City of Guelph Source Protection Project

Water Quality Threats Assessment Report

Draft

March 2010

Stantec

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Executive Summary

In June 2007 the City of Guelph (the City) retained a team led by AquaResource Inc. (AquaResource) working with Stantec Consulting Ltd. (Stantec) to complete a study to assess groundwater and surface water vulnerable areas and vulnerability scoring, and to complete work relating to the identification of threats to water quality and water quantity. This contract was extended in 2009 after the Ministry of the Environment (MOE) published its Technical Rules (MOE, 2009a), which provided revised detailed instructions regarding the water quality vulnerability and threats assessment under the Clean Water Act. The City of Guelph Water Quality Threats Assessment to the Lake Erie Source Protection Committee will be finalized in February 2010 pending minor updates to the Groundwater and Surface Water Vulnerability Report.

The City of Guelph has 115,000 residents (2006 Statistics Canada data) and it is one of the largest cities in Canada to rely almost exclusively on groundwater for its potable water supply. The population is projected to reach 144,500 by the year 2021. The groundwater supply system comprises 23 groundwater wells distributed throughout the City. In 2008, 19 of the production wells were operated on a near continuous basis and four were out of service due to water quality or maintenance concerns. The majority of the wells draw water from deep confined bedrock formations, primarily the Gasport Formation (formerly the Amabel Formation) but to a lesser extent the Guelph, Eramosa and Goat Island Formations. The Vinemount Member, within the Eramosa Formation, is considered to be a regional aquitard and confines the Gasport Formation.

In addition to the groundwater supply wells, the City obtains water from the Arkell Spring Grounds collector system, also referred to as the Glen Collector. The system collects shallow groundwater from the overburden through a series of small diameter perforated pipes; this water is conveyed to the F. M. Woods Water Treatment plant for disinfection and distribution. In addition, the City has a water supply intake on the Eramosa River at the Arkell Spring Grounds that is used in association with the Arkell Recharge System. From April to November annually, water is pumped from the Eramosa River into a recharge pit and infiltration trench where it recharges the overburden aquifer supplying the Glen Collector System. This artificial groundwater recharge system is maintained by the City to augment groundwater flow and provide seasonal increases in water supply to the City.

The City has produced a report entitled Groundwater and Surface Water Vulnerability Report (AquaResource, 2010) which was presented in draft form to the Lake Erie Source Protection Committee in November 2009. The main results of this report are the delineation of vulnerability zones (i.e., Wellhead Protection Areas and Intake Protection Zones). The Technical Rules (MOE, 2009a) developed in support of the Clean Water Act require the delineation of WHPAs for drinking water wells. The WHPAs include the WHPA-A (100 m), WHPA-B (two year time-of-travel), WHPA-C (five year time-of-travel) and WHPA-D (25 year time-of-travel) area. Similarly, the Intake Protection Zones (e.g., IPZ-1, IPZ-2, and IPZ-3) are delineated based on the estimated travel time from within the contributing area to the intake. The vulnerability zones (e.g., WHPAs and IPZs) which were then used to produce maps of vulnerability scores for the City's drinking water supplies. These vulnerability scores are used in this report to assess the significance of water quality threats.

The MOE's Technical Rules (MOE, 2009a) require that the water quality threats assessment be completed to identify drinking water issues, threats related to activities, and threats related to conditions. Drinking water issues are instances where water quality parameters exceed or are likely to exceed relevant standards at a drinking water well or surface water intake. A drinking water threat relating to an activity is identified where a land use or activity has the potential to adversely affect the quality of any water that is or may be used as a source of drinking water. A condition relates to past activities that may have led to the presence of existing soil, sediment, or groundwater contamination that has the potential to impact one of the City's drinking water wells or surface water intakes.

The scope of this assessment included the compilation of existing data relating to water quality monitoring data, as well as land use activities and environmental reports to identify issues, threats, and

conditions. As described in the report, there are potentially more than a thousand significant water quality threats and numerous potential conditions, and further work will be required to refine the list of conditions and threats to a higher level of certainty.

ISSUES

The Clean Water Act, 2006 requires that drinking water quality issues be identified for each vulnerable area. The Technical Rules identify an issue with respect to water quality under the following:

114. (1) The presence of a parameter in water at a surface water intake or in a well, including a monitoring well related to a drinking water system to which clause 15(2)(e) of the Act applies, if the parameter is listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines and,

(a) the parameter is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water, or

(b) there is a trend of increasing concentrations of the parameter at the surface water intake, well or monitoring well and a continuation of that trend would result in the deterioration of the quality of the water for use as a source of drinking water.

(2) The presence of a pathogen in water at a surface water intake or in a well, including a monitoring well, related to a drinking water system to which clause 15(2)(e) of the Act does apply, if a microbial risk assessment undertaken in respect of the pathogen indicates that,

(a) the pathogen is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water, or

(b) there is a trend of increasing concentrations of the pathogen at the surface water intake or well and a continuation of that trend would result in the deterioration of the quality of the water for use as a source of drinking water.

(3) In respect of drinking water systems in the vulnerable area that are not mentioned in clause 15(2)(e) of the Act, there is evidence of the widespread presence of a parameter listed in Schedule 2 or 3 of the Ontario Drinking Water Quality Standards or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines at surface water intakes or in wells, including monitoring wells, related to those systems, and

(a) the parameter is present at a concentration that may result in the deterioration of the water for use as a source of drinking water, or

(b) there is a trend of increasing concentrations of the parameter at the intake, well or monitoring well and a continuation of that trend would result in the deterioration of the quality of the water for use as a source of drinking water.

For this assessment of water quality issues, the City's drinking water quality monitoring results for the period of 1990 to 2008 were compared against provincial drinking water quality standards.

The review identified two water quality parameters that may be associated with an issue including Trichloroethylene (TCE) and nitrate. Based on the available data, six wells, including Carter, Emma, Membro and Edinburgh, and Smallfield and Sacco, either exceeded the drinking water objectives or appear to be trending toward exceeding the drinking water objectives. In addition to the above wells, chlorinated organic compounds including TCE, Dichloroethylene (DCE) and Tetrachloroethylene (PCE) have also been detected at very low concentrations at a number of additional wells which further emphasizes the need to manage drinking water threats within the City.

While not classified as issues in this report, trends in sodium and chloride concentrations in groundwater are a concern. There are increasing sodium and chloride concentrations at a number of wells indicating road salting impacts. Sodium concentrations were either at or above the Medical Advisory Level (20

mg/L) but below the Aesthetic Objective (200 mg/L) at a number of other wells. Although the concentrations in these wells are well below the Aesthetic Objective, the ODWQS require the local Medical Officer of Health be notified when the sodium concentration exceeds 20 mg/L so the City should continue to monitor concentrations at those wells accordingly. Consideration should also be given to how the City of Guelph will handle sodium and chloride levels that exceed the Medical Advisory Level.

DRINKING WATER QUALITY THREATS

The Clean Water Act defines a threat as:

"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, and includes an activity or condition that is prescribed by the regulations as a drinking water threat."

The Technical Rules describe a methodology for the identification of drinking water quality threats that combines vulnerability scoring maps with detailed information relating to land use and activities. The specific information relating to land use and activities is referred to as circumstances within the Technical Rules.

This report describes the identification of significant water quality threats with the following components:

- Development of Water Quality Threats Database;
- Enumeration of Non-Agricultural Water Quality Threats;
- Assessment of Managed Lands and Agricultural Based Threats; and,
- Assessment of Impervious Areas.

Development of Water Quality Threats Database

The threats assessment was based on a database built from a number of data sources acquired or purchased from various agencies. Each data source was assigned an uncertainty value based on the age of the data, the source it was acquired from, the reliability of the source, and data maintenance. This database was configured so that all relevant water threats data available for a parcel within the City could be retrieved, reported, or mapped in a Geographic Information System (GIS).

Enumeration of Non-Agricultural Drinking Water Threats

The objective of this stage of the threats assessment was to identify which activities within the City of Guelph would be potentially classified as significant drinking water quality threats based on the information contained in the threats database and the vulnerability mapping. This significant threat classification required that assumptions relating to the specific circumstances for each activity (e.g., volume and type of chemical) needed to be made based on available data. The database was designed with the ability to report on these assumptions for each property so that the classification can be revised when new data becomes available.

The significant threat enumeration approach resulted in 1,670 significant threats being identified corresponding to 1,041 locations in the City. Several properties indicated multiple threats, as well as both chemical and pathogen threats. In total, 33 of the properties were enumerated as significant pathogen threats. These were composed of 5 properties indicating handling and storage of non-agriculture source materials (NASM) associated with a meat packing plant and the remaining 28 were associated with septic systems.

Significant non-agricultural threats were not identified in the Intake Protection Zones.

Several stages of quality control/quality assurance (QA/QC) were completed during and after the threat enumeration process. Any errors or discrepancies identified in QA/QC program were resolved and re-checked during data follow up. The results should then be considered as a conservatively high estimate

of the number of significant threats within the City, and it is expected that the number of significant threats identified will decrease with additional data collection to address data gaps.

One of the objectives for this assessment was to identify the areas where future development could result in new significant water quality threats. This task was completed using Official Plans (OP's) and making assumptions of the types of activities that could take place within OP land use categories.

Review of this data indicates that there are several areas where new industrial activities and other threats could be introduced near the Calico, Sacco, Smallfield, Membro, Edinburgh, Clythe Creek, Queensdale and Downey wells. As such, the City should monitor areas and develop policies to manage drinking water quality risks.

Assessment of Managed Lands and Agricultural Based Threats

Managed lands and agricultural based threats were determined based on the Revised Technical Memorandum from GRCA, dated September 23, 2009 (GRCA, 2009). The threats identified in the analysis are based on assumptions relating to those lands which might be subject to the application of fertilizer, agricultural source material and non-agricultural source material (NASM) as well as rough estimates of the number of livestock and nutrient units associated with those lands.

Based on the current dataset and given the largest calculated percent managed lands for the WHPAs and IPZs, no significant threats were identified in the City's WHPAs or IPZs. It should be noted that the nutrient units generated for this exercise should be viewed as an initial assessment due to the limited data sets available for the calculations and that the calculations have not been updated to reflect the 2010 vulnerability mapping or scoring. As such the initial estimates should not be interpreted as an indication that there are no agricultural threats.

Impervious Surfaces / Road Salting

As required under the Technical Rules, this study considered impervious surface areas in the City's WHPAs to undertake an assessment of potentially significant threats from road salt application. As per the TDWT, the calculations of percent impervious area were completed over WHPA A, WHPA B and IPZ1 vulnerable areas. This assessment included all roadways and highways, but did not include an analysis of parking lots or pedestrian walk ways.

The maximum calculated percent impervious area was 17%. However, the TDWT only identify impervious areas as being significant water quality threats for road salt application when the impervious surface area is greater than 80%. As a result, no significant threats for road salt application were identified for the City of Guelph. However, application of road salt was indicated as a moderate threat in areas of calculated impervious surface area greater than 8% with a vulnerability score of 8-10.

CONDITIONS

The Clean Water Act, 2006, defines Conditions as those areas that result from past activities where there is existing contamination located within a vulnerable area. The Technical Rules provide the following instructions on the identification of conditions:

126. If the source protection committee is aware of one of the following conditions that results from past activities, the committee shall list it as a drinking water threat under clause 15(2)(g)(ii) of the Act:

(1) The presence of a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area.

(2) 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.

(3) The presence of a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or a wellhead protection area, if the contaminant is listed in Table 2 of the Soil, Ground

Water and Sediment Standards and is present at a concentration that exceeds the potable groundwater standard set out for the contaminant in that Table.

(4) 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.

(5) 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.

This phase of the study has reviewed all available data relating to contaminated sites and identified those areas with the potential to be classified as Conditions under the Clean Water Act.

Sources of Data

This study relied on the following sources of data to identify potentially contaminated sites>

- City of Guelph Contaminated Site Inventory. The City of Guelph maintains an inventory of known contaminated sites where the City has had some level of historical involvement as either the property owner or interactions with property owners. The City maintains hardcopies of engineering or monitoring reports for some of these sites.
- MOE Pilot Project. The MOE and GRCA undertook a Pilot Project to identify information needs for Drinking Water Source Protection. As part of this project, the City of Guelph provided the MOE with a listing of properties from its threats database that had been identified as potential water quality threats. The MOE then retrieved its files for those properties, where available, and scanned more than 400 documents relating to properties in the City that were potential water quality threats. The MOE provided the documents collected in this Pilot Project to the City of Guelph in September, 2009 and these documents were reviewed in terms of the additional information they could provide the City with respect to existing soil or groundwater contamination issues. The documents, however, were not current and in many cases only included information up to about 2006-2007.

For this assessment, information provided from the above sources was compiled into an electronic database to begin organizing data that would be necessary to classify sites as conditions under the Clean Water Act. Information contained in this database includes site address and site name, the City's site reference code, a table of all known environmental reports or documents and a record of the types of contamination reported at the site (i.e., Volatile Organic Compounds (VOC), Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) and an indication of the current state of remediation where known. While the City's documentation provides a considerable amount of information for the contaminated sites, there are many gaps where the City either does not hold copies of current site monitoring reports or where additional site investigations had not been completed to confirm the status of known or potential contamination.

Results

Based on the information compiled relating to contaminated sites, the City has identified a total of 76 properties within the City of Guelph that potentially could be classified as conditions under the Clean Water Act. 12 properties have been identified as potential conditions with respect to chlorinated compounds, which may be responsible for some of the drinking water issues identified. As described in the previous section, all sites with reported incidences of soil or groundwater contamination are included in the contaminated site database. The type of contamination (e.g, soil/groundwater, Chlorinated VOC, BTEX) and remediation status is also recorded. The type of contamination reported at the site is of particular importance as the main issues identified with respect to the City's drinking water supplies include chlorinated compounds (i.e. TCE) and one of the main objectives of this assessment is to identify sites that may have contributed to this issue.

The scope and schedule of the current study was not sufficient to complete a thorough technical review of all the documents provided by either the City or the MOE. Furthermore, the City may not have possession of all documentation that may describe the current status of these sites. Without a more detailed review of the technical reports and assurance that the most recent monitoring reports are available, it is not possible to conclude that soil or groundwater contamination at a site is above a drinking water standard and this is a key requirement in a site being classified as a Condition under the Clean Water Act. The results in this section should only be considered as a first step in the identification of conditions with respect to the City's drinking water supplies, and all documentation relating to potential conditions should be obtained from the MOE (and other agencies) and be reviewed in a greater level of detail to understand the current status of these sites.

DATA GAPS AND UNCERTAINTY

The following data gaps and uncertainties were documented for the issues, threats, and conditions assessment.

Issues

There are no significant gaps with respect to drinking water quality issues. The City maintains a comprehensive drinking water quality monitoring program to identify any current or potentially future water quality parameters that might exceed drinking water standards or show a trend of exceeding those standards in the future.

Threats

The data gaps and uncertainties are presented below for water quality threats as well as recommendations for addressing them:

- Vulnerability Scoring. The vulnerability scoring used to classify water quality threats has uncertainties relating to both the vulnerable areas (WHPAs) and vulnerability mapping used in to create vulnerable scoring maps. While this mapping was completed using the best available information, there is an opportunity to reduce the uncertainty of this component of the assessment as the modelling tools and hydrogeological conceptual model is refined in the future.
- Non-Agricultural Threats. The current assessment identifies significant water quality threats based only on existing datasets and not a survey of actual site or property circumstances. As a result, the uncertainty associated with the significant water quality threats identified is high. A survey of the activities associated with these significant threats should be completed to reduce this uncertainty. Furthermore, there are a few instances in the threats database where properties and businesses could not be reliably matched with the City's tax roll data base. These instances can be addressed with a field visit.
- Agricultural Threats. There is insufficient data to complete representative nutrient unit calculations and analysis of livestock operations that could lead to significant chemical and pathogen threats for WHPAs A, B, C, D, E and IPZs 1 and 2. Additionally, this assessment was not updated to reflect the 2010 vulnerability mapping or scoring. While there were no significant agricultural threats identified, the uncertainty of this assessment is high. A detailed survey of the agricultural property should be completed to reduce this uncertainty.
- Impervious Areas / Road Salting. There is a need to refine the analysis of impervious areas to include pedestrian walkways and parking lots, which was not completed as part of this assessment.
- Transmission of Sewage. The TDWT identifies the transmission of sewage (i.e., sanitary sewers) as a drinking water threat. However, the circumstances relating to the classification of these threats depend on the transmission rate of sewage. The City chose not to pursue the classification of sanitary sewers and the transmission of sewage within this phase of the assessment. Further

analysis is needed for the City to estimate wastewater flows to complete this component of the assessment.

- Classification of Low and Moderate Threats. The scope of this assessment was to identify those activities which would potentially be classified as significant threats given the worst-case assumption of circumstances for those activities. After completing a detailed survey, the City can proceed to classify activities as low and moderate threats.

Conditions

This study identifies a total of 76 properties within the City where groundwater or soil concentrations of hazardous chemicals may be greater than relevant standards. Furthermore, there are 12 properties identified as potential conditions with respect to chlorinated organic compounds, which are related to the City's drinking water issues at a number of its wells. The uncertainty associated with the potential conditions is high, as this assessment is based on general review of a large set of documents. The City should complete a detailed technical review of all relevant documents for the potential conditions and ensure that the most recent documentation for all sites is made available before proceeding to identify those properties as conditions under the Clean Water Act. This assessment should also consider changes to the Soil, Ground Water and Sediment Standards which are planned to be effective in 2011.

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1.0 Introduction

In the fall of 2005, the Ontario government introduced Bill 43, the Clean Water Act (the "Act") to protect drinking water at the source as part of an overall commitment to human health and the environment. Protecting "source water" is the first step in a multi-barrier approach to ensure the quality and sustainability of our drinking water supply. The Act received Royal Assent on October 19, 2006 establishing a framework for the development and implementation of Source Protection Plans across Ontario.

The framework for Source Protection, as set out in the Act, requires the development of a watershed-based Assessment Report. This Assessment Report, to be prepared by the Source Protection Authority, includes a watershed characterization, a water budget, municipal water supply strategies (aligned with drinking water systems), a groundwater and surface water vulnerability assessment, a threats assessment and issues evaluation, and water quality and quantity risk assessment studies. Upon completion of the Assessment Reports, Source Protection Plans will be developed for the Source Protection Regions. The Source Protection Plan will outline locally based risk management measures to reduce or to prevent risks to drinking-water supplies, and include a recommended implementation strategy.

Source Protection Teams are required to undertake a series of studies to prepare an Assessment Report; these studies are outlined in the Ministry of Environment's Technical Rules (MOE, 2009a). The Technical Rules require that a water quality threats assessment be completed to identify drinking water issues, threats related to activities, and threats related to conditions. Drinking water issues are instances where water quality parameters exceed or are likely to exceed relevant standards at a drinking water well or surface water intake. A drinking water threat relating to an activity is identified where a land use or activity has the potential to adversely affect the quality of any water that is or may be used as a source of drinking water. A condition relates to past activities that may have led to the presence of existing soil, sediment, or groundwater contamination that has the potential to impact one of the City's drinking water wells or surface water intakes.

In June 2007 the City of Guelph (the City) retained a team led by AquaResource Inc. (AquaResource) working with Stantec Consulting Ltd. (Stantec) to complete a study to assess groundwater and surface water vulnerable areas and vulnerability scoring, and to complete work relating to the identification of threats to water quality and water quantity. This contract was extended in 2009 after the Ministry of the Environment (MOE) published its Technical Rules (MOE, 2009a), which provided revised detailed instructions regarding the water quality vulnerability and threats assessment under the Clean Water Act.

The scope of this assessment included the compilation of existing data relating to water quality monitoring data, as well as land use activities and environmental reports to identify issues, threats, and conditions. The study follows the Province's requirements for this assessment as written in the Technical Rules. The City has produced a report entitled Groundwater and Surface Water Vulnerability Report (AquaResource, 2010). The main results of this report are maps of groundwater and surface water vulnerability scores, which are used in this report to assess the significance of water quality threats.

1.1 CITY OF GUELPH WATER SUPPLY

The City of Guelph has 115,000 residents (2006 Statistics Canada data) and it is one of the largest cities in Canada to rely almost exclusively on groundwater for its potable water supply. The population is projected to reach 144,500 by the year 2021. The groundwater supply system comprises 23 groundwater wells distributed throughout the City, as shown on Figure 1. In 2008, 19 of the production wells were operated on a near continuous basis and four were removed from the system due to water quality or maintenance concerns.

In addition to the groundwater supply wells, the City obtains water from the Arkell Spring Grounds collector system, also referred to as the Glen Collector. The system collects shallow groundwater from

the overburden through a series of small diameter perforated pipes; this water is conveyed to the F. M Woods Water Treatment plant for disinfection. In addition, the City has a water supply intake on the Eramosa River at the Arkell Spring Grounds that is used in association with the Arkell Recharge System. From April to November, water is pumped from the Eramosa River into a recharge pit and infiltration trench where it recharges the overburden aquifer supplying the Glen Collector System. This artificial groundwater recharge system is maintained by the City to augment groundwater flow and provide seasonal increases in water supply to the City.

1.2 RELATED STUDIES

The City has completed numerous studies that contribute to the current knowledge and understanding relating to threats to the quality of its drinking water supplies. The most relevant studies are summarized in the following subsections.

1.2.1 Guelph-Eramosa Township Groundwater Study

The Guelph-Eramosa Township Groundwater Study was completed in 2003 by Gartner Lee Ltd (2003a). The objective of the study was to assemble relevant data and information that could be used to develop a long-term plan to manage both the quantity and quality of the groundwater resources within Township, and specifically the Township production wells. The study included characterization of the susceptibility of the aquifer to surface contamination, and preparation of a potential contaminant sources inventory within the Township wellhead protection areas based on land use information.

1.2.2 Guelph- Puslinch Groundwater Protection Study

The Guelph-Puslinch Groundwater Protection Study was completed in 2006 by Golder Associates Ltd. The study also included regional groundwater characterization, development of a three-dimensional groundwater flow model, groundwater susceptibility (vulnerability) mapping, a regional contaminant source inventory (threats database), and a groundwater use assessment.

1.2.3 Wellington County Groundwater Protection Study

The County of Wellington Groundwater Protection Study (Golder, 2006b) was initiated in 2003 to refine the regional scale mapping completed in the first round of MOE-funded groundwater studies in 2001/2002. The updated study focused on areas susceptible to groundwater contamination, as well as wellhead protection areas. The study also focused on formulating a groundwater protection strategy for the County of Wellington by merging hydrogeological maps across the County.

One of this project's deliverables was a regional potential contaminant sources database. This database was prepared in a similar format to that of the Guelph-Puslinch Groundwater Protection Study.

1.2.4 City of Guelph Source Protection Project

In June 2006, the City retained a team, led by AquaResource Inc. (AquaResource) and included Stantec Consultants (Stantec) and S. S. Papadopulos and Associates, Inc (SSPA), to conduct a Groundwater Study and an Intake Protection Zone Study. Two reports were produced, including an evaluation of Groundwater Vulnerability Threats (AquaResource, 2007a) and an evaluation of Surface Water Vulnerability (AquaResource, 2007b). The groundwater and surface water assessments were completed in accordance with the MOE's preliminary guidance documents on groundwater and surface water vulnerability and threats assessment. This threats database compiled in this assessment formed the basis of this study.

1.2.5 Tier Three Water Budget and Water Quantity Risk Assessment

The City is completing a Tier Three Water Budget and Quantity Risk Assessment which is also required under the Clean Water Act. The purpose of this study, being conducted by AquaResource, is to assess

the longer-term sustainability of the City's wells from a water quantity perspective, and to identify any significant threats to water quantity. A major component of this study is the development of a detailed three-dimensional groundwater flow model of the City's aquifer system. The Tier Three model has been developed with more extensive local hydrogeologic data and characterization than that included in the Guelph-Puslinch Township Groundwater Protection Study. As a result of the improvements in the Tier Three groundwater flow model, the City chose to use it to delineate the well head protection areas, or WHPAs used in the Groundwater Vulnerability Assessment to develop the vulnerability scoring maps used in this study.

1.3 GROUNDWATER AND SURFACE WATER VULNERABILITY

The water quality threats assessment builds on work contained in a report entitled Groundwater and Surface Water Vulnerability Report (AquaResource, 2010). This Study was undertaken by the City of Guelph to meets its requirements under the Clean Water Act relating to the vulnerability of groundwater and surface water supplies. This work is consistent with the Ministry of Environment's Technical Rules (MOE, 2009a) for the delineation of Wellhead Protection Areas (WHPAs) for groundwater wells and Intake Protection Zones (IPZs) for surface water intakes and the assignment of vulnerable scores for areas within the WHPAs and IPZs.

These vulnerability scores for groundwater are illustrated on Figure 2. The vulnerability scores for the City's surface water intake on the Eramosa River are illustrated on Figure 3. Finally, Figure 4 illustrates the surface water vulnerability scoring related to the City's Carter well which is designated as groundwater under the direct influence (GUDI) of surface water as determined accordance with subsection 2 (2) of O. Reg. 170/03 (Drinking Water Systems) made under the Safe Drinking Water Act,

The following sections summarize the groundwater and surface water vulnerability study.

1.3.1 Groundwater Vulnerability - Methodology

The Technical Rules (MOE, 2009a) provide three general steps in completing the vulnerability assessment for groundwater supplies. These steps are summarized below, with additional detail provided in the subsections that follow:

1) Delineate wellhead protection areas;
2) Create Vulnerability Maps; and,
3) Complete Vulnerability Scoring.

The first step in the groundwater vulnerability assessment is the delineation of wellhead protection areas (WHPAs). The Clean Water Act treats WHPAs as regulated vulnerable areas, and these areas will be controlled with specific policies within the source protection plan. The Technical Rules (MOE, 2009a) developed in support of the Clean Water Act require the delineation of WHPAs for drinking water wells. The WHPAs include the WHPA-A (100 m), WHPA-B (two year time-of-travel), WHPA-C (five year time-of-travel) and WHPA-D (25 year time-of-travel) area.

The WHPAs for the City's current and planned wells were delineated using a particle tracking technique and the groundwater flow model currently being developed in support of the City's Tier Three Water Budget and Local Area Risk Assessment. The WHPAs are estimated based on the City's projected water demand for 2031.

A large portion of the City's land area was found to be contained within the two-year WHPA (WHPA-B) and most of the land area is contained within the five-year WHPA (WHPA-C).

Groundwater vulnerability maps are created to identify areas where the groundwater supply aquifer has a high, medium or low vulnerability to contamination from ground surface. For this study a modified version of the groundwater intrinsic susceptibility index (GwISI) was developed which takes into account a map of

overburden thickness in addition to the estimated GwISI value at wells (e.g., water well records, municipal wells). A modified version of the GwISI method is implemented to better represent the influence of areas having low or high overburden thickness where there are few estimates of the ISI value from which to interpolate.

This study follows the MOE's vulnerability scoring methodology as written in the Technical Rules to assign scores to vulnerable areas within the City's WHPAs. The results identify large areas of the City having high vulnerability scores equal to 8 or 10. These areas with high vulnerability are typically located within the WHPA-A (e.g., 100 m) or WHPA-B (e.g., two-year time-of-travel) areas and have relatively thin overburden, and these results are intuitive in that where the bedrock is close to ground surface it is more vulnerable to contamination.

1.3.2 Surface Water Vulnerability – Surface Water Intakes

The Eramosa River has been a source of drinking water for the City of Guelph for many years. The Arkell Spring Grounds was developed by the City in 1908 to replace the Eramosa River as a source of water supply. Prior to that time, water was pumped directly from the Eramosa River to open reservoirs at the former York Road Pumping Station which is now the site of the current F.M. Woods Water Pumping Station. The development of the Arkell Spring Grounds involved the installation of a collector system to intercept groundwater springs/seeps from the outwash sands and gravels that are exposed along the south valley wall of the Eramosa River. The system also required the construction of an aqueduct to convey the water from the Arkell Spring Grounds to the York Road Water Pumping Station.

Following the MOE's guidance and the Technical Rules (MOE, 2009a) the following vulnerable areas are delineated for the Eramosa River Intake:

1) Intake Protection Zone 1 (IPZ-1) - This vulnerable area is based on a semi-circle of 200 m radius, extending upstream of the intake. The IPZ-1 intake is also extended downstream to the Arkell weir/impoundment below the Intake. A setback of 120 m or the extent of the Conservation Authority Regulated Area is applied.

2) Intake Protection Zone 2 (IPZ-2) - The IPZ-2 vulnerable area is delineated beginning at the IPZ-1 and extending up stream of Eden Mills to the Indian Road bridge across the Eramosa River. During high flow conditions, the time-of-travel from this location to the Intake is estimated to be approximately 6 hours. Delineation of the IPZ-2 was based on the results of a dye-tracer test scaled up to a higher flow using a hydraulic model. While the Technical Rules require a minimum two-hour time-of-travel criteria, the City prefers that the longer time period be used to represent the IPZ-2 reflecting the amount of time that might be needed for the municipality to respond to an upstream spill.

3) Intake Protection Zone 3 (IPZ-3) - The IPZ-3 vulnerable area is delineated to include all watercourses providing water to the intake, buffered to either 120 metres or the Conservation Authority Regulated Area, whichever is greater. These watercourses include the Eramosa River, Blue Springs Creek, and their tributaries.

The following table lists the vulnerability scores that have been assigned as part of this study:

Table 1 - Vulnerability Scores for Eramosa Intake IPZs

Intake Protection Zone	Vulnerability Score
IPZ-1	10
IPZ-2	7
IPZ-3 Built Up Areas	5
IPZ-3 Agricultural Areas	3
IPZ-3 Natural Areas	1

The vulnerability scores reflect both the guidelines provided in the Technical Rules as well as a practical assessment of the relative vulnerability of the lands contributing water to the Eramosa River Intake.

1.3.3 Carter Well - GUDI Well Vulnerability

The Technical Rules require the delineation of separate vulnerable areas for groundwater wells where the well obtains water from a raw water supply that is groundwater under the direct influence (GUDI) of surface water as determined accordance with subsection 2 (2) of O. Reg. 170/03 (Drinking Water Systems) made under the Safe Drinking Water Act, 2002.

The City's Carter wells are considered to be GUDI Systems and are located adjacent to Torrance Creek, a small watercourse draining an area of the southeast quadrant of the City of Guelph. The system consists of two bedrock wells located at a distance of about 3 m apart. The wells obtain their water from the shallow bedrock which, at this location, consists of the Guelph Formation.

The Technical Rules require that the WHPA-E and WHPA-F vulnerable areas be delineated for GUDI Systems. These areas are analogous to the IPZ-2 and IPZ-3 vulnerable areas and summarized below:

1) WHPA-E: Based on a rough time-of-travel estimate, it was recommended that the entire length of Torrance Creek be considered within the WHPA-E for the Carter Wells. It is noted here that while the estimated water velocity is not based on hydraulic calculation, the relatively short length of the Creek warrants having the entire length included within the WHPA-E area. The WHPA-E is further delineated using the greater of a lateral setback of 120 m or the Regulated Area as defined by the GRCA.
2) WHPA-F: A WHPA-F was not delineated for the Carter Wells, as the WHPA-E includes all of Torrance Creek.

A vulnerable score of 7 was assigned to the WHPA-E for the Carter wells.

1.4 CONTENTS OF THIS REPORT

This report discusses the methodology used to delineate vulnerable areas and complete vulnerability scoring for the City of Guelph's groundwater wells and surfaced water intakes. It includes the following sections:

Section 1. Introduction

Section 2. Drinking Water Issues Evaluation

Section 3. Drinking Water Threats: Water Quality

Section 4. Drinking Water Threats: Conditions

Section 5. Conclusions and Recommendations

Section 6. References

2.0 Drinking Water Issues Evaluation (Part XI.1)

2.1 INTRODUCTION

The Clean Water Act, 2006 requires that drinking water quality issues be identified for each vulnerable area. The Technical Rules identify an issue with respect to water quality under the following conditions:

114. (1) The presence of a parameter in water at a surface water intake or in a well, including a monitoring well related to a drinking water system to which clause 15(2)(e) of the Act applies, if the parameter is listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines and,

(a) the parameter is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water, or

(b) there is a trend of increasing concentrations of the parameter at the surface water intake, well or monitoring well and a continuation of that trend would result in the deterioration of the quality of the water for use as a source of drinking water.

(2) The presence of a pathogen in water at a surface water intake or in a well, including a monitoring well, related to a drinking water system to which clause 15(2)(e) of the Act does apply, if a microbial risk assessment undertaken in respect of the pathogen indicates that,

(a) the pathogen is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water, or

(b) there is a trend of increasing concentrations of the pathogen at the surface water intake or well and a continuation of that trend would result in the deterioration of the quality of the water for use as a source of drinking water.

(3) In respect of drinking water systems in the vulnerable area that are not mentioned in clause 15(2)(e) of the Act, there is evidence of the widespread presence of a parameter listed in Schedule 2 or 3 of the Ontario Drinking Water Quality Standards or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines at surface water intakes or in wells, including monitoring wells, related to those systems, and

(a) the parameter is present at a concentration that may result in the deterioration of the water for use as a source of drinking water, or

(b) there is a trend of increasing concentrations of the parameter at the intake, well or monitoring well and a continuation of that trend would result in the deterioration of the quality of the water for use as a source of drinking water.

For this assessment of water quality issues at the City of Guelph's municipal wells, water quality sample results taken during the period of 1990 – 2008 were compared against drinking water quality standards including the Provincial Water Quality Objectives, Aesthetic Objective, and Ontario Drinking Water Standards. Table 2 identifies the water quality parameters and their related standards, which were either exceeded at the City of Guelph's wells or where there is an upwards trends with the possibility of exceedance at the City of Guelph's wells. The review identified two water quality parameters that may be associated with an issue including Trichloroethylene (TCE) and nitrate. While not classified as issues, sodium and chloride concentration are increasing at several wells within the city and they must continue to be watched closely within the City to identify and manage impacts associated with road salting activities. In addition, there have been other chemicals such as cis-1,2-DCE observed at the city's wells and while these detections do not present themselves as issues at the present time, the City will remain diligent in evaluating monitoring wells to identify trends and potential future water quality issues.

Table 2 - Provincial Standards for Water Quality (Ontario Drinking-Water Quality Standards Regulation O. Reg. 169/03)

Parameter	***Source***	***Criteria***
Sodium[1]	Aesthetic Objective	200 mg/L
Chloride	Aesthetic Objective	250 mg/L
Trichloroethylene (TCE)	Ontario Drinking Water Quality Standard, MAC	0.005 mg/L
Nitrate	Ontario Drinking Water Quality Standard, MAC	10 mg/L

Notes: [1]The Medical Advisory Level for Sodium is 20 mg/L, but water may continue to be distributed and consumed at these concentrations.

2.2 RESULTS

As described above, this assessment reviewed water quality for all parameters at the City's water supply wells and focused on TCE and nitrate as issues and sodium and chloride as parameters of concern. The following section summarizes the results for wells where issues have been identified and the subsequent section summarizes data for those wells were issues have not been identified. This first section also contains time series charts summarizing water quality trends for all identified issues. Appendix A contains time series charts for these water quality parameters for all water supply wells.

2.2.1 Summary of Wells with Issues

2.2.1.1 Carter Wells

The Carter Wells differentiate themselves from most of the other wells in the City in that they obtain their water supply from the Guelph Formation in shallow bedrock. This aquifer is not protected by an aquitard and is therefore more susceptible to contamination than many of the other wells in the city.

As illustrated on Figure 5, Nitrate concentrations at the Carter wells have risen above the Ontario Drinking Water Quality Standard since approximately 2002. While these concentrations are higher than the standard, they are combined and diluted with other waters from the Arkell Spring Grounds at the Woods Station before distribution with the result being no negative human health impact.

Nitrate may be introduced into the groundwater as a result of land application of fertilizer or manure, or as a constituent of discharge from septic systems.

Sodium concentrations at the Carter well have been above the Medical Advisory Level (20 mg/L) but this does not reflect an issue at the well.

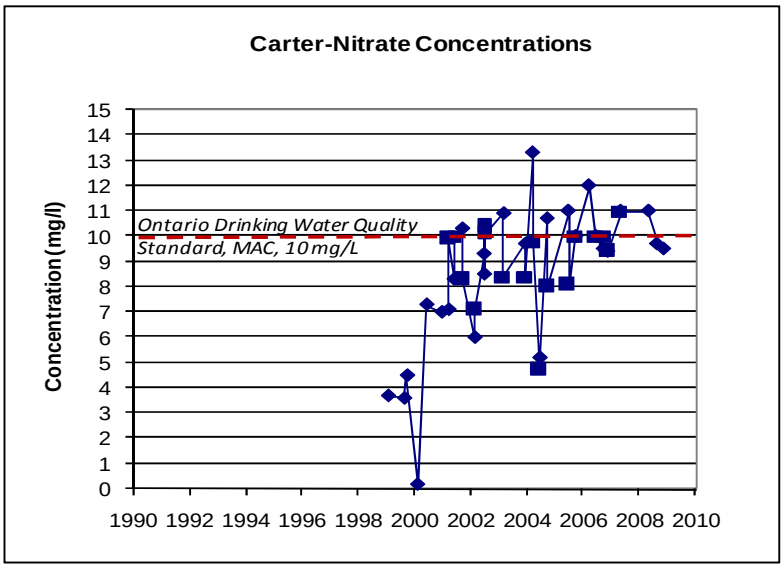

Figure 5 - Carter Wells - Nitrate Concentrations

2.2.1.2 Emma Well

The Emma Well is located in the northeast area of the city and obtains its water supply from the deep Gasport/Amabel aquifer. Figure 6 illustrates the concentration trend for TCE at the Emma Well. TCE concentrations at the well have been rising since approximately 2000 and have not yet appeared to stabilize. While these concentrations remain lower than their drinking water quality standards the City is concerned about the potential for concentrations to increase further and therefore represent an issue that should be managed.

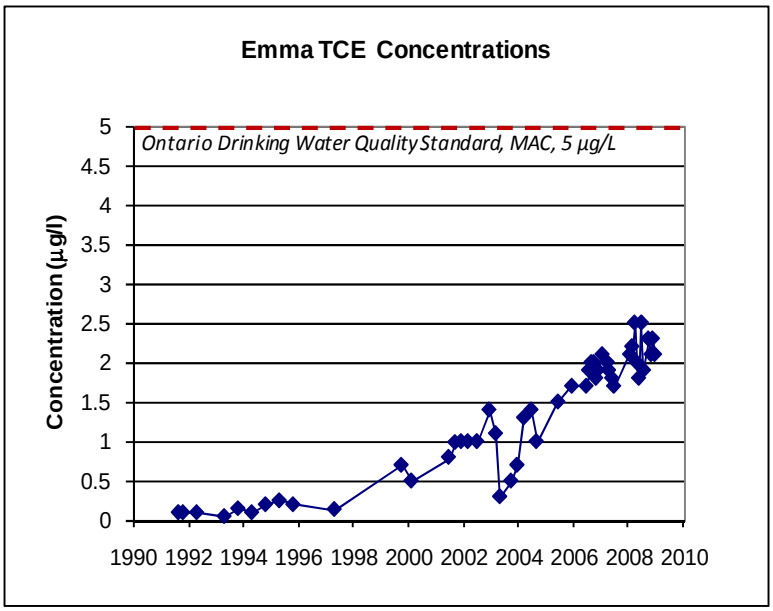

Figure 6 - Emma Well - TCE Concentration

Sodium and chloride concentrations at the Emma well appear to be remaining constant, with sodium concentrations at approximately 60 mg/L and chloride concentrations at approximately 110 mg/L. Both constituents are below their Aesthetic Objectives.

2.2.1.3 Membro/Edinburgh Wells

The City of Guelph's Membro Well, and to a lesser extent the nearby Edinburgh Well, has been impacted by TCE since approximately 1994 as illustrated on Figure 7. The TCE concentrations reached a peak of 4 µg/L in 2001 but have been reduced and are maintained at approximately 2.5 µg/L, which is half of the MAC. While the TCE concentrations are below the MAC and the trend has been relatively stable since about 2002, the current concentrations are higher than in the 1990's. The change in this trend may be related to the installation of a liner in the well. The City should continue to manage the issue and implement monitoring programs that may help to identify the source of this contamination.

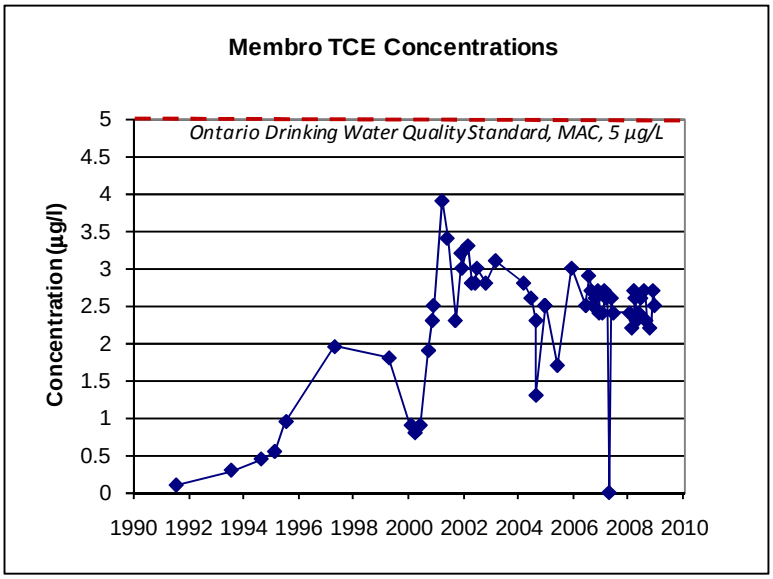

Figure 7 - Membro Well - TCE Concentration

Sodium and chloride concentrations at the Membro well have been historically very high and above their Aesthetic Ojectives but have fallen below these values.

TCE concentrations at the Edinburgh well had been detected but at very low concentrations. Sodium and chloride concentrations at the well had also been following an upwards trend, with chloride concentrations measuring above the Aesthetic Objective (250 mg/L) before the well was taken offline.

2.2.1.4 Smallfield/Sacco Wells

The Smallfield and Sacco Wells are located in the Northeast area of the City with a high density of commercial and industrial land uses within their WHPAs. The City began to observe high TCE concentrations at the Smallfield well in 1993 as illustrated on Figure 8. Similarly, TCE contamination was observed in the Sacco well at approximately the same time as illustrated on Figure 9. The City took the wells off-line at that time. The City continues to consider the Smallfield and Sacco Wells as a future sources of water and is currently evaluating the return to service and treatment alternatives for the wells. Recently sampling (December, 2008) of the Smallfield Well under pumping conditions resulted in initial TCE concentrations of 134 µg/l at the start of the test and reducing to 25 µg/l after 13 days of pumping. During the same test, TCE concentrations in the Sacco Well were below the ODWS MAC of 5 µg/L in all samples, with concentrations remaining steady between 0.3 and 0.5 µg/L over the pumping test period.

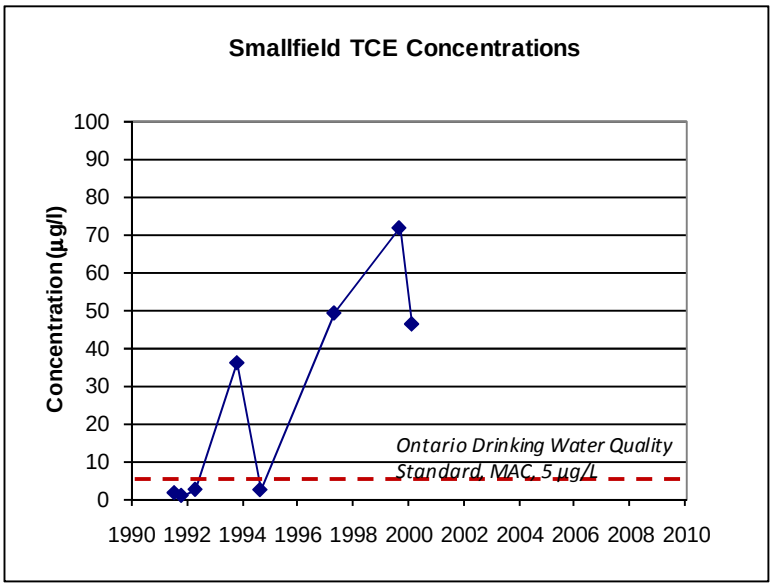

Figure 8 - Smallfield Well - TCE Concentration

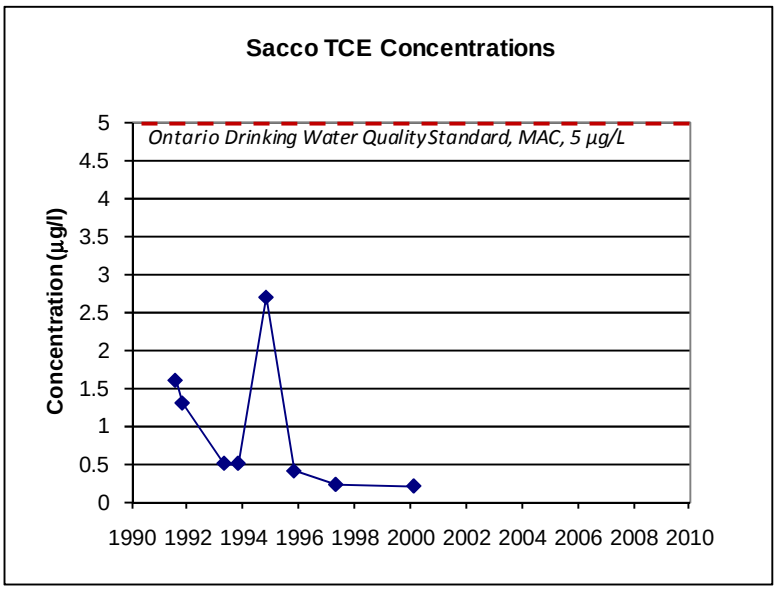

Figure 9 - Sacco Well - TCE Concentration

2.2.2 Summary of Wells Without Issues

Appendix A contains time series charts for Sodium, Chloride, TCE and Nitrate, where applicable, for each of the Cities production wells. The following table briefly describes water quality results and trends for wells where issues have not been identified in the previous section.

Table 3 - Summary of Water Quality Trends

Well	***Water Quality Trend***
Arkell 1 Well	Until comprehensive testing was discontinued in 2004, Sodium and Chloride concentrations at the Arkell 1 well were low with no apparent trend. The City has not tested water quality at the Arkell 1 well recently, since all water is pumped through the F.M. Woods Pumping Station and tested at that location.
Arkell 6 Well	Up until 2004 when comprehensive testing was discontinued, Sodium concentrations had an increasing trend at the Arkell 6 well and had exceeded the Medical Advisory Level (20 mg/L) at that time. The City has not tested water quality at the Arkell 6 well recently, since all water is pumped through the F.M. Woods Pumping Station and tested at that location.
Arkell 7 Well	Up until comprehensive testing was discontinued in 2004, Sodium and Chloride concentrations at the Arkell 7 well were low. The City has not tested water quality at the Arkell 7 well recently, since all water is pumped through the F.M. Woods Pumping Station and tested at that location.
Arkell 8 Well	Up until comprehensive testing was discontinued in 2004, Sodium concentrations were approximately equal to the Medical Advisory level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). The City has not tested water quality at the Arkell 8 well recently, since all water is pumped through the F.M. Woods Pumping Station and tested at that location.
Burke Well	Sodium and chloride concentrations at the Burke well are following an upwards trend, with sodium concentrations currently exceeding the Medical Advisory Level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). Chloride concentrations are low.
Calico Well	Sodium and chloride concentrations at the Calico well are following an upwards trend, with sodium concentrations currently exceeding the Medical Advisory Level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). Chloride concentrations are low.
Clythe Well	The Clythe Creek well has been out of service due to natural water quality issues (hydrogen sulphide). Within the period of testing, sodium concentrations at the Clythe well were above the Medical Advisory Level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). Chloride levels had an upwards trend, but remained well below the Aesthetic Objective (250 mg/L).
Dean Well	Over the period of testing, sodium and chloride concentrations at the Dean Well both showed an upwards trend, with the concentrations of both constituents being approximately half of their respective aesthetic objectives.
Downey Well	Sodium and chloride concentrations at the Downey well are following an upwards trend, with sodium concentrations currently exceeding the Medical Advisory Level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). Chloride concentrations are low.
Helmar Well	Sodium and chloride concentrations at the Helmar Well are following an upwards trend, with sodium concentrations currently exceeding the Medical Advisory Level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). Chloride concentrations are low.
Paisley Well	Sodium and chloride concentrations at the Paisley Well are following an upwards trend, with sodium concentrations currently exceeding the Medical Advisory Level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). Chloride concentrations are low. TCE concentrations have been observed at the well since approximately 2000, and while they should be watched closely for any upwards trends, the concentrations are well below the MAC.
Park Well	While the Park well is located nearby, it has not appeared to be impacted by TCE to the extent of the Emma well. Sodium and chloride concentrations at the well have an increasing trend and are relatively high.
Queensdale Well	Chloride concentrations at the Queensdale well are relatively low with no apparent upwards trend. Sodium concentrations have recently risen above the Medical Advisory Level (20 mg/L).
University Well	Sodium and chloride concentrations at the University Well are following an upwards trend, with sodium concentrations currently exceeding the Medical Advisory Level (20 mg/L) but well below the Aesthetic Objective (200 mg/L). Chloride concentrations have risen above 160 mg/L which is below the Aesthetic objective (250 mg/L).

Well	Water Quality Trend
Water Street Well	Sodium and chloride concentrations at the Water Street well are moderate with no apparent upwards trend. Sodium concentrations are above the Medical Advisory Level (20 mg/L). TCE has been observed at the Water Street Well over the past number of years, and since this well is in the vicinity of the Membro and Edinburgh well, this may indicate more widespread TCE contamination in the area. While the longer term TCE trend appears to be downwards, there is a recent reported result greater than 2 µg/L which may indicate a data quality problem.
Woods Treatment Plant	Water quality results at the Woods Treatment Plant are a reflection of mixed water from each of the Arkell Wells and the Glen Collector. Nitrate concentrations are approximately 3 mg/L, which is well below the MAC. All other constituents are well below drinking water objectives.

2.3 SUMMARY OF ISSUES IDENTIFIED

Based on the available data, four wells, including Carter, Emma, Membro, and Smallfield, either exceeded the drinking water objectives or appear to be trending toward exceeding the drinking water objectives. Table 4 summarizes the water quality standards for each of the four municipal wells.

Table 4 - Identified Issues

Municipal Well	Issue
Carter Well	Nitrate above drinking water standard[1]
Emma Well	TCE concentrations are approximately approximately ½ of the drinking water standard with an increasing trend.
Membro / Edinburgh Wells	TCE concentrations approximately ½ of the drinking water standard at Membro Well with no increasing trend.
Smallfield / Sacco Wells	TCE concentrations above drinking water standard at Smallfield Well.

Notes: [1] *Water from the Carter Well is combined with other waters from the Arkell Spring Grounds to lower the nitrate concentrations to a level that is less than the drinking water standard.*

In addition to detections at the above wells, TCE and other VOCs (e.g., cis-1,2-DCE) have been detected at very low concentrations at a number of additional wells. Sodium concentrations were either at or above the Medical Advisory Level (20 mg/L) but below the Aesthetic Objective (200 mg/L) at a number of other wells. Although these wells are well below the Aesthetic Objective, province requires that the local Medical Officer of Health be notified when the sodium concentration exceeds 20 mg/L so the City should continue to monitor concentrations at those wells accordingly. There are increasing sodium and chloride concentrations at a number of wells indicating road salting impacts.

Consideration should be given to how the City of Guelph will handle sodium and chloride levels that exceed the Medical Advisory Level.

2.4 DATA GAPS

There are no significant gaps with respect to drinking water quality issues. The City maintains a comprehensive drinking water quality monitoring program to identify any current or potentially future water quality parameters that might exceed drinking water standards or show a trend of exceeding those standards in the future.

2.5 UNCERTAINTY

The uncertainty with respect to the classification of drinking water issues in the City is low as the conclusions are supported by consistent water quality monitoring trends. The issues identified have been of concern by the City over a relatively long period of time.

3.0 Drinking Water Threats: Water Quality (Part XI.2)

3.1 INTRODUCTION

This section describes the approach used to identify and map drinking water quality threats following the requirements of the Clean Water Act (2006) and the Technical Rules (MOE, 2009a).

The Clean Water Act defines a threat as:

"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, and includes an activity or condition that is prescribed by the regulations as a drinking water threat."

The Technical Rules describe a methodology for the identification of drinking water quality threats that combines vulnerability scoring maps with detailed information relating to land use activities. The specific details relating to land use activities and related threats to drinking water are referred to as 'circumstances' within the Technical Rules. The Technical Rules list approximately 2,000 circumstances, each of which prescribe a threat as being a low, moderate or significant water quality threat for a property depending on the vulnerability score as well as other details (e.g., volume of chemicals stored) for that activity.

The scope of this assessment included the compilation of several datasets relating to land use activities and potential water quality threats within the City of Guelph. These datasets were incorporated into a single database that references each potential threat to the City of Guelph's official land parcel map. Properties having the potential of being classified as a significant threat with respect to the City's drinking water were identified based on this database, and the 'worst case' assessment of the activities and circumstances at each property was also recorded. Low and moderate water quality threats and corresponding activities were not classified within this assessment.

As required in Part XI.2 of the Technical Rules (MOE, 2009a), a series of tasks were completed for the identification and classification of drinking water quality threats associated with activities within the vulnerable areas for the City of Guelph's drinking water wells and surface water intakes. The tasks are listed in Table 5 and discussed in greater detail in the subsequent sections.

Table 5 - List of Tasks for the 2009 Drinking Water Quality Threats Assessment

Task	Description
2007 Guelph Threats Database Compilation	Previous work undertaken in 2006 and 2007 by AquaResource, Stantec and SSPA (2007) involved compiling data on businesses and properties within the delineated vulnerability areas and assembling the data into an electronic database (hereto referred to as the 2007 Guelph Threats Database)
2008 Additional Threats Assessment Work	Using the 2007 Guelph Threats Database refinement of identified businesses/properties was completed. This task involved field verification of many businesses and removal of duplicate businesses or businesses no longer in operation. This work finished in November 2008 due to changes to the Technical Rules, introduction of Tables of Drinking Water Threats (MOE, 2009b) and new guidance on Threat Assessment.
Development of 2009 Guelph Threats Database	The 2007 Guelph Threats Database was expanded as part of this current work to accommodate new datasets and to facilitate the enumeration of drinking water threats according to the Province's methodology.
Assessment of Managed Lands and Agricultural Based Threats	Area of managed lands (agricultural and non-agricultural) and estimated nutrient units were calculated in order to evaluate land based (predominantly agricultural) threats in WHPAs and IPZs as per the technical guidance provided by GRCA (2009).

Task	Description
Impervious Surfaces	Road networks as percent impervious areas were calculated to determine road salt application threats in applicable WHPAs and IPZs.
Sanitary Sewer Network	A compilation of sanitary sewer mapping was completed as part of a limited evaluation of potential threats from transmission of human sewage in the sanitary sewer networks for the City of Guelph.
Identify Future Significant Threats	Official Planning documents were reviewed for the City of Guelph, County of Wellington and Town of Milton to determine areas in WHPAs and IPZs that may be potential future drinking water threats based these on future proposed land use and zoning.
Enumeration of Drinking Water Threats	This task relies on the above information to classify significant drinking water threats for the City of Guelph.

3.1.1 Previous Source Protection Threats Assessment Work

3.1.1.1 2007 Guelph Threats Database

Previous water quality threats assessment work undertaken in 2006 and 2007 by AquaResource, Stantec and SSPA (2007) involved compiling data on businesses and properties within the delineated vulnerability areas and assembling the data into an electronic database (hereto referred to as the 2007 Guelph Threats Database). Data collected in 2006-2007 included data from the City of Guelph taxation records, an Ecolog ERIS database search of the City of Guelph from 2002, data from a limited field survey of businesses in the City of Guelph, and a business listing from the Yellow pages. Some of this information had been compiled as part of the Guelph Puslinch Groundwater Study (Golder, 2006a). The database was used to develop a preliminary threat inventory and classified threats based on specific chemical groups (e.g. chlorinated solvents). This inventory was the basis for further stages of threat assessment and refinement as discussed below.

3.1.1.2 2008 Additional Threats Assessments Work

Threats inventory work was undertaken by AquaResource and Stantec in 2008 as part of the requirements of the Clean Water Act and early versions of technical guidance. This phase of work included field verification of potential threats. Additionally, NAICS (North American Industrial Classification System) codes were assigned to businesses in order to classify threats based on the type of business and the potential chemicals used for those types of businesses. Refinement of the data sets was also completed at this time to eliminate duplicate data and increase the accuracy of the database. This work was undertaken until November 2008 when the first versions of the Technical Rules (MOE, 2009a) and the Tables of Drinking Water Threats (MOE, 2009b) were published. This phase of work terminated when these new documents were released in order to develop a new scope of work and deliverables that were consistent with the MOE's new requirements.

3.2 DEVELOPMENT OF 2009 GUELPH THREATS DATABASE

The 2009 database work built on the datasets from 2007 and 2008 and supplemented them with new datasets. The database reviewed in detail to identify and fix multiple listings, out-of-business listings and mismatches between businesses and tax datasets.

As part of this work, new datasets were acquired or purchased from various sources as listed in the table below.

Table 6 - Inventory of Data Sources Purchased or Acquired for 2009 Guelph Threats Database Work

Data Source	***Data Provider***	***Date Acquired***
Provincial and Federal database search ▪ Environmental Registry (EBR) ▪ Regulation 347 Waste Generators ▪ Ontario PCB inventory ▪ Regulation 347 Waste Receivers ▪ National PCB inventory ▪ National Pollutant Release Inventory ▪ Anderson's Disposal Sites ▪ Chemical Register ▪ Fuel Storage Tanks ▪ Scott's Manufacturing Directory	Ecolog ERIS	October 2008
Operational and non-operational retail fuel sites, cancelled retail fuel sites, commercial fuel oil tanks	Technical Standards and Safety Authority (TSSA)	June 2009
Property Taxation Records and corresponding data	MPAC Municipal Connect™	May – November 2009
Parcel Mapping and Property Codes	City of Guelph Planning Department	September 2009
Storm Water Pond Inventory 2008	City of Guelph	September 2009
Septic System Inventory	City of Guelph	October 2008
Limited Field Survey of agricultural properties	Stantec	May 2009
Vulnerability Scoring	AquaResource and Stantec	December 2009

Appendix B contains a detailed summary of all data sets. Each data source was assigned an uncertainty value based on the age of the data, the source it was acquired from, the reliability of the source, and data maintenance.

Development of the 2009 Guelph Threats Database involved the following tasks:

1) Development of spatial reference data. This task included loading and cross-checking properties and business in the City of Guelph, Town of Milton and County of Wellington's parcel map and tax roll data, where available.

2) Geo-referencing of Threats Data. The 2007 threats database was geo-referenced with the City of Guelph's parcel mapping.

3) Comparison of Datasets. The 2007 and 2008 databases were compared to identify any data sets that were out of date. Based on the review, it was determined that the Ecolog ERIS 2002 search data and 2007 Yellow Pages data sets were out of date or not of value, and were therefore not linked into the 2009 database.

4) Loading of New Data. Newly acquired data was loaded into the database and linked to tax roll data and parcel spatial data, where possible. Each property was then assigned a unique location identifier separate from the tax roll number. Data checking included linking historical data to new datasets, removal of duplicate data, and elimination of businesses that were no longer in operation. Appendix C contains a detailed schema of the database and how data was organized. It also contains additional details of the screening and checking of the data sets used to create the 2009 database.

5) Field Verification. The field verification exercise was completed in July-August 2008 to confirm the locations of businesses that were identified as potential threats.

6) Assigning Vulnerability Scores to Parcels. The vulnerability mapping was overlain on the parcel mapping, and each property was linked to a vulnerability zone identifier. This was the base for which all properties were organized for the threat allocation and enumeration process (Figure 10). For the storm water management (SWM) ponds, the City of Guelph zoning information was overlaid to determine the land use of the drainage area for the SWM pond.

7) Develop Database Queries and Reports. Database queries and reports were developed to review and screen drinking water threats and support the classification of significant drinking water quality threats. Logic was built into the database to screen threats based on vulnerability and WHPA/IPZ as presented in the Tables of Drinking Water Threats (TDWT) (MOE, 2009b). Further information regarding the logic for the database and this step is also presented in Appendix C. This was the method used to query, organize and allocate threats for activities on individual parcels. Land based threats (i.e., agricultural) were allocated in a different manner as described in Section 3.3 below.

3.3 APPLICATION OF NUTRIENTS TO LANDS

This section describes work completed to identify and classify managed lands, nutrient units, livestock operations and corresponding agricultural threats.

3.3.1 Approach

Threats relating to application of fertilizer, agricultural source material, and non-agricultural source material were determined based on the Revised Technical Memorandum from GRCA, dated September 23, 2009 (GRCA, 2009) by using the vulnerable area land segments. The threats captured by land use based analysis are predominantly agricultural in nature and are dependent on the calculation of managed lands and/or nutrient units. These threats include:

- The application of agricultural source material (ASM) or non-agricultural source material (NASM) (percent managed land and nutrient units per acre);
- The application of commercial fertilizer (percent managed land and nutrient units per acre);
- The use of land as an outdoor confinement area or a farm-animal yard (nutrient units per hectare);
- The use of the land as livestock grazing or pasture land (nutrient units per acre); and
- Storage of agricultural source material (nutrient units per acre).

Therefore, in order to determine if any of the five threats were significant in the WHPAs or IPZs for the City of Guelph, the following approach to the threat allocation was taken:

1) Determination of percent managed lands for agricultural and non-agricultural lands within the WHPAs and IPZs for the City of Guelph;
2) Calculation of nutrient units (NU) based on barn size and livestock information available for farms identified in the WHPAs and IPZs for the City of Guelph; and,
3) Enumeration of the significant threats based on the new guidance and the results of items 1 and 2 above.

The details of the methods and calculations of managed lands and nutrient unit assessment are presented in AquaResource and Stantec (2010) and in Appendix D.

3.3.2 Results

No significant water quality threats have been identified based on the managed lands and agricultural based threats assessment.

Calculations for the percent non-agricultural managed lands, agricultural managed lands and total percent managed lands are presented on Figures 11 and 12 and in Table D1 (Appendix D). For non-agricultural land use, the percent managed land ranged from 0% in the IPZ 1 for the Eramosa Intake to 43% in WHPA-A (Membro). For agricultural land use, the percent managed land ranged from 0% in the majority of WHPA-A zones to 52% at in the WHPA-C. The highest total percent managed land was indicated for WHPA-C at 57%. These results are generally consistent with the land use observed in these vulnerability zones.

The nutrient unit calculations were completed based on preliminary vulnerability mapping and scoring. They were not updated to represent the final 2010 mapping and scoring as a result of limited time and resources. Based on the limited data available for the nutrient unit calculations, only 17 agricultural properties were identified in WHPA-B, WHPA-C, WHPA-D, WHPA-E and IPZ-2 areas with sufficient data to calculate nutrient units and/or limited information regarding livestock operations. Calculations of nutrient units per acre are presented in Table D2 (Appendix D) and results are presented in Figures 11 and 12. Following the guidance provided by GRCA (2009), WHPA-A areas within the urban area of the City of Guelph (where livestock would not be housed and where predominant land use was non-agricultural) were assigned a NU/acre of 0 (Figure 11). Sufficient data regarding livestock operations in the IPZ-1 area was not available to complete the nutrient unit calculations. Additionally, the WHPA-A areas for Arkell 1, 6, 7 and 8 wells and for the Carter wells are predominantly woodlot and greenspace (i.e., limited managed lands), and therefore, nutrient units were not calculated for these areas (Figure 11 & 12). The calculated nutrient units per acre ranged from 0.05 NU/Acre for WHPA-D to 3.8 NU/Acre for IPZ 2. Generally, higher NU/Acre values were found for the smaller vulnerability zones (IPZ-2 and WHPA-E).

A summary table indicating the percent managed land and nutrient units calculated for each WHPA and IPZ is presented below:

Table 7 – Summary of Calculated Percent Managed Land and Nutrient Units/Acre for WHPAs and IPZs

WHPA/IPZ	***Percent Managed Lands (%)***	***Nutrient Units/Acre***
WHPA-B	17	0.5
WHPA-C	57	0.3
WHPA-D	52	0.05
WHPA-E	19	2.8
IPZ-1	15	-
IPZ-2	7	3.8

As noted above, the TDWT (MOE, 2009b) indicates the following agricultural threats require the calculation of percent managed lands and/or nutrient units/area:

- The application of agricultural source material (ASM) or non-agricultural source material (NASM) (percent managed land and nutrient units per acre);
- The application of commercial fertilizer (percent managed land and nutrient units per acre);
- The use of land as an outdoor confinement area or a farm-animal yard (nutrient units per hectare);
- The use of the land as livestock grazing or pasture land (nutrient units per acre); and
- Storage of agricultural source material (nutrient units per acre).

The minimum percent of managed lands required for the applicable chemical threats to be significant is between 40% and 80%, and the minimum NU/acre required is at least 0.5 NU/acre (or 120 NU/hectare for animal confinement and/or pasture and grazing). Therefore, based on the current dataset and given the largest calculated percent managed lands for the WHPAs and IPZs, the highest NU/acre calculated and

the corresponding vulnerabilities, no significant chemical threats were identified for any of the above listed prescribed agricultural threats in the WHPAs or IPZs for the City of Guelph.

It should be noted that the nutrient units estimates generated for this assessment are preliminary due to the limited data sets available for the calculations and have not been updated to reflect updates to parcels for the 2010 vulnerability mapping or scoring. Sufficient detailed data from agricultural properties was not available to ascertain if pathogen threats (such as manure storage, grazing, pasture or outdoor confinement) were present on parcels within the IPZs and WHPAs for the City of Guelph.

3.3.3 Data Gaps and Uncertainty

There was insufficient data collected in this study to complete livestock and nutrient unit calculations for all agricultural lands. Although it is unlikely that any significant chemical threats with respect to the land application of nutrients will be identified in the vulnerable areas, an assessment of potential threats from pathogens could identify parcels in these vulnerable areas where these threats could be significant. As such, the uncertainty of this aspect of the study is high to reflect the fact that it is incomplete and was not updated using the final vulnerability mapping or scoring.

3.4 IMPERVIOUS SURFACES / ROAD SALTING

3.4.1 Approach

Following the requirements of the Technical Rules 16(11), an assessment of impervious surfaces was completed to identify potentially significant threats from road salt application. The calculations of percent impervious area were completed over the WHPA-A, WHPA-B and IPZ-1 (with vulnerability scores 9-10), which are the areas where the application of road salt can be considered a significant threat as per the TDWT.

The following methodology was used to undertake this task.

1) Map Impervious Areas. Utilizing the Ontario Road Network (MNR, 2009), buffers were created at specific distances, depending on the road type (i.e. highway, major road, local road). Based on the Ontario Road Network's (MNR, 2009) class field, each road segment was buffered based on an average measured lane width of 2.3 metres. Highways were assumed to be three lanes wide each way, therefore six lanes in total (13.8 metres), major roads were assumed to be two lanes each way (9.2 metres, and local roads and rural roads were assumed to be one lane each way (4.6 metres). All the buffered road segments were merged to eliminate overlaps that would occur at the ends of each road segment intersection.
2) Create Polygon Grid. Using the vulnerability mapping (AquaResource, 2010), a 1000 x 1000 m grid system (polygon) was created that encompassed the entire WHPA-A, WHPA-B and IPZ-1 areas. The grid polygons were then clipped to the WHPA-B boundary (Figure 13).
3) Overlay Impervious Areas on Grid. The resulting polygon was then overlaid with the grid system polygons to split up the road buffers to each grid polygon. The result produced road buffers that contained the grid ID.
4) Calculate Impervious Area for Each Grid Polygon. The total area of roads was calculated for each grid polygon.

3.4.2 Results

Figure 13 illustrates the percent impervious area for each grid polygon. This assessment includes all roadways and highways, but does not include parking lots or pedestrian walk ways. The results of the calculations of impervious area are presented in Table D3 (Appendix D). This exercise was completed as

a spatial analysis and the resulting threats information was stored separately from the data in the 2009 Guelph Database.

Of the 179-1km^2 areas (Figure 13) in WHPA-A, WHPA-B and IPZ-1 where the calculations were completed:

- 43 areas indicated percent impervious area of not great than 1%;
- 91 areas indicated percent impervious area between 1 - 8%;
- 45 areas indicated percent impervious area between 8 – 80%; and
- 0 areas indicated percent impervious area > 80%.

Note that the maximum percent impervious area was 17% (Table D3) (Figure 13). Therefore, given the prescribed threats and circumstances for road salt application threats as presented in the TDWT (MOE, 2009b) and, given the vulnerability over WHPA-A, WHPA-B and IPZ-1 areas, as well as the small percent impervious areas calculated, no significant threats for road salt application were identified for the City of Guelph.

3.4.3 Uncertainty

While there is a need to refine the analysis of impervious areas to include pedestrian walkways and parking lots, this analysis will not increase the percent impervious area in the grid polygons to greater than 80%. As a result, significant threats for application of road salt will not be identified unless the area of the polygon is reduced substantially. The uncertainty of the analysis is therefore low based on the polygon size assumed.

3.5 SANITARY SEWER NETWORK

3.5.1 Approach

The TDWT (MOE, 2009b) includes sanitary sewer networks as potential threats to drinking water quality. Sanitary sewer pipes can be considered in the threat category:

"The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage".

The TDWT (MOE, 2009b) identify sanitary sewers as a significant threat to drinking water under the following circumstances for groundwater:

- The system is part of a wastewater collection facility that collects or transmits sewage containing human waste, but does not include a sewage storage tank or a designed bypass, and the system is designed to convey anywhere from 10,000 to more than 100,000 cubic metres of sewage per day (this is a significant threat for multiple compounds).
- The system is a wastewater treatment facility that discharges directly to land or surface water through a means other than a designed bypass, and the system is designed to discharge treated sanitary sewage at average daily rate anywhere from 17,500 to more than 50,000 cubic metres on an annual basis. (this is a significant threat for specific compounds only)
- The system is a treatment tank or storage tank that is part of a sewage works within the meaning of the *Ontario Water Resources Act,* the tank treats or stores sanitary sewage containing human waste and is below grade, and the system is associated with a wastewater treatment facility that is designed to discharge treated sanitary sewage at an average daily rate that is more than 2,500 but not more than 17,500 cubic metres on an annual basis. (This is a significant threat for vinyl chloride only).

- The system is a treatment tank or storage tank that is part of a sewage works within the meaning of the *Ontario Water Resources Act*, the tank treats or stores sanitary sewage containing human waste, and the system is associated with a wastewater treatment facility that is designed to discharge treated sanitary sewage at an average daily rate anywhere from 2,500 to more than 50,000 cubic metres on an annual basis (this is a significant threat for multiple compounds).
- The system is a wastewater collection facility that collects or transmits sewage containing human waste*, but does not include any p*art of the facility that is a sewage storage tank or works used to carry out a designed bypass, and the discharge from the system may result in the presence of one or more pathogens.

The scope of this threats assessment identifies sanitary sewers as water quality threats; however, it does not classify the sewers as significant threats as calculations of discharge and transmission rates were not available.

3.5.2 Results

Figure 14 maps out sanitary sewers across the City of Guelph and highlights the four areas where sewer segments are constructed at an elevation near the bedrock surface. This mapping was completed as part of the vulnerability study (AquaResource, 2010) where areas where sewers are completed near the bedrock surface were considered as potential contaminant migration pathways.

3.5.3 Uncertainty

The TDWT identifies the transmission of sewage (i.e., sanitary sewers) as potential water quality threats. However, the circumstances relating to the classification of these threats depend on the transmission rate of sewage. The City chose not to pursue the classification of sanitary sewers and the transmission of sewage within this phase of the assessment. Further analysis is needed for the City to estimate wastewater flows to complete this component of the assessment. The uncertainty of this assessment is high.

3.6 FUTURE POTENTIAL SIGNIFICANT THREATS

Following the requirements of the Technical Rules, one of the objectives for this assessment was to identify the areas where future activities could result in new significant water quality threats. This task was completed using the vulnerability scoring map, Official Plans (OP's) and assumptions relating to the types of activities that could take place within OP land use categories.

This study reviewed the Official Plans (OP's) for the City of Guelph (City of Guelph, 2006), the area surrounding the City of Guelph in the County of Wellington (County of Wellington, 2009) and the Town of Milton (2008). OP maps were reviewed to identify commercial and industrial land use zoning in areas of high vulnerability scores to determine if additional potential threats could be added in the future to the issues contributing areas and/or capture zones of the municipal water wells for the City of Guelph. The results of this exercise were stored in the Geographic Information System, separate from the data in the 2009 Guelph Threats Database.

Figure 15 illustrates the vulnerability mapping overlaid with the OP maps for the City of Guelph, Township of Puslinch, Township of Guelph Eramosa and Town of Milton. In general, the TDWT identifies any activities that could result in future significant threats. Where new activities are introduced in the City, and those activities result in a circumstance contained within the TDWT, a new significant threat may be introduced. The City of Guelph will need to manage new developments to identify these new activities when and if they arise.

A review of this data identifies several areas where future activities could be introduced into areas with high vulnerability score areas resulting in new significant water quality threats:

- Areas immediately around the Calico, Sacco and Smallfield wells in the western part of the City of Guelph;
- Areas around the Membro and Edinburgh wells, and adjacent to the Clythe Creek well in the central portion of the City of Guelph;
- Areas immediately south of the Queensdale well, in the southwestern portion of the City of Guelph; and
- Areas near the Downey Road well in the southern portion of the City of Guelph.

Additionally, waste disposal/management land use is also indicated for the areas between the Clythe Creek well and the Helmar well.

3.7 ENUMERATION OF DRINKING WATER QUALITY THREATS

3.7.1 Approach

The threats enumeration task relied on the threats database and a series of conservative worst case circumstances for businesses and properties to identify those activities having the potential to be classified as a significant drinking water threat. A detailed survey will be required for each potentially significant threat to confirm the activities and circumstances at each property, and therefore reduce the uncertainty associated with these threats.

For all circumstances other than the handling of Dense Non-Aqueous Phase Liquids (DNAPL), the TDWT (MOE, 2009b) requires that the vulnerability score be greater than or equal to 8 for a significant water quality threat to be present. The threat enumeration exercise initially focused only on those areas having a vulnerability score greater than or equal to 8 to identify potential significant threats. Additionally, circumstances relating to the handling and storage of DNAPLs can be significant in WHPA-A, WHPA-B and WHPA-C areas where the vulnerability score is greater than 2. Activities where these circumstances could occur were identified in this exercise as a priority for enumerating significant threats.

Figure 16 illustrates a flow chart of the decision path for enumeration of significant threats. There were four options from acquiring and reviewing the property data to threat enumeration, based on the amount and certainty of the data available for each property:

- Option 1: Insufficient data to assign threats;
- Option 2: Greater than one data source (with a certainty of data source = 0 to 1);
- Option 3: Only one data source (with a certainty of data source = 0 to 1); and
- Option 4: Only one data source (with a certainty of data source = 1 to 2).

Where necessary, comments were added to businesses/properties in the database to support the classification of threats. Where only a business or property owner name was available and data was not found on the property use or activity, a comment was assigned to the parcel indicating that sufficient data was not available to identify threats for that parcel (i.e. Option 1). In total, this study identified 78 properties/businesses where sufficient data was available to assign threats. Where at least one activity could be identified for a business/property and that activity could not be a significant threat based on the vulnerability score, a comment was added indicating the activity was not a significant threat for the applicable vulnerability.

For each property, data from the 2009 Guelph database was then queried to view data from the various sources for each property. Based on the data available for that property, a threat category and

corresponding applicable circumstances were then assigned to each property (i.e. Option 2 and Option 3). This step relied on a worst-case assumption of the circumstances that may accompany that property. Appendix C provides the database design and logic to complete this task.

Where limited data was available from the data sources and certainty in the data was not high, an assumption matrix (Appendix E) was used to help assign threats (i.e. Option 4). The assumption matrix was constructed for land use activities encountered in the data sets for the City of Guelph and were used to help identify potentially contaminating activities and the associated potential contaminants of concern (PCOCs). The following sources were used to develop the assumption matrix:

- Table 2 - Potentially Contaminating Activities from the MOE Proposal for Amending Ontario Regulation 153/04, Brownfield Record of Site Condition (EBR Registry Number 010-4642), October 2008;
- Canadian Water and Wastewater Association (CWWA) website in the 'Directory of Contaminants Database' (http://www.cwwa.ca/Contaminants/Search.asp), last updated September 24, 2004; and
- Threats and specified chemicals or pathogens listed in the TDWT (MOE, 2009b).

The assumption matrix was constructed to compare a land use activity (e.g. dry cleaner) to a list of contaminants of concern (from the sources listed above), and linked the activity and PCOCs to an applicable threats category from the TDWT. In order to assign the threat, assumptions on the land use activity were compiled (e.g. grade of handling, grade of storage, facility type, storage volume, etc..) and in the case where data was not available for the property, assumptions were made that would enumerate the threat as significant.

Several stages of quality control and quality assurance (QA/QC) were completed during and after the threat enumeration process. The first involved cross checking properties that should be assigned threats based on vulnerability, to confirm that they were assigned a threat (if applicable) or that a comment was added to the property to indicate insufficient data was available to allocate a threat. The second stage involved a check of approximately 20% of the properties by someone other than the database user to review the threat assignments and uncertainty assignments against the data available for each property and confirm an appropriate threat had been allocated. Any errors or discrepancies identified in this stage were resolved and re-checked during data follow up.

3.7.2 Results

Based on the data analysed and the threat enumeration exercise, the following activities were identified in the vulnerability zones as detailed in the table below.

Table 8 - List of Activities by Zone and Vulnerability Zone

Vulnerable Area	Vulnerability Score	Activity
WHPA A	10	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage within the meaning of the Ontario Water Resources Act.
		The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
		The handling and storage of a dense non- aqueous phase liquid.
		The handling and storage of an organic solvent.
		The handling and storage of fuel.
		The handling and storage of non-agricultural source material
		The handling and storage of pesticide.
WHPA B	6	The handling and storage of a dense non- aqueous phase liquid.
	8	The handling and storage of a dense non- aqueous phase liquid.
	10	The application of pesticide to land.
		The storage of snow
		The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage within the meaning of the Ontario Water Resources Act.
		The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
		The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.
		The handling and storage of a dense non- aqueous phase liquid.
		The handling and storage of an organic solvent.
		The handling and storage of commercial fertilizer.
		The handling and storage of fuel.
		The handling and storage of non-agricultural source material
		The handling and storage of pesticide.
		The handling and storage of road salt.
WHPA C	4	The handling and storage of a dense non- aqueous phase liquid.
	6	The handling and storage of a dense non- aqueous phase liquid.
	8	The handling and storage of a dense non- aqueous phase liquid.

Refer to Figure 17 for the locations of the activities in each of the corresponding vulnerability zones.

The activities identified were generally associated with the following land uses:

- Metal manufacturing (including tools and automotive parts);
- Meat packing plants and food processing;
- Septic systems;
- Vehicle repair and maintenance operations;
- Waste disposal sites;
- Photography, printing and/or duplicating centers;
- Retail fuel sites; and

- Dry cleaners and laundries.

No activities were identified in the WHPA-E, IPZ-1 or IPZ-2 areas that could be significant threats. It is noted that these areas are generally comprised of wooded areas (greenspace) and some agricultural lands.

The following table summarizes the number of potential significant threats:

Table 9 - Type and Number of Significant Non-Agricultural Threats

Threat Type	***WHPA-A***	***WHPA-B***	***WHPA-C***	***Total***
The application of pesticide to land.		2		2
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	3	71		74
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.		42		42
The handling and storage of a dense non- aqueous phase liquid.	9	749	145	903
The handling and storage of an organic solvent.	7	235		242
The handling and storage of commercial fertilizer.		2		2
The storage of snow		1		1
The handling and storage of fuel.	8	357		365
The handling and storage of non-agricultural source material (NASM)	1	4		5
The handling and storage of pesticide.	1	31		32
The handling and storage of road salt.		2		2
TOTAL				**1,670**

The 1,670 potential significant threats correspond to approximately 1,041 locations. Several parcels include multiple threats. In total, 33 of the properties were classified as significant pathogen threats, including five properties indicating handling and storage of NASM associated with a meat packing plant and the remaining 28 were associated with septic systems. These pathogen threats were located in WHPA-A (3 locations) and WHPA-B (30 locations) vulnerability score 10 zones.

The non-agricultural significant threats were generally located within the City of Guelph boundaries. Outside of the City of Guelph, seven significant threats were located in the Township of Puslinch and 20 significant threats were located in the Township of Guelph-Eramosa. The highest concentrations of non-agricultural significant threats were located in proximity to the Sacco and Smallfield well fields in the western portion of the City of Guelph, and between the Membro/Water Street well fields and Emma/Park well fields, near the central portion of the City of Guelph. Several significant non-agricultural threats were also located south of the Clythe Creek well.

Overall, the distribution of non-agricultural significant threats for the City of Guelph was as follows:

- 29 significant threats were identified in the WHPA-As;
- 1,496 significant threats were identified in WHPA-B;
- 145 significant threats were identified in WHPA-C; and
- 0 significant threats were identified in WHPA-D.

No significant non-agricultural threats were identified in the WHPA-E, IPZ-1 or IPZ-2.

3.7.3 Data Gaps

Based on the results of the threats enumeration exercise the database was documented to identify data gaps and uncertainties for all relevant data records. Data gaps were classified as the following:

- Spatial Data Gaps – identified when there was no spatial data or incorrect spatial data available for a record;
- Spatial/Tabular Data Gap – identified when the tax roll/parcel data was inconsistent with other data sources for a specific property;
- Lack of data – identified where key data was not available for a property (e.g. no civic address available); and
- Non-matches – where records could not be matched to tax roll or parcel fabric for properties based on incomplete information or poor quality data sources.

Spatial data and spatial/tabular data gaps were addressed by linking properties to the best available data source for spatial matching. Typically the best data source was to the tax roll data set. Where this could be accomplished, these records were also tied to the corresponding parcel fabric.

Lack of data gaps were not addressed as part of this assessment. The lack of data gap pertained to the limited amount of data available from all data sources collected to date for determining livestock type on several of the agricultural properties in the 2009 Guelph Database.

Non-matched records were addressed in several ways. Firstly, records that should not be matched to tax roll information were separated out, (i.e., storm water pipe and sanitary sewer networks) and were stored in the database without tax roll numbers or linked parcel fabric. Individual properties/businesses that could not be matched to tax roll data were assigned a unique value in the tax roll number field (based on a sequential numerical system) so they could be maintained, assigned threats and queried. This was only done for properties that had coordinate data and/or civic addresses.

Remaining properties that could not be matched or lacked data were tabulated and were stored as ‘null’ records in the database. The breakdown of the data management and data gaps are as follows:

- 10,444 records were stored in the database;
- 2,808 of the records were linked to tax roll (or unique value as described above) and/or parcel fabric;
- 7,620 of the records were points or lineaments for sanitary sewer pipe, storm water pipe and road networks, therefore they did not have tax roll numbers or parcel fabric linked to the record; and
- The remaining 16 records were non-matches.

3.7.4 Uncertainty of Data Sources

Each of the data sources was assigned an uncertainty score using a scale of 0 to 2 based on the following:

- 0 indicating high certainty in the quality and/or the source of the data;
- 1 indicating moderate certainty in the quality and/or the source of the data; and
- 2 indicated low certainty in the quality and/or source of the data acquired.

Each dataset in the 2009 database was assigned one of the three uncertainty values presented above. These uncertainties in the datasets were taken into consideration when enumerating threats as per the decision tree (Figure 16).

Generally, there was moderate confidence in the data sources used for this exercise, with most recording uncertainty levels between 1 and 0, and where only 10 of the 33 data sources indicated a level of 2. Table B1 (Appendix B) lists the assigned uncertainty values for each data source in the 2009 Guelph Database.

3.7.5 Uncertainty of Enumeration Results

Uncertainty in the enumeration of threats for the City of Guelph was generally moderate to high. This is indicated from the summary of uncertainty assigned to the threats as presented below:

- One significant threat was assigned an uncertainty score of 0, as current available knowledge of the property and its activities is known with a high level of certainty. This threat would be classified as having an uncertainty of low;
- 1333 of the threats were assigned an uncertainty score of 1. These are properties where the activities on the property likely result in a significant threat, however additional property specific data collected through a survey may indicate the activities on these properties could be moderate threats; and
- 336 were assigned an uncertainty score of 2. These are properties where conservative assumptions about activities on the property have lead to identifying the property as a significant threat, however additional property specific data collected through a survey will likely result in the activities on these properties being identified as moderate or low threats.

The result of this approach and enumeration process was that it is likely that a large number of properties/businesses have been enumerated as significant threats due to low certainty in data, a lack of data, or conservatively high assumptions of the amount of chemicals being handled onsite. Therefore, it is likely that further refinement and verification of data sets from surveys of property owners as well as addressing data gaps noted above would reduce the number of significant threats.

3.8 THREATS – CONTRIBUTING AREAS TO ISSUES

The following provides a summary of the significant threats identified in the contributing areas to the wells with issues. It should be noted that the TDWT identifies the following:

131. Despite anything else in these rules, an activity is or would be a significant drinking water threat if,

(1) the activity is associated with a drinking water issue described in subrule 114(1) or (2);

As such, properties within the issues contributing areas (i.e., the area within the 25 year capture zone for each well) with activities that would be contributing to an issue at a corresponding well were also reviewed and quantified as part of this threat assessment.

3.8.1 Carter Wells

No significant threats were identified within the contributing area of the Carter wells. However, Golder (2006c) indicated that there was manure storage at a hobby farm and horse operation within the WHPA-E and the contributing area of the Carter wells. Additionally, Golder (2006c) indicated manure spreading also in an area that appears to be within the WHPA-E and the contributing area for the Carter wells. These may also be sources of the nitrate issues at the Carter wells, however given the vulnerability of the WHPA-E and the limited data available regarding livestock operations in this area, a full assessment of manure storage and spreading was not possible for this assessment. Additional work may be required to further assess the sources of nitrate in the Carter wells

3.8.2 Membro Well and Edinburgh Wells

The Membro and Edinburgh wells were identified as indicating issues for TCE. The following chemical threats were identified within the contributing area of the Membro well field that could be sources of the issues at this well:

- Operation of a waste disposal site (1 properties);
- Handling and storage of DNAPLs (352 properties); and
- Handling and storage of organic solvents (91 properties).

3.8.3 Smallfield and Sacco Wells

The Smallfield and Sacco well fields were identified as indicating issues for TCE. The following chemical threats were identified within contributing area of the Smallfield and Sacco well fields that could be sources of the issues at this well:

- Handling and storage of DNAPLs (117 properties); and
- Handling and storage of organic solvents (29 properties).

3.8.4 Emma Well

The Emma well was identified as indicating issues for TCE. The following chemical threats were identified within the contributing area of the Emma well field that could be sources of the issues at this well:

- Operation of a waste disposal site (4 properties);
- Handling and storage of DNAPLs (45 properties); and
- Handling and storage of organic solvents (2 properties).

4.0 Drinking Water Threats: Conditions (Part X.3)

4.1 INTRODUCTION

The Clean Water Act, 2006, defines Conditions as those areas that result from past activities where there is existing contamination located within a vulnerable area. The Technical Rules (126) provide the following instructions on the identification of conditions:

126. If the source protection committee is aware of one of the following conditions that results from past activities, the committee shall list it as a drinking water under clause 15(2)(g)(ii) of the Act:

(1) the presence of a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area;

(2) 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

(3) the presence of a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or a wellhead protection area, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the potable groundwater standard set out for the contaminant in that Table;

(4) 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

(5) 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.

This section does not definitively classify areas within the City as conditions. While the City is aware of numerous contaminated sites located in its vulnerable areas, the City does not have sufficient documentation relating to the current concentration of those contaminants in soil or groundwater. Most importantly, this section describes the compilation of information that has been made available to the City in order to prioritize existing sites and develop a plan to be able to identify conditions under the Clean Water Act.

Information considered in this review of contaminated sites included: engineering and environmental site reports held on file by the City of Guelph, past evaluations of contaminated sites in the City, and a series of files relating to properties provided to the City by the Ministry of Environment. This review process documents and maps known sites with existing contamination, including information relating to the type of contamination and whether or not the contamination levels exceeded provincial drinking water quality standards (historically or currently). Remediation status was also assessed, where information was available.

4.2 SUMMARY OF POTENTIALLY CONTAMINATED SITES

This section outlines the process and sources of information used to identify potential conditions for the City of Guelph, addressing abandoned landfills, the City of Guelph Contaminated Site Inventory, and documents recently provided to the City by the Ministry of Environment.

4.2.1 Abandoned and Former Landfills

A series of investigations by Gartner Lee identified a number of abandoned and former landfills across the City of Guelph which operated from 1929 to 2003 (Gartner Lee Limited, 1990,1991). Table 10 summarizes these landfills including a brief description of its location and years of operation.

Table 10 – Abandoned and Former Landfills

#	*Landfill Name*	*Description*	*Years in Operation*
1	Royal City Park	Both Sides of River	1929-30
2	James Street East	River Flats & Cutten Property	1931-32; 1950-51
3	Alice Street	East of Duke, North of Alice	1933
4	York Road	Wyndham to Victoria	1935-50; 1953-58
5	Wellington/Edinburgh	South East Corridor Soccer Field	1950-52
6	Riverside Park	Marilyn to Band Shell	1958-63
7	Riverview Drive	Mill Race Behind Fire Sub Station	1958-63
8	Bristol Street	Edinburgh to Roland	1959-60
9	Waterloo Ave	At Wellington	1960-62
10	Pollution Control Plant	Near Hanlon	1961
11	Guthrie Park	Algon Forest Street	1962-63
12	John McCrae School	North Near Park	1962-63
13	Eastview Road*	Watson Road	1963-2003
14	Old Gas Works Site	Wellington Street	Unknown
15	Huron Street	Manitoba to Oliver	Unknown
A	London Road	N Side Between Bagot & Edinburgh	Unknown
B	Edinburgh Road North	N. Of London Road behind #249	Unknown
C	Willow Road	West of Edinburgh	Unknown

** The Eastview Landfill is a former municipal landfill operated by the City. It is now closed for waste disposal but leachate collection and containment systems are still in operation. Operation of the landfill is governed by an MOE Certificate of Approval.*

All of the sites are located within the 2-year WHPA-B, with the exception of the Eastview Landfill which lies along the boundary of the 2-year WHPA.

The Gartner Lee investigations included limited surface and groundwater sampling in addition to some assessments of the threat of these landfills as sources of contamination. Most of the information provided in these studies is dated in terms of the types of sampling and analysis completed. There are more recent technical studies available for some of the sites, such as the gas works site and the Eastview Road landfill, but in general the information made available for the landfill sites is insufficient to characterize the current conditions of these sites.

As a result, additional studies are recommended to develop a better understanding of the potential for these sites to be threats to current drinking water supplies. These studies may begin with a thorough review of the City's files to identify any remaining reports or documentation and any groundwater monitoring that has been completed since the Gartner Lee investigations.

4.2.2 City of Guelph Contaminated Site Inventory

The City of Guelph developed an inventory of known contaminated sites where the City has had some level of historical involvement as either the property owner or interactions with property owners. The City maintains hardcopies of engineering or monitoring reports for some of these sites. The City contracted Gartner Lee (2002) to carry out a technical review of existing reports and summarize the status of these sites in terms of relevant operations, site history, contamination occurrences, and remediation.

For this assessment, the existing information was compiled into an electronic database to begin classifying sites as conditions under the Clean Water Act. Information contained in this database includes site address and site name, the City's site reference code, a table of all known environmental reports or documents and a record of the types of contamination reported at the site (i.e., VOC, BTEX) and an indication of the current state of remediation where known. While the City's documentation provides a considerable amount of information for the contaminated sites, there are many gaps where the City either does not hold copies of current site monitoring reports or where additional site investigations had not been completed to confirm the status of known or potential contamination. The information is also dated in that it presents information collected in the past. It is not known if contaminant concentrations reported in the past are consistent with concentrations that may be found today.

4.2.3 MOE Pilot Project

The MOE and GRCA undertook a Pilot Project to identify information needs for Drinking Water Source Protection. As part of this project, the City of Guelph provided the MOE with a listing of properties from the 2007 Threats Database that had been identified as potential water quality threats. The MOE then retrieved its files for those properties, where available, and scanned documents relating to properties in the City that were potential water quality threats. The MOE provided the documents collected in this Pilot Project to the City of Guelph in September, 2009 and these documents were reviewed in terms of the additional information they could provide the City with respect to existing soil or groundwater contamination issues. The documents, however, were not current and in many cases only included information up to about 2006-2007.

The MOE provided the City with a total of 432 digital documents relating to numerous properties located within and outside of the City. The database developed in support of the City's contaminated site inventory was expanded to include all of these additional sites. Wherever possible, properties identified in the MOE dataset were reconciled with the existing City of Guelph Inventory. Similarly to the City of Guelph inventory, the documents provided by MOE were reviewed for site history, contamination, and remediation progress.

4.3 RESULTS

Based on the information compiled relating to contaminated sites, this section identifies properties within the City of Guelph that potentially could be classified as conditions under the Clean Water Act. As described in the previous section all sites with reported incidences of soil or groundwater contamination are included in the contaminated site database. The type of contamination (e.g., soil/groundwater, cVOC, BTEX) and remediation status is also recorded. The type of contamination is recorded as one of the following:

- Chlorinated compounds (e.g., trichloroethylene, vinyl chloride)
- BTEX (e.g., Benzene, toluene, ethylbenzene, xylenes)
- Other (e.g., metals, fuel oil)

The type of contamination reported at the site is of particular importance as the main issue identified with respect to the City's drinking water supplies is trichloroethylene (TCE) and one of the main objectives of this assessment is to identify sites that may have contributed to this issue.

The distribution of identified contaminated sites with the City's WHPAs is summarized in the following table:

Table 11 - Distribution of Potentially Contaminated Sites

WHPA	***Chlorinated Compounds***	***BTEX***	***Other Contaminants***	***Total Number of Sites***
WHPA B – 2 Year	11	15	36	62
WHPA C – 5 Year	0	1	4	5
WHPA D – 25 Year	1	2	6	9
Total	12	18	46	76

The scope and schedule of this study was not sufficient to complete a thorough technical review of documents provided by either the City or the MOE. For many of the sites identified as having recorded instances of contamination, the City may not have possession of all documentation that may describe the current status of these sites. Without being assured that the most recent monitoring reports are available, it is difficult to conclude that soil or groundwater contamination at a site is above a drinking water standard and this is a key requirement in a site being classified as a Condition under the Clean Water Act. The results in this section should only be considered as a first step in the identification of conditions with respect to the City's drinking water supplies, and all documentation relating to potential conditions should be obtained from the MOE (and other agencies) and be reviewed in a greater level of detail to understand the current status of these sites.

4.3.1 Sites with Chlorinated Compounds

As described in Section 2 of this report, several of the City's existing water supply wells have issues relating to chlorinated compounds such as TCE. This section describes the properties in the City that have current or historical soil or groundwater contaminated by chlorinated compounds, and identifies those that are within the contributing area of the municipal wells having issues. It must be noted, however, that this discussion is based on the available information and that other sites may have chlorinated compounds in the soil or groundwater but be unreported or not within the City's database. Similarly, the information used in this assessment may not be current and more recent information may provide evidence to confirm or refute this assessment.

Table 15 lists sites where evidence of chlorinated compound contamination was found and list of contaminants present. A description of each of these sites is provided in the next section, summarizing the information found in the documents provided for this study.

Table 12 - Contaminated Sites with Chlorinated Compounds Present

Property	Activity on Property Identified as Significant Threat?	Contamination Reported
1	No	PCE, TCE
2	Yes	TCE
3	Yes	Free Phase Oil; Hexavalent chromium; 1,1-DCE; TCE; TCA; 1,1-DCA; BTEX
4	No	BTEX; PCE; TCE; TCA; DCE; CIS- 1,1-DCE;
5	Yes	BTEX; cis-1,2-DCE; TCE; PCBs
6	Yes	TCE; TCA
7	Yes	TCE
8	Yes	TCE
9	No	Hydrocarbon; TCE; DCE; CIS-1,1-DCE; PCE; Vinyl Chloride
10	Yes	VOC (unknown); TPH
11	No	PCB; Chlorinated Benzene Compounds; DCE; 1,1-DCE; BTEX; LNAPLs
12	Yes	TCE
13	No	Vinyl Chloride; Benzene; PCE;

4.3.1.1 Site 1

Previous studies document the presence of Tetrachloroethylene (PCE) (170 µg/L), TCE (52 µg/L), and Total Petroleum Hydrocarbons (TPH) exceedances in the groundwater on this property. While the TPH was likely related to site activities, the PCE and TCE impacts are likely related to the dry cleaning outlet located near the site. The site is considered to be potentially sensitive due to the shallow bedrock condition. No additional documents have been reviewed for this site or any nearby properties.

This property is located within the contributing area of the Membro, Water and Edinburgh Wells, which have been identified as having TCE issues.

4.3.1.2 Site 2

A Phase II investigation was completed to assess groundwater and soil contamination. All soil and groundwater samples were below the MOE water quality criteria except for one sample with a TCE concentration of 170 µg/L and a high TPH concentration.

This property is located within the contributing area of the Sacco/Smallfield Wells, which have been identified as having TCE issues.

4.3.1.3 Site 3

An environmental assessment of the property was conducted in the mid 1990's. The site was impacted by chlorinated solvents and remedial actions involving groundwater extraction/treatment were undertaken. A

1997 hydrogeologic investigation found trichloroethane (1,100 µg/L) and 1,1- dichloroethane (138 µg/L) exceeded the MOE criteria.

A 1998 groundwater monitoring report documents free phase oil observed at several wells, which was treated and removed in 1998. Hexavalent chromium and BTEX contamination was also observed at a couple of wells. VOCs at wells were observed and 1,1-DCE was observed in exceedance of the MOE criteria.

This property is located near the boundary between the contributing areas of the Emma Well and the Membro Well, both of which have been identified as having potential TCE issues.

4.3.1.4 Site 4

Various volatile organic compounds have been detected in wells installed on this property. The prevalent VOCs detected were chlorinated solvents, with the highest concentrations established in two wells installed along the west property boundary. While monitoring and sampling was recommended to determine the full extent and source of the TCE, no additional documents were available for this assessment.

This property is located within the contributing area of the Sacco/Smallfield Wells, which have been identified as having TCE issues.

4.3.1.5 Site 5

A Phase II investigation of this property identified the presence of concentrations of chlorinated solvent and aromatic hydrocarbons, including TCE. No additional information has been reviewed regarding the outcome of this investigation after 1999.

This property is located within the contributing area of the Sacco/Smallfield Wells, which have been identified as having TCE issues.

4.3.1.6 Site 6

Early studies determined that soil and groundwater on property were impacted by ethyl benzene, benzene, xylenes, and PCE. A detailed investigation of the problem was undertaken in 1995. Impacted soils were excavated and treated on-site using a bio-pile technology, where the effects of source removal were assessed through a limited groundwater monitoring program. Other parameters detected in the groundwater through the groundwater monitoring program included acetone, methyl ethylene, styrene and various chlorinated solvents including TCE.

A follow-up investigation in 1997 reported that the ethyl benzene concentration in the groundwater had declined due to natural degradation and source removal. Chlorinated solvents were detected in a number of additional wells installed along the southern property boundary.

This property is located within the contributing area of the Sacco/Smallfield Wells, which have been identified as having TCE issues.

4.3.1.7 Site 7

TCE contamination has been detected in soil and groundwater on this property. A consultants monitoring report identifies groundwater concentrations of TCE as high as 22,130 ug/L, suggesting the presence of free phase TCE on the property.

This property is located within the contributing area of the Sacco/Smallfield Wells, which have been identified as having TCE issues.

4.3.1.8 Site 8

A groundwater monitoring program was completed on this property in 2006. Samples confirmed the presence of TCE within the groundwater at concentrations exceeding the MOE standards.

This property is located within the contributing area of the Sacco/Smallfield Wells, which have been identified as having TCE issues.

4.3.1.9 Site 9

The property is impacted by chlorinated solvents that were reportedly released from a leaking underground storage tank. An extensive investigation of the property was completed in 1992 and included the installation of a groundwater extraction/treatment system. A 2004 Groundwater Monitoring Report indicated that VOCs, including TCE (up to 274µg/L), were found in the groundwater. However, the groundwater extraction and treatment system was operating as designed and capturing overburden groundwater at the site. In general, VOC concentrations in the overburden groundwater were reported to be decreasing in the areas affected by the onsite remediation system. The concentrations of VOCs in the shallow bedrock and intermediate bedrock were not decreasing and remained within historical ranges at concentrations above MOE guideline levels.

This property is located within the contributing area of the Membro, Water and Edinburgh Wells, which have been identified as having observed TCE concentrations.

4.3.1.10 Site 10

The property owner had an environmental audit carried out that revealed the presence of dissolved VOC and TPH in some bore holes that surpassed the Ministry of Environments generic criteria. The extent of the contamination is unknown and specific VOCs are not identified.

This property is located near the boundary between the contributing areas of the Emma Well and the Membro Well, both of which have been identified as having potential TCE issues.

4.3.1.11 Site 11

Groundwater contamination has been reported at this site since 2002 and a groundwater remediation system has been installed to manage this contamination. A 2005 monitoring report confirmed that while the extraction wells were operating as designed, VOC, PCB, and SVOC were still found in the groundwater.

This property is located near the boundary between the contributing areas of the Emma Well and the Membro Well, both of which have been identified as having potential TCE issues.

4.3.1.12 Site 12

Available documents suggest that groundwater contamination due to the presence of TCE was found in the vicinity of this property and that the property is a potential source of contamination for other properties. Specific information relating to well locations or sampling results was not made available.

The property is located within the contributing area of the Emma Well, which has been identified as having a potential TCE issue.

4.3.1.13 Site 13

A subsurface investigation was completed in the vicinity of this property. The purpose of the investigation was to gather information relating to groundwater conditions and to conduct limited excavation of impacted soil at the property. Various VOCs were detected at low concentrations in groundwater samples collected from a monitoring well installed on the property. PCE was detected above the MOE Criteria. TCE was also detected but at a very low concentration.

Groundwater monitoring results later than 2006 are not available for the area.

The properties are located within the contributing area of the Emma Well, which has been identified as having a potential TCE issue.

4.3.2 Abandoned Landfills as Conditions

As discussed in Section 4.2, previous studies have identified a number of abandoned landfills across the City. In most cases, there is insufficient data available to determine soil or groundwater concentrations in the vicinity of the landfills, and as a result it is not possible to classify any of these landfill areas as conditions. While any of the landfills have the potential to contribute contaminants into groundwater, a number of the abandoned landfills are located along the Speed River (e.g., landfills 1, 2, 4, 5, 8, 9, 10 and 12) and within the contributing area for the Membro / Edinburgh / Water Street wells that have been impacted, to some extent, by TCE and other constituents. The potential for these landfills to have contributed to these issues cannot be determined given the currently available information.

4.4 DATA GAPS

This study identifies a total of 76 properties within the City where groundwater or soil concentrations of hazardous chemicals may be greater than relevant standards. Furthermore, there are 12 properties identified as potential conditions with respect to chlorinated organic compounds, which are related to the City's drinking water issues at a number of its wells. The uncertainty associated with the potential conditions is high, as this assessment is based on general review of a large set of documents. The City should complete a detailed technical review of all relevant documents for the potential conditions and ensure that the most recent documentation for all sites is made available before proceeding to identify those properties as conditions under the Clean Water Act. This assessment should also consider changes to the Soil, Ground Water and Sediment Standards which will be implemented in 2011.

4.5 DATA GAPS AND UNCERTAINTY

The uncertainty associated with the potential conditions is high, as this assessment is based on general review of a large set of documents. The City should complete a detailed technical review of all relevant documents for the potential conditions and ensure that the most recent documentation for all sites is made available before proceeding to identify those properties as conditions under the Clean Water Act. This assessment should also consider changes to the Soil, Ground Water and Sediment Standards which will be implemented in 2011.

5.0 Conclusions

The MOE's Technical Rules (MOE, 2009a) require that the water quality threats assessment be completed to identify drinking water issues, threats related to activities, and threats related to conditions. Drinking water issues are instances where water quality parameters exceed or are likely to exceed relevant standards at a drinking water well or surface water intake. A drinking water threat relating to an activity is identified where a land use or activity has the potential to adversely affect the quality of any water that is or may be used as a source of drinking water. A condition relates to past activities that may have led to the presence of existing soil, sediment, or groundwater contamination that has the potential to impact one of the City's drinking water wells or surface water intakes.

The scope of this assessment included the compilation of existing data relating to water quality monitoring data, as well as land use activities and environmental reports to identify issues, threats, and conditions. As described in the report, there are potentially more than a thousand significant water quality threats and numerous potential conditions, and further work will be required to refine the list of conditions and threats to a higher level of certainty.

5.1 ISSUES

The review identified two water quality parameters that may be associated with an issue including Trichloroethylene (TCE) and nitrate. Based on the available data, six wells, including Carter, Emma, Membro and Edinburgh, and Smallfield and Sacco, either exceeded the drinking water objectives or appear to be trending toward exceeding the drinking water objectives. In addition to the above wells, chlorinated organic compounds including TCE, Dichloroethylene (DCE) and Tetrachloroethylene (PCE) have been detected at low concentrations at a number of additional wells which further emphasizes the need to manage drinking water threats within the City.

While not classified as issues in this report, trends in sodium and chloride concentrations in groundwater are a concern. There are increasing sodium and chloride concentrations at a number of wells indicating road salting impacts. Sodium concentrations were either at or above the Medical Advisory Level (20 mg/L) but below the Aesthetic Objective (200 mg/L) at a number of other wells. Although the concentrations in these wells are well below the Aesthetic Objective, the ODWQS require the local Medical Officer of Health be notified when the sodium concentration exceeds 20 mg/L so the City should continue to monitor concentrations at those wells accordingly. Consideration should also be given to how the City of Guelph will handle sodium and chloride levels that exceed the Medical Advisory Level.

5.2 THREATS

This report describes the identification of significant water quality threats with the following components:

- Development of Water Quality Threats Database;
- Enumeration of Non-Agricultural Water Quality Threats;
- Assessment of Managed Lands and Agricultural Based Threats; and,
- Assessment of Impervious Areas.

Development of Water Quality Threats Database

The threats assessment was based on the development of a database built from a number of data sources acquired or purchased from various agencies. Each data source was assigned an uncertainty value based on the age of the data, the source it was acquired from, the reliability of the source, and data maintenance. This database was configured so that all relevant water threats data available for a parcel within the City could be retrieved, reported, or mapped in a Geographic Information System (GIS).

The database and queries were designed to screen each property in the database for threats based on its vulnerability score, location in a vulnerable area and the activities at the property, as presented in the Tables of Drinking Water Threats (TDWT) (MOE, 2009b).

Assessment of Managed Lands and Agricultural Based Threats

Managed lands and agricultural based threats were determined based on the Revised Technical Memorandum from GRCA, dated September 23, 2009 (GRCA, 2009). The threats identified in the analysis are based on assumptions relating to those lands which might be subject to the application of fertilizer, agricultural source material and non-agricultural source material (NASM) as well as rough estimates of the number of livestock and nutrient units associated with those lands.

Based on the current dataset and given the largest calculated percent managed lands for the WHPAs and IPZs, no significant threats were identified in the City's WHPAs or IPZs. It should be noted that the nutrient units generated for this exercise should be viewed as an initial assessment due to the limited data sets available for the calculations and that the calculations have not been updated to reflect the 2010 vulnerability mapping or scoring. As such the initial estimates should not be interpreted as an indication that there are no agricultural threats.

Impervious Surfaces / Road Salting

As required under the Technical Rules, this study considered impervious surface areas in the City's WHPAs to undertake an assessment of potentially significant threats from road salt application. As per the TDWT, the calculations of percent impervious area were completed over WHPA A, WHPA B and IPZ1 vulnerable areas. This assessment included all roadways and highways, but did not include an analysis of parking lots or pedestrian walk ways.

The maximum calculated percent impervious area was 17%. However, the TDWT only identify impervious areas as being significant water quality threats for road salt application when the impervious surface area is greater than 80%. As a result, no significant threats for road salt application were identified for the City of Guelph. However, application of road salt was indicated as a moderate threat in areas of calculated impervious surface area greater than 8% with a vulnerability score of 8-10.

Enumeration of Non-Agricultural Drinking Water Threats

The objective of this stage of the threats assessment was to identify which activities within the City of Guelph would be potentially classified as significant drinking water quality threats based on the information contained in the threats database and the vulnerability mapping. This significant threat classification required that assumptions relating to the specific circumstances for each activity (e.g., volume and type of chemical) needed to be made based on available data. The database was designed with the ability to report on these assumptions for each property so that the classification can be revised when new data becomes available.

The significant threat enumeration approach identified a total of 1,670 activities being identified that would result in the classification of a significant drinking water quality threat based on the assumptions made relating to the circumstances for each of those activities. The 1,670 significant threats correspond to 1,041 locations in the City. Several properties indicated multiple threats, as well as both chemical and pathogen threats. In total, 33 of the properties were enumerated as significant pathogen threats.

Future Threats

One of the objectives for this assessment was to identify the areas where future development could result in new significant water quality threats. This task was completed using Official Plans (OP's) and making assumptions of the types of activities that could take place within OP land use categories.

Review of this data indicates that there are several areas where new industrial activities and other threats could be introduced near the Calico, Sacco, Smallfield, Membro, Edinburgh, Clythe Creek, Queensdale and Downey Road well fields. As such, the City should monitor areas and develop policies to manage drinking water quality risks.

5.3 CONDITIONS

This study identifies a total of 76 properties within the City where groundwater or soil concentrations of hazardous chemicals may be greater than relevant standards. Furthermore, there are 12 properties identified as potential conditions with respect to chlorinated organic compounds, which are related to the City's drinking water issues at a number of its wells.

5.4 DATA GAPS AND UNCERTAINTY

The following data gaps and uncertainties were documented for the issues, threats, and conditions assessment.

5.4.1 Issues

There are no significant gaps with respect to drinking water quality issues. The City maintains a comprehensive drinking water quality monitoring program to identify any current or potentially future water quality parameters that might exceed drinking water standards or show a trend of exceeding those standards in the future.

5.4.2 Threats

The data gaps and uncertainties are presented below for water quality threats as well as recommendations for addressing them:

- Vulnerability Scoring. The vulnerability scoring used to classify water quality threats has uncertainties relating to both the vulnerable areas (WHPAs) and vulnerability mapping used in to create vulnerable scoring maps. While this mapping was completed using the best available information, there is an opportunity to reduce the uncertainty of this component of the assessment as the modelling tools and hydrogeological conceptual model is refined in the future.
- Non-Agricultural Threats. The current assessment identifies significant water quality threats based only on existing datasets and not a survey of actual site or property circumstances. As a result, the uncertainty associated with the significant water quality threats identified is high. A survey of the activities associated with these significant threats should be completed to reduce this uncertainty. Furthermore, there are a few instances in the threats database where properties and businesses could not be reliably matched with the City's tax roll data base. These instances can be addressed with a field visit.
- Agricultural Threats. There is insufficient data to complete representative nutrient unit calculations and analysis of livestock operations that could lead to significant chemical and pathogen threats for WHPAs A, B, C, D, E and IPZs 1 and 2. Additionally, this assessment was not updated to reflect the 2010 vulnerability mapping or scoring. While there were no significant agricultural threats identified, the uncertainty of this assessment is high. A detailed survey of the agricultural property should be completed to reduce this uncertainty.
- Impervious Areas / Road Salting. There is a need to refine the analysis of impervious areas to include pedestrian walkways and parking lots, which was not completed as part of this assessment. The uncertainty of this aspect of the work is low because it is unlikely that the inclusion of walkways and parking lots will increase the impervious estimates substantially enough to result in a significant threat.
- Transmission of Sewage. The TDWT identifies the transmission of sewage (i.e., sanitary sewers) as a drinking water threat. However, the circumstances relating to the classification of these threats

depend on the transmission rate of sewage. The City chose to not pursue the classification of sanitary sewers and the transmission of sewage within this phase of the assessment. Further analysis is needed for the City to estimate wastewater flows to complete this component of the assessment.

- Classification of Low and Moderate Threats. The scope of this assessment was to identify those activities which would potentially be classified as significant threats given the worst-case assumption of circumstances for those activities. After completing a detailed survey, the City can proceed to classify activities as low and moderate threats.

5.4.3 Conditions

The uncertainty associated with the potential conditions is high, as this assessment is based on general review of a large set of documents. The City should complete a detailed technical review of all relevant documents for the potential conditions and ensure that the most recent documentation for all sites is made available before proceeding to identify those properties as conditions under the Clean Water Act. This assessment should also consider changes to the Soil, Ground Water and Sediment Standards which will be implemented in 2011.

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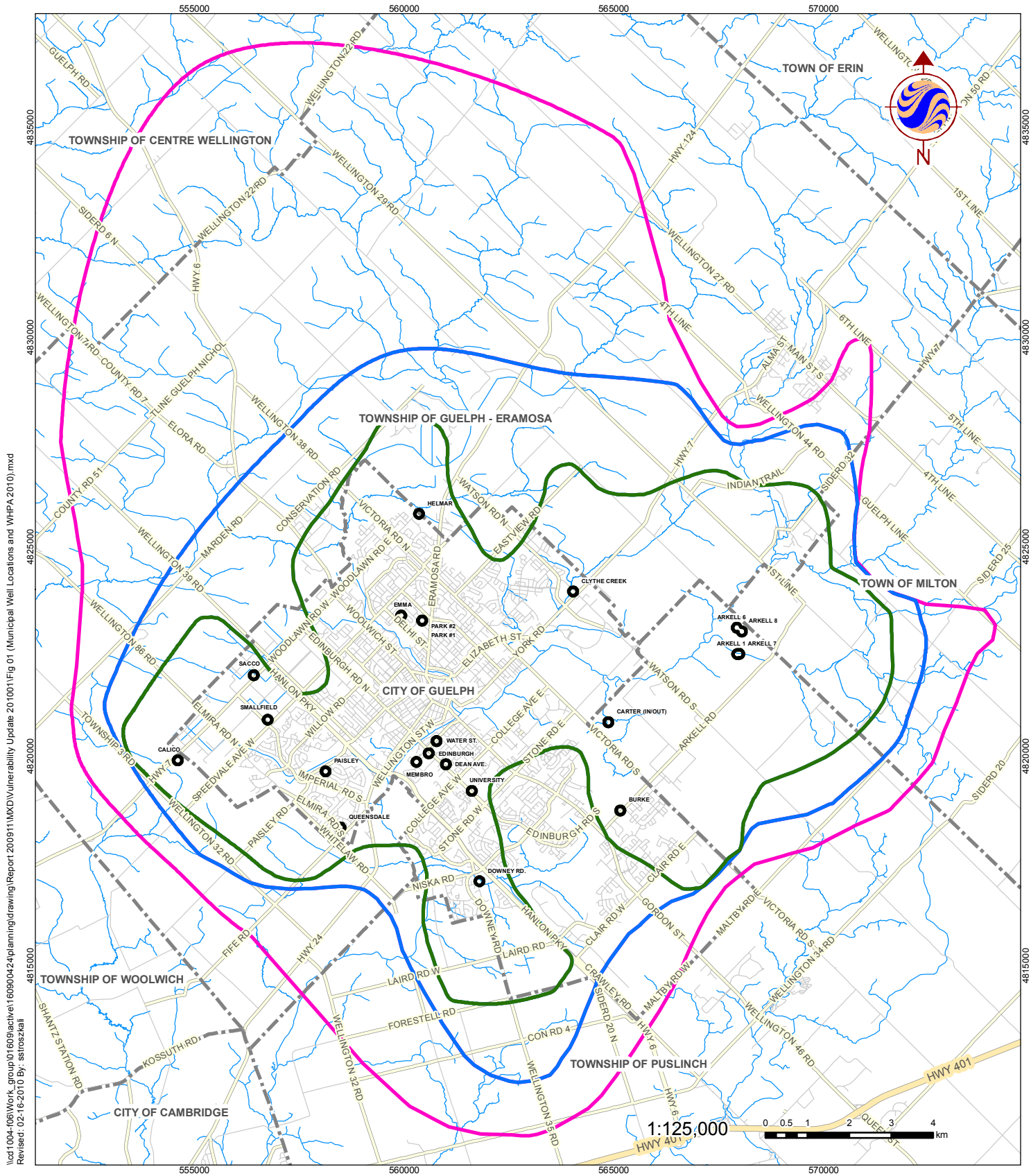


Legend

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Lower Tier Municipality
- Watercourse

Notes

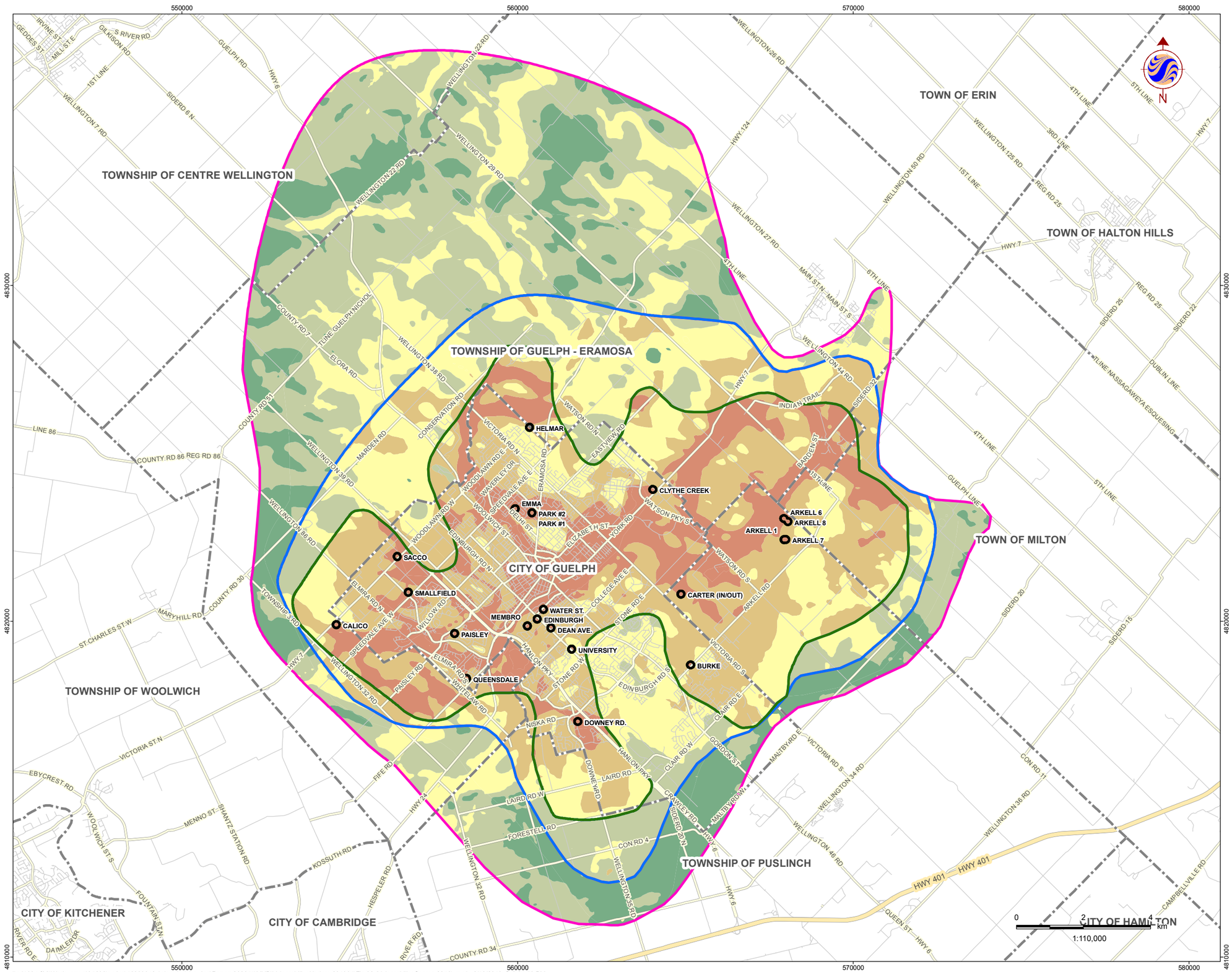
1. Coordinate System: UTM Zone 17 NAD 83.
2. Capture Zones provided by AquaResource, 2010.

Client/Project
City of Guelph
Water Quality Assessment Report

Figure No.
1

Title
Municipal Well Locations and Wellhead Protection Areas Update 2010

Stantec



Legend

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Lower Tier Municipality
- Highway
- Major Road
- Local Road

Vulnerability Score

- 2
- 4
- 6
- 8
- 10

Notes

1. Coordinate System: UTM Zone 17 NAD 83.
2. Capture Zones and Vulnerability Scores provided by AquaResource, 2010.

Stantec

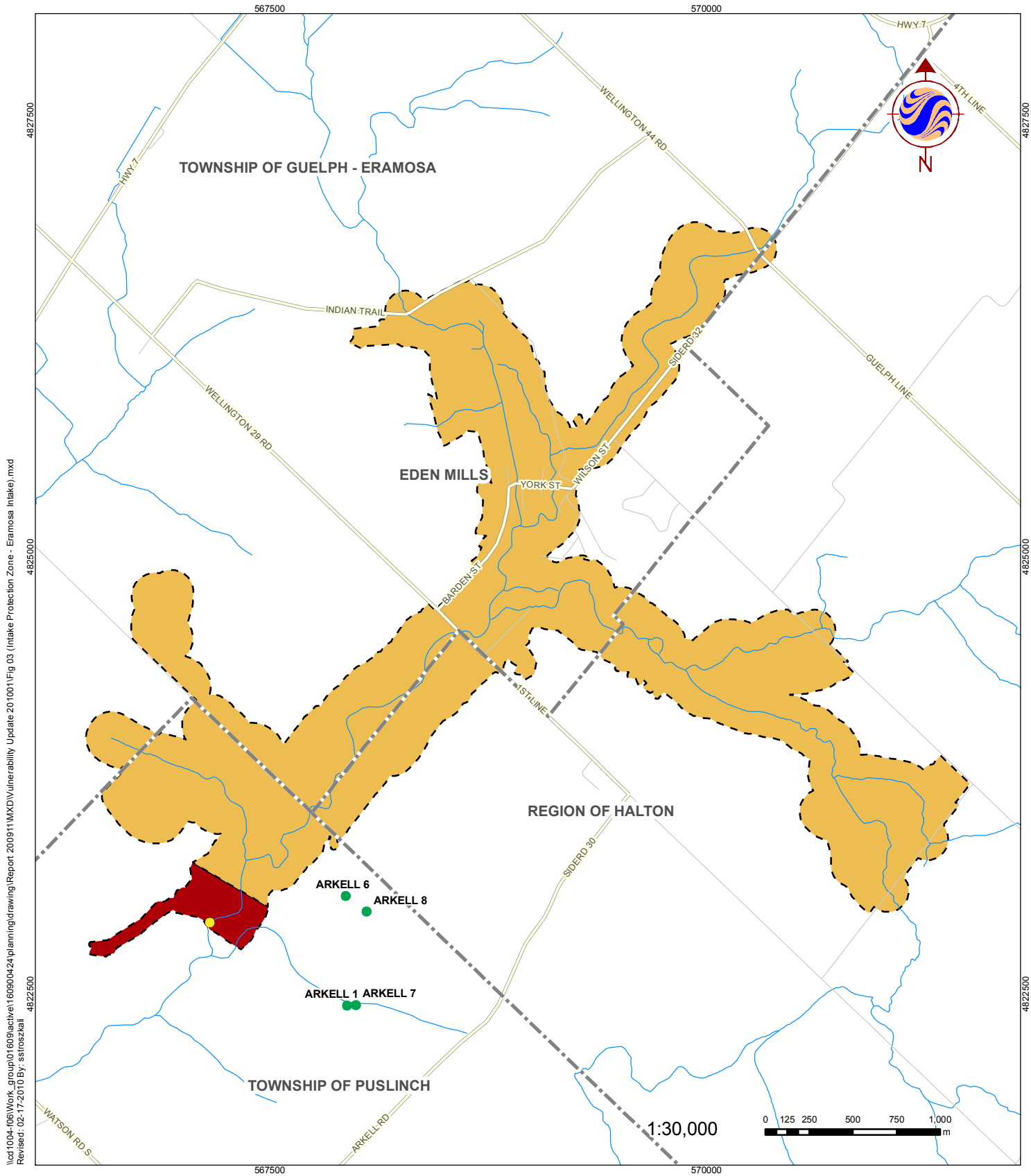
February 2010
160900424

Client/Project
City of Guelph
Water Quality Assessment Report

Figure No.
2

Title
Vulnerability Zones Update 2010

\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 02 (Vulnerability Scores 2010).mxd - 2/16/2010 @ 2:21:56 PM
Revised on: February 16, 2010 By: sstroszkali



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Legend

- Production Well
- Intake Location
- Lower Tier Municipality
- Watercourse
- IPZ1
- IPZ2

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
2. IPZ1 and IPZ2 boundaries provided by AquaResource, 2009.
3. Watercourses provided by the Grand River Conservation Authority, 2009.

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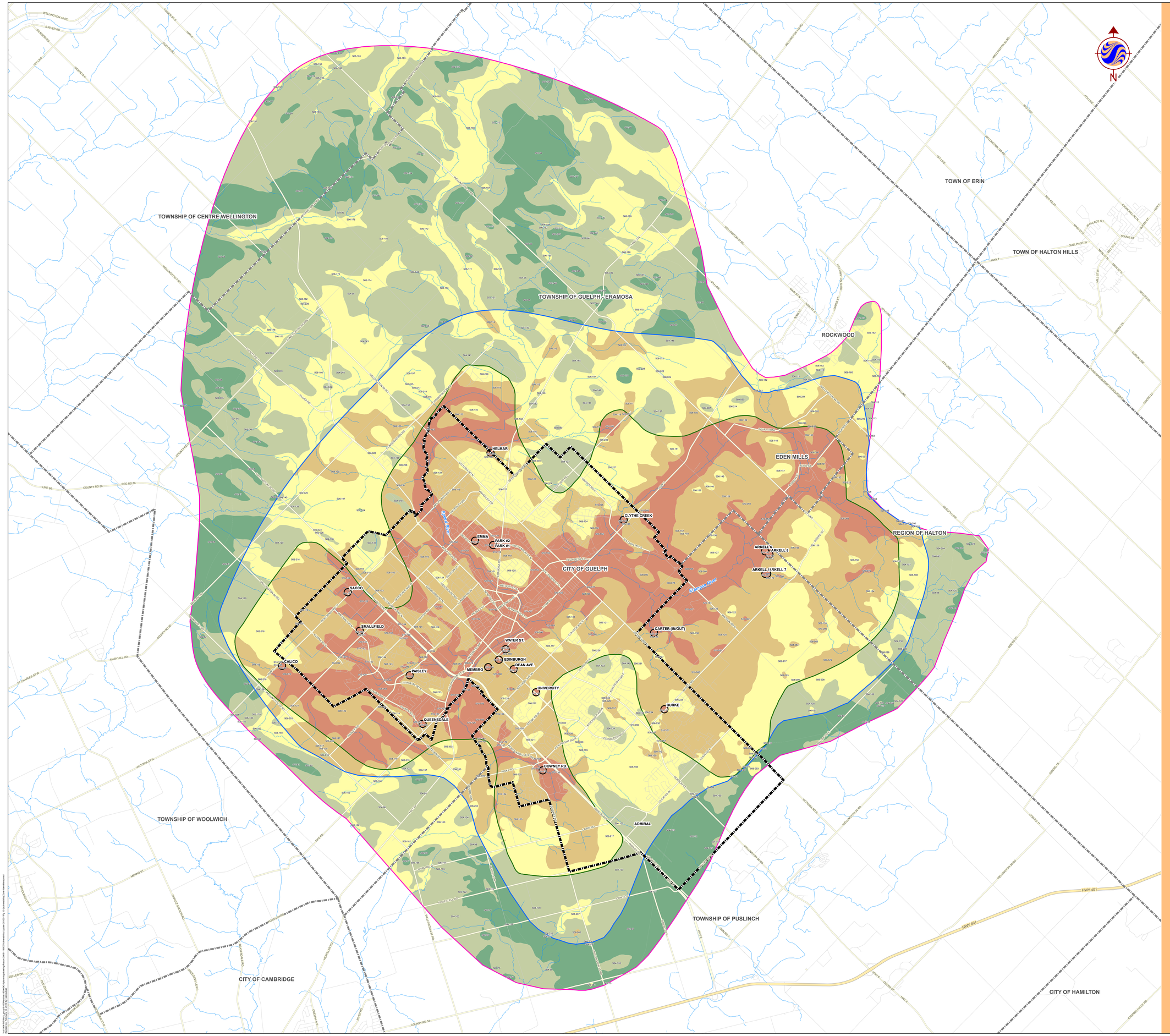
Figure No.
3

Title
Intake Protection Zone - Eramosa Intake



Stantec

49 Frederick Street
Kitchener ON Canada
N2H 6M7
Tel. 519.579-4410
Fax. 519.579-6733
www.stantec.com

Consultants

Legend

- City of Guelph
- Lower Tier Municipality
- Watercourse
- Highway
- Major Road
- Local Road
- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D

Vulnerability Score

- 2
- 4
- 6
- 8
- 10

Notes

1. Capture Zones and Vulnerability Scores provided by AquaResource, 2010.
2. Watercourses provided by the Grand River Conservation Authority, 2009.

Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

File Name:

	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

CITY OF GUELPH
WATER QUALITY ASSESSMENT REPORT

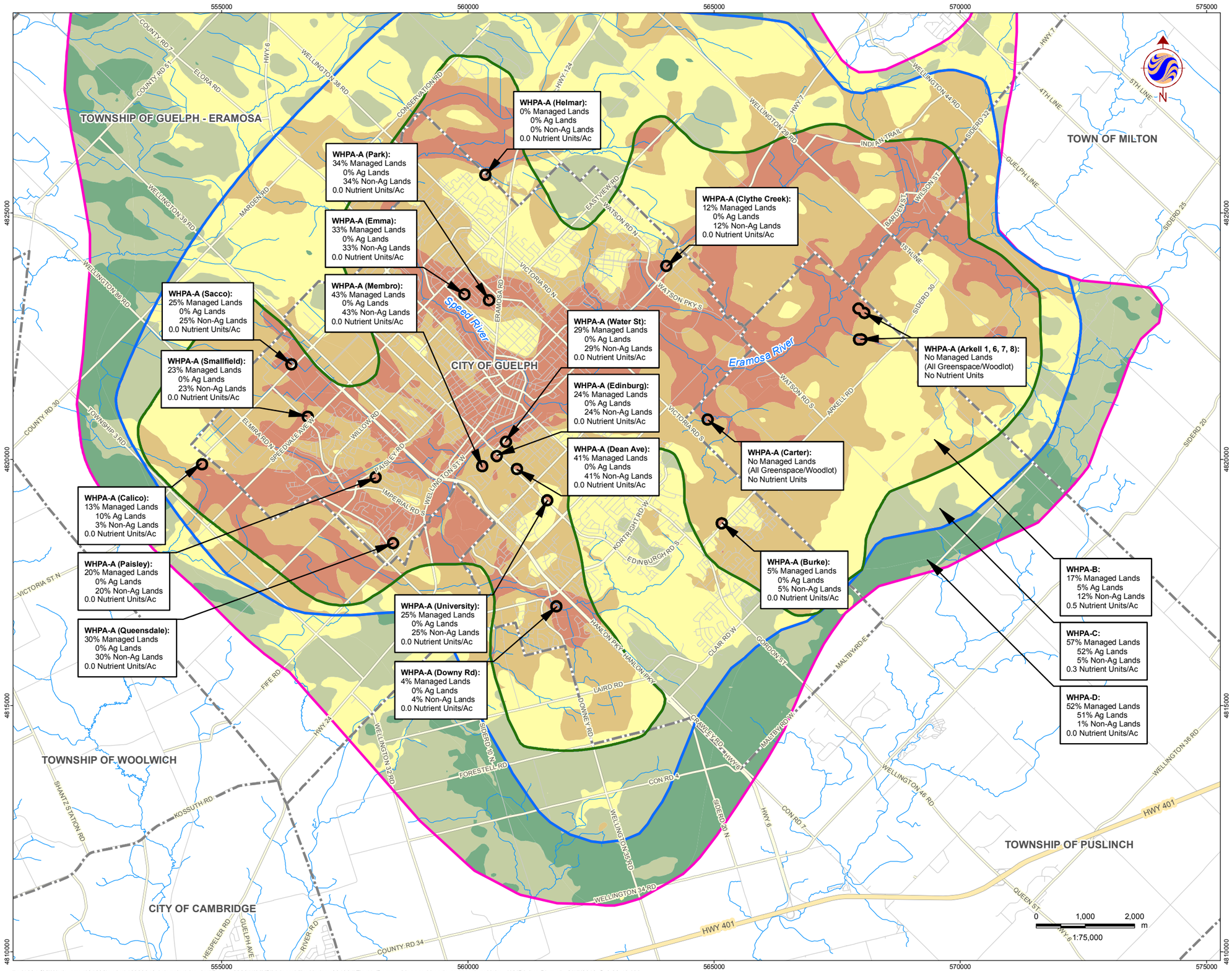
Guelph, Ontario, Canada

Title

Vulnerability Zone Identifiers

Project No.	Scale				
160900424	1:35,000	0	500	1,000	1,500 m

Figure No.	Sheet		Revision
10		of	0



Legend

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Lower Tier Municipality
- Watercourse
- Highway
- Major Road
- Local Road

Vulnerability Score

- 2
- 4
- 6
- 8
- 10

Notes

1. Coordinate System: UTM Zone 17 NAD 83.
2. Capture Zones and Vulnerability Scores provided by AquaResource, 2010.
3. Watercourses provided by the Grand River Conservation Authority, 2009.
4. As per GRCA (2009), assign 0 Nutrient Units/Ac to urban WHPA-As with predominant land use as non-agricultural managed lands.
5. For WHPAs C and D, percent managed lands and nutrient units were only calculated for Vulnerability Scores 6 or greater.
6. Nutrient Units were not updated to represent the 2010 vulnerability mapping or scoring.

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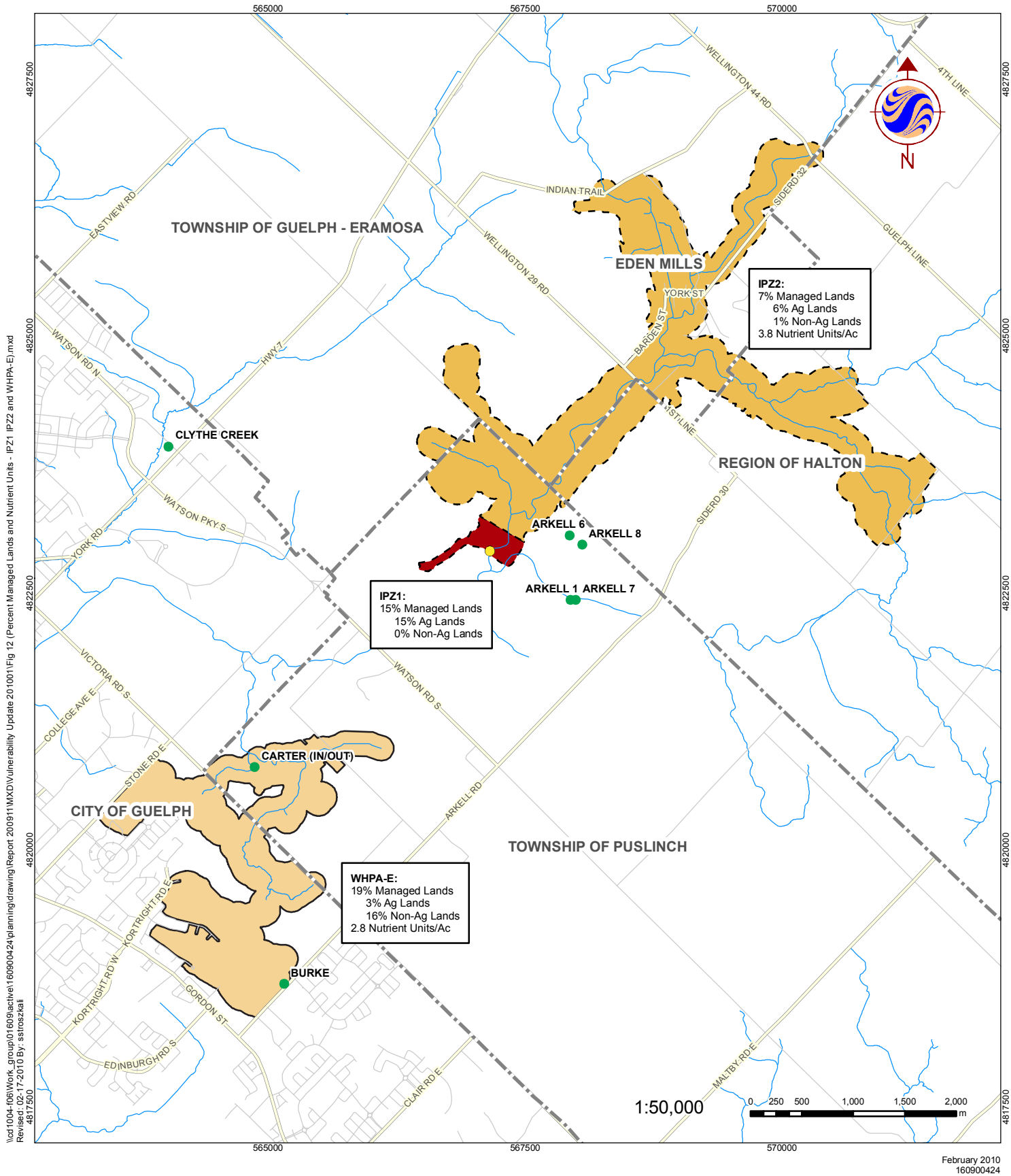
Figure No.
11

Title
Percent Managed Lands and Nutrient Units - WHPA A to D

\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 11 (Percent Managed Lands and Nutrient Units - WHPA A to D).mxd - 2/17/2010 @ 9:02:49 AM
Revised on: February 17, 2010 By: sstroszkali



\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 12 (Percent Managed Lands and Nutrient Units - IPZ1 IPZ2 and WHPA-E).mxd
Revised: 02-17-2010 By: sstroszkali

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Legend

- Production Well
- Intake Location
- Lower Tier Municipality
- Watercourse
- IPZ1
- IPZ2
- WHPA-E

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
2. IPZ1, IPZ2, and WHPA-E boundaries provided by AquaResource, 2009.
3. Insufficient livestock operation data to complete nutrient unit calculations for IPZ1 area.
4. Watercourses provided by the Grand River Conservation Authority, 2009.

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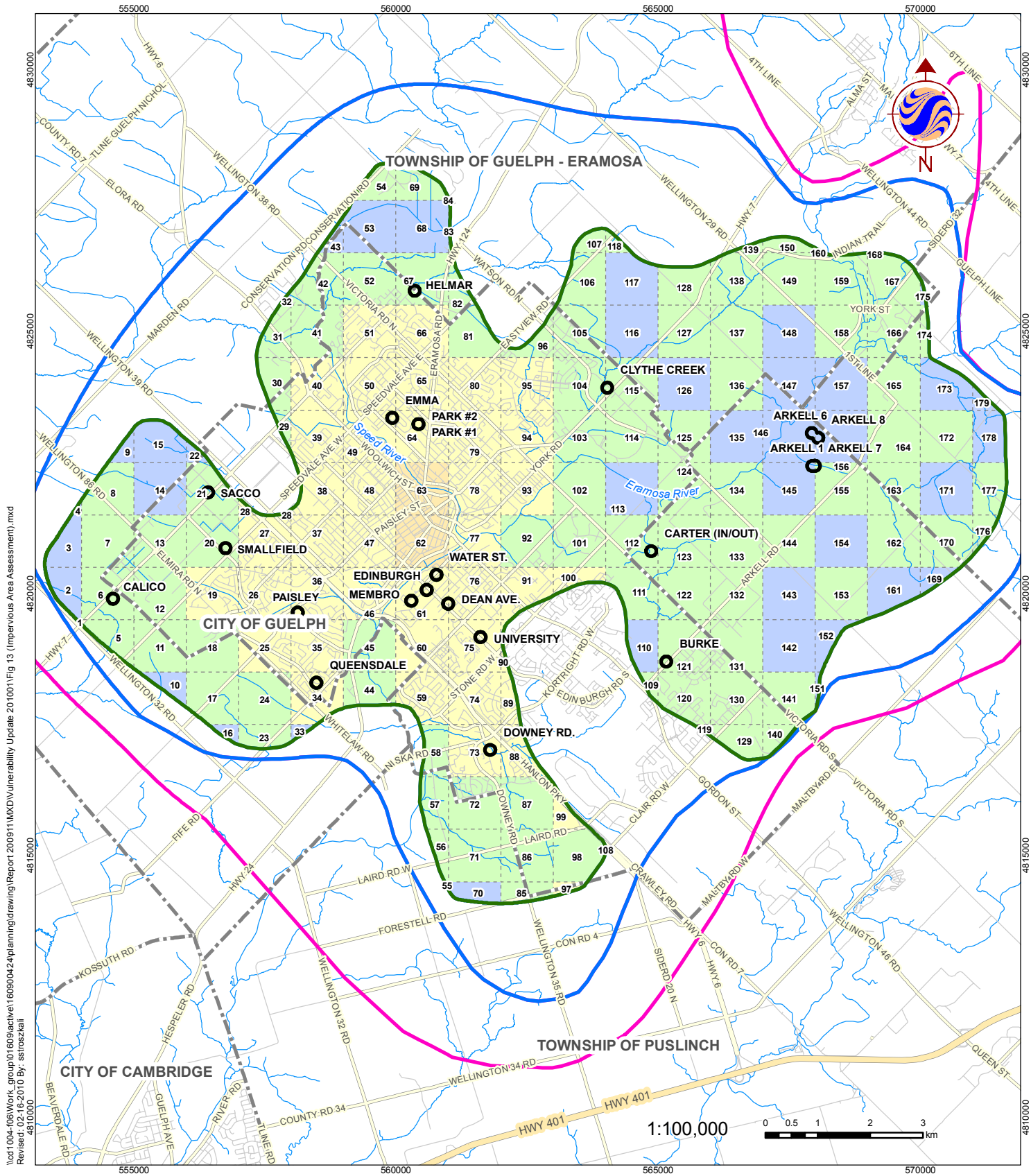
Figure No.
12

Title
Percent Managed Lands and Nutrient Units - IPZ1, IPZ2, and WHPA-E



\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 13 (Impervious Area Assessment).mxd
Revised: 02-16-2010 By: sstroszkali

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160900424

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Legend

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Lower Tier Municipality
- Road Salt Grid
- Watercourse

% Impervious

- 0 - 1
- 1 - 8
- 8 - 15
- 15 - 20
- > 20

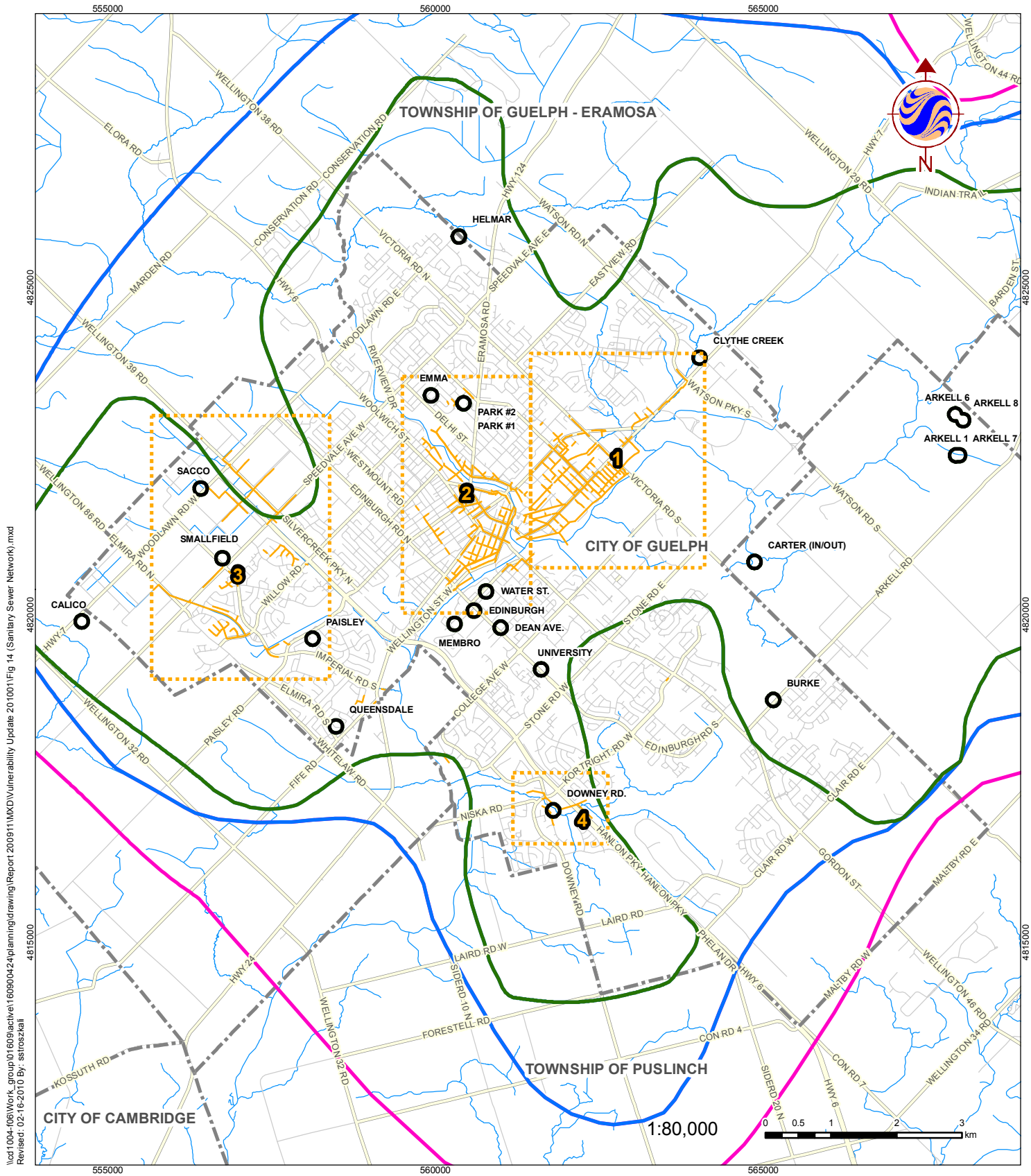
Notes

1. Coordinate System: UTM Zone 17 NAD 83.
2. Capture Zones provided by AquaResource, 2010.
3. Watercourses provided by the Grand River Conservation Authority, 2009.

Client/Project
City of Guelph
Water Quality Assessment Report

Figure No.
13

Title
Impervious Area Assessment



\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 14 (Sanitary Sewer Network).mxd
Revised: 02-16-2010 By: sstroszkali

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160900424

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Legend

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Sanitary Sewers
- Areas of Sewers Close to Bedrock
- Lower Tier Municipality
- Watercourse

Notes

1. Coordinate System: UTM Zone 17 NAD 83.
2. Capture Zones provided by AquaResource, 2010.

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City of Guelph
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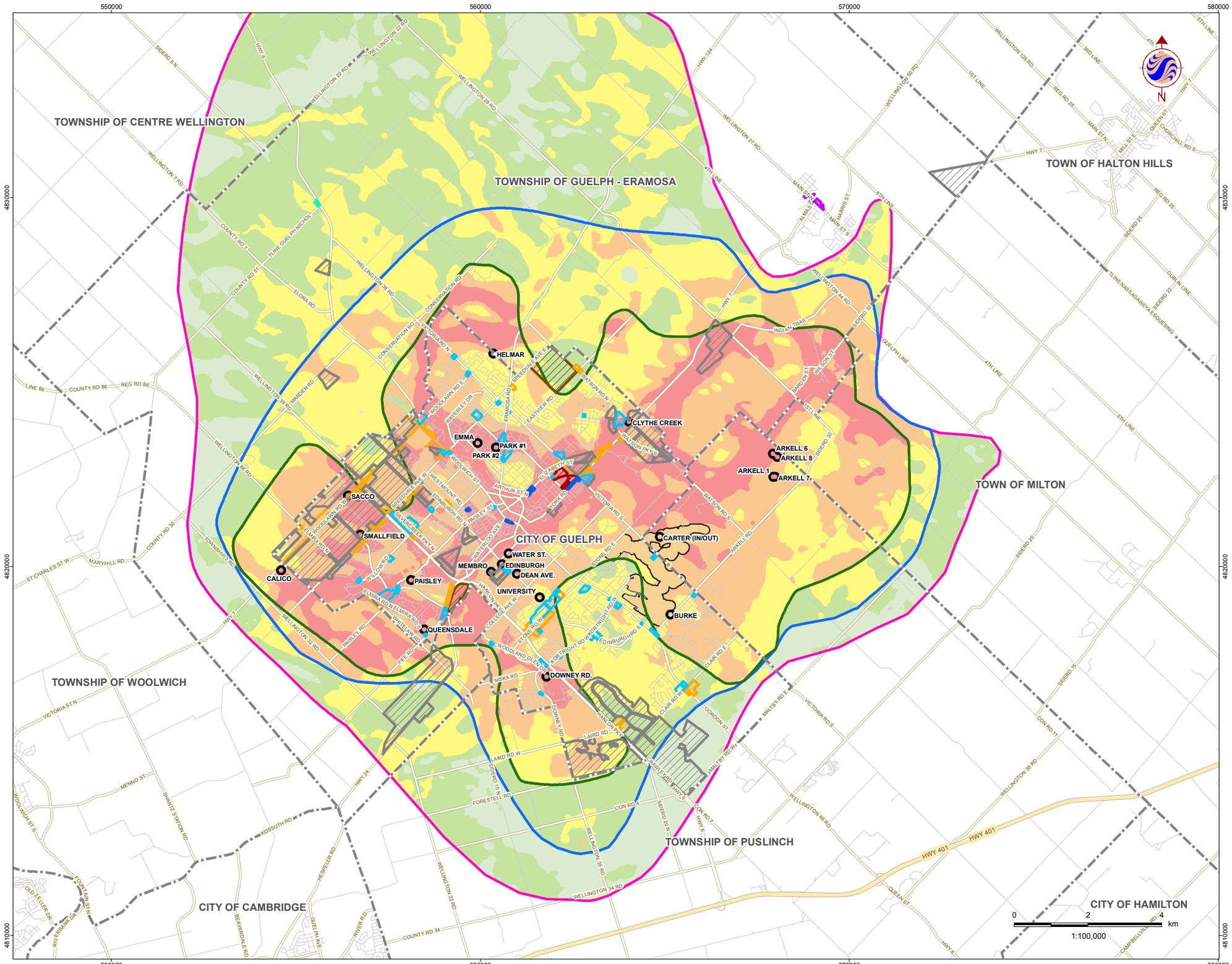
Figure No.
14

Title
Sanitary Sewers



Legend

- Central Business District
- Industrial
- Commercial
- Mixed Commercial
- Light Commercial
- Industrial
- Mixed Business
- Service Commercial
- Waste Management
- Lower Tier Municipality
- Highway
- Major Road
- Local Road
- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- WHPA-E

Vulnerability Score

- 2
- 4
- 6
- 8
- 10

Notes

1. Coordinate System: UTM Zone 17 NAD 83.
2. Capture Zones and Vulnerability Scores provided by AquaResource, 2010.

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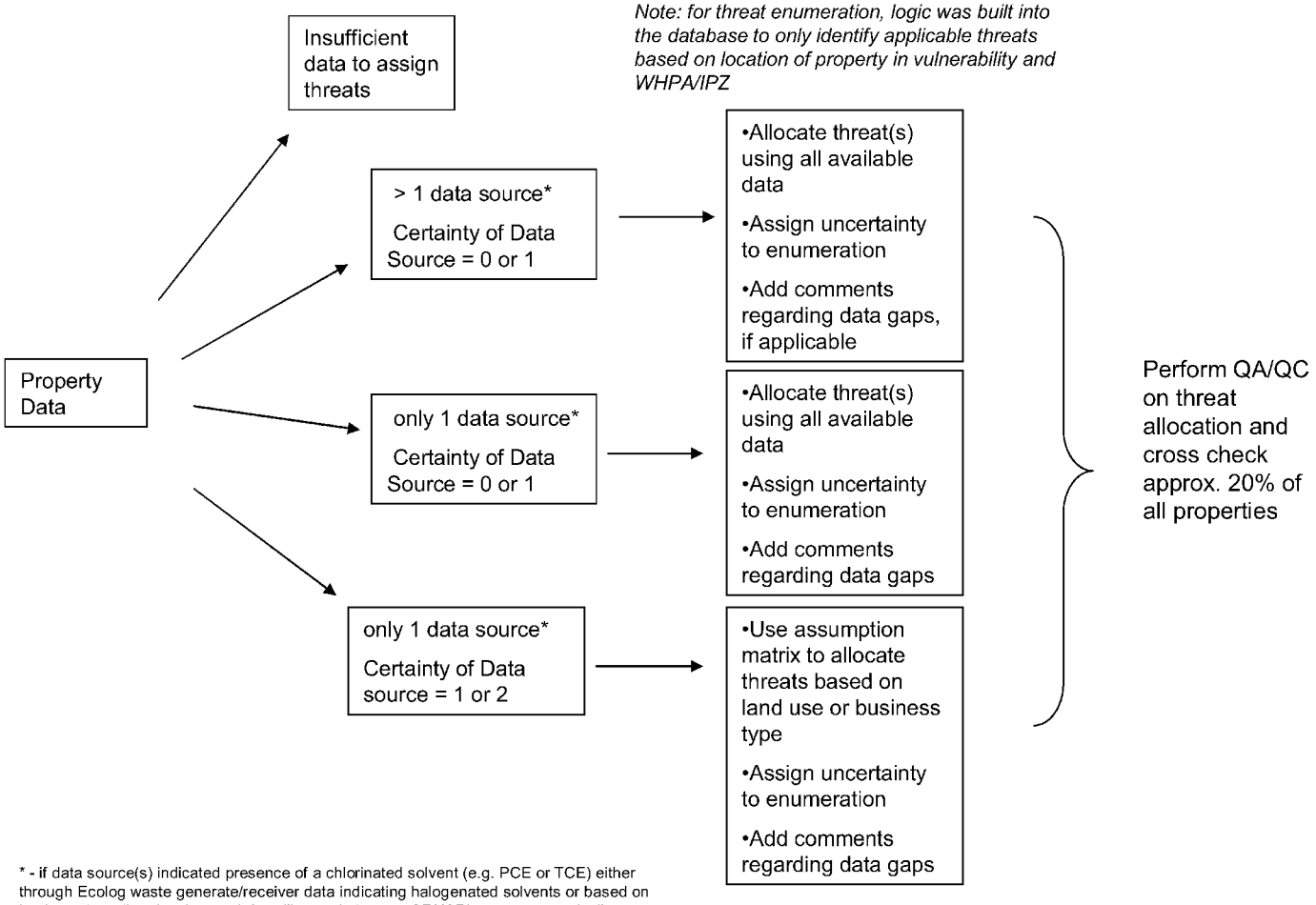
Figure No.
15

Title
Areas of Future Potential Threats

\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 15 (Areas of Future Potential Threats).mxd - 2/17/2010 @ 3:04:38 PM
Revised on: February 17, 2010 By: sstroszkali



* - if data source(s) indicated presence of a chlorinated solvent (e.g. PCE or TCE) either through Ecolog waste generate/receiver data indicating halogenated solvents or based on business type (i.e. dry cleaners), handling and storage of DNAPLs was automatically assigned to the property as a significant threat for WHPAs A to C, vulnerability 2 -10.

\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 16 (Decision Tree for Threat Enumeration).mxd
Revised: 02-16-2010 By: sstroszkali

February 2010
160900424

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Water Quality Assessment Report

Figure No.
16

Title
Decision Tree for Threat Enumeration

555000 560000 565000 570000 575000

4825000 4820000 4815000 4810000

TOWNSHIP OF GUELPH - ERAMOSA

TOWN OF MILTON

CITY OF GUELPH

TOWNSHIP OF WOOLWICH

CITY OF CAMBRIDGE

TOWNSHIP OF PUSLINCH

WHPA-B (Score 6):

- The handling and storage of a dense non-aqueous phase liquid.

WHPA-B (Score 8):

- The handling and storage of a dense non-aqueous phase liquid.

WHPA-C (Score 6):

- The handling and storage of a dense non-aqueous phase liquid.

WHPA-C (Score 8):

- The handling and storage of a dense non-aqueous phase liquid.

WHPA-C (Score 4):

- The handling and storage of a dense non-aqueous phase liquid.

WHPA-A (Score 10):

- The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage within the meaning of the Ontario Water Resources Act.
- The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
- The handling and storage of a dense non- aqueous phase liquid.
- The handling and storage of an organic solvent.
- The handling and storage of fuel.
- The handling and storage of non-agricultural source material.
- The handling and storage of pesticide.

WHPA-B (Score 10):

- The application of pesticide to land.
- The storage of snow.
- The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage within the meaning of the Ontario Water Resources Act.
- The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
- The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.
- The handling and storage of a dense non-aqueous phase liquid.
- The handling and storage of an organic solvent.
- The handling and storage of commercial fertilizer.
- The handling and storage of fuel.
- The handling and storage of non-agricultural source material.
- The handling and storage of pesticide.
- The handling and storage of road salt.

HELMAR
SACCO
SMALLFIELD
CALICO
PAISLEY
QUEENSDALE
EMMA
PARK #1
PARK #2
CLYTHE CREEK
ARKELL 6
ARKELL 8
ARKELL 1
ARKELL 7
CARTER (IN/OUT)
WATER ST.
MEMBRO
EDINBURGH
DEAN AVE.
UNIVERSITY
BURKE
DOWNEY RD.

COUNTY RD 7
COUNTY RD 51
ELORA RD
HWY 6
WELLINGTON 36 RD
CONSERVATION RD
VICTORIA RD N
HWY 124
WATSON RD N
SPEEDVALE AVE E
EASTVIEW RD
WELLINGTON 7 RD
HWY 7
WELLINGTON 44 RD
INDIAN TRAIL
SIDERD 32
4TH LINE
5TH LINE
WILSON ST
BARDEN ST
1ST LINE
SIDERD 25
WELLINGTON 38 RD
MARDEN RD
WELLINGTON 36 RD
WOODLAWN RD E
WAVERLEY DR
RIVERVIEW PR
WOODLAWN RD W
WOOLWICH ST
DELHI ST
ERAMOSA RD
ELIZABETH ST
WATSON PKY S
SIDERD 30
SILVERCREEK PKY N
SPEEDVALE AVE W
EDINBURGH RD N
WESTMOUNT RD
LONDON RD W
NORFOLK ST
PAISLEY ST
YORK RD
VICTORIA RD S
WATSON RD S
COUNTY RD 30
TOWNSHIP 3 RD
WILLOW RD
ELMIRA RD N
IMPERIAL RD N
WATERLOO AVE
WATER ST
STONE RD E
ARKELL RD
SIDERD 20
HWY 7
WELLINGTON 32 RD
ELMIRA RD S
IMPERIAL RD S
WELLINGTON ST W
COLLEGE AVE W
STONE RD W
KORTRIGHT RD W
EDINBURGH RD S
PAISLEY RD
HWY 24
WOODLAND GLEN DR
CLAIR RD E
VICTORIA ST N
FIFE RD
WHITELAW RD
NISKA RD
HANLON PKY
CLAIR RD W
GORDON ST
MALTBY RD E
VICTORIA RD S
WELLINGTON 34 RD
LAIRD RD
DOWNEY RD
MALTBY RD W
CRAWLEY RD
HWY 6
WELLINGTON 46 RD
WELLINGTON 36 RD
FORESTELL RD
CON RD 4
CON RD 7
SIDERD 20 N
HWY 401
SHANTZ STATION RD
KOSSUTH RD
WELLINGTON 35 RD
HESPELER RD
GUELPH AVE
RIVER RD
COUNTY RD 34
QUEEN ST

0 1,000 2,000 m
1:75,000

Legend

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Lower Tier Municipality
- Highway
- Major Road
- Local Road

Vulnerability Score

- 2
- 4
- 6
- 8
- 10

Notes

1. Coordinate System: UTM Zone 17 NAD 83.
2. Capture Zones and Vulnerability Scores provided by AquaResource, 2010.

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Figure No.
17

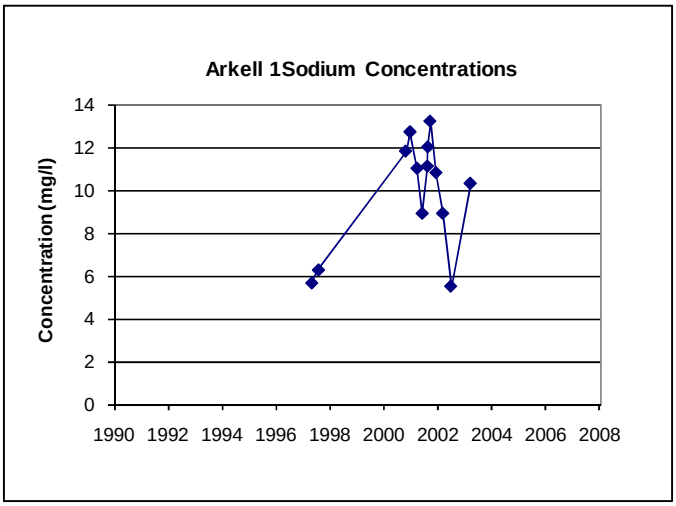
Title
Vulnerability Zones With Activities

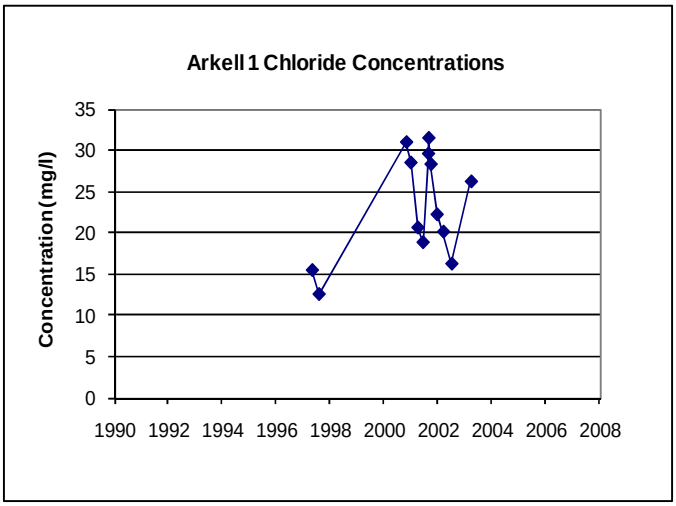
\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Vulnerability Update 201001\Fig 17 (Vulnerability Zones with Activities).mxd - 2/16/2010 @ 4:16:10 PM
Revised on: February 16, 2010 By: sstroszkali

Appendix A. Municipal Well Water Quality Time Series Charts

Water Quality Trends

Arkell 1

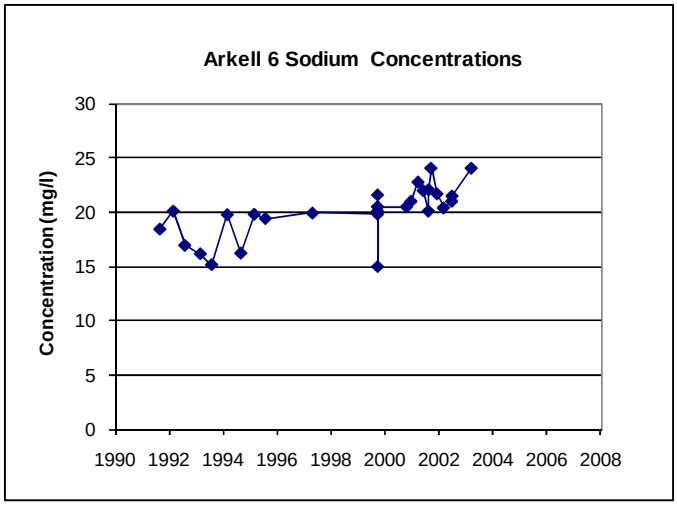


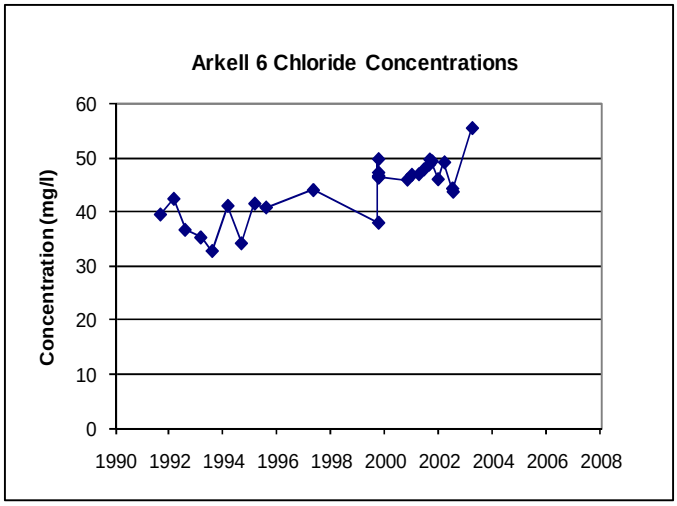


Data provided by City of Guelph (2009)

Water Quality Trends

Arkell 6

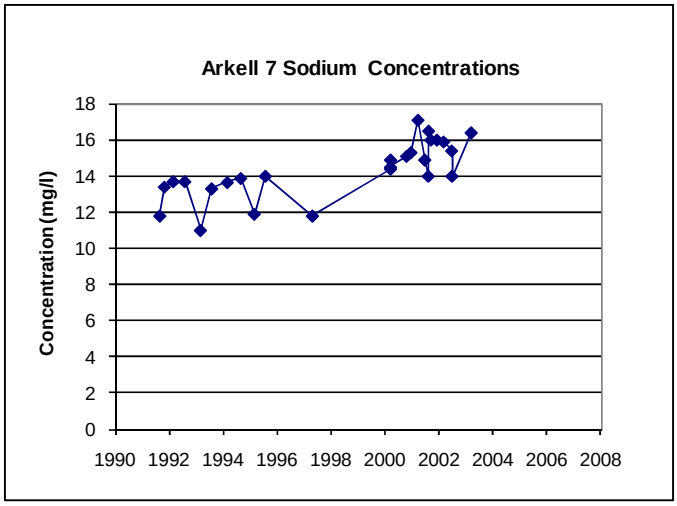


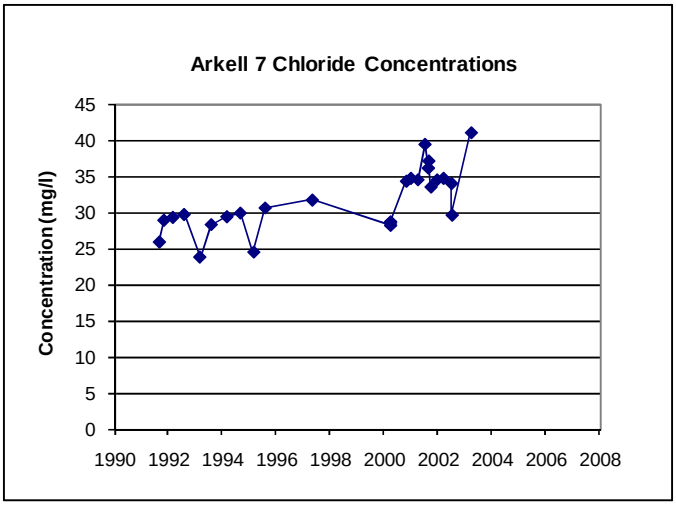


Data provided by City of Guelph (2009)

Water Quality Trends

Arkell 7

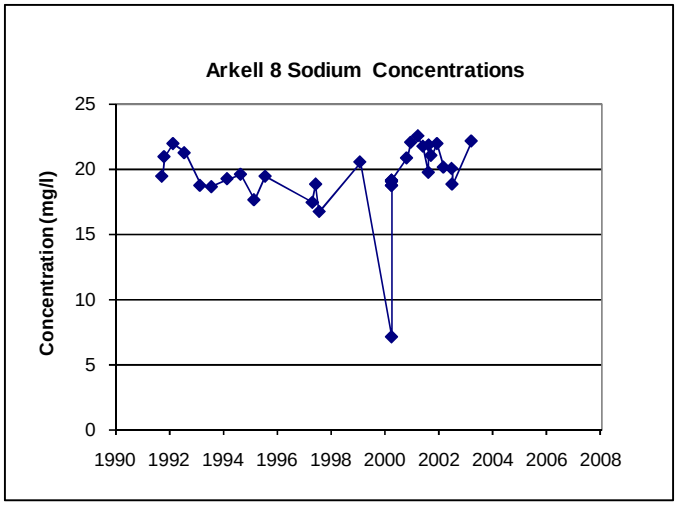


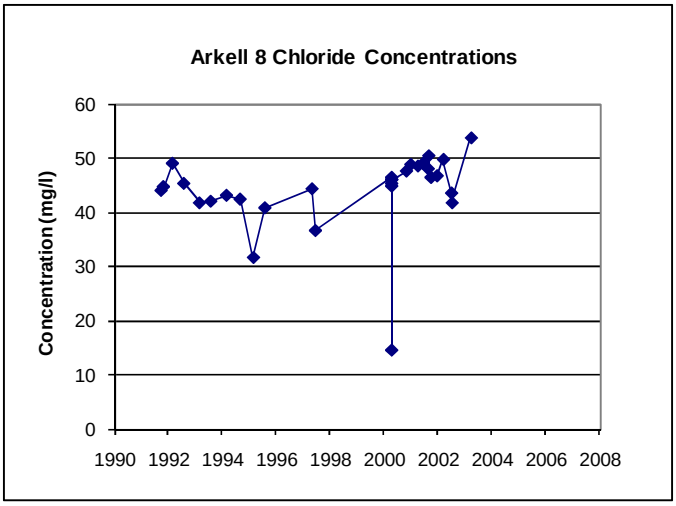


Data provided by City of Guelph (2009)

Water Quality Trends

Arkell 8

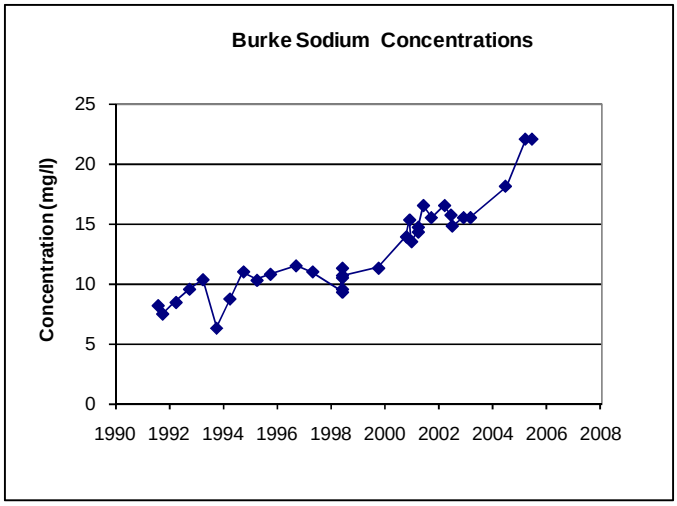


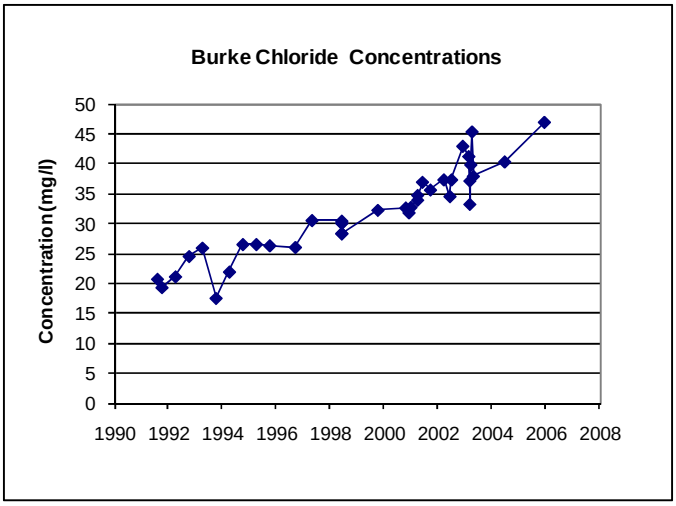


Data provided by City of Guelph (2009)

Water Quality Trends

Burke

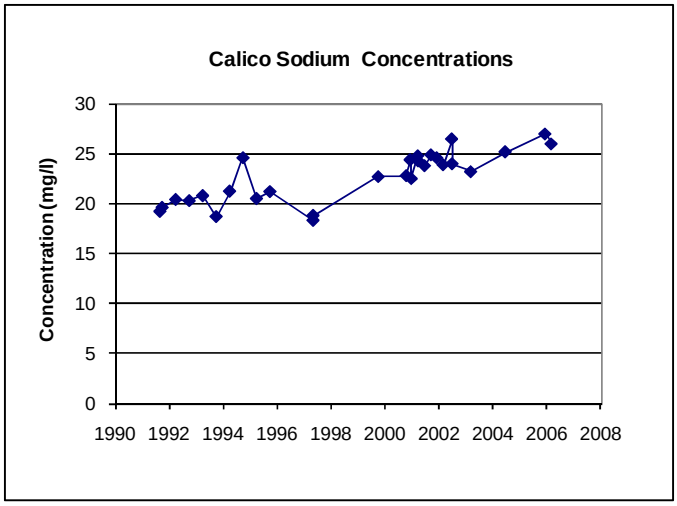


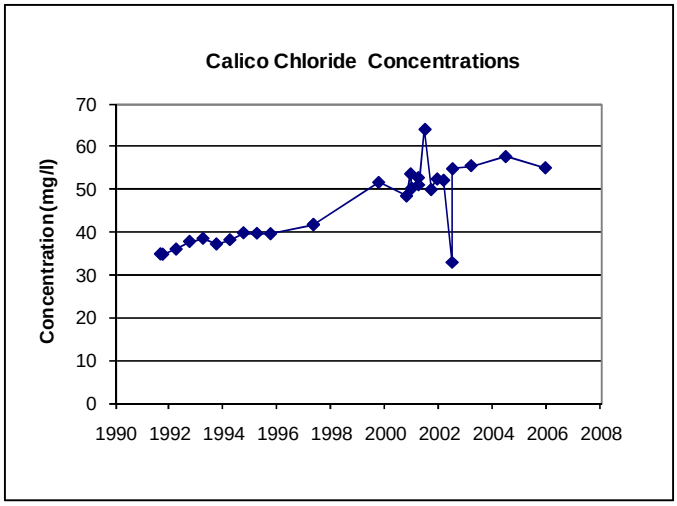


Data provided by City of Guelph (2009)

Water Quality Trends

Calico

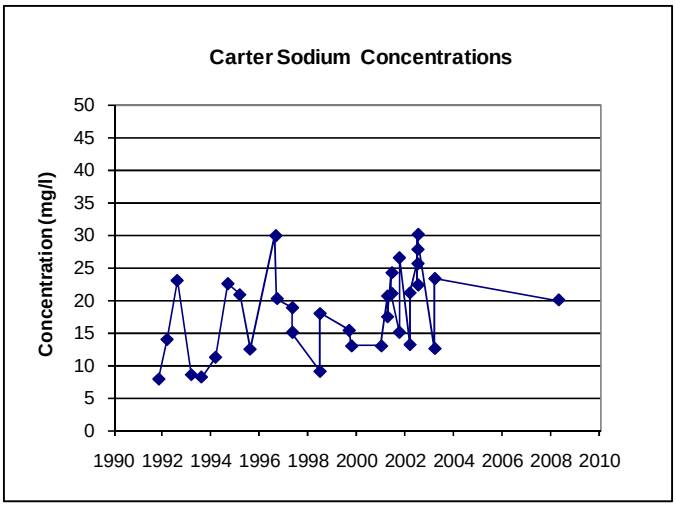


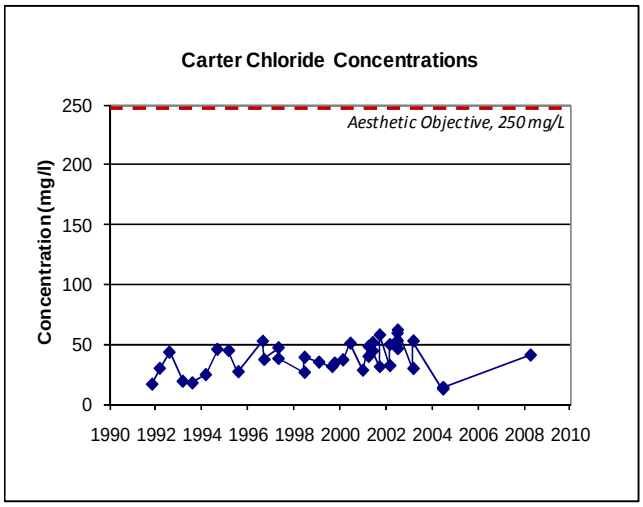


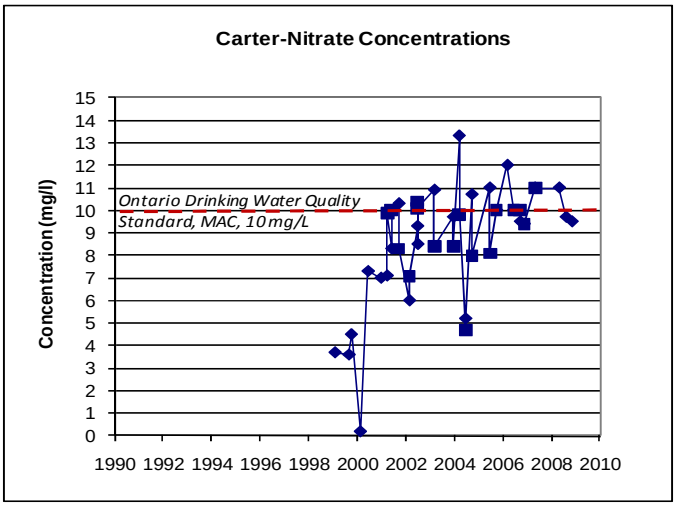
Data provided by City of Guelph (2009)

Water Quality Trends

Carter



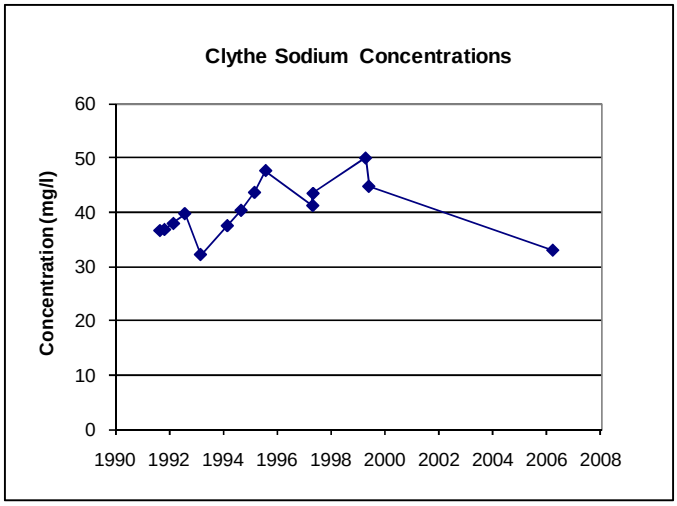


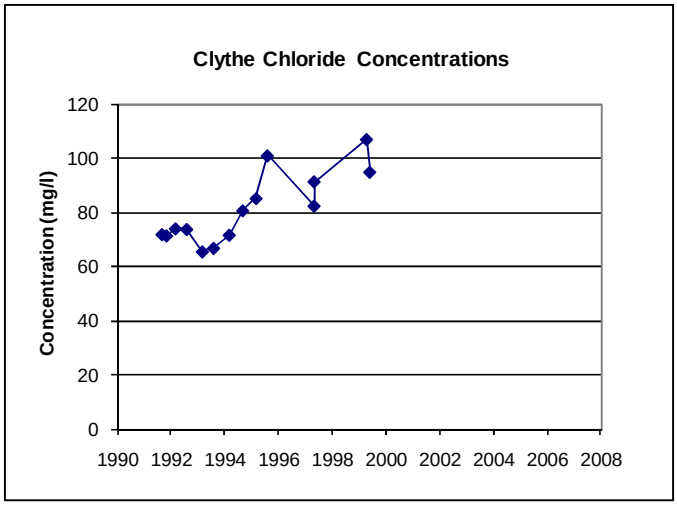


Data provided by City of Guelph (2009)

Water Quality Trends

Clythe

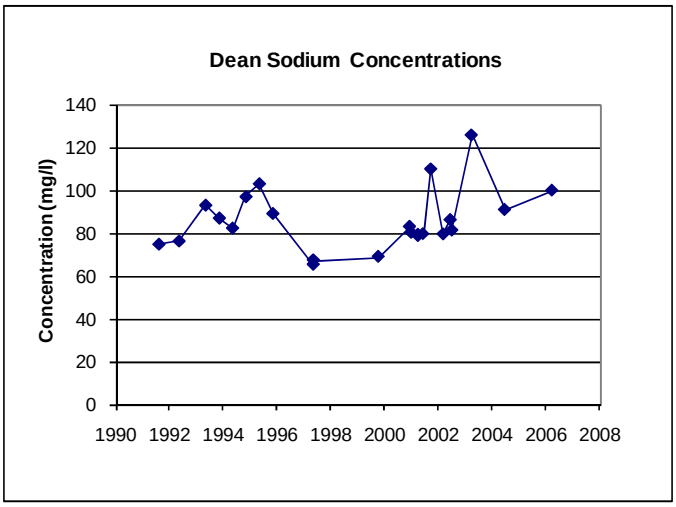


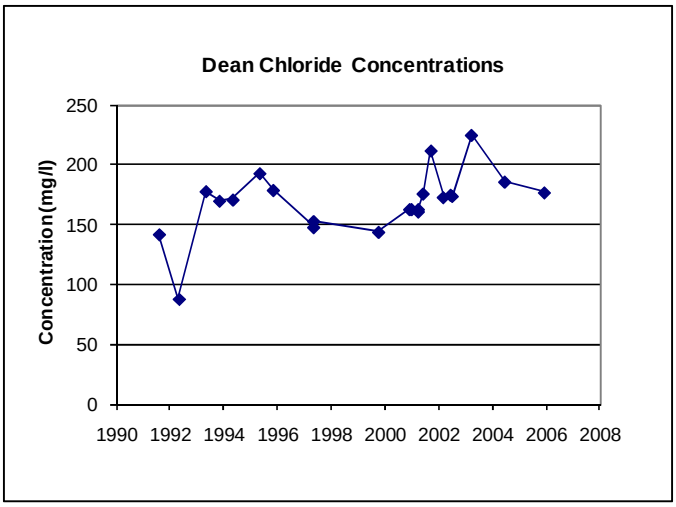


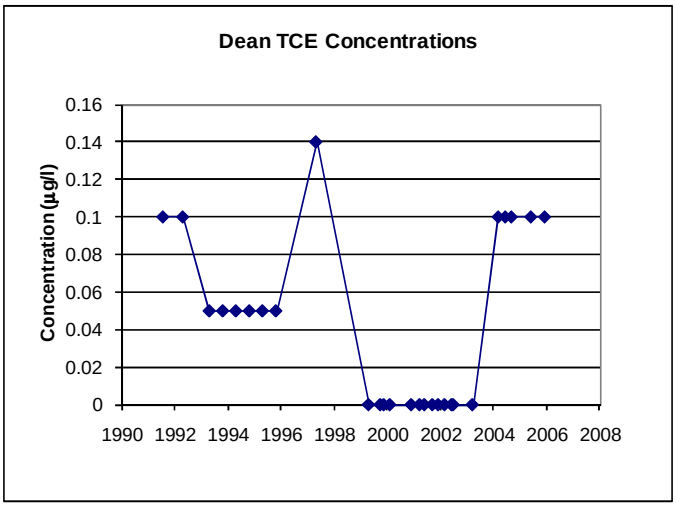
Data provided by City of Guelph (2009)

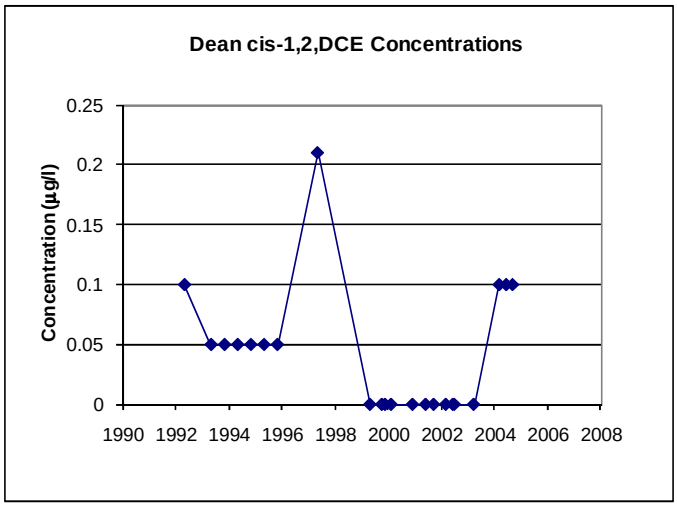
Water Quality Trends

Dean





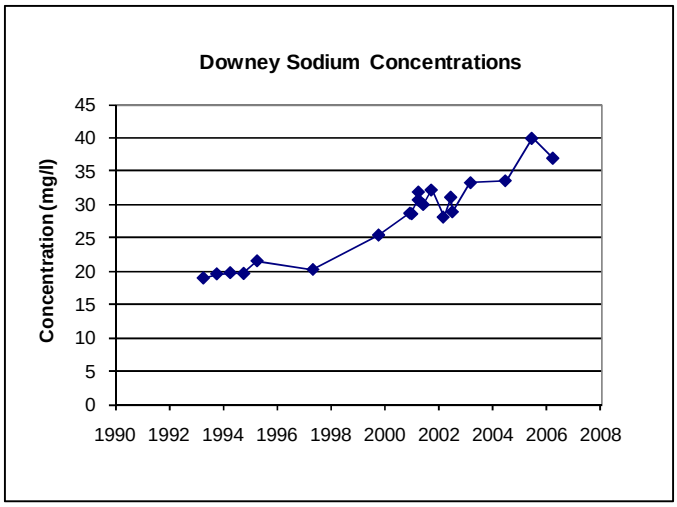


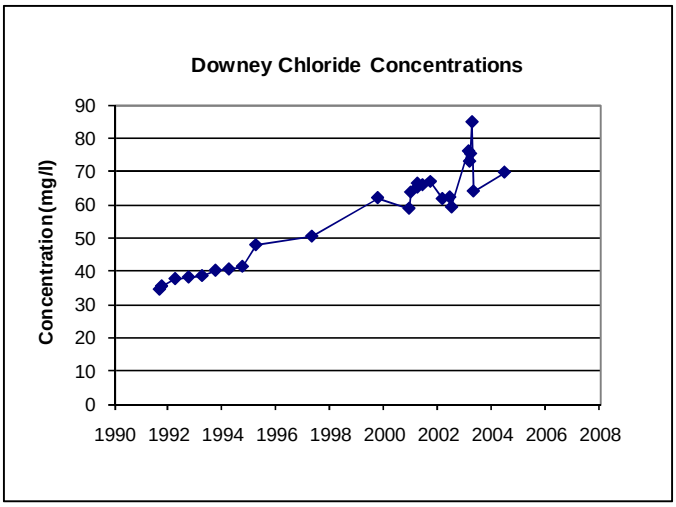


Data provided by City of Guelph (2009)

Water Quality Trends

Downey

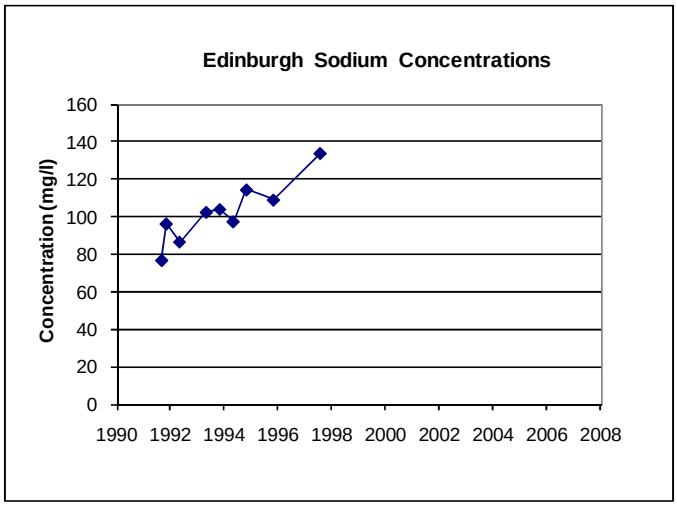


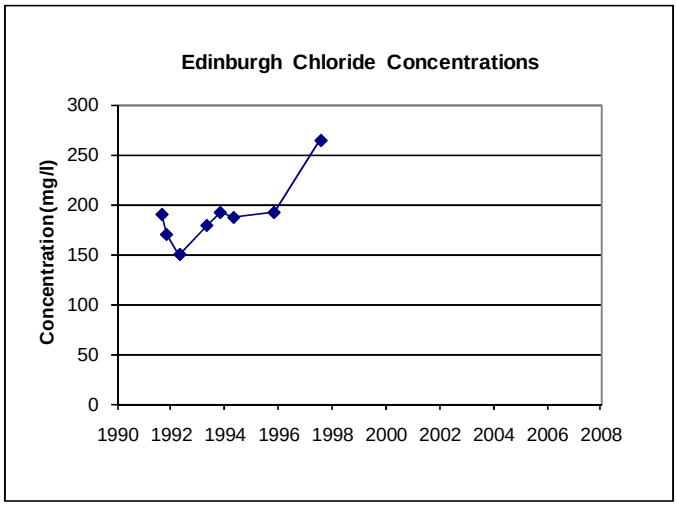


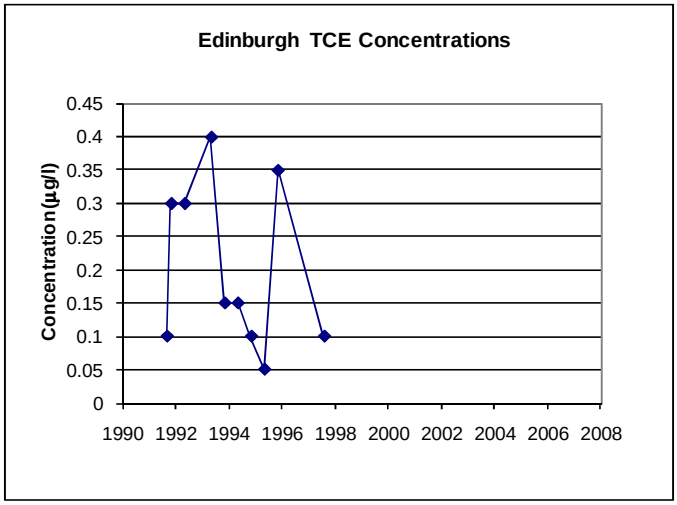
Data provided by City of Guelph (2009)

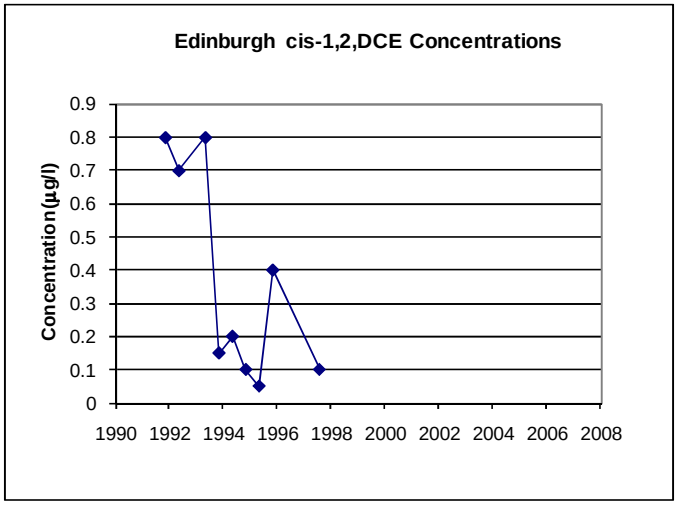
Water Quality Trends

Edinburgh









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Water Quality Trends

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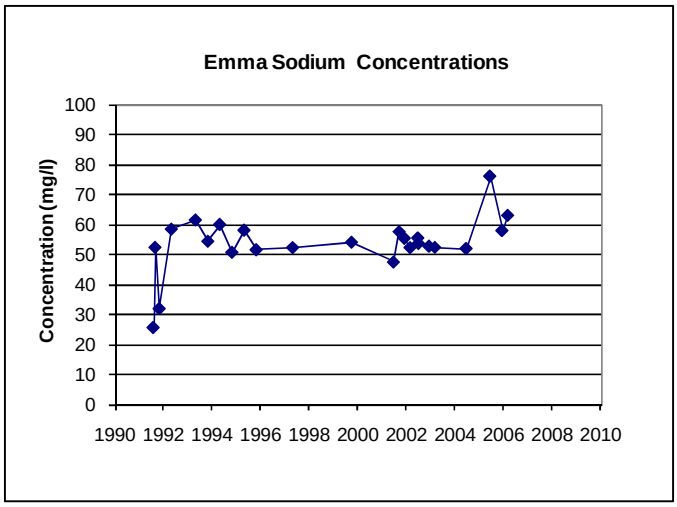

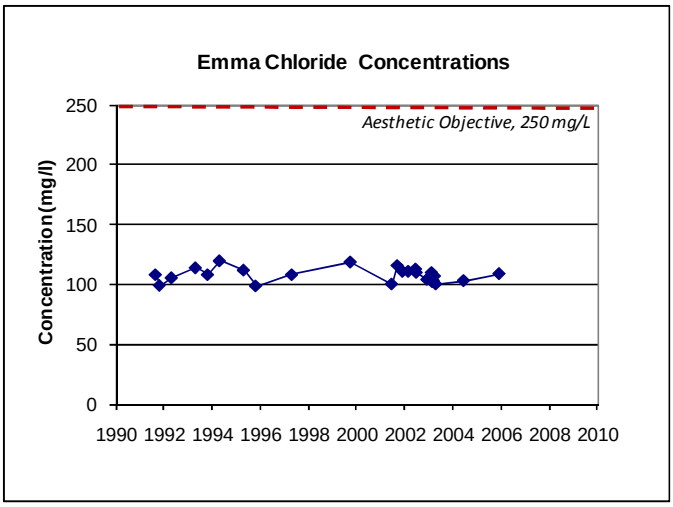

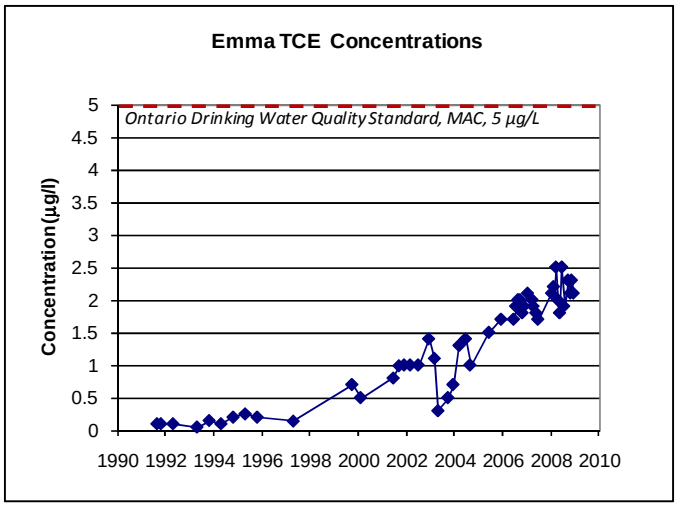

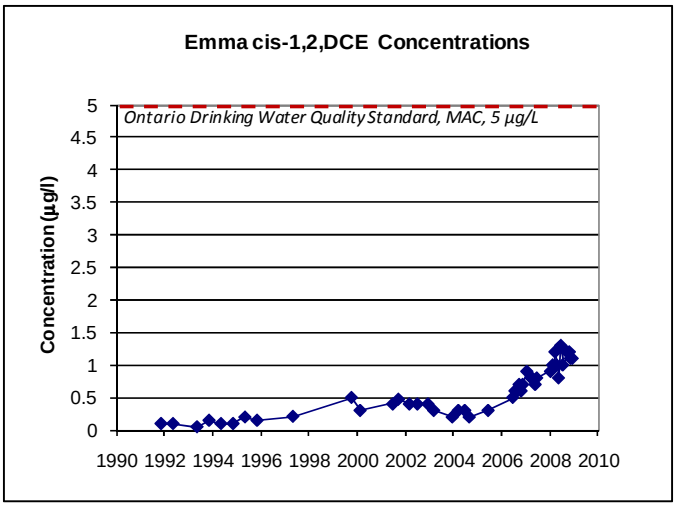

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Water Quality Trends

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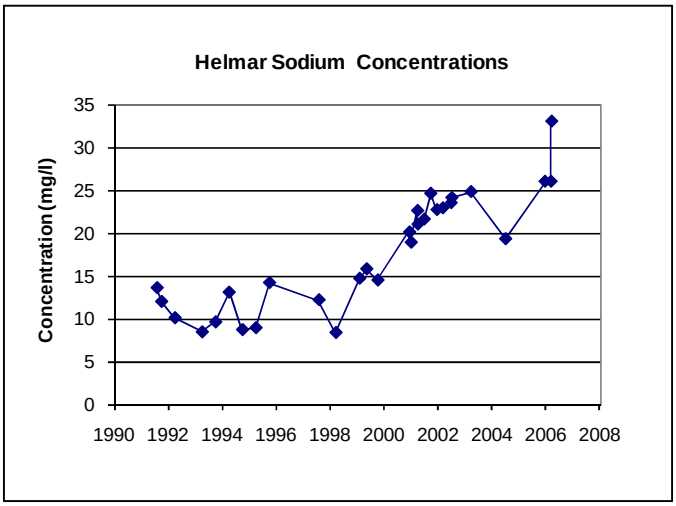
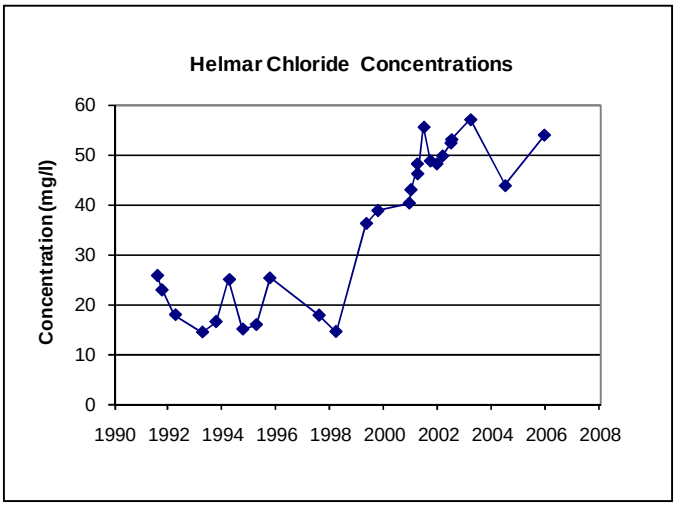
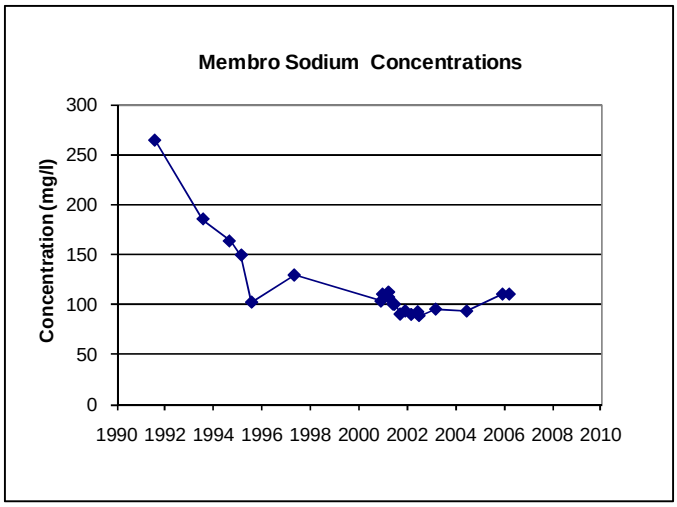


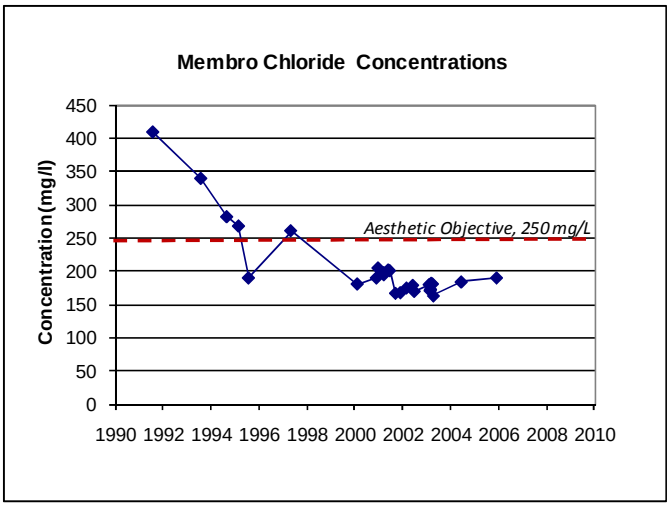


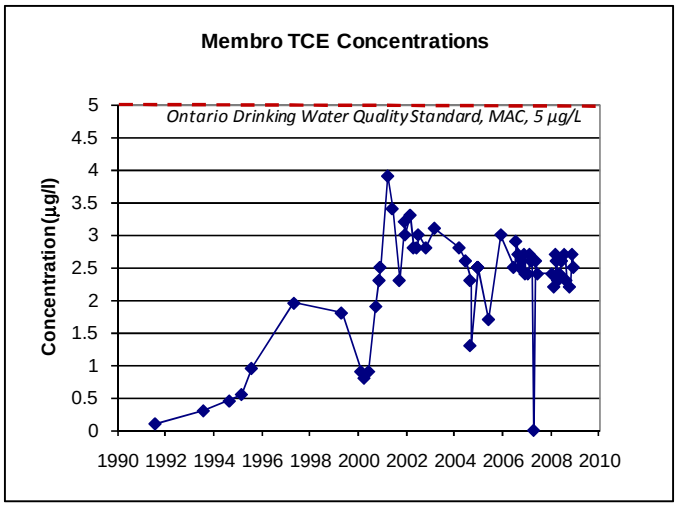
Data provided by City of Guelph (2009)

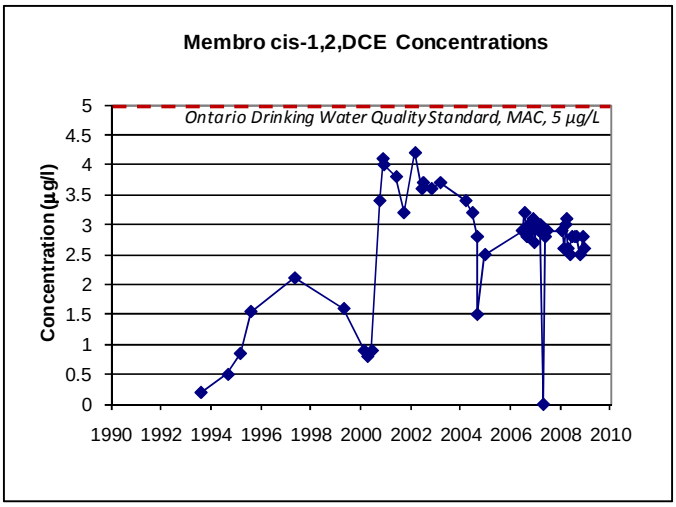
Water Quality Trends

Membro





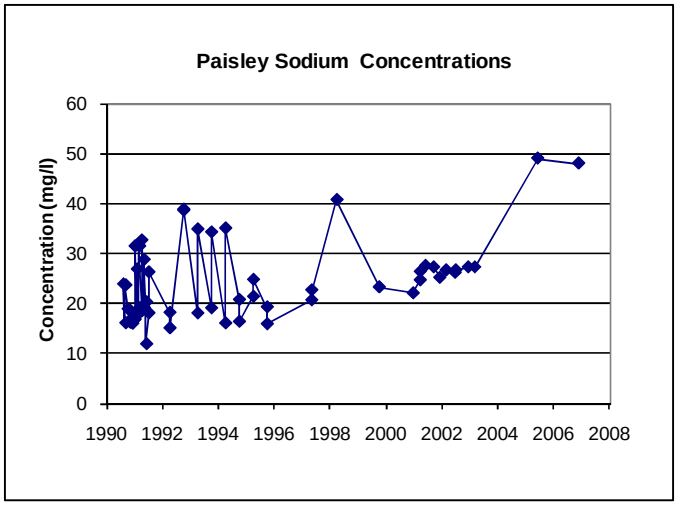


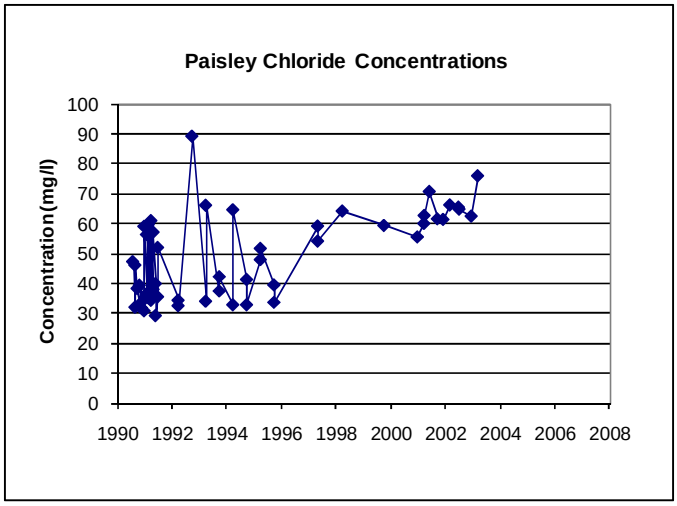


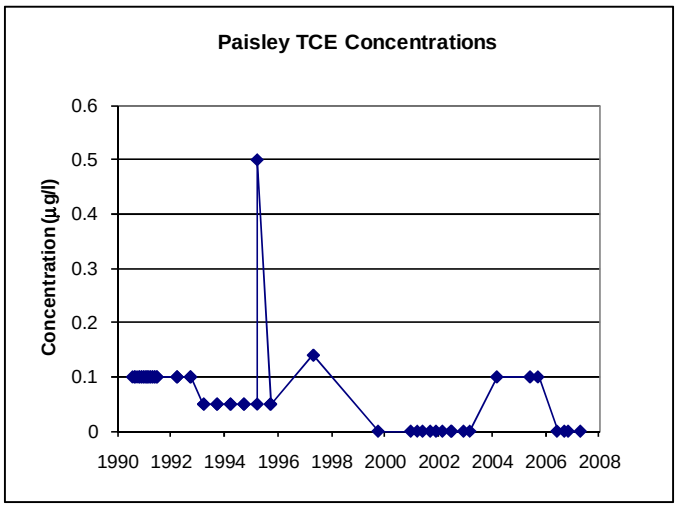
Data provided by City of Guelph (2009)

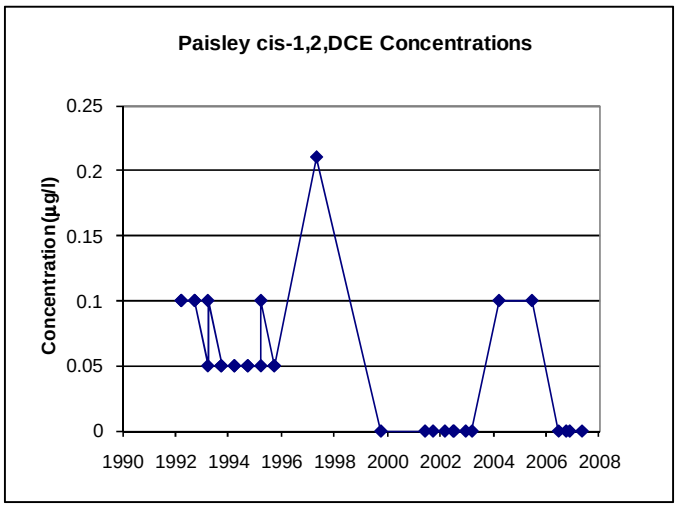
Water Quality Trends

Paisley





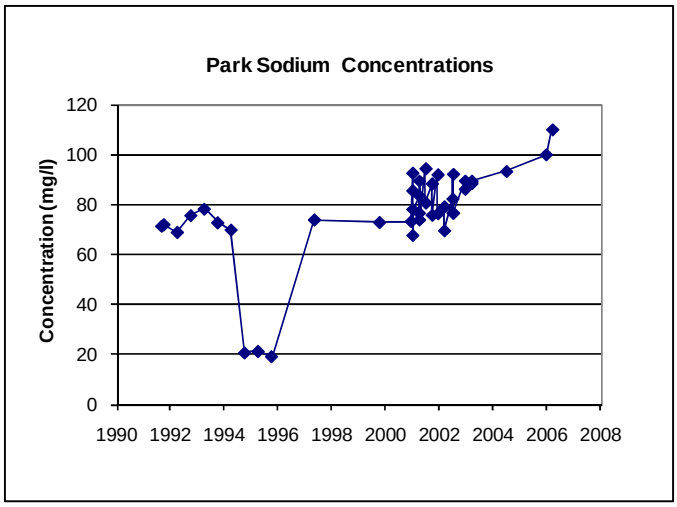


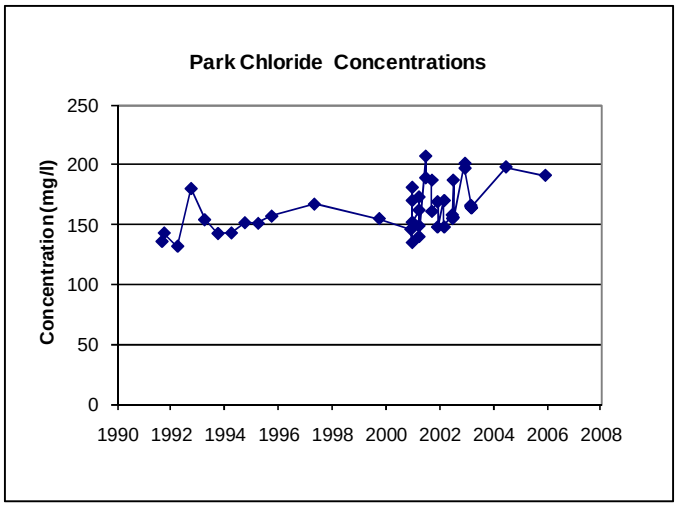


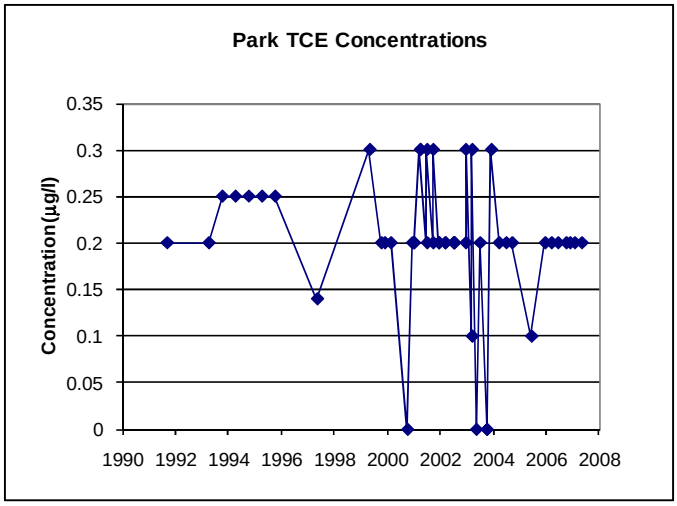
Data provided by City of Guelph (2009)

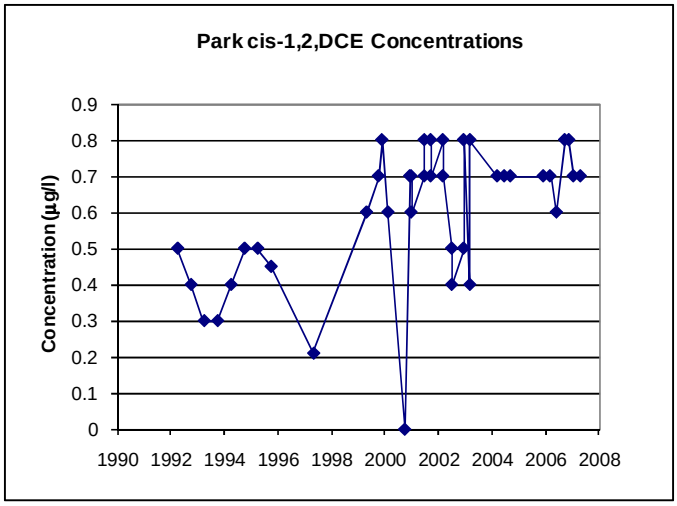
Water Quality Trends

Park





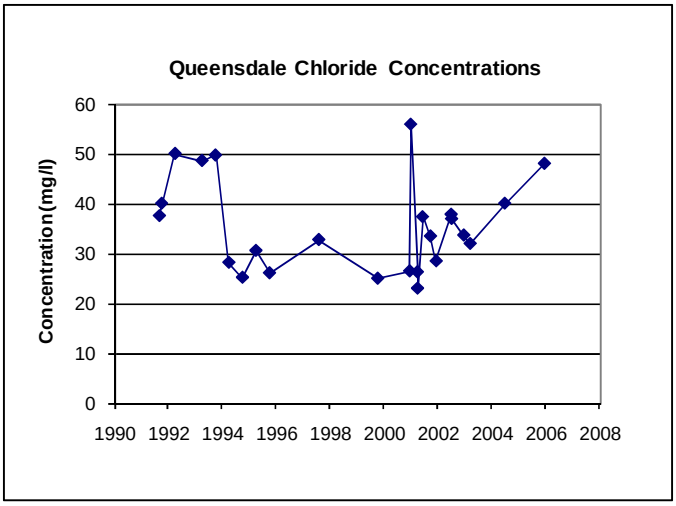


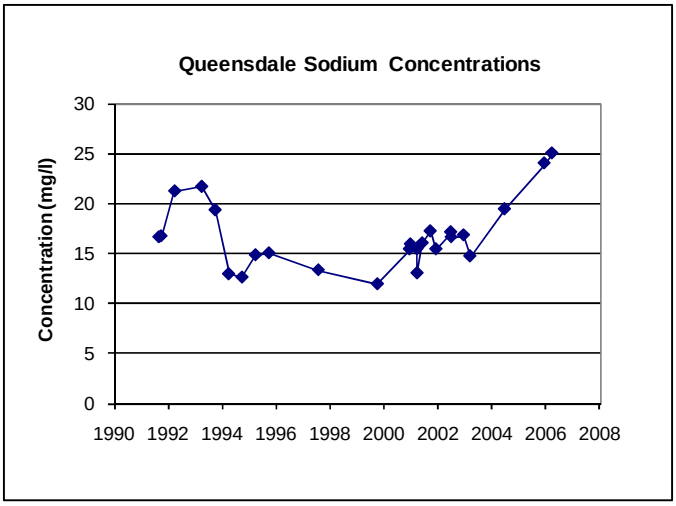


Data provided by City of Guelph (2009)

Water Quality Trends

Queensdale





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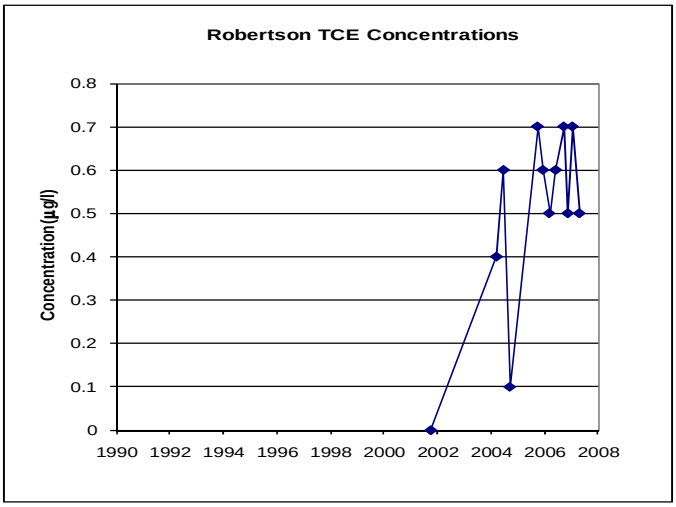
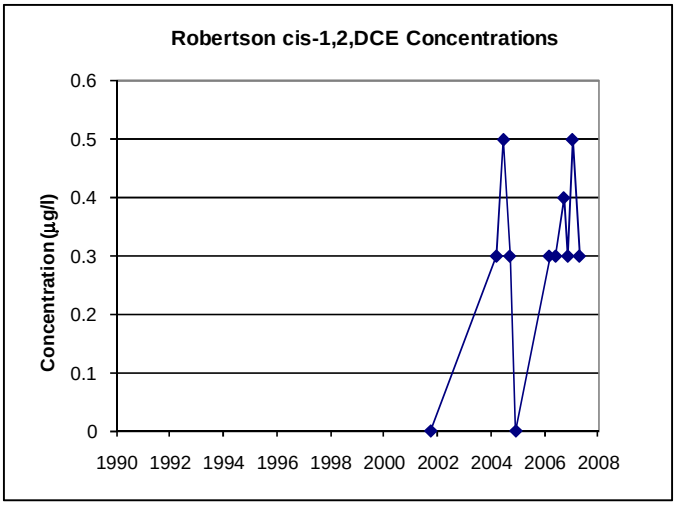
Water Quality Trends

Robertson

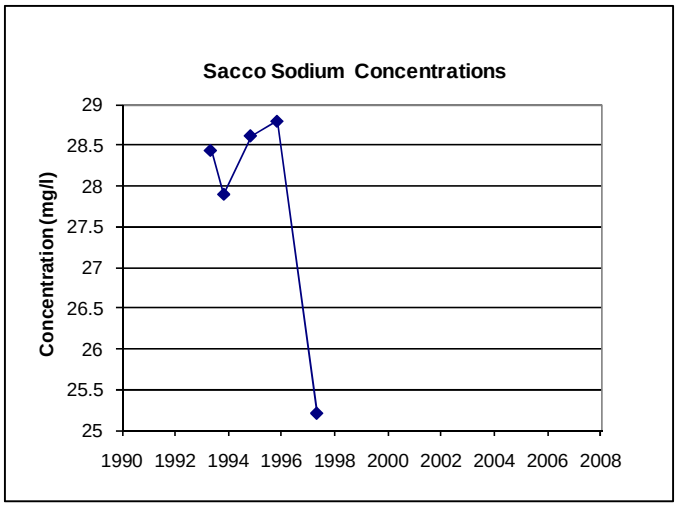


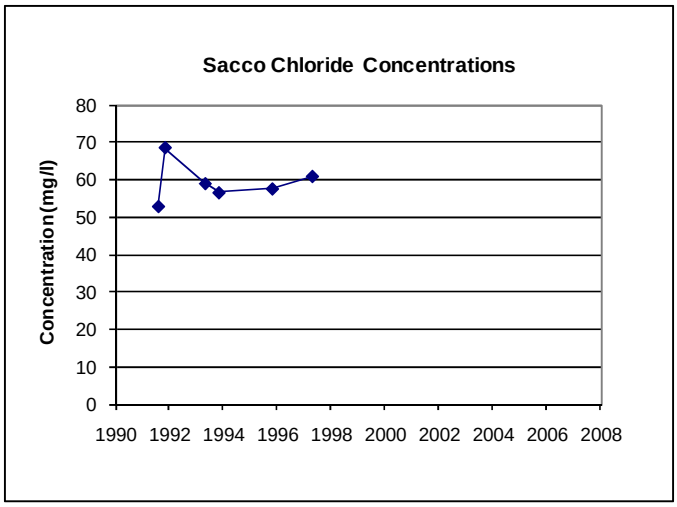


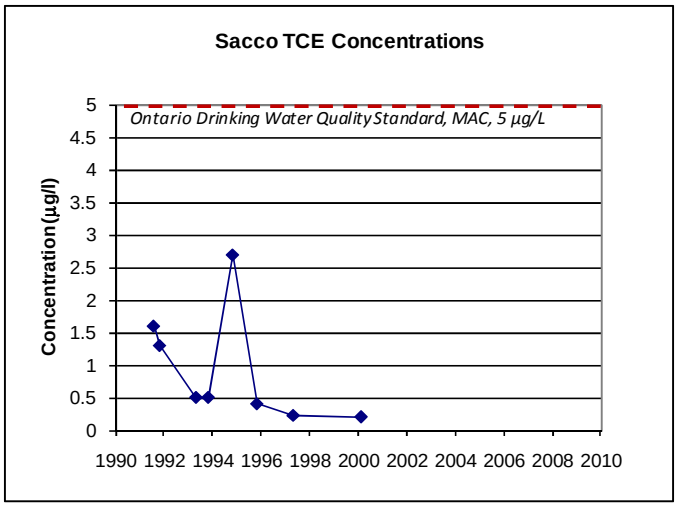
Data provided by City of Guelph (2009)

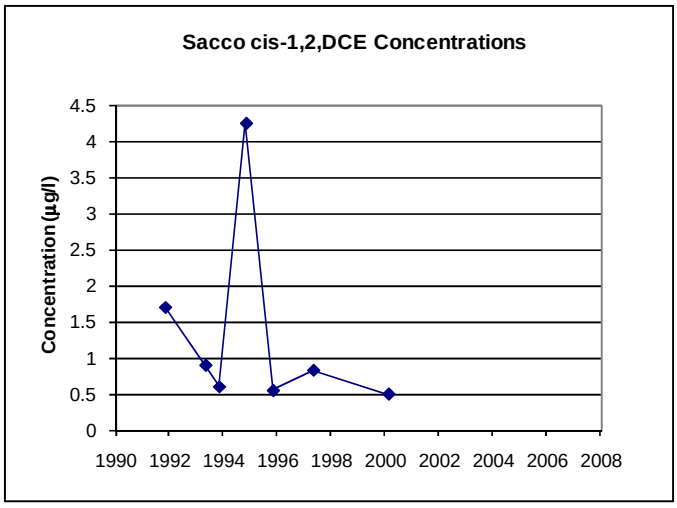
Water Quality Trends

Sacco









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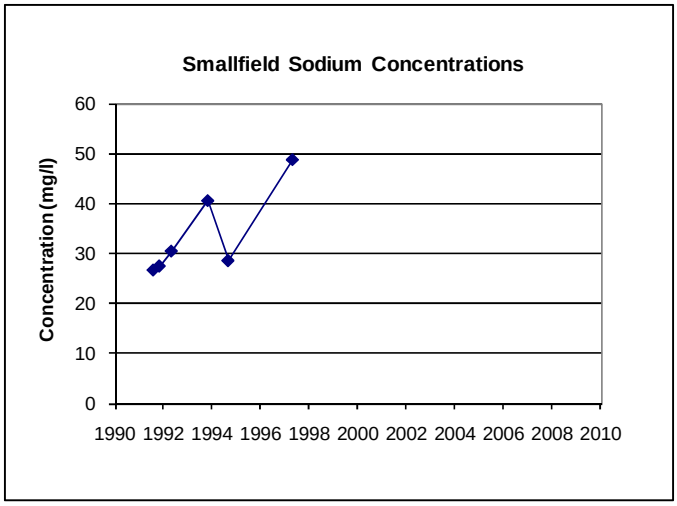
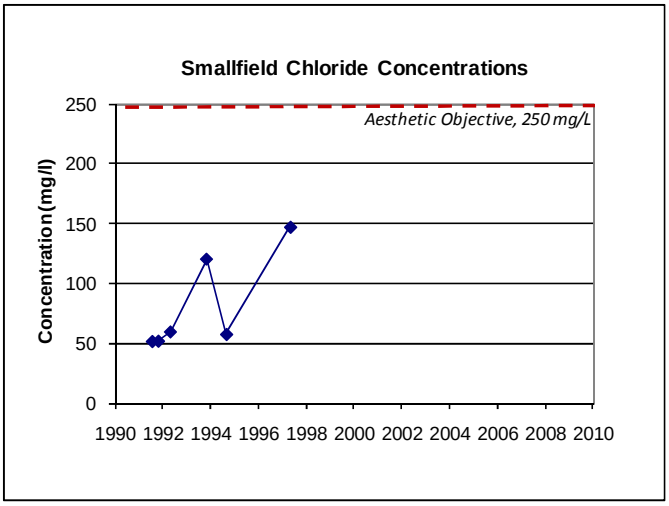
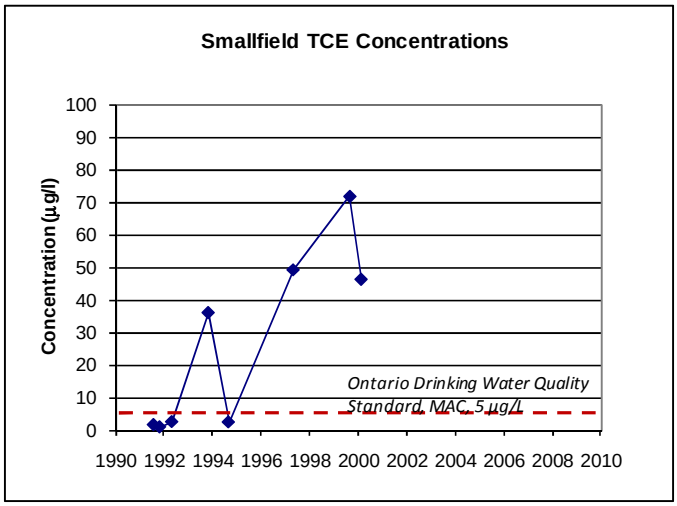
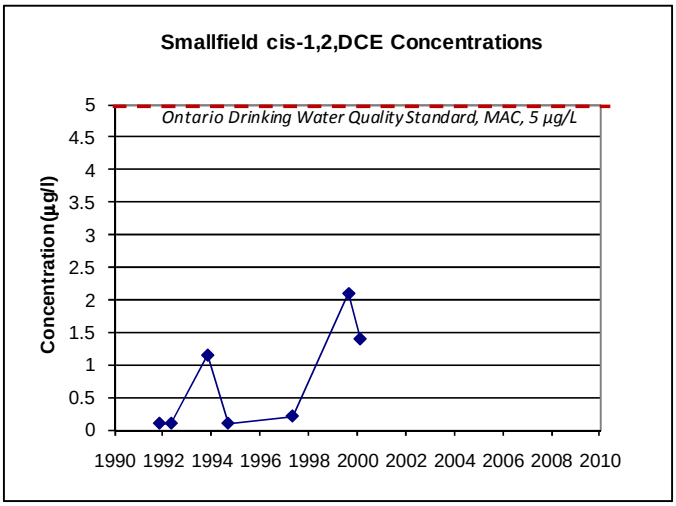
Water Quality Trends

Smallfield





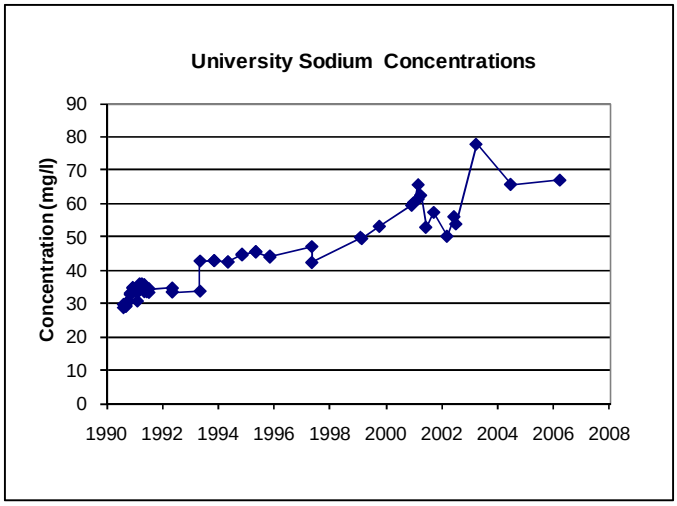


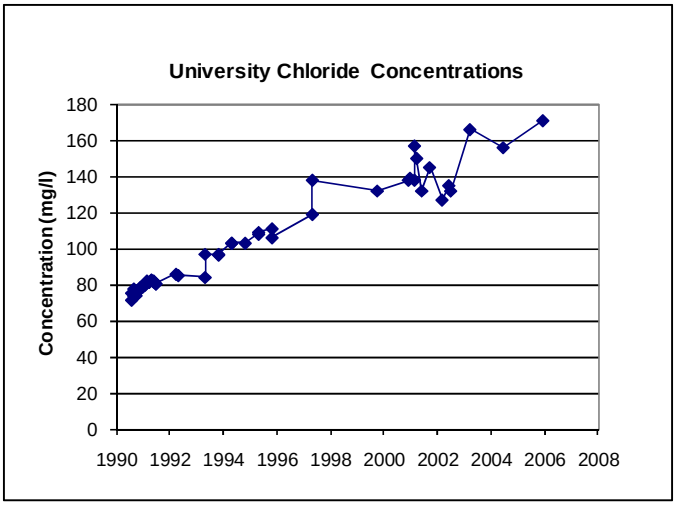


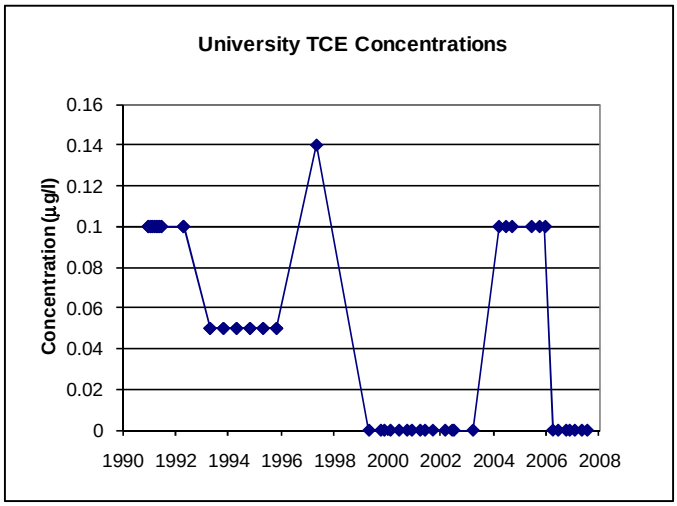
Data provided by City of Guelph (2009)

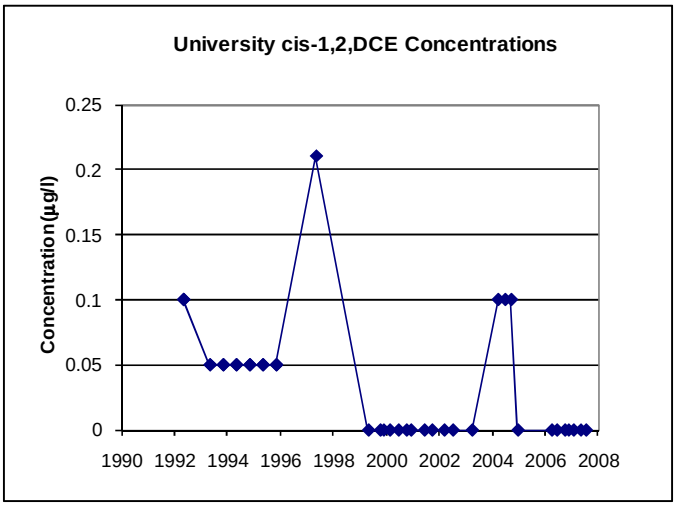
Water Quality Trends

University





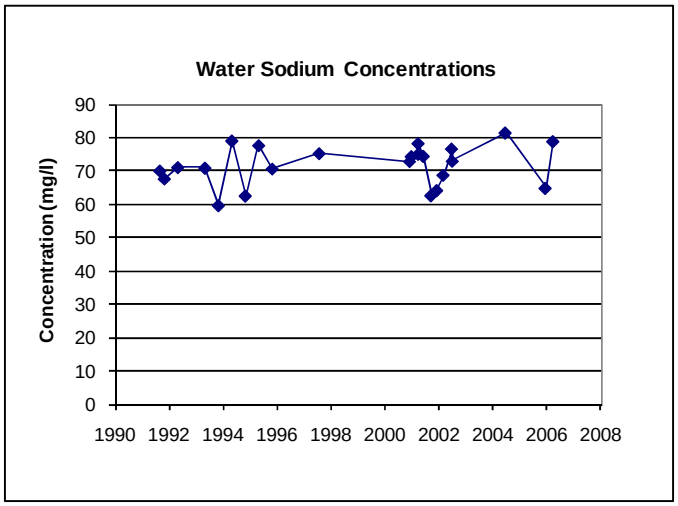


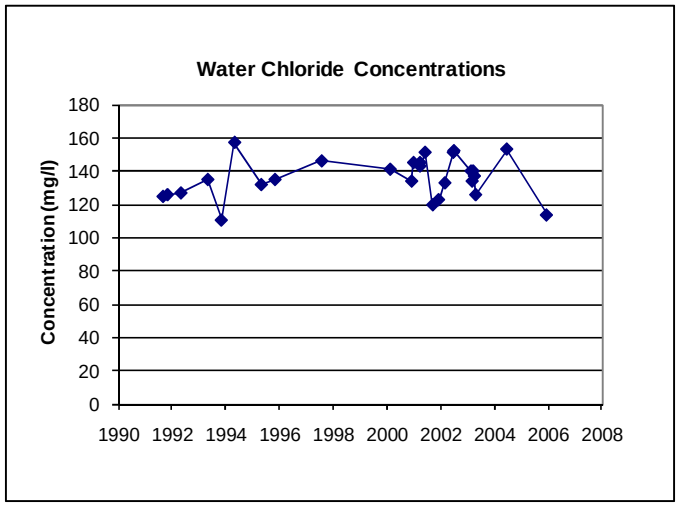


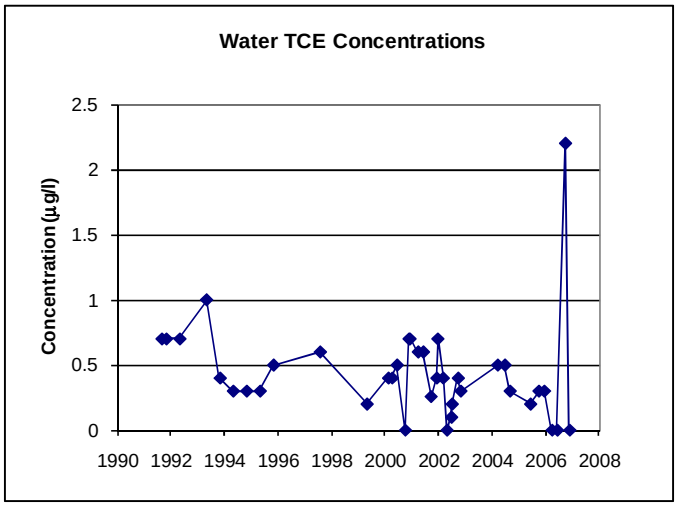
Data provided by City of Guelph (2009)

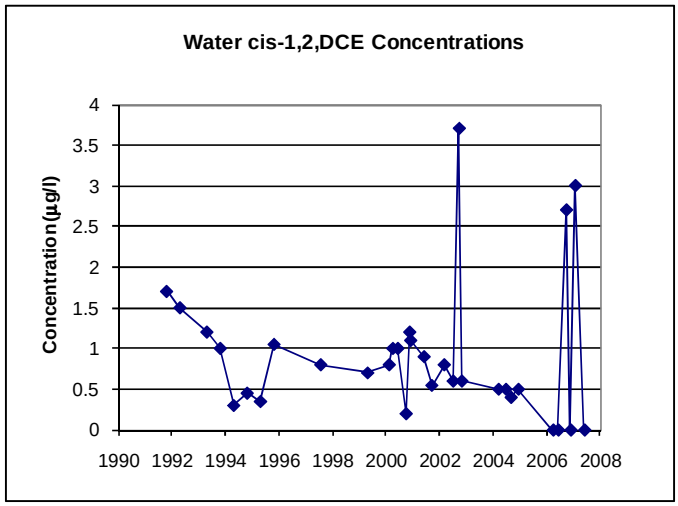
Water Quality Trends

Water





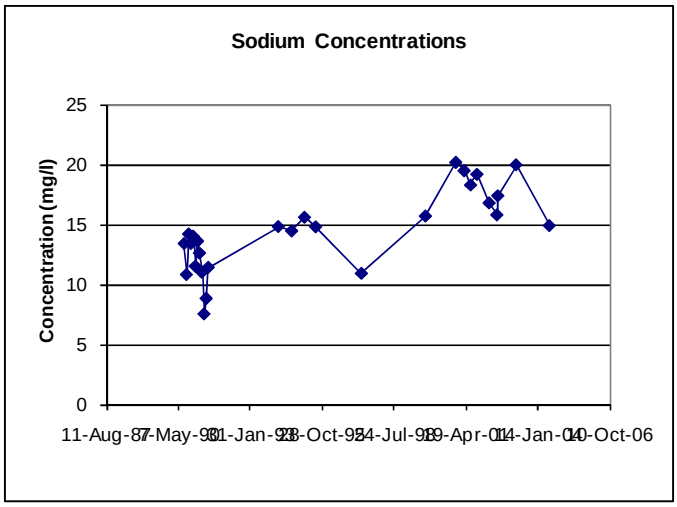


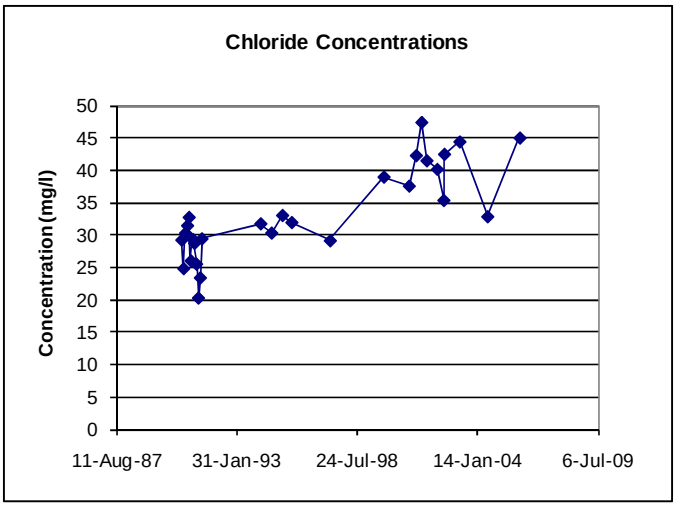


Data provided by City of Guelph (2009)

Water Quality Trends

Woods





Data provided by City of Guelph (2009)

Appendix B. List of Details of Data Sources

ECOLOG ERIS – 2008 Data

EcoLog Environmental Risk Information Services Ltd can search the following databases. The extent of historical information varies with each database and current information is determined by what is publicly available to EcoLog ERIS at the time of update.

Provincial Government Source Databases:

Environmental Registry 1994-Sept 2007 (EBR)
The Environmental Registry lists proposals, decisions and exceptions regarding policies, Acts, instruments, or regulations that could significantly affect the environment. Through the Registry, provincial ministries notify the public of upcoming proposals and invite their comments. For example, if a local business is requesting a permit, license, or certificate of approval to release substances into the air or water; these are notified on the registry.

Ontario Regulation 347 Waste Generators Summary 1986-Aug 2008 (GEN)
Regulation 347 of the Ontario EPA defines a waste generation site as any site, equipment and/or operation involved in the production, collection, handling and/or storage of regulated wastes. A generator of regulated waste is required to register the waste generation site and each waste produced, collected, handled, or stored at the site. This database contains the registration number, company name and address of registered generators including the types of hazardous wastes generated.

This information is a summary of all years from 1986 including the most currently available data. Some records may contain, within the company name, the phrase “See & Use…” followed by a series of letters and numbers. This occurs when one company is amalgamated with or taken over by another registered company. The number listed as “See & Use”, refers to the new ownership and the other identification number refers to the original ownership. This phrase serves as a link between the 2 companies until operations have been fully transferred.

Ontario Inventory of PCB Storage Sites 1987-Oct 2004 (OPCB)
The Ontario Ministry of Environment, Waste Management Branch, maintains an inventory of PCB storage sites within the province. Ontario Regulation 11/82 (Waste Management - PCB) and Regulation 347 (Generator Waste Management) under the Ontario EPA requires the registration of inactive PCB storage equipment and/or disposal sites of PCB waste with the Ontario Ministry of Environment. This database contains information on: 1) waste quantities; 2) major and minor sites storing liquid or solid waste; and 3) a waste storage inventory.

Ontario Regulation 347 Waste Receivers Summary 1986-2005 (REC)
Part V of the Ontario Environmental Protection Act (“EPA”) regulates the disposal of regulated waste through an operating waste management system or a waste disposal site operated or used pursuant to the terms and conditions of a Certificate of Approval or a Provisional Certificate of Approval. Regulation 347 of the Ontario EPA defines a waste receiving site as any site or facility to which waste is transferred by a waste carrier. A receiver of regulated waste is required to register the waste receiving facility. This database represents registered receivers of regulated wastes, identified by registration number, company name and address, and includes receivers of waste such as: landfills, incinerators, transfer stations, PCB storage sites, sludge farms, and water pollution control plants. This information is a summary of all years from 1986 including the most currently available data.

Federal Government Source Databases: Diagram Identifier:

National PCB Inventory 1988-June 2004 (NPCB)
Environment Canada’s National PCB inventory includes information on in-use PCB containing equipment in Canada including federal, provincial and private facilities. All federal out-of-service PCB containing equipment and all PCB waste owned by the federal government or by federally regulated industries such as airlines, railway companies, broadcasting companies, telephone and

telecommunications companies, pipeline companies, etc. are also listed. Although it is not Environment Canada's mandate to collect data on non-federal PCB waste, the National PCB inventory includes some information on provincial and private PCB waste and storage sites.

National Pollutant Release Inventory 1993-2006 (NPRI)
Environment Canada has defined the National Pollutant Release Inventory ("NPRI") as a federal government initiative designed to collect comprehensive national data regarding releases to air, water, or land, and waste transfers of 178 specified substances.

Private Source Databases:

Anderson's Waste Disposal Sites 1860s-Present (ANDR)
The information provided in this database was collected by examining various historical documents which aimed to characterize the likely position of former waste disposal sites from 1860 to present. The research initiative behind the creation of this database was to identify those sites that are missing from the *Ontario MOE Waste Disposal Site Inventory*, as well as to provide revisions and corrections to the positions and descriptions of sites currently listed in the MOE inventory. In addition to historic waste disposal facilities, the database also identifies certain auto wreckers and scrap yards that have been extrapolated from documentary sources. *Please note that the data is not warranted to be complete, exhaustive or authoritive. The information was collected for research purposes only.*

Chemical Register 1992, 1999-Jan 2008 (CHEM)
This database includes information from both a one time study conducted in 1992 and private source and is a listing of facilities that manufacture or distribute chemicals. The production of these chemical substances may involve one or more chemical reactions and/or chemical separation processes (i.e. fractionation, solvent extraction, crystallization, etc.).

Fuel Storage Tanks Current to August 2007 (FST)
The TSSA, under the *Technical Standards & Safety Act* of 2000 maintains a database of registered private and retail fuel storage tanks in Ontario with fields such as location, tank status, license date, tank type, tank capacity, fuel type, installation year and facility type.

Scott's Manufacturing Directory 1992-Jan 2007 (SCT)
Scott's Directories is a data bank containing information on over 70,000 manufacturers in Ontario. Even though Scott's listings are voluntary, it is the most comprehensive database of Ontario manufacturers available. Information concerning a company's address, plant size, and main products are included in this database. This database begins with 1992 information and is updated annually.

OTHER DATA SOURCES

Property Codes – City of Guelph Planning Department (2009)
A list of the property codes and their descriptions for the City of Guelph were provided by the Planning Department in 2009. The codes were then matched to properties with roll numbers in order to potentially identify additional land use information through the code descriptions provided to each property.

Storm Water Facility Inventory (2008)
A list of the storm water facilities including storm water management ponds was provided by the City of Guelph in 2009. Both a GIS file and an excel spreadsheet were made available with information about the storm water management ponds including pond name, location, in some cases drainage area and when the pond was constructed. This file was based on data collected in 2008.

MPAC Municipal Connect™ Database
MPAC's Municipal Connect™ database provides detailed information about properties in Ontario. The data ranges from taxation information, area of property and buildings on the property, a property code and description of land use, soil type and ownership information.

Technical Safety and Standards Association (TSSA)
The Fuels Safety Division of the TSSA provides information related to the storage and handling of fuels at current of historical operational fuel storage sites or sites. TSSA can provide information on outstanding instructions, incident reports, fuel oil spills and contamination records related to current or historical operational fuel storage sites.
.
It should be noted that the Fuels Safety Division did not register private fuel underground or above ground storage tanks príor to January 1990 or furnace oil tanks prior to May 1, 2002. Also, the Fuels Safety Division does not register private waste oil tanks in apartments, office buildings, residences etc., or above ground gasoline or diesel tanks.

Table B1: Uncertainty scores for Data Sources

DataSource	Uncertainty_Score
Agriculture_Field_Survey	1
ANDR	1
Arkel_PCI_Inventory	2
CHEM	1
City of Guelph	0
COAL	1
EBR	1
FST	1
Fuel_Storage	1
GEN	1
Guelph Quadrant reports	2
Hazardous_Waste_Gererators	1
MANUAL	2
MOE_Site_Record	2
MPAC Municipal Connect	0
Municipal_wells	2
NAICS_misc	2
NPCB	1
NPRI	1
Oil_and_Gas	1
OPCB	1
PES	1
REC	1
Salt_Storage	1
Scotts_Data	1
SCT	1
Septic_Systems	2
Sources	2
Storm Water Inventory	0
TSSA	1
UST_Data	1
WHPA Field Survey	2
Windshield_Survey_July_08	2

Appendix C. Threats Inventory Database

Appendix C – Threats Inventory Database

C1 Approach

To create a database to store and query all the relevant data sets for the City of Guelph Threat Assessment.

C1.1 Background

AquaResource, Stantec and SSPA had created a database for warehousing the various activities within the areas of concern that were potential threats to source water in 2007. The main data source for that activity was acquired from previous work done by Golder Associates Ltd. (2006 (a) and (b)) which contained an EcoLog ERIS search dataset from 2002. Data from other sources (such as the City of Guelph), was also contained within the database (e.g. sanitary sewer pipe segments and salt storage facilities). This data was used in conjunction with capture zone mapping to assign North American Industry Classification System (NAICS) codes to properties and assign threats. Due to the lack of comprehensive information within the data set, the NAICS codes assigned were generally not to the level of detail that was required to make a decision with certainty, regarding the threat for the specific property. Lessons learned from that exercise, including improving reliability and completeness of the datasets, were used in the current assignment.

C1.2 Data Sources (Historical Data / New Data)

For this round of data collection, Stantec chose to employ a centralized and sequential approach to data compilation. The primary dataset driving the whole activity was the parcel/tax roll number dataset that was made available by the City of Guelph to Aqua Resource and Stantec in 2008. The AquaResource, Stantec and SSPA (2007) dataset (Historical) that was compiled for the previous business/properties was then linked to the tax roll number dataset using parcel information/coordinates. Locations that matched were added to the new database. As coordinates were not always reliable, steps of “fuzzy” matches and manual quality control (QC) to verify the locations were performed using addresses, company names, and owner names. This added a sizable amount of data (locations) to the main database. Subsequently, a similar approach was employed to add the acquired EcoLog (2008) dataset and verify matching. For a complete list and details of data acquired for the 2009 database, see Appendix B.

C1.3 Database Structure

The database structure was kept simple but comprehensive. For an illustration of the tables and relationships that are contained within the database, refer to Figure C2 for the database schema. One main table that organized the database was DT_LOCATION_MASTER. It contained a unique listing of all the properties of interest including their coordinates, vulnerability zones and roll numbers that were identified by a unique identification (LOC_ID). This was then related to various tables that contained the information that was acquired from Historical sources, EcoLog 2008 and TSSA. Also, if the information was acquired manually by visiting the properties (i.e., such as the limited agricultural survey in 2009), it was maintained in its own table. All these tables contained a field called Meta_Comment which presented information about the source of the dataset and also served as an inventory of changes made to each individual record. The data tables also contained a User_Comment field which was used for documenting any information used for assigning threats. Reference tables were used to normalize the data tables and control vocabulary and valid values. The threats and circumstances that were used for threat allocations were stored using associative tables (e.g. at_location_threats).

See Figure C1 below for a diagram illustrating data acquisition and flow through the database.

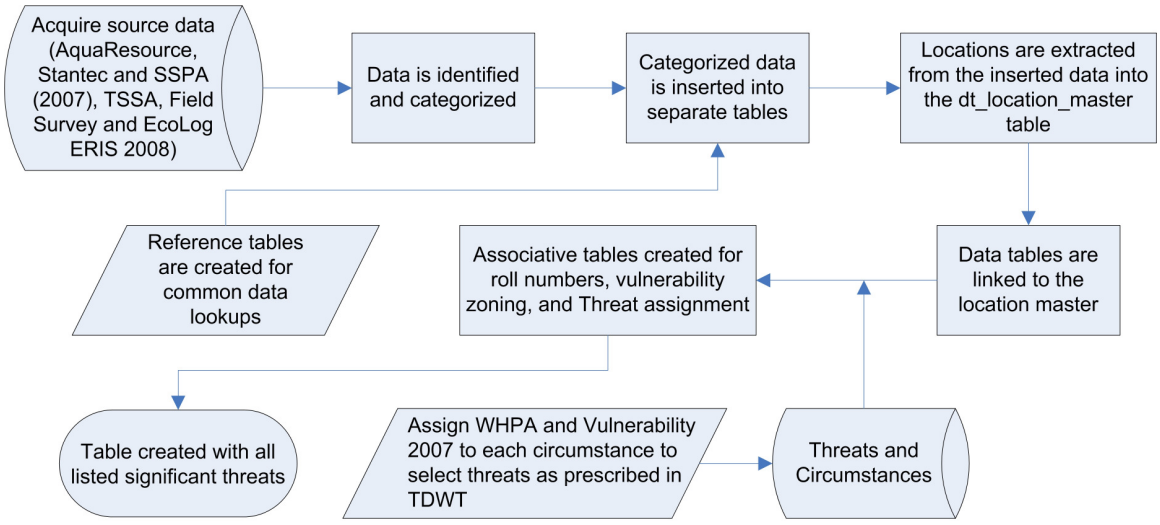


Figure C1 – Database flow Diagram

C1.4 Data Integrity

For maintaining database integrity, the database was designed using one primary table for all locations. This table contained all the locations that were of concern and had unique entries. In order for the dataset to be complete and accurate, thorough QC was performed on the datasets comparing the existing data to the source files. The Historical dataset had duplicate information that needed to be resolved. EcoLog (2008) also had many data sources, and information from all of the datasets was to be preserved for threats assignments. The duplicate information in the Historical dataset and Ecolog 2008 dataset was eliminated through a variety of sequential queries that retrieved records of identical locations and closely matched descriptions. Even though this task was automated and efficient, it failed to rid the database of all the duplicates. Subsequently, manual QC of the database was undertaken to reduce the number of records to be analyzed for threats allocations. The records were grouped by parcel and then compared individually to eliminate remaining extraneous entries. The automated and manual cleanup reduced a collection of nearly 37,000 total records down to just over 10,000 unique master records.

The EcoLog (2008) database was imported completely and provided information from various sources (see Appendix B). The database application interface was designed to show the various data sources linked to locations so as to qualify a location as a potential threat based on correct and detailed information. Even using this rigorous method resulted in incomplete information being available to assist in making the decisions. Stantec then relied on other sources such as physical knowledge of the area, online maps and Municipal Property Assessment Corporation (MPAC) data to verify the locations and property information.

C1.5 Data Import and Filtering Methodology

As noted above, several different datasets were imported and filtered for the database. The major datasets that were incorporated are described below.

Locations:

The locations for the properties in the DT_LOCATION_MASTER table were confirmed as being of relevance and within the municipalities concerned based on coordinate over lay of the vulnerability mapping from AquaResource (2009). The areas and municipalities outside of the subject area (maximum extent or WHPA D) were removed from the dataset. Locations that were exact matched between the tax roll number dataset and the Historical dataset were subsequently appended to the main database. The next step involved importing locations from the Historical dataset with direct matches. The remaining locations were added based on tax roll number approximate string matches ("fuzzy" matches) on business names and coordinates within 10 meters. Subsequently,"fuzzy" matches on business name and address were also performed.

In order to clean up the dataset resulting form this exercise, automated removal of duplicates was performed based on matching property / business names and addresses. The database personnel and senior reviewer, then performed manual quality checks and removed subsets of records with matching addresses. Also, the dataset was cleaned up by relating the locations to correct numbers based on most current information and updating datasets that were acquired from the Historical dataset. Finally, the centroids for the final set of locations were updated based on tax roll numbers, if available, or by the existing approximate coordinates. If tax roll numbers were not available, fake roll numbers were assigned to properties with known coordinates and/or civic addresses.

Historical data for Threats:

The Historical dataset that was compiled in 2007 and contained datasets from several sources. In order to process the information from that dataset in accordance with the database layout and threat allocation methodology employed for this work, the Historical dataset was parsed into individual tables based on ThreatFeatureType. For example, dry cleaning locations were appended to DT_DNAPL, and livestock operations were appended to DT_AGRICULTURE.

For the 2009 work program, review of the 2007 data sets was completed to determine if any data sets did not provide recent and/or useful data for the threats allocation program. Based on the review, it was determined that the Ecolog ERIS 2002 search data was out of date and not of value, and was therefore not linked (not reported) to the 2009 datasets. It was also determined that the Yellow Pages business listing dataset from 2007 was also out of date and did not provide useful information, and therefore was not be linked (not reported) to the 2009 datasets.

EcoLog 2008:

EcoLog ERIS provided the 2008 dataset to Stantec in a pdf format. However, in order to improve the usability if the dataset and to enable data queries, the EcoLog pdf reports were processed using Optical character recognition (OCR) software and converted to MS Excel™ spreadsheets. Subsequently automated macros were used to flatten the datasets. These were then normalized using reference tables and imported into the main database. Locations from the EcoLog 2008 database were then appended to DT_LOCATION_MASTER based on methodology described above.

TSSA:

TSSA records were provided as hard copies. This data was not usable in this format. As such, data from the TSSA dataset were manually entered into the main database using an entry form

as shown below in Figure C3. This was then related to the main location table and queried as remaining data tables.

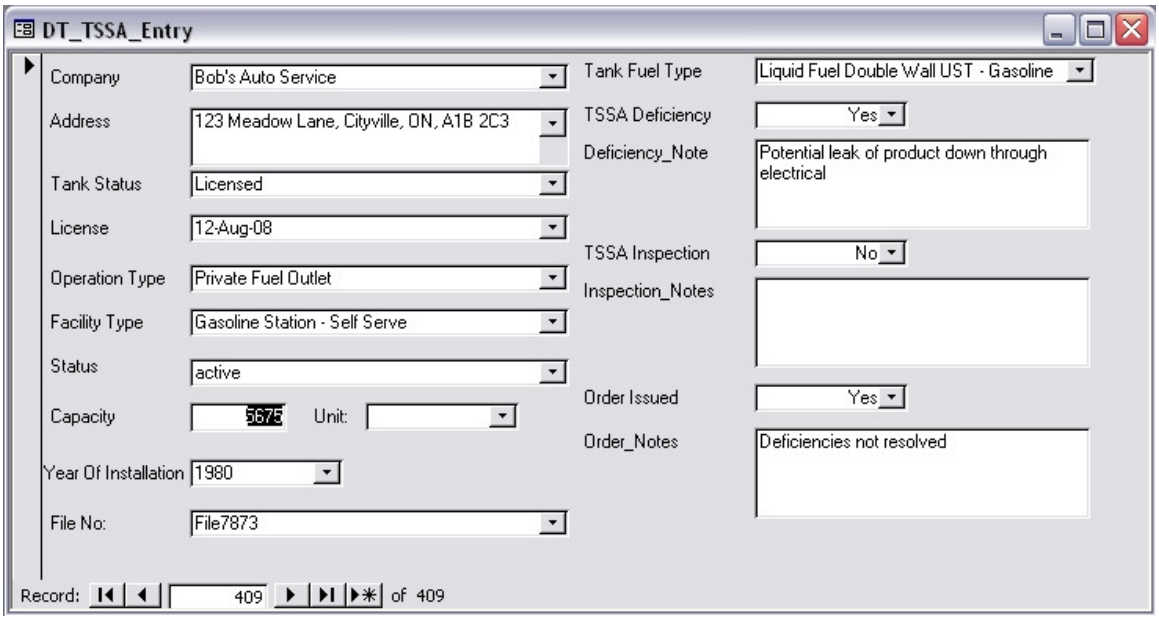


Figure C3 – Entry Screen for TSSA records.

Agricultural Properties (Roadside Survey):

For the agricultural facilities, a limited roadside survey was conducted in 2009 to obtain information regarding the presence of livestock and agricultural activities. Data from these surveys were then manually inputted into DT_AGRICULTURE through an input form similar to the TSSA form presented in Figure C3 as above.

2009 Vulnerability Mapping

Initial threat allocations were completed using 2007 vulnerability mapping as a first attempt at threat enumeration. Upon receiving AquaResource (2009) vulnerability mapping for these zone identifiers was updated and a query of the differences was completed so threat enumeration could be updated with 2009 mapping. Once threats were re-enumerated, they were cross checked for at least 20% of the properties to determine that threat assignments had been completed and were appropriate for the 2009 vulnerability scores. For all reportable locations within vulnerability zone 8+ without threat assignment, a threat assignment of “no significant threats identified” and a user comment of “Insufficient data to allocate threats” was entered. Data was also queried for all DNAPL assigned threats to check if circumstances still applied in 2009 vulnerability zones. The threat and circumstance allocations based on 2007 mapping were then deleted where those threats were no longer applicable using the 2009 zoning maps.

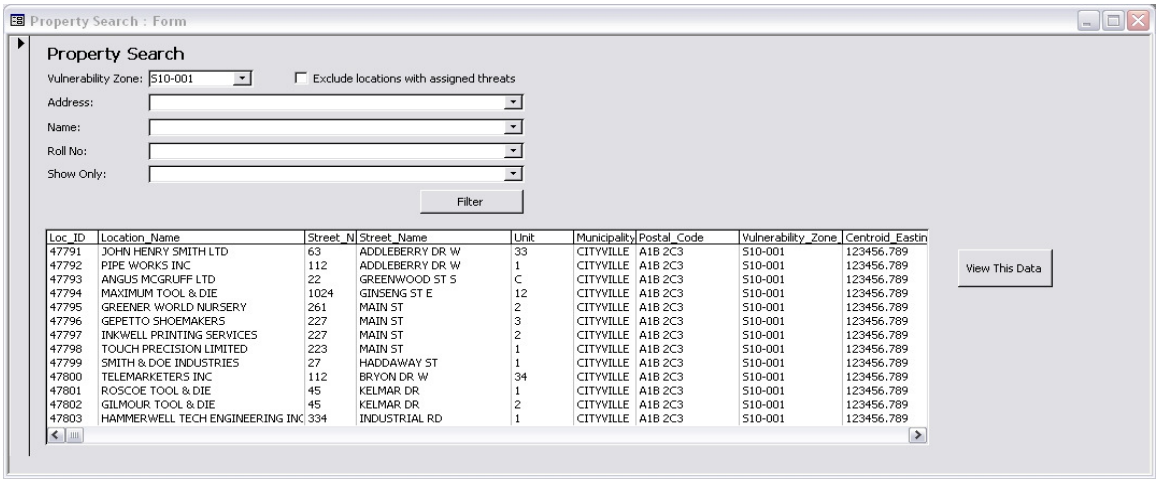
C1.6 Threat Selection Logic

The Tables of Drinking Water Threats (TDWT) (MOE, 2008) pdf file was processed using Optical character recognition (OCR) software and converted to MS Excel™ spreadsheets. A macro was written in MS Excel™ to use pattern recognition to compress the data tables into a flat format. The unique circumstance descriptions were used to populate an RT_CIRCUMSTANCE table. The unique threat descriptions were then used to populate an RT_THREAT table. The full flat file was imported into AT_CIRCUMSTANCE_ZONE, creating a unique record per "circumstance + zone + threat" combination for each property. For each record, the threat ranges were then populated for significant, moderate and low.

The result was when data for each property was viewed; available threats and circumstances were filtered by the selected zoning, matching the individual property's zone vulnerability to the significant ranges in AT_CIRCUMSTANCE_ZONE.

C1.7 Application Interface

The interface was created on a similar premise as the database. Locations were selected by groupings such the vulnerability zone identifiers (Figure C4). Records marked as not reportable were not returned, nor are any records not containing associated data. From the list, all the properties that had been filtered by the zone identifier, a property could be selected and the "View This Data" button returned the records from the associated tables for that property.



Loc_ID	Location_Name	Street_N	Street_Name	Unit	Municipality	Postal_Code	Vulnerability_Zone	Centroid_Eastin
47791	JOHN HENRY SMITH LTD	63	ADDLEBERRY DR W	33	CITYVILLE	A1B 2C3	510-001	123456.789
47792	PIPE WORKS INC	112	ADDLEBERRY DR W	1	CITYVILLE	A1B 2C3	510-001	123456.789
47793	ANGUS MCGRUFF LTD	22	GREENWOOD ST S	C	CITYVILLE	A1B 2C3	510-001	123456.789
47794	MAXIMUM TOOL & DIE	1024	GINSENG ST E	12	CITYVILLE	A1B 2C3	510-001	123456.789
47795	GREENER WORLD NURSERY	261	MAIN ST	2	CITYVILLE	A1B 2C3	510-001	123456.789
47796	GEPETTO SHOEMAKERS	227	MAIN ST	3	CITYVILLE	A1B 2C3	510-001	123456.789
47797	INKWELL PRINTING SERVICES	227	MAIN ST	2	CITYVILLE	A1B 2C3	510-001	123456.789
47798	TOUCH PRECISION LIMITED	223	MAIN ST	1	CITYVILLE	A1B 2C3	510-001	123456.789
47799	SMITH & DOE INDUSTRIES	27	HADDAWAY ST	1	CITYVILLE	A1B 2C3	510-001	123456.789
47800	TELEMARKETERS INC	112	BRYON DR W	34	CITYVILLE	A1B 2C3	510-001	123456.789
47801	ROSCOE TOOL & DIE	45	KELMAR DR	1	CITYVILLE	A1B 2C3	510-001	123456.789
47802	GILMOUR TOOL & DIE	45	KELMAR DR	2	CITYVILLE	A1B 2C3	510-001	123456.789
47803	HAMMERWELL TECH ENGINEERING INC	334	INDUSTRIAL RD	1	CITYVILLE	A1B 2C3	510-001	123456.789

Figure C4 – Property Search Form to select locations of interest.

The associated data to these locations was shown on a separate tab listed by tables (Figure C5). The user could then peruse the information available and assign threats and circumstances on the following tab with user specific comments.

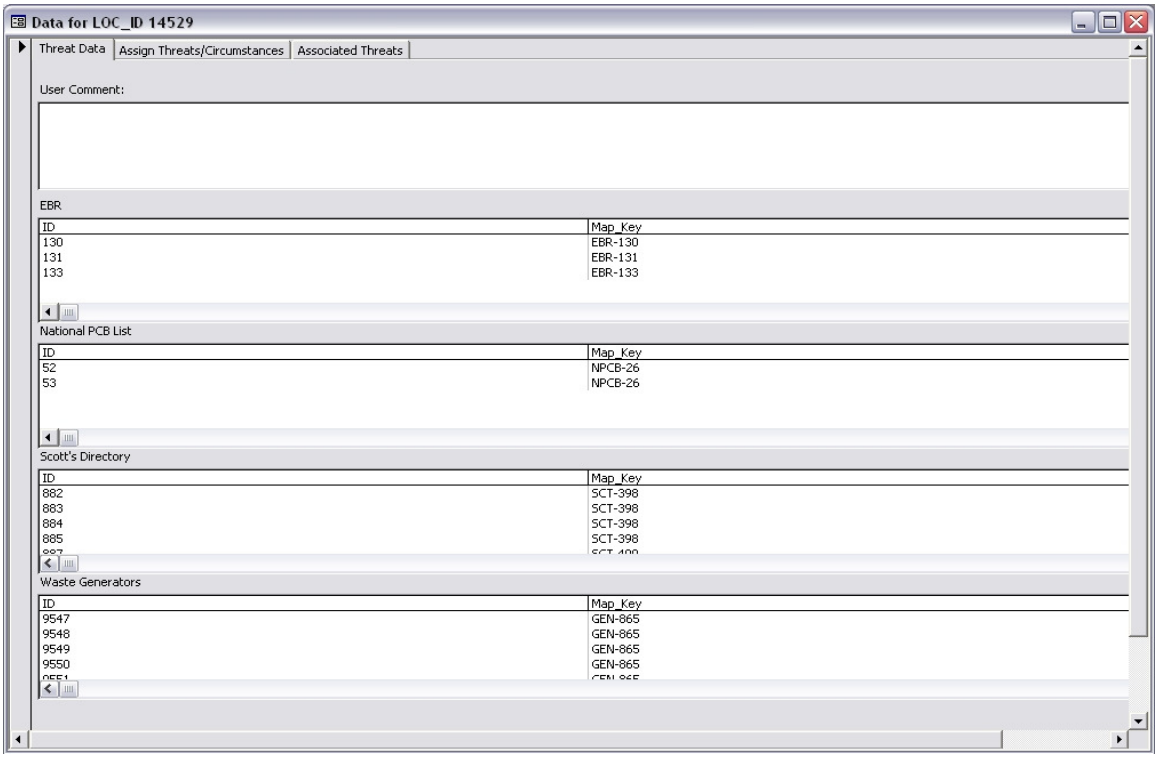


Figure C5 – Threat Data form displaying the various data sources by table.

As seen below in Figure C6, the threat and circumstance assignment could be made using the drop down functionality. User comments could be added to the each threat assignment to provide reasoning for the threat selection. As noted in Section C1.6 above, the user could only select the threats and circumstances as presented in the TDWT (MOE, 2008) that were applicable for the specific WHPA/IPZ and vulnerability zone for the specific property. When completed, users could easily assess which circumstances were applied by going through the Yes/No flag as presented below.

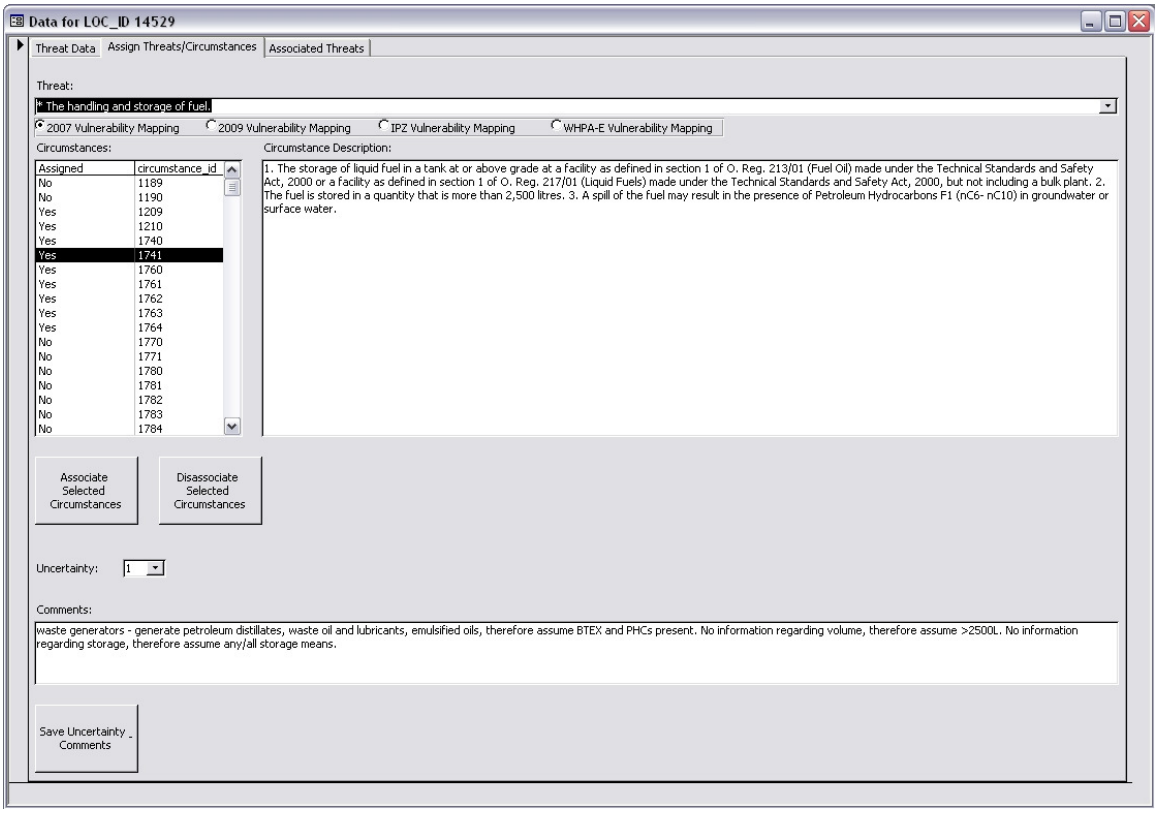


Figure C6 – Assign Threat/Circumstances form to assign Circumstances based on available information in the Threat Data form.

The assigned threats were then summarized in a separate tab as seen in Figure C7.

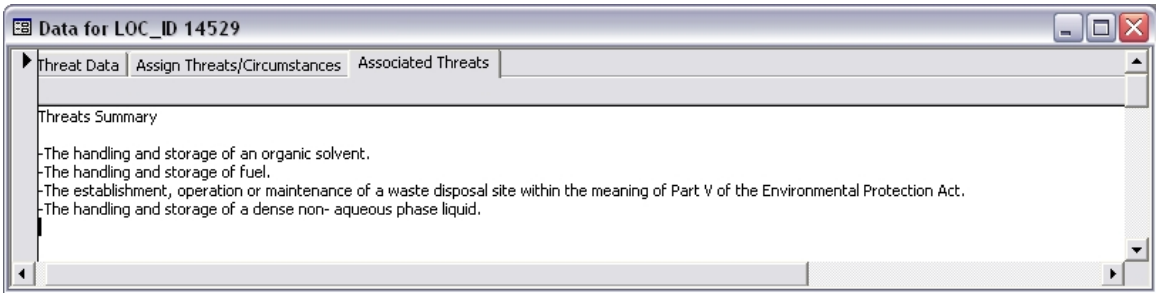


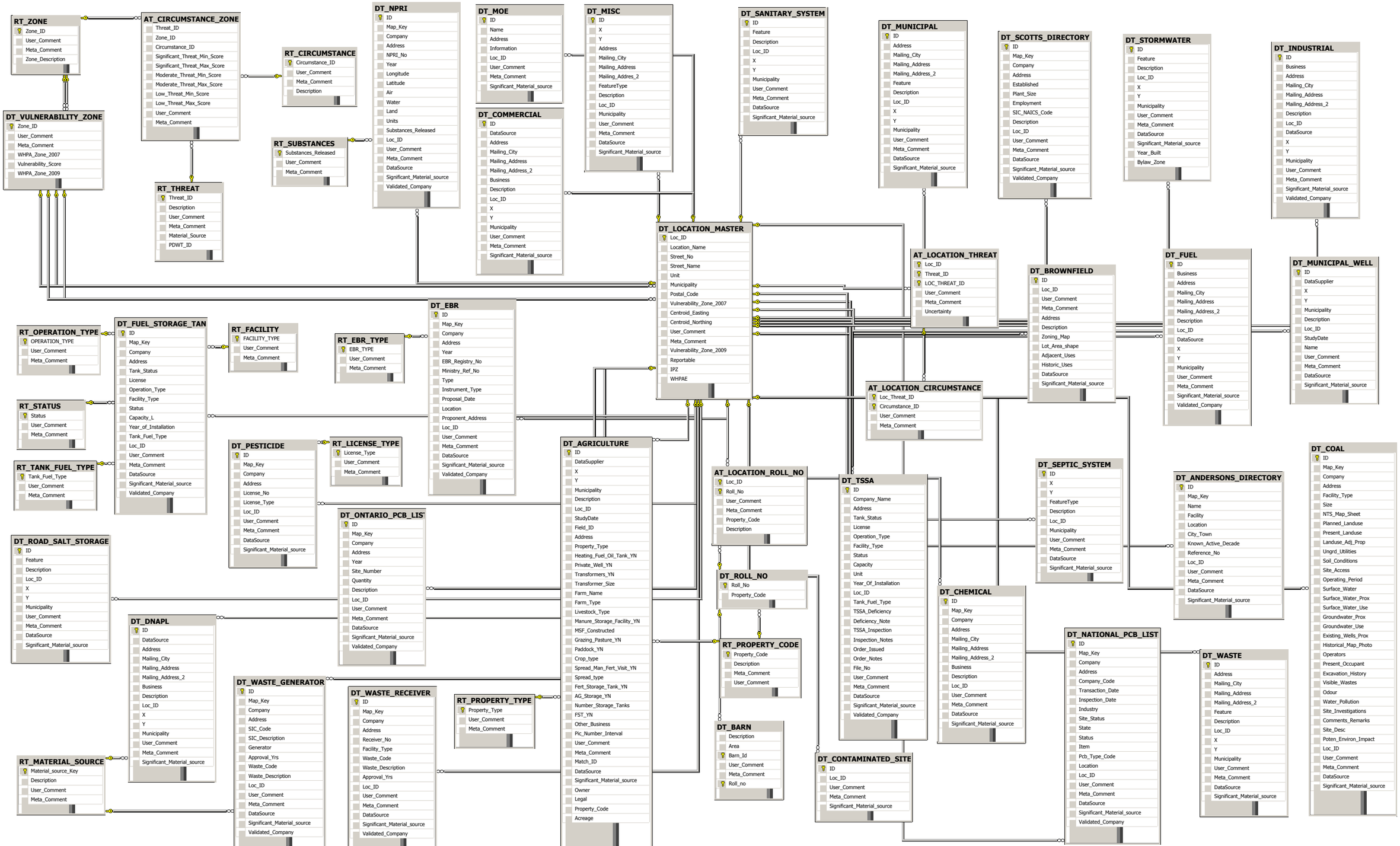
Figure C7 – Associated Threats list all the threats that have been assigned based on circumstance assignments in the previous form.

As the database is in MS Access™, queries and reports were written to acquire necessary information and to provide summaries. The final product was a summary table for all threat assignments generated using the database.

C1.8 Database Maintenance and Updates

As this database contains static data, it is envisioned that the City of Guelph will be appending additional available data and edit the database as property uses change. With that vision, each data set from EcoLog (2008) has been kept in separate tables. This will make the task of compiling and cleaning the future datasets more efficient. Additionally, the location information such as tax roll numbers or vulnerability zones may change in the future and may require updates. Again, the one primary location table will make the task of updates to the database easier and more efficient.

FIGURE C2 - Database Schema



Appendix D. Managed Land Percentages, Nutrient Units and Percent Impervious Areas

Managed Lands and Agricultural Based Threats

Unlike activity based threats such as 'handling and storage of fuel' which were determined on a parcel by parcel basis, land use based threats such as 'application of fertilizer to land' were determined based on the Revised Technical Memorandum from GRCA, dated September 23, 2009 (GRCA, 2009) by using the vulnerable area land segments. The threats captured by land use based analysis are predominantly agricultural in nature and are dependent on the calculation of managed lands and/or nutrient units, these threats include:

- The application of agricultural source material (ASM) or non-agricultural source material (NASM) (percent managed land and nutrient units per acre);
- The application of commercial fertilizer;
- The use of land as an outdoor confinement area or a farm-animal yard (nutrient units per hectare);
- The use of the land as livestock grazing or pasture land (nutrient units per acre); and
- Storage of agricultural source material (nutrient units per acre).

Therefore, in order to determine if any of the five threats were significant for WHPAs or IPZs for the City of Guelph, the following approach to the threat allocation was taken:

1. Completion of determination of percent managed lands for agricultural and non-agricultural lands within the WHPAs and IPZs for the City of Guelph;
2. Calculation of nutrient units (NU) based on barn size and livestock information available for farms identified in the WHPAs and IPZs for the City of Guelph;
3. Enumeration of the significant threats based on the new guidance and the results of points 1 and 2.

Estimation of the Percent Managed Lands

This task was undertaken using aerial photograph and GIS-based image classification to determine the percentages of agricultural and non-agricultural managed lands for each WHPA and IPZ for the City of Guelph.

The digital image classification exercise identified the entire area of interest for the percent managed lands in each WHPA or IPZ. This exercise involved counting the number of green coloured pixels in an area to allow for calculation of the entire area that was green (this is henceforth referred to as 'green pixilation'). Details of how the image classification exercise was carried out and QA/QC for this exercise are presented below. After the image classification had calculated the total area of green space, zoning information from the City of Guelph Planning Department (2009) was overlaid with the WHPA/IPZ area to aid in the determination of the type of land use (agricultural or non-agricultural) within each WHPA/IPZ. As per GRCA (2009), in locations where a portion of a parcel touched or crossed a WHPA or IPZ boundary, the entire parcel was included in the percent managed land calculation, and the area including the entire parcels was used as the denominator in said calculation. Additionally, the Ontario Ministry of Natural Resources (MNR) Base Map (2009) was used to subtract greenspace (i.e. woodlots, wetlands, etc) from the total area of green pixilation. It should be noted that for WHPAs C and D, this exercise was only carried out for areas of vulnerability scores 6 or greater, as per the GRCA (2009).

Once the area of managed lands was determined with the method presented in this appendix and as described above, all of the areas of agricultural and non-agricultural managed lands were

tabulated. Then the following calculations were done to determine the percentage of managed lands for each WHPA and IPZ:

Eq'n 1: Percent Agricultural Managed Land = $\frac{\text{Area of Agricultural Lands } (m^2)}{\text{Total Area of WHPA/IPZ } (m^2)}$

or

Eq'n 2: Percent Non-Agricultural Managed Land = $\frac{\text{Area of Non-Agricultural Lands } (m^2)}{\text{Total Area of WHPA/IPZ } (m^2)}$

Note that non-agricultural lands were comprised of lawns on residential, commercial, industrial and institutional properties as well as golf courses and lawn space that fell into a category of Other (e.g. boulevards and unspecified grassed areas).

Estimation of Nutrient Units

In GRCA (2009), Nutrient Units are expressed as:

"The number of animals housed, or pastured, at one time on a Farm Unit, that generate enough manure to fertilize the same area of crop landbase under the most limited of either nitrogen or phosphorus as determined by OMAFRA's Nutrient Management (NMAN) software."

Or in the case where no animals are housed:

"The weight or volume of manure of other biosolids used annually on a Farm Unit, that fertilizes the same area of crop landbase under the most limited of either nitrogen or phosphorus as determined by OMAFRA's Nutrient Management (NMAN) software."

In order to complete the determination of nutrient units (NU) for WHPAs and IPZs for the City of Guelph, several methods were used, including incorporating data from a limited field survey of agricultural properties. The following sections summarize the methods used.

Stantec undertook a limited field survey in May 2009 of agricultural properties located within the 2007 vulnerability zones 8 and 10 in WHPA A and B as presented in AquaResource, Stantec and SSPA (2007). The number of properties where a limited field survey form was completed was 42. Where possible, livestock and livestock handling information was recorded from the roadside surveys that were completed. The number of properties where livestock operations were observed was 17. This information was then compiled with data from the 2007 Guelph database for agricultural properties and was linked to tax roll information in the 2009 database. Properties within the City of Guelph and County of Wellington boundaries were then additionally queried by tax roll number in MPAC Municipal Connect ™ and information including barn size, potential livestock operations data (such as type of livestock on-site) and acreage of each available property were extracted and added into the database for applicable properties. For properties within the Town of Milton boundaries, an aerial photograph analysis was completed to identify the areas of barns on each applicable agricultural property. Access to MPAC Municipal Connect ™ was not available for the Town of Milton, and, as such, additional information about potential livestock operations on the properties could not be obtained.

Based on the compilation of the field survey information and the database information, significant data gaps were found regarding properties with livestock operations in the WHPAs and IPZs. The following number of limited properties were identified as having sufficient data (i.e. barn size information and the type of livestock present) to undertake a nutrient unit calculation:

- 0 properties in WHPA A;
- 12 properties in WHPA B;

- 3 properties in WHPA C;
- 2 properties in WHPA D;
- 0 properties in IPZ 1;
- 5 properties in IPZ 2; and
- 1 property in WHPA E.

Given the limited data, to be conservative and determine an initial assessment, the nutrient units were calculated based on barn size using the Barn/Nutrient Unit Relationship Table in GRCA (2009).The calculation used to determine the nutrient units per WHPA or IPZ is as follows:

Eq'n 1: Barn Area (m^2) / $m^2/NU_{Livestock}$ = Total NU (sum all NU per WHPA or IPZ if more than one property available)

Eq'n 2: Total NU / Acreage of Agricultural Lands in WHPA or IPZ = NU/Acre for WHPA or IPZ

Note that the largest barn and highest nutrient generating animal, if more than one type of livestock was identified on the property, were used to estimate the number of nutrient units on each property.

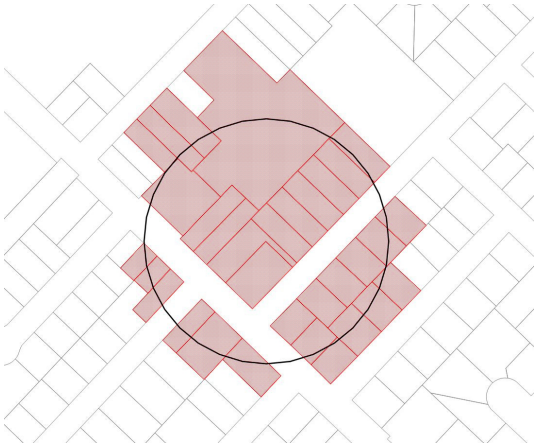
Estimates of nutrient units were not completed for properties that did not have sufficient data (i.e. no information regarding livestock type), and these were identified as a data gap.

Percent Managed Lands Calculations:

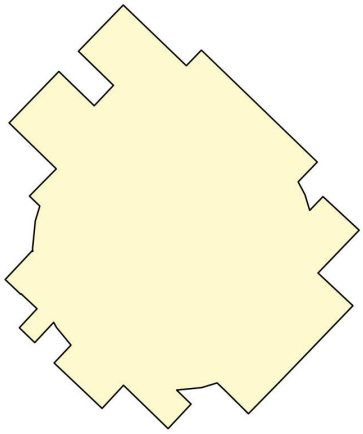
Problem: To determine the percentage of managed lands in urban and rural areas within each WHPA zone.

Approach: By querying the pixel colour values of the aerial imagery, the approximate area of managed lands can be calculated.

1. Using 2009 vulnerability mapping (AquaResource, 2009), perform a spatial query to determine which parcels are touching a WHPA, as per the GRCA Technical Memorandum dated September. 23, 2009 (GRCA, 2009). If a portion of the lot was touching the WHPA boundary, then the entire lot was included in the managed lands area calculations. For WHPA B, C, D and E zones, as well as IPZs 1 and 2, only areas with vulnerability scores >= than 6 were used.



2. The selected parcels were merged to form a single polygon that was used as the extents of the pixel query.



3. The GRCA aerial photography imagery was then clipped to the extent of the WHPA and touching parcels.

4. A query of the pixels of the clipped aerial image that fall within the range: Red = 50 to 145, Green = 70 to 140, and Blue = 20 to 105 was then completed. The range was chosen so that it would query a good representation of the managed lands. If the range becomes too low, it may select shadows, marshy water bodies, and roof tops. If the range was too high, then the query may select driveways, roads, and sidewalks.

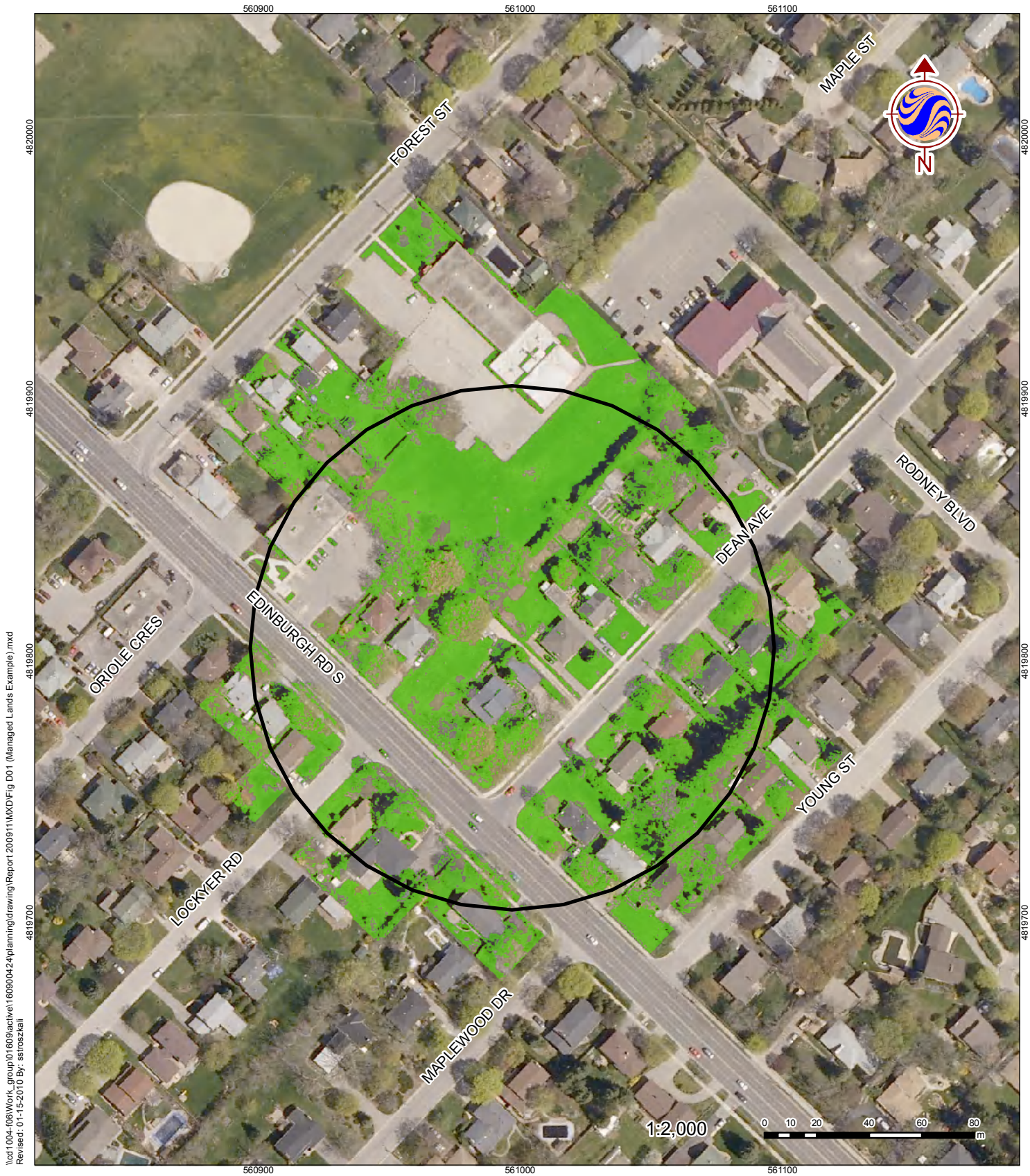
5. The selected pixels were copied to a new image, all the pixels are converted to black (Red = 0, Green = 0, Blue = 0), and then using Manifold's (Version 8) auto-digitizing feature, all the black pixels are digitized to a polygon feature (See Figure D1).

6. Using the Ministry of Natural Resources' water body and wooded areas GIS data (Ministry of Natural Resources Ontario Base Map, © Queen's Printer for Ontario, 2009), as well as the GRCA's wetlands GIS data (GRCA, 2009a), areas were clipped out from the resulting Managed Lands polygon, as wooded areas, wetlands, and water bodies would not be considered managed lands. (i.e. not areas where nutrients would be applied).

7. The Managed Lands polygon was overlaid with the parcel fabric which contains zoning data (City of Guelph (2009), Township of Puslinch (2009), Township of Guelph-Eramosa (2009), Town of Milton (2009)) in order to merge the zoning information with the managed lands polygons.

8. The resulting polygon contained multiple polygons with similar zoning (i.e. there will be multiple polygons for managed lands in residential zones, commercial zones, etc). Therefore, the polygon areas was "dissolved" by zoning and the sum the areas of each polygon. The result were a single area calculation (in square metres) for each zoning type (i.e. Agricultural, Commercial, Golf Course, Industrial, Rural Industrial, Institutional, Residential Rural Residential, and Other / Unknown).

The data from each zoning type for each WHPA was then tabulated in Table D1. Calculation of percent managed lands were then completed for the percent non-agricultural, the percent agricultural land and the total percent agricultural land over the entire WHPA area.



\\cd1004-f06\Work_group\01609\active\160900424\planning\drawing\Report 200911\MXD\Fig D01 (Managed Lands Example).mxd
Revised: 01-15-2010 By: sstroszkali

January 2010
160900424

Stantec

Legend

Area of Managed Lands Based on Pixelation Exercise

Capture Zones

Zone A

Notes

1. Coordinate System: UTM Zone 17 NAD 83.
2. Orthoimagery provided by the Grand River Conservation Authority. Flown by First Base Solutions, 2006.
3. Capture Zones provided by AquaResource, 2009.

Client/Project
City of Guelph
Water Quality Assessment Report

Figure No.
D1

Title
Example of WHPA-A Managed Lands Pixelated Area

Table D1 - Calculations of Managed Lands Area Based on Pixilation Exercise

Managed Lands Area by Land Use (sq m)

WHPA	WELL FIELD	TOTAL AREA	AGRICULTURAL	INSTITUTIONAL	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	OTHER/UNKNOWN	PARK / OPEN SPACE	URBAN RESERVE	FLOODWAY	OFFICE-RESIDENTIAL	*Total Managed lands*	*% Non-Ag Lands*	*% Ag Lands*	*Total % Managed Lands*
	BURKE	269,160.00		1.80	3,287.78			6,588.35		4,594.34			*14,472.28*	*5*	*0*	*5*
	CALICO	473,676.00	48,956.12			1,157.14	2,931.27	10,131.11					*14,219.53*	*3*	*10*	*13*
	CLYTHE CREEK	254,546.00			2.55	62.53	8,457.44	4,592.38		9,826.06	7,864.81		*30,805.76*	*12*	*0*	*12*
	DEAN AVE.	45,774.00		5,117.48	12,120.52	259.12		1,134.32					*18,631.44*	*41*	*0*	*41*
	DOWNEY RD.	200,975.00			2,614.23			105.60		4,894.80			*7,614.64*	*4*	*0*	*4*
	EDINBURGH	54,319.00			8,224.35	290.66	3,491.48	935.23					*12,941.73*	*24*	*0*	*24*
	EMMA	43,435.00			13,131.25			1,193.16					*14,324.40*	*33*	*0*	*33*
	HELMAR	1,066,044.00	27.99		45.21			1,709.76		187,963.32			*189,718.29*	*0*	*0*	*0*
A	MEMBRO	106,080.00		4,862.31	14,116.53		2,646.95	1,458.91		14,871.61	7,536.01		*45,492.32*	*43*	*0*	*43*
	PAISLEY	58,228.00			1,746.86			168.48	9,965.91				*11,881.25*	*20*	*0*	*20*
	PARK	67,783.00		7,190.60	14,769.05			1,198.02				0.68	*23,158.35*	*34*	*0*	*34*
	QUEENSDALE	35,793.00			9,243.18			1,671.03					*10,914.21*	*30*	*0*	*30*
	SACCO	113,856.00				10,795.92	16,953.17	1,141.40					*28,890.49*	*25*	*0*	*25*
	SMALLFIELD	117,911.00					26,156.09	379.00					*26,535.09*	*23*	*0*	*23*
	UNIVERSITY	644,985.00		140,810.10	20,218.21	39.66		2,490.66					*163,558.63*	*25*	*0*	*25*
	WATER ST.	58,697.00		8,025.18	7,587.90			1,139.28			18.46		*16,770.82*	*29*	*0*	*29*

WHPA B		TOTAL AREA	AGRICULTURAL	INDUSTRIAL	COMMERCIAL	INSTITUTIONAL	RESIDENTIAL	OFFICE-RESIDENTIAL	URBAN RESERVE	OTHER/UNKNOWN	PARK / OPEN SPACE	GOLF COURSE	*Total Managed Lands*	*% Non-Ag Lands*	*% Ag Lands*	*Total % Managed Lands*
		132,865,022.80	6,606,376.94	1,002,315.51	345,999.53	1,431,582.58	6,893,921.50	31,105.56	502,023.17	3,570,629.88	1,313,874.47	221,367.73	*21,919,196.87*	*12*	*5*	*17*

WHPA C		TOTAL AREA	AGRICULTURAL	INDUSTRIAL	COMMERCIAL	INSTITUTIONAL	OFFICE-RESIDENTIAL	RESIDENTIAL	URBAN RESERVE	OTHER/UNKNOWN	PARK / OPEN SPACE	*Total Managed Lands*	*% Non-Ag L*	*% Ag L*	*Total % Managed Lands*
		48,238,023.24	25,093,803.78	359,262.77	123,943.39	182,997.43	11,892.83	1,054,643.87	72,998.18	473,021.26	95,502.36	*27,468,065.87*	*5*	*52*	*57*

WHPA D		TOTAL AREA	AGRICULTURAL	COMMERCIAL	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	RURAL RESIDENTIAL	OTHER/UNKNOWN	PARK / OPEN SPACE	*Total Managed Lands*	*% Non-Ag Lands*	*% Ag Lands*	*Total % Managed Lands*
		31,170,152.14	16,051,802.14	2,898.74	7,239.58	95.29	30,273.51	7,239.58	158,366.51	816.89	*16,258,732.24*	*1*	*51*	*52*

WHPA E		TOTAL AREA	AGRICULTURAL	COMMERCIAL	GOLF COURSE	INSTITUTIONAL	RESIDENTIAL	URBAN RESERVE	OTHER/UNKNOWN	PARK / OPEN SPACE	*Total Managed Lands*	*% Non Ag Lands*	*% Ag Lands*	*Total % Managed Lands*
		5,464,187.30	177,113.67	3,262.96	225,767.80	73,350.59	355,857.99	6,427.34	203,495.39	875.00	*1,046,150.74*	*16*	*3*	*19*

	TOTAL AREA	AGRICULTURAL	COMMERCIAL	RURAL RESIDENTIAL	OTHER/UNKNOWN	*Total Managed Lands*	*% Non-Ag Lands*	*% Ag Lands*	*Total % Managed Lands*
IPZ1	4,668,165.65	692,213.14			37.61	*692,250.75*	*0*	*15*	*15*
IPZ2	8,689,501.04	531,144.29	781.69	39,154.63	19,722.12	*590,802.72*	*1*	*6*	*7*

Notes: *WHPA As for Arkell wells and Carter well were comprised of woodlot and greenspace, therefore there was no managed land identified.*

Agricultural Land Use Area

Non-Agricultural Land Use Area(s)

Table D2 - Calculations of Nutrient Units Based on Information From Agricultural Properties with Data on Livestock Operations

loc_id	description	farm_type	livestock	Acreage	barn_desc	barn_area (sqft)	barn area (m)	NU Math	WHPA	WHPA E or IPZ	Livestock type (corresponding to Barn/Nutrient Table below)	WHPA_ZONE ID	WHPA	WHPA-E	IPZ
47690	horse farm / manure	NULL	NULL	14.75	202 - Type Ii Barn	1536	468.29	18.01	B		**Horses**	S08-062	B	NULL	NULL
		NULL	NULL	14.75	203 - Type Iii Uninsulated Barn	1536	468.29	18.01				S08-062	B	NULL	NULL
47691	horse farm / manure	NULL	NULL	22.54	201 - Type I Barn	2816	858.54	33.02	B		**Horses**	S10-065	B	NULL	NULL
47692	Holsteins (OFA)	NULL	NULL	79.7	201 - Type I Barn	4686	1428.66	109.90				S08-062	B	WHPA-E	NULL
		NULL	NULL	79.7	203 - Type Iii Uninsulated Barn	4400	1341.46	103.19				S08-062	B	WHPA-E	NULL
		NULL	NULL	79.7	203 - Type Iii Uninsulated Barn	2240	682.93	52.53				S08-062	B	WHPA-E	NULL
		NULL	NULL	79.7	203 - Type Iii Uninsulated Barn	1080	329.27	25.33				S08-062	B	WHPA-E	NULL
		NULL	NULL	79.7	203 - Type Iii Uninsulated Barn	5200	1585.37	121.95	B	E	**Holsteins**	S08-062	B	WHPA-E	NULL
47735	(sheep farm) and dog kennel / sheep, dogs, horses	LIVESTOCK	Horses	17.98	201 - Type I Barn	1400	426.83	30.49				S10-065	B	NULL	IPZ-2
		CROPS	NULL	17.98	201 - Type I Barn	1400	426.83	30.49				S10-065	B	NULL	IPZ-2
		LIVESTOCK	Horses	17.98	203 - Type Iii Uninsulated Barn	1728	526.83	37.63				S10-065	B	NULL	IPZ-2
		CROPS	NULL	17.98	203 - Type Iii Uninsulated Barn	1728	526.83	37.63	B	2	**Sheep**	S10-065	B	NULL	IPZ-2
		LIVESTOCK	Horses	17.98	203 - Type Iii Uninsulated Barn	799	243.60	17.40				S10-065	B	NULL	IPZ-2
		CROPS	NULL	17.98	203 - Type Iii Uninsulated Barn	799	243.60	17.40				S10-065	B	NULL	IPZ-2
47737	large beef cattle operation / >30 cattle	NULL	NULL	176.9	203 - Type Iii Uninsulated Barn	960	292.68	32.52				S08-020	C	NULL	IPZ-2
		NULL	NULL	176.9	203 - Type Iii Uninsulated Barn	1296	395.12	43.90				S08-020	C	NULL	IPZ-2
		NULL	NULL	176.9	203 - Type Iii Uninsulated Barn	5544	1690.24	187.80				S08-020	C	NULL	IPZ-2
		NULL	NULL	176.9	203 - Type Iii Uninsulated Barn	6400	1951.22	216.80	C	2	**Beef**	S08-020	C	NULL	IPZ-2
		NULL	NULL	176.9	203 - Type Iii Uninsulated Barn	3040	926.83	102.98				S08-020	C	NULL	IPZ-2
		NULL	NULL	176.9	203 - Type Iii Uninsulated Barn	2160	658.54	73.17				S08-020	C	NULL	IPZ-2
		NULL	NULL	176.9	203 - Type Iii Uninsulated Barn	1800	548.78	60.98				S08-020	C	NULL	IPZ-2
47739	private farm	LIVESTOCK	cattle	85.02	201 - Type I Barn	3870	1179.88	131.10	B	2	**Beef**	S08-079	B	NULL	IPZ-2
		LIVESTOCK	cattle	85.02	203 - Type Iii Uninsulated Barn	1600	487.80	54.20				S08-079	B	NULL	IPZ-2
47751	Holstein Farm / manure (30 cows, 12 horses)	LIVESTOCK	Horses	122.06	202 - Type Ii Barn	2040	621.95	23.92				S08-079	B	NULL	IPZ-2
		LIVESTOCK	Horses	122.06	202 - Type Ii Barn	3540	1079.27	41.51				S08-079	B	NULL	IPZ-2
		LIVESTOCK	Horses	122.06	203 - Type Iii Uninsulated Barn	2220	676.83	26.03				S08-079	B	NULL	IPZ-2
		LIVESTOCK	Horses	122.06	203 - Type Iii Uninsulated Barn	2880	878.05	33.77				S08-079	B	NULL	IPZ-2
		LIVESTOCK	Horses	122.06	203 - Type Iii Uninsulated Barn	1368	417.07	16.04				S08-079	B	NULL	IPZ-2
		LIVESTOCK	Horses	122.06	203 - Type Iii Uninsulated Barn	360	109.76	4.22				S08-079	B	NULL	IPZ-2
		LIVESTOCK	Horses	122.06	201 - Type I Barn	4920	1500.00	57.69	B	2	**Horses**	S08-079	B	NULL	IPZ-2
47755	poultry farm	NULL	NULL	32.42	203 - Type Iii Uninsulated Barn	2160	658.54	26.34	B		**Chickens**	S10-065	B	NULL	NULL
		NULL	NULL	32.42	203 - Type Iii Uninsulated Barn	1536	468.29	18.73				S10-065	B	NULL	NULL
47757	Farm (horse farm) / 25 horses, 105 acres of pasture, veterinary services	CROPS	Livestock r	103	203 - Type Iii Uninsulated Barn	1060	323.17	12.43				S08-079	B	NULL	IPZ-2
		CROPS	Livestock r	103	201 - Type I Barn	4920	1500.00	57.69	B	2	**Horses**	S08-079	B	NULL	IPZ-2
		CROPS	Livestock r	103	202 - Type Ii Barn	650	198.17	7.62				S08-079	B	NULL	IPZ-2
47853	private farm / horses, crops	NULL	N/A	N/A	Unknown Barn Type		388.18	14.93	D		**Horses**	S06-028	D	NULL	NULL
47843	private farm / horses, crops	NULL	N/A	N/A	Unknown Barn Type		456.00	17.54	C		**Horses**	S08-020	C	NULL	NULL
47846	Private Farm - cattle farm / 40 cows, 50 pigs	LIVESTOCK	N/A	N/A	Unknown Barn Type		573.61	81.94	B		**Swine**	S10-065	B	NULL	NULL
47835	Private Farms / cattle, sheep	NULL	N/A	N/A	Unknown Barn Type		373.94	41.55	B		**Beef**	S06-126	B	NULL	NULL
47839	private farm / approx 20 cows, 1 donkey	LIVESTOCK	N/A	N/A	Unknown Barn Type		346.69	49.53	B		**cow/calf unknown**	S10-079	B	NULL	NULL
47827	Private Farm (horse boarding/riding instruction) / horses	NULL	N/A	N/A	Unknown Barn Type		1368.67	52.64	D		**Horses**	S04-037	D	NULL	NULL
47831	Private - Horse Vacations and Trail Rides (For Sale) / 30 horses	NULL	N/A	N/A	Unknown Barn Type		132.91	5.11	C		**Horses**	S06-086	C	NULL	NULL
47837	Horse Training Centre - approx. 50 horses	NULL	N/A	N/A	Unknown Barn Type		1919.24	73.82	B		**Horses**	S06-126	B	NULL	NULL

Notes: For farms in Town of Milton (indicated in shaded cells), as barn size was obtained by aerial photograph analysis, only barn size for largest barns on propeties are listed above.

	WHPA	NUs	Nutrient Unit/Acre
NU/ Area ML			
	WHPA B	730.28	0.447
	IPZ 2	500.92	3.817
	WHPA C	239.45	0.266
	WHPA D	67.57	0.049
	WHPA E	121.95	2.786

Areas of Agricultural Managed Lands per WHPA or IPZ

WHPA		Area (sq m)	Area (acre)	Area (hectare)
WHPA-E		177,113.67	43.77	17.71
WHPA B		6,615,383.23	1634.70	661.54
WHPA C		3,638,582.89	899.11	363.86
WHPA D		5,574,847.77	1377.58	557.48
IPZ2		531,144.29	131.25	53.11

From GRCA Revised Tech Memo (2009)
Barn/Nutrient Unit Relationship Table (sq m/NU)

	sq m/NU
Holsteins - pack barn	13
horses	26
cow/calf unknown	7
sheep	14
beef	9
chickens	25
swine	7

Table D3 - Calculations of Percent Impervious Areas

Grid	ImperviousArea (sq m)	Total Area/km^2	% Impervious
1	4,056.85	154.98	3.82%
2	480,722.18	-	0.00%
3	499,116.78	-	0.00%
4	27,461.07	-	0.00%
5	531,229.07	7,268.71	1.37%
6	1,000,000.00	29,622.14	2.96%
7	1,000,000.00	12,830.58	1.28%
8	821,184.70	14,331.85	1.75%
9	164,112.50	-	0.00%
10	304,619.47	-	0.00%
11	997,081.23	14,934.90	1.50%
12	1,000,000.00	39,839.01	3.98%
13	1,000,000.00	54,926.80	5.49%
14	1,000,000.00	7,929.93	0.79%
15	716,651.38	-	0.00%
16	126,021.46	-	0.00%
17	930,612.01	20,877.42	2.24%
18	1,000,000.00	19,608.67	1.96%
19	1,000,000.00	87,409.01	8.74%
20	1,000,000.00	56,169.14	5.62%
21	806,332.94	41,428.97	5.14%
22	111,304.23	-	0.00%
23	430,609.49	11,925.10	2.77%
24	1,000,000.00	10,019.39	1.00%
25	1,000,000.00	89,387.54	8.94%
26	1,000,000.00	115,086.89	11.51%
27	998,075.06	119,121.14	11.94%
28	71,967.35	8,806.04	12.24%
29	155,628.42	11,735.48	7.54%
30	546,469.93	7,461.88	1.37%
31	495,981.67	24,410.65	4.92%
32	31,647.69	173.73	0.55%
33	83,089.59	-	0.00%
34	908,041.40	86,066.73	9.48%
35	1,000,000.00	106,662.33	10.67%
36	1,000,000.00	117,683.09	11.77%
37	1,000,000.00	130,960.68	13.10%
38	868,312.56	79,707.27	9.18%
39	992,692.22	86,968.66	8.76%
40	1,000,000.00	80,126.51	8.01%
41	1,000,000.00	29,027.40	2.90%
42	808,690.50	21,149.09	2.62%
43	173,664.98	-	0.00%
44	636,541.13	15,427.57	2.42%
45	1,000,000.00	31,388.86	3.14%
46	1,000,000.00	140,042.64	14.00%
47	1,000,000.00	143,880.55	14.39%
48	1,000,000.00	148,586.67	14.86%
49	1,000,000.00	118,180.72	11.82%
50	1,000,000.00	119,135.66	11.91%
51	1,000,000.00	113,171.26	11.32%
52	1,000,000.00	34,668.15	3.47%
53	971,219.25	-	0.00%
54	418,637.44	27,535.15	6.58%
55	4,519.00	-	0.00%
56	256,631.65	7,803.24	3.04%
57	510,667.04	9,632.17	1.89%
58	486,901.59	15,594.35	3.20%
59	871,379.04	98,242.13	11.27%
60	1,000,000.00	109,081.66	10.91%
61	1,000,000.00	108,391.25	10.84%
62	1,000,000.00	171,906.81	17.19%
63	1,000,000.00	164,633.00	16.46%
64	1,000,000.00	116,818.22	11.68%
65	1,000,000.00	136,537.88	13.65%
66	1,000,000.00	112,736.20	11.27%
67	1,000,000.00	28,976.93	2.90%
68	1,000,000.00	1,554.82	0.16%
69	510,912.96	8,709.51	1.70%
70	365,609.07	388.34	0.11%
71	1,000,000.00	20,807.12	2.08%
72	1,000,000.00	41,188.96	4.12%
73	1,000,000.00	109,095.60	10.91%
74	1,000,000.00	130,706.31	13.07%
75	1,000,000.00	99,767.93	9.98%
76	1,000,000.00	119,990.50	12.00%
77	1,000,000.00	101,783.10	10.18%
78	1,000,000.00	133,495.23	13.35%
79	1,000,000.00	125,739.23	12.57%
80	1,000,000.00	117,107.61	11.71%
81	813,062.37	17,595.28	2.16%
82	271,717.16	9,777.03	3.60%
83	38,557.18	814.25	2.11%

Table D3 - Calculations of Percent Impervious Areas

84	568.25	8.85	1.56%
85	366,560.91	25,617.31	6.99%
86	1,000,000.00	37,684.03	3.77%
87	995,176.24	41,296.43	4.15%
88	591,552.62	63,219.41	10.69%
89	292,792.16	29,541.59	10.09%
90	86,557.31	7,736.31	8.94%
91	792,200.77	72,597.47	9.16%
92	1,000,000.00	37,775.75	3.78%
93	1,000,000.00	90,798.99	9.08%
94	1,000,000.00	88,660.60	8.87%
95	1,000,000.00	92,240.33	9.22%
96	383,785.30	25,966.10	6.77%
97	117,658.04	12,270.45	10.43%
98	875,876.84	14,557.41	1.66%
99	276,743.15	31,175.02	11.27%
100	359,553.30	28,765.47	8.00%
101	1,000,000.00	59,186.08	5.92%
102	1,000,000.00	20,991.10	2.10%
103	1,000,000.00	51,902.12	5.19%
104	1,000,000.00	75,943.32	7.59%
105	997,526.42	45,759.17	4.59%
106	754,774.66	16,197.23	2.15%
107	223,724.15	4,634.04	2.07%
108	137.19	-	0.00%
109	129,098.33	7,796.98	6.04%
110	544,192.14	1,458.48	0.27%
111	795,543.67	12,983.60	1.63%
112	1,000,000.00	23,401.16	2.34%
113	1,000,000.00	7,757.67	0.78%
114	1,000,000.00	38,814.37	3.88%
115	1,000,000.00	38,729.34	3.87%
116	1,000,000.00	7,076.18	0.71%
117	924,039.76	1,392.26	0.15%
118	125,740.51	4,223.29	3.36%
119	35,817.78	5,052.24	14.11%
120	878,880.38	67,446.53	7.67%
121	1,000,000.00	78,854.35	7.89%
122	1,000,000.00	21,724.45	2.17%
123	1,000,000.00	12,272.97	1.23%
124	1,000,000.00	29,245.50	2.92%
125	1,000,000.00	15,994.63	1.60%
126	1,000,000.00	-	0.00%
127	1,000,000.00	22,881.95	2.29%
128	751,382.19	21,390.21	2.85%
129	525,782.19	15,940.74	3.03%
130	1,000,000.00	64,641.74	6.46%
131	1,000,000.00	48,334.17	4.83%
132	1,000,000.00	47,474.94	4.75%
133	1,000,000.00	17,137.86	1.71%
134	1,000,000.00	16,565.75	1.66%
135	1,000,000.00	5,119.26	0.51%
136	1,000,000.00	11,524.09	1.15%
137	1,000,000.00	11,596.71	1.16%
138	974,829.05	24,426.15	2.51%
139	83,985.59	1,835.43	2.19%
140	257,131.16	7,892.43	3.07%
141	955,375.99	18,912.15	1.98%
142	1,000,000.00	-	0.00%
143	1,000,000.00	5,835.20	0.58%
144	1,000,000.00	35,360.67	3.54%
145	1,000,000.00	2,882.17	0.29%
146	1,000,000.00	-	0.00%
147	1,000,000.00	7,314.11	0.73%
148	1,000,000.00	9,621.84	0.96%
149	1,000,000.00	27,999.84	2.80%
150	252,169.27	7,402.23	2.94%
151	49,311.42	-	0.00%
152	390,233.42	1,517.13	0.39%
153	999,649.18	14,981.46	1.50%
154	1,000,000.00	-	0.00%
155	1,000,000.00	24,636.49	2.46%
156	1,000,000.00	6,881.79	0.69%
157	1,000,000.00	9,304.82	0.93%
158	1,000,000.00	39,448.98	3.94%
159	977,282.08	10,804.15	1.11%
160	7,996.47	-	0.00%
161	777,490.95	3,006.23	0.39%
162	1,000,000.00	14,452.44	1.45%
163	1,000,000.00	10,957.80	1.10%
164	1,000,000.00	18,561.71	1.86%
165	1,000,000.00	21,401.65	2.14%
166	1,000,000.00	31,307.33	3.13%
167	897,533.92	25,873.41	2.88%
168	1,376.35	-	0.00%
169	225,606.90	1,679.44	0.74%

Table D3 - Calculations of Percent Impervious Areas

170	976,566.42	20,029.23	2.05%
171	1,000,000.00	3,188.87	0.32%
172	1,000,000.00	14,585.35	1.46%
173	815,925.19	-	0.00%
174	158,615.06	2,055.80	1.30%
175	38,385.90	-	0.00%
176	228,308.64	3,956.81	1.73%
177	616,262.61	7,404.51	1.20%
178	618,451.97	5,565.22	0.90%
179	124,771.04	891.97	0.71%

Appendix E. Assumption Matrix for Allocating Threats

This table has been set up to mimic the TDWT and to illustrate where assumptions and decisions have been made to enumerate significant threats. The "Circumstances of the Threat Category" column are the circumstances listed in the TDWT. The next column "Site Specific Information or Assumptions Used to Address Circumstances," lists the decisions/assumptions that were made for the differing choices.

Notes:

+ indicates potential contaminants of concern determined by professional judgment

1 - Potential contaminants of concern associated with potentially contaminating activity have been taken from Table 2 - Potentially Contaminating Activities from the MOE Proposal for Amending Ontario Regulation 153/04, Brownfield Record of Site Condition (EBR Registry Number 010-4642), October 2008.

2 - Indicates land use activities not included in the MOE 2008 list of potentially contaminating activities, but that are still potential drinking water threats as described in the TDWT.

3 - Potential Contaminants of concern associated with business types in the Canadian Waste Water Association (CWWA) website in the 'Directory of Contaminants Database' (http://www.cwwa.ca/Contaminants/Search.asp), las updated September 22, 2004.

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
Adhesives/Resins[1]	epoxy resins, formaldehyde, phenol, phthalate esters, polyvinyl acetate	The handling and storage of a dense non-aqueous phase liquid.	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all handling and storage methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	1 chemical	A spill may result in the presence of vinyl chloride (VC) or another DNAPL that could degrade to VC in groundwater and surface water
Agriculture (Intensive)[1]	carbamate pesticides, organochlorine/organophosphate pesticides, herbicides, metals (e.g. aluminum, arsenic, cadmium, copper, iron, lead, magnesium, potassium), nitrate-nitrogen, petroleum hydrocarbons (PHCs), pathogens+	The handling and storage of fuel.	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
		Handling and storage of pesticides	11	1233-1320	Quantity stored	<25 kg	Unless data is available, assume quantity of stored is > 2500 kg
						25-250 kg	
						250 - 2500 kg	
						> 2500 L=kg	
					Chemicals present	11 chemicals	A spill of pesticide or material containing pesticide may result in the presence of one or more of the listed pesticides in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
		The application of agricultural source material (ASM) to land	3	1-12	Managed Land	<40%	Unless data is available, will assume largest managed land percentage
						40% - 80%	
						>80%	
					Annual Nutrient Units/Acre	<0.5	Unless data is available regarding farm animal type, will assume highest nutrient unit generating animals on-site
						0.5 - 1.0	
						>1.0	
					Available nitrogen and phosphorous in nutrients applied exceeds crop production requirements for crops on the land for threat year by 15% or more		Unless data is available regarding application volume of ASM, will assume exceeding by 15% or more
					Chemicals present	Nitrogen and/or Phosphorous (total)	The application may result in the presence of nitrogen and/or phosphorous (total) in groundwater or surface water
		The application of agricultural source material to land	*3*	*1944*	*ASM is applied to land in any quantity*		*Unless data is available regarding fertilizing of crops, will assume ASM is applied in any quantity to land*
					Pathogens present	*One or more pathogens*	*The application of ASM may result in the presence of one or more pathogens in groundwater or surface water*
		The application of commercial fertilizer to land	8	19-36	Managed Land	<40%	Unless data is available, will assume largest managed land percentage
						40% - 80%	
						>80%	
					Annual Nutrient Units/Acre	<0.5	Unless data is available regarding farm animal type, will assume highest nutrient unit generating animals on-site
						0.5 - 1.0	
						>1.0	
					Available nitrogen and phosphorous in nutrients applied exceeds crop production requirements for crops on the land for threat year by 15% or more		Unless data is available regarding application volume fertilizer applied will assume exceeding by 15% or more
					Chemicals present	Nitrogen and/or Phosphorous (total)	The application may result in the presence of nitrogen and/or phosphorous (total) in groundwater or surface water
		The application of non-agricultural source material (NASM) to land	6	37-54	Managed Land	<40%	Unless data is available, will assume largest managed land percentage
						40% - 80%	
						>80%	
					Annual Nutrient Units/Acre	<0.5	Unless data is available regarding farm animal type, will assume highest nutrient unit generating animals on-site
						0.5 - 1.0	
						>1.0	
					Available nitrogen and phosphorous in nutrients applied exceeds crop production requirements for crops on the land for threat year by 15% or more		Unless data is available regarding application volume of NASM, will assume exceeding by 15% or more
					Chemicals present	Nitrogen and/or Phosphorous (total)	The application may result in the presence of nitrogen and/or phosphorous (total) in groundwater or surface water
		The application of non-agricultural source material (NASM) to land	*6*	*1972-1973*	*The application of any quantity of NASM that contains materials from seafood processing operation, a dairy producer, a dairy product manufacturing operation, an animal food manufacturing operation that manufactures food from animal sources, or a pulp and paper mill*		*Unless data is available regarding source, will assume NASM comes from meat plant or sewage plant*
					The application of any quantity of NASM that contains materials from a meat plant or sewage works		
					Pathogens present	*One or more pathogens*	*The application may result in the presence of one or more pathogens in groundwater or surface water*

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
		The application of pesticide to land	10	55-87	Area of land to which pesticides are applied	<1 hectare	Unless data is available regarding the area of land, will assume >10 hectares
						1 - 10 hectares	
						>10 hectares	
					Chemicals present	11 chemicals	The application of one or more of the listed pesticides may result in their presence in groundwater or surface water
		The storage of agricultural source material (ASM)	4	1321-1344	Type of Storage	At or above grade	Unless data is available regarding method of storage, will assume below grade storage
						Below grade	
						A portion, but not all of the ASM is stored above grade	
						Permanent nutrient storage facility	
						Temporary nutrient storage site	
					Annual rate of nutrient units per acre of farm units	<0.5	Unless data is available regarding nutrient units, will assume at least 0.5 NU per acre of farm unit
						0.5 - 1.0	
						>1.0	
					Chemicals present	Nitrogen and/or Phosphorous (total)	A spill of material or runoff from the area where the material is stored may result in the presence of nitrogen in groundwater or surface water
		The storage of agricultural source material (ASM)	*4*	*1962-1964*	*Type of Storage*	*At or above grade*	*Unless data is available regarding type of storage, will assume any/all types of storage*
						Entirely below grade	
						Permanent nutrient storage facility	
						Temporary nutrient storage site	
					Pathogens present	*One or more pathogens*	*A spill of the material or runoff from an area where either material is stored may result in the presence of one or more pathogens in groundwater or surface water*
		The handling and storage of commercial fertilizer	9	1393-1408	Type of facility	Where it is manufactured or processed or wholesaled	Unless data is available regarding type of facility, will assume retail sale
						For retail sale	
					Total mass stored	<25 kg	Unless data is available, will assume >2500kg
						25 - 250kg	
						250 - 2500kg	
						>2500kg	
					Chemicals present	Nitrogen and/or Phosphorous (total)	A spill of fertilizer or material containing the fertilizer any result in the presence of nitrogen and/or phosphorous (total) in groundwater or surface water
		The handling and storage of non-agricultural source material (NASM)	7	1409-1432	Type of Storage	Above grade	Unless data is available, will assume that NASM is stored above grade
						Below grade	
						A portion, but not all of the ASM is stored above grade	
						Permanent nutrient storage facility	
						Temporary nutrient storage site	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					The mass of nitrogen in NASM stored	<0.5 tonnes	Unless data is available, will assume that mass of nitrogen is at least 0.5 tonnes
						0.5 - 5.0 tonnes	
						>5.0 tonnes	
					Chemicals present	Nitrogen and/or Phosphorous (total)	A spill of material or runoff from the area where the material is stored may result in the presence of nitrogen and/or phosphorous (total) in groundwater or surface water
		The handling and storage of non-agricultural source material (NASM)	*7*	*1965-1968*	*The NASM contains material generated by a seafood processing operation, a dairy producer, a dairy product manufacturing operation, an animal food manufacturing operation that manufactures food from animal sources, or a pulp and paper mill*		*Unless data is available, will assume that NASM contains material generated by a meat plant*
					The NASM contains material generated by a meat plant		
					Type of Storage	*Above grade*	*Unless data is available, will assume that NASM is stored below grade*
						Entirely below grade	
					Pathogens present	*One or more pathogens*	*A spill of the material or runoff from an area where the material is stored may result in the presence of one or more pathogens in groundwater or surface water*
		The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	21	335-346	Land Use	Outdoor confinement area or farm-animal yard	Unless data is provided, will assume with land use (both applicable for significant groundwater threats)
						Livestock grazing or pasturing land	
					Annual Nutrient Units/Acre	<0.5	Unless data is available, will assume >1.0 NU/acre
						0.5 - 1.0	
						>1.0	
					Chemicals present	Nitrogen and/or Phosphorous (total)	The land use may result in the presence of nitrogen or phosphorous (total) in groundwater or surface water
		The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	*21*	*1945-1946*	*Land Use*	*Livestock grazing or pasturing land for one or more animals*	*Unless data is provided, will assume with land use (both applicable for significant groundwater threats)*
						Outdoor confinement area or a farm animal yard for one or ore animals	
					Pathogens present	*One or more pathogens*	*the land use may result in the presence or one or more pathogens in groundwater surface water*
Boat Building[1]	copper thiocyanate, metals (e.g. copper, chromium, lead, mercy, zinc), organotin compounds (e.g. tributylin), PHCs, solvents	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all methods of handling
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage
						Below grade	
						Portion below grade	
					Facility Type	Reg 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site and therefore not applicable for a gas station
						Reg 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution, therefore not applicable

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up volume quantity to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs and PCE and/or TCE	A spill may result in the presence of perchloroethylene (PCE) and/or trichloroethylene (TCE) and/or vinyl chloride (VC) in groundwater. Use of petroleum hydrocarbons may also result in a presence of PAHs in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage and handling methods
						At grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Breweries[3]	Ammonia, oil and grease (i.e. PHCs), phosphorous	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all methods of handling
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage
						Below grade	
						Portion below grade	
					Facility Type	Reg 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site and therefore not applicable for a gas station
						Reg 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution, therefore not applicable

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up volume quantity to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
Cement or Lime Manufacturing[1]	metals, PHCs	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg 213/01 or 217/01 but not a bulk plant	Reg 213/01 represents storage on-site for use on site
						Reg 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	5 chemicals	A spill may result in the presence of PHCs in groundwater
Commercial Heating Oil Tank[2]	benzene, toluene, ehtylbenzene and xylenes (BTEX), PAHs, PHCs	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and PHCs in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all handling and storage methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs	A spill may result in the presence of PAHs in groundwater
Dry Cleaning/Laundromat[1]	chlorinated hydrocarbons (e.g. TCE, ethane, 1,1,1-trichloroethane, carbon tetrachloride PCE), PHCs, volatile organic compounds (VOCs)	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage if data is not available
						Below grade	
						Portion below grade	
					Facility Type	Reg 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and/or PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all handling and storage methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs, PCE and/or TCE, and VC	A spill may result in the presence of PCE and/or TCE and/or VC in groundwater. Use of petroleum hydrocarbons may also result in a presence of PAHs in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage/handling
						Below grade	
						Portion below grade	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Electrical Generation. Transformation, power stations[1]	fly ash, metals (e.g. selenium), BTEX, PAHs, Polychlorinated biphenyls (PCBs), PHCs, PAHs+	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and/or PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs	A spill may result in the presence of PAHs in groundwater
		The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	1	1879-1883	Storage means of PCB waste	Stored in drums at or above grade	Unless data is available, will assume PCBs are stored outdoor and not in a container
						Stored in tanks below grade	
						Stored in a tank partially below grade	
						Stored outdoor and not in a container	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Applicable Regulation.	The PCB waste is stored at a PCB waste disposal site as described in Section 3 of Regulation 362 (Waste Management – PCBs), R.R.O. 1990, made under the Environmental Protection Act or was delivered to a site under written instructions of a Director in accordance with clause 8(a) of that regulation	Unless data is available, assume site is a PCB waste disposal site as indicated by the noted Regulation
					Chemicals present	PCBs	A spill of the waste may result in the presence of one or more PCBs in groundwater or surface water.
Electronics, Component Manufacturing, Reconditioning[1]	Metals (e.g. copper, tin, lead), solvents	The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence PCE and/or TCE	A spill may result in the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all handling methods
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Food Processing Plant (Human or Animal food)[3]	cyanide, oil and grease (i.e. PHCs), total kjeldahl nitrogen, phosphorous, boron, sulphide	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case.

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
		The handling and storage of non-agricultural source material (NASM)	*7*	*1965-1968*	*The NASM contains material generated by a seafood processing operation, a dairy producer, a dairy product manufacturing operation, an animal food manufacturing operation that manufactures food from animal sources, or a pulp and paper mill*		*Unless data is available, will assume that NASM contains material generated by a meat plant*
					The NASM contains material generated by a meat plant		
					Type of Storage	*Above grade*	*Unless data is available, will assume that NASM is stored below grade*
						Entirely below grade	
					Pathogens present	*One or more pathogens*	*A spill of the material or runoff from an area where the material is stored may result in the presence of one or more pathogens in groundwater or surface water*
Gasoline Station[1]	Metals (e.g. barium, cadmium, copper, lead, nickel, zinc), monocyclic aromatic hydrocarbons (e.g. BTEX), PAHs, PHCs, phenols	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all methods of handling methids
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site and therefore not applicable for a gas station
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up volume quantity to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and/or PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage means
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs	A spill may result in the presence of PAHs in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
Glass Manufacturing[3]	metals, oil and grease (i.e. PHCs)	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all methods of handling
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case.
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up volume quantity to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
Golf Course[1]	herbicides, metals (e.g. aluminum, arsenic, cadmium, copper, iron, lead, magnesium, potassium), nitrate-nitrogen, organochlorine and organophosphate pesticides	Handling and storage of pesticides	11	1233-1320	Quantity stored	<25 kg	Unless data is available, assume quantity of stored is > 2500 kg
						25-250 kg	
						250 - 2500 kg	
						> 2500 L=kg	
					Chemicals present	11 chemicals	A spill of pesticide or material containing pesticide may result in the presence of one or more of the listed pesticides in groundwater
		Application of pesticide	10	13-36	Area of application	< 1 ha	Unless data is available, assume >10 ha application area
						1-10 ha	
						>10 ha	
					Chemicals present	11 chemicals	Application of pesticide may result in the presence of one or more of the listed pesticides in groundwater
		Handling and storage of commercial fertilizer	9	1393-1408	Quantity stored	<25 kg	Unless data is available, assume quantity of stored is > 2500 kg
						25-250 kg	
						250 - 2500 kg	
						> 2500 L = kg	
					Chemicals present	Phosphorous (total) and/or nitrogen	A spill of fertilizer or material containing fertilizer may result in the presence phosphorous (total) or nitrogen in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
Laboratories (Commercial Analytical, Analysts)[1]	metals, nitrate-nitrogen, solvents	The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence PCE and/or TCE	A spill may result in the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage/handling
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Medical and Diagnostic Laboratories[3]	Oil and grease (i.e..PHCs), metals, phnolics, phosphorous, cyanide, TKN	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all methods of handling
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up volume quantity to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	5 chemicals	A spill may result in the presence of PHCs in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
Medical Equipment and Supplies Manufacturing[3]	Oil and grease (i.e..PHCs) and metals	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all methods of handling
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all methods of storage
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case.
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up volume quantity to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
Metal finishing, treatments, smelting or refining[1]	chlorinated hydrocarbons (e.g. PCE), cyanide, metals (e.g. .aluminum, barium, cadmium, copper, chromium, lead, nickel, silver, tin, zinc), BTEX,	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case.
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and/or PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Grade of storage	At or above grade	Unless data is available, assume any/all storage and handling methods
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs and PCE and/or TCE	A spill may result in the presence of PAHs in groundwater. Also assume PCE/TCE may be used on-site to clean equipment/tools, therefore a spill may result the presence of PCE and/or TCE in groundwater
Metal Product Manufacturing (Misc.)[3]	Oil and grease (i.e. PHCs), metals, cyanide, sulphate, TKN, ammonia, phosphorous, formaldehyde, phenolics, solvents	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs and PCE and/or TCE	A spill may result in the presence of PAHs in groundwater. Also assume PCE/TCE may be used on-site to clean equipment/tools, therefore a spill may result the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage/handling
						Below grade	
						Portion below grade	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Metal treatment or coating[1]	metals (e.g. aluminum, cadmium, chromium, lead), solvents (e.g. PCE, TCE, carbon tetrachloride (CT), etc..)+, synthetic resins	The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PCE and/or TCE	Assume PCE/TCE may be used on-site to clean equipment/tools, therefore a spill may result the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage/handling
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Paints[1]	metals (e.g. arsenic, barium, cadmium, chromium, cobalt, lead, manganese, mercury, selenium, zinc, titanium), solvents (e.g. toluene), synthetic resins	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	5 chemicals	A spill may result in the presence of BTEX in groundwater
Pharmarceutical and Medicine Manufacturing[3]	phophorous, ammonia, Total Kjeldahl Nitrogen (TKN), solvents, TCE, metals, oil and grease (i.e. PHCs)	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PCE and/or TCE	A spill may result the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage/handling
						Below grade	
						Portion below grade	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Photography/Photographic Studios[1]	ammonium compounds, ethanol, formaldehyde, metals (e.g. chromium, silver), phosphorous, sulphur compounds, thiocyanates, cyanides, PHCs, photographic chemicals, solvents (e.g. PCE, TCE, CT, etc..)+, inks, dyes, oils	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PCE and/or TCE	Assume PCE/TCE may be used on-site to clean equipment/tools, therefore a spill may result the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage and handling methods
						Below grade	
						Portion below grade	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Plastics (including fiberglass)[1]	metals, (e.g. cadmium), phthalate esters, solvents (e.g. PCE, TCE, CT, etc..)+, styrene, synthetic resins, sulphates	The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PCE and/or TCE	Assume PCE/TCE may be used on-site as solvents in the processing of plastics, therefore a spill may result the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage and handling methods
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Printing and Duplicating[1]	metals (e.g. chromium), solvents (e.g. PCE, TCE, CT, etc..)+	The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence PCE and/or TCE	A spill may result in the presence of PCE and/or TCE in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage and /handling methods
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Road Salt - Handling and Storage[2]		The handling and storage of road salt	13	1433 - 1444	Storage Type	Exposure/runoff from precipitation or snowmelt	Unless data is available, assume exposure to precipitation and runoff
						Protected from precipitation, runoff & snowmelt	
					Quantity stored	< 500 tonnes	Unless data is available, assume >500 tonnes
						500 - 5000 tonnes	
						>5000 tonnes	
					Chemicals present	2 chemicals	Runoff from area may result in the presence of chloride or sodium in source water
Road Salt Application[2]	sodium and chloride	The application of road salt	12	88 - 95	Percentage of total impervious surface area	< 1 %	The amount of impervious surface was calculated using the Technical Rules (MOE, 2008) as presented in Section 3.1.3 of this report.
						1 - 8 %	
						8 - 80 %	
						> 80 %	
					Chemicals present	2 chemicals	Assume application will result in the presence of chloride or sodium in surface water
Rubber Processing[1]	metals (e.g. lead, zinc), BTEX, reactive monomers (e.g. isoprene, isobutylene), solvents (e.g. PCE, TCE, CT, etc..)+, sulphur compounds	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill may result in the presence of BTEX in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence PCE and/or TCE	A spill may result in the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage/handling
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Scrap metal recovery, auto wreckers[1]	metals (lead, cadmium, magnesium, mercury), BTEX, PHCs, PAHs, PCBs, solvents (e.g. PCE, TCE, CT, etc..)+, VOCs	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and/or PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs and PCE and/or TCE	A spill may result in the presence of PAHs in groundwater. Also assume PCE/TCE may be used on-site to clean equipment/tools, therefore a spill may result the presence of PCE and/or TCE in groundwater
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage/handling
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Septic Systems[2]	acetone, chloride, 1,4-dichlorobenzene (para), nitrogen, phosphorous (total), sodium	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	2	831-842	The system is an earth pit privy, privy vault, greywater system, cesspool, or a leaching bed system and its associated treatment unit		
					Applicable Regulations	System is subject to the Ontario Building Code Act, 1992	Unless information is available regarding applicable regulation, will assume OWRA applies
						The system is a sewage works with the meaning of the Ontario Water Resources Act	
					Chemicals present	5 chemicals	A discharge from the system may result in the presence of one or more of the listed chemicals in groundwater or surface water
		The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	*2*	*1955*	*The system is an earth pit privy, privy vault, greywater system, cesspool, or a leaching bed system and its associated treatment unit*		
					Applicable Regulations	*System is subject to the Ontario Building Code Act, 1992*	*Unless data is available, assume either Regulation is applicable (i.e. both are applicable to significant threats)*
						The system is a sewage works with the meaning of the Ontario Water Resources Act	
					Pathogens present	*One or more pathogens*	*A discharge from the system may result in the presence of one or more pathogens in groundwater or surface water*

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
Storage of Snow[2]	lead, cyanide sodium, chloride, copper, nitrogen, PHCs, zinc	The storage of snow	14	1445 - 1532	Grade of Storage	At or above grade	Unless data is available, assume snow is stored below grade (below grade is applicable for significant groundwater threats)
						Below grade	
					Area upon which the snow is stored	At least 0.01 but not more than 0.5 ha	Unless data is available, assume at least 0.01 ha storage area
						More than 0.5 but not more than 1.0 ha	
						More than 1.0 but not more than 5.0 ha	
						More than 5.0 ha	
					Chemicals present	11 chemicals	Runoff from the area in which snow is stored may result in the presence of one or more of the listed contaminants in groundwater or surface water
Storm Water Pond[3]		The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage - *Storm Water Management Facility*	2- c	477 - 704	Drainage area	< 1 ha	Assume storm sewer network adequately resembles drainage area. When drainage area is not provided, assume >100 hectares
						1 - 10 ha	
						10 - 100 ha	
						> 100 ha	
					Drainage area type	Predominantly rural, agricultural, or low density residential	Land use type was defined using GIS zoning information from the City of Guelph for the drainage areas
						High density residential land use	
						Industrial or commercial	
					Chemicals present	19 chemicals	Assume discharge from storm water facility may result any of the in the presence of any of the 19 listed chemicals
Textile Operations[1]	chlorinated hydrocarbons (e.g. PCE), dyes and dye residues, metals (e.g. cadmium, chromium, titanium, carbon, zinc, aluminum, tin), BTEX, organochlorine pesticides, phenols	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
					Chemicals present	4 chemicals	A spill may result in the presence of BTEX in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	Aat or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PCE	A spill may result in the presence of PCE in groundwater
		Handling and storage of pesticides	11	1233-1320	Quantity stored	<25 kg	Unless data is available, assume quantity of stored is > 2500 kg
						25-250 kg	
						250 - 2500 kg	
						> 2500 L=kg	
					Chemicals present	11 chemicals	A spill of pesticide or material containing pesticide may result in the presence of one or more of the listed pesticides in groundwater
Vehicle Maintenance/Repair Garage[1]	Chlorofluorocarbons, metals (e.g. copper, cadmium, lead, zinc), BTEX, PHCs, phenols, solvents, volatile organic compounds (VOCs)	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg. 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and/or PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs, PCE and/or TCE	A spill may result in the presence of PAHs in groundwater. Also assume solvents used on site could be PCE and TCE, therefore a spill may result in the presence of PCE and/or TCE in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage and /handling methods
						At grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater
Vehicle manufacturing and associated industries[1]	Metals (e.g. cadmium, chromium, copper, lead, magnesium, mercury, zinc), BTEX, chlorofluorocarbons, chlorinated organic solvents, PHCs, phenols, solvents	The handling and storage of fuel	15	127 - 326	Grade of handling	Above grade in relation to storage	Unless data is available, assume any/all handling methods
						Below grade in relation to storage	
					Grade of storage	At or above grade	Unless data is available, assume any/all storage methods
						Below grade	
						Portion below grade	
					Facility Type	Reg. 213/01 or 217/01 but not a bulk plant	Reg 213/01 represents storage on-site for use on site
						Reg. 217/01 bulk plant or facility that manufactures or refines fuel	Reg. 217/01 represents retail of fuel or storage for later distribution and is not applicable in this case
					Storage Volume	< 25 L	Where fuel storage volume data is available (e.g. TSSA or FST records) round up to largest volume category. Where this data is not available, assume fuel storage is >2500 L
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	8 chemicals	A spill may result in the presence of BTEX and/or PHCs in groundwater
		The handling and storage of a dense non-aqueous phase liquid	16	102 - 126	Grade of handling	Below grade in relation to storage	Unless data is available, assume any/all storage and handling methods
						Above grade in relation to storage	
					Grade of storage	At or above grade	
						Below grade	
						Portion below grade	
					Chemicals present	Presence of PAHs and PCE and/or TCE	A spill may result in the presence of PAHs in groundwater. Also assume PCE/TCE may be used on-site to clean equipment/tools, therefore a spill may result the presence of PCE and/or TCE in groundwater

Land Use Activity	Contaminants of Potential Concern (MOE, 2008)	Applicable Threat Categories	Threat Category #	from Tables of Drinking Water Threats	Circumstances of the Threat Category		Site Specific Information or Assumptions Used to Address Circumstances
		The handling and storage of an organic solvent	17	1345 - 1392	Grade	At or above grade	Unless data is available, assume any/all storage and handling methods
						Below grade	
						Portion below grade	
					Quantity stored	< 25 L	Unless data is available, assume quantity of stored is > 2500 kg
						25 - 250 L	
						250 - 2500 L	
						> 2500 L	
					Chemicals present	4 chemicals	A spill of the solvent may result in the presence of any/all of the listed organic solvents in groundwater