DRINKING WATER SOURCE PROTECTION

ACT FOR CLEAN WATER

Thames-Sydenham and Region Source Protection Committee

St. Clair Region Source Protection Area

Assessment Report

January 14, 2011

Amendments initiated under s.36 of the of CWA - July 2023

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Thames-Sydenham and Region Assessment Report – St. Clair Region

Updated July 2023

Assessment Reports for Lower Thames Valley, St. Clair Region and Upper Thames River Source Protection Areas

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1.0 Introduction and Background

Following the tragedy in Walkerton (May, 2000) when the town's drinking water became contaminated with a specific strain of *Escherichia coli* (*E. coli*) and *Campylobacter* bacteria, Justice O'Connor presided over the Walkerton Inquiry. Justice O'Connor made 121 recommendations in a two-part report which recommended a multi-barrier approach to protecting Ontario's *drinking water*. Many of Justice O'Connor's recommendations were implemented with the introduction of the Safe Drinking Water Act, 2002 (*SDWA*). The *SDWA* spoke to the treatment, distribution and testing of *drinking water* as well as the training of operators and notification protocols. The Clean Water Act, 2006 (*CWA*) addressed O'Connor's recommendations pertaining to the watershed-based protection of *drinking water* sources referred to as Drinking Water Source Protection.

The Clean Water Act, 2006 required the establishment of *Source Protection Committees* to oversee the process locally. The *Source Protection Committee* developed and consulted on a work plan document called the Terms of Reference and submitted it to the Minister of the Environment for Approval. Based on the approved Terms of Reference the *Source Protection Committee* completed an Assessment Report and *Source Protection Plan*. The Assessment Report is a science-based document that forms the basis of the *Source Protection Plan*. The Plan contains policies to reduce the *threats* (identified in the Assessment Report) to the drinking water sources.

The Clean Water Act, 2006 requires that Assessment Reports be completed for areas within Source Protection Areas of a Source Protection Region (*SPR*). The Assessment Reports contain detailed information that identifies *vulnerable* areas associated with *drinking water systems*, assesses the level of vulnerability, identifies *issues* related to the drinking water sources, identifies *activities* within those vulnerable areas that pose *threats* to the systems, and assesses the *risk* due to *threats*. These Assessment Reports have been completed for the three

Source Protection Areas of the Thames-Sydenham and Region *SPR* as shown in the following Map 1-1 of Appendix 1.

1.1. Document Overview

This Assessment Report is modular in nature. It is comprised of several Sections and Appendices. The Sections are, in effect, a summary of various technical studies which are described later in this section. Each of the Sections is summarized in Section Summaries contained in Appendix 2. Material pertinent to a specific *drinking water system* is summarized in System Summaries included in Appendix 3. Maps form a large part of the content of the Assessment Report, and are contained in Appendix 1 and 5. Tabloid sized (11"x17") maps are included in this report, and may be printed on letter sized paper and remain mostly legible. The entire document is available on Compact Disk (CD) complete with the appendices to the Assessment Report.

Each Section of the Assessment Report is outlined below:

1.1.1.1. Introduction and Background (Section 1)

The first section provides an overview of the process and background behind the Assessment Report. It refers to mapping products related to the extent of the Source Protection Region and Source Protection Areas as well as the municipal partners involved in developing the *Source Protection Plan*.

1.1.1.2. Watershed Characterization (Section 2)

The Watershed Characterization Reports for the region were completed in 2008. A three volume report was produced for the St. Clair Region Source Protection Area. A summary of the report was developed which included all of the mapping products used in the Watershed Characterization Report. The summary of the St. Clair Region Watershed Characterization Report is included in Appendix 5. The summary and the full Watershed Characterization Reports are available in portable document format (Adobe PDF) on Compact Disk (CD).

1.1.1.3. Water Budget and Water Quantity Stress Assessment (Section 3)

A Conceptual Water Budget was developed for the Thames-Sydenham and Region. This report is included as Appendix 6 of this Assessment Report. The Conceptual Water Budget compiles

water quantity information from the region, such as precipitation and water takings, for use in the Tier 1 Water Budget. In the Tier 1 Water Budget, a preliminary *stress assessment* indicating the *potential for stress* in *subwatersheds* of the region is undertaken. The *potential for stress* is then considered to determine whether additional work is required to refine the water budget in that area. If the potential *stress* could affect a *drinking water system* included in the Terms of Reference for the region (generally municipal *drinking water systems*), the additional refinement will be completed through a Tier 2 and potentially a Tier 3 Water Budget. If, however, the potential *stress* does not have an impact on the water systems in the area, the work should be undertaken through different programs. The Tier 1 Water Budget is included in Appendix 7 of this report. As the Tier 1 Water Budget did not identify a *potential for stress*, which would affect a municipal *drinking water system* in the St. Clair Region Source Protection Area, no Tier 2 or Tier 3 Water Budgets are included in this Assessment Report.

1.1.1.4. Vulnerability Assessment (Section 4)

The Vulnerability Assessment section includes the identification of the *vulnerable areas*, the assessment of vulnerability within those areas, and the *uncertainty* in that assessment as required by the Clean Water Act. The work related to this section was undertaken through a number of technical studies which were generally completed on the geographic scale of the upper tier municipalities (counties). This section summarizes the work completed on a Source Protection Area basis for each type of vulnerable area. The work is also summarized for each *drinking water system* in the System Summaries included in Appendix 3. A peer review of the vulnerability assessment work was undertaken.

1.1.1.5. Issues Evaluation (Section 5)

The Issues Evaluation Section describes the methods applied and the findings of the *issues* evaluation process across the Source Protection Area. The detailed methodology for the *issues* evaluation process is included in Appendix 8. A table of *issues* identified is included in the Issues Evaluation section as well as a description of the impact of identifying an *issue* and additional work required to determine the *activities* which may be contributing to the *issue*. The findings reported in this section are also included in the System Summaries in Appendix 3.

1.1.1.6. Conditions Assessment (Section 6)

The Conditions Assessment section of the Assessment Report includes a description of the work undertaken to assess the potential *conditions* (*drinking water threats* due to past *activities*) which have been identified to date. This is an ongoing process requiring additional work.

1.1.1.7. Threats and Risk Assessment (Section 7)

The Threats and Risk Assessment section of this Assessment Report includes a list of the types of *threats* which are or would be a *risk* to *drinking water systems* in the region and the number of locations where *significant threats* are believed to be undertaken. It is not the intent of this report to identify individuals who are believed to be engaged in those *activities* or specific properties associated with the *activities*. Policies developed in the *Source Protection Plan* will be focused on general types of *activities* which are or would be *threats* to *drinking water*. This section also outlines the additional work required to investigate those *activities* believed to be *threats*. As with the other sections, an overview of this information is presented in the System Summaries included in Appendix 3.

1.1.1.8. Great Lakes (Section 8)

The Great Lakes section includes the required references to other work undertaken in the region related to Great Lakes water quality and how the Assessment Report supports and complements that work and vice-versa. It identifies additional work required in this area once all the Assessment Reports for Source Protection Areas which drain into the Great Lakes are completed. Of special relevance to this section are the drinking water quality *issues* identified at Great Lakes intakes in the St. Clair Region SPA, which can be found in Section 5 of the Assessment Report.

1.1.1.9. Data Gaps and Next Steps (Section 9)

Data gaps and next steps are listed in this section. Data gaps could be those such as infrequent groundwater sampling, inaccurate tile drainage network information, etc. Many of the next steps involve work plans to fill the data gaps or additional work required to reduce the *uncertainty* related to various components of the Assessment Report. Data gaps and next steps pertaining to an individual system are listed in the System Summaries included in Appendix 3.

1.2. Clean Water Act Rules and Regulations

The Clean Water Act, 2006 established the requirements to develop a *Source Protection Plan* and set up the framework to develop that plan. In order to define the work and enable aspects of the work to be completed, regulations and *rules* were required. The development of these *rules* and regulations was led by the Drinking Water Source Protection Branch of the Ministry of the Environment. These regulations were developed through consultation with stakeholders including the *Source Protection Committee* chairs and committees and the staff of the Conservation Authorities working with the *Source Protection Committees*. Many consultation sessions were held with sector representatives of those who may be impacted by the *rules* and regulations.

1.2.1. Regulations

A regulation was introduced to establish Source Protection Areas and Regions (O. Reg. 284/07). This regulation established the Thames-Sydenham and Region Source Protection Region and the three Source Protection Areas within the region which are described in the sections to follow. This Source Protection Region was a recognition of the partnerships already established by the Conservation Authorities to allow them to begin to prepare for the work which the Clean Water Act would require.

A regulation was introduced to establish *Source Protection Committees* (O. Reg. 288/07). The regulation described the make-up of the committees and also the process for establishing the committees. The regulation required that the Source Protection Authorities in the region form the committee while the chair was to be appointed by the Minister of the Environment.

A General Regulation (O. Reg. 287/07) was also introduced which determines much of the process behind developing Terms of Reference, Assessment Reports and *Source Protection Plan*s. The General Regulation also establishes the 21 *activities* which can be considered *drinking water threats*, called the Prescribed Drinking Water Threats. The General Regulation was created by merging and updating a number of separate regulations. The General Regulation identifies the requirements for an Assessment Report along with sections of the Clean Water Act and the *rules* described below. The requirements of the Act, Regulation and

rules are summarized in the Assessment Report Checklist which is included in Appendix 10. The checklist indicates where the requirements have been satisfied in this Assessment Report.

A regulation was introduced to regulate the service of documents (O. Reg. 231/07). The regulation described the methods of giving and serving documents and the individuals who may be given or served a document.

1.2.2. Technical Rules

In order to fully define the contents of, and methodologies used in developing Assessment Reports, the Ministry of the Environment, Conservation and Parks (*MECP*) released *Technical Rules*: *Assessment Report* (December 12, 2008). During the drafting of the Proposed Assessment Report, the Director (*MECP*) was in the process of amending those *rules* (November 2009). Amendments not addressed in that report were incorporated into the Amended Proposed Assessment Report and are still reflected in the current Updated Assessment Report.

The *Technical Rules 2013*: *Assessment Report* replaced interim guidance developed by *MECP* to guide much of the technical work initiated in 2006 and 2007. The guidance was developed in a modular manner with each module describing a specific component of the work. Those guidance modules provided the basis for the organization of many of the technical studies. The organization of this report is partially reflective of those modules.

This Assessment Report aligns with the 2017 Technical Rules.

1.2.3. Local Guidance Documents

The *rules* and regulations leave room for local discretion by the *Source Protection Committee* and system operating authorities. In many cases, local guidance documents were required to provide consistent guidance across the region. This local guidance developed by the Thames-Sydenham and Region in consultation with municipal staff and consultants includes:

- Issues Evaluation Methodology
- Threats and Risk Assessment
- Transport Pathways Consideration

The local guidance was intended to provide local interpretation and application of the technical rules 2013. These methodologies were reflected in the work undertaken by consultants on behalf of the project leads for the technical studies. Where appropriate, these local guidance documents are referenced in this report.

1.2.4. Tables of Drinking Water Threats

Along with the technical rules 2013 the province released 'Tables of Drinking Water Threats', which list a number of *activities* considered to be *threats* based on the Prescribed Drinking Water Threats in the General Regulation as well as the *circumstances* under which *threats* can be considered significant, moderate or low *risk* within certain vulnerable areas. Two tables are provided which describe the *activities* related to chemical and *pathogen threats* separately. The *MECP* threats tables, as they are commonly called, describe the specific *circumstances* which affect the *risk* level of the *activity*. *Circumstances* include such factors as the volume of contaminant, the method of release, the type of contaminant, the density or area that the *activity* is undertaken in, etc. The tables are organized according to the Prescribed Drinking Water Threats established in the General Regulation (O. Reg. 287/07).

While the objective of the AR is to identify *threats* and assess their *risk* to water quality in accordance with thresholds established for significant, moderate and low *risk scores*, the outcome of this exercise is commonly referenced in terms of significant, moderate and low *threats.*

1.2.5. Mapping Symbology

Along with the *Technical Rules 2013*: *Assessment Report*, the province also released and updated guidance on Assessment Report mapping standards, called the *Mapping Symbology* for the Clean Water Act (Version 3.0, April 2009). This guidance will allow mapping products produced in the 19 Source Protection Regions in the province to have a consistent look. This guidance has been used to develop the various mapping products included in this Assessment Report and the supporting studies. As the *mapping symbology* has been updated over the period that much of the work was undertaken, it is likely that not all aspects of the mapping products meet the current *MECP* guidance. Similarly, much of the work undertaken in the

technical studies met the symbology of the time that the work was undertaken. In many cases this work has been updated to meet more recent versions of the rules and, where possible, the related mapping products have been updated to meet the guidance at the time of the updating. No efforts have, or will be, undertaken to update all of the previously completed technical studies to the evolving mapping standards. Where the *mapping symbology* included in the Assessment Report substantially affects the products presented, updates to these products may be required. As such, care must be taken in comparing mapping products in the Assessment Report to the Technical work that they are sourced from. A careful review of the legend is required before interpreting the products.

1.2.6. Source Protection Plan

Following the completion of the Assessment Report, a *Source Protection Plan* must be developed by the *Source Protection Committee*. The focus of the *Source Protection Plan* is to reduce or manage the *risks* to drinking water sources. The *Source Protection Plan* contains policies focused on *activities* which are identified as *threats*. Ontario regulation 287/07, among other things, defines the scope and content of a *Source Protection Plan*. The regulation outlines the nature of the policies which would be included in the *Source Protection Plan*. These policies may include:

- education and outreach programs (leading to voluntary *risk* reduction)
- incentive programs (leading to voluntary *risk* reduction)
- land-use planning approaches (e.g., official plans, zoning bylaws, site plan controls, development permits)
- new or amended provincial instruments (e.g., Certificates of Approval)
- *risk* management plans
- prohibition
- *restricted land uses.*

The discussion paper outlines that the more restrictive policies listed above would only be able to be applied to significant *drinking water threats*. Similarly, the policies related to *significant threats* are mandatory and must be implemented, whereas the policies related to *moderate and low drinking water threats* leave some discretion to the implementer. The *Source Protection*

Plan may also include various policies related to monitoring. The regulation is anticipated to be finalized this spring.

1.3. Source Protection Committee

Source Protection Areas were established through O. Reg. 284/07. This regulation established the Lower Thames Valley Source Protection Authority, the St. Clair Region Source Protection Authority and the Upper Thames River Source Protection Authority. This regulation also combined the three Source Protection Authorities into the Thames-Sydenham and Region Source Protection Region, building on a partnership that these three Conservation Authorities established to prepare for Source Protection Planning.

In the Thames-Sydenham and Region, the three Source Protection Areas have Conservation Authorities which, as specified in the Clean Water Act, will perform the powers and duties of a Source Protection Authority. As such, the Conservation Authorities were required to form a *Source Protection Committee* (*SPC*) for the region. They are also required to provide support to that committee. In order to carry out their responsibilities, each Conservation Authority meets individually as a Source Protection Authority. While many of their responsibilities can be undertaken individually, Conservation Authorities (and Source Protection Authorities, as appropriate) established various committees to undertake those items which required collective involvement.

A Management Committee was established to undertake the day-to-day administration related to the program. The Management Committee includes the General Managers of the three Conservation Authorities who meet regularly with the Source Protection Project Manager. The Management Committee, among other things, ensures that the *Source Protection Committee* has the resources to undertake their responsibilities as funded by the *MECP*.

A striking committee was formed with representation from all three Source Protection Authorities to form the *Source Protection Committee*. The striking committee provided recommendations to the Source Protection Authorities for appointment. When members of the *Source Protection Committee* require reappointment or to fill vacancies on the *Source Protection Committee*, the striking committee will be required to be re-established.

The Clean Water Act identifies the general make-up of the *Source Protection Committee* as having one third of its members representing each of the municipalities, sectors and other stakeholders. The Conservation Authorities in the region further refined the make-up of each third and established a striking committee to form the *Source Protection Committee* on behalf of the three Source Protection Authorities in the region. A discussion paper was developed and distributed to the municipalities in the region for their input. Consultation with First Nations was also undertaken to encourage their participation on the *Source Protection Committee*. Those discussions led to the appointment of three First Nations members on the *Source Protection Committee.* These members were named by the London District Chief's Council to represent the eight First Nations in the Region. First Nations involvement in other aspects of the project was also encouraged, including the participation in relevant technical studies and input into the Watershed Characterization Report and Terms of Reference. A source water protection technical study was completed for the Chippewas of the Kettle and Stony Point December 14, 2011 and has been incorporated into this Updated Assessment Report.

The make-up and representation of the *Source Protection Committee* are summarized in the following table:

Table 1-1 SPC members and representation

Chair		Robert Bedggood
Municipalities	Chatham-Kent Lambton London Middlesex Elgin Oxford Perth, Stratford, St. Marys, Huron	Sheldon Parsons Darrell Randell Patrick Donnelly James Maudsley Brent Clutterbuck Pat Sobeski Joe Salter
Sectors	Agriculture	John Van Dorp Patrick Feryn Don McCabe
	Industry/Commercial	Dean Edwardson Earl Morwood
	Aggregate and Quarries	Paul Hymus
	Oil and Gas	Hugh Moran
Other		George Marr Doug McGee Joseph Kerr Carl Kennes Valerie M'Garry John Trudgen Charles Sharina
First Nations		Kennon Johnson Augustus Tobias Darlene Whitecalf
Liaisons	Medical Officers of Health Province Source Protection Authority	Jim Reffle Teresa McLellan Murray Blackie

Once established, the *Source Protection Committee* was required to establish rules of order and operating procedures. The *Source Protection Committee's* rules of order are posted on the region's web site at the address included in the footers of this report. In order to guide them through the Source Protection planning process, the *Source Protection Committee* developed a Mission Statement and Guiding Principles. The *Source Protection Committee's* guiding principles and mission statement are summarized as follows:

Table 1-2 SPC Mission Statement and Guiding Principles

Mission Statement
Protect sources of drinking water by developing a plan based on science and local cooperation.

Guiding Principles

We value:

- Fair and reasonable solutions
- Consensus within our diverse area group
- Clarity of information
- Open communication
- Respecting diversity of opinion

More details on the committee's Mission Statement and Guiding Principles are posted on the region's web site, listed in the footer of this page.

The *Source Protection Committee* meets regularly to review and assess work conducted for the Assessment Report, to consider amendments to the Terms of Reference, and to discuss source protection planning for the region. The meeting agenda and minutes are available at the region's web site.

1.4. Role of the Conservation Authorities

The Conservation Authorities provide the resources to the *SPC* to complete their work. This includes the provision of technical and administrative staff such as hydrogeology, engineering, geographic information system and communications specialists. This team is led by the Source Protection Project Manager, Chris Tasker, and technical leads at each of the Source Protection Authorities. The lead at the St. Clair Region Source Protection Authority is Girish Sankar, Manager of Water Resources.

1.5. Terms of Reference

The first major task of the *Source Protection Committee* was to come up with a work plan that will guide the source protection planning process for the following five years. The work plan – called the Terms of Reference, was developed with input from municipalities and stakeholders. The Terms of Reference outlines who does what, when it will happen and how much it will cost. It guides the *Source Protection Committee* through the completion of the Assessment Report and the *Source Protection Plan*.

Two municipal working groups, for surface water and groundwater related studies, were established to help complete the work plan for the Terms of Reference. The groups were

chaired by *SPC* members and comprised of municipal staff and water treatment plant operators, who provided technical input.

Public Open Houses on the Terms of Reference were held in September of 2008 at Ridgetown, St. Marys and Wyoming. A follow-up Public Meeting was held in London. In addition, comments were received through the posting of the Terms of Reference on the region's web site. The *SPC* submitted the proposed Terms of Reference to the Source Protection Authorities (SPAs) on December 18, 2008. Comments were received by the *SPAs* and submitted to the Minister of the Environment for approval. The Terms of Reference for the St. Clair Region Source Protection Area were approved by the Minister of the Environment on April 20, 2009. This approval set the due date of the Assessment Report one year from the posting of the approval of the Terms of Reference. The report was further amended to produce the Amended Proposed Assessment Report dated February 2011. An Updated Assessment Report dated May 13, 2011 was consulted on and submitted to the MECP. Comments from the MECP resulted in revisions and the Updated Assessment Report dated November 18, 2011 was approved. MECP approval letters and direction for revisions are included in Appendix 14. It has since been updated to the Updated Assessment Report dated November 14, 2014 and submitted for approval in early 2015.

1.6. Thames-Sydenham and Region Source Protection Region

The Thames-Sydenham and Region Source Protection Region is located in southwestern Ontario bounded by Lake Erie in the south and by Lake Huron to the north of the western end of the region. It is surrounded by the Lake Erie Source Protection Region to the east and the Essex Region Source Protection Area to the west of its southern end. To the north and west of the northern part of the region is the Ausable-Bayfield Maitland Valley Source Protection Region. The region is shown in Map 1-2 in Appendix 1.

The Thames-Sydenham and Region is comprised of three Source Protection Areas. The Upper Thames River Source Protection Area is to the north and east of the region. The Lower Thames Valley Source Protection Area is to the south and west of the Upper Thames River Source Protection Area while the St. Clair Region Source Protection Area is north of the Lower

Thames Valley Source Protection Area. The three Source Protection Areas are also shown in Map 1-1 in Appendix 1.

1.6.1. St. Clair Region Source Protection Area

The St. Clair Region Source Protection Area (*SCRSPA*) includes parts of the municipalities listed in Table 1-3 below.

Table 1-3 Municipalities in the SCRSPA

Middlesex, County of	Dawn-Euphemia, Township of
Lambton, County of	Enniskillen, Township of
Chatham-Kent, Municipality of	Lambton Shores, Municipality of
Adelaide-Metcalfe, Municipality of	Oil Springs, Village of
Middlesex Centre, Municipality of	Petrolia, Town of
Newbury, Village of	Plympton-Wyoming, Town of
Southwest Middlesex, Municipality of	Point Edward, Village of
Strathroy-Caradoc, Municipality of	Sarnia, City of
Brooke-Alvinston, Township of	St. Clair, Township of
	Warwick, Township of

The region also includes three First Nation *reserves* as shown on Map 1-1 in Appendix 1.

Table 1-4 First Nations of the SCRSPA

Chippewas of Kettle and Stony Point First Nation *
Aamjiwnaang First Nation
Walpole Island First Nation
** Kettle and Stony Point First Nation area is only First Nation with an intake included in the assessment report. The technical study was completed December 14, 2011*

.The municipalities receive their *drinking water* from intakes on Lake Erie, Lake Huron, the St. Clair River and the Chenal Ecarte. Private wells supply water to the remainder of the residents in the region. Map 1-3 shows the location of the intakes in the area.

The largest settlement in the area is Sarnia, however parts of Middlesex, Lambton and Chatham-Kent are in the region. Settlement areas are shown in Map 1-4. The approximate population of these settlement areas is indicated by the relative size of the symbol indicating the

location of the settlement. These populations have been included based on available information or estimated based on the number of parcels in the settlement area.

More details on the area, its water systems and the population of the area are included in Section 2.0 - Watershed Characterization.

1.7. Technical Studies

The Assessment Report is a summary and compilation of a number of technical reports. Technical reports were completed on the following areas:

- Watershed Characterization
- Conceptual Water Budget
- Various levels of Water Budgets (Tier 1, 2 or 3)
- Municipal Technical Studies
- Intake Protection Zones 1, 2 and 3.

The Municipal Technical Studies were completed through partnerships between the municipalities and the Conservation Authorities. Leads for each study were established. The studies were led by the Conservation Authorities (CAs) or by a municipality. Most of the municipal technical studies were organized based on the geographic extent of the upper tier municipalities (counties). Municipal involvement in the Municipal Technical Studies was through staff responsible for the operation of the *drinking water systems* participation in steering committees for these projects. The watershed characterization and the conceptual water budget studies were led by the Conservation Authorities and completed by Conservation Authority staff.

Certain components of the technical studies were subjected to peer review. Vulnerability Assessment technical reports were peer reviewed by a four member peer review committee comprised of hydrodynamic and groundwater modelling experts with experience in vulnerability assessment studies. This peer review is described in more detail in Section 4.0 – Vulnerability Assessment. The water budget work was also subject to a peer review process. The Ministry of Natural Resources (MNR) also participated in the peer review as well as people who have

been involved in water budget work of the neighbouring Source Protection Areas. Components from the studies have been compiled into these Assessment Reports.

1.8. Consultation

Regulations require consultation on the Assessment Reports. This consultation, much like that of the Terms of Reference, required a public meeting and posting of the Assessment Report for comment. Two posting periods were required: one posted by the *Source Protection Committee* for consultation on the draft proposed Assessment Report; and the second posted by the Source Protection Authority for comments on the proposed Assessment Report. The proposed Assessment Report was then submitted to the Ministry of the Environment, Conservation and Parks along with comments received in the final posting period. The Director has now approved this Assessment Report and any revisions to the Assessment Report are referred to as an Updated Assessment Report.

As with the Amended Proposed Assessment Report, an Updated Assessment Report requires consultation with those affected by the updates. As some of the current updates are considered broad updates local consultation has been carried out in those areas where new vulnerable areas have been defined. A broad regional consultation has also been planned for the updated Assessment Report and amended proposed Source Protection Plan which exceeds the requirements for consultation on either the Draft Proposed or Proposed Assessment Report consultation including an open house in each Source Protection Area and a consultation period of more than a month.

The *Source Protection Committee* identified the need to undertake a more detailed and locally focused consultation on the contents of the Assessment Report. A multi-phase consultation plan was developed and is included in Appendix 4 (and on the web site). The plan identifies three consultation phases. The first two phases of consultation provide a more local focus on the vulnerable areas associated with the municipal water supplies. The first phase includes the (peer reviewed) vulnerability assessment of the areas while the second phase adds discussion on the *threats* and *issues* identified in the vulnerable areas. Both phases included individual correspondence with property owners in the proposed vulnerable areas as well as advertisements in local newspapers. Maps of the areas and fact sheets were distributed with

invitations to attend the local meetings. These materials were also made available on the region's web site.

The third phase of consultation was the required public meeting and posting of the draft proposed, and then the proposed Assessment Report for comment. This phase was more of a regional focus involving open houses in each of the Source Protection Areas.

The draft proposed Assessment Report must be published on the Internet for a 35-day comment period, and copies made available to stakeholders including the public. A copy of the notice of the posting of the draft proposed Assessment Report must be published in newspapers and distributed to the municipal clerks, First Nation band chiefs, landowners (engaging in an *activity* known by the *SPC* that is or would be a *significant threat*), other *SPCs* listed in the Terms of Reference, persons or bodies related to Great Lakes Water Quality Agreements, Remedial Action Plans and Lake- wide Management Plans for their comments. At least 21 days after publishing the draft proposed report on the Internet, the required public meeting took place.

The proposed Assessment Report was published on the Internet for a 30-day comment period, and copies of the report submitted to municipal clerks and band chiefs. Amendments required by the Director were incorporated into an amended Proposed Assessment Report which involves local consultation of those affected by the changes made to the report.

Table 1-5 Summary of SCRSPA Assessment Report Consultation *

Item	Schedule (week of)
* *Please refer to Assessment Report Consultation in Appendix 4 for details on Assessment Report consultation*	

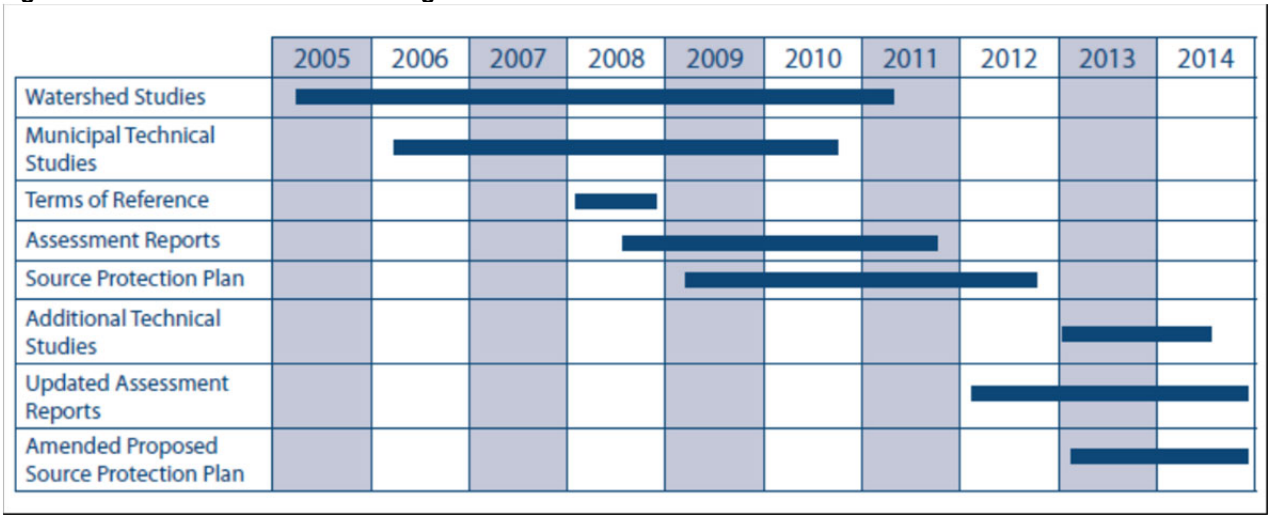
The Assessment Report has now been approved by the Minister and an Updated Assessment Report has been prepared based on additional work. This update includes the revision of IPZ-3 zones for the three surface water intakes in the St. Clair SPA and the addition of IPZ-1 and 2 for the Kettle and Stony Point Intake. The Updated Assessment Report will be posted for a public

comment period followed by submission, along with comments, to the Ministry. Any updates to the Assessment Reports with include Early Engagment with MECP, Pre-consultation and Public Consultation.

1.9. Schedule

The due date of the Assessment Report was set with the posting of the approval of the Terms of Reference for the Source Protection Area. The Clean Water Act identifies that Assessment Reports are to be submitted within one year of the posting of the approval of the Terms of Reference. The *Technical Rules 2013*: *Assessment Report* allowed for certain data gaps, provided a work plan was included that outlined the work to be undertaken to fill those data gaps. The types of data gaps allowed by the revised *rules* are described in the Data Gaps and Next Steps section of this Assessment Report. The following schedule describes at high level the work required to complete the Assessment Report and Source Protection Plan and update the Assessment Report and amend the Source Protection Plan before the approval of the first Source Protection Plan for the Thames-Sydenham and Region.

Figure 1-1 Source Protection Planning Schedule



1.10. Local Acceptance, Approvals and Next Steps

The Assessment Report consultation plan illustrates a number of review and acceptance stages in the development of the Assessment Reports for the Source Protection Areas. This ultimately

culminates in the approval of the Assessment Reports by the Director of Source Protection Planning for the Ministry of the Environment, Conservation and Parks.

Local acceptance of the Assessment Reports is also included in the consultation process. Prior to inclusion in the Assessment Report, the components have been reviewed and accepted by the *Source Protection Committee*. This review included:

- presentations to the *Source Protection Committee* by those undertaking the work;
- peer review of the work;
- review of the products from the technical studies which are to be included in the Assessment Report;
- review of summary level information included in the Assessment Report in the form of section summaries and system summaries; and
- ultimately, the acceptance of the Assessment Report.

Municipal and other local involvement in the development of the Assessment Report has been included in many ways. Municipalities have been involved in many of the technical studies throughout the region, especially those which are focused on the sources of *drinking water* for their municipal systems. Operating Authority staff participated in technical steering committees on these projects. Where appropriate, operating Authority staff kept their commissions or councils up to date on the completion of the technical work. Updates on the progress of Source Protection Planning have been distributed to municipalities throughout the work stages of the Assessment Report. Municipal comments were also requested on the Watershed Characterization Reports and the Conceptual Water Budget. Representatives on the *Source Protection Committee* have been instrumental in keeping their representation updated on the Source Protection Planning process including organizing and attending meetings with stakeholders.

During the first two phases of the consultation, municipal staff and councils were circulated invitations to the open houses and offers were made of presentations to municipal councils. Municipal Planners were invited to attend a municipal planners forum where the materials included in the Assessment Reports were discussed.

The third phase of consultation is comprised of two steps: consulting on the draft proposed Assessment Report, and then on the proposed Assessment Report. In the third phase of consultation, the notice of publishing of the draft proposed Assessment Report was sent to municipal clerks and band chiefs. The draft proposed Assessment Report was distributed on Compact Disk (CD) to the municipalities and First Nations for their comments. It is hoped that through ongoing involvement in the Assessment Report development process as discussed above, the municipal input has been adequately addressed in the Assessment Report. Municipalities, First Nations and other stakeholders had 35 days from the time the notice was posted to review and provide comments on the draft proposed Assessment Report. These comments were to be considered by the *Source Protection Committee* in finalizing the proposed Assessment Report.

The proposed Assessment Report was posted on the Internet for a 30-day comment period. This posting asked for comments to be submitted to the Source Protection Authority. Further, a copy of the proposed Assessment Report was submitted to the municipal clerks and band chiefs.

The current report is an Updated Assessment Report which fills in many of the data gaps identified in previous Assessment Reports. Local consultation with those affected by the updates will be conducted.

In submitting the Assessment Report to the Ministry of the Environment, Conservation and Parks, the Source Protection Authority is to include any outstanding comments including any municipal or First Nations concerns over the Assessment Reports. The Director can approve the Assessment Report as submitted or require further amendments to the Assessment Report.

1.10.1. Engaging First Nations

The First Nations have been encouraged to participate in the development of the Assessment Report in a number of ways. That participation has been rather limited and very informal in nature. First Nations forums were set up in 2008-2009 across the region. As of January, 2010, two First Nation representatives have been appointed to the *Source Protection Committee* by the London District Chiefs Council. A First Nations liaison hired by the Conservation Authorities

has been instrumental in the involvement of First Nation communities in many aspects of Source Protection Planning. The Chippewas of Kettle & Stony Point First Nation passed a band council resolution requesting the Minister to include their intake in the Terms of Reference for the region and allow them to undertake the technical work to delineate Intake Protection Zones for their intake. The source water protection study for the Chippewas of Kettle and Stony Point First Nations intake was completed December 14, 2011. This Assessment Report includes the IPZ 1 and 2 for Kettle and Stony Point Intake. Comments received from the First Nations will be considered by the *Source Protection Committee* along with others received during this posting.

1.10.2. Amendments to the Assessment Report

As there were a number of data gaps in previous versions of the Assessment Report updates to the Assessment Report were anticipated. The Data Gaps section of this report identifies the gaps and discusses plans to fill those gaps.

The Assessment Report can be updated at any time that the *Source Protection Committee* becomes aware of the need to update the report. Further, changes in understanding or factors such as land use which may have an impact on the Assessment Report may be brought to the attention of the *Source Protection Committee*. As a result of this new information or understanding, the *Source Protection Committee* may update the Assessment Report. Any updates to the Assessment Report would require consultation of those affected by the updates. The *Source Protection Committee* will also need to consider updates to the Assessment Report when the *Source Protection Plan* is reviewed. The period for review of the *Source Protection Plan* is established by the Minister in the approval of the *Source Protection Plan*.

Many of the data gaps identified in the Data Gaps and Next Steps section of the Updated Assessment Report (November, 2011) resulted in amendments to the Assessment Report. The current report is an Updated Assessment Report which fills in these previously identified gaps. Local consultation with those affected by the updates will be conducted.

The terms ‘updated’ or ‘amended’ used throughout the report may refer to a future Assessment Report following approval of this Updated Assessment Report or to this Assessment Report itself.

2.0 Watershed Characterization

Justice O'Connor recommended that watershed-based *Source Protection Plans* be developed. The recommendations were part of the inquiry which investigated the May 2000 bacterial contamination of the Town of Walkerton's water supply. Compiling a summary of information pertinent to *drinking water* sources is one of the first steps in developing a *Source Protection Plan*.

Under the Clean Water Act (2006), the Assessment Report must identify all watersheds in the source protection area and characterize the water quality and quantity in each identified watershed. The Regulations and Rules under the Clean Water Act (2006) require that the physical and human geography also be characterized. This information is contained in a watershed characterization report.

2.1 Watershed Characterization Report

The St. Clair Region Watershed Characterization Report, completed in 2008, is based on information available at the time. Updated characterization information is included in other sections of the Assessment Report. Some of the water budget related mapping products are available in the Conceptual Water Budget, which is included as an appendix to the Assessment Report.

The Watershed Characterization Report summarizes information on the physical, social and economic characteristics of the St. Clair Region watershed. It reviews surface water and groundwater quality, and summarizes known *issues* and concerns pertaining to *drinking water* sources. A series of maps help to illustrate the information presented in the report. Each of the components of the watershed characterization report will be described in the sections that follow.

The summary of the St. Clair Region Watershed Characterization Report is included in Appendix 5 in the St. Clair Region Source Protection Area Assessment Report; complete with all maps. The entire Watershed Characterization Report is available on compact disk (CD).

2.2 Data Sources

A wide range of data sources have been used as resources to prepare the Watershed Characterization Report and the accompanying maps. Data used to characterize the St. Clair Region watershed include the sources provided in Table 2-1 below. For a complete list of resources, refer to the St. Clair Region Source Protection Area Watershed Characterization Report, December, 2008.

Table 2-1 Watershed Characterization Report Data Sources

Component	Data Source
Bedrock Geology	Waterloo Hydrogeologic. 2004. Six Conservation Authorities FEFLOW Groundwater Model: Conceptual Model Report.
Surficial Geology	Waterloo Hydrogeologic. 2005. Southwestern Region Edge-Matching Study. Surficial Geology of Southern Ontario. Ontario Geological Survey Miscellaneous Release –Data 128.
Physiography	Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario, 3rd edition.
Soils Information	Ontario Ministry of Agriculture and Food and Agriculture Canada, Soils Ontario Version 1.0. Ontario Soils Surveys
Groundwater Hydrogeology	Waterloo Hydrogeologic. 2004. Six Conservation Authorities FEFLOW Groundwater Model: Conceptual Model Report. Waterloo Hydrogeologic. 2005. Southwestern Region Edge-Matching Study. Municipal Groundwater Studies. MOE.
Surface Water Hydrology	DesRivieres, Dennis. 1972. The Great Enniskillen Swamp: Speculation, drainage and settlement. Western Ontario Historical Notes BM Ross & Associates, Ltd. 1997. Model Calibration Manual Stream Gauge Data Ontario Ministry of Agriculture and Food and Agriculture. Municipal Drain Classification (Fisheries and Oceans Canada project) data. St. Clair Region Conservation Authority. November 1996. Shoreline Management Plan.
Naturally Vegetated Areas	Environment Canada. 2004. How much habitat is enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern. Second Edition. Nelson, M. 2001. Sydenham River – Landuse and Landcover Assessment.

Table 2-1 Watershed Characterization Report Data Sources

Component	Data Source
	Unpublished report from School of Rural Planning and Development, University of Guelph. DesRivieres, Dennis. 1972. The Great Enniskillen Swamp: Speculation, drainage and settlement. Western Ontario Historical Notes. OMNR and Canadian Wildlife Services, Environment Canada. 1984. An Evaluation System for Wetlands of Ontario. Unpublished report. Staton, S. and A. Doolittle. July 2003. Sydenham River Riparian Inventory. Annual Report to the IRF, Department of Fisheries and Oceans, Great Lakes Laboratory for Fisheries and Aquatic Sciences
Aquatic Ecology	Poos, Mark. 2004. Science in support of policy: assessment and recovery of fish species at risk in the Sydenham River. M.Sc. thesis, University of Guelph. Seidler, A. and M. Andreae. June 2004. Upper East Sydenham Fisheries Management Plan. Unpublished report. Ontario Ministry of Natural Resources. 1975. Unpublished Stream Survey Data by Scott and Payne. Metcalfe-Smith, J., J. Di Maio, S.K. Staton and S.R. De Solla. 2003. Status of the Freshwater Mussel Communities of the Sydenham River, Ontario, Canada. American Midland Naturalist 150:37-50. Metcalfe-Smith, J.L., D.J. McGoldrick and D.T. Zanatta. 2004. Implementation of a Monitoring Program to Track the Recovery of Endangered Freshwater Mussels in the Sydenham River, Ontario *in* Proceedings of the Species at Risk 2004 Pathways to Recovery Conference. March 2004, Victoria, BC. Mackenzie, H. and M. Andreae. 2005. Benthic Macroinvertebrate Field Study 2004. St. Clair Region Conservation Authority report.
Human Characterization	Ontario Ministry of Finance. Ontario Population Projections, 2006-2031. Lambton County Official Plan, www.lambtononline.com (August 2006) Middlesex County Official Plan, adopted by County Council September 9, 1997, amended by Official Plan Amendment No. 2 Chatham-Kent Official Plan, adopted January 2005 City of Sarnia Official Plan, January 12, 2001, Office Consolidation as amended July, 2006
Drinking Water Sources	Ministry of Environment Permit To Take Water (PTTW) database. Municipal Groundwater Studies. MOE.
Water Quality	Provincial Water Quality Monitoring Network. Provincial Groundwater Monitoring Network. Drinking Water Surveillance Program.

Table 2-1 Watershed Characterization Report Data Sources

Component	Data Source
	Drinking Water Information System. Annual Drinking Water System Reports. Ministry of Environment Inspection reports. Water treatment plant laboratory data. Ambient Groundwater Chemistry Study of the Thames River and St. Clair Region Watersheds. Waterloo Hydrologic Incorporated, 2008.

2.3 Components of the Watershed Characterization Report

2.3.1. Watersheds and Subwatersheds

The Source Protection Area (*SPA*) watershed boundary within the Source Protection Region (*SPR*), as well as the *subwatersheds* within the *SPA*, are identified and described. Map 1-1 in Appendix 1 illustrates the Thames-Sydenham and Region watershed and *subwatershed* boundaries.

The St. Clair Region Source Protection Area includes those lands draining into southern Lake Huron, the St. Clair River and its immediate tributaries such as the Chenal Ecarte, and northern Lake St. Clair. The St. Clair Region Source Protection Area covers 4,129 square kilometres.

2.3.2. Physical Geography

This component describes the location and types of natural vegetative cover, aquatic habitats, and species habitats within the Source Protection Area that are on the Species at Risk in Ontario List. It also describes the history, structure and composition of the surface, just below the surface, and deep beneath the surface (geology). In addition, this component describes natural landscape features (physiography), soil types, and surface shape and features (topography). Water movement on the surface (surface hydrology), such as rainfall, and water movement below the ground (groundwater hydrogeology), and climate, including air temperature and flooding are also included. A few details are given below but do not provide a complete picture of the characterization. For accurate descriptions, refer to the St. Clair Region Watershed and Region Watershed Characterization Report (2008).

2.3.2.1. Geology, Physiography and Soil Types

'Bedrock' is the rock formation deep under the ground, over which lies the 'overburden' rock formation. There is an area of higher bedrock on the eastern side of the St. Clair Region *SPA* in the Warwick area. In general, the lowest bedrock surface elevations correlate with the shorelines of Lake Huron, Lake St. Clair and the St. Clair River. There is also a bedrock valley in the Strathroy area that runs from Lake Huron south to Lake Erie. The *SPA* is located on the eastern edge of the Michigan Basin, which is a large carbonate-dominated sedimentary basin centred in the State of Michigan. Over time, the sediments in the basin became bedrock layers that cover the ancient Canadian Shield rock. In the western portion of the *SPA*, the sedimentary bedrock units exhibit a regional dip (slope) of 0.2% to the southwest. As a result, several different types of bedrock including Port Lambton Group, Kettle Point Formation, Hamilton Group and Dundee Formation underlie the area.

The surficial geology (physiography) is influenced by the type and nature of overburden. Map 7 in Appendix 5 shows the St. Clair Region watershed physiography. The major physiographic regions in the area are the extensive clay plains including the Lambton, Ekfrid and Chatham Flats clay plains. These have varying characteristics depending on their origin.

The Bothwell and Caradoc sand plains are the other large physiographic features of the St. Clair watershed. In the northeastern part of the area, remnant glacial moraines, beaches and shorecliffs have localized impacts on the drainage and landscape. Within the St. Clair area, silt and clay soils predominate and cover approximately 67% of the St. Clair Region *SPA* watershed. Various types of loams make up the major portion of the remaining soils.

2.3.2.2. Topography, Hydrology and Hydrogeology

The topography in the St. Clair area is divided into four main *subwatersheds*. The Sydenham River drains approximately 67% of the area to the Chenal Ecarte, which discharges into Lake St. Clair. The three shoreline subwatershed areas have several smaller watercourses that drain about 15% of the area to Lake Huron, 12% to Lake St. Clair, and 6% to the St. Clair River. The main Sydenham River is only approximately 5 kilometres in length running from Wallaceburg to the river's outlet in the Chenal Ecarte, which is the eastern channel of the St. Clair River as it discharges into Lake St. Clair. The main Sydenham River is very flat with a gradient of less than

0.1 m per kilometre and water levels are affected by lake levels and wind conditions. Downstream of the Sydenham River, the Chenal Ecarte divides into two distinct channels and flows for 2.4 kilometres to Lake St. Clair through a large area of low swampy land that forms Walpole and St. Anne Islands. In Wallaceburg, the river divides into the East and North Branches. Both branches have a very flat gradient for several kilometres upstream of Wallaceburg. Water levels in these sections can also be affected by lake levels and wind conditions.

The St. Clair River serves as a connecting channel draining Lake Huron south into Lake St. Clair, and forms the western boundary of the St. Clair Region. Historically, the majority of the flat area along the St. Clair River was wetland with a small number of creeks draining a narrow area of land adjacent to the river. Much of the shoreline now has hardened shore protection and the majority of wetlands have been removed by systematic tiling of the land.

The shoreline of Lake Huron forms the northern boundary of the St. Clair Region area. It has varied topography ranging from delta areas in Sarnia to bluffs at Kettle Point.

Within the region, there are a number of *aquifers* and aquitards that vary greatly in spatial extent and thickness. Two distinct *aquifer* types, bedrock and overburden, were identified during cross-section interpretations. The depth of the bedrock *aquifer* to the surface is shown in Map 12 of Appendix 5.

Hydrology and climatic conditions are monitored locally by a combination of Environment Canada monitoring stations, including ones in Sarnia, Wallaceburg and Petrolia. From plotting 10 year running averages over the data years of 1950 to 2005, an increase in the precipitation linear trend line is seen in the region.

2.3.2.3. Natural Vegetative Cover

Wetlands make up 32.6 square kilometres or 0.8% of the SCRCA watershed area, as shown in Map 20 of Appendix 5. There are approximately 512 square kilometres of woodland/forest cover within the entire SCRCA watershed, equating to 12% of the total watershed, as shown in Map 21 of Appendix 5. The areas with the highest woodland cover are the Chippewas of Kettle and

Stony Point, Aamjiwnaang, and Bkejwanong Territory (Walpole Island) First Nation lands. The largest contiguous forest outside of the First Nation lands is Bickford Oak Woods in St. Clair Township. Table 2-2 shows the distribution of wetlands and woodlands in the *SCRSPA subwatersheds*.

Table 2-2 Distribution of Wetlands and Woodlands within the SCRSPA

	Area (sq km)	Wetland (sq km)	Wetland (%)	Woodland (sq km)	Woodland (%)
Bear Creek	632	1.27	0.20	87	14
Black Creek	324	0.46	0.10	44	14
Brown Creek	156	0.14	0.10	20	13
Lake Huron Tributaries	646	0.48	0.10	88	14
Lake St. Clair Tributaries	448	12.39	2.80	29	6
Lower East Sydenham	396	0.20	0.05	24	6
Lower North Sydenham	252	0.47	0.20	24	10
Middle East Sydenham	539	4.32	0.80	84	16
St. Clair River Tributaries	261	0.03	0.01	43	16
Upper East Sydenham	459	12.80	2.80	72	16
Total	**4113**	**32.60**	**0.8**	**512**	**12**

The area of land adjacent to streams is often called the riparian zone or buffer zone. Within the *SCRSPA* watershed, both urban and rural land uses have resulted in a loss of a vegetated riparian zone of forested, prairie habitat and wetland land forms. In some areas of the region, streams have been diverted, straightened and vegetation removed from the entire length and width of the channel. The only area in the St. Clair Region for which an analysis of riparian zones was conducted is the Sydenham River. Analysis of the 30 m buffer composition indicated that between 61% and 91% of main tributaries had natural vegetation buffers. As would be expected in areas dominated by agricultural land use, low order (smaller) tributaries had less (18% to 35%) coverage in natural vegetation. The lowest riparian cover occurs in the lower reaches of the Sydenham River. The highest cover is in the Middle East Sydenham and Black Creek watershed areas.

2.3.2.4. Aquatic Ecology

There are over 6000 km of watercourses in the St. Clair Region Source Protection Area watershed. From 1999 to 2004, the St. Clair Region Conservation Authority carried out field work to analyze local watercourses. Most of the work was done at road crossings that provided easy access. Watercourses were classified as N (natural or not municipal drain), T (tiled or closed surface), U (unclassified) and open Municipal Drains (Type A, B, C, D, E or F). The open municipal drains are categorized as based on stream flow, thermal regime and fish species.

Approximately 4500 km of watercourses have been classified (Map 18 of Appendix 5). One-quarter of the watercourses (1500 km) have not been classified since they begin between public roads and were not accessible without obtaining landowner permission.

Intermittent municipal drains (Type F) are the largest category of classified watercourses with over 2000 km mapped. Warm water municipal drains, which provide habitat for common baitfish species (Type C), are the second most common category with 1100 km mapped. Natural watercourses (Type N) are the third most common category with 900 km mapped. Approximately 500 km of closed or tiled watercourses have been mapped to date in the SCRCA watershed.

A great diversity of aquatic species currently inhabits the waters of this region. 45 aquatic species of mussels, fish and reptiles have been designated by the federal Committee on the Status of Endangered Wildlife in Canada (*COSEWIC*) as Endangered, Threatened or of Special Concern, or are candidate species for assessment.

During the last 30 years, 82 species of fish have been recorded in the St. Clair Region. This represents almost half of the 165 fish species known from Ontario. Information on the fish communities has been collected in the field by using seine netting, minnow trapping, backpack electro-fishing and boat electro-fishing.

The Sydenham River supports the richest freshwater mussel community of any river in Canada. Freshwater mussels are valuable indicators of environmental degradation because they are affected by many kinds of habitat alteration and pollution. Historically, 33 native mussel species

were recorded for the Sydenham. Extensive sampling from 1997 to 1999 found 30 live species, including the Threehorn Wartyback which was a new species of record for the river. However, the work in the late 1990s indicated that conditions were deteriorating. Four species (wavy-rayed lampmussel, slippershell, paper pondshell and lilliput) were represented only by empty shells.

Aquatic macroinvertebrates have been used effectively to evaluate the quality of water in rivers, streams and lakes. Benthic, or bottom-dwelling, macroinvertebrates live on or in the substrate of water bodies and include organisms such as mayflies, stoneflies, aquatic worms and snails. Benthic macroinvertebrates provide an excellent tool for water quality assessment because different species have different tolerances to pollution. The SCRCA has been monitoring the benthic macroinvertebrate community beginning in 1999 when 20 sites were sampled. Since then, between 34 and 68 sites are sampled per year at locations distributed across the region.

Based on the six years of benthic monitoring, all of the watershed areas have ‘Poor’ to ‘Fairly Poor’ aquatic health (Map 24 of Appendix 5). A broad overview of the data indicates that the Upper East Sydenham has the best quality of aquatic habitat, based on achieving the lowest average FBI of 5.81 which still places it in the ‘Fairly Poor’ category. In increasing order of impact, Brown Creek, Middle East Sydenham, Black Creek, Lower East Sydenham, Bear Creek and the Lake Huron Tributaries are in the same category of ‘Fairly Poor’. The most impacted watershed areas are the Lake St. Clair Tributaries, St. Clair River Tributaries and Lower North Sydenham, in the ‘Poor’ category. It is also of note that the majority of the ‘Good’ sites were found in the East Sydenham watersheds.

Within the St. Clair region, the Sydenham River watershed has received the most intensive examination for Species at Risk. 45 aquatic species of mussels, fish and reptiles have been designated by the federal *COSEWIC* as Endangered, Threatened or of Special Concern or are candidate species for assessment (Appendix 1).

The Sydenham River is globally and nationally significant for its population of rare freshwater mussels. Four of the mussels are designated as globally rare by The Nature Conservancy from Arlington, Virginia. The Mudpuppy Mussel and Snuffbox are rare to uncommon; the Northern

Riffleshell subspecies is very rare; and the Rayed Bean is very rare to extremely rare. Nine of the mussels that are found in the Sydenham have been designated by *COSEWIC* as Endangered and one has been designated as Threatened. An additional 13 mussel species are candidates for review by *COSEWIC* for nationally rare status. It total, 23 species or 68% of the mussel species known from the Sydenham River are in need of conservation action.

Eight fish species are identified as Species at Risk including Northern Madtom (Endangered), Eastern Sand Darter and Spotted Gar (Threatened), and Bigmouth Buffalo, Blackstripe Topminnow, Grass Pickerel, Greenside Darter and Pugnose Minnow (Special Concern). Ten fish species from the Sydenham are considered provincially rare.

Nine reptiles from the St. Clair region are provincially rare and are identified by *COSEWIC* as Species At Risk. The Spotted Turtle is Endangered. The Butler's Garter Snake, Eastern Fox Snake, Eastern Hognosed Snake, Spiny Softshell Turtle, Eastern Massassauga Rattlesnake, and Queen Snake are Threatened. The Eastern Milksnake and Northern Map Turtle are Special Concern.

Invasive species have had a significant negative impact on local ecosystems by out-competing native species, carrying *pathogens*, disrupting communities, causing extinction, altering the food chain, disturbing habitat, affecting environmental/ecosystem health, and impacting water quality.

Introduced fish species found in the *SPA* include the common Carp, Goldfish, Alewife, Round Goby and Sea Lamprey. As the Sydenham River is nationally significant for its native mussel fauna, one of the most serious invasive species for this region is the Zebra Mussel (*Dreissena polymorpha*). Although it has only been reported at one site in the lower North Sydenham, this European species has already decimated the native mussels of the Great Lakes.

Common reed/giant reed (*Phragmites australis*) is probably the most aggressive wetland species in this region. This invasive plant forms dense monocultures that displace native fish and wildlife habitat.

The Watershed Characterization Report also discusses the impacts human activities have had on aquatic ecology. The St. Clair Region *SPA* is situated in a highly developed part of southern Ontario. The aquatic community faces many pressures from urban and rural land uses and human activities. Most of the watercourses have been greatly altered by human influences. On larger watercourses, many of the influences accrue from urban development, including channel alteration, bank hardening, storm water runoff, and sewage effluent input. Rural influences often involve smaller watercourses where habitat changes and alterations such as drains and channelization are aimed at improving agricultural operations.

Intermittent drain systems actually provide a significant function to the watershed. They provide fish habitat when wet and, in many cases, significant spawning areas during spring flooding. In recent years, many of these intermittent watercourses have been converted to closed systems. The trend to close drain systems has altered the hydrograph, hydrologic regime and fluvial dynamics of the receiving watercourses and has led to an increase in erosion in downstream watercourses. Changes such as the removal of cobble from the channels and the lack of pool riffles result in aquatic communities limited to hardy warm water species.

2.3.3. Human Geography

The St. Clair Region Conservation Authority (SCRCA) includes most of Lambton County, part of Middlesex County and part of the Municipality of Chatham-Kent (see Map 1-1 Appendix 1). The SCRCA watershed covers approximately 4,100 square kilometres. The total area of each census region and the proportion within the St. Clair Region area are summarized in Table 2-3:

Table 2-3 Census Regions – St. Clair Region Source Protection Area

Census Region	Total Area (sq. km)	Area within St. Clair Region		
		Square km	Percentage of Municipality	Percentage of SCR Watershed
Lambton	3,002	2,780	93	67
Middlesex	3,333	697	21	17
Chatham-Kent	2,490	652	26	16
Total	**8,825**	**4,129**		

The total population in the St. Clair Region Source Protection Area is about 167,000 based on the 2001 census. Most of the population is concentrated in urban communities surrounded by agricultural land. Map 2.1 in Appendix 1 shows population density in the St. Clair Region *SPA*.

Over 92% of Lambton County is in the St. Clair Region Conservation Authority (SCRCA) watershed. Lambton Shores is the only local municipality with a portion that is outside the watershed. The City of Sarnia has the largest population (70,876) which represents about 56% of the total population (126,971) in Lambton County. Most of the Sarnia population is concentrated in the northwestern part of the city and in a strip of urban development along the Lake Huron shoreline.

Table 2-4 Population Statistics for Lambton County

	Population (2001)	Land Area in sq km	Population Density per sq km	Area within St. Clair SP (%)
Lambton County	126,971	3,001	42	92.6%
- City of Sarnia	70,876	800	88	100%
- St. Clair	14,659	620	23	100%
- Lambton Shores	10,571	340	31	37.3%
- Plympton-Wyoming	7,359	320	23	100%
- Petrolia	4,849	13	373	100%
- Warwick	4,025	290	13	100%
- Enniskillen	3,259	340	10	100%
- Brooke-Alvinston	2,785	310	9	100%
- Dawn-Euphemia	2,369	450	5	100%
- Point Edward	2,101	3	700	100%
- Oil Springs	758	8	95	100%

The municipality of Chatham-Kent is the result of the restructuring that transformed 22 local municipalities into one. The population is generally located in urban centres surrounded by agricultural land. All of the former Town of Wallaceburg with a population of 11,772 (about 11% Chatham-Kent) is in the *SCRCA* watershed. The Dresden and Bothwell communities also have higher local population densities. Most (about 40%) of the population of Chatham-Kent is in the former City of Chatham which is in the Lower Thames Valley Conservation Authority watershed.

Table 2-5 Population Statistics for Chatham-Kent

	Population (2001)	Land Area in sq km	Population Density per sq km	Area within St. Clair SP (%)
Chatham-Kent	107,341	2,470	43	26.2%
Wallaceburg	11,114	11	1,010	100%
Dresden	2,572	3	847	100%
Bothwell	981	2	490	50%
Camden (Township)	2,161	174	12	86.2%
Chatham (Township)	6,002	356	17	85%
Dover (Township)	3,923	280	14	42.4%
Zone	1,002	114	9	49%

About 21% of Middlesex County is in the St. Clair Region Source Protection Area. Most of the land is rural agricultural with low population density. Approximately 83% of the Middlesex Census Region population is in the City of London and none of the city is in the SCRCA watershed.

The most significant urban area in the St. Clair Region watershed is the former Town of Strathroy, which is now part of the Municipality of Strathroy-Caradoc. Other smaller urban areas in Middlesex include Newbury and Mount Brydges.

Table 2-6 Population Statistics for Middlesex County

	Population 2001	Land Area in sq km	Population Density per sq km	% area within St. Clair SP Area
Middlesex County (incl. City of London)	403,185	3,317	122	20.9%
City of London	336,539	422	798	0%
Middlesex County (excluding London)	66,635	2,895	23	23.9%
- Strathroy-Caradoc	19,105	274	70	53.5%
- Middlesex Centre	14,250	587	24	26.5%
- Adelaide-Metcalfe	3,155	332	10	67.9%
- Southwest Middlesex	6,135	428	14	41.6%
- Newbury	395	2	197	100%

There are three First Nation Reserves within the St. Clair Region *SPA* as indicated in Table 2-7.

Table 2-7 Population Statistics for First Nations in the St. Clair Region SPA

	Number of Registered Males and Females on Own Reserve (December 2009)
Bkejwanong Territory (Walpole Island First Nation)	2,180
Chippewas of Kettle & Stony Point First Nation	1,283
Aamjiwnaang First Nation	826

Based on Ontario Ministry of Finance predictions, significant differences in the growth rates across the region are predicted over the next 25 years. Map 1-4 of Appendix 1 shows the Areas of Settlement (as per the Places to Grow Act, 2005) in the St. Clair Region Source Protection Area. The information on projections for Chatham-Kent, Lambton and Middlesex Census Divisions has been extracted from the Ministry's report and is summarized in Table 2-8:

Table 2-8 Population Projections Census Divisions - Ontario Ministry of Finance

	2001	2006	2011	2016	2021	2026	2031
Chatham-Kent*	111,900	111,000	108,600	108,300	108,300	108,600	108,700
Lambton	131,800	132,300	132,200	133,100	134,400	135,9100	137,000
Middlesex	422,000	436,200	453,700	473,800	493,700	512,800	530,100

* see below

Middlesex is projected to have growth of about 22%, which is slightly above the provincial projection for southwestern Ontario. Lambton with 4% will see some growth over the 27-year period of the projections. Chatham-Kent (-1%) is expected to continue to see a population decline.

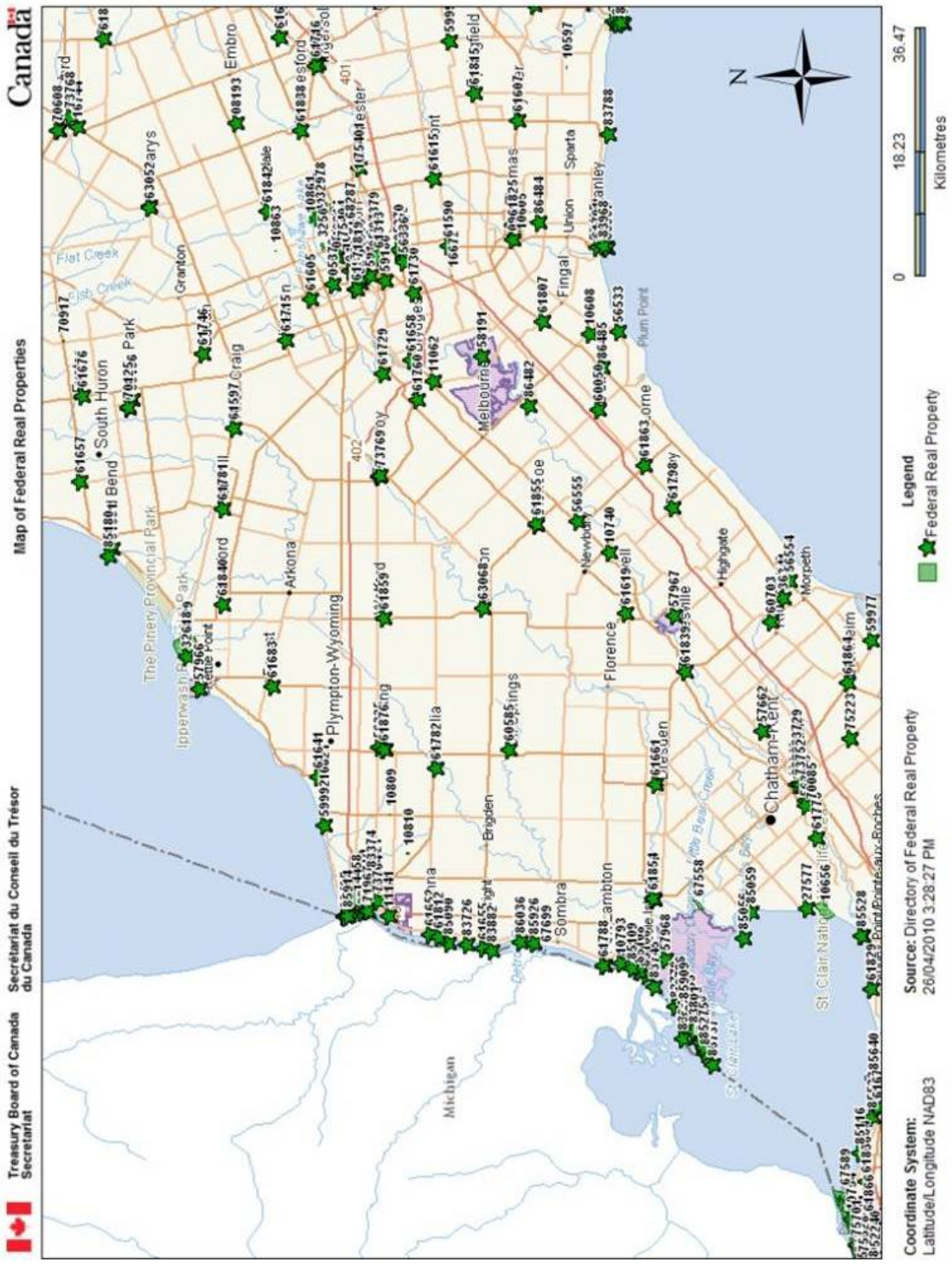
It should be noted (*) that the Ontario Ministry of Finance population projections do not take into account the proactive development strategy being implemented by Chatham-Kent. The Chatham-Kent Official Plan projects a higher growth rate of approximately 6% and a population of 122,600 in 2021 based on a medium growth scenario.

The watershed characterization report discusses the interaction between human and physical geography.

Map 25 of Appendix 5 shows the generalized land cover in the St. Clair Region *SPA*. Agriculture is the dominant land use, but a wide variety of industrial, commercial and institutional land uses also provide employment for people. The City of Sarnia has developed a strong industrial land base due to its proximity to the St. Clair River, Highway 402 and a border crossing into the United States.

General locations of federal lands in and around the St. Clair Region Source Protection Area are shown in Figure 2-1.

Figure 2-1 Federal Lands in the St. Clair SPA



The Figure was generated using an on-line tool available at the Treasury Board of Canada Secretariat website (http://www.tbs-sct.gc.ca/dfrp-rbif/home-accueil.asp?Language=EN), map navigator page.

Brownfield and Community Improvement Plans (*CIP*) vary from municipality to municipality in the St. Clair Region. The City of Sarnia, due to its industrial history, has a large area occupying approximately 2,295 hectares that is identified in the Brownfield Community Improvement Plan. The majority of the city's industrial base is located within the project area south of Confederation Street and includes an area surrounded by the Aamjiwnaang First Nation. In Chatham-Kent, the Brownfield Strategy and *CIP* are unique in that the *CIP* covers the entire municipality, not just older industrial areas. The Strategy and *CIP* need to address several communities that exist within the broader community since the Municipality of Chatham-Kent was created from the amalgamation of a number of municipalities (both urban and rural). The Strategy and *CIP* address brownfields that result from urban activity, as do most municipal strategies, and also address brownfields that are a legacy of agriculture and agri-business.

Lambton County and southwestern Ontario have a long history related to the oil and gas industry as discussed earlier in the section on existing industries. Map 26 of Appendix 5 shows the concentration of oil and gas wells across the area. According to a 1996 study, Lambton County produced approximately 6-10% of the Province's total natural gas and 13-17% of its oil.[1] Chatham-Kent is the second largest producer of oil and gas in Ontario. Many of the historic oil wells obtained crude oil from a depth of less than 200 metres from rock formations of Devonian age. These oil wells were not subject to current regulations and standards which deal with exploration, operations and environmental concerns. The existence of improperly plugged abandoned oil wells and tanks in Enniskillen, Petrolia and Oil Springs is an environmental threat to surface water and groundwater resources. These abandoned wells are subject to current decommissioning requirements when they are found.

[1] Manocha, J. and T. Carter. 1996. Underground Hydrocarbon Storage in Ontario. Petroleum Resources Centre, OMNR.

Salt caverns located approximately 600 metres below the surface are used by the petrochemical industries for the safe storage of hydrocarbons. While rock salt is soluble in water, it is quite insoluble in hydrocarbons.

Water was the most important means of initial transportation for the municipalities along the St. Clair River. The gradual gradient in the Sydenham River also allowed accesses to both Wallaceburg and Dresden. Water transportation continues to be important for local industries providing connections to other ports on the Great Lakes and links to the world via the Seaway. The Sarnia harbour provides winter dockage for lake freighters.

There are a number of deep water ports or docking facilities along the St. Clair River in Lambton County. Shipping via the river is beneficial to local industries, particularly the agricultural sector shipping grain (Sarnia elevators) and the petrochemical industries. The petrochemical industries ship product, fuel freighters and receive large pieces of equipment. Industrial dock facilities located along the river include Imperial Oil, Shell, Dow, Suncor and Lanxess.

The Ontario Power Generating Lambton Station has a coal receiving dock. Port facilities also exist at Courtright, Sombra and Mooretown. These are utilized for off-loading of aggregates from Manitoulin Island, Michigan and Ohio.

Agriculture is the dominant land use in the SCRCA. With a growing season that averages 203 to 207 days in length, the region's climate is very favourable and is considered part of the "breadbasket" area of Canada. Market conditions and soils have led to cash crop cultivation becoming the dominant land use. However, there is a wide range of specialty crops of tomatoes, fruits and vegetables as well as a variety of livestock operations from beef and dairy cattle to poultry and eggs. As shown on Map 28: Land Capability for Agriculture, most of the soils in the region are Class 1, 2 or 3 soils that are suitable for the sustained production of common field crops.

Major Field Crops in SCRCA Census Regions indicate that the majority of farmland is used for the cultivation of soybeans, corn and wheat. According to Kevin Mariott, Director of Ontario

Soybean Growers, Lambton was one of the first counties to grow soybeans in Ontario in the 1930s and 1940s. Most of the soybeans are sold for commercial use.

Most of the corn grown is also sold for commercial purposes. Two of the major customers are NewLife Feeds which makes livestock feed in Wyoming, and Casco which makes corn starch and sweeteners in Middlesex County. Recent construction of ethanol plants in Chatham-Kent and Lambton County also provide a market for local corn production. Wheat is still a major crop that is commonly used as a rotation crop.

In addition to crop cultivation, a proportion of farmland is allocated to the raising of livestock. Within the three census regions included in the St. Clair Region *SPA*, over 20% of the Ontario turkey and swine production occurs. Hog production is cost-efficient due to the reliable supply of locally-grown feed grain. Transportation costs are also reduced due to proximity to the U.S. border where half of the hogs are exported.

Over the last 40 years, a significant trend in the agriculture industry has been the conversion from a mixed land use (livestock pasture and crop cultivation) to crop cultivation land use. Also, in more recent years, agricultural land use activity has focused on farm acreage consolidation. Larger acreage is needed in order to render farms viable from a crop cultivation standpoint. In some instances, more land is acquired for the purposes of waste management practices and policies associated with livestock production. To prevent conflicts between non-farm rural residents and agricultural activity on prime agricultural lands, most municipalities have adopted policies preventing the severance of agricultural lands.

2.3.4. Water Quality

This component describes the water quality across the St. Clair Region *SPA*. The selection of indicator substances (*parameters*) is discussed. The watershed inland surface water, the ambient groundwater, municipal well raw (untreated) water, and the municipal surface water intake raw water quality data are reviewed and assessed using certain standards or guidelines. Where possible, trend lines are shown and statistical analyses performed.

Both *drinking water* quality standards and aquatic protection guidelines are used to assess water quality. The comparison is only intended to provide a means of quality assessment by using an established value and is not intended to judge conformance of raw (untreated) water to the standards or guidelines. The operation of a water treatment plant, including treated and distributed water quality, is governed separately under the Safe Drinking Water Act.

For inland watercourses, the assessment of water quality is based on information that has been collected at Provincial Water Quality Monitoring Network (*PWQMN*) sites and Canada-Ontario Agreement (COA) on Great Lakes Water Quality sites in the St. Clair Region.

The 75th percentile values are used to review the levels of *parameters* in samples taken at the surface water monitoring stations. A 75th percentile level is the value below which 75% of the values, in a data set, fall. The 75th percentile phosphorus levels are routinely higher than the Interim Provincial Water Quality Objective of 0.03 mg/L at all locations. The highest phosphorus levels are at Petrolia, Avonry and Oil Springs which are all in the North Sydenham branch. The 75th percentiles at these stations are 6 to 8 times the Provincial Water Quality Objectives (PWQO) of 0.03 mg/L phosphorus. The 75th percentile levels are the lowest at Hickory Drive (E. Sydenham), Rokeby Line (E. Sydenham), Wallaceburg (Sydenham) and Little Bear Creek (Lake St. Clair). Levels at these stations are less than three times the PWQO.

The 75th percentile nitrate levels at all stations are higher than the modified Canadian Council of Ministers of the Environment (CCME) guideline of 2.93 mg/L for the protection of aquatic life. Little Bear Creek in the Lake St. Clair *subwatershed* is the only station that has a 75th percentile nitrate level that is above the Ontario Drinking Water Quality Standards of 10 mg/L.

All of the other stations have 75th percentile values between the modified CCME guideline and the Ontario Drinking Water Quality Standards (the 75th percentile or upper quartile, is the value below which 75% of the values fall). However, several stations have 90th and 95th percentile values that are above the Ontario Drinking Water Quality Standards. A maximum concentration of 19.5 mg/L was recorded at Petrolia. The lowest 75th percentile levels of approximately 5 mg/L are at Wallaceburg (Sydenham) and Talford Creek (St. Clair River). In general, 75th percentile values are higher in the North Sydenham than in the East Sydenham.

All of the stations have *E. coli* present and are above the Ontario Drinking Water Quality Standards. All eight stations have 75th percentile values higher than the Provincial Water Quality Objective for recreational waters. The 75th percentile concentrations of *E. coli* range from approximately 200 counts/100 mL to 650 counts/100 mL. Five of the eight stations have 90th percentile values that are over 10 times the PWQO guidelines.

This Watershed Characterization section provides a summary of existing groundwater monitoring programs and an outline of the work that was undertaken to consolidate historic information. It also gives a brief synopsis of known groundwater quality issues, an overview of groundwater quality in terms of chemical *parameters* and a summary of groundwater quality for microbial *parameters* for municipal water supply systems and the Provincial Groundwater Monitoring Network.

As of May 2007, SCRCA has nine monitoring wells. While some have been monitoring water levels since 2002, most were brought into the system in 2006. There are a few chemical *parameters* that are above health related Ontario Drinking Water Quality Standards. These include fluoride (three wells), boron (one well), and selenium (one well). Several *parameters* are also above the *aesthetic objectives* or *operational guidelines* for *drinking water*. These include total dissolved solids (seven wells), iron (seven wells), hardness (six wells), chloride (five wells), manganese (four wells), dissolved organic carbon (three wells), and alkalinity (one well). High levels (over 200 mg/L) of sodium have been found in five of the *PGMN* wells and eight wells had sodium above 20 mg/L.

Parameters without Ontario Drinking Water Quality Standards are compared to the highest laboratory detection limit (of three laboratories) and these *parameters* are detected: cobalt (three wells), vanadium (three wells), nickel (five wells) and styrene (one well).

Phosphorus is above the PWQO of 0.03 mg/L (for the prevention of nuisance algae growth) in three *PGMN* wells in the St. Clair region. Besides these three wells, phosphorus may be above the PWQO in six more wells but it is uncertain, owing to a detection limit (0.05 mg/L) of one of the laboratories, which is higher than the PWQO of 0.03 mg/L.

Water quality was examined for the six municipal surface water intakes that draw raw water from Lake Huron, the St. Clair River and Lake Erie to supply communities in the SCRCA watershed. The Lake Huron intakes include the Lake Huron Primary Water Supply System, Petrolia Water Treatment Plant and the Lambton Area Water Supply System. The Wallaceburg Water Treatment Plant takes St. Clair River water from the Chenal Ecarte channel. Lake Erie intakes include the Chatham Water Treatment Plant and the West Elgin Treatment Plant.

There are also two First Nation intakes in the watershed. There is *DWSP* information available for the Bkejwanong Territory (Walpole Island First Nation) water treatment plant intake and these data have been used to do a partial assessment of raw water quality.
In a technical study of the Chippewas of the Kettle and Stony Point First Nations finished December 14, 2011 included raw water quality data sampled by the operational staff at the water treatment plant several times a week (2006-2011), as well as beach water quality sampling data sampled on a weekly basis through the swimming season (2006-2010). The nearest DWSP to the Kettle and Stony Point intake is located near Grand Bend and is outside the IPZ-2 of the Kettle and Stony Point.

This raw water quality was compared to the environmental variables available for the same time period in an effort to understand the conditions which result in a degradation of water quality at the intake.

2.3.5. Water Quantity

In this component, the water use across the Source Protection Area is discussed. Section 34 of the Ontario Water Resources Act (*OWRA*) requires anyone taking more than a total of 50,000 litres of water per day to acquire a Permit To Take Water (*PTTW*). Water taking includes uses which return the water to the source, as well as those which do not. Water taking also includes taking water into storage. In Section 3 – Water Budget and Water Quantity Stress Assessment water use is considered in more detail, including quantifying how much of the water taking is consumptive.

Water takers have a responsibility to ensure that the amount of water they use does not threaten the environment or existing water users. Some water takings are exempt from the requirement to obtain a permit. These include takings by an individual for ordinary household purposes, and water takings for the direct watering of livestock or poultry or for firefighting purposes. The approximate water taking (use) by sector (agricultural, commercial, industrial, municipal, water supply, dewatering, remediation, construction) is presented and described. The water taking for each *subwatershed* catchment area is also presented. These catchment areas are delineated through the Conceptual Water Budget study, which is described in Section 3 – Water Budget and Water Quantity Stress Assessment.

In the St. Clair region, the agricultural sector has around 57% of the total permits (see table 2-9). While the agricultural sector has the largest number of permits, the use is seasonal and the amount of water being used may not be as high as other sectors that have year round operations. Water supply makes up about 10% of the water taking permits, and includes takings by municipalities, campgrounds and communal uses.

Table 2-9 Water Taking Permits in the St. Clair Region SPA

Water Taking Sector	Water Use	Number of Permits	Percent of Total Permits
Agricultural	Field and pasture crops, fruit orchards, market gardens/ flowers, nursery, other – agricultural, sod farm, tender fruit, tobacco	264	57%
Commercial	Aquaculture, bottled water, golf course irrigation, mall/ business, other – commercial, snowmaking	27	6%
Construction	Other – construction, road building	33	7%
Dewatering	Construction, other – dewatering, pits and quarries	16	4%
Industrial	Aggregate washing, cooling water, food processing, other – industrial, pipeline testing, power production	26	6%
Miscellaneous	Dams and reservoirs, heat pumps, other – miscellaneous, pumping test, wildlife conservation	40	9%
Recreational	Aesthetics, other – recreational, wetlands	8	2%
Water Supply	Campgrounds, communal, municipal, other – water supply	47	10%

2.3.6. Drinking Water Systems

There are six municipal *drinking water systems* which service people living in the St. Clair Region *SPA* of which one is located outside the *SPA*. In addition, there are two First Nation Systems which, The Kettle and Stony Point First Nations System was added to the this Assessment Report, following the completion of a technical study on December 15, 2011. Table 2-10b includes details of the First Nations System
(create table for First Nations info.).

Details are provided in Table 2-10. The *drinking water* supply systems servicing the St. Clair *SPA* are shown in Map 1-3. It should be noted that several of the systems are linked providing emergency access to *drinking water*.

Table 2-10 Municipal Drinking Water Systems Servicing the St. Clair Region Source Protection Area

Drinking Water System	Source Water	Operating Authority	Approx. Pop. Served	Pumping Rates (cubic metre)			
				Intake or Well	Maximum Annual	Average Annual	Average Monthly
Lambton Area Water Supply System	St. Clair River	Lambton Area Water Supply System (LAWSS – a joint board formed by the municipalities served by the system)	104,000	Intake	22,343,625	21,842,266	1,820,105
Petrolia Water Treatment Plant	Lake Huron	Corporation of the Town of Petrolia (PWSS) and Waterworks Environmental Services Inc.	9,700	Intake	2,052,202	1,854,210	154,517
Wallaceburg Water Treatment Plant	Chenal Ecarte	Municipality of Chatham- Kent PUC	11,800	Intake	2,044,981	1,927,368	160,614
Chatham	*						
West Elgin	*						
Lake Huron Primary Water Supply System* (LHPWSS)	**						

* These systems service areas (outlined below) are within the St. Clair Region SPA, however the intake is located in the Lower Thames SPA.
** This system services areas (outlined below) are within the St. Clair Region SPA, however the intake is located in the Ausable Bayfield SPA.

Table 2-11 (a) First Nations Water Systems Servicing the St. Clair Region Source Protection Area

Drinking Water System	Source Water	Operating Authority	Approx. Pop. Served	Pumping Rates (cubic metre)			
				Intake or Well	Maximum Annual	Average Annual	Average Monthly
Kettle and Stony Point First Nations Intake	Lake Huron	Chippewas of the Kettle and Stony Point First Nations	1,279	Intake	1180 cubic meter/day	202,219	18,277

The Lambton Area Water Supply System (*LAWSS*) services the City of Sarnia, Village of Point Edward, Town of Plympton-Wyoming, Township of St. Clair, Municipality of Lambton Shores,

Alvinston, and Township of Warwick. The Town of Petrolia (at Bright's Grove) Water Treatment Plant services the Town of Petrolia, Township of Enniskillen, Village of Oil Springs, Township of Dawn- Euphemia, and parts of the Township of Brooke-Alvinston. The Wallaceburg Water Treatment Plant services the Town of Wallaceburg.

The Chatham water treatment plant services the areas of Chatham, Pain Court, Grande Pointe, Mitchell's Bay, Dresden, Tupperville and Thamesville. The West Elgin water treatment plant services the areas of West Elgin, Dutton /Dunwich, Southwest Middlesex, Bothwell and Newbury. The Lake Huron Primary Water Supply System services the communities of London, Lambton Shores, North Middlesex, South Huron, Bluewater, Middlesex Centre, Lucan-Biddulph and Strathroy-Caradoc. The Kettle and Story Point System serves the Chippewas of Kettle and Stony Point First Nations.

2.4 Data Gaps

The Data gaps encountered during the preparation of the watershed characterization report are listed in Table 2-11 below.

Table 2-12 Watershed Characterization Data Gaps relevant to the St. Clair Region Source Protection Area

Subject	Data Gaps
Surficial Geology	Mapping does not include the geology of the overburden with depth. No recent data are available. A map of the lateral extent of aquifers cannot be derived without a comprehensive subsurface study. The lithology and groundwater parameters such as recharge need to be correlated and related to water quality. There is a lack of subsurface information; interpretation at depth relies entirely on the water well information system (WWIS). There is no data available to map multiple overburden aquifers. Limited PGMN monitoring data make it difficult to characterize groundwater.
Groundwater Quantity Information	There is no detailed subsurface geology or aquifer definition. Critical areas such as recharge areas, groundwater flow paths or interaction between aquifers and aquitards have not been mapped or their extent has not been identified in our area.
Wetland Evaluation	Missing data for First Nation watersheds. Data not available for Lambton Shores area west of Ausable-Bayfield CA. Wetland data have not been evaluated for overlap with recharge woodland cover, distribution in recharge area or status with respect to significant natural areas.
Riparian Zones	Missing data
Fisheries Evaluation	Data for Lambton Shores area not available. Distribution of fish species has not been analyzed with respect to groundwater discharge areas, or with respect to sensitivity to turbidity, siltation, thermal fluctuations or increases in chemical concentrations. Data for the last 30 years has not been analyzed with respect to each subwatershed area.
	Aylmer District Fisheries Management Plan, Chatham District Fisheries Management Plan. Ontario Ministry of the Environment Sport Fish Contaminant Monitoring Program have not been reviewed
Mussel Evaluation	Missing data
Inland Surface Water Quality	PWQMN data for physical and chemical parameters do not exist for 1997 – 2001. PWQMN data for microbial parameters do not exist for 1996 – 2002. Heritage oil contamination data do not exist.
Intakes surface raw water quality – physical and chemical	*DWSP* data for these WTPs: Town of Petrolia, West Elgin, & Chippewas of Kettle & Stony Point First Nation. Great Lakes monitoring, RAP and SLEA data not reviewed.
Intakes surface raw water quality - microbial	*DWIS* data for: Lambton Area WSS & Lake Huron PWSS Recent data for Bkejwanong Territory (Walpole Island First Nation) WTP, and Chippewas of Kettle & Stony Point First Nation WTP.
Groundwater Quality & Characterization	It is impossible or, at a minimum, difficult to identify critical areas such as recharge areas, groundwater flow paths or interaction between aquifers and aquitards and how these affect groundwater chemical evolution along flow paths at this time. There is little or no information on groundwater quality trends over time, e.g. *DWIS* database to 2003.
Water Usage	Many permits in PTTW database have expired dates and it is unclear if they have been renewed. Older permits only have maximum water taking per day. Difficult to determine actual usage.
ISI Map	The 5 km overlap does not match between municipalities. The ISI method used a prescriptive approach defined by the MOE; however, there were differences in mapping water tables and how the data values were kriged. In some cases an area in one municipality is mapped as low and high in the other municipality.
Highly Vulnerable Areas / Aquifers	Lack of subsurface mapping information. Without subsurface mapping, it is difficult to determine the lateral extent of the aquifer.

3.0 Water Budget and Water Quantity Stress Assessment

The Clean Water Act is intended to reduce the *threats* to the quality and quantity of *drinking water* sources. In order to do this, *threats* within *vulnerable areas* are identified and assessed to determine the relative *risk* to the *drinking water* source. The Clean Water Act and its regulations identify 21 *activities* which can be *drinking water threats*. These *activities* include two which are related to the quantity of *drinking water*. One is 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. The other water quantity *threat* is an *activity* that reduces the recharge of an *aquifer*. To determine the *risks* to *drinking water* quantity from either of these *threats*, it is necessary to understand the level of *stress* on a *drinking water* system's source. The Water Budget is the tool used to understand the level of *stress* on a system or within a watershed.

Where there is little *potential for stress*, there are no *threats*. On the other hand, where there is a significant *potential for stress*, *activities* contributing to the *stress* will be *significant threat*s. The Clean Water Act requires that the *Source Protection Committee* develop a *Source Protection Plan* that reduces the *risk* associated with *significant threats* so that they cease being significant and prevents new *significant threats* from being undertaken in these areas.

The Water Budget looks at the balance of water within an area known as a watershed. It considers inputs or supply to the watershed which include: precipitation (rain and snow), flow into the watershed from up river, flow into the watershed through groundwater and flow imported into the watershed such as that which is piped water from the Great Lakes. The Water Budget balances these inputs with removals from the watershed, or demand, which include: discharges into the next watershed through stream flow or groundwater, use of water which is consumptive in nature (and therefore does not return the water to the same source from which it was removed), evaporation and transpiration (use of the water by plants). The water budget considers a balance between supply and demand that includes a reserve quantity that is

removed from the supply in the *stress* calculation. The components of the water budget are described in detail in the Conceptual Water Budget (attached as Appendix 6), the Tier 1 Water Budget and summarized in the following sections.

The Water Budget is developed in stages referred to as tiers. These tiers involve more detailed analysis and refined data as they progress. In this manner, only those areas with the potential to be *stressed* require detailed modelling and analysis; those which appear not to be *stressed* receive a less detailed screening. Each of these tiers is described in the following sections. The St. Clair Region Source Protection Area is included with the other Source Protection Areas in the Thames-Sydenham and Region Conceptual Water Budget and the Tier 1 Water Budget. Only areas where there is a moderate or significant *potential for stress* on *drinking water systems* included in the Terms of Reference (only municipal systems in the *SCRSPA*) proceed to a Tier 2 Water Budget. Only those areas which are confirmed to have a significant or moderate *stress* level proceed with a Tier 3 Water Budget. It is only through a Tier 3 Water Budget that water quantity *threats* are assessed. As the *potential for stress* on *drinking water* sources was determined to be low through the Tier 1 Water Budget, a Tier 2 or Tier 3 Water Budget is not required for the St. Clair Region Source Protection Area. As a result, there are no water quantity *threats* to *drinking water* sources in the St. Clair Region Source Protection Area.

3.1 What is a Water Budget?

A water budget quantifies and compares the components of the hydrologic cycle. Much like a bank account, if more water is leaving than is coming in, the water in the watershed will be depleted over time. If in balance, the water use is sustainable. Each component of the water budget must be quantified so that the demand can be compared to the supply. If the demand is greater than the supply, the reserves, like the savings in a bank account, will be depleted. Over time this would result in reduced water levels in water bodies and *aquifers*. Normal and cyclical fluctuations in water level make it necessary to look at the components of the water budget over long periods of time rather than looking at short-term trends in levels. This is especially true in groundwater systems where changes in water levels are more difficult to monitor and analyze.

3.2 Components of the Water Budget

3.2.1. Precipitation

Precipitation, or rain and snow, is the primary component of the supply component of the water budget. Long-term precipitation was analyzed from various meteorological stations around the region. Map 3-2 illustrates the precipitation stations used in the water budget and the spatial variation of the average annual precipitation over the region. Annual average precipitation decreases moving east to west along the *SCRSPA* from about 914 mm/a at the extreme east to about 806 mm/a at the extreme southwest. On average, the St. Clair Region Source Protection Area receives 850 mm per year of precipitation.

3.2.2. Evapotranspiration

Evapotranspiration (or ET) is the precipitation which either evaporates into the atmosphere or is used by the plants. Water used by plants is also given back to the atmosphere through a process known as transpiration. Together the evaporation and transpiration are known as Evapotranspiration. There is little variation across the region other than as a result of the variation in precipitation. Map 3-3 shows the evapotranspiration across the region. Water which evaporates or is used by the plants is not available as supply and is therefore subtracted from the precipitation in the supply calculations. ET accounts for more than half of the precipitation in the region.

Irrigation, although also used by plants and lost back to the atmosphere through evaporation and transpiration, is considered in the demand part of the water budget. Irrigation water is removed from a groundwater or surface water source, and is consumptive to that source. ET, on the other hand, is loss from the precipitation component of the water budget. Another important distinction is that irrigation occurs only in very localized areas where it is required by a crop. ET is directly related to precipitation, temperature and is fairly uniformly distributed across the watershed.

3.2.3. Surface Runoff

Precipitation which falls in the watershed and does not evaporate or get absorbed into the plants either infiltrates into the ground or runs off into streams and rivers. The runoff from the

watershed is not available for the supply as it leaves the watershed quickly. Although some of the water which infiltrates into the ground also leaves the watershed relatively quickly, most of the water which seeps deeper into the ground is said to recharge the *aquifers* which is discussed in the following section.

3.2.4. Recharge

Recharge is the water from precipitation which soaks into the ground and recharges the *aquifers* in the ground. This is the water which maintains stream flow during periods between runoff events and is referred to as base flow. The water budget assumes that over time the recharge is equivalent to the base flow discharge from the watershed. This relationship is considered more closely in Tier 2 and 3 of the water budget work where calibrated surface and groundwater models are used to describe the components of the water budget including recharge. In the absence of these calibrated models, the average base flow from a watershed is the best indication of the recharge in the watershed.

In order to establish the recharge in a *subwatershed* the stream flow records are reviewed and runoff is removed from the records to calculate the base flow. Various methods can be used to separate base flow from runoff. In the Tier 1 Water Budget the second pass of the BFLOW filter was applied. This is a method which was developed by Arnold et. al. (1995) and is well accepted in this area. The effects of pollution control plant discharges are taken into account in separating the base flow. This prevents recharge estimates derived from base flow estimation from being artificially elevated from that of natural conditions. In areas where stream flow information was not available, records from a nearby stream flow station (where hydrologic conditions are similar) were used to estimate base flow for the un-gauged *subwatershed*. Monitoring programs in these areas would improve base flow estimates in these *subwatersheds*. However, as with any monitoring program, they must be established sufficiently in advance of undertaking the work to have collected sufficient data for meaningful analysis. This should be considered for future updates to the water budget.

Once base flow was determined for each *subwatershed*, the base flow was distributed across the *subwatershed* using a slightly modified version of an infiltration model developed by MECP (1995). The original method uses soil type, slope and land use to calculate the infiltration factors

across the watershed. For the Tier 1 water budget this method was modified slightly, using surficial geology mapping in place of county soils maps. County soils maps are completed to different levels of detail in different counties, and some have been updated more recently than others. As such, there can be discontinuities across county boundaries, and, as they were created mainly for agricultural purposes, they were not completed in urban areas. Surficial geology mapping has the advantage of being continuous across the study area, and includes urban areas.

3.2.5. Water Use (Demand)

Water use in the water balance and *stress* calculations is referred to as Demand. While demand would be the simplest of the terms to monitor, records of water use are not required, except where permits for the use are required. Water use, other than domestic and livestock watering, requires a Permit to Take Water, however until recently, records of water used were not required to be recorded and submitted. Even where the records are required as part of the permit process, they have only been required for the past few years. This recent record keeping is undertaken by the permit holder with little or no quality control on the data entered. This information is submitted by the permit holder and has only become available to the water budget team near the completion of much of this water budget work. In future revisions to the water budget the actual use records will provide a better estimate of the demand. For the Tier 1 Water Budget, estimations of actual use were based on adjusted maximum permitted values, or other sources of estimation in some cases. Large water users were polled to provide a better estimate of water demand.

Estimates of water use which does not require a permit to take water (often referred to as *non-permitted* water use) was also included in the calculations of demand. While municipal systems require a permit to take water and records of this demand is well established through municipal pumping records, an estimate of the water used from private water systems is also required. Generally, this demand is minor; however it is important that it not be neglected in the water budget and *stress assessment*. Non-municipal system domestic demand is estimated based on per capita consumption estimations multiplied by population reported in census data.

Livestock watering also does not require a permit. This demand was estimated in a similar manner using livestock census data and typical water use by livestock type (as per Kreutzwiser & de Loe, 1999).

Both of these *non-permitted* uses are assumed to be distributed evenly across groundwater and surface water sources.

The Permit to Take Water information was analyzed to determine the demand in each *subwatershed* and combined with the *non-permitted* demand discussed above. Water use was considered separately for surface water and groundwater as required by the *Technical Rules 2013*: Assessment Reports. Consumptive factors were applied to the surface water demand based on the use the water was being taken for. These factors were recommended by the province in the water budget guidance. The consumptive factors applied to the water use are shown in the Tier 1 Water Budget. Consumptive factors were generally not applied to groundwater use as water removed from *aquifers* is generally not returned to the same *aquifers*. Groundwater is usually returned to surface water bodies after it is used, resulting in the use being completely consumptive. Water taken for aggregate washing and wildlife conservation are exceptions where consumptive factors were applied. In these cases, permits allow for large quantities to initially fill ponds, but then only a small amount is taken to compensate for evaporation and/or water removed in product in the case of aggregate extraction.

Irrigation demand is estimated based on permitted values. As discussed in the section on evapotranspiration, most of the water applied to crops is used by the crops or evaporates back into the atmosphere. This is even truer for irrigation where the amount of water applied is intended to saturate the root zone and not result in any significant runoff or recharge. As such, the consumptive factors for irrigation reflect that little, if any, water is returned to the source from which it was taken.

Table 3-1 and Table 3-2 summarize the water demand in the area by type and source. It is important to realize that water use by industry and institutions supplied by municipal systems does not require a separate permit and is therefore included in the permitted values for the municipal system. Water taken from the Great Lakes and connecting channels is not included in Table 3-1. Demands are only considered if the water is taken from within the subwatershed under examination. It should be noted that there was no groundwater use for the Construction, Dewatering, Institutional, Miscellaneous, Recreational, Remediation and Water Supply categories as well as no Water Supply use for surface water.

Table 3-1 Water demand in the SCRSPA (m^3/day)

Groundwater Use Total Permits 246 **Subwatershed**	**Code**	**Agricultural** Crops, Orchards, Market Gardens/ Flowers, Nursery, Sod Farm, Tobacco	**Commercial** Aquaculture, Bottled Water, Golf Course, Mall\Business, Snowmaking	**Industrial** Aggregate Washing, Cooling, Food Processing, Pipeline and Power Production	**Non-permitted Use** Livestock Watering, Private wells	**Grand Total**
East Sydenham Headwaters	01S	1059	650	1330	1340	**4379**
Upper Sydenham	02S	1420	0	0	546	**1966**
Brown Creek	03S	0	0	0	496	**496**
Middle East Sydenham	04S	47	0	0	870	**917**
Lower East Sydenham	05S	625	0	0	670	**1295**
Lower North Sydenham	06S	0	0	0	272	**272**
Bear Creek Headwaters	07S	165	243	0	859	**1267**
Lower Bear Creek	08S	0	0	0	226	**226**
Black Creek	09S	0	0	0	252	**252**
Lambton Shores Tributaries	10S	0	0	0	246	**246**
Plympton Shoreline Tributaries	11S	0	413	0	459	**872**
Cow and Perch Creeks	12S	0	145	0	623	**768**
St. Clair River Tributaries	13S	0	0	0	368	**368**
Lake St. Clair Tributaries	14S	370	0	0	323	**693**
Grand Total		**3686**	**1451**	**1330**	**7550**	**14017**

Table 3-2 Water demand in the SCRSPA (m^3/day)

Surface Water Use Total Permits 285 **Subwatershed**	**Code**	**Agricultural** Crops, Orchards, Market Gardens & Flowers, Nursery, Sod Farm, Tobacco	**Commercial** Aquaculture, Bottled Water, Golf Course, Malls & Business, Snowmaking	**Construction** Road Building, Other	**Miscellaneous** Dams & Reservoirs, Heat Pumps, Wildlife Conservation	**Recreation** Aesthetics, Wetlands, Other	**Non-permitted Use** Livestock Watering, Private wells	**Grand Total**
East Sydenham Headwaters	*01S*	953	0	0	0	0	241	**1194**
Upper Sydenham	*02S*	1520	0	0	327	59	252	**2158**
Brown Creek	*03S*	0	0	0	0	0	313	**313**
Middle East Sydenham	*04S*	1387	0	0	29	0	321	**1737**
Lower East Sydenham	*05S*	3152	0	0	0	0	161	**3313**
Lower North Sydenham	*06S*	476	0	112	167	0	38	**793**
Bear Creek Headwaters	*07S*	77	0	0	87	500	527	**1191**
Lower Bear Creek	*08S*	27	0	0	472	0	111	**610**
Black Creek	*09S*	0	15	0	2100	0	121	**2236**
Lambton Shores Tributaries	*10S*	0	416	0	0	0	107	**523**
Plympton Shoreline Tributaries	*11S*	0	467	0	0	1270	206	**1943**
Cow and Perch Creeks	*12S*	33	251	0	1017	0	206	**1507**
St. Clair River Tributaries	*13S*	651	173	0	864	0	69	**1757**
Lake St. Clair Tributaries	*14S*	4215	670	0	2543	0	58	**7486**
Grand Total		**12491**	**1992**	**112**	**7606**	**1829**	**2731**	**26761**

3.2.6. Water Budget Summary

Each *subwatershed* in the region is examined in terms of the water budget components for both surface and ground water systems on an annual average basis. Components include:

- Q_P, precipitation,
- $Q_{SW\text{-}in}$, surface water flows in,
- $Q_{GW\text{-}in}$, groundwater flows in, (assumed zero in Tier 1)
- Q_{ET}, evapotranspiration,

- Q_{SW-out}, surface water flows out,
- Q_{GW-out}, groundwater flows out, (assumed zero in Tier 1)
- Q_{GW-C}, consumptive groundwater use,
- Q_{SW-C}, consumptive surface water use, and
- ΔS, change in storage, (assumed zero in Tier 1)

The water budget equation can be summarized as:

$$Q_P + Q_{SW-in} + Q_{GW-in} = Q_{ET} + Q_{SW-out} + Q_{GW-out} + Q_{GW-C} + Q_{SW-C} + \Delta S$$

Table 3-3 summarizes the annual water budget in units of annual average m^3/day. Water budget balances are compared to the total water supply for each watershed (i.e. Precipitation + SW supply), and the error is less than 10% of the estimated supply, which indicates that estimates are reasonable, given the inherent uncertainties in each individual component. Although *stress* calculations rely on monthly information, average annual water budget components are included as a summary to demonstrate the balance.

Table 3-3 Water budget summary (m^3/day)

SW	Name	Q_{ET}	Q_P	Q_{sw-out}	Q_{sw-in}	Q_{gw-c}	Q_{sw-c}	ΔS	Balance	%error (of total supply)
01S	East Sydenham Headwaters	336800	590960	224645	0	4378	1193	0	23944	4.1%
02S	Upper Sydenham	328152	585519	533583	224645	1966	2158	0	-55695	-6.9%
03S	Brown Creek	233208	396610	212015	0	496	313	0	-49422	-12.5%
04S	Middle East Sydenham	830506	1367497	984661	745598	8699	1738	0	287490	13.6%
05S	Lower East Sydenham	615437	948193	1188006	984661	1295	3313	0	124804	6.5%
06S	Lower North Sydenham	383249	579459	868240	745573	272	792	0	72480	5.5%
07S	Bear Creek Headwaters	603229	975485	285276	0	1266	1191	0	84523	8.7%
08S	Lower Bear Creek	402376	639827	493927	285276	226	610	0	27965	3.0%
09S	Black Creek	517387	829305	251647	0	252	2236	0	57784	7.0%
10S	Lambton Shores Tributaries	202300	336001	118959	0	246	388	0	14109	4.2%
11S	Plympton Shoreline Tributaries	385409	619036	197275	0	871	1943	0	33538	5.4%
12S	Cow and Perch Creeks	412223	637203	214914	0	769	1506	0	7792	1.2%
13S	St. Clair River Tributaries	399980	610006	212321	0	368	1757	0	-4419	-0.7%
14S	Lake St. Clair Tributaries	740994	1112236	346921	0	692	7486	0	16143	1.5%

3.3 Phases of Water Budget Work

3.3.1. Conceptual Water Budget

The Conceptual Water Budget, or conceptual understanding, is the first phase of the water budget development. In this stage, background information is collected on the components of the water budget. The information is analyzed to determine the various components of the water budget based on historical and readily available data on a coarse scale. The conceptual Water Budget was completed for the entire region. The region was divided into 6 *subwatersheds* for the purposes of this analysis. The Conceptual Water Budget is included as Appendix 6 of the Assessment Report.

3.3.2. Tier 1 Water Budget

The Tier 1 Water Budget utilizes the information collected and analyzed in the Conceptual Water Budget. In Tier 1, the *potential for stress* is assessed in *subwatersheds* within the region. As with the Conceptual Water Budget, the Tier 1 Water Budget was documented in one report for the entire Thames-Sydenham and Region. For the purposes of the Tier 1 Water Budget, the region was subdivided into 32 *subwatersheds*, as shown in Map 3-1. A water budget and *stress assessment* were calculated for each of these *subwatersheds*. Map 3-5 indicates the *potential for stress* on surface water sources, while Map 3-6 illustrates the *potential for stress* on the groundwater sources.

3.3.3. Tier 2 Water Budget

Although a Tier 2 Water Budget was required for the Upper Thames River Source Protection Area, one was not necessary for the St. Clair Region Source Protection Area as no municipal systems were in *subwatersheds* which have a moderate or significant *potential for stress*.

3.3.4. Tier 3 Water Budget

The Tier 3 Water Budget is a local area water balance undertaken on the scale of a single water supply system and is intended to examine the reliability of that supply. As no watersheds in the St. Clair Region Source Protection Area advanced to a Tier 2 Water Budget, a Tier 3 Water Budget was not required.

3.3.5. Peer Review of the Water Budget

Each phase of the water budget is subject to a peer review process. The project team and consultants work closely with the peer reviewers to ensure that the work undertaken is technically sound and meets the requirements of the *technical rules* 2013 and relevant provincial guidance. As work on the project progresses, the materials are presented to the peer review committee for their comments. Those comments are considered by the peer review team and consultants and are generally incorporated into the final report. The comments, along with their responses, are also incorporated into a peer review record which becomes part of the water budget report. The Conceptual Water Budget and Tier 1 Water Budget have been successfully completed and accepted by the MNR.

3.4 Water Quantity Stress Assessment

The level of *potential for stress* is calculated based on the following formula as defined in the *Technical Rules 2013*: *Assessment Report*:

$$\%\ \text{Water Demand} = \frac{Demand}{Supply - Reserve} x100$$

Percent Water Demand is calculated separately for groundwater and surface water as are the other terms in the *percent water demand* equation above.

For surface water, *Demand* is the monthly estimated use of all surface water sources within the subwatershed being examined. *Supply* is the monthly estimated median daily flow. The median daily flow includes water from pollution control plant discharges, which may have originated from outside the subwatershed under consideration (which could include groundwater sources or Great Lakes and connecting channels). *Reserve* is the 90th percentile monthly flow, or the flow that is exceeded 90 percent of the time for the month being analyzed, and calculated on the same data set as used for estimating medial monthly flows.

For groundwater, supply includes a number of components as discussed above. For the Tier 1 Water Budget, supply is simplified to include recharge and groundwater flow into the watershed. As discussed above, recharge is estimated using base flow. Groundwater flow into the

watershed can be calculated through the use of a calibrated groundwater model. Developing and calibrating a groundwater model is however not part of the scope of the Tier 1 Water Budget. As a large scale regional groundwater model was available for the region, it was attempted to be used for this purpose. It was, however, determined that it was not adequate for the purposes of describing flows between watersheds at the scale required for the Tier 1 Water Budget. In the absence of a good estimate for groundwater flow into the *subwatershed*, it is possible to neglect the inflow of groundwater in the supply term. This results in a conservative estimate of the *percent water demand*. It was felt that in *subwatersheds* where there is considerable demand and the watersheds are relatively small, a large portion of the supply could be coming from adjacent *subwatersheds* as groundwater flows in and, therefore, the *percent water demand* could be overly conservative. A better approximation at the Tier 1 stage is not available, however the groundwater model developed at the Tier 2 stage will allow better consideration of this component in the *stress assessment* calculation.

Groundwater reserve is 10% of the supply, as required in the *Technical Rules* 2013 *Assessment Report*. A water reserve estimate is intended to protect a portion of water from being considered within the *stress* calculations, adding a conservative element to this calculation. This water is removed from the supply in the *stress assessment*.

The *Percent Water Demand* is used as an indication of the *stress* level in the watershed. This stress level is described in this document as the "*potential for stress*" as it better describes the situation given the *uncertainty* associated with the calculations. Generally, a Tier 1 *stress assessment* is understood to have a considerable *uncertainty* associated with the *percent water demand* calculations which would be reduced through subsequent analysis in the Tier 2 or 3 Water Budgets, where warranted. At the completion of the Tier 1 Water Budget, it is important to understand that conclusions drawn from this analysis are indicative of whether more analysis is required; not an absolute determination that there is a stress. Given the level of conservatism, as discussed above, this is especially important to keep in mind when considering the watersheds which are being described as having a significant *potential for stress*. However, for the watersheds which have been described as having a low *potential for stress*, this conservatism allows us to be confident that they do not have significant levels of *stress*. The sensitivity analysis required for watersheds which are *almost* moderate gives even

more confidence in this conclusion. Watersheds with a moderate *potential for stress* also advance to the next stage of analysis, along with those identified with a significant *potential for stress*. At the next stage, additional analysis is required to be able to determine the *percent water demand* and, therefore the *stress* level, with a higher level of confidence. If this moderate or significant *potential for stress* affects a municipal water supply, additional analysis would be undertaken. However, in the St. Clair Region Source Protection Area, *subwatersheds* which show a significant or moderate *potential for stress* do not affect municipal *drinking water* sources. Therefore, additional analysis is required to adequately determine the level of *stress* for these watersheds. This work will need to be undertaken through other programs before the water budget and, specifically, the *percent water demand* can be used in the implementation of other programs such as the Permit to Take Water program.

In assessing the *potential for stress*, various scenarios as identified in the *technical rules* 2013 must be considered. These consider current and future municipal demand under both average and drought scenarios. Drought scenarios are not considered in the Tier 1 Water Budget. Scenario A and B discussed in Table 3-4 below relate to the current and future municipal demand (respectively). As there are no additional planned systems in the St. Clair Region Source Protection Area, the scenario related to planned systems (scenario C) is not applicable and therefore not included in Table 3-4. Table 3-5 describes the *potential for stress* based on the *percent water demand* for the applicable scenarios which must be compared to the ranges shown in Table 3-4. Additional criteria as described in Rule 32 and 33 are also considered in the *stress assessment*. If the intake or well was not able to operate due to insufficient quantity of water or a low water level, the *potential for stress* is described as moderate and the subwatershed would advance to the next tier.

Table 3-4 Potential for stress based on percent water demand under current and future municipal water demand

Potential for Stress	Surface Water % Water Demand	Groundwater % Water Demand	
Based on	Max'm monthly	Max'm monthly	Avg annual
Significant	Greater than or equal to 50%	Greater than or equal to 50%	Greater than or equal to 25%
Moderate	Less than 50% but greater than 20% (or between 18 and 20%, inclusive, but under sensitivity analysis increases to greater than 20%)	Less than 50% but greater than 25%	Less than 25% but greater than 10% (or between 8 and 10%, inclusive, but under sensitivity analysis increases to greater than 10%)
Low	Less than or equal to 20% (after sensitivity analysis if greater than or equal to18%)	Less than or equal to 25%	Less than or equal to 10% (after sensitivity analysis if greater than or equal to 8%)

Table 3-5 Surface water potential for stress based on Tier 1 stress assessment (August Conditions)

Subwatershed	Code	Supply (Q_{50})	Reserve (Q_{90})	Demand	Potential for stress
East Sydenham Headwaters	01S	50630	32659	5966	Moderate
Upper Sydenham	02S	82166	49594	9765	Moderate
Brown Creek	03S	20736	6739	322	Low
Middle East Sydenham	04S	100224	53566	8677	Low
Lower East Sydenham	05S	105408	53566	19073	Moderate
Lower North Sydenham	06S	18403	4666	3171	Moderate
Bear Creek Headwaters	07S	5789	691	1583	Moderate
Lower Bear Creek	08S	9850	1967	747	Low
Black Creek	09S	5184	605	2320	Significant
Lambton Shores Tributaries	10S	2419	259	951	Moderate
Plympton Shoreline Tributaries	11S	4061	432	2647	Significant
Cow and Perch Creeks	12S	4406	518	1821	Moderate
St. Clair River Tributaries	13S	4320	518	5168	Significant
Lake St. Clair Tributaries	14S	7085	864	28828	Significant

Table 3-6 Groundwater potential for stress based on Tier 1 stress assessment (Average Annual Conditions)

Subwatershed	Code	Q_{supply}	$Q_{reserve}$	Q_{demand}	Potential for stress
East Sydenham Headwaters	01S	105509	10551	4378	Low
Upper Sydenham	02S	128919	12892	1966	Low
Brown Creek	03S	81239	8124	496	Low
Middle East Sydenham	04S	87233	8723	917	Low
Lower East Sydenham	05S	56863	5686	1295	Low
Lower North Sydenham	06S	45963	4596	272	Low
Bear Creek Headwaters	07S	77813	7781	1266	Low
Lower Bear Creek	08S	62263	6226	226	Low
Black Creek	09S	68404	6840	252	Low
Lambton Shores Tributaries	10S	31229	3123	246	Low
Plympton Shoreline Tributaries	11S	53610	5361	871	Low
Cow and Perch Creeks	12S	58363	5836	769	Low
St. Clair River Tributaries	13S	57506	5751	368	Low
Lake St. Clair Tributaries	14S	94164	9416	692	Low

Table 3-7 Groundwater potential for stress based on Tier 1 stress assessment (Maximum Monthly Conditions)

Subwatershed	Code	Q_{supply}	$Q_{reserve}$	Q_{demand}	Potential for stress
East Sydenham Headwaters	01S	105509	10551	11299	Low
Upper Sydenham	02S	128919	12892	9066	Low
Brown Creek	03S	81239	8124	496	Low
Middle East Sydenham	04S	87233	8723	1152	Low
Lower East Sydenham	05S	56863	5686	4420	Low
Lower North Sydenham	06S	45963	4596	272	Low
Bear Creek Headwaters	07S	77813	7781	2566	Low
Lower Bear Creek	08S	62263	6226	226	Low
Black Creek	09S	68404	6840	252	Low
Lambton Shores Tributaries	10S	31229	3123	246	Low
Plympton Shoreline Tributaries	11S	53610	5361	1652	Low
Cow and Perch Creeks	12S	58363	5836	1031	Low
St. Clair River Tributaries	13S	57506	5751	368	Low
Lake St. Clair Tributaries	14S	94164	9416	2540	Low

Although some *subwatersheds* in the St. Clair Region Source Protection Area have a potential to be *stressed*, that *stress* does not affect any municipal *drinking water systems*. Map 3-5 shows the *potential for stress* in surface water of the *subwatersheds* within the St. Clair

Region Source Protection Area. Map 3-6 shows that there are no *subwatersheds* with more than a low level of groundwater *stress* in the St. Clair Region Source Protection Area.

Thus, for the purposes of the Clean Water Act, the *potential for stress* on municipal *drinking water systems* in the Source Protection Area is LOW.

3.4.1. Uncertainty in the Stress Assessment

As the *stress assessment* for the St. Clair Region Source Protection Area was completed as part of a Tier 1 Water Budget, some *uncertainty* in the data and analysis is expected. Surface water *stress assessment*s for the watersheds, which include direct tributaries to the Great Lakes or Lake St. Clair, are likely over estimating the *percent water demand*, and therefore the *potential for stress*. This is expected as some of the water takings near the Great Lakes are likely drawing their water from the Great Lakes rather than drawing water from the *subwatershed* being assessed. Although permits where this is likely to be the case have been removed from the demand used in the *stress* calculations, it is suspected that more, especially in areas with little topographic relief from the lake level, are also effectively drawing water from the lake. Unfortunately, the permit to take water database coordinates are not reliable enough to make further judgments as to whether the permit reflects a demand from the watershed being assessed or from the Great Lake which is beyond the study area. Although a full Tier 2 Water Budget would not be required to reduce the *uncertainty* in these watersheds, further analysis would be necessary to gain a better understanding of the demand in these areas and whether they rely on water from the lake rather than the watershed being considered. In these watersheds, the potential *stress* does not affect municipal *drinking water systems*, thus this work must rely upon other programs to undertake a more detailed assessment of the potential from *stress*.

Although this *uncertainty* has little effect on the *Source Protection Plan*, it is of considerable importance in interpreting this analysis for use in other programs such as the Permit to Take Water Program.

3.5 Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas (*SGRA*) are defined through the water budget work. These areas are determined through the use of the recharge calculated in the Tier 1 Water Budget and discussed in Section 3.2.4 above. This recharge is compared to both the average recharge of the area and to the effective precipitation (precipitation less evaporation) of the area to determine if the recharge at that location is significant. Rule 44 identifies the criteria for determining whether a recharge area is significant:

> 44(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
> 44(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.

In considering which area was appropriate to base average recharge upon, different scales of analysis were considered:

- Entire SGRA area;
- 2 *subwatersheds* used in water budget analysis, and
- 14 *subwatersheds* considered in the Tier 1 analysis.

The best compromise between using too small and too large an averaging area was to use the 2 watersheds from the CWB as representative for the average recharge area.

Table 3-8 below summarizes the recharge and the conditions which must be met for an area within a particular *subwatershed* to be deemed significant. Recharge and effective precipitation are presented for each of the 14 Tier 1 *subwatersheds* for reference and *SGRA* calculations then based upon the average values for the larger CWB *subwatershed* in which the T1 *subwatersheds* are contained. It is worth noting that, in most cases, rule 44(1) provides a more conservative criterion for *SGRA* declaration than rule 44(2). Rule 44(1) was therefore used to define the SGRA.

Table 3-8 Criteria for Significant Groundwater Recharge Areas

Subwatershed	Code	Annual Average Recharge	Effective Precip (precip - evaporation)	Rule 44(1) Threshold based on annual average recharge	Rule 44(2) Threshold based on effective precipitation
East Sydenham Headwaters	01S	172	397		
Upper Sydenham	02S	205	393		
Brown Creek	03S	191	367		
Middle East Sydenham	04S	59	346		
Lower East Sydenham	05S	52	290		
Lower North Sydenham	06S	66	270		
Sydenham River		**101**	**325**	**116**	**179**
Bear Creek Headwaters	07S	75	342		
Lower Bear Creek	08S	90	324		
Black Creek	09S	77	333		
Lambton Shores Tributaries	10S	90	370		
Plympton Shoreline Tributaries	11S	82	340		
Cow and Perch Creeks	12S	80	288		
St. Clair River Tributaries	13S	80	275		
Lake St. Clair Tributaries	14S	71	270		
Bear Creek		**77**	**324**	**89**	**178**

Rule 45 indicates that the area must have "a hydrological connection to a surface water body or *aquifer* that is a source of drinking water for a *drinking water system*". For the purposes of this rule it is important to realize that a *drinking water system* can be a single residential water well. Map 34 in Thames Watershed Characterization Report summary included as Appendix 5 illustrates that wells are located throughout the region. In areas where shallow sandy deposits provide for recharge areas, well installation is simple through the use of sand points driven to a modest depth. These types of water wells are, in most cases, installed without a permit and therefore not included in the water well information system used to produce Map 34. Further, it is not intended by the *rules* that the connection be direct or immediate, but rather that there is a "hydrologic connection." This recognizes that water not only flows vertically through the ground but also flows laterally from areas of higher levels to areas of lower water levels. Thus, it is generally accepted that *aquifers* are recharged from areas up gradient from the *aquifer* as well as directly above. Although through Tier 2 and 3 Water Budgets a much better interpretation of the extent of *aquifers* will be understood, currently in the St. Clair Region Source Protection

Area there is little information on a localized scale on the extent of the *aquifers*. Thus, a precautionary, conservative approach is warranted and all areas which meet the criteria for significance are included as *SGRA*.

Map 4-8 illustrates the *Significant Groundwater Recharge Areas* in the St. Clair Region Source Protection Area.

3.6 Data Gaps and Next Steps

Table 3-9 summarizes data gaps identified through the Tier 1 Water Budget and Water Quality Stress Assessment. This table has been updated to reflect the completion of the Tier 1 peer review and improvements to the SGRA. As the *stress assessment* was completed through a Tier 1 Water Budget, it is expected that data gaps would remain. If work was to proceed to a Tier 2 Water Budget, many of these gaps would need to be addressed at that time. As the *potential for stress* has no effect on municipal water systems, additional work is not required through Source Protection Planning. These gaps become more of a problem for other programs, such as the Permit to Take Water Program, which would benefit from results with a lower level of *uncertainty*.

These gaps do not affect the reliability of the analysis for use in the development of the *Source Protection Plan*.

Table 3-9 Data gaps related to Water Budget and Water Quantity Stress Assessment

Gap	Description
Determine Inland takings drawing from Great Lakes	• Confirm location and watercourse conditions related to water takings near Lake Erie and Lake St. Clair • Recalculate percent water demand • Reassess potential for stress in these areas • Update Assessment Report only if warranted
Improved understanding of water use	• Obtain actual water use data from all significant water users through the PTTW reporting system • Requires reassessment after sufficient data has been reported, perhaps when Assessment Report requires future update
Un-gauged Areas	• Temporary stream gauging on small lake draining tributaries to improve understanding of how these behave • Surface Water Model to better understand distribution of flows in un-gauged subwatersheds
Climate Change	• Consider the impact of Climate change on the water budget and the stress assessment
Refine ET	• Improve calculation of ET to include consideration of soil types and land use at a local level

4.0 Vulnerability Assessment

In order to protect *drinking water* sources it is necessary to identify areas where *activities* can affect the *drinking water* sources. The Clean Water Act refers to these areas as *Vulnerable Areas* and requires that they be identified in the Assessment Report. The Vulnerability Assessment section of the Assessment Report summarizes the work to delineate these *vulnerable areas* which was undertaken through various studies. The studies involved the operating authorities of the water systems and were undertaken through partnerships involving the Conservation Authorities in the region. The Clean Water Act also requires that these *vulnerable areas* be assessed to determine their relative level of *vulnerability*. There are three types of *vulnerable areas* which must be identified and assessed:

- *Intake Protection Zones* (*IPZ*)
- *Wellhead Protection Areas* (*WHPA*)
- *Highly Vulnerable Aquifers* (*HVA*)

Activities in these *vulnerable areas* will be reviewed to determine the *risks* that they pose to the *drinking water* sources. The *vulnerability* of the area, combined with the hazard associated with the *activity*, provide a relative indication of the level of *risk* associated with a *threat*. The *Source Protection Plan* is focused on reducing the level of *risk* associated with *threats*. As such, the identification of the *vulnerable areas* and the assessment of *vulnerability* are cornerstones to the development of the *Source Protection Plan*.

Each type of *vulnerable area* is described in the following sections which summarize the identification and assessment of the *vulnerability* within the areas.

4.1 Peer Review of Vulnerability Assessment

All aspects of the *vulnerability* assessment are subject to a thorough peer review process. This process is described in Peer Review of *Vulnerability* Assessment, Terms of Reference (March 2008). This process includes the forming of a peer review committee comprised of four professionals with extensive experience in one or more of the areas related to the *vulnerability* assessment of the *vulnerable areas*. Two members of the committee are professional geoscientists familiar with the assessment of groundwater *vulnerability*; one with experience related to *Groundwater Under the Direct Influence* (*GUDI*) wells, while the other is also a member of the peer review committee for the Water Budget work. The third member of the peer review committee has extensive experience related to the surface water *vulnerability* assessment and is working on similar projects in other regions. A fourth member joined the committee in the peer review of *vulnerability* assessment studies of groundwater systems spanning the Oxford and Perth Counties in the Upper Thames River Source Protection Area (*SPA*) and the Lake Erie Source Protection Region (*SPR*). The peer review committee reviewed each technical report, met with the consultants and project teams to discuss the project and submitted comments based on their review and the discussion. Comments were considered and responded to by the consultant or project team members. These comments and the responses form part of the peer review record along with the terms of reference for the peer review committee discussed above. The peer review process added considerable value to the technical report by ensuring that the work was well documented.

One point that involved considerable discussion by the peer reviewers was the *uncertainty* analysis undertaken in the technical studies. The *rules* allow for *uncertainty* to be determined as either high or low. While it was generally reported that the *uncertainty* associated with the *vulnerability* assessment or delineation of the *vulnerable areas* was acceptable for the intended purpose, there was a wide variation in what consultants viewed as a low level of *uncertainty*. The *uncertainty* reported in this report reflects that which has been identified in the technical reports. However, following the completion of the peer review of all of these studies, it has been suggested that the peer reviewers provide a relative comparison of the *uncertainty* of the projects so that a consistent interpretation between studies is available. This may result in changes to the *uncertainty* reported in this Assessment Report, which would be documented in a subsequent amendment to the Assessment Report.

4.2 Intake Protection Zones

An *Intake Protection Zone* (*IPZ*) is delineated around an intake in a surface water body. In the St. Clair Region Source Protection Area (*SCRSPA*), three municipal intakes draw water from Lake Huron, St. Clair River, and the Chenal Ecarte. In addition to the three municipal intakes, there are two First Nations Intakes. The Kettle and Stony Point First Nations Intake is included in this assessment report and is located in Lake Huron. (Revise map 4-1 to include Kettle and Stony Point). Map 4-1 in Appendix 1 shows the location of the intakes and the *IPZ* around the intakes. An *Intake Protection Zone* is comprised of an *IPZ-1*, *IPZ-2* and *IPZ-3*, each of which contains a water body (such as a lake or river) portion and a land portion. The *IPZ-1, IPZ-2 and IPZ-3* in the *SCRSPA* were delineated through two projects as discussed below.

4.2.1. Surface Water Vulnerability Assessment Projects

A project was led by the St. Clair Region Conservation Authority (*SCRCA*), in partnership with the Lambton Area Water Supply System (*LAWSS*) and Town of Petrolia, for two surface water intakes in the *SCRSPA*. *LAWSS* and the Town of Petrolia actively participated in the technical steering of the project along with staff from the Conservation Authority. R. V. Anderson Associates Limited was the primary consultant and retained Baird and Associates to undertake the hydrodynamic modelling work. The two intakes studied in this project serve the water treatment plants of *LAWSS* and Town of Petrolia at Bright's Grove.

A large project, led by the Essex Region Conservation Authority (*ERCA*), was initiated through a partnership between *ERCA* and the Conservation Authorities in the Thames-Sydenham and Region and the plant operators. This project included one intake in the *SCRSPA* serving the Wallaceburg water treatment plant, two intakes in the Lower Thames Valley Source Protection Area, and seven intakes in the Essex Region Source Protection Area. Stantec Consulting Limited was the primary consultant and retained Baird and Associates to undertake the hydrodynamic modelling work. The Municipality of Chatham-Kent Public Utilities Commission (*PUC*) was an active partner in the project and participated in the technical steering of the project.

A technical study of the Kettle and Stony Point intake was led by the Ausable Bayfield Conservation Authority, in partnership with the Chippewas of Stony and Kettle Point. HCCL and Riggs engineering were the consultants on the project.

The above referenced technical reports are peer reviewed and components finalized, so that they could be included in the Assessment Report. The technical reports are listed below In Table 4-1.

Table 4-1 Technical Studies on Drinking Water Threats and Risk Assessment

Drinking Water Systems	Technical Study on Threats and Risk Assessment
Lambton Area Water Supply System (LAWSS)	Final Surface Vulnerability Report - Lambton Area Water Supply System (LAWSS) Water Treatment Plant. R.V. Anderson Associates and W.F. Baird and Associates Coastal Engineers Ltd. October 2009.
Town of Petrolia Water Treatment Plant	Final Surface Vulnerability Report - Town Of Petrolia Water Treatment Plant. R.V. Anderson Associates and W.F. Baird and Associates Coastal Engineers Ltd. October 2009.
Wallaceburg Water Treatment Plant	Technical Memorandum: Delineation, Vulnerability and Uncertainty Level Analysis for the Wallaceburg Water Treatment Plant. Essex Chatham-Kent Source Protection Planning Technical Study. Stantec Consulting Ltd. February 2010.
Kettle and Stony Point Water Treatment System	Kettle and Stony Point First Nations Intake Protection Zone Delineation and Vulnerability Analysis for the Kettle and Stony Point Intake. Chippewas of the Kettle and Stony Point First Nations. Final Report. HCCL and Riggs Engineering Ltd. December 14, 2011.

4.2.2. Intake Characterization

The intakes of the *SCRSPA* are described in Table 4-2. Basic characteristics including depth of the intake from the lake's surface and distance from shore are included below. The depth to the intake is based on depth from the top of the entry point where raw water enters the system to the low water level in the lake. The type of the intake is assigned based on the types indicated in the *Technical Rules 2013*: *Assessment Report*.

Vulnerable areas must be defined for all intakes connected to municipal *drinking water systems*. The intake at the mouth of the St. Clair River, where Lake Huron flows into that river, serves the Lambton Area Water Supply System (*LAWSS*). The *LAWSS* intake is considered to be located on a connecting channel to the Great Lakes as the St. Clair River is part of the system that

drains the Upper Great Lakes to the Lower Great Lakes. Therefore, it is classified as a Type B intake.

The intake on Lake Huron at Bright's Grove serves the Town of Petrolia water treatment plant, and is classified as a Type A intake. A First Nations intake is located on Lake Huron at the Kettle and Stony Point First Nations which serves the Chippewas of Kettle and Stony Point First Nations. This intake is classified as a Type A intake.

The Fourth intake in the *SCRSPA* is located on the Chenal Ecarte and serves the community of Wallaceburg. The Chenal Ecarte is often called a 'distributary' (river branch flowing away from the main stream) of the St. Clair River. The flow from the St. Clair River is divided into multiple channels including the Chenal Ecarte as it flows into Lake St. Clair through the St. Clair delta.

The *Technical Rules* 2013 require the classification of intakes into one of 4 types:

- type A intake if the intake is located in a Great Lake;
- type B intake if the intake is located in a connecting channel;
- type C intake if the intake is in a river and neither the direction nor velocity of the flow of the water at the intake is affected by a water impoundment structure; or
- type D intake if the intake is not type A, B, or C.

Classifying the type of intake for Wallaceburg was the focus of several discussions early in the *vulnerability* assessment. Since the intake is not located on a Great Lake, it is not a Type A intake. According to the *Technical Rules 2013*, the St. Clair River is a connecting channel. As described above, the Wallaceburg intake is located on the Chenal Ecarte. The Chenal Ecarte is one of the several distributaries that flow from the designated connecting channel, the St. Clair River, to Lake St. Clair. There are no impoundment structures on the Chenal Ecarte. The Chenal empties into Lake St. Clair which could be considered a natural impoundment, however not an impoundment structure identified in the *rules*.

The flow in the Chenal Ecarte is influenced by many factors, including the water levels in Lake St Clair. The Sydenham River flows into the Chenal Ecarte, south of Wallaceburg, before flowing to Lake St. Clair. Flow in the Chenal Ecarte can reverse (to the north) when the flow in

the Sydenham River is high or winds from the south are strong, and particularly when there is low flow in the St. Clair River (such as during ice jams). This results in the Sydenham River (not a connecting channel) flowing past the intake. The local hydrodynamic conditions at the Wallaceburg intake, such as reverse flow, must be considered in the delineation of an *intake protection zone*.

Therefore the consultant was requested to first review the hydrodynamic conditions and determine the *intake protection zone* delineation which best suited the flow and water quality conditions at the Wallaceburg intake. Thereafter the intake type was selected which most closely reflected the zone delineated.

While the type of intake influences the shape and size of the *intake protection zone* delineated, the *Technical Rules* 2013 allow for modifications to the *IPZ-1* delineations of all 4 types of intakes to allow for local hydrodynamic conditions (Rule 64). The *IPZ-1* delineation (shape) for a Type A and D intake are the same, however the *Technical Rules 2013* allow for the C intake *IPZ-1* to be modified to be the same as that of a Type A and D intake. The modification would ensure the water quality at the Type C intake is protected having regard to direction and flow at the intake (Rule 63). The application of Rule 63 and Rule 64 could result in an *IPZ-1* that is the same for all 4 types of intakes. The delineation of *IPZ-2* is the same for all 4 intake types due to the time of travel criteria which is applied to all types of intakes.

In addition to having an affect on the shape of the *IPZ-1*, the type of intake also has a bearing on the range of *vulnerability scores* which could be assigned to the intake, as discussed in Section 4.2.6. The type of intake also has a bearing on the delineation and scoring of *IPZ-3*.

The consultant conducting the Wallaceburg *vulnerability* assessment study delineated the *IPZ-1* considering the local hydrodynamic conditions at the Wallaceburg intake as allowed in the *Technical Rules* 2013and the flow of the Chenal Ecarte from the St. Clair River to Lake St. Clair. After delineating the *IPZ-1* and *IPZ-2*, the consultant suggested that the Wallaceburg intake best fit the Type B (connecting channel) intake. Correspondence from the Ministry of the Environment, Conservation and Parks dated April 30, 2010 confirms this classification of the Wallaceburg intake as a type B intake under Technical Rule 55.1 and said correspondence can

be found in Appendix 14. The Type B classification was used to assess the *vulnerability* in the *IPZ-1* and *IPZ-2* associated with the intake. During the *vulnerability* assessment and delineation of *IPZ-3*, methods used in delineation of type C and Type B intakes may be considered due to the impact that the Sydenham River has on the intake at times and the history of spills originating beyond the *IPZ-1* and *IPZ-2* upstream on the St Clair River. These methodologies will be discussed with MECP at that time. The *IPZ-3* delineation is discussed later in this report.

Table 4-2 Intake Characteristics

Intake		LAWSS	Town of Petrolia	Wallaceburg	Kettle and Stony Point First Nations
Intake Type		B (Connecting Channel)	A (Great Lake)	B (Connecting Channel)	A (Great Lake)
Approximate Population Served		104,000	10,000	11,800	1,279
Pump Rate	Maximum Annual	22,343,625	2,052,202	2,044,981	438,000
	Average Annual	21,842,266	1,854,210	1,927,368	202,219
	Average Monthly	1,820,105	154,517	160,614	18,277
Rated (design) Capacity of Plant (cubic metres per day)		181,844	12,000	18,200	1,180
Distance from Shore		180 m (pipe length)	365 m	8 m	850 m
Depth of Intake		14 m below Lake Huron Low Water Datum (176.0 m International Great Lakes Datum 1985)	3.4 m below Lake Huron Low Water Datum (176.0 m International Great Lakes Datum 1985)	1.3 m below Low Water Datum (NOAA Nautical Chart 14850)	Intake is located in water depth 7-8 m and draws form approx. 1 m above lake bed
Intake Location		St. Clair River	Lake Huron	Chenal Ecarte	Lake Huron

4.2.3. IPZ-1 Delineation

The *vulnerability* within an *Intake Protection Zone* is first assessed by delineating an *IPZ-1*. An *IPZ-1* must be delineated for all intakes which are connected to *drinking water systems*.

For a Type A intake (Great Lake intake), according to the *Technical Rules 2013*, an *IPZ-1* is a circle with a radius of 1 km, centred from the entry point where raw water enters a system. Where the circle touches shore, the zone is extended on land by 120 m or to the regulatory limit, where water from that area drains into the in-lake part of the *IPZ-1*. The regulatory limit is defined by Conservation Authorities pursuant to the Conservation Authorities Act to include

areas which are flooded under a severe regulatory event. This area also includes slope and erosion hazard areas along lakeshore and watercourses.

The *IPZ-1* for the Town of Petrolia intake (a Type A intake) is a 1 km circle until it touches land where a 120 m setback was used, since there is no regulatory limit for that area. The IPZ-1 boundary for Kettle and Stony Point First Nations Intake, also a Type A intake, is delineated in accordance with the Technical Rules (2013) 61 (1) and 62. The boundary is a 1 km circle until it touches land where a 120 m setback is used, since there is no regulatory limit for this area.

For a Type B intake (connecting channel intake), according to the *Technical Rules 2013*, an *IPZ-1* is comprised of a semicircle extending upstream of the entry point where raw water enters a system, and a rectangle extending downstream of the intake centre. The semicircle has a radius of 1 km, and the rectangle has a length of 2 km and width of 100 m. Where the circle touches shore, the zone is extended in-land by 120 m or to the regulatory limit, where water from that area drains into the water body part of the *IPZ-1*.

The semicircle *IPZ-1* for the *LAWSS* intake (a Type B intake) is perpendicular to the river flow. The *LAWSS IPZ-1* includes the marina, which is considered to be a part of the in-water portion of the *IPZ-1*. Water flowing from the marina would flow towards the intake due to the current direction towards the mouth of the St. Clair River. Since there is no regulatory limit for this area, a 120 m setback on shore was used. This setback also applies to the marina shore.

For the Wallaceburg intake (a Type B intake), the *IPZ-1* was modified to account for local hydrodynamic conditions, as allowed by Rule 64. The modelling report 'In-water *IPZ-2* Delineation for Essex Region and Chatham-Kent Intakes – Phase II Studies' (Baird Consulting Ltd., January 2010) and a technical memorandum 'Wallaceburg Intake – Additional Model Runs in Support of *IPZ-2* Delineation' (Baird Consulting Ltd., February 2010) included as an appendix in the Stantec report listed in Table 4-1 identified that high flow conditions in the Sydenham River, strong south wind events, and spring melt events result in reverse flow conditions in the Chenal Ecarte. Both ADCP measured flows and modelled reverse flow events, identify that flows on the Chenal Ecarte at both the surface and river bottom are reversed and significantly exceed normal flows on the Chenal Ecarte. Further discussions with Chatham-Kent Public Utility

staff identified that reverse flow conditions in the Chenal Ecarte occur on numerous occasions throughout the year. Therefore, in order to adequately represent reverse flow conditions in the Chenal Ecarte, the semicircular delineation was extended to a fully circular delineation of the *IPZ-1*, increasing the total downstream distance to 1,000 m from the entry point where raw water enters the Wallaceburg system.

Further, the delineation of the upland portion of the Wallaceburg *IPZ-1* does not include the regulatory limit. The area of the Regulation Limit described by O. Reg. 171/06 of the Conservation Authorities Act for the St. Clair Region Conservation Authority (SCRCA) incorporates the flood plain (100-year flood level), hazardous lands, wetlands, dynamic beaches, and areas of erosion. The area of Regulation Limit is expansive in the Wallaceburg area and, if applied to the *IPZ-1*, may extend the vulnerable area considerably. The previous *Technical Rules* (December 2008) which were followed in the initial delineations, required that the regulatory limits not be included in the *IPZ-1* (Rule 62) and *IPZ-2* (Rule 67) delineations. When the *Technical Rules* were amended in November 2009, Rules 62 and 67 were removed. In the current *Technical Rules* (November 2009), Rule 15.1 was added, which allows for the use of an alternate approach or method to those prescribed in the current *Technical Rules*.

Where the *IPZ-1* abutted the riverbank, a 120 m setback was applied on land; however, this setback was truncated on the north and east sides of the Chenal Ecarte where dyke structures exist. The St. Anne Island within the Walpole Island First Nation and adjacent to the Chenal Ecarte does not fall within the jurisdiction of this assessment at this time. The 120 m setback applied to the Chenal Ecarte has been noted on Map 4-4 in Appendix 1. Information regarding the flow of water from the St. Anne Island into the Chenal Ecarte has been collected; however additional information would be required to denote specific areas which could provide water to the intake within the two hour time of travel.

4.2.4. IPZ-2 Delineation

A second zone, called the *Intake Protection Zone-2* (*IPZ-2*) is delineated based on travel time to the intake under moderate flow and wind conditions. Determining the extent of the *Intake Protection Zone-2* in the water body (such as a lake or river) is the first step. The upland extent from the shore is then delineated for areas draining into the water body portion of the *IPZ-2*.

4.2.4.1. In-water Delineation

The work related to delineating the *IPZ-2* for the *LAWSS* and Town of Petrolia intakes are described in the report 'In-Lake Intake Protection Zone Delineation for *LAWSS* and Petrolia Intakes', Baird 2009, and in the report 'Addendum: Influence of Wave Induced Currents on In-water IPZ-2 for Petrolia Intake', Baird, 2009, which are contained as appendices to the relevant technical studies listed in Table 4-1. The work related to delineating the in-water portion of the *IPZ-2* for the Wallaceburg intake is described in the report 'In-water Intake Protection Zone Delineation for Essex Region and Chatham-Kent Intakes-Phase II Studies', Baird 2010, which is contained as an appendix to the relevant technical study identified in Table 4-1.

In the Thames-Sydenham and Region, hydrodynamic computer models were used to simulate currents driven by wind and wave action within the Great Lakes and connecting channels in order to delineate the in-water extent of the *IPZ-2*. The models were used also to simulate particle movement in the water body and determine the time of travel to the intakes. Various scenarios were run to determine areas which can contribute water or potential contaminants within the time required to close the intake. In the Thames-Sydenham and Region, all operators determined that they could close intakes within two hours of being notified of a situation which might cause a deterioration of the *drinking water*. Two hours is the minimum time allowed by the Clean Water Act for the delineation of *IPZ-2.* The work related to the delineation of the in-water portion of the IPZ-2 for the Kettle and Stony Point First Nations Intake is described in the report, 'Technical Report – Kettle and Stony Point IPZ-2 Delineation and Vulnerability Analysis' Riggs 2011, which is contained in the appendix to the relevant technical study identified in Table 4-1.

Numerical modelling was undertaken in support of the preliminary *IPZ-2* delineation using Baird's proprietary three-dimensional hydrodynamic model named MISED. The model includes the western end of Lake Erie, the Detroit River, Lake St. Clair and the St. Clair River, and was used to delineate the in-water portion of the *IPZ-2* of the Wallaceburg intake. This model was extended into Lake Huron to model hydraulics in Lower Lake Huron and upper St. Clair River, so as to include the Town of Petrolia and *LAWSS* intakes.

Wind data was used to define the boundary conditions, initial conditions, and external forcing mechanisms for the model. A statistical analysis was undertaken to define the directional wind

speeds for varying return period events, for use in the model runs. Event based model runs were undertaken and reverse particle tracking was used to delineate the preliminary in-water *IPZ-2*s for the intakes. The model was run for a range of conditions using combined 10-year return period events considering wind and water flow. The MISED model was calibrated and validated with measured water level and current (flow) data from Acoustic Doppler Current Profiler (ADCP) measurements taken in the Chenal Ecarte, St. Clair River and other locations.

A model named HYDROSED was run to evaluate wave-driven currents at the Town of Petrolia intake. The wave driven currents from the HYDROSED model were combined with the wind driven currents from the MISED model to delineate the Town of Petrolia *IPZ-2*. Wave driven currents were not considered to be an *issue* at the *LAWSS* intake due to its location in relatively deep water, at the inlet to the St. Clair River. Therefore, this type of an analysis was not undertaken for the *LAWSS* intake.

For the Kettle and Stony Point Intake, numerical modeling representing bathymetric and shoreline geometry around the intake was necessary to define the IPZ-2. The ADCIRC 3-D model was used to delineate the IPZ-2 region using local and regional physical data and environmental variables. A model named STWAVE was run to evaluate wave stresses in the near shore region of the Kettle and Stony Point Intake. The wave driven currents from the STWAVE model, along with the wind driven currents from the ADCIRC 3-D model force the hydrodynamic analysis.

Under normal conditions, flow in the Chenal Ecarte canal is in a southerly direction. The Chenal Ecarte joins with the Sydenham River, south of Wallaceburg. Flow in the Chenal Ecarte can reverse (to the north) when the flow in the Sydenham River is high or winds from the south are strong, and particularly when there is low flow in the St. Clair River. In addition, it is not unusual for surface currents to be in the opposite direction to the currents near the riverbed. The surface currents are influenced by wind direction. The above site specific flow characteristics at the Wallaceburg intake were considered in selecting the model runs for this intake. The following runs were undertaken:

1. Ten year return period high flow in the St. Clair River with the 1-year return winds for 8

directions, at 45 degree intervals. High flow conditions in the Sydenham River (such as the 2-year return period event), result in reverse flow in the Chenal Ecarte. An average flow (10.1 m3/s) was therefore used in the Sydenham River, to ensure that the reverse flow condition did not dominate. These runs were used to evaluate the distance the IPZ-2 would extend northward up the Chenal Ecarte.

2. Ten year return period low flow in the St. Clair River and the 2 year return period high flow in the Sydenham River, with the 1-year return winds for 8 directions, at 45 degree intervals. During these conditions, there is reverse flow in the Chenal Ecarte (flow is to the north). These runs were used to evaluate the distance the IPZ-2 would extend up the Sydenham River.

4.2.4.2. In-land Delineation

Once the in-lake extent of the *Intake Protection Zone-2* was delineated, the upland extent of the *IPZ-2* could be determined. Where the in-water portion of the *IPZ-2* touches shore, the time remaining from the two hours is used to determine the distance the *IPZ-2* extends up tributaries. For example, if a tributary outlet is 1 hour and 30 minutes from the intake then the remaining 30 minutes is used to determine how far the zone should extend up the tributaries. The remaining time is referred to as residual travel time. Estimates of the water course velocities under bank full conditions are used to determine distance up the tributaries for the residual travel time. Bank full conditions usually occur during a runoff event which occurs, on average, every two to five years (generally referred to as a two or five year storm). Along the parts of the tributaries that contribute water to the intake within the two-hour period, the *IPZ-2* extends 120 m from the high water mark or to the extent of the regulatory limits. As described in Section 4.2.1, the regulatory limit includes areas which are flooded under a severe regulatory event. It also includes slope and erosion hazard areas along lakeshore and watercourses.

For the in-land portions of Kettle and Stony Point, *LAWSS IPZ-2* and Petrolia *IPZ-2*, a 120 m setback on shore was used since there are no regulatory limits for these areas. As part of the numerical modelling for the Petrolia IPZ-2, creek velocities were estimated for Perch Creek and Cow Creek. The estimated creek velocities were used to determine how far upstream the IPZ-2 should extend based on the two-hour response time.

The Wallaceburg intake and the community it services are located in an extensive, flat floodplain near the confluence of the Sydenham River and the Chenal Ecarte. Much of the Wallaceburg study area is dyked and is drained by pumped systems that pump water to the Chenal Ecarte, Sydenham River and Running Creek. The Regulatory Limit in the area is vast, as there are few topographic barriers to control the expansion of flood waters. If the IPZ-2 were to be extended to the regulatory limits the zone would extend far beyond the 2 hour response time which the municipality identified. The *Source Protection Committee* supported the proposal of the consultants and Authority staff in delineating *IPZ-2* based on the 2 hour time of travel using a 120 m setback from water courses without considering the regulatory limit. Correspondence was received from the Ministry of the Environment, Conservation and Parks dated May 6, 2010, confirming an exemption under Technical Rule 15.1 from the regulatory limit requirement.

Based on hydrodynamic modelling, the residual times of travel were determined at outlets of drain and sewer systems for: Wiser Drain and Pumping Works, Skinner Pumping Works, Sutherland Pumping Works, Rabideau Pumping Works, Townline Pumping Works, Base Line stormwater pump station, Base Line storm sewer, VLA storm sewer, McDonald Tap Drain stormwater pump station and a private pumping system. Where the Wallaceburg IPZ-2 abutted land and is not influenced by a Municipal drain, a 120 m setback was applied along the Chenal Ecarte and Sydenham River. This setback was truncated on the majority of the north bank of the Chenal Ecarte and both banks of the Sydenham River where dyke structures exist. The distance up pumped municipal drains was determined through an assessment of the pump capacity and storage within the drains. This assessment included discussion with local pump operators. The inclusion of *transport pathways* and *storm sewersheds* in the in-land portion of the *IPZ-2* are described in the next subsection.

4.2.4.3. Storm Sewersheds and Transport Pathways

IPZ-2 is also extended to include any *storm sewersheds* which drain within the *IPZ-2*. *Storm sewersheds* are areas drained by storm sewers and catch basins. *Storm sewer systems* refer to the storm sewers (pipes), catch basins and outlets that drain a *storm sewershed*. Areas where *transport pathways* allow water to drain to the *IPZ-2* may also be included within *IPZ-2*, again to

the extent that they can contribute water within the two-hour response time used to define the extent of *IPZ-2*. *Transport pathways* could include natural or man-made pathways such as drains, creeks, agricultural tile drains, or overland flow. While areas contributing to the *IPZ-2* could be determined by topographic information, this has often been artificially altered by agricultural and urban drainage. Information on these drains is available, however the property-specific information, especially related to tile drainage, is not considered to be accurate enough for the purposes of establishing *transport pathways*. As a result, the *Source Protection Committee* (*SPC*) chose to include all parcels abutting the setbacks to watercourses where there was the potential that they drain, either naturally or artificially, to the watercourse in the *IPZ-2*. Through the Tier 2 (site-specific) Risk Assessment, if these areas were found to be beyond the time of travel or drain away from the *IPZ-2*, the inclusion of these areas would be reconsidered. These changes would be made through an amended Assessment Report.

Maps 4-1a, 4-2, 4-3 and 4-4 in Appendix 1 show the *IPZ-1* and *IPZ-2* for the intakes in the St. Clair Region Source Protection Area.

4.2.4.4. LAWSS IPZ-2 Transport Pathways

Transport pathways were included into the *IPZ-2* for the *LAWSS* intake as those first parcels abutting the 120 m setback. This includes Canatara Park, to the east of the Sarnia Yacht Club at the marina.

4.2.4.5. LAWSS IPZ-2 Storm Sewersheds

The *IPZ-2* for the *LAWSS* intake includes a small storm sewer discharge located in the eastern portion of the zone. The storm sewershed for the discharge is a small area that includes approximately a dozen residential properties that were included in the final *IPZ-2* with an area of approximately 9.6 hectares. The storm sewer outfall discharges directly into Lake Huron and into the in-lake portions of the *IPZ-2*.

The *LAWSS IPZ-1* and *IPZ-2* are illustrated on Map 4-2 in Appendix 1. The majority of the *LAWSS IPZ-2* lies within Lake Huron, upstream of the intake. There are areas on the United States side of the border that may contribute flow to the *LAWSS* intake within the two-hour time of travel. The inland areas on the American side of the *LAWSS IPZ-2* have not been delineated.

Any delineations extending beyond the international border including a 120 m setback from the shoreline are shown as hatched areas on Map 4-2 in Appendix 1. The Thames-Sydenham and Region Source Protection Region extends only to the Canadian side of the border. The jurisdiction of this assessment does not extend beyond that.

4.2.4.6. Town of Petrolia IPZ-2 Transport Pathways

The *transport pathways* located in *IPZ-2* for Petrolia's intake are: Cow Creek, Perch Creek, and storm sewer outfalls that discharge into the tributaries. As part of the work to delineate *IPZ-2*, the drainage ditches in the area were surveyed and velocities of the ditches were estimated. The velocities were then used to determine the extent of *IPZ-2* based on the two-hour time of travel. The Donald Lamont Drain *subwatershed* boundary encompasses approximately 2.8 km^2 (280.7 hectares) and drains in a northerly direction towards Cow Creek along the east side of Waterworks Road. Two ditches drain to Perch Creek: the Hind Drain which is situated along the west side of Telfer Road, and the Pulse Creek Drain which conveys flow along Brigden Road and then flows westerly, ultimately converging with Perch Creek just south of Lakeshore Road. Stormwater is also conveyed along the east side of Mandaumin Road, which has been considered to have the same velocity as the C.N.R. North Townline Drain for the travel time analysis.

The approximate drainage areas (located in *IPZ-2*) for Perch Creek and Cow Creek are 855 hectares and 1,007 hectares respectively.

4.2.4.7. Town of Petrolia IPZ-2 Storm Sewersheds

IPZ-2 includes any *storm sewersheds* drained by the storm sewers that discharge to Cow Creek as any contaminants that enter the *storm sewer system* will reach Cow Creek and have potential impacts on the intake. These include the *storm sewershed* of the Town of Bright's Grove.

The Town of Petrolia *IPZ-1* and *IPZ-2* are illustrated on Map 4-3 in Appendix 1. The Town of Petrolia *IPZ-1* and *IPZ-2* includes most of the Perch Creek and Cow Creek catchment areas including the watercourses that drain to them, mostly up to Highway 402 in the south.

4.2.4.8. Wallaceburg IPZ-2 Transport Pathways

In the *transport pathways* analysis, the drainage areas of three small pump systems were included in their entirety where the residual time of travel was expected to be sufficient to drain the entire area. In each case, the drainage area was less than 100 hectares and included no more than five agricultural parcels. These systems were: the Wiser Drain and Pumping Works, the Rabideau Pumping Works and a private pumping system that was formerly part of the Rabideau Pumping Works. As well, the one-parcel setback was applied to properties along the Skinner Outlet Drain, the Townline Drain, and the Sydenham River between Base Line and Baldoon Rd. Five additional properties were included in the *IPZ-2* where drainage via *transport pathways* was expected to contribute water to the intake within the two-hour time of travel. Four of these properties were located along Beattie St. immediately northeast of the outlet of the Townline Drain, and one on Base Line, adjacent to the Wallaceburg water treatment plant.

4.2.4.9. Wallaceburg IPZ-2 Storm Sewersheds

Storm sewersheds of four *storm sewer systems* were determined to contribute to the source water within the two-hour time of travel. Two of these *storm sewer systems* operating under gravity alone were included in the *IPZ-2* delineation. Each was determined to have sufficient residual time of travel remaining to include the entire catchment area (*storm sewershed*). These two systems were: the VLA storm system (draining to McDonald Tap Drain in the Sutherland Pumping Works), and the Base Line storm system located at the west side of Sydenham River (draining to Sydenham River at Base Line). A third system, the McDonald Tap Drain stormwater pumping system, discharges stormwater collected from the western end of the community of Wallaceburg into the McDonald Tap Drain. This catchment area (*storm sewershed*) for this system was included in its entirety. The fourth *storm sewer system* within the two-hour time of travel to the intake is the Base Line stormwater pumping system. Time of travel calculations allowed for 579 m of sewer network to be included upstream of the pump station along Base Line, and 274 m of sewer network to be included along Gillard St. upstream of the connection with Base Line. Parcels adjacent to these pipe extents within the *storm sewershed* boundary were included in the *IPZ-2* delineation as *storm sewersheds*.

As mentioned under the discussion on *IPZ-1* delineation, St. Anne Island within the Walpole Island First Nation and adjacent to the Chenal Ecarte does not fall within the jurisdiction of this assessment at this time. The 120 m setback applied to the Chenal Ecarte has been noted on Map 4-4 in Appendix 1. Information regarding the flow of water from St. Anne Island into the Chenal Ecarte has been collected; however additional information would be required to denote specific areas which could provide water to the intake within the two-hour time of travel.

The Wallaceburg *IPZ-1* and *IPZ-2* is illustrated on Map 4-4 in Appendix 1. The upland Wallaceburg *IPZ-1* and *IPZ-2* is comprised of rural, industrial, and residential land, most of which lies between the Chenal Ecarte, the Sydenham River, and Running Creek. On-land setbacks of 120 m were applied to the south and west, and to dyking and other relative high points to the north and east. The Wallaceburg in-water *IPZ-2* extends 3.2 km upstream from the intake in the Chenal Ecarte, and 4.9 km downstream from the intake in the Chenal Ecarte and Sydenham River. Agricultural areas extending southeast to Swan Line, north to Dufferin Ave., and east to the community of Wallaceburg were included in the *IPZ-2*, in addition to two urban areas along Base Line and west of Forhan St.

4.2.4.10. Kettle and Stony Point IPZ-2 Transport Pathways

The Kettle and Stony Point intake transport pathways located in the IPZ-2 are Duffus Creek and three (un-named) local drains, referred to as TP1, TP2 and TP3. The transport pathways empty into Lake Huron.

4.2.4.11. Kettle and Stony Point IPZ-2 Storm Sewersheds

There are no known storm sewer system outfalls or tile drain outlets within the IPZ-2 area of the Kettle and Stony Point Intake System.

4.2.5. IPZ-3 Delineation Methodology

A third zone around intakes has been developed. This zone is referred to as an *Intake Protection Zone-3* (*IPZ-3*). For Great Lakes and connecting channel intakes (Type A and B), the *IPZ-3* includes areas which can contribute contaminants under an *extreme event* at a

concentration which would result in a deterioration of the source water for the purpose of human consumption.

As per Rule 68 an *IPZ-3* may be delineated if modelling demonstrates that a release of a chemical parameter or pathogen from an activity or a proposed activity during an *extreme event* would be transported to the intake and result in the deterioration of the water for use as a source of drinking water. In general, an *IPZ-3* is to be delineated if modelling demonstrates that contaminants released during an *extreme event* may be transported to an intake. The Technical Rules 2013 define an *extreme event* as a period of heavy precipitation or up to a 100 year storm (wind), or a freshet. General approaches to the modelling were provided in the MECP's Technical Bulletin: Delineation of *Intake Protection Zone-3* Using Event Based Approach (EBA) dated July 2009. The hydrodynamic modelling report from Baird & Associates, (May 2011) was used to address *IPZ-3* delineation for all intakes.

In order to delineate the extent of the *IPZ-3* it is necessary to establish the concentration of contaminant which would result in a deterioration of the water for use as a source of drinking water. The Ontario Drinking Water Quality Standards were selected as the benchmark to be applied to the IPZ-3 delineation. This is consistent with the benchmarks used for identifying an *Issue*.

In delineating the *IPZ-3* event based modelling is used. The area between the modelled spill location and the intake where the spill would result in an exceedance of the benchmark is also referred to as an *Event Based Area* (*EBA*). An *EBA* may include the part or all of the *IPZ-1*, 2 or 3. Within the *EBA* an activity which could result in a spill of the type modelled is identified as a *significant drinking water threat*. The Source Protection Plan will include policy to ensure that these threats cease to be or never become significant. These policies will apply to an EBA.

A Model was developed by Baird and Associates through the *IPZ-2* work which was used for the delineation of *IPZ-3*. This model was used to explore the possible extent of boundaries to an *IPZ-3* through reverse particle tracking. The model was then used to determine concentrations of a contaminant which would arrive at an intake following a possible spill similar to the scenarios which were modelled. The model was used to simulate the contaminant travel within

the great lakes and connecting channel while an analytic approach described in MECP's Technical Bulletin was used to consider the dispersion and dilution within the tributaries flowing towards the intakes.

A more recent study (2013) was carried out following recommendation from Baird (2011) to investigate areas outside of the approved IPZ-3 that were likely to result in exceedances following a possible spill. The IPZ-3 boundaries has been revised based on this study.

4.2.5.1. LAWSS and Petrolia Intakes

The modelling completed for the intakes followed the general approach outlined in the MECP Technical Bulletin (July 2009) and incorporated both reverse particle tracking and contaminant transport modelling. Wind on Lake Huron is the main force driving contaminants to Petrolia and *LAWSS* intakes. Tributaries transport contaminants from the watershed and upstream to the lake, where they may then be transported by wind driven currents to the intakes. Because the intake is located at the upstream end of the St. Clair River, flow in the St. Clair River is not as important a consideration for event selection.

The model was run in reverse to determine the possible extent of the area where particles (representing contaminants) end up when travelling in reverse from intakes. This approach is referred to in the MECP Bulletin as the boundary approach. Within this area, spill locations were chosen that were representative of potential spill locations. The model was used to determine contaminant concentrations arriving at the intake under the *extreme events* modelled. The model was used for two runs of differing 100-year return periods determined using a joint probability analysis. The parameters considered in the joint probability analysis included the duration of wind, flow in St. Clair River, and flow in tributaries. Spill locations were selected to simulate a spill of a contaminant from a tanker truck, ferry, ship and pipeline at locations where it is likely that a spill of this size could occur. This would be similar to a spill of a similar size from fixed storage locations, although none were inventoried as part of this work, Perch and Cow creeks were selected for the simulated tanker truck spill and Lake Huron was selected for the ship spill contaminant modelling. Gasoline (with 2% benzene) was chosen to be the contaminant. For each tributary, a road crossing near the mouth and a road crossing near the headwaters was identified for a spill release. The spill locations were also considered

representative of potential fixed fuel locations in the area. Spill locations considered for the LAWSS and Petrolia intakes are shown in Map 4.2b and Map 4.3b respectively. Refer to Appendix A-10 for the circumstance of modelled spills. If it was found that the contaminant reached the intake at a concentration above the benchmark (Ontario Drinking Water Quality Standard of 0.005mg/L for benzene), an *IPZ-3* would be delineated. In the instances where it was justified to delineate an *IPZ-3*, Baird and Associates recommended extending the delineation to the headwaters and watershed limits of the watercourses, and to include all smaller tributaries between said watercourses and the applicable intake as spills in these locations are expected to result in similar concentrations (above the Ontario Drinking Water Quality Standard) arriving at the intake. Additional fuel spill locations were added in a recent study (2013) to explore the possibility of contaminants reaching the intake at concentrations greater than the drinking water standard. A revised IPZ-3 has been delineated as shown in Map 4.3b to reflect the results from the study. As specified in the Technical Rules 2013, the Floodplain Regulation Limit was also used in delineating the extent of the *IPZ-3* along subject waterways, where this limit exceeded the 120 metre setback.

4.2.5.2. **Wallaceburg Intake**

The modelling completed for the Wallaceburg intake followed the general approach outlined in the MECP Technical Bulletin (July 2009), and incorporated both reverse particle tracking and contaminant transport modelling. For the Wallaceburg Intake – flow in the St. Clair River and in the Sydenham River are the main driving forces for transporting contaminants to the intake. High flows in the Sydenham River can result in flow reversals in the Chenal Ecarte, where the Wallaceburg intake is located. The flow in the Sydenham also has a considerable affect on the velocity of flow past the intake even when water is flowing past the intake towards the Sydenham River.

A joint probability analysis was performed to define the combinations of wind, lake level (or flow in connecting channels) and tributary flow with a given return period, to produce 100 year return period events. Two events were selected for modelling, with one event incorporating the reverse flow in Chenal Ecarte where water from the Sydenham flows up the Chenal Ecarte past the intake. The other event modelled used the mean from the Sydenham River and a high flow on the St Clair River. This combination of flows resulted in slower velocities past the intake than

would be experienced in summer low flow periods. The effect of lower flows from the Sydenham River was also modelled to see the impact on travel times to the intake. Although travel times of spills were slower than previous studies had suggested, the modelling indicated that, under the event conditions modelled, the concentrations exceeded the benchmark used.

There were four spill locations modelled with the above listed events. Spill locations considered for the Wallaceburg intake is shown in Map 4.4b and Map 4.4c. Refer to Appendix A -10 for the circumstance of modeled spills. Two of the spills were fertilizer spills at the Tupperville Bridge on East Sydenham River and the ferry crossing of the St. Clair River at Sombra. A pipeline spill on the St. Clair River (south of Sarnia) and a tanker truck spill on North Sydenham River were also modelled. For those spills which the contaminant was shown, through modelling to reach the intake at a concentration above the benchmark (Ontario Drinking Water Quality Standard of 0.005mg/L for benzene), an *IPZ-3* was delineated. In instances where an *IPZ-3* was delineated,

Baird and Associates recommended extending the delineation to the headwaters and watershed limits of the modelled watercourses and to include all smaller tributaries located between said watercourses and the intakes as spills in these locations are likely to result in similar concentrations (above the Ontario Drinking Water Quality Standard) arriving at the intake. Further to the modelling work that was carried by Baird in 2011, three additional spill scenarios were considered in a recent study (2013). One along Talfourd Creek; Baby Creek; and Clay Creek respectively. Scenarios at Highway 40 crossing of Talfourd Creek and Clay Creek were fuel spills (68,000 L gasoline, 2% benzene), however, the spill on Baby creek is a rail tank spill from a rail crossing on Baby Creek (34,000 L, 2% benzene).

As specified in the Technical Rules 2013, the Floodplain Regulation Limit was also used in delineating the extent of the *IPZ-3* along subject waterways, where this limit exceeds the 120 metre setback.

4.2.5.3. LAWSS IPZ-3 Delineation

The *LAWSS* modelling work was completed by assessing two scenarios. The first scenario used in delineation involved simulating a fuel taker truck spill (gasoline 2% benzene) at a road crossing (Highway 402) on Cow Creek(1) and Perch Creek(2), the spill locations are shown in

Map 4.2b. Based on model results, the fuel tanker spill would result in an exceedance of the Ontario Drinking Water Standard benchmark for benzene. The second scenario involved simulating a fuel spill (3) from a ship on Lake Huron. This modelling simulation also resulted in an exceedance of the Ontario Drinking Water Quality Standard benchmark at the LAWSS intake.

The resultant *IPZ-3* delineation was based upon a combination of both phases of work. The *IPZ-3* was truncated at Highway 402 as no spills were modelled to the south of the highway. Further, an *EBA* was created within which an activity is or would be a *significant drinking water threat* based on results from event modelling. Refer to Map 4.2b for *EBA*. The *EBAs* on Map 4.2b corresponds to the fuel spills that pose a significant threat to the drinking water source.

4.2.5.4. Petrolia IPZ-3 Delineation

As per Rule 68 an *IPZ-3* may be delineated if modelling demonstrates that a release of a chemical parameter or pathogen from an activity or a proposed activity during an *extreme event* would be transported to the intake and result in the deterioration of the water for use as a source of drinking water. The Thames Sydenham Region SPC has accepted the Ontario Drinking Water Quality Standard to identify deterioration of raw water quality at the intake.

The initial delineation was based upon two fuel spills from a tanker truck at a road crossing (Highway 402) on each of Cow Creek(1) and Perch Creek(2) as shown in Map 4.3b. These were determined through modelling to result in exceedances of the Ontario Drinking Water Quality Standard for benzene, at the Petrolia intake. As a result the *IPZ-3* extends upstream along the Perch and Cow Creeks to include drainage from Highway 402. As specified in the Technical Rules 2013, the Floodplain Regulation Limit was also used in delineating the extent of the *IPZ-3* along subject waterways, where this Limit exceeds the 120 metre setback.

The *IPZ-3* delineation to the west of the intake was truncated at the narrow section of the regulation limit as overland flow beyond this location would flow away from this watercourse and therefore away from the Petrolia intake. Baird recommended extending the *IPZ-3* delineation to the east to include the drain on Lakeshore Road and all watercourses located between Lakeshore Road and Highway 402 that drain into Lake Huron. This recommendation was

based on the expectation that similar concentrations would arrive at the intake from spills on Lakeshore Road and Boonie Doon Creek.

To further investigate Baird's recommendation, a recent study (2013) was conducted using analytical approach. Four additional spill locations to the east of the intake were considered as shown by spill locations 11, 12, 13 and 14 in Map 4.3b. A dilution factor approach was used to calculate the concentration of contaminant from the mouth of tributary to the Petrolia intake. This dilution factor was obtained from the previous IPZ-3 delineation work completed by Baird in 2011 for spills along Perch and Cow Creeks. The use of a dilution factor to calculate concentrations at the intake is an estimate. Utilizing this approach maintained consistency in the current work as this factor was calculated from the previous IPZ-3 modelling.

Further, an *EBA* was delineated where an activity is or would be a *significant drinking water threat* based on results from event modelling. Refer to Map 4.3b for EBA. The *EBAs* on Map 4.3b corresponds to the fuel spills that are a significant threat to the drinking water source..

4.2.5.5. Wallaceburg IPZ-3 Delineation

The initial modelling work at Wallaceburg was completed in two phases. The first phase involved simulating a pipeline spill (gasoline with 2% benzene) upstream of the St. Clair River and a fertilizer spill at the Sombra ferry crossing on the St.Clair River, as shown by spill locations (4) and (5) in Map 4.4b. Based on model results, the pipeline spill would result in an exceedance of the Ontario Drinking Water Quality Standard benchmark for benzene at the Wallaceburg intake. It was recommended to extend the delineation approximately 7 km north of Corunna as a spill within this area is expected to result in similar concentrations (above the Ontario Drinking Water Quality Standard) arriving at the intake.

Model results showed that a fertilizer spill of 34,000 Kg (46% Nitrogen) at Sombra ferry crossing resulted in exceedance of the Ontario Drinking Water Quality Standard benchmark of 1mg/l of Nitrite (as nitrogen) at the Wallaceburg intake. The Tables of drinking water threats refer to Nitrogen (potentially interpreted as either Nitrate or Nitrite) as a potential threat, however, based on discussion with MECP, the Ontario Drinking Water Standard for Nitrate was considered and

not Nitrite. Also, the Director's letter (included in Appendix 13) identifies Nitrate as the parameter of concern for the transportation of fertilizer as a drinking water threat. This lead to calculating the appropriate fertilizer spill that would result in exceedance of Nitrate at the intake. An extrapolated spill of 124,000 Kg (3.64 times that of Nitrate) of 46% Nitrogen was calculated to result in an exceedance of ODWQS of Nitrate (10 mg/L) at the Wallaceburg intake. It should be noted that a spill of a different fertilizer (other than 46%) with similar nitrogen content would also be considered as a significant threat to the Wallaceburg Intake, however the mass of the fertilizer which would be considered a significant drinking water threat would be dependent on the Nitrogen content.

Given the complex cycle of Nitrogen, the concentrations provided in the consultant report have also been compared to the ODWSs for Nitrite (NO2), 1mg/l, and it was found that 34,000 kg could possibly result in an exceedance for Nitrite however, based on the above noted discussions with MECP this amount of fertilizer is not considered a significant drinking water threat.

The second phase involved simulating a fertilizer spill at the Tupperville bridge crossing on the East Sydenham as shown by spill location (6) in Map 4.4.b, and longitudinal dispersion analysis along the North Sydenham River as represented by spill location (7) in Map 4.4b. Based on the Ontario Drinking Water Quality Standard benchmark of 1mg/l for Nitrite (as nitrogen) at the Wallaceburg intake. As such a spill quantity for Nitrate has not been calculated. However, an assessment of fuel (2% Benzene) at the Tupperville bridge did result in an exceedance of the Ontario Drinking Water Quality Standard. For the Spill on the North Sydenham River Baird recommended extending the *IPZ-3* delineation 6.5 km on the north Sydenham River based on the longitudinal dispersion analysis. This analysis identified that on these Sydenham River branches the 2 year return flows resulted in higher concentration of contaminant being transported to the intake than with the less frequent events (larger flows) used for simulation in other locations.

In addition to the above spill scenarios, a more recent study (2013) considered three additional fuel spill (2% Benzene) scenarios, one along Talfourd Creek, Baby Creek and Clay Creek respectively. The spill locations are identified by 8, 9 and 10 in Map 4.4b. Based on the

longitudinal dispersion analysis, the above fuel spills would result in an exceedance of the Ontario Drinking Water Quality Standard benchmark for benzene at the Wallaceburg intake.

The resultant *IPZ-3* delineation was based upon a combination of both the studies (2011 and 2013). Map 4.4b and Map 4.4c shows the IPZ-3 delineation and the sub-areas where the activities are a significant threat. A setback of 120 m from the high water mark (or top of bank) was applied to all watercourses. As specified in the Technical Rules 2013, the Floodplain Regulation Limit was also used in delineating the extent of the *IPZ-3* along subject waterways, where this limit exceeds the 120 metre setback. The regulation limit extends further south from the modeled locations and is attributed to the flat topography of Wallaceburg, these areas have been included in the *IPZ-3* delineation as per the Technical rules 2013. The setback and regulated areas were truncated at subwatersheds as overland flow would be traveling away from the watercourse.

Further, an *EBA* was delineated where an activity is or would be a *significant drinking water threat* based on results from event modelling. Refer to Map 4.4b and 4.4c for *EBA* , the sub-areas correspond to the fuel and fertilizer activities that are a significant threat within the IPZ-3.

The hydrodynamics in the Wallaceburg area are extremely complex. There are a large number of tributaries flowing into the Chenal Ecarte, including the Sydenham River. *IPZ-3* delineation has been limited to the number of scenarios undertaken. Additional scenarios should be considered in the future to extend the *IPZ-3* delineation up the tributaries. Possible *IPZ-3* extension could include several other significant tributaries in the region: Running Creek (a distributary which connects the Chenal Ecarte to the North Sydenham River and can flow in either direction depending on conditions and drain pump operations); Otter Creek; and drains or ditches that feed into Chenal Ecarte and the North and East branches of the Sydenham River. Scenarios modelled do not include these watercourses and therefore they are not included as a part of *IPZ-3* delineation. It is important to recognize that modelling is a tool that has been used in this study to improve our understanding of the vulnerability of the intakes to specific activities and more scenarios modelled in the future will improve our understanding.

4.2.6. Vulnerability Assessment of Intake Protection Zones

Within the *Intake Protection Zones*, the *vulnerability* must be assessed based on a number of factors. These factors include the *vulnerability* of the source and the area in the *Intake Protection Zone*:

Area Vulnerability factor: According to the *Technical Rules* 2013, *IPZ-1* is assigned an area *vulnerability* factor of 10, while the factor for *IPZ-2* is between 7 and 9. A higher number corresponds to a higher *vulnerability*. The area *vulnerability* factor for *IPZ-2* is dependent on the percentage of area that is land in the *IPZ-2*, land cover, soil type and permeability of the land, slope of any setbacks, and the hydrological and hydrogeological conditions in the area that contribute water to the area through *transport pathways*. The above mentioned evaluation factors have been given equal weight based on professional judgment.

Area *vulnerability* factor for the *LAWSS IPZ-2*

Percentage of the Area of the IPZ-2 that is Composed of Land: Approximately 3% of the *LAWSS IPZ-2* is located on land minimizing any impacts for land use activities; therefore the vulnerability can be considered low for this factor. Land Cover, Soil Type, Permeability of the Land, Slope of the Land: The land cover is predominately residential along the shores of Lake Huron. The land is generally flat with sand dunes and/or trees in the land portions of the *IPZ-2*. Overall, due to these considerations, the vulnerability can be considered low. Hydrological, Hydrogeological, and Transport Pathways: Predominately, Lake Huron flows to the mouth of the St. Clair River near the intake which produces high current and velocity value. There was found to be one storm sewer shed within *IPZ-2* east of the *LAWSS* intake on Lake Huron that is counted as a *transport pathway*. This slightly increases the value of the factor. Based on these factors, the area *vulnerability* factor for the *LAWSS IPZ-2* is selected to be 8 (from a range of 7 to 9).

Area *vulnerability* factor for the Petrolia *IPZ-2*

Percentage of the Area of the IPZ-2 that is Composed of Land: Approximately 40% of the Petrolia *IPZ-2* is located on the land. The land component may increase the potential for contaminants from land to adversely affect the intake thereby increasing the vulnerability of the intake. Land Cover, Soil Type, Permeability of the Land, Slope of the Land: The land cover that

is located in the *IPZ-2* is predominately agricultural that would result in higher run-off during rain events. The area located in *IPZ-2* is predominately tiled drained therefore any potential runoff would migrate to the tributaries and/or the intake quickly in a rain event. There land is generally flat in the *IPZ-2* which would slow the overland flow. Overall, due to these considerations, the vulnerability of this intake was increased. Hydrological, hydrogeological, and Transport Pathways: The identified *transport pathways* include Cow Creek, Perch Creek, and local drainage ditches that drain either o the creeks or into Lake Huron. The presence of local tributaries and drainage ditches also contributes to the higher score. Considering these factors, an area *vulnerability score* of 9 (from a range of 7 to 9) was assigned to the Petrolia *IPZ-2*.

Area *vulnerability* factor for the Wallaceburg *IPZ-2*

Percentage of the Area of the IPZ-2 that is Composed of Land: A greater percentage of land area within an *IPZ-2* may increase the potential for the area to contain more land use activities. Collectively or independently, land use activities may contribute contaminants to the source water. Therefore, a greater percentage of land area within the vulnerable area supports a higher area vulnerability factor. It was determined that the Wallaceburg *IPZ-2* is comprised of 95% land and 5% of water. The percent of *IPZ-2* that is land supports a high area vulnerability factor. Land Cover, Soil Type, Permeability of the Land, Slope of the Land: The upland area of the Wallaceburg *IPZ-2* is characterized by flat topography exhibiting almost no relief. The upland *IPZ-2* is composed of 95% land (1,068 ha) of which 14% (152 ha) is impervious land cover. The pervious portions of the land are comprised of sandy loam and silty clay loam. These poorly drained soils contribute to increased runoff; however, the low relief of the land lowers the potential for runoff in the area. The land cover, soil type, and permeability analysis support a low area vulnerability factor. Hydrological, hydrogeological, and Transport Pathways: *Anthropogenic* transport pathways such as storm sewers, municipal drains, tile drained areas, and natural transport pathways such as waterways may potentially transport contaminants to the source water. Therefore, a greater number of transport pathways support a higher area vulnerability factor. Few municipal drains and storm sewer networks are located in the vulnerable area, although six municipal drains and four *storm sewer systems* discharge within the in-water extent of the *IPZ-2*. The area is comprised of an extensive system of transport pathways. The complexities of the transport pathways support a higher vulnerability factor.

Based on these factors, the area *vulnerability* factor for the Wallaceburg *IPZ-2* is selected to be 8 (from a range of 7 to 9).

Area vulnerability factor for the Kettle and Stony Point IPZ-2

Percentage of *IPZ-2* that is composed of land: Less that 33% of the Kettle and Stony Point First Nations Intake IPZ-2 is located on land, minimizing the impact of land use activities. Therefore the vulnerability can be considered low for this factor resulting in a sub factor score of 7.

Land Cover, Soil Type, Permeability of the Land, Slope of the Land: The land cover is a mix of vegetated and developed that will allow for higher run-off during rain events. The land is predominantly flat in the *IPZ-2* which would slow the overland flow. The soil type is mostly silt and clay. The permeability of the silt and clay soil is between 33-66%. The slope of the land is less than 2%. Overall, due to these considerations, the vulnerability is considered moderate, resulting in a sub factor of 8.

Hydrological, hydrogeological, and Transport Pathways: Rather than using the decision matrix to determine the transport pathway sub factor, site specific knowledge was used. Area vulnerability factor for the Kettle and Stony Point First Nations Intake IPZ-2 was calculated with the use of a decision matrix. The are no storm sewers or tile drains within *IPZ-2* which would suggest a low transport vulnerability sub-factor. However, MECP investigations (MECP, 2005) suggest that Duffus Creek can generate elevated bacteria loadings to the nearshore area, and therefore is a transport pathway with known potential to increase the vulnerability of the zone. A value for the Transport Pathway sub-factor of 8.0 is therefore considered appropriate for use in the calculations.

Source Vulnerability factor: According to the *Technical Rules 2013*, for a Great Lakes intake, such as the Petrolia intake or the Kettle and Stony Point Intake, the source *vulnerability* factor is between 0.5 and 0.7. For a connecting channel intake, such as the *LAWSS* and Wallaceburg intakes, the source *vulnerability* factor is between 0.7 and 0.9. A higher number corresponds to a higher *vulnerability*. According to the *Technical Rules 2013*, this factor is dependent on depth of the intake, distance of the intake from shore, and the number of recorded *issues* related to the intake. In addition to the factors required to be considered by the *rules*, the Ministry of

Environment, Conservation and Parks (*MECP*) guideline for minimum submergence of an intake and the Michigan *vulnerability* categories for Great Lakes intakes (based on distance and depth) were considered in assessing the source *vulnerability* factor.

Table 4-2 summarizes the intake characteristics including depth and length of each municipal intake in the *SCRSPA*. The plant operators noted concerns of shipping activities as well as spills affecting the water quality at the *LAWSS* intake. The source *vulnerability* factor assigned to the *LAWSS* intake, considering the deepness and length of the intake as well as water quality concerns, is 0.8 (from a range of 0.7 to 0.9). At the Petrolia intake, a shallower depth and shorter length of the intake as well as plant operators concerns of sewer line break near the intake, and elevated turbidity in raw water contribute to a source *vulnerability* factor of 0.7 (from a range of 0.5 to 0.7). The Wallaceburg intake is shallow and short, and is susceptible to riverbank influences, surface contamination and water column mixing. The intake lies in the St. Clair River Area of Concern (*AOC*). Concerns noted by the plant operator include elevated nitrate and turbidity levels during precipitation events. Considering all of these factors, a source *vulnerability* factor of 0.9 (from a range of 0.7 to 0.9) was assigned to the Wallaceburg intake. The source vulnerability factor assigned to the Kettle and Stony Point intake, considering the intake depth, offshore length and water quality, is 0.5 (from a range of 0.5 to 0.7).

The Source Vulnerability factor is then multiplied by the Area Vulnerability factor to determine the *Vulnerability Score* of the zone. The *vulnerability* factors and scores of the *Intake Protection Zones* of the St. Clair Region Source Protection Authority are summarized in Table 4-3.

Table 4-3 Summary of Vulnerability Score of Intakes

Intake	Area Vulnerability Factor		Source Vulnerability Factor	Vulnerability Score	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
LAWSS	10	8	0.8	8.0	6.4
Town of Petrolia	10	9	0.7	7.0	6.3
Wallaceburg	10	8	0.9	9.0	7.2
Kettle and Stony Point	10	8	0.5	5	4

Due to the nature of the *Technical Rules 2013* in assigning source vulnerability factors to Great Lakes intakes, the *vulnerability scores* would be below 8 in all cases. This influences the level of *threat* that could occur in a *vulnerable area* around a Great Lakes intake, as discussed in Section 7 - Threats and Risk Assessment Section of this Assessment Report. For an *activity* to be considered a *threat* it must occur in an area with a *vulnerability score* greater than 4. A *significant threat* may be identified in an area with *vulnerability scores* of 8 or more. In the *IPZ* of the Town of Petrolia intake (on Lake Huron), *activities* are not classified as *significant threats* because for a Great Lakes intake, the *vulnerability scores* that can be assigned are less than 8. However, for a connecting channel intake, according to the *Technical Rules 2013*, *vulnerability scores* of 8 are possible. As seen from Table 4-3 above, *significant threats* may be identified in the *IPZ-1* of the *LAWSS* and Wallaceburg intakes.

4.2.7. Uncertainty in Intake Protection Zone delineation

The *Technical Rules* 2013 require that the degree of *uncertainty* in the *vulnerability* assessment of surface water *Intake Protection Zones* be assessed. The *uncertainty* can only be characterized as 'high' or 'low'. Baird and Associates Ltd. undertook the hydrodynamic modelling to delineate the in-water portion of the *IPZ-2* for the *LAWSS*, Petrolia and Wallaceburg intakes, using best available data. Similarly, using the best available data, HCCL and Riggs Engineering Ltd. undertook the hydrodynamic modelling for the Kettle and Stony Point intake. The *uncertainty* analysis is described in detail in Appendix 13 of this Assessment Report. Due to such things as data gaps and model limitations, there is *uncertainty* with the delineation of the *vulnerable areas*. In areas of lower *vulnerability*, this *uncertainty* would not affect assessment of *risk* or the types of policies which would be developed in the *Source Protection Plan*. However, in areas of higher *vulnerability* which require *threats* assessments and policy development, the *Source Protection Committee* is satisfied that the *uncertainty* for all four intakes in the *SPA* is low enough for the purposes intended.

Similarly for *IPZ-3* hydrodynamic modeling was used to model contaminant concentrations at the intake resulting from a spill at select locations during an *extreme event*. Appendix 13 details the factors used in assigning an uncertainty level to this work. Although the consultant indicates that the uncertainty level is high, the modelling demonstrates that these spills can result in a deterioration of the drinking water source. Additional work is required to assess the likelihood of

lesser spill quantities and other locations also resulting in a deterioration of the drinking water source. Further calibration and validation of the model is required to be able to rely upon the model results as they pertain to the timing of the arrival and passing of the spill at the intake.

4.3 Wellhead Protection Areas

Wellhead Protection Areas or *WHPAs*, as they are often referred to, are the *vulnerable areas* which are delineated around groundwater sources of *drinking water*. Wells are used to extract the water from *aquifers* in the ground where water is contained in spaces, voids or fractures in the soil or rocks. Often many wells are used in an area to extract sufficient water to supply the needs of the customers. Multiple wells in an area are often referred to as a well field.

In the St. Clair Region Source Protection Area, there are no municipal wellheads, and therefore no *WHPAs* have been delineated. In the two other Source Protection Areas of the Thames-Sydenham and Region, *WHPAs* were delineated using computer based three-dimensional groundwater flow models.

The work related to *Wellhead Protection Areas* in the Thames-Sydenham and Region may be viewed in the Assessment Reports of the Lower Thames Valley Source Protection Area and the Upper Thames River Source Protection Area.

4.4 Highly Vulnerable Aquifers

The *vulnerability* of an *aquifer* must be assessed using one of the four methods described in Rule 37 of the *Technical Rules 2013: Assessment Report*:

- *Intrinsic susceptibility index* (*ISI*).
- Aquifer vulnerability index (*AVI*).
- Surface to aquifer advection time (*SAAT*).
- *Surface to well advection time* (*SWAT*).

Rule 15.1 also allows the use of a method which is equivalent or better than these methods provided the reason for the use of this method is documented in the Assessment Report and the Director has provided approval for the use of the alternative method.

These methodologies can be applied, on a much larger scale, to the assessment of the *vulnerability* (or intrinsic susceptibility as it is also referred to) of the first significant *aquifer* across the entire Source Protection Region. Areas which are identified through these methods as being highly vulnerable, and the *aquifers* beneath them, are to be identified as *Highly Vulnerable Aquifers* according to Rule 43 of the *Technical Rules 2013: Assessment Report*.

In the Thames-Sydenham and Region, *Highly Vulnerable Aquifers* (*HVA*) were mapped using the *Intrinsic Susceptibility Index* (*ISI*). The *ISI* method uses an index of depth and permeability of the materials which offer protection to the *aquifers*. The permeability of the material overlying the *aquifer* supplying the well is assessed at each location with a well record. The Ministry of the Environment, Conservation and Parks (*MECP*) Water Well Information System (*WWIS*) contains borehole information collected at the time of the well construction. The province undertook a project to characterize the materials identified in this database so that a 'k' value can be assigned to each material identified in the well log. The 'k' value is then multiplied by the thickness of the material in metres and summed over the depth to the *aquifer* of interest. It results in a score which is then categorized as high, medium or low as identified in Rule 38 (1). A high *vulnerability* is assessed where the sum of the thickness times the k value is less than 30. A medium *vulnerability* is assessed in areas where the sum of the products of thickness and k is less than 80 and greater than or equal to 30. Higher scores are considered low *vulnerability*.

ISI was available across the entire region from the county groundwater studies. In some areas the other *vulnerability* assessment methodologies (*AVI*, *SWAT* or *SAAT*) have been calculated and mapped, however they have not been applied across the entire region. A seamless product across the region is needed. It is acknowledged that there will likely be challenges in matching the *vulnerability* assessment map discussed here, with the mapping products developed by neighbouring source protection regions. This will need to be considered in subsequent Assessment Reports after all of the neighbouring regions' products have been developed. This will present a challenge for municipalities which are within more than one Source Protection Region. These differences will also need to be considered in the development of the *Source Protection Plan* in those areas. In determining which *vulnerability* assessment method to apply in the region it was also important to consider the data which is available to support the

methodology. As the data necessary to apply these other methods is not available in many of the areas, it was not possible to apply the other methods across the entire region without undertaking considerably more work. As such, *ISI* was used to assess the *vulnerability* in the Thames-Sydenham and Region.

Although the county groundwater studies followed a consistent terms of reference and methodology and were reviewed through an *MECP* developed peer review process, there were significant challenges when *edge-matching* the work between adjacent studies. Many of the products developed through the groundwater studies (such as water table elevation and overburden thickness) were *edge-matched* in the Southwest Region Edge-Matching Study Results (Waterloo Hydrologic Inc., 2005). *ISI*, however, was not able to be seamlessly matched throughout the region. Instead, a product was developed which identified the areas of overlap between study areas where the *ISI* was one or two levels different (Map 17 of Appendix 5). In order to use this product to describe the intrinsic *vulnerability* in the region, it needed to be updated to ensure seamless mapping across the entire region. Further, it is important that consistent methodologies be applied to all areas within the region. The work described in this section is described in detail in the *Highly Vulnerable Aquifer* Identification (Upper Thames River Conservation Authority, November 2009) report.

The *ISI* scores from the wells across the region were obtained from the data of the county groundwater studies. This data covered most of the region, however it was identified that in the western end of Elgin County there were very few points where the *ISI* had been calculated. Updated Water Well Information System (*WWIS*) data was reviewed in the hopes that it contained additional information in this area which was not used during the county groundwater studies. The updated *WWIS* had been corrected to reduce the locational *uncertainty* of many of the data points. This newer data resulted in very few additional points in the western end of Elgin County. Therefore it was necessary to reconsider the location screening which was applied to the data. In the previous study, lot centroid values were removed from the interpolation due to the level of *uncertainty* in the location of the well. Due to the lack of data in this area, it was determined that it was better to use the lot centroid information than have the entire area interpolated based on data from outside this area, as was done in the previous study. As a result, the wells with a modest level of locational *uncertainty* were included in the

analysis. Dillon was contracted to undertake the *ISI* calculations for the wells in this area so that they could be included in the regional interpolation of the *ISI* scores. These points, when supplemented with the surficial geology discussed below, result in significant improvements in the assessment of the *vulnerability* in this area from that which was available from the county groundwater studies.

The *ISI* calculations consider the *vulnerability* only at points where information on the depth and type of materials overlaying the water table is available. The information source for this geologic interpretation was the Water Well Information System (*WWIS*). This database includes a characterization of the materials encountered in the drilling of water wells. Materials are described by the drillers and then entered into this information system along with other details associated with the well, such as the static level of the water in the completed well. As discussed earlier, the *ISI* score had previously been calculated at each well. This data, augmented with the newly calculated *ISI* in the parts of western Elgin County, was used as the basis for the initial *vulnerability* map. Geographic Information System (*GIS*) tools are often used to interpolate values between the discrete points where the value is known. These tools determine the best fit of a surface through the thousands of values across a region. Various computer algorithms are available in the *GIS* programs to undertake this interpolation or smoothing. The county groundwater studies used different tools to undertake this smoothing of the *ISI*. For a seamless product across the entire Source Protection Region it was necessary to use the same algorithms across the entire region. The 'Natural Neighbour' method was used by many of the studies to provide an interpolation of data between neighbouring water well locations. In some of the studies, the results were similar to the 'Kriging' method. Natural Neighbour is, however, simpler to apply with fewer options as to how to apply the method. This is an advantage as this method will be better able to be reproduced and updated in the future. Natural Neighbour was therefore used for the seamless update of the *ISI* across the region.

Another difference between the studies was in which values of intrinsic *vulnerability* were interpolated. In some studies the *ISI* scores were interpolated, whereas other studies interpolated an index which represented whether the score was high, medium or low. As discussed above, an *ISI* score of less than 30 results in a high *vulnerability*. These were assigned an index value of 1, whereas medium vulnerabilities were assigned an *ISI* of 2 and

lows were assigned an *ISI* of 3. In many of the county groundwater studies, these 1, 2 and 3 values were interpolated across the study areas. This resulted in a continuously variable surface with values ranging from less than 1 to greater than 3. It was therefore necessary to determine the breakpoints between high, medium and low within this continuous surface to determine where the lines should be between the high, medium or low area. In investigating this, the study team found that this was not well documented and that it was apparent that various breakpoints were used for the separation of high, medium and low areas. For the purposes of this update, the scores were interpolated rather than the index values, allowing the breakpoints specified in the *rules* to be used in the delineation between high, medium and low *vulnerability*.

As discussed above, an *ISI* score is only calculated at points where the WWIS contained information. Even with the extensive number of wells which were used, there are areas where there are no wells to define the *vulnerability*. A simple illustration of this is to consider where wells are generally located. They will normally be located in an area where there are homes or other buildings. The buildings tend to be located close to the roads. As a result, areas between the roads tend not to have many wells. Sand and Gravel information from the surficial geology (*OGS*) was used to define features which were not well represented in the *ISI* data. In some areas, the surficial geology sand and gravel areas suggest that small areas of high *vulnerability* identified through the *ISI* mapping may be more extensive or connected to other areas which the *ISI* had identified as high *vulnerability*. This required professional judgment through an extensive comparison of the well records within and around these features to determine whether areas of *Highly Vulnerable Aquifers* were missed in the *ISI* mapping that was developed. This work was undertaken by the region's staff hydrogeologist and was peer reviewed as described in the peer review section above. Where the sand and gravel information agreed with the water well records, the extent of the surficial geology feature (sands and gravels) was used to connect smaller pockets of high *vulnerability*. Where water well information did not seem to agree with the surficial geology information, examination of the well record and air photo interpretation were used to determine if the well record should be included in the *ISI* interpolation. Further, an assessment as to whether the sand and gravel area identified in the surficial geology features is likely to contain an *aquifer* was also undertaken where these areas were being added to the highly *vulnerable areas* identified through the seamless *ISI*. Where individual

pixels smaller than 200 m square were identified in the seamless *ISI* mapping they were screened out.

The areas where the *ISI* score was calculated or interpolated to be less than 30 are identified as *Highly Vulnerable Aquifers*. The use of a second data source (surficial geology features) and professional judgment to supplement and confirm the results of the *ISI* work give more certainty to the areas delineated as *Highly Vulnerable Aquifers*. This also resulted in a more comprehensive identification of *Highly Vulnerable Aquifers* across the region than could be provided by the *ISI* information calculated and interpolated from well locations. Map 4-5 in Appendix 1 illustrates the *Highly Vulnerable Aquifers* within the St. Clair Region Source Protection Area. As per the *Technical Rules* 2013, all *Highly Vulnerable Aquifers* have a *vulnerability score* of 6.

These areas of high *vulnerability* identified as *HVA*s were overlaid over the areas of medium or low *vulnerability* from the seamless *ISI* developed as described above to produce a seamless *vulnerability* mapping across the region. In this manner, areas identified as *Highly Vulnerable Aquifers* were assigned a *vulnerability* of high. Those areas which were not identified as *Highly Vulnerable Aquifers* retained the low or medium *vulnerability* from the seamless *vulnerability* mapping. The resulting regional scale map, showing aquifer vulnerability (low, medium and high) across the watershed is included as Map 4-6 in Appendix 1.

4.5 Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas or *SGRAs* are delineated through the Water Budget Process. In the St. Clair Region Source Protection Area, these were delineated through the Tier 1 Water Budget. The delineation of the *SGRAs* are described in detail in Section 3 – Water Budget and Water Quantity Stress Assessment.

Rule 44 defines *Significant Groundwater Recharge Areas* as those areas where the recharge is:

- more than 1.15 times the average recharge in the area or

- 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.

The areas which meet either of these criteria are shown in Map 4-7 in Appendix 1 which shows the delineated *SGRA*. Map 4-7 filters out areas which are based on single grids from the analysis (less than 25 ha in area).

Rule 46 allows professional judgement in the determination of areas deemed to exhibit significant recharge or not. For example, if an area is known to provide significant recharge on a local scale due to it's unique physiography, but does not show up as significant using the methodology described above, it can be changed in the SGRA mapping to be significant. In the modelling done for SGRA determination in the SCR, river valleys and flood plain areas were initially shown to be SGRAs. In the opinion of some of the Water Budget Peer Review Committee (PRC) members, these areas are more appropriately defined as groundwater discharge rather than recharge areas, due to their low elevations and to the general groundwater hydraulic gradient towards them. However, there is also a body of research which shows that river valley areas can potentially exhibit both types of behaviour, dependent upon the season, and other PRC members felt it was appropriate to consider them as recharge areas. In the end it was agreed that they would be considered discharge areas, and thus removed from the SGRA mapping in Map 4-7.

The SGRA presented in this updated Assessment Report reflect the changes described in section 3 of this Assessment Report. The current methodology for assessing the SGRA relies on surficial geology for distributing the recharge within a subwatershed.

4.6 Uncertainty in Groundwater Analysis

The Technical rules 2013 require that the degree of uncertainty in the vulnerable assessment of groundwater be assessed. Appendix 13 of this Assessment Report describes the uncertainty analysis. The Highly Vulnerable Aquifer area mapping product is a derivative product based

primarily on *ISI* scores. Due to a number of factors related to the data available, there is a uncertainty associated with the ISI scores. Surficial geological mapping of sand and gravel was incorporated into the ISI mapping which reduced the uncertainty, however, the uncertainty would still remain elevated. As a result there is uncertainty associated with the delineation of *HVA* although the committee is satisfied that it is low enough for the purposes intended.

4.7 Data Gaps and Next Steps

The data gaps encountered in the assessment of vulnerability are listed in Table 4-6.

Table 4-4 Vulnerability Assessment Data Gaps Relevant to the St. Clair Region SPA

Data Gap	Description
Better drainage information to delineate IPZ-2 transport pathways and storm sewersheds	Adjustments may be made to IPZ-2 transport pathways and storm sewersheds as a result of better drainage information determined through site-specific (Tier 2) Risk Assessment
Impacts to the drainage ditch flow due to culverts (Petrolia upland IPZ-2)	The consideration of the impacts of road crossings for the drainage ditch study should be undertaken; a detailed analysis may impact the velocities in the drainage ditches, which may refine the upland IPZ-2 delineation for the Petrolia intake
Cow Creek flows (Petrolia upland IPZ-2)	Gauging Cow Creek would allow a better understanding of the watershed and the flows that are experienced in the creek thereby reducing the uncertainty associated with the velocity estimations
Lake current measurements and wind Data comparison (Petrolia in-water IPZ-2)	No ADCP data was available in lower Lake Huron to validate the model in the vicinity of Petrolia's intake, and wind data used in the model should be checked against other wind stations in the area for consistency
Consideration of natural processes in modelling in-water portion of LAWSS and Petrolia IPZ-2	The consideration of the dispersion of contaminant plumes through natural diffusion movements as a result of density currents may also help with a better refinement of LAWSS and Petrolia in-water IPZ-2
St. Anne Island Drainage Data (Wallaceburg upland IPZ-2)	Hydraulic information
Drainage data for channels connecting Running Creek and Chenal Ecarte (Wallaceburg upland IPZ-2)	Hydraulic information
Cram Drain (Wallaceburg upland IPZ-2)	Pump information
Extreme conditions ADCP data	To help better understand the reverse flow

Table 4-4 Vulnerability Assessment Data Gaps Relevant to the St. Clair Region SPA

Data Gap	Description
(Wallaceburg in-water IPZ-2)	conditions
Verification of Sydenham River flow data (Wallaceburg in-water IPZ-2)	Flow data for the Sydenham River was provided by SCRCA in a provisional format and had not yet been verified. The model calibration suggests that the values may be high, or alternatively the adjustment factor used to account for ungauged portion of the tributary may be high
Edge-matching of HVA and SGRA with neighbouring regions	This work will be considered when neighbouring regions' HVA and SGRA maps are complete
Aquifer mapping	Better understanding of the conceptual geologic model including mapping of the lateral extent of the aquifers, aquitards and recharge areas feeding these aquifers

5.0 Issues Evaluation

Under the Clean Water Act (2006), *drinking water* quality *issues* must be identified for *drinking water systems* included in the Assessment Report. In the St. Clair Region Source Protection Area (*SPA*), there are surface municipal *drinking water systems*, shown in Map 1-3. A *drinking water* quality *issue* is a *parameter* (substance) or *pathogen* (disease-causing microorganism) shown to deteriorate, or trend towards a deterioration of raw (untreated) water quality. This Section of the Assessment Report describes what substances in source (untreated) water may be considered *issues* as well as the methodology used to identify *issues*. A list of *drinking water* quality *issues* identified in the St. Clair Region Source Protection Area is also provided.

5.1 What is a Drinking Water Quality Issue?

The *Technical Rules 2013: Assessment Report* indicates which substances can be considered in the identification of *drinking water* quality *issues* in raw (untreated) source water. They are the *Schedule 1*, *Schedule 2* and *Schedule 3 parameters* of the Ontario Drinking Water Quality Standards (Reg. 169/03 of the Safe Drinking Water Act, 2002) and *Table 4 parameters* of the Technical Support Document for the Ontario Drinking Water Quality Standards, Objectives and Guidelines (an *MECP* publication, PIBS4449e01, June 2006). *Pathogens*, which are disease-causing organisms, can also be considered in the identification of *drinking water* quality *issues*.

The *Schedule 1 parameters* are the two indicator microorganisms, total coliform and *Escherichia coli (E. coli)*. These *parameters* are routinely tested in raw source and treated water, and also in distribution systems, under the Safe Drinking Water Act (2002). The testing of *Schedule 1 parameters* in raw water helps indicate possible pathogenic contamination in the raw water prior to treatment.

The *Schedule 2 parameters* are chemical substances such as lead, nitrate and atrazine. The *Schedule 3 parameters* are radioactive material such as uranium-235. The *Schedule 1, 2* and *3*

parameters have human-health based treated *drinking water* standards called *Maximum Acceptable Concentrations (MAC)*. The *Schedule 1, 2* and *3 parameters* and their safe levels (in treated *drinking water*) are listed in Tables 5-1, 5-2 and 5-3.

The *Table 4 parameters* are physical (such as taste, colour and turbidity) and chemical (such as sodium, iron and chloride) substances. Some of these affect the aesthetic quality of the water (taste, odour), and hence their treated water criteria are called *Aesthetic Objectives (AO).* Yet other Table 4 substances may interfere with the efficient and effective treatment, disinfection and distribution of the water (alkalinity, hardness), and their treated water criteria are called *Operational Guidelines (OG).* The *Table 4 parameters* and their objectives and guidelines (in treated *drinking water*) are listed in Table 5-4.

Pathogens are disease-causing protozoa, bacteria or viruses. Protozoa and bacteria are single-celled microscopic living organisms, while viruses are smaller than, and can live in, a single cell. *Pathogens* can cause severe or fatal waterborne illness in humans. Some are resistant to commonly used disinfectants at water treatment plants. Examples of *pathogens* include *Salmonella, Campylobacter, E. coli* strain O157:H7, *Legionella* and *Helicobacter pylori* (waterborne bacteria), noroviruses, hepatitis A and rotaviruses (intestinal viruses), and *Giardia* and *Cryptosporidium* (protozoa). In the *Technical Rules 2013: Assessment Report*, unlike *parameters* listed in *Schedule 1, 2* and *3*, and Table 4, *pathogens* are not limited to a specific list. The *Schedule 1 parameters* (total coliform and *E. coli*) are routinely monitored, as described earlier, to indicate possible pathogenic contamination of raw water sources. However, specific *pathogens* are not monitored routinely in raw water sources unless there is an indication that monitoring of a specific *pathogen* is warranted.

Table 5-1 Schedule 1 Parameters (from O. Reg. 169/03 of the Safe Drinking Water Act, 2002) and their Treated Drinking Water Quality Standards

Item	Microbiological Parameter	Standard (MAC, counts/100 mL)
1.	*Escherichia coli (E. coli)*	Non detectable
2.	Total coliforms	Non detectable

Table 5-2 Schedule 2 Parameters (from O. Reg. 169/03 of the Safe Drinking Water Act, 2002) and their Treated Drinking Water Standards

Item	Chemical Parameter	Standard (MAC, mg/L)	Item	Chemical Parameter	Standard (MAC, mg/L)
1.	Alachlor	0.005	40.	Diuron	0.15
2.	Aldicarb	0.009	41.	Fluoride	1.5 [b]
3.	Aldrin + Dieldrin	0.0007	42.	Glyphosate	0.28
4.	Antimony	0.006	43.	Heptachlor + Heptachlor Epoxide	0.003
5.	Arsenic	0.025	44.	Lead	0.010 [c]
6.	Atrazine + N-dealkylated metabolites	0.005	45.	Lindane (Total)	0.004
7.	Azinphos-methyl	0.02	46.	Malathion	0.19
8.	Barium	1.0	47.	Mercury	0.001
9.	Bendiocarb	0.04	48.	Methoxychlor	0.9
10.	Benzene	0.005	49.	Metolachlor	0.05
11.	Benzo(a)pyrene	0.00001	50.	Metribuzin	0.08
12.	Boron	5.0	51.	Microcystin LR	0.0015
13.	Bromate	0.01	52.	Monochlorobenzene	0.08
14.	Bromoxynil	0.005	53.	Nitrate (as nitrogen)	10.0 [d]
15.	Cadmium	0.005	54.	Nitrite (as nitrogen)	1.0 [d]
16.	Carbaryl	0.09	55.	Nitrate + Nitrite (as nitrogen)	10.0 [d]
17.	Carbofuran	0.09	56.	Nitrilotriacetic Acid (NTA)	0.4
18.	Carbon Tetrachloride	0.005	57.	N-Nitrosodimethylamine (NDMA)	0.000009
19.	Chloramines	3.0	58.	Paraquat	0.01
20.	Chlordane (Total)	0.007	59.	Parathion	0.05
21.	Chlorpyrifos	0.09	60.	Pentachlorophenol	0.06
22.	Chromium	0.05	61.	Phorate	0.002
23.	Cyanazine	0.01	62.	Picloram	0.19
24.	Cyanide	0.2	63.	Polychlorinated Biphenyls (PCB)	0.003
25.	Diazinon	0.02	64.	Prometryne	0.001
26.	Dicamba	0.12	65.	Selenium	0.01
27.	1,2-Dichlorobenzene	0.2	66.	Simazine	0.01
28.	1,4-Dichlorobenzene	0.005	67.	Temephos	0.28
29.	Dichlorodiphenyltrichloroethane (DDT) + metabolites	0.03	68.	Terbufos	0.001
30.	1,2-Dichloroethane	0.005	69.	Tetrachloroethylene (perchloroethylene)	0.03
31.	1,1-Dichloroethylene (vinylidene chloride)	0.014	70.	2,3,4,6-Tetrachlorophenol	0.1
32.	Dichloromethane	0.05	71.	Triallate	0.23
33.	2,4-Dichlorophenol	0.9	72.	Trichloroethylene	0.005
34.	2,4-Dichlorophenoxy acetic acid (2,4-D)	0.1	73.	2,4,6-Trichlorophenol	0.005
35.	Diclofop-methyl	0.009	74.	2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0.28
36.	Dimethoate	0.02	75.	Trifluralin	0.045
37.	Dinoseb	0.01	76.	Trihalomethanes (THMs)	0.100 [e]
38.	Dioxin and Furan	0.000000015 [a]	77.	Uranium	0.02
39.	Diquat	0.07	78.	Vinyl Chloride	0.002

Notes: (a) Total toxic equivalents when compared with 2,3,7,8-TCDD. **(b)** When added to drinking water, it is recommended to adjust the fluoride concentration to be 0.5 to 0.8 mg/L for optimal level of tooth decay control. Where supplies contain naturally occurring levels higher than 1.5 mg/L but less than 2.4 mg/L, the Ministry of Health and Long Term Care recommends an approach through local boards of health to raise public and professional awareness to control excessive exposure to fluoride from other sources. **(c)** This standard applies to water at the point of consumption. **(d)** Where both nitrate and nitrite exist, the total of both should not exceed 10 mg/L. **(e)** This standard is expressed as the running annual average of quarterly samples measured at point reflecting the maximum residence time in the distribution system.

Table 5-3 Schedule 3 Parameters (from O. Reg. 169/03 of the Safe Drinking Water Act, 2002) and their Treated Drinking Water Standards

Item	Radiological Parameter	Standard (MAC, in becquerels per litre)	Item	Radiological Parameter	Standard (MAC, in becquerels per litre)
Natural Radionuclides			Artificial Radionuclides Continued		
1.	Beryllium-7	4000.0	40.	Iron-55	300.0
2.	Bismuth -210	70.0	41.	Iron-59	40.0
3.	Lead-210	0.1	42.	Manganese-54	200.0
4.	Polonium-210	0.2	43.	Mercury-197	400.0
5.	Radium-224	2.0	44.	Mercury-203	80.0
6.	Radium-226	0.6	45.	Molybdenum-99	70.0
7.	Radium-228	0.5	46.	Neptunium-239	100.0
8.	Thorium-228	2.0	47.	Niobium-95	200.0
9.	Thorium-230	0.4	48.	Phosphorus-32	50.0
10.	Thorium-232	0.1	49.	Plutonium-238	0.3
11.	Thorium-234	20.0	50.	Plutonium-239	0.2
12.	Uranium-234	4.0	51.	Plutonium-240	0.2
13.	Uranium-235	4.0	52.	Plutonium-241	10.0
14.	Uranium-238	4.0	53.	Rhodium-105	300.0
Artificial Radionuclides			54.	Rubidium-81	3000.0
15.	Americium-241	0.2	55.	Rubidium-86	50.0
16.	Antimony-122	50.0	56.	Ruthenium-103	100.0
17.	Antimony-124	40.0	57.	Ruthenium-106	10.0
18.	Antimony-125	100.0	58.	Selenium-75	70.0
19.	Barium-140	40.0	59.	Silver-108m	70.0
20.	Bromine-82	300.0	60.	Silver-110m	50.0
21.	Calcium-45	200.0	61.	Silver-111	70.0
22.	Calcium-47	60.0	62.	Sodium-22	50.0
23.	Carbon-14	200.0	63.	Strontium-85	300.0
24.	Cerium-141	100.0	64.	Strontium-89	40.0
25.	Cerium-144	20.0	65.	Strontium-90	5.0
26.	Cesium-131	2000.0	66.	Sulphur-35	500.0
27.	Cesium-134	7.0	67.	Technetium-99	200.0
28.	Cesium-136	50.0	68.	Technetium-99m	7000.0
29.	Cesium-137	10.0	69.	Tellurium-129m	40.0
30.	Chromium-51	3000.0	70.	Tellurium-131m	40.0
31.	Cobalt-57	40.0	71.	Tellurium-132	40.0
32.	Cobalt-58	20.0	72.	Thallium-201	2000.0
33.	Cobalt-60	2.0	73.	Tritium	7000.0
34.	Gallium-67	500.0	74.	Ytterbium-169	100.0
35.	Gold-198	90.0	75.	Yttrium-90	30.0
36.	Indium-111	400.0	76.	Yttrium-91	30.0
37.	Iodine-125	10.0	77.	Zinc-65	40.0
38.	Iodine-129	1.0	78.	Zirconium-95	100.0
39.	Iodine-131	6.0			

Table 5-4 Table 4 Parameters (from the Technical Support Document for the Ontario Drinking Water Quality Standards, Objectives and Guidelines, MOE 2006) with their Treated Drinking Water Aesthetic Objectives and Operational Guidelines

Table 4 Parameter	AO	OG
1,2-Dichlorobenzene	0.003[a] mg/L	
1,4-Dichlorobenzene	0.001[a] mg/L	
2,4-Dichlorophenol	0.0003[a] mg/L	
2,3,4,6-Tetrachlorophenol	0.001[a] mg/L	
2,4,6-Trichlorophenol	0.002[a] mg/L	
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0.02[a] mg/L	
Alkalinity (as $CaCO_3$)		30-500 mg/L
Aluminum		0.1 mg/L
Chloride	250 mg/L	
Colour	5 TCU	
Copper	1 mg/L	
Dissolved Organic Carbon	5 mg/L	
Ethylbenzene	0.0024 mg/L	
Hardness (as $CaCO_3$)		80-100 mg/L
Heterotrophic Plate Count (HPC)-General bacteria population expressed as colony counts on a heterotrophic plate count		f
Iron	0.3 mg/L	
Manganese	0.05 mg/L	
Methane	3L/ m^3	
Monochlorobenzene	0.03[a] mg/L	
Odour	Inoffensive	
Organic Nitrogen		0.15 mg/L
pH		6.5-8.5 (no units)
Pentachlorophenol	0.03[a] mg/L	
Sodium	b	
Sulphate	500[c] mg/L	
Sulphide	0.05 mg/L	
Taste	Inoffensive	
Temperature	15^0C	
Toluene	0.024 mg/L	
Total Dissolved Solids	500 mg/L	
Turbidity	5 NTU[d]	e
Xylenes	0.3 mg/L	
Zinc	5 mg/L	

Notes: (a) Refer to Table 5-2 (Schedule 2 parameters) for MAC standard. **(b)** The AO for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets. **(c)** When sulphate levels exceed 500 mg/L, water may have a laxative effect on some people. **(d)** Applicable for all waters at the point of consumption. **(e)** The OGs for filtration processes are provided as performance criteria in the Procedure for Disinfection of Drinking Water in Ontario. **(f)** Increases in HPC concentrations above baseline levels are considered undesirable.

5.2 Impact of Identifying an Issue

According to Rules 114, 115, 131 and 141, *activities* or *conditions* that contribute to drinking water quality *issues* (known to be partially or wholly due to *anthropogenic* sources), are deemed *significant* drinking water *threats* regardless of assigned vulnerability scores. This applies to intake protection zones and wellhead protection areas only, for drinking water systems identified in the Source Protection Area Terms of Reference.

Should an issue be identified as per Technical Rule 114, the issue contributing area must be delineated as per Rule 115. Also as per rule 115, activities that contribute to the issue within the issue contributing area must be identified and are deemed to be a significant risk to the source of drinking water for those systems included in the Terms of Reference. Significant risks must be mitigated through the Source Protection Plan. If the information required to delineate the ICA and identify the activities contributing to an issue are not readily ascertained, rule 116 allows for a work schedule to be identified to ascertain the information specified in rule 115.

As per Technical Rules (2017) 68, 130 and 131, a third intake protection zone (IPZ-3) for surface water
Intakes may be delineated to include the activities and area known to contribute to the drinking Water quality issue.

In addition to the identification of an issue by rule 114, rule 115.1 allows for the identification of an issue which is not identified in accordance with rule 114. This is often referred to as an issue identified under that Act to differentiate it from an issue identified under the rules (specifically rule 114). Issues identified as per rule 115.1 do not require the delineation of an ICA and cannot have significant threats identified which contribute to the issue. They may however be addressed through specify action policies and be the subject of monitoring and reporting. Further, *issues* in *HVAs* or those linked to a system not identified in the Terms of Reference may lead to the identification of moderate drinking water threats (not significant threats). Systems not identified in the Terms of Reference may be those included in the source protection planning process through municipal council resolution or by the Minister (MECP). No additional systems in the *SCRSPA* have been identified in this manner.

5.3 Issue Evaluation Methodology

Identifying *issues* is a key step in the overall process of protecting *drinking water* quality. *Issues* were identified in the St. Clair Region Source Protection Area by following the Thames-Sydenham and Region Issues Evaluation Methodology (May 14, 2009), depicted in Figure 5-1. This methodology was developed to guide the technical work to assess an issue under the Rules (rule 114). The methodology is provided in Appendix 8. The evaluation is a two-step process. Firstly, in the screening step, raw (untreated) water quality data is compared to a benchmark and *parameters* may be flagged if they meet the screening criteria. The benchmarks for chemical, physical and radioactive *parameters* are generally half the applicable human health based Ontario *Drinking Water Quality* standards (*Maximum Acceptable Concentrations,* or *MAC*), and the full levels of the *Aesthetic Objectives (AO) and Operational Guidelines (OG)*, and any plant operating authority concerns. Secondly, in the identification step, an investigation of the *parameters* flagged through the first step is undertaken. This includes a review of trends and spikes, frequency and duration of occurrence, presence at or trending towards the applicable *MAC*, *AO* or *OG* benchmark, consideration of existing water treatment plant capabilities and discussions with the water treatment plant operating authority.

Pathogens are also evaluated in a two-step process that differs from the evaluation of the *Schedule 1, 2, 3* and *Table 4 parameters*. In the first step (screening), *pathogens* are flagged if they are a concern to the operating authority, known to occur in raw water, persist in treated water, or have caused a waterborne outbreak in the past. A *pathogen* that is flagged through the screening process must be subject to a microbial risk assessment to identify whether it is an *issue*. This assessment involves *pathogen* characterization, exposure assessment and *risk* characterization. Some of the elements considered in a microbial risk assessment are: pathological characteristics, infection mechanisms, resistance to control or treatment, survival, persistence, seasonality, reliability of treatment processes and route of human exposure.

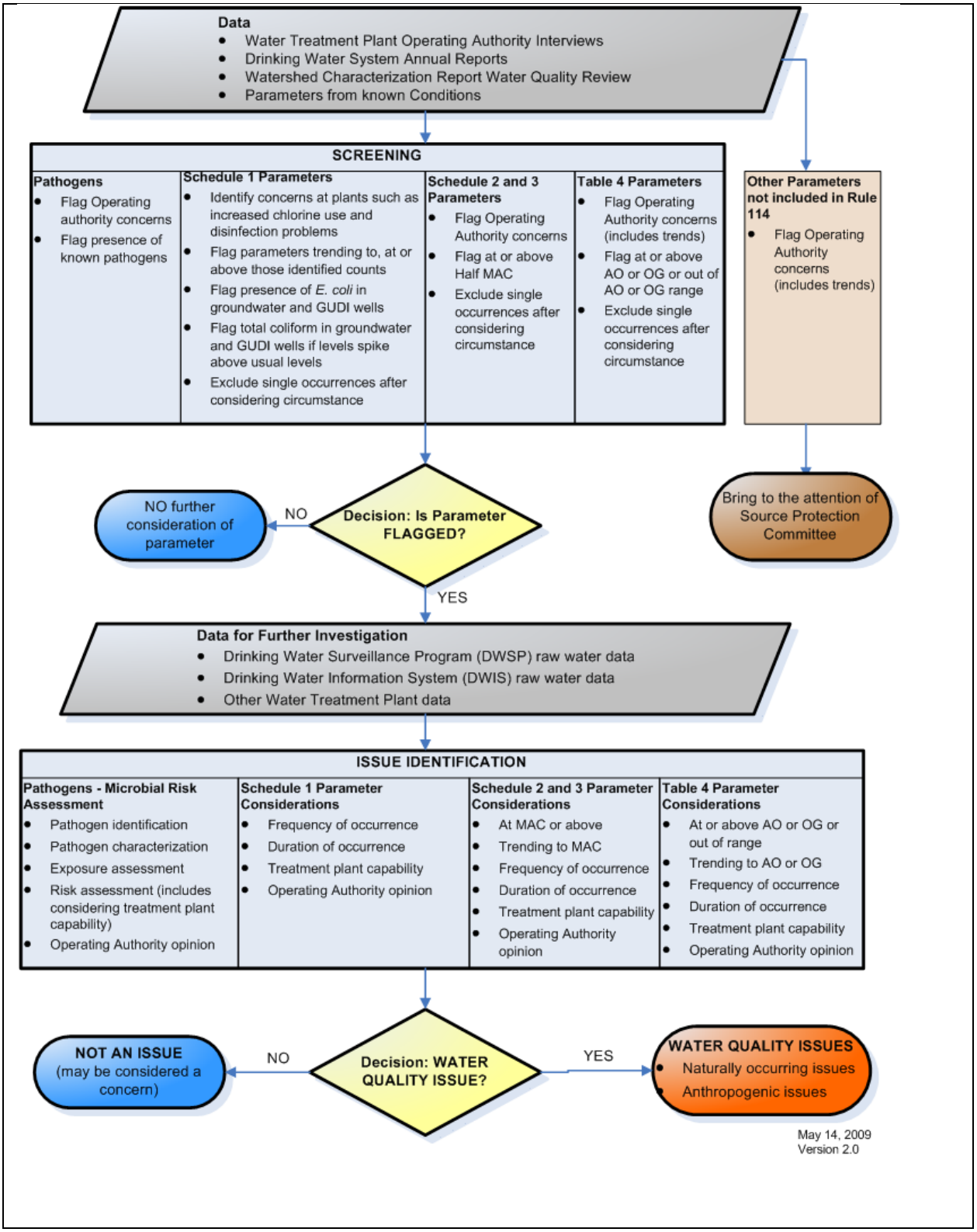


Figure 5-1 Thames-Sydenham and Region Issues Evaluation Methodology

5.4 Issues Evaluation Technical Studies

As described in Section 4 – Vulnerability Assessment, a large project was led by the St. Clair Region Conservation Authority (*SCRCA*), in partnership with the Lambton Area Water Supply System (*LAWSS*) and Town of Petrolia, for two surface water intakes in the *SCRSPA*. *LAWSS* and the Town of Petrolia actively participated in the technical steering of the project along with staff from the Conservation Authority. R. V. Anderson Associates Limited was the primary consultant. The two intakes studied in this project serve the water treatment plants of *LAWSS* and Town of Petrolia at Bright's Grove.

A large project, led by the Essex Region Conservation Authority (*ERCA*), was initiated through a partnership between *ERCA* and the Conservation Authorities in the Thames-Sydenham and Region and the plant operators. This project included one intake in the *SCRSPA* serving the Wallaceburg water treatment plant, two intakes in the Lower Thames Valley Source Protection Area, and seven intakes in the Essex Region Source Protection Area. Stantec Consulting Limited was the primary consultant. The Municipality of Chatham-Kent Public Utilities Commission (*PUC*) was an active partner in the project and participated in the technical steering of the project.

A water raw water quality assessment was completed by Riggs Engineering Inc. that used data collected at the raw water tap in the treatment facility from 2004-2010. There was no pervious comparable data available so the raw water data from the Grand Bend intake was used. This data is used for comparison purposes only.

The technical studies are listed below in Table 5-5.

Table 5-5 Technical Studies on Drinking Water Quality Issues Evaluation

Drinking Water Systems	Technical Study on Issues Evaluation
Lambton Area Water Supply System (LAWSS)	Lambton Area Water Supply System (LAWSS) Final Report – Drinking Water Issues and Threats, October 2009, R.V. Anderson Associates Limited.
Town of Petrolia Water Treatment Plant	Town of Petrolia Water Treatment Plant Final Report – Drinking Water Issues and Threats, October 2009, R.V. Anderson Associates Limited.

Wallaceburg Water Treatment Plant	Technical Memorandum: Issues Technical Memorandum: Issues Identification for the Thames Sydenham Region Water Treatment Plants. Essex Chatham-Kent Source Protection Planning Technical Study. Stantec Consulting Ltd. November 2009.
Kettle and Stony Point First Nations Water Treatment System	Ausable Bayfield Source Protection Authority Kettle Point Intake Zone Study Final Report - Kettle Point Raw Water Quality Characterization, November 2011, Riggs Engineering Ltd.
Issues Contributing Area	Wallaceburg Intake Review, St. Clair Region Conservation Authority, 2014

5.5 Identified Issues

Certain *parameters* that met the screening criteria, in the first step of *issues* evaluation, were flagged. In the second step of *issues* evaluation, flagged *parameters* were further investigated to identify *drinking water* quality *issues* in the St. Clair Region *SPA*. The identified *issues* are listed as allowed under Technical Rule 115.1, and described in Table 5-6. . In the St. Clair Region *SPA*, some of the *issues* are naturally occurring. The sources of the rest of the *issues* are yet to be determined, and may be wholly or partially *anthropogenic* (man-made sources, i.e. due to the activities on land). The sources may be determined as more information becomes available to the SPC, and included in a subsequent assessment report. No *pathogens* are identified as *issues* in the raw (untreated) source water in the St. Clair Region *SPA*.

It is important to note that the *drinking water* quality *issues* identified in Table 5-6 are based on raw (untreated) water quality and do not represent the quality of water after treatment. The operation of a water treatment plant including treatment and distribution are governed separately by the Safe Drinking Water Act (2002).

The flagged *parameters* that were not identified as *drinking water* quality *issues* include those of aesthetic concern, treated water disinfection by-products, microbial indicators and naturally occurring substances. More information on flagged *parameters* is provided in Appendix 9 of the Assessment Report. The identified *issues* and flagged *parameters* will be subject to a re-evaluation in subsequent Assessment Reports.

Available information and data on spills in the St. Clair River may be considered as part of the *IPZ-3* work in an amended Assessment Report.

Table 5-6 Drinking Water Quality Issues Identified in Raw (Untreated) Water to Municipal Intakes in the St. Clair Region Source Protection Area

System	Issue*	Brief Description of Evaluation	Natural or Anthropogenic Source
Town of Petrolia at Bright's Grove (Lake Huron intake)	None were identified		
LAWSS (St. Clair River intake)	None were identified		
Kettle and Stony Point	None were identified		
Wallaceburg (Chenal Ecarte intake)	Nitrates (Nitrates no longer an issue)	In the St. Clair Watershed Characterization report (Dec 2008), there were two exceedances of the half MAC of 5 mg/L, identified for nitrate. Work proceeded to identify the ICA. Modelling was undertaken to assess nitrate contributions from the subwatersheds of the Sydenham River. The Sydenham River flows by the intake when flow reverses north up the Chenal Ecarte past the intake. It was determined that all subwatersheds contribute relatively equally to the issue, however there was considerable uncertainty as to the relative contribution of areas connected to the watercourses by transport pathways. Common sources of nitrate include fertilizer and agricultural source material applied to land, septic system and waste water treatment effluent and storm water runoff. Further, through analysis of more recent data, it was found that nitrates in the Sydenham River may be leveling off and possibly decreasing. Therefore, operators are no longer flagging a concern of nitrates.	Both natural and anthropogenic causes
	Organic nitrogen	Approximately 72% (52 of 72 samples) of the available *DWSP* data (data from 1990 to 2007) measured above the 100% OG benchmark of 0.15 mg/L, with a highest level of 1.8 mg/L in 1990. The trend line implies that the organic nitrogen levels have been decreasing over time; however, considering the consistent sampling measuring above the OG, organic nitrogen was identified as an issue.	Possibly both natural and anthropogenic causes, further investigation required
	Turbidity	Turbidity has been identified as a concern from the water treatment plant manager. The plotted turbidity samples of this raw water quality analysis indicate approximately 44% (38 of 77) of the sampling results between 1989 to 2006 measure above the 100% AO benchmark of 5 NTU, with a highest level of 839 NTU in 2004. The water treatment plant manager indicated that elevated turbidity levels cause operational concerns and challenges.	Possibly both natural and anthropogenic causes, further investigation required
	Hardness	Hardness levels in approximately 53% (37 of 70) of the samples analyzed from 1989 to 2006 were above the 100% OG benchmark range of 80 to 100 mg/L. The maximum value recorded was 180 mg/L and the minimum recorded value was	Naturally occurring

		93.5 mg/L. The average hardness level for the analyzed data set is 102.5 mg/L. The trend line implies that the hardness concentration slightly decreases over time; however, considering the consistent sampling measuring above the OG upper limit of the benchmark, hardness was identified as an issue.	
*These issues are identified as allowed under Technical Rule 115.1			

5.6 Work Plan

If a *drinking water* quality *issue* is identified as per Rule 114, the area and the *activity* contributing to a *drinking water* quality *issue* must also be identified as per Rule 115. In the St. Clair Region SPA, some of the *issues* are naturally occurring and are therefore understood to not be subject to Rule 115.

5.7 Data Gaps

Schedule 2 and 3 (chemical and radiological) data and Table 4 (chemical and physical *parameters*) data for the Town of Petrolia intake raw water (at Bright's Grove), other than 2003 to 2005 data, were not available. Additional data collection would facilitate future *issues* evaluation.

As mentioned in Section 5.5, the sources or causes of some of the *issues* are yet to be determined. This is a data gap. Details of how to accomplish this determination is provided in Table 5-7. Filling of this data gap, as more information becomes available to the SPC, may help identify *issues* as per Rule 114, and therefore lead to identifying the area and activity contributing to those *issues* as required by rule 115.

Through work to delineate and ICA it was determined that the information available left too much uncertainty in the extent of the ICA and the activities contributing to the issue. Further, the analysis of more recent water quality results identify the potential for the nitrate levels in the Sydenham River to be leveling off or possibly declining. It is noted that the source water for this intake is from the St Clair River, however, the intake gets its water from the Sydenham River during flow reversal events.

Table 5-7 Determination of Sources of an Issue

System	*Issue*	Brief Description of Work
Wallaceburg (Chenal Ecarte intake)	Nitrates (no longer an issue)	Nitrate is a naturally occurring ion that is part of the global nitrogen cycle and is ubiquitous in the environment. There are two main land uses that have the potential to contribute nitrate to surface water: wastewater discharge (treatment plant or septic systems) and agriculture activities. Nitrates are soluble in water and areas that have characteristics for increased potential of runoff generation (clay soil, elevated slope) may allow nitrates to be transported during spring melt events, high precipitation events or events to water bodies (Bhumbla, 2009). The upland vulnerable areas for the Wallaceburg water treatment plant are composed of mainly Thames clay loam, Brookston silt loam, Brookston clay loam and Brookston clay (Agriculture and Agri-Food Canada, 2008) and thus have the characteristics of generating runoff. .
	Organic nitrogen	This *issue* is possibly due to both natural and anthropogenic causes. Organic nitrogen may be attributed to natural sources such as forests and atmospheric deposition (dry deposits or in the form of precipitation) or by anthropogenic sources such as animal pastures, agricultural systems, urban/suburban storm water runoff (Bioavailability of DON from natural and anthropogenic sources to estuarine plankton. Limnology and Oceanography 47(2):353-366.Seitzinger S.P., R.W. Sanders, and R. Styles. 2002) and wastewater treatment plant effluent (Dissolved organic nitrogen characterization and bioavailability in wastewater effluents. Water Environment Research Foundation Report 02-CTS-1a. Pagilla, K. May 31 2010). Sampling for organic nitrogen in the tributaries discharging near the intake, at the tributary outfalls, sewer outfalls, in the sediments, nearshore and in the intake raw water would need to be conducted to help determine the cause of organic nitrogen. Reverse flow condtions may also need to be considered.
	Turbidity	This *issue* is possibly due to both natural and anthropogenic causes. Natural causes of turbidity may be erosion, natural decay of plants and animals, and algal growth. Human activities that could contribute to turbidity include runoff from cultivated fields or construction sites, waste discharges and dredging. A study of correlation between wind or runoff events and the intake turbidity levels may need to be conducted. Similarly, a correlation between the in-land drains (natural or man-made) turbidity just before the outlet, and the intake turbidity (after an event) may need to be done. Aerial photos showing plumes after an event may help or sampling along drains and at their outlets may be needed. An examination of the composition of the turbidity (organic, inorganic) and its occurrence with other naturally occurring substances may also help determine the cause of turbidity. Reverse flow condtions may also need to be considered.
	Hardness	Identified to be naturally occurring. No further action required for this *issue* according to MECP guidance.

6.0 Conditions Assessment

In order to protect *drinking water* sources, it is necessary to identify the *threats* that pose a *risk* to *drinking water* sources. The *drinking water threats* that may be considered in identified *vulnerable areas* are those due to: *prescribed activities*, *other activities*, *conditions* (past activities) and *activities* (including *conditions*) contributing to identified *drinking water* quality *issues*. A *condition* is the result of a past *activity* and may pose a *risk* to a *drinking water* source. This Section of the Assessment Report describes the criteria for a *condition* to exist, as per Technical Rule 126, and the preliminary investigation made in assessing *conditions* in the St. Clair Region Source Protection Area. Section 5 - Issues Evaluation describes the *drinking water* quality *issues* identified in this source protection area, while Section 7 - Threats and Risk Assessment describes the assessment of *risks* due to *prescribed activities* and *other activities*.

The *Source Protection Committee* is required to identify, as a *drinking water threat*, any *condition* of which it is aware. The *Source Protection Plan* is focused on reducing the level of *risk* associated with *threats*. The identification of *threats* in *vulnerable areas*, including those due to *conditions*, is an important step in the development of the *Source Protection Plan*. The Clean Water Act requires that activities that are identified as *significant drinking water threats* must be managed to the point that they no longer become significant. The *Source Protection Committee* may also develop policies for *moderate and low drinking water threats*, however it is anticipated that the types of policies which can be applied to *moderate and low threats* will not be as broad as for the *significant threats*.

Conditions must be identified in *vulnerable areas*. The *vulnerable areas* are *Intake Protection Zones (IPZ), Wellhead Protection Areas (WHPA), Highly Vulnerable Aquifers (HVA)*. The delineation and assessment of these *vulnerable areas* are described in Section 4 - Vulnerability Assessment of the Assessment Report. In the St. Clair Region Source Protection Area, *Intake Protection Zones* are delineated around intakes of three *drinking water systems* that use Lake

Huron, the St. Clair River and the Chenal Ecarte as a source. Map 4-1 shows the location of the *IPZ* around the municipal intakes. Map 4-7 show the *HVA* delineations in the St. Clair Region Source Protection Area.

Through the technical work on Threats and Risk Assessment, a preliminary review of data made available by the Ministry of Environment, Conservation and Parks (*MECP*) for the assessment of *conditions* was undertaken. The Threats and Risk Assessment studies involved the operating authorities of the *drinking water systems* and were undertaken through partnerships involving the Conservation Authorities in the region. As described in Section 4, a project was led by the St. Clair Region Conservation Authority (*SCRCA*), in partnership with the Lambton Area Water Supply System (*LAWSS*) and Town of Petrolia, for 2 surface water intakes in the *SCRSPA*. R. V. Anderson Associates Limited was the primary consultant and retained Baird and Associates to undertake the hydrodynamic modelling work. The 2 intakes studied in this project serve the water treatment plants of *LAWSS* and Town of Petrolia at Bright's Grove.

A large project, led by the Essex Region Conservation Authority (*ERCA*) was initiated through a partnership between *ERCA* and the Conservation Authorities in the Thames-Sydenham and Region and the plant operators. This project included 1 intake in *SCRSPA* serving the Wallaceburg water treatment plant, 2 intakes in the Lower Thames Valley Source Protection Area, and 7 intakes in the Essex Region Source Protection Area. Stantec Consulting Limited was the primary consultant and retained Baird and Associates to undertake the hydrodynamic modelling work. The Municipality of Chatham-Kent Public Utilities Commission (*PUC*) was an active partner in the project and participated in the technical steering of the project. The technical reports for the above described studies are listed in Table 6-1 below.

Table 6-1 Technical Studies on Drinking Water Threats and Risk Assessment

Drinking Water Systems	Technical Study on Threats and Risk Assessment
Lambton Area Water Supply System	Lambton Area Water Supply System (LAWSS) Final Report – Drinking Water Issues and Threats, October 2009, R.V. Anderson Associates Limited.
Petrolia Water Treatment Plant	Town of Petrolia Water Treatment Plant Final Report – Drinking Water Issues and Threats, October 2009, R.V. Anderson Associates Limited.
Wallaceburg Water Treatment Plant	Technical Memorandum: Threats Analysis for the Wallaceburg Water Treatment Plant. Essex Chatham-Kent Source Protection Planning Technical Study. March 2010. Stantec Consulting Ltd.
Lambton Area Water Supply System, Petrolia Water Treatment Plant, Wallaceburg Water Treatment Plant	1. Technical Memo regarding Creation of Impervious, Managed Land and Livestock Density Maps. Thames-Sydenham and Region. Jason Wintermute. February 2, 2010. 2. Technical Memo regarding the Assessment of Chemical Threats from the Use of Land as Livestock Grazing, Pasturing Land, and Outdoor Confinement Area or a Farm-Animal Yard. Thames-Sydenham and Region. Jason Wintermute. September 29, 2010. 3. Technical Memo regarding the Assessment of Chemical Threats from the Application of ASM, NASM and Commercial Fertilizers. Thames-Sydenham and Region. Jason Wintermute. November 9, 2010.
Kettle and Stony Point Water Supply System	Intake Protection Zone Delineation and Vulnerability Analysis for the Kettle Point Intake, December 2011, HCCL and Riggs Engineering

6.1 Conditions Assessment Methodology

6.1.1. Occurrence of Conditions

As per the *Technical Rules (2017) 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,* 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 presence of a contaminant in groundwater that is discharging into an intake protection zone, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards, the concentration of the contaminant exceeds the potable groundwater standard set out for that contaminant in the Table, and the presence of the contaminant in groundwater could result in the deterioration of the surface water for use as a source of drinking water.

Conditions may exist as a result of the presence of non-aqueous phase liquids in groundwater in a *HVA,* or *WHPA*. Non-aqueous phase liquids do not mix with water. Light Non-Aqueous Phase Liquids (*LNAPLs*) float on top of water, and examples are oil and gasoline. *Conditions* may also exist due to the presence of more than 100 litres of Dense Non-Aqueous Phase Liquids (*DNAPLs*) in the surface water of an *IPZ*. *DNAPLs* are liquids that do not mix with water and are heavier than water. *DNAPLs* are of concern in groundwater since they sink into the ground, settle at the bottom of and contaminate an *aquifer*. Examples of where *DNAPLs* are used include: dry cleaning, pesticides, brake cleaners, glues, varnishes, automotive coolant and nail polish.

The Soil, Ground Water and Sediment Standards refer to an *MECP* publication, 'Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act' (March 9, 2004). This document, consisting of 6 tables (called Tables 1 to 6), sets out the prescribed contaminants and the applicable site condition standards for those contaminants for the purposes of Part XV.1 ('Records of Site Condition') of the *Environmental Protection Act*. The prescribed standards for contaminants are set out by indicating the maximum concentrations of

the contaminants in soil, groundwater and sediment for a type of property use (such as agricultural or commercial). These are expressed in microgram per gram (µg/g) dry weight for soil and sediment, and as microgram per litre (µg/L) for groundwater, unless otherwise indicated in the table. Contaminants listed in the tables include metals, nutrients, polyaromatic hydrocarbons, pesticides, petroleum constituents and *dense non-aqueous phase liquids*.

Under the Clean Water Act, *conditions* may be identified if a contaminant in sediment exceeds its applicable standard from Table 1 of the *MECP* publication Soil, Ground Water and Sediment Standards. The sediment standards in Table 1 (Full Depth Background Site Condition Standards) are values within the range of measured background sediment where data is available in the 1993 Sediment Guidelines and are considered to provide a level of human health and ecosystem protection consistent with background, and protective of sensitive ecosystems. These sediment standards are for all property uses.

Table 2 ('Full Depth Generic Site Condition Standards in a Potable Ground Water Condition') is used to determine if a *condition* exists in the groundwater of a *WHPA* or *HVA*, by comparing the contaminant concentration with the standard for potable groundwater, which applies to all property uses.

Table 4 ('Stratified Site Condition Standards in a Potable Ground Water Condition') is used to determine if a *condition* exists in the surface soil of an *IPZ*, in properties used for industrial, commercial or community purposes.

6.1.2. Information Used to Identify Conditions

A preliminary investigation of potential *conditions* has been undertaken based on information available. To date, investigation of *conditions* includes the following measures:

- Those undertaking municipal technical studies were requested to determine if there are *conditions* which the plant operating authorities are aware of, and the consultants were to investigate to determine if it was in fact a *condition*.
- *MECP* provided information from their local offices to determine if their files contain any information which might lead to identifying a *condition*. This information was restricted to a fixed radius around intakes and wells. Although it has been provided to the

consultants for their consideration, not all of the consultants have been able to review the information. Further, the information does not include the entire *vulnerable areas*.

- It is anticipated that stakeholders, including the public, may bring up information on potential *conditions* and an investigation will be required to determine if they are *conditions*. Some of these have been noted in this report, but are yet to be reviewed to determine if they should be considered a *condition*.

The two sets of data made available by the Ministry of Environment, Conservation and Parks (*MECP*) to check for *conditions* are data from the 'Brownfields Registry' and '*MECP* Data Scanning'. Brownfields are lands on which industrial or commercial *activity* took place in the past and that may need to be cleaned up before they can be redeveloped. The Brownfields Registry data from *MECP* contained summarized information from individual Records of Site Condition (*RSC*) available on the Brownfields Site Registry. The Brownfields Environmental Site Registry provides access to the individual *RSCs* where contamination information about each individual *RSC* property is documented. Records of Site Condition are not a listing of all contaminated sites in the province (no such list exists). The information provided is only applicable to properties that have undergone a land use change and for which an *RSC* has been accepted. The Brownfields data from *MECP* contained all records up to December 11, 2008. The *MECP* Data Scanning information included all Ministry of the Environment, Conservation and Parks files pertaining to water, within 500 metres around a groundwater wellhead and 1000 m around a surface water intake.

6.1.3. Risk Assessment Methodology for Conditions

Should the committee become aware of a *condition* as described above, the *condition* is to be considered a *drinking water threat*. As with all *drinking water threats*, the *risk score* of a *condition* is identified in the *Technical Rules 2013: Assessment Report*, as the product of the *vulnerability score* and *hazard score*.

Risk = Vulnerability X Hazard

The assessment of *prescribed activities*, *other activities* and a description of the *MECP Table of Drinking Water Threats* (2017) is provided in Section 7 – Threats and Risk Assessment of this Assessment Report. As per Technical Rule 139 (Nov. 2009), the *hazard score* of a *condition* is:

(a) **10**, if there is evidence that the situation is causing off-site contamination

(b) **10**, if the *condition* is on a property where a well, intake or monitoring well (existing and planned *drinking water systems* that are major residential, included in the Terms of Reference by resolution or upon order of the Director, or serve reserves) is located

(c) **6**, if (a) and (b) do not apply.

The *risk score* of a *threat* due to a *condition* in *IPZ, WHPA, HVA* would depend on the *vulnerability scores*, and whether the *hazard score* of the *condition* is 6, or 10. Table 6-2 shows the general relationship between the *hazard score* and the resulting *threat* level for *conditions*.

Table 6-2 Threat Level Determination for Conditions

Hazard Score	Vulnerability Score	Risk Score	Threat Level
10	8 or greater	80 or greater	Significant*
	6 to less than 8	60 to less than 80	Moderate
	Greater than 4 but less than 6	Greater than 40 but less than 60	Low
	4 or less	40 or less than 40	No threat
6	Not possible	80 or greater	Significant*
	10	60 to less than 80	Moderate
	7 to less than 10	Greater than 40 but less than 60	Low
	Less than 7	40 or less than 40	No threat

Notes:
*There are additional scenarios where, regardless of the risk score, a threat is considered significant.

A *condition* is a *significant threat*, if the risk score is at or above 80 (as per Rule 140). According to Rule 141, a *condition* resulting from a past activity would be deemed a *significant threat* if:

- it is associated with an identified *drinking water* quality *issue*;
- it is identified as a *threat* that contributes (or may contribute) to an *issue*;
- it is located in an identified *issue*-contributing area within a *vulnerable area*; and
- there is evidence that the *condition* is or may be causing off-site contamination, or the *condition* is on a property where a well, intake or monitoring well is located.

As well, as per Rule 140.1, a *condition* is deemed a *significant threat* if it is demonstrated that a chemical or pathogen release due to a *condition* results in a deterioration to intake drinking water quality in an *IPZ-3* based on an extreme event approach (rule 68).

6.2 Conditions Assessment Findings

The efforts completed to date serve as a preliminary investigation for identifying conditions. A more comprehensive investigation will be conducted when more information is available, and the Source Protection Committee would consider conditions identified as per Rule 126 while developing a *Source Protection Plan* for the area. Since the Wallaceburg intake is within the St. Clair River Area of Concern (*AOC*), a review of the information and data available on the *AOC*, such as water, soil and sediment quality data within the *intake protection zone*, may be done.

The St. Clair River *AOC* area is a compilation of Canadian *subwatersheds* which directly drain to the St. Clair River. The *AOC* area drains approximately 14% of western Lambton County and 4% of northwest Chatham-Kent. This proportional area amounts to approximately 433 km² of Lambton County and approximately 108 km² of Chatham-Kent. Walpole Island is situated within the delta of the St. Clair River. 147 km² of Walpole Island lands drain to the delta watercourse features. The *AOC* includes 60 km of shoreline along the St. Clair River, 25 km along the Chenal Ecarte and 7 km along Lake St. Clair. The St. Clair River is located between the Canadian\US border and is situated adjacent to Lambton County on the Canadian side of the river. An additional 1.8 km section along the Chenal Ecarte is also included in Lambton County. The municipality of Chatham-Kent physically abuts the Chenal Ecarte for a distance of 23.2 km and Lake St. Clair for a distance of 7 km. Tributaries which ultimately discharge to the St. Clair River measure 285 km, while the total kilometres of tributaries that discharge to the Chenal Ecarte and Lake St. Clair measure 4,963 km. Twelve Beneficial Use Impairments (*BUI*s) were identified including “restrictions on *drinking water* consumption, or taste and odour problems” (source: St. Clair River Watershed Plan, *AOC* Area 1-A, Patty Hayman, December 2009). One

of the objectives to address this *BUI* is to “eliminate the need to close water treatment plant intakes due to chemical spills.” Available data and information on water, soil and sediment quality data within the *intake protection zone* may be reviewed in order to see whether the criteria of a *condition* are met as per Rule 126.

6.3 Data Gaps and Next Steps for Conditions

Data on past activities that may have resulted in *conditions* are sparse, thus a comprehensive investigation is yet to be conducted. If information such as:

- data from the Spills Action Centre of the *MECP*;
- additional data from *MECP* regional files (*MECP* Data Scanning) for *IPZ , HVA* and where the *vulnerability* is greater than 4

were made available to the *Source Protection Committee*, this information would be reviewed to determine if data reviewed might meet the criteria of a *condition* as per Rule 126. Findings would be included in an amended Assessment Report. The *Source Protection Committee* will continue to investigate any information on potential *conditions* that are brought to their attention. Should any *conditions* be identified as per Rule 126, it will be necessary to amend the Assessment Report to include those *conditions*. Technical studies on *conditions* for Kettle and Stony Point First Nation intake on Lake Huron commenced in spring 2011. Estimated timeline for the completion of that study is provided in Section 9.

7.0 Threats and Risk Assessment – Water Quality

In order to protect *drinking water* sources, it is necessary to identify the *activities* within *vulnerable areas* that pose a *threat* to *drinking water* sources. It is also necessary to assess the *risks* due to the identified *threats*. This section describes the *threats* and *risk* assessment work pertaining to water quality, conducted in the St. Clair Region Source Protection Area. The *risk* associated with water quantity *threats* is considered in Section 3 - Water Budget and Water Quantity Stress Assessment of the Assessment Report.

A *drinking water threat* is an "*activity* or *condition* that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of *drinking water*" (Clean Water Act, 2006). Risk Assessment is the process of assessing the *threats* to determine their relative *risk* to the *drinking water* source. It considers the *vulnerability* of the area that the *activity* is being undertaken in. It also considers the hazard associated with the *activity*.

Following the completion of the Assessment Report, a *Source Protection Plan* must be developed by the *Source Protection Committee*. The focus of the *Source Protection Plan* is to reduce *risks* to *drinking water* sources by managing the *threats* causing those *risks*. The *Source Protection Plan* will contain policies focused on *activities* which are identified as *threats* within the *vulnerable areas*. Hence, the identification of the *threats* and the assessment of *risks* due to the *threats* are key to the development of the *Source Protection Plan*. Further, the *Source Protection Plan* must mitigate those *risks* to *drinking water* sources that are deemed to be *significant*. The policies related to *significant threats* are mandatory and must be implemented. Source protection policies may include incentive programs, education and outreach, new or amended provincial instruments, and *risk* management plans.

The Threats and Risk Assessment studies involved the operating authorities of the *drinking water systems* and were undertaken through partnerships involving the Conservation Authorities in the region. As described in Section 4 of this Assessment Report, a project was led by the St. Clair Region Conservation Authority (*SCRCA*), in partnership with the Lambton Area Water Supply System (*LAWSS*) and Town of Petrolia, for 2 surface water intakes in the *SCRSPA*. R. V. Anderson Associates Limited was the primary consultant and retained Baird and Associates to undertake the hydrodynamic modelling work. The 2 intakes studied in this project serve the water treatment plants of *LAWSS* and Town of Petrolia at Bright's Grove.

A large project, led by the Essex Region Conservation Authority (*ERCA*) was initiated through a partnership between *ERCA* and the Conservation Authorities in the Thames-Sydenham and Region and the plant operators. This project included 1 intake in *SCRSPA* serving the Wallaceburg water treatment plant, 2 intakes in the Lower Thames Valley Source Protection Area, and 7 intakes in the Essex Region Source Protection Area. Stantec Consulting Limited was the primary consultant and retained Baird and Associates to undertake the hydrodynamic modelling work. The Municipality of Chatham-Kent Public Utilities Commission (*PUC*) was an active partner in the project and participated in the technical steering of the project. LTVCA staff created mapping products needed in threats analysis, and analysed certain types of threats.

The technical reports for the above described studies are listed in Table 7-1 below:

Table 7-1 Technical Studies on Drinking Water Threats and Risk Assessment

Drinking Water Systems	Technical Study on Threats and Risk Assessment
Lambton Area Water Supply System	Lambton Area Water Supply System (LAWSS) Final Report – Drinking Water Issues and Threats, October 2009, R.V. Anderson Associates Limited.
Petrolia Water Treatment Plant	Town of Petrolia Water Treatment Plant Final Report – Drinking Water Issues and Threats, October 2009, R.V. Anderson Associates Limited.
Wallaceburg Water Treatment Plant	Technical Memorandum: Threats Analysis for the Wallaceburg Water Treatment Plant. Essex Chatham-Kent Source Protection Planning Technical Study. March 2010. Stantec Consulting Ltd.
Lambton Area Water Supply System, Petrolia Water Treatment Plant, Wallaceburg Water Treatment Plant	1. Technical Memo regarding Creation of Impervious, Managed Land and Livestock Density Maps. Thames-Sydenham and Region. Jason Wintermute. February 2, 2010. 2. Technical Memo regarding the Assessment of Chemical Threats from the Application of ASM, NASM and Commercial Fertilizers. Thames-Sydenham and Region. Jason Wintermute. November 9, 2010. 3. Technical Memo regarding the Assessment of Chemical Threats from the Use of Land as Livestock Grazing, Pasturing Land, and Outdoor Confinement Area or a Farm-Animal Yard. Thames-Sydenham and Region. Jason Wintermute. March 2011.
Kettle and Stony Point Water Supply System	Intake Protection Zone Delineation and Vulnerability Analysis for the Kettle Point Intake, December 2011, HCCL and Riggs Engineering
Thames Sydenham Region	Technical Memo, Terry Chapman, Stephen Clark

From these technical studies, information is compiled and provided in this section of the Assessment Report. This section is organized into discussions on the types of *activities* that may be considered as *drinking water* quality *threats*, the methodology used to identify *threats* and assess *risks*, the lists of *threats* in *vulnerable areas* with maps showing these, and lastly the next steps and data gaps.

7.1 Drinking Water Quality Threat Identification and Risk Assessment Methodology

Drinking water quality *threats* in *vulnerable areas* must be identified and assessed as to their *risk* to the *drinking water* source. The *vulnerable areas* are *Intake Protection Zone (IPZ), Wellhead Protection Area (WHPA), Highly Vulnerable Aquifers (HVA)*. *IPZ* are comprised of *IPZ-1, IPZ-2* and *IPZ-3*, while *WHPA* are comprised of *WHPA-A, WHPA-B, WHPA-C, WHPA-D,*

WHPA-E and *WHPA-F*. It should be noted, however, there are no municipal water systems that use groundwater in the St. Clair Region *SPA*. The vulnerability assessment (including delineation and assignment of *vulnerability scores*) of these *vulnerable areas* is described in Section 4 – Vulnerability Assessment of this Assessment Report. In the St. Clair Region Source Protection Area, three *drinking water systems* draw their source water from Lake Huron, the St. Clair River and the Chenal Ecarte. Map 4-1 shows the location of the *IPZ* around the municipal intakes. Map 4-5 shows the delineated *HVA* in the St. Clair Region Source Protection Area.

The *drinking water* quality *threats* that may be considered in the identified *vulnerable areas* are those due to: *prescribed activities*, *other activities*, *conditions* (past activities) and *activities* contributing to identified *drinking water* quality *issues*. The *Technical Rules 2013: Assessment Report* Part XI describes the listing of *drinking water* quality *threats*. In the Thames-Sydenham and Region, a local guidance document was developed to provide clarification and local interpretation of the relevant sections in the Clean Water Act, its regulations and the associated *technical rules* pertaining to the *threats* and *risk* assessment. The methodology is included in Appendix 10.
To identify where low, moderate and significant threats can be identified it is recommendated to use both the Ontario Drinking Water Threats and Circumstances Table Tool and link that so the WHPAs and IPZs scoring maps.

The sections below summarize the types of *threats* and the methodology followed in the region to identify *threats* and assess *risks*.

7.1.1. Prescribed Drinking Water Threats

Through the Clean Water Act and General Regulation 287/07, a list of 22 *prescribed drinking water threats* is provided. That list is reproduced in Table 7-2.

Table 7-2 Activities Prescribed as Drinking Water Threats

1. The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.

Table 7-2 Activities Prescribed as Drinking Water Threats

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. O. Reg. 385/08, s. 3.
22. The establishment and operation of a liquid hydrocarbon pipeline. O.Reg. 206/18, s.1.

The *risk* associated with *activities prescribed* as water quantity related *threats* (numbers 19 and 20 in the above table) are considered in Section 3 – Water Budget and Water Quantity *Stress Assessment* of this Assessment Report. The *activities* 1 to 18 and 21 are *prescribed* drinking water *threats* related to *drinking water* quality and are discussed in this section. They may be summarized into:

- Application, handling and storage of *agricultural source material* (manure), *non-agricultural source material* (bio-solids), commercial fertilizer, pesticide or road salt
- Handling and storage of fuel, *dense non-aqueous phase liquids*, or organic solvents
- Management of runoff that contains aircraft de-icing chemicals
- Livestock grazing or pasturing land, outdoor confinement areas or farm-animal yards
- Snow storage

- Systems that collect, store, transmit, treat or dispose of sewage
- Waste disposal sites

An *activity* may pose a *risk* to *drinking water* quality based on the following factors which are described further in this section:

- the *vulnerable area* where the *activity* is located;
- the *vulnerability score* assigned to that area;
- the *circumstances* related to the *activity*; and
- the *hazard score* resulting from the *activity* under the *circumstances* related to the *activity*.

An *activity* is deemed to be a significant, moderate or low *threat* depending on the calculated *risk score*. The *risk score* is calculated by multiplying the *vulnerability score* assigned to a *vulnerable area* with the *hazard score* of the *activity*.

Risk = Vulnerability X Hazard

Table 7-3 shows the relationship between the *risk score* calculated and the resulting *threat* level. The highest possible *risk score* is 100. A *risk score* of 80 or greater results in a *significant threat* level. Some exceptions include *issue*-based *threats* which are deemed *significant* regardless of the *vulnerability area* and score, and *activities* related to *Dense Non-Aqueous Phase Liquids* (*DNAPLs*) which are *significant threats* in *WHPA-A* (100 m radius), *WHPA-B* (2 year capture zone excluding A), and *WHPA-C* (2 to 5 year capture zone) regardless of the *vulnerability score*. *Pathogens* are not viewed as *threats* at all, outside of *WHPA-A, WHPA-B, WHPA-E* and *IPZ-1* and *IPZ-2*.

Table 7-3 Threat Level Determination

Risk Score	Threat Level
80 or more	Significant

60 or greater, but less than 80	Moderate
Greater than 40, but less than 60	Low
40 or less than 40	No threat

As mentioned earlier, the *vulnerable areas* are *IPZ, WHPA, HVA* and *SGRA*. According to the *Technical Rules (2017): Assessment Report*, *vulnerability scores* for Great Lakes *IPZ* range from 3.5 to 7 (depending on whether it is for *IPZ-1* or *IPZ-2*), and for Connecting Channels (Type B Intake), *vulnerability scores* can range from 4.9 to 9. An *activity* can only be identified as a *threat* if it is occurring in a *vulnerable area* and the *vulnerability score* of the area is greater than 4. In an area where the *vulnerability score* is 8 or greater, the *threat* may be *significant* (dependent on the *circumstances* associated with *activity*). The highest *vulnerability score* possible for a Great Lakes *IPZ* is 7, while *a Type B – Connecting Channel IPZ* can have *vulnerability scores* of up to 9. As a result, it is not expected that there will be any *significant threats* of the Great Lakes *IPZ*s. It is, however, possible to have *significant threats* in Type B – Connecting Channel *IPZ*s, dependent upon the assigned *vulnerability score*. The *IPZ-3* for Type A and B intakes are not assigned vulnerability scores as per the Technical Rules (2017). However, through the issues based and events based threats assessment approach, *significant threats* can be identified.

HVA are assigned a *vulnerability score* of 6 as described in Section 4 – Vulnerability Assessment. Hence there can be no *significant threats* in these *vulnerable areas*.

In order to assess the *risks* due to the *prescribed drinking water* quality *threats*, the Ministry of Environment, Conservation and Parks (*MECP*) has developed '*Tables of Drinking Water Threats*' based on the 21 *prescribed threats*. The *MECP tables of drinking water threats* include the results of the *risk score* calculation and identify the *threat* level associated with an *activity* based on the *vulnerability score* of the area in which the *activity* is being undertaken. The *MECP tables of drinking water threats* provide the *circumstances* under which an *activity* may be categorized as a low, moderate or *significant threat*. Hence, the *circumstances* of the *activity* are

considered to determine the level of *risk* associated with a water *threat*. The *circumstances* to be considered include the type of material, the quantity of material and whether it might be released to surface water or groundwater. Each combination of *circumstances* for an *activity* is assigned a *hazard score*. The *hazard score* ranges between 4.1 to 10 for chemical *threats*, 5 to 10 for *pathogens*, and 8.3 to 10 for *DNAPLs*.

There are two separate tables in the *tables of drinking water threats* for *activities* related to chemicals and for *activities* related to *pathogens*. Chemicals include, but are not limited to, nitrogen and phosphorus (related to the application of commercial fertilizers, and *agricultural source material* and *non-agricultural source material* to land), atrazine, dicamba, glyphosate (related to the application of pesticide on land), trichloroethylene, vinyl chloride (related to the handling and storage of *dense non-aqueous phase liquids*), *BTEX*, certain petroleum hydrocarbons (related to the handling and storage of fuel), chloroform (related to the handling and storage of organic solvent), sodium and copper (related to the storage of snow). *Dense non-aqueous phase liquids* (*DNAPLs*) are considered under chemical related *activities* except in *WHPA-A, WHPA-B* and *WHPA-C* where they are considered separately, as explained in the *risk* determination discussion below. *DNAPLs* are heavier than water and do not mix with water. They are of concern in groundwater since they sink into the ground, settle at the bottom of and contaminate an *aquifer*. Examples of *activities* or products containing *DNAPLs* include: dry cleaning, pesticides, brake cleaners, glues, varnishes, automotive coolant and nail polish. *Pathogens* are disease-causing microorganisms and in the *tables of drinking water threats*, they are not limited to a specific list of types of *pathogens*. *Activities* that may cause the presence of *pathogens* include, but are not limited to, the application of *agricultural source material and non-agricultural source material* to land, livestock grazing, and sewage discharge.

The Clean Water Act requires the enumeration of locations at which a *significant threat* is thought to occur. Also, a list of *activities* which are or 'would be' *threats* is to be included. Generally, this is addressed by including all *activities* listed in the *prescribed* lists even if they are not currently occurring in an area. *Activities* not currently occurring in the *vulnerable areas*, 'would be' *threats* if the *activity* was to occur in the future. The *circumstances* which result in *significant threats* must also be identified in the Assessment Reports.

As part of the identification of certain *prescribed* chemical *drinking water threats*, an intermediate step involving the creation of maps showing impervious area, managed lands and livestock density is necessary. A determination of the percentage of impervious area is needed to determine the level of *threat* associated with the application of road salt. Also, the percentage of managed lands is required, as this is related to the level of *threat* for the application of *agricultural source material* (*ASM*), commercial fertilizer or *non-agricultural source material* (*NASM*). The *technical rules* 2013 also require that the livestock density for an area, expressed in terms of nutrient units/acre, be determined as a means of estimating the potential for the generation, storage and application of *agricultural source materials* (*ASM*) in an area.

Any *pathogen threats* associated with these *activities* are assessed separately using the *pathogen* table of the *tables of drinking water threats*. The calculations made to map the impervious area, managed lands and livestock density are described briefly below.

7.1.1.1. Impervious Area

For determining the *risk* level associated with the application of road salt, the percentage of impervious area must be determined. Impervious areas related to application of road salt include roads, parking areas and sidewalks. The percentage of impervious surface areas must be calculated within each square kilometre of *vulnerable areas* (Rule 16). The percentage impervious is calculated for each square kilometre as determined by overlaying a 1 kilometre by 1 kilometre grid over the *vulnerable area* with a node of the grid located at the centroid of the Source Protection Area. Geographic Information System (*GIS*) tools were used to undertake this calculation for each grid which touched a *vulnerable area*. The Percent of Impervious Areas within the grids touching an *IPZ-1, IPZ-2*, *HVA* have been calculated and maps completed. Maps 7-1a, 7-1b and 7-1c are presented in Appendix 1. This work is not required for *IPZ-3* as these zones within the SCR SPA are not assigned a vulnerability score and the event modelling does not require this mapping.

7.1.1.2. Managed Lands

In determining the percentage of managed lands, *Source Protection Committees* must determine the areas where there may be application of *agricultural source material* (*ASM*), commercial fertilizer, or *non-agricultural source material* (*NASM*). These areas are expressed as

percentages of the total area being evaluated. Mapping the percentage of managed lands is not required where the *vulnerability score* for an area is less than the *vulnerability score* necessary for the *activity* to be considered a *threat* in the *Table of Drinking Water Threats* (2017). Managed lands can be broken into two types: agricultural managed land and non-agricultural managed land. Agricultural managed land includes areas of cropland, fallow and improved pasture that may receive nutrients. Non-agricultural managed lands include golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer). Both managed land and agricultural managed lands are to be calculated within each of the *vulnerable areas* (individually for each *IPZ-1*, *IPZ-2* and *IPZ-3* as well as for *HVA*).

The percentage of managed land area within a *vulnerable area* is the sum of agricultural managed land and non-agricultural managed land, divided by the total area of *all land* within a *vulnerable area*, multiplied by 100. This was undertaken for each *IPZ-1* and *IPZ-2.* Where a parcel of managed land is partially within a *vulnerable area*, only the portion of the parcel within the *vulnerable area* is used in the calculations. This work is not required for *IPZ-3* as these zones within the SCRSPA are not assigned a vulnerability score and the event modelling does not require this mapping.

7.1.1.3. Livestock Density

Livestock density is used as a surrogate measure of the potential for generating, storing, and land applying *Agricultural Source Material* (*ASM*) as a source of nutrients within a defined area. The livestock density is expressed in nutrient units per acre (NU/Acre). The calculation of livestock density in a specified area requires the following steps:

1. Estimate the number of each category of animals present within the specified area,
2. Convert the number of each category of poultry and livestock present into nutrient units (NU), to enable all livestock to be compared on an equivalent unit of measure in terms of the nutrients produced by each type,
3. Sum the total NU of all categories of poultry and livestock within the specified area and then divide this NU value by the area of agricultural managed land within the same specified area.

For the assessment of chemical threats related to the land application of nutrients, the "specified area" mentioned above refers to the vulnerable area being examined (only if a threat can exist there), while the agricultural managed land refers to all agricultural managed land including cropland and pastureland. This work is not required for *IPZ-3* as these zones within the SCRSPA are not assigned a vulnerability score and the event modelling does not require this mapping.

For the assessment of chemical threats related to the use of land for livestock grazing, pasturing or outdoor confinement area or animal yard, the "specified area" mentioned above refers to the whole of the farm itself being examined, while the agricultural managed land refers to only that agricultural managed land being assessed, i.e. grazing land, pasture land, outdoor confinement area or animal yard. This work is not required for *IPZ-3* as these zones within the SCRSPA are not assigned a vulnerability score and the event modelling does not require this mapping.

7.1.1.4. Risk Assessment using Managed Lands and Livestock Density

The percentage of managed land and the livestock density of an area are used together as a surrogate for representing the quantity of nutrients present as a result of nutrient generation, storage, and land application within an area. The *risk* assessment using managed lands and livestock density calculations is described below.

Chemical Threats Related to the Land Application of Nutrients

Table 1 of the *MECP tables of drinking water threats* requires that both percentage of managed lands and livestock density be considered when evaluating the *circumstances* with regard to each of the thresholds for land application of nutrients. Table 7-4 summarizes the chemical *hazard scores* for various combinations of percentage of managed lands and livestock densities. These are the consolidated *hazard scores*, incorporating the quantity, toxicity and fate scores. The highlighted combinations of percentage of managed land and NU/Acre give a hazard rating for land application of nutrients that, when combined with the area *vulnerability scores* of 9 or 10, would result in *significant risk* to source waters. To calculate *risk*, the *hazard score* is multiplied by the *vulnerability score* for the area.

Table 7-4 Chemical Hazard Scorings for Various Combinations of Percentage of Managed Lands and Livestock Densities

Percentage Managed Land of Total Land	Nutrient Units (NU) per Acre of Cropland		
	< 0.5 NU/acre	0.5 to 1.0 NU/acre	> 1.0 NU/acre
GROUNDWATER			
> 80%	**8 Significant in areas of Vulnerability Score 10**	**8.4 Significant in areas of Vulnerability Score 10**	**8.4 Significant in Areas of Vulnerability Score 10**
40 to 80%	6.8	7.6	**8.4 Significant in areas of Vulnerability Score 10**
< 40%	6	6.8	**8 Significant in areas of Vulnerability Score 10**
SURFACE WATER			
> 80%	**8.8 Significant in areas of Vulnerability Score 10**	**9.2 Significant in areas of Vulnerability Score 10 or 9**	**9.2 Significant in areas of Vulnerability Score 10 or 9**
40 to 80%	7.6	**8.4 Significant in areas of Vulnerability Score 10**	**9.2 Significant in areas of Vulnerability Score 10 or 9**
< 40%	6.8	7.6	**8.8 Significant in areas of Vulnerability Score 10**

Chemical Threats Related to the Use of Land for Livestock Grazing, Pasturing or Outdoor Confinement Area or Farm-Animal Yard

In general, the use of land as livestock grazing or pasture land will be a *significant* chemical *threat* in:

- *Vulnerable Areas* scoring 9 if the livestock density is sufficient to generate nutrients at an annual rate that is more than 1.0 Nutrient Units per acre (NU/acre); or
- *Vulnerable Areas* scoring 10 if the livestock density is sufficient to generate nutrients at an annual rate that is at least 0.5 NU/acre for surface water (in an *IPZ*) or more than 1.0 NU /acre for groundwater; and
- if the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater. The *tables of drinking water threats* refer to Phosphorus in groundwater, but do not identify any *threats* associated with it in a *WHPA*.

The use of land as livestock outdoor confinement area or a farm-animal yard will be a *significant* chemical *threat* in:

- *Vulnerable Areas* scoring 10 if the number of animals confined in the area at any time is sufficient to generate nutrients at a rate of more than 300 nutrient units (NU) per hectare of the area annually for groundwater and at a rate of more than 120 NUs per hectare of the area annually for surface water (*IPZ*); or
- *Vulnerable Areas* scoring 9 if the number of animals confined in the area at any time is sufficient to generate nutrients at a rate of more than 120 NUs per hectare of the area annually for surface water (in an *IPZ*); and
- the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater. The *tables of drinking water threats* refer to Phosphorus in groundwater, but do not identify any *threats* associated with it in a *WHPA*.

Chemical Threats Related to Agricultural Source Material Storage

The *technical rules* (2017) and associated *tables of drinking water threats* state that the use of land to store *Agricultural Source Material* (*ASM*) would be a *significant* chemical *threat* in *Vulnerable Areas* scoring 9 or 10 if the weight or volume of manure stored annually on a farm parcel is sufficient to annually land apply nutrients at a rate that is more than 1.0 Nutrient Units per Acre (NU/Acre) of the farm parcel. Under the Table of *Drinking Water Threats* (2017) this is determined by the NU stored on farm parcel divided by the size of farm parcel. Furthermore, another *circumstance* for *ASM* storage is that a spill of the material or runoff from the area where the material is stored (i.e. a point source release) may result in the presence of Nitrogen or Phosphorus in groundwater (*WHPA*) or surface water (*IPZ*).

7.1.2. Other Activities

The Clean Water Act also allows the *Source Protection Committee* to include *activities* that they consider being *drinking water threats* but are not *prescribed drinking water threats*. This requires approval of the Director. These are called other activities (Rule 119) and are often referred to as local threats. The Source Protection Committee can also identify additional circumstances (not already in the tables of drinking water threats) under which they consider the activity to be a prescribed drinking water threat. The Source Protection Committee is considering a few such

other activities, as discussed in Section 7.2.9. The SPC considered including geothermal systems (harnessing underground temperature), pipelines and transportation (shipping, rail or road transport of materials). Only transportation (of fuel and fertilizer) and pipelines (fuel) were requested based on the results of event based modelling which is discussed further in section 7.2.8 and 7.2.9. As part of the updates to the Table of Drinking Water Threats in 2017, 'the establishment and operation of liquid hydrocarbon pipelines' has been identified as a new prescribed threat and not a local threat in the Thames-Sydenham Source Protection Region.

Other activities may be listed as *threats* only if the *Source Protection Committee* identifies them as *drinking water threats*, and similar to the *prescribed threats*, if the *hazard score* is greater than 4 and the *risk score* calculated is greater than 40. The *hazard score* must be calculated based on certain criteria set out in the *technical rules* (2017), and further must be agreed upon by the Director (*MECP*). Based on the hazard score and vulnerability score of an area, these local threats may be considered a low, moderate or significant drinking water threat. The tables in appendix 10 identify where these activities are considered low, moderate or significant threats to drinking water. Event based modelling allows the threat to be considered a significant drinking water threat irrespective of the vulnerability score of the area as the modelling demonstrates its effect on the intake.

7.1.3. Threats Arising from Conditions

Conditions are a result of past activities. In general, *conditions* are the presence of:

- non-aqueous phase liquids in *WHPA*, *HVA*
- a single mass of more than 100 litres of *dense non-aqueous phase liquids* in surface water in an *IPZ*
- a contaminant in the groundwater of an *HVA* or *WHPA*, in surface soil of an *IPZ*, or in sediments in a *vulnerable area*, that exceeds a certain *MECP* 'criteria' for different land uses

The list above is only a summary of the types of situations that can be considered *conditions*. The actual list of situations are in Section 6 – Conditions Assessment of the Assessment Report, along with what the *MECP* 'criteria' are from *MECP* published tables of standards for soil, groundwater and sediments for land uses such as commercial, residential and industrial.

If *Conditions* (resulting from past activities) are identified, the *hazard score* is either 6 or 10 depending on certain factors (Rule 139). There are additional scenarios where, regardless of the *risk score*, a *condition* is a *significant threat*. These scenarios are when a *condition* is related to a *drinking water* quality *issue* or an *IPZ-3*. For more information, refer to Section 6 – Conditions Assessment of this Assessment Report.

7.1.4. Threats Arising from Issues

A *drinking water issue* is a *parameter* (a substance) or *pathogen* (a disease-causing microorganism) which is shown to deteriorate, or trends towards a deterioration of raw (untreated) water quality for the purposes of drinking. The *issues* identified in the St. Clair Region Source Protection Area are summarized in Section 5 – *Issues* Evaluation of the Assessment Report. They are identified as per Rule 115.1. The sources of some of the issues are yet to be determined.

According to Rules 114, 115, 131 and 141, *activities* or *conditions* that contribute to drinking water quality *issues* (known to be partially or wholly due to *anthropogenic* sources), are deemed *significant* drinking water *threats* regardless of assigned vulnerability scores. This applies to intake protection zones and wellhead protection areas only, for drinking water systems identified in the Source Protection Area Terms of Reference.

If an *issue* is identified, the *activities* that contribute to the identified *issue* and the areas where they occur (within *vulnerable areas*, as described above) must also be identified.

For the *activities* or *conditions* contributing to *issues* that are deemed to be *significant threats* as described above, the *risks* the *activities* or *conditions* pose must be reduced through the source protection plan. The *issues* identified in the St. Clair Region Source Protection Area are identified as per Rule 115.1. The sources of some of the issues are yet to be determined, and are identified as a data gap in Section 5. Filling of this data gap, as more information becomes available to the SPC, may help identify *issues* as per Rule 114, and therefore lead to identifying the area and activity contributing to those *issues* as required by rule 115.

Further, *issues* in *HVAs* or those linked to a system not identified in the Terms of Reference may lead to the identification of moderate drinking water threats (not significant threats). Systems not identified in the Terms of Reference may be those included in the source protection planning process through municipal council resolution or by the Minister (MECP).

7.1.5. Local Guidance and Technical Studies

In the Thames-Sydenham and Region, the *threat* and *risk* assessment work was done according to the Threats and Risk Assessment Local Guidance Version 1.2 (September 9, 2009). This guidance document provides clarification and local interpretation of the relevant sections in the Clean Water Act, its regulations and the associated *technical rules* 2013 pertaining to the *threats* and *risk* assessment. It is provided in Appendix 10.

The *threats* analysis for *IPZ-1 and IPZ-2* of the Petrolia Water Treatment Plant intake in Lake Huron, the Lambton Area Water Supply System intake in the St. Clair River and the Wallaceburg Water Treatment Plant in the Chenal Ecarte was based on reviewing the Ministry of Environment, Conservation and Parks *tables of drinking water threats* and the *vulnerability scores* of these *IPZs*. The *vulnerability scores* and *vulnerable areas* were considered to generate the listing of land use *activities* that are or would be *drinking water threats* in each *vulnerable area*. The listing details land use *activities* that, given the *vulnerability score* for each specific *vulnerable area*, would present low, moderate, or significant *drinking water threats*.

Additionally, for the *LAWSS*, Petrolia and Wallaceburg *IPZ-1* and *IPZ-2*, a desktop survey conducted using *GIS* mapping also helped to identify potential threats for the inventory. Using various municipal, provincial and federal sources of information, specific land use *activities* were identified and assigned to some land parcels. Also, discussions with the steering committee and local water treatment plant operators helped further to identify land use *activities* not previously identified in the initial screening process.

Determining the applicable *circumstances* is based on a combination of site-specific knowledge of *activities* on the property, available information on local or regional characteristics, and on professional opinion. Where possible, site-specific data from information provided through

available public records and interviews are considered. In many cases, selection of the relevant *circumstance* is based largely on professional opinion as to the likelihood of a *circumstance* being applicable, as site inspections have not been conducted to date. A Tier 2, or site-specific, *risk* assessment to confirm the number of locations at which it is believed that *significant threats* are or would occur, would be conducted while developing *source protection plans* (2012) if needed.

7.1.6. Events Based Significant Threats Assessment Studies

In the Thames-Sydenham and Region, a comprehensive *threat* assessment for *IPZ-3*. was completed by CA staff using similar methodologies to the previous inventory work. It was generally completed as a desktop exercise with drive-by inspections where appropriate. However the spills scenarios used to delineate an *IPZ-3* based on event specific modelling were also used to identify *activities* that could be *significant threats*. The events based modelling is described in detail in Section 4.2.5.

Number of locations of significant drinking water threats provided in the tables 7-5 in the following section are based on this inventory work. It will be important that site inspection as part of routine compliance monitoring or threats verification be undertaken by Risk Management Inspectors as part of the implementation of the SP.

The events based approach is based on Technical Rules (2013) 68, 69 and 130 and further direction from MECP based on their Technical Bulletin 'Delineation of Intake Protection Zone 3 Using the Events Based Approach (EBA)', dated July 2009, as well as a memorandum issued November 15, 2010. As discussed in Section 4.2.5, an *IPZ-3* is to be delineated if modelling demonstrates that contaminants released during an extreme event may be transported to an intake.

In addition, according to Rule 130, an *activity* is or would be a *significant threat* in an *IPZ* if modelling demonstrates that the contaminant reaches the intake at a concentration that deteriorates the water as a drinking water source. In the St. Clair Region SPA, for purposes of *IPZ-3* delineation and threats assessment, a contaminant concentration at or above the Ontario

Drinking Water Quality Standards is considered to be indicative of the deterioration of a drinking water source.

A future *activity* may also be considered where it is known that the *activity* will be taking place or is expected to take place in the future. Also, it is important to note that Technical Rule 130 may also be used to identify potential *significant threats* not only in *IPZ-3s*, but also in *IPZ-1s* and *IPZ-2s*.

The identification of *significant threat*s using the events based spills modelling approach, in the *LAWSS*, Petrolia and Wallaceburg *IPZ-3s*, are described in Section 7.2.2 and Section 7.2.7.

7.2 Drinking Water Quality Threats and Risk Assessment

For the *IPZ-1s* and *IPZ-2s*, from the *prescribed* list of *activities*, the *drinking water threats* and their *circumstances* were identified in *vulnerable areas* of each *drinking water system*. They are described further in this section and can also be found on the provinces' Table of Drinking Water Threats under the 2017 Technical Rules website at https://www.ontario.ca/page/tables-drinking-water-threats or through the Threats Tool website at https://swpip.ca/.For the *IPZ-3s*, significant threats were identified through events based modelling of various contaminant spill scenarios.

The Source Protection Committee has identified 'other' (not prescribed) activities or circumstances (not in the tables of drinking water threats) based on results of event based studies undertaken. A request was made to the Director to add the transportation of fuel and fertilizer along provincial highways, county and local roads and waterways as a 'local threat' in the updated Assessment Report. It was also requested to consider transportation of liquid petroleum products through pipelines as a local drinking water quality threats. The letter approving these local threats is attached in Appendix 10. As part of the updates to the Table of Drinking Water Threats in 2017, Liquid Hydrocarbon pipelines are now considered a prescribed threat and not a local threat. The *Source Protection Committee* has also expressed a concern over the potential *risk* that geothermal systems pose to groundwater *aquifers*. The *Source Protection Committee* will give further consideration to these *activities* and may include them in an amended Assessment Report if they cannot be adequately addressed through other means.

The investigation to determine if there are any *conditions* (*threats* resulting from past *activities*) is yet to be completed at the time of drafting this Assessment Report. A potential *condition* in the St. Clair Region Source Protection Area related to the St. Clair River as an Area of Concern will be investigated. More studies will be undertaken on identifying and assessing *conditions* and the Assessment Report will be amended if necessary. These are discussed in Section 6 – Conditions Assessment.

Activities that contribute to *issues* (known to be partially or wholly due to anthropogenic causes) are deemed a *significant risk* by the Clean Water Act in an *IPZ* or *WHPA*. The area and *activities* contributing to such a *drinking water* quality *issue* must be identified. However the work to determine the sources of issues is yet to be done and is noted as a data gap in Section 5 – *Issues* Evaluation of the Assessment Report.

The following subsections describe the findings of the *threats* identification, and results of the *risk* assessment for each *drinking water system*. This includes the identification of *significant threats*, number of locations at which *significant threats* are or would occur, and areas within *vulnerable areas* where low, moderate or *significant threats* could occur.

7.2.1. Threats Identified through Calculation and Mapping of Impervious Surfaces, Managed Lands and Livestock Density

The maps indicating impervious surfaces, managed lands and livestock density in the region were updated based on *MECP* guidance received during the drafting of this Assessment Report (see Maps 7-1a, 7-1b, 7-1c, 7-2, 7-3, 7-4, 7-5, 7-6, 7-7 of Appendix 1). The identification of the *threats* related to these mapped areas are completed. The *threats* related to these mapping products are the application of *agricultural source material* (*ASM*) and *non-agricultural source material* (*NASM*) to land, the application of commercial fertilizer to land, and the application of road salt. Livestock density and agricultural managed land are also used in the farm-level risk assessment related to the *threat* 'use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.'

Within the *SCRSPA*, only the Wallaceburg *IPZ-1* has a vulnerability score sufficient to allow for possible significant chemical threats from the application of *ASM*, *NASM* or commercial fertilizers. Mapping of managed lands and livestock density shows that the Wallaceburg *IPZ-1* has a managed land percentage between 40-80% and a livestock density between 0.0 and 0.5 NU/acre. Aerial photography shows no livestock operations on parcels that fall within the Wallaceburg *IPZ-1* on that side of the Chenal Ecarte being reviewed. According the "Tables of Drinking Water Threats" (MECP, November 2009), with these circumstances, *significant threats* do not occur.

For activities related to the use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard, no chemical or pathogen *threats* were identified in *IPZ*s with vulnerability scores at or greater than 4.5 (chemical) and 4.2 (pathogen) due to current land use (scores lower than these do not result in these activities being identified as *threats* in *IPZ*s). Aerial photography shows no livestock operations on parcels that fall within the Wallaceburg *IPZ-1* on that side of the Chenal Ecarte being reviewed. With these circumstances, *significant threats* do not occur.

Due to the vulnerability scoring of the *IPZ* for Great Lakes intakes, and for *HVA* the analysis will not result in the identification of any *significant threats* in these *vulnerable areas*.

Therefore no *significant threats* related to the activities described above were identified within the *vulnerable areas* of the St. Clair Region *SPA*.

7.2.2. Number of Locations of Significant Threats

Table 7-5 provides the number of locations where *significant threats* are thought to occur, based on current land use, within the *vulnerable areas* of the St. Clair Region Source Protection Area. These numbers include *threats* due to chemical and *pathogen*-related *activities*. As can be seen from Table 7-5, there are no locations of *activities* that 'are or would be' *significant threats* within the Petrolia *IPZ-1 and IPZ-2*, the *LAWSS IPZ-2*, the Wallaceburg *IPZ-2*, the *HVA*. This is due to the range of *vulnerability scores* in these *vulnerable areas*. The *significant threats* in the *EBA* areas are event based threats and more information on this is provided in section 7.2.7.

In the *LAWSS IPZ-1* and the Wallaceburg *IPZ-1*, though it is possible to have *significant threats* occur with the assigned *vulnerability score* of 8 and 9, a review of the current land use indicates that there are no *significant threats* in these areas. Table 7-5 shows that there are no locations where significant threats are thought to occur, based on current land use, within the vulnerable areas of the St. Clair Region Source Protection Area. Further, there are no locations or activities that 'are or would be' significant threats within the Petrolia *IPZ-1* and *IPZ-2*, the *LAWSS IPZ-2*, the Wallaceburg *IPZ-2,* and the *HVA*. This is due to the range of vulnerability scores in these areas.

Table 7-5 Number of Locations of Significant Drinking Water Threats

System and Vulnerable Area	Vulnerability Score	Number of Locations of Significant Threats
Lambton Area Water Supply System		
IPZ-1	8	0
IPZ-2	6.4	0
EBA-Fuel	-	1
Petrolia Water Treatment Plant		
IPZ-1	7	0
IPZ-2	6.3	0
EBA-Fuel	-	2
Wallaceburg Water Treatment Plant		
IPZ-1	9	0
IPZ-2	7.2	0
EBA-Fuel	-	10
EBA-Fertilizer	-	6
Kettle and Stony Point		
IPZ-1	5	0
IPZ-2	4	0
HVA		
HVA	6.0	0
		0

7.2.3. Threats in Lambton Area Water Supply System (LAWSS) Intake Protection Zones

Table 7-6 shows the levels of *threats* that are possible in this *vulnerable area*. Map 7-8 shows areas in the *LAWSS IPZ-1* and *IPZ-2* where *activities* may pose low, moderate or *significant threats*. The level of *threat* is dependent upon where the *activity* is occurring, the *vulnerability*

score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-6 Levels of Threats Related to Pathogens and Chemicals in the LAWSS IPZs

Vulnerable Area	Vulnerability Score	Level of Threat for Activities Related to Pathogens			Level of Threat for Activities Related to Chemicals		
		Significant	Moderate	Low	Significant	Moderate	Low
IPZ-1*	8	Yes	Yes	Yes	Yes	Yes	Yes
IPZ-2*	6.4	No	Yes	Yes	No	Yes	Yes
IPZ-3*	NA	No	No	No	No	No	No
* Event modelled threats are significant in the EBA within IPZ-1, 2 and 3							

When current land use is also considered, the number of locations where *significant threats* could occur in the *vulnerable areas* in the *LAWSS IPZ-1 and IPZ-2* is shown in Table 7-7. Land use in *IPZ-1* and *IPZ-2* is mainly residential. While Table 7-7 shows that it is possible to have *significant threats* in *IPZ-1* based on the assigned vulnerability score, the current land use in this zone would not yield this level of *threat*.

Table 7-7 Number of Locations of Significant Threats in the LAWSS IPZs

Vulnerable Area	Vulnerability Score	Number of Locations Where Significant Threats Related To	
		Pathogens	Chemicals
IPZ-1	8.0	0	0
IPZ-2	6.4	0	0
EBA-Fuel	NA	0	1

7.2.4. Threats in Petrolia Water Treatment Plant Protection Areas

Table 7-8 shows the levels of *threats* that are possible in this *vulnerable area*. Due to the *vulnerability scores* of these areas, there are no *significant threats* in either *IPZ-1* or *IPZ-2*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur. Map 7-9 shows areas in the Petrolia Water Treatment

Plant *IPZ-1* and *IPZ-2* where *activities* may pose low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*IPZ-1 or 2*) where the *activity* is occurring, the *vulnerability score* and the *circumstances* associated with the *activity*.

Table 7-8 Levels of Threats Related to Pathogens and Chemicals in the Petrolia Water Treatment Plant IPZs

Vulnerable Area	Vulnerability Score	Level of Threat for Activities Related to Pathogens			Level of Threat for Activities Related to Chemicals		
		Significant	Moderate	Low	Significant	Moderate	Low
IPZ-1*	7.0	No	Yes	Yes	No	Yes	Yes
IPZ-2*	6.3	No	Yes	Yes	No	Yes	Yes
IPZ-3*	NA	No	No	No	No	No	No
* Event modelled threats are significant in the EBA within IPZ-1, 2 and 3							

The number of locations where *significant threats* could occur in the *vulnerable areas* of the Petrolia Water Treatment Plant *IPZs* is shown in Table 7-9. The land use *activities* within the zone are mostly residential with some agriculture in the outer areas of *IPZ-2*. There are no locations where significant threats are or would occur due to the *vulnerability scores* of the Petrolia *IPZ-1* and *IPZ-2* each being lower than 8.

Table 7-9 Number of Locations of Significant Threats in the Petrolia Water Treatment Plant IPZs

Vulnerable Area	Vulnerability Score	Significant Threats Related To	
		Pathogens	Chemicals
IPZ-1	7.0	0	0
IPZ-2	6.3	0	0
EBA-Fuel	NA	0	2

7.2.5. Threats in Wallaceburg Water Treatment Plant Protection Areas

Table 7-10 shows the levels of *threats* that are possible in this *vulnerable area*. Map 7-10 shows areas in the Wallaceburg *IPZ-1* and *IPZ-2* where *activities* may pose low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*IPZ-1* and *IPZ-2*) where the *activity* is occurring, the *vulnerability score* and the *circumstances* associated with the

activity. Refer to Appendix 10 for detailed lists of *threats* and the *circumstances* under which they occur.

Table 7-10 Levels of Threats Related to Pathogens and Chemicals in the Wallaceburg IPZs

Vulnerable Area	Vulnerability Score	Level of Threat for Activities Related to Pathogens			Level of Threat for Activities Related to Chemicals		
		Significant	Moderate	Low	Significant	Moderate	Low
IPZ-1*	9	Yes	Yes	Yes	Yes	Yes	Yes
IPZ-2*	7.2	No	Yes	Yes	No	Yes	Yes
IPZ-3*	NA	No	No	No	No	No	No
* Event modelled threats are significant in the EBA within IPZ-1, 2 and 3							

When land use is also considered, the number of locations where *significant threats* are or would occur in the *vulnerable areas* in the Wallaceburg *IPZ-1* and *IPZ-2* are zero, as shown in Table 7-11, and as discussed in Section 7.2.1. The land use in *IPZ-1* is mostly agricultural with some limited residential along the Chenal Ecarte. The *IPZ-2* is mostly agricultural with pockets of residential and industrial areas in the outer areas of the zone.

Table 7-11 Number of Locations of Significant Threats in the Wallaceburg IPZs

Vulnerable Area	Vulnerability Score	Significant Threats Related To	
		Pathogens	Chemicals
IPZ-1	9	0	0
IPZ-2	7.2	0	0
EBA-Fuel	NA	0	10
EBA- Fertilizer	NA	0	6

7.2.6. Threats in Kettle and Stony Point Intake

No *threats* were identified in the consultants Technical Studies associated with the Kettle and Stony Point intake.

Table 7-12 Levels of Threats Related to Pathogens and Chemicals in the Kettle and Stoney Point IPZs

Vulnerable Area	Vulnerability Score	Level of Threat for Activities Related to Pathogens			Level of Threat for Activities Related to Chemicals		
		Significant	Moderate	Low	Significant	Moderate	Low
IPZ-1	5	0	0	0	0	0	0
IPZ-2	4	0	0	0	0	0	0

Table 7-13 Number of Locations of Significant Threats in K & S IPZs

Vulnerable Area	Vulnerability Score	Significant Threats Related To	
		Pathogens	Chemicals
IPZ-1	5	0	0
IPZ-2	4	0	0

7.2.7. Threats in HVA

Table 7-5 indicates the number of locations where *significant threats* could occur in the *vulnerable areas* of the St. Clair Region Source Protection Area based on current land use. Due to *vulnerability* scoring of the *HVA* being below 8, *activities* are not classified as *significant threats* in these *vulnerable areas*. Map 4-5 and 4-7 show the *HVA* in the St. Clair Region Source Protection Area. Table 7-12 shows the levels of *threats* that could occur in these *vulnerable areas*. Refer to Appendix 10 for detailed lists of moderate or low *threats* and the *circumstances* under which they occur.

Table 7-14 Levels of Threats Related to Pathogens, Chemicals and DNAPLs in HVAs

Vulnerable Area	Vulnerability Score	Level of Threat for Activities Related to Pathogens			Level of Threat for Activities Related to Chemicals			Level of Threat for Activities Related to DNAPLs		
		Significant	Moderate	Low	Significant	Moderate	Low	Significant	Moderate	Low
HVA	6	No	No	No	No	Yes	Yes	No	Yes	Yes

As can be seen from Table 7-12, there are no *significant threats*, and no *pathogen* related *threats* in *HVA* in the St. Clair Region Source Protection Area. It is possible however to have low

and moderate levels of chemical *threats*, including *dense non-aqueous phase liquids* (*DNAPLs*), for a *vulnerability score* of 6 in *HVA*.

7.2.8. Events Based Threats Assessment

As described in Section 7.1.6, according to Rule 130, an *activity* is or would be a *significant threat* in an *IPZ* (1, 2 or 3) if modelling demonstrates that the contaminant reaches the intake at a concentration that deteriorates the water as a drinking water source. In the St. Clair Region SPA, for purposes of *IPZ-3* delineation and event based threats assessment, a contaminant concentration at or above the Ontario Drinking Water Quality Standards is considered to be indicative of the deterioration of a drinking water source. Also, a future *activity* may be considered where it is known that the *activity* will be taking place or is expected to take place in the future.

The chemical spills considered in the event specific modellings described in Section 4.2.5 of this Assessment Report were used to delineate the *IPZ-3.* Two types of contaminants were modelled: fuel and fertilizer. Under the events modelled, these spills resulted in contaminants reaching the intake at concentrations above the Ontario Drinking Water Quality Standard for the contaminants. As such, spills similar to these would be considered to deteriorate the quality of drinking water. Until further work has been done, these activities outside the *IPZ-3* cannot be considered as a significant drinking water threat.

Fuel with a 2% benzene concentration was considered at multiple locations. The spills were modelled under the extreme events identified in Section 4.2.5 and were found to arrive at the intake at a concentration considered to result in a deterioration of the drinking water source. A tanker truck of about 34,000 litres of fuel was modelled at Perch and Cow Creek crossings of Highway 402, to simulate spills reaching the Petrolia and *LAWSS* intakes. Transportation (or) storage of over 34,000 litres of fuel was determined to be a *significant threat* to these intakes, if the spill occurs within the *IPZs*. A fuel spill from a ship, shown by location (3) in Map 4.2b with a spill of one million litres was also determined to be a *significant threat* to this intake.

A fuel spill of 34,000 liters was modelled on East Sydenham River and found to result in a deterioration of drinking water quality at the Wallaceburg intake. A similar spill was assessed in

the North Sydenham River and was found to result in a deterioration of the drinking water quality at the intake.

A fertilizer spill of 124,000 kg of Urea (46% Nitrogen) was modelled at the Sombra ferry crossing at St. Clair River and was found to result in the deterioration of the drinking water source. Thus, spills of other fertilizers with similar nitrogen content would also be considered a *significant threat* in this part of the Wallaceburg *IPZs.*

A pipeline rupture of 275,000 litres at the St. Clair River upstream of Corunna was modelled and found to be a *significant threat* to the Wallaceburg intake. Refer to IPZ-3a in Map 4.4b for the area where the transportation of liquid petroleum products through pipelines would be a significant threat. Within this area one pipeline was identified as a significant threat.

All of the modelled spill scenarios were simulations of spills that occurred during the transportation of these materials. This illustrates the importance of spills contingency planning considering the potential impacts of spills during the handling of fuels and fertilizers (during transportation) on the municipal drinking water intakes. Where volumes of these sizes are stored or handled within the delineated *IPZs* they should also be considered *significant threats*. Although existing locations of the handling and storage of these materials have not yet been inventoried it is important that the consideration of *significant threats* from the spills modelling exercise be used in the planning of future activities in these areas. Although the inland extent of the *IPZ-3* has not been assessed, it is expected that any *activity* where spills from storage of these volumes of materials outlet directly to the *IPZ-3* should also result in deteriorating the quality of drinking water. This could be subject to event and contaminant specific modelling in the future to confirm the specific details of a potential spill that would be considered a *significant threat*.

The spill modelling scenarios were selected as a starting point to assess the extent of the area where a spill could pose a significant risk to municipal drinking water sources. In 2013, additional work was undertaken to include other event based areas (EBA) and to assess the extent of the IPZ-3 to include the entire EBA. Based on the results from this study the IPZ-3 has been revised to include the entire EBA.

Further, additional spill scenarios (location, contaminant type and volumes) may to be assessed to determine if the area of IPZ-3 should be extended beyond those delineated. This work may be undertaken in the future and would be reflected in a subsequent update to this Assessment Report.

This work confirms that spills in these locations can reach the intakes at a concentration which would deteriorate the water for the purposes of drinking. The modelling considered a limited number of scenarios and is based on specific events and conditions. It therefore does not represent all possible situations. Although the analysis did not confirm that ODWQS would be exceeded at LAWSS it did identify that the spill would reach the intake. Similarly smaller volumes, while not identified as a SDWT, would under the correct conditions result in a drinking water impairment at the intake. While the areas delineated are used for the purposes of delineating an *EBA* within which significant drinking water threat policies would apply, areas outside of the *EBA* would, under the correct conditions, contribute concentrations to the intake which could exceed ODWQS. It is therefore important that an abundance of caution be used in and beyond these areas to report spills.

7.2.9. Local Threats

The modeled scenarios included spills from fixed fuel storage tanks and fuel tanker trucks activities, at various locations. If modeling indicated that the contaminant considered reached the intake and exceeded a certain benchmark, then the activity would be considered a significant threat. Fixed fuel storage tanks are considered ‘prescribed’ drinking water quality threats, as they are included under the activity of ‘handling and storage of fuel’ in the MECP Drinking Water Threats Tables. However the transportation of fuel (such as by tanker trucks) is not an activity listed in these Threats Tables. The Source Protection Authority has assessed the handling and storage of fuel for moderate and low risks using the new hazard scoring. No enumeration is needed for low or moderate risks.

Based on results of event based approach undertaken, a request was made to the Director to add the transportation of fuel as an ‘other’ or local threat. The letter identifying transportation of fuel and fertilizer and transportation of liquid petroleum products through pipelines as local

drinking water quality threat, is attached in Appendix 10. . As part of the updates to the Table of Drinking Water Threats in 2017, Liquid Hydrocarbon pipelines are now considered a prescribed threat and not a local threat.

7.3 Site Specific Risk Assessment

A site-specific, *risk* assessment, to confirm the existence of *significant threats* will be necessary as part of implementation. Although additional efforts have been made to verify *significant threats*, this has not included on site verification of the threat. Although this level of effort was considered as part of the threats verification, it would still be necessary during implementation. Further, it will also be necessary as part of compliance monitoring for part IV implementation in both locations where *significant threats* have been identified and those where threats have not been identified. This is due in part to the potential for activities and circumstance to change at any location without any regulatory approval process. As part of the consultation on the Assessment Report, those who are believed to be engaging in a *significant threat* will be notified.

7.4 Data Gaps

A comprehensive inventory of storage facilities would assist in the *significant threats* identification in the *IPZ*s. As mentioned in Section 7.2.7, additional spill scenarios will also help determine if the *IPZ-3* and *EBA* delineations could extend beyond those delineated. Spills of other types of contaminants at different locations and volumes will also help determine *significant threats* to the intakes. This work would be part of a subsequent Assessment Report.

If a drinking water quality issue is identified at a well or intake as per Rule 114 and is known to be partially or wholly due to anthropogenic causes, the area and the activity contributing to a drinking water quality issue must also be identified as per Rule 115. In the St. Clair SPA, some of the issues are naturally occurring and are therefore understood to not be subject to Rule 115.

A preliminary investigation has been completed to determine if there are any *conditions*. More work will be undertaken on identifying and assessing *conditions* for potential *threats*, and the Assessment Report will be amended if necessary.

8.0 Great Lakes

The Clean Water Act (2006) requires that the Great Lakes Agreements be considered in an Assessment Report and *Source Protection Plans*, if a Source Protection Area (*SPA*) contains water that flows into a Great Lake (Section 14). The *Technical Rules 2013: Assessment Report* also requires that a description be provided on how the Great Lakes Agreements were considered in work undertaken (Rule 9) towards the Assessment Report.

The St. Clair Region Source Protection Area (*SCRSPA*) is one of the three *SPAs* that the Thames-Sydenham and Region Source Protection Region (*SPR*) is comprised of. This *SPA* is based on the St. Clair Region Conservation Authority jurisdiction. Conservation Authorities are established on a watershed basis. Within the St. Clair Region Source Protection Area, waters either drain into Lake Huron, the St. Clair River or Lake St. Clair through the Chenal Ecarte. Lake St. Clair is not a Great Lake but it is included while considering Great Lakes in the source protection planning process. For source water protection purposes, the Lake Erie basin is considered to be comprised of Lake St. Clair, the Detroit River and Lake Erie.

In the *SCRSPA*, several communities receive their *drinking water* from Lake Erie, the Chenal Ecarte, the St. Clair River or Lake Huron through municipal water treatment plants located both in and outside of this *SPA.* There are three municipal primary intakes in the *SCRSPA* that draw water from the Chenal Ecarte, the St. Clair River and Lake Huron. Map 1-3 shows the watershed boundaries of the *SCRSPA*, and the location of the surface water intakes that serve communities in the watershed.

8.1 Impact of Considering Great Lakes

The Clean Water Act requires *Source Protection Plans* to consider policies that relate to the Great Lakes. The Ministry of Environment, Conservation and Parks (*MECP*) document 'A Discussion Paper on Requirements for the Content and Preparation of Source Protection Plans' (June 2009) provides some details on how Great Lakes policies may be included in the *Source Protection Plan*. Those details are reproduced below.

The Clean Water Act gives the *MECP* the authority to set targets for the Great Lakes or any part thereof, to address any water quality or quantity *issue* related to the use of the Great Lakes as a source of *drinking water* (Section 85). Targets are anticipated to direct and coordinate action on a *drinking water* source protection *issue* or an emerging Great Lakes problem. The Minister also has the option of establishing a Great Lakes target for a group of source protection areas. If a target applies to multiple source protection areas, the Minister may direct the source protection authorities to jointly decide on what the relative target should be for each individual source protection area, to contribute to the overall target.

The Clean Water Act also provides that the *source protection plan* may identify one or more Great Lakes target policies as a “designated Great Lakes policy” (Section 22). Where a *source protection plan* does not designate any of the Great Lakes policies, the Minister may direct a source protection authority to do so during the process of reviewing and approving the *source protection plan*.

Also, policies that govern monitoring to assist in implementing and in determining the effectiveness of a Great Lakes target policy may be established.

8.2 Great Lakes Agreements

Under the Clean Water Act, the Great Lakes Agreements to be considered (Section 14) are listed below:

1. The Great Lakes Water Quality Agreement of 1978 between Canada and the United States of America, signed at Ottawa on November 22, 1978, including any amendments made before or after this section comes into force.
2. The Great Lakes Charter signed by the premiers of Ontario and Quebec and the governors of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin on February 11, 1985, including any amendments made before or after this section comes into force.
3. The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem 2002 entered into between Her Majesty the Queen in Right of Canada and Her Majesty the Queen in Right of Ontario, effective March 22, 2002, including any amendments made before or after this section comes into force.
4. The Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement.
5. 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.

The first four Agreements are discussed below. At the time of drafting of this report, the *Source Protection Committee* is not aware of any other Agreement, signed by the Government of Ontario or the Government of Canada, related to the Great Lakes and prescribed by the regulations.

8.2.1. Great Lakes Water Quality Agreement

Negotiations to amend the GLWQA were launched in early 2010. On February 12, 2013, the Governments of Canada and the United States ratified the Great Lakes Water Quality Agreement of 2012.

The Agreement facilitates binational action on threats to water quality and ecosystem health. Under the Great Lakes Water Quality Agreement, the governments of Canada and the United States agreed “to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem”. This is accomplished in part through the development and implementation of binational Lakewide Management and Action Plans

(LAMPs) for each lake. Through the development of issue related strategies, the LAMP will identify actions required to restore and protect the lakes and evaluate the effectiveness of those actions.

The Thames-Sydenham and Region Source Protection Region is straddled by Lakes Erie and Huron. Lake Erie's ecosystem and economy are threatened by algal blooms that have become a regular occurrence throughout the Western basin of the lake during summer months, leading to poor aesthetics, recreational beach closures and reduced tourism revenue. The blooms are attributed primarily to excessive nutrient inputs from urban and rural land uses. In addition, Lake Erie water quality is affected by habitat loss and degradation and the introduction of non-native aquatic and terrestrial plant species. The top priority for Lake Erie Lakewide Action and Management Plan (LAMP) partners is to address excess algal blooms by reducing nutrient inputs to the lake. The Lake Erie LAMP is coordinated by a committee of water quality and natural resource managers from both Canada and the United States, with participation from federal, provincial, state and local governments that have a role in implementation.

Although no formal Lakewide Management Plan exists for Lake Huron, the Lake Huron Binational Partnership was formed in 2002 to meet commitments in the Canada-United States Great Lakes Water Quality Agreement for lakewide management. The Partnership facilitates information sharing, sets priorities, and coordinates binational environmental protection and restoration activities. The U.S. Environmental Protection Agency, Environment Canada, Michigan Departments of Natural Resources and Environmental Quality, and the Ontario Ministries of Environment and Natural Resources form the core of the Partnership. The Lake Huron Binational Partnership focuses on key priorities and on the ground actions that help to improve and protect the overall quality of Lake Huron including controlling non-point source pollution and improving fish spawning and nursery habitat.

Areas of Concern (AOC) are locations within the Great Lakes identified as having experienced high levels of environmental harm. Under the 1987 Great Lakes Water Quality Agreement between Canada and the United States, 43 such areas were identified, 12 of which were Canadian and 5 of which were shared binationally. The 2012 Great Lakes Water Quality Agreement reaffirms both countries' commitments to restoring water quality and ecosystem

health in Great Lakes Areas of Concern. The St. Clair River, a binational AOC is located within the Thames-Sydenham and Region Source Protection Region. In order to improve the environmental conditions of the AOC, a Remedial Action Plan (RAP) has been developed for the St. Clair River. The St. Clair River RAP is a partnership between Canadian and U.S. federal governments, provincial (Ontario) and state (Michigan) governments, with cooperation from the public and stakeholders through the St. Clair Binational Public Advisory Committee. Environment Canada and the Ontario Ministry of the Environment, Conservation and Parks are the lead government agencies for the Canadian side of the St. Clair River Remedial Action Plan. The St. Clair Region Conservation Authority is working with these agencies to assist in the local implementation of the plan.

The municipal water intake that serves the Wallaceburg *drinking water* treatment plant is located in Chenal Ecarte, which is within the St. Clair River Area of Concern (*AOC*) under the Canada-Ontario Agreement. A Remedial Action Plan (*RAP*) has been established for this *AOC*. Hence the Great Lakes Water Quality Agreement is relevant to the current Assessment Report. According to St. Clair River Watershed Plan, *AOC* Area 1-A, the *RAP* process has identified 12 Beneficial Use Impairments (*BUI*) in the St. Clair River *AOC (Table 8-1)*. One of the Beneficial Use Impairments is “restrictions on *drinking water* consumption, or taste and odour problems.”

Table 8-1 Beneficial Use Impairments for the St. Clair River AOC

1. **Restriction on Fish and Wildlife Consumption**
   Eliminate the need for restrictions on human consumption of fish and wildlife for reasons of health.
2. **Tainting of fish and wildlife flavour-recommended for re-designation as "not impaired"**
   Eliminate the reporting of fish tainting reported.
3. **Degradation of fish and wildlife populations**
   Attain and maintain healthy, diverse and self-sustaining biological communities and habitats. Ensure no net loss of fish and wildlife habitat and reclaim, rehabilitate and enhance habitat where possible.
4. **Fish tumours or other deformities**
   Ensure the fish population does not exhibit fish tumours or other deformities.
5. **Bird (or other animal) deformities or reproduction problems**
   Ensure bird (or other animal) population does not exhibit deformities or reproduction problems.
6. **Degradation of benthos**
   Ensure the benthic community structure and contaminant body burdens are not negatively impacted.
7. **Restrictions on dredging activities**
   Eliminate restrictions on dredging activities due to contaminant levels.
8. **Restrictions on drinking water consumption, or taste and odour problems**
   Eliminate the need to close water treatment plant intakes due to chemical spills.
9. **Beach closings and water contact sports**
   Eliminate beach closings due to bacterial levels.
10. **Degradation of aesthetics**
    Eliminate reportings of oily surface films, spills and combined sewer overflow (CSO) events.
11. **Added costs to agriculture or industry**
    Eliminate water treatment plant closures or associated interruptions in water supply to industrial and agricultural users.
12. **Loss of Fish and Wildlife Habitat**
    Eliminate the loss of fish and wildlife and habitat and restore habitat necessary to maintain healthy, diverse and self-sustaining biological communities.

(Source, St. Clair River Watershed Plan, December, 2009)

Related to *BUI* number 8, restrictions on *drinking water* consumption, or taste and odour problems, the following observation was made in the above report: spills are untreated discharges of pollutants that typically include chemicals, fuels and sewage most commonly from industrial, municipal, commercial, and agricultural sources. Within the *AOC*, the spill of chemicals, oils, hydrocarbons and wastes from the industrial lands in the upper St. Clair River are the focus. Compared to other U.S./Canadian connection channel corridors, for Canadian

spills, the St. Clair River has a greater number of spills. This is due to the presence of the industrial sector in Sarnia. Since the mid-1990s, the number of serious spills along the St. Clair River corridor has declined. Restrictions on *drinking water* consumption were originally identified as one of the beneficial use impairments in the St. Clair River. The 1997 Stage 1 *RAP* update stated that *drinking water* was no longer considered impaired due to the reduction in spills from chemical industries affecting the downstream water supplies of Wallaceburg and Walpole Island First Nation.

The Great Lakes Water Quality Agreement (*GLWQA*) is considered in the St. Clair Region Source Protection Area Assessment Report in the *vulnerability* assessment. In the *vulnerability* assessment, the status of the St. Clair River as an *AOC* is considered in the assignment of the source *vulnerability* factor of the Wallaceburg intake, which lies in the *AOC*.

The Great Lakes Water Quality Agreement will also be considered in *conditions* assessment in an amended Assessment Report. According to the St. Clair River Watershed Plan, December 2009 “due to presence of contaminants in varying degrees of concentration, degradation of the benthos in the St. Clair River was a major environmental *issue*. Recent sediment assessments of Talford creek identified the presence of contaminants; the most degraded samples taken from the creek outlet to the St. Clair River. Deposition of the contaminants at the mouth of Talford Creek can be attributed to spills upstream in the St. Clair River. The contaminated sediment has resulted in the benthic community being impaired, along with body burdens of benthics.” It should be noted, however, that no sampling of benthic biota has taken place within Wallaceburg’s *IPZ-1* or *IPZ-2*.

Information on sediment, soil and water quality needs further consideration to determine if *Conditions* (*threats* due to a past *activity*) occur in the Wallaceburg *Intake Protection Zones*. *Conditions* identified will be reported in an amended Assessment Report.

8.2.2. The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem

Information on this Agreement is reproduced from the Ministry of Environment, Conservation and Parks website (http://www.ene.gov.on.ca/en/news/2007/081602mb.php). The governments of Canada and Ontario have signed an agreement to protect the Great Lakes that includes cleaning up 15 Areas of Concern where the natural environment has been severely degraded, reducing harmful pollutants, and improving water quality. The Agreement also aims to conserve fish and wildlife species and habitats, lessen the threat of aquatic invasive species and improve land management practices within the Great Lakes Basin. The Agreement, which is valid until 2010, contains new areas of cooperation such as protecting sources of *drinking water*, understanding the impacts of climate change and encouraging sustainable use of land, water and other natural resources. The implementation of this Agreement helps fulfill the obligations of the Great Lakes Water Quality Agreement.

The Agreement contains four Annexes, the first of which focuses on efforts to complete the actions necessary to restore the degraded ecosystems in four Areas of Concern including the St. Clair River. Therefore this Agreement is relevant to the current Assessment Report, and its consideration is described in Section 8.2.1.

8.2.3. The Lake St. Clair Management Plan

Under the Great Lakes Water Quality Agreement, the Four Agency Management Committee established a framework for bi-national coordination of environmental issues on Lake St. Clair (U.S. Environmental Protection Agency, Environment Canada, Ontario Ministry of Environment, Conservation and Parks, Michigan Department of Environmental Quality. 2004). There are no intakes, however, within the St. Clair Region *SPA* that draw water from Lake St. Clair. Information on the Lake St. Clair Management Plan is available from the Lake St. Clair Canadian Watershed Management Plan report (Lake St. Clair Canadian Watershed Coordination Council, 2009).

8.2.4. The Great Lakes Charter and the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement

The Great Lakes Charter contains agreements between the eight Great Lakes states in the United States and the Province of Ontario and the Government of Quebec. 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" (http://www.cglg.org/pub/charter/index.html).

The Great Lakes Charter was supplemented in 2001 by the Great Lakes Charter Annex, and its implementing agreements, including the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement, pertaining to the watershed of the Great Lakes and the St. Lawrence River upstream from Trois-Rivières, Québec within the jurisdiction of eight states in the United States and the Province of Ontario and the Government of Quebec (http://www.mnr.gov.on.ca/en/Business/Water/2ColumnSubPage/STEL02_164560.html).

These Agreements are not considered relevant to the work conducted for the St. Clair Region Source Protection Area Assessment Report. The Water Budget and Water Quantity *Stress Assessment* included in this Assessment Report consider supply and demand within the watershed of the Thames-Sydenham and Region. Great Lakes water budgeting must be undertaken on a much larger scale. The information developed through the Water Budget work in the Thames-Sydenham and Region, along with those developed in the other Source Protection Regions, can be used by others when considering the larger scale Great Lakes basin water budgets. This work is beyond the scope of the Assessment Report and *Source Protection Plan* in the Thames-Sydenham and Region.

8.3 2004 Lake Huron Bi-national Partnership Action Plan

The St. Clair Region *SPA* includes the southern portion of Lake Huron and one intake (Petrolia Water Treatment Plant Intake) is located in this area. A Lake-wide Management Plan is yet to

be established for Lake Huron. In 2004, a report was prepared entitled Lake Huron Bi-national Partnership Action Plan. This plan does provide an overview of issues and recommends actions to address these issues. The text below is the executive summary of this report.

"In 2002, the Bi-national Executive Committee formally endorsed the formation of a Lake Huron Bi-national Partnership in order to coordinate environmental activities in the Lake Huron basin. The United States Environmental Protection Agency, Environment Canada, Michigan's Departments of Environmental Quality and Natural Resources and Ontario's Ministries of Environment and Natural Resources form the core of the Partnership by providing leadership and coordination. However, a flexible membership is being promoted which is inclusive of other agencies and levels of government, Tribes/First Nations, non-government organizations and the public on an issue-by-issue basis.

The approach to Lake Huron differs from the Lake-wide Management Plans (*LaMPs*) of Lakes Superior, Michigan, Erie and Ontario in that there has been no systematic assessment of beneficial use impairments, identification of causes, definition of critical pollutants, determination of chemical sources and loadings, and release of a report for comment. The alternative approach focuses on areas of obvious importance, tackles these as priorities in the first action plans, and will expand over time to include other activities that investigate the less severe or obvious issues in the lake. Three priority issues - contaminants in fish and wildlife; biodiversity and ecosystem change; fish and wildlife habitat - were given priority for immediate action while other issues will be tracked and added as the Partnership pursues this process of updating and expanding activities over time.

Actions in Areas of Concern or resulting from specific local priorities are also part of the Partnership's agenda. These actions, which are being managed domestically, include the continued efforts at Saginaw Bay, monitoring of Spanish Harbour's recovery and science-based investigations of bacterial and algae fouling of beaches along the southeast shore of the lake. Other Lake Huron concerns include: low water levels, botulism, cormorant populations, blue-green algae blooms in Georgian Bay, aquaculture, emerging contaminant concerns and global climate change.

This 2004 Action Plan provides information on priority issues, trends, goals, research, monitoring, on-the-ground activities and future needs. Consistent with an adaptive management approach, it is not fully comprehensive, but will be expanded and added to over time. Contaminant trends in fish and wildlife have been summarized, current knowledge of changes in the fish community, threats to aquatic life and habitat have been outlined along with proposed draft environmental objectives for fisheries management. More detail on any of these topics can be obtained from source documents and fact sheets developed by the Partnership. The Action Plan section itself highlights the activities already underway and planned over the short-term (2 years) and future efforts over the long-term (5 years). These actions are geared towards improving knowledge, understanding function and change, monitoring trends, and restoring, rehabilitating and protecting the Lake Huron ecosystem."

The one intake in the St. Clair Region *SPA* on Lake Huron at Bright's Grove, which serves the Town of Petrolia, does not lie within an identified Area of Concern. At the time of writing of this report, it is understood that the Lake Huron Bi-national Partnership Action Plan is not prescribed by the Regulations. However the Action Plan was reviewed to see if any actions were implemented in the *Intake Protection Zone* delineated at Bright's Grove. No Specific references were made to this area in the plan.

8.4 Next Steps for Great Lakes

The Thames-Sydenham and Region will continue to be involved with the St. Clair River *AOC*. A St. Clair River Remedial Action Plan Coordinator has recently been hired by the St. Clair Region Conservation Authority. This technical support may be consulted to help identify causes of *issues* or concerns at raw water intakes. If the *MECP* identifies Great Lakes targets, policies specific to those targets will need to be developed under the *Source Protection Plan*. Further, if the *MECP* identifies targets that apply across several Source Protection Regions and Source Protection Areas, the Lake Erie working group and the St. Clair River Bi-national Public Advisory Council may provide an opportunity to work together to satisfy shared regulatory requirements. As technical studies on the Kettle and Stony Point First Nation intake on Great Lakes have commenced only in spring 2011, the consideration of Great Lakes Agreements in the work on this intake is yet to be done. Estimated timeline of the technical work related to this intake is provided in Section 9.

9.0 Data Gaps and Next Steps

The development of Assessment Reports is required by the Clean Water Act, the related regulations and the *Technical Rules 2013: Assessment Report*. Together these documents outline the materials which are required in the Assessment Reports. The Clean Water Act and the regulations also outline the process for developing, consulting on, submitting, and revising the Assessment Reports.

Through information from various technical studies, the Assessment Report must identify and assess *vulnerable areas*, evaluate *drinking water* quality *issues*, and identify and assess *threats* to the sources of *drinking water*. This section of the Assessment Report describes the known data gaps in the technical studies conducted, the plans to fill the gaps and the next steps in the *Source Protection Planning* process.

9.1 Data Gaps

The different types of data gaps summarized in this section relate to the availability of information and the timing of Provincial guidance updates, such as the *Technical Rules* 2013.

The *Technical Rules 2013: Assessment Report* identifies many of the requirements of the Assessment Report. For some of these requirements, the *technical rules* 2013 allows for the submission of a work plan if the information necessary to complete the item is not available. These items include work related to the delineation of *threats* relating to *issues* contributing areas, Tier 3 Water Budget, *Wellhead Protection Area*, *WHPA-E* and *WHPA-F* associated with *Groundwater Under Direct Influence* (*GUDI*) of surface water and *Intake Protection Zone-3* (*IPZ-3*) for surface water intakes.

Other gaps identified throughout the Assessment Report are a result of information or guidance not being available, or not available in time to be included in the Assessment Report. In other cases, the analysis required to include the item in the Assessment Report could not be completed in time. In October 2009, the Ministry of the Environment, Conservation and Parks clarified the definition of a data gap as well as definitions for other terms used to identify specific types of limitations and these continue to be developed. While some data gaps were addressed in the Updated Assessment Report of November 2011 as well as in this Updated Assessment Report dated November 14, 2014, additional gaps have been identified in Table 9-1 as requiring further review and will be incorporated into a future Assessment Report where time and budget allow.

Table 9-1 provides the work plan to fill the identified gaps in the St. Clair Region Source Protection Area Assessment Report. This Table identifies the gap, provides a description of the gap and its current status, lists the steps to be undertaken in the work plan to fill the gap, and provides the anticipated work plan completion date..

Table 9-1 Work Plan to fill Data and Analysis Gaps

Gap	Description	Work Plan	Planned Completion Schedule
Drainage information	▪ Better drainage information to refine IPZ-2 transport pathways and storm sewersheds for the LAWSS, Petrolia and Wallaceburg intakes ▪ Drainage information to refine Wallaceburg intake IPZ-2 up-tributary extents, for channels connecting Running Creek and Chenal Ecarte ▪ Information regarding the flow of water from St. Anne Island into the Chenal Ecarte has been collected; however additional drainage information would be required to denote specific areas which could provide water to the intake within the two hour time of travel, to help delineate the upland extent of Wallaceburg intake IPZ-2	▪ Obtain better drainage information determined through a site-specific (Tier 2) Risk Assessment for the LAWSS, Petrolia and Wallaceburg intakes ▪ Adjustments may be made to IPZ-2 up-tributary extents, transport pathways and storm sewersheds for the LAWSS, Petrolia and Wallaceburg intakes ▪ Delineate upland extent of Wallaceburg intake IPZ-2 on St. Anne Island side of the Chenal Ecarte	Dependent upon submission of a subsequent Assessment Report
Pump information	▪ Location, drainage area and pump regimes of pump located at the west end of Cram Drain, to refine the Wallaceburg intake IPZ-2	▪ Obtain information on Cram Drain pump to further refine Wallaceburg intake upland IPZ-2	Dependent upon submission of a subsequent Assessment Report

Table 9-1 Work Plan to fill Data and Analysis Gaps

Gap	Description	Work Plan	Planned Completion Schedule
Additional analysis for IPZ-3 delineation	▪ Additional work will assist in identifying significant threats in the IPZs and in possibly extending the delineated IPZ-3s	▪ Consider additional spill modelling scenarios (contaminant type, location, volume) through the events based modelling approach	Dependent upon submission of a subsequent Assessment Report
Edge matching of HVA and SGRA with neighbouring regions	▪ Edge matching of HVA and SGRA with neighbouring regions is to be completed in order to form seamless mapping between source protection regions	▪ This work will be considered when neighbouring regions' HVA and SGRA maps are complete ▪ Methodologies will be determined in consultation with the neighbouring regions once the extent of the challenges are known	Dependent on when neighbouring regions complete HVA and SGRA maps
Conditions Assessment	▪ MECP data delivered to consultants, but not all consultants have reviewed or considered it ▪ A few potential conditions have been identified which require further investigation	▪ Have consultants review and report on data distributed by MECP ▪ Request same data for the rest of the vulnerable areas ▪ Investigate potential conditions ▪ Submit report to Source Protection Committee for consideration ▪ Include in a subsequent Assessment Report if appropriate	Dependent upon submission of a subsequent Assessment Report
Impact of Climate Change	▪ Little work related to climate change in the St. Clair Region Source Protection Area ▪ Work undertaken in Upper Thames River Source Protection Area although focused more on flooding and infrastructure than on water supply ▪ Impact on source water protection is unknown	▪ Revisit this section following the completion of this section in the Upper Thames River Source Protection Area Assessment Report to determine the relevance to the St. Clair Region Source Protection Area ▪ Amend Assessment Report if warranted	To be determined
Inland takings drawing from Great Lakes and connecting channels	▪ Determine Inland takings that draw from Great Lakes and connecting channels	▪ Confirm location and watercourse conditions related to water takings near Lake St. Clair, Lake Huron and the St. Clair River ▪ Recalculate percent water demand ▪ Reassess potential for stress in these areas ▪ Update Assessment Report only if warranted ▪ This work would be dependent on other programs as the potential stress does not impact drinking water systems included in the Terms of Reference, however, if updated information becomes available, future Assessment Reports should be updated to reflect that information	Subsequent Assessment Report, dependent on other programs

Table 9-1 Work Plan to fill Data and Analysis Gaps

Gap	Description	Work Plan	Planned Completion Schedule
Improved understanding of water use	▪ Use actual water use data in water budget work	▪ Obtain actual water use data from all significant water users through the PTTW reporting system ▪ Requires reassessment after sufficient data has been reported, perhaps when Assessment Report requires future update ▪ This work would be dependent on other programs as the potential stress does not impact drinking water systems included in the Terms of Reference, however, if updated information becomes available, future Assessment Reports should be updated to reflect that information	Subsequent Assessment Report, dependent on other programs
	▪	▪	

9.2 Next Steps

Prior to the submission of the Assessment Report to the Director, the Clean Water Act identifies consultation requirements. The required consultation is part of a more comprehensive consultation plan being conducted in the Thames-Sydenham and Region involving local and regional consultation on the draft proposed, the proposed and the amended proposed Assessment Report, and the technical work that has informed it. See Section 1 - Introduction and Background for more information on the Assessment Report consultation process. Once consultation is complete and the *Source Protection Committee* has considered input received through the consultation, this Updated Assessment Report is submitted to the Director (Ministry of Environment, Conservation and Parks) for approval. The Director has approved the previous (Nov 2011) Updated Assessment Report for the St. Clair Region SPA.

Work may continue on filling the data gaps discussed above provided adequate resources are available to the SPA and SPC to advance the protection of drinking water sources.

The *Source Protection Committee* has identified that the Assessment Report is, in fact, a living document which will require periodic amendments and updates. Review and update of the Assessment Report will be required as identified in the Clean Water Act. The period of the

review will be determined by the Director in its approval of the Assessment Report. Aside from the required review of the Assessment Report, the *Source Protection Committee* has the ability to update the Assessment Report at such time when it becomes aware that the material in the Assessment Report has an effect on the *Source Protection Plan* developed. Any updates to the Assessment Report will require consultation of those affected by the updates.