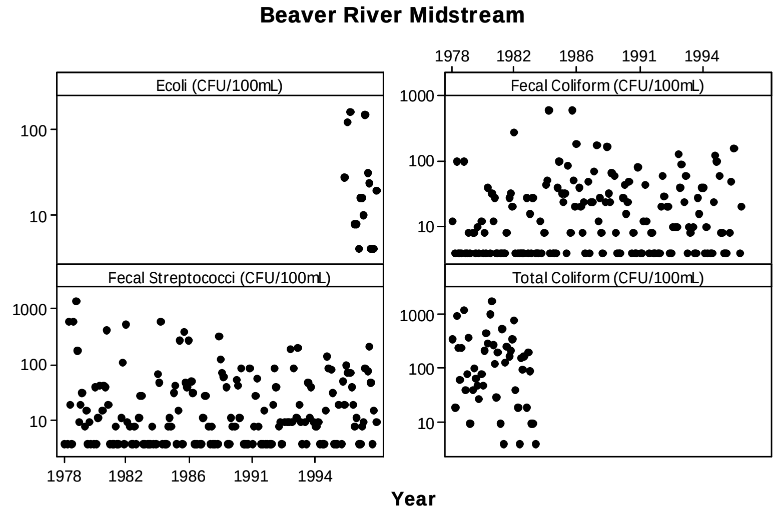


Figure 3.5.18 Time series of microbial data from Beaver River

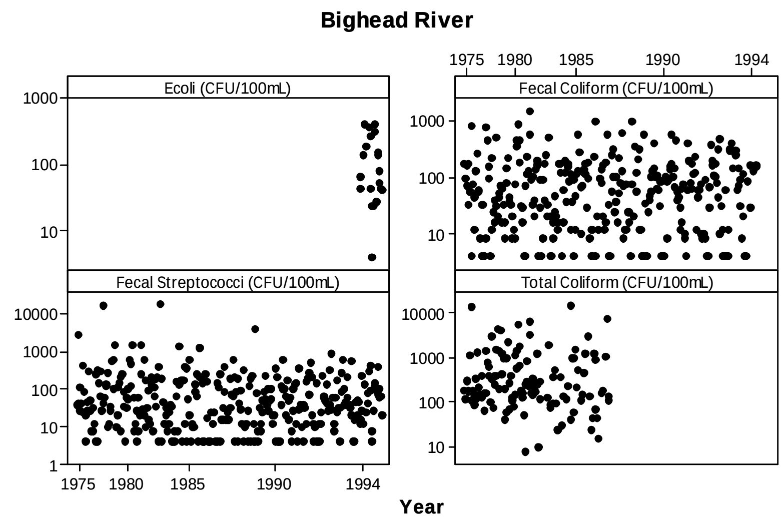


Figure 3.5.19 Time series of microbial data from Bighead River

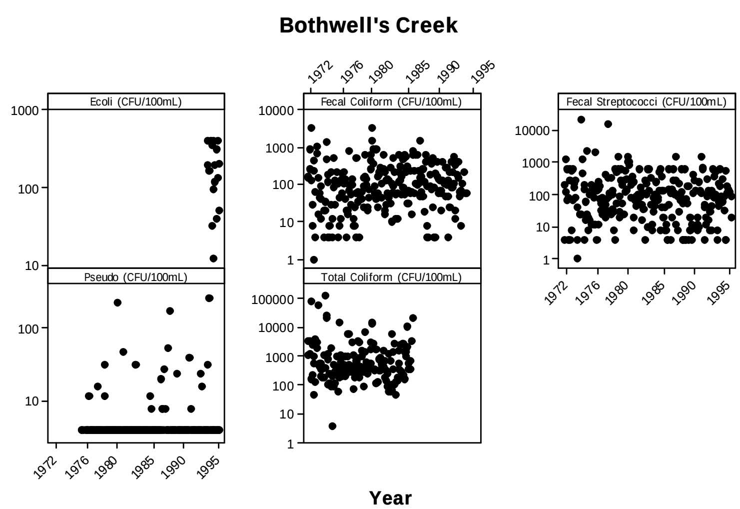


Figure 3.5.20 Time series of microbial data from Bothwell's Creek

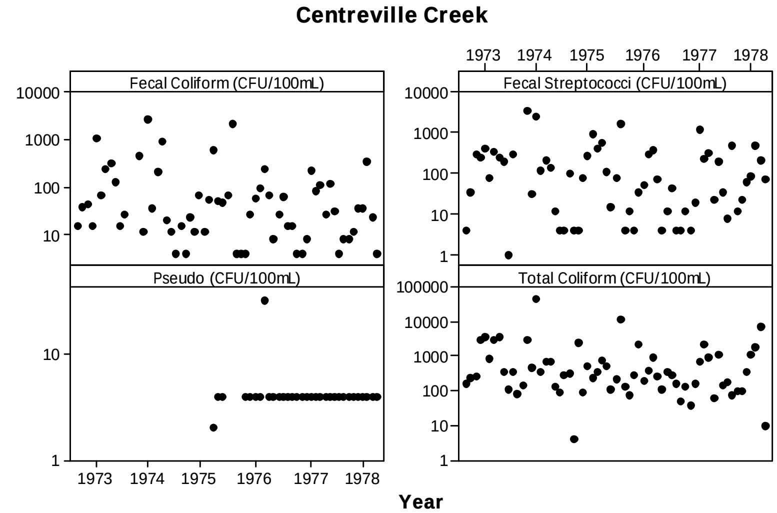


Figure 3.5.21 Time series of microbial data from Centreville Creek

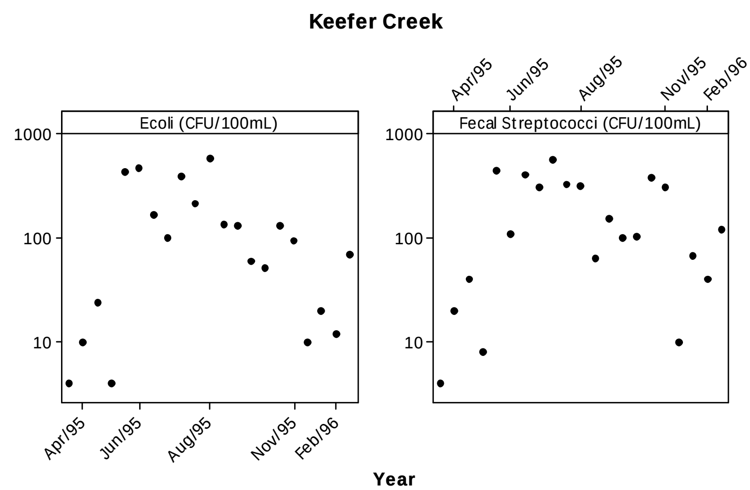


Figure 3.5.22 Time series of microbial data from Keefer Creek

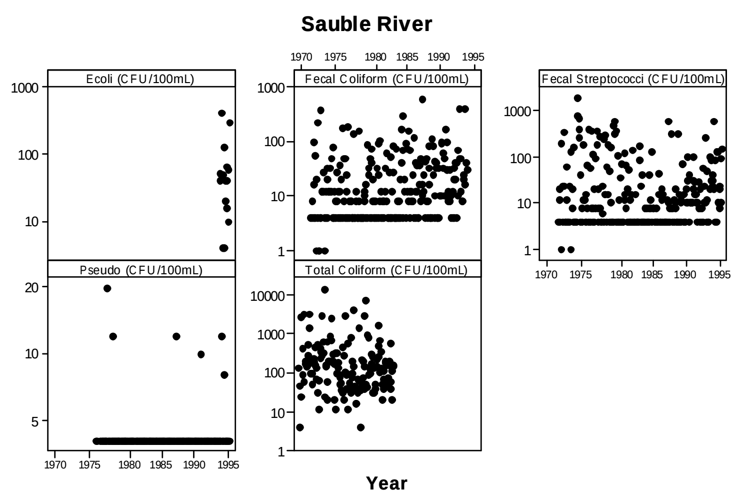


Figure 3.5.23 Time series of microbial data from Sauble River

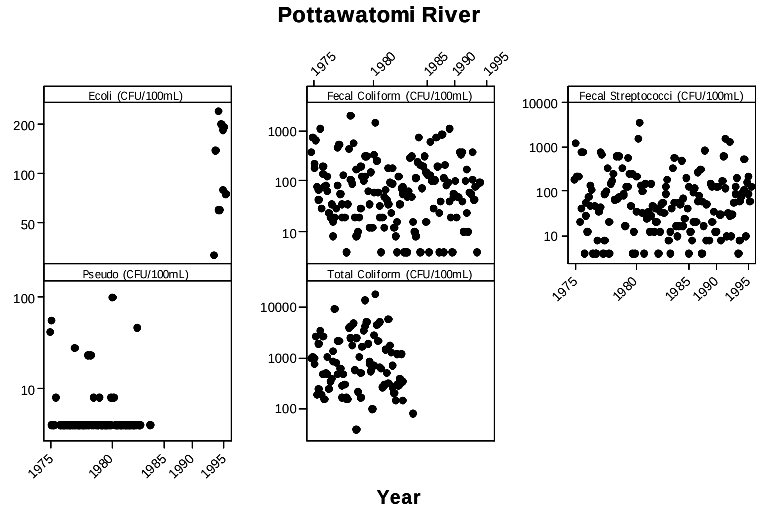


Figure 3.5.24 Time series of microbial data from Pottawatomi River

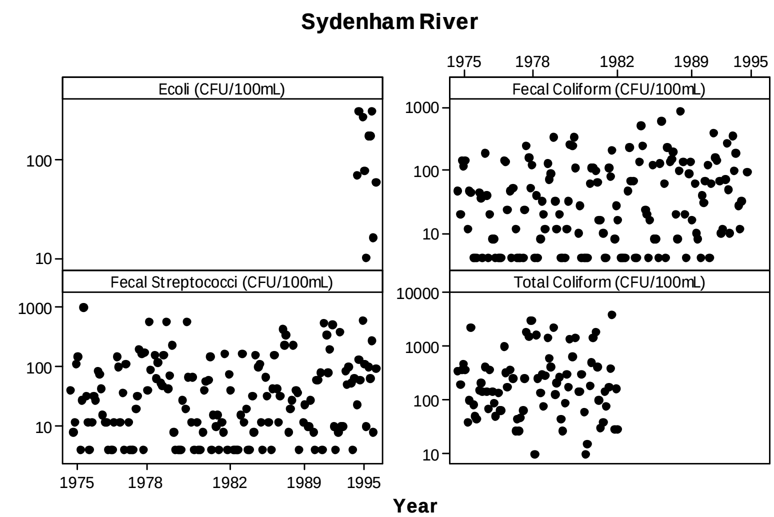


Figure 3.5.25 Time series of microbial data from Sydenham River

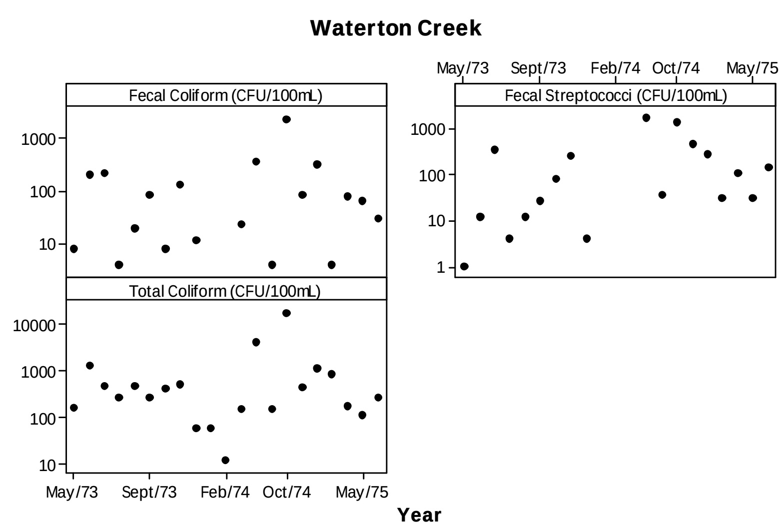


Figure 3.5.26 Time series of microbial data from Waterton Creek

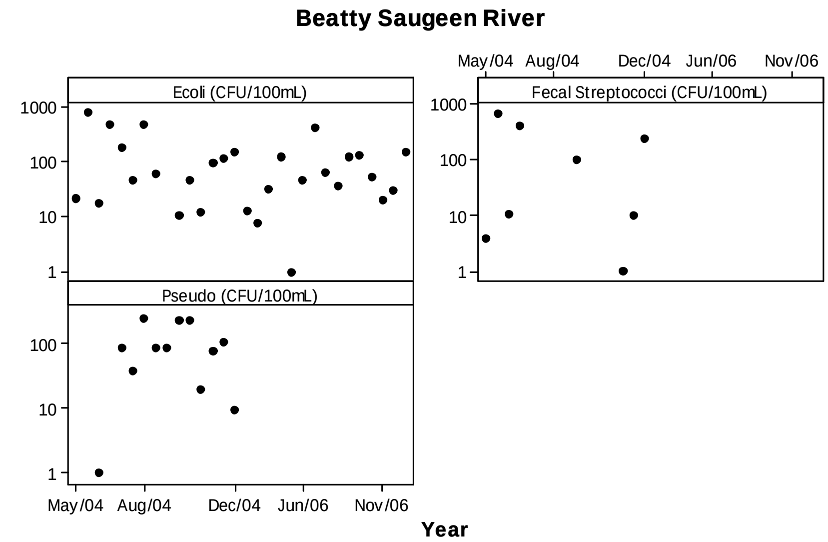


Figure 3.5.27 Time series of microbial data from Beatty Saugeen River

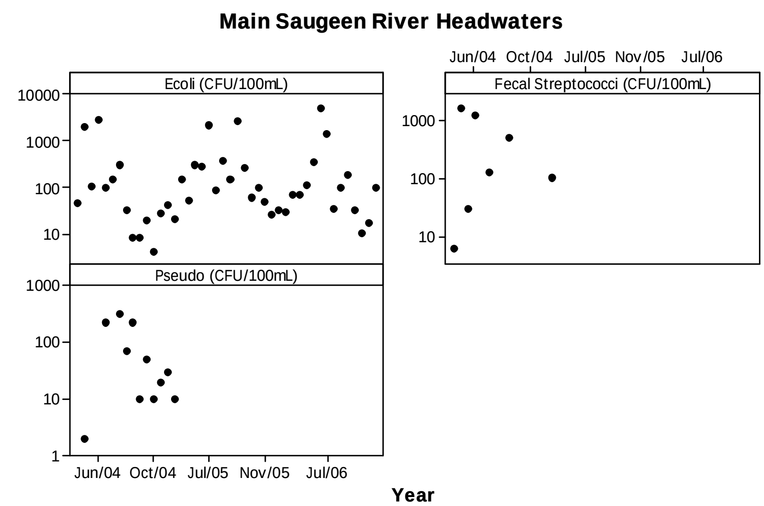


Figure 3.5.28 Time series of microbial data from Main Saugeen River (Headwaters)

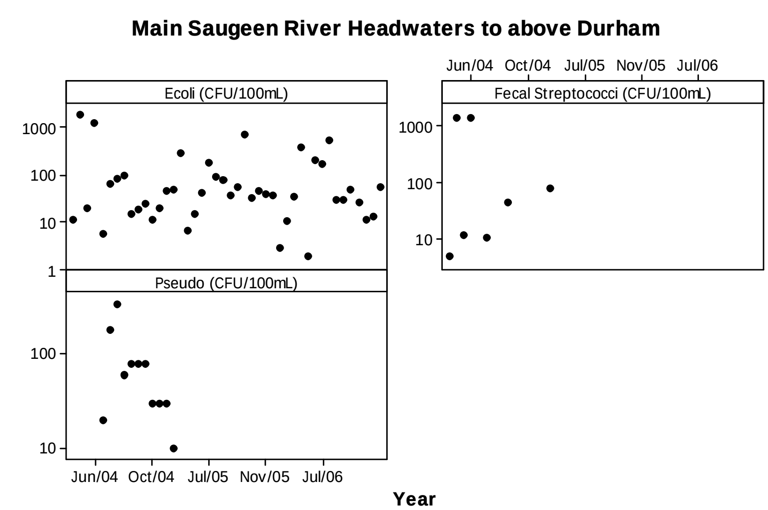


Figure 3.5.29 Time series of microbial data from Main Saugeen River headwaters to above Durham

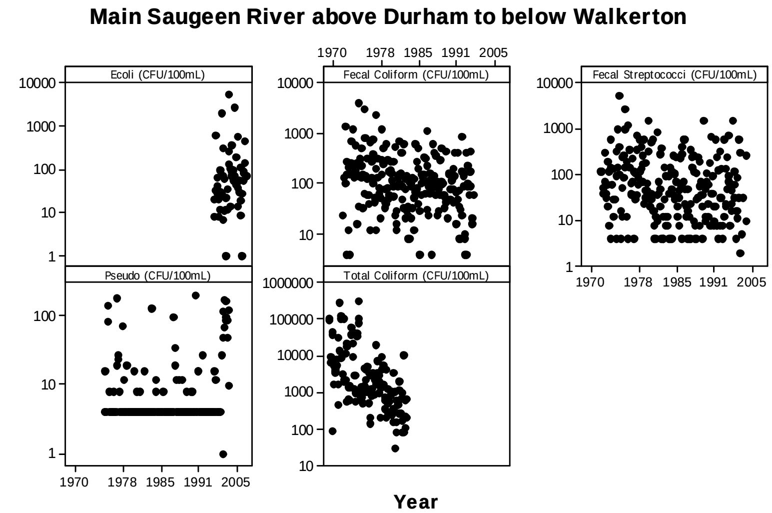


Figure 3.5.30 Time series of microbial data from Main Saugeen River above Durham to below Walkerton

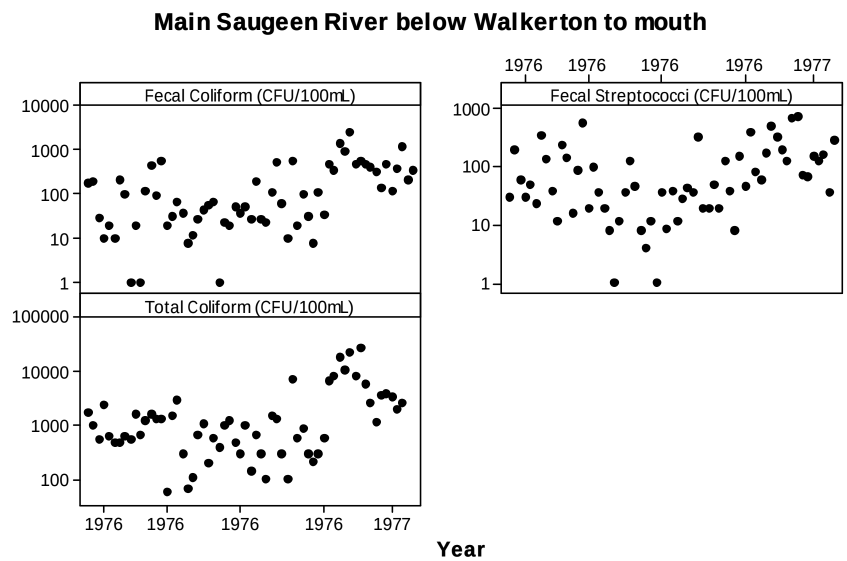


Figure 3.5.31 Time series of microbial data from Main Saugeen River below Walkerton to mouth

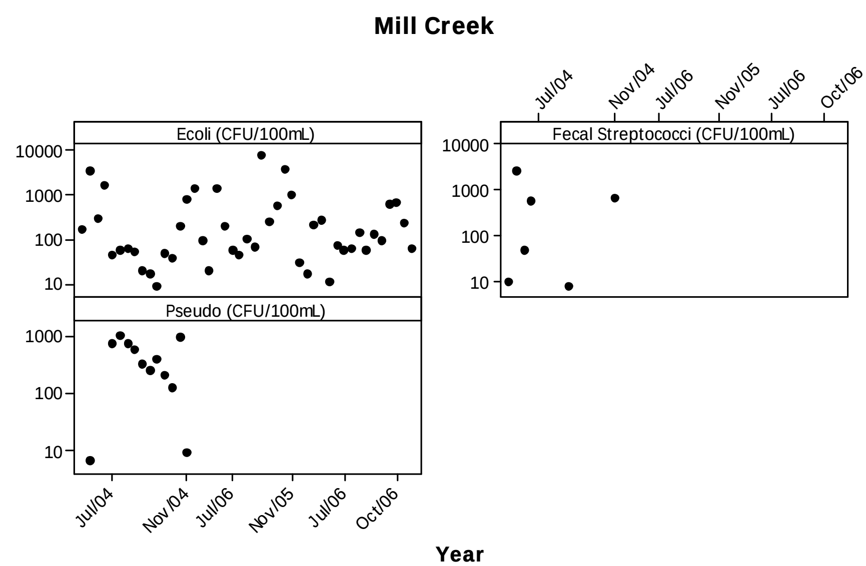


Figure 3.5.32 Time series of microbial data from Mill Creek

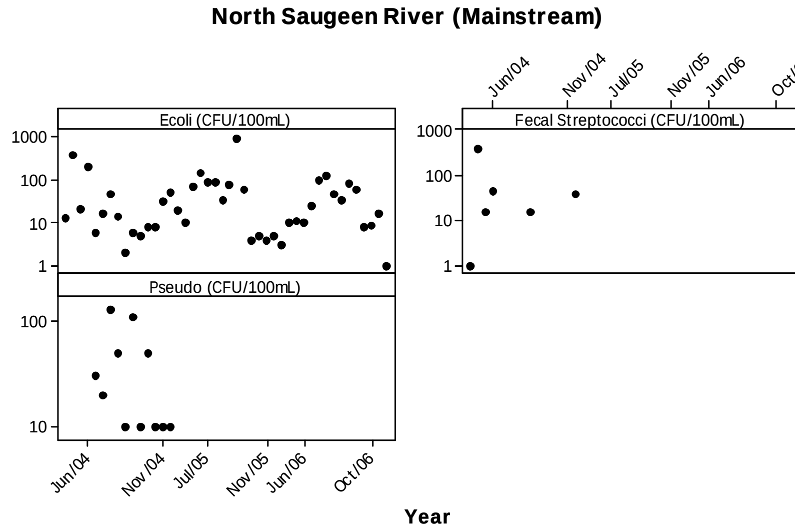


Figure 3.5.33 Time series of microbial data from North Saugeen River (Mainstream)

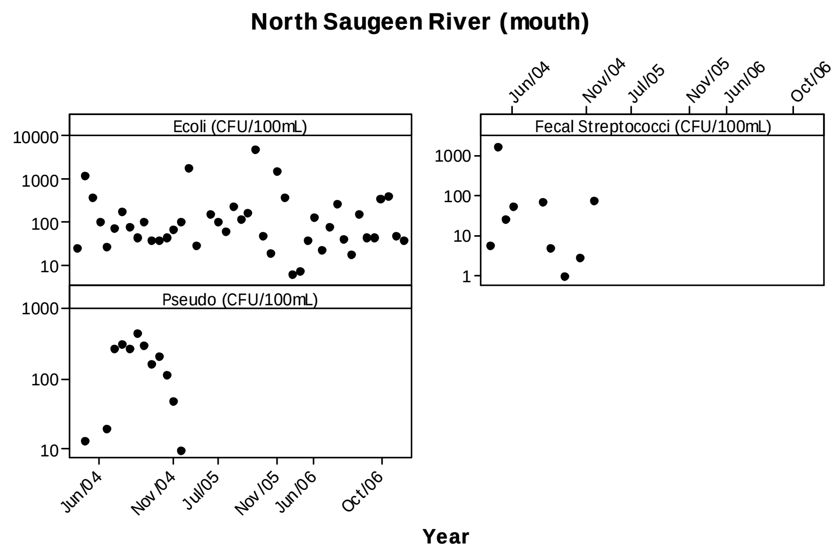


Figure 3.5.34 Time series of microbial data from North Saugeen River (mouth)

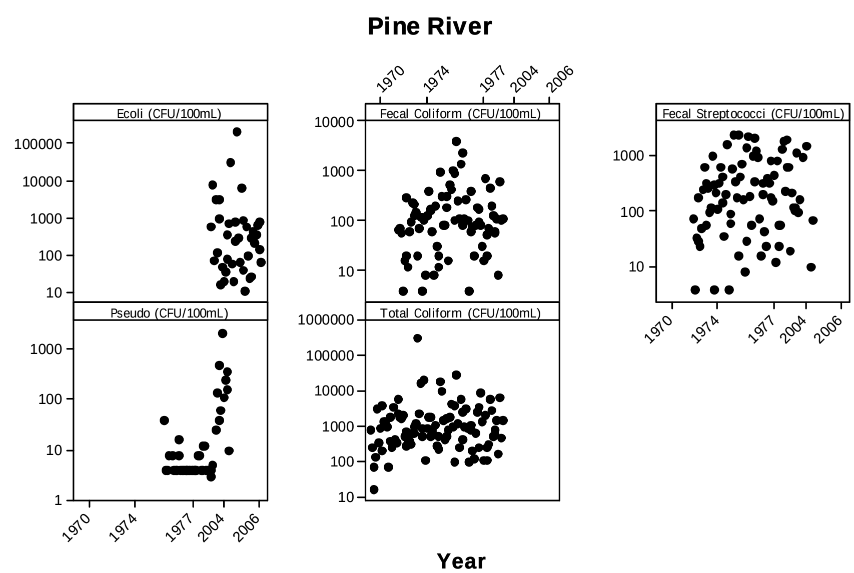


Figure 3.5.35 Time series of microbial data from Pine River

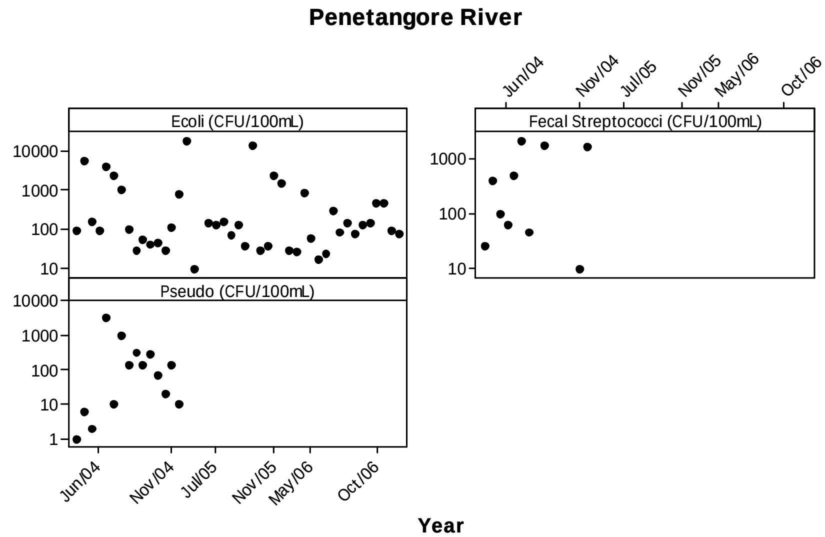


Figure 3.5.36 Time series of microbial data from Penetangore River

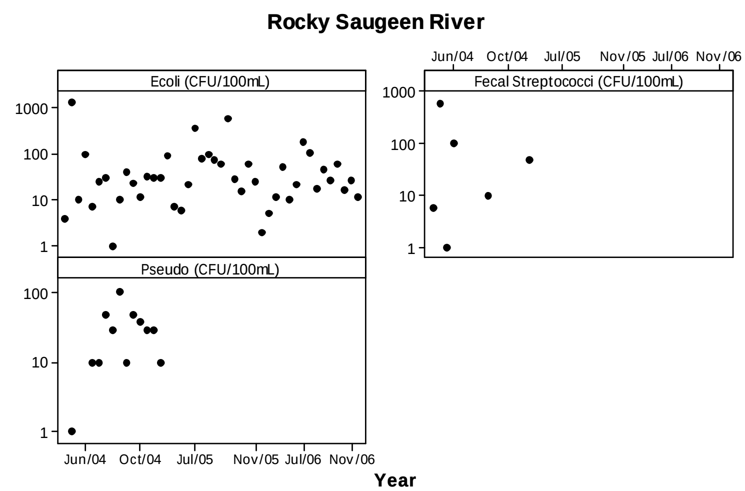


Figure 3.5.37 Time series of microbial data from Rocky Saugeen River

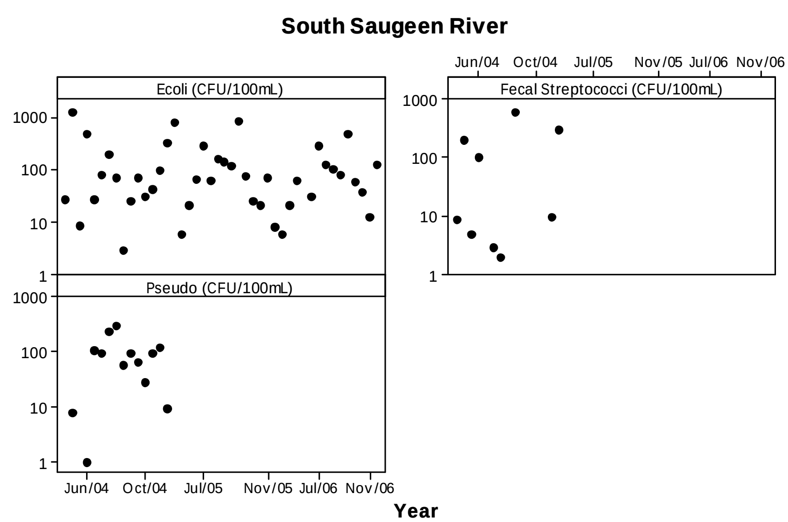


Figure 3.5.38 Time series of microbial data from South Saugeen River

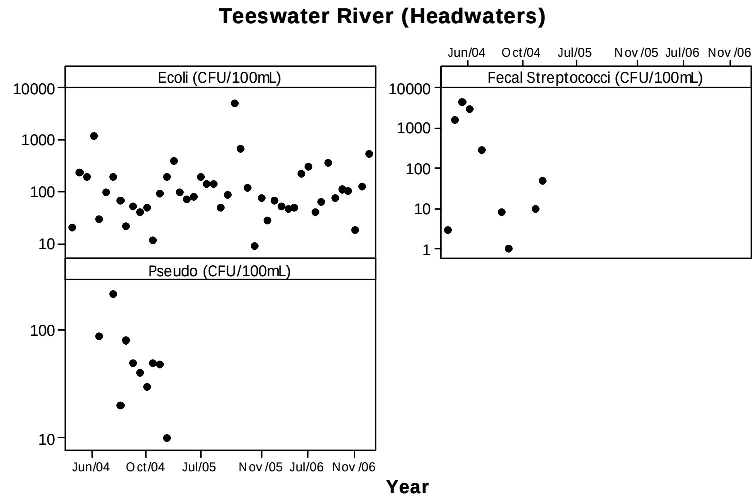


Figure 3.5.39 Time series of microbial data from Teeswater River (Headwaters)

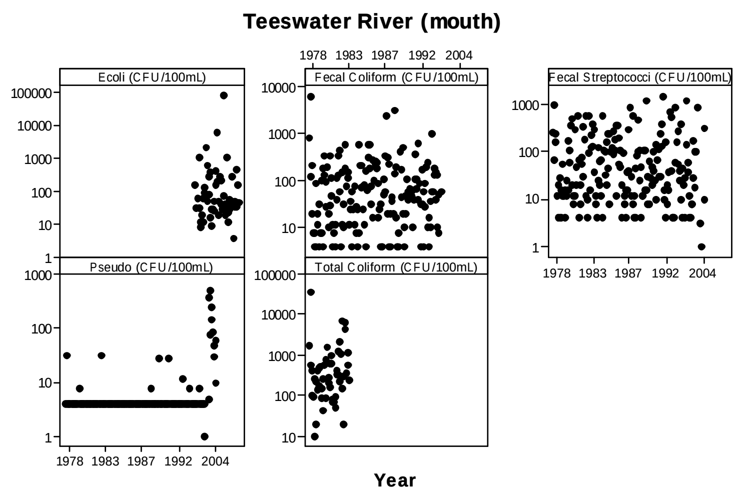


Figure 3.5.40 Time series of microbial data from Teeswater River (mouth)

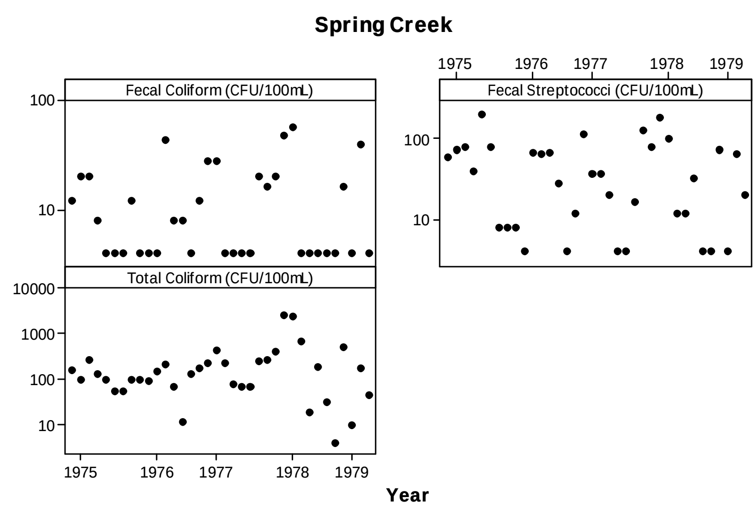


Figure 3.5.41 Time series of microbial data from Spring Creek

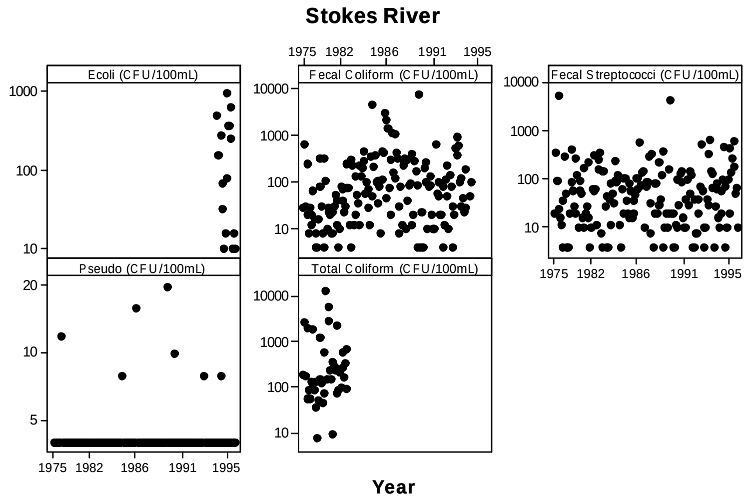


Figure 3.5.42 Time series of microbial data from Stokes River

3.6 Macroinvertebrate Assessment of Water Quality

Currently, Saugeen Conservation participates in the Ontario Benthos Biomonitoring Network (OBBN) as a means of measuring water quality conditions and overall ecological health within the various watersheds. The OBBN is a provincially standardized program that was jointly developed with Environment Canada – Environmental Monitoring and Assessment, Environment Canada – National Water Research Institute, and the Ontario Ministry of the Environment. The OBBN uses a reference condition approach that compares reference sites to test sites. Reference sites may not be pristine, but serve as a measure to test sites that may represent a site showing a particular stress. Test sites can be statistically compared to reference sites to determine if they are similar or not. The SC program is currently in the development stages and has been establishing reference sites. No results have been published to date.

Benthic data collection has taken place on various tributaries of the larger watersheds within the Grey Sauble SPA. The various ranges of water quality indices and stream widths have corresponding letter grades that provide a measure of water quality (Table 3.39). Benthic data has been collected by GSC and reported on, but GSC uses the BioMAP – Bioassessment of Water Quality (Griffiths, 1999) protocol. This index provides a measure of water quality based on the type and abundance of benthic macroinvertebrate species. All taxa are assigned sensitivity values and ranked from highest sensitivity to lowest. The BioMAP(q) WQI is calculated as the average of the top 25% of taxa.

Map 18 indicates the location of the biomonitoring sites in the Grey Sauble SPA and Saugeen Valley SPA. Limited biomonitoring work has been undertaken in the Northern Bruce Peninsula SPA. However, the Bruce Peninsula Biosphere Association collected data in 2003-2006 from multiple sites on the Crane River, Willow Creek and Spring Creek.

The BioMAP scores have been summarized by subwatersheds in the Grey Sauble SPA. Temporally, in the Grey Sauble SPA, benthic data has been collected in the late 1970s to mid 1980s, and more consistently from 2000 to present. Spatially, the data collection has occurred in the watersheds of the Beaver River, Bighead River, Bothwell’s Creek, Colpoy’s Creek, Gleason Brook, Indian Brook, Indian Creek, Johnson Creek, Keefer Creek, Pottawatomi River, Rankin River, Sauble River, Sydenham River, and Waterton Creek.

TABLE 3.39 - Grading scheme for BioMAP assessment of water quality conditions

	A	*B*	*C*	*D*	*F*
Creek (<4m)	4.0	>3.4	3.4 – 3.2	<3.2	<2.6
Stream (4-16m)	>3.4	>3.0	3.0 – 2.6	<2.6	<2.0
River (16-64m)	>3.0	>2.4	2.4 – 2.0	<2.0	<1.5
BioMAP (q)	unimpaired		transition	impaired	

3.6.1 Beaver River

There have been 13 tributaries of the Beaver River, as well as the main stem, sampled in the early 1980s (1981 and 1983) and from 2000 to 2005. Over this time, 74 samples have been collected to assess local water quality conditions. Most of the samples (29) have been collected on the main stem of the Beaver River. Typically, water quality conditions in the Beaver River watershed have scored quite well. Over 50% of the samples collected have been graded as "excellent", while less than 10% have qualified as poor or very poor (Figure 3.6.1).

3.6.2 Bighead River

There have been 16 tributaries of the Bighead River, as well as the main stem, which have been sampled through 1979 and 1980, and from 2000 to 2005. Over this time, 87 samples have been collected to evaluate local water quality conditions. The largest portion of the samples has been collected on the main stem of the Bighead River and on a smaller tributary (Rocklyn Creek). The majority of the samples have scored good to excellent (59%), with the exception of the Northwest Tributary and Oxmend Creek, both scoring very poor consistently (Figure 3.6.2).

3.6.3 Bothwell's Creek

Bothwell's Creek and one of its tributaries have been sampled from 2000 to 2005. Over this time, 10 samples have been collected, eight of which have been on Bothwell's Creek. Seventy percent of the samples scored good or higher demonstrating good water quality conditions (Figure 3.6.3).

3.6.4 Pottawatomi River

Three tributaries of the Pottawatomi River, as well as the main stem, were sampled in 1973 and from 2000 to 2005. Over this time, 33 samples have been collected to assess local water quality conditions. Most of the samples (18) have been collected on the main stem of the Pottawatomi River. Overall, the water quality conditions in the Pottawatomi River and tributaries have scored well, with the exception of the Kilsyth tributary, which has scored poorly (Figure 3.6.4).

3.6.5 Rankin River

There have been two tributaries of the Rankin River, as well as the main stem, which have been sampled in 2000 and 2004 through 2005. Ten samples have been collected, six of which indicated fair to poor water quality conditions (Figure 3.6.5).

3.6.6 Sauble River

Typically, water quality conditions in the Sauble River watershed have scored quite poorly. Approximately 76% of the samples have scored from fair to very poor. Sixteen tributaries of the

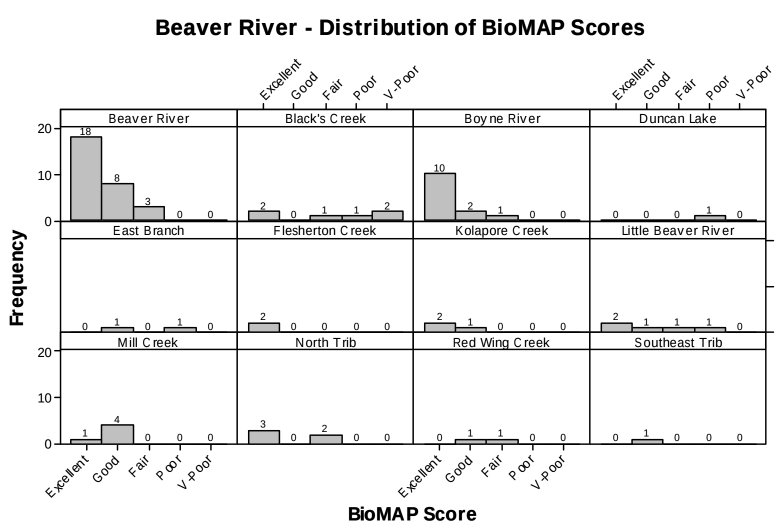
Sauble River and the main stem have been sampled in 1984, and from 2000 through 2005. Over this time 68 samples have been collected, the largest portion (50) in 1984 (Figure 3.6.6).

3.6.7 Sydenham River

Five tributaries of the Sydenham River and the main stem have been sampled in 1973, 1978, 1983, and from 2000 to 2005. During this period, 35 samples have been collected to help evaluate local water quality conditions in the Sydenham River watershed. Overall, the water quality conditions have scored quite well, with 83% scoring either good or excellent (Figure 3.6.7).

3.6.8 Miscellaneous Watersheds

Limited data has been collected in Colpoy's Creek, Gleason Brook, Indian Brook, Indian Creek, Johnson Creek, Keefer Creek, and Waterton Creek. The benthic information that does exist is summarized in Figure 3.6.8. There was one sample in 2002 on Colpoy's Creek. The water quality conditions received a score of excellent. There have been two samples taken on Gleason Brook, one in 2004 and 2005. Each sample scored a grade of good for water quality conditions. Indian Brook was sampled twice in 1994, and once in the years 2002, 2004, and 2005. The water quality conditions scored from fair to excellent. There was one sample taken in both 2004 and 2005 from Indian Creek. The results indicated excellent water quality conditions. One sample was taken in 2003 from Johnson Creek. The result indicated excellent water quality conditions. One sample per year has been taken from Keefer Creek from 2003 to 2005 inclusive. The results ranged from good to excellent water quality conditions. There have been two samples taken from Waterton Creek, one in 2004 and one in 2005, which scored fair and excellent respectively.



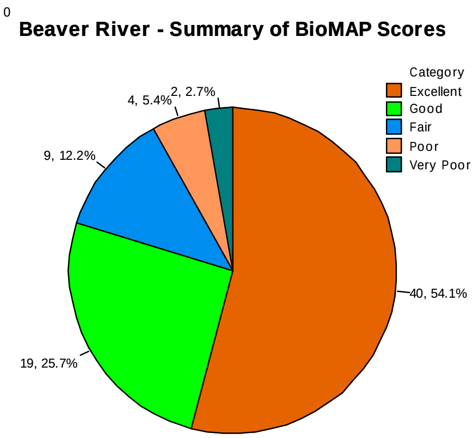
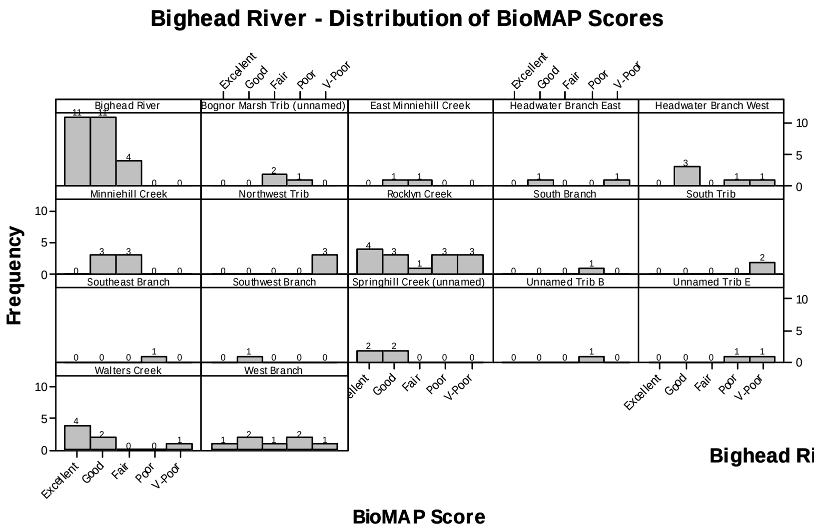


Figure 3.6.1 Summary of BioMAP scores for the Beaver River



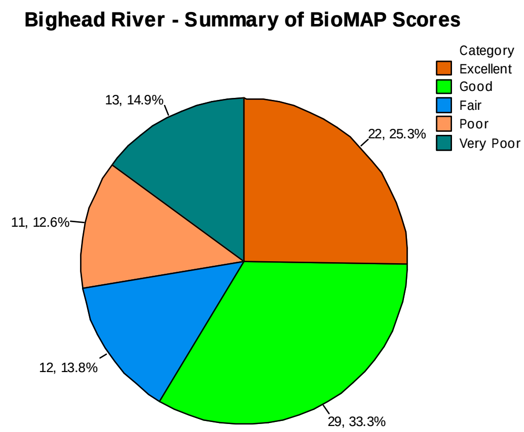
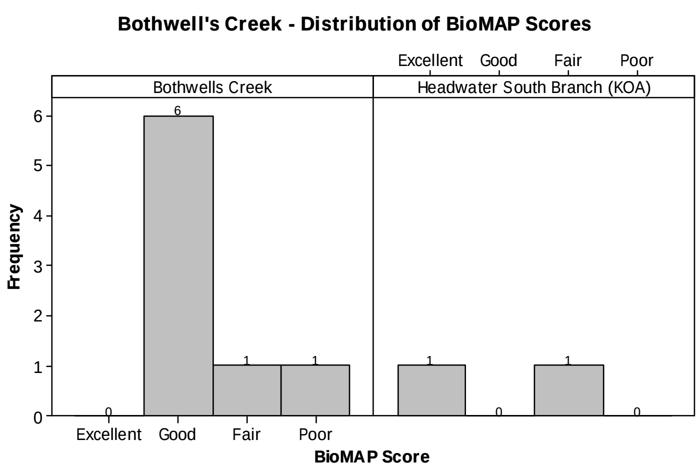


Figure 3.6.2 Summary of BioMAP scores for the Bighead River



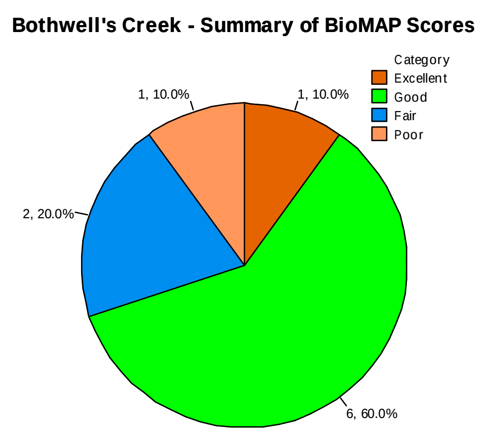
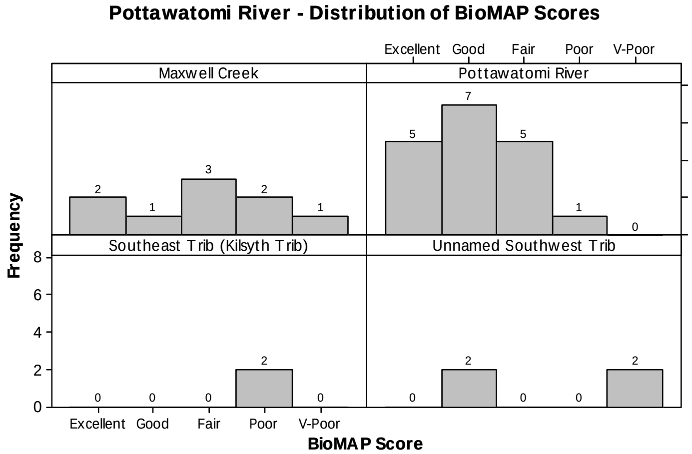


Figure 3.6.3 Summary of BioMAP scores for Bothwell's Creek



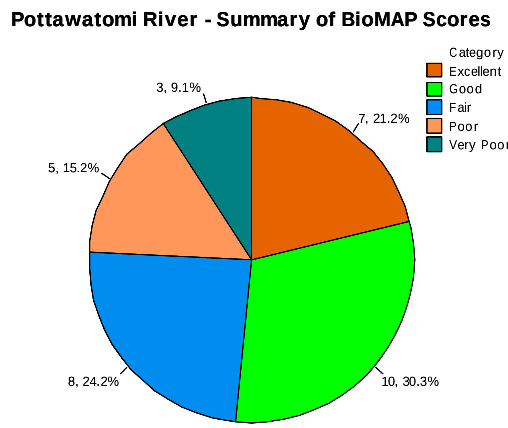
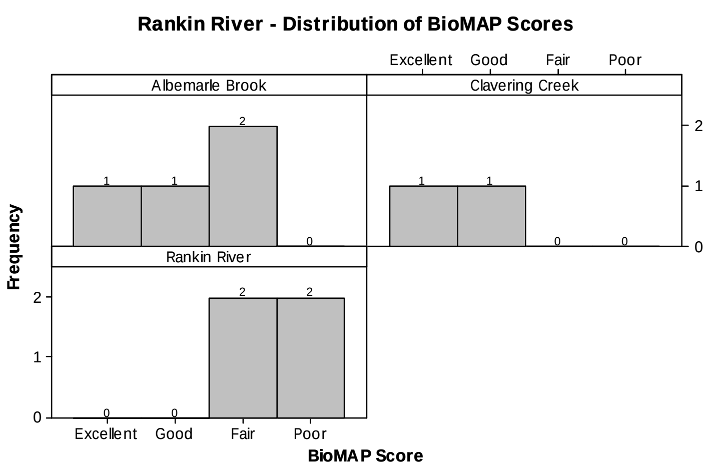


Figure 3.6.4 Summary of BioMAP scores for the Pottawatomi River



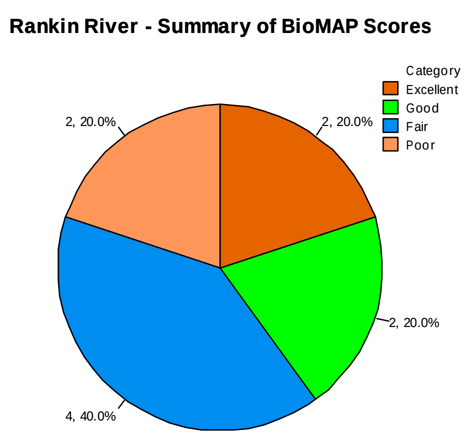
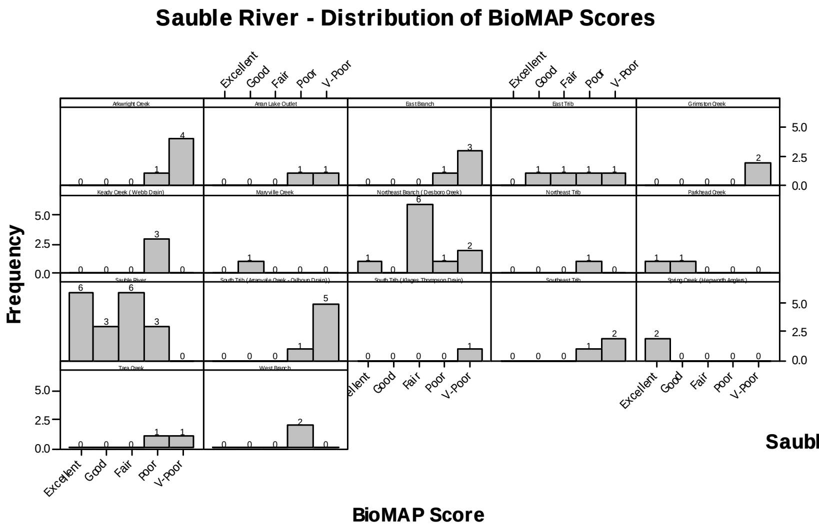


Figure 3.6.5 Summary of BioMAP scores for the Rankin River



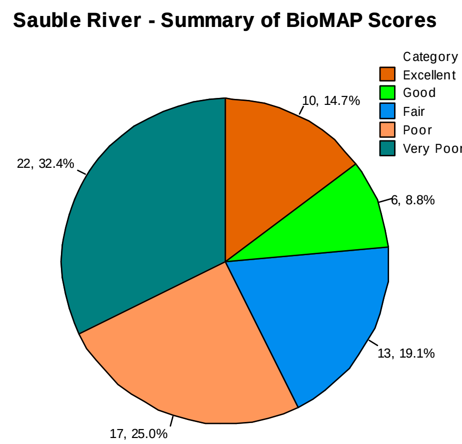
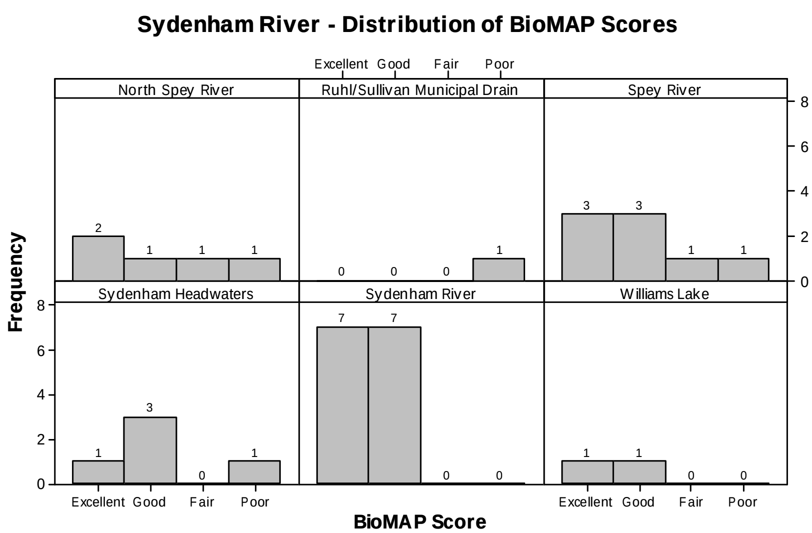


Figure 3.6.6 Summary of BioMAP scores for the Sauble River



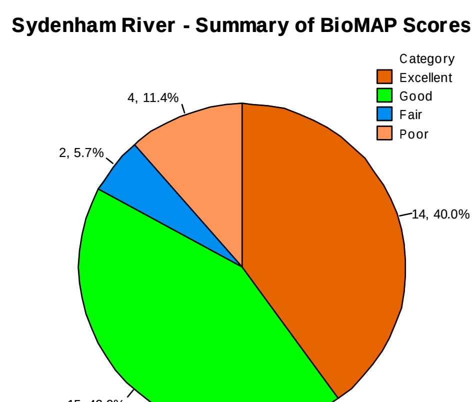


Figure 3.6.7 Summary of BioMAP scores for the Sydenham River

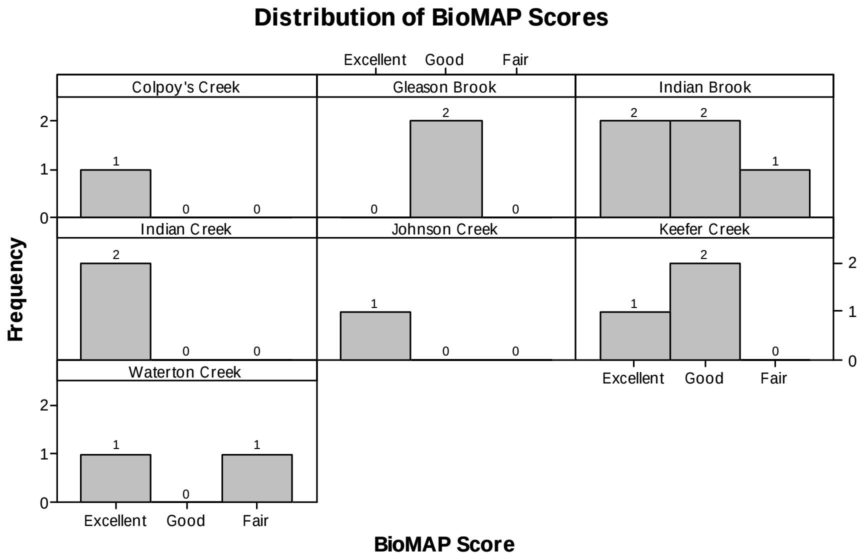


Figure 3.6.8 Summary of BioMAP scores for multiple watersheds with limited data.

3.7 Data and Knowledge Gaps

WC Deliverable	***Data Set Name***	***Data Gap Problem***	***Comment***
Water Quality		Benthic data is limited	• Unable to assess aquatic health of stream systems. • More representative of long–term water quality
Water Quality	PWQMN	Spatial availability of monitoring stations for watersheds	• No active monitoring in NBP • Watersheds too large to capture potential issues
Water Quality	PWQMN	Stream discharge data not collected at monitoring locations	• Relate stream discharge and concentrations to determine loadings
Water Quality	PGMN	Spatial/temporal availability of data is limited	• Not enough data to identify trends
Water Quality	DWSP	Water chemistry not available for all DWS	• Voluntary program which does not cover all DWS in planning region

Chapter 4

WATER QUANTITY

4.0 WATER QUANTITY

A basic understanding of the processes and components of the hydrologic cycle within the area, and the quantity of flow between specific components of that cycle is an important part of Source Protection Planning. As part of the Source Protection Program, a detailed water budget is being developed for the SPR. This section is developed in accordance with MOE guidance (October, 2006) to provide the reader with an understanding of the availability, sources and usage of water in the planning region. The reader seeking a more detailed examination of the quantity of water in the SPR is directed to the Saugeen, Grey Sauble, Northern Bruce Peninsula Planning Region Draft Conceptual Water Budget (2007).

Any discussions of the quantity of water in the SPR must necessarily begin with a discussion of the sources of water. This discussion will outline, in general terms, the major reservoirs of water available in the study area. Further discussion will include the various uses of water in the study area and identify the sources upon which these usages are dependant.

4.1 Water Sources

There are four major groups or categories of sources in the Region: Great Lakes; Inland lakes and streams; bedrock aquifers; and overburden aquifers.

4.1.1 Lake Huron

The region is bordered on the west and north by the waters of Lake Huron and Georgian Bay. Lake Huron (including Georgian Bay) is the primary water supply for all large settlements located along the lakeshore. The Lake is considered a highly reliable, high quality source of water for potable supplies, but is also a critical driver of the local tourism and cottage industry. Lake Huron is also exploited as a source of cooling water for the Bruce Nuclear Power Plant. Numerous private supplies, particularly along the shore of Georgian Bay, exploit Lake Huron.

Lake Huron and Georgian Bay receive water from all the components of the hydrologic cycle in the SPR. River systems, overburden and bedrock aquifers all naturally discharge towards Lake Huron and Georgian Bay. Water from the Lake Huron system is outlet via the St. Clair River to Lake Erie. Water is also removed from the system via evaporation.

The Great Lakes system is the largest fresh water system in the world. The tremendous volume of water stored in the Lake Huron system and available for drinking water is considered outside the scope of Source Protection Planning and is considered an international issue.

4.1.2 Inland Lakes and Streams

The inland surface water system is composed of a complicated, interconnected network of lakes, wetlands and streams. These systems receive direct runoff from the ground surface as well as groundwater discharge from both the overburden and bedrock aquifers and outlets to Lake Huron and/or Georgian Bay. The Region is defined by the watershed boundaries of the Saugeen River, the Sauble River and the numerous streams that drain into Georgian Bay and Lake Huron. Although there are no municipal supplies reliant on any stream, they are of crucial importance for the tourism and recreation industry, attracting canoeists and anglers from around the world. This is particularly a result of the high quality cold water fishery that is found in the area.

Inland lakes are also important for the tourism and recreation industry, and are exploited in one municipality as a source of municipal water supply (Ruhl Lake in Hanover). Inland lakes are also exploited, only rarely, for private drinking water.

4.1.3 Bedrock Aquifers

Bedrock aquifers are by far the most important source of drinking water for the Watershed Region. Municipal supplies located away from the shore of Lake Huron and Georgian Bay rely almost exclusively on groundwater from the bedrock aquifer for their drinking water. A large majority of documented private wells also rely on the bedrock aquifers for their water supplies.

The bedrock aquifers are composed of an aggregate of the bedrock Formations and, within each specific bedrock formation, water quality and quantity can differ dramatically - largely a consequence of the chemical and physical characteristics of the rocks themselves. The bedrock aquifers are composed primarily of Paleozoic aged carbonate rocks. Water enters the bedrock aquifers chiefly as precipitation infiltrating through intermediary deposits of unconsolidated material which overlie them. In areas where there is very little cover and bedrock is exposed on the surface, water is known to enter directly into the bedrock aquifer through sinkholes and open fractures. A significant, yet unknown, portion of water enters the bedrock aquifer laterally from outside the study area, as the “groundwatershed” of the bedrock aquifers does not conform exactly with the known surface watershed boundaries.

Water in the bedrock aquifers travels predominantly from the central-eastern portion of the Planning Region radially towards Lake Huron and Georgian Bay where the water is ultimately discharged. The absolute volume of water available in the bedrock aquifers is not known at this time.

4.1.4 Overburden Aquifers

Located within the unconsolidated glacial deposits overlying the bedrock aquifers are numerous overburden aquifers. These aquifers are locally important sources of drinking water. They are essential for their contribution to surface waters and ultimately recharge for the bedrock aquifers. These aquifers are for the most part unconfined and are generally much more susceptible to contamination from surface waters than the bedrock aquifers.

Unfortunately, there exists very little information on the overburden aquifers for the watershed region. Due to the preference of local drillers for the bedrock aquifers, few well records exist for the overburden aquifers. As such, very little information exists for these aquifers and flow directions, water quality and quantity are poorly understood.

4.2 Climate

The Region has a mid-latitude continental climate, with hot, dry summers dominated by convective precipitation events and with cool and wet spring and fall seasons typified by mid-latitude cyclonic weather patterns. Winters are generally cold and dominated by snowfall.

The climate is locally moderated by its proximity to Lake Huron. The prevailing westerly winds put the Region to the lee of the Lake, enhancing its moderating effects in the summer months and leading to frequent lake-effect snowfall events during the winter. The proximity to Lake Huron also tends to moderate temperatures in the winter season.

Climate data, including precipitation, temperature, snow depth, streamflow and wind direction and speed, have been measured at CA operated streamflow monitoring sites throughout the Region. This data is typically available for the period 1985-present. Additional sites, operated and maintained by Environment Canada, have data vailable for longer periods of record.

4.3 Water Use

How water sources are used throughout the watershed must be clearly understood for management decisions. For example, potentially contentious areas can be identified based on population densities, as well as the intensity of water use (irrigation vs. recreation), and can serve as a major tool in risk analyses for Source Protection.

Water is used in a variety of ways throughout the planning region. Drinking water is obtained municipally (surface water intakes and wells) and rurally (communal and private wells). The demand on surface water and groundwater is greater with higher population densities. In rural areas, the demand on water resources is spread over a larger land base. Agricultural, commercial, and industrial operations can also pose significant demands on water resources. In addition, these operations can affect the chemical and physical properties.

The following sections will explore water use in more detail.

4.3.1 Data Sources

A number of sources of data for water usage are available for the Saugeen-Grey Sauble-Northern Bruce Peninsula Planning Region. These data include the Provincial Permit To Take Water (PTTW) database, the Water Well Information System, Agricultural water usage and census data, Municipal Well annual reports and Certificates of Approval, and existing groundwater studies. These data are useful for approximating the amount of water being extracted in the region. Takings from surface and groundwater sources are represented graphically (by subwatershed) in Map 26A.

Permitted takings, and specifically the PTTW database, are not considered to accurately reflect actual takings in the region. This is due to the lack of historical actual takings for permit holders and these data not being included in the PTTW database. This creates a scenario where permitted values, which often reflect maximum permitted rather than typical takings, are used in water usage analysis.

In order to address this discrepancy, a telephone survey of permit holders was undertaken as part of the Grey and Bruce Counties Groundwater Study (WHI, 2003). The results of this survey effectively reduced the takings (where the survey was answered) and these results are incorporated into this document.

4.3.2 Drinking Water Classification

Drinking or potable water typically comes from groundwater and surface water. Municipal drinking water can be obtained either way, but surface water has some degree of treatment (i.e. solids removal or chlorination) applied. Groundwater is heavily relied upon in rural settings, and both communal and private wells serve a substantial population base. The majority of people obtain their water from Lake Huron/Georgian Bay, bedrock aquifers, and overburden aquifers.

Ontario Ministry of Environment (MOE) records indicate that there are approximately 24,000 wells in the planning region with varying designations (Table 4.1). Map 31 gives a visual representation of well locations in the planning region. Tables 4.2 and 4.3 further describe the spatial distribution of the number of wells in each watershed/municipality, the density of wells, type of wells, etc. A caveat to acknowledge when using this database is that it is incomplete, but serves as the best source of information at present.

TABLE 4.1 - Classification of Various Well Usages in the Planning Region
(Source: MOE Water Well Information System, 2003)

Well Use	***Number***	***% of Region Total***
Commercial	356	1.48
Cooling or A/C	11	0.05
Domestic	17834	74.15
Industrial	100	0.42
Irrigation	50	0.21
Municipal	118	0.49
Not Used	314	1.31
Public Supply	432	1.80
Stock	4049	16.84
Unknown	787	3.27
TOTAL	24051	100.00

The data shows that the majority of the wells are used for domestic purposes (74%). Livestock/domestic usage accounts for ~17%. The remaining 9% accounts for commercial, cooling, industrial, irrigation, public supply, not used, and unknown purposes.

Currently, the updated well database from the MOE is not available to further define the wells within the region, i.e. municipal and communal well classifications. Therefore, information on water wells within the SPR is limited to the 2003 WWIS database. Albeit, existing well data does provide useful information to generalize the types of ways water is used from wells in the region.

TABLE 4.2 - Number of Wells by Municipality in the Planning Region (Source: MOE-WWIS, 2003)

MUNICIPALITY	*COUNTY*	*AREA (km^2)**	*# OF WELLS*	*DENSITY OF WELLS (Wells per km^2)*	*# OF ACTIVE WELLS*	*# OF INACTIVE WELLS*
City of Owen Sound	Grey	23.43	53	2.26	28	25
Clearview Township	Simcoe	558.04	12	0.02	8	4
Municipality of Arran-Elderslie	Bruce	465.83	643	1.38	474	169
Municipality of Brockton	Bruce	569.57	994	1.75	782	212
Municipality of Grey Highlands	Grey	891.61	2092	2.35	1530	562
Municipality of Kincardine	Bruce	538.15	935	1.74	708	227
Municipality of Meaford	Grey	591.48	1566	2.65	1178	388
Municipality of Morris-Turnberry	Huron	378.34	25	0.07	21	4
Municipality of Northern Bruce Peninsula	Bruce	787.91	2673	3.39	2122	551
Municipality of South Bruce	Bruce	488.52	724	1.48	533	191
Municipality of West Grey	Grey	884.35	2025	2.29	1433	592
Town of Collingwood	Simcoe	33.81	39	1.15	27	12
Town of Hanover	Grey	10.06	39	3.88	33	6
Town of Minto	Wellington	301.73	211	0.70	97	114
Town of Saugeen Shores	Bruce	173.82	310	1.78	235	75
Town of South Bruce Peninsula	Bruce	557.32	2212	3.97	1777	435
Town of The Blue Mountains	Grey	286.59	1145	4.00	888	257
Township of Chatsworth	Grey	599.99	1574	2.62	1174	400
Township of Georgian Bluffs	Grey	610.71	2247	3.68	1729	518
Township of Howick	Huron	288.43	36	0.12	22	14
Township of Huron-Kinloss	Bruce	442.58	367	0.83	304	63
Township of Melancthon	Dufferin	313.07	12	0.04	10	2
Township of Southgate	Grey	645.71	934	1.45	612	322
Township of Wellington North	Wellington	492.49	236	0.48	120	116
TOTAL			21,104		15,845	5,259

* Land area represents all of municipality and not just portion within planning region.

TABLE 4.3 - Wells by Primary Water Use for Municipalities in the Planning Region (Source: MOE-WWIS, 2003)

MUNICIPALITY	# OF WELLS	DOMESTIC	MUNICIPAL	PUBLIC SUPPLY	STOCK	COMMER-CIAL	INDUS-TRIAL	COOL-ING/AC	IRRIGA-TION	NOT USED	UN-KNOWN
City of Owen Sound	53	40	0	0	3	3	0	1	1	2	3
Clearview Township	12	4	0	0	6	1	0	0	0	1	0
Munic. of Arran-Elderslie	643	347	6	7	258	4	3	1	1	11	5
Munic. of Brockton	994	573	13	23	317	20	7	1	1	26	13
Munic. of Grey Highlands	2092	1660	5	42	294	24	5	0	2	11	49
Munic. of Kincardine	935	630	4	31	240	13	6	0	3	2	6
Munic. of Meaford	1566	1211	1	14	189	18	3	1	1	15	113
Munic. of Morris-Turnberry	25	10	0	0	15	0	0	0	0	0	0
Munic. of Northern Bruce Peninsula	2673	2328	2	32	86	22	3	1	3	29	167
Munic. of South Bruce	724	385	4	14	282	17	4	1	1	9	7
Munic. of West Grey	2025	1288	4	31	620	33	14	1	3	11	20
Town of Collingwood	39	34	0	0	2	0	0	0	0	2	1
Town of Hanover	39	9	0	1	6	3	1	0	1	5	13
Town of Minto	211	154	1	1	51	3	0	0	0	0	1
Town of Saugeen Shores	310	194	4	22	60	8	3	2	2	10	5
Town of South Bruce Peninsula	2212	1895	10	50	116	47	14	1	3	18	58
Town of The Blue Mountains	1145	916	5	9	91	10	10	0	2	32	70
Twp. of Chatsworth	1574	1192	7	27	270	21	5	0	0	36	16
Twp. of Georgian Bluffs	2247	1814	6	27	236	59	10	0	5	15	75
Twp. of Howick	36	20	0	3	12	1	0	0	0	0	0
Twp. of Huron-Kinloss	367	183	13	23	130	8	2	0	2	4	2
Twp. of Melancthon	12	8	0	0	4	0	0	0	0	0	0
Twp. of Southgate	934	633	2	20	258	8	0	0	2	6	5
Twp. of Wellington North	236	151	3	4	74	0	1	0	0	2	1
TOTAL	21,104	15,679	90	381	3,620	323	91	10	33	247	630
PERCENTAGE	100.0	74.3	0.4	1.8	17.1	1.6	0.4	0.0	0.2	1.2	3.0

4.3.2.1 Municipal Wells

Extensive studies have focused on municipal wells used for drinking water across Ontario. The various counties in the planning region have completed comprehensive groundwater studies: Grey and Bruce Counties in 2003 by Waterloo Hydrogeologic; Wellington County in 2006 by Golder Associates; Huron County in 2001 by Golder Associates, and the AEMOT Groundwater Management Study in 2001.

There are four classifications for municipal wells based on the definitions set forth in Regulation 170 of the Ontario Safe Drinking Water Act, 2002: large municipal residential systems; small municipal residential systems; large municipal non-residential systems; and small municipal non-residential systems. The main criteria for the classifications are the amount of water per unit time that can be used, if it serves a residential development, and the number of residences that have access. Table 4.4 summarizes the different classes of municipal drinking water systems.

By grouping municipal, commercial, and public supply wells, there are approximately 900 wells (~4 % of all wells in the planning region) that could be considered “municipal” under Regulation 170. Although, municipal wells account for a small percentage of the total wells, a significant population (many receptors in terms of risk analysis) in the region depends on an adequate quality and quantity of water supply.

TABLE 4.4 - Classification of Municipal Drinking Water Systems (Reg. 170/02, Safe Drinking Water Act, 2002).

Drinking System Class	***Pump Rate (L/s)***	***Major Residential Development***	***No. of Residences***
large municipal residential	-	Yes	>100
small municipal residential	-	Yes	<101
large municipal non-residential	>2.9	No	-
small municipal non residential	<2.9	No	-

4.3.2.2 Communal Wells

Wells of this sort are common in rural settings, campgrounds, or trailer parks. Communal wells can be a source of drinking water for many individuals. As defined in Regulation 252 of the Ontario Safe Drinking Water Act, communal wells are categorized in a similar method as municipal wells. They are defined as: non-municipal year-round residential systems; non-municipal seasonal residential systems; large non-municipal non-residential systems; and small non-municipal non-residential systems. Table 4.5 summarizes the different classes of communal drinking water systems. As mentioned previously, with the current data it is difficult to determine the number of wells that would meet the criteria for communal.

TABLE 4.5 - Classification of Communal Drinking Water Systems (Reg. 170/02, Safe Drinking Water Act, 2002).

Drinking System Class	***Pump Rate (L/s)***	***Major Residential Development***	***No. of Residences***
large municipal residential	-	Yes	>5 campground/trailer park connections
small municipal residential	-	Yes	>5 campground/trailer park connections*****
large municipal non-residential	>2.9	No	<5 campground/trailer park connections
small municipal non residential	<2.9	No	<5 campground/trailer park connections

* Drinking water system must not be operated for at least 60 consecutive days in every calendar year, or from April 1 to March 31.

4.3.2.3 Private Groundwater Supplies

Many wells exist in the planning region that provide drinking water for rural residences. Depending on the condition of these wells and the types of land use activities surrounding them, they can pose significant risk to groundwater resources. See Tables 4.2 and 4.3.

Approximately 74 % of the wells are for domestic residential use. This is a best estimate when incorporating the accuracy of the database and the fact that some domestic wells may actually be considered communal. Also, approximately 17 % of the wells have livestock as the primary use and domestic as secondary. The point to be taken from this is rural areas depend heavily on groundwater resources. Lastly, not all wells are active.

4.3.2.4 Surface Water Intakes (SWI)

Municipal drinking water can be obtained from various surface water sources. In this region, Lake Huron, and Georgian Bay and Ruhl Lake provide communities with drinking water. The raw surface water is treated before distribution to residences. SWIs are highly susceptible to the introduction of contaminants and, therefore, require close monitoring and protection. Table 4.6 identifies municipal drinking water derived from surface water sources. The information was gathered from the Ontario Ministry of Environment Permit to take Water (PTTW) database, and Drinking Water System (DWS) Inspection Reports, which typically provide good quantity, and high quality water data.

Ruhl Lake is one of the primary sources of drinking water for the Town of Hanover and is the only system in the SPR that obtains surface water from an inland source. Ruhl Lake is also unique in that, although the water is drawn from a lake, it is predominately fed from groundwater and has limited inputs from the surface. This poses problems in determining how to properly delineate a wellhead protection zone and/or an intake protection zone to adequately protect the water source.

TABLE 4.6 - Summary of municipal surface water drinking supplies in the Planning Region. (Source: MOE Permit to Take Water (PTTW) database, and Drinking Water System (DWS) Inspection Reports)

Client	DWS Name	DWS Category	DWS #	Water Source	Capacity (m^3/day)
Municipality of Northern Bruce Peninsula	Lion's Head Water Treatment Plant	Large Municipal Residential	220002672	Isthmus Bay	1832
Municipality of Meaford	Meaford Water Treatment Plant	Large Municipal Residential	210000176	Georgian Bay	26848
Town of Blue Mountains	Thornbury Water Treatment Plant	Large Municipal Residential	220001762	Georgian Bay	20000
Town of South Bruce Peninsula	Wiarton Water Treatment Plant	Large Municipal Residential	220002681	Colpoy's Bay	5934
City of Owen Sound	R.H. Neath Water Treatment Plant	Large Municipal Residential	220001799	Owen Sound Bay	9092
Township of Georgian Bluffs	East Linton Water Treatment Plant	Large Municipal Residential	220007659	Georgian Bay	748
Township of Georgian Bluffs	Presqu'ile Water Treatment Plant	Small Municipal Residential	220007597	Georgian Bay	328
Town of Saugeen Shores+	Port Elgin Water Treatment Plant	Large Municipal Residential	220002707	Lake Huron	7855
Town of Saugeen Shores	Southampton Water Treatment Plant	Large Municipal Residential	210000078	Lake Huron	9072
Municipality of Kincardine	Kincardine Water Treatment Plant	Large Municipal Residential	220002716	Lake Huron	16625
Town of Hanover	Hanover Water Treatment Plant	Large Municipal Residential	210000167	Ruhl Lake	9850

+ As of the writing of this document, the community of Port Elgin is receiving its water from the Southampton Water Treatment Plant and the Port Elgin Water Treatment Plant will be decommissioned once the new Southampton intake is complete.

4.3.3 Recreational Water Use

Inland streams and lakes in the SPR provide multiple opportunities for recreational activities. Sport fishing, canoeing/kayaking, swimming, water sports, and boating all have intrinsic value when evaluating the various water uses. Lake Huron and Georgian Bay also provide the same opportunities, but on a larger scale. Recreational water activities are important for aesthetic and economic reasons for both residents of the region and for tourists. Ensuring that there is sufficient water quality and quantities for these opportunities continue is very important.

4.3.4 Ecological Water Use

The primary objective of the Source Water Protection program is to protect drinking water sources from contamination and over use. It is not just humans that depend on good quality and abundant water sources. Water is a necessity for all living things. Water of good quality is a prerequisite for healthy aquatic and terrestrial systems. When we work towards protecting source water, we also provide ecological protection through this widespread ecological dependence on water.

The extensive river systems of the planning region, and the lands adjacent to them, are home to a diverse and abundant variety of plant and animal species. The zones where water meets land, the riparian zone, is of particular importance, as these areas can be one of the richest and most productive ecological zones within a watershed. They protect our river by providing a buffer between the river and the intensively used urban and farm land on which much of our economy depends. They also protect people and property by keeping floodplain land intact.

Riparian zones are ecological water users. The health and extent of all the plant and animal components of these zones rely on the water. The better the quality of water available to the species within these zones, the healthier are the zones.

Like the riparian zones along our shorelines, the wetland features throughout the watershed region are also important ecological features and an ecological water user. They too provide habitat for an array of plants and animal. Wetlands play a role in preventing floods and droughts and also improve the quality of water.

Our society has not always respected riparian zones and wetlands. Over the years, many of the wetlands and riparian zones have been cleared and farmed or built upon. It has been estimated that 70% of the wetland within the region have been lost. In some cases, cultivated land extends to the very top of stream and river banks. This situation provides no natural erosion protection and provides an opportunity for direct runoff from agricultural land into rivers and streams. Many farm operations still provide cattle access to watercourses, which further accelerates erosion rates and degrades water quality. Many of our urban areas have also degraded our riparian zones by filling and developing these areas, thus making them prone to erosion and flooding from either the river or from storm water.

By working to protect, preserve, and rehabilitate these ecological features and users of water, and by providing them with exceptional water quality, we in turn will have a healthier watershed where sources of water are more easily protected.

4.3.5 Agricultural Water Use

It is important to understand the extent of agricultural land within a region, as agricultural practices influence water quality (i.e. surface runoff) and quantity (i.e. irrigation). Agriculture uses high quantities of water that are difficult to quantify and, depending on they type of farming activities, water permits are not required. The Canadian Land Inventory (CLI; http://geogratis.cgdi.gc.ca/CLI/frames.html) information was used to classify agricultural land in the region. This source has its limitations because the data are from 1986 and have a low resolution (1:250,000). The MOE well database (Tables 4.7 and 4.8) and the permits-to-take-water (PTTW) in the region show that the majority of water used is for livestock watering and irrigation activities respectively.

TABLE 4.7 - Number of Wells by Watersheds in the Planning Region (MOE – WWIS, 2003)

SUBWATERSHED	# WELLS	AREA (km^2)	DENSITY OF WELLS (wells/km^2)	# ACTIVE WELLS	# INACTIVE WELLS
Saugeen Valley SPA					
Beatty Saugeen River	392	273.75	1.43	257	135
Lake Fringe (SVCA)	769	254.23	3.02	597	172
Main Saugeen River	3009	1689.85	1.78	2192	817
North Saugeen River	698	269.07	2.59	535	163
Penetangore River	292	192.13	1.52	228	64
Pine River	247	194.57	1.27	201	46
Rocky Saugeen River	683	281.77	2.42	452	231
South Saugeen River	1395	797.93	1.75	876	519
Teeswater River	977	682.11	1.43	740	237
Grey Sauble SPA					
Beaver River	1999	617.21	3.24	1550	449
Big Bay Creek	19	9.40	2.02	16	3
Bighead River	650	351.65	1.85	483	167
Bothwell Creek	299	62.60	4.78	227	72
Centreville Creek	42	14.14	2.97	33	9
Gleason Brook	87	44.79	1.94	69	18
Indian Brook	75	33.92	2.21	51	24
Indian Creek	197	83.62	2.36	145	52
Johnson Creek	2	18.58	0.11	1	1
Keefer Creek	78	38.82	2.01	56	22
Lake Fringe (GSCA)	2759	487.37	5.66	2122	498
Little Beaver River	99	14.37	6.89	67	32
Pottawatomi River	546	113.31	4.82	386	160
Sauble River	2260	915.52	2.47	1711	545
Stoney Creek	53	32.11	1.65	32	13
Sucker Creek (SBP)	78	47.38	1.65	56	22
Sucker Creek (Meaford)	7	36.84	0.19	4	0
Sydenham River	738	199.97	3.69	547	191
Waterton Creek	106	57.55	1.84	71	35
Northern Bruce Peninsula SPA					
Black Creek	10	12.00	0.83	9	1
Brinkman's Creek	24	32.72	0.73	13	11
Crane River	77	86.01	0.90	58	19
Judges Creek	131	85.76	1.53	86	45
Lake Fringe (NBP)	1784	345.57	5.16	1445	339
Old Woman's River	180	27.14	6.63	136	44
Sadler Creek	30	22.50	1.33	20	10
Sideroad Creek	22	46.28	0.48	19	3
Spring Creek	214	53.47	4.00	192	22
Stokes River	181	78.24	2.31	118	63
Willow Creek	52	24.23	2.15	47	5
TOTAL	21261	8628.48	2.4695.61	15848	5259

SBP = Town of South Bruce Peninsula

TABLE 4.8 - Number of Wells in Watersheds by Primary Water Use (MOE – WWIS, 2003).

SUBWATERSHED	# OF WELLS	DOMESTIC	MUNIC-IPAL	PUBLIC SUPPLY	STOCK	COMMER-CIAL	INDUS-TRIAL	COOLING/AC	IRRIGA-TION	NOT USED	UN-KNOWN
Saugeen Valley SPA											
Beatty Saugeen River	392	238	1	12	136	2	0	0	0	2	1
Lake Fringe (SVCA)	769	575	7	41	100	15	8	2	1	12	8
Main Saugeen River	3009	1808	21	50	956	47	18	2	7	54	46
North Saugeen River	698	511	0	12	123	9	4	0	0	34	5
Penetangore River	292	168	7	11	91	8	1	0	4	0	2
Pine River	247	99	7	11	116	5	2	0	1	4	2
Rocky Saugeen River	683	484	2	5	169	8	2	0	1	3	9
South Saugeen River	1395	913	5	25	408	23	7	0	1	5	8
Teeswater River	977	565	2	24	361	15	3	1	0	0	6
Grey Sauble SPA											
Beaver River	1999	1645	4	37	218	16	7	0	2	19	51
Big Bay Creek	19	11	0	0	3	1	0	0	0	0	4
Bighead River	650	448	4	7	138	5	1	0	0	12	35
Bothwell Creek	299	249	1	3	15	5	2	0	0	4	20
Centreville Creek	42	30	0	0	3	1	0	0	1	3	4
Gleason Brook	87	61	0	0	20	0	0	0	0	2	4
Indian Brook	75	52	0	3	15	1	3	0	0	0	1
Indian Creek	197	141	0	4	37	1	0	0	1	1	12
Johnson Creek	2	2	0	0	0	0	0	0	0	0	0
Keefer Creek	78	60	0	0	10	1	0	0	0	1	6
Lake Fringe (GSCA)	2759	2250	10	30	79	45	8	2	6	33	157
Little Beaver River	99	80	2	0	10	0	1	0	1	4	1
Pottawatomi River	546	427	0	5	62	38	3	0	1	4	6
Sauble River	2260	1748	13	52	328	37	18	2	3	14	41
Stoney Creek	53	35	0	2	7	0	0	0	0	0	1
Sucker Creek (SBP)	78	67	0	1	7	0	0	0	0	0	3
Sucker Creek (Meaford)	7	2	0	0	0	0	0	0	0	0	2
Sydenham River	738	587	3	11	96	18	0	0	0	6	17
Waterton Creek	106	66	0	4	27	0	0	0	0	2	7
Northern Bruce Peninsula SPA											
Black Creek	10	10	0	0	0	0	0	0	0	0	0
Brinkman's Creek	24	16	0	0	4	0	0	0	0	0	4
Crane River	77	59	0	5	4	0	0	0	0	0	9
Judges Creek	131	94	0	1	27	1	2	0	1	1	4
Lake Fringe (NBP)	1784	1578	2	16	25	10	1	1	1	28	122
Old Woman's River	180	151	0	6	18	3	0	0	0	0	2
Sadler Creek	30	23	0	1	0	2	0	0	0	0	4
Sideroad Creek	22	17	0	0	0	0	0	0	0	0	5
Spring Creek	214	202	0	3	0	1	0	0	0	0	8
Stokes River	181	165	0	0	6	5	0	0	1	0	4
Willow Creek	52	43	0	0	0	0	0	0	0	0	9
TOTAL	21261	15680	91	382	3619	323	91	10	33	248	630

SBP = Town of South Bruce Peninsula

The CLI agricultural classifications are generic, but include improved pasture and forage crops, orchards and vineyards, and unimproved pasture and range land. The areal coverage of these classifications accounts for approximately 5000 sq km (58%) of the total 8600 sq km of land in the planning region. Assuming the distribution of agricultural land is representative of current conditions, there is a potential for a high demand for water resources. Subsequent to the demand for water resources, the physical characteristics of the terrain and land use activities influence how the water moves over and into the land.

Water usage for agricultural practices by watershed can be estimated using the de Loe method (de Loe, 2002). This method uses the 2001 Census of agriculture to obtain details of the types of agricultural practices that are being undertaken. Knowing the type of cropping that takes place allows the application of a water use coefficient that is specific to individual crops. The water use coefficients were initially derived by Myslik (1991) and later refined by Ecologistics (1993), Kreutzwiser and de Loe (1999), and de Loe, et al. (2001).

4.3.6 Industrial and Commercial Water Use

Industrial and commercial processes require the use of water to operate machinery, manufacture products, or serve as the main ingredient of the product. Water can be obtained from Lake Huron, inland surface water, and/or groundwater. Regardless of the source, MOE approval must be granted before water resources can be utilized for the aforementioned processes. Examples of the major industrial operations include power production, cooling water, food processing, brewing and soft drinks, aggregate washing, and pipeline testing. Examples of major commercial uses of water are snowmaking, bottled water, aquaculture and golf course irrigation (Table 4.9).

Groundwater wells that are used for industrial or commercial processes account for about 2 % of the 24,000 total wells in the region. Although, this is a small amount on a relative scale, the water withdrawals for a well can reach up to 24 billion L/yr for food processing.

Approximately 100 times more surface water is used compared to groundwater for industrial and commercial activities. Water use can be defined as consumptive and non-consumptive where the former signifies that water is exported or leaves the planning region and latter uses water for some purpose, but is released back into the system. The largest industrial water use in the region is for power production and cooling water. These particular activities represent a maximum potential to use 6.1 trillion litres per year of water. An estimate of potential maximum of total water use for industrial and commercial activities accounts for around 25.3 trillion litres per year (non-consumptive) from groundwater and surface water sources. Water withdrawls from Lake Huron account for 99.5% of the total water used for industrial and commercial purposes when factoring in power generation/cooling water. Excluding the major water needs from Lake Huron, approximately 130 billion litres per year (potential maximum) are used for other purposes. To put this in perspective, this volume of water represents approximately 1 % of the total volume of water in Lake Huron (3540 cubic km).

TABLE 4.9 - Industrial and Commercial Potential Maximum Water use per year Under Permits to Take Water in the Planning Region. (MOE-PTTW, 2005)

Water Use	Source	Millions L/yr (Max)
Aggregate Washing	Pond	4200
	Stream	150
	Total	**4350**
Aquaculture	Reservoir	72
	Spring	4290
	Stream	18600
	Well	6660
	Total	**29562**
Bottled Water	Pond	39.3
	Spring	807
	Stream	13000
	Well	4010
	Total	**17856.3**
Brewing and Soft Drinks	Well	1850
	Total	**1850**
Cooling Water	Lake Huron	13400000
	Total	**13400000**
Food Processing	Well	23900
	Total	**23900**
Snowmaking	Georgian Bay	3270
	Lake Huron	27900
	Nottawasaga Bay	2380
	Pond	3580
	Spring	589
	Stream	1580
	Well	2750
	Total	**42049**
Golf Course Irrigation	Inland Lake	0.6
	Pond	338
	Stream	568
	Well	113
	Total	**1019.6**
Other - Commercial	Lake Huron	16.6
	Pond	218
	Stream	4780
	Well	270
	Total	**5274.6**
Other - Industrial	Georgian Bay	9.2
	Pond	2690
	Well	205
	Total	**2904.2**
Pipeline Testing	Stream	2.7
	Total	**2.7**
Power Production	Lake Huron	11800000
	Total	**11800000**
Total		**25328768**

4.4 Summary

In general the SPR has ample water available for drinking water purposes. In particular, the Lake Huron/Georgian Bay system and the bedrock aquifer system are regional scale reservoirs. These reservoirs are not considered susceptible to shortages from short-term climate changes due to the high volume of water within them. Further, these systems are not likely to be impacted from anthropogenic activities given the existing land-use, water usage and projected population increases.

Smaller reservoirs, such as the overburden aquifer system and the inland surface water system, are inherently more vulnerable to shortages as a function of the relatively low volume of water stored in the system. These systems must be evaluated on an individual basis as the differences in water storage and volume can vary dramatically from one reservoir to another.

4.5 Data Gaps

The primary data gap for understanding water use within the area lies within quantifying actual takings from the PTTW database as well as for private domestic supplies. Attempts have been made to try and corroborate permitted takings in the past, but have proven less than fruitful as they are voluntary in nature. Large scale water users have recently been asked to submit to the MOE actual pumping rates as conditions of their permits and for analysing any future permit renewals. This data, however, has not been made available for this report. It is anticipated that this will be made available in the future and incorporated in this document and any water budgeting activities. The information has been requested from the Ministry of Environment.

Quantifying Municipal takings is currently being undertaken as a part of the Municipal Technical studies being completed by outside consultants. This data will also be available in the near future and can be incorporated into this document and any water budgeting activities. Quantifying water takings form private domestic wells is a large data gap, largely due to omissions and errors within the provincially-maintained Water Well Information System (WWIS). At this time, it is not anticipated that this data gap will be addressed locally, largely due to the magnitude of the work and expertise required to update this database.

Chapter 5

VULNERABLE AREAS

5.0 DESCRIPTION OF VULNERABLE AREAS

5.1 Identification of Source Protection Areas

For the scope of the report, the main protection areas that are being examined are municipal wellhead protection areas (WHPAs), municipal surface water intakes (IPZs), and other sensitive physiographic features (recharge/discharge areas, wetlands, exposed bedrock, etc) that could have an adverse effect on source water. A detailed assessment of wellhead protection areas and intake protection zones are on-going, and will be provided at a later time. These components are being delineated for Modules 3 (Groundwater Vulnerability Analysis) and 4 (Surface Water Vulnerability Analysis) of the Assessment Report.

Understanding vulnerable areas is a critical step in the development of a Source Protection Plan. Vulnerable areas can be defined as those areas where the potential impacts of human activity on the land surface are more likely to cause impacts on available sources of drinking water, in terms of both water quantity and water quality.

For the purposes of developing Source Protection Plans for the Saugeen Valley SPA, Grey Sauble SPA and Northern Bruce Peninsula SPA, an inventory of these vulnerable areas at a regional scale is necessary. Numerous studies have been completed in recent years that developed methodologies for and identified vulnerable areas. The intention of this chapter is to summarize this readily available information.

Vulnerable areas are unique to the source of drinking water for which they were developed, such that an area may be vulnerable with respect to one source, but not be considered to be vulnerable with respect to another. In addition, the activities that may impact one source may not be considered a threat to another. As a result of this relationship, it is appropriate to discuss vulnerable areas according to the sources for which they were developed, and this chapter is structured as such. This fact is also important for consideration during the development of the Source Protection Plans, as each source will require unique strategies in order to mitigate the threats to drinking water supplies in vulnerable areas.

5.2 Groundwater

Groundwater is overwhelmingly the most utilized source of drinking water throughout the SPR. It is estimated that over 50% of the population of the planning region relies on groundwater for their personal supplies, including both municipal and private wells. Protecting groundwater resources will be a key element of all Source Protection Plans in the SPR.

Groundwater water resources in the planning region have been divided into two major groupings of aquifers, namely bedrock and overburden aquifers. Bedrock aquifers are considered the most reliable, from a water quality and quantity perspective, and are readily available as they underlie the whole of the study area. These bedrock aquifers are considered to be relatively secure aquifers, especially in the southern portion of the SPR where they are protected by thick sequences of unconsolidated glacial material. In the northern portion of the SPR close to the Niagara Escarpment, these aquifers are considered more vulnerable, but are historically considered to have good water quality and quantity. Bedrock aquifers are also less susceptible to water quantity issues due to the large volume of water that flows through the system.

Overburden aquifers are sporadically dispersed, as they are associated with coarse grained glacial or glaciolacustrine deposits. Overburden aquifers are highly variable in their quality and quantity, and are more susceptible to both contamination from anthropogenic activity and to drought conditions.

There are a number of different approaches that have been applied in order to identify the vulnerable areas for (both bedrock and overburden) aquifers in the planning region. These are generally developed from the geology of the area, and reflect a general rule that coarser grained materials allow for faster movement (i.e. they have higher hydraulic conductivities) of water, as both groundwater flow within aquifers and infiltrating water from the ground surface to the water table. Faster travel times for infiltration and groundwater flow allow contaminants in water less opportunity for attenuation and dilution. In addition, aquifers with higher hydraulic conductivities allow water to be discharged at higher rates and are, therefore, more susceptible to changes in recharge rates.

5.2.1 Intrinsic Susceptibility Index (ISI) and Aquifer Vulnerability Index (AVI)

Intrinsic Susceptibility Index (ISI), along with the earlier Aquifer Vulnerability Index (AVI), is a calculated value that estimates the susceptibility of a groundwater resource to contamination. The susceptibility of an aquifer to contamination is a function of the susceptibility of the aquifer to the infiltration of contaminants, which can be evaluated at a regional scale using ISI.

ISI mapping is available for the entire planning region from a number of county groundwater studies, including: Grey and Bruce Counties (2003); Huron County (2003); Dufferin County (2003); and Wellington County (2006). These studies were undertaken with funding from the Ontario Ministry of the Environment and, as such, were expected to utilize a standardized methodology for determining ISI. However, minor modifications to the ISI calculation were encountered, and as a result an Edge-Matching project was undertaken to rectify these issues. Wellington County results were developed using the AVI method.

As part of the Edge-matching study, ISI Mapping was redeveloped using a common methodology. Map development begins with assigning an ISI value for each well within the Water Well Information System (WWIS) for the study area. This is accomplished by summing the product of the thickness of each unit (b) in the well log and a corresponding K-factor (see Appendix E), as represented in the equation below. The thickness (a.k.a. depth) for which ISI was calculated at each well is calculated from the ground surface to the water table for the unconfined aquifer, and from the ground surface to the top of any confined aquifer.

$$ISI = \sum_{1}^{i} b_i \bullet K_{Fi}$$

where:

- i = the number of geologic units recorded in the water well record (borehole)
- b = the thickness of each geologic unit recorded in the water well record.
- K_F = the Representative K-Factor as outlined in the MOE Terms of Reference:

After assigning individual wells ISI values, the mapping was developed by interpolating these values between wells. These interpolated areas were then subdivided and classified following the Technical Terms of Reference into one of three susceptibility groupings: low (ISI > 80), medium (30 ≤ ISI ≤ 80) and high (ISI < 30) (MOE, 2001).

In areas of thin overburden it was recognized that the vulnerability to the underlying aquifers was increased due to the highly fractured nature of the bedrock. In order to accommodate these concerns, polygons representing overburden thickness of less than 6.0 meters were assigned an ISI value of 20 (high susceptibility). In some areas with documented karst development, polygons representing the identified karst areas within the planning region were overlain and assigned an ISI value of 20 (high susceptibility). Where modifications to the original ISI mapping were made, the ISI map was re-interpolated to provide a final ISI map.

ISI mapping for the entire planning region is shown in Map 38 accompanying this report. Areas with high susceptibility tend to be those that have very shallow overburden deposits, such as the areas close to and along the Niagara Escarpment. Areas with known sinkhole development also show high susceptibility. It is important to note that for the southern portion of the study area, groundwater resources tend to be relatively well protected from surface activities. The relatively large area considered to be highly susceptible in the study area is largely a function of the general lack of unconsolidated glacial materials in these areas. The highly fractured nature of the bedrock in these areas supports this designation.

5.2.1.1 Limitations of ISI Mapping

It is important to understand the limitations of the produced ISI mapping when developing a Source Protection Plan. Although ISI mapping is a well-documented and accepted methodology in Ontario for assessing aquifer vulnerability it does have a number of limitations, including:

1. ISI mapping is intended to be viewed and interpreted at a regional scale and is not intended to be interpreted at a property or site-specific scale
2. The primary source of data for calculating ISI is the WWIS, which is known to have several deficiencies in both the lack of records for existing wells, and more importantly in the location of the existing records
3. ISI does not take into account hydrogeological characteristics of aquifers which may make them more or less susceptible
4. ISI is interpolated between known data points and does not take into account geological features/boundaries that may be the cause of significant differences between the points.
5. ISI cannot account for the condition of existing wells, which may represent a more important pathway for the contamination of aquifers than infiltration of meteoric water.

With these limitations in mind, ISI is still a useful tool in evaluating the overall susceptibility of a given aquifer at a regional scale. However, it is most important to note that ISI should never be substituted for comprehensive site-specific investigation, and a qualified geoscientist should determine the accuracy of the index at a property scale.

5.2.2 MOE Groundwater Susceptibility Mapping

Initial attempts at defining the hydrogeologic environments susceptible to contamination were carried out by the Ontario Ministry of Environment (MOE, 1985). Broad scale mapping was created that separated the province into distinct hydrogeologic environments. These environments were subsequently evaluated for their susceptibility to contamination, based on:

1. the permeability of the materials commonly found at the ground surface;
2. groundwater movement in the materials;
3. the presence of major shallow aquifers; and
4. the use of groundwater in the area.

These regions were developed primarily upon the existing quaternary geologic and physiographic mapping for the province. Based on this broad scale mapping effort, the planning region is dominated by "highly variable" susceptibility, with areas of high susceptibility associated with the former Lakes Nippissing-Algonquin shoreline deposits, and kame deposits within the Wawanosh, Wyoming and Horsehoe moraines. The broad region defined as the "Huron Slope" (Chapman and Putnam, 1984) was considered to be low susceptibility, primarily as a function of the fine grained sediments and soils in this area. Areas of exposed bedrock, with negligible glacial material, are once again considered highly susceptible, thus making the northern portion of the study area and those areas associated with the Niagara Escarpment highly susceptible.

This mapping is considered a good reference point for understanding the susceptibility of groundwater resources for the area. However, these maps are focused primarily on the surficial geology of the area and do not address the vulnerability of the important bedrock aquifer system.

5.2.3 Shallow Susceptibility Index Mapping (SSI)

During the My Land, Our Water (MYLOW) phase II pilot study completed by Saugeen Conservation and the Maitland Valley Conservation Authority, it was recognized that ISI and MOE Susceptibility mapping were insufficient for those areas. In fact, due to local shallow groundwater conditions and a large Old Order Mennonite population serviced by shallow wells, it was determined that the ISI layer underestimated the vulnerability of this region. This was primarily due to a lack of data points, attributed to underreporting of shallow bored and dug wells and the subsequent lack of inclusion in the MOE water well database (WWIS).

In order to address these concerns, and acknowledging the limited well information, another vulnerability layer was developed to give landowners an alternative to ISI. The Surficial Susceptibility Index (SSI) is a semi-quantitative method for estimating the security of a potential shallow aquifer based on the permeability of the soils and the first subsoil layer (Quaternary geology) - the higher the permeability, the higher the susceptibility.

The susceptibility of these shallow aquifers can be estimated by overlay of the permeability of the soils and the quaternary geology in a GIS environment. In order to do this, the soils layer and quaternary geology layer were overlain and simplified values given to each type of soil and geological unit. The combination of different soils and subsoil types were given values based on their estimated rate of infiltration in order to approximate the susceptibility of a given area.

Soil permeability values were derived from the hydrologic soil classification groupings, where "A" soils are the most permeable and "D" the least. Soils with more than one association were grouped according to the best fit with known data. Geological materials were similarly grouped in just two groupings, low permeability and high permeability, based on existing quaternary geological mapping and the materials associated with each type of deposit. These groupings, for both soils and quaternary geology, are highly simplified, but allow for not only a comparison of the relative susceptibility of each area, but also as a predictor for where shallow overburden aquifers may be encountered. The matrix for determining the SSI is shown below in Table 5.1.

TABLE 5.1. - Matrix for determining Shallow Groundwater Susceptibility values based on hydrologic soil grouping and permeability of quaternary geology.

Geology	***Soils***		
	D	***B/C***	***A***
Low permeability	1	3	5
High permeability	2	4	6

In SSI, values from 1 to 3 are considered low susceptibility, 4 and 5 considered moderately susceptible and 6 is considered highly susceptible to contamination. Refer to Appendix F for the classification of soil and geology units.

5.2.3.1 Results

SSI is presently available for the Saugeen Valley SPA portion of the planning region only. The results of the SSI for this jurisdiction are weighted heavily by the quaternary geology. This is partially a product of the genetic association of soils with the underlying quaternary geology. SSI does highlight areas that are not identified by existing ISI mapping and is considered a useful tool for defining where ISI needs to be refined or more investigative work completed.

5.2.3.2 Limitations of SSI

SSI is developed primarily as a predictive tool and is based on the soils mapping and quaternary geology mapping, as well as broad scale geological interpretation. As a result, the final product has incorporated a number of potential errors, and should be viewed as such. It is important to note that no field verification of this methodology has been undertaken.

5.2.4 Wellhead Protection Areas (WHPA)

Wellhead Protection Areas (WHPA) were generated for the study area as part of the MOE Groundwater studies completed for Huron, Bruce, Grey, Dufferin Counties (2003) and for Wellington County (2006). A WHPA is the two-dimensional projection onto the ground surface of the three-dimensional volume of groundwater that is pumped from a well field. WHPAs themselves are composed of a number of Wellhead Capture Zones (WHCZ) that reflect the time required for water to move to the well from different areas of the aquifer. These Time-Of-Travel (TOT) WHCZ's were applied for all municipal groundwater supplies within the study area as part of the MOE Groundwater studies.

TOT capture zones that were calculated for municipal supplies that had WHPAs delineated for them are shown in Map 41.

5.2.4.1 Methodology

Delineation of wellhead protection areas (WHPAs) is accomplished through the application of numerical groundwater models. The physical relationships governing the movement of groundwater can be incorporated into numerical models to simulate the existing groundwater flow system. Once calibrated, this model can be used to determine the pathways of groundwater in the aquifer and to calculate the travel time between any two points along those pathlines. TOT capture zones for pumping wells are calculated by releasing many particles originating in a circle around the well, and running the model in reverse. These capture zone results form the basis for delineating WHPAs for the municipal well.

5.2.4.2 Limitations of WHPA Modeling Results

WHPAs produced from numerical models incorporate a number of assumptions, input parameters, and boundary conditions. Each model is a representation of the understanding of the area surrounding the municipal well, and in all cases this representation has been simplified to facilitate model development. The WHPA modeling results represent a best estimate of the actual WHPAs and provide excellent guidance regarding the specific water source for each well.

As additional information becomes available, the numerical models will be revised and WHPAs re-evaluated. Furthermore, water taking will be different in the future, as communities grow and additional groundwater wells are developed.

One important limitation is that the capture zones are projected to ground surface, and does not reflect the time required for water to travel from ground surface to the aquifer. This is particularly true when the wells that are being evaluated pump water from a deep aquifer that is overlain with fine-grained sediments (silts and clays).

5.2.4.3 Results

Map 41 shows, at a regional scale, the TOT capture zones that were produced as part of the MOE groundwater studies. The size and shape of WHPAs are largely a function of the amount of water being pumped, the permeability of the aquifer from which it is being pumped, and the overall regional gradient. Large WHPAs occur in areas where there are high gradients, high permeabilities and large volumes being pumped.

Of particular importance to this study are those WHPA's in which the aquifer is considered to be susceptible to impact from surface water, or the well is considered to be Groundwater Under the Direct Influence of surface waters (GUDI wells). These WHPAs reflect a high probability of impact on the aquifer via surface activities and will necessitate a different approach to mitigating potential impacts than those WHPAs that are not susceptible or GUDI.

5.2.5 Surface to Well Advection Time (SWAT) Wellhead Protection Areas

In order to address some of the limitations of the original TOT WHPAs developed during the MOE sponsored groundwater studies, a number of pilot projects were undertaken in the area to develop Surface to Well Advection Time (SWAT) capture zones for a select group of municipal wells. SWAT incorporates the time it takes for water to infiltrate through the unsaturated zone to the water table, as well as the TOT from that point to the actual well.

In order to determine the travel times through the unsaturated zone, an advection time calculation was done using estimated average porosities and saturation values. This advection time estimate based on the understanding of the local geology is the time required for any given water particle to travel from the ground surface to the top of the aquifer. Once the advection time was calculated it was added to the previously defined TOT capture zones to determine the total SWAT.

5.2.5.1 Results

The use of the SWAT information allows for greater understanding of the influence of activities on the ground surface on the actual wells in these areas. Those wells with significant potential impact, based on this SWAT modeling, will likely require different planning and implementation tools in order to accomplish the goal of protecting the long term sustainability of the well.

5.2.6 Recharge/Discharge Areas

Areas where groundwater interacts with the ground surface are critical to develop our understanding of both groundwater and surface water systems. These areas are also extremely sensitive, as they allow interaction between relatively good quality, un-impacted groundwater with commonly impacted surface waters. These areas are commonly separated into those areas where groundwater is being outlet into surface water bodies, called discharge areas, and areas where surface water is infiltrating into groundwater bodies, called recharge areas.

5.2.6.1 Discharge Areas

Discharge areas are important sources of water for surface water bodies. High quality and consistent quantities of water being discharged into streams and lakes from aquifers provide essential water for the natural function of those streams and lakes. Estimating areas of discharge can be accomplished by comparing the known water table surface with the ground surface. Where that water table surface is higher than the ground surface, one could reasonably expect to find groundwater discharging onto the ground surface or into streams and lakes. Realistically, the geology and soils of the area may preclude the discharge of water due to its fine texture and resultant low permeability. As a result, it is often difficult to predict where discharge is occurring without considering the geology and soil structure of the ground surface in a given area.

The most reliable method for delineating discharge areas is through the aquatic ecology of the streams and rivers themselves. Streams, drains, and lakes throughout the study area have had their aquatic habitat intensively studied and classified. The results have been to categorize the watercourses (and even specific reaches of individual watercourses) into cold and warm water fisheries habitat.

In order to create a map of predicted discharge areas from overburden aquifers, the water table elevation layer was intersected with the ground surface layer in a GIS environment. Areas where the water table surface is above the ground surface are those areas where discharge is predicted to occur, if geological and soil conditions permit.

Map 17 shows the distribution of these discharge areas and cold and warm water streams throughout the SPR. Of interest is the association of cold water streams with coarser grained quaternary deposits, including those associated with moraines, glacial outwash and contact deposits, as well as glaciolacustrine shoreline deposits. These coldwater streams then represent discharge from overburden aquifers, rather than the deeper bedrock aquifers.

The relatively high percentage of the SPR where discharge from overburden aquifers is predicted is noted. This corresponds well with known characteristics of the planning region, as well as with locations of wetlands (e.g. Greenock Swamp). The planning region has a proliferation of discharge areas, which reflects the more groundwater-influenced nature of the surficial systems.

5.2.6.2 Recharge Areas

Recharge areas are those areas from which aquifers are being replenished by surface waters. These areas are inherently vulnerable as they allow generally poorer quality surface water access to otherwise well-protected groundwater resources. It is important to recognize that recharge is essential for maintaining water levels within a given aquifer, as it is the only input of water. Recharge is happening throughout the region, as a given portion of rainfall is infiltrated through the soil surface. Outlining a recharge area, therefore, is largely a subjective exercise aimed at identifying those areas where the rate of recharge is considered to be high.

Understanding recharge in the SPR is a complex exercise, as there exists numerous aquifers, all of which have their own recharge areas and discharge areas. For overburden aquifers, which are for the most part unconfined, recharge is happening *in situ*. That is, meteoric water (precipitation) is infiltrating through the soil and near-surface quaternary sediment and eventually reaching the water table, effectively recharging those aquifers. The location of these recharge areas can thus be delineated by the existing distribution of these quaternary materials (see for example MOE Susceptibility mapping from 1985).

The more difficult task is in defining recharge areas for confined aquifers in the SPR, particularly the deep bedrock aquifer system. Bedrock aquifers are exposed only in a very small area throughout the planning region and, as a result, infiltrating surface water must pass through intermediate overburden aquifers before ultimately recharging the bedrock aquifer (an exception to this is sinkholes, which are discussed below in section 5.2.7). Effectively, recharge to the deeper bedrock aquifer is from overlying overburden aquifers, rather than meteoric water.

With this fact in mind, an experimental procedure was developed to try to identify those areas, where:

1. The geology allows for high rates of groundwater flow; and
2. The hydraulic conditions exist that allow for this flow to occur

In order to accomplish the first, the concept of geological "windows" was developed. Geological windows are areas where the grain-size of the materials is considered coarse enough to allow for rapid movement, or flow, of groundwater – sands and gravels. In order to determine where these "windows" exist, GIS data layers created as part of the MOE Groundwater studies were manipulated.

Rather than try and identify those areas with thick sequences of sand and/or gravel overlying the bedrock, a negative reasoning approach was utilized, as it is easier to identify areas with no significant silt or clay layer. The approach is listed below:

1. Ground Surface (m.a.s.l.) – Bedrock surface (m.a.s.l.) = Overburden thickness (m)
2. Overburden thickness (m) – Sand & Gravel thickness (m) = thickness of silt and clay (m)
3. Where Thickness of silt and clay < 1m = geological "windows"

This was done by subtracting the bedrock surface elevation from the ground surface elevation, which gives an estimate of the thickness of the overburden in any given location. From there, the thickness of sand and gravel, calculated in the MOE Groundwater studies, could be subtracted from the overburden thickness. The resultant overburden thickness should be composed of either silt or clay. For the purposes of this procedure, we considered anything less than 1m thickness of silt and clay to be insignificant (note that due to interpolation errors for all the data layers, there were some negative values which are theoretically impossible). Map 39 was created which outlines these geological "windows" in the overburden.

Having mapped where the geology is favourable for rapid groundwater movement, the second stipulation must be satisfied in order to delineate recharge areas that have hydraulic conditions that allow for recharge to occur. The first hydraulic condition is to allow for rapid infiltration of meteoric water and is generally satisfied by the geological "windows" procedure described above. Areas with no significant clay or silt layer are expected to have high infiltration rates. The second condition that must be satisfied is that water pressure in the shallow aquifers must be greater than the bedrock aquifers – where a downward gradient exists. This pressure manifests itself in the elevation of the water table and potentiometric surfaces, respectively. This was accomplished by subtracting the potentiometric surface (in masl) from the water table surface (in masl). Where this value is negative (i.e. the potentiometric surface is higher than the water table) it is assumed that water is being discharged from the higher pressure bedrock aquifer into the overburden aquifer (Map 40). Where this value is positive (i.e. the water table surface is higher than the potentiometric surface), it is assumed that water is being recharged into the bedrock aquifer from the overburden aquifer (Map 36).

In order to define our recharge areas, the areas where recharge is expected to occur to the bedrock aquifer from the overburden aquifer were intersected with the geological windows, creating areas where recharge to the bedrock aquifers is expected. Conversely, areas where discharge is expected were intersected with the geological windows in order to determine where significant discharge from the bedrock aquifer to the overburden may be occurring. These areas are shown in Map 40.

It is important to address the limitations of this procedure in order to understand the reliability of the information presented. Firstly, the data sources that are being utilized to develop this information are interpolated layers from regional scale studies and may not be accurate at a smaller scale. Accordingly, this information should be viewed from a regional perspective and should never replace good quality site-specific geological interpretation. Secondly, the primary data source for these layers is the WWIS, for which locations and particularly elevations are suspect, once again highlighting the regional scale at which this information should be viewed. The third and most salient limitation is an understanding that this procedure completely ignores any horizontal flow of groundwater in the overburden aquifers. In fact, recharge through the geological windows may originate from distal areas and flow through the overburden aquifer a significant distance (and time) before recharging the bedrock aquifer. The fourth and final limitation is that this is a non-quantitative, conceptual geological method for where recharge is occurring. Three-Dimensional groundwater modeling may provide more accurate and hydrogeologically significant recharge areas.

5.2.6.3 Hummocky Terrain

Hummocky terrain is a topographic term used to describe areas where surface water has little or no outlet. These areas are typically formed along moraine complexes in highly permeable, granular materials and are considered to be diagnostic of moraines. In these areas, the initial geometry of the material deposited during recession of the glaciers is unchanged by overland flow and surface water systems as most or all meteoric water is quickly infiltrated. As a result, these areas represent important areas of recharge.

Map 35 shows the identified areas of hummocky terrain within the planning region, overlain on the quaternary geology mapping. It is important to note that this information has not been field verified and is based solely on remote sensing techniques.

5.2.7 Karst Aquifers and Sinkholes

Karst is a term originally developed to describe the topography that develops in areas where significant dissolution of the bedrock has occurred. It has since been applied to any dissolution feature found in bedrock, and includes caves, solution-enhanced fractures (“grikes”) and sinkholes. Karst is typically associated with carbonate bedrock sequences that, due to their composition, are less resistant to dissolution. As a result of the carbonate composition of the Paleozoic rocks underlying the study area, karst features have been identified.

Karst features are significant with respect to vulnerability as they allow for rapid transport of water both within and between aquifers. This, by default, makes those aquifers with karst features more susceptible to contamination and less likely to have the capacity to mitigate any impact.

In the SPR, the most dramatic karst features are found in the form of sinkholes and caves (i.e. the well-known “Grotto” at Bruce Peninsula National Park). Sinkholes can loosely be defined as areas where surface waters are directly accessing the bedrock aquifers and are recognized by semi-circular depressions. These depressions are commonly situated in low areas and, as such, surface drainage is directed towards them. The situation has been further exacerbated by the use of sinkholes as outlets for agricultural drainage, post European settlement of the area.

In order to investigate the potential impacts of sinkholes on local water supplies a number of studies have been completed in the area. The first study focused on a large area of the southern portion of the SPR, in which sinkholes were identified and mapped, and information stored in a common database for further analysis. In addition, two boreholes were drilled in attempts to outline the geological characteristics and environments that favour development of sinkholes (WHI, 2003). An additional study was undertaken in order to document karst features throughout the northern portion of the planning region (WHI, 2004). The Ontario Geological Survey is currently investigating the extents and impacts of karst through the planning region (Brunton, 2006).

With respect to understanding vulnerable areas associated with sinkholes, the primary concern must be with the areas of the ground surface that drain into the sinkholes. These areas contribute water to surface water bodies that are in turn drained into a sinkhole, which allows for rapid infiltration into the bedrock aquifer and circumventing the process of infiltration through overburden materials. In addition, aquifers in which sinkholes have been identified are more likely to have additional karst-like properties, such as high permeabilities and enhanced fracture flow within them.

Sinkholes identified in the database and the areas which drain into them have been plotted on Map 37. These areas will require special consideration during the development of a Source Protection Plan.

5.2.8 Village Well Fields

Village well fields are areas that will require special attention in the development of a Source Protection Plan. Village well fields (a.k.a. "well clusters") are those areas/villages that have no municipally operated water system, and rather rely on numerous private/shared systems, owned and operated by the landowners. There exists significant debate over the number of wells/homes required to delineate a settlement as a village well field, or whether regard should be had for density of wells/homes within the settlement. This is further complicated by the fact that it is often difficult to define the boundary of an unorganized settlement. No definitive guidance has been established for the categorization of a settlement as a village well field.

These areas are of particular concern, largely because of the concentrated population, all utilizing on-site septic disposal systems. Private well head practices also tend to be less rigorous than that of municipal systems and poorly situated, improperly constructed wells present a dense distribution of potential pathways for the contamination of the aquifer. Once contaminated, nearby wells are likely to be contaminated without significant dilution due to the high density of homes in these areas. In essence, village well fields are of concern due to the fact that there exist significant threats, multiple potential pathways and a high population of receptors (i.e. water users) within a restricted area. These effects are further exacerbated by the fact that these areas have sporadic to non-existent treatment for potable water supplies. In effect, there exists the possibility of having no "barriers" for drinking water protection in these areas.

No comprehensive mapping of these areas has been made available for the development of a Source Protection Plan at this time. In addition and as previously mentioned, a standardized or recommended methodology for evaluating the potential vulnerability within village well fields does not exist. This should be considered a significant data gap that needs to be addressed prior to development of a Source Protection Plan.

5.3 Surface Water

There are 12 surface water intakes within the planning region. The source of water for all of the intakes is from Lake Huron (including Georgian Bay) with the exception of Hanover, which takes water inland from Ruhl Lake. The locations of the Great Lakes intakes are East Linton, Kincardine, Lion's Head, Meaford, Owen Sound, Southampton (2), Tobermory, Thornbury, and Wiarton. (Map 26).

Intake protection zones will define various areas (IPZ1, IPZ2, TWCA-total water contributing area) of vulnerability and will be created for each intake (Module 4). Each area will serve to identify potential threats to drinking water in each IPZ that is delineated (Module 5) to create a semi-quantitative risk assessment for the drinking water intakes (Module 6).

Delineating areas that are susceptible from surface water bodies is a more complicated task than for groundwater. In general, the natural susceptibility of a given watercourse is defined by the soils, slope, and precipitation patterns of its drainage area. The other major factor contributing to the susceptibility of a given watercourse is the land use and land management practices within its drainage area. Although soils, slope and precipitation data are readily available, susceptibility cannot be accurately defined without considering land use and land management. These data are often outdated and in constant flux, as land management practices vary seasonally, and between landowners.

Overall, three approaches for determining the susceptibility of a water course have been utilized, including: the use of the Universal Soil Loss Equation (USLE) and Modified USLE (MUSLE) developed for and utilized by the US Department of Agriculture (Wishmeier and Smith, 1978); the time of travel approach, whereby a given period of time for which water running off the ground takes to join a receiving watercourse is evaluated, and; the use of standard runoff hydrograph approaches to hydrologically model the drainage area. Of these approaches, the hydrologic modeling approach is the most fruitful and accurate.

In the SPR, very little data exists for surface water vulnerability, with the exception of the run-off index created as part of the My Land, Our Water (MYLOW) phase II pilot study completed by Saugeen Conservation and the Maitland Valley Conservation Authority, and floodplain mapping created for emergency management.

5.3.1 Floodplain Mapping

In general, those areas located closest to a watercourse are thought to contribute more to the water quality of the watercourse as a whole. In particular, those areas which are periodically flooded can be considered vulnerable areas, not only for the potential damage caused by flooding, but also due to the potential water quality impacts from flood waters over the lands themselves.

Floodplain mapping has been created for urban areas along most major branches of the Saugeen, Sauble, Bighead and Beaver Rivers for the purpose of emergency management and the development of zoning by-laws. These maps are created from hydraulic models that simulate water levels during flood events of varying magnitude. It has not been established what magnitude flood event, typically measured as a probability of occurrence within a given time period (i.e. a 1 in 5 year flood is less magnitude than a 1 in 100 year flood), should be considered to define a vulnerable area. Nor is it well understood what impacts a discrete flooding event has on the long term water quality of a watercourse.

Conservation Authorities administer their Development, Interference with Wetlands and Alteration to Shorelines and Waterways Regulations. The Regulations conform to the Generic Regulation (Ontario Regulation 97/04). The Regulation empowers Conservation Authorities to prevent or restrict development in areas where the control of flooding, erosion, dynamic beaches, pollution or the conservation of land may be affected by development. The intent is to ensure development does not place life and property at risk.

Although comprehensive, engineered mapping does not exist for all floodplains at this point, zoning by-laws have typically incorporated floodplains where they occur, using the regional (1 in 350 years) or 1 in a 100 year floods. As a result, very few new structures have been permitted within floodplains.

As part of source protection planning, floodplains could be considered and policies within them revisited in order to protect surface water bodies.

5.4 Summary

Vulnerable areas have been defined using several different methodologies for both surface and groundwater resources. It is important in the development of the source protection plan for the study area to not only delineate these areas as accurately as possible, but also to understand the methodologies used to derive them. These methodologies are necessarily limited by the data available in developing them, as well as the scale at which they were developed. It is essential, therefore, to consider these limitations during development of the plan.

5.5 Data and Knowledge Gaps for Vulnerable Areas

Surface water and groundwater large municipal drinking water supplies are well documented. Technical studies have addressed these facilities and clearly delineated water contributing areas surrounding these drinking water supplies. The details of these studies are outlined in Modules 3 and 4.

Knowledge gaps exist for private wells, cluster or village wells, and communal wells. Wellhead protection areas for these areas have not been completed. At this point, the study of these systems is outside the scope of the report.

<u>*Chapter 6*</u>

EXISITING SPECIFIC THREAT INVENTORIES

6.0 EXISTING SPECIFIC THREATS INVENTORIES

A detailed threats inventory has been established for existing WHPAs and IPZs from technical studies completed in 2006/2007 as a component of the SP Assessment Report. The studies were completed from a grant provided by the Ontario MOE. The results of this inventory are being prepared in report form. The findings of this report will be addressed in Module 5 of the Assessment Report. The inventory identifies specific threats (any type of contaminant) that currently, or has the potential to adversely affect water quality or quantity from ground or surface sources.

The threats identified are typically, but not exclusively, from anthropogenic sources, such as agricultural, industrial, or commercial activities. Essentially a threat is considered to be any type of contaminant or a land use activity that is associated with the degradation in water quality or quantity. This chapter will explore potential threats in the Source Protection Region

A threat is defined as any contaminant (chemical or pathogen), which directly or indirectly, negatively impacts, has the potential to negatively impact, or interferes with, the use or availability of any drinking water source from a water quality perspective. These threats may be associated with a land use activity or may be a naturally occurring process.

An issue is classified as the realization of a specific threat within a drinking water source. They are derived through a semi-qualitative risk assessment based on existing information and research on watershed characteristics, drinking water supply problems and local knowledge. In general, issues are identified in terms of water quality, where concentrations of contaminants have either exceeded or are approaching water quality guidelines (Ontario Drinking Water Standards, Provincial Water Quality Objectives, etc.).

A concern is similar to an issue except that it is not supported by scientific information (e.g. monitoring results). Concerns are introduced through public discussions, complaints, and one-on-one conversations, and in order to be classified as such, a concern must be documented in telephone conversations, watershed characterization correspondence, newspaper articles, or recorded in meeting minutes.

Threats to drinking water sources can exist in a variety of forms or can be intrinsically related to activities that occur both within and outside of the SPR. The following threats are categorized by land use activities and are based on general knowledge within the region. Threats to water quantity are outlined in the Conceptual Water Budget (2007).

6.1 Airborne Threats

The summer months along the Lake Huron shoreline can be subjected to adverse air quality conditions. Degradation of air quality from ground level ozone and particulate can present the possibility of unwanted settling of airborne material into water bearing systems. The actual chemicals can vary greatly, but airborne deposited dioxins have been measured along the Lake Huron shoreline (Internet, 2007; http://ijc.org/rel/boards/iaqab/pr9799/dioxin.html)

6.2 Agricultural

The SPR is predominately agricultural. Although many farms operate under management plans, the general activities of agricultural practices represent several types of threats to source drinking waters.

Livestock farming is the most common agricultural practice in the region. As a result, manure storage and application (microbial contamination) represents a threat to surface and ground sources of drinking water. Also, tile drainage, pesticide, fuel, and fertilizer storage (nitrates/phosphates) are typical for most types of farming and represent threats to drinking water sources. Stream sedimentation resulting from erosion of cultivated fields poses a threat to drinking water. The accumulation of antiquated farm equipment and other materials also represent sources of contamination.

6.3 Cemeteries

Cemeteries are a threat to groundwater drinking water sources, but the exact influence and amount of inputs to these sources is not well documented.

6.4 Septic Beds

Septic systems can pose a threat to drinking water. The intensity (village well fields vs. sparse cottage developments), construction of system, and condition of septic systems all can potentially contribute to adverse water quality conditions. Grey water can carry pathogens and metals which pose a threat to drinking water. Accelerated development along the Lake Huron shoreline also poses as a threat to drinking water sources.

6.5 Industrial and Manufacturing Activities

Limited information is available for the types and amount of contaminants associated with industrial and manufacturing processes. Power generation, food processing, wood processing, and aggregate extraction have the potential to alter desirable water quality and quantity conditions. All of these activities occur within the region and represent a knowledge gap for specific information on the types of threats and activities that occur.

6.6 Marinas

Marinas in proximity to surface water intakes pose a threat to drinking water. These facilities often have fuel storage and sewage storage/septic beds.

6.7 Municipal Infrastructure

Municipal facilities are required for normal operations within urban or sub-urban environments and these structures represent threats to drinking water sources. Traffic corridors (roads, trails, etc), landfills, wells (municipal and private), sewage treatment plants (wastewater) and sewage bypasses, storm water sewers, and road salt storage facilities all pose direct threats or the means to alter water quality conditions.

6.8 Wildlife

The effect of wildlife fecal matter has the potential to impact drinking water sources. The higher populations of gull and geese often exist near shoreline environments and, therefore, are more susceptible to increased concentrations of total coliforms and *E. coli*.

Chapter 7

IDENTIFIED ISSUES AND CONCERNS

7.0 SUMMARY OF IDENTIFIED ISSUES AND CONCERNS

7.1 Identified Issues

Water quality issues for this report are defined as a realization of a threat within a drinking water source. Documentation exists whereby concentrations of a particular contaminant either approach or exceed water quality guidelines, standards, or objectives.

Common issues for drinking water quality (both surface water and groundwater) in the planning region include barn yard runoff (manure), municipal bypass, wildlife, road salt, nitrates, blue-green algae, raw sewage spills, septic beds, sodium, pathogens (E. coli, Cryptosporidium, Giardia, etc), turbidity, and arsenic. Table 7.1 elaborates on specific threats associated with contaminant and/or land uses that have the potential, or have contributed to water quality issues. The threats/issues/concerns listed in Table 7.1 are not considered to be exhaustive, but reflect current readily available information. The information was presented in a tabular format instead of a map because the level of information required to produce a useful map was not available. Also, in some cases privacy issues could potentially prevent the information being displayed. Updates to this database will continue to reflect new issues and concerns.

7.2 Identified Concerns

Water quality concerns differ from issues in that an issue has supporting scientific evidence that a particular contaminant can make drinking water unpotable, while a concern may not. Water quality concerns are not substantiated by sufficient scientific information (i.e. monitoring, toxicology related studies, etc) that can unequivocally prove human health is at risk.

Water quality concerns encountered in the planning region include chlorine dioxide treatments at water treatment plants, the presence of pharmaceuticals, and biosolid spreading (Table 7.1).

TABLE 7.1 Summary of Threats, Issues, and Concerns for Drinking Water Sources.

Threats/ Issues/ Concerns	*Description*	*Contaminant*	*Category*	*Reporting Agency*	*Identified From:*	*Geographic Location*
Agricultural activities	Runoff from drainage/agricultural drains	Pathogens, fertilizers, pesticides, water quantity	Concern			Extensive
	Intensive livestock operations	Pathogens, nitrates, phosphates, chloride, chemical sprays for controlling insect, bacterial, viral, and fungal pests on livestock	Concern			Extensive
	Application of fertilizers	Nitrates, phosphorus to streams	Issue	MOE, Munic. of Brockton	Radio, TV, News print	Extensive
	Land application of manure	Nitrates, pathogens, algae	Issue	MOE, Munic. Of Brockton, Munic of Huron-Kinloss, Munic of Grey Highlands, Town of Hanover (algae)	Radio, TV, News print	Extensive

Threats/ Issues/ Concerns	Description	Contaminant	Category	Reporting Agency	Identified From:	Geographic Location
Agricultural activities	Manure storage/spillage	Antibiotics/hormones/pathogens	Issue	MOE	Walkerton Herald Times	Formosa
	Land use - rural riparian zone protection					
	Chemical storage	Pesticides, fertilizer residues				
	Pump out sewage: human waste, animal waste, sludge Biosolids/septage	Pathogens, nitrogen	Concern	Municipal Bylaws		Southgate, Melancthon
	Pesticides	Endocrine disruptors				
Urban Land Use	Storm water runoff, increased impermeability	Urban runoff, gasoline, oil, other petroleum products, road salt, pathogens	Concern (road salt)	Environmental Group	National Post	Extensive
	Municipal storm sewer outfalls - outlets		Concern	Sierra Legal Defense Fund		Extensive
	Pesticides	Endocrine disruptors				
	Municipal sewers and storm water drains	Municipal wastewater, sludge, treatment chemicals, urban runoff, gasoline, oil, road salt, pathogens				
	Land development around WHPAs					
	Leaking car oils (gas)	Oils, solvents				
	Cemeteries	Leachate - Formaldehyde, lawn care chemicals				
	Pharmaceuticals (medicines, prescriptions, etc.)	Hormones, etc.	Concern *MOE study shows no problems	MOE		Hanover
Waste Disposal	Fuel storage/dispersing	Pathogens, petroleum, organic and inorganic compounds				
	Old leaky oil tanks	Oils, solvents				
	Landfill sites	Leachate, organic and inorganic chemical contaminants, pathogens, nitrates, oils, metals				
	Old Landfill sites	Organic and inorganic chemicals, metals, oils				
	Bio Gas Systems	Manure storage	Concern	OMAFRA – limited info to class as concern	Radio	Mid-western Ontario
Natural Groundwater Factors	Municipal effluents - MOE standards	**(inclusive for entire natural groundwater section)** Fluoride, hardness, iron, sulphates, sodium, chloride, radionuclides, magnesium, lead, nitrates	Issue (sodium)	MOE-PGMN	Owen Sound Sun TImes	Tiverton, Paisley, Walkerton
	Sulphur in groundwater	Sulphur				Hanover area
	Unused wells (gas and water) that are not properly abandoned	Surface runoff, organic chemicals and metals, gasoline, road salt	Concern			Extensive
	Used wells not up to code	Surface runoff, organic chemicals and metals, gasoline, road salt				

Threats/ Issues/ Concerns	Description	Contaminant	Category	Reporting Agency	Identified From:	Geographic Location
Natural Groundwater Factors	Provincial Parks' water systems					
	private drillers/timber harvesting					
Septic Systems	Disposal of sewage sludge	Nutrients, pathogens, metals, pharmaceuticals, TP		Density, ages, locations, functionality, public knowledge of operational procedures	Health Unit, CURB data, Healthy Futures, MOE compliance sites,	Extensive
	Unknown condition of existing septic systems	Pathogens, metals, **(All parameters in this section)**	Issue	Munic. Of Huron-Kinloss, Grey Bruce HU	Inspection programs, Water Quality data sources, Building permits	Extensive
	Septic systems (private/cottages)	Pathogens, nitrates, chloride, sulfate, calcium, magnesium, potassium, and phosphate	Issue/Concern	Grey Bruce HU	Inspection programs, Water Quality data sources, Building permits	Extensive
	Overflows from sewage treatment plants or sewer systems					
	Private service in hamlets					
Pesticide and Chemical Use	Refueling near water	Oils, solvents, gasoline				
	Oil/chemical runoff from household use	Fuels, pesticides				
	Pesticide use in WHPA	Various				
	Excess nutrient/pesticide application for cosmetic use in urban areas	Fertilizers, herbicides, insecticides				
	Turbidity in Lake Huron WTPs from pesticides					
	Old vehicle storage/junk yards	Oils, solvents				
Aggregates	Aggregate extraction	**(For aggregates in general)** Increase in water temperature, sediment, fuel, hydrocarbons, pathogens		Monitoring data on effects of aggregate extraction done by external agency (not company)	Aggregate industry reports, MNR Operational Requirements	Extensive
	Aggregate below the water table					
	Quarries/pits					
	Existing pits operating below the water table					

Threats/ Issues/ Concerns	Description	Contaminant	Category	Reporting Agency	Identified From:	Geographic Location
Destruction or Reduction of Wetlands	Wetland destruction through development and use (e.g. ATV, wildlife bioaccumulation etc.)	Various		Field studies/local evaluation of wetlands on water quality standpoint (more extensive than is currently done),	Evaluated wetlands, provincial wetland reports/evaluations,	Extensive
	Marinas	Diesel fuels, oil, wood preservative and treatment chemicals, paints, waxes, varnishes, automotive wastes				
Industrial	Exposure of aquifer to air pollution	Various				
	Industrial discharge into a watercourse	Metals, chemicals		Reporting frequency, non-compliance	MOE - permits, enforcement, monitoring	Point source, generally urban
	Oil tanks, chemicals, Heavy machinery	Nitrate, above-ground and underground tanks: Heating oil, diesel fuel, gasoline, other petroleum products, other commercially used chemicals				
	Brownfields					
	Shipping	Ballast water – invasive species	Concern	Lake Huron Centre for Coastal Conservation	Radio	Lake Huron Shoreline
	Other industrial sites for storage/use of chemical i.e. Dry Cleaners	Solvents (perchloroethylene, petroleum solvents, Freon), spotting chemicals (trichloroethane, methylchloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate)				
Water Quantity	Municipal takings		Issue	Town of Hanover		Hanover
	Leaking water lines		Issue	Munic. Of Brockton		Walkerton
	Commercial	Water bottlers	Concern			Extensive

ACRONYMS

Acronym	*Meaning*
Alka	Alkalinity
ANSI	Area of Natural and Scientific Interest
AO	Aesthetic Objective
AVI	Aquifer Vulnerability Index
BioMAP	Bioassessment of Water Quality
CA’s	Conservation Authorities
$CaCO_3$	Calcium Carbonate (Hardness)
CEQG	Canadian Environmental Quality Guidelines
Cl	Chloride
CLI	Canadian Land Inventory
CNR	Candidate Nature Reserve
Cu	Copper
CWQI	Canadian Water Quality Index
DFO	Department of Fisheries and Oceans
DWIS	Drinking Water Information System
DWQG	Drinking Water Quality Guidelines
DWS	Drinking Water System
DWSP	Drinking Water Surveillance Program
FN	First Nations
FTU	Formazine Turbidity Unit
GIS	Geographic Information System
GLIS	Great Lakes Index Stations Monitoring
GRCA	Grand River Conservation Authority
GSC	Grey Sauble Conservation (Grey Sauble Conservation Authority, formally GSCA)
GTA	Greater Toronto Area
GUDI	Groundwater Under Direct Influence
HadCM3	Hadley Centre Coupled Model, version 3
IMAC	Interim Maximum Acceptable Concentration
IPZ	Intake Protection Zone

Acronym	***Meaning***
ISI	Intrinsic Susceptibility Index
LIO	Land Information Ontario
MAC	Maximum Acceptable Concentration
MI	Macroinvertebrates
MMAH	Ministry of Municipal Affairs and Housing
MNBP	Municipality of Northern Bruce Peninsula
MNDM	Ministry of Northern Development and Mines
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MUSLE	Modified Universal Soil Loss Equation
MVCA	Maitland Valley Conservation Authority
MYLOW	My Land, Our Water
NCC	Nature Conservancy of Canada
NGO	Non-Governmental Organization
NO3	Nitrate
NO3-N	Nitrate-Nitrogen
NRVIS	Natural Resources Values Information System
NTU	Nephelometric Turbidity Units
NVCA	Nottawasaga Valley Conservation Authority
OBBN	Ontario Benthos Biomonitoring Network
ODWS	Ontario Drinking Water Standards
OG	Operational Guideline
OGDE	Ontario Geospactial Data Exchange
OGS	Ontario Geological Survey
OMAF	Ontario Ministry of Agriculture and Food
OMAFRA	Ministry of Agriculture, Food and Rural Affairs
PCM	Parallel Climate Model
PGMN	Provincial Groundwater Monitoring Network
PTTW	Permit to Take Water
PWQMN	Provincial Water Quality Monitoring Network
PWQO	Ontario Provincial Water Quality Objectives

Acronym	*Meaning*
SC	Saugeen Conservation (formally known as Saugeen Valley Conservation Authority, SVCA)
SOLRIS	Southern Ontario Land Resource Information System
SP	Source Protection
SPA	Source Protection Area
SPC	Source Protection Committee
SPR	Source Protection Region
SSI	Shallow Susceptibility Index
SWAT	Surface to Well Advection Time
SWI	Surface Water Intakes
SWP	Source Water Protection
TOT	Time of Travel
TP	Total Suspended Solids
TSS	Total Suspended Solids
Turb	Turbidity
TWCA	Total Water Contributing Area
USLE	Universal Soil Loss Equation
WHCZ	Wellhead Capture Zones
WHPA	Wellhead Protection Areas
WS	Water System
WTP	Water Treatment Plant
WWIS	Water Well Information System
Zn	Zinc

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APPENDIX A

SUMMARY TABLE

KNOWLEDGE AND DATA GAPS

TABLE A.1 – Summary of Knowledge and Data Gaps

WC Deliverable	Data Set Name	Data Gap Problem	Comment
Fish Species		Too sparse	Lack of thermal and fish population studies
Benthic Species		Too sparse	GSCA and MNBP not active in Ontario Benthos Biomonitoring Network
Species-at-risk		Too sparse	Little to no info on spatial extent of species or habitats at risk
Invasive Species		Too sparse	Little to no info on spatial extent of invasive species or habitats at risk
Wells	MOE Wells	Spatially inaccurate; partially populated	Well type not classified (municipal, communal, etc.) per Regulations 170/03 and 252/05 of SDWA
Forestry		Dated information on forest cover	Lack of recent information on extent of forest cover and composition

WC Deliverable	Data Set Name	Data Gap Problem	Comment
Water Quality		Benthic data is limited	• Unable to assess aquatic health of stream systems. • More representative of long–term water quality
Water Quality	PWQMN	Spatial availability of monitoring stations for watersheds	• No active monitoring in NBP • Watersheds too large to capture potential issues
Water Quality	PWQMN	Stream discharge data not collected at monitoring locations	• Relate stream discharge and concentrations to determine loadings
Water Quality	PGMN	Spatial/temporal availability of data	• Not enough data to identify trends

		is limited	
Water Quality	DWSP	Water chemistry not available for all DWS	• Voluntary program which does not cover all DWS in planning region

Water Quantity Data and Knowledge Gaps

The primary data gap for understanding water use within the area lies within quantifying actual takings from the PTTW database as well as for private domestic supplies. Attempts have been made to try and corroborate permitted takings in the past, but have proven less than fruitful as they are voluntary in nature. Large scale water users have recently been asked to submit to the MOE actual pumping rates as conditions of their permits and for analysing any future permit renewals. This data, however, has not been made available for this report. It is anticipated that this will be made available in the future and incorporated in this document and any water budgeting activities. The information has been requested from the Ministry of Environment.

Quantifying Municipal takings is currently being undertaken as a part of the Municipal Technical studies being completed by outside consultants. This data will also be available in the near future and can be incorporated into this document and any water budgeting activities. Quantifying water takings form private domestic wells is a large data gap, largely due to omissions and errors within the provincially-maintained Water Well Information System (WWIS). At this time, it is not anticipated that this data gap will be addressed locally, largely due to the magnitude of the work and expertise required to update this database.

Vulnerable Areas Data and Knowledge Gaps

Surface water and groundwater large municipal drinking water supplies are well documented. Technical studies have addressed these facilities and clearly delineated water contributing areas surrounding these drinking water supplies. The details of these studies are outlined in Modules 3 and 4.

Knowledge gaps exist for private wells, cluster or village wells, and communal wells. Wellhead protection areas for these areas have not been completed. At this point, the study of these systems is outside the scope of the report.

APPENDIX B

WATERSHED RESOURCE DOCUMENTS

Title	Date	Description	On File
Fisheries - Sydenham River (Lower): Chinook Habitat Assessment and Productivity Estimate. P. Morrison and C.D. Wren. B.A.R Environmental. Ontario Ministry of Natural Resources, Owen Sound District.	Sept. 1989	This study includes (A) a survey of the lower Sydenham River and its tributaries (Weavers Creek and Armstrong Creek) that determines the area of suitable spawning habitats for chinook salmon, (B) recommends appropriate numbers of adult chinook salmon that should be allowed access to the Sydenham River and (C) Uses published values from scientific literature to estimate the numbers of chinook salmon alevin and smolt that can be produced from the available habitat. S: The study area comprises the lower Sydenham River and its tributaries (Weavers and Armstrong's Creeks) between the Mill Dam and the base of Inglis Falls above the city of Owen Sound.	OMNR, Owen Sound
Fisheries - Sydenham River (Lower): Stream Habitat Assessment. Ron Maher. Grey Sauble Conservation Authority.	1984	The objectives of this study were: (A) collect information pertaining to the quality and quantity of fish habitat in the lower Sydenham River (B) produce maps of the river detailing the fish habitat (C) document erosion and sedimentation problems (D) provide data for assessing changes in aquatic habitat quality (E) provide data which can be used in planning management programs for the Sydenham River. S: The habitat assessment of the Sydenham River was confined to the stream below Inglis Falls.	GSCA
Fisheries - Fish Habitat Map. Ontario Ministry of Natural Resources. Owen Sound.		This detailed habitat map shows stream beds, substrate, vegetation, stream flows and terrain characteristics. Map Scale 1 : 474	OMNR, Owen Sound
Hydrology - Hydrology Stream Gauge Analysis	June 1989	A Report On Low Flow Characteristics in Ontario. Cumming and Cockburn Limited. Report for the Ministry of Environment. .	
Water Quality - Water Quality and Biology of Owen Sound Harbour. Ministry of Environment. Water Resources and Assessment Unit, Southwestern Region.	April 1980	This report compiles small surveys conducted in Owen Sound Harbour during the summer months of 1975, 1976, and 1978. The surveys document the existing water quality in Owen Sound Harbour. This documentation includes the analysis of water chemistry and bacteriology, sediment quality, aquatic plants and bottom dwelling invertebrate organisms. S: Mouth of Sydenham River along the Southeastern Shoreline of the Owen Sound Harbour. Also Mouth of the Pottawatomi.	GSCA
Water Quality - Documentation of the Nuisance Alga Cladophora. Report for theMinistry of Environment. John Westwoodand M. Johns, Technical Assessment Section.	June 1992	This report was produced to document evidence of degraded water quality in the Sydenham River. Increased nutrient loadings have resulted in the unfortunate arrival of nuisance growths of the alga Cladophora. Includes water sample analysis, effects of Cladophora, nutrient sources, summary and recommendations. S: The Sydenham River flows 35 km from its source, Williams Lake in Holland Township, to the City of Owen Sound.	GSCA
Water Quality - Sydenham River Water Quality. Henderson, Paddon and Associates. Report for the Sydenham Sportsmen Association.	Feb. 1990	Objectives of this water quality study were to determine the impacts of decaying Chinook Salmon and make recommendations as to whether the number of salmon allowed to migrate up the Sydenham River should be restricted. S: Sydenham River.	OMNR, Owen Sound

Title	Date	Description	On File
Fisheries - Summer Creel Census and Stocking Assessment. Ontario Ministry of Natural Resources.	1983		OMNR, Owen Sound
Water Quality - Water Quality Assessment. Ontario Ministry of Natural Resources.	1993		OMNR, Owen Sound
Water Quality - Winter Water Chemistry. Ontario Ministry of Natural Resources.	1984		OMNR, Owen Sound
Wetlands - Inventory. Ontario Ministry of Natural Resources.			OMNR, Owen Sound
Wetlands - Contour Map. Ontario Ministry of Natural Resources.			OMNR, Owen Sound
Fisheries - Location of Trap Nets Map. Ontario Ministry of Natural Resources.	1970		OMNR, Owen Sound
Erosion - Preliminary Erosion and Sedimentation Control Study: Sydenham Township. Triton Engineering Services. Report for Grey Sauble Conservation Authority.	Oct. 1986		GSCA
Fisheries - Report: A Public Fishing Area. Ontario Ministry of Natural Resources.	1968		OMNR, Owen Sound
Fisheries - Correspondence re: Fish Sanctuary. Ontario Ministry of Natural Resources.	1973		OMNR, Owen Sound
Hydrology - Stormwater Study of Annexation and Industrial Park Areas City of Owen Sound. Henderson, Paddon and Associates Ltd. Owen Sound.	Dec. 1988	The emphasis of this study was to assess stormwater management alternatives which would control both the stormwater quality and quantity of water to predevelop peak flows. S: Telfer Creek, Kenny Drain, Owen Sound Industrial Park.	
Fisheries - Class Environmental Assessment for Chesley Lake Walleye Spawning Habitat Assessment Program. Ontario Ministry of Natural Resources.	1988		OMNR, Owen Sound
Fisheries - Daily Trap Netting Summaries. Ontario Ministry of Natural Resources.	1987		OMNR, Owen Sound
Fisheries - Spawning Rehabilitation Project. Ontario Ministry of Natural Resources.	1988-1989		OMNR, Owen Sound
Fisheries - Fish Growth Studies Report. Ontario Ministry of Natural Resources.	1958		OMNR, Owen Sound
Fisheries - Creel Census Program. Charlotte Kobelka. Ontario Ministry of Natural Resources.	1986		OMNR, Owen Sound
Fisheries - Fisheries Assessment, Aquatic Habitat Inventory / Assessment and Summer Creel Census of Chesley Lake. John Almond. Ontario Ministry of Natural Resources.	1987		OMNR, Owen Sound
Water Quality - Water Quality Assessment of Chesley Lake. Bruce Hawkins. Ministry of Environment. Water Resources Assessment Unit.	May, 1989		MOE, London
Fisheries - Results of a volunteer creel census program. Ontario Ministry of Natural Resources.	1986		OMNR, Owen Sound

Title	Date	Description	On File
Fisheries - Fish Habitat Assessment Map. Ontario Ministry of Natural Resources. Owen Sound.		This detailed habitat map shows stream beds, substrate, vegetation, stream flows and terrain characteristics. Map Scale 1:474	
Fisheries - Electro-fishing Survey. Ontario Ministry of Natural Resources.	1987		OMNR, Owen Sound
Fisheries - Gradient Profile. Ontario Ministry of Natural Resources.			OMNR, Owen Sound
Fisheries - Water Chemistry Results. Ontario Ministry of Natural Resources.	1983		OMNR, Owen Sound
Fisheries - Chinook Salmon Molting Investigation. Ontario Ministry of Natural Resources.	1983		OMNR, Owen Sound
Fisheries - Fish Habitat Map. Ontario Ministry of Natural Resources. Scale 1:474.	1984	This detailed habitat map shows stream beds, substrate, vegetation, stream flows and terrain characteristics. Map Scale 1:474	OMNR, Owen Sound
Fisheries - Rainbow Trout Population Assessment. Ont. Ministry of Natural Resources.	1974, 1978		OMNR, Owen Sound
Fisheries - Chinook Salmon Molting Study. Ontario Ministry of Natural Resources.	1985		OMNR, Owen Sound
Erosion - Erosion Control Study. Gamsby and Mannerow Limited. Report for the Sauble Valley Conservation Authority.	1979		GSCA
Fisheries - Fish Habitat Assessment Map. Ontario Ministry of Natural Resources. 1:474.	1986		OMNR, Owen Sound
Fisheries - Rainbow Trout Habitat Assessment and Population Assessment Programs of Streams and Rivers. Ontario Ministry of Natural Resources. Owen Sound.	1983-1987		OMNR, Owen Sound
Fisheries - Lake Inventories. Ontario Ministry of Natural Resources. Owen Sound.	1983		OMNR, Owen Sound
Fisheries - Trap Netting Program. Ontario Ministry of Natural Resources.	1981, 1983, 1984		OMNR, Owen Sound
Waterfowl - Waterfowl Management Proposal. T.R. Gadawski. Ducks Unlimited.	Oct. 1980	This five page report gives a description of the study area, discusses management issues and makes recommendations for future management programs.	
Wetland - Completed Project Sheet. Ducks Unlimited.	1982		GSCA
Wetland - 60" Aerial Photos. Ducks Unlimited & Grey Sauble Conservation Authority.	June 1981		GSCA
Wetland - Keppel Township Study. Grey Sauble Conservation Authority.	1984-1986		GSCA
Wetland - Reconnaissance Level Survey. J. Johnson. Ontario Ministry of Natural Resources.	1984		OMNR, Owen Sound
Wetland - (Big Mudd) Wetland Assessment. Grey Sauble Conservation Authority.	Sept. 1987		GSCA
Wetland - (Little Mudd Lake) Inventory. Ontario Ministry of Natural Resources. .	1969		OMNR, Owen Sound

Title	Date	Description	On File
Wetland - (Big Mudd) Inventory. Ontario Ministry of Natural Resources.	1966, 1974		OMNR, Owen Sound
ANSI - Property Owners List. Ontario Ministry of Natural Resources.	Jan. 1987		OMNR, Owen Sound
ANSI - Checklist. K. Lindsay. Ontario Ministry of Natural Resources.	No date		OMNR, Owen Sound
ANSI - Check sheet. J. Johnson. Ontario Nature Reserves Program and Ontario Ministry of Natural Resources.	Dec. 1980		OMNR, Owen Sound
ANSI - Reconnaissance Level Survey. J. Johnson. Ontario Ministry of Natural Resources.	1984		OMNR, Owen Sound
Land Use - An Impact Assessment of the Bighead River Adjacent to the Meaford Centre Street Waste Disposal Site. Ministry of the Environment.	Dec. 1991	This report documents any possible impacts that the landfill site may be having on the Big Head River.	MOE, London, Contact Bruce Hawkins.
Water Quality - Bighead River Water Quality Inventory. Ontario Ministry of Natural Resources. Owen Sound.			OMNR, Owen Sound
Water Quality and Hydrology - Bighead River Water Quality and Hydrology. Ministry of the Environment, Water Resources Assessment Unit Southwestern Region.	1982	This study establishes an information base for future water resource management and any needed pollution abatement activities. This generalized survey includes information on hydrology, water temperature, chemical and bacterial data, storm event, and bottom fauna. S: The Bighead flows into the Georgian Bay at Meaford and drains an area of 340 square kilometres.	GSCA
Watershed Study - Bighead River Watershed Study. Todd Starr and Craig Betts. Environmental Youth Corps. Grey Sauble Conservation Authority & East Grey Anglers and Hunters.	1992	The goals of this study were to: identify areas along the Bighead river with degraded water quality and fish habitat, determine the casual factors involved in degradation, prioritize areas where cooperative remedial measures would be beneficial.	GSCA
Contour map. Ontario Ministry of Natural Resources.			
Erosion - Erosion Control in the Town of Meaford. Report for the North Grey Region Conservation Authority. Ainley and Associates Ltd.			GSCA
ESA - Reconnaissance Level Survey. Ontario Ministry of Natural Resources.	1984		OMNR, Owen Sound
ESA - Checklist. Niagara Escarpment Commission.			
Fisheries - Correspondence re: Highway 26. Ontario Ministry of Natural Resources..	1986		OMNR, Owen Sound
Fisheries - Invertebrate Identification Ontario Ministry of Natural Resources.	1972		OMNR, Owen Sound
ANSI - Life Science Representation Requirement for Upland Forest Habitats in Site District 6-5: A Comparative Study of Robson Lakes, Kinghurst Forest and Traveston Creek Forest. V.R. Brownell. Ontario Ministry of Natural Resources.	1981		OMNR, Owen Sound
ESA - Reconnaissance Level Survey. Eagles. Ontario Ministry of Natural Resources.	1983		OMNR, Owen Sound

Title	Date	Description	On File
ESA - Reconnaissance Level Survey. J. Johnson. Ontario Ministry of Natural Resources.	1984		OMNR, Owen Sound
ESA - Checklist. D.G Cuddy. Niagara Escarpment Study.	April 1976		
Fisheries - Fish Population Assessment. Ontario Ministry of Natural Resources.	1979		OMNR, Owen Sound
Fisheries - Inventory, Ontario Ministry of Natural Resources.	1979, 1983		OMNR, Owen Sound
Erosion - Pottawatomi River Slope Stabilization and Habitat Enhancement Project. Ontario Ministry of Natural Resources, Owen Sound District.	1984, 1987	This project proposes to protect degraded sections of the Pottawatomi River by using cedar logs, limestone rock, steel t-bars or wire to create in stream habitat. S: The project study area consists of the reaches of the Pottawatomi River upstream of Jones Falls in Derby Township, Grey County.	GSCA
Fisheries - Chinook Salmon. S. J. Kerr et al. Ontario Ministry of Natural Resources.	March 1988		OMNR, Owen Sound
Water Quality - Water Quality Bio Maps: Biological Monitoring and Assessment Program for Ontario. Ronald Griffiths. Ministry of Environment. Water Resources Assessment Unit. London.	1992		
Fisheries - Lake Inventory. Ontario Ministry of Natural Resources. Owen Sound.	1983		
Wetlands - Property Owners List. Ontario Ministry of Natural Resources.	Jan. 1987		
Hydrology - Master Drainage Plan Final Report. Cumming, Cockburn and Associates. Report for the Grey Sauble Conservation Authority.	May 1992	This report presents and ecological analysis and Master Drainage Plan for the Bannister Drain Watershed. It is a comprehensive review based on the interrelationships of the physical, biological and social features of the watershed and their cumulative impacts. S: The Bannister Drain watershed is a relatively small tributary to the Sauble River located in the west central portion of Amabel Township.	GSCA
Fisheries - Fish shocking test. Ontario Ministry of Natural Resources.	1966.		OMNR, Owen Sound
Fisheries - Stream Assessment With Parameters Affecting Fish Habitat Examined and Rehabilitative Or Enhancement Techniques Suggested. Grey Sauble Conservation Authority.			GSCA
Fisheries- Inventory. Ontario Ministry of Natural Resources.	1974		OMNR, Owen Sound
Fisheries - Creel Census Raw Data. Ontario Ministry of Natural Resources.	1962		OMNR, Owen Sound
Fisheries - Limnological Survey. Ontario Ministry of Natural Resources.	1983-1984		OMNR, Owen Sound
Wetlands - Wetland Assessment. Grey Sauble Conservation Authority.			
Wetland - Southern Ontario Provincially and Regionally Significant Wetlands. V. Glooschenko et al., World Wildlife Fund and Ontario Ministry of Natural Resources.	1987		OMNR, Owen Sound
Wetland - Wetland Assessment. Grey Sauble Conservation Authority			GSCA
Wetland - Property Owners List. Ontario Ministry of Natural Resources.	Jan. 1987		OMNR, Owen Sound

Title	Date	Description	On File
Wetlands - Species Identification Map 1:10,000. Ontario Ministry of Natural Resources.			OMNR, Owen Sound
Fisheries - A Stream Assessment With Parameters Affecting Fish Habitat. John Bittorf. Grey Sauble Conservation Authority.	Summer 1988		GSCA
Fisheries - Habitat Evaluations and Community Evaluations. John Morton and Blake Smith personal communication. Ontario Ministry of Natural Resources.	1992		OMNR, Owen Sound
Wetlands - Aerial Maps. Ducks Unlimited and Grey Sauble Conservation Authority.	June 1986		GSCA
Wetlands - Completed Project Sheet. Ducks Unlimited.	1985		
Waterfowl - Rankin Resources Management Area: Waterfowl Marsh Project. Ministry of Natural Resources, Owen Sound District.	1986	The purpose of this project was to create a prime wetland condition and provide the habitat necessary to increase the populations of waterfowl and many other related wildlife species in addition to improving recreational and educational opportunities.	OMNR, Owen Sound
Wetland - Rankin Resources Management Area: Master Plan. Ministry of Natural Resources.			OMNR, Owen Sound
Wetland - Rankin Resources Management Area: Background Document. Ministry of Natural Resources, Owen Sound District.	Sept. 1981		
Wetland - Rankin Wildlife Management Area. Ministry of Natural Resources, Owen Sound District.	Mar. 1975		OMNR, Owen Sound
Wetland - Rankin Project 60" Aerial Maps. Ducks Unlimited.	Jan. 1985		OMNR, Owen Sound
Wetlands - Reconnaissance Level Survey. J. Johnson. Ontario Ministry of Natural Resources.	Mar. 1986		OMNR, Owen Sound
Drainage - Sauble River Drainage Study. Report for the Sauble Valley Conservation Authority. Ecologistics Limited.	Dec. 1984	This report presents the results of a watershed drainage study that identified both positive and negative consequences of land drainage on the resources of the Upper Sauble River Watershed. The study (a) documents and analyzes historical trends in drainage work, and in stream ground water supply, water quality and aquatic habitats (b) provides information on the possible impacts of potential future drainage changes (c) provides existing and future drainage alterations. S: The study area includes resources along the 360 square kilometre Sauble River Watershed upstream of Highway 21.	GSCA
Erosion - Erosion Inventory Report. Sauble Valley Conservation Authority.	Summer 1984	This study identifies areas of erosion and classifies their priority for remedial work. S: Sauble River, Rankin River, Indian River, un-named creek in Keppel Township.	GSCA
Erosion - Erosion at the Sauble River Mouth. Report to the Sauble Valley Conservation Authority. Henderson, Paddon and Associates.	Dec. 1984	This study discusses issues related to channel changes such as property erosion, property damage to boats and safety. It proposes the construction of a dike to provide a stable barrier to limit the river cross sections and smoothly transition the river into the lake. S: Mouth of the Sauble River at Sauble Beach, Township of Amabel, County of Bruce.	GSCA
Fisheries - Habitat and Community Evaluations. John Morton and Blake Smith personal communication. OMNR.	1992	S: Various Lakes including: Arran, Berford, Boat, Eugenia, Charles, Williams, Spry, Sky, Shallow, Robson, McNabb, McCullough, Isaac.	OMNR, Owen Sound

Title	Date	Description	On File
Floodline - Sauble River Flooding. Report to the Sauble Valley Conservation Authority. Henderson, Paddon and Associates.	Dec. 1984	This study discusses issues related to channel changes such as property erosion, property damage to boats and safety. It proposes the construction of a dike to provide a stable barrier to limit the river cross sections and smoothly transition the river into the lake. S: Mouth of the Sauble River at Sauble Beach, Township of Amabel, County of Bruce.	GSCA
Floodline - Sauble River Floodline Mapping Study Final Report. Report for the Grey Sauble Conservation Authority. Cumming Cockburn Limited.	Mar. 1990	The scope of this investigation, associated with the undertaking of the floodline study, includes: background information, channel identification, flooding characteristics, hydrologic investigations, hydraulic investigations, flood level predictions, encroachment analysis. S: the Grey Sauble Conservation Authority Watershed lies within Bruce and Grey Counties and includes the following municipalities, Town of Wiarton, Villages of Hepworth, Shallow Lake and Tara, and Townships of Albemarle, Amabel, Arran, Derby, Elderslie, Keppel and Sullivan. In addition, the region includes more than 30 hamlets of various sizes.	
Floodline - Sauble River Hydraulic Analysis: Floodline Mapping. Report for the Grey Sauble Conservation Authority. Cumming and Cockburn Limited.	Oct. 1989	The main purpose of the hydraulic analysis is to transform peak discharge estimates into flood profiles along the study reach. This is undertaken by utilizing a mathematical model to simulate water surface profiles corresponding to the 2, 5, 10, 20, 50, 100 year and Regional flood events. S: Various locations including: Sauble River/ Falls near County Road 21.	GSCA
Floodline - Sauble River Hydrology Study: Floodline Mapping. Report for the Sauble Valley Conservation Authority. Crysler and Lathem Limited.	Sept. 1979	This study investigates the return of flood flows at various points in the watershed and that of the major tributaries. S: The Sauble River Basin lies within Bruce and Grey Counties and the following municipalities: Town of Wiarton, Villages of Hepworth, Shallow Lake and Tara, Townships of Albemarle, Amabel, Arran Derby, Elderslie, Keppel and Sullivan. In addition, the region includes more than 30 hamlets of various sites.	GSCA
Floodline - Sauble River Topographic Mapping Inspection Report. Report for the Grey Sauble Conservation Authority. Cumming and Cockburn Limited.	Dec. 1988	This mapping check report is in conjunction with the Floodline Mapping study completed in 1990. This report compares spot elevations, identifiable contour crossings and horizontal controls. Also provided are methodologies, ground control point descriptions and other essential information. S: Sauble River Watercourse.	
Hydrology - Sauble River (Sauble Falls) Hydrology Stream Gauge Analysis: A Report On Low Flow Characteristics in Ontario. Cumming and Cockburn Limited. Report for the Ministry of Environment.	June 1989		
Hydrology - Sauble River Hydrologic Study. Conservation Management Systems. Report for the Grey Sauble Conservation Authority.	Nov. 1985	This report presents the results for future agricultural land drainage development and its effect on stream flows in the Sauble River Watershed upstream of Allenford. S: The study area includes resources along the 360 square kilometre Sauble River Watershed upstream of Highway 21.	GSCA
Water Quality - Sauble River Water Quality and Biology. Ministry of the Environment.	Jan. 1980	The purpose of this study is to assess the discharges form Gay Lea Foods Co. Ltd. upon the Sauble River. Results: disruption of aquatic plant community, elevated total phosphorus and degraded water quality and biology.	MOE, London
Water Quality - Sauble River (Curb Plan) Water Quality: Clean Up Rural Beaches. Report for the Ontario Ministry of the Environment. Grey Sauble Conservation Authority.	1989	The objective of this program is to identify the relative impact of pollution sources, and develop a course of action leading to the restoration and long term maintenance of acceptable water quality at Sauble beaches. The primary objective of each local study is to identify the relative impact of pollution sources, their pathways to beaches, and to develop a Clean Up Rural Beaches (CURB) plan specific to the watershed upstream of each beach. S: Sauble River Watershed.	GSCA

Title	Date	Description	On File
Water Quality - Sauble River Water Quality: Rural Beaches Impact Study Annual Reports. Reports for the Ministry of the Environment. Grey Sauble Conservation Authority.	1986-1989	This study investigates and recommends ways to alleviate bacteria; contamination in the Sauble River System. The four year plan has pin pointed the areas of prime concern within the Sauble River Watershed where future remedial action efforts will be focused. S: The Sauble River System and its tributaries.	GSCA
Fisheries - Fish Stocking Receipts and Requests. Ontario Ministry of Natural Resources.	1971		OMNR, Owen Sound
Fisheries - Fish Stocking Records. Ontario Ministry of Natural Resources.	1957		OMNR, Owen Sound
Wetland - Species Identification Map 1:10,000. Ontario Ministry of Natural Resources.			OMNR, Owen Sound
Erosion - Sydenham River Erosion Control Project: Slope Stability and Erosion Study. Report for Proctor and Redfern. Gartner Lee Associates Limited.	Jan. 1981	This report documents the existing physical conditions, provides an analysis of slope stability and comments on possible remedial measures for erosion problems occurring at the mouth of the Sydenham River. S: The study area is located near the mouth of the Sydenham River in the City of Owen Sound. It extends from approximately 60 meters upstream of the 8th Street bridge, downstream to the 10th Street bridge.	GSCA
Erosion - Sydenham River Erosion Control Study. Report for the North Grey Region C.A.		This study assesses the erosion problems along a specific portion of the Sydenham River. Through reconnaissance survey and soils analysis problems are identified. Included are preliminary designs and cost estimates for remedial works, a cost-benefit analysis. and recommendations. S: The study area is located near the Mouth of the Sydenham River and extends from the Tenth Street Bridge upstream to approximately 60 metres upstream of the Eighth Street Bridge.	GSCA
Fisheries - Chinook Salmon Redd Site Characteristics and Spawning Activity. S.J Kerr and S.G. Murray. Ontario Ministry of Natural Resources, Owen Sound District.	Dec. 1986	By monitoring fish movements and spawning activity, this study attempts to raise the issue of the potential of spawning competition between individual fish species of the Great Lakes. The study area is comprised of the lower Sydenham River (below Inglis Falls) and two of its tributaries Armstrongs Creek and Weaver / Neath Creek.	OMNR, Owen Sound
Fisheries - Rainbow Trout Assessment Program - Sydenham, Bighead, Pottawatomi, Beaver Rivers. Ontario Ministry of Natural Resources. Owen Sound.	1983-1987		OMNR, Owen Sound
Water Quality - Sauble River Clean Up Rural Beaches (CURB) Annual Reports. Reports for the Ministry of the Environment. Grey Sauble Conservation Authority.	1992-1995	Reports summarize remedial projects, water quality analysis, case studies and landowner participation	GSCA
Everest Nurseries Quarry Application			GSCA
Water Quality - Thermal Stability Throughout GSCA Watershed	2002	Thermal Stability of area streams using DFO Protocol	GSCA Watershed Dbase
Water Quality - Thermal Stability Throughout GSCA Watershed	2003	Thermal Stability of area streams using DFO Protocol	GSCA Watershed Dbase

Title	Date	Description	On File
Erosion - Bighead River Erosion Control in the Town of Meaford. Report for the North Grey Region Conservation Authority. Ainley and Associates.	May 1979	This study is concerned with the erosion prone areas on the Bighead River in the Town of Meaford. It investigates the extent of erosion and possible causes thereof through maps, aerial photography, topographic survey and reconnaissance survey. S: Erosion prone areas in the Town of Meaford between the Bakeshop Bridge and the Bighead River Bridge on Highway No. 26.	GSCA
Floodline - Clarksburg Floodline Mapping, Beaver River Watershed. Report for the North Grey Region Conservation Authority. MacLaren Engineers.	Apr. 1983	This is a report on floodline mapping for Clarksburg. Data presented in the report includes: principal references and data sources, general description of the Beaver River Watershed, methodology for hydrology computations and hydraulic computations. Floodline maps are included in this report.	GSCA
Hydrology - Stream Habitat Assessment for Pottawatomi River	1984	This report is a compilation of data including a gradient profile summary, bank stability and stream cover analysis. S: Units along the Pottawatomi River.	GSCA
Flood and Erosion - Control Project. Report for the Grey Sauble Conservation Authority. Ainley and Associates.	Sept. 1985		GSCA
Erosion - Bighead River Clay Banks: Erosion and Sedimentation Study. Report for the Grey Sauble Conservation Authority. Cumming and Cockburn.	Jan. 1987	This study investigates the problems of erosion and flooding in the Meaford Inner Harbour. The main objectives of the investigation are to identify each of the major erosion prone areas, undertake a grain size distribution analysis of the sediment, quantify the rate of erosion, and discuss costs and environmental impacts of dredging the sediment at the river mouth. S: The study area is located to the immediate south west of the Town of Meaford and encompasses the reach of the Bighead River from Owen St. Bridge (Beautiful Joe Park) upstream to the 7th line concession.	GSCA
Land Use - Bighead River Land Uses. Randy Whelen. Report for the Grey Sauble Conservation Authority.	1988	Land uses are listed in table format. Measurements were taken from the Agricultural Land use Systems Maps produced by OMAF in 1982.	GSCA
Biological Inventories Report: Bognor Marsh and Wodehouse Management Areas and Inglis Falls and Pottawatomi Conservation Areas.	1992	Biological Inventories Report: Bognor Marsh and Wodehouse Management Areas and Inglis Falls and Pottawatomi Conservation Areas.	GSCA
Indian Brook Chinook salmon smolting study	1985	Indian Brook Chinook salmon smolting study seine net 3 stations between mouth and highway 26	MNR files
Survey file of blacks creek		Stocking and survey notes on blacks creek	MNR files
MNR Lake Surveys		All lake surveys are linked to this file, all file folders can be found at MNR Area Office for further details.	MNR files
MNR Mill Creek Survey1974-1997		Stream survey of Mill Creek affiliated with the Mill Creek Salmon Survey but includes all fish.	MNR files
Rainbow Trout Population Assessment Program	start 1961	Rainbow Trout Population Assessment Program	MNR files
1978-1986 Mitchell--Kolapore Creeks Rainbow trout Population Assessment		1978-1986 Mitchell--Kolapore Creeks Rainbow trout Population Assessment	MNR files
MNR Stream Surveys		Mis. Folders with no field reports attached, that can be found on file under the stream name in MNR files	OMNR, Owen Sound
Lake survey of Wilcox Lake		lake Survey of Wilcox lake from 1961-1986	MNR files
Fisheries -Aquatic Habitat Inventory Stream Assessment. Lower Wodehouse Creek, Gordon Toth. Ont Ministry of Natural Resources.	1983	Fisheries -Aquatic Habitat Inventory Stream Assessment. Lower Wodehouse Creek, Gordon Toth. Ont Ministry of Natural Resources. June-July 1983	OMNR, Owen Sound

Title	Date	Description	On File
Fisheries - Habitat Map. Ontario Ministry of Natural Resources. Owen Sound. This detailed habitat map shows stream beds, substrate, vegetation, stream flows and terrain characteristics. Map Scale 1:474			OMNR, Owen Sound
Fisheries - Reconnaissance Level Survey. J. Johnson. Ontario Ministry of Natural Resources			OMNR, Owen Sound
Wetland - Contour Map. Ontario Ministry of Natural Resources.			OMNR, Owen Sound
Fisheries - Inventory. Ontario Ministry of Natural Resources.			OMNR, Owen Sound
Wetlands - Wetlands - Reconnaissance Level Survey. Ontario Heritage Foundation and Ontario Ministry of Natural Resources.			
Fisheries - Brown Trout Survey.	1965		OMNR, Owen Sound
Fauna - Ecology and Botany Study. Ontario Ministry of Natural Resources.	1976		OMNR, Owen Sound
Wetland - Preliminary Lake and Watershed Study. Ontario Ministry of Natural Resources.	1976		OMNR, Owen Sound
Water Quality - Evaluation. Ontario Ministry of Natural Resources.	1976		OMNR, Owen Sound
Fisheries - Environmental Appraisal Private Dam and Pond. OMNR.	1978		OMNR, Owen Sound
ANSI - Evaluation of Earth Science Features. Ontario Ministry of Natural Resources.	1980		OMNR, Owen Sound
Fisheries - Chinook Salmon Smolting Study in the Bighead, Sydenham, Pottawatomi, Rankin, Sauble and Beaver Rivers.	1983-86	This three year study includes field collection records and details of smolting operations.	OMNR, Owen Sound
Fisheries - Aquatic Habitat Inventory. Ontario Ministry of Natural Resources.	1983		OMNR, Owen Sound
Fisheries - Stream Inventory. Ontario Ministry of Natural Resources. Owen Sound.	1983		OMNR, Owen Sound
Fisheries - Rainbow Trout Life History Characteristics. Sharon Langille. Ontario Ministry of Natural Resources. Owen Sound.	May 1985	The purpose of this report is to outline aging techniques and summarize life history characteristics of the Beaver River Rainbow Trout population.	OMNR, Owen Sound
Water Quality - Pottawatomi River Water Quality and River Habitat Assessment.	1986	This report is a compilation of data including: a watershed map, air and water temperatures, spawning habitat, nursery habitat and canopy cover. S: Pottawatomi River including Maxwell Creek, south of Owen Sound.	OMNR, Owen Sound
Fisheries - Chinook Salmon Smolting Activity in Six Selected Lake Huron and Georgian Bay Tributaries.	1986	This study was initiated to collect information on the early life history of chinook salmon in a set of selected streams and rivers within the Owen Sound district.	OMNR, Owen Sound
Water Quality - Pottawatomi River Water Quality Inventory.	1986		
Fisheries - Fish Stocking Records. Ontario Ministry of Natural Resources.	1988	Fish Identification. Ontario Ministry of Natural Resources. 1977, 1978.	OMNR, Owen Sound

Title	Date	Description	On File
Fisheries - Creel Survey. Jerry Nickerson. Salmonid Environmental Consulting. Report for the Ontario Ministry of Natural Resources. Owen Sound.	1992	Objectives of this survey were to estimate angling effort and harvest provide biological data regarding harvested fish and provide socioeconomic data regarding angling population.	OMNR, Owen Sound
Fisheries - Meeting redredging proposal. Ontario Ministry of Natural Resources.	Jan. 1992		OMNR, Owen Sound
Fisheries - Rainbow Trout, Partitioning the Beaver River for the Management of Migratory and Resident Salmonid Populations. BAR Environmental Incorporated. Report for The Ontario Ministry of Natural Resources.	1992	This report assesses the habitat for various trout species as well as the present distribution of trout in the Beaver River.	OMNR, Owen Sound
Fisheries - Habitat Map		This detailed habitat maps shows stream beds, substrate, vegetation, stream flows and terrain characteristics. Map Scale 1:474	OMNR, Owen Sound
MNR Owen Sound Area, Salmonid Biomass Survey, 2002	2002		OMNR, Owen Sound
MNR Owen Sound Area: Salmonid Biomass Survey 2004	2004	Annual Biomass Survey for salmonids only, other species not included	OMNR, Owen Sound
Water Quality Assessment of Indian Brook Near the Solid Waste Disposal Site of Collingwood Township	1994	Brief benthic and water chemistry study upstream and downstream of Collingwood Twp dump site	MNR files
Water Quality - Pottawatomi River Water Quality Data. Ministry of Environment.	1964-present	This report is a compilation of historical data on water quality for various sections of the Pottawatomi River.	GSCA
Water Quality and Hydrology - Beaver River. Ministry of the Environment.	1981-82	This study documents the biological, chemical, and hydrological status of the Beaver River.	MOE, London
Water Quality of the Upper Sauble River Watershed	1985	In-depth inventory of benthic, water chemistry, bacterial, hydrology and vegetation	GSCA
Hydrology - Stream Gauge Analysis, A Report On Low Flow Characteristics in Ontario. Cumming and Cockburn Limited. Report for the Ministry of Environment.	June 1989		
Water Quality - Bio Maps, Biological Monitoring and Assessment Program for Ontario. Ronald Griffiths. Ministry of Environment. Water Resources Assessment Unit. London.	1992		
Water Quality - Pottawatomi River Bio Maps: Biological Monitoring and Assessment Program for Ontario.	1992	Water Quality - Pottawatomi River Bio Maps: Biological Monitoring and Assessment Program for Ontario. Ronald Griffiths. Ministry of Environment. Water Resources Assessment Unit. London. 1992.	
Fisheries and Aquatic Habitat Assessment of all Watercourses Crossing Hwy 10 from Markdale to Chatsworth, and Implications of Proposed Highway Improvement Works	2005	Fisheries and Aquatic Habitat Assessment of all Watercourses Crossing Hwy 10 from Markdale to Chatsworth, and Implications of Proposed Highway Improvement Works	GSCA
Land Use - The Wodehouse Creek Karst. D.W. Cowell and D.C. Ford. McMaster University and Niagara Escarpment Commission.	1975		
Provincial Water Quality Monitoring Network		Chemical Analysis of water samples taken by the GSCA	
Volunteer monitoring for GSCA			

APPENDIX C

FISH and PLANT SPECIES

TABLE C.1 - Summary of fish sightings by year and watershed.

Fish sp.		Grey Sauble SPA Subwatersheds																
Latin name	Common name	Sauble R.	Rankin R.	Sucker Cr.	Big Bay Cr.	Gleason Br.	Beaver R.	Bighead R.	Centreville Cr.	Indian Br.	Little Beaver R.	Bothwells Cr.	Indian Cr.	Johnson Cr.	Keefer Cr.	Pottawatomi R.	Waterton Cr.	Total Sites
Ameiurus melas	Black Bullhead	2001																1
Notropis heterodon	Blackchin Shiner	2001																1
Rhinichthys atratulus	Blacknose Dace	2001					2005	2001		2005	2001	2001		1977	2005		1979	9
Notropis heterolepis	Blacknose Shiner	2001																1
Percina maculata	Blackside Darter	2001																1
Pimephales notatus	Bluntnose Minnow	2001	2001	2001			1968	1980	1979	2001				1977			1977	9
Hybognathus hankinsoni	Brassy Minnow			2001				1980	1979									3
Noturus miurus	Brook Silverside							2001										1
Labidesthes sicculus	Brook Stickleback	2001	2001	2001			2005	2004	1979			2001	2004	1977	2001	2003	2004	12
Culaea inconstans	Brook Trout	2004					2005	2004		2001		2004				2001		6
Salvelinus fontinalis	Brown Bullhead	2004																1
Ameiurus nebulosus	Brown Trout	2004	2001				2002	2004				2004			1987			6
Salmo trutta	Burbot						1997											1
Lota lota	Central Mudminnow	2001	2001	2001		2004	2005	2001							1987	2002		8
Umbra limi	Channel Catfish						1971											1
Oncorhynchus tshawytscha	Chinook Salmon	2005						2004		1987		2004			2004	2002		6
Oncorhynchus kisutch	Coho Salmon	2004																1
Cyprinus carpio	Common Carp						2005											1
Notropis cornutus	Common Shiner	2001	2001	2001			1997	1980	1979	1984	2001			1977			1977	10
Semotilus atromaculatus	Creek Chub	2001	2001	2001			1997	2004	2004	2004	2001	2001		1977	2001	2004	2004	13
Etheostoma sp.	Darters sp.							1986										1
Notropis atherinoides	Emerald Shiner			2001						2001								2
Pimephales promelas	Fathead Minnow			2001			1983	2001	1979	1992							1977	6
Notemigonus crysoleucas	Golden Shiner						2005			1983								2
Etheostoma exile	Iowa Darter	2005	2001				1983											3
Etheostoma nigrum	Johnny Darter	2001						1980		1985		1983		1977	1987		1979	7
Erimyzon sucetta	Lake Chub						1983										2005	2
Micropterus salmoides	Largemouth Bass						2005											1

Fish sp.		Grey Sauble SPA Subwatersheds																
Latin name	Common name	Sauble R.	Rankin R.	Sucker Cr.	Big Bay Cr.	Gleason Br.	Beaver R.	Bighead R.	Centreville Cr.	Indian Br.	Little Beaver R.	Bothwells Cr.	Indian Cr.	Johnson Cr.	Keefer Cr.	Pottawatomi R.	Waterton Cr.	Total Sites
Etheostoma microperca	Least Darter	2001																1
Lepomis megalotis	Longear Sunfish	2001																1
Rhinichthys cataractae	Longnose Dace					2004	1997	1980	1979	2004		1984					1979	7
	Minnow sp.	2005	2004	2004	2005	2005	2005	2005	2003	2005	2005	2005	2004	2005				13
Cottus bairdi	Mottled Sculpin	2001					2005	1980	1979	1984				1977	1984	2005	1979	9
Ichthyomyzon fossor	Northern Brook Lamprey						1987											1
Hypentelium nigricans	Northern Hog Sucker						1972											1
Phoxinus eos	Northern Redbelly Dace	2001	2001	2001			2005	2004	1979	1984		2001		1977	2001	2001	1979	12
Margariscus margarita	Pearl Dace	2001	2001	2001			1983	2004										5
Percidae	Perch sp.											1984						1
Lepomis gibbosus	Pumpkinseed	2001					2005											2
Oncorhynchus mykiss	Rainbow Trout	2004					2005	2004		2005		2004	2004		2004	2004	1979	9
Etheostoma caeruleum	Rainbow Darter	2001	2001									1973						3
Osmerus mordax	Rainbow smelt									1985								1
Notropis umbratilis	Redfin Shiner	2001																1
Ambloplites rupestris	Rock Bass	2004					2005	1986		1987		1984		1977	1987		2004	8
Notropis rubellus	Rosyface Shiner	2001																1
Neogobius melanostomus	Round Goby															2005		1
Cottidae	Sculpin sp.		2005				1987	1986	1979	1987		2001			1987			7
Micropterus dolomieui	Smallmouth Bass	2004	2004				2005	2005				1984	2002	1977	1987			8
Cyprinella spiloptera	Spottail Shiner						1983		1979	1983								3
Notropis hudsonius	Sunfish sp.						2003											1
	Trout sp.						2005	2003										2
Stizostedion vitreum	Walleye						1983											1
Catostomus commersoni	White Sucker	2001					2005	1986	1979	2001	2001	2001		1977	2001	2004	1977	11
Perca flavescens	Yellow Perch			2001			2005					1979						3

TABLE C.2 - Summary of fish and vegetation collected by year and subwatershed.

		Saugeen Valley SPA Subwatersheds								Northern Bruce Peninsula SPA Subwatersheds							
Fish/Plant Species		Beatty Saugeen River	Main Saugeen River	North Saugeen River	Penetangore River	Pine River	Rocky Saugeen River	South Saugeen River	Teeswater River	Brinkman's Creek	Crane River	Old Woman's River	Sadler Creek	Sideroad Creek	Spring Creek	Stokes River	Willow Creek
Latin Name	Common Name																
Aeshna									1972								
Alopecurus																	
Asteraceae									1990								
Caltha																	
Caltha palustris ssp. palustris											1974			1974		1974	
Carex			1973				1974		1994		1974					1974	
Catostomus					1977	1987											
Ceratophyllum			1979					1972									
Cottus		1986	2000					1986									
Cyperaceae		1985															
Cyperus		1985												1974			
Eleocharis		1985	1972	1972					1979				1974			1974	
Elodea		1972	2000						1972								
Eriocaulon																	
Etheostoma		1985	1982		1986	1987								1983			
Ichthyomyzon		1985	1982														
Ictalurus																	
Iridaceae																	
Iris			1973						1978							1974	
Juncus			1979	1999			1972	1972	1981								
Lemna			1979						1979								
Lemnaceae																	
Lepomis																1998	
Lythrum													1974				
Micropterus				1958		1980											
Moxostoma		1985	1977														
Myriophyllum			1979	1971			1974		1981		1974						
Nocomis						1987											
Notropis			1981					1978									
Noturus																	
Nuphar			2000						1972								
Nymphaea			1973	1971					1979								
Oncorhynchus			1988			1987											
Phoxinus							1981							1978			
Phragmites			1973						1978								
Polygonum			1972				1974		1979								
Potamogeton			1979	1972			1971	1972	1980		1974	1974					
Ranunculus																	
Rhinichthys			1987			1987											
Sagittaria			1979	1972		1980	1974	1972	1979								
Salmo																	
Scirpus			1979	1971					1981								
Sparganium									1977								
Stizostedion		1972															
Typha			1979	1971		1980	1974	1972	1979		1974	1974	1974	1974		1974	
Vallisneria			2000				1974	1972								1974	
Juncus effusus ssp. solutus	A Rush								1981								
Alosa pseudoharengus	Alewife		1986														
Myriophyllum alterniflorum	Alternate-Flowered Water Milfoil								1979								
Lampetra appendix	American Brook Lamprey	1985	1981					1994									
Fundulus diaphanus	Banded Killifish		2000											1978	1983		1978

		Saugeen Valley SPA Subwatersheds								Northern Bruce Peninsula SPA Subwatersheds							
Fish/Plant Species		Beatty Saugeen River	Main Saugeen River	North Saugeen River	Penetangore River	Pine River	Rocky Saugeen River	South Saugeen River	Teeswater River	Brinkman's Creek	Crane River	Old Woman's River	Sadler Creek	Sideroad Creek	Spring Creek	Stokes River	Willow Creek
Latin Name	Common Name																
Ameiurus melas	Black Bullhead																
Notropis heterodon	Blackchin Shiner										1983				1983		
Rhinichthys atratulus	Blacknose Dace	1976	2000	1972	1983	1980	1981	1997	1994		1983						
Notropis heterolepis	Blacknose Shiner		2000					1994	1979		1974	1974	1983	1978	1978	1974	
Percina maculata	Blackside Darter		1995		1977			1983	1972								
Lepomis macrochirus	Bluegill																
Pimephales notatus	Bluntnose Minnow	1983	2000	1999	1986	1980	1972	1994	1994		1974	1983		1974	1983	1998	
Amia calva	Bowfin																
Hybognathus hankinsoni	Brassy Minnow	1986	2000			1980		1976			1978	1983			1983	1974	
Noturus miurus	Brindled Madtom		1973														
Elodea canadensis	Broad Waterweed																
Sagittaria latifolia	Broadleaf Arrowhead																
Typha latifolia	Broad Leaf Cattail		1973	1972													
Labidesthes sicculus	Brook Silverside								1979								
Culaea inconstans	Brook Stickleback	1986	2000	1998	1977	1980	1974	1994	1993		1983	1994	1978		1983	1974	1978
Salvelinus fontinalis fontinalis	Brook Trout	2000	2000	2000	2000		2000	2000	2000		2000				2000		2000
Ameiurus nebulosus	Brown Bullhead	1987	1982						1982			1994					
Salmo trutta	Brown Trout	2000	2000	2000			2000	2000	1982		2000						2000
Ictaluridae	Bullhead Catfish family																
Lota lota	Burbot																
Cyprinidae	Carp and Minnow family	1987	2000	1983	1986	1987	1988	1997	1990				1983	1983		1983	1983
Umbra limi	Central Mudminnow	1986	2000	1998	1986		1981	1994	1994			1994	1983	1983	1983	1974	1978
Ictalurus punctatus	Channel Catfish		1972														
Oncorhynchus tshawytscha	Chinook Salmon		2000		2000							2000					
Coregonus artedi	Cisco																
Oncorhynchus kisutch	Coho Salmon		1972											1974			1983
Cyprinus carpio	Common Carp		1972											1983			
Ceratophyllum demersum	Common Hornwort		1973	1972													
Hippuris vulgaris	Common Mare's Tail																
Notropis cornutus	Common Shiner	1998	2000	1972	1983	1980	1981	1994	1994		1983	1983	1978	1978	1983	1998	1978
Semotilus atromaculatus	Creek Chub	1998	2000	1983	1994	1980	1981	1997	1994		1983	1983	1983		1983	1998	1978
Potamogeton crispus	Curly Pondweed																
Lemna turionifera	Duckweed	1972	1979					1972	1981								
Hybognathus regius	Eastern Silvery Minnow																
Vallisneria americana	Eel Grass								1981		1974						
Notropis atherinoides	Emerald Shiner		1986		1994			1994							1978		
Semotilus corporalis	Fallfish																
Etheostoma flabellare	Fantail Darter	1985	1982					1994	1979								
Pimephales promelas	Fathead Minnow	1983	1983	1972	1977	1980	1981	1994	1993		1974	1983	1978	1978	1983	1974	1978
Phoxinus neogaeus	Finescale Dace	1998	2000				1981	1972	1993				1978		1983	1974	1978
Utricularia intermedia	Flatleaf Bladderwort																
Potamogeton zosteriformis	Flatstem Pondweed																
Caltha natans	Floating Marsh Marigold												1974				
Potamogeton natans	Floating Pondweed		2000														
Dorosoma cepedianum	Gizzard Shad		1986														
Moxostoma erythrurum	Golden Redhorse		1986														
Notemigonus crysoleucas	Golden Shiner		1979						1981		1978					1998	
Utricularia vulgaris	Greater Bladderwort																
Scirpus acutus	Hard Stemmed Bulrush																
Nocomis biguttatus	Hornyhead Chub	1998	2000	1972	1983		1981	1994	1979								
Eleocharis equisetoides	Horse Tail Spikerush												1974				

		Saugeen Valley SPA Subwatersheds								Northern Bruce Peninsula SPA Subwatersheds							
Fish/Plant Species		Beatty Saugeen River	Main Saugeen River	North Saugeen River	Penetangore River	Pine River	Rocky Saugeen River	South Saugeen River	Teeswater River	Brinkman's Creek	Crane River	Old Woman's River	Sadler Creek	Sideroad Creek	Spring Creek	Stokes River	Willow Creek
Latin Name	Common Name																
Etheostoma exile	Iowa Darter		2000		1977			1994	1972		1978	1974		1978	1978	1998	
Etheostoma nigrum	Johnny Darter	1998	1983	1972	1977	1980	1981	1994	1994		1983	1994		1974	1983	1998	1978
Couesius plumbeus	Lake Chub			1968		1980	1972										
Salvelinus namaycush	Lake Trout																
Coregonus clupeaformis	Lake Whitefish																
Neobeckia aquatica	Lake Cress																
Petromyzontidae	Lamprey family		1981														
Potamogeton amplifolius	Large Leaf Pondweed		2000						1979								
Micropterus salmoides	Largemouth Bass	1998	2000														
Etheostoma microperca	Least Darter		1982			1980		1994	1979		1983				1983	1974	
Eleocharis acicularis	Least Spike Rush																
Lemna minor	Lesser Duckweed																
Percina caprodes	Logperch		1972		1983												
Lepomis megalotis	Longear Sunfish																
Potamogeton nodosus	Longleaf Pondweed											1974					
Rhinichthys cataractae	Longnose Dace	1998	1991			1980	1976	1994	1985								
Catostomus catostomus	Longnose Sucker		1973														
Notropis volucellus	Mimic Shiner		1986												1978		
Hiodontidae	Mooneye family							1976									
Cottus bairdi	Mottled Sculpin	1998	2000	1999	1977		1981	1994	1994		1983						
Umbridae	Mudminnow family		1972						1982								
Esox masquinongy	Muskellunge		2000														
Typha angustifolia	Narrow Leaved Cattail		1979														
Pungitius pungitius	Ninespine Stickleback		1983														
Ichthyomyzon fossor	Northern Brook Lamprey								1993								
Hypentelium nigricans	Northern Hog Sucker		1983		1983				1993								
Esox lucius	Northern Pike		2000	2000				2000	2000	1983		2000	1978	2000	1983	2000	1983
Potamogeton alpinus	Northern Pondweed		1972														
Phoxinus eos	Northern Redbelly Dace	1986	2000			1980	1981	1994	1993		1983	1994	1978	1978	1983	1974	1978
Margariscus margarita	Pearl Dace	1985	2000	1999	1983		1981	1972	1993			1974				1974	
Percidae	Perch family	1987	1982														
Pontederia cordata	Pickerel Weed			1972													
Esocidae	Pike family					1987											
Oncorhynchus gorbuscha	Pink Salmon																
Potamogeton subsibiricus	Pondweed	1972	1973														
Lepomis gibbosus	Pumpkinseed		1979		1986				1979			1974				1983	
Etheostoma caeruleum	Rainbow Darter	1998	1993	1972	1994	1980	1972	1976	1994		1983	1983		1974	1983	1998	1978
Osmerus mordax	Rainbow Smelt		1986														
Oncorhynchus mykiss	Rainbow Trout	2000	2000		2000	1980	1981	1986	1988			1983	1974	1974	1994		1983
Notropis umbratilis	Redfin Shiner		1983												1978		
Potamogeton richardsonii	Redheadgrass		2000														
Clinostomus elongatus	Redside Dace		2000														
Nocomis micropogon	River Chub	1985	1983		1983			1994	1977								
Ambloplites rupestris	Rock Bass	1998	2000	1972	1994	1987	1981	1994	1994		1983	1983		1983	1983	1983	1983
Notropis rubellus	Rosyface Shiner	1998	1983	1972				1976	1979								
Potamogeton pectinatus	Sago Pondweed								1977								
Notropis stramineus	Sand Shiner		1986								1970						
Cottidae	Sculpin family	1987	2000				1988		1982								
Petromyzon marinus	Sea Lamprey	1998	1972														
Sagittaria rigida	Sessile Fruited Arrowhead																
Moxostoma macrolepidotum	Shorthead Redhorse		1986														
Hybopsis storeriana	Silver Chub														1983		

Fish/Plant Species		Saugeen Valley SPA Subwatersheds								Northern Bruce Peninsula SPA Subwatersheds							
		Beatty Saugeen River	Main Saugeen River	North Saugeen River	Penetangore River	Pine River	Rocky Saugeen River	South Saugeen River	Teeswater River	Brinkman's Creek	Crane River	Old Woman's River	Sadler Creek	Sideroad Creek	Spring Creek	Stokes River	Willow Creek
Latin Name	Common Name																
Ichthyomyzon unicuspis	Silver Lamprey		1977														
Moxostoma anisurum	Silver Redhorse		1986														
Najas flexilis	Slender Naiad																
Potamogeton berchtoldii	Slender Pondweed																
Potamogeton pusillus	Slender Pondweed																
Cottus cognatus	Slimy Sculpin	1976	2000	1972			1981								1983		
Micropterus dolomieu	Smallmouth Bass		2000	2000	2000	1987		2000	2000						1983	2000	
Osmeridae	Smelt family																
Oncorhynchus nerka	Sockeye Salmon		1972														
Scirpus validus	Soft Stemmed Bulrush								1977								
Aeshna mutata	Spatterdock Darner																
Eleocharis geniculata	Spike Rush						1972										
Salvelinus namaycush x fontinalis	Splake		1972														
Cottus ricei	Spoonhead Sculpin																
Cyprinella spiloptera	Spotfin Shiner		1986														
Notropis hudsonius	Spottail Shiner		1993									1974			1983		
Gasterosteidae	Stickleback family		1987					1997	1989								
Noturus flavus	Stonecat		1983		1983				1979						1983		
Notropis chrysocephalus	Striped Shiner																
Catostomidae	Sucker family		2000			1980			1982				1983				
Centrarchidae	Sunfish family		1983														
Noturus gyrinus	Tadpole Madtom		1982						1972								
Gasterosteus aculeatus	Threespine Stickleback																
Salmonidae	Trout Family																
Percopsidae	Trout Perch family		1986														
Percopsis omiscomaycus	Trout Perch																
Stizostedion vitreum vitreum	Walleye							1976									
Hydrophyllum appendiculatum	Water Leaf																
Polygonum amphibium	Water Smartweed																
Brasenia schreberi	Watershield																
Catostomus commersoni	White Sucker	1998	2000	1972	1994	1987	1981	1994	1994		1983	1994	1978	1978	1983	1998	1978
Nymphaea odorata ssp. odorata	White Water Lily		1973														
Myriophyllum verticillatum	Whorled Water Milfoil																
Ameiurus natalis	Yellow Bullhead		1983						1972								
Nuphar variegata	Yellow Cowlily																
Perca flavescens	Yellow Perch		1986	2000	1986				1979			2000			1983		
Nuphar advena	Yellow Pond Lily								1992								

APPENDIX D

WETLANDS DATABASE

The following table was compiled from information from the Natural Heritage Information Centre of the MNR. The table includes information only about those wetlands in the planning region for which evaluations have been completed. Approximately half of the wetland area in the planning region has yet to be evaluated.

TABLE D.1 – Wetlands Database

NAME	NHIC ID	AREA (ha)	SIGNIFICANCE	UTM Centroid (Zone 17)		COUNTY
				EASTING	NORTHING	
Saugeen Valley SPA						
Baie Du Dore Wetland	7175	95	Provincial	455700	4909200	Bruce
Beaver Meadow Wetland	8133	67	Provincial	526300	4893200	Grey
Bell's Lake Wetland	10497	431.2	Provincial	521000	4907400	Grey
Binns Lake Wetland Complex	10498	51	Provincial	526800	4913200	Grey
Boothville Swamp	7907	152.8	Provincial	528500	4889300	Grey
Camp Creek Wetland Complex	10508	464.5	Provincial	510500	4887500	Grey
Carlsruhe East Wetland Complex	10509	0	Local	495600	4881700	Bruce
Chepstow Swamp	8105	308.6	Provincial	476000	4885000	Bruce
Dickies Creek Wetland Complex	9172	784	Provincial	467500	4865000	Bruce & Huron
Dornoch Swamp	10490	183.6	Local	513000	4907500	Grey
Dromore Swamp Wetland Complex	9001	183.6	Local	530900	4884600	Grey
East Formosa Wetland Complex	10511	83	Local	487500	4877500	Bruce
East Holyrood Wetland Complex	10512	50	Local	469300	4872800	Bruce
Edengrove Wetland Complex	8107	105.8	Provincial	483500	4895500	Bruce
Elderslie Swamp	10479	477.4	Local	483300	4908700	Bruce
Glammis Bog	10518	79.3	Provincial	469000	4898000	Bruce
Greenock Swamp Wetland	8110	8947.6	Provincial	471700	4884700	Bruce
Harrison Lake Fen	9002	49.5	Local	508000	4908200	Grey
Kingarf Wetland Complex	10510	111	Local	464500	4885500	Bruce
Kinghurst Swamp	10489	507.5	Local	501500	4907500	Grey
Kinloss Creek Wetland Complex	10503	917	Provincial	465400	4874200	Bruce
Lakelet Lake Wetland Complex	9175	740	Provincial	496400	4866200	Huron

NAME	NHIC ID	AREA (ha)	SIGNIFICANCE	UTM Centroid (Zone 17) EASTING	NORTHING	COUNTY
Letterbreen Bog	8117	129.3	Provincial	516700	4875800	Grey
Lorne Beach Swamp	7173	28	Local	451500	4898500	Bruce
Louise Swamp	8993	54.7	Local	498300	4901800	Grey
Louise, Boyd and McDonald Lakes	8120	289.2	Provincial	504300	4901000	Grey
MacGregor Point Wetland Complex	7492	420.2	Provincial	461000	4916000	Bruce
McKechnie Creek Wetland	10492	124.9	Provincial	513500	4901500	Grey
McLean Lake Wetland	8122	141.1	Provincial	509800	4898000	Grey
Melancthon #36 Wetland	10548	304	Local	457400	4884500	Dufferin
Mountain Creek Wetland	8126	174.4	Provincial	509400	4905400	Grey
Muskrat Creek Wetland Complex	8761	251	Local	480300	4866800	Huron
Negro Lakes Wetland	8128	29.3	Provincial	512200	4909600	Grey
North Lakelet Wetland Complex	8763	289.5	Local	497000	4872000	Bruce
North Teeswater Wetland Complex	10516	18	Local	474600	4872300	Bruce
Nuttley Fen	10480	7.5	Provincial	480800	4911500	Bruce
Portlaw Fen	7878	134.4	Provincial	540500	4893600	Grey
Proton Station Wetland Complex	7879	816.8	Provincial	539900	4892000	Grey
Robson Lakes-Hamilton Creek-Lily Oak Wetland	10484	876.7	Provincial	520900	4919300	Grey
Scott Point Wetland Complex	7422	201.8	Provincial	457000	4911600	Bruce
South Saugeen River Wetland	9429	146	Provincial	509200	4872700	Grey
South Walkerton Wetland Complex	10515	92	Local	486100	4881800	Bruce
Stewart and Minkes Lakes Wetland	7884	97.2	Provincial	506500	4913800	Grey
Stewart Swamp	10523	47.5	Local	447500	4888500	Bruce
Teeswater Wetland Complex	9178	862	Provincial	472000	4868000	Huron
The Sinkhole Wetland	10485	138.3	Local	525000	4909500	Grey
Topcliff Swamp Wetland Complex	10506	291	Provincial	526600	4889000	Grey
Traverston Creek Wetland	10477	213.6	Provincial	524000	4901000	Grey
Turner-Gillies-Wilcox Wetland Complex	7888	408	Provincial	535200	4893700	Grey
Welbeck Wetland Complex	7889	318	Provincial	510800	4901700	Grey
West Kinlough Wetland Complex	10513	129	Local	463500	4881500	Bruce
West Neustadt Wetland Complex	10517	41	Local	497900	4879300	Bruce
Westford Complex Wetland	10514	19	Local	468500	4874700	Bruce
Yoevil Swamp Wetland Complex	10507	752	Provincial	524900	4881600	Grey

NAME	NHIC ID	AREA (ha)	SIGNIFICANCE	UTM Centroid (Zone 17) EASTING	NORTHING	COUNTY
Grey Sauble SPA						
Albemarle Brook Wetland	7903	239.1	Provincial	484500	4966500	Bruce
Allenford Station Wetland	7904	446.4	Provincial	489000	4931000	Bruce & Grey
Arran Lake Wetland	7905	1235.6	Provincial	478800	4922500	Bruce
Bannister Swamp Wetland Complex	10526	413.6	Provincial	480000	4941000	Bruce
Beaver Valley Lowlands Wetland	10495	744.6	Provincial	537500	4920500	Grey
Beaverdale Bog Wetland	10494	124	Provincial	529000	4918000	Grey
Big Mud/Little Mud Lakes Wetland	7906	215.2	Provincial	487000	4960000	Bruce
Bognor Marsh Wetland	8132	146.9	Provincial	516700	4932400	Grey
Chesley Lake Wetland	10527	204.5	Local	482000	4933000	Bruce
Chiefs Point Wetland Complex	7419	167.6	Provincial	478800	4948200	Bruce
Clavering Creek Wetland	8106	160.2	Provincial	488500	4945500	Bruce
Congers Creek Wetland	10493	185.6	Local	509200	4920300	Grey
Eugenia Lake Wetland	8108	1303.1	Provincial	546000	4908000	Grey
Flesherton Swamp	10496	337.8	Provincial	533300	4904000	Grey
Gleason Lake Wetland	10522	81.8	Provincial	497900	4957800	Grey
Gould Lake Wetland	8111	189	Provincial	482500	4936800	Bruce
Headwaters to Pottawatomi River Wetland	8112	304.8	Provincial	494500	4930000	Grey
Hell Hole Wetland	8113	106.5	Provincial	481000	4945000	Bruce
Hoath Head Wetland	8992	139	Local	513200	4929500	Grey
Howdenvale Bay Wetland	7185	36.5	Provincial	476700	4962800	Bruce
Indian Creek Wetland	8114	257.8	Provincial	502000	4954000	Grey
Little Germany Wetland Complex	8118	343.4	Provincial	542000	4914400	Grey
Long Swamp	8119	1439.6	Provincial	497700	4934700	Grey
Marshall's Lake Wetland	10488	74.9	Local	510900	4926500	Grey
McGill Lake Wetland	8121	152	Provincial	514000	4926000	Grey
McNab Lake Wetland	8124	431.8	Provincial	493400	4943500	Grey
Mountain Lake Skinner Marsh Wetland Complex	8127	1092.6	Provincial	496000	4950000	Grey
North Spey Wetland Complex	10491	261.4	Local	509500	4926400	Grey
Oliphant Wetland	177	173	Provincial	478000	4953000	Bruce
Oxenden Creek Wetland	10524	345.1	Provincial	493500	4954500	Grey
Rankin River Wetland	7880	2749.6	Provincial	483000	4955400	Bruce
Red Bay Wetland Complex	7457	353.1	Provincial	477800	4961500	Bruce
Rocklyn Swamp	10483	318.8	Provincial	533000	4925000	Grey

NAME	NHIC ID	AREA (ha)	SIGNIFICANCE	UTM Centroid (Zone 17) EASTING	NORTHING	COUNTY
Sangs Creek Fen	10478	179.1	Provincial	477600	4927400	Bruce
Shallow Lake Wetland	7881	449	Provincial	493100	4938500	Grey
Shouldice Wetland	7882	886.4	Provincial	498000	4941000	Grey
Skipness Complex and Mancester Lake Wetland	7883	157.3	Provincial	485000	4934700	Bruce
Slough of Despond Wetland	10505	172	Local	502000	4957500	Grey
Sucker Creek (Owen Sound) Wetland	7191	146	Provincial	475500	4964500	Bruce
Swamp North of Beattie Lake	10499	109.7	Provincial	477300	4966800	Bruce
Sydenham River Lowlands Wetland	10482	500.4	Local	505000	4926000	Grey
Tara Wetlands	7885	131.2	Provincial	492300	4917400	Bruce & Grey
The Glen Wetland	7886	384.6	Provincial	501500	4944500	Grey
Townline Lake Wetland	8998	118	Local	494500	4933600	Grey
Unnamed (Sutherland Project) Wetland	10504	1.8	Local	500700	4942500	Grey
Walters Creek Wetland	10487	106	Local	523500	4923500	Grey
Wiarton Wetland Complex	10525	213.7	Local	489000	4950000	Bruce & Grey
Wodehouse Marsh Wetland	10486	516	Local	531500	4918000	Grey
Northern Bruce Peninsula SPA						
Barney Lake Wetland Complex	7418	151.1	Provincial	447000	5006400	Bruce
Black Creek Swamp Wetland	7176	37.9	Provincial	471500	4980000	Bruce
Brinkman Creek Wetland	10532	83.5	Provincial	462600	4995300	Bruce
Britain Lake Wetland Complex	10531	175.1	Provincial	472500	4997700	Bruce
Cemetary Bog	8999	56.2	Local	478500	4978000	Bruce
Corisande Bay Wetland	7179	59.6	Provincial	456000	4997700	Bruce
Crane Lake Wetland	10538	4	Provincial	467500	5002200	Bruce
Dorcas Bay Wetland	7180	110.1	Provincial	455000	5004500	Bruce
Eastnor Swamp	10501	442.8	Local	481000	4971000	Bruce
Gauley Bay Wetland Complex	7420	199.1	Provincial	468000	4983500	Bruce
Gillies Lymburner Lakes Wetland Complex	10530	209.3	Provincial	473500	5005500	Bruce
Greenhouse Harbour Wetland	7183	27.4	Provincial	466600	4982100	Bruce
Horseshoe/Bartley Wetland	10536	81.3	Local	460000	5006300	Bruce
Lower Andrew/Upper Andrew Lakes Wetland	10537	167.5	Provincial	464500	5006400	Bruce
Old Woman's River Wetland	10500	72.9	Local	473500	4980200	Bruce
Otter Lake/Cherry Hill/Ira Lake Wetland Complex	10528	693.1	Provincial	477200	4990000	Bruce
Sadler Creek Wetland Complex	7423	261.4	Provincial	462700	4990700	Bruce

NAME	NHIC ID	AREA (ha)	SIGNIFICANCE	UTM Centroid (Zone 17) EASTING	NORTHING	COUNTY
Scugog Lake Wetland	10535	73.9	Provincial	458400	4996100	Bruce
Spring Creek Wetland Complex	10529	514.2	Provincial	466000	4987000	Bruce
Stokes Bay Wetland	8131	236.8	Provincial	469500	4982400	Bruce
Tobermory Bog Wetland	8997	56.4	Provincial	449000	5008000	Bruce
Whiskey Still Marsh	10534	14.7	Provincial	455800	5001000	Bruce
William Henry Marsh	10533	36.2	Local	452200	5005100	Bruce
Wingfield Basin Wetland	7163	71.4	Provincial	476500	5009000	Bruce

APPENDIX E

GENERIC REPRESENTATIVE PERMEABILITY (K-FACTOR)

TABLE E.1 – Generic Representative Permeability (K-factor)

Geomaterial	*Representative K-Factor (dimensionless)*	*K-Value (m/s) @75% range*	*Highest K-Value (m/s)*
Gravel Weathered dolomite/limestone Karst Permeable basalt	1	1.00E-01 1.00E-06 1.00E-03 1.00E-03	0.1
Sand	2	1.00E-2	1.00E-2
Peat (organics) Silty sand Weathered clay (<5m below surface) Shrinking/fractured & aggregated clay Fractured igneous & metamorphic rock Weathered shale	3	1.00E-3 1.00E-4 1.00E-4** 1.00E-4** 1.00E-5 1.00E-5***	1.00E-3
Silt Loess Limestone/dolomite	4	1.00E-6 1.00E-6 1.00E-6	1.00E-6
Weathered/fractured till Diamicton (sandy, silty) Diamicton (silty, clayey) Sandstone	5	1.00E-7 1.00E-7*** 1.00E-8*** 1.00E-7	1.00E-7
Clay till Clay (unweathered marine)	8	1.00E-9*** 1.00E-10	1.00E-9
Unfractured igneous & metamorphic rock	9	1.00E-13	1.00E-13

From Schedule C of the Groundwater Studies 2001/2002 Technical Terms of Reference. MOE, Nov. 2001

* Representative K-Factors are relative numbers and do not correspond directly to the exponent or index of the observed K-Values for the geomaterial in the group.
** Correspondence with descriptors of observed K-Values in Freeze & Cherry 1979, Prentice-Hall.
Derived using the length of the line to determine the 75% value and rounding to the highest K-Value.
*** Estimated value based on field studies in Ontario

APPENDIX F

SOIL AND GEOLOGY VALUES FOR SSI

The classes for estimating the permeability of the Quaternary Geology Units for the Maitland Valley CA watershed are listed below. Relative classifications were developed specifically for this project and may not be suitable for use in other applications or analysis.

TABLE F.1 – Soil and Geology Values for SSI

Permeability Rating for SSI	***Standard Code Unit Name from ABCA, MVCA and UTRCA Quaternary Geology Digitizing Project***
Low	Catfish Creek Till: stony, clayey silt to silty sand matrix
Low	Cultural features: fill; man-made deposits
Low	Dunkeld Till (Huron-Georgian Bay lobe): silt matrix
Low	Elma Till (Huron-Georgian Bay lobe): stony, silt to sandy silt matrix
Low	Glaciolacustrine Deep Water deposits: clay, silt, silty and very fine sand;
Low	Maryhill Till (Erie lobe): clay matrix
Low	Modern Fluvial deposits: clay, silt, sand, gravel, muck; alluvial and stream deposits, deposited on modern flood plains
Low	Mornington Till (Huron-Georgian Bay lobe): silty clay matrix
Low	Organic deposits: muck, peat, marl; bog and swamp deposits
Low	Port Stanley Till (Erie lobe): silty clay to sandy silt matrix
Low	Rannoch Till (Huron lobe): silty clay to sandy silt matrix
Low	St. Joseph Till (Huron lobe): silt to silty clay matrix
Low	Stratford Till (Huron-Georgian Bay lobe): sandy silt matrix
Low	Tavistock Till (Huron-Georgian Bay lobe): silty clay to sandy silt matrix
Low	Wartburg Till (Huron-Georgian Bay lobe): clay matrix
Low	Wildwood Silts (Huron lobe): silt; lacustrine deposits
High	Bass Island Formation: dolostone
High	Bedrock: Undifferentiated
High	Bois Blanc Formation: limestone with chert
High	Detroit River Group: limestone, dolostone
High	Dundee Formation: limestone
High	Eolian deposits: fine sand, silt; dunes and sand plains
High	Eolian deposits: fine to medium sand; dunes and sand plains
High	Fluvial deposits: gravel, sand, silt; alluvial deposits
High	Glaciofluvial Ice-contact deposits: gravel; esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
High	Glaciofluvial Ice-contact deposits: sand, silt; esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
High	Glaciofluvial Ice-contact deposits: undifferentiated sand, gravel, silt and till; esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits

Permeability Rating for SSI	*Standard Code Unit Name from ABCA, MVCA and UTRCA Quaternary Geology Digitizing Project*
High	Glaciofluvial Outwash deposits: gravel, gravelly sand; proglacial river and deltaic deposits
High	Glaciofluvial Outwash deposits: sand; proglacial river and deltaic deposits
High	Glaciolacustrine Beach and Shoreline deposits: coarse sand, gravel; beach, bar, deltaic, shallow water and nearshore deposits
High	Glaciolacustrine Shallow Water deposits: fine to medium sand; deltaic and nearshore deposits
High	Hamilton Group: shale, limestone
High	Lacustrine Shoreline deposits: sand, gravel; nearshore and beach deposits
High	Older Fluvial deposits: sand, gravel; alluvial deposits
High	Salina Formation: shale, dolostone, evaporites

Primary Material attribute of the quaternary Geology mapping and the corresponding SSI rating

Permeability Rating for SSI	*Primary Material Attribute Provincial Quaternary Geology Layer from OGDE*
Low	Clay, silt
Low	Clay, silt, sand, gravel
Low	Diamicton
Low	Organic Deposits
High	Gravel
High	Paleozoic Bedrock
High	Sand
High	Sand, Gravel
High	Silt, sand
High	Silt, Sand, Gravel