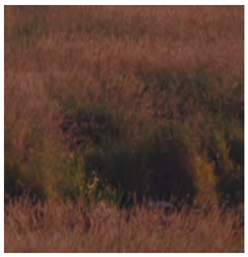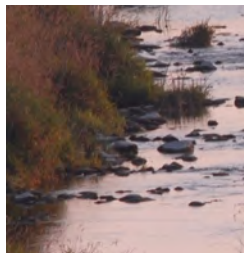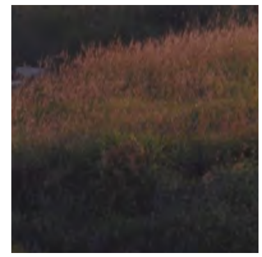

Maitland Valley Source Protection Area

Assessment Report

Amended March 26, 2024

Volume I – Text of Report

www.sourcewaterinfo.on.ca

DRINKING WATER SOURCE PROTECTION
Our Actions Matter
Ausable Bayfield Maitland Valley Source Protection Region

Ontario

Made possible through financial support of the Government of Ontario

MAITLAND VALLEY ASSESSMENT REPORT: PREFACE

Summary of Report Approvals and Amendments

Version 1: Assessment Report, 2012

The initial findings and comments herein were approved by the Province of Ontario January 19, 2012. The Assessment Reports were prepared under the *Clean Water Act, 2006*, Ontario Regulation 287/07 – General and the 2009 Technical Rules.

Version 2: Updated Assessment Report, amended December 10, 2014

The Assessment Report was updated in 2014 to reflect threats verification work, revised mapping for consistency with the Source Protection Plan, and to address minor errors.

Version 3: Assessment Report, amended February 5, 2019

The Assessment Report and Source Protection Plan were amended in 2019 under Section 34 of the *Clean Water Act, 2006* to include the following changes to well systems and to address minor errors:

- Re-delineation of Blyth Wellhead Protection Area to include new well #5
- Adjustment of the Benmiller and Molesworth Wellhead Protection Areas due to the recent replacement of the wells
- Revision of the Dungannon Wellhead Protection Area to reflect recent removal of well # 1, and
- Addition of the Ripley municipal drinking water system.

A description of these water supply systems can be found in Chapter 4.

Version 4: Assessment Report, amended March 26, 2024

The Assessment Report and Source Protection Plan was amended in 2024 under Section 36 of the *Clean Water Act, 2006*.

Amendments were prepared using the 2021 Technical Rules. Sections of the Assessment Report that were not updated as part of this Section 36 amendment may refer to earlier versions of the Technical Rules.

The following list provides a high-level summary of amendments:

Chapter 3: Water Budget

- Update the Tier 3 Water Quantity Risk Assessment

Chapter 4: Vulnerable Areas, Threats and Risks

- Minor update to Palmerston and Auburn Wellhead Protection Areas
- Revision of the Belgrave Wellhead Protection Area to reflect replacement of the McCrea Street well,
- Revision of the Wingham WHPA map to update transport pathways
- Removal of references to SGRA vulnerability scores
- Updated risk assessment (threat numbers)
- Removed duplicate water supply system information where it was repeated in more than one section (e.g. Belgrave supplies water to two municipalities so was repeated under both); retained this information under the municipality where the wells are located.
- Reorganized maps and revised map numbers accordingly

Chapter 6: Future Work

- Minor update to reflect completion of Tier 3 Water Budget

Chapter 8: Outcomes

- Update section on threats and refer reader to Chapter 4 for details

Acknowledgements

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Additional thanks to all consultants whose work provided the scientific basis of this report.

Note: In June 2014, the Ministry of Natural Resources (MNR) was renamed the Ministry of Natural Resources and Forestry (MNRF), and the Ministry of the Environment (MOE) was renamed the Ministry of the Environment and Climate

Change (MOECC). In June 2018, the Ministry of the Environment and Climate Change (MOECC) was renamed the Ministry of the Environment, Conservation and Parks (MECP). The new and former names of both Ministries are used within this document.

MAITLAND VALLEY: CHAPTER 1

INTRODUCTION

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All the water that will ever be is, right now.

– *National Geographic*, October 1993

1.0 Introduction

Clean drinking water is essential to human health, the economy and the environment. However, over the past decade there have been incidents, large and small, of drinking water contamination. This contamination results in illness, costly clean-up and public health impacts or expensive changes to drinking water systems. The drinking water tragedy that occurred in Walkerton in 2000 was a turning point in the Ontario approach to drinking water safety. As a result of the O'Connor Report from the Walkerton Inquiry, the Province of Ontario developed a program for protecting drinking water sources as part of a multi-barrier approach for clean, safe drinking water. Protection of water at the source is the first barrier in the multi-barrier approach. That approach also includes barriers such as training, treatment, testing, and distribution.

Among many other actions, the province passed the *Clean Water Act* in 2006. The *Clean Water Act, 2006* provides the legislative framework for drinking water source protection planning in Ontario. The intent of the Act is to ensure that Ontario's drinking water is safeguarded from contamination or depletion. To bring this about, the Act established source protection committees across the settled parts of the Province. The Source Protection Committee is required to complete three tasks, as outlined in the *Clean Water Act, 2006*:

- Write terms of reference to identify what work needs to be done and who is responsible to complete that work
- Compile assessment reports for each source protection area that brings together the science and technical information required to develop a source protection plan
- Produce source protection plans for each source protection area that will outline measures necessary to reduce or eliminate the threats identified in the assessment reports

The Ausable Bayfield Maitland Valley Drinking Water Source Protection Committee (SPC) issued formal Notice of Commencement of Source Protection Plan Policy Preparation in early 2011 to municipal administrators, First Nations, and to owners of properties where potential significant drinking water threats might exist.

The SPC provided notice on May 23, 2012 that drafts of proposed source protection plans were ready for public inspection and comment. The committee invited citizens to three public meetings, and one web and telephone conference, to review the drafts, ask questions, and make written comments. These public meetings took place in June of 2012.

The SPC approved Proposed Source Protection Plans on Tuesday, August 14, 2012. The Ausable Bayfield and Maitland Valley source protection authorities submitted the plans, along with public comments, to the Province of Ontario on Friday, August 17, 2012.

The committee provided notice on December 6, 2013 of revisions to Proposed Source Protection Plans. The source protection authorities submitted the revisions and the proposed plans to the Ontario Ministry of the Environment (MOE) following an advertised 46-day period of public comment beginning on December 6, 2013 and concluding on January 21, 2014.

The plans included polices that make use of implementation tools such as public education, incentives, municipal land use planning and bylaws, risk management plans and in some cases prohibition. They also included requirements for monitoring local progress on source protection. Municipalities are to be involved in implementing the source protection plans, in part through updates to their municipal official plans and zoning bylaws. The foundation for this plan is the assessment report, a science-based delineation of vulnerable areas and analysis of risks to drinking water sources.

1.1 Phases of Drinking Water Source Protection Planning

The source protection planning process is intended to continue over the long-term, similar to activities by the provincial government and municipalities under the Ontario Planning Act. Source protection is one component of watershed management, which involves the following steps: scientific research, planning, monitoring, and the evaluation of success. This Assessment Report is the culmination of five years of scientific research.

On the part of the Province, there has been a clear commitment to implement drinking water source protection planning immediately after the results of the O'Connor Inquiry were finalized. During the time that the Province was crafting the *Clean Water Act, 2006*, there was significant activity to prepare the way for source protection on a watershed basis:

- Expert panels were created to provide the government with technical and planning advice
- A white paper was written
- Funding was provided to conservation authorities to build capacity and put resources in place so that source waters could be protected
- Some of this capacity was built through ensuring the appropriate human resources existed locally within the conservation authorities
- Technical studies were undertaken to characterize the watersheds, understand the regional water budgets and gain a better understanding of municipal residential well fields

In 2007, the *Clean Water Act, 2006* was enacted. *Ontario Regulation 287/07* formalized the partnerships between Conservation Authorities to create 19 source protection regions. As well, it resulted in the creation of nineteen source protection committees charged with the preparation of terms of reference, assessment reports and source protection plans for their region or area. Chairs of these committees were provincially appointed and given a five-year time frame to complete the preparation of the documents. Committee members were locally appointed in keeping with the regulations.

Since the introduction of regulations in 2007, the Committee and staff have been ensuring that studies being prepared in support of the Assessment Report to meet the regulation requirements. The results of these studies are the foundation for this report.

1.2 The Participants

Guiding the drinking water source protection process is the Source Protection Committee (SPC), which was established through the *Clean Water Act, 2006*. This Committee comprises a provincially-appointed chair and local members representing a variety of viewpoints. The committee not only works toward the identification of risks to drinking water, it also considers issues relating to water quality or quantity in vulnerable areas and implications to the Great Lakes in the context of the international agreements. The outcomes of this process are refined through an extensive consultation process. In the Maitland Valley Source Protection Area, the Source Protection Committee has benefitted by the input of four local working groups comprised of stakeholders of various backgrounds. These working groups have been studying the science and regulated process for identifying risk. They have considered many ideas pertaining to local water quality threats and provided feedback to the Source Protection Committee. In addition, each property within the two-year time-of-travel area (Wellhead Protection Area B), and

100-metre area (Wellhead Protection Area A), has been contacted by mail. The general public also learned about DWSP through newspaper flyers, radio and television shows, brochures, meetings, advertisements, and other public outreach by the SPC.

Municipalities are key partners in the development and delivery of source protection planning. A municipal working group has provided insights to the Source Protection Committee throughout the development of the Assessment Report. In addition, the SPC Chair and staff have made numerous presentations to municipal meetings, council meetings and had regular contact with the operators of municipal systems. **Appendix C** provides a synopsis of the consultation and meetings held to gather general comments and those specifically on the Draft Proposed Assessment Report for the Source Protection Committee (SPC) to consider.

Municipalities included in the Maitland Valley Source Protection Area

Bruce County

Huron-Kinloss

South Bruce

County of Huron

Ashfield-Colborne-Wawanosh

Central Huron

Goderich

Howick

Huron East

Morris-Turnberry

North Huron

County of Perth

North Perth

Perth East

West Perth

County of Wellington

Mapleton

Minto

Wellington North

A number of other government ministries and bodies work closely with the SPC and staff to aid in the completion of the Assessment Report including:

- Ministry of the Environment and Climate Change;
- Ministry of Natural Resources and Forestry;
- Ministry of Municipal Affairs and Housing; and
- Ministry of Agriculture, Food and Rural Affairs.

The local health units agreed that the Huron County Health Unit would be the primary contact for the SPC and have a liaison member attending the meetings.

Finally, the federal government has many interests in the Source Protection Region. Environment Canada and Fisheries and Oceans Canada are federal organizations that have been, or will be, involved in the source protection planning process.

Adjacent source protection regions, specifically the Saugeen Grey Sauble Northern Bruce Peninsula and Lake Erie regions, have been working cooperatively on the various aspects of the process to minimize discrepancies and work toward products that are compatible between regions.

1.3 Consultation Requirements

A fundamental principle for drinking water source protection is consultation with stakeholders. In addition to the stakeholder engagement described above, the SPC undertook a formal consultation on the Assessment Report in accordance with the *Clean Water Act, 2006* and *Ontario Regulation 287/07*. A detailed description of the formal consultation is outlined below and examples of notices and letters can be found in **Appendix C**.

Formal consultation was initiated on January 5th, 2010 with a Draft Proposed Assessment Report being published on the Ausable Bayfield Maitland Valley Drinking Water Source Protection (ABMV DWSP) website (see **Appendix C** for an example of the Internet posting). In addition to the draft being posted on the Internet, copies of the Draft Proposed Assessment Reports were made available at both the Maitland Valley Conservation Authority and the Ausable Bayfield Conservation Authority administrative offices for public inspection on January 5th, 2010. A newspaper notice indicating the details of the consultation were placed in the following weekly publications and other media sources (an example of the notice can be found in **Appendix C**):

1. The Middlesex Banner,
2. The Exeter Times-Advocate,
3. The Lakeshore Advance,
4. The Forest Standard,
5. The Huron Expositor,
6. The Clinton News-Record,
7. The Parkhill Gazette,
8. The Wingham Advance-Times,
9. The Listowel Banner,
10. The Minto Express,
11. The Lucknow Sentinel
12. The Goderich Signal-Star,
13. The North Huron Citizen,
14. The Mitchell Advocate,
15. The Citizen (Blyth),
16. The Focus News Magazine,
17. The Rural Voice.

Additionally a copy of the notice was sent for posting at each of the public libraries, and (where possible) at municipal offices located throughout the source protection region.

A letter, including the notice was sent by registered mail to: the Clerk of each municipality listed in the Terms of Reference, the Chief of Bands of First Nations, the Chair of all neighbouring SPCs, and every person established under the Great Lakes Water Quality

Agreement (GLWQA), Lakewide Management Plans (LaMPs), and Remedial Action Plans (RAPs). Examples of these letters, along with the mailing lists are included in **Appendix C**. A letter was also sent to every person engaging in activities that are or would be a significant drinking water threat listed in the assessment report. An example of this letter is included in **Appendix C**.

Six public meetings were held (three in each SPA) on the Draft Proposed Assessment Reports in Bayfield (Thursday January 21, 3-5 p.m. and 6-8 p.m.), Wingham (Wednesday, January 27, 3-6 p.m.), Blyth (Thursday, February 18, 4-6 p.m.), Zurich (Thursday, February 25, 3-6 p.m.), Grand Bend (Saturday, March 6, 10 a.m. – noon, and 1-3 p.m.), and Palmerston (Saturday, March 6, 10 a.m. – noon, and 1-3 p.m.). The meeting on March 6th was also presented as a webinar and teleconference to accommodate seasonal residents and others who could not attend in person.

The final step in the consultation process was to post the Proposed Assessment Report on the DWSP website and advertize that final comments could be forwarded to the Source Protection Authorities. This was completed on May 4th, 2010. See **Appendix C** for an example of the Internet posting, notice, and sample letters sent to the Clerk of each municipality and the Chief of Bands. Mailing lists for these groups are also in **Appendix C**.

1.4 Scope and Purpose of the Assessment Report

The main purpose of the Report is to prioritize drinking water issues and threats within the vulnerable areas that are described in Chapter 4. This information will assist the community, led by the Ausable Bayfield Maitland Valley Source Protection Committee, to prepare the source protection plans. Drinking water threat activities, conditions and issues that are prioritized in this document will likely be the subject of extensive discussion during the development of the plan.

The report also serves as a summary of technical findings. For more detailed findings about a specific location, the reader is invited to reference the individual technical reports, each of which are listed in the References section and are held by the Ausable Bayfield and Maitland Valley conservation authorities at their respective administrative offices (Exeter and Wroxeter).

The *Clean Water Act, 2006* establishes the following minimum objectives for the Assessment Report:

a) Identify all the watersheds in the source protection area

b) Characterize the quality and quantity of water in each watershed

c) Set out a water budget for each watershed, which describes how water enters and leaves the watershed and describes the groundwater and surface water flows in the watershed and how water is used

d) Identify all significant groundwater recharge areas and highly vulnerable aquifers that are in the source protection area

e) Identify all surface water intake protection zones and wellhead protection areas that are in the source protection area

f) Describe the drinking water issues relating to the quality and quantity of water in each of the vulnerable areas identified under clauses (d) and (e)

g) List activities that are or would be drinking water threats, and conditions that result from past activities and that are drinking water threats

h) Identify the areas where an activity listed under clause (g) is or would be a significant drinking water threat, and the areas where a condition listed under clause (g) is a significant drinking water threat

This Assessment Report includes detailed local information in support of each of the above objectives.

The ensuing chapters provide the details on each of these topics as required by the legislation, regulations and technical rules. Chapter 2 delineates the Maitland Valley Source Protection Area and provides the overview of the watersheds, the physiography, human geography, and interactions of humans on the landscape (objectives A and B). The next chapter provides a water quantity stress assessment which is based on a synopsis of the water budget reports (conceptual, Tier 1, Tier 2) (objective C and part of D). The water quality risk assessment is contained in Chapter 4 (objective D, E and F). This chapter identifies the sources of drinking water in the area and provides details on defined vulnerable areas. Furthermore, the chapter identifies the high-risk activities, issues and conditions which could contribute to source water contamination. Chapter 5 provides local thinking on adaptation to climate change. The next chapter (Chapter 6) identifies future research needs. The seventh chapter provides an overview of how the Source Protection Committee has considered the Great Lakes in their deliberations. A final chapter is a summary of key findings that the Source Protection Committee should take under consideration when formulating the source protection plans.

The Assessment Report comprises three volumes. Volume 1 is the text and tables. Volume 2 is the book of maps for the report. Volume 3 is the appendices. **Appendix A** is the Table of Drinking Water Threats organized by vulnerability score and type of vulnerable area. This has been done so that the reader can view the location on a map and then look up the type of wellhead protection area (WHPA) or intake protection zone (IPZ). Once the type of water source is found, the vulnerability score or IPZ score can be located. With these two pieces of information, the reader can then establish what types of circumstances would generate significant, moderate, and low risks in that area. **Appendix B** contains the glossary and **Appendix C** is the record of public consultation.

MAITLAND VALLEY: CHAPTER 2

WATERSHED CHARACTERIZATION

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2.0 Watershed Characterization

The Watershed Characterization uses existing information to summarize the watershed's fundamental natural and human-made characteristics, their status and trends. This chapter provides a synopsis of the required information. For a more detailed report, see the full watershed characterization posted on the ABMV DWSP website at: www.sourcewaterinfo.ca.

2.1 Watersheds in the Maitland Valley Source Protection Area

The Maitland Valley Source Protection Area (MV SPA) is a level to rolling fertile agricultural area. It has a very high livestock concentration and limited natural areas. There is extensive artificial drainage in the south and east of the area with more natural area to the north. The MV SPA comprises two watersheds: Maitland and Nine Mile River as well as numerous short streams along the Lake Huron shoreline known as the Gullies (Map 2.1). The Maitland is further divided into the following subwatersheds: North Maitland, Lower Maitland, Little Maitland, Middle Maitland and South Maitland (Map 2.2). The entire watershed area is 3,266 km2 with a population of about 60,000. The population density for the area is 18.37/km2.

<u>Maitland</u>

The Maitland watershed is the largest watershed in the Ausable Bayfield Maitland Valley Source Protection Region and includes the South, Middle and Little Maitland tributaries. The main stem of the Maitland River is divided into the North and Lower Maitland rivers and empties into Lake Huron at Goderich. Residents living in this watershed use groundwater as their drinking water supply. Bedrock aquifers tend to be protected by deep overburden deposits while shallow aquifers are more susceptible to contamination. The presence of sinkholes makes shallow, vulnerable aquifers in areas near Brussels susceptible to contamination. Flooding sometimes occurs in the flatlands of the South and Middle Maitland watersheds, where clay soil and a lack of natural vegetation combine to speed runoff. However, Hullett Provincial Wildlife Area (HPWA) provides some filtration of contaminants in this area. In the rest of the watershed, filtration and percolation are boosted by wetlands, forests, and coarser soils, and flooding occurs less frequently. The Saratoga Swamp provides a filtration mechanism for Sharpe's Creek, which in turn flows into the Lower Maitland River. Despite filtration, contaminants sometimes reach Lake Huron, causing beach postings. The best cold water flows in the watershed are found in Sharpe's Creek and Lakelet Creek. Basins of cold water can be found in the North and Lower Maitland. Residents of the Maitland watershed use groundwater and Lake Huron as their drinking water supply.

<u>Nine Mile</u>

The Nine Mile watershed is wide and rectangular in its upper region, and narrow at Port Albert where it outlets into Lake Huron. The Nine Mile River is in excellent condition, largely due to the clear, cold groundwater released by shallow aquifers. Residents living in this watershed use groundwater as their drinking water supply. Most wells draw from bedrock aquifers, though some draw from layers of sand and gravel in the ample overburden. Bedrock aquifers in the area are protected by deep overburden and clay deposits above the aquifers. The watershed also has the most forest cover in the planning region, and its woodlands reduce contamination from runoff. Small wetlands in the upper watershed provide filtration. Flooding is occasional and occurs at the juncture of several streams at Lucknow, and where ice jams at Port Albert.

<u>Shore Gullies and Streams</u>

Several short streams flow into Lake Huron between Grand Bend (Ausable Bayfield Source Protection Area) and the Eighteen Mile River (Maitland Valley Source Protection Area). Most of these streams are parallel and are about six to eight km in length. The streams' clay soils, straightened channels and steep near-shore gradients increase the pace of storm runoff. While vegetation is generally too sparse to provide adequate filtration in this area, a notable exception is Boundary Creek, which has more forest cover and reaches coarse glacial deposits rich in groundwater. Boundary Creek is filtered by a portion of the Saratoga wetland. Erosion occurs at the shore cliffs, the sediment from which is transported south by coastal processes. Erosion is a natural process but human activity may slow or speed the process. Most residents in this area draw water from deep bedrock wells. The area's septic systems are facing higher demand due to the conversion of seasonal cottages to permanent residences. Septage contaminants have the potential to reach Lake Huron through clay soils that are insufficient for filtration.

2.2 Overview of Physical Geography

2.2.1 Watershed Description

<u>Maitland</u>

The Maitland River watershed is 2,572 km^2, the largest of the five main watershed units. It includes the South, Middle and Little Maitland River tributaries. The river is 150 km long and falls 235 m to Lake Huron at Goderich.

Physiography

The oval-shaped South Maitland basin is a clay-till plain crossed by three narrow north/south till moraines. The watershed's main distinction is the broad band of hilly, coarse textured Wawanosh kame moraine. A large organic deposit is associated with the Hullett Marsh and several gravel eskers rise out of the clay till plains.

The main physiographic unit of the funnel-shaped Middle Maitland unit is the Teeswater drumlinized till plain. The upper reaches of the watershed flow off the Milverton Moraine onto a flat, wet, and clay-till plain with some extensive muck soils. Several distinctive esker gravel ridges up to 15 m high cross the plain and provide valuable aggregate (Conservation Authorities Branch 1967).

The elongated Little Maitland watershed rises in the Dundalk till plain. It lies in a drumlinized till plain with a complex pattern of spillways. Two large, organic, soil-based wetlands bracket the valley in the lower end and two prominent eskers bisect the valley further upstream.

The North Maitland's north boundary is a series of kames and its eastern headwaters rise in the Dundalk till plain. Drumlins of the Teeswater Drumlin Field sprinkle the middle and lower watershed. The spillway pattern becomes increasingly dense down through the watershed to the point that large areas north of Wroxeter form complete spillways among the protruding drumlins. Several eskers and organic deposits occur throughout the system.

The Lower Maitland River watershed has a highly varied physiography. Upper areas include the drumlinized till plain with a network of drumlins and spillways. A broad kame band bisects the basin north-south just east of the wide Wyoming Moraine, itself bisected with the major spillway. The river outlet cuts through the shore sand plain below the Lake Warren beach (Chapman and Putnam 1984).

Topography

The topography generally increases from the relatively level till plains in the south and east to the steep kames in the north. The till moraines gently slope, the drumlins moderately slope in a rolling landscape and the kame moraines more steeply slope in an irregular pattern. Eskers have short steep sides; the valley slopes of the Lower Maitland are very high and steep. The Maitland River mouth at Goderich provides eastern Lake Huron’s only deep harbour for large ships (Beecroft 1984).

Soils

Poorly drained Brookston clay dominates the soils of the level plains in the upper South and Middle Maitland watersheds. Elsewhere loamier associations and better drainage become more prevalent. Some kame soils and spillways have sandier series; eskers are gravelly. Several large accumulations of organic soils occur in the basin. Bonte-Gelok and Joy (1999) measured the extent of poor and imperfect soil drainage in Huron County, rating South with the most (63%), followed in order by Middle, Little, North and Lower. Maitland soils are generally classed as having high capability for agriculture. Lower ratings occur in the very wet areas, steeper slopes and stonier kames (Conservation Authorities Branch 1967). South Maitland and Lower Maitland rank the worst soil erosion for the Maitland system (MVCA 1984).

Surface Hydrology

The Maitland River bends to the north and west side of the basin with the major tributaries flowing in from the southeast. The largest tributaries are the South Maitland and Middle Maitland Rivers. The South Maitland joins the Maitland downstream of Auburn. The Middle Maitland meets the main channel at Wingham immediately below the Middle Maitland’s confluence with the Little Maitland.

The upper South and upper Middle watersheds rate the most channel modification in MVCA (Steele et al. 1995). In the South Maitland basin, the indistinct upper river valley, extensive municipal drainage and clearance and clay soils all contribute to flashy flows after storms and low stream levels at other times. Dykes reduce the Hullett Marsh’s natural roles for filtering and flow modification. The river’s runoff curve is higher than the Maitland average. The hydrology changes markedly, however, in the lower reaches, where the high percolation in the spillway and Wawanosh kame moderates flows. Eskers may offer some groundwater discharge to a few upper tributaries.

Flooding has long been a concern on the Middle Maitland. Reasons include: its headwaters topography of higher gradients that quickly flatten out, large volumes of snow melt, rain on frozen ground, ice jams and extensive clearance and drainage. The close confluence of all the upstream tributaries may also be a factor. Extreme summer storms occasionally flood; the worst flood was from a freak storm in August 1883 (Department of Planning and Development 1954). An eight-phase Listowel conduit project started in 1979 and opened in 1991 has prevented flooding in subsequent extreme events (MVCA Partnerships 2003). The watershed, however, still carries a substantial flood risk and recent studies recommend riparian (riverbank) planting and channel naturalization (MVCA 2004).

The North Maitland River's eastern headwaters flow across the till plain. Past Harriston, however, the main channel and most tributaries follow the spillway pattern. The north tributaries often originate from kames. The North Maitland's kames and spillways both discourage artificial drainage and provide steady groundwater discharge. The result is that the North Maitland River, with Nine Mile River, rates as the most pristine in the planning region. The Nine Mile's more permeable landscape results in a relatively high base flow index for the Maitland Valley area, a lower-than-average runoff curve (runoff potential) and a fairly high percolation rating (B.M. Ross no date).

The North Maitland watershed contains the only natural lake of significant size in MV SPA: Lakelet Lake is located near the north boundary and associated with the kame unit.

The Lower Maitland follows the major spillway through a narrow valley eight to 30 m deep winding among drumlins and large areas of kame. Within a few kilometres of Lake Huron, the valley is almost 50 metres deep with steep banks and limestone exposed at the base (Conservation Authorities Branch 1967). The rock creates small falls and rapids. At the mouth, ice jams or lake storms can cause flooding. High Lake Huron water levels – from both long term cycles and very brief wind-generated seiches – can influence the Maitland for 1-2 km upstream (Conservation Authorities Branch 1967).

The Lower Maitland has some major tributaries beyond the North, Middle, Little and South contributions. Blyth Brook flows in along a spillway off the drumlinized till plain and then through the kame unit. Sharpe's Creek originates in the Saratoga Swamp, follows the deep spillway that splits the Wyoming Moraine and drops abruptly (30 metres in the last two kilometres) to the Maitland.

Nine Mile River

The Nine Mile River watershed covers 243 km^2. It has a wide rectangular upper portion connected to the lake with a narrow handle that outlets into Lake Huron at Port Albert.

Physiography

The watershed headwaters are in the large Wawanosh kame moraine and much of the area is the Wyoming Moraine that abuts the kame to the west. This till moraine is split by the spillway that supports the major coldwater streams to the south, the closest being Sharpe's Creek. The narrow lower part of the watershed crosses the glacial Lake Warren bevelled till plain below the Lake Warren beach (Chapman and Putnam 1984).

Topography

Slopes range from irregular steep areas in the kame to longer more moderate and gentle slopes on the till moraine to level topography on the bevelled till plain.

Soils

The upper watershed soils are coarse kame-associated series. Clay till series have developed on the till moraine and bevelled till plain. Sandy and gravely outwash soils occur in the spillway. The soils are generally well-drained; only 26% are poor or imperfect drainage (Bonte-Gelok and Joy, 1999). Upper Nine Mile is rated high soil erosion for MVCA (MVCA 1984 Plan).

Surface Hydrology

The headwaters rise in the Wawanosh kame. In Lucknow, Anderson Creek, Dickies Creek and Ackert Drain/Kinloss Creek join to form Nine Mile River and impose occasional flood damage (MVCA 1984). Below Lucknow, the river follows the spillway southwest across the Wyoming Moraine and over the glacial Lake Warren beach. There it turns west to flow straight to the shore across the bevelled till plain, carving down to lake level. The kames and spillways both discourage artificial drainage and provide steady, cold groundwater discharge. The result is that the Nine Mile River rates the highest base flow index and the most pristine water quality in the planning region and supports a valuable trout fishery.

The river flows down the westward spine of the watershed; several short tributaries originate in the kame at the east divide and flow west to join the river in sequence. The Nine Mile River is rated low channel modification in the MVCA context (Steele et al. 1995).

<u>Shore Gullies and Streams</u>

The total area of the Shore Gullies and Stream watershed unit is 692 km^2. It includes the basins of all the short streams flowing into Lake Huron from just north of Grand Bend to Eighteen Mile River. The basin of each stream tends to be narrow and most are parallel, flowing westward and carving down to lake level. The unit forms a very long narrow strip along the shore, interrupted only by the narrow outlet valleys of the larger basins.

Physiography

Headwaters originate on the west slopes of the Wyoming Moraine. The physiographic sequence westward to the lake is down the glacial Lake Warren beach and across Lake Warren's bevelled till plain that usually includes a narrow strip of sand plain (Chapman and Putnam 1984). As the streams approach the lake, they cut down as much as 20 m to form deep gullies to the shore.

The shore is actively eroding to form shore cliffs. Goderich breakwater to Kettle Point is a closed littoral cell for shoreline sand transport; those two extremes trap any sand from the north. Goderich to just north of Grand Bend contributes sediment to the cell's shoreline budget; Grand Bend to Kettle Point receives it. Over millennia (the pre-breakwater cell extended to Point Clark just north of the planning region) this process has eroded away the north bluffs and Lake Algonquin beach. On the other hand, in the accretion area to the south, the Algonquin Beach swings far inland behind the sand deposits and the geologically recent lagoon. Gully erosion of the shore streams between Goderich and Grand Bend also contributes sediment – 12% of the sand plain accretion (Snell and Cecile Environmental Research 1991).

The Goderich breakwater shortens the natural cell, reduces sand supply, thereby narrowing accretion beaches from their natural width. Ongoing bluff erosion is natural as these geologically young landforms evolve and is an essential supply to accretion areas and beaches. Structures like groynes that interfere with the sediment transport can have distant adverse effects (Baird and Associates 1994).

Topography

The watersheds are generally level with gently sloping headwaters off the Wyoming Moraine. The lakeshore is a very steep bluff which ranges from 20-22 metres in the north, and peaks around 28 metres around Goderich. As the gullies gouged down to lake level, they too created very steep banks.

Soils

Soils are predominantly the Huron/Perth/Brookston clay tills. Narrow strips of Burford, an outwash gravel, occurs at the Lake Warren beach line; Berrien, shallow sand over clay, marks the narrow sand plain that runs the length of the Lake Warren bevelled till plain. The clay tills are high capability soils; the Burford and Berrien have some low fertility and droughty limitations. The Shore Gullies and Streams unit rates high for proportion of poorly and imperfectly drained soils – 68% in the Huron County portion (Bonte-Gelok and Joy 1999). Besides the gullies themselves, the main erosion issue is the proximity of older cottages to the largely natural shoreline bluff erosion (MVCA 1989). Field erosion and compaction are also serious problems (Snell and Cecile et al. 1995).

Surface Hydrology

Samuel Strickland (circa 1830) noted the “fine spring streams” in the rolling land east of the lake (Beecroft 1984). Today they are largely agricultural drains. Few are long enough to have tributaries. Some gullies were present at settlement as steep shore ravines stabilized under forest cover. Human activities have extended them. Land clearance, accelerated overland drainage, tile outlets, channel straightening and cultivation to gully edge all contributed to their growth (Conservation Branch 1949). The short, narrow streams have very short reaction times to storm events. The lack of forest cover also accentuates the sharp hydrographs. The gullies generally drain so quickly that flooding is not an issue.

<u>Lake Huron</u>

Local surface water in the nearshore of Lake Huron has suffered degradation from intensification of seasonal shoreline development (Peach 2006). Some nodes have experienced substantial growth: Goderich and Bayfield are examples. Given the movement of water currents, the effects of intensification can have impacts in areas where there is little development. Looking towards the future, lower lake levels as a result of climate change may bring increased pressure for development at the beach level of the shoreline. Without development, ideally the lower lake level would allow vegetative succession to occur and better dune stewardship (Donnelly 2006).

2.2.2 Natural Heritage

Map 2.3 depicts the location and types of natural vegetative cover in the MV SPA and **Table 2.1** lists the percentage of land coverage of each.

Table 2.1 Location and types of natural vegetative cover and the percentage of land coverage of each

Type of Vegetative Cover	Area in km^2	% Coverage in SPA
Wetlands	195.61	7.97
Natural Area		
Clearings	6.72	0.27
Old field	59.29	2.41
Plantation	32.18	1.31
Woodland	466.9	19.01
Totals	565.09	23.01
Riparian		
Clearings	0.13	0.01
Old field	11.87	0.48
Plantation	1.47	0.06
Woodland	36.9	1.50
Totals	50.37	2.05

Source: MNR's NHIC dataset

2.2.3 Aquatic Ecology

Pre-settlement rivers had more cold or cool water habitat maintained by springs and forest shade. Today, species sensitive to warm water or sediment are severely limited by land use activities, turbidity and sedimentation, increased temperatures and modified hydrology (Veliz 2001). Today's cold and warm water streams are distinguished on **Map 2.4**

2.2.3.1 Fisheries

<u>Maitland</u>

A 1963 survey found 42 fish species (Conservation Authorities Branch 1967). By far the most common were: Creek Chub, Hornyhead Chub, Common Shiner and Rainbow Darter. Very common but less widely distributed were: Rock Bass, White Sucker, Blacknose Dace, Bluntnose Minnow, Johnny Darter and Brook Stickleback. Trout were found only in the North and Lower Maitland basins, the basins with the most numerous cold or cool water systems. Sharpe's Creek, a Lower Maitland tributary, had the best cold water flow. The Little, Middle and South each had small reaches of cool water. The majority of streams either dry up in summer or form stagnant pools suitable only for minnows, suckers and catfish.

The MVCA 1984 Watershed Plan indicates 21 cold water streams in a pattern very similar to the 1963 survey; most streams align with spillways and a few rise in kames or moraines. Base flow patterns, however, did not fully correspond to the cold water streams. Of all of the watercourses within the Maitland watershed, 37% are cold or cool with 23% lacking trout or salmon, and 14% having either trout or salmon present. 44% of the watercourses are warm water, with 35% having no top predators and 9% with top predators. 19% of the watercourses within the Maitland are intermittent.

<u>Nine Mile</u>

Of all of the watercourses within the watershed, 69% are cold/cool. Of this 69%, 35% have no trout or salmon present and 34% do have trout or salmon present. Of the rest of the watercourses, 6% are warm water with no top predators, and 25% are intermittent and are dry for at least three months of the year.

<u>Shore Gullies and Streams</u>

One of the most vegetated gully systems, Gully Creek, has cold water habitat and supports runs of migratory salmonids. Most gullies, however, have poor aquatic habitat; their highly variable flow results in erosion, poor water quality and no base flow. Of all of the watercourses, 23% are cold/cool, 34% are warm water and 43% are intermittent. Of the 23% cold and cool watercourse, 16% have no trout or salmon present and 7% do, while of the 34% warm watercourses, 29% have no top predators and 5% do.

Off-shore shallow areas and shoals correspond to fish spawning areas, as does the sand deposition area offshore of Pinery Provincial Park and Port Franks. Offshore fish include Rainbow, Brown and Lake Trout; Coho, Chinook, and Pink Salmon; Freshwater Cod; Lake Whitefish; Chub; Smelt; and Alewife. Near-shore waters contain Yellow Perch, Walleye, Smallmouth Bass, Northern Pike and various pan fish. Commercial fisheries depend mainly on Whitefish and Yellow Perch with licensed anglers out of Goderich. Sport fisheries focus on Yellow Perch, Rainbow Trout, Brown Trout and Chinook Salmon in Lake Huron (Donnelly 1994).

2.2.3.2 Aquatic Macroinvertebrates

Narrow tolerance ranges of certain species of aquatic macroinvertebrates make them a valuable indicator of water quality.

<u>Maitland</u>

35% of the sites in the Maitland watershed were found to be unimpaired, with the proportion of unimpaired sites being the largest (60%) in the North Maitland (9/15). Next largest was the Lower Maitland with 42% (5/12), followed by the South Maitland with 37% (7/19), Little Maitland with 27% (4/15) and finally the Middle Maitland, where only 13% (2/16) of the sites were found to be unimpaired.

The different ratings for each of the branches are due to the varied amount of forest cover, gravel soils and landform which produce more stable flows and cooler water temperatures. The more unimpaired sites tended to the areas of higher forest cover and away from the till plain physiographic feature.

<u>Nine Mile River</u>

86% (6/7) of the sites in the Nine Mile watershed were found to be unimpaired due to the presence of sensitivity values of 3 and 4 for caddisfly, mayfly and stonefly insects. This watershed has cooler water temperatures, more forest cover and a more stable flow regime.

<u>Shore Gullies and Streams</u>

29% of the sites were unimpaired (2/7) which reflects the variable flow regime of this area and more clay soils. The streams with better ratings tended to be those ones with headwaters that touch the Wyoming Moraine. In 2001, Jamieson found Capniidae (Stonefly), a relatively pollution intolerant species, dominant in the Gully Creek site and Zurich Drain.

2.2.4 Species and Habitats at Risk

Table 2.2 lists the various at-risk fish, mussels, and aquatic reptiles that are on the Species at Risk in Ontario List (SARO) and are found within the Maitland Valley SPA.

Table 2.2: Species at Risk within the watersheds of the MV SPA and their listing under SARO

Common Name	Scientific Name	Watershed	SARO
FISH			
Black Redhorse	Moxostoma duquesnei	Maitland	THR
Redside Dace	Clinostomus elongates	Shoreline	END
Northern Brook Lamprey	Ichthyomyzon fosser	Maitland	SC
Lake Sturgeon	Acipenser fulvenscens	Shoreline	SC
MUSSELS			
Wavy-rayed Lampmussel	Lampsilis fasciola	Maitland	END
Rainbow Mussel	Villosa iris	Maitland	THR
AQUATIC REPTILES			
Queen Snake	Regina septemvittata	Maitland	THR
Wood Turtle	Glyptemys insculpta	Maitland	END
Eastern Hog-nosed Snake	Heterodon platirhinos	Maitland & Nine Mile	THR
Milksnake	Lampropeltis triangulum	Maitland & Nine Mile	SC
Snapping Turtle	Chelydra serpentina	Maitland & Nine Mile	SC
INSECTS			
Monarch	Danaus plexippus	Maitland & Nine Mile	SC
VASCULAR PLANTS			
American Ginseng	Panax quinquefolius	Maitland	END
Tuberous Indian-plantain	Arnoglossum plantagineum	Maitland	SC
Goldenseal	Hydrastis Canadensis	Maitland	THR
Green Dragon	Arisaema dracontium	Maitland	SC
Butternut	Juglans cinerea	Maitland & Nine Mile	END
American Chestnut (planted)	Castanea dentata	Maitland	END
BIRDS		Maitland	
Canada Warbler	Wilsonia Canadensis	Maitland & Nine Mile	SC
Black Tern	Chlidonias niger	Maitland	SC
Bald Eagle	Haliaeetus leucocephalus	Maitland & Nine Mile	SC
Chimney Swift	Chaetura pelagica	Maitland & Nine Mile	THR
Common Nighthawk	Chordeiles minor	Maitland & Nine Mile	SC
Golden Eagle	Aquila chrysaetos	Maitland & Nine Mile	END
Least Bittern	Ixobrychus exilis	Maitland & Nine Mile	THR
Red-headed Woodpecker	Melanerpes erythrocephalus	Maitland	SC
Short-eared Owl	Asio flammeus	Maitland & Nine Mile	SC

EXT = Extirpated
END=Endangered
THR=Threatened
SC=Special Concern
Source: Maitland Valley Conservation Authority database

2.3 Water Quality and Quantity

2.3.1 General Overview of Surface Water Quality and Quantity

The surface water quality in the Maitland Valley Source Protection Area reflects traditional rural non-point source issues of nitrogen, phosphorus and bacteria. More urban contaminates such as chloride and copper are not present in concentrations above the Provincial Water Quality Objective (PWQO).

The dominance of heavy textured soils – often poorly drained, cleared land and open drains makes the whole area highly responsive to hydrologic events. The main event is the spring thaw and associated rainfall. Flows peak in March and April and decline sharply the rest of the year. Smaller peaks follow storms at other seasons. Events flush high concentrations of accumulated sediments, nutrients and bacteria through the system to Lake Huron.

Within this pattern, however, the variation in form across the region creates a north-south trend. The clay soil, poor drainage, drain density and lack of natural cover are all more prevalent in the south. Coarse-textured spillways and kames increase northward. The lower agricultural capability encourages more natural cover and less built drainage. These soils support near-surface groundwater aquifers that discharge into the stream system. The result is a northward trend of increasing flows, decreasing concentrations but greater loadings. The stream water quality improves but the total amount of contaminants transported to the Lake Huron beaches increases; in effect, the travel time decreases. *E. coli* levels tend to increase downstream and at the northern beaches (Bonte-Gelok and Joy 1999; Hocking 1989).

The most productive clean, cold water flow source is the major spillway splitting the Wyoming Moraine through the Bayfield, Lower Maitland and Nine Mile River watersheds. Streams through this feature (e.g., Sharpe's Creek, Nine Mile River) are the most pristine of the planning region and the receiving waters of the lower Bayfield and lower Maitland Rivers benefit greatly from their input.

The form of the short shoreline gullies and streams determines their role. They represent the extreme of clay soils, drainage density and lack of natural cover in the Source Protection Region. As streams carve down to lake level, gully erosion, a process encouraged by the intensive land use and drainage, increases sediment loads. Cottage density boosts septic system loading. The very short travel time to the shore limits in-course attenuation. Shore gullies are major contributors to shoreline contamination (Hocking 1989).

Potential sources of non-agricultural water contaminants can include snow dumps, landfills, food processing plants, industry, septic systems and golf courses. Although many sewage treatment plants have been upgraded, it is unknown whether older ones are causing contamination problems.

Spatial trends of current water quality are represented in statistical graph form in **Table 2.3**. Thirty water quality sites are compared for nitrate, total phosphorus and *E. coli* by grouping all data collected in the years 2001-2005. **Maps 2.5, 2.6** and **2.7** show the estimated *E. coli*, nitrogen and phosphorous concentrations respectively across the Source Protection Area.

Recent trends suggest phosphorus concentrations are decreasing, nitrates are rising, and fecal coliform is increasing in some areas (Bonte-Gelok and Joy 1999). Nitrates exceed Ontario Drinking Water Standards (ODWS). In the last 20 years, conservation authority programs have raised farmer awareness of the issues; in 1984, many farmers were unaware of the severity of the problem (Balint 1984).

In an intensively used landscape such as the MV SPA, spills and bypasses from municipal, agricultural and industrial operations are an on-going risk to streams and their biota.

For more detailed information on water quality and quantity in the MV SPA, please see Chapter 3: The Water Budget.

Table 2.3 Nitrate, total phosphorus and *E. coli* concentrations at current water quality monitoring sites in the MV SPA

Watershed Site	Years	Nitrate as N (mg/l)					Total Phosphorus (mg/l)					*E.Coli* (cfu/100ml)					
		n	median	25th	75th	max	n	median	25th	75th	max	n	median	geomean	25th	75th	max
Nine Mile River																	
Lucknow	01-05	41	1.25	1.06	1.80	6.23	41	0.021	0.018	0.03	0.088	15	290	301	215	450	900
Port Albert	01-05	134	1.69	1.26	2.40	6.48	75	0.018	0.012	0.025	0.182	93	130	132	67.25	262.5	3400
Maitland River																	
North Maitland																	
Salem	05	14	6.13	5.76	7.97	13.90	14	0.012	0.009	0.02	0.412	13	1000	683	357.5	1900	7000
B-Line	04-05	16	2.95	1.78	4.56	8.61	16	0.013	0.011	0.019	0.033	17	150	120	40	300	990
Little Maitland																	
Jamestown	01-05	41	4.26	2.19	6.83	9.17	41	0.024	0.02	0.035	0.1	17	210	207	60	550	3900
Middle Maitland																	
NE Listowel	04-05	29	6.16	1.80	7.99	14.00	29	0.071	0.043	0.099	0.294	27	1000	709	190	2200	10000
Trowbridge	01-05	41	2.51	0.55	6.68	10.20	42	0.06	0.035	0.084	0.206	17	240	221	100	420	1530
Wingham	04-05	17	4.67	2.46	7.16	10.70	17	0.025	0.019	0.036	0.137	17	130	123	30	470	960
Middle Maitland Tributaries																	
Henfryn	01-05	41	6.11	1.20	9.66	14.80	41	0.044	0.027	0.076	0.184	16	290	216	152.5	457.5	800
Beauchamp	04-05	17	4.81	3.71	7.36	9.52	17	0.031	0.021	0.073	0.17	16	175	161	87.5	335	1050
South Maitland																	
Summerhill	04-05	17	4.31	2.48	6.21	10.60	17	0.02	0.016	0.026	0.076	17	120	116	30	300	1650
Lower Maitland																	
Blyth East	04-05	28	3.22	2.46	3.92	7.17	28	0.037	0.028	0.05	0.343	27	280	261	102.5	890	6300
Blyth	01-05	42	3.64	2.34	4.82	10.10	42	0.032	0.023	0.043	0.081	17	150	172	80	510	3400
Zetland	01-05	41	4.31	1.83	6.26	9.74	41	0.024	0.017	0.033	0.102	17	130	126	50	240	1110
Benmiller	03-05	62	3.88	1.43	5.74	10.50	49	0.019	0.013	0.039	0.315	57	100	91	43.25	210	2400
Goderich	01-05	41	3.79	1.08	5.52	9.89	41	0.016	0.013	0.021	0.051						
Shoreline Watersheds (north to south)																	
Boyd	01-05	51	5.18	0.51	7.55	13.00	21	0.03	0.015	0.039	0.085	51	230	213	70	609	9500
Eighteen Mile	01-05	62	3.72	1.10	5.80	9.79	31	0.028	0.018	0.042	0.143	62	256	226	76	540	7700
Kintail	01-05	63	0.50	0.10	4.27	11.30	33	0.13	0.039	0.221	0.333	63	240	208	62.5	688	17000
Kerrys	01-05	99	3.60	1.67	6.35	13.10	55	0.027	0.018	0.061	0.36	97	280	244	86	712.5	12000
Kingsbridge	01-05	57	5.07	0.20	7.13	13.50	30	0.09	0.034	0.144	0.327	57	480	536	207.5	1550	17000
Griffins	01-05	69	1.60	0.20	6.92	19.40	39	0.106	0.038	0.163	0.501	68	569	544	210	1610	20000
Midhuron	01-05	61	2.10	0.20	6.78	13.90	33	0.067	0.032	0.168	0.721	61	240	269	88.5	835.5	5500
Boundary	01-05	77	2.81	0.54	4.42	13.50	33	0.041	0.028	0.086	0.6	77	360	314	100	857.5	11000
Bogies	01-05	63	2.87	0.34	5.83	11.00	33	0.03	0.019	0.047	0.253	63	105	146	49.25	397.5	42000
Allans	01-05	63	4.30	3.15	5.89	12.10	33	0.027	0.018	0.041	0.708	61	170	213	97.75	472.5	39000
Desjardine	03-05	25	4.30	0.44	7.85	14.00	25	0.034	0.018	0.044	0.145	25	110	156	45.75	570	25000

Some sites have not been sampled for the entire period. Refer to the Years column.

The watersheds have been ordered from north to south, sites within each watershed ordered from upstream to downstream.

(light yellow) Result exceeds the CCME Guideline of 2.93 mg/l nitrate as N, or the PWQO of 0.03 mg/l of total phosphorus or 100 cfu/100ml for *E.coli*

(orange) Result exceeds the Ontario Drinking Water Standard of 10 mg/l nitrate as N

Source: MVCA water quality database

2.3.2 General Overview of Groundwater Quality and Quantity

The county groundwater reports (Huron: International Water Consultants et al, 2003; Minto and North Wellington: Burnside 2001 a & b; Bruce and Perth: Waterloo Hydrogeologic 2003 a & b) conclude that the bedrock aquifer is generally well protected by the depth and fine texture of the overburden. Overburden wells typically have lower total dissolved solids, hardness, sodium, sulphate and iron levels but higher concentrations of dissolved organic carbon, chloride and bacteria. They also show greater occurrence of volatile organic compounds, pesticides and total petroleum hydrocarbons, although only trace to low levels. Nitrates were more likely in overburden wells but were very rarely above Ontario Drinking Water Standards (Golder 2001). The Provincial Groundwater Monitoring Network results indicate no concerns with pesticides, herbicides, fungicides, hydrocarbons or nitrates. The land use has not yet had any serious influence on the quality; only natural parameters like fluoride, hardness and iron are noted. Seaforth and Egmondville well water showed naturally elevated levels of radium-226, an element that can be removed with a water softener (Golder, 2000). Singer et al. (1997) found many samples of poor natural water quality in all the bedrock units that are within the Source Protection Region. Commonly exceeded Provincial Drinking Water Objectives are total dissolved solids, sulphate and iron.

Caveats on the water quality assessments include the short data record, the lengthy residence time of contaminants in the overburden before they reach the bedrock, and the possibility of problems at private wells because of poor wellhead management (MVCA 2004). The 2002 results of sentinel well sampling program show little seasonal variation (Golder 2003).

Short circuits can directly and quickly contaminate aquifers. Access points potentially include sinkholes, non-decommissioned wells, and rivers that have chiselled down to bedrock (e.g., lower sections of the Maitland). The biggest threats for this type of groundwater contamination are from application of nitrates near wells, road salt, landfills and hydrocarbon (fuel) storage (MVCA 2004). Depending on overburden depths and textures, improperly functioning or high density septic systems can contaminate groundwater (International Water Consultants et al. 2003).

Several township reports indicate that municipal wells could be susceptible to surface activities. All reports agree that shallow overburden aquifers – important contributors to streams and wetlands - are more sensitive than the bedrock aquifers.

A summary of overall water quality for the important overburden and bedrock aquifers in the Maitland Valley Source Protection Area is included below in **Tables 2.4** and **2.5**, respectively.

Groundwater is judged adequate to meet the area needs today and well into the future. Huron County withdrawals are conservatively estimated to be 17% of aquifer recharge. Wellington – Minto report estimated that about 1% of the infiltrated groundwater is used. Most groundwater withdrawals are returned to the watershed although to more surficial systems.

For more detailed information on water quality and quantity in the MV SPA, please see Chapter 3: The Water Budget.

Table 2.4 Summary of water quality for overburden aquifers in the Maitland Valley Source Protection Area

Aquifer	Location	Water Quality	Key Issues
Holmesville	Runs the length of the planning region in a north south orientation	Good	Hardness Iron contamination Trace presence of nitrates
Seaforth	Within the Seaforth moraine	Poor Evidence of high susceptibility to contamination via surface water	Bacteria Hardness Iron Widespread presence of nitrates Trace presence of hydrocarbons and pesticides

Source: Watershed Characterization 2006

Table 2.5 Summary of water quality for bedrock aquifers in the Maitland Valley Source Protection Area

Aquifer	Location	Water Quality	Key Issues
Salina	Narrow strip on the eastern fringe of the MV SPA	Good	Hardness Iron
Bass Islands	Narrow strip immediately west of the Salina	Good	Sodium Presence of nitrates
Bois Blanc	Narrow strip immediately west of the Bass Islands	Excellent	None Identified
Lucas	Subcrops throughout a large portion of the planning region.	Moderate to Good	Fluoride Iron Hardness Localized evidence of salt contamination Radionuclides

Source: Watershed Characterization 2006

2.4 Overview of Human Geography

2.4.1 Human Characterization and Settlement Areas

Small nomadic bands may have followed caribou herds through a spruce forest landscape as long as 11,000 years ago (W. Fox in Beecroft 1984). Subsequent aboriginal use was based on hunting. By the late 1600's Chippewas settled in the area and developed a trade in flint found at Kettle Point. European settlement was deterred by Niagara Falls, the distance to the Nipissing route, poor river navigability and the Thedford Swamp. It was the Huron Road built by the Canada Company in 1828 that finally brought settlers to the area (Conservation Authorities Branch 1967; Beecroft 1984).

The relative remoteness discouraged industry and large cities while the rich soils encouraged agriculture. Agriculture remains a major economic mainstay of the community. It is only with the advent of the automobile that the tourism industry boomed (Butler and Hilts 1978) based on the allure of the Lake Huron shore. More recently, good roads and ready access to Canadian and U.S. markets have encouraged industry beyond agricultural support and processing.

From 1951 to 1996, the Huron County farm population decreased from 46% of the total to 18%, still much higher than the 3% proportion of farmers nationally (Huron County Planning and Development Department 2001). The recent rise in rural non-farm population results in non-farm population exceeding farm population in most townships (Bonte-Gelok and Joy 1999). The higher population growth areas have been along the shoreline. **Map 2.8** shows the areas of settlement for the Maitland Valley Source Protection Area.

2.4.2 Population Distribution and Density

Four counties and 12 municipalities lie within the Maitland Valley Source Protection Area (**Map 2.9**) The MV SPA averages 18 persons per kilometre squared in population density; the majority of which are rural residents. In the 2006 census, Huron County was composed of 60% rural residents – more than any other Southwestern Ontario county (Statistics Canada, 2007). **Table 2.6** and **Map 2.10** show the population and population density for each municipality that lies within the MV SPA.

Table 2.6 Municipal population and population density for the MV SPA

Municipality	Population	Population Density (per km^2)
Huron County	59,325	17.5
Ashfield-Colborne-Wawanosh	5,409	9.2
Central Huron	7,641	17.1
Goderich	7,563	956.1
Howick	3,882	13.5
Huron East	9,310	13.9
Morris-Turnberry	3,403	9.0
North Huron	5,015	28.0
Bruce County	65,349	16.0
Huron-Kinloss	6,515	14.8
South Bruce	5,939	12.2
Perth County	74,344	33.5
North Perth	12,254	24.8
Perth East	12,041	16.8
West Perth	8,839	15.3
Wellington County	200,425	75.4
Mapleton	9,851	18.4
Minto	8,504	28.3
Wellington North	11,175	21.3

Source: Statistics Canada 2007

2.4.3 Land Use

Agriculture dominates the Maitland Valley Source Protection Area with small urban areas scattered throughout. Cottage development has spread along the lakeshore. Forest concentrations occur in the Lower Maitland Valley and the major spillway and delta unit that includes the Saratoga Swamp. There are a number of Conservation Areas, private campgrounds, and one provincial park: Point Farms. Several gravel pits occur in the major spillway unit. No reserves, as defined under the *Indian Act* (Canada), are located within the MV SPA. In 1989, the Maitland was 80% agriculture, 2% urban and 18% natural (MVCA 1989).

Federal lands located in the Maitland Valley Source Protection Area are presented on **Map 2.11**. They include the Department of Fisheries and Oceans, and Public Works.

2.4.4 Urban Development

The MV SPA is predominantly rural and any towns or villages located in the area were all considered independent municipalities prior to the municipal restructuring and amalgamation which began in 1996. The largest is Goderich with a population of 7,500. Towns are scattered throughout the region and the urban footprint (which includes any town, village, hamlet or other groupings of houses) covers 1.41% of the Maitland watershed, 1.94% of the Nine Mile, and 2.28% of the Shorelines and Gullies watershed.

Ontario's recent *Greenbelt Plan and Places to Grow Policy* does not apply to the MV SPA. The 2005 Provincial Policy Statement directs growth to existing urban areas and protects agricultural lands by discouraging lot creation (Ontario Ministry of Municipal Affairs and Housing 2005).

2.4.5 Industrial/Commercial Sectors Distribution

As agricultural employment declines, industrial and commercial sectors have grown in importance. In 2002, Huron County employment in manufacturing and construction sectors outstripped all others (Statistics Canada 2002). Most manufacturers are small. The largest product categories are food related (farm feed supplies, food products and processing) and fabricated metal. Other major manufacturing categories include mining (salt), wood products, furniture, printing and publishing, and equipment – industrial, commercial, electric and transportation. Industries are well distributed in towns and villages throughout the region. Manufacturing is the fastest growing sector of the Huron County economy both for business start-ups and job creation and has replaced farming as the largest generator of Huron's economy.

Tourism is a major employment sector in the area. Lake Huron is the main attraction and the lakeside location has generated many business and activities for visitors and cottagers. Cottage prices are climbing. As the cost of gasoline rises, the area's relative proximity to major population centres such as Toronto and Detroit may increase its attraction. Major tourist centres are Bayfield and Goderich.

2.4.6 Agriculture Sector Distribution

Significantly, the Maitland watershed has the highest livestock manure production/ha (8,950 kg/ha) in Canada, 10 times the national average. Manure components show similar patterns with the Maitland having the highest nitrogen component in Canada at 57.5 kg/ha and the highest phosphorus component at 16.6 kg/ha. (Statistics Canada 2007).

Cultivated lands include continuous row crops, corn systems, extensive field vegetables, grain systems, hay systems, mixed systems, orchards, soybeans, edible beans, and tobacco systems. Pasture lands include grazing systems, pastured systems and pastured woodlots. Lands which do not fall in one of these two categories include, but are not limited to, built-up urban lands, extraction sites, recreation sites, water, woodlots, and wetlands.

In 1996, Huron County housed approximately 240,000 livestock units: 405,000 hogs, 4.5 million chickens and 165,000 cattle (Huron County Planning and Development Department 2001). These numbers mark a decline in cattle since 1971 but an increase in poultry and swine for little change in total livestock units. In the same period, improved land area decreased while un-improved areas grew (Bonte-Gelok and Joy 1999).

Between 1996 and 1999, Huron saw a 54% increase in hogs marketed per producer. Between 1996 and 2000, 391 building permits were issued for new or expanded barns to accommodate an additional 58,000 livestock units. Hogs accounted for 72% of the livestock units. In 1996, every municipality still had adequate area to accommodate the manure. Intensity of production has risen dramatically since then, and new barns are much larger (Huron County Planning and Development Department 2001). The 1996 to 2000 building permits for new or expanded barns showed some concentration in Middle

Maitland, Little Maitland and North Maitland watersheds but occurred in all other areas as well. Livestock density remains highest in the Maitland watershed (Huron County Planning and Development Department 2001).

The most recent census conducted in 2006 showed that there were 142,816 cattle, 711,745 pigs, and 5.2 million chickens in Huron County (Statistics Canada 2007).

2.4.7 Aggregates

A 2004 Aggregate Resource Inventory Paper for Huron County notes all aggregate as sand and gravel; there is no bedrock-derived aggregate. Between 1998 and 2002, total production averaged about 2.8 million tonnes per year and the average since 1981 has been about 2.7 million tonnes per year. Most of the 169 pits are in the north and central parts of the County and associated with major spillways and eskers. Glacial lake beaches, sand plains and some coarser textured moraines can also provide aggregate. The area previously known as Goderich and Grey townships had the highest number of licensed pits in 2002. Many of the primary deposits can have potential conflicts with adjacent agriculture, wetlands, ANSIs and recreational uses (Dodds et al. 2005). The focus of exploitation on major spillways could raise concerns of potential interference with shallow overburden aquifers vital to wetlands and streams.

Huron County's distance to markets makes it a small player on the provincial scale. Slow population growth and few new major infrastructure projects would indicate no dramatic increase in production in the short term. In the longer term, however, as resources closer to large urban markets deplete, Huron County may see a rise in production (Dodds et al. 2005).

2.4.8 Cottage Development

Over the last 60 years, a band of cottage development has spread along much of the Lake Huron shoreline. By 1993, Huron County shoreline townships had over triple the number of seasonal residents as permanent ones (Bonte-Gelok and Joy 1999). Some older areas built close to the cliffs are now experiencing erosion threats from natural processes. In some areas gullies are threatening to erode cottage foundations. Malfunctioning septic systems are also degrading water quality. Many older cottages have expanded, exacerbating the erosion and septic system problems (Snell and Cecile et al. 1995).

The majority of lakeshore residences use private septic systems. Many of these systems are now used well beyond their design capacity as piped lake water supplies provide limitless volumes and conversions transform cottages into year-round residences. There is pressure for expansion of shore communities and cottage developments on the coastal sand plain outside protected areas.

2.4.9 Landfills

The Waste Management Master Plan for the County of Huron (Stage 3 1997) identifies one existing landfill site, Morris, to have long term potential in the MV SPA. There are 26 years of identified capacity, with a possibility of more capacity (up to 40 years) at these sites if a staged expansion program is granted by the Ontario Ministry of the Environment

(MOE) (CH2M Gore & Storrie Ltd. 1997). A potential new landfill site has been identified in the Township of Ashfield-Colborne-Wawanosh, but further work on this site will be postponed until the above landfill has been optimized.

Bonte-Gelok and Joy (1999) documented wastewater treatment plant lagoons and landfills for Huron County. From available data, they found little evidence of water quality issues from landfills, nor any relationship between treatment plants and water quality trends.

2.4.10 Oil and Gas

According to the Ontario Oil, Gas and Salt Resources Library, the MV SPA has a record of 174 wells, only five of which are active natural gas wells and two are brine wells (Ontario Oil, Gas and Salt Resources Library 2010).

2.4.11 Transportation

Because the area is rural and does not have a large city, most of the roads are county or municipal roads with the exception of the four King's Highways. Highway 21 begins at Highway 402 and heads north to Lake Huron, following the coast until Southampton where it then heads inland to Owen Sound. In the MV SPA, it connects the towns of Goderich, Port Albert and Point Clark. Highway 4 runs north-south and connects to Highway 8 at Clinton. Highway 8 runs northwest to southeast, connecting the towns of Goderich, Clinton and Seaforth then continuing outside of the Source Protection Region to Mitchell, Sebringville and Stratford before joining Highway 7 to Kitchener-Waterloo. Lastly, Highway 23 is a main artery through Perth County. It runs in a southwest-northeast direction beginning from Highway 7 at Elginfield, and connects the communities of Mitchell, Monkton, Listowel, Palmerston, Harriston and ends at the intersection of Highways 9 (to Walkerton) and 89 (to Mount Forest).

Spills along these highway corridors have been raised as a concern by the SPC. However, more research is required to determine how to quantify this as a threat. This may be included in an updated version of the Assessment Report.

There are two minor airports located within the MV SPA in Goderich, and Wingham. In the area there are also a number of short line railway lines (mostly used for fertilizer, grain and salt).

2.4.12 Wastewater Treatment

Septic Systems

Impact on water depends on age, density, design, soil, and tile connections. Septic system numbers for the different watersheds may be outdated. In the Ausable, Parkhill and Mud Creek areas, 4,049 systems area estimated (Hocking - CURB 1989).

In the Bayfield area, 1,450 are estimated, while in the Shore Streams and Gullies it is 1,848 (Hocking - CURB 1989). The Bayfield area is rated as 'high density' by Bonte-Gelok and Joy (1999) and the highest density of the watersheds in Huron County goes to the Shorelines and Gullies. The Nine Mile has a low density (Bonte-Gelok and Joy 1999) and there is no information for Maitland.

Most of the documentation applied to systems built in heavy soils and was concerned with effects of malfunctioning on surface water quality. Cottages built on the shoreline sand plain, however, correspond to a major overburden recharge area and raise concerns for the shallow overburden aquifers.

The Huron County Health Unit has undertaken a septic system re-inspection program for the communities of Amberley Beach, Port Albert, Bluewater Beach, Black's Point, St. Joseph and Egmondville. The Health Unit targeted these areas because of the combination of high classification, history of sewage ponding, odour complaints, and a history of poor-quality beach water for adjacent lakeshore communities; some of the communities volunteered for the program (Scharfe and the Ashfield-Colborne Lakefront Association 2005). In 2005, the Health Unit performed 174 re-inspections; three of the systems had failed and needed to be replaced. For 2006, the number of re-inspections had exceeded the number from 2005 and only two systems required replacement. These numbers are conservative estimates of failures because it does not take into account the systems that failed, but could be repaired because the failure was due to a lack of maintenance. As well, the re-inspection program is currently of a voluntary nature, and landowners with known failed systems may be unwilling to contact the re-inspection program.

Stormwater Management

In addition to its regulatory role, the Conservation Authorities (CAs) are often called upon to provide support services in the review of development applications made under the Planning Act, generally being in the position as either having the required technical expertise or otherwise assuming the role as resource managers. With regard to stormwater management, the Maitland Valley Conservation Authority (MVCA) generally acts in an advisory capacity to the local municipality. The Conservation Authority, generally, would encourage that suitable, effective stormwater management be implemented supporting a development proposal. The degree of stormwater management required will depend on the nature of the development proposal. Typically, change in land use will trigger the need for stormwater management. Development can take many forms and may proceed as a proposed plan of subdivision or condominium, may proceed by way of severance, or may involve a relatively small parcel of land such as in the case of an infill situation within an existing developed area.

The MVCA has developed policy documentation that sets out policies, criteria, and targets as guides towards the application of stormwater management within the MVCA's area of jurisdiction. The MVCA endorses the concept of an integrated approach to stormwater management through the planning process. The development of Watershed Plan(s), Master Drainage Plan(s) etc. which are endorsed by a municipality and address stormwater management needs at a community scale, regional scale, or on a watershed basis are encouraged. It is recommended that such plans be recognized within municipal land use plans such as the Official Plan or a Secondary Plan.

A municipality's Official Plan or Secondary Plan may make provisions for stormwater management. In such case, stormwater management requirements might be described as a statement of policy objectives. The policy/criteria is likely to be generic in nature and may not address in detail the specific stormwater management requirements which would be associated with a specific development proposal as would typically be addressed by a detailed stormwater management report.

In many municipalities where municipal wastewater and storm sewers are in place, storm water bypasses and overflows by cross connections are an issue. Discharge of chlorine and ammonia from wastewater into Lake Huron is also an issue that has been discussed through various site specific studies (Luinstra 2006).

Many of the more urbanized areas of the SPA contain municipal or communal systems that collect and treat sewage and wastewater. Although most of these sewage treatment systems provide primary and secondary treatment and disinfection, the discharge from these systems can cause an increase in microbial release into the surrounding environment. In addition, sewage treatment by-passes and overflow that occur during times of heavy rains and snow melt, which cause an overflow of microbial load to by-pass the treatment facility and flow into neighbouring watercourses. For further information on the frequency of municipal bypasses, refer to MOE's Spills Action Centre.

The Town of Goderich was the only facility that directly discharged into Lake Huron (Howell et al. 2005), but received funding from the Canada-Ontario Municipal Rural Infrastructure Fund (COMRIF) to complete the separation of storm and sanitary sewers and to upgrade the sewage treatment plant to prevent the occasional release of partially treated sewage into the lake during high rainfall events (Ashfield-Colborne Lakefront Association 2005).

2.5 Overview of Interaction between Physical and Human Geography

2.5.1 Drinking Water Sources

In towns in the MV SPA, the main source of drinking water tends to be municipal wells, and in rural areas most sources are individual or communal wells. Most wells are bedrock wells. For example, in Huron County, more than 80% of the wells reach bedrock (International Water Consultants et al. 2003). Some municipal surface water systems are fed by Lake Huron and service nearby rural areas. All Bruce County, Perth County, and Township of Wellington North residents use groundwater sources (Rush 2003, Waterloo Hydrogeologic 2003a). A Huron County survey in 2000 found one-third of the wells above the drinking water guideline for bacteria and 10% above the guideline for nitrate (MVCA 2003).

All drinking water systems located in the MV SPA and the area served by each system are shown in **Map 2.12**. The locations of monitoring wells in the MV SPA are shown on **Map 2.13**. Drinking water systems (DWS) are also listed in **Table 2.7** by system number, system classification, address, and number of users served by each system. Where cells in the table appear blank, the data is unavailable. The pumping rates for the maximum annual, average annual and monthly average pumping rates for all large municipal residential drinking water systems are listed in **Table 2.8**.

2.5.1.1 Municipal Wells

In the MV SPA, municipal wells supply about 30% of population including seasonal residents.

2.5.1.2 Communal Wells

In the area, public supplies taken from non-municipal wells are estimated to serve about 10% of the population. They occur in ten campgrounds and several small subdivisions (International Water Consultants et al. 2003).

2.5.1.3 Private Groundwater Supplies

Domestic wells are numerous. For example, in Huron County about 3,400 domestic wells supply approximately 45% of the population including seasonal residents. A residential shift from individual private wells to municipal wells is emerging as a recent trend. It is estimated that there are 16,000 individual wells in the Source Protection Region (Gutteridge and Innes 2008).

2.5.1.4 Surface Water Intakes

The only Lake Huron intake within the MV SPA is located at Goderich. It supplies a population of approximately 7,500 people (the Town of Goderich), and the amount of water consumption is 900,000 gallons per day.

2.5.2 Ecological Water Use

All ecosystems rely on water. Lake, river, stream, pond and wetland systems are particularly dependent. Lake Huron is one of the biggest fresh water ecosystems in the world. Inland, the SPA has very little natural ponding; Lakelet Lake in North Maitland is the largest, well-buffered by forest.

Groundwater from the surface overburden layer is critical to several important ecosystems. Groundwater provides cold water fish habitat, maintains wetlands, sustains base flow that supports aquatic habitat during droughts and contributes clear water to dilute pollution.

Stream habitat quality in the SPA generally improves from south to north. Physiography drives much of this trend; streams flowing through kames and spillways have much more access to the permanent and cold flows from near-surface groundwater aquifers than do streams on clay plains. Kames and spillways are also lower capability agricultural land than clay plains and support more forest, a form of natural infrastructure that protects water quality and quantity. Like forest, wetlands too are much more numerous towards the north, maintained by near-surface groundwater discharge and surface inflows. They both rely on water and protect it.

2.5.3 Agricultural Water Use

Rainfall is the main water supply for crops. For other water needs, agriculture in the Source Protection Region relies on groundwater and use by livestock operations is by far the greatest. Livestock operations use water for drinking, washing and cooling livestock, rinsing barns, mixing and spraying of pesticides or herbicides and for washing equipment. In Huron County's case, livestock uses 4.8 million m^3 per year of which approximately 3 million m^3 is groundwater. Huron County irrigation uses 1.2 million m^3 per year of which about 0.8 million m^3 is from groundwater. Agricultural water usage was developed based on 2006 census data for the subwatersheds following methodology developed by de Loë (2001). Streams and drains are outlets for tile drainage. Greenhouse operations can use large volumes of groundwater.

2.5.4 Industrial Water Use

Among industries, aggregate washing operations and Sifto Salt in Goderich use very large volumes of water, though the vast majority of this water is returned through all types of drainage and infiltration. Water returned to the watershed by Sifto Salt is in keeping with MISA protocols. Food processing plants and golf course operations can also be large users. In Huron County, industry accounts for 37% of groundwater use most of which is aggregate washing.

Table 2.7 Drinking water system classification in the Maitland Valley Source Protection Area

Table 2.7 Drinking water system classification in the Maitland Valley Source Protection Area

DWS Number	Drinking Water System Name	Classification	Address	Population Served
Township of Ashfield-Colborne-Wawanosh				
220007588	Benmiller Inn Well Supply	SMRS	Ashfield-Colborne-Wawanosh	60
220007757	Huron Sands Well Supply	SMRS	Ashfield-Colborne-Wawanosh	120
220008499	Century Heights Subdivision Well Supply	SMRS	Ashfield-Colborne-Wawanosh	200
260007842	Dungannon Well Supply	LMRS	Ashfield-Colborne-Wawanosh	330
260003474	R252 Point Farms Provincial Park – Main Pumphouse Well Supply	LNMNRS	Ashfield-Colborne-Wawanosh	
260026455	R252 Happy Hollow Camp Well Supply	NMSRS	Ashfield-Colborne-Wawanosh	
260035321	R252 Falls Reserve (Well A) Well Supply	NMSRS	Ashfield-Colborne-Wawanosh	
260035334	R252 Falls Reserve (Well C) Well Supply	NMSRS	Ashfield-Colborne-Wawanosh	
260036400	Camp Menesetung Well Supply	NMSRS	Ashfield-Colborne-Wawanosh	
260038571	R252 Mackenzie Tend and Trailer Park Well Supply	NMSRS	Ashfield-Colborne-Wawanosh	
260068965	R252 Lower Bogies Beach Well Supply	NMSRS	82703 Graham St., Goderich, N7A 3X9	
260007543	Meneset on the Lake (Well 1) Well Supply	NMYRRS	33809 Airport Rd., Goderich, N7A 3Y2	
260031798	Huron Have Village Well Supply	NMYRRS	82261 Bluewater Hwy, Goderich, N7A 3Y3	
260039806	Horizon View Estates Well Supply	NMYRRS	Horizon View Rd.	
260046319	Meneset on the Lake (Well 3) Well Supply	NMYRRS	81448 Cree Lane Goderich, N7A 3Y2	
260046332	Meneset on the Lake (Well 2) Well Supply	NMYRRS	33809 Algonquin Lane, Goderich, N7A 3Y2	
260018967	Saratoga Residence Well Supply	SNMNRS		
260010192	Brookside Elementary School Well Supply	SNMNRS	R.R.#7 Lucknow, ON N0G 2H0	
260038714	Camp Keewaydin Upper/Lower Well Supply	SNMNRS	86161 Churchill Dr.	
260046046	R252 Maitland Inlet Marina Well Supply	SNMNRS	Lot 33709 Concession Pt Block A(22R-2139) Goderich (Geographic Township)	
260049933	R252 Goderich Sunset Golf Club Well Supply	SNMNRS	33937 Golf Course Rd., West, Colborne Township, N7A 3Y3	
260049972	R252 Stickers Family Restaurant & Gas Barr Well Supply	SNMNRS	Village of Auburn	
Unassigned	Camp Kintail	SNMNRS	85153 Bluewater Hwy. at Presbyterian Camp Rd., N0M 1S0	
Unassigned	Cedar Lane B&B	SNMNRS	38134 Glens Hill Rd.	
Unassigned	Christ Church 1	SNMNRS	7 London Rd., Port Albert	
Unassigned	Community Heritage Hall	SNMNRS	120 Goderich St.	
Unassigned	Cozy Cottages	SNMNRS	10 Melbourne St., Port Albert, N7A 3X9	
Unassigned	Dunlop Motel	SNMNRS	82036 Bluewater Hwy.	

DWS Number	Drinking Water System Name	Classification	Address	Population Served
Unassigned	Exchange B&B	SNMNRS	34003 Blyth Rd.	
Unassigned	Hamilton Gas & Diesel	SNMNRS	37045 Amberley Rd., Lucknow	
Unassigned	Happy Hollow Family Camping	SNMNRS	70 Melbourne St., Port Albert	
Unassigned	Inn at Port Resort and B&B	SNMNRS	Central Welling St., Port Albert	
Unassigned	Kathi's Guesthouse B&B	SNMNRS	37364 Londesboro Rd., Goderich, N7A 3Y1	
Unassigned	Kerry Creek B&B	SNMNRS	85283 Kingsbridge Line, Lucknow, N0G 2H0	
Unassigned	Lake Huron Resort	SNMNRS	82803 Bluewater Hwy.	
Unassigned	Lakeside Flea & Farmers Market	SNMNRS	33842 Market Rd., off Bluewater Hwy.	
Unassigned	Little House in the Hollow B&B	SNMNRS	36826 Dungannon Rd.	
Unassigned	Nile United Church	SNMNRS	36968 Nile Rd.	
Unassigned	Riverside Park	NMSRS	83623 Bluewater Hwy., Port Albert, N7Z 3X9	
Unassigned	Former Saltford Valley Hall (now Samuel's Hotel)	SNMNRS	34031 Saltford Rd.	
Unassigned	Screaming Spitfire	SNMNRS	81643 Bluewater Hwy., Goderich	
Unassigned	Sepoy Retreat B&B	SNMNRS	86705 Harper Line	
Unassigned	Sherwood Place B&B	SNMNRS	36736 Glens Hill Rd.	
Unassigned	Sky Ranch Drive - In	SNMNRS	81669 Bluewater Hwy.	
Unassigned	St. Augustine Church 2	SNMNRS	Glen Hill Rd. at St. Augustine Line	
Unassigned	St. Helen's Hall	SNMNRS	85656 St. Helen's Line	
Unassigned	St. Joseph's Catholic Church 2	SNMNRS	84675A Bluewater Hwy., Kingsbridge	
Unassigned	The Olde Village Café	SNMNRS	78 Southampton St., Dungannon	
Unassigned	The School	SNMNRS	85581 Bluewater Hwy. at Horizon View Rd.	
Unassigned	Theresa's Garden B&B	SNMNRS	36007 Belgrave Rd., Lucknow, N0G 2H0	
Unassigned	Trinity United Church 1	SNMNRS	36698 Belfast Rd.	
Unassigned	Woodbine Farms B&B	SNMNRS	36569 Glens Hill Rd.	
Unassigned	Woody's Place	NMSRS	82929 Bridge Rd., Auburn	
Municipality of Central Huron				
220007793	Kelly Well Supply	LMRS	Lot 20, Concession 1, Goderich	24
220007837	McClinchey Well Supply	LMRS	79256 Fuller Drive	15
260005281	Auburn Well Supply	LMRS	Central Huron	30
220001539	Clinton Well Supply	LMRS	17 Park Lane	4500
260035191	R252 Shelter Valley Campground Well Supply	NMSRS	36534 Huron Rd RR 2, Clinton, ON, N0M 1L0	
260059072	R252 Holmesville Community Centre Well Supply	SMNRS	180 Community Centre Line, Holmesville, N0M 1L0	

DWS Number	Drinking Water System Name	Classification	Address	Population Served
260010283	Holmesville Elementary School Well Supply	SNMNRS		
260010309	Hullett Central Elementary School Well Supply	SNMNRS	Box 130, 269 King St. Londesboro, ON	
260018291	Homestead Group Home Well Supply	SNMNRS	Naftel's Creek	
260048178	R252 Woodlands Links Golf Club Clubhouse Well Supply	SNMNRS	37858 Huron Rd., Clinton, N0M 1L0	
Unassigned	1864 Stonehouse B&B	SNMNRS	82153 Baseline Rd., Goderich, N7A 4C7	
Unassigned	Audrey's B&B	SNMNRS	86822 Base Line	
Unassigned	Century Agricultural Centre	SNMNRS	80332 County Rd. 8	
Unassigned	Auburn Riverside Retreat Family Campground	SNMNRS	38382 Blyth Rd., Auburn	
Unassigned	Benmiller United Church	SNMNRS	37006 Londesborough Rd., Benmiller	
Unassigned	Christmas & Country B&B	SNMNRS	39213 Hullett-McKillop Rd.	
Unassigned	Comfy Cozy B&B	SNMNRS	565 Nairn Dr. Goderich, N7A 3X8	
Unassigned	Fellowship Bible Chapel	SNMNRS	220 King St., Londesborough	
Unassigned	General Store & Restaurant	SNMNRS	271 County Rd. 4	
Unassigned	Glen - Aire B&B	SNMNRS	79135 Porters Hill Line	
Unassigned	Godley B&B	SNMNRS	81198 Old Road Dr.	
Unassigned	Holmesville United Church	SNMNRS	500 Main St., Holmesville	
Unassigned	Huron Chapel Evangelical Missionary Church	SNMNRS	199 John St., Auburn	
Unassigned	Hullett Provincial Wildlife Area Maintenance & Office Complex	SNMNRS	41378 Hydro Line Rd.	
Unassigned	In Lee of the Pines	SNMNRS	35147 Union Adrd., Goderich, N74 3X8	
Unassigned	Kinburn Hall	SNMNRS	41588 King St., Kinburn	
Unassigned	Kitchigami Family Camp Ground	SNMNRS	33827 Kitchigami Rd., Goderich	
Unassigned	La Brassine B&B	SNMNRS	34332 Kitchigami Rd.	
Unassigned	Lion's Hall	SNMNRS	282 Londesboro Rd.	
Unassigned	Londesborough United Church	SNMNRS	338 Londesboro Rd.	
Unassigned	Nairn Drive B&B	SNMNRS	560 Nairn Dr., Goderich	
Unassigned	Outaways B&B	SNMNRS	400 Main St., Holmesville	
Unassigned	Silver Birch Motel	SNMNRS	79764 Bluewater Hwy.	
Unassigned	The Bluffs	SNMNRS	79271 Bluewater Hwy.	
Unassigned	The Farmstead B&B	SNMNRS	38928 Blyth Rd.	
Unassigned	The Old Mill	SNMNRS	82790 County Rd. 4	
Unassigned	The White Carnation Banquet Hall	SNMNRS	150 Parr Line Rd., Holmesville	
Unassigned	Union Marsh Scout Camp	SNMNRS	33976 Union Rd.	
Unassigned	Wagon Wheel B&B	SNMNRS	81922 London Rd.	

DWS Number	Drinking Water System Name	Classification	Address	Population Served
Town of Goderich				
260038441	Camp Hermosa Inc. Well Supply	NMSRS	82931 Glendale Rd., Goderich, N7A 3X9	
260061113	R252 Innisfree Park Goderich Well Supply	NMSRS	33520 Rowcliff Drive, Goderich, N7A 3X8	
260020085	Princess Huron Lake Front Resort Well Supply	NMYRRS	Lot 9 Concession 1, Goderich	
260045240	R252 Goderich Airport Well Supply	SMNRS	33868A Airport Rd., Goderich N7A 4G7	
260010218	Colborne Central Elementary School Well Supply	SNMNRS	Po Box 304 Stn Main, Goderich ON,	
260059332	R252 Dunlop Motel Well Supply	SNMNRS	82036 Hwy 21, Goderich N7A 3Y2	
Township of Howick				
260031603	R252 Ron's Campsite (Well 1) Well Supply	NMSRS	Howick	
260031616	R252 Ron's Campsite (Well 2) Well Supply	NMSRS	Howick	
260020709	Belle Haven Apartments Well Supply	NMYRRS	91138 Belmore Line, Belmore	
260060242	R252 Wroxeter Hall Well Supply	SMNRS	1094 Centre St., Wroxeter, N0G 2X0	
260060255	R252 Gorrie Hall Well Supply	SMNRS	2059 Victoria St., Gorrie, N0G 1X0	
260060268	R252 Fordwich Hall Well Supply	SMNRS	3092 Old Mill St., Fordwich, N0G 1V0	
260060307	R252 Fordwich Ball Park Well Supply	SMNRS	3084 Albert St., Fordwich, N0G 1V0	
260060320	R252 Gorrie Ball Park Well Supply	SMNRS	2079 Alma St., Gorrie, N0G 1X0	
260060346	R252 Howick Municipal Office Well Supply	SMNRS	44816 Harriston Rd., Gorrie, N0G 1X0	
260060359	R252 Wroxeter Ball Park Well Supply	SMNRS	1120 Marietta St., Wroxeter, N0G 2X0	
260060398	R252 Howick Community Centre Well Supply	SMNRS	45088 Harriston Rd., Gorrie, N0G 1X0	
260060437	R252 Howick Pool Well Supply	SMNRS	2046 James St., Gorrie, N0G 1X0	
260010296	Howick Central Elementary School Well Supply	SNMNRS	R. R. #1 Gorrie, ON N0G 1X0	
260022516	Howick Maples Well Supply	SNMNRS	87852 Fordwich Line, Gorrie, N0G 1X0	
Unassigned	Aunt Bea's Family Restaurant	SNMNRS	3064 Fordwich Line, Fordwich	
Unassigned	Bed and Breakfast 1	SNMNRS	44373 County Rd. 87, Gorrie	
Unassigned	Brethren in Christ Church	SNMNRS	3073 Fordwich Line, Fordwich	
Unassigned	Café Wrox	SNMNRS	1083 Centre St., Wroxeter	
Unassigned	Camp David	SNMNRS	44083 Creamery Rd.	
Unassigned	Driftwood Beach Park	SNMNRS	90856 Driftwood Beach Rd., at County Rd. 30	
Unassigned	Fordwich Ball Park	SNMNRS	William St., Fordwich	
Unassigned	Fordwich United Church	SNMNRS	3080 Fordwich Line, Fordwich	
Unassigned	Gorrie Bible Fellowship Church	SNMNRS	87917 Gorrie Line	
Unassigned	Gorrie United Church	SNMNRS	2048 Albert St. S., Gorrie	
Unassigned	Gorrie Visitation Centre	SNMNRS	2050 Victoria St., Gorrie	

DWS Number	Drinking Water System Name	Classification	Address	Population Served
Unassigned	Maitland Valley Conservation Authority Administration Centre	SNMNRS	1093 Marietta St., Wroxeter	
Unassigned	Mobile Home Park 2	NMYRRS	3075 William St., Fordwich	
Unassigned	St. Stephen's Anglican Church	SNMNRS	2058 John St., Gorrie	
Unassigned	The Big Scoop	SNMNRS	1091 Centre St., Wroxeter	
Unassigned	The Village Restaurant	SNMNRS	2056 Victoria St., Gorrie	
Unassigned	Trinity Anglican Church 3	SNMNRS	3069 Louisa St. E., Fordwich	
Unassigned	Wroxeter United Church	SNMNRS	1090 Centre St., Wroxeter	
Municipality of Huron East				
220001487	Brussels Well Supply - Well #1	LMRS	66 McCutcheon St.	1277
220001487	Brussels Well Supply - Well #2	LMRS	66 McCutcheon St.	1277
220001511	Seaforth Well Supply	LMRS	40 Welsh St.	3000
260040001	R252 Family Paradise Campground (Well 1) Well Supply	NMSRS	Huron East	
260040014	R252 Family Paradise Campground (Well 2) Well Supply	NMSRS	Huron East	
260010270	Grey Central Elementary School Well Supply	SNMNRS	Ethel, ON N0G 1E0	
260015756	Fordwich Village Nursing Home Well Supply	SNMNRS	3063 Adelaide St., Fordwich, N0G 1V0	
260057304	R252 Duff's United Church Well Supply	SNMNRS	83136 Brussels Line, Walton, N0K 1Z0	
Unassigned	Brubacher Restaurant & Bakery	SNMNRS	44399 Brandon Rd., Ethel	
Unassigned	Cavan United Church	SNMNRS	86145 North Line, Winthrop	
Unassigned	Cornerstone Bible Fellowship Church	SNMNRS	444466 Brandon Rd., Ethel	
Unassigned	Cranbrook Hall	SNMNRS	84335 McNabb Line, Cranbrook	
Unassigned	Ethel Community Centre	SNMNRS	44356 Brandon Rd., Ethel	
Unassigned	Ethel Park	SNMNRS	44477 Brandon Rd., Ethel	
Unassigned	Ethel United Church	SNMNRS	44418 Brandon Rd., Ethel	
Unassigned	Knox Presbyterian Church 2	SNMNRS	84343 McNabb Line, Cranbrook	
Unassigned	Molesworth Lanes	SNMNRS	86710 Molesworth Line	
Unassigned	Rivers Edge Golf Course	SNMNRS	84389 McNabb Line, Cranbrook	
Unassigned	The Walton Inn	SNMNRS	83001 County Rd. 25, Walton	
Unassigned	Walton Community Hall	SNMNRS	42653 Blyth Rd., Walton	
Unassigned	Walton Park	SNMNRS	42655 Blyth Rd., Walton	
Unassigned	Winthrop Ball Park	SNMNRS	42727 Winthrop Rd.	
Unassigned	Zion Mennonite Fellowship Church	SNMNRS	449092 Cranbrook Rd.	
Township of Huron-Kinloss				

DWS Number	Drinking Water System Name	Classification	Address	Population Served
220008863	Whitechurch Well Supply	LMRS	Huron-Kinloss	93
220002663	Lucknow Well Supply -Well #4	LMRS		1100
220002663	Lucknow Well Supply - Well #5	LMRS		1100
260017719	Lucknow and District Christian School Well Supply	SNMNRS	PO BOX 550, Lucknow, ON, N0G 2H0	
260066755	R252 Kinloss Community Centre Well Supply	SNMNRS	Lot 13 Concession 1 Kinloss (Geographic Township)	
Township of Mapleton				
260046722	R252 Mapleton Municipal Buildings Well Supply	SMNRS	7275 Sideroad No. 3 Rd., Drayton, N0G 1P0	
Town of Minto				
220000031	Clifford Well Supply - Well # 1	LMRS		711
220000031	Clifford Well Supply - Well # 3	LMRS		711
220000031	Clifford Well Supply - Well # 4	LMRS		711
220000077	Harriston Well Supply - Well #1	LMRS		1809
220000077	Harriston Well Supply - Well #2	LMRS		1809
220000077	Harriston Well Supply - Well #3	LMRS		1809
220000059	Palmerston Well Supply - Well #1	LMRS		1809
220000059	Palmerston Well Supply - Well #2	LMRS		1809
220000059	Palmerston Well Supply - Well #3	LMRS		1809
220000059	Palmerston Well Supply – Well #4	LMRS		1809
260034242	R252 Drew Hall Well Supply	SMNRS	MINTO	
260041951	R252 Minto Office Well Supply	SMNRS	MINTO	
260022399	Minto Meadow Well Supply	SNMNRS	6497 10th Line, Harriston, N0G 1Z0	
Unassigned	Glenlee Parochial School	SNMNRS	6644 6th Line	
Unassigned	Cedarvale Christian School	SNMNRS	5334 School Rd. 7	
Unassigned	Teviotdale Truck Stop	SNMNRS	6753 Wellington Rd. 109	
Municipality of Morris-Turnberry				
220008257	Belgrave Well Supply - Well #1: McCrea	LMRS	23 McCrae St., Belgrave N0G 1H0	90
220008257	Belgrave Well Supply - Well #2: Jane	LMRS	32 Hamilton St., Belgrave N0G 1H0	245
260037167	Turnberry Estates Well Supply	NMYRRS	Lot 7 Concession B Turnberry (Geographic Township)	
260058929	R252 Morris-Turnberry Municipal Office Well Supply	SMNRS	41342 Morris Rd., Brussels, N0G 1H0	
260058994	R252 Bluevale Community Hall Well Supply	SMNRS	32 Clyde St., Bluevale, N0G 1H0	
260015730	Braemar Retirement Centre Well Supply	SNMNRS	719 Josephine St., N., Wingham N0G 2W0	

DWS Number	Drinking Water System Name	Classification	Address	Population Served
260033189	R252 Lindon Motel Well Supply	SNMNRS	86512 London Road, RR 4, Wingham, ON, N0G 2W0	
260057005	R252 Wingham Golf & Curling Well Supply	SNMNRS	40292 Jamestown Rd., Wingham, N0G 2W0	
260057538	R252 Walton Inn Well Supply	SNMNRS	83001 Brussels Line, Walton, N0K 1Z0	
260065754	R252 Golden Mayan Foods Ltd. Well Supply	SNMNRS	42169 Amberley Rd., Bluevale, N0G 1G0	
Unassigned	Bluevale Community Hall	SNMNRS	Clyde St., Bluevale	
Unassigned	Bluevale Kountry Kitchen	SNMNRS	5 Clyde St., Bluevale	
Unassigned	Bluevale United Church	SNMNRS	89 Queen St., Bluevale	
Unassigned	Diesel Car Diner Restaurant & Truck Stop	SNMNRS	42658 Amberley Rd.	
Unassigned	Jack Van Camp (Belgrave)	NMYRRS	Belgrave, ON	
Unassigned	Knox Presbyterian Church 1	SNMNRS	42 Clyde St., Bluevale	
Unassigned	Knox Presbyterian Church 5	SNMNRS	10 Brandon St., Belgrave	
Unassigned	Levan Airport	SNMNRS	40647 Amberley Rd., Wingham	
Unassigned	Mitchell's Country B&B	SNMNRS	42501 Walton Rd.	
Unassigned	Pioneer Conservation Area & Ball Park	SNMNRS	21 Park Rd., Bluevale	
Unassigned	Royal "T" Diesel / Gas Bar	SNMNRS	90279 London Rd., Wingham	
Unassigned	Shammon's Village Spa 1	SNMNRS	14 County Rd., Belgrave	
Unassigned	Shannon's Spa 2	SNMNRS	14 London Rd., Belgrave	
Unassigned	Leslie Motors	SNMNRS	41401 Amberley Rd., Bluevale	
Unassigned	Fireside Café	SNMNRS	86348 County Rd. 4	
Unassigned	Kingdom Hall 1	SNMNRS	30 Maitland St., Wingham	
Unassigned	Wingham Lindon Motel	SNMNRS	86512 County Rd. 4	
Township of North Huron				
220001520	Wingham Well Supply - Well # 3	LMRS		2845
220001520	Wingham Well Supply - Well # 4	LMRS		2845
220001496	Blyth Well Supply - Well #1	LMRS		975
220001496	Blyth Well Supply - Well #2	LMRS		975
	Blyth Well Supply - Well #5	LMRS		
260010244	East Wawanosh Elementary School Well Supply	SNMNRS	Belgrave, ON N0G 1E0	
260035555	Wawanosh Nature Centre Well Supply	SNMNRS	38854 Nature Centre Rd.	
Unassigned	Auburn School House B&B	SNMNRS	83516 Hoover Line	
Unassigned	Cooks Fish out Pond	SNMNRS	85185 Marnoch Line	
Unassigned	Hedley's Trout Farm	SNMNRS	84534 Marnoch Line	

DWS Number	Drinking Water System Name	Classification	Address	Population Served
Unassigned	The Blyth Community Church	SNMNRS	302-308 Blyth Rd.	
Unassigned	Walnut Grove Farm B&B	SNMNRS	39721 Amberley Rd., Wingham	
Unassigned	Wawanosh Park Conservation Area	SNMNRS	38781 Glens Hill Rd.	
Unassigned	Westfield Hall	SNMNRS	39162 Westfield Rd.	
Unassigned	Wingham Pentecostal Church	SNMNRS	21 Lloyd St., Wingham	
Municipality of North Perth				
220003975	Gowanstown Subdivision Well Supply	SMRS	Lot 24 Conc. 4 Wallace (Geographic Township)	70
260034996	Molesworth Well Supply	SMRS	Lot 61 Conc. 1 Wallace (Geographic Township)	110
260065260	Atwood Well Supply - Well #1	LMRS		250
260065260	Atwood Well Supply - Well #2	LMRS	102 Parkview Crescent	250
220000512	Listowel Well Supply - Well #4	LMRS	580 Main St.	6600
220000512	Listowel Well Supply - Well #5	LMRS	580 Main St.	6600
220000512	Listowel Well Supply - Well #6	LMRS	580 Main St.	6600
260030394	King Street Well Supply	NMYRRS	North Perth	
260031811	The Village at Listowel Well Supply	NMYRRS	RR 3, Listowel, ON N4W 3G8	
260054587	Village Green Well Supply	NMYRRS	2100 Hwy. 23, North of Listowel, N0G 2P0	
260034944	R252 Kurtzville Arena Well Supply	SMNRS	Perth County Rd. 88,Kurtzville, ON, N4W1L3	
260034957	R252 Elma – Logan Community Centre Well Supply	SMNRS	Main Street, Atwood, Ontario N0G 1B0	
260034970	R252 Monkton Library Well Supply	SMNRS	216 Winstanley St, PO Box 203, Monkton, ON N0K 1P0	
260034983	R252 Gowanstown Municipal Office Well Supply	SMNRS	North Perth	
260035815	R252 Wallace Optimist Park Well Supply	SMNRS	Line 87, North of Listowel	
260010257	Elma Township Elementary School Well Supply	SNMNRS	RR # 2 Atwood, ON N0G 1B0	
260010387	Wallace Elementary School Well Supply	SNMNRS	Gowanstown, Ontario, N0G 1Y0	
260018668	Listowel Christian School Well Supply	SNMNRS	Box 151, Line 87, 6020 Wallace Twp., Listowel, Ontario, N4W 3H2	
260022360	WWPPS-Pleasant View School Well Supply	SNMNRS	4953 Line 80 Listowel, N4W 3G9	
260022607	Elm Creek Well Supply	SNMNRS	8410 Conc. 3 Listowel, N4W 3G8	
260044928	R252 Trowbridge Community Centre Well Supply	SNMNRS	243 West St., Trowbridge, N4W 3G7	
260047775	R252 Poole Mennonite Church Well Supply	SNMNRS	Lot 16 Concession 3 Mornington (Geographic Township)	
260053599	R252 First Baptist Church Well Supply	SNMNRS	6161 Perth Line 86, Listowel, N4W 3H2	

DWS Number	Drinking Water System Name	Classification	Address	Population Served
260056459	R252 Petro-Canada Bulk Plant (Listowel) Well Supply	SNMNRS	R.R. #3, Listowel, ON, N4W 3H2	
260063349	R252 Donegal United Church Well Supply	SNMNRS	5269 Perth Line 72, Con. 10, Lot 31, Atwood, ON N0G 1B0	
Township of Perth East				
260063024	Crystal Lakes Mobile Homes Court Well Supply	NMYRRS	Lot 11 Conc.1 Ellice (Geographic Township)	
260018460	Morning Star Christian School Well Supply	SNMNRS	4088 King St, Millbank, ON N0K 1L0	
260030732	Galbraith Conservation Area Well Supply	SNMNRS	Perth East, Ward of Mornington Lot: 1 Concession: 9,10	
Township of Wellington North				
260034827	R252 South Luther Hall Well Supply	SNMNRS	Wellington North	
260034840	R252 Kenilworth Office Well Supply	SMNRS	Wellington North	
260034853	R252 Damascus Hall Well Supply	SMNRS	Wellington North	
260022581	Farewell Well Supply	SNMNRS	9173 Conc. 10 Mount Forest, N0G 2L0	
Municipality of West Perth				
260007933	New Quality Meat Products Well Supply	LNMNRS	West Perth	
260032188	R252 Fullarton Hall Well Supply	SMNRS	West Perth	
260032214	R252 Logan Shop and Township Hall Well Supply	SMNRS	West Perth	
260032266	R252 Brodhagen Community Centre Well Supply	SMNRS	West Perth	

LMRS - Large Municipal Residential System
SMRS - Small Municipal Residential System
LMNRS - Large Municipal Non-Residential System
SMNRS - Small Municipal Non-Residential System
NMYRRS - Non-Municipal Year-Round Residential System
NMSRS - Non-Municipal Seasonal Residential System
LNMNRS - Large Non-Municipal Non-Residential System
SNMNRS - Small Non-Municipal Non-Residential System
Source: Databases provided by MOE and Health Units; 2006

Table 2.8 The maximum annual, average annual and average monthly pumping rates of surface water intakes and wells that are part of the system

DWS Number	Drinking Water System Name	Max. Annual Pumping Rate (m3/day)	Avg. Annual Pumping Rate (m3/day)	Year of Avg. Monthly Pumping Rate	Avg. Monthly Pumping Rate (m3/day)											
					Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
220007793	KELLY WELL SUPPLY	35	13	2013	11	11	11	12	16	16	18	16	13	12	12	12
220007837	MCCLINCHEY WELL SUPPLY	27	6	2013	4	4	5	4	5	9	12	11	7	5	4	4
260005281	AUBURN WELL SUPPLY	27	6	2013	5	5	5	5	6	6	5	6	8	6	6	6
220001539	CLINTON WELL SUPPLY	2581	1649	2013	1746	1873	1727	1650	1612	1629	1653	1531	1546	1676	1565	1579
220001487	BRUSSELS WELL SUPPLY - Well #1	978	617	2013	611	610	607	627	613	618	528	624	681	655	576	655
220001487	BRUSSELS WELL SUPPLY - Well #2	577	6	2013	7	1	1	1	3	1	1	1	1	1	58	1
220001511	SEAFORTH WELL SUPPLY -TW1	208	79	2013	130	91	82	51	87	89	87	83	52	65	63	68
220001511	SEAFORTH WELL SUPPLY -PW1	926	271	2013	241	268	203	273	393	354	266	342	282	336	278	269
220001511	SEAFORTH WELL SUPPLY -PW2	1505	775	2013	896	884	795	900	832	842	770	760	788	657	573	607
220008257	BELGRAVE WELL SUPPLY - Well #1: McCrea	244	55	2013	48	54	51	52	69	61	64	60	52	53	46	52
220008257	BELGRAVE WELL SUPPLY - Well #2: Jane	85	11	2013	12	18	9	7	9	10	13	13	12	12	10	9
220003975	GOWANSTOWN WELL SUPPLY	30	8	2013	8	9	9	9	10	8	8	7	8	7	7	7
260034996	MOLESWORTH WELL SUPPLY	36	23	2013	23	23	24	24	23	23	25	27	23	22	21	23
260065260	ATWOOD WELL #1	91	30	2013	26	32	34	39	24	32	37	31	33	26	25	25
260065260	ATWOOD WELL #2	75	34	2013	32	24	22	18	45	43	39	36	39	36	36	35

DWS Number	Drinking Water System Name	Max. Annual Pumping Rate (m3/day)	Avg. Annual Pumping Rate (m3/day)	Year of Avg. Monthly Pumping Rate	Avg. Monthly Pumping Rate (m3/day)											
					Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
220000512	LISTOWEL WELL SUPPLY - Well #4	1558	718	2013	705	753	801	724	851	804	669	676	660	677	639	653
220000512	LISTOWEL WELL SUPPLY - Well #5	1584	736	2013	788	774	814	819	852	815	672	672	656	655	649	653
220000512	LISTOWEL WELL SUPPLY - Well #6	1796	737	2013	720	829	816	822	834	821	669	697	668	680	639	650
210000238	GODERICH WATER TREATMENT PLANT	7507	3689	2013	3261	3407	3251	2983	3962	4136	5149	4747	4037	3580	2829	2871
220000031	CLIFFORD WELL SUPPLY - Well # 1	877	125	2013	147	126	139	125	115	117	117	101	125	111	133	145
220000031	CLIFFORD WELL SUPPLY - Well # 3	336	95	2013	85	90	82	95	119	97	119	117	91	110	35	104
220000031	CLIFFORD WELL SUPPLY - Well # 4	193	37	2013	27	47	31	35	30	33	30	31	39	32	67	40
220000077	HARRISTON WELL SUPPLY - Well #1	599	62	2013	34	49	223	50	41	48	54	50	53	50	48	46
220000077	HARRISTON WELL SUPPLY - Well #2	1120	375	2013	400	398	407	326	382	384	357	394	344	342	363	410
220000077	HARRISTON WELL SUPPLY - Well #3	1009	553	2013	508	501	290	544	543	597	695	597	546	588	562	668
220000059	PALMERSTON WELL SUPPLY - Well #1	272	59	2013	62	58	66	55	54	64	61	55	61	59	55	55
220000059	PALMERSTON WELL SUPPLY - Well #2	554	255	2013	263	251	238	258	270	297	269	257	228	259	235	241
220000059	PALMERSTON WELL SUPPLY - Well #3	1024	458	2013	254	476	437	492	570	536	493	481	498	479	345	436

DWS Number	Drinking Water System Name	Max. Annual Pumping Rate (m3/day)	Avg. Annual Pumping Rate (m3/day)	Year of Avg. Monthly Pumping Rate	Avg. Monthly Pumping Rate (m3/day)											
					Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
220000059	PALMERSTON WELL SUPPLY - Well #4	565	110	2013	316	105	99	91	90	72	89	75	94	89	127	78
220007588	BENMILLER INN WELL SUPPLY	180	43	2013	29	29	29	28	36	38	46	57	92	70	46	74
220007757	HURON SANDS WELL SUPPLY	72	20	2013	NA	NA	NA	13	21	21	34	25	18	15	6	NA
220008499	CENTURY HEIGHTS WELL SUPPLY	337	101	2013	73	73	87	75	116	121	168	121	103	78	93	98
260007842	DUNGANNON WELL SUPPLY	174	88	2013	112	100	120	94	93	90	95	85	83	81	61	48
220008863	WHITECHURCH WELL SUPPLY	53	26	2013	29	27	26	27	29	26	29	25	23	24	24	27
220002663	LUCKNOW WELL SUPPLY -Well #4	560	43	2013	29	88	36	45	58	30	35	33	30	56	45	32
220002663	LUCKNOW WELL SUPPLY - Well #5	1213	514	2013	526	451	528	492	528	652	704	511	487	437	387	458
220001520	WINGHAM WELL SUPPLY - Well # 3	650	500	2013	363	426	452	419	572	613	603	650	645	507	379	369
220001520	WINGHAM WELL SUPPLY – Well# 4	730	654	2013	659	621	563	657	730	705	703	691	561	634	670	643
220001496	BLYTH WELL SUPPLY-Well #1	239	196	2013	270	194	171	187	200	212	212	239	198	181	187	168
220001496	BLYTH WELL SUPPLY-Well #2	219	175	2013	219	171	156	147	190	182	180	145	204	170	182	152

Source: Well System Annual Inspection Reports

References

Author	Title	Date	Purpose
Ausable Bayfield Conservation Authority	Watershed Plan Summary	1985	A handy summary to assist plan implementation
Ashfield-Colborne Lakefront Association	Minutes of the Coordinators Meeting, 2005-05-13. http//www.northwesthuron.com/org/CC-2005-05.html	2005	To provide details on the Town of Goderich's plan to separate storm and sanitary sewers.
Ausable Bayfield Conservation Authority	Appendix to: Environmentally Significant Areas of the Ausable Bayfield Conservation Authority. Watershed Plan Report 2	1984 revised in 1995	To document the ESAs and include updated information
B.M. Ross and Associates Ltd.	Hydrology Study Technical Manual	no date	To provide direction and prioritization for the watershed strategy
Baird and Associates	Consideration for Shore Protection Structures	1994	provide technical guidance re engineered shoreline protection
Balint, David S.	Analysis of the Manure Management - Water Quality Program of the Ausable-Bayfield Conservation Authority	1984	To build on earlier studies by more ground truthing and an education program
Beecroft, M.	Windings: A History of the Lower Maitland River. Maitland Conservation Foundation, Maitland Valley Conservation Authority	1984	Provide historical information on the Maitland River
Bonte-Gelok, Shelly and Douglas M. Joy	Huron County Surface Water Quality Data Study	1999	To collect available water quality information, identify trends and causes, and incorporate the data into a GIS
Burnside Environmental	Town of Minto: Groundwater Management and Protection Study	2001a	To develop groundwater protection strategies.
Burnside Environmental	Township of Wellington North: Groundwater Management and Protection Study	2001b	To develop groundwater protection strategies.
Butler, R.W. and S.G. Hilts	Patterns of Land Use and Change on the Lake Huron Shore, Bosanquet Township, Ontario	1978	To provide background papers for a geography field trip
CH2M Gore and Storrie Ltd.	County of Huron Water Management Master Plan: Stage 3 Report, Solid Water Management Master Plan Preliminary Draft.	1997	A detailed plan for the future of waste management in Huron County

Author	Title	Date	Purpose
Chapman, L.J. and D.F. Putnam	Physiography of Southern Ontario, 3rd Edition, Ontario Geological Survey, Special Volume 2	1984	To document the physiography
Conservation Authorities Branch, Department of Energy and Resources Management	Maitland Valley Conservation Report, Ontario Department of Energy and Resources Management, Toronto.	1967	A detailed description as a basis for management recommendations
Conservation Branch, Department of Planning and Development	Ausable Valley Conservation Report 1949. Department of Planning and Development, Toronto.	1949	A detailed description as a basis for management recommendations
de Loë, R.	Agricultural and Rural Water Use in Ontario	2001	Provided methodology for estimating water usage based on the number of livestock for a given area
Department of Planning and Development	Middle Maitland Conservation Report. Toronto.	1954	A description as a basis for management recommendations
Dodds, C., B. Treble and A. Vanderloo	Huron County Aggregate Strategy: A Report from the Technical Committee to the Steering Committee.	2005	Data on aggregates in Huron County and the future of the industry
Donnelly, P.	Shoreline Management Plan 1994 (revised 2000), ABCA	1994	develop policy to reduce or eliminate storm damage on shore development
Donnelly, P.	Email Interview dated November 29, 2006. Lake Huron Centre for Coastal Conservation.	2006	develop policy to reduce or eliminate storm damage on shore development
Golder Associates Ltd.	Report on Groundwater Resource Assessment County of Huron, Ontario. County of Huron, Department of Planning and Development.	2000	Provide water quality and quantity data for groundwater sources in Huron County
Golder Associates Ltd.	Groundwater Quality Assessment: Huron County Groundwater Study. County of Huron, Department of Planning and Development.	2001	Provide water quality and quantity data for groundwater sources in Huron County
Golder Associates Ltd.	2002 Sentinel Well Monitoring Program: Huron County Groundwater Study. County of Huron, Department of Planning and Development.	2003	Data from groundwater monitoring program with analysis trends
Gutteridge, A. and D. Innes	Well Record Improvement Project, Phase Two, 2007 Summary. ABCA	2008	Provide information on the number and location of private wells in the ABMV Source Protection Region

Author	Title	Date	Purpose
Hocking, Doug	Rural Beaches Strategy Program: Target Sub-Basin Study Report April, 1988 to March 1989	1989	To reduce bacteria contamination and monitor improvements
Hocking, Doug	Clean Up Rural Beaches (CURB) Plan for the Lake Huron Beaches in the Ausable Bayfield Watershed	1989	To understand sources as a basis for a remedial plan
Howell, T., Abernethy, S., Charlton, M., Crowe, A., Edge, T., House, H., Lofranco, C., Milne, J., Scharfe, P., Steele, R., Sweeney, S., Watson, S., Weir, S., Weselan, A., and Veliz, M.	Sources and Mechanisms of Delivery of E. coli (bacteria). Pollution to the Lake Huron Shoreline of Huron County.	2005	Provide information on sources of *E. coli* along Lake Huron shoreline.
Huron County Planning and Development Department	Intensive Livestock Operations and Manure Management: Huron County Interim Control Study. Report for Discussion.	2001	Provide statistical information on the status of farming operations in Huron County
International Water Consultants Ltd., B.M. Ross and Associates Ltd. and Waterloo Numerical Modelling Corp.	County of Huron Groundwater Assessment and Municipal Wellhead Source Protection Study. Ontario Ministry of the Environment.	2003	To develop a characterization of the regional aquifer and a strategy for groundwater protection
James F. Maclaren Ltd.	Report on Preliminary Evaluation of Groundwater Hydrology for the Maitland Valley Conservation Authority	1977	To identify the location of any critical groundwater recharge areas
Luinstra, B. (Geologist for Luinstra Earth Sciences)	Interview on September 11, 2006	2006	To provide information on issues related to storm water bypasses.
Maitland Valley Conservation Authority	Watershed Plan	1984	To develop programs appropriate for the priority issues
Maitland Valley Conservation Authority	Maitland Conservation Strategy	1989	To focus management on causes of resource problems
Maitland Valley Conservation Authority	Maitland Watershed Partnerships	2003	To report on CA activities and watershed status
Maitland Valley Conservation Authority	MVCA Municipal Groundwater Workshop Materials. CD.	2004	Provide context on the status of groundwater quality and quantity
Oil, Gas and Salt Resources Library	www.ogsrlibrary.com accessed on Apr. 4, 2010	2010	Provide data on oil, gas and salt wells in the SPR.
Ontario Ministry of Municipal Affairs and Housing	*Provincial Policy Statement.* http://www.mah.gov.on.ca/Page10679.aspx	2005	To provide policy on future development in Ontario

Author	Title	Date	Purpose
Peach, G.	Phone Interview: Hardening of Lake Huron shoreline. Lake Huron Centre for Coastal Conservation.	2006, Nov. 23	To report on Lake Huron shoreline status
Rush, R.	Maitland Valley Characterization Report. Guelph Water Management Group.	2003	Summary of existing information on areas within Maitland Valley
Scharfe, P. and the Ashfield-Colborne Lakefront Association.	Huron County Health Unit Septic Reinspection Program, Phase 1. http://www.northwesthuron.com	2005	Identify the status of private septic systems in Huron County
Singer, S.N., C.K. Cheng and M.G. Scafe	The Hydrogeology of Southern Ontario. Volume 1. Ontario Ministry of Environment and Energy.	1997	Provide data on the quality of water in bedrock aquifers in the planning region
Snell and Cecile Environmental Research	Shoreline Management Plan: Environmental Review Component Goderich to Kettle Point	1991	environmental considerations for the Shoreline Management Plan
Snell and Cecile Environmental Research	Ausable Bayfield Conservation Authority Watershed Management Strategy	1995	identify priority sub-watersheds for CA programs
Statistics Canada	Population Counts, 2001. *http://www12.statcan.ca/english/census01/products/standard/popdwell/Table-UR-D.cfm?T=1&PR=35&SR=1&S=1&O=A*	2002	Provincial census data
Statistics Canada	Population Counts, 2006. http://www12.statcan.ca/english/census06/data/popdwell/Table.cfm?T=302&PR=35&S=1&O=A&RPP=25	2007	Provincial census data
Steele, R., J. Bowles and J. Fitzgibbon	Basic Health Indices. MVCA	1995	Provide information on channel modification in the Maitland watershed
Veliz, Mari	Fish Habitat Management Plan. ABCA	2001	To document current fisheries, opportunities and strategies for improvement
Waterloo Hydrogeologic Inc.	Grey and Bruce Counties Groundwater Study	2003	To develop a characterization of the regional aquifer and a strategy for groundwater protection
Waterloo Hydrogeologic Inc.	Perth Groundwater Study	2003	To develop a characterization of the regional aquifer and a strategy for groundwater protection

MAITLAND VALLEY: CHAPTER 3

WATER BUDGET

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List of Tables and Figures

3.1 Summary of Conceptual Water Budget Results

The goal of any water budget is to characterize, as accurately as possible, the fluxes of water through the hydrologic system one is attempting to define. In order to do this, a basic understanding of the processes and components within the area and the flow between specific components of that cycle must be understood. This process of developing a basic understanding of the processes and components of the hydrologic cycle and developing a methodology for quantifying and correcting these fluxes is referred to as a conceptual water budget. Such a Conceptual Water Budget was completed for the Ausable Bayfield Maitland Valley Source Protection Region (2007) and the summary of the pertinent aspects of that report are presented for the Maitland Valley Source Protection Area (SPA), below.

3.1.1 Description of Region

The *Watershed Description (2006)* provides an overview of how physiography, topography and soils generally influence the surface hydrology of the planning region and the SPA. The overview material presented is organized by the major watershed/drainage system present in the study area, specifically:

- Maitland River
- Nine Mile River
- Shore Streams and Gullies

The Maitland River system drains approximately 75% of the Maitland Valley Source Protection Area, while the Nine Mile River drains approximately 8% of the study area. The series of varied shore streams and gullies drain a significant 18% of the SPA.

The *Conceptual Water Budget (2007)* document provides a more detailed description of the character of each of these main surface systems by presenting the historical observations and summarizing the findings and outcomes from earlier hydrologic modeling exercises that focused on these surface water systems.

3.1.2 Key Components and Processes

For the Maitland Valley Source Protection Area, the key components and processes to be considered for water budgeting are shown in **Figure 3.1**. This schematic strives to explain the pathways and fluxes of water between the key reservoirs.

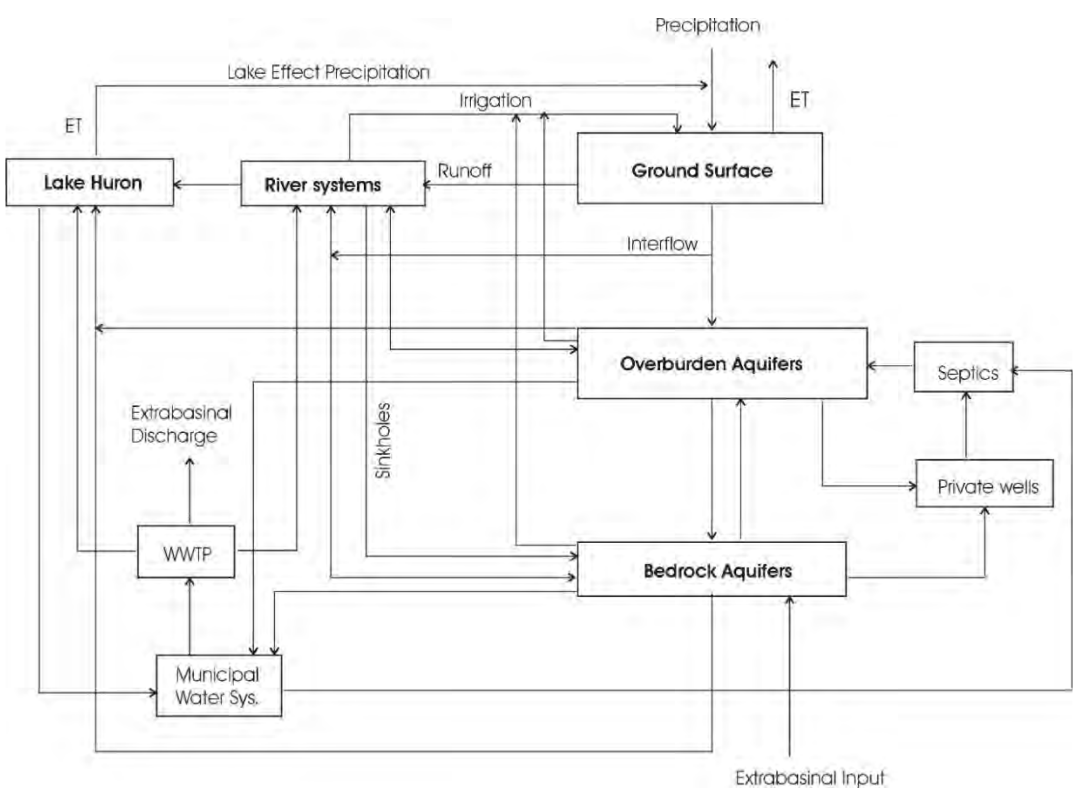
Ground Surface

The initial inputs into the system as a whole are in the form of precipitation. In addition, it is noted that a significant portion of groundwater entering the bedrock aquifer system is derived from extrabasinal sources. Precipitation falling to the ground is initially partitioned into surface runoff, which moves directly to surface systems, or into infiltration. Storage on or within the ground surface occurs as soil field capacity and depressional storage. From this point a portion of the water on or in the ground surface is released back into the atmosphere via evapotranspiration (ET on **Figure 3.1**). Evapotranspiration occurs throughout the system whenever water is exposed to the atmosphere or within the root zone of plant life. During dry periods, precipitation is augmented from the river systems, overburden and bedrock aquifers via irrigation. Ground surface topography is shown on **Map 3.1**.

River Systems

River systems receive direct runoff from the ground surface as well as groundwater discharge from both the overburden and bedrock aquifers. Interflow from infiltrating water is also diverted to River systems. All river systems in the Region have outlet into Lake Huron. Major River systems of the Maitland and Nine Mile Rivers drain approximately 80% of the Region, the remaining 20% of the Region drained directly into Lake Huron via smaller streams along the lake shore. River systems are not heavily exploited as sources of water in the Source Protection Region but a significant amount of irrigation is documented, removing water from the river systems and placing it on the ground surface.

Figure 3.1 Schematic of the Components and Fluxes of the ABMV Region Water Budget



Source: Luinstra 2006

Interflow

A portion of infiltrating water is redirected to surface water systems before entering the saturated zone via interflow. Tile drainage acts as a conduit which may accelerate interflow, particularly in areas with high permeability soils in the planning region, though its influence is not well documented.

Overburden Aquifers

The remainder of infiltrating water reaches the saturated zone within either the overburden or bedrock aquifers as recharge. The overburden aquifers also receive inputs of water from river systems via losing streams, septic systems and potentially discharge from the underlying bedrock aquifers. Groundwater flow within the overburden aquifers tends to follow the topography of the area, especially where they are unconfined. Confined overburden aquifers are not common in the watershed, and flow patterns within these tend to be complex, and can only be described at a local level. Overburden aquifers discharge water to the bedrock aquifers, private wells and most importantly to the river systems where they represent high quality sources of groundwater discharge for cold water streams. Water extracted for domestic consumption from private wells is subsequently discharged back into the overburden aquifers via septic systems.

Bedrock Aquifers

Inputs into the bedrock aquifers include recharge originating from the ground surface where the bedrock is exposed, recharge from overlying overburden aquifers, recharge from river systems via losing streams and most notably in the Maitland Valley Source Protection Area, via sinkholes which act as direct conduits for runoff into the bedrock aquifers. An important input into the bedrock aquifers is derived from extrabasinal sources located to the east and north of the study area. Water from the bedrock aquifer naturally flows in an east to west direction, where it eventually discharges into Lake Huron and, in certain areas, into river systems. In addition, large volumes of water are extracted from the bedrock aquifers for industrial and municipal water uses. The majority of this water is treated in Municipal Waste Water Treatment Plants (WWTP in **Figure 3.1)** and released into the river systems. However, an unknown portion of this water is diverted to the overburden aquifers via private wells or municipal wells and septic systems.

Lake Huron

Lake Huron is the ultimate destination for water within the system. Lake Huron receives water from all the components shown in **Figure 3.1**. River systems, overburden and bedrock aquifers all naturally discharge into the Lake. Water from WWTPs also outlets directly into Lake Huron. The key process for Lake Huron is the extraction of water from the lake for drinking water purposes. The Lake Huron shoreline within the Maitland Source Protection Area is host to a large water system which is exploiting Lake Huron at Goderich. Within this Source Protection Authority, all water that is extracted from Lake Huron is returned via WWTP, except for that lost to leakage and evapotranspiration.

3.2 Climate of the Study Area

The climate of a region is a significant factor affecting its overall water budget. Precipitation, either in the form of rain or snow, provides the major input to a region's water cycle. Air temperatures influence the form of precipitation, runoff patterns, evapotranspiration rates and soil and ground cover conditions, all affecting water balance. Wind patterns at a macro level affect air moisture and precipitation patterns, particularly as they are influenced by Lake Huron to the west of the study area. At the local level, winds affect evapotranspiration in the growing season and the drifting and accumulation of snow across the landscape.

Map 3.2 shows the location of the main active or recently active climatological stations located within or in close proximity to the Maitland Source Protection Area, including those that have been developed through the years by the local conservation authorities, primarily for flood forecasting purposes.

3.2.1 Precipitation

Table 3.1 summarizes the Atmospheric Environment Services (AES) climate normals (1971 – 2000) for all AES stations within the study area for which these long-term climate normals have been prepared. Long-term data from these stations indicate that annual precipitation in the study area ranges from 975 mm to 1185 mm. In general, the precipitation levels are fairly uniform across the months, although the tendency is for the fall period (September through November) to receive slightly more precipitation than the other months of the year. Snowfall makes up a good portion of the annual precipitation for the SPA.

Table 3.1 Long term Climate Normals for Stations within and near the Maitland Valley SPA

CLIMATE STATION	DRAINAGE AREA (km^2)	CLIMATE STATISTIC	MONTH												
			JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Annual**
Blyth	54.9	**Temperature**													
(6120819)		Daily Average (°C)	-7.5	-6.7	-1.7	5.5	12.3	17.3	20.2	19.1	15.1	8.8	2.7	-3.6	**6.8**
1971-2000		Standard Deviation	3.3	3.5	2.6	2.1	2.2	1.7	1.4	1.8	1.3	1.9	1.9	3.1	**1.3**
		Daily Maximum (°C)	-4.1	-2.9	2.5	10.1	17.9	22.9	25.9	24.6	20.1	13	5.8	-0.6	**11.3**
		Daily Minimum (°C)	-10.8	-10.5	-5.9	0.8	6.7	11.7	14.5	13.6	10	4.5	-0.5	-6.5	**2.3**
		Precipitation													
		Rainfall (mm)	24.9	22.9	39.1	68.4	89.8	85.1	72.7	105.9	115.4	89.2	80.7	40	**834**
		Snowfall (cm)	102.9	55.9	33.9	13.4	0.4	0	0	0	0	3.6	40.5	99.8	**350.4**
		Precipitation (mm)	127.8	78.8	73	81.8	90.2	85.1	72.7	105.9	115.4	92.8	121.2	139.8	**1184.3**
Lucknow	54.9	**Temperature**													
(6124700)		Daily Average (°C)	-6.7	-6.6	-1.7	5.7	12.3	16.8	19.5	18.8	14.6	8.5	2.7	-3.4	**6.7**
1971 - 1993		Standard Deviation	2.5	2.7	2.3	1.9	2	1.5	1.2	1.3	1.1	1.8	1.4	2.4	**1**
		Daily Maximum (°C)	-2.9	-2.1	3.2	11.2	18.9	23.2	25.7	24.6	20.1	13.2	6.2	0	**11.8**
		Daily Minimum (°C)	-10.5	-10.9	-6.5	0.2	5.8	10.4	13.2	13	9	3.7	-0.8	-6.7	**1.7**
		Precipitation													
		Rainfall (mm)	15.9	15.2	38.5	64	79	82.2	69.5	99.4	109.6	94.4	79.9	34.5	**781.9**
		Snowfall (cm)	111.2	67.6	32.8	11.4	0.3	0	0	0	0	3	26	86.6	**338.9**
		Precipitation (mm)	127.1	82.8	71.3	75.5	79.3	82.2	69.5	99.4	109.6	97.3	105.9	121.1	**1120.9**
Wroxeter	54.9	**Temperature**													
(6129660)		Daily Average (°C)	Temperature data not collected												
1971 - 2000		Standard Deviation													
		Daily Maximum (°C)													
		Daily Minimum (°C)													
		Precipitation													
		Rainfall (mm)	20.4	19	38.9	59.7	86.7	85.3	77.2	99.1	99.3	77.7	68.8	34	**766.1**
		Snowfall (cm)	64.6	36.8	23.6	6.2	0	0	0	0	0	1.1	23.7	54.8	**210.8**
		Precipitation (mm)	85	55.8	62.5	65.9	86.7	85.3	77.2	99.1	99.3	78.8	92.4	88.9	**976.9**

Source: Atmospheric Environment Services

The Ausable Bayfield Maitland Valley Source Protection Region initiated a study to address the data concerns associated with the current available precipitation datasets. The study involves comparing historical AES climate (precipitation and air temperature) data with historical conservation authority (CA) data. The analysis is being undertaken by Schroeter and Associates using data filling techniques they have developed and described in Schroeter et al. (2000). The outcome of this project is a minimum 55 year (1950 to 2006) complete set of daily precipitation and air temperature data as well as hourly precipitation data for the CA and AES stations in the Maitland Valley Source Protection Area. These datasets will be valuable for use in more fully characterizing precipitation amounts, form and distribution throughout the study area and will be valuable input files for numerical modeling tools.

3.2.2 Air Temperature

Daily maximum, minimum and average air temperature is a common climatological input for most numerical water budget models. Therefore, historical data characterizing this weather measurement from the study area will be valuable. **Table 3.1** summarizes the long-term normals for air temperature as measured at the main AES stations within the SPA. The average annual temperature ranges from 6.7°C to 8.0°C. Lake Huron tends to moderate air temperatures, having a decreasing impact as one moves inland. Average daily air temperatures are typically below freezing for the months including December through March in the study area. Comparing the average annual long-term normal temperatures over the past 20 years would suggest a very slight rise in the average annual temperature. Four of the six stations with data available for comparison show increases ranging from +0.1°C to +0.7°C. The other two stations saw a 0.3°C drop in the same time period. Overall, the difference in average temperature at the long-term stations is a minimal +0.17°C.

Air temperature data has not been collected as long at many of the CA climate stations. Many temperature sensors were installed in 2000 or later. Data filling techniques described for precipitation data (See Section 3.2.1) have also been applied to daily maximum, minimum and average air temperature data for the SPA to acquire a complete set of air temperature data for characterization and numerical modeling purposes (Schroeter et. al. 2000).

3.2.3 Wind, Barometric Pressure and Solar Radiation

Relatively few climatological stations in the study area have measured wind speed and direction, barometric pressure, or solar radiation in the past. These data are useful as inputs for estimating potential evapotranspiration and may assist in other modeling tasks in the future. A few CA stations have been equipped to record these data, primarily since 2003, although some of the stations have been recording some or all of this information since 1990.

Some initial use has been made of this climatological data to assist in estimating actual evapotranspiration rates occurring in the study area. The analysis, described in the section to follow, was completed for the 2004 calendar year only as this was the first and only full year of detailed data available. Nevertheless, it does demonstrate how such data may be used in future modeling exercises and will assist in evaluating the importance of collecting and maintaining such data.

3.2.4 Evapotranspiration

A report on the water quantity resources of Ontario (Acres Consulting Services, 1984) estimates that the mean annual evapotranspiration averaged over the province is 415 mm. The provincial average varies from less than 300 mm in the north to over 600 mm in the south. The report estimates that, in the southern areas of the province, approximately 60% of the precipitation that falls is lost to the atmosphere through evapotranspiration. This would suggest the Maitland Source Protection Area should be experiencing evapotranspiration rates in the range of 500 to 575 mm/year. In a separate study, Dickinson and Diiwu (2000) suggested actual evapotranspiration should lie between 500 mm and 550 mm in Ontario’s southwest and 450 mm to 500 mm in Central Ontario.

The weather stations that collect data on air temperature, wind speed, barometric pressure and solar radiation are capable of estimating potential evapotranspiration (PET). Such stations have only been operational in the study area since mid-2003. A methodology for estimating actual evapotranspiration (AET) was developed using the PET calculated by the weather station at the Wroxeter station and the existing Basin Runoff Forecast Unit (BRFU) hydrology (flood forecasting) model for the SPA. **Table 3.2** summarizes the results for each of the SPAs gauged watershed units. This methodology used the BRFU model to estimate the water content of the top soil layer. Soil water content decreased the longer the elapsed time since the last precipitation event, reducing the amount of actual evapotranspiration that could occur. Immediately following a significant rainfall event that restored the water in the top soil layer, AET was allowed to rise to the PET for the day and slowly decline based on the modeled soil moisture content until the next rain event. The data in **Table 3.2** estimates actual ET in the study area to fall between 375 mm and 450 mm. This is slightly less than expected and may be a function of the lower precipitation inputs to the estimation approach and possibly the lower temperatures experienced in the 2004 growing season.

Table 3.2 Estimation of Actual ET within the Study Area's Gauged Watershed Units

Gauged Watershed Unit	Estimated Actual Evapotranspiration (2004) (mm)
Maitland	
Harriston (02FE011)	332
Wingham A (02FE005)	358
Bluevale (02FE007)	369
Listowel (02FE003)	385
Boyle Drain (02FE010)	384
Ethel (02FE013)	379
Belgrave (02FE008)	379
Blyth (02FE014)	391
Summerhill (02FE009)	389
Wingham B (02FE002)	374
Benmiller (02FE015)	384
Nine Mile	
Lucknow A (02F002)	392
Lucknow B (CA Station)	387

Source: Data calculated from CA gauges

3.2.5 Land Cover

Map 3.3 presents land cover in the Maitland Valley Source Protection Area. It is based on data published through the Ontario Ministry of Agriculture and Food's (OMAF) agricultural land inventory project undertaken in the late 1970s and early 1980s (OMAF, 1983). As such, the information on this map is dated. Nevertheless, it does give a regional overview of the trends in land cover across the study area. Approximately 82% of the SPA is agricultural land under various crops and cropping practices. Approximately 15% of the area is under undisturbed vegetative cover (i.e. woodlots, natural areas). Only 3% of the land area has been developed for urban and industrial use.

Based on the 1983 data, agricultural cropping activities which result in less vegetative cover through the year are distributed throughout the study region but are somewhat more concentrated in the south and in the lakeshore gully areas of the SPA. Areas with higher livestock based agriculture (e.g. dairy or beef) are more likely to see increased areas of pasture and hay production and more land in rotation under grass cover throughout the year. Since this land use survey was completed, some land managers, particularly those operating farms that are non-livestock based, have moved to using conservation tillage practices to reduce production costs and provide improved soil cover, particularly during the non-growing season. This extent of use of conservation tillage practices in the area, however, is not well documented.

The Maitland Valley Source Protection Area teamed with the Ontario Ministry of Agriculture, Food and Rural Affairs to assess the applicability of the 1983 land cover data relative to current conditions. Land cover information is being collected in the field for the sub-watersheds listed in **Table 3.3**. Data gathered will be compiled and the results compared with the 1983 mapping. As well, where possible, information is being collected on the tillage practices being used in the area. This will further enhance the understanding of the land cover conditions in the study area. The data also has the potential to be used to verify remotely sensed land cover data when it becomes available and could assist with calibrating remotely sensed images.

Table 3.3 Areas of Study for Updated Land Cover Project

Study Area Drainage System	Sub-basin(s) where 2005 Land Cover is being Collected
Maitland	Listowel, Blyth Brook
Nine Mile	--
Shore Streams and Gullies	Desjardin Drain, St. Joseph Creek, Kerry's Creek, Eighteen Mile

Source: McKague, K., OMAFRA

3.2.6 Infiltration

The capacity of the landscape to partition falling precipitation as either interception water, runoff, or infiltration, plays a major role in the pathways for contaminant movement. Therefore some understanding is needed, both spatially and temporally, as to the potential for infiltration versus runoff to occur across the study region. Soils mapping as well as land use mapping were combined to provide a spatial overview of the relative potential for infiltration versus runoff across the study region, while default model input parameters used by the BRFU flood forecasting model were summarized to give some indication of temporal effects on infiltration capacity.

Soils information classified by hydrologic soil group is shown on **Map 3.4**. It is seen from this map that soils with a lower final infiltration rate (soil groups D and C) are more dominant in the southern half of the SPA and in bands inland along the lakeshore, suggesting higher levels of runoff from these lands. It is important to remember, however, that this soil classification approach does not account for “short-circuit” flow pathways that can develop in these finer-textured soils in dry weather in the form of cracks or macropores. Large cracks have the potential to develop, particularly in the summer months, due to the shrinking of clays forming the soil matrix. The result is an increase in the infiltration capacity of these soils even though they have relatively impermeable soils.

Temporally, infiltration capacity varies significantly depending on the soil and cover conditions of the SPA at the time of the precipitation event. Attempts have been made in the past to capture this reality in the parameters used to define infiltration in the BRFU flood forecasting models for the major river systems of the study area. The baseline (maximum) infiltration rate is representative of July conditions. In other months of the year the infiltration rate is adjusted downward by an adjustment factor to account for seasonal variations. Low infiltration values in the winter months are a function of frozen soil conditions that typically are present at that time. Observed historical runoff/streamflow patterns also show a similar trend to lower infiltration and higher runoff in the early spring and late fall periods.

3.3 Runoff and Streamflow

Streamflow has been monitored for a number of years in the Maitland Valley Source Protection Area and provides the basis for assessing the hydrologic response of the study watershed units. **Map 3.2** identifies the current stream gauging stations and their associated gauged watersheds. No long-term data currently exists to assist with characterizing the runoff response of lakeshore streams and gullies. Historical daily and maximum/minimum streamflow data recorded and archived by Water Survey of Canada for stations within the SPA are summarized on a monthly basis in **Table 3.4**. The length of record for each station is identified in the table’s first column. In general, the southern area of the SPA tends to experience lower total annual runoff volumes.

Seasonal variability in runoff across all monitoring stations and associated watershed is worth mentioning. An analysis of the data presented in **Table 3.4** reveals that, on average across the SPA, approximately 76% of the total runoff occurs in the months beginning December through to May (i.e. much of the non-growing season). If baseflows were removed from this total streamflow volume, then it is expected that this percentage would increase. Such conditions suggest that an ideal water budget needs to be effective at modeling winter hydrology, snowmelt and early spring hydrologic conditions.

Table 3.4 Historic Daily Maximum/Minimum Flow Data for the Maitland Valley SPA

PLANNING REGION SUBWATERSHED	DRAINAGE AREA (km^2)	STREAMFLOW STATISTIC	MONTH JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
NINE MILE RIVER															
Lucknow A (02F002)	54.9	Day Count (days)	527	481	527	510	527	510	527	523	480	496	480	508	6096
(1980 - 1996)		Average Daily Flow (m^3/s)	1.31	1.56	2.61	2.09	0.86	0.54	0.26	0.3	0.55	0.7	1.34	1.47	1.13
		Maximum Daily Flow (m^3/s)	18.9	16.8	17.4	15.6	10.4	6.99	2.33	6	22.5	7.56	10.7	11.8	22.5
		Minimum Daily Flow (m^3/s)	0.25	0.36	0.32	0.5	0.2	0.11	0.03	0.06	0.09	0.09	0.14	0.36	0.03
NORTH MAITLAND															
Harriston (02FE011)	112	Day Count (days)	527	480	527	481	496	480	501	527	510	527	510	527	6093
(1981 - 1998)		Average Daily Flow (m^3/s)	1.99	2.15	4.41	3.23	1.08	0.71	0.24	0.27	0.69	0.88	2.15	1.9	1.64
		Maximum Daily Flow (m^3/s)	41.5	40.3	45	40	22.5	20.1	3.85	5.73	31.8	20.4	34.1	34.5	45
		Minimum Daily Flow (m^3/s)	0.12	0.18	0.12	0.48	0.15	0.08	0.01	0.02	0.03	0.03	0.17	0.14	0.01
Wingham A (02FE005)	528	Day Count (days)	1519	1384	1550	1495	1524	1500	1550	1550	1500	1550	1500	1550	18172
(1953 - 2002)		Average Daily Flow (m^3/s)	7.5	9.25	18.6	18	6.85	3.56	1.75	1.7	2.34	4.2	6.98	8.21	7.39
		Maximum Daily Flow (m^3/s)	154	144	243	286	191	108	39.4	53.8	89.9	222	105	117	286
		Minimum Daily Flow (m^3/s)	0.65	0.85	1.16	2.44	0.43	0.34	0.19	0.2	0.17	0.34	0.34	0.69	0.17
LITTLE MAITLAND															
Bluevale (02FE007)	326	Day Count (days)	961	876	960	931	961	930	961	961	930	992	960	992	11415
(1967 - 2002)		Average Daily Flow (m^3/s)	5.37	5.81	13	11.7	3.96	1.89	0.93	1.26	1.67	2.75	5.11	5.62	4.91
		Maximum Daily Flow (m^3/s)	89	90.3	172	167	83.8	21.4	15.5	94	63.9	48.7	64	81.5	172
		Minimum Daily Flow (m^3/s)	0.62	0.96	0.98	0.99	0.37	0.08	0.09	0.06	0.09	0.06	0.16	0.21	0.06
MIDDLE MAITLAND															
Listowel (02FE003)	77.7	Day Count (days)	1520	1385	1550	1500	1550	1500	1550	1550	1500	1550	1500	1550	18205
(1953 - 2002)		Average Daily Flow (m^3/s)	0.89	1.15	2.65	2.45	0.78	0.38	0.2	0.21	0.36	0.54	0.99	1.16	0.98
		Maximum Daily Flow (m^3/s)	37.3	33.1	55.8	47.6	27	46	8.16	19.1	39.8	32.8	31.1	21.7	55.8
		Minimum Daily Flow (m^3/s)	0.01	0.01	0.04	0.11	0	0	0	0	0.01	0	0.01	0.01	0
Boyle Drain (02FE010)	197	Day Count (days)	372	339	372	360	341	330	341	353	360	403	390	403	4364
(1989 - 2002)		Average Daily Flow (m^3/s)	1.94	2.27	8.22	8.8	1.67	0.35	0.1	0.43	0.52	0.8	1.96	2.55	2.5
		Maximum Daily Flow (m^3/s)	31.7	29.2	104	71.6	38.8	15.9	2.27	31.1	10.4	27.9	25.8	29.2	104
		Minimum Daily Flow (m^3/s)	0.06	0.1	0.11	0.32	0.02	0	0	0	0	0	0.01	0.06	0
Ethel (02FE013)	416	Day Count (days)	465	424	464	421	434	420	434	434	420	440	450	465	5271
(1983 - 1998)		Average Daily Flow (m^3/s)	7.55	8.07	17.2	11.1	3.16	2.14	1.73	1.94	3.61	4.37	9	7.55	6.54
		Maximum Daily Flow (m^3/s)	93.3	124	121	115	49.9	53	49.7	42.4	104	89	79.4	84.7	124
		Minimum Daily Flow (m^3/s)	0.58	0.54	0.48	1.05	0.29	0.06	0.04	0.01	0.03	0.12	0.33	0.49	0.01
Belgrave (02FE008)	648	Day Count (days)	961	876	961	901	930	900	930	930	900	961	930	961	11141
(1967 - 1998)		Average Daily Flow (m^3/s)	9.88	11.4	26	22.8	6.17	2.69	1.61	2.37	3.65	5.37	10.7	11.4	9.53
		Maximum Daily Flow (m^3/s)	138	200	282	237	138	68.8	52.2	135	139	122	118	115	282
		Minimum Daily Flow (m^3/s)	1.26	1.31	1.15	2.08	0.48	0.22	0.12	0.16	0.14	0.16	0.3	0.53	0.12
BLYTH BROOK															
Blyth (02FE014)	77.7	Day Count (days)	310	282	310	320	341	330	341	341	330	341	333	372	3951
(1984 - 2002)		Average Daily Flow (m^3/s)	1.44	1.21	3.6	2.17	0.66	0.37	0.16	0.21	0.66	0.97	1.69	1.54	1.2
		Maximum Daily Flow (m^3/s)	21.6	23	28.5	26.6	5.32	5.48	2.28	5.56	25.7	9.04	25.1	23.5	28.5
		Minimum Daily Flow (m^3/s)	0.19	0.23	0.26	0.34	0.14	0.04	0.01	0.01	0.01	0.02	0.07	0.12	0.01
SOUTH MAITLAND															
Summerhill (02FE009)	376	Day Count (days)	1085	989	1085	1050	1085	1050	1085	1085	1050	1116	1080	1116	12876
(1967 - 2002)		Average Daily Flow (m^3/s)	6.96	9.21	15.6	11.1	3.86	1.98	0.97	1.06	1.98	3.68	6.93	7.89	5.91
		Maximum Daily Flow (m^3/s)	115	191	148	113	72.4	61.4	30.2	35.4	89.4	58.4	75	72.4	191
		Minimum Daily Flow (m^3/s)	0.25	0.56	0.71	1.09	0.3	0.11	0	0.01	0	0.04	0.1	0.22	0
MAITLAND (Main Branch)															
Wingham B (02FE002)	1630	Day Count (days)	1333	1215	1364	1350	1395	1350	1395	1391	1320	1364	1320	1364	16161
(1953 - 2002)		Average Daily Flow (m^3/s)	21.4	26.8	61.1	57.4	19.2	8.67	4.4	4.69	6.85	12.8	20.8	25.6	22.4
		Maximum Daily Flow (m^3/s)	372	464	680	626	303	136	115	297	347	464	261	315	680
		Minimum Daily Flow (m^3/s)	1.25	1.44	3.03	6.48	1.3	0.62	0.14	0.14	0.06	0.28	0.4	0.95	0.06
Benmiller (02FE015)	2510	Day Count (days)	434	395	434	420	434	420	434	434	420	434	420	434	5113
(1989 - 2002)		Average Daily Flow (m^3/s)	59.6	60.6	84.8	71.4	34.3	22	10	10.1	12	22.4	48.2	43.6	39.8
		Maximum Daily Flow (m^3/s)	553	523	487	447	406	357	82.9	131	124	185	429	405	553
		Minimum Daily Flow (m^3/s)	8	6.95	8.8	13	3.37	2.67	1.36	0.87	0.77	1.37	1.72	3.2	0.77

Source: Water Survey of Canada

3.3.1 Baseflow

The baseflow (groundwater discharge) fraction of total streamflow was estimated for the years 2003 through 2004 using a graphical baseflow separation technique applied in a module of the BRFU hydrologic model developed for the SPA river systems. In general, baseflow values lie between 105 mm/year and 420 mm/year and are shown below in **Table 3.5**. Many of the higher baseflow values observed may be influenced by direct anthropogenic activities. For example, Listowel's baseflow, which in the analysis was shown to have the Highest Baseflow Index (BFI), is likely being augmented to some extent by waste water treatment plant discharge upstream. Data on wastewater plant outflows will be required to further assess their full impact.

Table 3.5 Average Annual Baseflow and Baseflow Index for the Maitland SPA

Gauged Watershed Unit	Average Annual Estimated Baseflow (mm)	Baseflow Index
Maitland	-	-
Harriston (02FE011)	216	0.45
Wingham A (02FE005)	288	0.47
Bluevale (02FE007)	212	0.48
Listowel (02FE003)	191	0.45
Boyle Drain (02FE010)	157 (see note 1)	0.35 (see note 1)
Ethel (02FE013)	159	0.37
Belgrave (02FE008)	208	0.40
Blyth (02FE014)	418	0.63
Summerhill (02FE009)	190	0.33
Wingham B (02FE002)	195	0.41
Benmiller (02FE015)	297	0.44
Nine Mile	-	-
Lucknow A (02F002)	1553 (see note 2)	0.82
Lucknow B (CA Station)	1613 (see note 2)	0.82

Note 1: Data calculated for 2004 only.

Note 2: Errors are known to exist with the rating curve for this gauge station. BFI, however is believed to be reflect the observed ratio of baseflow to total flow from watershed.

Source: CA Gauges

3.4 Groundwater System

3.4.1 Geology

3.4.1.1 Precambrian Basement Rocks

Underlying all of the study area and a large majority of the North American continent are the metamorphic rock associated with the large physiographic feature called the Canadian Shield. These rocks are not exposed in the study area and what is known of them is known from oil and gas exploration wells which were terminated in the Precambrian rocks. From these drilling data, the rocks which underlie our area have been correlated with rocks of the Grenville Province, understood to have been formed between 1.7 and 2.5 billion years ago. East and north of the study area these rocks are exposed to the surface. In these areas, these rocks are dominated by metamorphosed plutonic rocks with thin bands of meta-volcanic and meta-sedimentary sequences. These rocks form the foundation upon which the later carbonate rocks were deposited.

Although the Precambrian geology of the area is not considered to have a significant influence on the hydrogeology of the area, it has played a significant role as a regional control on the deposition of later rocks. Two major features which have acted as regional-scale controls on the deposition, and are attributed to these rocks, are the development of the Michigan Basin and the Algonquin Arch.

The Michigan basin is composed of younger carbonate rocks but is centered along a failed rift zone (the North American rift) which unsuccessfully began to open approximately 1.1 billion years ago. The basin which formed as a result provided the initial depression into which the younger carbonate rocks were deposited, and began approximately 545 million years ago. The basin is centered in the middle of the main peninsula (a.k.a. the “thumb”) of Michigan and it is the regional structure that the carbonate rocks of the study area are associated.

The second major Precambrian feature which has controlled the deposition of the younger carbonate rocks in our area is the Algonquin Arch. The Algonquin Arch is a linear uplift of the Precambrian rocks that extends roughly from the Algonquin Park in central Ontario southwest through to the Windsor area. The Algonquin Arch is poorly understood, but may have formed during an early phase of orogeny in the Appalachians. The arch likely acted as a barrier between waters circulating between the Michigan Basin and those associated with the fore-arch basinal waters of the Appalachians. As such it has had a profound effect on the depositional facies of similar aged rocks on either of its flanks. It is of particular note to our study area, that the Algonquin arch, during deposition of the Lucas Formation, likely restricted flow in the western portion of the Michigan Basin leading to development of Sabkha sequences in these rocks with which modern day sinkholes have developed. In fact, over time, the Algonquin Arch has had such a significant influence on the topography of the area that even today the boundaries between the Lake Huron and Lake Erie and Ontario basins can still be roughly traced along the spine of the Arch.

Some smaller Precambrian features may have also had an effect on present day topography, as it has been noted that major bedrock valleys in the younger carbonate rocks (i.e., the Dundas Bedrock Valley) and even modern river valleys have similar orientations as some of the larger Precambrian faults.

3.4.1.2 Paleozoic Bedrock of Southern Ontario

After a non-conformity spanning approximately 500 million years, deposition of the sedimentary rocks of the Michigan Basin commenced. The Michigan Basin is the dominant regional structure controlling deposition of rocks in central North America during this time. The Michigan Basin is a roughly circular depression centered within the present day State of Michigan and on the failed North American paleo-rift. The entire sequence of rocks within the Michigan Basin was deposited in warm seas analogous to modern day deposition in tropical regions. Periodic climatic and sea level changes led to the slight differences in the lithologies which were deposited. As an example of this, during periods of relatively high sea level, deeper water sediments such as shales and mudstones were deposited, while during lower stands, shallow water limestone, sabkha and reefal facies dominated. Indeed, there are likely several points during the deposition of these rocks that they were aerially exposed and eroded. In addition, differences in water chemistry led to slightly different chemical compositions of the rocks themselves.

The rocks of this area dip slightly towards the interior of the Michigan basin (southwest for the study area) and as such, the oldest rocks are exposed in the far northeastern portion of the study area. **Map 3.5** shows the major bedrock units in the SPA. For the purposes of this document, only bedrock units which subcrop in the SPA will be discussed, from oldest to youngest beginning with the Lucas formation. These formations are used as domestic and municipal sources of drinking water throughout the study area, which will be dealt with in Section 3.4.2 of this report.

Salina Formation

The Salina formation subcrops in only the far northeastern section of the study area but underlies the entire study area. The Salina formation, deposited during the Silurian Era approximately 410 to 440 million years ago, is composed of between 200 and 50 metres (true thickness) of interbedded shales, dolostones and evaporates. The Salina is well known throughout the study area for its ample deposits of evaporites, particularly that of halite (rock salt) from which it gets its name. Extensive historic mining of these deposits has occurred throughout the study area and continues today with the large salt extraction facilities (both a mine and a brine well/evaporation system) at Goderich. A major feature of the Salina is a large dissolution front from which the salt deposits are absent (likely dissolved during diagenesis) which extends on a roughly north-south line situated just east of Goderich. The effect of this dissolution front on the deposition of younger rocks is unknown, but it is thought to have a relationship to the development of karstic features in overlying formations.

The Salina formation is an important source of drinking water in the study area. Several municipal wells penetrate and are drawing water from the Salina formation as well as numerous private domestic supplies.

Bass Islands Formation

Deposited on top of the Salina formation is the Upper Silurian Bass Islands formation. This formation forms a relatively thin band of rocks in the northeastern section of the study area due to the relative thin section of rocks it is composed (approximately 30 m true thickness). The Bass Islands formation is dominated by a brown, oolitic limestone with minor interbeds of relatively resistant dolomitic shales.

Based on the limited area of subcrop within the study area, the Bass Islands formation is not considered to be a major source of drinking water. However, several municipal wells penetrate and are drawing water from the Bass Islands formation as well as numerous private domestic supplies.

Bois Blanc Formation

Overlying the Bass Islands formation is the Bois Blanc formation. This relatively thin formation (~50 m true thickness) is composed of fossiliferous limestones interbedded with siliceous shales.

The top of the Bois Blanc formation is delineated by an unconformity at which time the rocks were exposed subaerially and eroded. The resultant weathering and fracturing of these rocks and their coarse grain size makes the Bass Islands formation a layer of high permeability which may have a disproportionately important role in the flow of groundwater in the area.

Through the study area and extending both north and south of the study area right to Lake Huron and Lake Erie, the erodible Bois Blanc formation has led to the development of a large bedrock valley which is correlated herein as part of the Dundas Valley. This valley extends from Wingham in the north part of the study area to Atwood in the east. To the north of the study area this valley is followed by the Saugeen River on its course to Lake Huron and extends southward towards Lake Erie where it has been named the Dundas Valley.

This bedrock valley is an important bedrock topographical feature that has a profound effect on the regional flow of groundwater. The bedrock valleys tend to have been filled with coarse grained gravels and sands which preferentially concentrate flow into the valleys. North of the study area the predominant west-southwest direction of regional groundwater flow is reversed in the Bois Blanc, discharging into the bedrock valley and eventually Lake Huron, either via the Saugeen River or through preferential subterranean flow in the valley itself (WHI, 2003).

The Bois Blanc formations' high permeability has also led to its extensive exploitation as a source of groundwater in the study area. Although it is a relatively thin and not an extensive formation, drillers have targeted the Bois Blanc for water supplies due to its high yields (Singer et al., 1997).

Detroit River Group

Overlying the Bois Blanc formation is an extensive Detroit River Group. The Detroit River Group is a 60 to 90 metres thick sequence of limestones and dolostones that are separated into two distinct formations in the study area, the Amherstburg and Lucas formations. Due to the relative importance of the Detroit River Group the two formations will be dealt with independently.

Amherstburg Formation

The Amherstburg formation is composed of brown limestones, is further separated into reefal and non reefal facies. The reefal facies, named the Formosa Reef member, is composed of biohermal reefs which outcrop just north of the study area in the village of Formosa. These reefal facies are located at all stratigraphic levels suggesting a prolonged period of reef development during deposition of the Amherstburg.

The Amherstburg is used extensively for municipal and private water supplies and is considered to be a high quality, high yield aquifer for the area.

Lucas Formation

The Lucas formation is composed of non-fossiliferous, microcrystalline limestones and dolostones. The Lucas formation subcrops in a small area within the far northeastern portion of the study area, including an inlier within the overlying Dundee formation that may be evidence of another bedrock valley in the area which extends from Hensall to Lake Huron at St. Joseph. The Lucas outcrops within the Maitland Valley SPA near the Seaforth area.

The Lucas was deposited in extremely warm waters during a prolonged period of restricted flow within the Michigan Basin. These conditions led to the development of typical Sabkha sequences in the Lucas, which may also be responsible for the characteristic chemistry and groundwater within the Lucas.

Near the contact between the Lucas and the overlying Dundee the Lucas has been associated with karst development. Within the study area, several sinkholes (see **Map 3.6**) are developed along the contact between the Lucas and the Dundee. Several studies have been conducted, and are continuing, which are investigating the relationship between the Lucas and karst development in the Study area (WHI, 2002, 2004)

The Lucas formation is considered a high quality, high yielding aquifer in the study area and as such is used extensively as a source of drinking water. Numerous municipal wells have been completed into the Lucas formation for this purpose. The water has notoriously high levels of fluoride. In fact, the pioneering study on tooth decay that led to the use of fluoride in toothpaste was initiated in a community (outside of the study area) which was exploiting the Lucas for its groundwater, and where a dentist noticed a dramatic decrease in the instance of tooth decay.

Dundee Formation

Overlying the Lucas is the grey brown, highly fossiliferous Dundee formation. The Dundee formation is characterized by fossiliferous limestones and can be identified by the presence of the fossil zooplankton species *tasmanides*. The Dundee subcrops through a large portion of the SPA and outcrops along the shore of Lake Huron between Goderich and Bayfield as well as within the beds of the Ausable and Bayfield Rivers.

The relatively competent Dundee formation is a well-known aquifer of variable quality and quantity and is exploited widely for domestic drinking water supplies. In an area located east of the village of Hensall; the Dundee is thought to be host to a relatively shallow, perched aquifer.

3.4.1.3 Pleistocene Glacial Geology

Paleozoic-Pleistocene Non-Conformity

Following deposition of the Paleozoic carbonate rocks, a long non-conformity of approximately 300 million years ensued. During this period the bedrock was exposed aerially and was eroded extensively. Erosion during this period was a major factor in the development of bedrock valleys in the study area, while weathering and fracturing of the upper surface of the rocks produced zones of high permeability which are important hydrogeological features for the study area.

Large bedrock valleys were carved into the bedrock surface by surface waters during this time and these continue to be important features, partially controlling the flow and distribution of groundwater in the region. **Map 3.7** shows the elevation of the top layer of the bedrock units. The bedrock surface slopes generally to the west, crossed by a number of smaller bedrock valleys.

Wisconsinan Glaciation

Numerous cycles of glacial advance (stades) and retreat (interstades) covered the study area, further eroding the bedrock and depositing unconsolidated materials. The latest glacial sheets of ice reached their furthest extents during the late Wisconsinan approximately 10,000 to 12,000 years ago. They are responsible for all of the unconsolidated overburden in the study area. During this period, major lobes of the Wisconsinan ice sheet covered the area, eroding pre-existing glacial deposits as well as the bedrock surface. In particular, the deposits of the Source Protection Region can be associated with two separate advances of the Wisconsinan Stade, the Port Bruce Stade and the Port Huron Stade, as well as the correspondent Mackinaw and Twocreeken Insterstades.

The dominant features associated with Port Bruce Stade are the deposition of the Elma, Tavistock, Stratford and Rannoch tills. The subsequent retreat of the ice sheets during the Mackinaw Interstade, glacial Lake Arkona was formed leaving behind paleoshoreline deposits and scarps. The re-advance of the ice sheets during the Port Huron Stade led to the deposition of the St. Joseph till in the study area. It also led to the formation of many of the physiograhic features which dominate the landscape today, such as the Wyoming, Wawanosh and Seaforth moraines, as well as many of the glacial outwash features. During the latest retreat of the glaciers during the Twocreeken Insterstade, Lake Warren was formed leading to the deposition of shoreline deposits at the base of the Wyoming moraine. Subsequent melting and recession led to the establishment of Lake Algonquin and Lake Nippissing.

Map 3.6 shows the Physiography of the study area and shows, at a crude scale, the distribution of glacial deposits. **Map 3.8** shows the surficial geography. The most prominent feature in the area is the prevalence of till deposits which exist throughout the study area and underlie a significant portion of the watershed. Perched atop these till deposits, and less frequently incised into the till deposits, are numerous moraines, spillways, eskers and syn-glacial and post-glacial lake deposits. These deposits are extremely important features as they tend to include coarser grained gravels and sands, which serve as valuable sources of aggregate, and also tend to host many surficial aquifers. These deposits will be dealt with in more detail in the section 3.4.2 of this report.

Post Glacial Lakes

During and immediately following the recession of the glaciers large lakes were formed. The shoreline deposits from these lakes and the deltaic deposits from the rivers which had outlet into them, form important deposits of sand and gravel material for the watersheds. Shorelines tended to leave cuestas behind which have become important topographical features. In the study area, four major post glacial lakes are documented, in order of development, lakes Warren (the oldest), Nippissing, Algonquin and present-day Lake Huron. The lakes formed extensive, largely flat clay plains offshore of the shoreline deposits. These clay plains are a key element in the hydrology of the shoreline streams and gullies of the study area.

3.4.1.4 Holocene Erosion and Deposition

Erosion and deposition of sediment continues today. The major rivers of the Source Protection Region continue to erode and transport sediment, which is eventually deposited into Lake Huron, and shape their respective valleys. Lake Huron is a major erosional force and continues to erode the glacial sediments along its shoreline, in the process mining and transporting sediment in cells along the shore.

3.4.2 Hydrogeology

Major aquifers in the Maitland Valley Source Protection Area can be divided grossly into two major types – bedrock and overburden. Bedrock aquifers are by far the most important source of drinking water for the Source Protection Region. All municipal supplies outside of the Goderich Water Supply System rely 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.

3.4.2.1 Bedrock Aquifers

The bedrock aquifers are composed of an aggregate of the bedrock formations discussed in Section 3.4.1.2. 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.

Throughout the majority of the study area, the bedrock aquifer is confined by an overlying layer of clay and silt till. The aquifer itself is exposed at the surface in only a few locations and is known to have a potentiometric surface well above its contact with the overlying glacial deposits. **Map 3.9** shows the potentiometric surface for the bedrock aquifer for the Maitland Valley Source Protection Area with groundwater flow directions outlined. A major feature of the potentiometric surface is the dramatic drop off which occurs on a north-south trend just southeast of Clinton. This evidence is corroborated by anecdotal accounts of known aquifer elevations from drillers in the area. This drop off corresponds with an increase in permeability within the Lucas formation which is likely associated with karst development in the area. The dramatic gradient shown on the map may also be partly an artifact of the existence of two bedrock aquifers in the area: the deeper aquifer situated within the Lucas formation and a shallow, perched aquifer within the overlying, more competent Dundee formation.

Regional Groundwater Flow

Groundwater flow within the bedrock aquifers radiates away from the Dundalk area and follows a generally west to southwest flow path towards Lake Huron. An important note of discussion for the purposes of this water budgeting exercise is that a significant portion of groundwater inside the Maitland Valley SPA originates from the north and east outside of the SPA.

Groundwater-Surface Water Interactions

Significant Groundwater Recharge Areas (SGRAs) for the Maitland Valley SPA have been delineated using a physical based approach calibrated to Tier 1 surface water models. A thorough discussion on this methodology can be found in Section 3.8 of this chapter.

Little is known about the discharge of water from the bedrock aquifer. Based on potentiometric surfaces for the bedrock aquifer, it is thought that the bedrock aquifer likely discharges into the overlying overburden aquifers in the area but the extent of such an interaction is unknown. In the lower reaches of the major rivers (particularly the Bayfield River) bedrock is exposed in the river beds and it is assumed that the bedrock aquifers in these areas are discharging directly into the rivers. Ultimately the bedrock aquifers are also thought to discharge directly into Lake Huron in the offshore.

Within the Source Protection Region several sinkholes have been documented. These sinkholes have extensive surface drainage areas which are drained directly into the sinkholes, providing a direct conduit of surface water to the bedrock aquifers themselves. Several studies have been completed investigating the development of the sinkholes and the extent of the resultant interaction between surface water and groundwater. These studies indicate that a high volume of water is recharged into the bedrock aquifer via sinkholes.

3.4.2.2 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 and 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, very little information exists on the overburden aquifers for the Source Protection 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. In addition, it is recognized that there exists a number of overburden aquifers that are not exposed on the ground surface and for which no mapping exists. Where known, these aquifers have been outlined and will be discussed.

3.4.2.2.1 Surficial Overburden Aquifers

Lake Warren Shoreline Aquifer

Forming a narrow band and extending across, and north and south of the entire Source

Protection Area is the former Lake Warren shoreline. These former beaches and dunes have formed well sorted, well rounded sand deposits which are ideal potential aquifers. This aquifer is an important source of cold water for the numerous lakeshore streams and gullies. In addition, several documented private wells are located within this aquifer. This is an unconfined aquifer, and is likely recharged *in situ*, otherwise, very little is known about it.

Lake Huron Beach Aquifer

Located within the beach deposits along the present-day shoreline of Lake Huron, the Lake Huron Beach Aquifer is used sporadically as a source of drinking water by various cottagers. This aquifer is an aggregate aquifer composed of a number of unconfined aquifers that are likely recharged *in situ* with some contribution from surface runoff from nearby bluffs, where they exist. Flow within this aquifer is likely towards Lake Huron.

Holmesville Outwash Aquifer

Located between the Wyoming and Wawanosh moraines, the Holmesville outwash deposit comprises an unknown thickness of gravel and sand. This aquifer is host to numerous aggregate extraction operations and is anecdotally well known as a high quantity, high quality aquifer. Several private wells are documented within this aquifer and some smaller developments rely on springs from this aquifer as sources of drinking water (e.g., Fernhurst Glen).

This aquifer is likely recharged *in situ*, with some contribution from the surrounding, topographically higher moraines. The Holmesville Aquifer is an important source of water for a number of surface water bodies, including the coldwater stream, Sharpe's Creek, as well as the Saratoga swamp. Otherwise, very little is known about this aquifer. The Holmesville aquifer also likely discharges directly into, and is an important source of baseflow for, the lakeshore streams and gullies that extend inland far enough to exploit it.

Wawanosh Kame Moraine Aquifer

The Wawanosh moraine is composed of large kame deposits and is an ideal location for potential surficial aquifers. The Wawanosh moraine forms a distinct topographic high within the Maitland River and Nine Mile River watersheds and is often characterized by hummocky terrain. This preponderance for hummocky terrain makes the Wawanosh Moraine an area of high infiltration and groundwater recharge for the study area. The extent to which the moraine contributes water to bedrock aquifers is unknown, but it does directly overlie bedrock in a number of locations and may be an important source of inline recharge for the bedrock aquifers.

The Wawanosh moraine is the major source of water for the coldwater Nine Mile River system and portions of the Maitland River where it crosses the moraine. Usage by private wells is poorly documented in water well records, but the aquifer was used historically for water extensively.

Information about usage, groundwater flow and groundwater quality are lacking for this aquifer.

Howick Aquifer

The Howick aquifer is located in the northern part of the study area and is centred on Howick Township. This composite aquifer is situated within a large outwash deposit and glacial spillways which form the rolling topography of this area. In addition, numerous drumlins associated with the Teeswater drumlin field and smaller eskers and spillways which are dispersed through northern Huron and Perth counties are included in this aquifer.

This aquifer is likely recharged *in situ*. It is an important source of water for the North Maitland River, Lakelet Lake, Lakelet Creek and Blind Lake Bog. This aquifer is also likely an important source of inline recharge for the bedrock aquifer as it has incised the underlying tills and lies directly on bedrock. The extent of this interaction is poorly understood.

Of particular interest for this aquifer is the concentration of Mennonite and Amish communities in the aquifer. These communities tend to rely on shallow aquifers for drinking water which are considered to be more vulnerable to contamination than bedrock sources.

This aquifer is poorly understood, with little to no information about groundwater flow, water quantity and quality.

3.4.2.2.2 Confined Overburden Aquifers

Atwood/Dundas Bedrock Valley Aquifer

This aquifer is situated within sand and gravel that has infilled the Dundas bedrock valley and has been subsequently covered with clay and silt rich tills. This aquifer is confined and likely both recharges and discharges the surrounding bedrock aquifers. This aquifer could be considered transient for water flowing within the bedrock aquifer.

The effect of the high permeability materials that comprise this aquifer could funnel water outside of the watershed region but this relationship is poorly understood.

3.4.2.2.3 Other Overburden aquifers

Numerous other sand and gravel deposits, which cannot be accurately described at the scale of this report, exist throughout the Source Protection Area (see **Map 3.10** for overburden thickness). These deposits may have local importance as sources of groundwater but are not well documented, and are poorly understood.

3.4.2.3 Groundwater/Surface Water Interactions

Shallow overburden aquifers are important sources of baseflow for many surface water streams. These aquifers help to moderate flow and provide cold water, valuable for specific fisheries. Shallow overburden aquifers, particularly unconfined aquifers, are areas of increased infiltration due to their coarse grained composition and topography.

Cold Water Fisheries

Map 3.11 shows the cold water fisheries throughout the Source Protection Area. Cold water fisheries are indicative of areas where significant discharge from shallow overburden aquifers is occurring. In fact, a large portion of flows in the surface water systems can be attributed to groundwater discharge. This component of surface water flow is critical for maintaining baseflow and ecological health of the surface water system. Cold water fisheries, as a general rule, also tend to have a higher quality of water as well as quantity due to the dilution of overland runoff from groundwater discharge. This is an example of how the issues of water quantity and quality cannot be considered discretely, but should be viewed as a single component within the framework of a water budget.

Map 3.11 also shows the locations of dams in the MV SPA. All dams in the MV SPA are not actively regulated and logs are typically installed during the late spring, and removed prior to the winter. Dams have a negligible impact on surface water flows in the area.

Hummocky Terrain

Hummocky terrain is described as areas with broad, gently sloping swales, within which there is increased depressional storage and increased flow lengths for overland flow. These factors lead to slower runoff to surface waters and a coincident increase in infiltration. Indeed, hummocky terrain tends to predominate within very coarse grained materials where overland flow is not likely to occur. Hummocky terrain is thus important as it may produce a disproportionately high volume of recharge to underlying aquifers.

Hummocky terrain has been identified in the Maitland Valley Source Protection Area, yet the full extent of its development has not been mapped. This is considered a data gap for the SPA and several methodologies for mapping hummocky terrain are being tested.

3.4.2.4 Groundwater Monitoring

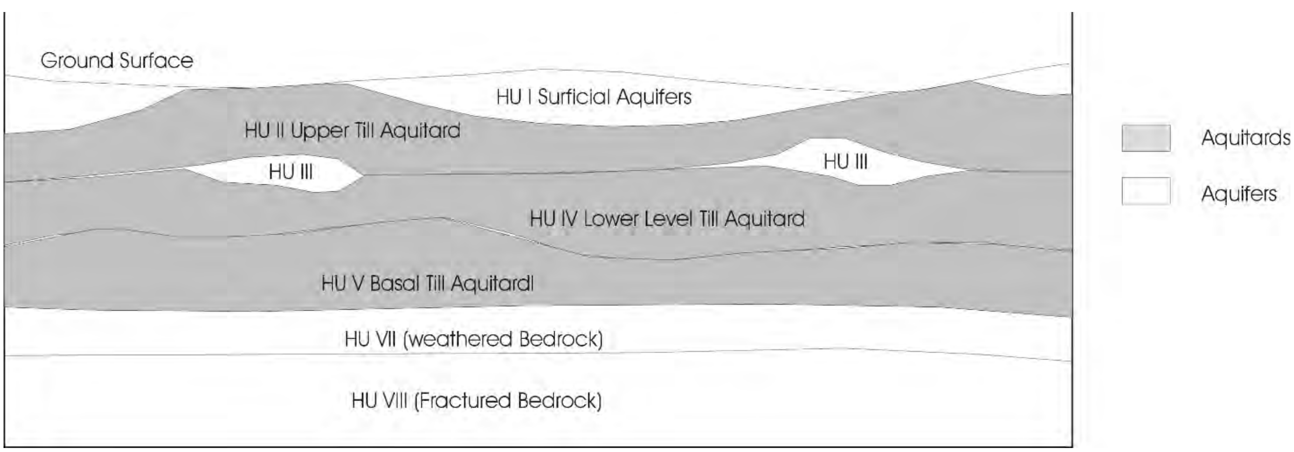
Groundwater monitoring locations were established in the Maitland Valley Source Protection Area in 2003 as part of the Provincial Groundwater Monitoring Network (PGMN). These sites have been equipped with water level and temperature loggers and are recording hourly values for these parameters. Due to the relatively short period of record it is not possible to examine long term trends of groundwater levels throughout the Source Protection Region. PGMN monitoring locations are shown on **Map 3.2**.

3.4.2.5 Hydrostratigraphy

In order to develop a numerical groundwater model, the aquifers and aquitards must be developed into a hydrostratigraphy. As part of a regional scale three dimensional groundwater model developed for southern Ontario, a hydrostratigraphy has been developed for the SPA. For this purpose, the geology of Southern Ontario has been broken into eight hydrostratigraphic units (HU), of which seven are thought to occur in the Maitland Valley Source Protection Area. **Figure 3.2** shows a schematic representation of the hydrostratigraphy, developed as part of this project.

For the purposes of developing a numerical model, each hydrostratigraphic layer was given an elevation, thickness and representative hydraulic conductivities. These layers were then incorporated into a groundwater flow model and calibrated to stream flow data for streams with significant groundwater discharge, as well as to known groundwater levels from existing monitoring sites and the Water Well Information System.

Figure 3.2 Hydrostratigraphy of Study Area.



Source: modified from WHI, 2006

Precipitation was applied across the entire study area and the model was used to help to determine the pathways of the water.

Hydrostratigraphic Unit (HU) I Upper Unconfined Aquifers

These aquifers are located at the ground surface and include Howick, Holmesville, Seaforth Moraine, Wawanosh Moraine, Lake Warren Shoreline, and Lake Huron Shoreline aquifers.

HU II Upper Till Aquitard

This layer is composed of the various surficial tills in the study area, including the St. Joseph, Rannoch and Elma Tills. This aquifer is an effective aquitard in the study area.

HU III Intermediate Sands and Gravels Aquifer

This unit includes the Hensall Aquifer.

HU IV Lower level Tills Aquitard

These include the lower stratigraphic tills including the Tavistock till.

HU V Basal Sand and Gravel Deposit Aquifer

This unit is not present in the study area.

HU VI Basal Tills Aquitard

This unit is not present in the study area.

HU VII Weathered and Fractured Bedrock Aquifer

This unit includes the upper 3-5 metres of the bedrock aquifers, which has enhanced permeability as a result of weathering and fracturing.

HU VIII Bedrock Aquifer

This unit includes the remaining bedrock aquifers.

3.5 Water Use

3.5.1 Data Sources

A number of sources of data for water usage are available for the Maitland Valley Source Protection Area. These data include the Provincial Permit To Take Water (PTTW) database (see **Maps 3.12 and 3.13**), the Water Well Information System, agricultural water usage studies, Statistics Canada census data and Municipal Well annual reports. These data are useful for approximating the amount of water being extracted in the region. **Table 3.6** shows groundwater takings in the MV SPA, while **Table 3.7** shows surface water takings for the SPA.

Table 3.6 Groundwater use in the Maitland Valley SPA by category (in m^3/year)

Subwatershed	Permitted Use	Domestic Use	Agricultural Use	Total	Area (m^2)	mm
Goderich & Bayfield Gullies	3,218,756	10,873	299,104	3,528,733	109,349,871	32.27
Little Maitland	117,651	16,556	793,134	927,341	370,949,346	2.50
Lower Maitland	3,320,502	30,945	971,319	4,322,765	533,717,780	8.10
Middle Maitland	0	39,584	1,382,445	1,422,029	646,444,198	2.20
MVCA Gullies	64,875	19,447	514,924	599,246	377,712,529	1.59
North Maitland	0	38,172	1,020,445	1,058,616	575,960,639	1.84
South Maitland	111,310	25,163	1,042,382	1,178,855	447,646,312	2.63
Upper Nine Mile	0	12,812	325,878	338,689	245,713,661	1.38

Table 3.7 Permitted surface water use in the Maitland Valley SPA

Subwatershed	Permitted Use (L/yr)	Permitted Use (m^3/year)	Area (m^2)	mm
Goderich and Bayfield Gullies	0	0	109,349,871	0.000
Little Maitland	0	0	370,949,346	0.000
Lower Maitland	24,140,340	24,140	533,717,780	0.045
Middle Maitland	0	0	646,444,198	0.000
MVCA Gullies	0	0	377,712,529	0.000
North Maitland	0	0	575,960,639	0.000
South Maitland	0	0	447,646,312	0.000
Upper Nine Mile	4,542,494	4,542	245,713,661	0.018

3.5.2 Municipal Water Takings

Water takings for municipal drinking water supplies comprise a high volume of water takings within the Maitland Valley Source Protection Area. Most of these takings are exploiting bedrock aquifers with only one supply reliant on Lake Huron.

The Goderich Water Supply System, which serves the Town of Goderich, is a major taker within the Maitland Valley Source Protection Area. However, most of the water taken in this system is returned via discharge from the Goderich WWTP. As such, the Goderich Water Supply System represents only minor consumptive water taking in the region.

Quantifying municipal water takings was completed as part of the Tier 1 Water Budget. Results from this exercise are shown below.

3.5.3 Agricultural Water Takings

Agriculture, including livestock feeding operations and irrigation, represents the largest land use within the Maitland Valley Source Protection Area. 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. Surface water takings associated with agriculture increase to the southern portion of the region, particularly in areas where bedrock water is known to be poor in quality.

Quantifying takings from agriculture is a difficult task. Most livestock facilities are not required to obtain a Permit to Take Water (PTTW), and as such, estimations of usage will be made for the different sectors. The University of Guelph completed an agricultural water usage survey which examined takings for different sectors, and this information has been correlated with agricultural census data in order to provide an estimate of overall water takings as part of the Tier 1 Water Budget.

Irrigation facilities often have PTTWs, and as such some information on their water takings may be obtained. However, the PTTW database often lists maximum allowable takings and may not represent actual takings. The newly amended PTTW regulation will require flow monitoring for all permits but this data is not yet available. With the aim of gaining a greater understanding of these takings, contact with operators was made in order to access records (required under existing permits) of takings (Luinstra Earth Sciences, 2006). The results of this work were incorporated into the Tier 1 Water Budget.

3.5.4 Private Domestic Consumption

Private consumption in the Maitland Valley Source Protection Area almost exclusively exploits the overburden and bedrock aquifers. The typical scenario involves drilled, or less commonly, bored wells which recycle water into shallow overburden aquifers via a septic system.

The overall amount of water which is transferred from deeper aquifers to shallower aquifers needs to be addressed in order to accurately represent the flow of groundwater in the area numerically. To estimate this quantity, an average consumption per household was attributed to individual wells in the Water Well Information System as part of the Tier I Water Budget.

3.5.5 Industrial and Recreational Uses

Several industries within the Maitland Valley Source Protection Area rely on large quantities of water for production. These include aggregate extraction operations, greenhouses, harvesters, and golf courses among others. Other recreational uses include constructed wetlands, reservoirs for recreation and flow augmentation.

Most of these operations rely on the bedrock aquifer. However, several takings of surface water are documented in the PTTW database. To gain a greater understanding of these takings, contact with operators was made in order to access records (required under existing permits) of takings (Luinstra Earth Sciences, 2006). The results of this work were incorporated into the Tier 1 Water Budget.

3.6 Summary of Conceptual Water Budget Results

There are two dominant sources of municipal drinking water in the study area: Lake Huron and the bedrock aquifers. These sources can be considered to be large, high quantity sources. In addition, based on this preliminary water budgeting exercise and the overview of water usage in the area, takings from these sources tend to be small relative to the overall availability of water in the area.

3.7 Summary of Tier 1 Water Budget

A Tier 1 water budgeting exercise is intended to estimate the hydrologic stress of subwatersheds for the purpose of screening out areas from further, more detailed assessment. This is done using the best available data for the major hydrologic components and processes of these subwatersheds ("watershed elements"). This data is then compared to the amount of consumptive water demand within a given subwatershed to determine the degree of stress in the hydrologic system due to human water usage.

This section is a summary of the Ausable Bayfield Maitland Source Protection Region Tier 1 Water Budget Report (Luinstra Earth Sciences 2008) which has been completed in compliance with the Technical Rules (MOE 2008).

3.7.1 Subwatersheds for Tier 1 Water Quantity Stress Assessments

For the Tier 1 Water Budget, new subwatersheds are proposed for the purposes of performing subwatershed stress assessments. These subwatersheds were delineated according to a hierarchy of factors, developed with the assistance of the Peer Review Committee, including:

- Total water contributing area for municipal water supplies
- Limits of existing subwatersheds used for modeling purposes
- Areas of concentrated water usage
- Physiographic and hydrologic characteristics

Based on the developed criteria, eight (8) different watersheds were delineated for the purposes of the Tier 1 surface water quantity stress assessment, namely:

- North Maitland River;
- Little Maitland River,
- Middle Maitland River,
- South Maitland River,
- Lower Maitland River,
- Maitland-Bayfield Gullies (the Lakeshore Gullies between the mouths of the Maitland and Bayfield Rivers),

- Nine Mile River
- MVCA Gullies (the remaining Lakeshore Gullies in the MVCA jurisdiction).

These units are shown on **Map 3.14**. A detailed rationale for the delineation of Tier 1 subwatersheds can be found as Appendix A to the Tier 1 Water Budget report (Luinstra Earth Sciences, 2008).

3.7.2 Modeling

Quantitative estimates of the flow of water between the watershed elements for these subwatersheds were derived from existing surface and groundwater models.

3.7.2.1 Surface Water Modeling

Surface water modeling was carried out for the entire Maitland Valley Source Protection Area using the Soil and Water Assessment Tool (SWAT). This tool was used to simulate long-term evapotranspiration, streamflow, and deep drainage for all the major river systems located within the Maitland Valley Source Protection Area including the Maitland River, the Nine Mile River, as well as the extensive set of lakeshore gullies and streams situated along the Source Protection Region's Lake Huron shoreline. A report outlining the steps required to complete the modeling was developed by McKague and Mao (2007).

The simulated quantification of these watershed elements is essential in determining the Tier 1 subwatershed stress assessments for the region.

3.7.2.2 Groundwater Modeling

A fully calibrated 3D groundwater flow model was developed for the region using FeFlow groundwater modeling software. An existing model was completed at a coarse, regional scale for the combined jurisdictions of the Maitland, Ausable Bayfield, St. Clair, Upper Thames, Lower Thames and Essex Region Conservation Authorities, and as such, is collectively known as the Six CA Groundwater Model. Details on this project, including information on development and calibration of the conceptual and groundwater flow models are available in the *Six CA Groundwater Modeling Report* (WHI, 2006).

The groundwater flow in the model was calibrated against static water levels from MOE water well records, Provincial Groundwater Monitoring Network wells, and to fourth order or greater streams. Water well records were screened based on confidence in locations, and elevations from these water well records were adjusted using Digital Elevation Model (DEM) for the area.

For the purposes of that project, each of the five Tier 1 subwatersheds were separated and refined from the Six CA Scale Model. In order to extract models, the regional scale model was overlain with a layer outlining the Tier 1 subwatersheds. As the individual elements within the model were of a coarse scale, some elements traversed subwatershed boundaries. In order to address this problem, the finite element mesh near subwatershed boundaries was refined, to 100 m, 50 m and finally 25 m sizes at subwatershed boundaries prior to extraction using FeFlow. Boundary conditions for each Tier 1 subwatershed groundwater model were extracted using FeFlow from the fully calibrated regional-scale model.

Tier 1 subwatershed models were simulated for the period 1985-2005. Groundwater fluxes were developed using the continuous boundary flux methodology within the FeFlow water budgeting module.

Based on available data and parameters modeled as part of the Tier 1 Water Budget the following cursory numeric water budget was developed for the Region and is shown as part of **Table 3.8**, below.

Details of the development of the individual watershed elements and fluxes can be found in the *Ausable Bayfield Maitland Source Protection Region Tier 1 Water Budget Report* (Luinstra Earth Sciences, 2008) and that by McKague and Mao (2007).

Table 3.8 Tier 1 Water Budget for the Maitland Valley SPA. (All values expressed as mm/year of equivalent precipitation)

Tier 1 SubWat	GW-IN	PPT	IN	ET	Sur. Q	Rech.	Anthro	GW-Out	Bflow	Out
South Maitland	74	1119	1193	468	345	243	3	120	134	1044
Lower Maitland	34	1164	1198	476	311	342	8	107	214	1031
Middle Maitland	12	1031	1043	437	305	249	2	67	138	923
Little Maitland	462	996	1458	443	252	268	3	710	148	1528
G-B-Gullies	217	1058	1275	387	324	307	32	1	235	816
MVCA-gullies	90	1168	1258	354	432	324	2	215	254	1072
Nine Mile	275	1155	1430	419	304	393	1	305	282	1141
North Maitland	9	957	966	469	201	237	2	193	157	945

GW-IN = Groundwater flow in; PPT = Precipitation; ET = Evapotranspiration; Sur. Q = Streamflow; Rech. = Recharge; Anthro= Total Consumptive Water Use; GW-Out = Total groundwater flow out (includes Baseflow); Bflow = Baseflow.

3.7.3 Surface Water Supply Estimate

At any given time, the available drinking water supply in a river or stream is limited to the instantaneous flow rate. Surface water supply is a method for determining the amount of flow available based on streamflow data for the Maitland Valley Source Protection Area. The prescribed approach for determining the surface water quantity stress takes into consideration seasonal variability, and is therefore evaluated using an estimate of expected monthly flow values.

For each subwatershed within the study area, median flows were calculated to provide an estimate of surface water supply. Fiftieth percentile flows were derived from the daily SWAT analyses for each month and then converted to monthly flows (mm/month).

3.7.4 Surface Water Reserve Estimate

The water reserve estimate for a surface water system in Tier 1 is based on the maximum of a statistical measure of low flow or a known anthropogenic need (e.g. wastewater assimilation). The water reserve estimate is the means by which a portion of water may be protected from being considered within the stress calculations. The concept behind its use is to support other uses of water within the watershed including both ecosystem requirements (instream flow needs) as well as other human uses (primarily permitted uses). The reserve quantity is subtracted from the total water source supply prior to evaluating percent water demand.

For the scale of this Tier 1 assessment surface water reserve is not complicated by the need for assimilative capacity and is therefore most simply expressed as the tenth percentile flows for each subwatershed. Tenth percentile flows were derived from the daily SWAT analyses for each month and then converted to monthly flows (mm/month). In order to be consistent with MOE Technical Rules (2008), for the Tier 1 surface water stress assessment, reserve values are used for the months with the lowest monthly water supply estimates, rather than the lowest monthly water reserve estimates.

3.7.5 Groundwater Supply Estimate

An estimation of the amount of groundwater available to supply subwatersheds groundwater users is determined as a summation of groundwater recharge and lateral groundwater flow into the subwatershed. The percent water demand can then be calculated as both average annual and average monthly conditions for current and future (25 year) scenarios. For this Tier 1 analysis, aquifer storage is not considered and as such the water supply terms for the subwatersheds are assumed to be consistent on an average annual basis.

Groundwater flux through the system was developed from the Six CA FeFlow Model. Tier 1 subwatersheds were refined and extracted and flux values determined using continuous boundary flux within the FeFlow water budgeting module.

For the study area, two sources of recharge data are available, estimates derived from the Six CA Groundwater Model (annual only) and from the SWAT analysis (monthly and annual). **Table 3.8** summarizes groundwater flux through the Tier 1 subwatersheds derived from FeFlow. These recharge values derived from FeFlow for the Six CA Model will be used for the Tier 1 assessment. These data are considered the more conservative value, consistent with expectations for a Tier 1 Water Budget.

3.7.6 Groundwater Reserve Estimate

The groundwater reserve for Tier 1 analysis is determined by estimating the reserve quantity as 10% of the existing baseflow (groundwater discharge). Baseflow has been calculated from the Six CA Groundwater Model (annual only) and from the SWAT analysis (monthly and annual). **Table 3.8** shows estimated baseflow derived from SWAT analysis. For the purposes of the Tier 1 analysis, the SWAT based baseflow will be used as it is derived from more accurate streamflow data and has been rectified to actual baseflow determined from gauged streams, where possible.

3.7.7 Consumptive Groundwater Usage Estimate

3.7.7.1 Permitted Usage

Permitted groundwater usage is primarily documented through the PTTW database, as well as through municipal drinking water supply records. Similar to the permitted surface water takings, the best available water taking data (actual, estimated average, maximum permitted) was used to estimate permitted amounts, which were subsequently adjusted using the consumptive factor outlined in the MOE Technical Rules (2008).

3.7.7.2 Non-Permitted Agricultural Usage

Agricultural usage, particularly those not related to crop irrigation are exempt from requiring a Permit to Take Water. As a result, no documentation of this usage is available for analysis. Estimates of agricultural usage were developed based on agricultural data and projected watering requirements from the 2001 census data as part of de Loë (2001). This information is broken into watersheds for all of southern Ontario and was incorporated into the consumptive usage estimates. Estimated takings were then adjusted according to consumptive use factors provided by the MOE Technical Rules (2008).

3.7.7.3 Private-Domestic Usage

Private domestic usage is not considered within the MOE Technical Rules (2008). It was felt, due to the high reliance on groundwater for private potable water sources, that this taking should be incorporated into this Tier 1 water budgeting exercise.

Private well records for each subwatershed, available in the Ontario Ministry of the Environment's Well Record Information System (WWIS) were assigned a minimum taking value of 450 L/day, based on usage requirements set out in Ministry best practice documents for the sizing and evaluation of septic systems. These values were then adjusted according to consumptive use factors for domestic water takings provided by the MOE Technical Rules (2008).

3.7.8 Consumptive Surface Water Usage Estimate

3.7.8.1 Permitted Surface Water Usage

Permitted users are the only reliable source for surface water takings information for the area. Surface water takings are generally confined to irrigation activities, with the exception of the Lake Huron – based municipal (and private) water supply systems, which are necessarily excluded from the Tier 1 water budgeting exercise.

A study was completed in 2006 in order to attempt to determine actual takings for PTTW holders in the area (Luinstra, 2006). The results of this work have been included in the calculations of consumptive surface water use for the study area. The best available water taking data (actual, estimated average, maximum permitted) was used to estimate permitted amounts, which were subsequently adjusted using the consumptive factor outlined in the MOE Technical Rules (2008).

3.7.9 Future Usage Projections

Future increases in the usage of both (non-Lake Huron) surface water and groundwater are not considered significant for the study area. The study area is considered to be fully developed in that it has very little natural area that will likely be converted to either agricultural or residential land uses.

Population growth is projected to be minimal in the immediate future, with growth centered along the shore of Lake Huron and in existing towns and villages. Given the low consumptive water uses in the area it seems unlikely that future usage, based on today's projections, will lead to any additional stress on the natural system. Caution should be added that not all future uses can be accounted for or anticipated, and that no additional stresses are anticipated for the subwatersheds at the scale being investigated. However, large takings within specific areas may still lead to significant problems.

3.7.10 Tier 1 Surface Water Stress Assessment

The Tier 1 surface water stress assessment is designed to screen and flag those subwatersheds where the degree of stress is considered moderate or significant for further study. The stress assessment evaluates the ratio of the consumptive demand for permitted and non-permitted users to water supplies, minus water reserves within a given subwatershed.

Within the study area, for each subwatershed, the monthly water reserve (tenth percentile flows) was subtracted from the monthly water supply (median flows) for the month with the lowest monthly water supply in order to determine water availability. The percentage water demand was then calculated as a percentage of the consumptive demand versus this water availability, where:

% Water Demand = (Consumptive Demand / (Water Supply – Water Reserve)) X 100

Subwatershed stress levels are defined as: less than 20% - Low; Between 20 and 50% - Moderate; more than 50% - Significant. **Table 3.9**, below, outlines the water supplies, reserves, availability, consumptive demand, percentage water demand, and surface water quantity stress levels for each subwatershed in the study area. The stress levels are presented graphically in **Map 3.15**. All subwatersheds are considered to have low surface water quantity stress at the scale analyzed for the Tier 1 water budget.

Table 3.9 Percentage Water Demand for Surface Water Subwatersheds in the Study Area. (Expressed as equivalent mm of precipitation)

Tier 1 Subwatershed	Supply	Reserve	Consumptive Use	% Water Demand
South Maitland	125	42.6	0	0.0
Lower Maitland	205.4	50.4	0.007	0.0
Middle Maitland	38	5	0	0.0
Little Maitland	13.9	4.1	0	0.0
Goderich & Bayfield Gullies	7.3	0.1	0	0.0
MVCA-gullies	31.8	2.2	0	0.0
Nine Mile	33.4	3.2	0.004	0.0
North Maitland	32.3	20.6	0	0.0

Based on the criteria for determining surface water quantity stress, there are no subwatersheds considered to be under stress. There are no municipal surface water takings in the Maitland Valley SPA.

3.7.11 Tier 1 Groundwater Stress Assessment

Similar to the Tier 1 surface water stress assessment, the Tier 1 stress assessment for groundwater is designed to determine the degree of stress within each subwatershed. The stress assessment evaluates the ratio of the consumptive demand for permitted and non-permitted users to water supplies, minus water reserves within a subwatershed.

Within the Maitland Valley Source Protection Area, the groundwater reserve (10% of supply) was subtracted from the groundwater supply (recharge plus groundwater influx) in order to determine groundwater availability. The percentage water demand was then calculated as a percentage of the consumptive demand versus this water availability, where:

% Water Demand = **(**Consumptive Demand / (Water Supply – Water Reserve)**)** X 100

Subwatershed stress levels are defined for average annual fluxes, as: less than 10% - Low; Between 10 and 25% - Moderate; more than 25% - Significant, and for monthly maximum fluxes as: less than 25% - Low; Between 25 and 50% - Moderate; more than 50% - Significant. **Table 3.10**, below, outlines the water supplies, reserves, availability, consumptive demand, percentage water demand and groundwater quantity stress levels on an annual basis for each subwatershed in the study area.

Table 3.10 Annual Percentage Groundwater Demand for Groundwater Subwatersheds in the Study Area. (Units are mm/year unless otherwise specified)

Tier 1 Subwatershed	GW IN	Recharge	Supply	Baseflow	Reserve	Consumptive Use	% Water Demand
South Maitland	74	127	201.0	134	20.1	2.63	1.45
Lower Maitland	34	152	186.0	214	18.6	8.1	4.84
Middle Maitland	12	143	155.0	138	15.5	2.2	1.58
Little Maitland	462	134	596.0	148	59.6	2.5	0.47
God & Bay Gullies	217	141	358.0	235	35.8	32.27	10.02
MVCA-gullies	90	105	195.0	254	19.5	1.59	0.91
Nine Mile	275	149	424.0	282	42.4	1.38	0.36
North Maitland	9	144	153.0	157	15.3	1.84	1.34

The annual groundwater stress levels are presented graphically in **Map 3.16**. All subwatersheds are considered to have low annual groundwater quantity stress, with the exception of the Goderich and Bayfield Gullies, which are over the threshold developed for moderate stress. It is important to note that these stress assessments are relevant only at the scale analyzed for the Tier 1 Water Budget.

Based on the criteria for determining groundwater quantity stress, the Goderich and Bayfield Gullies subwatershed is considered to be under stress, passing the threshold for moderate stress with approximately 10.02% of available water under demand. This is a result of very high consumptive takings that create a water demand above the threshold for moderate stress despite the high water supply. There are several municipal groundwater supplies within the Goderich and Bayfield Gullies subwatershed.

Monthly groundwater stress is shown below in **Table 3.11**. Monthly stress values remain well below stress thresholds for all subwatersheds. This is a result of the relatively low consumptive takings relative to the overall supplies and flux of water through the subwatersheds.

Table 3.11 Monthly Percentage Groundwater Demand for Groundwater Subwatersheds in the Study Area. (Units are mm/month unless otherwise specified)

Tier 1 Subwatershed	Supply	Reserve	Consumptive Use	% Water Demand
South Maitland	15.41	1.54	0.25	1.80
Lower Maitland	14.26	1.43	0.69	5.38
Middle Maitland	11.88	1.19	0.18	1.68
Little Maitland	45.69	4.57	0.27	0.66
Goderich & Bayfield Gullies	27.44	2.74	2.86	11.58
MVCA-gullies	14.95	1.50	0.20	1.49
Nine Mile	32.5	3.25	0.11	0.38
North Maitland	11.73	1.17	0.15	1.42

The Goderich and Bayfield Gullies subwatershed require further investigation as part of a Tier 2 Water Budget to determine and verify any potential stresses, as it is host to several municipal groundwater supplies.

3.7.12 Uncertainty and Data gaps

3.7.12.1 Uncertainty

The uncertainty associated with the Tier 1 watershed stress assessments are specific to the subwatersheds that they have evaluated. Uncertainty, in this context, is a function of the confidence in the final stress assessment, including the cumulative uncertainty inherent in the data used to develop that stress assessment.

In cases where a subwatershed is considered low in stress but approaches the moderate threshold, this uncertainty must be examined more carefully, given the inherent inaccuracy of the model outputs for natural water flux and estimated consumptive water use. The fundamental principle is that Tier 1 stress assessments should be conservative and overestimate stress.

3.7.12.2 Uncertainty Associated with Consumptive Water Usage

In general, there is a high degree of uncertainty associated with consumptive water usage estimates due to the inherent inaccuracy of the available water takings data. In most cases, data on water takings are not reflective of actual takings, but rely on estimates based on permitted values.

In the case of the Maitland Valley SPA, permit holders were contacted and attempts were made to gather actual pumping values (Luinstra, 2006). These values were incorporated into the Tier 1 consumptive use estimates. However, actual takings were not available for all PTTWs, and as a result, the estimates contained herein can be considered conservative, in that they are likely overestimating takings.

3.7.12.3 Uncertainty Associated with Model Outputs

Model outputs are inherently uncertain. SWAT modeling for the study area was calibrated to measured streamflow where possible and generally is felt to be reasonably representative of actual conditions. However, it cannot be established that SWAT derived values are more conservative than measured or actual values. FeFlow modeling available for the study area was initially developed for a large, regional scale model. As a result of this, significant simplification of the hydrogeologic system for the study area was required. The resultant uncertainty must be considered high for groundwater flux data derived from this model.

3.7.12.4 Aggregate Subwatershed Uncertainty

Subwatershed uncertainty for groundwater and surface water stress is included in **Table 3.12**, below.

The aggregate uncertainty for all subwatersheds is low, with the exception of the Goderich and Bayfield Gullies. Uncertainty within the Goderich and Bayfield Gullies must be considered high due to the relatively high percentage water demand (10.02%) and the potential that the groundwater influx values derived from the FeFlow model have significant uncertainty. In addition, the high takings in this subwatershed are a function of one large taking to which actual taking data is not available.

Table 3.12 Surface Water and Groundwater Stress Assessment Uncertainty for Tier 1 Subwatersheds

Tier 1 SubWatershed	GW Stress	SW Stress	Cons. Use	Aggregate uncertainty
South Maitland	low	low	low	low
Lower Maitland	low	low	low	low
Middle Maitland	low	low	low	low
Little Maitland	low	low	low	low

Tier 1 SubWatershed	GW Stress	SW Stress	Cons. Use	Aggregate uncertainty
Goderich & Bayfield Gullies	high	low	high	high
MVCA-gullies	low	low	low	low
Nine Mile	low	low	low	low
North Maitland	low	low	low	low

3.7.12.5 Data and Knowledge Gaps

A number of data and knowledge gaps have been identified in the text for the Tier 1 Water Budget, and include:

1. Evaporation data
2. Streamflow and baseflow data for ungauged watersheds
3. Accurate WWTP discharge data and a system for keeping this data up to date
4. Certificate of Approval data in order to determine appropriate surface water reserves as defined by assimilative capacity
5. Delineation of significant recharge areas
6. Actual water takings for all PTTW holders, and a system for keeping this data up to date

3.7.12.6 Limitations

The key limitation to this work is scale. The stress assessments performed for the Tier 1 Water Budget were completed at the crude, subwatershed scale. For the surface water system, this scale may be considered appropriate for the purposes of drinking water source protection, given the lack of municipal or any other drinking water supply from the surface water system. For the groundwater system, the scale should be considered appropriate for the bedrock aquifer, which, although it is host to numerous municipal and private drinking water systems, is a regional scale system and the analysis performed herein considered sufficient. However, overburden aquifers are less well understood and are not well represented in the regional scale groundwater model developed for the study area.

3.8 Summary of Tier 2 Water Budget

A Tier 2 Water Budget was required for the Goderich and Bayfield Gullies subwatershed after it was shown to be moderately stressed for groundwater in the Tier 1 water budget process. Accordingly, the Tier 2 Water Budget focuses solely on this subwatershed, and considers only the groundwater system.

The Tier 2 Water Budget is a more detailed analysis of the moderate or significantly stressed Tier 1 subwatersheds and typically includes advanced modeling and more detailed estimates of consumptive water use. Groundwater and surface water models created as part of the Tier 1 Water Budget are considered to be of sufficient quality and scale for the development of the Tier 2 Water Budget and are employed to develop water quantity stress assessments for the Goderich and Bayfield Gullies subwatershed. Annual and monthly groundwater stress thresholds within the Tier 2 Water Budget are the same as those used for the Tier 1 water quantity stress assessment. Those subwatersheds that are assigned a significant or moderate water quantity stress as a result of the Tier 2 evaluation will require a Tier 3 or local-area water budget and water quantity risk assessment.

3.8.1 Tier 2 Subwatershed Delineation

The Tier 1 subwatershed initially designated for further analysis (the Goderich and Bayfield Gullies subwatershed) was refined based on the presence of large water takings and municipal well supplies in the area. Upon review, it was found that a single large water taking reported in the Goderich and Bayfield Gullies subwatershed was responsible for the bulk of the water takings in the area. Further, this taking was located at the very northern edge of the subwatershed. While it was located a far distance from any of the municipal wells in the Goderich and Bayfield Gullies subwatershed, it was located quite close to the Century Heights municipal supply, located in the MVCA Gullies Tier 1 subwatershed. Therefore it was appropriate to re-delineate the Tier 2 subwatersheds in order to better reflect the potential impacts of any takings on municipal groundwater supplies, respecting logical topographic boundaries.

Map 3.17 shows the newly formed Tier 2 subwatersheds. The Goderich and Bayfield Gullies subwatershed was reduced in size, and a portion of the subwatershed included in a new Tier 2 subwatershed named the Goderich Tier 2 subwatershed. Portions of the MVCA gullies and Lower Maitland Tier 1 subwatersheds were included in the newly formed Goderich Tier 2 subwatershed based on surface and groundwater flow regimes. **Table 3.13** identifies the municipal systems located in each of the Tier 2 subwatersheds within the Maitland SPA.

Table 3.13 Municipal Systems within Tier 2 Subwatersheds.

SPA	Tier II Subwatershed	Municipality	System
Maitland	Goderich	Ashfield-Colborne-Wawanosh	Century Heights
Maitland	Goderich and Bayfield Gullies	Central Huron	McClinchey; Kelly

The Goderich and Bayfield Gullies subwatershed is located within both the Maitland Valley and Ausable Bayfield Source Protection Areas. The Goderich subwatershed is located wholly within the Maitland Valley Source Protection Area.

3.8.2 Model Updates

3.8.2.1 Surface Water Models

Existing SWAT models were further refined using the Guelph All Weather Sequential Event Runoff model (GAWSER) in order to include climatic data for 2007, and measured baseflow values for the Goderich and Bayfield Gullies and Goderich subwatersheds. GAWSER was selected for use in the Tier 2 water quantity assessment after consultation with the Peer Review Committee. GAWSER is considered a more accurate package for simulation of recharge rates.

Models were then used to develop groundwater supply and reserve estimates as outlined below for each of the previously delineated SWAT subwatersheds located in **Map 3.17**. **Table 3.14 and 3.15** show the results of the fully calibrated GAWSER modeling results for the Goderich and Bayfield Gullies and Goderich subwatersheds for the period 1950-2007, respectively.

Table 3.14 GAWSER Modeling Results for the Goderich-Bayfield Gullies for 1950-2007. (All values expressed as equivalent mm of rainfall)

subWAT	PPT	ET	RUNOFF	Recharge
720	1018	673	280	65
721	1018	667	321	30
722	1018	664	305	49
723	1018	629	388	1
724	1018	499	519	0
725	1018	381	637	0
726	1018	641	362	15
727	1018	669	261	88
728	1018	635	378	5
729	1018	673	262	84

subWAT	PPT	ET	RUNOFF	Recharge
730	1018	674	280	65
731	1018	629	388	1
732	1018	674	280	64
733	1018	663	274	81
734	1018	663	280	75
735	1018	631	382	4
736	1018	676	269	74
737	1018	638	373	7
738	1126	419	516	191
739	1126	416	548	162
740	1126	408	631	86
741	1126	411	573	142
742	1126	413	559	154
743	1126	410	608	108
744	1126	408	630	87
745	1126	407	607	113
746	1126	415	543	168
747	1126	425	431	270
748	977	435	377	164
749	977	433	394	150
750	977	456	239	282
751	977	401	425	151
752	977	449	282	246
753	977	448	293	236
754	977	452	267	258
755	977	429	417	131
756	977	465	170	342
757	977	457	225	294
758	977	431	376	169
759	977	464	165	347
760	977	459	153	365
761	977	425	466	85

subWAT	PPT	ET	RUNOFF	Recharge
762	977	435	392	149
763	977	452	263	262
764	977	435	394	148

Table 3.15 GAWSER Modeling Results for the Goderich Subwatershed for 1950-2007. (All values expressed as equivalent mm of rainfall)

subWAT	PPT	ET	RUNOFF	Recharge
701	1018	115	902	1
702	1018	115	902	1
703	1018	115	902	1
704	1018	115	902	1
705	1018	115	902	1
706	1018	115	902	1
707	1018	115	902	1
708	1018	197	813	8
709	1018	303	713	2
710	1018	530	476	12
711	1018	634	381	3
712	1018	633	366	20
713	1018	664	309	45
714	1018	663	344	12
715	1018	663	297	58
716	1018	692	277	49
717	1018	692	277	49
718	1018	681	296	41
719	1018	667	313	38
674	1018	690	278	50
675	1018	689	280	49
676	1018	603	389	27
677	1018	675	292	51
678	1018	377	608	34
679	1018	274	666	78
463	1018	559	242	217

3.8.2.2 Groundwater Models

Groundwater flux through the system was further developed from the fully calibrated, three-dimensional Six CA FeFlow groundwater model. Tier 2 subwatersheds were extracted, and mesh refined while maintaining all assigned hydrogeological values derived from the Six CA model. This ensured that the calibration of the models was not impacted during extraction. Similarly, boundary-flux conditions were derived from the Six CA model, also ensuring that the calibration of the models was not impacted. This process allowed for extraction of models and refinement of the modeling mesh without impacting the calibration of the model. In essence the extracted models represent extracted portions of the larger, fully calibrated Six CA groundwater model, allowing for faster and more efficient computation at the local scale. These Tier 2 groundwater models are based on the fully calibrated, Six CA regional groundwater model.

3.8.2.2.1 Goderich and Bayfield Gullies Model

A fully calibrated, three-dimensional groundwater model was created for the Goderich Bayfield Gullies assessment area via extraction from the regional scale Six CA model. Model elements (mesh) were refined to 25m (average distance between nodes) around the assessment area boundaries preserving all original boundary conditions derived from the regional scale 6CA model. The model is composed of 78,628 elements and 15 layers.

3.8.2.2.2 Goderich Model

A fully calibrated, three-dimensional groundwater model was created for the Goderich assessment area via extraction from the regional scale Six CA model. Model elements (mesh) were refined to 25m around the assessment area boundaries preserving all original boundary conditions derived from the regional scale Six CA model. The model is composed of 26,166 elements and 15 layers.

3.8.3 Consumptive Groundwater Use Estimate

Consumptive use estimates developed for the Tier 1 water quantity stress assessment were re-evaluated as part of the Tier 2 Water Budget process. This activity focused on the PTTW data, which is considered the least accurate of the water usage information, due to the lack of reported takings for a majority of permit holders.

A study was completed in 2006 in order to attempt to determine actual takings for PTTW holders in the area (Luinstra, 2006). The results of this work have been included in the calculations of consumptive surface water use for the study area. For the Tier 1 water quantity stress assessment, the best available water taking data (actual, estimated average, maximum permitted) was used to estimate permitted amounts, which were subsequently adjusted using the consumptive factor outlined in the MOE Technical Rules (2008). For the Tier 2 water quantity stress assessment, it was felt that further confirmation of takings was appropriate for those permits located within the Goderich-Bayfield Gullies and Goderich subwatersheds. Accordingly, a request was made to the Ministry of the Environment, the regulator of permitted takings, to provide this information for all permits which had no information on actual takings. Data from the Water Taking Reporting System (WTRS) was used to estimate actual takings where such information was available. Permitted water takings are shown below in **Table 3.16**.

Table 3.16 Permitted water use in the Maitland SPA for the Goderich and Goderich Bayfield Gullies Subwatersheds (m3/day)

Permit	Operator	Max	Avg	Permitted Rate	Method	Aquifer	Cons Factor
93-P-0018	Sifto Evaporator plant	16353	16353	26512	Actual*	Bedrock	1

* reported 2008 values

The Sifto Evaporator Plant is the dominant permit holder for the Goderich Tier 2 subwatershed. This plant exploits the bedrock aquifer to provide cooling water for a brine evaporation facility. Actual data from 2008 was provided by the permit holder directly for this study. This taker is exploiting the deep bedrock aquifer, and discharging directly into the Maitland River. As the bedrock aquifer is confined in the study area, no water is returned to the source, therefore the consumptive factor for this taking was determined to be 1 (100% of the water takings were determined to be consumptive).

Municipal water takings were based on annual average values derived from legislated water reports. Municipal Water Takings within the Maitland Spa are shown below in **Table 3.17**.

Table 3.17 Municipal Pumping rates in the Maitland SPA for Goderich and Goderich-Bayfield Gullies Tier 2 subwatersheds (m3/day)

System	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Avg*	Avg**
McClinchey	5.5	5.4	4.7	5.0	6.8	9.2	9.6	9.6	9.7	6.6	4.9	4.9	6.8	8
Century Heights	140	129	146	138	153	114	97	147	135	101	103	115	129	160

*2009 Average Daily Taking. **Average daily taking for 2001-2009

Agricultural water usage was developed based on 2006 census data for the subwatersheds following methodology developed by de Loë (2001). Domestic usage was estimated based on the number of wells with records in each subwatershed, and assigning an estimated usage of 450 L/day for each well.

In the Tier 1 Water Budget, consumptive use was reduced through the usage of a consumptive use factor. In both the Goderich and Bayfield Gullies and Goderich subwatersheds, no consumptive factor was applied for the Tier 2 water quantity stress assessment. The takings in this area are from a deep bedrock aquifer, which is confined by a minimum of 25 metres of fine-grained, low permeability sediments. It is, therefore, prudent to consider all water takings in these areas to be consumptive relative to the source, in this case the deep bedrock aquifer.

Table 3.18 shows annual consumptive water usage for the Goderich and Bayfield Gullies and Goderich subwatersheds.

Table 3.18 Annual Rates of Consumptive Water Use (in m^3/day)

Subwatershed	Permitted use	Agricultural	Domestic	Municipal	Total Use
Goderich	16353	304	107	160	16924
Goderich & Bayfield Gullies	477	688	110	48	1323

Monthly consumptive water use is necessary to complete maximum monthly water demand for the Tier 2 Water Budget exercise. Permitted water takings were analyzed based on anticipated peak monthly flows, based on permit requirements. Municipal, domestic and agricultural takings were assumed to be constant over the year, and averaged for each month. **Table 3.19** shows maximum monthly rates of consumptive water usage for the Goderich and Bayfield Gullies and Goderich subwatersheds.

Table 3.19 Maximum Monthly Rates of Consumptive Water Use (in m^3/day)

Subwatershed	Commercial	Agricultural	Domestic	Municipal	Total Use
Goderich	16353	304	107	153	16917
Goderich & Bayfield Gullies	500	688	110	64	1362

3.8.4 Tier 2 Water Budget

A summary of the Tier 2 Water Budget values for the Goderich and Bayfield Gullies and Goderich subwatersheds, including precipitation (PPT), evapotranspiration (ET), runoff, recharge, groundwater flux in, and consumptive use are shown below in **Table 3.20**. Precipitation, evapotranspiration, runoff and recharge are derived from GAWSER modeling. Groundwater flow in is from the Six CA Regional FeFlow Model, and consumptive use is based on estimates developed for the Tier 2 Water Budget.

Table 3.20 Tier 2 Water Budget for the Goderich and Bayfield Gullies and Goderich Subwatersheds. (All values expressed as equivalent mm/year of rainfall)

Tier 2 Subwatershed	PPT	ET	RUNOFF	Recharge	Gw Flow IN	Use
Goderich	1018	552	338	129	123	116
Goderich & Bayfield Gullies	1023	543	338	142	153	5

3.8.5 Tier 2 Water Quantity Stress Assessments

3.8.5.1 Groundwater Supply Estimates

An estimation of the amount of groundwater available to supply a subwatershed's groundwater users is determined as a summation of groundwater recharge and lateral groundwater flow into the subwatershed. The percentage water demand can then be calculated as both average annual and average monthly conditions for current and future (25-year) scenarios. For this Tier 2 analysis, aquifer storage is not considered and as such the water supply terms for the subwatersheds are assumed to be consistent on an average annual basis.

Groundwater flux through the system was further developed from the Six CA FeFlow Model. Tier 2 subwatersheds models were refined and extracted; and flux values determined using continuous boundary flux within the FeFlow water budgeting module.

For the study area GAWSER modeling results were considered to be the most accurate reflections of actual recharge conditions, given the sensitivity of their calibration when compared with the FeFlow results. GAWSER was considered to be the more robust of the two surface water models (i.e., in comparison with SWAT) in calculating recharge. As a result, GAWSER-derived recharge values were used for the developing groundwater supply estimates for the Tier 2 subwatersheds.

3.8.5.2 Groundwater Reserve Estimate

The groundwater reserve for Tier 2 analysis is determined by estimating the reserve quantity as 10% of the calculated water supply for the subwatershed.

3.8.5.3 Tier 2 Water Quantity Stress Assessment Results

Tier 2 groundwater quantity stress assessment was developed for the Goderich and Bayfield Gullies and Goderich subwatersheds incorporating the results of the Tier 2 Water Budget and is shown in **Table 3.21**, below and graphically in **Map 3.18**.

Table 3.21 Tier 2 Annual Groundwater Quantity Stress Assessment for the Goderich and Bayfield Gullies and Goderich Subwatersheds. **(All values expressed in m^3/day)**

Tier 2 Subwatershed	GW IN	Recharge	Supply	Reserve	Cons. Use	% Water Demand	Stress
Goderich	17921	19847	37768	3777	16917	50	Significant
Goderich & Bayfield Gullies	38960	34241	73201	7320	1323	2	Low

Based on the Tier 2 groundwater quantity stress assessment a Tier 3, local area water budget is required for the Goderich Tier 2 subwatershed. The relatively low water demands for the Goderich and Bayfield Gullies indicate that it is not under water quantity stress.

3.8.6 Planned Systems

There are no planned systems for either the Goderich and Bayfield Gullies or Goderich Tier 2 subwatersheds.

3.8.7 Future Use Scenario

Technical rules require that a future use scenario be undertaken for all Tier 2 subwatersheds not already identified as being stressed under existing conditions. In order to complete this, population growth projections based on official plans are used to estimate future water consumption, and are evaluated based on present day water supply and reserve estimates.

For the Goderich and Bayfield Gullies, future population projections range from 20-35% for the 20 year time period (Lakeshore Class EA, 2010). Given the relatively low initial population, the impacts of future growth may have dramatic implications on the water quantity assessment. In order to evaluate this and be conservative, present water use was increased by 35% and water demand estimates produced, shown in **Table 3.22**.

Table 3.22 Water Quantity Stress for the Goderich and Bayfield Gullies Based on 35% Increase in Water Use

Tier 2 Subwatershed	GW IN	Recharge	Supply	Reserve	Consumptive Use	% Water Demand	Stress
God & Bay Gullies	38960	34241	73201	7320	2423	4	Low

These future water use conditions are highly conservative, as it is not expected that future population growth would require a 35% increase in water takings. Therefore, under extreme future use scenarios, no water quantity stress is anticipated for the Goderich and Bayfield Gullies subwatershed.

3.8.8 Drought Scenario

Technical rules require that a drought scenario be undertaken for all Tier 2 subwatersheds. The intention of the analysis is to determine if a prolonged period of drought could result in a drop in water levels that could interfere with the operation of municipal wells. This is done by comparing the drop in water levels in the aquifer, with the available drawdown for each municipal well.

In order to complete this analysis, the Feflow model for the Goderich and Bayfield Gullies was run in transient mode for a period of 2 years with no recharge. This analysis is thought to represent an extreme drought event.

Under these conditions, water levels across the subwatershed were reduced approximately 0.5-1.0 metres. These conditions were compared with available drawdowns in all municipal wells in the Goderich and Bayfield Gullies subwatershed. **Table 3.23** shows the results of this analysis.

Table 3.23 Available Drawdown in Municipal Wells and Observed Reductions in Water Levels in the Bedrock Aquifer Under 2-Year, Extreme Drought Conditions

Well	Pump Level (masl)	Steady-state water level* (masl)	Available Drawdown	Drought scenario water level (masl)	Modeled head reduction
Kelly	158.1	182.1	24 m	181.5	0.6 m
McClinchey	152.4	182.4	30 m	181.8	0.6 m

*under constant pumping conditions

Given the extremely high available drawdowns in the Goderich and Bayfield Gullies subwatershed, interference with operational capacity of municipal wells under drought conditions is unlikely.

3.8.9 Uncertainty

Uncertainty in the water budget process is closely tied to the data sources and models that have been utilized to develop the important data. In the case of the Goderich and Bayfield Gullies subwatershed, significant uncertainty exists due to the widely differing values for recharge which have been developed through separate groundwater and surface water modeling processes. In order to develop an estimate of the potential change in water quantity stress due to changes in water flux, two scenarios were developed.

Firstly, in **Table 3.24** a reduction of the water supply term by 20% was undertaken, in order to account for potential uncertainties in groundwater flux and recharge values.

Table 3.24 Water Quantity Stress Assessment with a 20% Reduction in Water Supply.

Tier 2 Subwatershed	GW IN	Recharge	Supply	Reserve	Cons. Use	% Water Demand
Goderich	17921	19847	30214.4	3021	16924	62
God & Bay Gullies	38960	34241	58560.8	5856	1346	3

Secondly, a 20% increase in demand was evaluated to account for potential uncertainties in consumptive water use and is shown in **Table 3.25**.

Table 3.25 Water Quantity Stress Assessment with a 20% Increase in Consumptive Water Use.

Tier 2 Subwatershed	GW IN	Recharge	Supply	Reserve	Cons. Use	% Water Demand
Goderich	17921	19847	37768	3777	20309	60
God & Bay Gullies	38960	34241	73201	7320	1615	2

Under both scenarios, no changes in water quantity stress are noted. Therefore, uncertainty for the Tier 2 water quantity stress assessments is considered low.

3.9 Tier 3 Water Budget (Local Area Risk Assessment)

The goal of a Tier 3 Water Budget, or Local Area Assessment, is to evaluate the likelihood that a municipality will be able to meet water quantity demands, with consideration of future land development, drought conditions, and other water uses. If the Local Area Risk Level is classified as Moderate or Significant, water quantity threats located within the Local Area must be identified.

Based on the outcome of the Tier 2 water quantity stress assessment, it was determined that a Tier 3 analysis was required for the Goderich subwatershed and the Century Heights municipal water system. This area has been identified as being under significant groundwater quantity stress, and more detailed work is required in order to assess the impacts of large commercial water takings on the long-term viability of the Century Heights system.

3.9.1 Study Area

The Study Area is the Goderich Subwatershed from the Tier 2 Assessment, located on the east coast of Lake Huron. It encompasses the Town of Goderich to the west, and portions of Township of Ashfield-Colborne-Wawanosh to the north and Municipality of Central Huron to the south. See Map 3.20.

The Study Area is host to one municipal water system, the Century Heights system, composed of two bedrock wells: wells 1 and 2. The Century Heights system is owned by the Township of Ashfield-Colborne-Wawanosh and services a population of approximately 200 residents.

3.9.2 Methodology

According to the Director's Technical Rules, detailed groundwater and surface water models are typically developed to quantitatively assess the Risk Level. Developing these models requires detailed groundwater and surface water data. While some data was available for this Tier 3 Assessment, there was not enough high-quality data to support the construction, calibration and application of a robust numerical model. However, the information that was available was considered sufficient to conduct a “scoped” qualitative Risk Assessment. The key information includes the following:

- sufficient separation of the shallow bedrock aquifers supplying water to the Century Heights wells versus the deeper bedrock aquifers supplying water to a large non-municipal permitted water taker;
- there is ample thickness of fine-grained overburden deposits, which mitigates the impacts of reduced recharge due to future development and hydraulically separates the municipal aquifer from cold water streams;
- minimal additional future demands planned for the Century Heights water supply system, and
- excess of available additional drawdown in the municipal wells to accommodate additional demands and impacts due to drought or reduced recharge. (Matrix, 2018)

Approval from the Director of the Source Protection Branch was provided in 2015, under Rule 15.1 of the Technical Rules, to complete the Risk Assessment without the use of a numerical model, using an alternate approach. The assessment was completed by Matrix Solutions Inc., and reviewed by a team of Peer Reviewers.

The Tier 3 report, entitled Century Heights Scoped Tier Three Local Area Risk Assessment Report was submitted by Matrix Solutions Inc. in March 2018. The report details the physical characterization of the study area, summarizes the water supply systems, describes the significance of the available data, and explains the alternative approach taken for the Risk Assessment. The following is a synopsis from the Century Heights Scoped Tier Three Local Area Risk Assessment Report (Matrix, 2018).

3.9.3 Vulnerable Area Delineation – WHPA-Q1, WHPA-Q2, and Local Area

With the absence of a numerical model, and given the small amount of Allocated Demand for the Century Heights wells, a WHPA-Q1 consisting of a 100-metre radius around Century Heights wells 1 and 2 was conservatively proposed.

A WHPA-Q2 cannot be delineated for this study, as the lack of a numerical model prevents the quantification of water level decline. In this Tier 3 Assessment, the Local Area is coincident with the WHPA-Q1 (i.e., 100 m buffer around wells 1and 2. See Map 3.21.

3.9.4 Local Area Risk Assessment

As anticipated, the Tier 3 water quantity risk assessment concluded that the risk level is ‘Low’. The Low risk level is based on the following factors:

- The Study Area was identified as requiring a Tier 3 assessment due to the groundwater takings of one large, industrial permitted water taking. Water level data collected while this facility was shut down provided sufficient evidence to show that this taking does not have a negative impact on the ability of the Century Heights municipal supply wells to provide the required volumes of water.

- The evaluation of the Century Heights water supply system indicated that it is pumping far below its permitted rate and is capable of meeting Existing and projected Allocated demand while qualitatively considering drought conditions, reductions in recharge and impacts to cold water streams. This is because of an excess of 11 m of Safe additional available drawdown (SAAD) in each well, and the presence of a thick confining till aquitard layer that hydraulically separates the municipal aquifer from land use change and cold water streams at surface. (Matrix, 2018)

The study concluded that the Century Heights water wells will be able to supply their Allocated pumping rates considering increased municipal water demand, future land development, drought conditions, and impacts on other water uses. Since a Significant or Moderate risk level was not assigned to the Local Area, no water quantity threats were identified. As such, there is no requirement for water quantity policies to be considered for the Source Protection Plan.

3.10 Significant Groundwater Recharge Areas

Under the *Clean Water Act, 2006*, *Technical Rules* for development of an Assessment Report have been established. These rules outline the delineation of four types of vulnerable areas within which policies will be developed and implemented to protect water, namely: wellhead protection areas, intake protection zones, highly vulnerable aquifers and significant groundwater recharge areas.

Significant recharge areas are to be developed using existing models and data from Tier 1 Water Budgets, and the *Technical Rules* allow for the use of professional judgment in the form of a technical Peer Review Committee. Specifically, the rules state:

> 44. Subject to rule 45, an area is a significant groundwater recharge area if,
>
> > (1) the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or
> >
> > (2) the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.
>
> 45. Despite rule 44, an area shall not be delineated as a significant

groundwater recharge area unless the area has a hydrological connection to a surface water body or aquifer that is a source of drinking water for a drinking water system.

46. The areas described in rule 44 shall be delineated using the models

developed for the purposes of Part III of these rules and with consideration of the topography, surficial geology, and how land cover affects groundwater and surface water.

(Technical Rules: Assessment Report, December, 2008) Clean Water Act, 2006

Further guidance was provided by the Ontario Ministry of the Environment on the development of significant groundwater recharge areas (SGRA) in the form of a Technical Bulletin (dated April, 2009). This bulletin highlighted what aspects of the methodology require professional judgment. Specifically, key decisions which require professional judgment are:

- Which methodology is to be used in order to determine SGRA (i.e. rule 44 (1) or (2))
- The scale at which these methodologies will be applied
- Incorporation of local geological and hydrological knowledge into the SGRA delineation process (see **Map 3.18**)

3.10.1 Karst and Sinkhole Drainage Areas

The Maitland Valley Source Protection Area is host to a unique category of geological features related to karst topography and, more specifically sinkhole development. Large sinkholes, located in several areas in the Region have had natural and agricultural drainage directed into them under the *Drainage Act* (although this practice is now discouraged). These features allow for direct recharge of the bedrock aquifers (WHI, 2002, 2004).

Under the guidance of the *Clean Water Act*, *2006* the areas which drain into these sinkholes are considered herein to be significant groundwater recharge areas under rule 44(2). In these areas, approximately 100% of the water remaining after subtracting the annual evapotranspiration from the annual precipitation recharges the underlying aquifer. In accordance with Rule 45, these areas are known to have influence on local private water wells, though the extent of that influence has not been adequately determined (WHI, 2004). Drainage areas which are connected to sinkholes that have direct connections to the underlying bedrock aquifers are shown on **Map 3.6**.

3.10.2 Hydrologic Response Units

In order to determine SGRAs at a finer scale than the Tier 1 subwatersheds, it was decided by the Peer Review Committee for this process, that another approach be implemented. This approach was designed to account for the geology, soils, land cover and topography of the region. In order to do this, a series of unique Hydrologic Response Units (HRUs) were created using available geology, landcover and topographical mapping. HRUs were developed following a similar methodology to that of the abutting Saugeen Grey Sauble Northern Bruce Peninsula and Lake Erie source protection regions. Once HRUs have been developed for the entire region, specific recharge values can be approximated.

Hydrologic Response Units were created by reclassifying and intersecting a number of data sets. The details of this are described below.

3.10.2.1 Surficial Geology

Surficial geological units were reclassified according to the texture of the materials of which they are composed. It should be noted that the surficial geological classifications also account, to a large extent, for the soil texture distribution and topography of the region, and are therefore considered redundant with respect to determining SGRAs. The reclassification of the surficial geological units is listed below in **Table 3.26**.

Table 3.26 Surficial Geology Reclassification for HRU Derivation

Geologic Grouping	Quaternary Geology Description
Impervious	Open Water, Alluvium
Clay Tills	St. Joseph Till, Glaciolacustrine Deep Water Deposits, Lacustrine Clay and Silt, Man-Made Deposits, Tavistock Till Fluvial Deposits, Modern Fluvial Deposits, Flood Plain Deposits
Silt Tills	Bruce Till, Dunkeld Till, Elma Till, Rannoch Till, Newmarket Till, Tavistock Till
Sand Tills	Catfish Creek, Wentworth Till
Sand and Gravels	Eolian Deposits, Fan or Cone Deposits, Aeolian Deposits, Glacial-outwash Sand, Glaciofluvial Ice-Contact Deposits, Glaciofluvial Outwash Deposits, Glaciolacustrine Deposits Beach Bar, Glaciolacustrine Deposits Shallow Water, Glaciolacustrine Shoreline Deposits, Modern Beach Deposits, Ice-contact deposits
Bedrock	Exposed Bedrock or Bedrock with Thin Drift.

3.10.2.2 Land Cover

Land cover datasets were created by overlaying the following existing datasets: forested areas (Ministry of Natural Resources (MNR) Forest Resource Inventory); wetland areas (MNR wetlands); and urban areas identified on the municipal parcel fabric. Land areas that did not fall into one of the three categories (forest, wetland or urban) are assigned as agricultural. Initial attempts at creating this synthetic landcover layer were reviewed and stream beds were poorly represented (i.e., they were reclassified as agricultural) as they have no unique land cover category. However, these stream beds are typically represented by the geological unit alluvium and, as such, it was deemed appropriate to reclassify these types of deposits as impervious within the new geological classifications for the purpose of SGRA delineation (see **Table 3.27**) rather than attempt to extract them manually from the Land Cover data set.

Table 3.27 Land Cover Reclassification for HRU Development

Land Cover Reclassification
Wetland
Forested
Urban
Agricultural
Hummocky

3.10.2.3 Hummocky Topography

Hummocky topography is those areas typified by highly variable, gentle slopes which have high depressional storage and closed depressions with no outlets. They are commonly associated with moraines in the Region. These areas typically have enhanced recharge rates due to the lack of outlet and increased depressional storage. Areas of hummocky topography were identified in the *Grey Bruce Groundwater Study* (WHI, 2003). These areas were then overlain on the land cover data set to create unique HRUs. All areas of identified hummocky topography were given the hummocky land cover designation. Final land cover categories are listed below in **Table 3.28**.

3.10.2.4 Hydrologic Response Unit Creation

Hydrologic Response Units (HRUs) were then created by combining all four reclassified datasets: Quaternary geology, land cover, karst and hummocky topography into 16 HRUs, as shown in **Table 3.28**, below.

It should be noted that clay till and silt till were grouped together into the ‘Low Permeability’ category, while sand till and sand and gravel grouped into the ‘High Permeability’ category for forested and hummocky land cover groups. This was done to be consistent with HRU development methodologies in abutting regions.

Table 3.28 HRU Classifications

HRU	Description
1	Impervious
2	Wetland
3	Clay / Clay Till Agricultural
4	Silt Till Agricultural
5	Sand Till Agricultural
6	Sand & Gravel Agricultural

HRU	Description
7	Low Permeability Forest
8	High Permeability Forest
9	Low Permeability Hummocky
10	High Permeability Hummocky Vegetation
11	Clay / Clay Till Urban
12	Silt Till Urban
13	Sand Till Urban
14	Sand & Gravel Urban
15	Bedrock
16	Karst

3.10.2.5 Assigning Recharge Values to HRUs

Recharge values for individual HRUs are typically derived from a surface water model calibration exercise using the GAWSER modeling package (see for example, AquaResource, 2008). Initial recharge values were assigned to each individual category of HRU based on accepted values derived from previous water budgeting exercises in surrounding SPAs.

3.10.2.6 Adjustment of Recharge Values

In order to develop unique recharge values for each HRU in the region, an adjustment exercise was undertaken. Existing SWAT models, created as part of the Tier 1 Water Budget for the Maitland Valley Source Protection Area, provided calibrated recharge estimates at a subwatershed scale (approximately 460 subwatersheds). For each of these subwatersheds, an estimate of recharge was developed by summing the initial assigned recharge values for all of the HRUs in that specific subwatershed. This value was then compared to the SWAT-developed recharge estimate and a scalar determined to adjust this value. This scalar was then applied to all the HRU recharge values in that subwatershed, such that each category of HRU had a unique recharge value within each subwatershed.

It should be noted that the relative value of recharge rates between different HRUs was maintained, but actual estimated recharge values were adjusted on a subwatershed scale.

3.10.3 Determination of Groundwater Recharge Areas

In order to determine which HRUs would be considered Significant Groundwater Recharge Areas the Peer Review Committee recommended the approach outlined in Rule 44 (1); whereby any HRU with an annual recharge rate more than 1.15 times the average for the surrounding area would be considered an SGRA. In order to develop an average for the surrounding area, it was decided that the Region would be split into the Maitland Valley Source Protection Area (jurisdiction of the Maitland Valley Source Conservation Authority/Source Protection Authority) and the Ausable Bayfield Source Protection Area (jurisdiction of the Ausable Bayfield Conservation Authority/Source Protection Authority).

Accordingly, mean annual adjusted recharge values for all HRUs in the Maitland Source Protection Area was developed, and all HRUs with values more than 1.15 times this mean were identified as potential SGRAs.

3.10.4 Determination of Significance

In order to determine significance, under rule 45, the identified SGRA must have a drinking water system located within it. In order to assess this, the HRUs identified as having annual adjusted recharge rates greater than 1.15 times the SPA mean were assembled into new, larger polygons. Due to the prevalence of wells throughout the area, an assumption was made that all recharge areas reasonably have the potential to be hydraulically connected to a drinking water system, consistent with Rule 45. Significant groundwater recharge areas are shown in **Map 3.19**.

3.10.5 Tier 2 and Tier 3 Significant Groundwater Recharge Areas (SGRAs)

Recharge values derived from GAWSER analysis for the Goderich and Bayfield and Goderich Tier 2 subwatersheds were incorporated into the delineation of significant recharge areas. GAWSER derived recharge values are dispersed to HRUs, and values for specific HRUs were included in the overall delineation of SGRAs in the area.

Recharge values for specific HRUs were averaged across each Source Protection Area, and those HRUs with recharge values greater than 115% of the average were identified as being groundwater recharge areas. All HRUs considered significant recharge areas in the Tier I water budget remain above the threshold of 115% of the average for the SPA, and all HRUs not considered significant recharge areas in the Tier I Water Budget remain below the threshold of 115% of the average for the SPA. For the Maitland Valley SPA the threshold was established at 209 mm/year based on mean recharge rates of 182 mm/year.

Due to the likely presence of undocumented wells in most areas and the high uncertainty of local geological conditions, the Ausable Bayfield Maitland Valley Source Protection Committee has resolved that a conservative approach be included in the delineation of SGRAs. Accordingly, hydraulic connection was inferred for all the identified HRUs with greater than 115% average recharge, and as such all were similarly considered to be significant groundwater recharge areas. Similarly, the ABMV SPC requested that all areas with greater than 115% average recharge be included, unless significant geological evidence suggested that they were not recharge areas. **Map 3.19** shows the significant groundwater recharge areas, based on HRUs where annual recharge exceeds 115% of the average (mean) for the Tier 2 subwatersheds.

Although different models were used in the determination of recharge for Tier 2 subwatersheds, SGRA delineation for the Tier 2 subwatersheds were unchanged from the Tier 1 delineations.

Tier 3: As additional data was not available to update the SGRA mapping for the Tier 3 Study Area, SGRAs remain the same as those completed in the Tier 2 Assessment.(Matrix, 2018)

3.10.6 Data Limitations and Uncertainty

The data used for the development of the SGRAs is based on existing climate data, Tier 1 surface water modeling outputs and existing geological and landcover data. These data sets were not developed for the explicit purposes of delineating SGRAs, and have certain limitations which can be attributed to them, specifically:

1. Climate data has been filled and corrected to try and account for missing data for discrete time intervals and locations where no monitoring stations exist
2. Surface water modeling has been completed for the entire Source Protection Area, yet has not been calibrated in certain regions due to a lack of monitoring data. In such cases models were calibrated to similar subwatersheds
3. Landcover data is valid only at the time it was collected, and has not been altered or corrected for changes in land use since the time of collection
4. The SGRAs have not been evaluated with respect to their hydrologic connection to specific aquifers themselves. Rather they have been calculated to the nearest surficial aquifer. Recharge areas for confined regional aquifers may lie outside areas. Future use of this delineation, specifically at local scales, should consider the aquifer of interest before employing this methodology

Uncertainty for SGRAs is a measure of the reliability of the delineations with respect to providing protection to the overall groundwater system, rather than specific aquifers. In this light, the methodology for calculating SGRAs is highly reliant on the surficial geology of the area and can be considered reliable for the overall groundwater system. The uncertainties for the SGRAs are therefore considered low for the Source Protection Area.

3.11 Peer Review

The water budget process was completed in consultation and with the approval of a Peer Review Committee. This committee was formed at commencement of the water budgeting exercise and met regularly throughout the process. The following were part of the Peer Review Committee for Tier 1 and Tier 2 water budgets:

Dr. Trevor Dickinson, Hydrologist and Professor Emeritus, University of Guelph

Stan DenHoed, P.Eng, Hydrogeologist, Harden Environmental

Sam Bellamy, P.Eng, Hydrologist, Matrix Solutions Inc.

Lynne Milford, Water Budget Analyst, Ontario Ministry of Natural Resources

Peer Review for Tier 3 Water Budget

The Century Heights Scoped Tier Three Local Area Risk Assessment Report (Matric 2018) was circulated to the following in 2017 for review and comment:

Kathryn Baker, Ontario Ministry of Environment and Climate Change

Steve Burns, B.M. Ross and Associates

Steve Jackson, Maitland Valley Conservation Authority

Lynne Milford, Ontario Ministry of Natural Resources,

Alec Scott and Donna Clarkson, Ausable Bayfield Conservation Authority

Florence Stalenhoef, Township of Ashfield-Colborne-Wawanosh

Chip Wilson,Town of Goderich,

References

Author & Publisher	Title	Date	Purpose
AquaResources	Saugeen, Grey Sauble and Northern Bruce Peninsula Tier 1 Surface Water Budget and Stress Report	2008	Tier 1 water budget for neighbouring region.
Ausable Bayfield Maitland Source Protection Committee	Watershed Description for the Ausable, Bayfield Maitland Source Protection Region	2006	General information on the Source Protection Areas
Ausable Bayfield Maitland Source Protection Committee	Conceptual Water Budget – Ausable, Bayfield Maitland Source Protection Region	2007	General information on the Source Protection Areas
Acres Consulting Services Limited, G. Lyon's Litho Limited, Fort Erie	Water Quantity Resources of Ontario	1984	Used to evaluate the validity of Evapotranspiration values
de Loë, R.	Agricultural and Rural Water Use in Ontario	2001	Provided methodology for estimating water usage a based on the number of livestock for a given area
Dickinson T. and J. Diiwu	*Water balance calculations in Ontario* (unpublished). Guelph ON: School of Engineering, University of Guelph	2000	Used to evaluate the validity of Evapotranspiration values
Environment Canada -Atmospheric Environment Service, Downsview, ON:	Canadian Climate Normals – Volume 3 – Precipitation 1951–1980	1982	Provided Climate normals for the SPA water budgeting

Author & Publisher	Title	Date	Purpose
Environment Canada Atmospheric Environment Service			exercise.
Luinstra Earth Sciences.	Permit To Take Water Update	2006	Provided updated PTTW usage information (survey) for water budgeting purposes
Luinstra Earth Sciences.	Tier 1 Water Budget for the Ausable Bayfield Maitland Source Protection region	2008	Tier 1 water budget for region
Matrix Solutions Inc.	Century Heights Scoped Tier Three Local Area Risk Assessment Report	2018	Tier 3 Water Budget report
McKague, K., and Mao, C.	Development of a Long-Term Numerical Water Budget Model for the Ausable Bayfield Maitland Valley Planning Region	2007	Contains results of hydrological modeling work completed for the SPA water budgeting exercise.
Ontario Ministry of Agriculture and Food, Toronto	Agricultural Resource Inventory	1983	Provided land cover estimates for the SPA water budgeting exercise.
Ontario Ministry of the Environment	Technical Rules	2008	Guidance document
Ontario Ministry of the Environment	Technical Memo – April 2009 – Significant Recharge Areas	2009	Guidance document
Schroeter, H. O., D. K. Boyd and H. R. Whiteley	Filling gaps in meteorological data sets used for long-term watershed modelling. In Proceedings of the Ontario Water Conference 2000, Richmond Hill, ON	2000	Provided methodology for filling data gaps in climatological data
Singer, S.N., Cheng, C.K., Scafe, M.G. (Ontario Ministry of the Environment and	The Hydrogeology of Southern Ontario	1997	Provides information on the hydrogeology of the SPR.

Author & Publisher	Title	Date	Purpose
Energy)			
Waterloo Hydrogeologic Incorporated (WHI)	Six Conservation Authorities FEFLOW Groundwater Modeling Project Final Report	2006	Contains results of hydrogeological modeling work completed for the SPA water budgeting exercise.
Waterloo Hydrogeologic Incorporated (WHI)	Grey Bruce County Groundwater Study	2003	Contains groundwater information for the county.
Waterloo Hydrogeologic Incorporated (WHI)	Phase I Sinkhole Study – Ausable Bayfield Conservation Authority	2002	Provided drainage areas and outlined connection between surface drainage and sinkholes in the ABCA area
Waterloo Hydrogeologic Incorporated (WHI)	Phase II Sinkhole Study – Ausable Bayfield and Maitland Conservation Authorities	2004	Provided drainage areas and outlined connection between surface drainage and sinkholes in the ABCA and MVCA areas

MAITLAND VALLEY: CHAPTER 4

VULNERABILITY, THREATS AND RISKS

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4.1 Regulatory Context

The Assessment Report gives specific attention to those municipal residential drinking water sources identified in the Terms of Reference. The purpose of this section is to identify where the sources of drinking water are susceptible to contamination given the natural environment and human activity around the source of water. This is determined by using scientific models which evaluate the vulnerability of the area around a drinking water source (what exists in nature). Then within these areas, what activities or conditions exist that use chemicals or contain pathogens that could, in a certain circumstance, contaminate drinking water (what humans do or have done). By identifying areas where the potential for such contamination is greatest, protection measures can be directed to the most vulnerable areas through the Source Protection Plan.

Vulnerable Areas

The *Clean Water Act, 2006*, identifies four types of vulnerable areas which are defined by regulation in the following way:

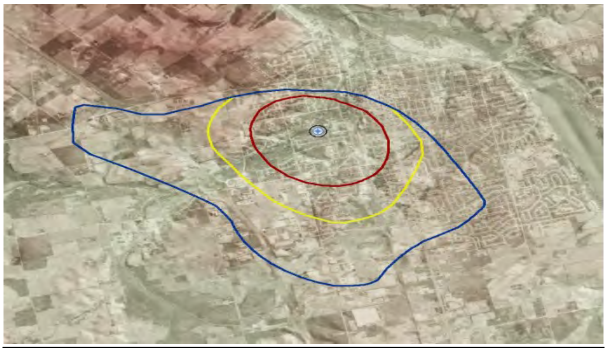
"*highly vulnerable aquifer*" means an aquifer on which external sources have or are likely to have a significant adverse effect, and includes the land above the aquifer;

"*significant groundwater recharge area*" means an area within which it is desirable to regulate or monitor drinking water threats that may affect the recharge of an aquifer,

"surface water intake protection zone" means an area that is related to a surface water intake and within which it is desirable to regulate or monitor drinking water threats,

"wellhead protection area" means an area that is related to a wellhead and within which it is desirable to regulate or monitor drinking water threats.

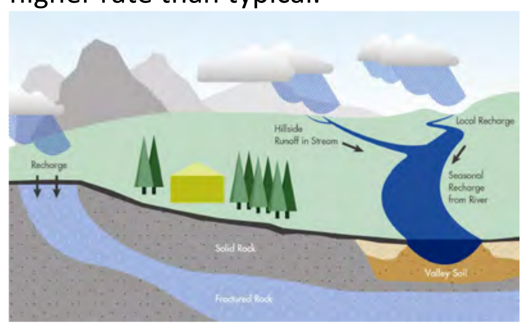
The *Technical Rules* (MOE, 2009) indicate how to delineate each type of vulnerable area and how to assess the degree of vulnerability within each. These methodologies will be expanded upon below. The degree of vulnerability is represented by a score where a score of 8 – 10 is considered high vulnerability, 6 – 8 is moderate vulnerability and 4 – 6 is low vulnerability.



A **wellhead protection area (WHPA)** is the area of land around a well that has an outer boundary from which it takes up to 25 years for water to travel to the wellhead.

A **highly vulnerable aquifer (HVA)** is an area of soil or rock where underground cracks or spaces allow water (and possibly contaminants) through more quickly from the surface to the aquifer.

A **significant groundwater recharge area** is land where rain or snow seeps underground into an aquifer at a higher rate than typical.



An **intake protection zone (IPZ)** is the area of water and land around a surface water intake defined by the distance water can travel from upstream or shore to the intake.

Groundwater Vulnerability Score is shown as a score where 2 is low vulnerability and 10 is high vulnerability. This score combines two ideas: The closer the wellhead, the higher the vulnerability score and the more vulnerable the aquifer, the higher the vulnerability score. Thus the score accounts for both horizontal and vertical movement of water into the aquifer that the well draws from.

4.2 Methods for Delineating Vulnerable Areas

Data was gathered for each of the four types of vulnerable areas in keeping with the *Technical Rules*. The methodology, limitations and uncertainty associated with this methodology are outlined below.

Highly Vulnerable Aquifers (HVAs):

Highly Vulnerable Aquifers (HVAs) are aquifers that are more susceptible to contamination. The Intrinsic Susceptibility Index (ISI), a measure of overburden porosity, was used to delineate HVAs in all areas. While the rules allow for several different approaches, the ISI method was chosen because data was readily available for the entire SPR. ISI for the region was available through county groundwater studies (Grey Bruce Groundwater Study, 2003; Perth County Groundwater Study, 2003; Huron County Groundwater Study, 2003). The areas above aquifers that were designated as having ‘high’ intrinsic susceptibility (ISI) are considered Highly Vulnerable Aquifers for the purposes of source protection planning.

ISI is a regional aquifer assessment tool designed to identify areas where those aquifer systems are sensitive to contamination via surface activities. Data used in the calculation for the index is derived from water well records housed in the Ministry of Environment's Water Well Information System (WWIS). Wells used in the calculation were screened based on location reliability codes in the WWIS, and only those deemed sufficiently accurate were included in the final ISI calculation. Details on the screening of data can be found in the corresponding reports (Grey Bruce Groundwater Study, 2003; Perth County Groundwater Study, 2003; Huron County Groundwater Study, 2003). The screening process leads to the exclusion of some data sources which may have an impact on the certainty associated with the ISI.

ISI is calculated for individual municipal wells and employs statistical methods for estimating values between wells. This process does not take into account discrete boundaries of local geological features which may be the source of the different index values. Exclusion of data points has a higher impact on the local scale calculations of ISI, as the exclusion of a single data point could have profound implications on the ISI locally, whereas at a regional scale the impact of a single data point has less significant ramifications.

Uncertainty associated with ISI is highly dependent on the scale at which they are viewed. From a regional scale perspective, ISI can be considered a good indicator of areas where aquifers are highly vulnerable, and as such, can be considered to have low uncertainty at that scale. However, when applied at a local scale, ISI cannot be considered accurate due to the statistical analysis involved in plotting them, and the exclusion of data points from the overall calculation. As such, it should be considered to have high uncertainty at the local, lot specific scale.

Some areas within the SPA which have surficial sands are not mapped as being Highly Vulnerable with the ISI process. The primary reason for this is the lack of wells or well records for these shallow aquifers from which the ISI was developed. Incorporation of surficial geology data into the delineation of highly vulnerable aquifers represents an opportunity for improvement for future source protection planning.

According to the *Technical Rules*, all HVAs have vulnerability scores of 6.

Significant Groundwater Recharge Areas (SGRAs):

A significant groundwater recharge area is land where rain or snow seeps underground into an aquifer at a higher rate than typical, and where water quantity may be vulnerable to certain activities.

Significant groundwater recharge areas (SGRAs) were calculated using a Hydrologic Response Unit (HRU) Approach for the Source Protection Area. HRUs were developed on a 15 m by 15 m grid for the entire SPA based on surficial geology and landcover, and were corrected at a subwatershed scale using Tier 1 water budget models. Individual recharge values for each type of HRU were developed on a subwatershed basis, and mean annual recharge values for the SPA were calculated.

Those HRUs with recharge values that exceed 115% of the mean recharge value for the SPA were identified as being High Volume Groundwater Recharge Areas in accordance with Rule 44 (2) of the Technical Rules. In order to be considered, the high volume recharge area must have a hydraulic connection with a drinking water system (i.e. a well). Due to uncertainties related to the location and distribution of well records, the SPC requested that all high volume recharge areas be included as significant recharge areas. This was considered appropriate given the lack of information on shallow wells and surficial aquifers in the region. Sinkholes, and areas that drain into sinkholes, were included as SGRAs based on Rule 44 (1), as all water which is not lost to evapotranspiration is recharged, either by infiltration or via runoff into surface water bodies which are outlet directly into sinkholes. SGRAs were further refined within those areas included in the Tier 2 water budget.

The data used for the development of the SGRAs is based on existing climate data, Tier 1 surface water modeling outputs and existing geological and landcover data. These data sets were not developed for the explicit purposes of delineating SGRAs, and have certain limitations which can be attributed to them, specifically:

1. Climate data has been filled and corrected to try and account for missing data for discrete time intervals and locations where no monitoring stations exist;
2. Surface water modeling has been completed for the entire Source Protection Area, yet has not been calibrated in certain regions due to a lack of monitoring data. In such cases models were calibrated to similar subwatersheds;
3. Landcover data is valid only at the time it was collected, and has not been altered or corrected for changes in land use since the time of collection;
4. The SGRAs have not been evaluated with respect to their hydrologic connection to specific aquifers themselves. Rather they have been calculated to the nearest surficial aquifer. Recharge areas for confined regional aquifers may lie outside areas. Future use of this delineation, specifically at local scales, should consider the aquifer of interest before employing this methodology.

Uncertainty for SGRAs is a measure of the reliability of the delineations with respect to providing protection to the overall groundwater system, rather than specific aquifers. In this light, the methodology for calculating SGRAs is highly reliant on the surficial geology of the area and can be considered reliable for the overall groundwater system. The uncertainty for the SGRAs is therefore considered low for the Source Protection Area.

According to the 2017 *Technical Rules,* SGRAs are no longer assigned a vulnerability score and therefore no significant, moderate or low drinking water threats related to water quality are assigned to them. Previously, SGRAs with a score of 6 had identified low and moderate threats. Once HVAs were delineated, it was observed that HVAs consistently aligned with SGRAs with a score of 6, making the scoring of SGRAs redundant.

Intake Protection Zones (IPZs):

The Maitland Valley Source Protection Area has one intake which is at Goderich. It is classified as a Type A intake, an intake located in a Great Lake. This intake is in Lake Huron approximately 500 metres off shore near the breakwater and at seven (7) metres depth.

Consultants with coastal modeling expertise were selected to undertake the delineation of IPZs (Baird and Associates). Their work was peer-reviewed by recognized and qualified experts who concurred with the outcomes and recommended potential improvements (HCCL), which are reflected in this document.

The in-water portion of an IPZ-1 is prescribed as a 1 km radius around the lake intake except where it intersects land. Where the IPZ reaches land, its inland extent is limited to the greater of 120 metres or the regulatory limit. The IPZ-2 is delineated as the two-hour time of travel to the intake under a series of wind and wave conditions considered typical for a 10-year period. The IPZ-2 was delineated using three-dimensional hydro-dynamic models (Delft 3D). This methodology was well-suited, given the intake's distance from shore, availability of data, complicated shoreline boundary conditions, and wave, sediment and water quality capabilities.

As wind is a significant influence on current directions, Baird undertook extensive reviews of wind data from the Goderich Municipal Airport, the Southern Lake Huron meteorological buoy (MEDS Station 45149), and the Princeton Ocean Model (POM). "The airport data were selected for use in the extreme value analysis due to the longer period of record (1986 to 2007). The buoy data were also not appropriate for use in the extreme value analysis as data were not collected during the winter season, which coincides with the highest wind events. The airport data were corrected to represent wind speed over water. The data were then compared with the POM data to identify possible data limitations or inconsistencies and required corrections were made." (Baird, 2010)

In addition, reverse particle tracking was undertaken to refine the IPZ-2. "The limits of the 2-hour travel distance extend approximately 1.2 km north, 3.6 km south, close to 1.0 km offshore of the intake, and within 100 m from shore at some locations. The in-lake IPZ-2 extends further to the south than to the north, as a result of the large circulation patterns in the lake (which mean that the current direction is not always the same as the wind direction) and localized eddy patterns in the vicinity of the intake. The eddy patterns are a localized effect, created by the harbour and breakwaters. As a result, the currents are predominantly to the north at the intake (this was described in some detail in the Phase 1 report)" (Baird, 2010).

The vulnerability scores for the intake are based on the attributes of the intake (length and depth), type of water body, the physical characteristics of the environment it is situated in, and the influences affecting intake water. It is essentially qualitative, based upon scores assigned to the contributing factors through the professional judgment of coastal modeling consultants. The vulnerability score is derived by multiplying the Area Vulnerability Factor by the Source Vulnerability Factor (as defined in the *Technical Rules*). The Area Vulnerability Factor for IPZ-1 is 10 as prescribed by the *Technical Rules*.

The area vulnerability factor for IPZ-2 must be assigned a whole number ranging from 7 to 9 based upon consideration of the following sub factors:

a. Percentage of area that is land within the IPZ-2;

b. Land cover, soil type and permeability; and

c. Transport pathways within the IPZ-2 upland environment.

Derivation of Area Vulnerability Factor for Goderich IPZ-2, Baird 2010:

Rule	**Criterion**	**Score**	**Rating**			**Sub-factor Score**	**Resulting Score**
			Low (7)	Moderate (8)	High (9)		
% Land 92(1)	Land-Water Ratio %	64%	<33	33-66	>66	8	8
Land Characteri-stics 92(2)	SCS CN – Count Twice!	>80	<55	55-80	>80	9	(9+9+8+8)/4 =8.5
	% Imperviousness (Permeability)	34	0-20	20-50	>50	8	
	Slope %	2.6	<2	2-5	>5	8	
Hydrological & Hydrogeolo-gical 92(3)	Outfalls in Proximit y	1 outfall located within 1 hr of intake	No outfalls within IPZ-2	Outfall within 1-3 hours of intake	Outfall within 1 hour of intake	9	(9+8)/2=8.5
	Drainage Density (km/km^2)	1.1	<1	1-3	>3	8	
Area Vulnerability Factor							(8+8.5+8.5)/3 =8.3 **Rounded to 8**

(Table 5.2 from Baird Phase 2 Addendum, May 2010)

Areas without watercourses and other transport pathways were extended inland from the Lake Huron shore 120 m.

An evaluation of each of these factors was completed for the Goderich intake and the Area Vulnerability Factor for IPZ-2 was determined to be 8.

According to the *Technical Rules*, the Source Vulnerability Factor must be assigned a value of 0.5 to 0.7 based on the following factors:

a. The depth of the intake,
b. The distance of the intake from land, and
c. The number of recorded drinking water issues related to the intake.

These factors were quantified for the Goderich intake and the Source Vulnerability Factor was determined to be 0.6, to reflect the proximity of the intake to sources of contamination (see the Surface Water Vulnerability Analysis for Goderich Intake, Baird 2010). Therefore, the final vulnerability score for the IPZ-1 is 6 and the score for IPZ-2 is 4.8.

Intake Vulnerability Criteria based on Intake Distance from Shore and Depth:

Category	**Nearshore-Shallow Water**	**Nearshore-Deep Water**	**Offshore-Shallow Water**	**Offshore-Deep Water**
Parameters	<300 m offshore <6 m depth	<300 m offshore ≥6 m depth	≥300 m offshore <6 m depth	≥300 m offshore ≥6 m depth
Vulnerability (MDEQ)	High	High to Moderate	High to Moderate	Moderate
Recommended Factor (C) for Type A Intakes	0.7	0.6	0.6	0.5

Table 5.3 from Baird Phase 2 Addendum, May 2010

Summary of Vulnerability Scores for Goderich:

Intake Type	**Area Vulnerability Factor (B)**		**Source Vulnerability Factor (C)**	**Vulnerability Score (V)**	
	IPZ-1	**IPZ-2**		**IPZ-1**	**IPZ-2**
A	10	8	0.6	6	4.8

(Table 5.4 from Baird Phase 2 Addendum, May 2010)

Like any methodology, this approach to vulnerability has limitations. Uncertainty is the confidence in the accuracy of IPZ delineations and vulnerability scores based on factors such as: data quality, quantity and distribution; ability of models and formulas to accurately delineate the zones; and accuracy and relevance of the vulnerability scores for the zones to represent the situation.

The table below provides a summary of uncertainty. The result is that the overall uncertainty is high for both the IPZ delineation and the vulnerability rating.

Summary of Uncertainty Ratings for IPZ Delineation and Vulnerability Scores for Goderich WTP:

IPZ	Uncertainty for IPZ Delineation		Uncertainty for Vulnerability Scores	
	Evaluation Factor	**Rating**	**Evaluation Factor**	**Rating**
IPZ-1	Data	High	Data	High
	QA/QC	Low	QA/QC	Low
			Accuracy of Vuln. Factors	High
	Overall	High	Overall	High
IPZ-2	Data	High	Data	High
	Modeling	High		
	QA/QC	Low	QA/QC	Low
	Calibration/ Validation	High	Accuracy of Vuln. Factors	High
	Overall	High	Overall	High

(Table 6.1 from from Baird Phase 2 Addendum, May 2010)

Under the Technical Rules, an IPZ-3 can be created to include threats which have the potential to interrupt the safe operation of a water supply. An IPZ-3 can be developed for a Great Lakes intake where the Source Protection Committee has identified land use activities that are of sufficient concern to warrant further investigation. These land use activities are then evaluated to determine if, under extreme conditions, they can cause an interruption of water supply. In order to be included, it must be shown that there is a hydrodynamic connection between the land use activity and the intake, and that a sufficient quantity of an identified contaminant could be released resulting in an interruption in the water supply.

In the Maitland Valley SPA, a screening procedure was implemented to identify potential land use activities that require a detailed analysis. This screening procedure began first by identifying all properties located within 120m of Lake Huron or any stream identified in the provincial stream network layer. These properties were further screened to eliminate land uses that are unlikely to have any sources of contaminants, such as natural environment and conservation lands. Finally, the properties were screened in order to identify only those properties which have a structure located within the 120m buffer surrounding the watercourses or Lake Huron. Under extreme events, any property located within the 120 m buffer of a watercourse has the potential to have a hydrodynamic connection with the intake located in Lake Huron (everything is upstream of Lake Huron).

Properties with a structure located within the 120m buffer were evaluated using aerial photography to identify any major storage tanks which could be of concern. Those included based on the aerial photography were then evaluated based on the volume, concentration, fate and toxicity of any contaminants stored on site. Land use activities were also evaluated based on the likely pathway of any spill to the watercourse. Land use activities that include partially of fully below grade storage were eliminated from the process as they are unlikely to result in rapid spill into surface water systems.

Remaining threats were then assessed for inclusion into an IPZ-3 by developing a realistic spill scenario and using a simple dilution calculation. This scenario considers the potential size and duration of any spill, the concentration of any contaminants, the location and hydrologic situation of the storage facility and the fate of the contaminant. In cases where multiple contaminants have been identified, the contaminant with the most conservative fate was considered for the dilution scenario. Land use activities which were included for the IPZ-3 assessment were then evaluated to determine if a sufficient hydrodynamic connection exists. Once that hydrodynamic connection has been demonstrated through modeling or analysis, a spill scenario was undertaken to determine if a spill has the potential to sufficiently impact the source of municipal drinking water such that it would cause an interruption in water supply.

If the spill scenario calculations determine that a spill could cause deterioration to the quality of the drinking water, and result in an interruption in supply, an IPZ-3 could be extended to include the evaluated land-use activities. It should be noted that no IPZ-3 has been delineated in the Maitland Valley Source Protection Area.

Wellhead Protection Areas (WHPAs):

The wellhead protection areas were modeled using three-dimensional groundwater flow models by identifying certain areas which correspond to Times of Travel to the well. For each well head the following times of travel have been modeled:

- 100m WHPA – A
- Two-year time of travel WHPA – B
- Five-year time of travel WHPA - C
- 25 year time of travel WHPA – D
- If there is a GUDI well, two-hour time of travel WHPA – E

  WHPA-A is not a time-of-travel model, rather it is a prescribed 100m buffer surrounding all municipal wells.

The groundwater modeling and time-of-travel calculations were all completed in keeping with the *Technical Rules*. The three-dimensional groundwater modeling code MODFLOW-SURFACT, developed by Waterloo Hydrogeologic Inc. (Now Schlumberger Water Services), was used for delineating the wellhead protection areas in the ABMV Source Protection Region. MODFLOW-SURFACT is a commercially available software package that simulates the groundwater flow using a finite difference formulation, incorporating the USGS-developed MODFLOW code. MODFLOW SURFACT is an advance groundwater modeling package that couples unsaturated and saturated subsurface conditions, which allows it to take into account preferential pathways. For each municipal well, the known individual wells are included in the model. The updated models were constructed using the hydrogeologic units from ground surface down to the lowest extents of the aquifers from which the municipal wells were taking their groundwater. Surface water boundaries interacting with the groundwater system were included in the groundwater models. The groundwater models were calibrated to provide good representation of the aquifer systems supplying the groundwater to the municipal wells. Once calibrated, the models were used to run multiple reverse-particle tracking scenarios in order to develop the times of travel for the wellhead protection area.

Recognized and qualified consultants (WESA) undertook a peer review of this methodology and concurred with the outcomes and recommended potential improvements. These will be addressed in an updated Assessment Report. Similar methods by each consultant provided seamless delineation between source protection regions.

This method was chosen because it utilizes the analytical complexity required by the rules while building on existing data. Uncertainty analyses are a conservative approach which is used to account for the intrinsic variations that exist in natural hydrogeologic environments.

The limitations of the modeling tasks are driven by the uncertainty of the data itself, primarily the recharge, hydraulic conductivity and variations in the temporal water level data. In developing the groundwater models for the ABMV Source Protection Region uncertainty was incorporated into the Wellhead Protection Areas. The WHPAs presented within the report include an uncertainty analysis and represent conservative but reasonable zones based on the information available. Sensitivity analysis was conducted, in which those model parameters, for which the WHPA delineations were sensitive to, were varied in a range, above and below the calibrated value, but remained within reasonable limits of that parameter. The most sensitive parameters were found to be recharge and hydraulic conductivity as is usually found with most groundwater modeling simulations. For hydraulic conductivity parameters the uncertainty range was typically assumed to be between a half or a full order of magnitude above and below the calibrated value. For recharge parameters the uncertainty range was assumed to range from twice to half of the calibrated value. The water level data used for calibrating the groundwater models was primarily the static water levels at the time of drilling from the provincial Water Well Information System. Since these water levels have been collected over many decades and at various times throughout the year the static water level at the time of drilling may be quite different from the water level under current conditions. Lastly, the WHPA Zone B and Zone C will generally have less uncertainty than the WHPA Zone D. The size of the WHPA Zone B is smaller and centered closer to the wellhead where the presence of more wells allows for the geology to be typically better understood than farther away from the wellhead. The projected pumping rates for 25 years were used for generating the WHPAs and unlikely to change drastically over the next two years, but may change drastically over the next 25 years for a variety of unforeseen reasons. For these reasons listed above, the WHPA Zone B and Zone C have low uncertainty and the WHPA Zone D has high uncertainty. (see Ausable Bayfield Maitland Valley Wellhead Protection Area Delineation Project, WNMI, 2009)

WHPA-E is required for wells that have been deemed to be Groundwater Under the Direct Influence of surface water (GUDI). In order to expand the protection of the well, a two-hour time of travel zone is completed within the closest surface water body to the well (WHPA-E). WHPA-E is initiated at the closest point to the well within that surface water body, and the in-water portion extends upstream for a period of two hours under 10-year flow conditions. Ten-year year flow velocities were established based on existing HEC-2 flood plain mapping and modeled results under 10-year flow conditions.

The on-land portion of the WHPA-E was extended to the greater of 120m or the Conservation Authority regulatory limit. Accordingly, for the Century Heights WHPA-E, the Conservation Authority regulatory limit was used to delineate the on-land extents of WHPA-E.

Vulnerability scores in WHPAs can be 2, 4, 6, 8, or 10 and are based on the time of travel and the ISI rating. The chart below shows how scores are determined in a WHPA.

Intrinsic Vulnerability	**Travel Time Zones**			
	100m	2 year	5 year	25 year
HIGH	10	10	8	6
MEDIUM	10	8	6	4
LOW	10	6	4	2

Details on data information sources for delineations and scoring are available in the consultant's reports. These reports are noted in the Reference section at the end of this chapter.

Transport Pathways

Within wellhead protection areas, vulnerability scores were developed by intersecting Aquifer Vulnerability scores, typically derived from the Intrinsic Susceptibility Index (ISI) or Aquifer Vulnerability Index (AVI), with the time-of-travel capture zones associated with the WHPA. Where anthropogenic transport pathways exist that circumvent the natural vulnerability of the aquifer, the Aquifer Vulnerability score can be increased according to the following technical rules 39, 40 and 41, listed below:

> 39. Where the vulnerability of an area identified as low in accordance with rule 38 is increased because of the presence of a transport pathway that is anthropogenic in origin, the area shall be identified as an area of medium or high vulnerability, high corresponding to greater vulnerability.
>
> 40. Where the vulnerability of an area identified as medium in accordance with rule 38 is increased because of the presence of a transport pathway that is anthropogenic in origin, the area shall be identified as an area of high vulnerability.

> 41. When determining whether the vulnerability of an area is increased for the purpose of rules 39 and 40 and the degree of the increase, the following factors shall be considered:
>
> (1) Hydrogeological conditions.
> (2) The type and design of any transport pathways.
> (3) The cumulative impact of any transport pathways.
> (4) The extent of any assumptions used in the assessment of the vulnerability of the groundwater.
>
> *Clean Water Act, 2006*, Technical Rules (December, 2009)

Based on these rules, before an adjustment to aquifer vulnerability to account for transport pathways can be made, the hydrogeology of the site, the type and design of any transport pathways, the cumulative impact of the pathways and any assumptions used in developing the original aquifer vulnerability rating must be considered.

Methodology

Preliminary identification of Transport Pathways was completed through aerial photo interpretation. Properties and areas of interest were identified from the 2007 photos in a GIS environment. Properties located in the WHPA were also visited as part of a larger effort to evaluate drinking water threats throughout the region. As part of these visits, routine questions were asked of the property owners about the location and condition of any wells on the property. The results of these site visits were entered and stored in a geo-referenced database, facilitating review as part of the Transport Pathways review.

Similarly, a number of stewardship programs have been carried out in the Region both relating to drinking water source protection, as well as municipal programs. Well head upgrades are a common constituent of these programs, and properties where upgrades were completed entered into a geo-referenced database and were useful tools in evaluating potential Transport Pathways.

As part of a provincial initiative to verify the Water Well Information System (WWIS) and as part of the data collection phase of the proposed Drinking Water Source Protection project, the Ausable Bayfield and Maitland Valley Conservation Authorities undertook a review of the Water Well Information System: specifically, the Water Well Records with respect to spatial accuracy and well record completeness. Phase One (2005) refined the WWIS based on existing data and Phase Two (2006/2007) field-verified these records with the ultimate goal of updating provincial records.

Field verification using Global Positioning System (GPS) technology was implemented to capture the position of the well. This location was compared against WWIS Records in order to verify their accuracy. To capture the well location, a team of two individuals visited properties within the 25-year time-of-travel wellhead protection area (WHPA) for municipal wells within the Ausable Bayfield Maitland Valley (ABMV) region. Upon completion of the GPS coordinate reading, a photograph was taken of the well in context to surrounding buildings, and the condition of the well was noted. This data was available for review of the Transport Pathways in the Region.

In the Ausable Bayfield Maitland Valley Source Protection Region (SPR) transport pathways can be grouped into several categories, namely: pits and quarries; private wells; and urban areas and private well clusters. Detailed methodology and consideration of these areas are outlined below. In assigning transport pathway adjustments, the hydrogeology of the site and the condition of the pathway were considered, as well as the cumulative impact of transport pathways.

Pits and Quarries

Pits and quarries were primarily identified through aerial photography. Where prudent, these operations were examined by a roadside or windshield survey in order to ascertain the type of operations. There are relatively few pits and quarries in the region. Where they exist, and dependent on their depth with respect to the water table, aquifer vulnerability was adjusted from low to moderate or high, or from moderate to high. Details of any such adjustments are provided in section 4.5 for individual WHPAs.

Private Wells

Private wells were first identified using the WWIS. Information made available from the well record improvement project undertaken by the Maitland Valley and Ausable Bayfield conservation authorities was used to evaluate the condition of the wells, which was current for the WHPAs for the year 2006. Additional information was gathered from site visits carried out as part of the Drinking Water Source Protection Committee consultation to determine if any upgrades had occurred since 2006.

Wells that were not in compliance with existing regulations were identified as being potential conduits for water that increase the vulnerability of the aquifer locally. Vulnerability scores were adjusted for 30m surrounding the well, and were adjusted a maximum of one level (i.e. low to moderate; or moderate to high).

Additionally, several properties for which no well record exists, nor any well obvious by site inspection, yet have structures which require water were identified. In these cases, vulnerability scores were adjusted for 60m surrounding any of the principal structures on the property, and were adjusted a maximum of one level.

Details of all vulnerability adjustments for private wells are provided in section 4.5 for individual WHPAs.

Urban Areas and Private Well Clusters

Urban areas inside WHPAs were delineated based on aerial photography. These areas warrant special consideration as potential areas for Transport Pathway adjustments under Technical Rule 41 (3) as the cumulative effects of a high density of abandoned historic wells are common. Although these areas today are serviced by a municipal well, most were historically serviced by private wells. Additionally, the age of these wells precludes the existence of a record for the wells.

As part of this review, the historical servicing of these urban areas was reviewed, and the areas themselves visited to determine if former private wells could be in existence. Where this information indicates that wells are in existence and are substantially non-compliant, vulnerability scores were adjusted for the areas, and were adjusted a maximum of one level.

In areas where the aquifer being exploited by the municipal well is poorly protected, vulnerability scores can be adjusted to account for a reduction in the natural protection of the aquifer due to the installation of underground services, including: sewer lines, septic systems, water supply and electricity supply lines.

Where the hydrogeology warranted it, aquifer vulnerability scores were adjusted a maximum of one level in these areas. Details of all vulnerability adjustments within urban areas are for individual WHPAs.

4.3 Overview and Description of Vulnerable Areas

The ISI method (as described previously) was used to determine groundwater vulnerability across the entire SPA and the results of this are shown on **Map 4.1**.

Highly vulnerable aquifers (HVAs) in the SPA are shown on **Map 4.2**. HVAs are scattered throughout the Source Protection Region.

Significant groundwater recharge areas in the SPA are associated with permeable hydrologic response units and are presented on **Map 4.3**. SGRAs correspond to sand plains that parallel the shoreline for the full length of the Source Protection Region.

There is a surface water intake from Lake Huron: Goderich. This intake serviced the Town of Goderich and is located approximately 500 metres offshore.

The Maitland Valley Source Protection Area has eight municipalities with municipal residential well systems: Huron East, Central Huron, Ashfield-Colborne-Wawanosh, Huron-Kinloss, North Huron, Morris-Turnberry, Minto, and North Perth

4.4 Threats, Conditions, Issues and Risk

The **threats** to drinking water are identified in *Ontario Regulation 287/07* as follows:

Table 4.1 List of Threats in Ontario Regulation 287/07, Section 1.1

1. The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.
2. The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
3. The application of agricultural source material to land.
4. The storage of agricultural source material.
5. The management of agricultural source material.
6. The application of non-agricultural source material to land.
7. The handling and storage of non-agricultural source material.
8. The application of commercial fertilizer to land.
9. The handling and storage of commercial fertilizer.
10. The application of pesticide to land.
11. The handling and storage of pesticide.
12. The application of road salt.
13. The handling and storage of road salt.
14. The storage of snow.
15. The handling and storage of fuel.
16. The handling and storage of a dense non-aqueous phase liquid.
17. The handling and storage of an organic solvent.
18. The management of runoff that contains chemicals used in the de-icing of aircraft.
19. An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body.
20. An activity that reduces the recharge of an aquifer.
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.
22. The establishment and operation of a liquid hydrocarbon pipeline. *

*In 2018, the province amended regulation 287/07 to include the establishment and operation of a liquid hydrocarbon pipeline as a prescribed drinking water threat. There are such no pipelines in the MV SPA.

The Source Protection Committee may recommend threats be added to the above list (**Table 4.1**). This can only be done upon provincial approval. <u>No</u> additional threats have been identified by the Ausable Bayfield Maitland Valley Source Protection Committee.

The Source Protection Committee may also identify **conditions** which constitute a risk. As per the *Technical Rules: Assessment Report* (Rule 126) *conditions* are any one of the following that exist in a *vulnerable area* and result from a past *activity*:

- the presence of a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area;
- the presence of a single mass of more than 100 litres of one or more dense non-aqueous phase liquids in surface water in a surface water intake protection zone;
- the presence of a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or a wellhead protection area, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the potable groundwater standard set out for the contaminant in that Table;
- the presence of a contaminant in surface soil in a surface water intake protection zone, if the contaminant is listed in Table 4 of the Soil, Ground Water and Sediment Standards is present at a concentration that exceeds the surface soil standard for industrial/commercial/community property use set out for the contaminant in that Table; and
- the presence of a contaminant in sediment, if the contaminant is listed in Table 1 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the sediment standard set out for the contaminant in that Table.

The Ausable Bayfield Maitland Valley Source Protection Committee has not identified any conditions within vulnerable areas in the Maitland Valley Source Protection Area.

It is possible for an extreme event to threaten a drinking water source. An **event based approach** was therefore used for surface water intakes, such as the Goderich intake, to determine whether contaminants released during an extreme event may be transported to an intake. This approach models an Intake Protection Zone 3 (IPZ-3), that includes areas beyond IPZ-1 and IPZ-2, based on extreme event conditions, (such as a 100-year storm), and an understanding of contaminant transport to the intake. Activities occurring within an IPZ-3 can then be identified as significant drinking water threats if it can be shown through modeling that a release of a specific contaminant would result in an issue at the intake. An initial study in the Maitland Valley SPA indicated that the concentration of salt resulting from a failure at a salt storage facility on the northern Pier of the Goderich Harbour had the potential to cause a disruption to the Goderich Intake during an extreme event. However, a motion recommending that further studies and modelling be conducted to confirm the potential was defeated by the ABMV Source Protection Committee in April of 2011. Therefore, no IPZ-3 was delineated.

Finally, there may be a documented water quality **issue** at a drinking water source. An example would be water contamination that threatens to exceed drinking water standards and treatment is beyond the capacity of the water treatment plant. The Source Protection Committee has identified that if a contaminant of concern reaches half the maximum acceptable concentration, then it is an issue. Currently, no issues are known for the Source Protection Region's municipal drinking water sources.

However, there is evidence of nitrates trending toward this threshold in individual and test wells in Huron East in proximity to the sinkholes. Also in Huron East, there was a history of radionuclides in the municipal wells in Seaforth. These wells have been replaced. However, there is concern that road salt use may contribute to the release of radionuclides. Further research is required for both these issues.

A **risk** to drinking water sources exists where the land is sufficiently vulnerable and the threat is great enough. The amount of risk is identified for a location given the degree of vulnerability where there is or may be a prescribed threat under certain circumstances (as identified in the *Table of Drinking Water Threats*). The degrees of risk are significant, moderate or low.

Identifying Threats

The Assessment Report provides an inventory of possible threats. In simple terms, the present land use is identified for each parcel in wellhead protection areas or intake protection zones. Then a range of threats (as noted above) that are normally associated with that type of land use are assigned to the parcel. Finally, the risk associated with that threat activity is determined. This method takes into account intrinsic risk and does not consider risk management activities. In other words, it uses the precautionary principle. Source Protection Plan policies will be based on the potential or intrinsic risk. However, as part of the Assessment Report, an attempt is made to identify the number and type of significant risks that actually exist in each wellhead protection area. The only locations where significant threats based on activities could exist are in the wellhead protection areas throughout the ABMV Source Protection Region.

Ontario Regulation 287/07 prescribes drinking water threats. This list was established after extensive research on the part of the Ontario Ministry of the Environment, Conservation, and Parks. There are 22 threats listed and they pertain to both water quality and water quantity threats. Water quantity threats are considered in the Water Budget process (see Chapter 3). For water quality, the threats are activities which could result in the release of chemicals of concern and/or pathogens. Chemicals are human-made substances of distinct molecular composition. Pathogens are agents that cause infection or disease and can be microorganisms, such as bacteria or protozoa, or viruses.

To understand if an area has the potential for significant, moderate or low threats, the reader should first determine which type of vulnerable area the property is located in:

- WHPA A – 100 metres around the wellhead
- WHPA B – Two-year time of travel around the wellhead
- WHPA C – Five-year time of travel around the wellhead
- WHPA D – 25 -year time of travel around the wellhead
- WHPA E – Two-hour time of travel at a GUDI well*
- IPZ 1 – One-kilometre radius around an intake (See page 4-5)
- IPZ 2 – Two-hour time of travel from the intake
- SGRA – Significant groundwater recharge area
- HVA – Highly vulnerable aquifer

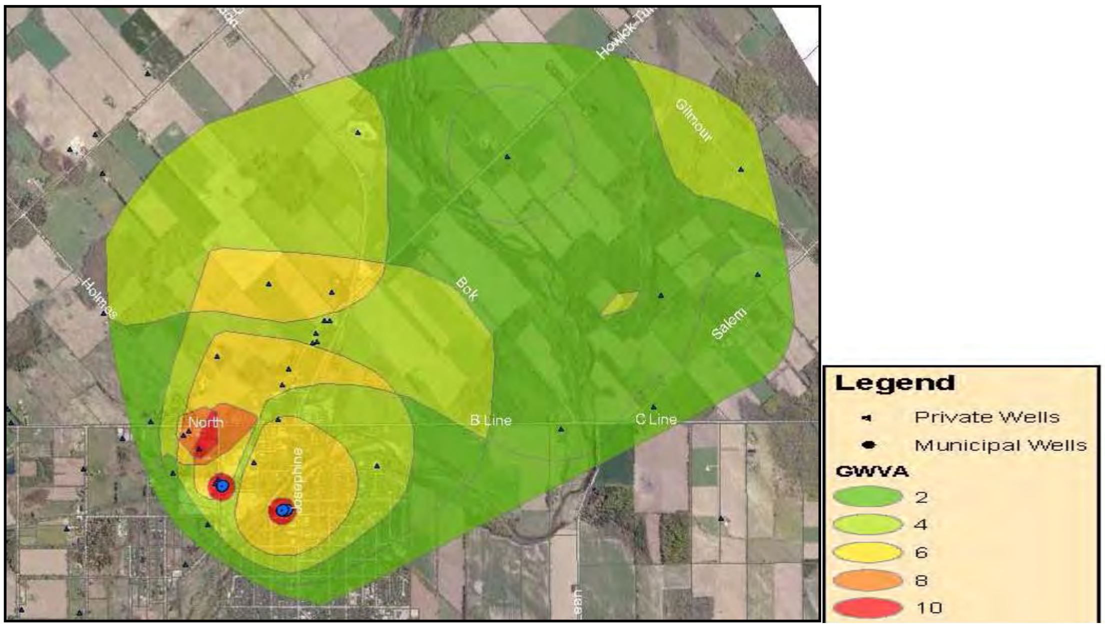
*GUDI means the well is groundwater under direct influence of surface water.

The vulnerability score should then be ascertained for the location. WHPA scores range from 2 to 10 where 10 is the most vulnerable. The IPZ scores range from 4 to 6 and HVAs score 6 or less. SGRAs are not assigned a score. The score is indicated by the colour on the map and map legend (see example below).

Once these two factors are known, the reader can then look up the circumstances in which an activity might be of significant, moderate or low risk. This is done using the Table of Drinking Water Threats in the Technical Rules at https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act.

A Threats Look Up Tool is available at: https://swpip.ca, which allows users to search through the Tables of Drinking Water Threats by the various activities and circumstances.

For example, where the area is located in a WHPA A, the vulnerability score is 10 (signified by the red circle). By using the Table of Drinking Water Threats, one can determine the number and type of possible chemical, DNAPL, or pathogen threats that may occur on the property. It does not mean that these threats exist rather that they might exist given the land uses on the property.



Below is a sample from the Table of Drinking Water Threats which describes specific circumstances in which the threat activity would present a risk. Often the circumstance relates to the quantity of the chemical of concern (it is more risky to have 2,500 litres of fuel stored than 25 litres). Further, these tables of threats and circumstances provide the corresponding degrees of risk (significant, moderate, or low) depending on the groundwater vulnerability score (it is more risky to have 2,500 litres of fuel stored where the score is 10 than where the score is 6).

Table 4.2 Sample from Table of Drinking Water Threats, Road Salt Application

Circumstance type and number	Circumstances	Areas of SDWT	Areas of MDWT	Areas of LDWT
Chemical C12.1.1	1. The road salt is applied in an area where the default percentage of impervious surface area, as	n/a	IPZ/ WHPA-E 9 – 10	IPZ/ WHPA-E 6 – 8.1

Circumstance type and number	Circumstances	Areas of SDWT	Areas of MDWT	Areas of LDWT
	set out on a total impervious surface area map, is less than 1 percent.			WHPA 8 – 10
Chemical C12.1.2	1. The road salt is applied in an area where the default percentage of impervious surface area, as set out on a total impervious surface area map, is at least 1 percent, but less than 8 percent in WHPA-A, B, C, C1, D or HVA; or is at least 1 percent, but less than 6 percent in IPZ-1, 2, 3 and WHPA-E.	n/a	IPZ/ WHPA-E 8 – 10 WHPA 10	IPZ/ WHPA-E 5.4 – 7.2 WHPA 6 – 8 HVA 6
Chemical C12.1.3	1. The road salt is applied in an area where the default percentage of impervious surface area, as set out on a total impervious surface area map, is at least 8 percent, but less than 30 percent in WHPA-A, B, C, C1, D or HVA; or is at least 6 percent, but less than 8 percent in IPZ-1, 2, 3 and WHPA-E.	IPZ/ WHPA-E 10	IPZ/ WHPA-E 8 – 9 WHPA 8 – 10	IPZ/ WHPA-E 4.9 – 7.2 WHPA 6 HVA 6
Chemical C12.1.4	1. The road salt is applied in an area where the default percentage of impervious surface area, as set out on a total impervious surface area map, is 30 percent or more in WHPA-A, B, C, C1, D or HVA; or is 8 percent or more in IPZ-1, 2, 3 and WHPA-E.	IPZ/ WHPA-E 9 – 10 WHPA 10	IPZ/ WHPA-E 7 – 8.1 WHPA 8	IPZ/ WHPA-E 4.5 – 6.4 WHPA 6 HVA 6

Technical Rules, 2021. *CWA, 2006*

The tables below summarize where in the vulnerable areas chemical, dense non-aqueous phase liquids (DNAPL) and pathogen threats, are or would be significant, moderate and low drinking water threats. The level of threat that an activity poses to a drinking water supply depends on the vulnerability scores within a vulnerable area. This table can be used in combination with the vulnerability maps that show vulnerability scores to determine where significant, moderate and low threats can be found. In addition, this table and the vulnerability maps can be used in combination with the provincial Table of Drinking Water Threats to determine the types of activities that would be deemed a significant, moderate and low drinking water threat in each area.

The provincial Table of Drinking Water Threats are found within the Technical Rules at https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act.

Table 4.3 Areas within Highly Vulnerable Aquifers Where Activities and Conditions are or would be Significant, Moderate and Low Drinking Water Threats

Threat	Vulnerability Score	Threat Level Possible		
		Significant	Moderate	Low
Chemical (including DNAPLs)	6		✓	✓
Pathogen	6			

Table 4.4 Deleted SGRA Table

Table 4.4: Areas within SGRA where Activities or Conditions are Drinking Water Threats, was deleted following change to Technical Rules which removed scores, and therefore any drinking water threats, for SGRAs

Sources of Water Considered

The Maitland Valley Source Protection Area has a surface water intake and wells serving municipal drinking water systems specified by the *Clean Water Act, 2006* and identified in the *Terms of Reference*. These sources are the Great Lakes intake, which is the Goderich Intake and the well systems identified as “Type 1 Wells” in the *Technical Rules*. Type 1 Wells are: existing and planned municipal drinking water systems that serve or are planned to serve major residential developments. This list was identified through the Terms of Reference.

Other sources of drinking water are not under consideration at this point. Municipalities may choose to elevate other systems into the source protection planning process, but none have elected to do so.

Table 4.5 Areas within Intake Protection Zones Where Activities and Conditions are or would be Significant, Moderate and Low Drinking Water Threats

Threat	IPZ	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical (including DNAPLs)	**IPZ-1**	8 – 10	✓	✓	✓
		6 – 7		✓	✓
		5			✓
	IPZ-2	8 – 9	✓	✓	✓
		6.3 – 7.9		✓	✓
		4.2 – 5.9			✓
		<4.2			
	IPZ-3	8 – 9	✓	✓	✓
		6 – 7.9		✓	✓
		4.5 – 5.9			✓

Threat	IPZ	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
		< 4.5			
Pathogen	**IPZ-1**	8 – 10	✓	✓	✓
		6 – 7		✓	✓
		5			✓
	IPZ-2	8 – 9	✓	✓	✓
		6.3 – 7.9		✓	✓
		4.2 – 5.9			✓
		<4.2			
	IPZ-3	0.8 – 9			

Table 4.6 Areas within Wellhead Protection Areas Where Activities and Conditions are or would be Significant, Moderate and Low Drinking Water Threats

Threat	WHPA	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	**A**	10	✓	✓	✓
	B	10	✓	✓	✓
		8	✓	✓	✓
		6		✓	✓
	C	8	✓	✓	✓
		6		✓	✓
		<6			
	D	6		✓	✓
		<6			
	E	8 – 9	✓	✓	✓
		6.3 – 7.9		✓	✓
		4.2 – 5.9			✓
		<4.2			
DNAPL	**A**	10	✓		
	B	6 – 10	✓		
	C	4 – 8	✓		
	D	6		✓	✓
		<6			
	E	3.5 – 9			
Pathogen	**A**	10	✓	✓	
	B	10	✓	✓	
		8		✓	✓
		6			✓
	C	4 – 8			
	D	2 – 6			
	E	8 – 9	✓	✓	✓
		6 – 7.9		✓	✓
		4.2 – 5.9			✓
		<4.2			

Methodology Notes

The storage, handling and application of pesticides, fertilizers and agricultural source material associated with agricultural activities can result in surface water runoff and potential pathogen and chemical contamination. This section utilizes information on managed lands and livestock density as an indicator of areas in a watershed where intensive agricultural and other land management activities are conducted.

Managed Lands Methodology

The purpose of the managed lands layer was to develop a portrayal of how much land was subject to human management. The management of land meant that the land was probably receiving nutrients or fertilizer. The managed land was created from all lands which were classed agricultural, large sports fields/golf courses, as well as a percentage of the residential area of all towns. A constraint was placed on the areas where land was managed to limit the area of interest to those areas where the vulnerability was ≥ 6.

The methodology for the analysis was completed in two separate steps. While the steps were distinct from each other, the methodology was the same.

First, using the wellhead protection and intake protection zones with vulnerability ≥ 6 the datasets were united together and then exploded into distinct polygons. These polygons denoted areas that were physically separated from any other polygon.

The Terranet parcel fabric was united with the areas of interest resulting in roadways being created via the closing of empty space between parcels. By using the MPAC property codes and farm operation codes those areas which were “managed” could be identified.

The area was calculated for all areas with the designation of agricultural managed land vs. non-agricultural managed land being noted. In addition, the footprint of the towns and cities was merged into the dataset. Those areas of the town which were not agricultural were further adjusted to account for the potential for fertilizers to be applied to the grassed areas of the towns. For those non-agricultural areas the land base was considered to be .35 the area or 35% managed land.

Given that unique polygons were created from the vulnerability polygons ≥ 6, the total areas for the polygons was created. The managed land was calculated and then further adjusted for the urban footprints. It is possible to calculate the percentage managed through the following formula:

Managed Land Percentage = Agricultural managed land + ((town footprint parcels exclusive agricultural land and roads * .45) + non-agricultural managed land / total area → for those areas of vulnerability ≥ 6 in the source water region summarized by distinct polygon.

Second, the managed land for the HVA/SGRA was completed in the same manner as above except the areas were handled distinctly from the WHPA/IPZ analysis. This may result in percentage managed land edge match differences at the transition zone between WHPA areas and HVA areas which are portrayed by different colours where they meet. As well, where the score is less than 6, it is not included, thus it appears as the air photo on the maps.

Nutrient Unit per Acre Methodology

The purpose of the livestock density map was to develop a layer which showed the nutrient amounts per acre (NU/acre) that were being generated. The livestock farms under consideration were limited to those in areas where the vulnerability was ≥ 6.

There were two distinct methodologies used in the creation of the NU/acre maps and datasets. The first method was internal to the wellhead protection areas and intake protection zones and involved field verified animal numbers and nutrient calculations for estimating the nutrient units for any given property in the significant areas. The second method was completed in SGRA/HVA areas and involved the use of the agricultural census (2006) data for census consolidated districts.

The areas internal to the WHPA and IPZ had the nutrient units calculated by estimating the nutrient units via field visits and air photo interpretation. To assist in the field visits, a set of maps was created for those properties designated with MPAC farm operation codes indicating livestock was present for those properties with vulnerability scores ≥ 6.

The property level maps were taken to the field by staff to record visit information such as the presence or absence of farm animals and the facilities to house the animals. These observations were completed via windshield survey.

Information was written on the orthophoto based property level maps designating which barns housed animals. The barn footprints were digitized and a square footage for any given barn could be established. By combining the observed animal species, provincial guide tables indicating NU/square foot for any given animal species, and the square footage of a barn, the overall nutrient units for any given farm could be estimated.

All barns housing animals were calculated on any given farm property and then summarized by property. This created the total nutrients on any given property. The woodlots were removed from the property thereby creating the managed land of the property. Since some of the land for a given farm may lie outside the wellhead protection zone the NU were pro-rated to account for only the land internal to the wellhead protection zone.

Two calculations are then completed. The first provides the NU/acre calculation for any give farm by summing the nutrient units/dividing by the hectares and then converting to NU/acre via a factor of 2.45. This provides the NU/acre for a given farm.

The second calculation takes all the nutrient units calculated in a given wellhead protection area and sums them. The total agricultural managed land on the contributory farms is summed and an overall NU/acre is derived from these two summations. The maps portray the nutrient units per acre where the vulnerability is equal to or greater than 6 and the lands are managed (e.g., Excluding the urban footprint or forested areas).

Nutrient units in the HVA/SGRA areas were calculated from the agricultural census (2006) data using total agricultural managed land, animal numbers and finally nu/animal tables for generating nu/acre estimates for each census consolidated district (CCS). The nu/acre was calculated for the entire CCS however when mapping only those HVA/SGRA areas with vulnerability ≥ 6 were symbolized. This methodology required the Directors approval. It was determined that for areas outside wellheads, the vulnerability scores were low enough to preclude significant risks and the results of this methodology would be equivalent to those of the methodology used within the wellhead areas.

Impervious Surface Methodology

Impervious surfaces are mainly constructed surfaces such as sidewalks, roads and parking lots that are covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water and prevent precipitation and melt water from infiltrating soils. Impervious surfaces can generate large amounts of runoff during storm events. Road salt used during winter road maintenance is regarded as a threat, and the percentage of impervious surfaces is an indicator of the potential for impacts due to road salt. A map showing the percentage of impervious surface in defined vulnerable areas is provided at the municipal level in this report.

The following is an explanation of the creation of the impervious surface layer. The first section is a list and explanation of the input datasets while the second section is an explanation of the methodology used in modifying the input datasets to create the resultant impervious surface layer.

<u>Input layers:</u>

- Highly Vulnerable Aquifers
- Wellhead protection areas delineating the municipal well capture zone areas for groundwater.
- Intake protection zones delineating the capture areas for the surface water intakes.
- The Terranet assessment parcel dataset. The dataset contains the boundaries of the land use parcels. Areas between the parcels represent roads.
- Footprints layer. This layer represents a delineation of the built up or urban area for cities and towns. This layer is used to adjust the impervious surface in urban areas to account for buildings, parking lots and driveways.
- Drinking Water Source Protection Region boundary. This layer is used to limit the data set to those areas inside the ABMV Source Protection Region.

This dataset was used to create 1km square areas to reduce the analysis area for the study to 1km. This allows the local features for any 1km area to be captured and not lost in a large area averaging technique.

<u>Methodology:</u>

The HVA, IPZ, and WHPA all contained a vulnerability score created previously. Those areas which have a vulnerability score of ≥ 6 represent those areas where impervious surface threats can exist. These areas were merged together to create the area of interest to analyze.

The parcel fabric was united with the areas of interest. All areas which were not a parcel were assigned the classification of road as these contribute to the impervious surface. In addition, after merging the footprints of the town, any areas which were in a parcel in the town footprints were assigned an impervious percentage to account for the driveways and buildings. A factor of .45 was used representing 45% of a parcel being impervious in towns.

Additional datasets were united to limit the analysis to both the source water region as well as to provide the 1km grid area scope. The 1km grid, via a unique grid identifier for any given 1km square, was used to summarize the data.

The final dataset represents the percentage of roads and 45 % of the town footprints (exclusive of the roads) in any area of vulnerability ≥ 6 divided by those areas of vulnerability ≥ 6 in any 1km square:

> Percent Impervious = Road area + (town footprint exclusive of roads * .45) / area of interest → for those areas of vulnerability ≥ 6 in the source water region based on a 1km grid summary.

The mapping of the impervious surface was completed using the standard symbology classes as required in the Mapping Symbology for the Clean Water Act, 2006 (MNR, 2009). The coloured areas on these maps represent only those areas with vulnerability ≥ 6. Therefore, some of the grid may contain impervious surface and some part of the grid cell may not. The inclusion of the 1 km grid linework facilitates the understanding of how the impervious surface change occurs at the limits of any grid cell.

Approach to Significant Threat Enumeration

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

It should be noted that the identification of threats is based on a blend of field research and a ‘desktop’ approach. The ‘desktop’ approach relied on Municipal Parcel Assessment Corporation (MPAC) data. This data indicates the type of land use taking place and can be associated with certain types of activities and presence of related chemicals or pathogens. The North American Industry Classification System code (NAICS) data was helpful in associating chemicals typically used at various types of land uses. During the course of the preparation of this document, there was consultation with property owners in vulnerable areas where significant risks would exist. Information was provided by many land owners which helped to refine the data base used to enumerate significant threats. However, not all property owners responded to requests for such information. In these cases, the desktop approach was the best source of information. This approach made the assumptions that:

1. Home heating is oil, in a basement tank,
2. Houses use septic tanks,
3. Businesses (including home occupations), industries and agricultural uses the five-year time of travel could store DNAPLs.

Due to these assumptions, the threat enumeration provided in the 2011 Assessment Report was conservative (i.e., assessing highest level of potential risk where there was not enough information to demonstrate otherwise). For the updated 2014 Assessment Report, additional information was collected through site visits, landowner contact, and drive-by assessments. For this approach, it was assumed that properties that had a gas meter did not use heating oil and would not pose a significant threat for fuel. It was also assumed that properties with access to municipal sewer did not have a septic system. Where there was insufficient information available to determine the presence or absence of a threat, a conservative approach was taken, and it was assumed that the activity was a potential significant threat. As a result of this verification, the number of potential significant threats dropped significantly.

Threats are assigned to parcels, and represent the best information available at the time of writing. Numbers are expected to vary over time, according to changes in land use and activities, and as additional information becomes available.

Note that some activities, such as Fertilizer application, Non-agricultural Source Material Application and Road Salt application cannot be a significant drinking water threat in some areas due to the percent managed land, livestock density and / or percent impervious surface.

2022 Updated Risk Assessment

A risk assessment was conducted in 2022 to address the changes to the 2021 Technical Rules, which resulted in potential significant threats for snow storage and salt application and storage. The threat numbers were estimated using desktop analysis and are unconfirmed.

4.5 Municipal Profiles

4.5.1 Ashfield-Colborne-Wawanosh

The Municipality of Ashfield-Colborne-Wawanosh (ACW) is located on the Lake Huron shore north of Goderich and completely within the Maitland Valley Conservation Authority jurisdiction. In 2006, the municipality's population was 5,409, unchanged from 2001. There are no large towns. Land use is 62% cropland, largely soybeans, corn, winter wheat and alfalfa. Much of the remainder is forested land associated with the till and kame moraines. Livestock density (cattle: 39.1/km^2; pigs: 104.4/km^2) is below the Huron County average, especially for pigs, but above Western Ontario averages (Statistics Canada 2007).

Map 4.ACW.IS shows the percentage of impervious surface area; **Map 4.ACW.ML** shows the location and percentage of managed lands, and **Map 4.ACW.LD** shows the livestock density within vulnerable areas for Ashfield-Colborne-Wawanosh.

4.5.1.1 ACW – HVAs and SGRAs

Maps 4.ACW.HVA and 4.ACW.SGRA show the locations of HVAs and SGRAs in ACW. The HVAs are scattered throughout the central and eastern portions of the municipality. SGRAs correspond to coarse-textured physiographic units which generally run north/south across the municipality; they include a sand plain, spillways and kame moraine. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

<u>Threats and Risks</u>

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in these areas. Table 4.3 can be used in combination with Map 4.ACW.HVA to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in ACW. There are no known conditions or issues in the municipality.

4.5.1.2 ACW – Wellhead Protection Areas

ACW has relatively small well systems: Benmiller, Century Heights, Dungannon, Huron Sands. **Map 4.ACW.WHPA** shows the WHPAs for each of these systems. The Lucknow WHPA extends into ACW but the wells are located in the Township of Huron-Kinloss. In addition, a small portion of the Goderich IPZ extends into ACW.

4.5.1.2.1 Benmiller

The following is a description of the Benmiller well system: Note that Well # 2 was put into service in January 2016, replacing Well # 1.

- Location: 81188 Pfrimmer Rd., Benmiller
- SPA: Well and WHPA are in the MV SPA
- Year constructed: Well # 2: 2006
- Depth: 70.1 m
- Users Served: 85
- Design Capacity: 196.3 m^3/day (2.3 litres/sec)
- Permitted Rate: 196.3 m^3/day (2.3 litres/sec)
- Average Usage: 59 m^3/day (2001-2005) *
- Modelled rate: 59 m^3/day *
- Treatment: Chlorination
  *WNMC et al, 2010

Note that the maps were revised in 2017 to reflect replacement of the well in 2016. Well # 2, originally drilled as a monitoring well, is located 30 metres from the pump house and former supply well #1. As this was considered to be a minor change, a new groundwater model and delineation was not required, as per SPC direction. Rather, the WHPA was shifted to account for the new well location.

<u>Groundwater Vulnerability</u>

Map 4.ACW.WHPA-IPZ show the WHPA extending in a narrow strip about 8.2 km eastward over agricultural land and forest to cross the Maitland into Central Huron. A vulnerability score of 10 applies only to WHPA-A, the 100 m radius around the well. WHPA-B, WHPA-C, and WHPA-D all have a vulnerability score of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Benmiller WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.7 Column 1 lists the drinking water threats in Benmiller's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. No other local circumstances were identified.

Map 4.Benm shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas within the WHPA where chemical, pathogen, and DNAPL threats can be significant, moderate and low threats to drinking water.

Table 4.7 Benmiller WHPA: Enumeration of Potential Significant Threats

Threat Type (numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
2. Sewage System	0	0	
12. Application of Road Salt	0		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	1		
Total:	**1**	**0**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties

Drinking Water Issues and Conditions:

Table 4.8 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.8 Benmiller WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.1.2.2 Century Heights

The following is a description of the Century Heights well system*:

- Location: Century Heights Subdivision, 400 m east of the Maitland River
- SPA: Well and WHPA are in the MV SPA
- Year constructed: 1979
- Depth: Well #1: 68.8 m, Well #2: 66 m
- Users Served: 145
- Design Capacity: 328 m^3/day (3.8 litres/sec)
- Permitted Rate: 328 m^3/day
- Average Usage: never exceeded 186 m^3/day (2.2 litres/sec)
- Treatment: Chlorination

*WNMC et al, 2010

Groundwater Vulnerability

Maps 4.ACW.WHPA-IPZ and 4.Cent show the WHPA, largely agricultural land and forest, extending in a long, tapered shape about 9.75 km eastward across the Sharpe's Creek and as far as the Maitland River at the boundary of Central Huron. A vulnerability score of 10 applies only to WHPA-A, the 100 m radius around the well. WHPA-B, WHPA-C, and WHPA-D all have a vulnerability score of 6 or less. Since Century Heights is a GUDI well (groundwater under the direct influence of surface water) a 2 hour time of travel zone is required. This zone is called WHPA-E and has a vulnerability score of 7.2.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Century Heights WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.9 Column 1 lists the drinking water threats in Century Heights' WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.9** also indicates the number of significant threat instances for each threat type. No other local circumstances were identified.

Map 4.Cent shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen, and DNAPL threats can be significant, moderate, or low.

Table 4.9 Century Heights WHPA: Enumeration of Potential Significant Threats

Threat Type (numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System		11	
12. Application of Road Salt	0		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	0		
16. Dense Non-Aqueous Phase Liquid Storage			0
Total:	**0**	**11**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.10 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.10 Century Heights WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.1.2.3 Dungannon

The following is a description of the Dungannon well system: Note that Well # 1 was decommissioned in 2017, leaving well # 2 as the role supply well for this system.

- Location: 37103 Dungannon Rd
- SPA: Well and WHPA are in the MV SPA
- Year constructed: 2002
- Depth: Well #2: 87.2 m
- Users Served: 262
- Design Capacity: 656.6 m^3/day (7.6 litres/sec)
- Permitted Rate: 438 m^3/day (5 litres/sec)
- Average Usage: 90 m^3/day (2004 - 2005)*
- Modelled rate: 90 m^3/day *
- Treatment: Chlorination and iron sequestration

*WNMC et al, 2010

In 2012 Well # 1 was taken out of service as arsenic levels had exceeded ODWS. Well # 1 was decommissioned in 2017 due to the arsenic level; maps were revised to reflect the resulting change in the WHPA. A new groundwater model and delineation was not considered necessary, as per SPC direction. Rather, the WHPA was revised to account for the removal of Well # 1 and submitted in 2018 as part of an amendment under Section 34 of the CWA.

<u>Groundwater Vulnerability</u>

Maps 4.ACW.WHPA-IPZ and 4.Dung show the WHPA extending in a broad swath about 3.75 km eastward across Sharpe's Creek. A vulnerability score of 10 applies only to WHPA-A, the 100 m radius around the well. WHPA-B, WHPA-C, and WHPA-D all have vulnerability scores of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Dungannon WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for one undocumented well which was not visited as part of the Well Location Update. In this case, the well was assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area as it is located entirely outside of all but the WHPA-A, which already has a maximum vulnerability score of 10.

Threats and Risks

Table 4.11 Column 1 lists the drinking water threats in Dungannon's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.11** also indicates the number of significant threat instances for each threat type.

Maps 4.Dung shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant moderate and low.

Table 4.11 Dungannon WHPA: Enumeration of Potential Significant Threats

Threat Type (numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System		4	
8. Commercial Fertilizer Application	1		
10. Pesticide Application	1		
12. Application of Road Salt	0		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	3		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			0
Total:	**5**	**4**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.12 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.12 Dungannon WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.1.2.4 Huron Sands

The following is a description of the Huron Sands well system:

- Location: 85019 Michelle St
- SPA: Well and WHPA are in the MV SPA
- Year constructed: 2001
- Depth: 77.7 m
- Users Served: 120
- Design Capacity: 328 m^3/day (3.8 litres/sec)
- Permitted Rate: 328 m^3/day (3.8 litres/sec)
- Average Usage: Not exceeded 28 m^3/day, 8.5% of the permitted rate
- Modelled rate: 20 m^3/day *
- Treatment: Chlorination and iron sequestration

*WNMC et al, 2010

Groundwater Vulnerability

Map 4.ACW.WHPA-IPZ and 4.Huro show the Wellhead Protection Area (WHPA) extending in a broad arc about 7.3 km to the southeast. A vulnerability score of 10 applies only to WHPA-A, the 100 m radius around the well. WHPA-B has a vulnerability score of 6, WHPA-C has a score of 4, and WHPA-D has a score of 2.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Huron Sands WHPA was adjusted for one undocumented well that was inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). This well was located as part of the project, and was found to be out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the well, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area as it is located entirely outside of all but the WHPA-A, which already has a maximum vulnerability score of 10.

Threats and Risks

Table 4.13 Column 1 lists the drinking water threats in Huron Sands' WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.13** also indicates the number of significant threat instances for each threat type.

Map 4.Huro shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant moderate and low.

Table 4.13 Huron Sands WHPA: Enumeration of Potential Significant Threats

Threat Type (numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
2. Sewage System		5	
8. Commercial Fertilizer Application	1		
10. Pesticide Application	1		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	0		
Total:	**2**	**5**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties

Drinking Water Issues and Conditions

Table 4.14 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.14 Huron Sands WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.1.2.5 Lucknow

A portion of the Lucknow WHPA extends into ACW. The wells are located in the Township of Huron-Kinloss. A description of the Lucknow system plus risk assessment can be found under Huron-Kinloss in section 4.5.6.

Table 4.15 Deleted

Table 4.16 Deleted

4.5.2 Central Huron

The Municipality of Central Huron is located on Lake Huron and falls entirely within the Source Protection Region, extending from the Maitland River in the north to the Bayfield River in the south. By conservation authority, Central Huron is 76% in Maitland Valley and 24% in Ausable Bayfield. The 2006 permanent population was 7,641, a decrease of 2.1% since 2001. There are also seasonal residents. The main town is Clinton (2006 population 3,082), upstream on the Bayfield River. Central Huron has attracted extensive shoreline development and pressure mounts to convert from seasonal occupation to year round. Two-thirds of the municipality is in crops – mainly soybeans, corn and winter wheat. Livestock density (cattle: 24.7/km^2; pigs: 126.2/km^2), while low compared to the rest of Huron County, substantially exceeds Western Ontario's average pig density of 78.7/km^2 (Statistics Canada 2006).

Map 4.CH.IS shows the percentage of impervious surface area; **Map 4.CH.ML** shows the location and percentage of managed lands, and **Map 4.CH.LD** shows the livestock density within vulnerable areas for Central Huron.

4.5.2.1 Central Huron – HVAs and SGRAs

Maps 4.CH.HVA and 4.CH.SGRA show the locations of HVAs and SGRAs in Central Huron. Most HVAs are scattered east from Holmesville. Two small HVAs fall in the west portion: one just beyond the south east corner of Goderich and the other immediately across the Maitland River from Benmiller. SGRAs correspond to coarse-textured physiographic units which generally run north/south across the municipality. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

<u>Threats and Risks</u>

Since the vulnerability scores for HVAs are 6 or less, only moderate and low drinking water threats may exist in these areas. **Table 4.3** can be used in combination with **Map 4.CH.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in Central Huron. There are no known conditions or issues in the municipality.

4.5.2.2 Intake Protection Zone – Goderich

The Goderich water intake is located offshore of the Town of Goderich. The Intake Protection Zone 2 (IPZ-2) reaches into Central Huron immediately south of

Goderich town limits. A description of the Goderich intake, IPZ and risk assessment can be found under Goderich in section 4.5.3

Table 4.17 Deleted

Table 4.18 Deleted

4.5.2.3 Central Huron – Wellhead Protection Areas

Central Huron's major wellfield is at Clinton. Smaller well systems are associated with shoreline development and include: McClinchey, Kelly, Vandewetering and SAM. Auburn is in Central Huron though most of its WHPA extends into North Huron. Benmiller is in Ashfield-Colborne-Wawanosh but its WHPA extends into Central Huron. **Map 4.CH.WHPA** shows the WHPAs for each of these systems.

Note that the SAM and Vandewetering groundwater systems are located in the Ausable Bayfield Source Protection Area. Details for these systems are in the Ausable Bayfield Assessment Report.

4.5.2.3.1 Auburn

The following is a description of the Auburn well system:

- Location: South-east edge of the hamlet of Auburn, 500 m east of the Maitland River.
- SPA: Well and WHPA are in the MV SPA
- Year constructed: 2005
- Depth: 56.4 m
- Users Served: 30
- Design Capacity: 61.9 m^3/day (0.7 litres/sec)
- Permitted Rate: 61.9 m^3/day (0.7 litres/sec)
- Average Usage: 9 m^3/day (2003 - 2005)*
- Modelled rate: 9 m^3/day *
- Treatment: Ultraviolet radiation and iron sequestration

* WNMC et al, 2010

<u>Groundwater Vulnerability</u>

Map 4.CH.WHPA and 4.Aubu show that the WHPA extends about 4 km to the east, most of which is in North Huron. A vulnerability score of 10 applies to WHPA-A which is almost entirely within Central Huron. WHPA-B, WHPA-C, and WHPA-D all have a vulnerability score of 6 or less. However, these zones are largely located in North Huron.

Note: in 2023 the WHPA was shifted 21 metres to account for an error in the well location. The supply well in Auburn was replaced in 2009 but the change in location was not captured during the wellhead protection area (WHPA) modelling project and subsequent writing of the Maitland Valley Assessment Report

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Auburn WHPA was adjusted for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.20 Column 1 lists the drinking water threats in Auburn's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.20** also indicates the number of significant threat instances for each threat type.

Map 4.Aubu shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen, and DNAPL threats can be significant, moderate, or low.

Table 4.20 Auburn WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
2. Sewage System		10	
9. Commercial Fertilizer Handling/Storage	1		

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
12. Application of Road Salt	2		
13. Storage of Road Salt	2		
14. Storage of Snow	1		
15. Fuel Handling/Storage	3		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			0
Total:	**9**	**10**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

<u>Drinking Water Issues and Conditions</u>

Table 4.21 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA. Research into additional existing threat sources will be undertaken and reported in a future update of the Assessment Report.

Table 4.21 Auburn WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.2.3.2 Benmiller

The Benmiller well is located in ACW and extends into Central Huron. A description of the Benmiller water supply system and risk assessment can be found in section 4.5.1 under ACW.

Table 4.22 Deleted

Table 4.23 Deleted

4.5.2.3.3 Clinton

The following is a description of the Clinton well system:

- Location: The three wells are all located in the vicinity of Park Lane and Princess Street in Clinton
- SPA: All three wells are in AB SPA, WHPA extends into MV SPA
- Year constructed: Well #3 – Established early 1900s, no record for other 2 wells.

- Depth: Well #1 – 99 m, Well #2 – 108 m, Well #3 – 110m
- Users Served: 4500
- Design Capacity: 4838 m^3/day (56 litres/sec)
- Permitted Rate: No known rate
- Average Usage: combined 1,968 m^3/day (2001 – 2005) *
- Modelled rate: 1,968 m^3/day
- Treatment: Gas Chlorination

* WNMC et al, 2010

Groundwater Vulnerability

Maps 4.CH.WHPA and 4.Clin show the wellhead protection area (WHPA) extending almost 15 km north-eastward into the agricultural land in the Maitland Valley. The only area with a vulnerability score of 10 is WHPA-A, the 100 m radius of the wells, which is located entirely within the AB SPA. Parts of WHPA-B and WHPA-C fall into the MV SPA and have vulnerability scores of 8 and 6. WHPA-D has vulnerability scores of 6 or less. Note that **Map 4.Clin** was revised in 2014 to reflect updated transport pathway information.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Clinton WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.24 Column 1 lists the drinking water threats in Clinton's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.24** also indicates the number of significant threat instances for each threat type.

Map 4.Clin shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, and low.

Table 4.24 Clinton WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System	1	1	
3. Agricultural Source Material Application			
4. Agricultural Source Material Storage			
6. Non-Agricultural Source Material Application			
10. Pesticide Application			
12. Application of Road Salt	8		
13. Storage of Road Salt	4		
14. Storage of Snow	8		
15. Fuel Handling/Storage	2		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			8
21. Grazing/Pasturing Livestock			
Total:	**23**	**1**	**8**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

<u>Drinking Water Issues and Conditions</u>

Table 4.25 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.25 Clinton WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.2.3.4 Kelly

The following is a description of the Kelly well system:

- Location: 7 km south of Goderich, 170m from Lake Huron shoreline
- SPA: Well and WHPA are in the MV SPA
- Year constructed: 1981
- Depth: 45.7m
- Users Served: 24
- Design Capacity: 196.1 m^3/day (2.3 litres/sec)
- Permitted Rate: 196.1 m^3/day (2.3 litres/sec)
- Average Usage: 22 m^3/day (2001-2005)*
- Modelled rate: 22 m^3/day *
- Treatment: Chlorination and iron sequestration

  * WNMC et al, 2010

Groundwater Vulnerability

Maps 4.CH.WHPA and 4.Kell show the wellhead protection area (WHPA) extending in a narrow strip about 2 km eastward from the well across cropland, forest and a gully. The only area with a vulnerability score of 10 is the WHPA-A, the 100 m radius around the well. WHPA-B, WHPA-C, and WHPA-D all have vulnerability scores of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Kelly WHPA was adjusted for an undocumented well which was not visited as part of the Well Location Update. In this case, the well were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

Threats and Risks

Table 4.26 Column 1 lists the drinking water threats in Kelly's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.26** also indicates the number of significant threat instances for each threat type.

Map 4.Kell shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, and low.

Table 4.26 Kelly WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
2. Sewage System		10	
10. Pesticide Application	0		
12. Application of Road Salt	0		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	0		
Total:	**0**	**10**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.27 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.27 Kelly WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.2.3.5 McClinchey

The following is a description of the McClinchey well system:

- Location: 5.6 km south of Goderich, 170 m from Lake Huron shoreline
- SPA: Well and WHPA are in the MV SPA
- Year constructed: 1967
- Depth: 43.3 m
- Users Served: 15
- Design Capacity: 100.8 m^3/day (1.1 litres/sec)
- Permitted Rate: 100.8 m^3/day (1.1 litres/sec)
- Average Usage: 8.3 m^3/day (2001 – 2005)*
- Modelled rate: 8 m3/day *
- Treatment: Chlorination and iron sequestration

* WNMC et al, 2010

Groundwater Vulnerability

Maps 4.CH.WHPA and 4.McCl show the wellhead protection area (WHPA) extending about 2 km eastward, widening to 500 metres toward the east end. A vulnerability score of 10 applies to WHPA-A, the 100 m radius around the well. WHPA-B has a vulnerability score of 6, WHPA-C has a score of 4 and WHPA-D has a score of 2.

Aquifer vulnerability was not adjusted for Transport Pathways in the McClinchey WHPA.

Threats and Risks

Table 4.28 Column 1 lists the drinking water threats in McClinchey's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.28** also indicates the number of significant threat instances for each threat type.

Map 4.McCl shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, and low.

Table 4.28 McClinchey WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
2. Sewage System	0	9	
10. Pesticide Application	1		
12. Application of Road Salt	0		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	0		
Total:	**1**	**9**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties

Drinking Water Issues and Conditions

Table 4.29 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.29 McClinchey WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.3 Goderich

The Town of Goderich is located on the shoreline of Lake Huron in the southern portion of the Source Protection Area. The population is approximately 7,600 (7,521 – 2011 Census) and growing modestly. The Town is entirely within the area and obtains drinking water through a Great Lake Intake. The intake also serves a small area south of the Town.

Map 4.GD.IS shows the percentage of impervious surface area; **Map 4.GD.ML** shows the location and percentage of managed lands; and **Map 4.GD.LD** shows the livestock density within vulnerable areas for the Town of Goderich.

4.5.3.1 Goderich – HVAs and SGRAs

Maps 4.GD.HVA and 4.GD.SGRA show the locations of HVAs and SGRAs in Goderich. The vulnerability score for all HVAs is 6; SGRAs are not assigned a score. There are no significant risks within these areas.

Threats and Risks

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in these areas. **Table 4.3** can be used in combination with **Map 4.GD.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in Goderich.

4.5.3.2 Intake Protection Zone – Goderich

The intake for Goderich is located at the southern break wall for the harbour. **Map 4.GD.IPZ** shows that the intake is approximately 500 metres off shore thus the IPZ-1 intersects with the land and is limited on shore to 120 metres. The IPZ -2 extends north into the mouth of the Maitland River, and includes much of the harbour. Given the storm drainage patterns, the IPZ-2 encompasses almost the entire Town (excludes those areas along the Maitland River where storm water discharges into the river because they exceed the 2 hour time of travel). It continues southward inland and crosses into the municipality south of the Town. No IPZ-3 was modeled at this time. It should be noted that the industrial nature of this harbour may prompt the delineation of an IPZ-3 at a later date.

For the Goderich Intake, there was an analysis of the impact of sewer discharges on water quality, specifically alkalinity**.** Storm sewer discharges only occur during and immediately following rainfall events. The purpose of this analysis was to determine if there is a relationship between daily rainfall and alkalinity at the Goderich Water Treatment Plant (WTP). A significant change in alkalinity, corresponding with a rainfall event, might indicate that the Goderich storm drainage outlets influence raw water quality at the WTP inlet. Goderich Water Pollution Control Plant (WPCP) rainfall data was available for 2003 to 2006. Rainfall data for Benmiller, close in proximity to Goderich, was available for 2003 to November 2006 and was used to determine if the nearby Maitland River contributed to changes in alkalinity at the WTP. There were rainfall events where alkalinity in the raw water at the Water Treatment Plant increased by more than 30% in a single day. The analysis concluded that the typical lag of two or more days between a rainfall event and an increase in alkalinity requires further investigation. A rainfall event would also tend to increase river flows and a 2 to 5 day delay between increased river flow and an alkalinity event was previously identified. Therefore, the weak relationship with rainfall identified may also be linked to river discharges.

Map 4.GD.IPZ and Table 4.30 show that the areas within the IPZ-1 have a vulnerability score of 6 and the IPZ-2 area has a vulnerability score of 4.8. **Table 4.30** also indicates the vulnerability scores determined by the consultants and verified through peer review as indicated at the outset of this chapter. The source factor is low given the position of the intake well out into Lake Huron.

While the uncertainty around scoring is somewhat high, given the low scores, no significant risks would be present.

Table 4.30 Goderich Intake – Vulnerability Score Summary

Location	**Vulnerability Factor**		**Source Vulnerability Factor**	**Vulnerability Score**	
	IPZ 1	**IPZ 2**	**-**	**IPZ 1**	**IPZ 2**
Goderich: Lake Huron	10	8 Medium	0.6 Low	6	4.8

(from Baird Phase 2 Addendum, May 2010)

While turbidity after storm events is present, this can be managed by the facility. There are no reports of any issues at this intake; the system is able to meet the required drinking water standards. The system capacity is 11,664 m^3/day (135 litres/sec). The matter of greatest interest is the role of this system within the context of international agreements on water taking from the Great Lakes. At present there is no apprehension about the direction of these agreements as they pertain to the study area.

Threats & Risk

Table 4.31 indicates that no significant risks from chemicals, pathogens, or DNAPLs would be present. **Table 4.5** can be used in combination with **Map 4.Gode** to determine where chemical and pathogen threats can be moderate and low risks in the intake protection zones for the Goderich intake. In addition, the table of drinking water threats within the Technical Rules can be used to determine the types of activities that would be deemed a moderate or low threat in the IPZ.

Table 4.31 Goderich Intake: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
Total:	**0**	**0**	**0**

Table 4.32 indicates that no issues with wells or conditions resulting from past activities were identified within the IPZ.

Table 4.32 Goderich: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.4 Howick

This municipality is located in the northern part of the Source Protection Area. The majority of the municipality is within the MV SPA and has a population of approximately 3,800 people. There are no municipal residential drinking water sources in this area. The population residing throughout the countryside relies on individual wells.

4.5.4.1 Howick – HVAs and SGRAs

Maps 4.HW.HVA and 4.HW.SGRA delineate the locations of HVAs and SGRAs respectively in the municipality. Together the HVAs and SGRAs cover much of the municipality. The vulnerability score for all HVAs is 6; SGRAs are not assigned a score. There are no significant risks within these areas.

Map 4.HW.IS shows the percentage of impervious surface area; **Map 4.HW.ML** shows the location and percentage of managed lands; and **Map 4.HW.LD** shows the livestock density within HVAs and SGRAs for Howick.

Threats and Risk

There are no municipal residential drinking water systems located within the municipality. However, part of the twenty-five year time of travel (WHPA-D) of the Clifford well system does cover a few hectares in the north-east end of the municipality. Nevertheless, no significant threat activities are present within the municipality of Howick. The table of drinking water threats within the Technical Rules can be used to determine the types of activities that would be deemed a moderate or low threat in the HVA.

There are also no known conditions or issues in the municipality (**Table 4.35**).

Table 4.34 Howick Risks to Drinking Water Summary

Threat	Circumstance	Number of Locations
None	None	None

Table 4.35 Howick Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.5 Huron East

The Municipality of Huron East is inland from Lake Huron and adjacent to Perth County. By conservation authority, Huron East is 72% in Maitland Valley and 28% is in Ausable Bayfield. In 2006, the municipality had a population of 9,310, a decline of 3.8% since 2001. The main towns are Seaforth (2006 population 2,634) and Brussels (2001 population 1,143). Cropland is 78% of the land area, dominated by corn, soybeans and winter wheat. Livestock density (cattle: 47.9/km^2; pigs: 298.6/km^2) is high (Statistics Canada 2007).

Map 4.HE.IS shows the percentage of impervious surface area; **Map 4.HE.ML** shows the location and percentage of managed lands; and **Map 4.HE.LD** shows the livestock density within vulnerable areas for Huron East.

4.5.5.1 Huron East – HVAs and SGRAs

Maps 4.HE.HVA and 4.HE.SGRA show the locations of HVAs and SGRAs in Huron East. The HVAs are scattered throughout Huron East with the larger ones tending to be in the north. There are relatively few SGRAs in Huron East. Most areas are narrow eskers or spillways; a larger area in the north-east corner corresponds with a kame. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

<u>Threats and Risks</u>

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in these areas. The table of drinking water threats within the Technical Rules can be used to determine the types of activities that would be deemed a moderate or low threat in the HVA.

There are no known conditions or issues in the municipality.

4.5.5.2 Huron East – Wellhead Protection Areas

Huron East's main well systems are Seaforth and Brussels. There is also a small system located in Brucefield which is in the Ausable Bayfield SPA. A small portion of the Molesworth well system is also located in Huron East. **Map 4.HE.WHPA** shows the WHPA's for these systems. Only WHPAs that fall within the Maitland Valley SPA will be discussed in this section. See the Ausable Bayfield Assessment Report for details on the Brucefield water supply system.

4.5.5.2.1 Brussels

The following is a description of the Brussels well system:

- Location: Well #1: 66 McCutcheon Dr., Well #2: 240 Turnberry St.
- SPA: Well and WHPA are in the MV SPA
- Year constructed: Well #1: 1951, Well #2: 1963
- Depth: Well #1: 60 m, Well #2: 60.4 m
- Users Served: 1800
- Design Capacity: 2,184 m^3/day (25.4 litres/sec)
- Permitted Rate: 1097 m^3/day (12.7 litres/sec)
- Average Usage: combined 537 m^3/day (2001-2001) *
- Modelled rate: Well 1 - 520 m^3/day; Well 2 - 17 m^3/day *
- Treatment: Well #1: Chlorination, Well #2: Chlorination and ultraviolet radiation

* WNMC et al, 2010

<u>Groundwater Vulnerability</u>

Maps 4.HE.WHPA and 4.Brus show that Well #1's WHPA reaches about 1.6 km to the east and 2.5 km to the south of the well. For both Well #1 and #2, WHPA-A and WHPA-B have a vulnerability score of 10, while WHPA-C has a score of 8, and WHPA-D has scores of 6 and 4.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Brussels WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

<u>Threats and Risks</u>

Table 4.36 Column 1 lists the drinking water threats in Brussels' WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario*

Regulation 287/07. No other type of local threat was identified. **Table 4.36** also indicates the number of significant threat instances for each threat type.

Map 4.Brus shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify areas where chemical, pathogen and DNAPL threats can be significant, moderate, or low.

Table 4.36 Brussels WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal system	1		
2. Sewage System	1	1	
7. Non-Agricultural Source Material Handling/Storage	0		
12. Application of Road Salt	7		
13. Storage of Road Salt	7		
14. Storage of Snow	7		
15. Fuel Handling/Storage	2		
16.Dense Non-Aqueous Phase Liquid Storage			4
21. Grazing/Pasturing Livestock	1	0	
Total:	**25**	**1**	**4**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.37 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.37 Brussels WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.5.2.2 Molesworth

The Molesworth municipal well is located in North Perth and extends into Huron East. A description of the Molesworth water supply system and risk assessment can be found in section 4.5.11 under North Perth.

Table 4.38 Deleted (see section 4.5.11)

Table 4.39 Deleted (see section 4.5.11)

4.5.5.2.3 Seaforth

The following is a description of the Seaforth well system:

- Location: 40 Welsh St.
- SPA: Wells located in MV SPA but WHPAs extend into AB SPA
- Year constructed: Well TW1: 2005, Well PW1: 2006, Well PW2: 2007
- Depth: Well TW1: 42.9 m, Well PW1: 105 m, Well PW2: 105 m
- Users Served: 2900
- Design Capacity: All 3 wells: 3456 m^3/day (40 litres/sec)
- Permitted Rate: TW1: 518.4 m^3/day, PW1: 3024 m^3/day, PW2: 3456 m^3/day
- Modelled Rate: 1628 m^3/day (WESA, 2009)
- Treatment: Sodium Hypochlorinate and Sodium Silicate

<u>Groundwater Vulnerability</u>

Maps 4.HE.WHPA and 4.Seaf show that the wellhead protection area (WHPA) is approximately 3 km long and 2.3 km wide. The majority of the WHPA falls into the MV SPA; however, a portion of it falls into the AB SPA. A vulnerability score of 10 applies to WHPA-A, the 100 m radius around the well and a portion of WHPA-B. The remainder of WHPA-B and part of WHPA-C has a vulnerability score of 8. The rest of the WHPA has a vulnerability score of 6 or less.

Aquifer vulnerability within the Seaforth WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.40 Column 1 lists the drinking water threats in Seaforth's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.40** also indicates the number of significant threat instances for each threat type. The Technical Rules provide details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Seaf shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, or low.

Table 4.40 Seaforth WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System		7	
3. Agricultural Source Material Application	2	2	
4. Agricultural Source Material Storage			
6. Non- Agricultural Source Material Application			
7. Non- Agricultural Source Material Handling/Storage			
8. Commercial Fertilizer Application			
10. Pesticide Application	1		
12. Application of Road Salt	3		
13. Storage of Road Salt	3		
14. Storage of Snow	3		
15. Fuel Handling/Storage	2		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			3
21. Grazing/Pasturing Livestock			
Total:	**14**	**9**	**3**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.41 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.41 Seaforth WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.6 Huron-Kinloss

The Township of Huron-Kinloss is located in Bruce County on the Lake Huron shore at the north end of the Maitland Valley Conservation Authority jurisdiction; 43% of the municipality is within the Maitland watershed. The remainder is in Saugeen watershed.In 2006, the population of Huron-Kinloss was 6,515, an increase of 4.7% since 2001. Several of the towns and all the shoreline development, however, are outside the Maitland watershed. The main town within the watershed is Lucknow (2006 population of 1,162). Cropland covers 72.5% of the municipality. Soybeans, winter wheat, corn and alfalfa are the main crops. Livestock density (cattle: 45/km^2; pigs: 40.3/km^2) is higher than the Western Ontario average for cattle but lower for pigs (Statistics Canada 2007).

Map 4.HK.IS shows the percentage of impervious surface area; **Map 4.HK.ML** shows the location and percentage of managed lands; and **Map 4.HK.LD** shows the livestock density within vulnerable areas for Huron-Kinloss.

4.5.6.1 Huron-Kinloss – HVAs and SGRAs

Maps 4.HK.HVA and 4.HK.SGRA show the locations of HVAs and SGRAs in Huron-Kinloss. The HVAs are all in the eastern section of the municipality. SGRAs correspond to coarse-textured physiographic units which generally run north/south across the municipality: a sand plain, spillways and kame moraine. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

Threats and Risks

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in these areas. **Table 4.3** can be used in combination with **Map 4.HK.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in Huron-Kinloss. There are no known conditions or issues in the municipality.

4.5.6.2 Huron-Kinloss – Wellhead Protection Areas

Within the MV SPA, Huron-Kinloss has two well systems: Lucknow and Whitechurch. Part of the WHPA for Lakeshore, a well system outside the Maitland Valley boundary, also extends into the Maitland Valley SPA. In 2018 Ripley was added to the Maitland Valley Assessment Report following the addition of a new well and subsequent WHPA re-delineation. The revised WHPA now extends into the Maitland Valley SPA. **Map 4.HK.WHPA** shows the locations of each of the WHPAs in the municipality.

4.5.6.2.1 Lakeshore (Point Clark)

Part of the WHPA-D extends into the Maitland Valley portion of Huron-Kinloss (**Map 4.HK.WHPA**). The well, the remainder of the WHPA and all significant threats are located in the Saugeen Valley SPA. No issues or conditions have been identified in this area.

4.5.6.2.2 Lucknow

The following is a description of the Lucknow well system:

- Location: Well #4: 533 Hamilton St., Well #5: 399 Bob St.
- SPA: Well and WHPA are in the MV SPA
- Year constructed: Well #4: 1957, Well #5: 1967
- Depth: Well #4: 54.8 m, Well #5: 58.8 m
- Users Served: 1100
- Design Capacity: 3404.16 m^3/day (39.4 litres/sec)
- Permitted Rate: Well #4: 820 m^3/day, Well #5: 3274.56 m^3/day
- Average Usage: 4: 43 m^3/day; 5: 517 m^3/day (2001-2006) *
- Modelled rate: 4: 48 m^3/day; 5: 637 m^3/day *
- Treatment: Chlorination

* CRA, 2007

<u>Groundwater Vulnerability</u>

Maps 4.HK.WHPA and 4.Luck show that the WHPA extends south-eastward from the wells to include about 7.7 km along the south Huron-Kinloss border and into ACW. In Huron-Kinloss, a vulnerability score of 10 applies to WHPA-A for both well number 4 and 5, as well as a small part of WHPA-B for well number 5. The remainder of WHPA-B for well 4 and 5 has vulnerability scores of 8 or 6. WHPA-C has vulnerability scores of 8, 6 and 4, and WHPA-D has vulnerability scores of 6, 4 and 2. Note that the WHPA map was revised in 2014 to reflect updated transport pathway information.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Lucknow WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.42 Column 1 lists the drinking water threats in Lucknow's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.42** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Luck shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, or low.

Table 4.42 Lucknow WHPA: Enumeration of Potential Significant Threats

Threat Type	Significant Instances		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System	1	4	
3. Agricultural Source Material Application		0	
4. Agricultural Source Material Storage		0	
6. Non-Agricultural Source Material Application			
7. Non-Agricultural Source Material Handling/Storage			
8. Commercial Fertilizer Application	1		
9. Commercial Fertilizer Handling/Storage			
10. Pesticide Application	1		
11. Pesticide Handling/Storage			
12. Application of Road Salt	2		
13. Storage of Road Salt	2		
14. Storage of Snow	2		
15. Fuel Handling/Storage	9		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			0
21. Grazing/Pasturing Livestock	2	2	
Total:	**20**	**6**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

<u>Drinking Water Issues and Conditions</u>

Table 4.43 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.43 Lucknow WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.6.2.3 Whitechurch

The following is a description of the Whitechurch well system:

- Location: Whitechurch, Corner of County Rd. 86 and Whitechurch St.
- SPA: Well and WHPA are in the MV SPA
- Year constructed: Well #1: 2008, Well #2: 2007
- Depth: Well #1: 73 m, Well #2: 55 m

- Users Served: 93
- Design Capacity: Well #1: 283 m^3/day, Well #2: 283 m^3/day
- Permitted Rate: Well #1: 283 m^3/day, Well #2: 283 m^3/day
- Average Usage: 25 m^3/day (2001-2006) *
- Modelled flow rate: 29 m^3/day *
- Treatment: Chlorination and iron sequestration

* CRA, 2007

Groundwater Vulnerability

Maps 4.HK.WHPA and 4.Whit show the WHPA extending about 1 km to the north east. A vulnerability score of 10 applies to WHPA-A, the 100 m radius around the well. Most of WHPA-B has a vulnerability score of 8, with the remainder having a score of 6. WHPA-C and WHPA-D have vulnerability scores of 6 or less.

Aquifer vulnerability was not adjusted for transport pathways in the Whitechurch WHPA.

Threats and Risks

Table 4.44 Column 1 lists the drinking water threats in Whitechurch's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.44** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Whit shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, or low.

Table 4.44 Whitechurch WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System		13	
10. Pesticide Application	1		
12. Application of Road Salt	0		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	2		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			0
21. Grazing/Pasturing Livestock	1	1	
Total:	**4**	**14**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.45 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.45 Whitechurch WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.6.2.4 Ripley

The Ripley Municipal Drinking Water System was added to the Maitland Valley (MV) Assessment Report following the addition of a supply well and subsequent WHPA re-delineation in 2017. The well system is located in the Saugeen Valley (SV) SPA. The WHPA-C and D of the newly delineated WHPA extend into the Maitland Valley SPA. As such, this system must be included in the MV Assessment Report and Source Protection Plan.

The description of well system, vulnerable areas and methodologies used to assess threats, transport pathways and vulnerable areas are detailed in the Assessment Report for the Saugeen Valley Source Protection Area (SGSNBP SPR, 2017)

The following is a general description of the Ripley well system:

- Location: Village of Ripley
- SPA: Wells are in the SV SPA; WHPA extends to MV SPA
- Year constructed: Well 1: 1947, Well 2: 1994, Well 3: 2011, Well 4: 2013
- Depth: Well 1: 84m, Well 2:85m, Well 3: 85m, Well 4: 85m
- Users Served: 680 persons
- Design Capacity: Well 1 and 2: 864 m^3/day; Well 3 and 4: Unknown
- Permitted Rate: Well 1 and 2: 864 m^3/day, Well 3 and 4: unknown
- Treatment: Chlorination

Enumeration of Significant Drinking Water Threats is included in Appendix E of the SV SPA Assessment Report (Table 4.6.G1.3 Ripley: Significant Drinking Water Threats by Activity and Land Use in WHPA A-D) (SGSNBP SPR, 2017).No significant threats have been identified for properties in the Maitland Valley portion of the Ripley wellhead protection area at time of writing.

Groundwater Vulnerability

Map 4.Ripl shows the WHPA extending about 18 km to the south-east. A vulnerability score of 10 applies to WHPA-A, the 100 m radius around the well. WHPA-B has a vulnerability score of 6. WHPA-C and WHPA-D have vulnerability scores of 6 or less.

Aquifer vulnerability was not adjusted for transport pathways in the Ripley WHPA.

Map 4.Ripl shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, or low.

4.5.7 Mapleton

This municipality is located in the eastern part of the Source Protection Area. Five percent of the municipality is within the study area having a population of approximately 450 people. There are no municipal residential drinking water sources in this area. The population residing throughout the countryside relies on individual wells.

4.5.7.1 Mapleton – HVAs and SGRAs

No HVA exist in the portion of the municipality within the MV SPA. **Map 4.MP.SGRA** delineates the locations of SGRAs. No significant, moderate, or low drinking water threats exist in these areas.

Since impervious surface, managed lands and livestock density are only mapped in vulnerable areas that have vulnerability scores of 6 or higher, none of these maps were required for Mapleton.

Threats & Risk

As there are no municipal residential drinking water sources there are no significant risks in this area (**Table 4.46**). There are also no known conditions or issues in the in the area (**Table 4.47**).

Table 4.46 Mapleton Risks to Drinking Water Summary

Threat	Circumstance	Number of Locations
None	None	None

Table 4.47 Mapleton Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.8 Minto

The Town of Minto is located in the north-west corner of Wellington County and the north-eastern portion of the Maitland Valley Conservation Authority; 64% of the municipality is in the watershed. In 2006, the population of Minto was 8,504, an increase of 4.2% since 2001. The main towns in the Maitland portion are Harriston (2006 population of 2108) and Palmerston (2006 population of 2,579).

Cropland covers about 77% of the municipality. Soybeans, corn, winter wheat and alfalfa are the main crops. Livestock density (cattle: 49.2/km^2; pigs: 228.7/km^2) is higher than the Western Ontario average (Statistics Canada 2007).

Map 4.MN.IS shows the percentage of impervious surface area; **Map 4.MN.ML** shows the location and percentage of managed lands; and **Map 4.MN.LD** shows the livestock density within vulnerable areas for Minto.

4.5.8.1 Minto – HVAs and SGRAs

Maps and 4.MN.SGRA show the locations of HVAs and SGRAs in Minto. The HVAs are scattered and small. SGRAs correspond to coarse-textured physiographic units: a network of spillways throughout the municipality, a kame moraine area north of Harriston, an esker in the west portion of Minto and scattered drumlins. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

<u>Threats and Risks</u>

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in these areas. **Table 4.3** can be used in combination with **Map 4.MN.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in Minto. The Technical Rules can be used to determine the types of activities that would be deemed a moderate or low threat in the HVA. There are no known conditions or issues in the municipality.

4.5.8.2 Minto – Wellhead Protection Areas

Harriston and Palmerston are the two main Minto well systems in the Maitland watershed. In addition, the well head protection area of Clifford, a town just outside the Maitland Valley watershed, extends into the MV SPA. **Map 4.MN.WHPA** shows the locations of each of the WHPAs in the municipality.

4.5.8.2.1 Clifford

The following is a description of the Clifford well system:

- Location: Well #1: 9 Allan St., Well #3,4: 25 Nelson St.
- SPA: Wells are in the Saugeen Valley SPA, part of WHPA is in the MV SPA
- Year constructed: Well #1: 1964, Well #3: 2004, Well #4: 2004
- Depth: Well #1: 52.4 m, Well #3: 35 m, Well #4: 43 m
- Users Served: 804
- Design Capacity: Well #1: 1304 m^3/day, Well #3: 1304 m^3/day, Well #4: 1304 m^3/day
- Permitted Rate: Well #1: 1304 m^3/day, Well #3: 1304 m^3/day, Well #4: 1304 m^3/day
- Average Usage: Well #1: 170 m^3/day, Well #3: 148 m^3/day, Well #4: 43 m^3/day
- Treatment: Chlorination and iron sequestration

Groundwater Vulnerability

Maps 4.MN.WHPA and 4.Clif indicate that the WHPA extends from the Saugeen Valley SPA into the Maitland Valley SPA about 1.5 km in a 2.5 km wide swath. Most of the WHPA is in Minto but a small portion reaches into the Township of Howick. The WHPA-A for both wells is outside of the MV SPA. The portion of WHPA-B inside the MV SPA has a vulnerability score of 8. All other WHPAs inside the MV SPA have a vulnerability score of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Clifford WHPA was adjusted for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.48 Column 1 lists the drinking water threats in Clifford's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.48** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Clif shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, or low.

Table 4.48 Clifford WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances***		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System	0		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			0
21. Grazing/Pasturing Livestock			
Total:	**0**	**0**	**0**

*Note: enumeration is for MVCA portion of Clifford WHPA only – WPHA-B and WPHA-C; WHPA-A is located in Saugeen SPA. See Saugeen Assessment Report for threat numbers outside Maitland Source Protection Area. Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.49 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.49 Clifford WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.8.2.2 Harriston

The following is a description of the Harriston well system:

- Location: Well #1: 117-131 King St., Well #2: 124 John St., Well #3: 107 King St.
- SPA: Well and WHPA are in the MV SPA
- Year constructed: Well #1: early 1930's, Well #2: 1961, Well #3: 1998
- Depth: Well #1: 61 m, Well #2: 59 m, Well #3: 56.6 m
- Users Served: 2108
- Design Capacity: Well #1: 976 m^3/day (11.3 litres/sec), Well #2: 2065 m^3/day (23.9 litres/sec), Well #3: 1633 m^3/day (18.9 litres/sec)
- Permitted Rate: Well #1: 976 m^3/day (11.3 litres/sec), Well #2: 2065 m^3/day (23.9 litres/sec), Well #3: 1633 m^3/day (18.9 litres/sec)
- Average Usage: Well #1: 475 m^3/day Well #2: 485.3 m^3/day, Well #3: 514.9 m^3/day
- Modelled rate: 1,374 m^3/day *
- Treatment: Chlorination and iron sequestration

* WNMC et al, 2010

<u>Groundwater Vulnerability</u>

Maps 4.MN.WHPA and **4.Harr** show the WHPA to be 6.8 km long and 2.9 km wide at its widest point, extending south-east and across the North Maitland River from the wells. A vulnerability score of 10 applies to WHPA-A, the 100 m radius around the wells. WHPA-B for both wells has a vulnerability score of 8. WHPA-C and WHPA-D have scores of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Harriston WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer

Note that vulnerability was revised in 2014 to reflect updated transport pathway information.

Threats and Risks

Table 4.50 Column 1 lists the drinking water threats in Harriston's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.50** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats.

Map 4.Harr shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, and low.

Table 4.50 Harriston WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances***		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System	1	1	
12. Application of Road Salt	4		
13. Storage of Road Salt	4		
14. Storage of Snow	4		
15. Fuel Handling/Storage	1		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			10
Total:	**14**	**1**	**10**

*Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.51 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.51 Harriston WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.8.2.3 Palmerston

The following is a description of the Palmerston well system:

- Location: Well 1 and 2: 215 William St., Well 3 and 4: 445 Whites Rd.
- SPA: Well and WHPA in MV SPA
- Year constructed: Well 1: 1928, Well 2: 1956, Well 3: 1956, Well 4: 2012
- Depth: Wells 1: 27.3 m, Well 2; 30.5 m, Well 3: 53.3 m: Well 4: 45.7 m
- Users Served: 2579
- Design Capacity: Well 1: 1970 m^3/day, Well 2: 1970 m^3/day, Well 3: 2307 m^3/day; Well 4: 2291 m^3/day
- Permitted Rate: 1,964 m^3/day (22.8 litres/sec) for Wells 1 and 2 combined, and 2,291 m^3/day (26.66 litres/sec) for Well #3 and Well #4 combined
- Average Usage: usage for Wells 1 and 2 combined was 207.9 m^3/day, Well 3: 499.2 m^3/day*
- Modelled rate: 1,2: 512 m^3/day; 3: 704 m^3/day *
- Treatment: Chlorination and iron sequestration

* WNMC et al, 2010

Note that Well 4 was constructed after the WHPA delineations were completed and therefore was not included in the initial maps. It is located approximately 17 metres from Well 3. Wells 3 and 4 supply the White's Road wellhouse and alternate duties as primary supply. WHPA-A for wells 3 and 4 has been adjusted to incorporate Well 4 and the maps amended accordingly (2023 amendment). No change was made to the remainder of the WHPA.

Groundwater Vulnerability

Maps 4.MN.WHPA and 4.Palm show the WHPA to be 4.6 km long and 2.7 km wide at its widest point and extending into North Perth. Only WHPA-A has a vulnerability score of 10, which is entirely within Minto. WHPA-B has vulnerability scores of 8 and 6. WHPA-C has a small portion with a score of 8, with the remainder of the zone scoring 6 or less. WHPA-D has scores of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Palmerston WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer. Note that the vulnerability was revised in 2014 to reflect updated transport pathway information.

Threats and Risks

Table 4.52 Column 1 lists the drinking water threats in Palmerston's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.52** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Palm shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, and low.

Table 4.52 Palmerston WHPA: Enumeration of Potential Significant Threats

Threat Type	Significant Instances		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	0		
2. Sewage System	1	1	
3. Agricultural Source Material Application	0	0	
4. Agricultural Source Material Storage			
6. Non-Agricultural Source Material Application			
7. Non- Agricultural Source Material Handling/Storage			
8. Commercial Fertilizer Application			
10. Pesticide Application			
11. Pesticide Handling/Storage			
12. Application of Road Salt	4		
13. Storage of Road Salt	4		
14. Storage of Snow	2		
15. Fuel Handling/Storage	2		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			6
21. Grazing/Pasturing Livestock			
Total:	**13**	**1**	**6**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties

Drinking Water Issues and Conditions

Table 4.53 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.53 Palmerston WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.9 Morris-Turnberry

The Municipality of Morris-Turnberry is located in north Huron County and central Maitland Valley watershed, extending northward so 5% is outside the Source Protection Region and in the Saugeen Valley watershed. In 2006, Morris-Turnberry population was 3,403, a decline of 2.7% since 2001. The municipality includes no large towns although it surrounds Wingham, a separate municipality. Land use is 55.8% cropland, largely soybeans, corn, alfalfa and winter wheat. Much of the remainder is forested. Livestock density (cattle: 55.8/km^2; pigs: 252.1/km^2) is high for both Huron County and Western Ontario (Statistics Canada 2007).

Map 4.MT.IS shows the percentage of impervious surface area; **Map 4.MT.ML** shows the location and percentage of managed lands, and **Map 4.MT.LD** shows the livestock density within vulnerable areas for Morris-Turnberry.

4.5.9.1 Morris-Turnberry – HVAs and SGRAs

Maps 4.MT.HVA and 4.MT.SGRA show the locations of HVAs and SGRAs in Morris-Turnberry. The HVAs are throughout the municipality with the largest area along the east side. SGRAs correspond to coarse-textured physiographic units which form a dense network across the municipality: spillways, kame moraine and drumlines. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

<u>Threats and Risks</u>

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in this area. Table 4.3 can be used in combination with **Map 4.MT.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in Morris-Turnberry. There are no known conditions or issues in the municipality.

4.5.9.2 Morris-Turnberry – Wellhead Protection Areas

Belgrave is the only WHPA entirely in the municipality. Parts of WHPAs for Wingham, Blyth and Brussels fall within Morris-Turnberry. **Map 4.MT.WHPA** shows the WHPA’s for each of these systems.

4.5.9.2.1 Belgrave

The following is a description of the Belgrave well system:

- Location: New McCrea St. Well: 23 McCrea St., Jane St. Well: 32 Hamilton St.
- SPA: Well and WHPA in MV SPA
- Year constructed: New McCrea St. Well:2021, Jane St. Well: 1983
- Depth: New McCrea St. Well: 42.7 m, Jane St. Well: 42.4 m
- Users Served: 245
- Design Capacity: 596 m^3/day (6.9 litres/sec)
- Permitted Rate: 501.1 m^3/day (5.8 litres/sec) (2021)
- Average Usage: 40 m^3/day (1999); 88.7 m^3/day (2018-2020)*
- Modelled rate: 88.7 m^3/day *
- Treatment: Chlorination and Filtration

*Burnside, 2021

Note that the McCrea Street well was replaced in 2022. The new well is located about 15 metres from the former well, and is completed in the same bedrock formation. WHPA-A was shifted accordingly. The pumping rate has doubled since the WHPA was modelled, so WHPAs B, C and D were expanded based on ratios of current to modelled rate (R.J.Burnside, 2021)

Groundwater Vulnerability

Maps 4.MT.WHPA and 4.Belg show that the WHPA extends about 5 km southward from the wells and away from Belgrave Creek over agricultural land and some forest. A vulnerability score of 10 applies only to WHPA-A, the 100 m radius around the wells. A portion of WHPA-B has a vulnerability score of 8, while the remainder has a score of 6. WHPA-C and WHPA-D have vulnerability scores of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Belgrave WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.54 Column 1 lists the drinking water threats in Belgrave's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.54** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Belg shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen, and DNAPL threats can be significant, moderate, or low.

Table 4.54 Belgrave WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per the *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	1		
2. Sewage System		46	
12. Application of Road Salt	NA		
13. Storage of Road Salt	1		
14. Storage of Snow	0		
15. Fuel Handling/Storage	1		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			2
Total:	**3**	**46**	**2**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties

Drinking Water Issues and Conditions

Table 4.55 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.55 Belgrave WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.9.2.2 Blyth

The Blyth municipal wells are located in the Municipality of North Huron and extend into Morris-Turnberry. A description of the Blyth water supply system and risk assessment can be found in section 4.5.10 under North Huron.

Table 4.56 Deleted (see section 4.5.10)

Table 4.57 Deleted (see section 4.5.10)

4.5.9.2.3 Brussels

The Brussels municipal wells are located in the Municipality of Huron East and extend into Morris-Turnberry. A description of the Brussels water supply system and risk assessment can be found in section 4.5.5 under Huron East.

Tabe 4.58 Deleted (see section 4.5.5)

Table 4.59 Deleted (see section 4.5.5)

4.5.9.2.4 Wingham

The Wingham municipal wells are located in the Municipality of North Huron and extend into Morris-Turnberry. A description of the Wingham water supply system and risk assessment can be found in section 4.5.10 under North Huron.

Table 4.60 Deleted (see section 4.5.10)

Table 4.61 Deleted (see section 4.5.10)

4.5.10 North Huron

The Municipality of North Huron is located in central Maitland Valley Conservation Authority, entirely within its jurisdiction. In 2006, the municipality's population was 5,015, an increase of 0.6% from 2001. North Huron includes the former Town of Blyth (2001 population of 987), the former Town of Wingham (population 1000), and the former Township of East Wawanosh (population 1000). Land use is 48% cropland, largely soybeans, corn, and alfalfa. Much of the remainder is forested land associated with spillways and kame moraines. Livestock density (cattle: 70.5/km^2; pigs: 83.4/km^2) is well above the Huron County average for cattle, though below Huron County and about equal to Western Ontario for pigs (Statistics Canada 2007).

Map 4.NH.IP shows the percentage of impervious surface area; **Map 4.NH.ML** shows the location and percentage of managed lands, and **Map 4.NH.LD** shows the livestock density within vulnerable areas for North Huron.

4.5.10.1 North Huron – HVAs and SGRAs

Maps 4.NH.HVA and 4.NH.SGRA show the locations of HVAs and SGRAs in North Huron. The larger HVAs are all in the south half of the municipality. SGRAs correspond to coarse-textured physiographic units which cover much of the municipality. They include spillways, kame moraines and drumlins. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

Threats and Risks

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in this area. **Table 4.3** can be used in combination with **Map 4.NH.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in North Huron. There are no known conditions or issues in the municipality.

4.5.10.2 North Huron – Wellhead Protection Areas

Blyth and Wingham are North Huron's only municipal well systems. Most of Auburn's WHPA, however, extends into North Huron. In addition, a sliver of Whitechurch's WHPA crosses into the Municipality. **Map 4.NH.WHPA** shows the WHPAs for each of these systems. Note that the Blyth WHPA was revised in 2017 to reflect the addition of Well #5.

4.5.10.2.1 Auburn

The Auburn municipal well is located in Central Huron and extends into North Huron and ACW. A description of the Auburn water supply system and risk assessment can be found in section 4.5.2 under Central Huron.

Table 4.62 Deleted (see section 4.5.2)

Table 4.63 Deleted (see section 4.5.2)

4.5.10.2.2 Blyth

The following is a description of the Blyth well system. Note that an additional groundwater well, Well # 5, was put into service in December, 2016, as a second isolated source of water for this system. Well # 5 supplements the current water needs and is part of a planned upgrade to the Blyth water system.

- Location: Well #1 and 2: 201 Thuell Rd;,Well # 5:377 Gypsy Lane Blyth
- SPA: Well and WHPA in MV SPA
- Year constructed: Well #1: 1953, Well #2: 1972; Well # 5: 2015
- Depth: Well #1: 73.2 m, Well #2: 79.25 m; Well # 5: 83.5 m
- Users Served: 975
- Design Capacity: 2877 m^3/day (33.3 litres/sec)
- Permitted Rate: 3505 m^3/day (40.6litres/sec)
- Average Usage: 400 m^3/day (2005-2014) *
- Modelled rate: 400 m^3/day *
- Treatment: Chlorination and Iron Sequestration

*WNMC, 2015

<u>Groundwater Vulnerability</u>

An updated groundwater model and WHPA delineation to include Well # 5 was completed by Waterloo Numerical Modelling Corporation in 2015 ((WNMC*, 2015*). The methodology to complete the updated WHPA delineation was consistent with that used in previous studies for this region, as described in Section 4.2 above. The Assessment Report maps were revised accordingly and submitted as an amendment of the Source Protection Plans as per Section 34 of the *Clean Water Act, 2006*. The amendment was approved in 2019.

Maps 4.NH.WHPA and 4.Blyt show the WHPA about 2 km long, extending generally northeast from the wells. The North Huron portion includes all of the WHPA-A and WHPA-B which have vulnerability scores of 10 and 8. The majority of WHPA-C is in North Huron and has vulnerability scores of 8 and 6. WHPA-D is split between North Huron and Morris-Turnberry and has scores of 6, 4 and 2.

Aquifer vulnerability was not adjusted for transport pathways in the Blyth WHPA.

Threats and Risks

Table 4.64 Column 1 lists the drinking water threats in Blyth's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of Ontario Regulation 287/07. No other type of local threat was identified. **Table 4.64** also indicates the number of significant threat instances for each threat type. No other local circumstances were identified.

Map 4.Blyt shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen, and DNAPL threats can be significant, moderate, or low.

Table 4.64 Blyth WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	1		
2. Sewage System			
3. Agricultural Source Material Application	1	1	
4. Agricultural Source Material Storage	0	1	
6. Non- Agricultural Source Material Application			
7. Non- Agricultural Source Material Handling/Storage			
8. Commercial Fertilizer Application	0		
10. Pesticide Application	0		
11. Pesticide Handling/Storage			
12. Application of Road Salt	3		
13. Storage of Road Salt	3		
14. Storage of Snow	3		
15. Fuel Handling/Storage	1		
16. Dense Non-Aqueous Phase Liquid Handling and Storage			3
21. Grazing and Pasturing Livestock	1	1	
Total:	**13**	**3**	**3**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.65 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.65 Blyth WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.10.2.3 Whitechurch

The Whitechurch well is located in Huron-Kinloss and extend into North Huron. A description of the Whitechurch water supply system and risk assessment can be found in section 4.5.6 under Huron-Kinloss.

Table 4.66 Deleted

Table 4.67 Deleted

4.5.10.2.4 Wingham

The following is a description of the Wingham well system:

- Location: Well #3 - Arthur St.; Well #4 23 Albert St W., Wingham
- SPA: Well and WHPA are in the MV SPA
- Year constructed: Well #3: 1973, Well #4: 1996
- Depth: Well #3: 102.1 m, Well #2: 92.3 m
- Users Served: 2,845
- Design Capacity: 11,836.8 m^3/day
- Permitted Rate: 11,816.2 m^3/day
- Average Usage: combined average 1797 m^3/day (1997-2001) *
- Modelled rate: 1797 m^3/day *
- Treatment: Chlorination and Iron Sequestration

*WNMC et al, 2010

<u>Groundwater Vulnerability</u>

Maps 4.NH.WHPA and 4.Wing show the WHPA to be a broad oval shape (approximately 5 km by 3.4 km) extending west and north from the wells. Most of the WHPA is in Morris-Turnberry; however, both wellheads are located in North Huron. A vulnerability score of 10 applies to WHPA-A, the 100 m radius around the wells. WHPA-B for the two wells have vulnerability scores of 8 and 6. The portions of WHPA-C and WHPA-D that are located in North Huron have vulnerability scores of 4 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Wingham WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Note that the vulnerability was adjusted in 2022 to reflect updated transport pathway information for Wingham. Several assumed wells were removed and the location of other wells was corrected.

Threats and Risks

Table 4.68 Column 1 lists the drinking water threats in Wingham's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.68** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats.

Map 4.Wing shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, and low.

Table 4.68 Wingham WHPA: Enumeration of Potential Significant Threats

Threat Type	Significant Instances		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	1		
2. Sewage System	1	3	
7. Non- Agricultural Source Material Handling/Storage	0	0	
10. Pesticide Application	0		
12. Application of Road Salt	5		
13. Storage of Road Salt	3		
14. Storage of Snow	5		
15. Fuel Handling/Storage	1		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			10
Total:	**16**	**3**	**10**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

<u>Drinking Water Issues and Conditions</u>

Table 4.69 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.69 Wingham WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.11 North Perth

North Perth is located in the north end of Perth County at the headwaters of the Middle and Little Maitland Rivers. Maitland Valley Conservation Authority jurisdiction applies to 98% of the municipality. North Perth abuts Upper Thames River Conservation Authority in the south and Grand River Conservation Authority in the east. In 2006, the municipality's population was 12,254, an increase of 1.7% since 2001. Listowel is the major town (2006 population of 6,303). Other settlements include: Atwood (2001 population of 278), Britton, Donegal, Gowanstown, Kurtzville, Monkton, Newry, Trowbridge and Wallace. Land use is 80.4% cropland, largely corn, soybeans, alfalfa and winter wheat. Livestock density (cattle: 79.4/km^2; pigs: 242.7/km^2) is high: slightly above Perth County averages for cattle and slightly below for pigs but well above Western Ontario averages for both (Statistics Canada 2007).

Map 4.NP.IP shows the percentage of impervious surface area; **Map 4.NP.ML** shows the location and percentage of managed lands, and **Map 4.NP.LD** shows the livestock density within vulnerable areas for North Perth.

4.5.11.1 North Perth – HVAs and SGRAs

Maps 4.NP.HVA and 4.NP.SGRA show the locations of HVAs and SGRAs in North Perth. The HVAs are few and very small. SGRAs correspond to coarse-textured physiographic units that are also infrequent in North Perth. They include a spillway network associated with the Little Maitland River in the north part of the municipality as well as a few drumlins and eskers. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

<u>Threats and Risks</u>

Since the vulnerability scores for the HVAs are 6 or less, only moderate and low drinking water threats may exist in this area. **Table 4.3** can be used in combination with **Map 4.NP.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in North Perth. There are no known conditions or issues in the municipality.

4.5.11.2 North Perth – Wellhead Protection Area

North Perth's main well system is at Listowel. Smaller well systems in the municipality are Molesworth, Atwood and Gowanstown. The Palmerston system, although in Minto, extends its WHPA into North Perth. **Map 4.NP.WHPA** shows the WHPAs for each of these systems.

4.5.11.2.1 Atwood

The following is a description of the Atwood well system:

- Location: Atwood, south part of the Hamlet
- SPA: Well and WHPA are in the MV SPA
- Year constructed: Well #1: 1997, Well #2: 2003
- Depth: Well #1: 24.4 m, Well #2: 49 m
- Users Served: 250
- Design Capacity: Well #1: 326 m^3/day, Well #2: 265 m^3/day
- Permitted Rate: Well #1: 326 m^3/day, Well #2: 265 m^3/day
- Average Usage: 69 m^3/day (2001-2005) *
- Modelled rate: Well 1: 36 m^3/day ; Well 2: 33 m^3/day *
- Treatment**:** Chlorination and iron sequestration

*WNMC et al, 2010

<u>Groundwater Vulnerability</u>

Maps 4.NP.WHPA and 4.Atwo show that the WHPA is a very narrow strip extending eastward about 7.3 km. A vulnerability score of 10 applies to the 100 m radius of the two WHPA-As, both associated with residential uses, as well as to a narrow (approximately 20 m wide) scrubland strip about ½ km east of Well #2. A vulnerability score of 8 applies to a small area in town between the two wells and to several narrow strips in agriculture and scrubland just east of Atwood; all areas with vulnerability scores of 8 are in WHPA-B. The remainder of the WHPA has a vulnerability score of 6 or less.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Atwood WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for an undocumented well which was not visited as part of the Well Location Update. In this case, the well was assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.70 Column 1 lists the drinking water threats in the Atwood WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.70** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Atwo shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen, and DNAPL threats can be significant, moderate, or low.

Table 4.70 Atwood WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	1		
2. Sewage System		0	
3. Agricultural Source Material Application	0	0	
4. Agricultural Source Material Storage			
6. Non- Agricultural Source Material Application			
7. Non- Agricultural Source Material Handling/Storage			
8. Commercial Fertilizer Application			
9. Commercial Fertilizer Handling/Storage			
10. Pesticide Application	0		
12. Application of Road Salt	2		
13. Storage of Road Salt	2		
14. Storage of Snow	2		
15. Fuel Handling/Storage	1		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			1
21. Grazing/Pasturing Livestock	0	1	
Total:	**5**	**6**	**2**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.71 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.71 Atwood WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.11.2.2 Gowanstown

The following is a description of the Gowanstown well system:

- Location: Gowanstown, 50 m east of Wallace Ave. in the south end
- SPA: Well and WHPA are in the MV SPA
- Year constructed: 1964
- Depth: 36.6 m

- Users Served: 70
- Design Capacity: 131 m^3/day (1.5 litres/sec)
- Permitted Rate: 71 m^3/day (0.8 litres/sec)
- Average Usage: 11 m^3/day (2002-2005) *
- Modelled rate: 11 m^3/day
- Treatment: Chlorination

* WNMC et al, 2010

<u>Groundwater Vulnerability</u>

Maps 4.NP.WHPA and 4.Gowashow the WHPA as a very narrow strip extending east-north-east about 7.6 km. The only area with a vulnerability score of 10 applies to the 100 m radius of WHPA-A. WHPA-B has a vulnerability score of 6, and WHPA-C and D have vulnerability scores of 4 and 2.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Gowanstown WHPA was adjusted for an undocumented well that was inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). This well was located as part of the project, and was found to be out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the well, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

<u>Threats and Risks</u>

Table 4.72 Column 1 lists the drinking water threats in Gowanstown's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.72** also indicates the number of significant threat instances for each threat type.

The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Gowa shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen, and DNAPL threats can be significant, moderate, or low.

Table 4.72 Gowanstown WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
2. Sewage System	0	17	
12. Application of Road Salt	0		
13. Storage of Road Salt	0		
14. Storage of Snow	0		
15. Fuel Handling/Storage	0		
Total:	**0**	**17**	**0**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

<u>Drinking Water Issues and Conditions</u>

Table 4.73 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.73 Gowanstown WHPA: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.11.2.3 Listowel

The following is a description of the Listowel well system:

- Location: Well #4: Wallace Ave., Well #5: 580 Main St., Well #6: Bright St.
- SPA: Wells and WHPA are in the MV SPA
- Year constructed: Well #4: 1946, Well #5: 1962, Well #6: 1989
- Depth: Well #4: 92.4 m, Well #5: 92.7 m, Well #6: 118.6 m
- Users Served: 5900
- Design Capacity: 9819 m^3/day (113.7 litres/sec)

- Permitted Rate: 9819 m^3/day (113.7 litres/sec)
- Average Usage: combine average of 2307 m^3/day (2001-2005) *
- Modelled rate: Well 4 - 795 m^3/day; Well 5 – 693 m^3/day ; Well 6 – 819 m3/day *
- Treatment: Chlorination
  * WNMC et al, 2010

Groundwater Vulnerability

Maps 4.NP.WHPA and 4.List show the WHPAs all extend east-north-east: Well #4's for about 7.4 km, Well #5's for about 8.9 km, and Well # 6's for about 10 km including about 2 km into the Grand River SPA. For all three wells, only WHPA-A has a vulnerability score of 10. The WHPA-Bs have a vulnerability score of 8 or 6, and WHPA-Cs and WHPA-Ds all have vulnerability scores of 6 or less

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Listowel WHPA was adjusted for several undocumented wells that were inspected and georeferenced as part of the Well Location Update completed by the Ausable Bayfield Maitland Valley Source Protection Region (2007). These wells were located as part of the project, and were found to have wells that are out of compliance with provincial requirements for well construction. Vulnerability was adjusted one level for a 30m area surrounding the wells, based on the updated coordinates.

Additional adjustments were completed for undocumented wells which were not visited as part of the Well Location Update. In these cases, wells were assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.74 Column 1 lists the drinking water threats in Listowel's WHPAs. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.List shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen, and DNAPL threats can be significant, moderate, or low.

Table 4.74 Listowel Wells #4, 5 and 6 WHPAs: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	1		
2. Sewage			
12. Application of Road Salt	12		
13. Storage of Road Salt	4		
14. Storage of Snow	8		
15. Fuel Handling/Storage	3		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			5
Total:	**28**	**0**	**75**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Table 4.75 (Deleted, 2014)

Table 4.76 (Deleted, 2014)

Drinking Water Issues and Conditions

Table 4.77 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.77 Listowel Well #4, #5, and #6 WHPAs: Issues and Conditions

Drinking Water Issue	**Parameter**
None	None
Drinking Water Condition	**Threat**
None	None

4.5.11.2.4 Molesworth

The following is a description of the Molesworth well system:

- Location: 8116-8112 Road 177
- SPA: Well and WHPA are in the MV SPA

- Year constructed: 2010 (located approximately 13 metres north-west of the former well)
- Depth: 47.8 m
- Users Served: 43 connections
- Design Capacity: 190 m^3/day (2.2 litres/sec)
- Permitted Rate: 190 m^3/day (2.2 litres/sec)
- Average Usage: 19.5 m3/day (2018-2020)
- Modelled rate: 30 m^3/day *
- Treatment: Chlorination and iron sequestration

* WNMC et al, 2010

Note that the Maps were revised in 2017 to reflect replacement of the well in 2010. As this was considered to be a minor change, a new groundwater model and delineation was not required, as per SPC direction. Rather, the WHPA was shifted to account for the new well location. The updated maps were submitted as an amendment of the Source Protection Plans as per Section 34 of the *Clean Water Act, 2006.*

Groundwater Vulnerability

Maps 4.NP.WHPA and 4.Mole show the WHPA as a narrow strip extending south-east over 6 km. The entire WHPA falls within the municipality of North Perth except for a very small portion of WHPA-A that reaches into Huron East. WHPA-A has a vulnerability score of 10, WHPA-B has a score of 6, WHPA-C has a score of 4 and WHPA-D has scores of 4 or 2.

A review of transport pathways was conducted with the following results. Aquifer vulnerability within the Molesworth WHPA was adjusted for an undocumented well which was not visited as part of the Well Location Update. In this case, the well was assumed to be within 30m of the principal structure on the property, and vulnerability was therefore adjusted for 60m surrounding the principal structure to account for the uncertainty with both the location of the well and the condition of the well.

No adjustments to the urban area were incorporated into the WHPA as all residences are on municipal water, there were not sufficient records of wells which pre-date the system, and the depth to the services (placed at typical depths) are insignificant in comparison to the depth to the municipal supply aquifer.

Threats and Risks

Table 4.78 Column 1 lists the drinking water threats in Molesworth's WHPA. They are all prescribed drinking water threats listed in Subsection 1.1(1) of *Ontario Regulation 287/07*. No other type of local threat was identified. **Table 4.78** also indicates the number of significant threat instances for each threat type. The table of drinking water threats within the Technical Rules provides details on circumstances pertaining to these threats. No other local circumstances were identified.

Map 4.Mole shows the WHPA and vulnerability scores. It can be used with Table 4.6 to identify the areas where chemical, pathogen and DNAPL threats can be significant, moderate, or low.

Table 4.78 Molesworth WHPA: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered according to *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	1		
2. Sewage System		14	
3. Agricultural Source Material Application	0	0	
12. Application of Road Salt	1		
13. Storage of Road Salt	1		
14. Storage of Snow	1		
15. Fuel Handling/Storage	2		
16. Dense Non-Aqueous Phase Liquid handling/Storage			1
Total:	**6**	**14**	**1**

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Drinking Water Issues and Conditions

Table 4.79 indicates that no issues with wells or conditions resulting from past activities were identified within the WHPA.

Table 4.79 Molesworth WHPA: Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.11.2.5 Palmerston

The Palmerston municipal wells are located in Minto and extend into North Perth. A description of the Palmerston water supply system and risk assessment can be found in section 4.5.8 under Minto.

Table 4.80 Deleted

Table 4.81 Deleted

4.5.12 Perth East

This municipality is located in the southern part of the Source Protection Area. Nine per cent of the municipality is within the study area having a population of approximately 1,100 people. The population residing throughout the countryside relies on individual wells.

Map 4.PE.IS shows the percentage of impervious surface area; **Map 4.PE.ML** shows the location and percentage of managed lands, and **Map 4.PE.LD** shows the livestock density within vulnerable areas for Perth East.

4.5.12.1 Perth East – HVAs and SGRAs

Maps 4.PE.HVA and 4.PE.SGRA show the locations of HVAs and SGRAs in the Municipality. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

Threats & Risk

As there are no municipal residential drinking water sources and HVAs score 6 or less, there are no significant risks in this area (**Table 4.82**). **Table 4.3** can be used in combination with **Map 4.PE.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in Perth East. There are no known conditions or issues in the portion of the municipality within the Maitland Valley SPA (**Table 4.83**).

Table 4.82 Perth East Risks to Drinking Water Summary

Threat	Circumstance	Number of Locations
None	None	None

Table 4.83 Perth East Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.13 South Bruce

This Township is located in the northern part of the Source Protection Area. Only one percent of the land area is within the study area. The population in this area is approximately 60 people. There are no municipal residential drinking water sources in this area. The population relies on individual wells.

Map 4.SB.IS shows the percentage of impervious surface area; **4.SB.ML**shows the location and percentage of managed lands, and **4.SB.LD** shows the livestock density within vulnerable areas for South Bruce.

4.5.13.1 South Bruce – HVAs and SGRAs

Maps 4.SB.HVA and 4.SB.SGRA delineate the locations of HVAs and SGRAs in the municipality. Almost the entire area is either SGRA or HVA. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score. There are no significant risks associated with SGRA or HVA.

Threats & Risk

As there are no municipal residential drinking water sources and the vulnerability scores for HVAs are less than 6, there are no significant risks in this area (**Table 4.84**). **Table 4.3** can be used in combination with **Maps 4.SB.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in South Bruce. There are no known conditions or issues in the portion of the municipality within the MV SPA (**Table 4.85**).

Table 4.84 South Bruce Risks to Drinking Water Summary

Threat	Circumstance	Number of Locations
None	None	None

Table 4.85 South Bruce Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.14 Wellington North

This Township is located in the northeastern part of the Source Protection Area and sixteen percent of the municipality is in the study area, having a population of about 1,800. There are no residential municipal drinking water sources in this area. This area has a dispersed population which is rural in character and the majority of the population relies on individual wells.

Map 4.WN.IS shows the percentage of impervious surface area; **Map 4.WN.ML** shows the location and percentage of managed lands, and **Map 4.WN.LD** shows the livestock density within vulnerable areas for Wellington North.

4.5.14.1 Wellington North – HVAs and SGRAs

Maps 4.WN.HVA and 4.WN.SGRA delineate the locations of HVAs and SGRAs in the Municipality. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score. There are no significant risks.

Threats & Risk

As there are no municipal residential drinking water sources there are no significant risks in this area (**Table 4.86**). **Table 4.3** can be used in combination with **Map 4.WN.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in Wellington North. There are no known conditions or issues in the portion of the municipality within the MV SPA (**Table 4.87**).

Table 4.86 Wellington North Risks to Drinking Water Summary

Threat	Circumstance	Number of Locations
None	None	None

Table 4.87 Wellington North Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.5.15 West Perth

This municipality is located in the southeastern part of the Source Protection Area. The portion of the municipality within the study area represents approximately three percent of the land mass and a population of approximately 230 people. There are no municipal residential drinking water sources in this predominantly rural area. Therefore, the majority of the population within this area relies on individual wells.

Map 4.WP.IS shows the percentage of impervious surface area; **Map** 4**.WP.ML** shows the location and percentage of managed lands, and **Map 4.WP.LD** shows the livestock density within HVAs and SGRAs (where the vulnerability score is 6) for West Perth.

4.5.15.1 West Perth – HVAs and SGRAs

Maps 4.WP.HVA and 4.WP.SGRA delineate the locations of HVAs and SGRAs respectively in the municipality. The vulnerability score for all HVAs is 6, while SGRAs are not assigned a score.

Threats & Risk

As there are no municipal residential drinking water sources there are no significant risks in this area (**Table 4.88**). **Table 4.3** can be used in combination with **Map 4.WP.HVA** to determine where chemical, pathogen, and DNAPL threats can be moderate and low risks in HVAs in West Perth. There are no known conditions or issues in the portion of the municipality within the MV SPA (**Table 4.89**).

Table 4.88 West Perth Risks to Drinking Water Summary

Threat	Circumstance	Number of Locations
None	None	None

Table 4.89 West Perth Issues and Conditions

Drinking Water Issue	Parameter
None	None
Drinking Water Condition	**Threat**
None	None

4.6 Maitland Valley SPA - Summary

Table 4.90 shows a summary of all of the potential significant threats for the MV SPA by parcel. These numbers represent the best information available at the time of writing. It is anticipated that numbers will vary over time, according to changes in land use, and as additional information becomes available. In 2017, the threat numbers for Benmiller, Blyth and Dungannon were updated to reflect changes in these WHPAs. In 2022, numbers were updated to reflect property changes and to address the amended 2021 Technical Rules, which recreated potential significant threats for snow and salt activities. Note that the numbers for snow and salt activities in particular are estimates, based on desktop assessment of land use. It is anticipated that these numbers will drop significantly once the activities can be confirmed.

Certain types of activities on residential sites that are incidental in nature and may be significant threats are not enumerated. These activities include storage of DNAPLs, storage of road salt and application of road salt, on residential properties.

Table 4.90 All* WHPAs: Enumeration of Potential Significant Threats

Threat Type	**Significant Instances**		
(numbered per *Clean Water Act, 2006*)	**Chemicals**	**Pathogens**	**DNAPL**
1. Waste Disposal Site	7	0	
2. Sewage System	6	158	
3. Agricultural Source Material Application	3	3	
4. Agricultural Source Material Storage	0	1	
6. Non- Agricultural Source Material Application	0	0	
7. Non- Agricultural Source Material Handling/Storage	0	0	
8. Commercial Fertilizer Application	3		
9. Commercial Fertilizer Handling/Storage	1		
10. Pesticide Application	6		
11. Pesticide Handling/Storage	0		
12. Application of Road Salt	53		
13. Storage of Road Salt	40		
14. Storage of Snow	47		
15. Fuel Handling/Storage	36		
16. Dense Non-Aqueous Phase Liquid Handling/Storage			53
21. Grazing/Pasturing Livestock	4	5	
Total:	**206**	**167**	**53**

*Atwood, Auburn, Belgrave, Benmiller, Blyth, Brussels, Century Heights, Clifford, Clinton, Dungannon, Gowanstown, Harriston, Huron Sands, Kelly, Listowel (Wells 4, 5, 6), McClinchey, Molesworth, Palmerston, Wingham, Lucknow, Seaforth, Whitechurch

References

Author & Publisher	Title	Date	Purpose
WNM Corp, BM Ross, IWS (WNMC et al, 2010)	Final Phase I Report ABCA / MVCA Groundwater Model Updates and Capture Zone Delineation (Report for Well Head Protection Area Delineation Project)	October, 2010	To provide the delineation of WHPAs in the area and details on methodologies, limitations and general characterization of the well systems
BM Ross Consulting	Surface Water Vulnerability Analysis: Town of Goderich Intake	October, 2009	To provide an explanation of the methodology, limitations and an inventory of possible threats to water quality in keeping with MOE Technical Rules
Conestoga Rovers & Associates (CRA, 2007)	2005-2006 Groundwater Technical Study, Saugeen-Grey Sauble-NBP SPA		Includes WHPA delineation for Huron-Kinloss
WESA	Groundwater Vulnerability Assessment: Municipality of Huron East (Seaforth)	October, 2009	To provide the delineation of Seaforth WHPA and details on methodologies, limitations and general characterization of the well system
Baird	Surface Water Vulnerability Analysis Goderich Intake	August 2007	To delineate the Goderich Intake Protection Zones
Baird	Surface Water Vulnerability Analysis for Goderich Intake Addendum: Numerical Modeling for IPZ-2 Delineation	May 2010	To refine the delineation of the Goderich Intake Protection Zones
Statistics Canada	Population Counts, 2006. http://www12.statcan.ca/english/census0 6/data/popdwell/Table.cfm?T=302&PR=35&S=1&O=A&RPP=25	2007	Provincial census data
Waterloo Numerical Modelling Corp. (WNMC, 2015)	Blyth Groundwater Modelling and Wellhead Protection Area Delineation Draft Technical Memo	May 2015	To provide updated WHPA delineation, to include addition of Well # 5 to the Blyth system
Matrix Solutions Inc. (Matrix, 2016)	Town of Ripley, Township of Huron Kinloss Wellhead Protection Area Delineation Ripley Wells 3 And 4	December 2016	To provide updated WHPA delineation Ripley
Saugeen, Grey Sauble, NBP Source	Saugeen Valley Source Protection Area Assessment Report, Chapter 4, Draft for Consultation	Draft, 2017	Includes updated information for Ripley

Author & Publisher	Title	Date	Purpose
Protection Region			
R.J. Burnside & Associates Limited (Burnside, 2021)	New McCrea Well Source Protection Letter (report)	October 28, 2021	New WHPA due to replacement of McCrea St Well
Province of Ontario	Technical Rules, *Clean Water Act, 2006* *https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act*	2009; 2017; 2021	Technical rules for assessing risks to sources of drinking water in Ontario and identifying vulnerable areas. 2021 version includes the Tables of Drinking Water Threats

MAITLAND VALLEY: CHAPTER 5

POTENTIAL IMPACTS FROM CLIMATE CHANGE

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5.1 What is Climate Change?

Climate is not a static phenomenon, but rather an ever changing natural system. Weather refers to the day-to-day atmospheric conditions that occur in a given location. Climate is the long-term average of these atmospheric conditions, and often covers a larger region (Garbrecht and Piechota 2006).

Changes in climate are not a new trend. Variations and cycles in climate are common and natural events. For example, an ocean-atmospheric pattern that occurs naturally is the El Niño pattern. There can also be more abrupt shifts in the climate, as well as long-term patterns. Climate change refers to progressive changes over a longer period of time (Garbrecht and Piechota 2006). To be considered an actual change in climate, and not simply a natural variation, the change must be persistent and measurable over time (Environment Canada 2008).

5.2 Causes of Climate Change

Climate change can be partially attributed to several natural processes. The Earth is dependent on solar radiation to sustain life (Prodonović 2008). However, any changes in solar output can have a profound impact on the amount of radiation reaching the Earth (Lemmen and Warren 2004). Other natural variations in Earth activity (e.g., volcanic activity) can also contribute to climate change.

It is commonly believed that anthropogenic, or human, activities over the last two centuries account for the drastic changes in the Earth's climate. One of the most commonly referred to activities is large-scale changes in land use, such as agricultural expansion and urbanization. These activities increase the amount of heat energy that is released into the atmosphere and reflected back to the Earth (Prodonović 2008; Environment Canada 2008).

One of the most frequently discussed human cause of climate change is an increase in the amount of greenhouse gases released into the Earth's atmosphere. Greenhouse gases include emissions such as carbon dioxide, nitrous oxide and ozone. These gases build up in the Earth's atmosphere making a layer that traps and reflects heat energy back to the Earth's surface; a process commonly known as the Greenhouse Effect (Lemmen and Warren 2004).

Greenhouse gases can also cause depletion in the ozone layer, exacerbating the effects of solar radiation (Environment Canada 2008). They are most significantly produced through the burning of fossil fuels, agricultural activities and forest clearing (Lemmen and Warren 2004). Additionally, greenhouse gases are increasing in abundance. Scientists have stated that the increase in the amount of greenhouse gases released into the atmosphere correlates with the change in human-related emissions (Environment Canada 2008). There is a general consensus among environmental scientists that human activity accounts for much of the change in climate that the Earth has experienced, although the amount is still unknown (Garbrecht and Piechota 2006).

5.3 Climate Change and Water

While climate change will undoubtedly affect many aspects of both the natural environment and human activity, it will have a profound impact on the world's water system. Water is an integral part of all aspects of the climate system, and is particularly sensitive to change. Most specifically, changes in temperature, precipitation and evapotranspiration affect the hydrologic cycle (de Loë and Berg 2006).

As previously mentioned, temperature increases are an effect of climate change. These changes directly impact the amount of precipitation that is received in any given region. Precipitation events are caused by several processes including the upward movement of air. Temperature increases tend to intensify air convection and foster the amount and intensity of precipitation (Bruce and Lean 2006). Evapotranspiration is also impacted by climate change. Due to more frequent and intense rainfalls in certain regions there is increased moisture on the Earth's surface. Increased temperature also serves to increase the atmosphere's moisture holding capacity. These two factors result in an increase of the amount of evapotranspiration (Bates, et. al. 2008). Other factors, such as population growth and pollution from human activities, influence the workings of the hydrologic cycle and quality of the water (Aerts and Droogers 2004). It is important to note that the hydrologic cycle is a closed system, and water is a finite resource.

5.4 Impacts of Climate Change on Water Quantity

Groundwater Quantity

Climate change is expected to influence the intensity, frequency and timing of precipitation events (Garbrecht and Piechota 2006). It is likely that the seasonal distribution of the precipitation events will also change, resulting in more precipitation in the form of rain in the winter months and less in the summer. These changes will lead to more extreme flooding and droughts (de Loë and Berg 2006). The seasonal shifts will cause most of the groundwater recharge to occur earlier in the year, resulting in less recharge during the dry summer months (Prodonović 2008).

These changes in climate are more likely to affect overburden aquifers rather than bedrock, as they are in part supplied by seasonal recharge. While deep aquifers will see little direct influence, their water supplies may be exposed to over-exploitation if a shallow aquifer fails (Lemmen and Warren 2004). Regions with current water shortages will likely face more severe problems.

Surface Water Quantity

Surface water is more vulnerable to climate change than groundwater. The majority of surface water flows are dependent on seasonal flows, such as those from yearly snowmelt. Any seasonal changes to precipitation will disrupt the nature of surface water flows. For example, peak runoff is expected to occur earlier in the year, meaning there will be less flow in ditches and municipal drains and streams in the summer months and reducing water supplies (Prodonović 2008). Indeed, there will be lower flows in all types of water basins that depend on surface water for their supply (Bates, et. al. 2008).

Lake Huron and other large bodies of water are expected to experience some water loss over the coming years due to climate change. As previously stated, rates of evapotranspiration are expected to increase, and the loss of water through this process is predicted to be highest on large bodies of water, such as the Great Lakes (de Loë and Berg 2006). Some models that have been used in recent years, estimate that the average levels of Lake Huron could drop as much as one metre within the next 50 years. (Swartz, et al. 2004).

Water Quantity in the Maitland Valley Source Protection Area

The amount and availability of drinking water in the Maitland Valley SPA is not expected to be significantly impacted by changes in climate in the short term. Most of the small urban centres in this region are supplied with drinking water from municipal well systems. The majority of the municipal well systems is fed by well-protected bedrock aquifers, and is not expected to experience any significant water loss. Currently, there is only one municipal well in this region that is sourced by an overburden aquifer, namely Well No. 3 in Clifford. As this well is supplied by a shallow aquifer, there is greater potential for water loss to this system. However, there is currently another bedrock well in use in Clifford, as well as a bedrock backup well specifically designed to compensate for any water loss in Well. No. 3.

The Lake Huron intake at Goderich is the only source of drinking water in this area that is supplied by surface water. This intake is also not expected to be significantly impacted by water loss. Studies have shown that the intake at Goderich is adequately located to receive an abundance of water to supply the area. Water levels in the lake would have to decline significantly (even more so than the predicted 1 metre) to affect the availability of drinking water from Lake Huron (Schwartz, et. al. 2004).

Other municipal systems that may be impacted by surface water loss are any surface water retention ponds that may exist in the area. However, the amount of water loss and the significance of the loss are still unknown. Additionally, any private or municipal operations that draw water from surface sources (under a Permit to Take Water) may also experience a slight shortage. Again, the significance of the shortage is unknown. Further exploration of water quantity issues resulting from climate change are discussed in Chapter 3 – Water Budget.

5.5 Impacts of Climate Change on Water Quality

Groundwater Quality

Changes in climate will also have some bearing on the quality of water. Heavier rain events and increased flooding will increase the amount of water running off the land. Thus there is a higher potential of contamination of the water systems. While groundwater systems appear to be fairly well protected, there is a risk of contaminated water entering these systems through preferential pathways, such as abandoned or cracked wells and sinkholes (Garbrecht and Piechota 2006).

Waterborne diseases are also a concern in connection with climate change. During times of flooding, water is stirred up and runs across land collecting anything in its path. It is not unusual for floodwater to carry disease. If preferential pathways are available, the disease ridden water can make its way into groundwater, and eventually drinking water supplies (de Loë and Berg 2006). Various coliform bacteria, such as *E. coli*, can be found in such floodwaters. Additionally the water can carry intestinal parasites such as Giardia and Cryptosporidium.

Surface Water Quality

Surface water quality will experience similar impacts to groundwater quality as a result of climate change, but perhaps to a greater degree. Intense runoff from heavy precipitation will increase erosion and turbidity. Additionally if surface water bodies have lower water levels before these intense rainfalls, the bottom sediments will have more opportunities to be re-suspended (Prodonović 2008). Contamination entering a surface water system is rarely from just one source (referred to as point source), but rather is composed of non-point source pollution, meaning a combination of pollutants from various sources (Garbrecht and Piechota, 2006).

Runoff from many sources can cause an increase in the bacteria counts in surface water. This will happen on a seasonal basis, and may result in an increase in waterborne diseases carried in the surface water (Field et al. 2007). Higher water temperatures, heavier precipitation and high flows will not only cause an increase in bacteria, but also in sediments, nutrients, pesticides and salt. All of these can be detrimental to both human and aquatic life (Bates, et. al. 2008). In particular, storm water retention ponds could prove to be a significant source of chemical and nutrient pollution. During expected heavy rainfalls, the turbidity in retention ponds will be increased causing sediment containing harmful chemicals and nutrients to rise. When retention ponds are flushed out during a heavy rain, the water will carry these pollutants into the surface water systems, further degrading water quality.

Water Quality in the Maitland Valley Source Protection Area

As with water quantity, the quality of drinking water in the Maitland Valley SPA is not expected to deteriorate severely. A large amount of drinking water in this area comes from groundwater sources, by way of municipal wells. As most of these wells are sourced by bedrock aquifers, they are fairly well protected. However, there is always a risk that contaminated water could enter these sources through preferential pathways.

Drinking water supplied from surface sources, may experience more water quality problems. The Goderich intake is the only surface source of drinking water in the Maitland Valley SPA. It is somewhat susceptible to water quality changes if the lake level were to drop significantly. First, the intake would potentially be closer to recreational uses, exposing the water to pollutants. Second, the water would also be more susceptible to sediment transfer from the Maitland River, and there would be less water to help with dilution. There is also the possibility of damage to the intake infrastructure from ice buildup (Swartz, et. al. 2004). Therefore, while water quality threats to drinking water in this area are not considerable, they do exist and should be examined.

5.6 Other Impacts of Climate Change

Along with water quantity and water quality impacts due to climate change, there are also other impacts that need to be given some consideration. If any problems occur at the Lake Huron intake at Goderich due to a change in climate, it may need to be extended or possibly relocated. This is a serious concern for this intake, due to its proximity to land and shipping lanes. Any change to this system would require large amounts of funding (Swartz et al. 2004). If there are any negative changes to water quality in either surface water or groundwater, there may be costs involved in upgrading the water treatment systems (de Loë and Berg 2006). Similarly, there is a chance that municipal well systems will experience such problems. Changes may be needed in infrastructure (well depth and treatment), and the possibility exists of a need for new water supplies.

5.7 Conservation Authority Policy on Climate Change

In 2008 the Maitland Watershed Partnerships Water Action Team updated their briefing note on climate change (MacRae 2008). This briefing note remarks that the MVCA should continue to implement programs that will help the community adapt to change, and reduce the community's vulnerability to negative impacts, such as water shortages. Its focus is on the agricultural community, as many residents in the MVCA jurisdiction are involved in this industry (Rush et al. 2004, MacRae 2008).

5.8 Climate Trends in the Maitland Valley Source Protection Area

A climate trends analysis was completed for the Maitland Valley Conservation Authority (MVCA) in 2010 by Huron Geosciences (2010). The goals of the project were to assemble, graphically display, and analyze available meteorological data within the MVCA jurisdiction. This was undertaken to provide guidance to the MVCA on providing services to their communities and member municipalities.

Overall, the trends indicate that total annual precipitation is increasing, and notably that precipitation is increasing in the autumn, winter and spring seasons. Precipitation intensity is increasing across the watershed, indicative of a change in the patterns of precipitation in the watershed. Precipitation intensity is most notably increasing during the summer months. Temperatures have been increasing throughout the watershed, which is almost exclusively the result of an increase in daily minimum temperatures.

The number of days where maximum temperatures have exceeded 30ºC has increased, indicative of warmer summer seasons. A marked decrease in the days where maximum daily temperatures do not exceed 0ºC for the watershed is noted throughout the watershed, and is likely the result of a reduced frozen period and increased frequency and duration of winter melting events.

In general, the impacts of the observed climate trends on drinking water sources are expected to be low. In the SPA, most municipal systems are reliant on either deep bedrock aquifers or Lake Huron for their respective water supplies. From a water quantity perspective, increases in precipitation would lead to increases in the supply to these sources. It is important to understand that the increases in precipitation documented herein are small when compared with both the uncertainty of the data; and more importantly, the overall storage of these two systems.

Increasing amounts of precipitation coupled with increases in intensity of precipitation are often associated with increases in soil erosion and ultimately on water quality of surface water systems. In the Maitland Valley SPA there are no municipal systems which are exploiting riverine systems, and impacts on the overall quality of water in Lake Huron are buffered by the large volume of water in the system. Potential impacts of increased precipitation will be an important consideration in the development of Great Lakes Targets for Lake Huron.

5.9 Data Gaps Concerning the Changing Climate

The impacts of climate change on water quality and quantity are poorly understood. While there is a certain level of understanding concerning climate change at the larger scale, there is very little actually known about the impacts on a watershed basis. Better observational data is needed to complete inventories and local scale data sets (Bates et al. 2008).

In addition, groundwater has traditionally received less attention than surface water, despite its importance as a drinking water source worldwide. While groundwater has been well monitored in the past, it has not been monitored and examined for the eventuality of a changing climate and its associated impacts. Therefore depletion levels and recharge rates have not been well modeled. The models that exist are based on limited data (Bates et al. 2008). Thus, more study is needed before confidently assessing the impacts of climate change on water at a watershed scale.

5.10 Conclusions

While large scale changes in climate can be fairly confidently predicted, climate change on a watershed scale cannot be forecasted as easily. However, it is generally believed that there will be effects from climate change in the Maitland Valley SPA, and that it will negatively affect the drinking water supply.

The effects on drinking water may not been seen immediately, and may not be a cause for concern in the short-term. However, the negative impacts to drinking water quantity and quality will only increase over the next few decades, turning it into a much larger problem. Actions need to be taken to prevent significant drinking water loss and degradation due to the changing climate. While climate change may be slowed if significant action is taken, it will not be stopped. Therefore, the population of the ABMV region will need to learn to adapt to a smaller water supply and to conserve this precious resource.

References

Author	Title	Date	Publisher	Purpose
Aerts, J. and P. Droogers, eds.	*Climate Change in Contrasting River Basins*	2004	CABI Publishing	This text discussed the hydrologic cycle in depth, as well as the impact climate change, and other factors, have on this cycle.
Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, eds.	*Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change*	2008	IPCC Secretariat	This paper gave a general overview of climate change, with relevant sections detailing expected impacts on water quality and quantity.
Bruce, J.P. and D. Lean	*Planning for Extremes: Adapting to Impacts on Soil and Water from Higher Intensity Rains with Climate Change in the Great Lakes Basin*	2006	Ontario Chapter of the Soil and Water Conservation Society	This book explained the relationship between temperature changes and precipitation events.
de Loë, R.C. and A. Berg	*Mainstreaming Climate Change in Drinking Water Source Protection in Ontario*	2006	Pollution Probe	Generally good information about climate change and how it fits in with Drinking Water Source Protection.
Environment Canada	*Frequently Asked Questions About the Science of Climate Change: 2008 Update*	2008		A general guide to the science behind climate change.

Author	Title	Date	Publisher	Purpose
Field, C.B., L.D. Mortsch, M Brklacich, D.L. Forbes, P. Kovacs, J.A. Betz, S.W Running and M.J. Scott	*Climate Change 2007: Impacts, Adaptations and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*	2007	Cambridge University Press	This text was helpful in understanding some of the impacts of climate change, mostly related to water quality.
Garbrecht, J.D. and T.C. Piechota, eds.	*Climate Variations, Climate Change and Water Resources Engineering*	2006	Environmental and Water Resources Institute of the American Society of Civil Engineers	A good general overview of climate change and its potential impacts.
Huron Geosciences	*Climate Trends Analysis in the Maitland Valley Watershed*	2010	In Press	Analysis of climate data in the Maitland Valley watershed.
Lemmen, D.S. and F.J. Warren, eds.	*Climate Change Impacts and Adaptation: A Canadian Perspective*	2004	Natural Resources Canada	A handy paper outlining climate change impacts for Canada.
MacRae, R.	*How Will Your Farm Cope with a Changing Climate?*	2008	Maitland Watershed Partnerships Water Action Team	An ongoing discussion on how the community can best adapt to climate change.
Prodonović, P.	*Response of Water Resources Systems to Climate Change*	2008	University of Western Ontario	A recent research paper that explained the specific impacts on climate change on both water quality and quantity.
Rush, R., with J. Ivy, R. de Loë, and R. Kreutzwiser	*Adapting to Climate Change in the Maitland Valley Watershed, Ontario: A Discussion Paper for Watershed Stakeholders*	2004	University of Guelph	This paper outlined how community members of the MVCA can adapt to a changing climate.

Author	Title	Date	Publisher	Purpose
Swartz, R.C, P, Deadman, D. Scott, L. Mortch	*Modeling the Impacts of Water Level Changes on a Great Lakes Community.*	June 2004	Journal of the American Water Resources Association	This article was helpful in delineating expected impacts on surface water resources due to climate change.

MAITLAND VALLEY: Chapter 6

FUTURE WORK

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6.1 Future Work

The Assessment Report delineates vulnerable areas and identifies potential and actual threats to drinking water in these vulnerable areas. This is based on the best available scientific knowledge, the guidance of experts and the available data. Over the course of time, new techniques and data will emerge. Likewise, during the preparation of this report, the Source Protection Committee has identified a number of topics for future consideration.

Great Lakes

The Ontario *Clean Water Act, 2006* speaks to the possibility of the Ontario Minister of the Environment setting targets for water quality in the Great Lakes. There are a number of benefits beyond those to drinking water which will accrue as efforts to maintain and improve water quality in the Great Lakes progresses. The shoreline and rural populations, tourist industry, and upland ecosystems will all benefit as better management practices take hold. As the Great Lakes Targets take shape, future source protection plans will have to address these.

Issues – Sinkholes and Seaforth

Issues-based threats may also be identified in the source protection area. Sinkholes are present in the eastern portion of the SPA and are surrounded by farms and rural residences. These features are transport pathways of surface water to groundwater. Preliminary evidence reveals that post storm events alter water chemistry (increased nitrates) in local drinking water sources. Other work of the Conservation Authority has delineated the issue contributing area. As these areas are not in a wellhead protection area, and do not constitute significant risks, policies will likely be left for the next iteration of the Source Protection Plans.

The Seaforth area is on a highly vulnerable aquifer and in the past, radionuclide contamination has been detected. Recently the municipality has developed new water supplies in the Seaforth area and wish to protect these sources from contamination. Research suggests that there is a strong correlation between salt contamination and radionuclide concentration. Therefore, the SPC recommends a study be undertaken to focus firstly on evaluating the local radionuclide/salt relationship (e.g., non-decommissioned brine wells, road salt), and secondly on identifying and locating potential sources which may be impacting local drinking water sources. This work will be completed for the next round of planning.

Clusters – Hamlet Well Fields

There are numerous hamlets or settlement areas within the SPA. The only ‘barrier’ for their water quality is the first barrier, source water protection. These clusters/hamlets are serviced by private individual wells and septic systems, and therefore, these areas are vulnerable to cross-contamination because of the proximity of individual wells to septic systems and neighboring businesses, industries, and agriculture. A review of best management practices suitable for these specific situations, effective policies, and areas where contamination is more common is recommended. Municipalities would be solicited for interest or lead the project. Based on these findings, policies would be developed to address threats.

Moderate Threats

The primary focus has been on addressing significant threats, however, over time, policies for moderate risks may be desirable. For example, there is concern about highly vulnerable aquifers and significant groundwater recharge areas and land uses. The presence of landfill sites, septic systems, and other uses in these areas has raised questions and public concerns. Future plans should focus on these specific instances and work with the public to develop appropriate policies and an understanding of source protection. Additionally, salt storage within the Goderich harbour is currently a moderate threat. Future committees may want to consider elevating it to a significant threat based on the potential impact to the intake in a 100-year storm event. More research is required before this decision can be made.

Local Threats

The *Clean Water Act, 2006* anticipates that some regions may want to establish local threats. In this region, there was discussion of transportation routes and underground storage of natural gas as activities which may be worthy of further consideration as local threats. As scientific evidence becomes more available the importance of this local concern will be evaluated. The Committee will consider these local threats in the next round of planning.

General Update

Since the inception of the work for the assessment report additional statistics and studies have been completed. This will continue to be the case. At the next review of the AR, the statistics for the Watershed Characterization should be updated. In addition, any new groundwater studies, aggregate or waste, salt, snow or emergency management plans, should be reviewed in the context of source protection. New wells or well decommissioning may need to be modeled or deleted from the assessment report. Future committees may also wish to investigate geothermal heat as a potential local threat. The threats database will also need to be revised as land uses change, lots are created, and development and abandonment take place.

MAITLAND VALLEY: CHAPTER 7

CONSIDERING THE GREAT LAKES

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The entire source protection area drains into Lake Huron through a variety of rivers and gullies. This chapter deals with the requirements of *the Clean Water Act, 2006*, which pertain to source protection areas that drain into the Great Lakes. Section 14 of the Ontario *Clean Water Act, 2006* requires that source protection committees consider the Great Lakes in the light of three agreements; the *Great Lakes Water Quality Agreement*, the *Great Lakes Charter* (including the Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement) and the *Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem*. Further, *Technical Rule* 2(g) states the Assessment Report shall contain

> "a description of how the Great Lakes agreements were considered in the work undertaken, if the source protection area contains water that flows into the Great Lakes or the St. Lawrence River."

The various chapters of this Assessment Report provide information and analysis on the water quality and quantity of Lake Huron. However, it is important to note that the Source Protection Committee has given specific consideration to Lake Huron at several of their meetings over the course of the past two years. As the information provided to the Committee was on the basis of the entire Source Protection Region, this chapter contains information that pertains to both the Ausable Bayfield Source Protection Area and the Maitland Valley Source Protection Area.

7.1 Consideration of the Great Lakes Agreements

The *Clean Water Act, 2006* requires that the Terms of Reference for Source Protection Areas that contain water that flows into the Great Lakes or the St. Lawrence River must consider the following documents: the *Great Lakes Water Quality Agreement*, the *Canada-Ontario Agreement Respecting the Great Lakes Ecosystem*, the *Great Lakes Charter*, and any other agreement to which the Government of Ontario or the Government of Canada is a party, that relates to the Great Lakes Basin and that is prescribed by the regulations (there are currently no other documents prescribed by the regulations). Further, the *Technical Rules* indicate that a written description of how these agreements were considered in the work undertaken in accordance with the *Technical Rules* must be included in the Assessment Report.

The length of the Lake Huron shoreline in the Ausable Bayfield Maitland Valley Source Protection Region (between Ipperwash to the south and Amberley to the north) is not subject to a lake wide management plan or a remedial action plan stemming from these agreements. Nonetheless, the Canada-Ontario Agreement/Great Lakes Divisional Project Manager for Lake Huron has both presented to the Source Protection Committee and received draft documents for comment.

Although all three prescribed documents share common goals with the source protection process, the *Great Lakes Water Quality Agreement* is the only prescribed document that has specific links to the preparation of this Assessment Report. The following sections describe the prescribed documents and indicate how they were considered during the preparation of this Assessment Report.

7.2 The Great Lakes Water Quality Agreement

The *Great Lakes Water Quality Agreement* is an agreement between the governments of Canada and the United States of America that expresses their commitment to restore and maintain the chemical, physical, and biological integrity of the Great Lakes Basin Ecosystem. It also reaffirms the rights and obligations of these two countries under the Boundary Waters Treaty. The Agreement outlines provisions for the development of cooperative programs and research and includes a number of objectives and guidelines to achieve its goals (Environment Canada, 2004a).

The SPC invited the Great Lakes Advisor for the MOE, Ted Briggs, to present information on how the agreements impact this section of Lake Huron (September 24, 2008). The lakewide management structure for the Great Lakes was given with particular emphasis on Lake Huron. The speaker provided information on the history of the *Great Lakes Water Quality Agreement* between the U.S. and Canada, the International Joint Commission, *Lake Wide Management Plans (LaMPs)*, and the *Canada – Ontario Agreement (COA)*. The key issues surrounding water quality and water quantity in Lake Huron were discussed. For example, questions regarding the levels of dioxins and the impact of humans on lake water levels were raised. It was explained that it is difficult to determine human impact on water levels and that standard levels of dioxins over time only occur in certain areas.

There are no LaMPs for Lake Huron within this source protection region. However, another type of approach is being undertaken. Healthy Watersheds Coordinator for the Ausable Bayfield Conservation Authority, Mari Veliz, gave a presentation on Community Action Planning for Lake Huron. The presentation focused on the broader Lake Huron issues and specific examples of recent projects were given. It was explained that with respect to bacteria, a library of microbes is being built but is time consuming and costly. With respect to nutrients, it was explained that monitoring needs to be conducted to determine the biggest threats. However, funding for monitoring is critical.

Deb Shewfelt, Mayor of Goderich, presented information on the Mayor's Collaborative Action Plan to protect the Great Lakes. This initiative functions within the framework of the International Joint Commission. The first step of the collaborative plan was to create an organization to exchange ideas on the Great Lakes. The memorandum of understanding for the organization was developed with the Province of Ontario with the aim of working closely together. One of the main initiatives of the group is to improve beaches by promoting tourism. The more a community reconnects people to the Lakes, the more support a community will receive. Some of the issues the organization is dealing with are; the removal of toxic algae from beaches and reducing the amount of untreated sewage and storm water discharges into the Great Lakes.

7.3 Canada-Ontario Agreement Respecting the Great Lakes Ecosystem

The Canada-Ontario Agreement Respecting the Great Lakes Ecosystem is an agreement between the governments of Canada and the Province of Ontario that supports the restoration and protection of the Great Lakes Basin Ecosystem. It outlines how the two governments will cooperate and coordinate their efforts to restore, protect, and conserve the Great Lakes basin ecosystem, and it contributes to meeting Canada's obligations under the *Great Lakes Water Quality Agreement* (Environment Canada, 2004b). Although this agreement is geared towards the protection of water quality, it does not contain any specific technical information that was applicable to the preparation of this Assessment Report.

7.4 Great Lakes Charter

The Great Lakes Charter is a series of agreements between the provinces of Ontario, Quebec, and the eight Great Lakes States that set out broad principles for the joint management of the Great Lakes (Environment Canada, 2005). The original Charter was developed in 1985 in response to the growing use of water and proposals to divert large quantities of water out of the Great Lakes Basin (Ontario Ministry of Natural Resources, 2005). The purposes of the Charter are "to conserve the levels and flows of the Great Lakes and their tributary and connecting waters; to protect and conserve the environmental balance of the Great Lakes Basin ecosystem; to provide for cooperative programs and management of the water resources of the Great Lakes Basin by the signatory States and Provinces; to make secure and protect present developments within the region; and to provide a secure foundation for future investment and development within the region." (Council of Great Lakes Governors, 1985)

The Great Lakes Charter was supplemented in 2001 by the *Great Lakes Charter Annex*, which reaffirmed the principles of the Charter and committed the Governors and Premiers of the Great Lakes States and Provinces to "developing an enhanced water management system that…protects, conserves, restores, and improves the waters and water-dependent natural resources of the Great Lakes Basin" (Council of Great Lakes Governors, 2001). *The Great Lakes Charter Annex* implementing agreements, including the *Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement*, attempt to provide this water management system (Environment Canada, 2005). Although this Charter is geared towards the protection of water quality and quantity, it does not contain any specific technical information that was applicable to the preparation of this Assessment Report.

Andrew Henry, Division Manager for the Lake Huron Primary Water Supply System, presented information on the impacts of the *Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement* on the Lake Huron Primary Water Supply which provides drinking water for much of the southern portion of the Source Protection Region. An overview of the evolution of the Agreement was given and the differences between inter-basin transfers and intra-basin transfers were clearly defined. Some of the major water quality and quantity issues for the Great Lakes were discussed and include:

- Monitoring and assessing the impacts to watersheds – water and wastewater volumes.
- Monitoring consumptive use.
- The quality and volumes of discharge back into the environment.
- Long-term evolution of threats and risks
- Long-term impacts of recharge – e.g., 60% of low flow down the Thames River is generated from the City of London wastewater. If existing transfers are reduced it could have drastic impacts.
- Adoption of ‘Water for Life’ concepts – managing environmental resources.

7.5 Great Lakes Targets

The *Clean Water Act, 2006* allows for the Ontario Minister of the Environment to establish targets relating to the use of the Great Lakes as a source of drinking water for any of the Source Protection Areas that contribute water to the Great Lakes. If targets are set, policies and steps would need to be established to achieve these targets. No targets have been set at this time.

7.6 Lake Huron Working Group

The source protection regions and areas draining into Lake Huron are the North Bay, Lake Simcoe, Saugeen Grey Sauble Northern Bruce Peninsula, the Ausable Bayfield Maitland Valley, and Thames Sydenham source protection regions. The chairs of the source protection committees and project managers have formed a working group to discuss and address common issues, share knowledge and engage in broader discussions on Great Lakes issues from a drinking water perspective.

7.7 Consideration of Lake Huron Intake Susceptibility

According to MOE guidance and the *Technical Rules (2008)* under the *Clean Water Act, 2006*, Great Lakes-based water supplies are not subject to analysis as part of the drinking water source protection water budgeting process and water quantity stress assessment. However, in order to provide consideration of the Great Lakes as prescribed in the *Technical Rules*, a sensitivity analysis was undertaken to determine how susceptible the LHPWSS and Goderich intakes are to fluctuating water levels in Lake Huron.

7.7.1 Determination of Optimal Intake Depth

Currently, no guidance is available to define what an optimal intake depth should be, based on water quantity and quality considerations. The updated Ministry of the Environment *Design Guidelines for Drinking-Water Systems (2008)* removed an existing recommendation of a minimum 10 m depth, and instead references a minimum depth of 3 m below historic low water levels based on navigational concerns. A survey of engineering design companies (Stantec, Riggs Engineering) who are typically involved with the siting and design of intakes revealed no agreed upon standards for the depth of a Great Lakes intake.

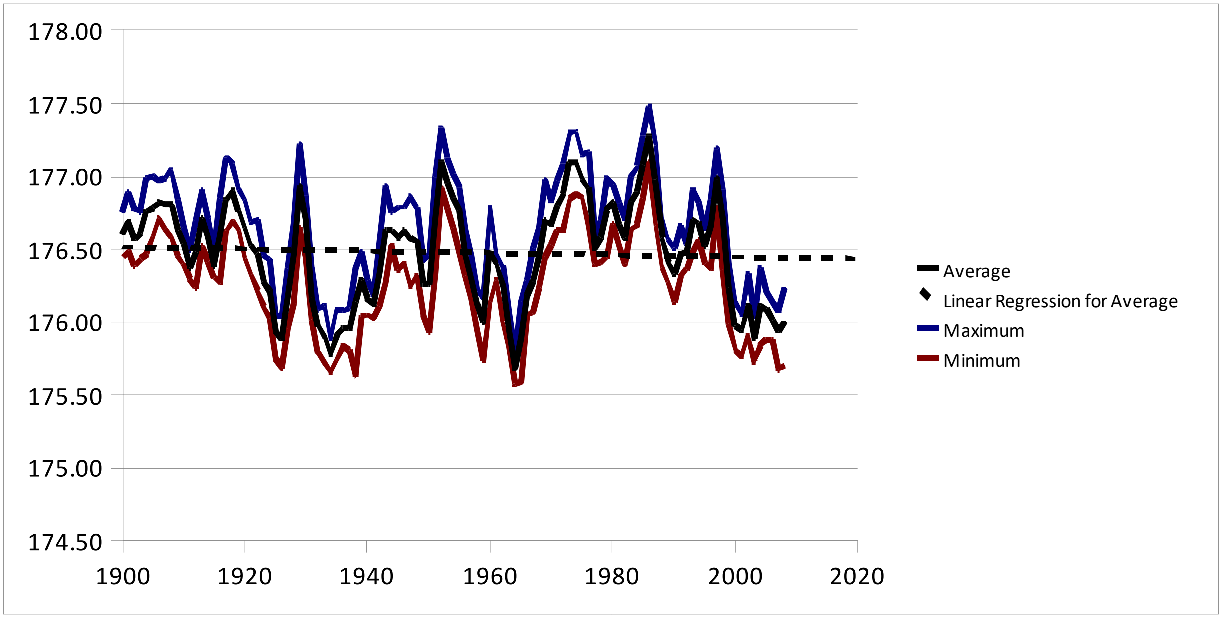
In the Saugeen, Grey Sauble, Northern Bruce Peninsula SPR, the consultants developing intake protection zones for the 10 Lake Huron outlets (Baird and Associates) used a wave breaking depth approach to develop recommended intake depths. This approach involves determination of the wave breaking depth, based on wave heights which are modeled using fetch and the 10-year return period winds from eight cardinal directions. This approach is based on the assumption that an intake developed below wave breaking depths will be subject to less turbidity due to wave/shore interaction. The results of this study indicate that the optimal depths for the Lake Huron intakes in the Saugeen, Grey Sauble, Northern Bruce Peninsula SPR range from 8 to 10 metres.

The Lake Huron intake at Goderich is located at an elevation of 169.7 m a.s.l. (metres above sea level). Chart Datum for Lake Huron is set at 176 m a.s.l which represents a depth of 6.3 m for the Goderich intake.

7.7.2 Lake Huron Water Levels

Lake Huron water levels for the period 1900-2008 are available from the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory (http://www.glerl.noaa.gov/). **Figure 7.1** below shows monthly average, maximum and minimum lake levels in this period expressed as metres above sea level (m a.s.l). In addition, a linear regression of the monthly data was developed from this data and is shown as the dashed line on the graph.

Figure 7.1 Monthly average, maximum and minimum water levels for the Lake Huron Michigan system (GLERL, 2009) expressed in m a.s.l. Linear regression for average values shown with dashed line.



Based on the available information, a long-term average lake level 176.27 m a.s.l was determined, with the absolute minimum lake level for the period set at 175.58 m a.s.l for April of 1964. A downward trend in overall lake levels was noted for the period of record, and as a result of this it seems prudent to provide for the possibility that levels may drop below this record low within the 25-year planning cycle. In order to estimate this, the difference between the long-term average and historic low (0.69 m) was used as a safety factor and subtracted from the historic low – providing a low water level of 174.89m a.s.l for the sensitivity analysis.

7.7.3 Sensitivity Analysis

The sensitivity of the Lake Huron intakes to water level is summarized in the **Table 7.1**, below.

Table 7.1 Sensitivity of the Goderich intake to fluctuating water levels in Lake Huron

Intake	Depth (datum)	Depth at low	Depth at low – safety factor
Goderich	6.3 m	5.9m	5.2m

The information on the depth of the intakes indicates that even during an extremely low Lake Huron water level period, the intakes are located at sufficient depth for water quantity purposes. The Goderich intake seems to be well-situated, and in the absence of any wave-breaking depth calculations, meets all current guidelines for intake depth.

References

Author & Publisher	Title	Date	Purpose
Council of Great Lakes Governors	*The Great Lakes Charter: Principles for the Management of Great Lakes Water Resources*. Retrieved 2009 from: http://www.cglg.org/projects/water/docs/GreatLakesCharter.pdf	1985	Reviewed for Source Protection Action
Environment Canada	*Great Lakes Water Quality Agreement*. (https://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=45B79BF9-1	2004a	Reviewed for Source Protection Action
Environment Canada	*The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem*. http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B903EE0D-1	2004b	Reviewed for Source Protection Action
Great Lakes Environmental Research Laboratory (GLERL)	*www.glerl.noaa.gov*	2009	Lake Huron water levels for intake sensitivity analysis
Ministry of Natural Resources	*Frequently Asked Questions: Great Lakes Charter Annex Implementing Agreements*. http://www.mnr.gov.on.ca/en/Business/Water/2ColumnSubPage/STEL02_164560.html	2005	Reviewed for Source Protection Action

MAITLAND VALLEY: CHAPTER 8

KEY OUTCOMES

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8.1 Key Outcomes

8.1.1 Drinking Water Sources

In the Maitland Valley Source Protection Area less than half the people receive their drinking water from municipal drinking water systems, while the remaining people have individual wells. The municipal systems can be classified as either surface water intakes or groundwater wells. The municipal systems have a varying degree of treatment facilities ranging from simple to state of the art facilities.

8.1.2 Water Quantity

The various stages of water budget analysis, carried out as part of the source protection exercise, have provided a much better understanding of the availability of water within the region. Overall, groundwater is plentiful in the region. Base flow, precipitation and evaporation are somewhat higher in the Maitland Valley SPA than the Ausable Bayfield SPA. Recharge is higher in the Nine Mile than the Maitland River watershed. Consumptive takings are also low. However, in a small subwatershed east of Goderich and in a small region of the gullies between Goderich and Bayfield, the Tier One Water Budget methodology triggered the need to proceed to a Tier 2 review of these subwatersheds. The Tier 2 review has demonstrated that there is a need to proceed to a Tier 3 review in the small area east of Goderich. In other words, with the exception of this one area, there is no sufficient stress on the quantity of water to require the SPC to proceed with more than general conservation related policies. Work for the Tier 3 Water Budget was completed in 2018. As anticipated, the Tier 3 risk assessment concluded that the water quantity risk level is ‘Low’. See Chapter 3 for details.

The reliance on water from plentiful aquifers and Lake Huron for much of the area has brought about a sense of security that there is ample water for the future. Barring unprecedented growth or catastrophic events, it would appear that stress on the water quantity is not an issue in the foreseeable future. One other potential concern might be the effect of climate change in terms of water quantity. Should climate change result in consistently drier years, the overall impact could mean less water available. Should the levels of the Great Lakes fall, it would have impacts on the Goderich intake.

8.1.3 Water Quality

The scientific research and data collection carried out by the Ausable Bayfield Maitland Valley Source Protection Committee has found that there are only minor water quality concerns throughout the region (generally naturally occurring abundance of fluoride), the water quality is reasonably good. However, drinking water still requires treatment to safeguard the people relying on these sources.

Given the location of the Goderich intake, there is some concern as the raw water quality is periodically turbid. At present, the intake system can deal with any water quality problems. Programs which encourage good land stewardship through incentive and education programs are needed to address the highly vulnerable aquifers and significant recharge areas.

8.1.4 Threats

When the *Clean Water Act, 2006* first became law there was a perception that it was going to directly impact every landowner in the source protection region. Now that the vulnerability mapping and scoring has been completed and the enumeration of significant threats has occurred, it has become evident that there are relatively few significant threats that have been identified for each municipal system. Twenty-two prescribed activity threats have been identified in the Clean Water Act. A *Table of Drinking Water Threats* has been compiled which indicates when an activity in a particular vulnerable area under certain circumstances becomes a significant threat. The Technical Rules were amended in 2021, with significant changed to the circumstances in the Tables of Drinking Water Threats. The Technical Rules can be accessed at https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act.

The threats have been identified by parcel. Possible threats were identified based on the intrinsic risk (beneficial management practices are not assumed). This provided the Source Protection Committee with the tools they required to generate source protection policies. Details on the risk assessment and enumeration of potential significant drinking water threats can be found in Chapter 4 of the Assessment Report. It is anticipated that numbers will vary over time, according to changes in land use, and as additional information becomes available.

8.1.5 Issues and Conditions

No issues or conditions were identified as being a significant risk at this time. There is interest in pursuing a better understanding of water quality influences in the Seaforth and sinkhole areas. The threshold for an issue was set by the Source Protection Committee as half the maximum allowable concentration of water quality parameter reached. Issues can be eliminated if it is treatable. The only condition that has been identified is a moderate theat.

8.2 Consideration for the Source Protection Plan

This *Assessment Report* form part of the foundation of the Ausable Bayfield and Maitland Valley Source Protection Plans. The ABMV Source Protection Committee has considered all the scientific work that has been collected throughout the development of the *Assessment Report*, all the input and comments from stakeholder groups and the cost-effectiveness of what is being proposed in the plans.

The development of the Maitland Valley Source Protection Plan is based on:

- **Public Involvement:** The participation in a number of opportunities throughout the development of the Terms of Reference and this report has been crucial to the entire planning process. Further opportunities for involvement will be developed as the planning aspects get underway.
- **Application of Source Protection Planning Tools:** The Province of Ontario developed a set of tools to be used in source protection plans. These range from softer tools like education, outreach and incentives to more stringent tools like requiring risk management plans and prohibition of certain activities. The Source Protection Committee will weigh options when determining which tools, or combination of tools, are best able to reduce or eliminate significant threats. They will also consider the cost-effectiveness. For example, many activities identified as potential threats may already be governed by standards or provincial prescribed instruments. Duplication of such requirements in a source protection plan is not cost effective.
- **Monitoring:** The Source Protection Committee will develop monitoring policies as an ongoing activity. Monitoring has two components. The implementation of the plan requirements will be monitored. As well the Committee will monitor the effectiveness of the tools used in the Source Protection Plan. If a particular tool like education and outreach is not effective in reducing threats to drinking water, then the committee will have to adapt and modify the plan so that whatever tool is used will be effective.
- **Three Time Frames:** The Source Protection Plan will reflect three types of goals:
    - **Future Threats;** this means the development of policies that will not allow activities to become drinking water threats.
    - **Existing Threats;** this involves creating measures that correct an existing activity or circumstance which is a threat to drinking water sources.
    - **Emergency Response;** it is clear that some threats are not incremental activity based threats, but threats that result from an emergency or unexpected situation like a spill. Therefore, the goal is to ensure that all existing and future emergency response plans in the area recognize the

vulnerable areas that have been delineated through the source protection planning process.

8.2.1 Matters Requiring Additional Consultation with Other Source Protection Committees

The Maitland Valley Source Protection Area has three other source protection regions that abut its watershed boundaries. The Lake Erie Source Protection Region lies to the east, the Thames-Sydenham and Region lies to the south, and the Saugeen Grey Sauble Northern Bruce Peninsula Source Protection Region lies to the north. Matters requiring additional consultation will include:

- Coordinated approach to technical work on WHPAs, and the related information management protocols.
- Coordinated approached to communication and source protection planning.
- Common approach to Great Lakes policy matters and addressing any Great Lakes targets when set.
- Consultation on any matters that impact both SPRs.

More details on these matters are available in the Terms of Reference, June 2009.