APPENDIX – SB (SHELBURNE)

R.J. BURNSIDE & ASSOCIATES LIMITED

- Groundwater Vulnerability Analysis, Issues Evaluation and Threats Assessment, Town of Shelburne. (2010a)

DILLON CONSULTING LIMITED: WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

- Dillon Consulting Limited WHPA Peer Review Report Memo
- Wellhead Time of Travel Capture Zone Peer Review Evaluation Results
    - Table 1: Shelburne

Groundwater Vulnerability Analysis, Issues Evaluation and Threats Assessment – FINAL
Town of Shelburne

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1.0 Introduction

The Ontario Government passed Bill 43, the Clean Water Act, 2006 to protect drinking water at the source as part of an overall commitment to human health and the environment. The Nottawasaga Valley Conservation Authority (NVCA) is partnering with a number of municipalities within its watershed area to complete the necessary technical studies in compliance with the Clean Water Act. The Act requires the development of a Watershed Based Source Protection Plan and involves the completion of a number of components, which are aimed at ensuring the provision of safe drinking water for the residents of Ontario.

The Act requires that within each watershed a Watershed Assessment Report be developed that presents the status of water resources and water used throughout that watershed. The current report developed for the Town of Shelburne addresses three components of the Watershed Assessment Report as originally outlined, being Groundwater Vulnerability Analysis, Issues Evaluation and Threats Inventory and Water Quality Risk Assessment. The report is based on tasks originally outlined by the Ministry of Environment (MOE) Source Protection Technical Studies Draft Guidance Module 3 – Groundwater Vulnerability Analysis (October 2006), Draft Guidance Module 5 – Issues Evaluation and Threats Inventory (October 2006) and Draft Guidance Module 6 – Water Quality Risk Assessment (October 2006). The procedures for computations and assessments outlined in these guidance modules were later updated primarily by the Technical Rules: Assessment Report (Updated November 2009) and other technical guidance offered by the MOE.

R.J. Burnside & Associates Limited (Burnside) was retained by the Town of Shelburne in partnership with the NVCA to carry out the necessary studies. The information compiled as part of this study and outlined in the following report has been completed according to the guidance and documentation available at time of reporting.

1.1 Previous Studies

This study will build on previous work completed for the Town of Shelburne including the Town of Shelburne Groundwater Management Study that was prepared by Burnside in 2002. The 2002 Burnside study included delineation of the capture zones for all of the municipal wells in Shelburne as well as in surrounding municipalities using a regional groundwater model developed by Schlumberger Water Services (formerly Waterloo Hydrogeologic). Another component of this previous study was the completion of a vulnerability analysis based on the Intrinsic Susceptibility Index (ISI). A Town wide potential contaminant source inventory database was also created.

1.2 Project Scope

As part of the Ontario Government's initiative towards greater source water protection, the current study builds on the results of earlier work and compiles information towards completion of the Assessment Report. Specifically, the current report sets out to provide:

- An assessment of groundwater vulnerability by completing Aquifer Vulnerability Index (AVI) mapping for the Well Head Protection Areas (WHPAs) and immediately surrounding areas;
- An inventory of transport pathways;
- Vulnerability scores for areas within WHPAs based on vulnerability and transport pathways;
- An inventory of issues that are impacting (or may impact) drinking water sources;
- An inventory of drinking water threats in vulnerable areas and, where possible, an identification of those drinking water threats contributing to drinking water issues;
- A list of significant threats within each vulnerable area;
- A list of conditions that are drinking water threats; and
- An assessment of uncertainty associated with results and list of data gaps.

2.0 Study Area

The Town of Shelburne (Figure 2.1) is situated at the headwaters of the Boyne River in the centre of Dufferin County. It is approximately 70 km northwest of Toronto and 25 km northwest of Orangeville. The Municipal boundaries for the Town of Shelburne bracket an area of approximately 10 km^2.

The Shelburne Water Supply System is owned by the Town of Shelburne and operated by the Ontario Clean Water Agency (OCWA). The water system services a population of approximately 5,000 people. The water system consists of five groundwater supply wells and three pump houses. The following sections provide an outline of the water supply system for the Town.

2.1 East Side Well Field

The Shelburne East Side well field consists of Wells PW1 and PW2 located on Dufferin Street, approximately 300 m south of Highway 89. These are the original two wells drilled for Shelburne Municipal Supply System in the 1950s. PW1 is a 300 mm diameter well, 23.5 m deep and is located on the southeast corner of Dufferin Street and Andrew Street in the pump house. PW2 is a 300 mm diameter well that is 30.5 m deep. The well is located at the northeast corner of Dufferin Street and Town Laneway. Both wells obtain their water from the upper 5 m of the bedrock aquifer which is in contact with a layer of granular material at the bottom of the overburden. PW1 is permitted to pump at a maximum rate of 19 L/s and PW2 at 11.3 L/s (PTTW# 1814-7QVK7S). PW1 has been recognized as a GUDI well (groundwater under direct influence of surface water).

2.2 West Side Well Field

The west side well field in Shelburne includes PW3, PW5 and PW6. Well PW3 is located in the west half of Lot 2, Concession 3 (former Township of Melancthon) in a pump house on Cedar Street. PW3 was constructed in 1977. The well has a 300 mm diameter casing and is 19.2 m deep. PW3 is equipped to pump 15.2 L/s (200 Igpm) and has a static water level that is approximately 2 to 3 m above grade. Although the majority of the water in PW3 is obtained from the bedrock/overburden contact, some water is obtained from deeper fractures in the bedrock. PW5 located approximately 38 m east of the 4th Line Melancthon in the pumphouse. The well has a 300 mm diameter casing and is 23.5 m deep. PW6 was constructed in 1989 and is a 150 mm diameter well, 24.4 m deep. The well is located approximately 4 m west of PW5. PW5 and PW6 are permitted to pump a maximum of 22.7 L/s combined (300 Igpm) (PTTW# 1814-7QVK7S).

Well records for the municipal wells are included in Appendix A. In 2009, all four supply wells were combined into one permit to take water PTTW# 1814-7QVK7S, which will expire December 31, 2014. A summary of the wells and their permitted rates is included in Table 1.

Table 1 Summary of Supply Wells Permit to Take Water ((PTTW# 1814-7QVK7S)

Well	Depth (m)	Permitted Flow	
		Maximum Rate (L/min)	Maximum Daily (L/day)
PW1	23.5	1,140	1,642,000
PW2	30.5	680	979,000
PW3	19.2	909	1,309,000
PW5/PW6	23.5 / 24.4	1,364	1,964,000

3.0 Physical Setting

3.1 Topography and Drainage

The general topography of the Town and the surrounding area is presented in Figure 3.1. The topographic highs generally correspond to the divide that separates the Grand River and Nottawasaga Valley River watersheds which is found just west of the Town. The ground surface elevations ranges from a high of over 500 m above mean sea level (amsl) in the north-western and south central part of the study area to lows of 420 amsl in the Boyne River Valley in the northeast portion of the study area.

There are two creeks that flow easterly through the Town of Shelburne and discharge into the Boyne River. Walters Creek arises near Shelburne Wells PW5/PW6 and flows from southwest to northeast, across the northern edge of Town. The Besley Drain also begins in the southwest corner of Shelburne but flows to the east across the south end of Town, bends 90 degrees and flows to the northeast past PW1/PW2. Walters Creek and the Besley Drain join northeast of Shelburne forming the headwaters of the Boyne River.

Tributaries of the Boyne River originate between 25th and 30th Sideroads near 2nd Line Amaranth, 2 km north of the Town boundary. Numerous tributaries of Willow Creek flow south to south-westerly and eventually join with the Grand River.

3.2 Physiography

The Town of Shelburne, located in the Upper Nottawasaga River Basin has a generally uniform physiography consisting of rolling hills and upland.

Figure 3.2 presents the physiography of the region based on Chapman and Putnam (1984). Figure 3.2 illustrates that the Town of Shelburne is located in an area that is mainly drumlinized till plains while spillway deposits and kame moraines surround the Town boundaries.

In the areas of the till plains the land surface is gently rolling. Subdued ridges separate poorly drained depressions which form swamps and bogs in the area. Shallow outwash deposits occur in the eroded till plains. Outside of the Town there is an assortment of kame sands and gravel and ice-contact melt water deposits. The outwash deposits become more prominent towards the south. The general slope is toward the east. The land surface is rugged, marked by rolling hills and, in places, is deeply dissected.

3.3 Geology

3.3.1 Overburden Geology

The surficial geology of the Town of Shelburne is presented in Figure 3.3. The overburden in the Town of Shelburne includes the following glacial formations: glacio-lacustrine (lake) sediments, fluvial (river) and glaciofluvial deposits and ice-deposited

drift. The glacio-lacustrine sediments consist of medium to fine grained sand, silt, and clay, deposited in ice-marginal lakes and ponds associated with glacial Lake Schomberg and subsequent phases of Lake Algonquin (Burnside, 2002). The materials in the fluvial and glacio-fluvial outwash deposits vary from well-bedded and sorted sand and gravel in outwash plains and meltwater channels, to irregularly stratified sand and gravel in kame hummocks.

Ice-deposited drift, commonly referred to as "till", consists of unsorted and unstratified sediment deposited directly by a glacier. The composition of the Tavistock Till which dominates in the Shelburne area of the Escarpment Upland Region is described as a silt to clayey silt textured till. The Tavistock Till is documented as either clay or silt in all of the logs of drilled wells included in this study area. Each of the monitor wells constructed encountered this fine grained Till layer with varying thickness. In the north-western portion of the study area, a deposit of Catfish Creek Till is evident. The Catfish Creek till is described as a clayey to silty till.

The elevated portions of the study area separating the Boyne and Nottawasaga Drainage areas (to the southeast of Shelburne) consist of glaciofluvial ice contact deposits. These deposits consist of sorted and stratified silt, sand, gravel that form distinctive isolated hills of sand and gravel referred to as kames. An assemblage of kame deposits forms a typical hummocky topography of relatively high relief. Kame terraces are typically flat on top and are formed by deposition by meltwater flowing between the melting ice front and an adjacent valley wall. One such kame is the hill located 2.5 km south of Primrose on Highway 10/24. Locally, the hill at 3rd and 4th Avenue (the water tower site), is also a kame deposit. Sand and gravel deposited by meltwater in a broad flat fan-like form is known as an “outwash plain”. The valley of Walters Creek and the Besley Drain are primarily outwash deposits although the streambeds have eroded the granular deposits and flow on Tavistock Till.

Tills are generally considered to be semi-permeable and do not readily transmit water. Lacustrine silt and clay sediments are also semi-permeable. Fluvial sands and gravels, and coarse-grained lacustrine sand deposits on the other hand are permeable and can transmit large quantities of groundwater.

Alluvial deposits consisting of clay, silt, and fine sand comprise the recent stream terraces in the area. While organic soils and material dominate the swamps and bogs, organic soils are generally underlain by very fine sand, silt and sometimes clay. The alluvial deposits are limited to the stream courses and the swamp deposits are seen along the Boyne River east of Shelburne.

The overburden thickness reflects the bedrock valleys and topographic highs in the study area. The overburden thickness ranges from 0 to 10 m in parts over the escarpment and in the deeply incised valleys. The overburden thickness in the Shelburne area varies from less than 10 m in the areas east and northeast to over 30 m beneath the central portion of the Town. The overburden thickness in the areas of Wells PW1, PW2 and PW3 is less than 15 m.

3.3.2 Bedrock Geology

Information on the bedrock geology of the area is available from various sources including: Ontario Geological Survey mapping, geological reports on Palaeozoic geology by various authors, and the review of well records. The bedrock underlying the study area consists of dolomite, limestone and shale deposited during the Ordovician and Silurian periods of the Palaeozoic Era.

The bedrock geology presented in Figure 3.4 illustrates that the uppermost bedrock at the Town of Shelburne is the Amabel Formation.

The Amabel Formation (Guelph-Amabel) dolomite Formation comprises the uppermost Silurian rocks. Amabel dolomites are underlain by Cabot Head shale and limestone in turn underlain by Whirlpool sandstone. The Amabel dolomites have been identified as the “best-water yielding rocks” in Nottawasaga River Basin (Sibul et al 1971).

The Cabot Head Formation generally consists of shale and is a fairly limiting water bearing unit. The Whirlpool Formation is relatively permeable and overlies the Silurian shale Formations which are known to be poor water producers. The water quality in Silurian shale is also known to be generally poor. The Ordovician rocks underlying the Town of Shelburne and neighbouring areas consist of Queenston red shale to limestone of the Trenton Group. Wells constructed in limestone and dolomite (Amabel and/or Guelph Formations) yield sufficient quantities of water for domestic use. Wells which penetrate shale and limestone east of the escarpment (e.g. in the Boyne River valley), if not dry, usually yield marginal supplies for domestic purposes.

The bedrock topography is particularly significant in Shelburne where the bedrock / overburden contact produces the vast majority of water to the Town’s municipal wells. The Niagara Escarpment located 4 km east of Shelburne forms the eastern boundary of the Amabel bedrock aquifer. Wells PW1 and PW2 are located in an area of lower bedrock elevation while wells PW3, PW5 and PW6 are located on a bedrock high on the west and north side of Town. The bedrock low in the area of Wells PW1 and PW2 may be an in filled valley that curves to the east and then north on the south side of Shelburne. This bedrock low eventually opens up at the face of the buried Niagara Escarpment 4 km east of Shelburne.

3.4 Water Table

The water table elevation ranges from greater than 500 masl in the northwest corner of the study area to less than 460 m masl in the Boyne River Valley. In general, the groundwater flows from west to east. A generalized water table map is shown as Figure 3.5.

4.0 Well Head Protection Areas

A Well Head Protection Area (WHPA) is an area that is related to a wellhead for which it is desirable to regulate or monitor drinking water threats (Clean Water Act, 2006).

4.1 Delineation of Well Head Protection Areas

Wellhead Protection Areas (WHPAs) for the Shelburne wells were delineated using a model developed for the previous groundwater management study (Burnside, 2001). The model was developed using the Visual MODFLOW package which is based on the standard USGS MODFLOW package. Visual MODFLOW, which is a pre and post processor for standard MODFLOW applications, also includes the particle tracking module MODPATH. MODPATH (Pollock 1989) is a three dimensional particle tracking package. The package was used to backwards track water particles from the wells studied based on their Time of Travel (TOT) through the aquifer. The model allows for a pumping rate to be attributed to a well and the path and time taken for particles to reach the well while pumping at that rate are calculated by the model.

4.1.1 Groundwater Model

The groundwater model from which the well head protection areas were delineated was developed as part of a groundwater management study completed in 2001 for the Town of Shelburne. The groundwater model was developed by Waterloo Hydrogeologic Inc (now Schlumberger Water Services) using the Visual MODFLOW package. The model domain included the towns of Orangeville, Shelburne and Mono as well as portions of the Townships of East Garafraxa, Amaranth, Mulmur and East Luther Grand Valley. The model domain stretched approximately 25 km from west to east and 35 km from north to south. The model was developed as a regional model with grid size varying from 25 m by 25 m in the vicinity of municipal wells to 250 m by 250 m in the area of the model boundaries.

The model was developed to represent five subsurface layers and was calibrated using approximately 1,000 data points from across the model domain. Existing data from the MOE water well database as well as from other sources was incorporated into the development of the model. The model was calibrated to steady state conditions with a NRMS (normalized root mean squared) error of 6.1%. This is considered to be well below the target level of 10% for groundwater models.

Sensitivity analysis was also conducted on the model to evaluate the impact of changes in input parameters on the calibrated model. It was noted from this exercise that the hydraulic conductivity of the Guelph-Amabel aquifer was one of the most sensitive parameters within the model. The modelling completed as part of the Burnside study (Burnside 2001) is the most comprehensive to have been completed in the area. The assumptions included in the building of the model as well as the model calibration process are very well documented and provide an adequate framework for the evaluation of the model. While additional work has taken place at the Shelburne wells since this 2001 study, there is no indication of a significant shift in the shape or orientation of the capture zones delineated by the 2001 study. Based on the

consistency of the capture zones and the available documentation on the development of the existing capture zones they have been utilized by the current study.

4.1.2 Limitations of Model

Based on the regional nature of the model several assumptions on lithology, recharge and aquifer properties were made. The model tries to use computer based algorithms to describe input parameters and predict real world conditions. It is recognized that there are limitations on the accuracy with which a computer based simulation can represent a real word situation. Therefore there are limits on the accuracy of the prediction produced by the model. It is known that real world variability and real world anomalies are not best approximated by modelling. The modelling approach instead provides a best estimate of the general or average trends in the aquifer.

It is noted that the model was satisfactorily calibrated which indicates that it provides a good representation of the real world situation. The model domain for the simulations conducted as part of the groundwater management study was selected to be regional in nature and therefore looks at aquifer performance over a large area. The regional nature of the domain results in simplifying assumptions being made over this large area. The background data that was used for the development of the model was based on information that existed at the time of the model development. It is recognized that this is also a model limitation as new information derived from recently constructed boreholes in the area may result in modifications to model assumptions or results.

4.1.3 Delineation of Capture Zones

With the completion and calibration of the groundwater model, the delineation of time of travel capture zones was undertaken using the MODPATH module of the Visual MODFLOW package. Capture zones were delineated based on reverse particle tracking. Where two capture zones were directly adjacent to each other professional judgement was used to determine the extent of each capture zone.

In completing the various TOT capture zones for the Shelburne wells, the operation of the wells along with their permit to take water (PTTW) pumping rates were combined with the model to produce the noted outcome. Table 2 illustrates that the permit rates used in the 2001 modelling are consistent with the current permit rates.

Table 2 Comparison of Modelled Permitted Rates and Current Permit Rates

Well	2001 Modelled Rates (L/min)	Current Permit Rates (L/min)
PW1	1,140	1,140
PW2	680	680
PW3	909	909
PW5/PW6	1363.8	1363.8

The WHPAs were delineated to be comprised of the following components:

- WHPA-A, being the surface and subsurface area centred on the well with an outer boundary identified by a radius of 100 m;
- WHPA-B, being the surface and subsurface areas within which the time of travel to the well is less than or equal to two years but excluding WHPA-A;
- WHPA-C, being the surface and subsurface areas within which the time of travel to the well is less than or equal to five years but greater than two years; and
- WHPA-D, being the surface and subsurface areas within which the time of travel to the well is less than or equal to steady state conditions in the aquifer but greater than five years.

The WHPAs for the Shelburne Wells are shown in Figure 4.1 as a combined product and then in Figure 4.2 to 4.4 as individual well fields.

The WPHA for PW1and PW2 were delineated as a single source based on the operational practices at these wells. Because of interference between these wells they cannot be operated at the same time. From the model output it is noted that WHPA-A through C are developed as concentric circles around both wells and extend out to a distance of approximately 800 m from the wells. The steady state zone (WHPA-D) extends a total of 4,000 m in a south-westerly direction; this extension of the WHPA-D is approximately 2,500 m wide. There is also a small finger of the WHPA-D that extends in a north-westerly direction from the wells. This finger is 5,000 m long and 500 m wide and is thought to have been a result of particles being deflected by the operation of PW5 and PW6. The total area of the PW1/ PW2 WHPA is approximately 1,043 ha.

At PW3 the WHPA is elongated in a north-westerly direction and extends approximately 6,000 m from the well. The WHPA is elongate in appearance and has a maximum width of 870 m. This WHPA is similar in shape and orientation to the finger-like projection on the PW1/ PW2 WHPA. The total area enclosed by the WHPA of PW3 is 419 ha.

The WHPA for wells PW5 and PW6 were delineated as a single unit based on the mode of operation of these wells. The WHPAs A through D are developed as concentric circles that have been slightly elongated in a westerly direction. The WHPA-D is developed as an elongated oval which trends initially westward before veering off to the northwest. The north-western trend in this zone is similar to the trend for the WHPAs at PW1/ PW2 and at PW3. The WHPA for PW5/ PW6 is approximately 5,800 m along its longest axis and 3,000 m at its widest point. The total area covered by this WHPA is approximately 1,298 ha.

4.2 Delineation of WHPA-E and WHPA-F

The Technical Rules: Assessment Report (Clean Water Act, 2006) require that all wells that are identified as GUDI (groundwater under the direct influence of surface water) as determined in accordance with subsection 2 (2) of O.Reg. 170/03 (Drinking Water Systems) made under the Safe Drinking Water Act, 2002 delineate an additional vulnerable area that is representative of its surface water vulnerability, known as a WHPA-E. WHPA-E is equivalent to an Intake Protection Zone-2 (IPZ-2) for a surface water intake. The IPZ-2 is delineated to represent the distance that a contaminant would

travel in the time required for the supply operator to respond to adverse conditions in the surface water body with which the system is associated. In the cases where a storm sewer system drains into the surface water body, the additional areas associated with the storm sewer shed may be included in the delineation.

The IPZ-2 is delineated with a prescribed minimum of two hours travel time (response time) upstream from the intake on the surface water body. For the WHPA-E it is assumed that the intake is located at the closest point on the surface water body associated with the GUDI status or where the cause for GUDI status is unknown on the closest surface water body.

GUDI studies have been conducted for the wells within the Town of Shelburne to determine if the supply aquifer is impacted by surface water as per requirements outlined in the Ontario Safe Drinking Water Act. Shelburne PW1 was identified as a GUDI well in a study completed by Burnside in 2002 for Shelburne wells PW1, 2, 3, 5 and 6 as required by Certificate of Approval No. 2253-59YGTA (Burnside, 2001).

Shelburne PW1 was classified as GUDI due to known interactions with the shallow groundwater system in the vicinity of the well. In 2000, Total coliform and *E.coli* were detected in water samples this well. Reconstruction of the well subsequent to this event has not been regarded as having enough of an impact to remove the GUDI designation as interaction with the shallow overburden sediments in the vicinity of the well is ongoing.

The closest water course to PW1 is the Besley Drain. The Besley Drain is a man-made open drainage ditch that collects water from lands southwest of the well. The drain begins just outside of the Town boundaries, flows east across the south end of town, bends 90 degrees and flows to the northeast past PW1/PW2. The ditch is located 25 m from the well and traverses PW1's WHPA-A.

The drain begins in a wetland area to the southwest of PW1 and proceeds in an easterly direction as a man-made drain across mainly agricultural areas before it enters town to the southwest of PW1. The lands surrounding the drain are relatively flat and flow within the channel is maintained through drainage outfalls from surrounding properties. Immediately south of PW1, the drain turns to flow north and northeast and traverses the WHPA-A of PW1. It is noted that a portion of the storm sewer system of the Town of Shelburne outfalls into the Besely Drain in the vicinity of PW1. It is noted that this outfall represents the outlet for the storm sewer network from a portion of the Town in the vicinity of the well.

A WHPA-E was delineated for PW1 in accordance to Rule 47 (5) and Rule 49 of the Technical Rules – Assessment Report (Clean Water Act 2006) (Figure 4.4). The WHPA-E was delineated using a combination of surface water modeling and GIS. Surface water modeling was completed using the HEC-RAS software which allows for the computation of stream flow based on assigned stream cross sectional profiles. Cross sectional profiles were developed for HEC-RAS using detailed topographical mapping available for the Town and also based on field visits conducted as part of this study. Steam velocities were estimated and used to project a time of travel of 2 hours

upstream on the associated stream channel. Burnside also obtained information on the storm sewer network in the vicinity of the well and performed calculations on the areas that would contribute storm water into the network that empties into the Besely Drain in the vicinity of the well. These areas that are a part of the so called “storm sewershed” were also included within the WHPA-E.

Using guidelines contained in the Technical Rules: Assessment Report (Clean Water Act 2006), a 120 m offset from the channel of the main Besely Drain was used to define the lateral extent of the WHPA-E in the areas outside of the storm sewershed. The methodology for the delineation of WPHA-E is provided in more detail, along with maps showing cross sectional locations in Appendix B.

The Technical Rules: Assessment Report (Clean Water Act 2006) requires that a WHPA-F is delineated when a WHPA-E has been delineated and a drinking water issue is identified that originates outside of the areas WHPA-A through WHPA-E. At Shelburne PW1 there were no issues identified although the well was recognized as being GUDI, this conclusion is further discussed in Section 8. As a result of the absence of issues at PW1, the delineation of WHPA-F for this source was not required.

5.0 Aquifer Vulnerability Analysis

The aquifer vulnerability was calculated using the Aquifer Vulnerability Index (AVI) method as outlined in the Draft Assessment Report Guidance Module 3 – Appendix 3 (December 2006). This was completed using ARCINFO in a GIS environment and was conducted outside of the environment of the groundwater flow model.

5.1 Calculation of Aquifer Vulnerability

The creation of the Aquifer Vulnerability Index (AVI) data and mapping as part of the current project was enhanced as a result of experience gained during the Provincial Groundwater Studies conducted between 2001 and 2004. This experience led to the re-evaluation of some of the parameters and a modification of the methodology used in the analyses.

The methodologies employed in the current AVI analysis were developed to help overcome inaccuracies in the water well database that is the base of all the calculations performed. The methodologies also sought to revise the method of interpolation of the data in order to improve the spatial validity of the results. The primary datasets used in this support role were the Ministry of Northern Development and Mines Surficial Geology of Southern Ontario and the Ministry of Natural Resources (MNR) Ontario Base Data.

This improved methodology resulted in AVI data that agreed with the other related datasets, an important aspect of spatial data-sets since ultimately these data are usually employed together for mapping and analysis purposes.

The water well database used for this study was produced by the MNR. Previous studies were conducted by utilizing data from the water well database maintained by the MOE. The main differences between these databases are that the MNR has updated the spatial coordinates of many of the wells to bring them closer to their actual location. Also, depth and elevation information for various elements in the MOE's version is rounded off to the nearest unit measure. Regardless, both versions have an inherent level of error for both spatial and attribute information. These errors are a result of compiling drill logs provided by drillers at the time the well was constructed. In the spatial context the locations of the wells were and are often based on coordinates read from 1:10,000 and 1:50,000 maps, sometimes they are just known by their lot and concession location. The attribute information in the database describing aspects such as lithology is based on the geologic knowledge of the driller and the method used in the well drilling. Such factors introduce a level of uncertainty in the data that can be reflected in wells within the same general area having significantly different lithological information.

Based upon a review of the data and experience in water well construction, it was noted that certain types of well construction methods provide less reliable geological information; these methods include:

- percussion drilling methods, which complicates the accurate recording of depth and geological profile due to the amount of destruction caused to the bored material; and
- dug wells which were typically constructed in the 1940s and 1950s using standard construction equipment (i.e. backhoe) with little regard for geological profiling.

In order to reflect the lack of confidence in the data provided by these types of wells, they were removed from the database and their information was not used in any of the further calculations.

Calculations for aquifer vulnerability are based upon the geologic material present and the thickness of the material overlying an aquifer. The following criteria were used to define the top of the aquifer of concern as it was reasoned that this information would be the most accurately recorded in the database:

1. For bedrock wells, the top of bedrock is considered the top of aquifer. This conservative assumption accounts for the fractured nature of bedrock aquifers and the relatively high flow rates through primary flow paths.

2. For overburden wells, the location of the top of the screen indicates the top of aquifer. If no screen information was recorded, then the depth of the well is used to define the top of aquifer. This reflects the fact that for domestic overburden wells, drilling usually at the point where a productive aquifer is encountered.

Based on the above criteria, the water well database was analyzed and the appropriate data was extracted to allow for the calculation of the AVI. The AVI is a product created by: assigning a “K” factor to the material of each geologic stratum recorded in the well drilling log; multiplying this number by the thickness of each stratum; and summing the total value for all strata above the aquifer of interest. This calculation is applied to each well in the study area. Values for the “K” factor were derived from MOE guidance provided as a part of the Draft Assessment Report Guidance Module 3 – Appendix 3 (December 2006); a summary of this information is included in Appendix C.

After completing AVI calculations using the MNR well database additional data from the Ministry of Northern Development and Mines Surficial Geology of Southern Ontario and the Ministry of Natural Resources (MNR) Ontario Base Data was incorporated. Areas shown as having bedrock close to or at the surface were processed to form addition “well” points and AVI scores were developed for these additional points based on the average values of well data that fell into these areas. This helped to check the correctness of the well database results and better define these highly susceptible areas.

5.2 Creation of AVI Surface

Following calculation of AVI for all data points, the values are then interpolated to create an AVI surface for the area of interest.

Various interpolation methods were evaluated including kriging, spline, radial-bias-function, and nearest neighbour. Statistical reports on the models’ performance were

evaluated, and all resulting surfaces were compared to the values of the original sample points (wells) and other geologic and topographic data.

The first method of interpolation attempted was kriging. Kriging, which is a statistical interpolator, is the most advanced interpolation method available. Unfortunately this method proved to be unable to provide acceptable results based on the sample values and distribution. ArcGIS Geostatistical Analyst was also employed for the analysis, but an acceptable semi-variogram model was not achievable based on AVI values (it should be noted that when the same sample points were tested using values such as static water level and well elevation, the kriging method produced good results).

Radial-Bias-Function produced good interpolation results when compared against the values in the sample points and how closely it agreed with topography and geologic features defined in other datasets. It was determined that the interpolation produced by the Australian National University's Digital Elevation Model algorithm (ANUDEM), provided the best results as it performed slightly better than the Radial-Bias-Function when compared against the supporting datasets and requirements for cartographic representation. The completion of the AVI interpolation was therefore completed using the ANUDEM algorithm. Following the interpolation, post processing was performed on the results to produce a vector polygon dataset, and areas less than 5 ha in size were merged with larger areas.

The final AVI surface used for this study is a combination AVI surface - using bedrock wells, supplemental points, and overburden wells greater than 500 m from a bedrock well. This combination AVI surface was created to reflect aquifer vulnerability for the municipal wells.

5.2.1 Limitations of AVI Methods

The AVI method is based on the calculation of a continuous data surface from individual input points. The input points in this case are wells within the various datasets used for this project. Each well would have been developed as part of a site specific purpose with very little coordination or collaboration across sites. The result of this ad hoc development of wells is that there is no spatial optimization between wells; hence the generated surface may reflect biases that exist in the input data. Also there is no control over the number of points in the database as wells are established where needed. It is noted that it is likely that the density of wells will be higher in more populated areas as less in areas with smaller populations; also the density of wells is likely to be higher in high productivity aquifers than in low productivity aquifers. These variations in density are also expected to influence the nature of the surface extrapolated between data points. Data used was complied based on well driller’s records and are expected to reflect the interpretations of the individual drillers.

The individual data points were also interpolated using GIS functions which assume that there is a degree of randomness to the data and that the surfaces are indeed continuous. Because of the nature of aquifers and the known potential for local and regional variations that are not described by the current dataset it is important to recognize that additional data from any area may provide additional insight into the

aquifer conditions that are not provided by the current study, it is important to note that in the current study additional data was used to verify the AVI results. Despite this verification the results of the analysis are based on simplifying assumptions that should only be applied using professional judgement. The conclusions arrived at based on these results are based on data that exists at present and it is recognized that future data may result in changes to the results.

5.3 Aquifer Vulnerability Ratings

The vulnerability indices were grouped to create ratings which were then used to construct an aquifer vulnerability map of the study area. AVI values less than 30 are rated as High Vulnerability. Values between 30 and 80 are Medium vulnerability. Any value greater than 80 is classified as having a Low Vulnerability. The various vulnerability ratings based on the computed index is shown in Table 3.

Table 3 AVI Index Ratings

AVI Index	Vulnerability Rating
<30	High
30 to 80	Medium
>80	Low

The AVI surface was prepared for the entire Town of Shelburne and identified areas as areas of high, medium and low susceptibility to contamination (vulnerability) based on the aquifer tapped by the municipal wells and as outlined in the previous sections.

The initial vulnerability map is provided in Figure 5.1. The map illustrates that within the Town of Shelburne's boundaries the aquifers are classed dominantly as medium vulnerability with two windows of high vulnerability located towards the western edge of town in the vicinity of the WHPA-A for PW3 and the WHPA-D for PW2. There is also a significant area of high vulnerability located on the eastern side of the Town and extending to outside of the municipal boundaries. There is also an area of low vulnerability that is located on the southern edge of the town in the vicinity of the WHPA-D for PW1. This area extends to outside the municipal boundary. There is also a small area of low vulnerability on the western edge of town in the vicinity of PW4 and PW5.

Areas of high vulnerability may be associated with the occurrence of sandy deposits in the vicinity of some of the drainage channels as shown on the overburden geology map or with the occurrence of thin overburden layers in the general vicinity of the municipality.

5.3.1 Transport Pathways

Rules 39 to 41 of the Technical Rules: Assessment Report (Clean Water Act 2006) allows for an increase in vulnerability rating of an aquifer due to the presence of

transport pathways that may increase the vulnerability of the aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer.

Transport pathways are developed where man-made features in the aquifer provide a path along which contaminants can migrate to the regional aquifer. Section 5.0 of the MOE Draft Assessment Report (MOE, 2006) provides a list of pathways that can allow contaminants to migrate to a drinking water source.

The vulnerability of an area may be increased from low to medium or high and from medium to high based on the presence of transport pathways. The Technical Rules: Assessment Report (Clean Water Act 2006) outline that when determining whether the vulnerability of an area is increased and the degree of increase the following factors should be considered:

1. Hydrogeological conditions
2. Type and design of any transport pathways
3. The cumulative impact of any transport pathways; and
4. The extent of any assumptions used in the assessment of the vulnerability of the groundwater

The following features were considered as transport pathways within the context of the current study.

Subsurface Utilities

Utilities that are constructed in the sub-surface are potential preferential pathways as they provide a pathway for contaminants to enter into the aquifer below. Utilities that may act as preferential pathways include storm-water trunk sewers and sanitary infrastructure. The depth of excavation for the construction of utilities will determine the risk that these features pose on the municipal supply aquifer. Since the aquifers used by the municipal supply wells are generally protected by an upper aquitard, the risk due to subsurface utilities is low. Within the Shelburne area, municipal information on the locations of sewers and other subsurface utilities was utilized within the current study to evaluate the potential for these utilities to become transport pathways. In the case where a utility was thought to present a possibility of becoming a transport pathway, the vulnerability rating of the underlying aquifer was increased to the next higher category to account for the presence of the pathway. Vulnerability was increased in a band that represented the width of the municipal right of way associated with that particular utility.

Domestic Water Wells

Domestic water wells are the most common man-made preferential pathway in rural areas. Improperly constructed wells can potentially introduce a cumulative impact to drinking water sources especially when the casing deteriorates. Similarly, if the well is no longer in use, improper abandonment also provides a preferential pathway for a contaminant to impact a drinking water source.

It is a requirement of Ontario Regulation 903 that unused wells be properly abandoned by a licensed well contractor. However, proper well abandonment is not actively enforced or monitored; therefore it is difficult to assess how many abandoned wells may exist within the WHPAs.

A review of water well records from the MOE water well database and a field survey were conducted to identify wells within the WHPAs. The wells were then ranked based on their risk to the supply aquifer. This process is described in detail in Appendix D. The survey resulted in the identification of 124 water wells within the WHPAs and classified 71 of the wells as high risk. A map of identified water wells and their risk ratings is provided in Figure D-1, Appendix D.

5.3.2 Increase in Vulnerability

The increase in vulnerability is generally limited to one rank (low to medium or medium to high) except in extreme cases where the constructed pathway is considered to increase the vulnerability of the aquifer from low to high. These cases may occur at pits or quarries that completely breach any low permeability layers overlying a deeper aquifer.

The main transport pathways of concern are water wells. Water wells present a risk to the municipal supply as they may create a conduit for contaminants to enter the aquifer. To account for the potential risk for contaminants to enter the aquifer by high risk wells, the vulnerability around each well for a 30 m radius was increased by one category. High risk wells were identified in a water well survey and risk analysis included in Appendix D. A 30 m radius has been chosen based on the recommended setback distance from contamination sources in the Ontario Regulation 903 as amended. This distance has also been incorporated in the Ontario Building Code.

The increase in vulnerability around high risk wells is shown in Figure 5.2 to 5.4. Within the current study an upgrade of vulnerability based on transport pathways was only performed for areas that fell within the WHPAs delineated as part of the study. It is possible to upgrade the overall vulnerability of the study area, however there is ongoing debate on the process by which this should be done and the proposed methodology. In the context of this discussion and the need to complete the Watershed Assessment Report the above methodology was agreed and implemented.

6.0 Vulnerability Scoring

As described in the Technical Rules: Assessment Report (Clean Water Act 2006), a vulnerability score is assigned to each vulnerable area according to the groundwater's susceptibility to becoming contaminated and that contamination reaching a well. Within WHPAs the vulnerability score is determined based on overlaying the aquifer vulnerability classification (high, medium, low) with the defined WHPA zones.

The vulnerability scoring was completed in accordance with Rule 83 of the Technical Rules: Assessment Report (Clean Water Act 2006). Vulnerability scores range from 10 for areas with the highest vulnerability to 2 for areas with low vulnerability. Scores were assigned as per Table 2(a) in Part VII of the Technical Rules: Assessment Report (Clean Water Act 2006). A summary of the process used to define vulnerability scores is outlined in the Table 4 below:

Table 4 WHPA Vulnerability Scores using AVI

	Vulnerability Score		
	High (<30)	**Medium (30-80)**	**Low (>80)**
WHPA-A 100 m (exclusion)	10 (irrespective of vulnerability)		
WHPA-B	10	8	6
WHPA-C	8	6	4
WHPA-C1	8	6	4
WHPA-D	6	4	2

The vulnerability scores developed for the Shelburne wells are shown in Figure 6.1 to 6.3.

6.1 Vulnerability Scores for WHPA-E

The Technical Rules: Assessment Report (Clean Water Act 2006) outline that the vulnerability score for a WHPA-E is determined based on the same principles as an IPZ-2 which is defined based on professional judgment as a product of Area Vulnerability (V_a) and Source Vulnerability (V_s) factors. Within the current study area vulnerability and source vulnerability were developed using the following methodology.

Area Vulnerability was calculated based on surficial geology, slope and land use within the delineated WHPA-E. Each factor was rated as either vulnerable or not vulnerable and assigned a score of 1 or 0, respectively. Scores were summed at the end of the analysis and based on total score of 1, 2, or 3, the area vulnerability was ranked as 7, 8 or 9.

Source Vulnerability was calculated based on the depth of the well and the dimensions of the associated water body and the inferred potential for dilution of contaminants within that body. Wells that were less than 15 m deep were regarded as vulnerable and given a score of 1, those greater than 15 m deep were scored as 0 for less vulnerable. The

dimensions of each water body and the potential for dilution of contaminants were examined. A water body with a large capacity for dilution was rated as low vulnerability and scored as 0 while a water body with low potential for dilution was rated as 1. These numbers were summed to produce the overall source vulnerability which was assigned as a summed score of 1 representing a source vulnerability of 0.9 and a summed score of 2 representing a source vulnerability of 1.0.

The overall vulnerability score for the WHPA-E at Shelburne PW1 as determined by the above methodology is 6.3. This score has been applied to the WHPA-E in Figure 6.4. Table 5 summarizes the derivation of the final vulnerability score for the WHPA-E of Shelburne PW1. The methodology used for the derivation of the vulnerability score is provided in Appendix B.

Table 5 WHPA-E Vulnerability Score

Well	Intake Type	Area Vulnerability Factor	Source Vulnerability Factor	Final Vulnerability Score
PW1	D	7	0.9	6.3

7.0 Vulnerability Uncertainty Assessment

The Technical Rules: Assessment Report (Clean Water Act 2006) require that an analysis of uncertainty be completed for all components of the Vulnerability Assessment including the vulnerability of groundwater on a regional scale, the delineation of the wellhead protection areas and the vulnerability of the wellhead protection areas.

The vulnerability assessment is a combination of several components each with their own uncertainty associated to them. These components include regional groundwater mapping and ISI vulnerability, WHPA delineation for groundwater and for surface water, mapping of transport pathways and increase in vulnerability based on transport pathways.

7.1 WHPA Uncertainty

7.1.1 Groundwater Flow Model Uncertainty

The groundwater model used for the WHPA delineation was developed to represent five subsurface layers and was calibrated using approximately 1,000 data points from across the model domain. Existing data from the MOE water wells database as well as from other sources was incorporated into the development of the model. The model was calibrated to steady state conditions with a NRMS error of 6.1%. This is considered to be well below the target level of 10% for groundwater models.

Sensitivity analysis was also conducted on the model to evaluate the impact of changes in input parameters on the calibrated model. This analysis indicated that the model responded most significantly to changes in hydraulic conductivity and therefore any errors in the estimation of this parameter are likely to have a significant impact on the model. Based on the regional nature of the model several assumptions on lithology, recharge and aquifer properties were made. Despite these assumptions it is recognized that groundwater modelling offers the most precise methodology for the delineation of WHPAs. Based on the stated NRMS error and the number of data points used for the calibration of the model it can be concluded that the model is a good representation of the hydrogeological understanding of the aquifer system in Shelburne. Hydraulic conductivity which was recognized as the most sensitive parameter in the model was estimated using representative values for the various formations that are consistent with the current body of knowledge within the field of hydrogeology. It can be concluded that based on the methodology and background professional assumptions that the calibrated model represents a low level of uncertainty in the predicted results.

Despite the low uncertainty of the model results, it is also known that there is a general uncertainty in the water well database that was used for the calibration of the model. However this uncertainty is a factor in all of the calculations performed during this study and would be persistent throughout any methodology selected for the delineation of WHPAs or the computation of vulnerability. The uncertainty of the database can therefore be assumed to be a professional uncertainty associated with evaluation of parameters that are for the most part in the subsurface and subject to individual

interpretations. Based on the evaluations that would have gone into the development of the model it is interpreted that the uncertainty associated with the database is low.

7.1.2 Capture Zone Delineation Uncertainty

Time of travel capture zones were delineated using the groundwater model above described. The use of groundwater models for this delineation is recognized as the most precise method of capture zone delineation. The uncertainty associated with the groundwater model has been discussed in the preceding section. Capture zones were delineated using reverse particle tracking. In this methodology, water particles are placed within the well and the groundwater model then predicts the pathway that this particle would have taken over time in on its journey to the well. Uncertainty in the delineation of capture zones is mainly associated with the number of particles that can be placed at the well. Due to the relatively small number of particles that can be released, there are distinct gaps between the pathways determined for each particle. Professional judgment is then used to interpolate between particle tracks and to produce a cumulative zone. The greatest level of uncertainty lies with the interpolation of shape of the zone in the area between particles. However based on known relationships groundwater flow is anticipated to be similar in adjacent areas as groundwater flow may be typified as being non convergent across flow lines. Therefore it can be assumed that the direct interpolation of areas between flow paths is reflective of the actual flow paths and do not represent an area of significant uncertainty. The uncertainty of the capture zone delineation is considered to be low.

7.1.3 Uncertainty of WHPA-E Delineation

Information used for the delineation of the WHPA-E included flood plain extent mapping and high definition terrain modeling. Cross-sectional analysis was completed using surface water modelling and GIS. The analysis associated with the delineation of the WHPA-E was conducted using methodology outlined in the MOE Draft Guidance Module 5 – Surface Water Vulnerability (December 2006). The cross sectional analysis was based on the high definition terrain model for the area which had a resolution of 1 m for the vertical. This terrain model provided detailed information for the analysis which was also verified by field visits. Professional judgment was used to estimate additional parameters necessary for the computation of stream flow in the study are. The field visits also helped with the verification of these assumptions. Considering the level of detail available for analysis and delineations there is low level of uncertainty assigned to the WHPA-E.

Based on the methodologies applied and the existing data for the computation and delineation of well head protection areas it can be concluded that there is low uncertainty associated with the groundwater modelling and delineation of WHPAs as part of the current project.

7.2 Vulnerability Uncertainty

7.2.1 Uncertainty of AVI Mapping

The main uncertainty in the AVI mapping is associated to the quality of the data used to interpret the geologic and numerical model layers. The main source of information used in the AVI mapping was the MNR water well database. This database has a high amount of uncertainty associated with it as described in Section 5.1. It is however noted that this database represents the most extensive dataset from which an analysis of aquifer properties can be undertaken. Within this project, the exclusion of some wells due to a considered low reliability, the inclusion of additional data including MNR data and the quality assurance review of the computed surfaces is expected to have reduced the uncertainty associated with the use of this database. This reduction of uncertainty is assumed to have been most significant within the WHPAs where the highest data density usually occurs. It is concluded that the uncertainty of the vulnerability mapping is therefore low within the WHPAs in the study area.

7.2.2 Uncertainty of Transport Pathways

In this study the vulnerability and vulnerability scores are impacted by the presence of transport pathways. The uncertainty in transport pathways is mainly associated to the use of water well records. Mapping of aggregate operations are fairly accurate and have low uncertainty.

The location of the wells mapped as transport pathways were taken from the MOE Water Well database. Information from the database regarding depth of wells and year of construction were used to assess the risk of the well. As previously described, there is a certain amount of uncertainty associated to the MOE Water Well Database. A water well survey was completed to reduce the uncertainty of the water well database by verifying the locations of the wells. Through the survey the locations of some of the wells within the WHPAs were improved, however the majority of the wells could not be located during the water well survey. It is noted that during the completion of the groundwater study in 2001, Burnside has also updated the positions of wells located in the vicinity of the municipal wells. This information was incorporated into the current study and therefore it can be assumed that there is generally a low level of uncertainty regarding the locations of wells within the WHPA. There does remain a higher level of uncertainty regarding the construction details of these wells, however the revision of vulnerability in the current methodology is only applied to a limited area around each well and in this light any uncertainty associated with this revision is of fairly limited extent in the context of this project. Therefore it can be concluded that the uncertainty associated with the vulnerability updates due to transport pathways is low.

Using information from the vulnerability mapping and the transport pathway update it is concluded that the uncertainty of the overall vulnerability score can be considered to be low.

8.0 Issues Evaluation

A drinking water issue is identified as the occurrence of a parameter or pathogen in water at a surface water intake or well at a concentration that result in or may result in the deterioration of the quality of the water for use as a source of drinking water (MOE, 2009a).

When a parameter that exceeds the Ontario Drinking Water Quality Standards (ODWQS) is naturally occurring in the source aquifer, there has been no deterioration of the water quality due to anthropogenic influences and therefore this exceedance is not considered to be an issue.

The Technical Rules: Assessment Report (Clean Water Act 2006) state that a drinking water issue includes when a 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 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.

Rules 114 (1,2) of the Technical Rules; Assessment Report (Clean Water Act 2006) provide that an issue is identified when a parameter or pathogen is identified as exceeding parameters listed in Schedule 1,2 and 3 and Table 4 of the Technical Support for the ODWQS at a water supply well or associated monitoring well for a drinking water system for which clause 15(2)(e) of the Clean Water Act applies. An issue may also be identified if the parameter is not exceeding but shows a trend of increasing concentrations that may result in an exceedance in the future. For drinking water systems that are not included in Clause 15(2)(e) of the Clean Water Act, only parameters of Schedule 2 and 3 and Table 4 of the Technical Support Document for the ODWQS are of concern and pathogens are not considered. Clause 15 (2)(e) of the Clean Water Act applies to all wells included in this study.

8.1 Methodology

As part of the issues evaluation, Burnside assessed whether any contaminants are impacting or have the potential to impact or interfere with Shelburne's drinking water source by a review of available water quality data. This included the following steps:

- Collection of water quality data.
- Water quality data was compared to the ODWQS to determine if any parameters were in exceedance.
- Parameters of consideration were identified and plotted to determine if there were any increasing trends.
- Parameters were assessed to be issue.
- Operator Interview.

8.2 Water Quality Review

Water quality data was collected from the following sources:

- Shelburne Groundwater Management Study, Burnside 2001;
- The MOE Drinking Water Systems O. Reg. 170/03, Annual Report 2003, 2004, 2006, 2007, 2008 and 2009; and
- PTTW Annual Monitoring Reports.

Monitoring well locations are provided in Figure D-1 (Appendix D).

Historical water quality results recorded between 1990 and 2000 from the Shelburne Water System were reviewed to identify any past water quality concerns (Burnside, 2002). The results of samples taken between 1990 and 2000 showed exceedences of Ontario Drinking Water Quality Standards (ODWQS) for the parameters of hardness, iron and manganese (Appendix E). These parameters are identified in the ODWQS as non-health related parameters and are not anticipated to interfere with the use of the groundwater as a source of drinking water.

The MOE Drinking Water Systems O. Reg. 170/03, Annual Report 2003, 2004, 2006, 2007, 2008 and 2009 for the Shelburne Water Supply System were reviewed to identify any water quality concerns. No exceedences were identified; however arsenic exceeded half the standard in 2003, 2004, 2006, 2008 and 2009. The ODWQS for arsenic is 25 µg/L.

The PTTW for the Shelburne wells requires that quarterly sampling for arsenic is completed at the production wells and monitoring wells (Burnside, 2009). Measured arsenic concentrations collected in 2004 to 2009 were reviewed. The results for production wells and monitoring wells are summarized in Appendix E, Tables E-1 and E-2.

Microbiological data collected by Ontario Clean Water Agency (OCWA) from 2006 and 2007 were reviewed. Well 1 had detectable levels of *E.coli* in two of the 71 samples, and total coliforms in 20 of the 71 samples. Well 2 had two of the 71 samples detectable for total coliforms, but none for *E.coli*, and Well 6 had one out of 70 samples detectable for total coliforms. Wells 3 and 5 had no detectable levels of *E.coli* or total coliforms. The Shelburne Water Supply System has adequate treatment to handle the occasional presence of pathogens and this occurrence is not considered to be an issue.

A summary of all chemical water quality data reviewed is included in Table E-3, Appendix E.

8.2.1 Limitations of Data

The water quality data reviewed includes data from 2000 to 2009. This is a limited time span making it difficult to identify trends, especially when not all parameters were sampled during each year.

8.3 Issues Analysis

The following parameters were identified as parameters of concern: iron, hardness, manganese and arsenic. These parameters have been plotted in Figures E-1 to E-6 to identify long term trends.

Iron

High iron concentrations in the groundwater have been identified in the annual reports as an aesthetic concern. Iron is an aesthetic objective, which means that it may impair the taste, smell or colour of the water or interfere with good water quality control practices. Iron concentrations plotted in Figure E-1 indicate that concentrations in Wells 2, 3, 5 and 6 are in exceedance of the ODWQS aesthetic guideline of 0.3 mg/L. To control the release of iron into the water, treatment including iron sequestering is applied to Shelburne's raw water before distribution. Since iron is an aesthetic objective and levels are treated to acceptable levels it is not considered a drinking water quality issue.

Hardness

Hardness concentrations ranging from 232 to 363 mg/L were reported in historical water quality data for the Shelburne wells (Figure E-2). These levels are elevated above the Operational Guideline (OG) range of 80-100 mg/L listed in the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines, 2006. This level of hardness is typical of drinking water obtained from a bedrock source and is therefore naturally occurring. Hardness in water is also an aesthetic objective and is typically handled using household water softeners; hardness therefore should not interfere with the use of water from these sources.

Manganese

Manganese is considered an aesthetic objective in the ODWQS. Elevated levels of manganese are a result of naturally occurring minerals in many bedrock aquifers. Figure E-3 illustrates that all but one data point fall below the ODWQS aesthetic objective of 0.05 mg/L. It is possible that this point represents an anomalous value that is not reflective of the overall values in the aquifer. Based on the noted level of manganese associated with the remaining values it is concluded that manganese is not considered a water quality issue for the Shelburne water supply system.

Arsenic

Currently the ODWQS for arsenic is 25 µg/L, however in 2006 Health Canada revised the CDWQG for arsenic to 10 µg/L (Health Canada, 2006). Ontario is currently reviewing the adoption of a more stringent ODWQS for arsenic (10 µg/L).

Figure E-4 indicates that the arsenic concentrations in Well 1 and 2 are well below the ODWQS. Arsenic levels seemed to be increasing up to 2005 but have decreased since and show no further increasing trend.

In Figure E-5 the arsenic concentrations of Well 3 are below the ODWQS and do not have any increasing trend. They are however above 10 µg/L and if the ODWQS were to change to 10 µg/L, would be in exceedance. Data collected from monitoring wells MW3-16 and MW3-20 show a cyclic variation in levels that represent seasonal or annual variations within the aquifer.

The arsenic concentrations for Well 5 and 6 are plotted in Figure E-6. The figure indicates that arsenic concentrations have hovered around the ODWQS in the past however current concentrations are not in exceedance. The data was plotted to identify long term trends and did not show any increasing trend. Current levels are however above 10 µg/L. If the ODWQS were to change to 10 µg/L, they would be in exceedance. It is noted that the Town of Shelburne is currently looking for new water supply wells and looking at treatment options for the arsenic.

Based on a review of the existing literature on this occurrence, it is concluded that the arsenic in the Shelburne wells is naturally occurring and common in groundwater originating from shale bedrock in this area. In accordance with the Technical Rules: Assessment Report (Clean Water Act 2006) with the arsenic in the Shelburne wells being naturally occurring there is no issue with this parameter and thus the delineation of an issue contributing area is not required.

There were no issues identified for the Shelburne Municipal Water Supply System.

9.0 List of Drinking Water Threats

9.1 Definition of Drinking Water Threats

According to MOE Guidance Module 5, a threat is defined as a chemical or pathogen contaminant that poses a potential risk to the drinking water sources (MOE, 2006). Threats are considered to be of two main types; threats related to current land use practices - activities and threats related to pre-existing circumstances - conditions. Both of these threat types are described in the following sections.

9.1.1 Description of Drinking Water Threats - Activities

The Technical Rules: Assessment Report (Clean Water Act 2006) provides a list of prescribed activities that are considered as threats under the current inventory. These threats are listed below:

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

Prescribed threats 19 and 20 are water quantity threats and are not relevant to this study.

In addition to the above prescribed threats, the Source Water Protection Committee has the ability to include additional threats specific to their source water protection area

where they see appropriate as long as the threat meets the criteria outlined in the Technical Rules Section XI.2. There were no additional threat activities added for this study.

The Table of Drinking Water Threats (Clean Water Act 2006) provides the circumstances for which a prescribed drinking water threat may be considered a drinking water threat of concern for each vulnerable area. The MOE has issued the above table to provide the threats and the circumstances under which they may be considered to be low, moderate or significant drinking water threats based on the combination of vulnerability and risk. As initially published the table is over 400 pages long and contains reference to all the prescribed threats recognised by the MOE. Due to its size, the use of the table has proven to be cumbersome. As a response to this feature of the table, the MOE has provided an update to the table as described below.

The revised table includes reference codes (e.g. 3(CW10M)) that refers to supplemental tables that list all of the threats and associated circumstances that are or would be significant, moderate and low drinking water threats in Wellhead Protection Areas. The MOE had provided these tables to assist with searches for threats, to simplify the manipulation of the table and for ease in communicating all possible threats in specific vulnerable areas. Each alphanumeric code refers to one of 76 supplemental tables that have been provided by the MOE. A list of these supplemental tables is provided in Appendix F.

Table 6 provides the reference numbers and codes for the tables that apply to the Shelburne WHPAs for pathogen, chemical and dense non-aqueous phase liquid (DNAPL) threats.

Table 6 Significant, Moderate or Low Drinking Water Threats: Pathogen, Chemical and DNAPL

Threat Type	Vulnerability Area	Vulnerability Score	Threat Classification and Provincial Table Reference Code		
			Significant	**Moderate**	**Low**
Chemical	WHPA A,B,C,D	10	1(CW10S)	3(CW10M)	6(CW10L)
		8	2(CW8S)	4(CW8M)	7(CW8L)
		6	-	5(CW6M)	8(CW6L)
	WHPA-E	6.3	-	30(CIPZWE6.3M)	38(CIPZWE6.3L)
DNAPL	WHPA A,B,C		9(DWAS)	-	-
	WHPA-D	6	-	10(DW6M)	11(DW6L)
Pathogen	WHPA A,B	10	12(PW10S)	13(PW10M)	-
		8	-	14(PW8M)	15(PW8L)
		6	-	-	16(PW6L)
	WHPA-E	6.3	-	56(PIPZWE6.3M)	65(PIPZWE6.3L)

Pathogen threats are only considered within WHPA-A and WHPA-B. DNAPL threats are classified as significant when located in WHPA-A, B or C regardless of the risk score.

Maps showing the vulnerable areas for this study that may include low, moderate or significant drinking water threats are provided in Figures 9.1 to 9.3.

9.1.2 Description of Drinking Water Threats - Conditions

In addition to present land use activities, any conditions resulting from past activities are also considered drinking water threats. As described in the Technical Rules: Assessment Report, the following conditions are considered drinking water threats if located within vulnerable areas:

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

Conditions are rated significant, moderate or low based on their hazard score multiplied by the vulnerability score of the vulnerability area they are located in. According to the Technical Rules: Assessment Report (Clean Water Act, 2006) (Rule 139), a condition may be assigned a hazard score of six or ten. A hazard score of 10 is applied if there is evidence that the condition is causing off-site contamination and/or the condition is on a property or well related to the drinking water system. A hazard score of 6 is applied in all other situations.

A map showing the vulnerable areas which may include low, moderate or significant conditions is provided in Figure 9.4.

10.0 Threats Inventory

The Technical Rules: Assessment Report (Clean Water Act 2006) requires that all significant threats within the vulnerable areas be identified. To identify the significant threats a database of threats within the vulnerable areas was created. This database was based on information previously collected during previous studies and following guidelines provided by the MOE in Draft Guidance Module 6 (MOE, 2006a). A summary of the process conducted to populate the database is provided below.

The threats inventory was compiled using the data from various sources that were reviewed as part of this study. The inventory was completed to include threats defined as both activities and conditions. Following the preliminary research, Burnside used field assessments to verify and complete the threats inventory process. As a conservative measure no effort to include the impact of management techniques that may be employed at any threat location was considered. It can therefore be concluded that the level of uncertainty associated with this inventory is high. It is through a re-evaluation of the prioritized threats that the level of uncertainty associated with the current results will be reduced.

10.1 Data Sources

The threats inventory was compiled using the data and information sources outlined below. Following the preliminary research Burnside used field assessments to complete the threats inventory. All threats were recorded in a database provided by the MOE.

10.1.1 Municipal Planning Documents

Municipal planning documents including The Town of Shelburne Official Plan September 2006 and Consolidated Zoning By-Laws September 2007 were reviewed to identify permitted land uses within the WHPA.

Land uses within the WHPA for Wells 1 and 2 include residential, commercial, natural environment, institutional, open space recreational, and industrial. Well 3 includes residential, natural environment, and non-urban land uses. Well 5 and 6 include non-urban and natural environment.

According to the Town of Shelburne Official Plan within residential lands, uses permitted include all forms of living accommodation except for mobile homes. Commercial areas will be predominantly used for commercial uses. Secondary uses can include recreational and cultural facilities, public, community and institutional uses, parks and open space and dwelling units located above commercial establishments. Light manufacturing is permitted as an accessory use to a permitted commercial use depending on size. Industrial areas will be predominantly used for industrial uses. Some uses permitted include manufacturing, processing, fabricating, and assembly of materials as well as repair, servicing, distribution, and storage of materials, transportation facilities, and commercial uses such as financial institutions, restaurants, and recreational establishments supportive of the industrial area. Open Space Recreation areas are primarily used for open space and/or recreational purposes. Some

uses permitted include parks, arenas, community centres, museums, recreational clubs, agriculture, forestry, wildlife management, and minor institutional and public uses. Natural Environment is predominantly used for conservation purposes. Passive recreational uses such as trails may be permitted in some areas subject to approval. Institutional areas will be predominantly used for institutional areas. Permitted uses include public buildings and establishments, religion institutions, schools, cemeteries, hospitals, convalescent homes, senior citizen homes, apartments, nursing homes, and group homes. Non-Urban is predominantly used for agricultural and rural purposes.

For more detailed definitions of land use areas refer to the Town of Shelburne, Official Plan (Town of Shelburne, 2006).

10.1.2 Aerial Photo Interpretation

Historical aerial photographs from 1983 were obtained from the University of Waterloo Map and Design Library and reviewed to identify land use changes and potential high-risk activities such as waste disposal sites within the well capture zones. Aerial Photography available to the Town of Shelburne based on a 2002 Ministry of Natural Resources (MNR) survey was also utilized as part of this study. While the resolution of the photographs limits the detail that can be observed of the surface conditions, the following is a summary of what can be discerned:

1983 Aerial Photography

The WHPA is located over the urban Town of Shelburne and its surrounding agricultural areas. Most of the WHPA is used for agricultural uses. Review of the photo identified a recorded waste disposal site on Greenwood Road. The disposal site recorded as closed in 1962, shows evidence of moved earth and construction activities on the site. Rural residences and farms are located along the County roads. There does not appear to be any pits or quarries located within the WHPA boundaries.

2006 Aerial Photography

In the 2006 air photographs, the urban boundaries of Shelburne are similar to the ones in 1983. New residential development has occurred east of the Town fairgrounds. The waste disposal site identified in the 1983 photograph is now grown over and is parkland. A large wood processing plant has been built at Wellington and Main St. A possible aggregate pit is located near the intersection of 2nd Line and Highway 89. Several rural residences and residential ponds have been built in the WHPA.

10.1.3 Ecolog ERIS Search

EcoLog Environmental Risk Information Services Ltd. (EcoLog ERIS) is a national database service, which provides specific environmental and real estate information for locations across Canada. A review of all available provincial, federal and private environmental databases was requested for the area comprising the WHPA for each of the wells included in the current study. The search included the following databases:

Federal Government Source Databases

- National PCB Inventory 1988-June 2004
- National Pollutant Release Inventory 1994-2004
- Environmental Issues Inventory System 1992-2001
- Federal Convictions 1988-January 2002
- Contaminated Sites on Federal Land June 2000-2005
- Environmental Effects Monitoring 1992-2004
- Fisheries & Oceans Fuel Tanks 1964-September 2003
- Indian & Northern Affairs Fuel Tanks 1950-August 2003
- National Analysis of Trends in Emergencies System (NATES) 1974-1994
- National Defence & Canadian Forces Fuel Tanks Up to May 2001
- National Defence & Canadian Forces Spills March 1999-February 2005
- National Defence & Canadian Forces Waste Disposal Sites 2001,2003
- National Environmental Emergencies System (NEES) 1974-2003
- Parks Canada Fuel Storage Tanks 1920-January 2005
- Transport Canada Fuel Storage Tanks 1970-May 2003

Provincial Government Source Databases

- Certificates of Approval 1985-September 2002
- Ontario Regulation 347 Waste Generators Summary 1986-2004
- Ontario Regulation 347 Waste Receivers Summary 1986-2004
- Private Fuel Storage Tanks 1989-1996
- Ontario Inventory of PCB Storage Sites 1987-April 2003
- Compliance and Convictions 1989-2002
- Waste Disposal Sites – MOE CA Inventory 1970-September 2002
- Waste Disposal Sites – MOE 1991 Historical Approval Inventory Up to October 1990
- Occurrence Reporting Information System 1988-2002
- Pesticide Register 1988-August 2003
- Wastewater Discharger Registration Database 1990-1998
- Coal Gasification Plants 1987, 1988
- Non-Compliance Reports 1992(water only), 1994-2003
- Ministry Orders 1995-1996
- Aggregate Inventory Up to May 2005
- Abandoned Aggregate Inventory Up to September 2002
- Abandoned Mines Inventory System 1800-2005
- Record of Site Condition 1997-September 2001
- Ontario Oil and Gas Wells (1999-Oct 2004; 1800-May 2004 available for 14 select counties)
- Drill Holes 1886-2005
- Mineral Occurrences 1846-October 2004
- Environmental Registry 1994-July 2003

Private Sources Databases

- Retail Fuel Storage Tanks 1989-June 2005
- Canadian Pulp and Paper 1999, 2002, 2004, 2005
- Andersen's Waste Disposal Sites 1930-2004
- Scott's Manufacturing Directory 1992-2005
- Chemical Register 1992,1999-June 2005
- Canadian Mine Locations 1998-2005
- Oil and Gas Wells October 2001-2005
- Automobile Wrecking & Supplies 2001-June 2005
- Anderson's Storage Tanks 1915-1953
- ERIS Historical Searches, March 1999-200

The database search identified numerous items within the search radius around the various WHPAs. Some items included Certificates of Approval's, registered waste generators, retail fuel storage tanks, spills recorded in the Occurrence Reporting Information System and waste disposal sites. All potential contaminant sources identified were verified in the field and compiled into a database. The source database for each item is included in the database.

10.1.4 Municipal Parcel Assessment Codes

Data from the Municipal Property Assessment Corporation (MPAC) was obtained from the NVCA. This data classifies parcels by land use and is generally used by Municipalities for tax purposes. For this reason it is a fairly up to date and a reliable source of information to identify land uses on a parcel basis. The data obtained was used for land use classification where other data was not available and for servicing information such as whether the parcel has water or sanitary services. The MPAC data was also useful in identifying agricultural land types.

10.1.5 Site Reconnaissance

Burnside conducted a drive-by roadside inspection of the WHPAs on June 27, 2007 to verify and compliment the dataset compiled during the records review portion of the assessment. The inspection comprised a fence line/roadside documentation of the properties in the WHPAs and their land uses included.

The Shelburne WHPAs include part of the Town of Shelburne and some surrounding rural lands west of the Town. Within Shelburne most of the commercial land use is located on the Main Street. Residential and institutional land uses are located on either side of Main Street. Industrial land use is located on Main Street but at the boundaries of the Town. This includes a large wood preserving plant and mill.

There is a large mix of ages of homes within the Town and some of the older homes look like they have the potential for an old well and septic system. Above ground storage tanks for heating fuel were also noted. Some new residential development is

taking place on the south, southwest boundaries of the Town. Rural lands outside of the Town were used for cash crops, some livestock and rural residential.

An old garbage dump site was visited during the field visit. The dump was fully rehabilitated and converted into a park. Monitoring wells were located within the area. No quarries or gravel pits were noted within the well capture zone during the site inspection.

10.2 Identified Threats - Activities

10.2.1 Managed Land and Agricultural Activities

The storage, handling and application of pesticides, fertilizers and agricultural source material associated with managed land and agricultural activities can result in surface water runoff and potential pathogen and chemical contamination.

Managed land is determined to be any land to which there may be the application of agricultural source material (ASM), commercial fertilizer, or non-agricultural source material (NASM). Managed land includes crop land, fallow land, improved pasture, golf courses, sports fields and lawns. Managed land can be broken down into two subsets; agricultural and non-agricultural managed land. Agricultural managed land includes cropland, fallow and improved pasture that may receive nutrients. Non-agricultural managed land includes golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer).

To measure the impacts from these activities on water supplies a methodology was developed in consultation with the LSRCA for the evaluation of percentage of managed land within each vulnerable area (WHPA for the current study) based on methods proposed by MOE in 2009. The methods used for this study are described in detail in Appendix G.

Under the methodology the percentage of managed land is computed based on the land area associated with that vulnerable area or area within the vulnerable area The percentage of agricultural managed lands are also evaluated separately from the overall managed land percentages. The overall percentage of managed land is used to categorize the landscape for further analysis of threats through the MOE provided Tables of Drinking Water Threats. For areas where the managed lands total accounts for less than 40% of the vulnerable area, the area is considered to have a low potential for nutrient application to cause contamination of drinking water sources. If the managed lands total accounts for 40% to 80% of the vulnerable area then the area is considered to have a moderate potential for nutrient application to cause contamination of drinking water sources. If the managed land total accounts for over 80% of the vulnerable area then the area is considered to have a high potential for nutrient application to cause contamination of drinking water sources. Maps of the vulnerable areas and associated managed land percentages for the Shelburne WHPAs are shown in Figures 10.1A and 10.1B.

10.2.2 Livestock Density

Livestock density is used as a surrogate measure of the potential for generating, storing and land applying ASM as a source of nutrients vulnerable areas. The livestock density is expressed as nutrient units per acre (NU/Acre) and is calculated based on the number of animals housed, or pastured on a farm unit that generate enough manure to fertilize an area of land. A more formal definition is provided in the MOE publication "*Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source Material, Non-Agricultural Source Material and Commercial Fertilizers*" (December, 2009). Methods used for calculation of livestock density are provided in Appendix G.

Livestock density was calculated for all properties that fell partially or totally within the WHPAs. The calculation was performed based on identifying the type of livestock that was housed on a particular farm and deriving the nutrient units per unit area of that farm unit associated with the particular livestock type. Based on the calculations, livestock density was divided using guidance provided by the MOE into the following ranges. Where the livestock density was <0.5 NU/acre (Nutrient Unit per acre) the potential for impact due to livestock was seen as low; where livestock density was 0.5 – 1.0 Nu/acre, the potential was medium and where the density was >1.0 NU/acre the potential is regarded as high. The livestock densities for vulnerable areas in the current studies are shown in Figures 10.2A and 10.2B.

For the current study, both livestock density and the managed land calculations were performed using aerial photography and satellite imagery along with GIS and MPAC data. The resulting analyses and the interpreted data was incorporated into the project database and utilized for the subsequent evaluations of threat ranking.

10.2.3 Septic Systems

Within the WHPAs, septic systems are assumed to be used at all rural homes and buildings outside of the Town limits. Septic systems that are not properly maintained can contribute to pathogen and chemical contamination in surface water. To identify properties with septic systems MPAC data was used to identify properties that had a building on it and were not municipally serviced. These parcels were assumed to have a septic system.

10.2.4 Sanitary Sewers

The Town of Shelburne is serviced with sanitary sewers. The wastewater is transported to the Shelburne Water Pollution Control Plant at the north-eastern edge of the town. The plant is currently approved to handle 2,971 m^3/day of wastewater (MOE, 2008). The sewers and their connections that transport the wastewater are considered threats as there is the potential for leaks to occur. For the enumeration of threats, only one threat has been enumerated to represent all sanitary sewers and connections within each vulnerable area.

According the to the Certificate of Approval (9972-7FY-JUB), sanitary trunk sewers run through the PW1/PW2 WHPAs starting near the intersection of Highway 10 and Highway 89 and run east along Highway 89 (MOE, 2008). There are no sanitary sewers within PW3 and PW5/6 WHPAs. The sewage pumping station and lagoons are not located within any of the WHPAs.

10.2.5 Impervious Surfaces

Impervious surfaces are defined in the Technical Rules as areas that receive road salt application and include roads and parking lots. The areas were determined using road mapping from the National Road Network (Natural Resources Canada) and satellite air photography to identify large parking lots and paved areas. Using a 1 km x 1 km grid centered over each vulnerability area, the percentage of impermeable surfaces within each square kilometre was calculated. The percentage of total impervious surface areas within each square kilometre of vulnerable areas is shown in Figure 10.3.

Road salt used on impervious surfaces such as roads and parking lost during the winter is regarded as a threat. The percentage of impervious surfaces is an indicator for the potential for impacts due to road salts. In areas with high levels of impervious surfaces (roads) there is an increased likelihood that road salts would be applied. The percent impervious surfaces within the area of application, is a circumstance provided in the Tables of Drinking Water Threats that factor into the determination of whether a threat is significant. The ranges for percentage of impervious surfaces per square kilometre provided in the Table of Drinking Water Threats (Clean Water Act, 2006) are >80%, 8-80%, 1-8% and <1%. The resulting analyses and the interpreted data was incorporated into the project database and utilized for the subsequent evaluations of threat rankings related to the application of road salt.

10.3 Identified Threats - Conditions

A review of available data regarding potential contamination within the WHPAs was completed. The data was based on information previously compiled for the project and included sources outlined in Section 10.1.3. Data available included databases from the Ecolog ERIS results such as Record of Site Condition, MOE Spills Database and Occurrence Reporting Information System and Data Hound files acquired from the MOE.

A historic landfill site is located at Greenwood Street within the WHPA-B of PW1 and PW2. According to the MOE 1991 Historical Waste Disposal Site Approval Inventory the site received municipal, rural and domestic waste and was closed in 1962. Water quality monitoring on the site was conducted from 1999 to 2005 (Burnside, 2005). Monitoring was discontinued with approval of the MOE since there were no increasing trends or potential significant impacts to water quality. Water quality results taken in May, 2005 exceeded the standards for potable water of Table 2 Soil, Groundwater and Sediment for the parameters of selenium and nitrate at one of the monitoring wells on site. There is no reported evidence that the site is causing off site contamination. According to the Technical Rules, the site is a condition with a hazard rating of 6. The risk score of the condition is 48 and therefore a low drinking water threat.

Two spills at an industrial site (wood preservative company) in Shelburne were identified by the MOE's Occurrence Reporting Information System. One spill occurred in 1990 and was 2,500 L of wood preservative spilled on the ground. The second spill occurred in 1991 and consisted of 2 L of oil spilt onto soil in the parking lot. These spills may have resulted in soil contamination however at this time there is no data to confirm that a condition exists. The Town of Shelburne may consider requesting this data from the land owners in the future.

There is one condition and one potential condition identified within the WHPAs for the Shelburne water supply system.

11.0 Identification of Significant Drinking Water Threats

The Clean Water Act requires that activities that are or would be drinking water threats within vulnerable areas be inventoried as part of the source protection process. As a part of the inventory process, the MOE provided guidelines for the ranking and classification of threats into significant, moderate and low risk categories. The following sections outline the process for inventory and classification of threats.

11.1 Threats Classification and Database

In order to classify activities in the study area the various databases and sources outlined in Section 10.1 were reviewed and information on site activities were compiled. Calculations outlined in Section 10.2 were referenced to determine circumstances under which each activity is taking place. The circumstances under which activities are considered threats and the classification of those threats are contained in the Table of Drinking Water Threats provided by the MOE.

The classification of threats is undertaken using the Tables of Drinking Water Threats defined by the MOE. The tables are comprised of two separate look-up-tables, one for chemicals and the other for pathogens. The Tables of Drinking Water Threats take into consideration all of the factors associated with the hazard of a particular chemical associated with an activity and the location of the activity within a vulnerable area.

The Tables of Drinking Water Threats allow each activity and the conditions it occurs under to be manually searched out from the table and provides an indication of the hazard associated with that activity through the hazard rating and an evaluation of the risk through the risk scores and categories.

In recognition of the potentially large number of data points that would need to be processed through the tables and the value of having a project database at the end of the process, the study team developed an automated process for the performance of the functions of the table. The development of the automated process allowed for the generation of hazard ratings and calculation of risk scores with the main quality control factor being the replication of the output defined by the Tables of Drinking Water Threats. It was noted that the automated process always produced the identical result to the manual process.

The automated process generates a project database that houses information on the threat and also includes the various component scores that are included in the final determination of risk category. The risk category in the automated process is calculated using processes described by the MOE in their document Threats EBR Lookups (MOE, 2009d) and is identical to that used by the Tables of Drinking Water Threats. The project utilized the automated process to enhance the speed and accuracy of the determination of threat categories over a manual search of the MOE Tables. The automated process used the Threats Look-up Tables Database v. 7.1.2 provided by the MOE (WRIP, 2009). As a quality control mechanism the calculated risk categories were verified by manual searches of the MOE Tables of Drinking Water Threats to ensure that

the automated calculations were correct for threats categorized as significant. A print out of the automated interface and database generated for the project is shown in Appendix H.

In order to ensure consistency in the approach for assumptions regarding various activities and the methodology for the evaluations of threats a consensus was arrived at among all consultants conducting work within the SGBSPR. Using the parameters defined in the consensus various threat subcategories and assumptions were provided, these assumptions are included as Appendix I.

Using the agreed approach the threat classification process was undertaken for all activities inventoried by the project database. For the current study the classification was undertaken using the automated database that replicated the MOE defined process. The following sections describe in more detail the calculations undertaken by the MOE threats classification system and replicated in the Burnside automated process.

11.1.1 Hazard Ratings

Each threat identified from the data review process is associated with at least one chemical or pathogen. The MOE tables provide a hazard rating for each chemical or pathogen that is to be considered as part of the current assessment.

Hazard ratings for the list of chemicals of concern were provided in the MOE Threats Look-up Tables Database (WRIP, 2009). For chemical threats this hazard rating was based on the following formula:

Hazard Rating = (0.25*T + 0.25*F + Q + RIM) / 2.5

Where T = Toxicity
F = Environmental Fate
Q = Quantity
RIM = Release to Environment (Release Impact Modifier)

This formula was developed by the MOE and provided in their guidance document Threats EBR Lookups (MOE, 2009c). As each threat activity has several chemicals associated with it, a hazard rating was calculated for each chemical. The Burnside automated process was developed to utilize the formula and values from the MOE process and the results of the automation were checked during development to ensure that the results corresponded to the manual MOE process. Using the automated process the highest hazard rating for each threat activity was assigned to that threat and was used to produce the risk score which will classify the threat as Low, Moderate or Significant.

The hazard rating assigned to each chemical threat is dependent on a quantity and Release Impact Modifier. These values are determined by the circumstances assigned to each threat activity which take into account the volume of chemical and the potential release pathways for which the chemical may enter the source water. Values for these parameters were assigned in the Burnside automation based on the prescribed values in

the MOE tables. The circumstances assigned to the threat were determined for each specific threat using information on threat activity. This process required some assumptions regarding typical storage practices and quantities of chemicals at a land use activity when site specific information was not available. The assumptions used for this study are further described in Appendix I. All assumptions are consistent with the minimum standards documented in the South Georgian Bay Lake Simcoe Source Protection Region recommendations (SGBLS Region, May 2010). It is expected that some of the circumstances will be refined for threats identified as significant as more information on the specific threat activity is collected.

For pathogen threats, the hazard ratings were taken from the MOE Look-Up tables Database (WRIP, 2009). These hazard ratings were based on the land use activity and the likelihood of it impacting the source water using a RIM rating. Table 7 provides the table for which the MOE pathogen hazard ratings were developed. The activity lists referred to in Table 7 are provided in MOE Guidance Module 5 (MOE, 2006). As for all other parameters, the values for Pathogen Hazard Rating within the Burnside automation were copied from the MOE prescribed values.

Table 7 Pathogen Hazard Ratings

Release Impact Modifier (RIM)	Activity List		
	List A (Significant)	List B (Moderate)	List C (Limited)
High	10	7	4
Moderate	9	6	3
Low	8	5	2

11.1.2 Risk Scores

The final component in the classification of the threats is the calculation of the risk score. The risk score is calculated by multiplying the vulnerability score as defined by the vulnerability component of the study (Section 6.0) with the hazard rating (Section 11.1.1) which provides a score out of 100. The risk score is classified as significant when the score is greater than 80, moderate when the score is less than 80 and greater than 60 and low when the risk score is less than 60 and greater than 40. All values lower than 40 are regarded as negligible and therefore these threats are not reported in the current study. In order to arrive at these numbers, the current project utilized the hazard rating coming out of the Burnside automated process as described above and the vulnerability score for the area of interest. These values were combined within a geodatabase with the resulting risk scores being used to classify the threats according to the prescribed categories of Significant, Moderate and Low within that database. In keeping with the requirements of the watershed Assessment Report, the activities that were categorized as significant based on the above described process were then included in further analysis as part of the current project. The overall geodatabase containing the automated hazard rating calculation component, the vulnerability scores, threat classification and other information on threats located in the vulnerable areas are included in the final project database.

11.2 Significant Drinking Water Threats

As per the Technical Rules; Assessment Report (Clean Water Act 2006), the enumeration of significant threats is required for the completion of the Assessment Report. Table 8 summarizes the significant threats identified in the WHPAs in the Town of Shelburne. A more detailed table is provided in Appendix J.

Table 8 Significant Drinking Water Threats

	Number of Significant Threats in WHPA		
Threat Type	**PW1 & PW2**	**PW3**	**PW5 & PW6**
Application of agricultural source material (ASM)	0	0	2
Application of commercial fertilizer	0	0	3
Application of pesticides	0	0	2
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	2	1	1
Handling and storage of fuel	5	1	1
Handling and storage of a DNAPL	12	0	0
Total Number of Activities	**19**	**2**	**9**
Total Number of Properties	**9**	**2**	**3**

As per the methodology provided by the SGBLS, only one threat has been counted to represent the potential presence of residential fuel tanks within a WHPA. Table 9 provides the number of potential properties within each WHPA that are located within a vulnerable area that would result in the storage of fuel as a significant drinking water threat.

Table 9 Potential Properties with Residential Fuel Tanks

Well	# Properties
PW1 & PW2	39
PW3	15
PW5 & PW6	1
Total	**55**

12.0 Prioritization of Threats

The intent of the Threats Assessment is to generate a list that prioritizes the threats located in the vulnerable areas related to the groundwater supply wells owned by the Town of Shelburne. Within the study area, there are four groundwater supply wells for which this prioritization will be undertaken.

As part of the Threats Assessment, all threats were assigned a risk rating of significant, moderate or low based on the Table of Drinking Water Threats.

Thirty threats have been classified as significant. Any list of priorities that is developed should itemize these 30 threats as the highest cause for concern. The significant threats are linked to four types of land uses within the WHPAs: residential, agricultural, commercial and institutional activities. For all threats that were categorized there were certain assumptions that were made in order to complete the evaluation undertaken as part of this study. These assumptions have been included in Appendix I. In order to reduce the level of uncertainty associated with the current study it is recommended that steps be taken to validate the assumptions and that a re-evaluation of risk be done using the updated information.

A total of 65 threats have been classified as moderate in the vulnerable areas of the watershed. Threats that are moderate should be reviewed to determine under which circumstances these threats may become significant. This will be critical for creating policies that will prevent moderate threats from becoming significant in the future.

As part of the re-evaluation process, it is recommended that additional information is gathered and is used to re-evaluate the threats. In some areas of the province, information gathering has been undertaken in the form of an online survey that seeks to gather information from property owners. A more direct approach is also possible in which specific properties of interest are visited and information on lists of chemicals stored and quantities are refined based on actual practices. It is noted that the threats categorization process does not recognize the impact of management practices, which may act to reduce the level of risk at a particular site. However in its determination of appropriate action plans for implementation at each threat, the Source Protection Committee (SPC) may choose to evaluate management practices.

13.0 Uncertainty of Threats Assessment

Uncertainty analysis investigates the effects of the lack of knowledge and other potential sources of error.

In this study a number of databases were used to create the threats inventory database. All databases have an error associated with them, whether it applies to the spatial or attribute information. The accuracy of the databases used depends on the source, the age of the information and the scale at which the spatial information was recorded. In this study, we were able to decrease the error in the information for the WHPAs through field reconnaissance. Information outside of these areas was not confirmed and has an increased uncertainty associated to it.

In addition to the uncertainty associated with the threats inventory the process of assigning hazard ratings to each threat brings in additional uncertainty. The uncertainty associated with the hazard rating is related to knowledge and understanding of which chemical contaminants are present for a specific land use activity.

To assign the hazard rating for each land use activity a series of assumptions were made which have an uncertainty associated to them. For this analysis it was assumed that any possible threats associated with an activity were present and that all potential chemicals were present. This information was provided by the MOE in the form of look-up tables. The circumstances and quantity for each threat were assigned based on available knowledge such as typical storage practices, typical chemical quantities and typical waste disposal practices for that particular land use activity.

Based on the uncertainty involved in the threats inventory and the hazard ratings for this study, the uncertainty for all of the threats has been classified as high. This level of uncertainty is expected in a Tier 1 analysis. Through the Tier 2 process, where additional information is collected through surveys, site visits or other sources of information, the uncertainty related to the hazard rating can be reduced.

13.1 Data Gaps

There are some known gaps in the data used as part of this study.

The spills identified in Section 10.1 could be further investigated. Groundwater and soil sampling information would be useful to evaluate if a condition exists.

14.0 Summary

The following summary is based on the results of this assessment.

- The Shelburne Well Supply consists of three well fields, PW1/PW2, PW3 and PW5/PW6. These wells provide water to the Town of Shelburne which has a population of approximately 5,000 people.

- Wellhead Protection Areas were delineated for each of the well fields using the existing permitted pumping rates.

- Aquifer vulnerability mapping indicates that the within the Town of Shelburne's boundaries the aquifers are classed dominantly as medium vulnerability. Areas of high vulnerability are located on the eastern side of the Town, extending to the outside of the municipal boundaries and on the western edge of town. These areas may be associated to the occurrence of sandy deposits in the vicinity of drainage channels or thin overburden.

- A transport pathway inventory indicated that water wells were the main pathway of concern. Based on a water well risk survey and analysis, vulnerability was increased around wells having a high potential to act as a transport pathway for contaminants to travel to the municipal aquifer.

- An issues evaluation was completed by reviewing available water quality results for the municipal pumping wells and related monitoring wells. No issues were identified. Arsenic levels may be of concern if the ODWQS decreases to 10 µg/L. However, arsenic has been identified as naturally occurring and therefore is not considered an issue.

- A threats inventory was completed for the wellhead protection areas using a combination of methods including a review of government and commercial databases, completion of a windshield field survey, and review of current aerial photographs. Land use activities were related to list of prescribed drinking water threats and classified as significant, moderate or low based on the Technical Rules: Assessment Report. Thirty significant threats were identified within the Shelburne wellhead protection areas.

15.0 Recommendations

The following recommendations are made based on the results of this study

- The SPC in consultation with the Town of Shelburne, should seek to gather additional site-specific information from land owners and businesses that have been categorized as significant threats. Information gathered from each location should seek to reduce the level of uncertainty associated with the categorization of risks. Information on site-specific chemicals, volumes of storage and management of these chemicals should be gathered. Information on the nature of land use and other relevant practices should also be gathered. Using the refined and updated information the risk score and categorization should be re-evaluated to confirm the status reported in this study.

- Various threats within the WHPAs have been categorized as moderate. It is recommended that the SPC continue to monitor these threats taking note of the circumstances under which they could become upgraded to significant. Where this upgrade is possible it is recommended that the SPC look at measures to mitigate or prevent this occurrence.

- The Town of Shelburne may wish to implement various measures and policies that would enhance the level of protection for the supply wells. These policies could be developed in collaboration with the SPC based on local knowledge and may consider some to the following practices:

  - Development within the WHPAs should be consistent with local Source Water Protection objectives
  - Future land use planning should consider restricting high-risk land use activities within areas of high vulnerability.

16.0 Limitations and Use of Report

The conclusions in this report are professional opinions based upon visual observations of the WHPA conditions existing at the time of our assessment. This report has been prepared in accordance with accepted environmental study and/or engineering practices. It should be noted that some of the information and resulting conclusions of this investigation are time sensitive.

Burnside does not guarantee the accuracy and reliability of the information provided by other persons or agencies and does not claim responsibility for undisclosed or non-visible environmental concerns.

The results of an investigation of this nature should, in no way, be construed as a warranty that the WHPA is free from any and all contamination from past or current practices. Sampling and analysis of soils, groundwater, and other material were not carried out as part of this investigation.

This report was prepared for the exclusive use of the Nottawasaga Valley Conservation Authority, the Town of Shelburne, and the MOE. Any use of, reliance on, or decisions based on this report by a third party are the responsibility of such third parties. Burnside accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. Reports or memoranda resulting from this assignment are not to be used, in whole or in part, outside the client's organization without prior written permission.

Respectfully submitted,

R.J. Burnside & Associates Limited

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Hydrogeologist

Reviewed By:

David Hopkins, B.Sc., P.Geo
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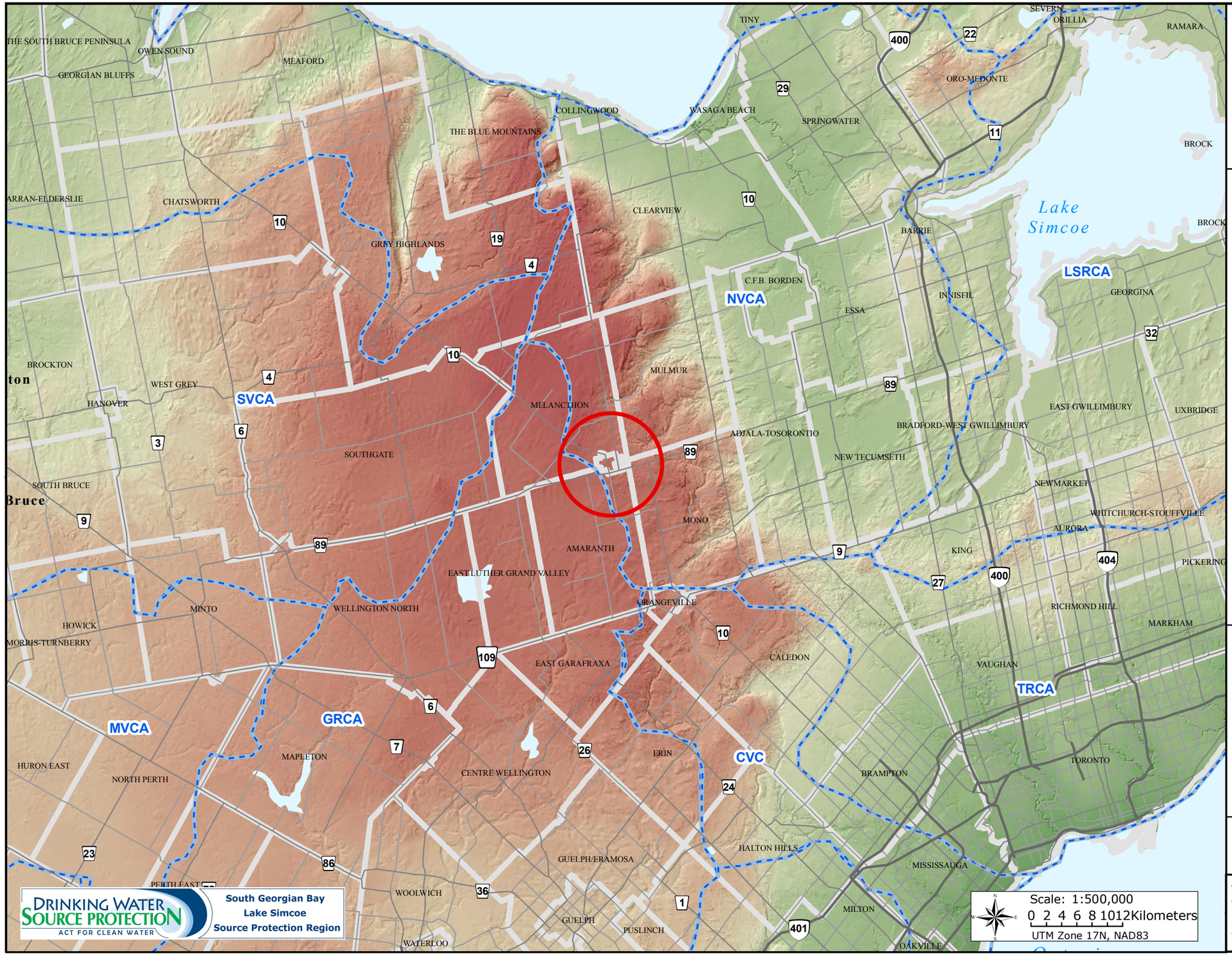
[THE DIFFERENCE IS OUR PEOPLE]

Figures

LOCATION OF STUDY AREA - TOWN OF SHELBURNE WELL SUPPLY



Legend

- Approximate Conservation Authority Jurisdiction Boundary
- Municipal Boundary
- Waterbody

Elevation (masl)

High : 520

Low : 75

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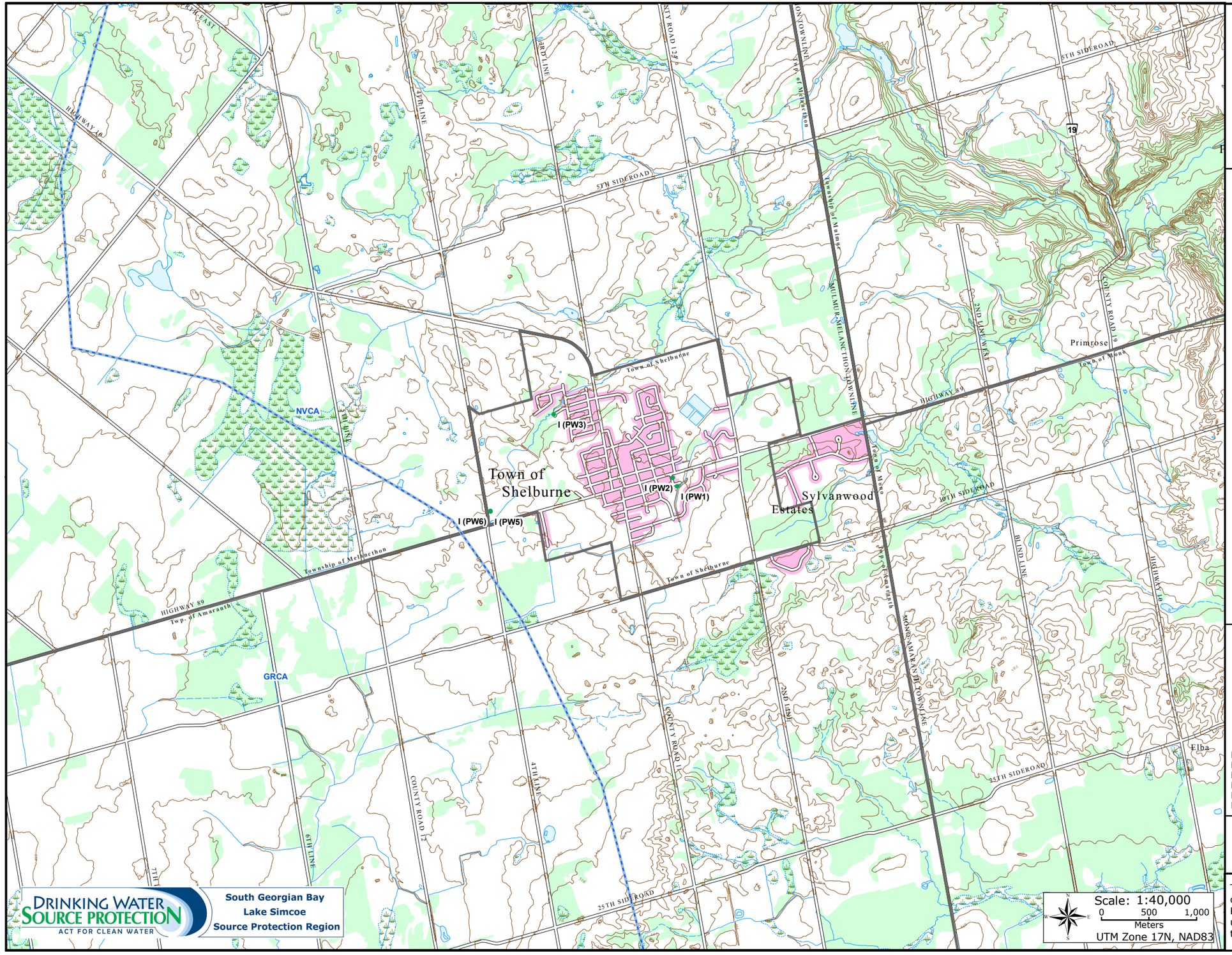
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 2.1

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

TOPOGRAPHY AND DRAINAGE - TOWN OF SHELBURNE WELL SUPPLY



Legend

- Production Well Location (Well Type - I)
- Approximate Conservation Authority Jurisdiction Boundary
- Municipal Boundary
- Contour
- Road: Undefined
- River/Stream: Seasonal
- River/Stream: Permanent
- Waterbody
- Wetland
- Urban Area
- Wooded Area

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Ontario

Figure 3.1

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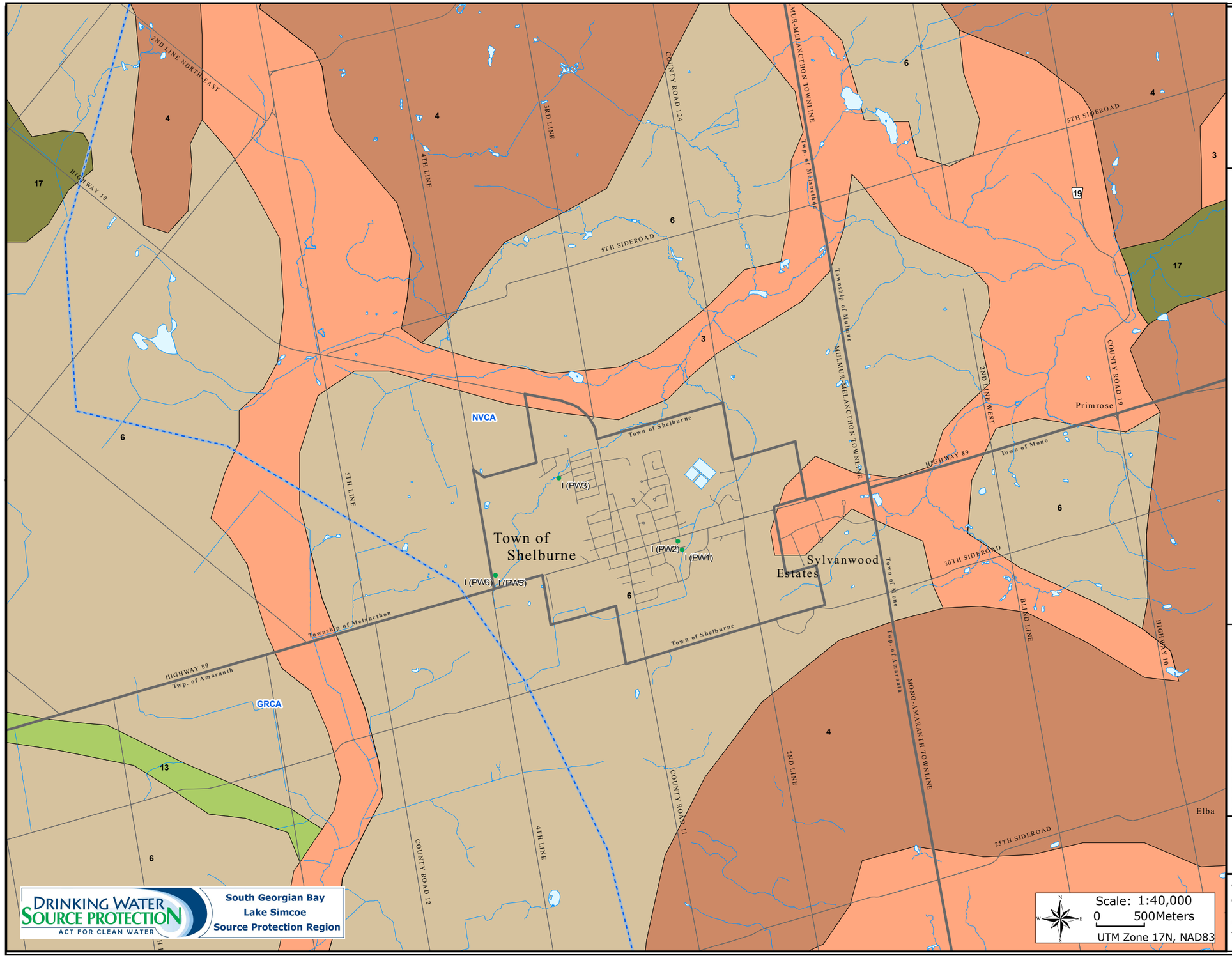
PHYSIOGRAPHY - TOWN OF SHELBURNE WELL SUPPLY



Legend

- Production Well Location (Well Type - I)
- Approximate Conservation Authority Jurisdiction Boundary
- Municipal Boundary
- Waterbody
- River/Stream: Permanent

Physiography

- 1 - Escarpments
- 2 - Till Moraines
- 3 - Spillways
- 4 - Kame Moraines
- 5 - Till Plains (Undrumlinized)
- 6 - Till Plains (Drumlinized)
- 9 - Limestone Plains
- 11 - Sand Plains
- 12 - Clay Plains
- 13 - Eskers
- 17 - Peat and Muck

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Figure 3.2

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OVERBURDEN GEOLOGY - TOWN OF SHELBURNE WELL SUPPLY

Legend

- Production Well Location (Well Type - I)
- Approximate Conservation Authority Jurisdiction Boundary
- Municipal Boundary
- Quarry
- Sand or Gravel Pit
- Drumlin or Drumlinoid Ridge
- Outcrop
- Meltwater Channel: Flow Direction Known
- Ice Contact Slope
- Edge or Mappable Landslide Scar
- Abandoned Channel: Terrace

Surficial Geology

- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- 5e: Undifferentiated older till and stratified sediment
- 6: Ice-contact stratified deposits
- 6a: In moraines, kames, eskers and crevasse fills
- 7: Glaciofluvial deposits
- 7a: Sandy deposits
- 7b: Gravelly deposits
- 8: Fine-textured glaciolacustrine deposits
- 8a: Massive-well laminated
- 9: Coarse-textured glaciolacustrine deposits
- 9c: Foreshore-basinal deposits
- 12: Older alluvial deposits
- 19: Modern alluvial deposits
- 20: Organic deposits

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Date: 2010-04-30

Ontario Geological Survey, 1997. Quaternary geology, seamless coverage of the province of Ontario; Ontario Geological Survey, ERLIS Data Set 14
ISBN 0-7778-9310-X

Ontario

Figure 3.3

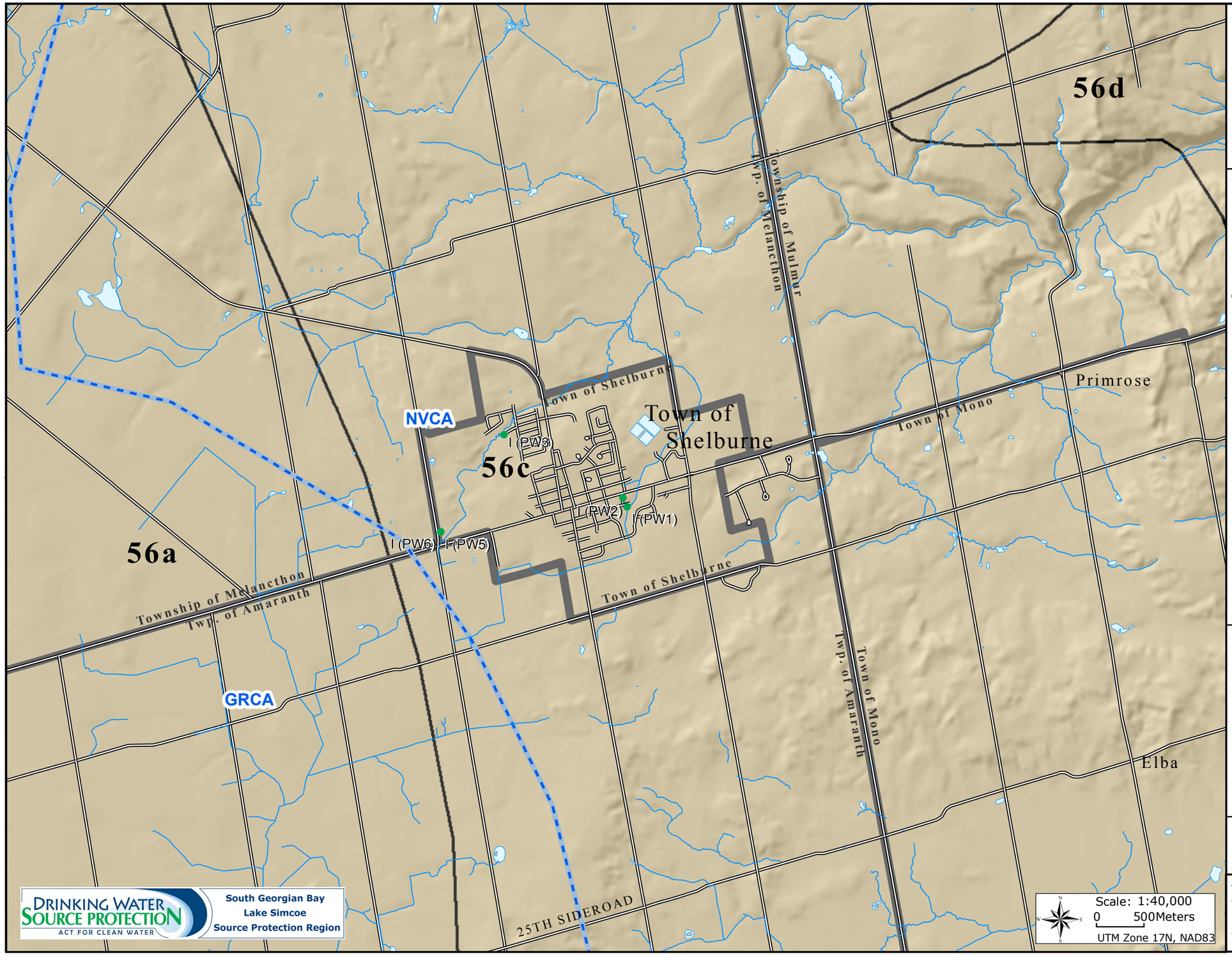
This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:40,000
0 500Meters
UTM Zone 17N, NAD83

BEDROCK GEOLOGY - TOWN OF SHELBURNE WELL SUPPLY



Legend

- Production Well Location (Well Type - I)
- River/Stream: Permanent
- Approximate Conservation Authority Jurisdiction Boundary
- Waterbody
- Municipal Boundary

Bedrock Geology

- 56a - Guelph Formation (Sandstone, shale, dolostone, siltstone)
- 56c - Amabel Formation (Sandstone, shale, dolostone, siltstone)
- 56d - Clinton Group; Cataract Group (Sandstone, shale, dolostone, siltstone)
- 55a - Queenston Formation (Shale, limestone, dolostone, siltstone)
- 55b - Georgian Bay Formation; Blue Mountain Formation; Billings Formation; Collingwood Member; Eastview Member (Shale, limestone, dolostone, siltstone)

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Project Number: MSA12364
Date: 2010-04-30

Data Sources:
Ministry of Natural Resources: Produced using information provided by the Ministry of Natural Resources, Copyright © Queen's Printer, 2009
Ontario Geological Survey 1991. Bedrock Geology of Ontario, Southern Sheet; Ontario Geological Survey, Map 2544, Scale 1:1,000,000.
R.J. Burnside & Associates Limited

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Figure 3.4

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GENERALIZED WATER TABLE - TOWN OF SHELBURNE WELL SUPPLY

Legend

- Production Well Location (Well Type - I)
- Approximate Conservation Authority Jurisdiction Boundary
- Watercourse: Permanent
- Watercourse: Intermittent
- Municipal Boundary

Water Table Elevation

Elevation (masl)

High : 500

Low : 450

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Project Number: MSA12364
Date: 2010-04-30

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Figure 3.5

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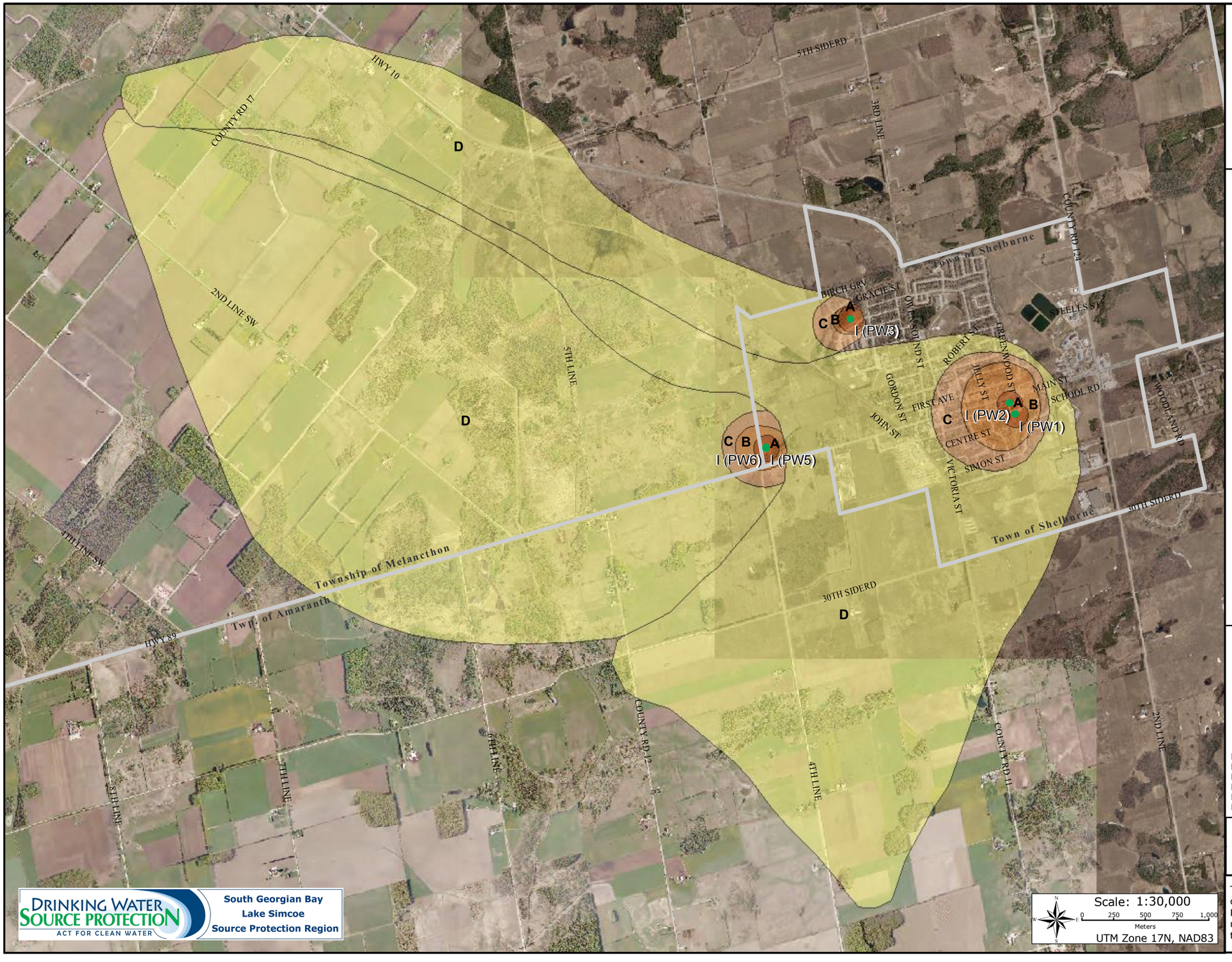
DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:40,000
0 500Meters
UTM Zone 17N, NAD83

Town of Shelburne
I (PW3)
I (PW2)
I (PW1)
I (PW6)
I (PW5)
Sylvanwood Estates
Primrose
Elba
Boyne
Provinc
NVCA
GRCA
HIGHWAY 10
HIGHWAY 89
HIGHWAY 19
5TH SIDEROAD
25TH SIDEROAD
30TH SIDEROAD
4TH LINE
3RD LINE
5TH LINE
6TH LINE
7TH LINE
2ND LINE
2ND LINE WEST
BLIND LINE
COUNTY ROAD 124
COUNTY ROAD 11
COUNTY ROAD 12
COUNTY ROAD 16
MULMUR-MELANCTHON TOWNLINE
MONO-AMARANTH TOWNLINE
Township of Mulmur
Town of Mono
Twp. of Amaranth
Township of Melancthon
Town of Shelburne

WELL HEAD PROTECTION AREAS TOWN OF SHELBURNE WELL SUPPLY



Legend

- Production Well Location (Well Type - I)
- Municipal Boundary

Well Head Protection Area Zone

- WHPA-A: 100m Buffer Zone (Pathogen Security/Prohibition Zone)
- WHPA-B: Pathogen Management Zone (2 Year Time of Travel)
- WHPA-C: DNAPL/Contaminant Protection Zone (5 Year Time of Travel)
- WHPA-D: Steady State Zone

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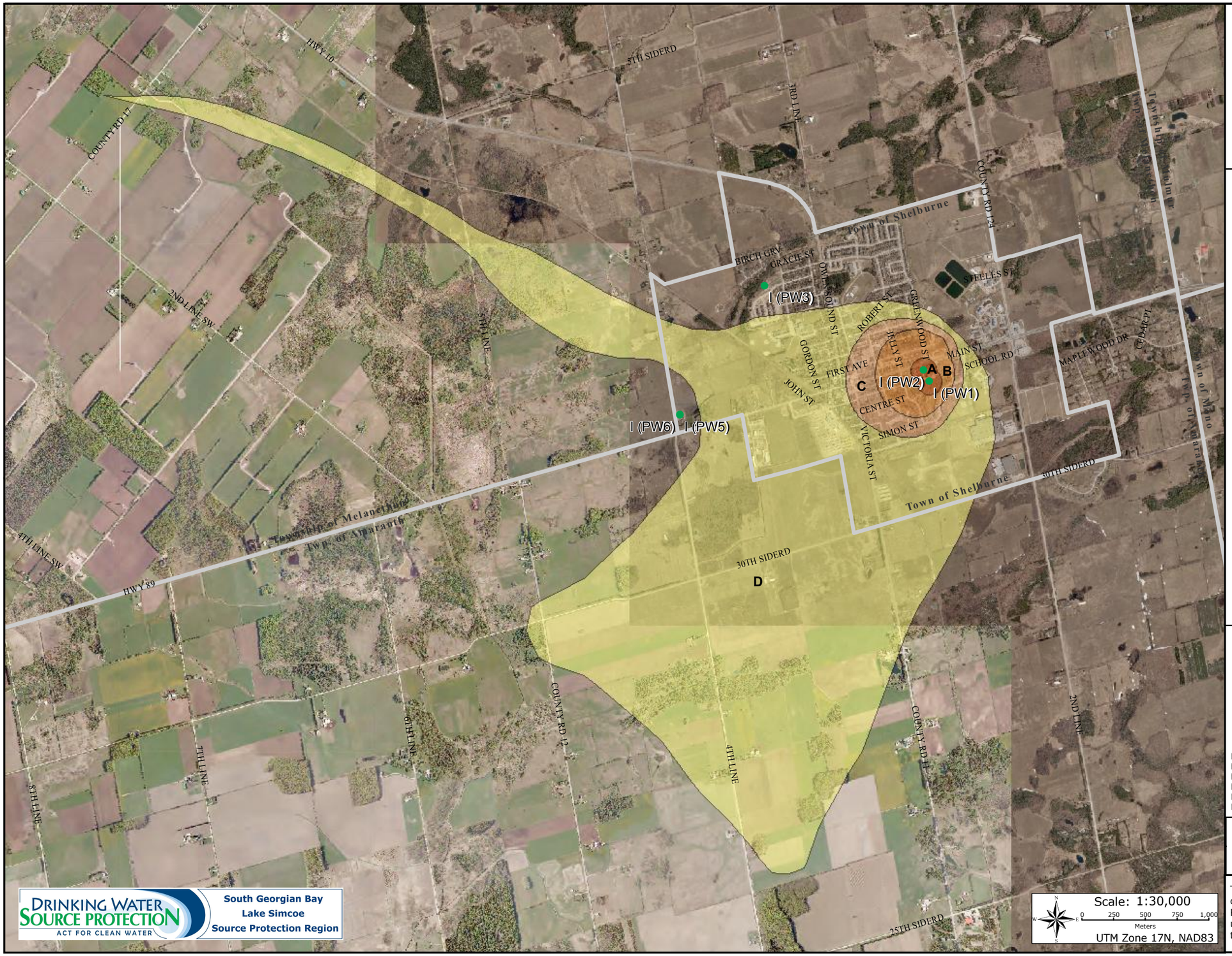
Project Number: MSA12364
Date: 2010-02-01

Ontario

Figure 4.1

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

WELL HEAD PROTECTION AREAS TOWN OF SHELBURNE WELL SUPPLY (PW1 & PW2)



DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000

0 250 500 750 1,000
Meters

UTM Zone 17N, NAD83

Legend

- Production Well Location (Well Type - I)
- Municipal Boundary

Well Head Protection Area Zone

- WHPA-A: 100m Buffer Zone (Pathogen Security/Prohibition Zone)
- WHPA-B: Pathogen Management Zone (2 Year Time of Travel)
- WHPA-C: DNAPL/Contaminant Protection Zone (5 Year Time of Travel)
- WHPA-D: Steady State Zone

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Project Number: MSA12364
Date: 2010-02-01

Ontario

Figure 4.2

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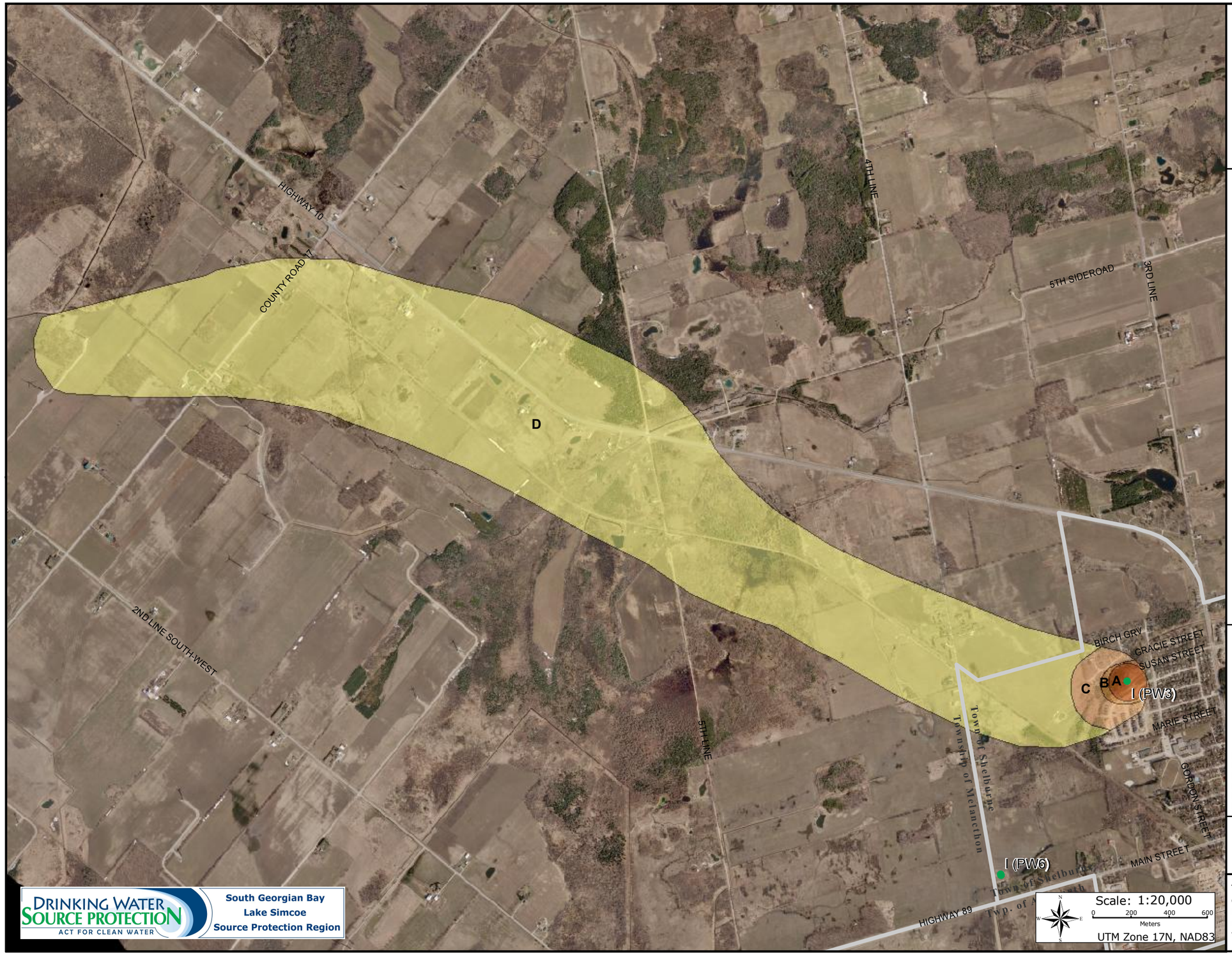
WELL HEAD PROTECTION AREAS - TOWN OF SHELBURNE WELL SUPPLY (PW 3)



Legend

- Production Well Location (Well Type - I)
- Municipal Boundary

Well Head Protection Area Zone

- WHPA-A: 100m Buffer Zone (Pathogen Security/Prohibition Zone)
- WHPA-B: Pathogen Management Zone (2 Year Time of Travel)
- WHPA-C: DNAPL/Contaminant Protection Zone (5 Year Time of Travel)
- WHPA-D: Steady State Zone

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Date: 2010-02-01

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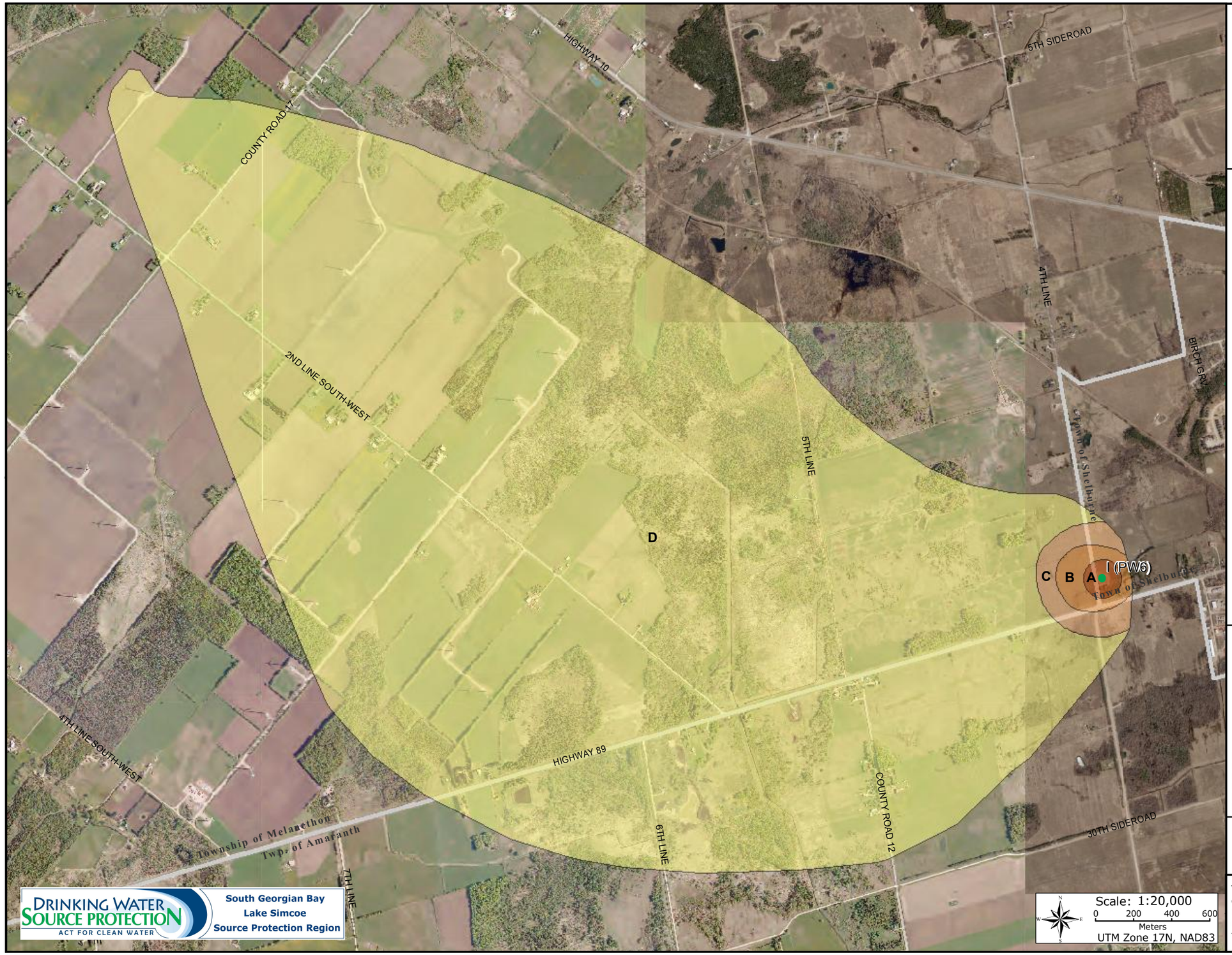
Figure 4.3

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

WELL HEAD PROTECTION AREAS TOWN OF SHELBURNE WELL SUPPLY (PW5 & PW6)



Legend

- Production Well Location (Well Type - I)
- Municipal Boundary

Well Head Protection Area Zone

- WHPA-A: 100m Buffer Zone (Pathogen Security/Prohibition Zone)
- WHPA-B: Pathogen Management Zone (2 Year Time of Travel)
- WHPA-C: DNAPL/Contaminant Protection Zone (5 Year Time of Travel)
- WHPA-D: Steady State Zone

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Figure 4.4

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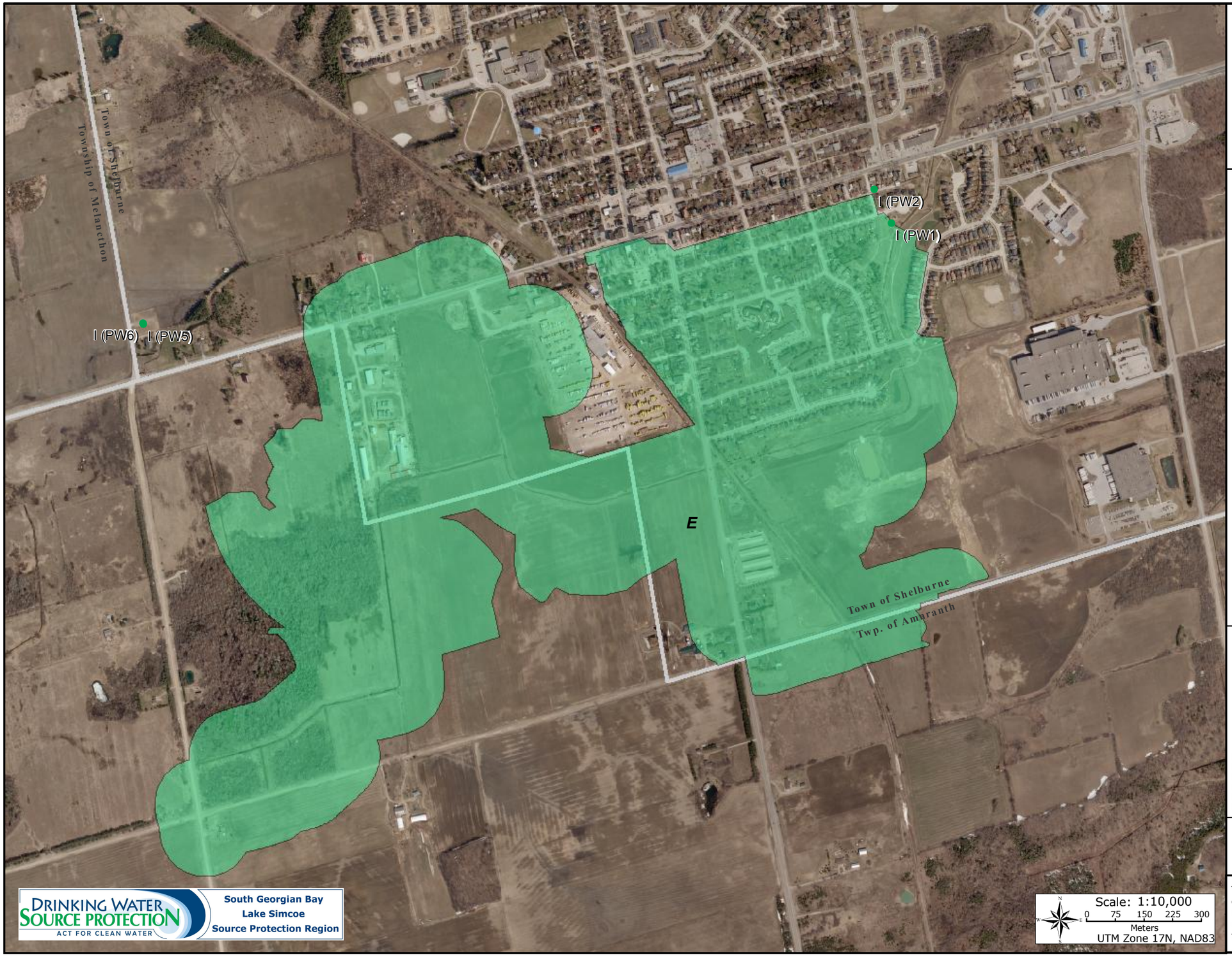
WELL HEAD PROTECTION AREAS E - TOWN OF SHELBURNE WELL SUPPLY (PW1)



Legend

- Production Well Location (Well Type - I)
- Municipal Boundary

Well Head Protection Area Zone

- WHPA-E: Surface Vulnerability Zone (GUDI Well)

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:10,000
0 75 150 225 300
Meters
UTM Zone 17N, NAD83

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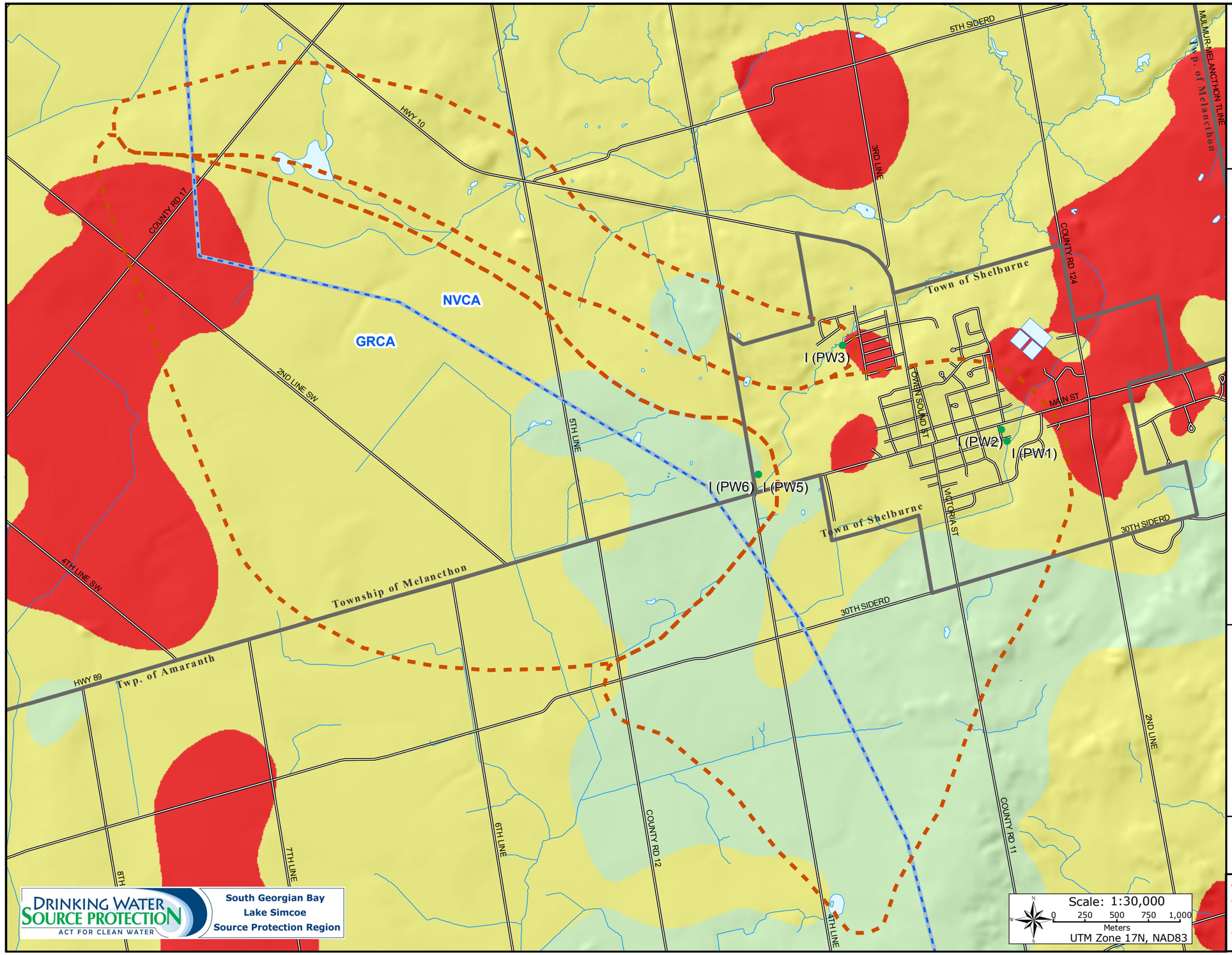
Figure 4.5

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

INITIAL AQUIFER VULNERABILITY - TOWN OF SHELBURNE WELL SUPPLY



DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

LEGEND

- Production Well Location (Well Type - I)
- Wellhead Protection Area Zones

Aquifer Vulnerability Rating

- High
- Medium
- Low
- Municipal Boundary
- Approximate Conservation Authority Jurisdiction Boundary
- River/Stream: Permanent
- Waterbody

Well Head Protection Area Zones
Zone A - 100m Buffer Zone (Pathogen Security/Protection Zone)
Zone B - Pathogen Management Zone (0 to 2 Year Time of Travel)
Zone C - DNAPL/Contaminant Protection Zone (2 to 5 Year Time of Travel)
Zone C1 - DNAPL/Contaminant Protection Zone (2 to 10 Year Time of Travel)
Zone D - Secondary Protection Zone (5 to 25 Year Time of Travel)

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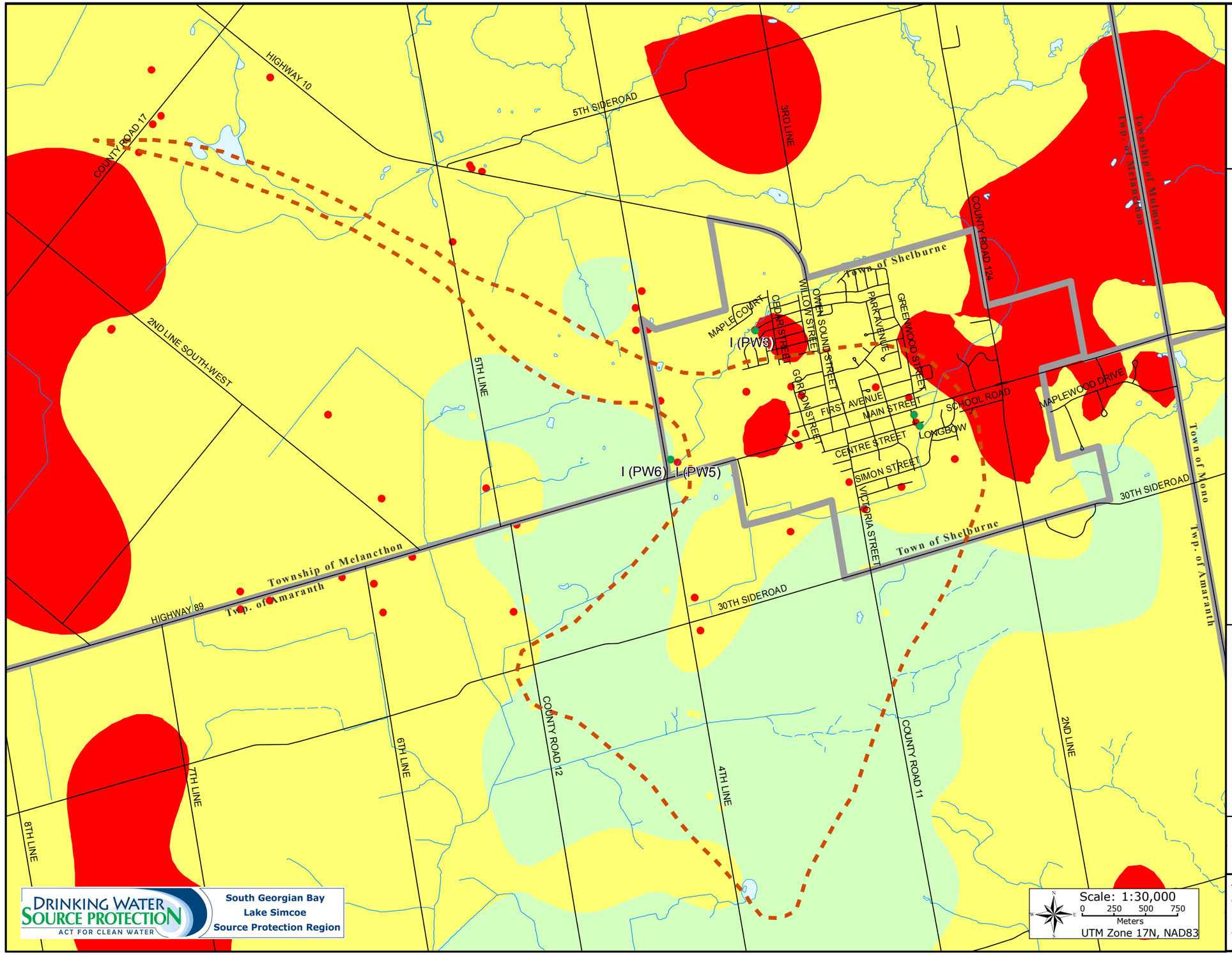
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 5.1

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

TRANSPORT PATHWAY UPDATE TO AQUIFER VULNERABILITY - TOWN OF SHELBURNE WELL SUPPLY (PW1 & PW2)



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Aquifer Vulnerablity Rating

- High
- Medium
- Low
- Municipal Boundary
- Road
- Watercourse: Permanent
- Watercourse: Intermittent
- Lake

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000
0 250 500 750
Meters
UTM Zone 17N, NAD83

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Date: 2010-04-30

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Figure 5.2

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

TRANSPORT PATHWAY UPDATE TO AQUIFER VULNERABILTY - TOWN OF SHELBURNE WELL SUPPLY (PW3)

HIGHWAY 10
COUNTY ROAD 17
2ND LINE SOUTH-WEST
5TH SIDEROAD
3RD LINE
4TH LINE
5TH LINE
BIRCH GRV
MAPLE COURT
CEDAR STREET
WILLOW STREET
GORDON STREET
MAIN STREET
Town of Shelburne
Township of Melancthon
Twp. of Amaranth
HIGHWAY 89
I (PW3)
I (PW6)
I (PW5)

Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Aquifer Vulnerablity Rating

- High
- Medium
- Low
- Municipal Boundary
- Road
- Watercourse: Permanent
- Watercourse: Intermittent
- Lake

Scale: 1:20,000
0 200 400 600
Meters
UTM Zone 17N, NAD83

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER
South Georgian Bay Lake Simcoe Source Protection Region

BURNSIDE

Created by: R.J. Burnside and Associates

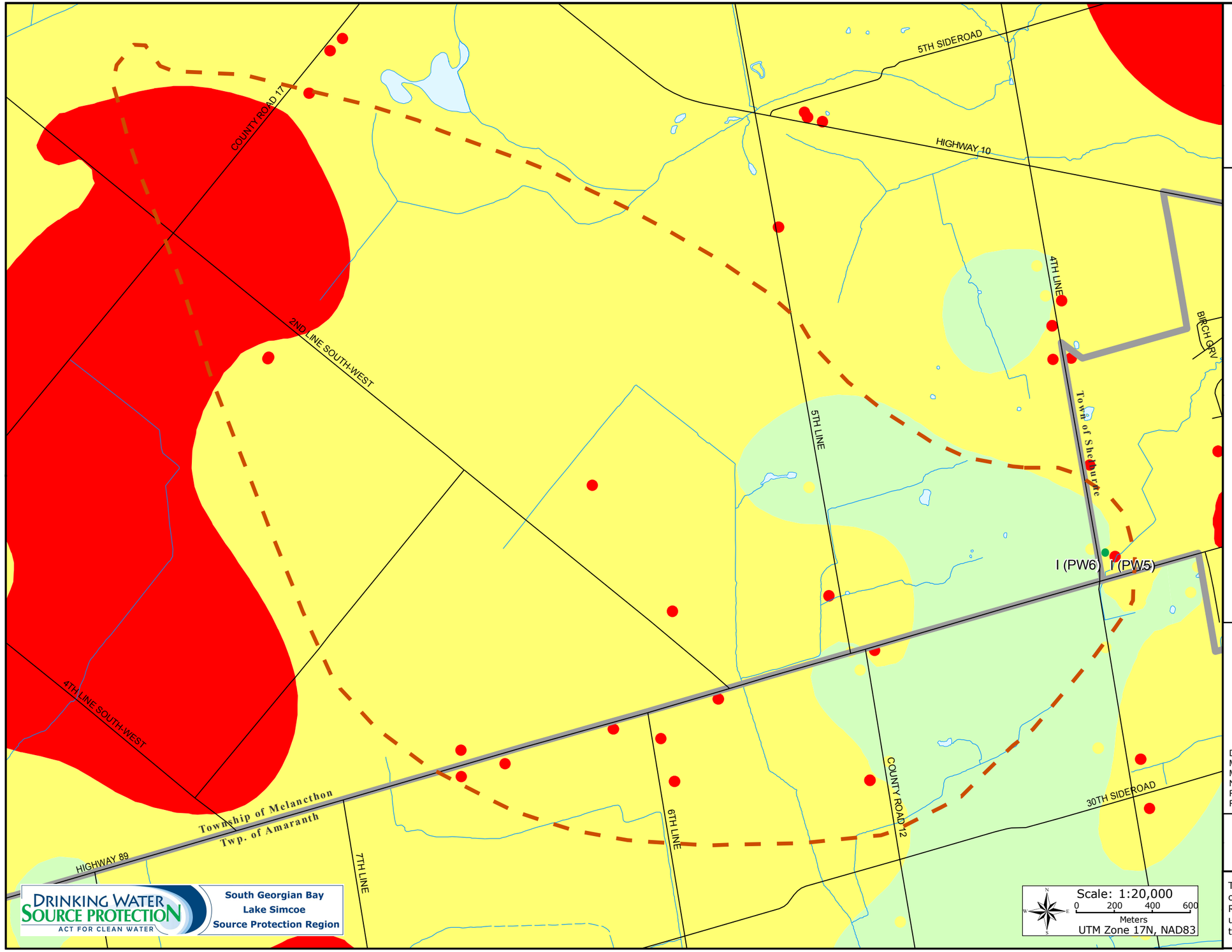
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 5.3

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

TRANSPORT PATHWAY UPDATE TO AQUIFER VULNERABILITY - TOWN OF SHELBURNE WELL SUPPLY (PW5 & PW6)



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Aquifer Vulnerablity Rating

- High
- Medium
- Low
- Municipal Boundary
- Road
- Watercourse: Permanent
- Watercourse: Intermittent
- Lake

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:20,000
0 200 400 600
Meters
UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 5.4

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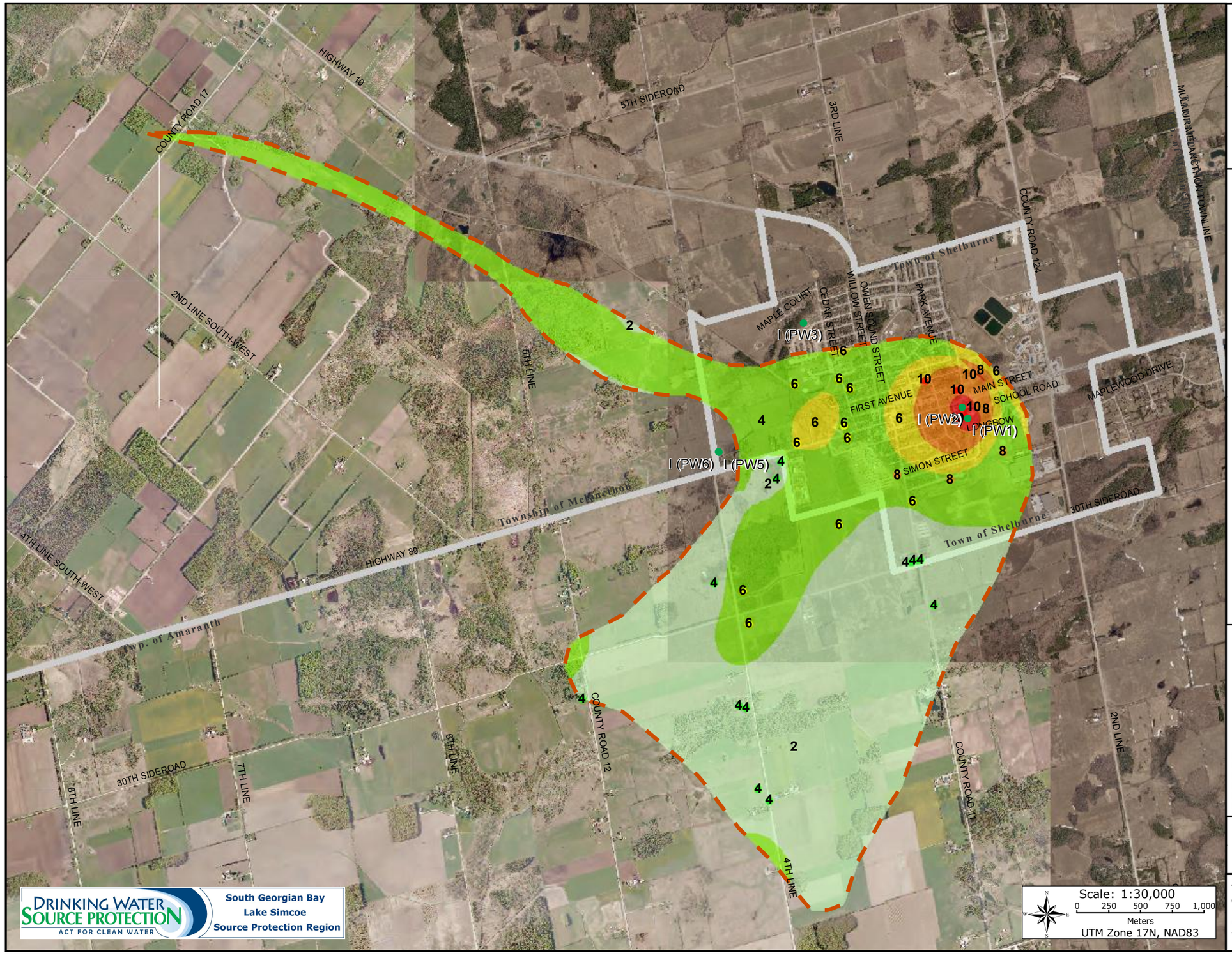
VULNERABILITY SCORES - TOWN OF SHELBURNE WELL SUPPLY (PW1 & PW2)



Legend

- Production Well Location (Well Type - I)
- Municipal Boundary
- Well Head Protection Area

Vulnerability Score

- 10
- 8
- 6
- 4
- 2

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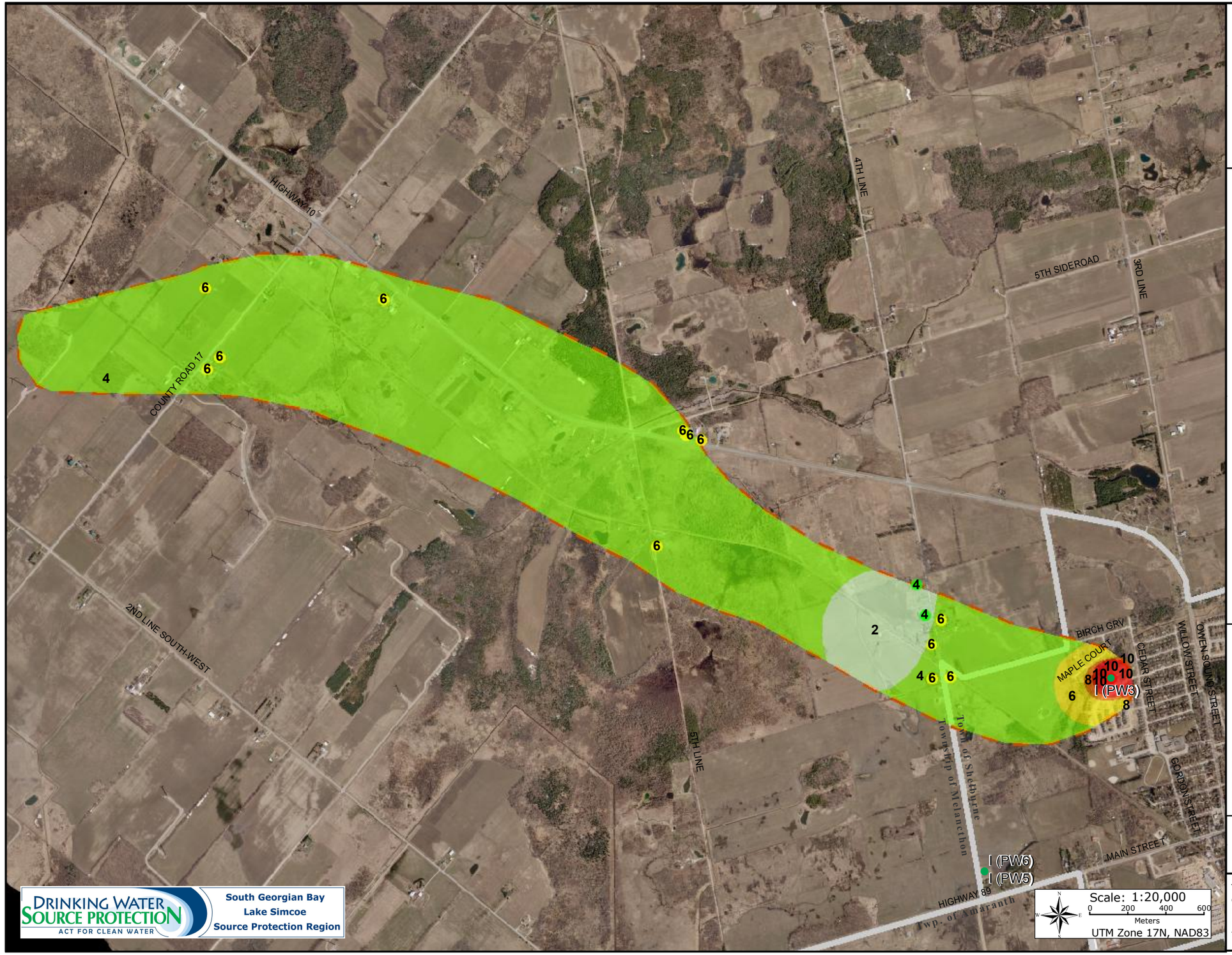
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 6.1

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

VULNERABILITY SCORES - TOWN OF SHELBURNE WELL SUPPLY (PW3)



Legend

- Production Well Location (Well Type - I)
- Municipal Boundary
- Well Head Protection Area

Vulnerability Score

- 10
- 8
- 6
- 4
- 2

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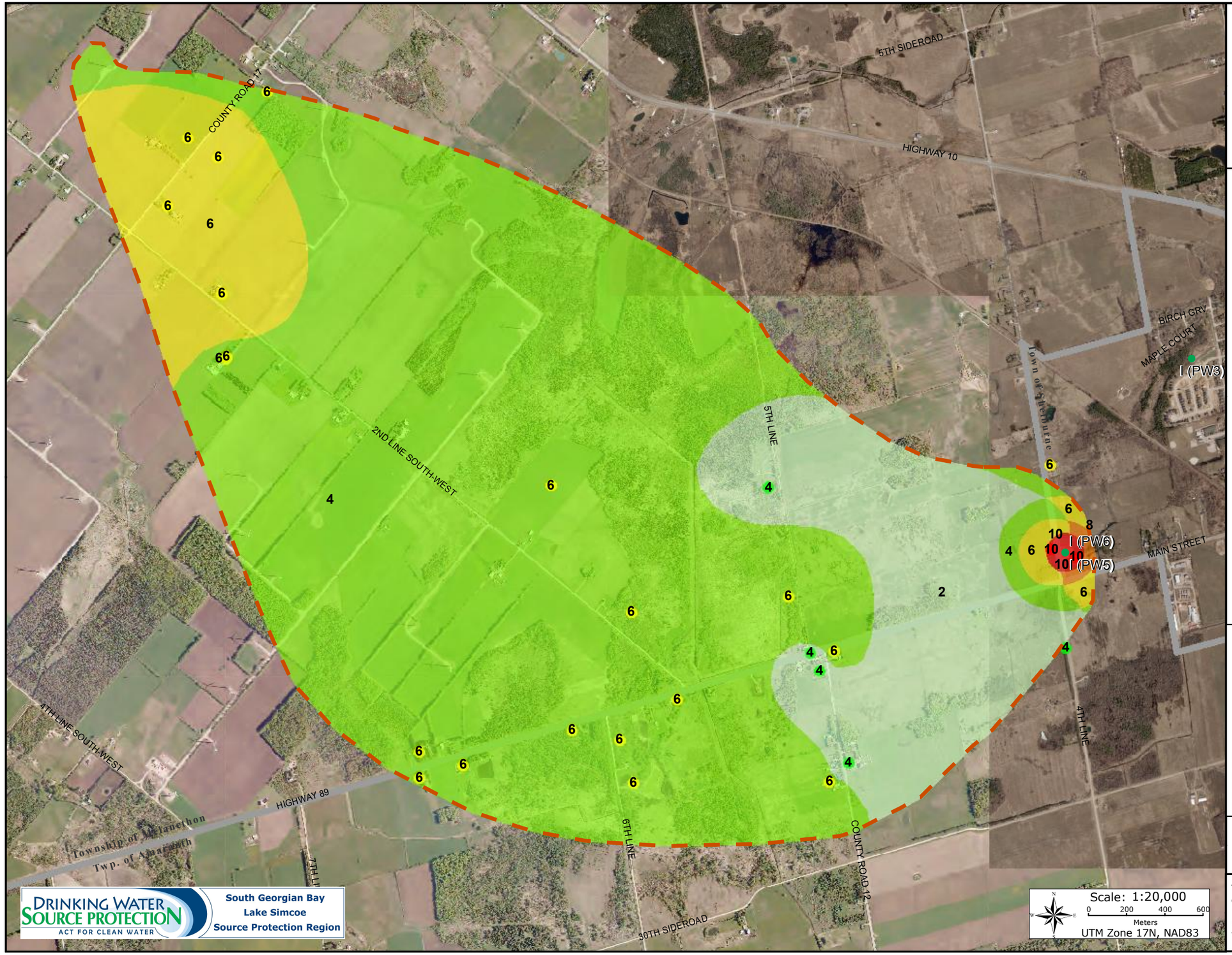
Project Number: MSA12364
Date: 2010-02-01

Ontario

Figure 6.2

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

VULNERABILITY SCORES - TOWN OF SHELBURNE WELL SUPPLY (PW5 & PW6)



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area
- Municipal Boundary

Vulnerability Score

- 10
- 8
- 6
- 4
- 2

BURNSIDE

Created by: R.J. Burnside and Associates

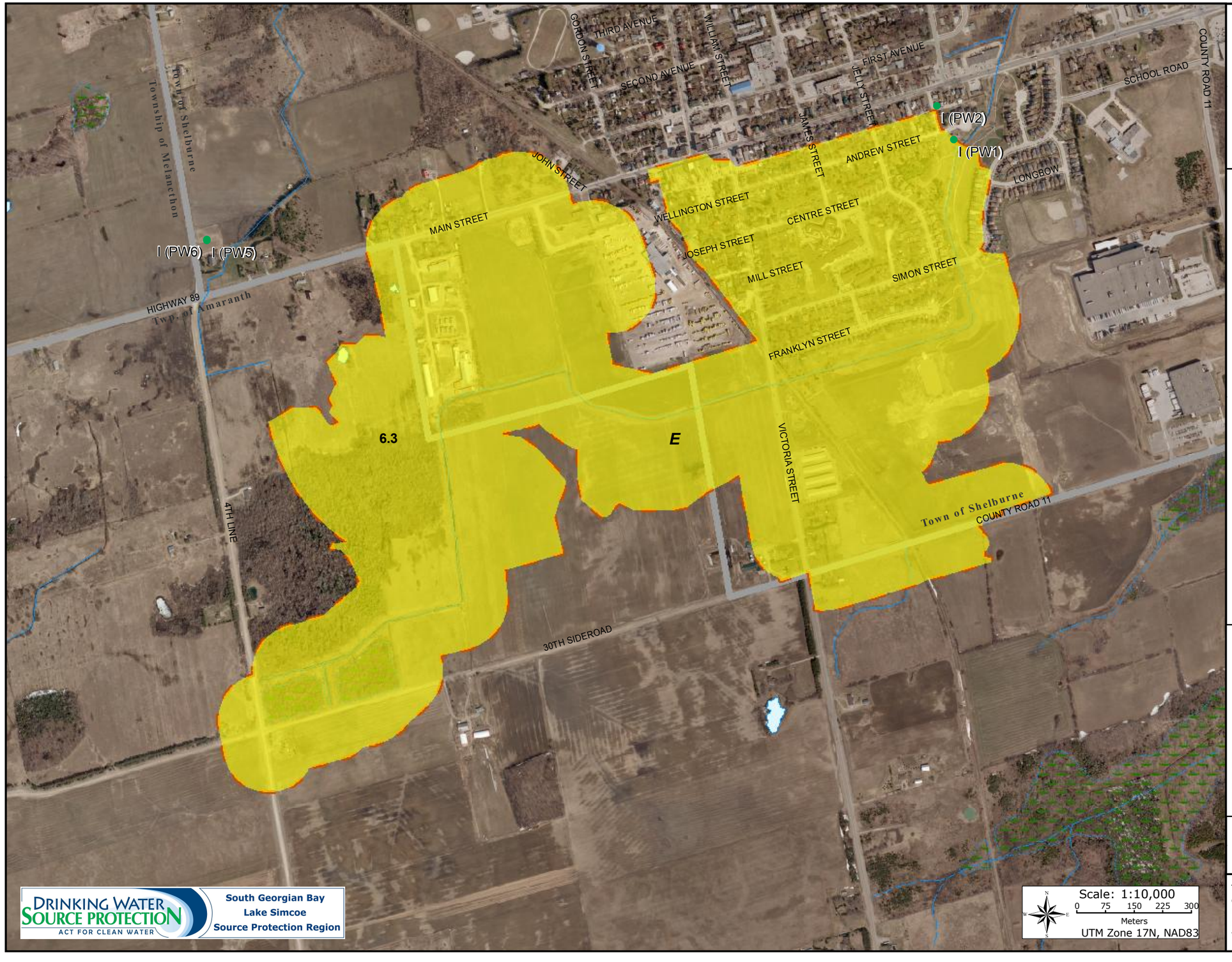
Project Number: MSA12364
Date: 2010-02-01

Ontario

Figure 6.3

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

VULNERABILITY SCORE WHPA E - TOWN OF SHELBURNE WELL SUPPLY (PW1)



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Vulnerability Score

- 7.2
- 6.4
- 6.3
- Municipal Boundary

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:10,000
0 75 150 225 300
Meters
UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

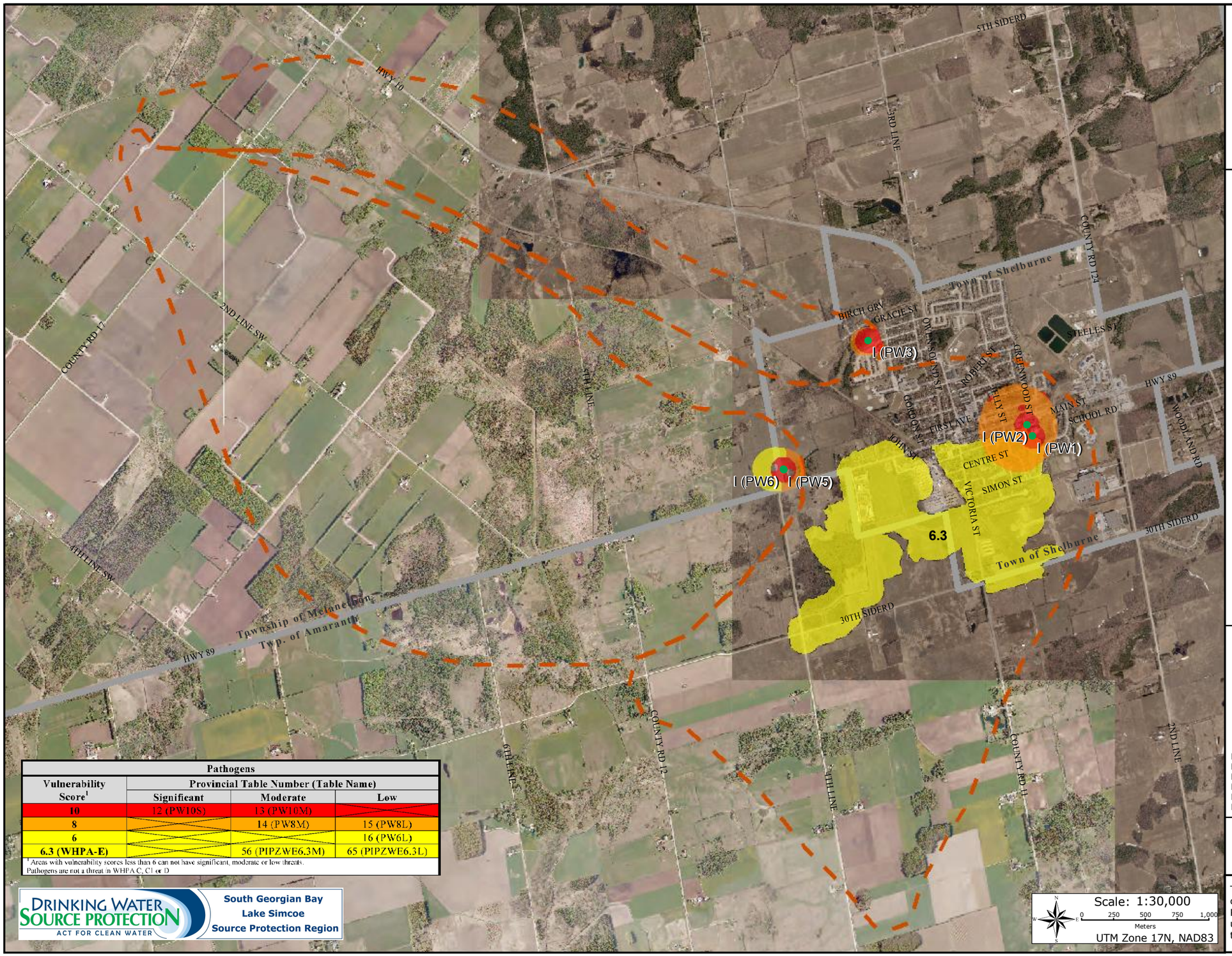
Project Number: MSA12364
Date: 2010-02-01

Ontario

Figure 6.4

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

AREAS OF SIGNIFICANT, MODERATE OR LOW THREATS - PATHOGENS TOWN OF SHELBURNE WELL SUPPLY



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Vulnerability Score

- 10
- 8
- 6
- 6.3
- Municipal Boundary

Pathogens			
Vulnerability Score[1]	Provincial Table Number (Table Name)		
	Significant	Moderate	Low
10	12 (PW10S)	13 (PW10M)	
8		14 (PW8M)	15 (PW8L)
6			16 (PW6L)
6.3 (WHPA-E)		56 (PIPZWE6.3M)	65 (PIPZWE6.3L)

[1] Areas with vulnerability scores less than 6 can not have significant, moderate or low threats.
Pathogens are not a threat in WHPA C, C1 or D

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000
0 250 500 750 1,000
Meters
UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

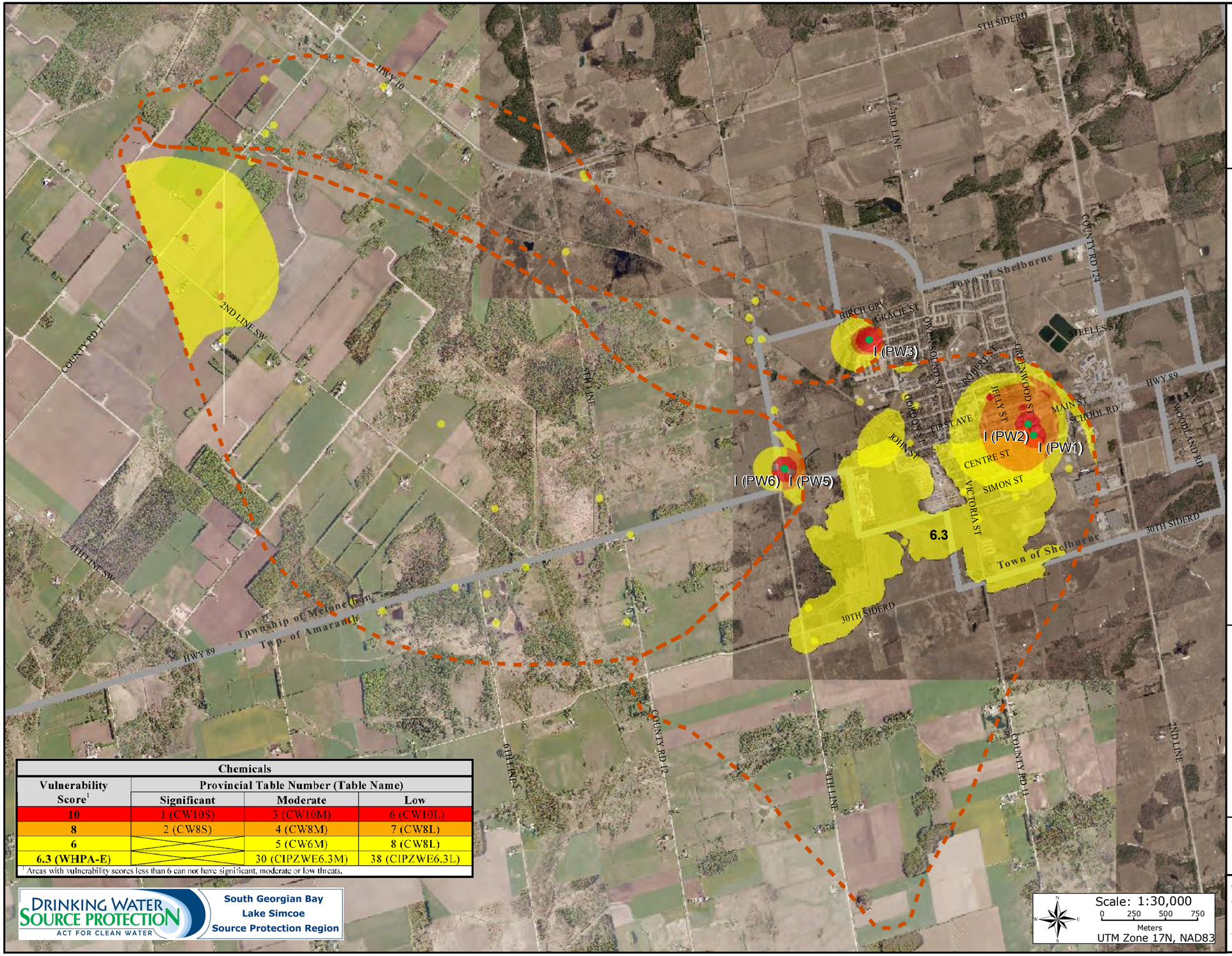
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 9.1

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

AREAS OF SIGNIFICANT, MODERATE OR LOW THREATS - CHEMICALS TOWN OF SHELBURNE WELL SUPPLY



Chemicals			
Vulnerability Score[1]	Provincial Table Number (Table Name)		
	Significant	Moderate	Low
10	1 (CW10S)	3 (CW10M)	6 (CW10L)
8	2 (CW8S)	4 (CW8M)	7 (CW8L)
6		5 (CW6M)	8 (CW8L)
6.3 (WHPA-E)		30 (CIPZWE6.3M)	38 (CIPZWE6.3L)

[1] Areas with vulnerability scores less than 6 can not have significant, moderate or low threats.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000
0 250 500 750
Meters
UTM Zone 17N, NAD83

Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Vulnerability Score

- 10
- 8
- 6
- 6.3
- Municipal Boundary

BURNSIDE

Created by: R.J. Burnside and Associates

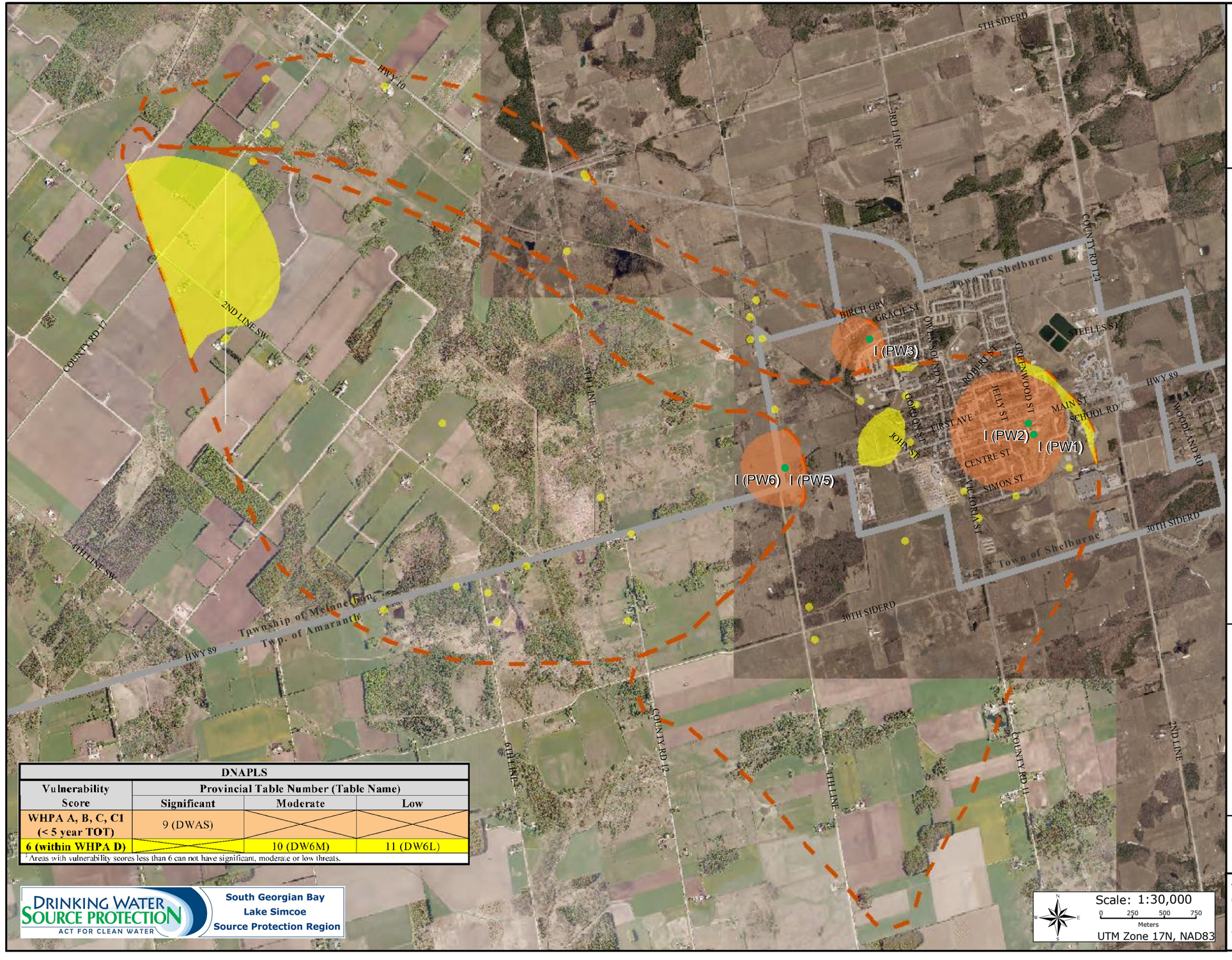
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 9.2

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

AREAS OF SIGNIFICANT, MODERATE OR LOW THREATS - DNAPLs TOWN OF SHELBURNE WELL SUPPLY



DNAPLS			
Vulnerability Score	Provincial Table Number (Table Name)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	9 (DWAS)		
6 (within WHPA D)		10 (DW6M)	11 (DW6L)

[1] Areas with vulnerability scores less than 6 can not have significant, moderate or low threats.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000
0 250 500 750
Meters
UTM Zone 17N, NAD83

Legend

- Production Well Location (Well Type - I)
- 5 Year Time-of-Travel
- Vulnerability Score of 6
- Well Head Protection Area
- Municipal Boundary

BURNSIDE

Created by: R.J. Burnside and Associates

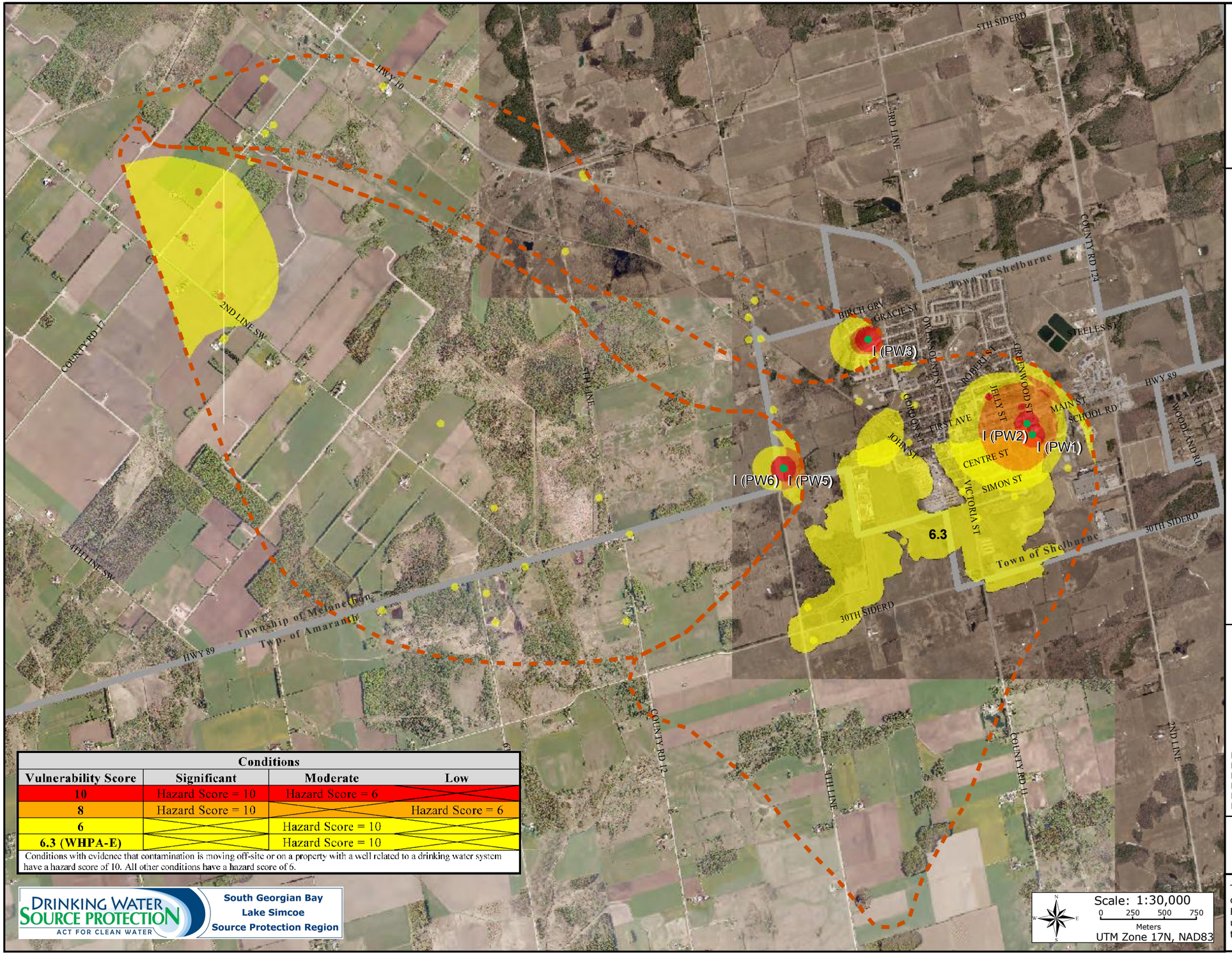
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 9.3

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

AREAS OF SIGNIFICANT, MODERATE OR LOW CONDITIONS TOWN OF SHELBURNE WELL SUPPLY



Conditions			
Vulnerability Score	**Significant**	**Moderate**	**Low**
10	Hazard Score = 10	Hazard Score = 6	
8	Hazard Score = 10		Hazard Score = 6
6		Hazard Score = 10	
6.3 (WHPA-E)		Hazard Score = 10	

Conditions with evidence that contamination is moving off-site or on a property with a well related to a drinking water system have a hazard score of 10. All other conditions have a hazard score of 6.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000
0 250 500 750
Meters
UTM Zone 17N, NAD83

Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Vulnerability Score

- 10
- 8
- 6
- 6.3
- Municipal Boundary

BURNSIDE

Created by: R.J. Burnside and Associates

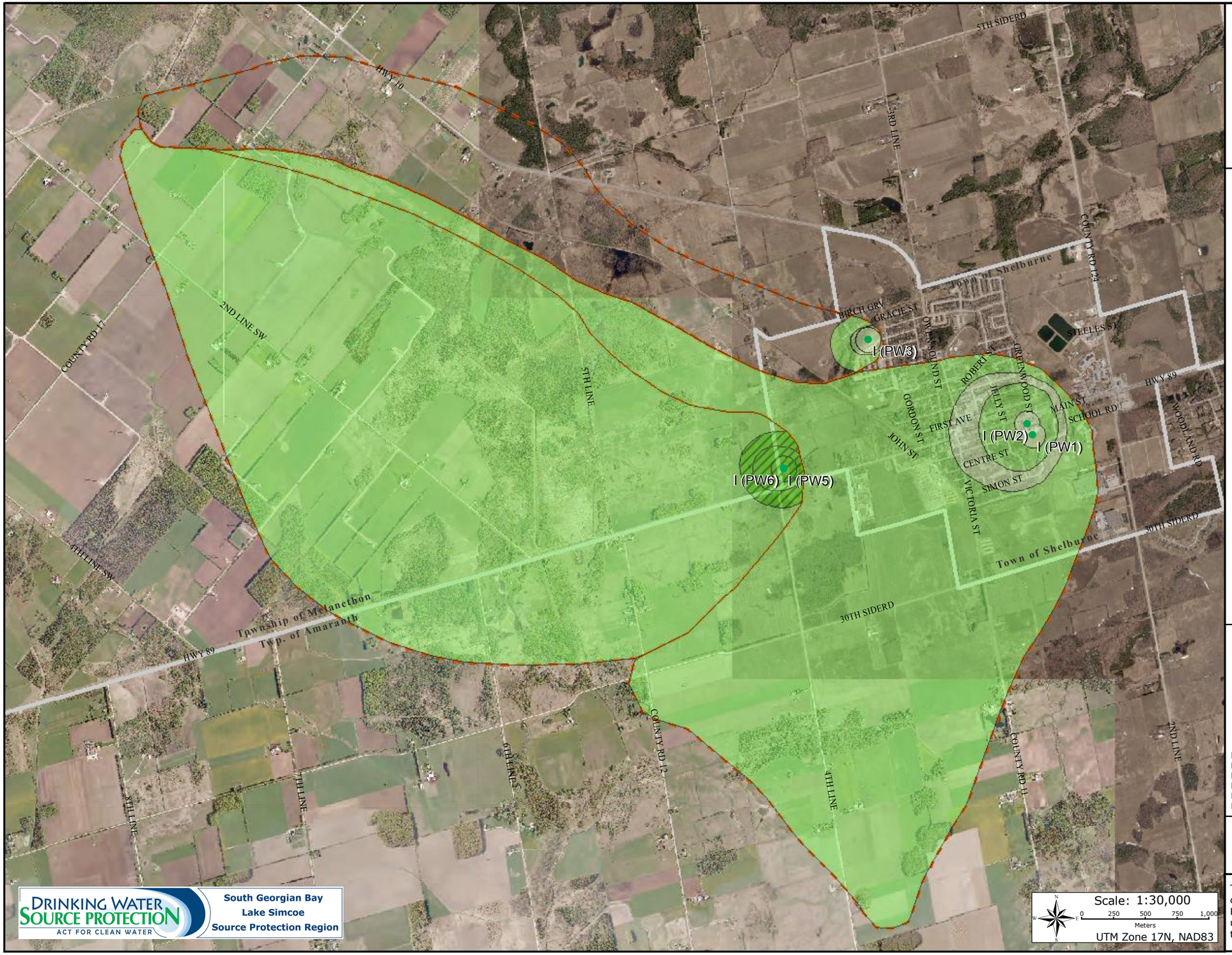
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 9.4

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

MANAGED LANDS - TOWN OF SHELBURNE WELL SUPPLY



Legend

- Production Well Location (Well Type - I)

Percent Managed Lands

- > 80 %
- 40 - 80 %
- < 40 %
- Non-Applicable
- Well Head Protection Area Zones
- Municipal Boundary

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000
0 250 500 750 1,000
Meters
UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

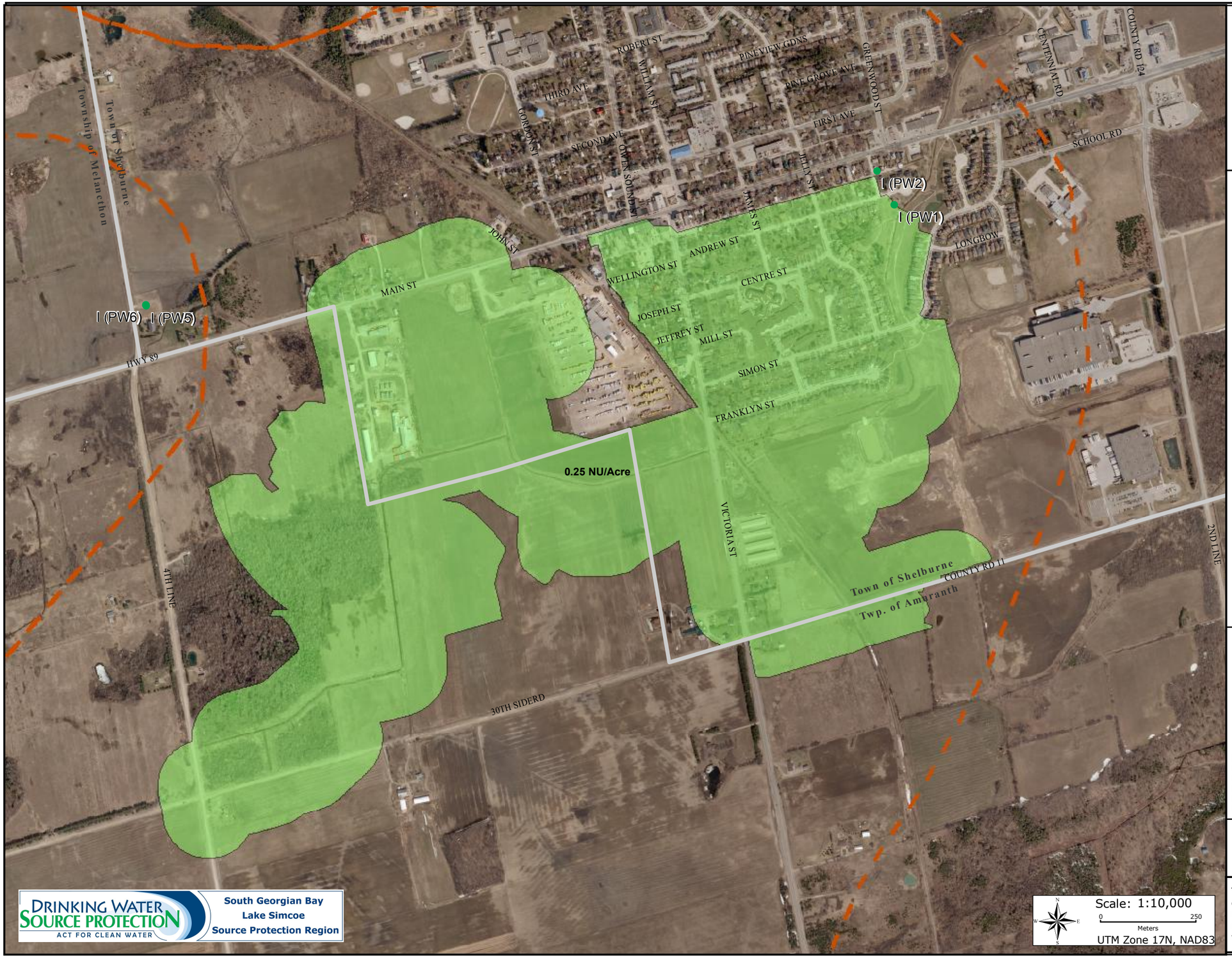
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 10.1A

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

MANAGED LANDS
WHPA E -
TOWN OF SHELBURNE
WELL SUPPLY
(PW1)



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Percent Managed Lands

- > 80 %
- 40 - 80 %
- < 40 %
- Non-Applicable
- Municipal Boundary

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

BURNSIDE

Created by: R.J. Burnside and Associates

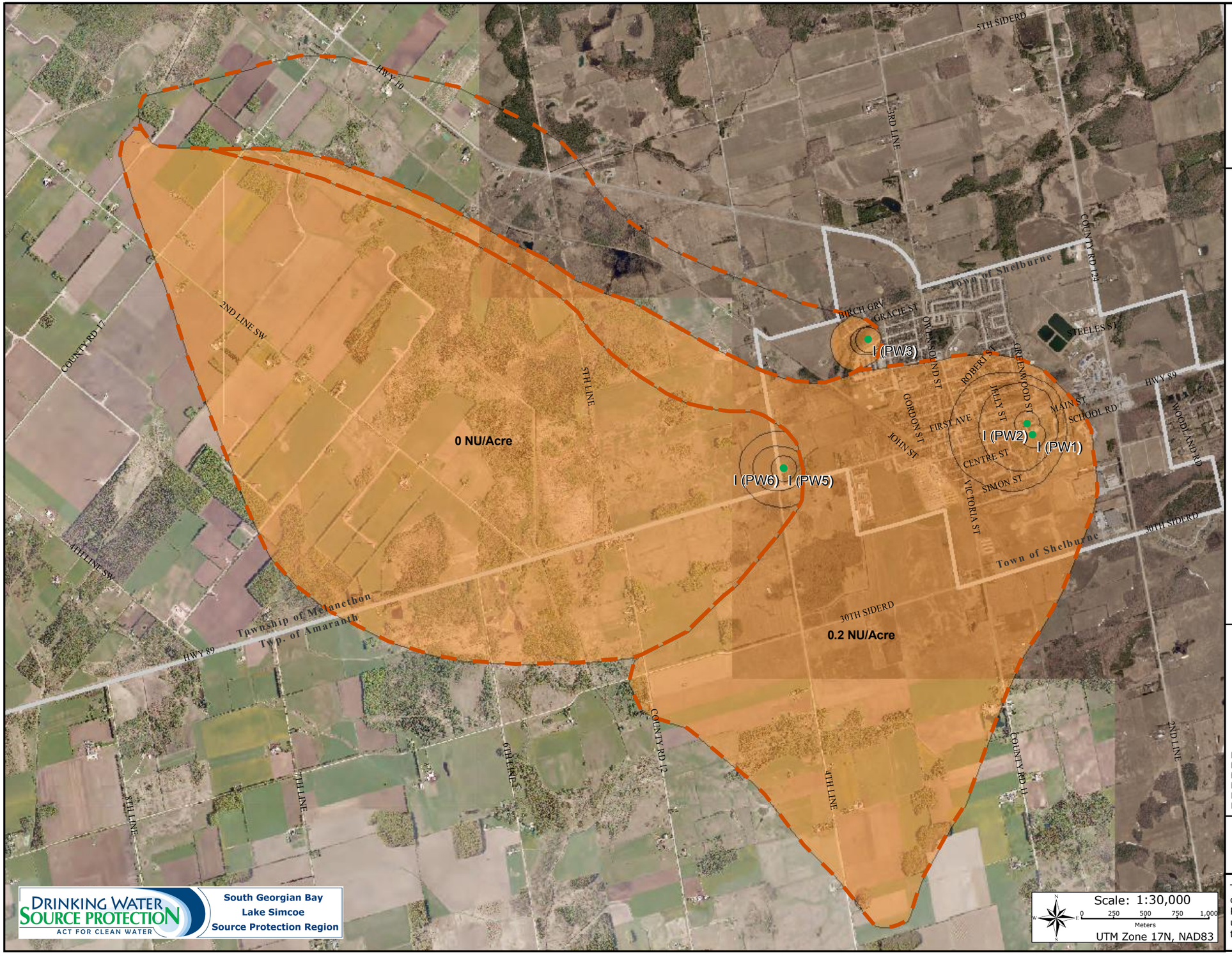
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 10.1B

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

LIVESTOCK DENSITY - TOWN OF SHELBURNE WELL SUPPLY



DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Legend

- Production Well Location (Well Type - I)

Livestock Density
Nutrient Units / Acre

- < 0.5 NU / Acre
- 0.5-1.0 NU / Acre
- > 1.0 NU / Acre
- Non-Applicable
- Well Head Protection Area
- Municipal Boundary

Scale: 1:30,000
0 250 500 750 1,000
Meters
UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

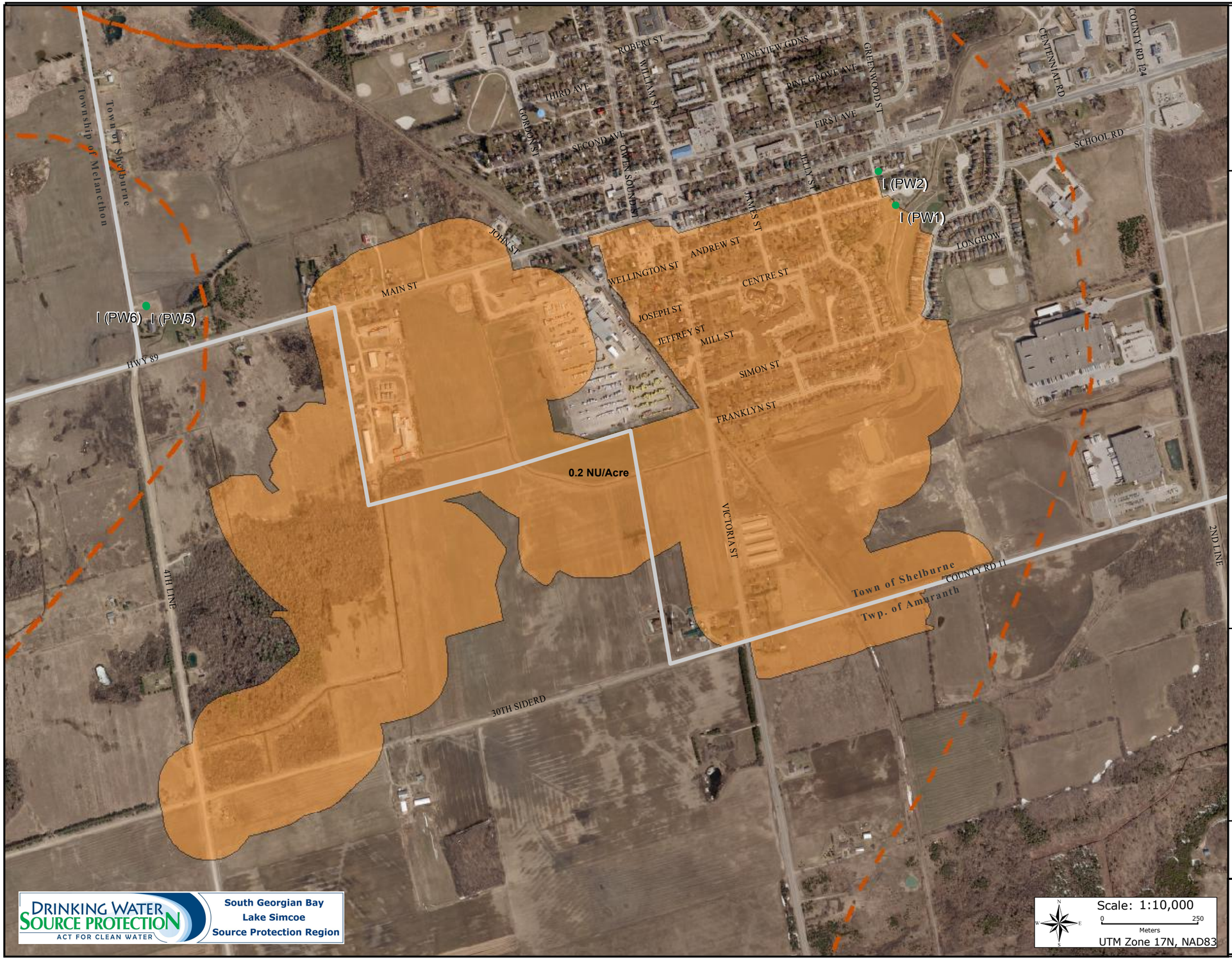
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 10.2A

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

LIVESTOCK DENSITY
WHPA E -
TOWN OF SHELBURNE
WELL SUPPLY
(PW1)



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

Livestock Density
Nutrient Units / Acre

- > 1.0 NU / Acre
- 0.5-1.0 NU / Acre
- < 0.5 NU / Acre
- Non-Applicable
- Municipal Boundary

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:10,000
0 250
Meters
UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

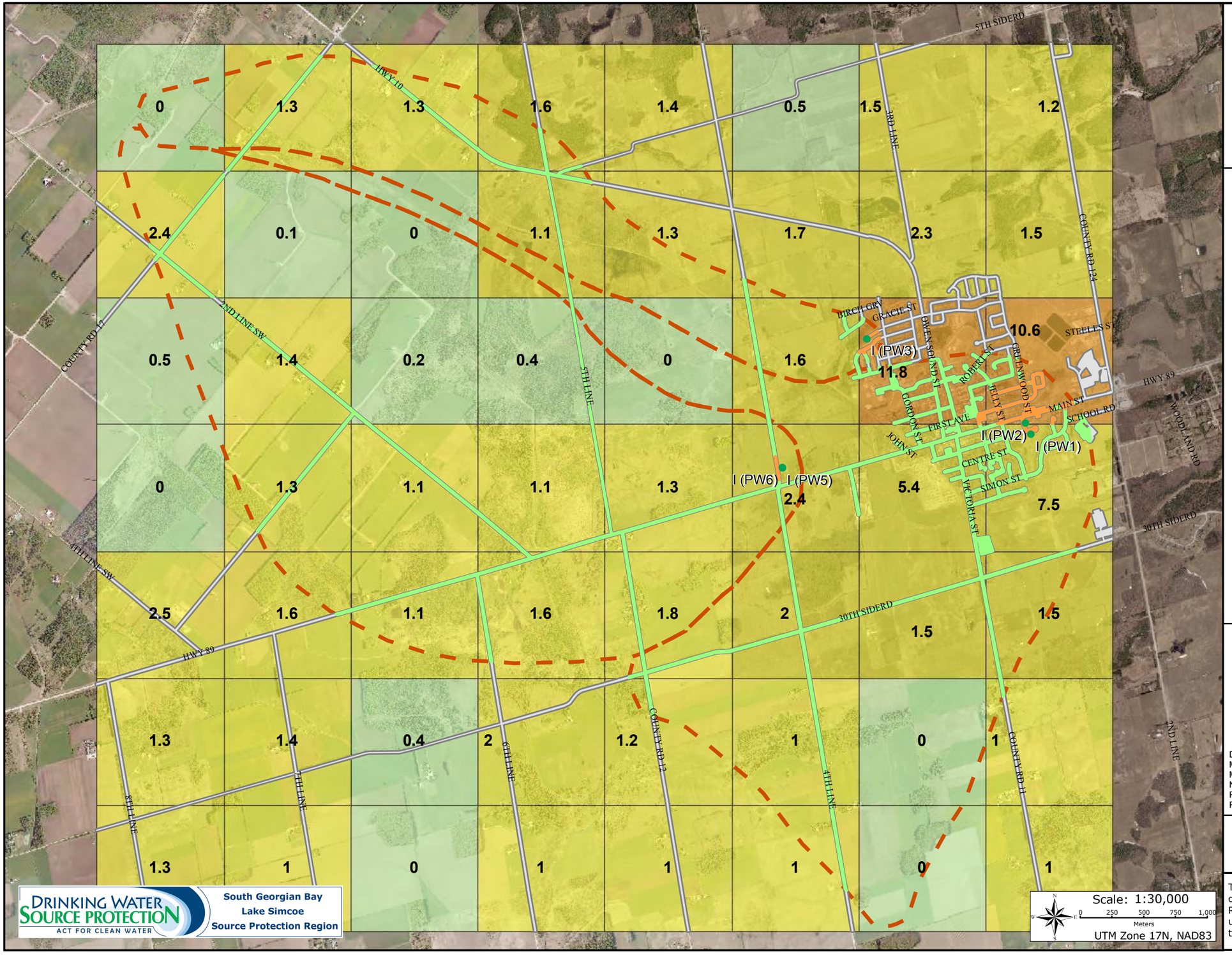
Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 10.2B

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

IMPERVIOUS SURFACES - TOWN OF SHELBURNE WELL SUPPLY



Legend

- Production Well Location (Well Type - I)
- Well Head Protection Area

% Impervious Surface (per km2)

- < 1%
- 1 - 8%
- 8 - 80%
- > 80%

Threat Level Road Salt Application

- Significant
- Moderate
- Low
- Non-Applicable

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:30,000

0 250 500 750 1,000
Meters

UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

Project Number: MSA12364
Date: 2010-04-30

Ontario

Figure 10.3

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BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Municipal Water Well Logs

17 No. 845

Well #1

Received March 30/51

UTM | | 12 | | | | | E
| 9 | 16 | | | | | N
Elev. | 9 | 16 | 1 | 5 | 95 |
Bas | | 4 | | | | |

ONTARIO

The Well Drillers Act

Department of Mines, Province of Ontario

Water Well Record

County ~~or Territorial District~~ Dufferin Township, Village, Town or City Village of Shelburne

Con. — Lot — Street and Number (if in Village, Town or City) ~~County~~ Village of Shelburne

Owner Village of Shelburne Address ~~R.R.~~ St. Andrew St.

Date Completed — (day) April (month) 1950 (year) Cost of Well (excluding pump)

Pipe and Casing Record

Casing diameter(s) 12"

Length(s) of casing(s) 33'

Type of screen —

Length of screen —

Distance from top of screen to ground level —

Is well a gravel-wall type?

Pumping Test

Date April 1950

Static level Flowing well - 80 gal/min

Pumping level

Pumping rate 350 gal/min - drawdown 0 ft.

Duration of test 72 hours

Distance from top of screen to ground level —

Water Record

Kind (fresh or mineral) fresh

Quality (hard, soft, contains iron, sulphur, etc.) medium hard

Appearance (clear, cloudy, coloured) clear

For what purpose(s) is the water to be used? Municipal

[redacted] is well from possible source of contamination? —

Wh[redacted] the source of contamination?

Enclose a copy of any mineral analysis that has been made of water —

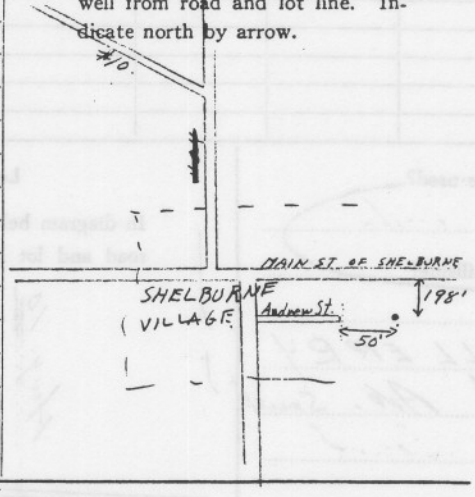
Depth(s) to Water Horizon(s)	Kind of Water	No. of Feet Water Rises
44'		44'

Well Log

Overburden and Bedrock Record	From	To
surface - crib bed -	0 ft.	3 ft.
red quick sand	3	8
grey " "	8	32'
rock gravel & silt	32	33
Niagara limestone	33	70
Clinton limestone	70	75

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Situation: Is well on upland, in valley, or on hillside?

Drilling Firm O. R. Beckerton

Ad[redacted] Shelburne

N[redacted] Driller Address

Date May 22 Licence Number

S. R. B.

Signature of Licensee

FORM 5

UTM | | Z | | E
5 | R | | | N
Elev. 5 | R | 1595
B 94 |

WELL #2 · Well 2

11 N° 071 847

GROUND WATER BRANCH
MAY 12 1959
ONTARIO WATER RESOURCES COMMISSION

The Ontario Water Resources Commission Act, 1957

WATER WELL RECORD

County or District: DUFFERIN Township, Village, Town or City: SHELBURNE

Con. .... Lot .... Date completed: 15 (day) April (month) 59 (year)

Owner: Village of Shelburne (print in block letters) Address: Shelburne Ont.

Casing and Screen Record		Pumping Test	
Inside diameter of casing	12½"	Static level	20'
Total length of casing	47'	Test-pumping rate	265 G.P.M.
Type of screen	—	Pumping level	25'
Length of screen	—	Duration of test pumping	2 hrs.
Depth to top of screen	—	Water clear or cloudy at end of test	Clear
Diameter of finished hole	12"	Recommended pumping rate	265 G.P.M.
		with pumping level of	25'

Well Log · Water Record — 85' of pump ... 7 stage

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, sulphur)
Hard sand clay	0	42			
shaley lime rock	42	47			
solid grey limestone	47	100	50 - 100	80	fresh
			main stream found at 60		

For what purpose(s) is the water to be used?
village water supply

Is well on upland, in valley, or on hillside?
upland

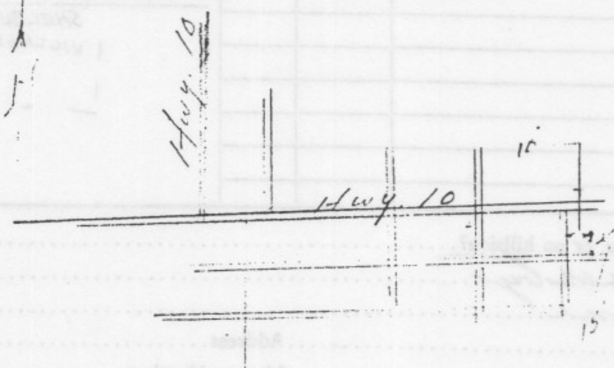
Drilling Firm: M. S. BELLERRY
Address: 45 2nd Ave. South
R.R. 4 [illegible]

Licence Number ....
Name of Driller ....
Address ....
Date: May 5 59

M. S. Bellerby
(Signature of Licensed Drilling Contractor)

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 5

May 24 2000 NOTE: The current pumping rate of the well may have changed from when the well was first constructed.

MINISTRY OF THE ENVIRONMENT

The Ontario Water Resources Act

WATER WELL RECORD

Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 1702657 | MUNICIP | CON.

2 ✓ Well #3

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Dufferin	Town of Shelburne	Reg Little Property	

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
P.U.C.	Shelburne Ont	DAY 5 MO 7 YR 71

21	ZONE	EASTING	NORTHING	RC	ELEVATION	RC	BASIN CODE
	17	563057	488144	3	0486	5	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
Black	top soil			0	3
Blue	clay & mud			3	20
Gravel	fine water bearing			20	32
[illegible]	limestone rock			32	38
Solid rock	for Brown			38	299
Blue	shale			299	320
Pieces of material 20 to 25 ft intervals					
Shaley Limestone 150 and 190			187 to 289		

31 |

32 | Thisis #3 test hole

41 WATER RECORD			51 CASING & OPEN HOLE RECORD				
WATER FOUND AT - FEET	KIND OF WATER		INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
20 to 310	☒ FRESH		8 1/2		.344	12	to 32
			6 1/4		.188	0	to 36
			reflect				

SCREEN	
SIZE(S) OF OPENING (SLOT NO.)	
DIAMETER	6 INCHES
LENGTH	8 FEET
MATERIAL AND TYPE	Stainless steel
DEPTH TO TOP OF SCREEN	38 FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☒ 1 PUMP ☒ 2 BAILER	220 GPM	3 HOURS — MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
flowing	4 FEET	[illegible]	[illegible]	2 1/2 FEET	4 FEET

IF FLOWING, GIVE RATE: approx 70 GPM

PUMP INTAKE SET AT — FEET. WATER AT END OF TEST: ☐ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☐ DEEP. RECOMMENDED PUMP SETTING — FEET. RECOMMENDED PUMPING RATE — GPM

GPM./FT. SPECIFIC CAPACITY

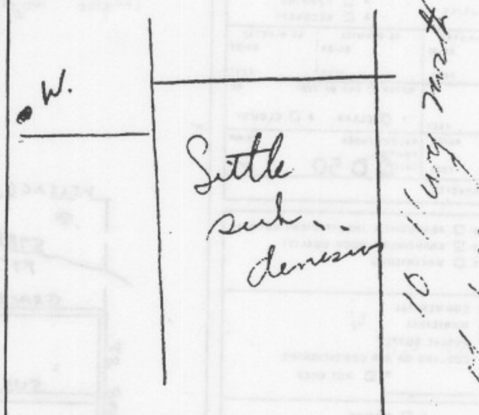
FINAL STATUS OF WELL: 1 ☐ WATER SUPPLY; 2 ☐ OBSERVATION WELL; 3 ☒ TEST HOLE; 4 ☐ RECHARGE WELL; 5 ☐ ABANDONED, INSUFFICIENT SUPPLY; 6 ☐ ABANDONED POOR QUALITY; 7 ☐ UNFINISHED

WATER USE: 1 ☐ DOMESTIC; 2 ☐ STOCK; 3 ☐ IRRIGATION; 4 ☐ INDUSTRIAL; ☐ OTHER; 5 ☒ COMMERCIAL; 6 ☐ MUNICIPAL; 7 ☐ PUBLIC SUPPLY; 8 ☐ COOLING OR AIR CONDITIONING; 9 ☐ NOT USED

METHOD OF DRILLING: 1 ☒ CABLE TOOL; 2 ☐ ROTARY (CONVENTIONAL); 3 ☐ ROTARY (REVERSE); 4 ☐ ROTARY (AIR); 5 ☐ AIR PERCUSSION; 6 ☐ BORING; 7 ☐ DIAMOND; 8 ☐ JETTING; 9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE INDICATE NORTH BY ARROW.



DRILLERS REMARKS

CONTRACTOR	
NAME OF WELL CONTRACTOR	Bellmont Drilling Co
LICENCE NUMBER	1315
ADDRESS	Shelburne Ontario
NAME OF DRILLER OR BORER	John E Bellinty
SIGNATURE OF CONTRACTOR	J E Bellinty
SUBMISSION DATE	DAY — MO — YR —

OFFICE USE ONLY	
DATA SOURCE	CONTRACTOR	DATE RECEIVED 040680
DATE OF INSPECTION	INSPECTOR
REMARKS	P / WI
CSS.ES	

MINISTRY OF THE ENVIRONMENT COPY

FORM 7 MOE 07-091

The Ontario Water Resources Act

WATER WELL RECORD

Well 4 A11E

Well 4

ONTARIO

1 PRINT ONLY IN SPACES PROVIDED
2 CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 1701773 U.C. MUNICIP 1702 CON

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Dufferin	Shelburne	Con III	22

NAME OF OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Shelburne P.U.C. Well #4	Drawer 250, Shelburne, Ont.	DAY 7 MO. June YR. 74

21 ZONE 17 EASTING 563449 NORTHING 4881535 RC 5 ELEVATION 1600 RC 5 BASIN CODE 22

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
brown	clay	sand		0	14
grey	sand		fine	14	15
grey	clay		sandy	15	26
brown	limestone		hard	26	41
brown	limestone		soft	41	45
"	"			45	134
grey	limestone			134	146
brown	limestone			146	170
br,yellow, grey	limestone			170	182
white	limestone			182	208
blue	shale			208	211
surface 1585.55 ft. above sea level					

31 D01746528 D015208 D02620581 D04161573 D04561585 D1346115

32 D1462115 D1706115 D1826115 D2081115 D2113115

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
027	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
1821	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
08	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.260	0	0027
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
0	10	limestone cuttings

PUMPING TEST

71 PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER

PUMPING RATE	DURATION OF PUMPING HOURS	MINUTES
0050 GPM	06	40

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: 1 ☐ PUMPING 2 ☐ RECOVERY
001 FEET	023 FEET	15 MINUTES FEET / 30 MINUTES FEET / 45 MINUTES FEET / 60 MINUTES FEET

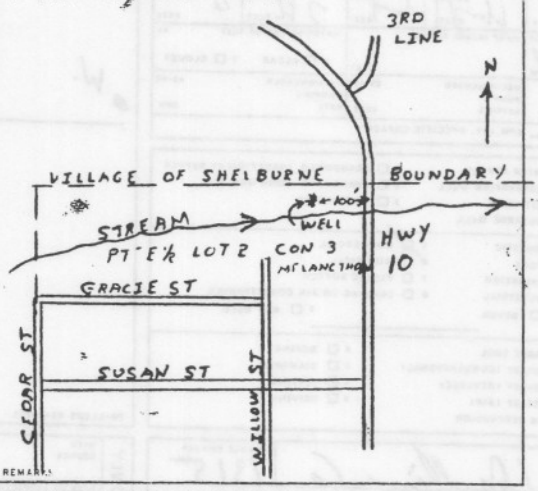
IF FLOWING GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	100 FEET	1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☒ DEEP	100 FEET	0050 GPM

GPM/FT. SPECIFIC CAPACITY

LOCATION OF WELL 6381

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 06

1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL 5 ☐ COMMERCIAL 6 ☒ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED 10 ☐ OTHER

METHOD OF DRILLING 1

1 ☐ CABLE TOOL 2 ☒ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Crowley Groundwater Limited — LICENCE NUMBER: 1621

ADDRESS OF WELL CONTRACTOR: Bertram Dr. Dundas

NAME OF DRILLER OR BORER: J.D. Crowley — LICENCE NUMBER: 1621

SIGNATURE OF DRILLER OR BORER — SUBMISSION DATE: DAY 7 MO. June YR. 74

MINISTRY OF THE ENVIRONMENT COPY

OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 1621 | DATE RECEIVED 040275

DATE OF INSPECTION | INSPECTOR

REMARKS: Well # 4

PK

WI

May 27 2008 NOTE: The current pumping rate of the well may have changed from when the well was first constructed.

Well 5

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 — 1704712 — MUNICIP 17 02 — CON.

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH CITY TOWN VILLAGE	CON BLOCK TRACT SURVEY ETC	LOT
DUFFERIN		PRODUCTION WELL	

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
TOWN OF SHELBURNE	203 MAIN STREET	DAY — MO 5 YR 93

21 — ZONE 17 — EASTING 562380 — NORTHING 4880437 — BC 3 — ELEVATION 494 — BC 5 — BASIN CODE

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
	Top Soil			0	2
Brown	Clay	Gravel		2	6
Brown	Sand	Gravel		6	8
Brown	Clay			8	14
Grey	Clay			14	45
Brown	Clay	Boulders		45	50
Brown	Limestone	Boulders	Broken Material	50	61
Brown	Limestone		Layers of broken rock	61	77

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
50	1 FRESH 2 SALTY 3 SULPHUR 4 MINERALS 5 GAS — not tested
	1 FRESH 2 SALTY 3 SULPHUR 4 MINERALS 5 GAS
	1 FRESH 2 SALTY 3 SULPHUR 4 MINERALS 5 GAS
	1 FRESH 2 SALTY 3 SULPHUR 4 MINERALS 5 GAS
	1 FRESH 2 SALTY 3 SULPHUR 4 MINERALS 5 GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH FEET FROM	TO
012	1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC	365	+2	62
	1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC		62	77
	1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC			

SCREEN

SIZE SLOT OF OPENING SLOT NO.	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER ETC.)
0	18	bentonite

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER — PUMPING RATE: 500 GPM — DURATION OF PUMPING: 1 HOURS — MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY			
		15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
2.27 FEET	11.91 FEET	10.60 FEET	11.33 FEET	11.64 FEET	11.91 FEET

IF FLOWING GIVE RATE — GPM

PUMP INTAKE SET AT: 55 FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

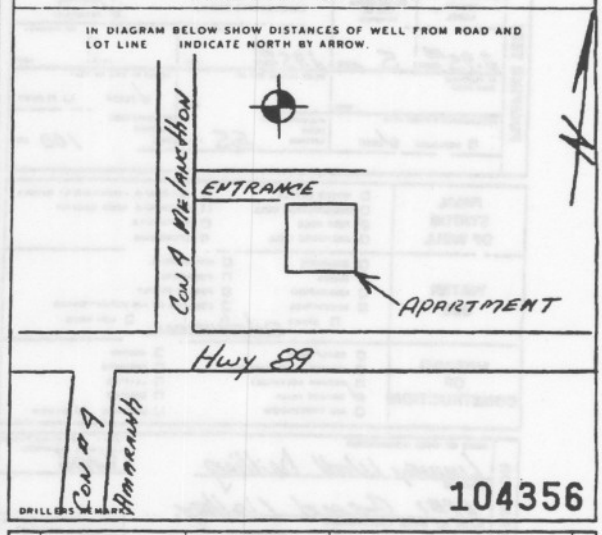
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING — FEET

RECOMMENDED PUMPING RATE — GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLER'S REMARKS: 104356

FINAL STATUS OF WELL	1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED ☐ DEWATERING
WATER USE	1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☒ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED
METHOD OF CONSTRUCTION	1 ☐ CABLE TOOL 2 ☒ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING ☐ DIGGING ☐ OTHER

CONTRACTOR

NAME OF WELL CONTRACTOR: Lunney well drilling — WELL CONTRACTOR'S LICENCE NUMBER: 3406

ADDRESS: RR #1 Grand Valley

NAME OF WELL TECHNICIAN: T.GERRITS — WELL TECHNICIAN'S LICENCE NUMBER: T 0080

SIGNATURE OF TECHNICIAN/CONTRACTOR — SUBMISSION DATE: DAY — MO 07 YR 93

OFFICE USE ONLY

DATA SOURCE — CONTRACTOR 3406 — DATE RECEIVED FEB 07 1994

DATE OF INSPECTION — INSPECTOR

REMARKS: CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

1704107

Well 6

TABLE 1
WELL RECORDS

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

PW1-89

RELIANCE 1 1

Fabrizia Construction Ltd RR#1 Alliston ONT Nov 22 - 99 to 80

LOG OF OVERBURDEN AND BEDROCK MATERIALS

GEOLOGICAL ECOLOGY	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
	Top Soil			0	2
Brown	Clay	Gravel	Sandy	2	5
Brown	Sand	Gravel		5	8
Brown	Clay	Sandy		8	13
Grey	Clay	Silty		13	15
Brown	Clay	Boulders		15	56
Broken	Limestone			56	59
	Limestone	Broken	Layers	59	80

WATER RECORD

	KIND OF WATER	
63 to 80	☐ FRESH ☐ SALTY ☐ UNKNOWN	☐ DRILLING ☐ DRILLING & DOMESTIC ☐ DOMESTIC ☐ LIVESTOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ COOLING & AIR CONDITIONING ☐ OTHER

CASING & OPEN HOLE RECORD

STEEL GALVANIZED CONCRETE OPEN HOLE PLASTIC	6"	+2	62
STEEL GALVANIZED CONCRETE OPEN HOLE PLASTIC	6"	62	80

SCREEN

PLUGGING & SEALING RECORD

0	Holeshigh Slurry

PUMPING TEST

☐ PUMP ☐ BAILER	AIR		100	1	
STATIC LEVEL	PUMPING LEVEL				
2.95	5	2.95			
☐ CLEAR ☐ CLOUDY					
☐ TURBINE ☐ SUBMERSIBLE	55		100		

LOCATION OF WELL

IN DRAWING GIVE SOME DISTANCES OF WELL FROM ROAD AND LOT LINE INDICATE NORTH BY ARROW

110 FT
600'
80 FT
Hwy 89
Limestone Comes up to 60'
MAIN PUMPED WELL
C.O.E.G

FINAL STATUS OF WELL	☐ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ DEWATERING
WATER USE	☐ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ COOLING & AIR CONDITIONING ☐ PUBLIC SUPPLY ☐ NOT USED Subdivision
METHOD OF CONSTRUCTION	☐ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☐ ROTARY (REVERSE) ☐ AIR PERCUSSION ☐ DIGGING ☐ BORING ☐ DRIVING ☐ JETTING ☐ OTHER

CONTRACTOR

Linnsey Well Drilling 3106

RR#1 Grand Valley

T. Smith J. Lapp 7-5080

Nov 29 99

OFFICE USE ONLY

Source: MOE of Ontario

R. J. BURNSIDE & ASSOCIATES LTD.
CONSULTING ENGINEERS, PLANNERS & HYDROGEOLOGISTS
15 TOWNLINE, ORANGEVILLE, ONTARIO L9W 3R4

Project No. M-744

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Appendix B

WHPA-E Delineation Methodology

Appendix B
WHPA-E Delineation Methodology

As required by the Technical Rules – Assessment Report (December 2008), a WHPA-E has been delineated for all wells identified as GUDI (groundwater under the direct influence of surface water) as determined in accordance with subsection 2 (2) of O.Reg. 170/03 (Drinking Water Systems) made under the Safe Drinking Water Act, 2002.

The Technical Rules provide that the delineation of the WHPA-E is equivalent to the methods describing the delineation of an Intake Protection Zone-2 (IPZ-2) for a surface water intake under the current guidelines.

The IPZ-2 is delineated to represent the distance that a contaminant would travel in the time required for the supply operator to respond to adverse conditions in the surface water body with which the system is associated. The IPZ-2 is delineated with a prescribed minimum of two hours travel time (response time) upstream from the intake on the surface water body. For the WHPA-E it is assumed that the intake is located at the closest point on the surface water body associated with the GUDI status or where the cause for GUDI status is unknown on the closest surface water body.

Calculation Procedure

The source water protection zone is defined by the potential for surface water to influence groundwater wells during major storm events and is based on a 2-hour travel time upstream of the GUDI well during bankfull flow conditions. In order to determine this zone, a Hydraulic Model was created using HEC-RAS to evaluate the channel velocity during bankfull conditions.

Cross-section geometry was determined from a Digital Terrain Mapping (DTM) with cross-section locations taken roughly every 50 to 100 m. The locations of the cross-sections used are provided in Figure B-1. The terrain model was created from photogrammetric acquired elevation data in 2008. ArcGIS and HecGeo-Ras were used to determine the channel geometry including the flow length for each section of the main channel as well as the left and right overbanks. Manning's "n" values for the main channel and overbanks were determined based on aerial photography. This information was imported into Hec-Ras and modeled using a steady state, sub-critical flow regime. A downstream boundary condition of normal depth was assumed with a bed slope of 0.002.

Bankfull conditions were determined for each reach by iterating the channel discharge within Hec-Ras until a majority of sections were at bankfull depth. This was completed for each flow change location within the watercourse starting at the downstream end and working upwards. For reaches which seem to have greater bankfull capacity than reach immediately downstream, the channel discharge from the upstream reach was assumed to be equal to that of the reach immediately downstream.

Once the appropriate channel discharge had been established for each reach within the watercourse, the channel velocity for each cross section was determined using Hec-Ras. The travel time for each cross section was then determined as the distance between cross-sections divided by the channel velocity for that cross section. The travel time for

Appendix B
WHPA-E Delineation Methodology

each section was then added beginning at the GUDI well and moving upstream until the total travel time was equal to 2 hours. This represents the limit of the water protection zone. The lateral extent of the zone was defined by using the regulatory or flood limit as the boundary for this zone. Where this data was missing a 120 m offset from the channel was used to define the lateral extent of the WHPA-E.

Design Assumptions

For reaches which contain large online ponds (>0.5 ha) the source water protection zone was assumed to end at the pond outlet as the hydraulic residence time within the pond would be greater than 2 hours. For reaches which were less than 2.0 km in length it was assumed that the source water protection zone will encompass the entire reach. For minor tributaries where the point of confluence at the main channel is less than 2 hours from the well, the entire tributary was assumed to be within the source water protection zone.

Vulnerability Scoring

The Technical Rules: Assessment Report (Clean Water Act 2006) outline that the vulnerability score for a WHPA-E is determined based on the same principles as an IPZ-2 which is defined based on professional judgment as a product of Area Vulnerability (V_a) and Source Vulnerability (V_s) factors. Within the current study area vulnerability and source vulnerability were developed using the following methodology.

Area Vulnerability

Area Vulnerability was determined from the following factors, surficial geology, slope and land use within the delineated WHPA-E. Each factor was rated as either vulnerable or not vulnerable and assigned a score of 1 or 0, respectively. Scores were summed at the end of the analysis and based on total score of 1, 2, or 3, the area vulnerability was ranked as 7, 8 or 9.

The surficial geology of the area is considered as the overburden sediments affect how much infiltration occurs and how much water becomes runoff. When the surficial geology consisted of predominantly course grained sediments it was assigned a score of 1. Surficial units consisting predominantly of fine grained sediments were assigned a score of 0.

Land use within the WHPA-E was considered for the vulnerability of the area as the activities within the area can cause a greater chance of contamination. Agricultural, residential, industrial land uses were assigned a score of one. Natural areas which have limited anthropogenic activities within them were assigned a score of 0.

The slope of the capture area can affect the vulnerability as the greater the slope the quicker contaminants will travel over the ground flow towards the source.

Table 1 outlines the factors used to determine the area vulnerability factor for the WHPA of Shelburne PW1.

Appendix B
WHPA-E Delineation Methodology

Table 1 Area Vulnerability Factor – Shelburne PW1

		Score
Surficial Geology	Till with some glaciofluvial (Predominantly fine grained)	0
Slope	1.3 %	0
Land Use	Agricultural w/ some residential	1
	Total	1 out of 3

The area vulnerability assigned to Shelburne PW1 WHPA-E is 7.

Source Vulnerability

Source Vulnerability was determined based on the intake type, the depth of the well and the dimensions of the associated water body and the inferred potential for dilution of contaminants within that body.

The Besley Drain was determined to be a Type D intake as it is a man-made drain and not a natural creek or river. The Source Vulnerability Factor for an Intake Type D is 0.8 to 1.0. To determine what number within this range the other two factors were considered.

Wells that were less than 15 m deep were regarded as vulnerable and given a score of 1, those greater than 15 m deep were scored as 0 for less vulnerable.

The dimensions of each water body and the potential for dilution of contaminants were examined, a water body with a large capacity for dilution was rated as low vulnerability and scored as 0 while a water body with low potential for dilution was rated as 1. These numbers were summed to produce the overall source vulnerability which was determined as a summed score of 1 representing a source vulnerability of 0.9 and a summed score of 2 representing a source vulnerability of 1.0.

Table 2 outlines the factors used to determine the source vulnerability factor for the WHPA of Shelburne PW1.

Table 2 Source Vulnerability Factor – Shelburne PW1

		Score
Intake Type	Type D	-
Well Depth	23.5 m	0
Water Body	Shallow ditch, low flow, low potential for dilution	1
	Total	1 out of 2

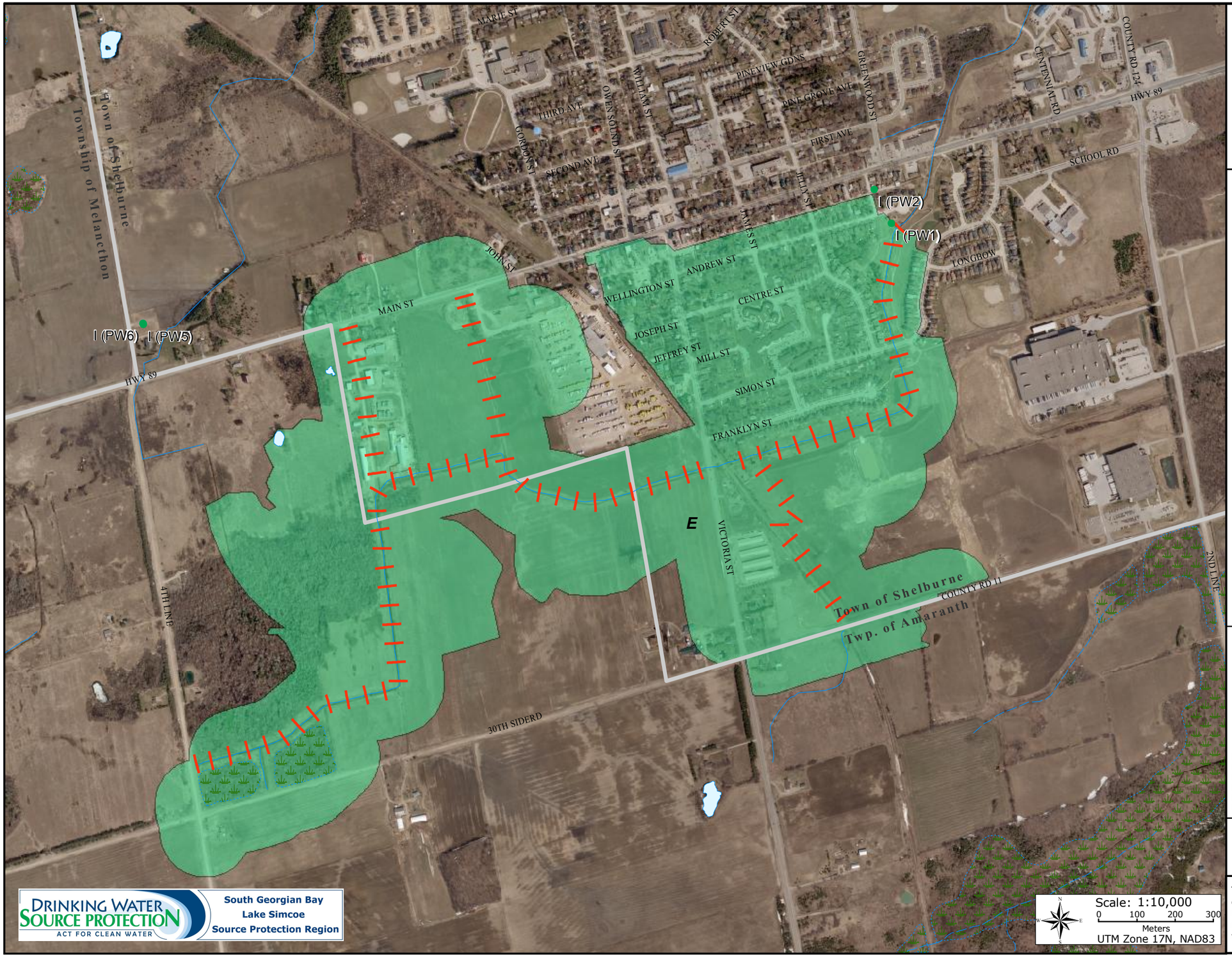
Using the above methodology the source vulnerability factor assigned to Shelburne PW1 WHPA-E is 0.9.

Appendix B
WHPA-E Delineation Methodology

Vulnerability Score

To determine the vulnerability score the area vulnerability factor is multiplied by the source vulnerability factor. This results in a vulnerability score for Shelburne PW1 WHPA-E of 6.3.

SURFACE WATER CROSS-SECTION - TOWN OF SHELBURNE WELL SUPPLY (PW1)



Legend

- Production Well Location (Well Type - I)
- Hydraulic Cross Section 3D
- WHPA-E: Surface Vulnerability Zone (GUDI Well)
- Municipal Boundary
- Watercourse: Permanent
- Watercourse: Intermittent
- Lake
- Wetland

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Scale: 1:10,000
0 100 200 300
Meters
UTM Zone 17N, NAD83

BURNSIDE

Created by: R.J. Burnside and Associates

Project Number: MSA12364
Date: 2010-02-01

Ontario

Figure B-1

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

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Appendix C

Aquifer Vulnerability K-Factors

GSC Classification of Geologic Materials and Cooresponding K-Factors

Description	K-Factor	Aquifer
clay, silty clay	6	No
clay, silty clay, topsoil	6	No
clay, silty clay, with muck, peat, wood frags	6	No
clay, silty clay, with rhythmic/graded bedding	6	No
covered, missing, previously bored	3	No
diamicton: cl to cl/si matrix	5	No
diamicton: cl to cl/si with gr/sa/si/cl interbeds	5	No
diamicton: cl to cl/si, stoney	5	No
diamicton: cl to cl/si, topsoil	5	No
diamicton: cl to cl/si, with muck, peat, wood frags	5	No
diamicton:si to sa/si matrix	5	No
diamicton: si to sa/si with gr/sa/si/cl interbeds	5	No
diamicton: si to sa/si with muck, peat, wood frags	5	No
diamicton: si to sa/si, stoney	5	No
diamicton: si to sa/si, topsoil	5	No
diamicton: si/sa to sa matrix	5	No
diamicton: si/sa to sa with gr/sa/si/cl interbeds	5	No
diamicton: si/sa to sa with muck, peat, wood frags.	5	No
diamicton:si/sa to sa, stoney	5	No
diamicton: texture unknown	5	No
dolomite	2	Yes
fill (incl topsoil, waste)	3	No
granite (poss. bedrock, prob. boulder)	1	No
gravel, gravelly sand	1	Yes
gravel, gravelly sand, topsoil	2	Yes
gravel, gravelly sand, with muck, peat, wood frags.	2	Yes
gravel, gravelly sand, with rhythmic/graded bedding	1	Yes
interbedded limestone/shale	2	No
limestone	1	Yes
miscellaneous; no obvious material code	3	No
organic	3	No
organic topsoil	3	No
potential bedrock	3	Yes
rock	3	Yes
sand, silty sand	3	Yes
sand, silty sand, with muck, peat, wood frags.	3	Yes
sand, silty sand, with rhythmic/graded bedding	3	Yes
sandstone.	5	No
shale	8	No
silt, sandy silt, clayey silt	4	No
silt, sandy silt, clayey silt, topsoil	4	No
silt, sandy silt, clayey silt, with muck, peat, wood frags.	4	No
silt, sandy silt, clayey silt, with rhythmic/graded bedding	4	No

Source:
Draft Guidance Modules, Module 3 - Groundwater Vulnerability Analysis, MOE, December 2006.

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Appendix D
Water Well Survey and Risk Assessment

Appendix D
Water Well Survey and Risk Analysis

According to the Technical Rules, the aquifer vulnerability must account for the presence and potential impact of constructed transport pathways within the Well Head Protection Areas (WHPAs). The presence of transport pathways may increase the vulnerability of an aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer.

In this study the main transport pathway of concern is water wells. To asses the risk that water wells pose on the supply aquifers Burnside has collected information regarding the location and nature of the wells located in the WHPAs. This was completed using the MNR water well records database and a field water well survey. The information was then used to produce risk ratings for each identified well based on construction and use of the well.

1.0 Water Well Records

A review of Water Well Records from the MNR Water Well Database was conducted to identify all wells located within the Shelburne WHPAs. Information from the database such as depth of well, year of construction, diameter of casing and construction methods were used to asses the risk for contamination of the well.

Individual water well logs were obtained for some of the wells in the WHPAs. These records were useful for locating well locations as they have a sketch of the well location from the driller.

2.0 Field Verification

Field verification water well surveys were completed within the WHPAs to identify wells not included in the MNR database and to improve on the locations of wells in the database. The survey was also used to collect information on the construction and condition of the wells within the WHPAs.

The surveys were conducted by Burnside on September 5, 2007 and consisted of a door to door survey and windshield survey to identify wells. Locations of wells were recorded using a GPS and included into the Burnside well database. The condition of the well, the height of casing and use of the well was noted. A summary of the survey results is included in Table D-1. Photographs of the municipal wells are provided in Attachment 1.

Since the first municipal well in Shelburne was constructed in the 1950's, homes older than 1950 within the Town were identified as potential properties with abandoned wells. During the survey, the field crew found that many residents were not home or did not want to participate in the survey. Many residents of older homes now serviced with municipal water did not know of a well on their property.

3.0 Well Uses

There were 124 wells identified within the WHPAs. A summary of the well uses provided by the MNR database or determined by the field survey are provided in Table 1.

Table 1 Well Use Summary

Well Use	Number of Wells
Municipal Supply	5
Monitoring Wells	15
Abandoned/Decommissioned	9
Domestic	64
Irrigation/Commercial	2
Stock	6
Unknown	23

3.1.1 Abandoned and Decommissioned Wells

Nine wells were identified through the MNR well records as being abandoned or decommissioned. These wells were test wells drilled during exploration for municipal water supply and were later decommissioned.

There may be other abandoned wells in Shelburne that were present before servicing that were not identified. If the well is no longer in use, without proper abandonment a preferential pathway for a contaminant to impact a drinking water source may exist. Similarly, a well no longer in use is unlikely to be maintained on a regular basis and, as a result, water quality impacts may go unnoticed. It is a requirement of Ontario Regulation 903 that unused wells be properly abandoned by a licensed well contractor and a well abandonment record submitted to the MOE. However, proper well abandonment is not actively enforced or monitored; therefore it is difficult to assess how many abandoned wells may exist.

3.1.2 Monitoring Wells

There were 15 monitoring wells identified within the WHPAs. Monitoring wells can present a risk when they are in poor condition and since they are only used occasionally for sampling. For the purpose of this analysis monitoring wells that intercept the municipal supply aquifer have been considered a moderate risk. Shallow monitoring wells that did not intercept the municipal aquifer were classified as low risk as well as piezometers.

3.1.3 Domestic Wells

There were 64 domestic wells identified in the well survey. A portion of these wells are located in areas that currently have municipal water services.

4.0 Well Risk Ratings

A well risk rating classification system has been developed to asses the potential risk a well may pose to the municipal aquifer. The classification system is based on the depth of the well, the aquifer that it creates a pathway for contaminants to enter and the

construction and condition of the well. Using these considerations, wells have been divided into 3 categories and 3 relative risk classes.

4.1 Well Risk Categories

All wells identified were assigned a well risk category determined by the aquifer the well is located in. The Shelburne municipal wells obtain water from bedrock aquifers. PW1 and PW2 obtain water from the upper 5 metres of unconfined bedrock in contact with granular overburden aquifer. PW3 and PW4 obtain water from deeper bedrock. PW5 and PW6 obtain water from a confined upper bedrock aquifer. Most domestic wells in the Town utilize the overburden/bedrock aquifer located at the contact of the overburden and bedrock. Depth of wells and the WHPA the well was located in were considered for categorizing the wells.

Category 1 Wells

This category consists of shallow overburden wells separated from the municipal aquifer by a confining aquitard.

Category 2 Wells

Wells in Category 2 are wells constructed in the deep overburden aquifer overlying the bedrock aquifer. These wells may or may not be connected to the aquifer of the municipal wells.

Category 3 Wells

Wells in Category 3 are wells constructed in the same bedrock aquifer as the municipal wells. These wells may provide a direct conduit for contaminants to reach the aquifer used for the municipal water supply.

4.2 Well Risk Classes

Each well was also assigned a well risk class based on the construction and condition of the well. This information was collected using water well database information and information collected during the field verification.

Class A Wells

Class A wells are wells that are constructed to conform with O.Reg 128/03. These wells have casings that are at least 40 cm above grade with a well cap. All wells drilled after 2002 should conform to O.Reg 128/03. Class A wells also include wells that were properly decommissioned.

Class B Wells

Class B wells are wells that may have some potential for surface water migration into the well casing. Wells with casing heights between 15 and 40 cm above grade with a well

cap were included in this class. Drilled wells constructed prior to 2002 but after well pitless adaptors came into use (1980) were also included in this class.

Class C Wells

Class C wells are wells that present a high risk of contamination by providing a direct pathway for surface water to enter the well casing. Wells with casing heights below 0.15 m above grade, wells in pits, and/or are in poor condition or abandoned are included in this category. Wells drilled prior to the use of pitless adaptors, which came into widespread use in the early 1980s, have wellheads in pits and as a result can pose a significant risk. Dug wells constructed at any time may be considered a higher risk preferential pathway to a water source due to the construction methods involved and lack of a proper surface seal.

Using the assigned category and class, each well is assigned a risk rating as shown by Table 2.

Table 2 Well Risk Ratings

Aquifer		Class		
	Category	A	B	C
Aquifer not connected	1	Low	Low	Low
Possibility of aquifer connection	2	Moderate	Moderate	High
Same aquifer as municipal source	3	Moderate	High	High
		Well properly Maintained	Some Threat to Water Quality	Well in Poor Condition

All wells are mapped in Figure D-1. The results from the Well Risk Ratings are summarized in the following Table 3.

Table 3: Well Risk Ratings Summary

WHPA	Wells with Risk Rating		
	Low	Moderate	High
WHPA-A	9	3	3
WHPA-B	2	4	2
WHPA-C/C1	3	4	3
WHPA-D	4	24	63
Total	18	35	71

Appendix D
Water Well Survey and Risk Analysis

There were 71 wells within the WHPAs identified as high risk wells. These wells have a high risk of creating a transport pathway for contaminant to enter the municipal supply aquifer. Wells categorized as high risk wells are wells that do not meet Ministry well standards and are located in the municipal supply aquifer or an aquifer that may be connected to the municipal supply aquifer.

Table D-1: Well Survey and Risk Ratings - Shelburne Wellfields

WHPA	Well ID	MOE Well ID	Depth (m)	Aquifer	Category	Casing Height (m)	Use Status	Year Category	Class	Risk Rating	Field Verified
A	**PW1**	1700845	25	Bedrock	3	-	Municipal Well	Pre-1980's	A	Low	Yes
A	**PW2**	1700847	33	Bedrock	3	-	Municipal Well	Pre-1980's	A	Low	Yes
A	**PW3**	1702657	105	Overburden / Bedrock	3	-	Municipal Well	Pre-1980's	A	Low	Yes
A	**PW6 (1-89)**	1704107	26	Bedrock	3	-	Muncipal Well	1980-2002	A	Low	Yes
A	**PW5 (1-93)**	1704712	25	Bedrock	3	-	Muncipal Well	1980-2002	A	Low	Yes
A	SH-MW1/00-12	1705660	12	Bedrock	3	0.87	Monitoring Well	1980-2002	B	Moderate	Yes
A	SH-MW3/00-20	1705638	20	Bedrock	3	0.81	Monitoring Well	1980-2002	A	Moderate	Yes
A	SH-MW3/00-16	1705639	16	Confined Overburden	2	0.88	Monitoring Well	1980-2002	A	Moderate	Yes
A	SH-MW1/00-6	-	6	Shallow Overburden	1	0.68	Monitoring Well	1980-2002	A	Low	Yes
A		1702655	105	Bedrock	3	-	Decommissioned	Pre-1980's	A	Low	No
A		1705823	14	No Information	-	-	Decommissioned	2002 +	A	Low	No
A	SH-MW5	1705808	9	Overburden	1	-	Monitoring Well	1980-2002	B	Low	No
A		1700846	23	Bedrock	3	-	Abandoned	Pre-1980's	C	High	No
A		1701772	87	Bedrock	3	-	Unknown	Pre-1980's	C	High	No
A		1702567	27	Bedrock	3	0.6	Domestic	Pre-1980's	C	High	No
B	Greenwood MWa	-	-	-	-	0.8	Monitoring Well	-	A	Moderate	Yes
B	Greenwood MWb	-	-	-	-	0.86	Monitoring Well	-	A	Moderate	Yes
B	Greenwood MWc	-	-	-	-	0.82	Monitoring Well	-	A	Moderate	Yes
B	Greenwood MWd	-	-	-	-	1.19	Monitoring Well	-	A	Moderate	Yes
B	TW6-89	1704034	30	Overburden / Bedrock	3	-	Decommissioned	1980-2002	A	Low	No
B	TW7-89	1704035	30	Bedrock	3	-	Decommissioned	1980-2002	A	Low	No
B		1702276	13	Overburden	2	-	Unknown	-		High	No
B		1701203	27	Bedrock	3	-	Abandoned	Pre-1980's	C	High	No
C		1706597	16	-	2	-	Unknown	2002 +	A	Moderate	No
C		1704718	75	No Information	3	-	Abandoned	1980-2002	B	Moderate	No
C	SH-MW2/00-16	1705659	16	Bedrock	3	0.88	Monitoring Well	1980-2002	A	Moderate	No
C	SH-MW2/00-10	-	10	Deep Overburden	2	0.67	Monitoring Well	1980-2002	A	Moderate	Yes
C		1703328	9	Shallow Overburden	1	-	Unknown	1980-2002	B	Low	No
C	SH-MW2/00-4	-	4	Shallow Overburden	1	0.74	Monitoring Well	1980-2002	A	Low	Yes
C1	TW1-89	1703865	27	Bedrock	3	0.61	Decommissioned	1980-2002	B	Low	No
C1		1704225	27	Bedrock	3		Unknown	1980-2002	B	High	No
C1	PW1-90	1704226	30	Overburden / Bedrock	3	0.61	Decommissioned	1980-2002	B	High	No
C1		1704715	-	Unknown	-	-	Unknown	1980-2002	B	High	No
D		1704865	50	Overburden / Bedrock	3	-	Domestic	1980-2002	B	Moderate	No
D		1703163	18	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1703329	29	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1703868	40	Overburden	2	-	Unknown	1980-2002	B	Moderate	No
D		1704943	49	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705148	23	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705193	25	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705460	31	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705538	30	Overburden	2	-	Domestic	1980-2002	B	Moderate	No

Table D-1: Well Survey and Risk Ratings - Shelburne Wellfields

WHPA	Well ID	MOE Well ID	Depth (m)	Aquifer	Category	Casing Height (m)	Use Status	Year Category	Class	Risk Rating	Field Verified
D	SH-MW4/00-17	1705607	17	Bedrock	3	1.12	Monitoring Well	1980-2002	A	Moderate	Yes
D		1705882	15	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1706208	30	Overburden	2	-	Domestic	2002 +	A	Moderate	No
D		1706334	-	Unknown	-	-	Unknown	2002 +	A	Moderate	No
D		1706335	-	Unknown	-	-	Unknown	2002 +	A	Moderate	No
D		1706405	31	Overburden	2	-	Domestic	2002 +	A	Moderate	No
D	SH-MW4/00-12	-	12	Deep Overburden	2	0.52	Monitoring Well	1980-2002	A	Moderate	Yes
D		1703074	21	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705120	30	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705461	19	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705637	15	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1705984	29	Overburden	2	-	Domestic	1980-2002	B	Moderate	No
D		1706396	60	Overburden	2	-	Domestic	2002 +	A	Moderate	No
D		1706463	98	Overburden	2	-	Domestic	2002 +	A	Moderate	No
D		1706486	102	Bedrock	3	-	Domestic	2002 +	A	Moderate	No
D		1700395	9	Shallow Overburden	1	-	Stock	Pre 1980	C	Low	No
D		1706625	5	Shallow Overburden	1	-	Unknown	2002 +	A	Low	No
D	SH-MW4/00-6	-	6	Shallow Overburden	1	0.7	Monitoring Well	1980-2002	A	Low	Yes
D		1700390	7	Shallow Overburden	1	-	Domestic	Pre 1980	C	Low	No
D		1701106	33	Bedrock	3	-	Domestic	Pre-1980's	C	High	No
D		1701436	37	Overburden / Bedrock	3	-	Domestic	Pre-1980's	C	High	No
D		1703560	47	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1700036	20	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1700057	31	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1700059	17	Overburden	2	-	Domestic	Pre 1980	C	High	No
D		1700060	27	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1700069	17	Overburden	2	-	Domestic	Pre 1980	C	High	No
D		1700070	16	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1700082	20	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1700394	34	Overburden	2	-	Stock	Pre 1980	C	High	No
D		1700396	20	Overburden	2	-	Stock	Pre 1980	C	High	No
D		1700399	20	Overburden	2	-	Stock	Pre 1980	C	High	No
D		1700843	30	Overburden	2	-	Unknown	Pre 1980	C	High	No
D		1701066	16	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1701504	37	Overburden	2	-	Domestic	Pre 1980	C	High	No
D		1701543	30	Overburden	2	-	Commercial	Pre 1980	C	High	No
D		1701627	20	Overburden	2	-	Domestic	Pre 1980	C	High	No
D		1701810	13	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1702120	12	Overburden	2	-	Domestic	Pre 1980	C	High	No
D		1702164	17	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1702274	20	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1702332	30	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1702359	43	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1702661	21	Overburden	2	-	Unknown	-		High	No
D		1702663	33	Bedrock	3	-	Unknown	Pre 1980	C	High	No
D		1703241	24	Bedrock	3	-	Domestic	1980-2002	B	High	No

Table D-1: Well Survey and Risk Ratings - Shelburne Wellfields

WHPA	Well ID	MOE Well ID	Depth (m)	Aquifer	Category	Casing Height (m)	Use Status	Year Category	Class	Risk Rating	Field Verified
D		1703410	25	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1703796	12	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1703866	28	Bedrock	3	-	Unknown	1980-2002	B	High	No
D		1703867	28	Bedrock	3	-	Unknown	1980-2002	B	High	No
D		1703913	26	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1703972	29	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704105	72	Bedrock	3	0.6	Unknown	1980-2002	B	High	No
D		1704233	23	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704385	35	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704413	32	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704709	-	Unknown		-	Unknown	-		High	No
D		1704711	-	Unknown		-	Unknown	1980-2002	B	High	No
D		1704713	19	Bedrock	3	-	Unknown	1980-2002	B	High	No
D		1704714	37	Bedrock	3	-	Unknown	1980-2002	B	High	No
D		1704737	30	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704745	40	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704894	37	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704945	44	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1705125	33	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1705888	30	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1700844	16	Bedrock	3	-	Unknown	Pre 1980	C	High	No
D		1704710	46	-	3	-	Unknown	-	C	High	No
D		1700344	20	Overburden	2	-	Domestic	Pre 1980	C	High	No
D		1700389	38	Overburden	2	-	Stock	Pre 1980	C	High	No
D		1701776	19	Bedrock	3	-	Irrigation	Pre 1980	C	High	No
D		1701890	20	Bedrock	3	-	Stock	Pre 1980	C	High	No
D		1702409	34	Bedrock	3	-	Domestic	Pre 1980	C	High	No
D		1703379	15	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1703602	23	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1703823	26	Bedrock	3	-	Unknown	1980 - 2002	B	High	No
D		1703829	24	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1703834	16	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1703880	37	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704104	27	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704657	36	Bedrock	3	-	Domestic	1980-2002	B	High	No
D		1704942	27	Bedrock	3	-	Domestic	1980-2002	B	High	No

" - " indicates information not available

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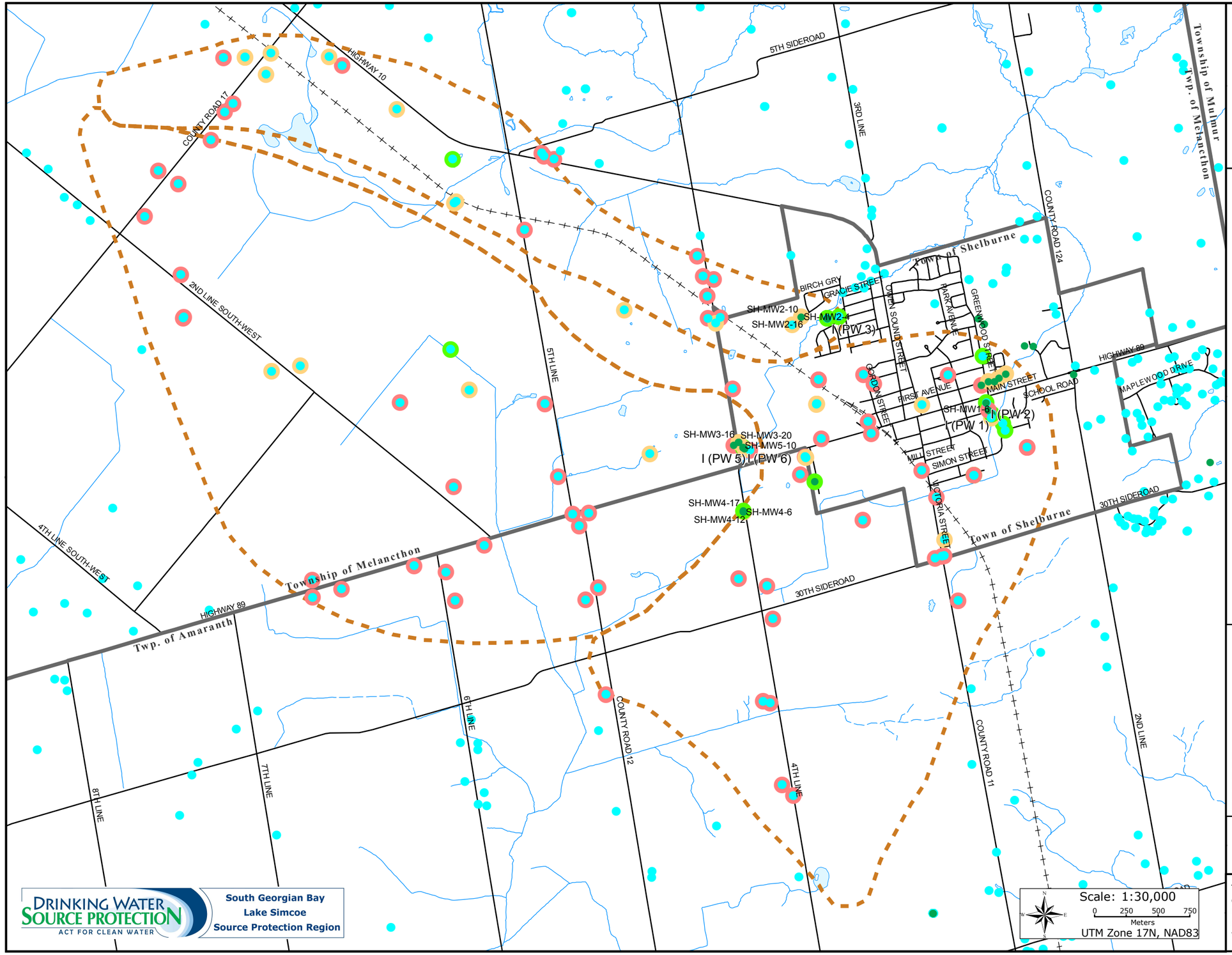
Attachment 1: Municipal Water Well Photographs

Municipal Water Well Photographs – Shelburne Water Supply

	
Pump House (PW1, PW2)	Pump House (PW5, PW6)
	
Pump Well 1	Pump Well 2

WATER WELL RISK RATING - TOWN OF SHELBURNE WELL SUPPLY



DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay
Lake Simcoe
Source Protection Region

Legend

Water Well (Type Class)

- Well Type - I
- Well
- Private Water Well

Water Well Risk Rating

- High
- Moderate
- Low
- Unknown
- Well Head Protection Area
- Municipal Boundary
- Lake
- Watercourse: Permanent
- Watercourse: Intermittent
- Road
- Abandoned (Not in Use, Not Decommissioned)

BURNSIDE

Created by: R.J. Burnside and Associates

Project Number: MSA12364
Date: 2010-06-15

Ontario

Figure D-1

This map was produced for the Town of Shelburne for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

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Appendix E
Water Quality

Table E-1: Arsenic Concentrations in Production Wells

	2004	2005				2006				2007					2008			
Production Well	**19-Oct**	**17-Jan**	**12-Apr**	**7-Jul**	**5-Oct**	**3-Jan**	**17-Apr**	**12-Jun**	**3-Oct**	**10-Jan**	**23-Mar**	**12-Apr**	**10-Jul**	**15-Oct**	**17-Jan**	**10-Apr**	**18-Jul**	**3-Nov**
PW#1 - Treated	-	-	2	3.1	2	8.41	2	5.66	1	1.8	-	5.8	1.6	-	1.3	1.6	1.5	5.5
PW#1 - Raw	-	-	-	-	-	-	-	-	-	-	<3	-	-	-	1.1	1.5	1.7	1.4
PW#2 - Treated	8.1	11	6	3.2	1.7	7.98	2	6.05	1	1.9	-	5.7	1.6	-	-	-	-	9.3
PW#2 - Raw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18.4	8.2
PW#3 - Treated	12	14	10	9.8	10.9	12	10	9.27	9	10.5	-	11.2	10.2	-	9.6	10.4	10.6	10.3
PW#3 - Raw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.2	9.5	10.1	9.3
PW#5 - Treated	12.2	18	12	11.4	11.7	15	13	17	11	12.8	-	13.5	12.7	-	12.3	12.8	13.3	13.3
PW#5 - Raw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.1	12	12.4	11.5
PW#6 - Treated	11.9	15	12	10.7	13.2	15	13	21.7	11	21	-	14.1	12.6	-	12.3	12.5	13.6	13.2
PW#6 - Raw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.3	11.7	12.2	11.8

Notes:
All concentrations are reported in µg/L.

Table E-2: Arsenic Concentrations in Monitoring Wells

	2004		2005				2006				2007			2008				2009	
Monitoring Well	**12-Jul**	**15-Oct**	**16-Feb**	**5-May**	**18-Aug**	**22-Nov**	**28-Mar**	**22-Jun**	**6-Sep**	**20-Dec**	**23-Mar**	**10-Jul**	**13-Nov**	**21-Jan**	**16-Apr**	**15-Jul**	**24-Oct**	**27-Jan**	**13-Jul**
SH-MW1-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<3	<3
SH-MW1-12	-	-	-	-	-	-	-	-	-	-	-	<3	0.95	<3	<3	<3	<3	<3	<3
SH-MW2-4	<2	<2	<2	<2	ND	ND	<0.60	<0.60	2.2	2.73	<0.60	<3	<0.60	<3	<3	<3	<3	<3	<3
SH-MW2-10	3	4	<2	2	1.3	2	2.19	2.05	3.37	3.9	1.82	<3	2.11	<3	<3	<3	<3	<3	<3
SH-MW2-16	9	4	6	4	1.4	6	10.1	9.33	10.5	12.8	10.4	11	10.4	12	10	10	12	10	11
SH-MW3-16	12	13	13	13	13	14	12.7	12	13.6	16.2	13.7	14	14.9	16	12	13	16	14	15
SH-MW3-20	3	2	<2	2	ND	5	8.16	6.5	8.06	10.9	8.94	8	8.3	11	8	10	11	10	11
SH-MW4-6	6	6	4	5	5.6	3	2.53	4.37	5.49	6.73	3.08	8	1.48	<3	<3	<3	4	<3	5
SH-MW4-12	16	18	17	16	18	18	17.1	16.5	17	18.4	19.1	18	19.1	<3	17	18	20	16	21
SH-MW4-17	15	10	13	7	7	12	16.2	15.4	15.8	18.6	19.8	17	16.5	19	15	16	17	16	18
SH-MW5-10	9	9	9	9	9.1	8	8.86	9.21	9.59	11.8	9.15	10	11.2	10	8	9	12	10	11

Notes:
All concentrations are reported in µg/L.

Table E-3
Summary of Chemical Water Quality Data
Town of Shelburne
Water Supply System

Parameter	Sample Type	Source of Data	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Boron (B)	Cadmium (Cd)	Chloride (Cl)	Chromium (Cr)	Copper (Cu)	Fluoride (F)	Hardness ($CaCO_3$)	Iron (Fe)	Manganese (Mn)	Mercury (Hg)	Nitrate as N	Nitrite as N	pH	Sodium (Na)	Sulphate (SO_4)	Turbidity	Zinc (Zn)
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH	mg/L	mg/L		mg/L
ODWQS			0.10	-	0.025	1.0	5.0	0.005	250	0.05	1.0	1.5	100	0.30	0.05		10.0	1	6.5-8.5	200	500		5.0
Well 1																							
1-Jul-90	R	1			<0.001					0.004	0.021												
1-Jul-93	R	1	0.08		<0.001	0.08	<0.05	0.001	36	<0.01	<0.01	1	**308**	<0.01	0.030	<0.001	<0.05	<0.05	6.87	8.4	35.4	0.48	0.03
29-Feb-96	R	1			0	0.134	0.143	0		0	0.005			0.023	0.007	ND	0.60	0					
8-Jan-97	R	1																0					
7-Jun-00	R	1	0.0021		0.006	0.132	0.034	0.00001		0	0.0192	0.96		0.293	0.012	0.00002	0.60	0				0.54	0.0141
29-Sep-00	R	1	0		0	0.103	0.04	0	63	0	0	1.3	**363**	0.044	0.011	ND	1.10	0	0.3	34.8	33.2	0.2	0.099
17-Jan-08	T	2		<0.0001		0.115	0.036	<0.00042		0.0012						0.00002							
3-Mar-09	T	2		<0.00018		0.116	0.0362	0.00004		0.0015						<0.00002							
12-Apr-10	R	3	<0.004		<0.003	0.11	0.035	<0.002	110	0.005	<0.003	0.8	**392**	0.043	0.015	<0.0001	0.46	<0.05	8.03	52.7	45.4	<0.5	0.071
Well 2																							
1-Jul-90	R	1			0.004					0.004	0.018												
1-Jul-93	R	1	0.09		<0.001	0.11	<0.05	0.001	51	<0.01	<0.01	0.94	**319**	<0.01	0.030	<0.001	<0.05	<0.05	6.99	7.76	49.9	0.65	<0.02
29-Feb-96	R	1			0	0.153	0.124	0		0	0			**0.333**	0.013	ND	0.20	0					
7-Jun-00	R	1	0.0021		0.006	0.132	0.034	0.00001		0	0.0192	0.96		0.293	0.012	0.00002	0.00	0				0.54	0.0141
29-Sep-00	R	1	0		0	0.118	0.038	0.003	64	0	0	1.2	**341**	0.162	0.012	ND	0.40	0	0.3	27.6	49.1	1.3	0.023
17-Feb-03	T	2															0.20	ND					
12-May-03	T	2															0.30	ND					
4-Sep-03	T	2		<0.0006	0.009	0.12	0.038	0.0001		<0.003		1.02				0.0001	0.22	<0.011		30.2			
18-Dec-03	T	2															0.23	<0.011					
12-Feb-04	T	2															0.32	<0.005					
29-Jan-07	T	2		<0.0002		0.115	0.032	<0.00006		0.0014						0.0002							
Wells 1 and 2																							
4-Sep-03	T	2										1.16								9.2			
3-Jan-06	T	2			0.00841												0.09	<0.005					
8-Feb-06	T	2		<0.0006		0.109	0.036	0.0001		<0.003						0.0002							
18-Apr-06	T	2			0.002												0.56	<0.005					
12-Jul-06	T	2			0.00566												<0.013	<0.005					
3-Oct-06	T	2			<0.001												0.28	<0.005					
29-Jan-07	T	2		<0.0002	0.0015												0.54	0.005					
17-Jan-08	T	2			0.0013							0.84					0.01	0.005		61.5			
19-Jan-09	T	2			0.0077												0.67	0.005					

Table E-3
Summary of Chemical Water Quality Data
Town of Shelburne
Water Supply System

Parameter	Sample Type	Source of Data	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Boron (B)	Cadmium (Cd)	Chloride (Cl)	Chromium (Cr)	Copper (Cu)	Fluoride (F)	Hardness ($CaCO_3$)	Iron (Fe)	Manganese (Mn)	Mercury (Hg)	Nitrate as N	Nitrite as N	pH	Sodium (Na)	Sulphate (SO_4)	Turbidity	Zinc (Zn)
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH	mg/L	mg/L		mg/L
ODWQS			0.10	-	0.025	1.0	5.0	0.005	250	0.05	1.0	1.5	100	0.30	0.05		10.0	1	6.5-8.5	200	500		5.0
Well 3																							
1-Jul-90	R	1			0.008					0.004	0.017												
1-Jul-93	R	1	0.07		<0.001	0.12	0.05	0.001	5	<0.01	<0.01	1.08	**232**	0.01	0.030	0.001	<0.05	<0.05	7.23	2.54	2.59	0.71	0.02
29-Feb-96	R	1			0	0.155	0.086	0		0	0			**0.368**	0.007	ND	ND	0					
8-Jan-97	R	1																0					
7-Jun-00	R	1			0.0107	0.136	0.024	0.00002		0.0002	0.0077	1.11		**0.374**	0.006	0.00002	ND	0				0.9	0.0053
29-Sep-00	R	1			0.006	0.134	0.018	0	7	0	0	1.3	**250**	**0.301**	0.005	ND	ND	0	0.21	7.94	21	3.5	0.004
17-Feb-03	T	2															ND	ND					
12-May-03	T	2															ND	ND					
4-Sep-03	T	2		<0.0006	0.015	0.12	0.018	0.0001		<0.003		1.15				0.0001	<0.021	<0.011		9.2			
18-Dec-03	T	2															<0.021	<0.011					
12-Feb-04	T	2															<0.013	<0.005					
3-Jan-06	T	2															0.055	<0.005					
29-Jan-07	T	2			0.0105	0.1331	0.026	<0.00006		<0.001						<0.00002	0.013	0.005					
17-Jan-08	T	2		<0.0002	0.0096							0.94					0.020	0.005		10.2			
19-Jan-09	T	2			0.0104												0.069	0.005					
Well 5																							
29-Feb-96	R	1			0	0.164	0.14	0.004		0	0.01			**0.403**	0.008	ND	ND	0					
8-Jan-97	R	1																0					
7-Jun-00	R	1	0.0019		0.0128	0.12	0.023	ND		0.0003	0.0009	1.2		**0.407**	0.006	0.00002	ND	0				0.64	0.0068
29-Sep-00	R	1	0		0.008	0.124	0.031	0	9	0	0	**1.5**	**232**	**0.346**	0.006	ND	ND	0	0.22	7.93	16.9	1.8	0.011
4-Sep-03	T	2		<0.0006		0.11	0.02	<0.001		<0.003		1.16				<0.0001				9.3			
12-Feb-04	T	2															<0.013	<0.005					
3-Jan-06	T	2			0.015												0.02	<0.005					
18-Apr-06	T	2			0.013												0.64	<0.005					
12-Jul-06	T	2			0.017												<0.013	<0.005					
3-Oct-06	T	2			0.011												<0.013	<0.005					

Table E-3
Summary of Chemical Water Quality Data
Town of Shelburne
Water Supply System

Parameter	Sample Type	Source of Data	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Boron (B)	Cadmium (Cd)	Chloride (Cl)	Chromium (Cr)	Copper (Cu)	Fluoride (F)	Hardness ($CaCO_3$)	Iron (Fe)	Manganese (Mn)	Mercury (Hg)	Nitrate as N	Nitrite as N	pH	Sodium (Na)	Sulphate (SO_4)	Turbidity	Zinc (Zn)
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH	mg/L	mg/L		mg/L
ODWQS			0.10	-	0.025	1.0	5.0	0.005	250	0.05	1.0	1.5	100	0.30	0.05		10.0	1	6.5-8.5	200	500		5.0
Well 6																							
29-Feb-96	R	1			0	0.183	0.144	0		0	0.007			0.114	**0.230**	ND	ND	0					
8-Jan-97	R	1																0					
7-Jun-00	R	1	0.0025		0.0126	0.122	0.035	ND		0.0001	0.0005	1.09		**0.416**	0.007	0.00002	ND	0				0.3	0.0032
29-Sep-00	R	1	0		0.007	0.112	0.024	0	11	0	0	1.4	**236**	0.229	0.006	ND	ND	0	ND	7.69	15.7	2	0.009
17-Feb-03	T	2																					
12-May-03	T	2																					
4-Sep-03	T	2		<0.0006		0.11	0.02	<0.001		<0.003		1.16				<0.0001				9.3			
18-Dec-03	T	2																					
12-Feb-04	T	2															<0.013	<0.005					
3-Jan-06	T	2			0.015												0.02	<0.005					
18-Apr-06	T	2			0.013												0.64	<0.005					
12-Jul-06	T	2			0.017												<0.013	<0.005					
3-Oct-06	T	2			0.011												<0.013	<0.005					
Well 5 and 6																							
29-Jan-07	T	2		<0.0002	0.021	0.115	0.028	<0.00006		<0.0001						<0.00002	0.030	0.005					
17-Jan-08	T	2			0.0123							0.98					0.013	0.005		9.5			
19-Jan-09	T	2			0.0131												0.303	0.005					

Notes:
R - Raw Water Sampled T - Treated Water Samples
ND - Not Detected
ODWQS - Ontario Drinking Water Quality Standards,
BOLD - Indicates exceedence of ODWQS

Data Sources:
1 -Data for 1990 to 2000 taken from *Shelburne Groundwater Management Study (Burnside, 2002)*
2 - Data from 2003 to 2006 from *Ministry of Environment, Annual Reports for Shelburne Water Supply System (MOE, 2003, 2004 ,2006-2009)*
3 - Data from 2010 PTTW Annual Monitoring Report (Burnside, 2010)

Figure E-1 Trend Analysis - Iron
Town of Shelburne

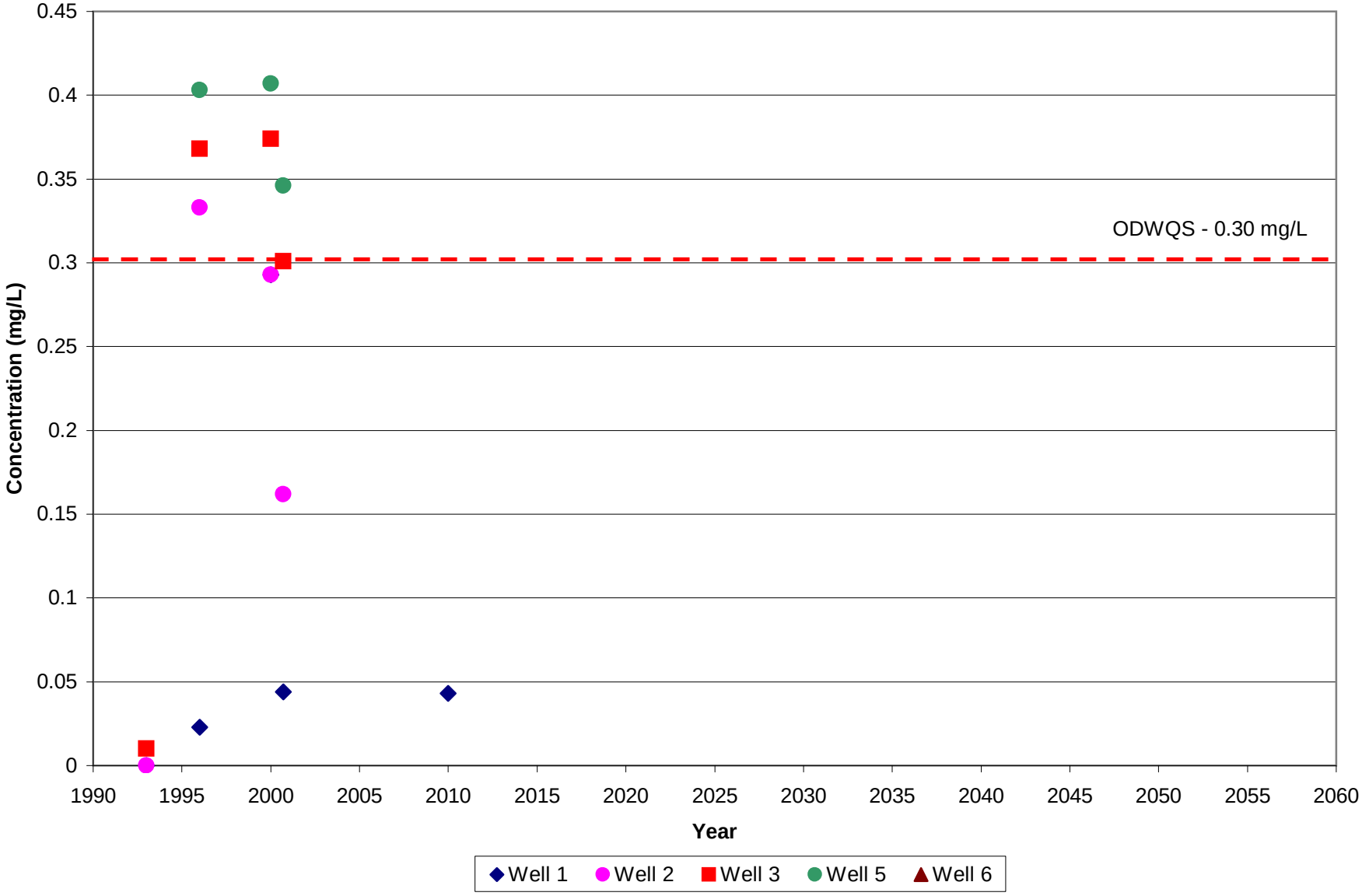


Figure E-2 Trend Analysis - Hardness
Town of Shelburne Water Supply System

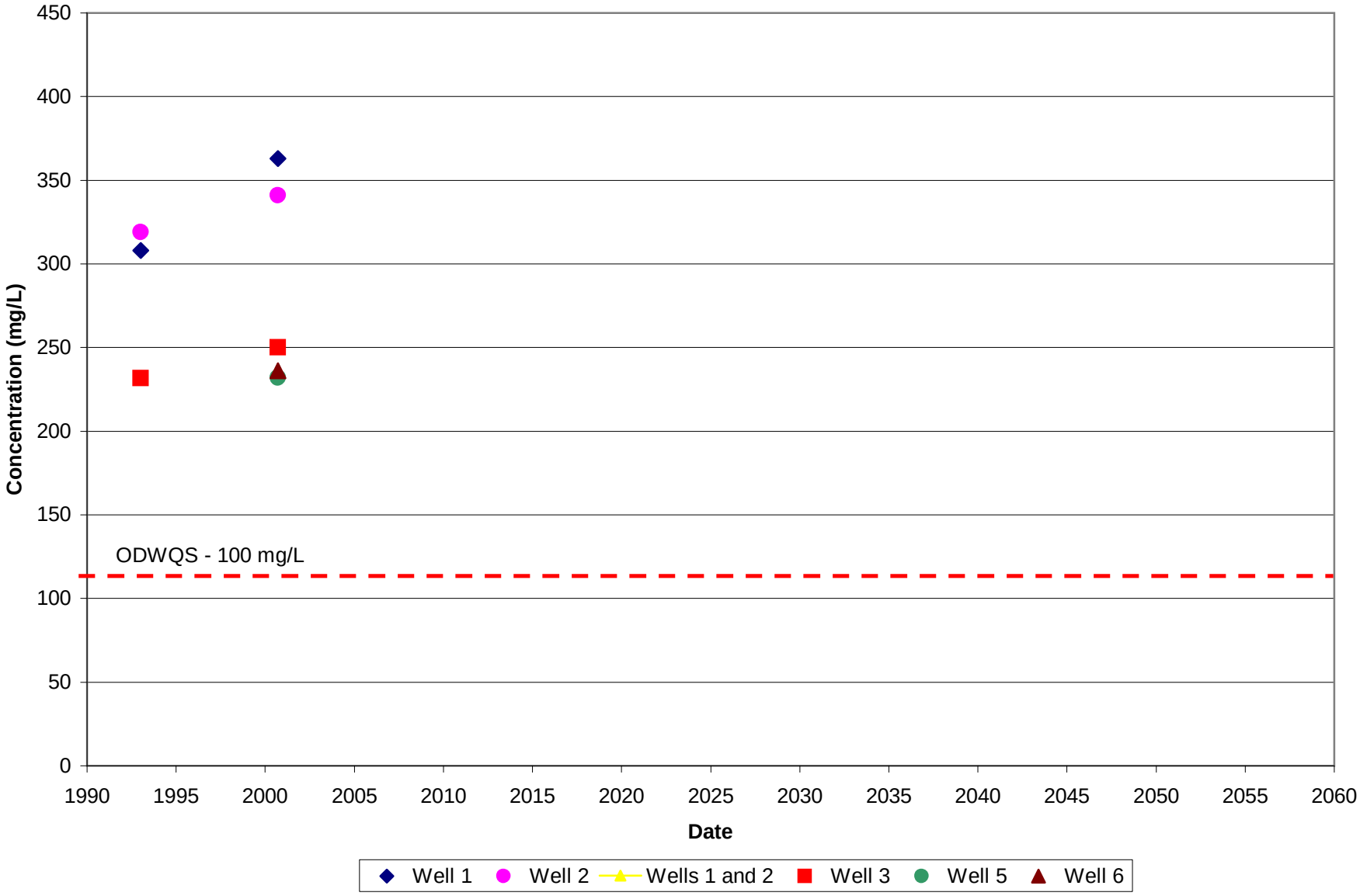


Figure E-3 Trend Analysis - Manganese
Town of Shelburne Water Supply System

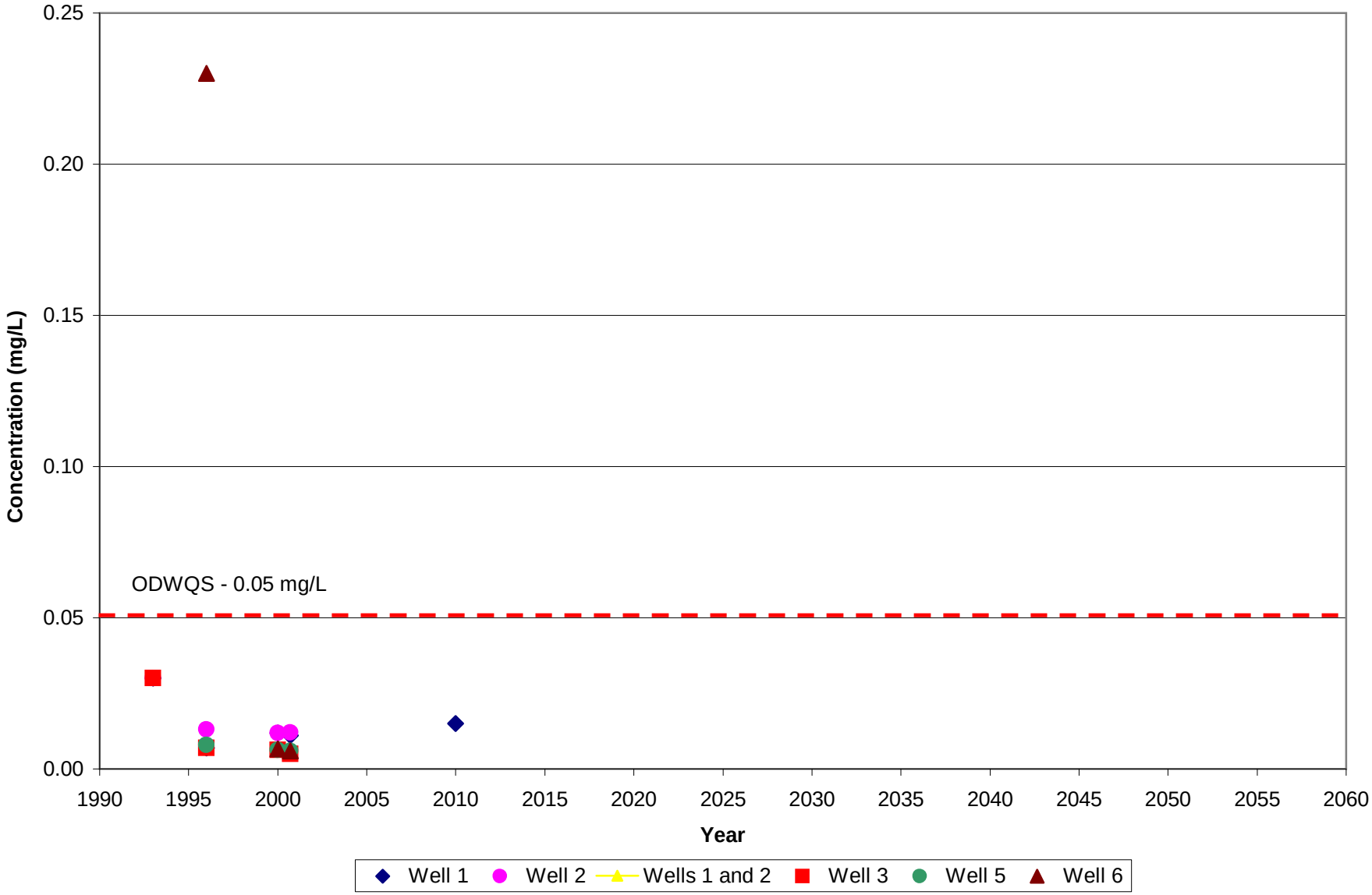


Figure E-4 Trend Analysis - Arsenic
Town of Shelburne Water Supply System - Wells 1 & 2

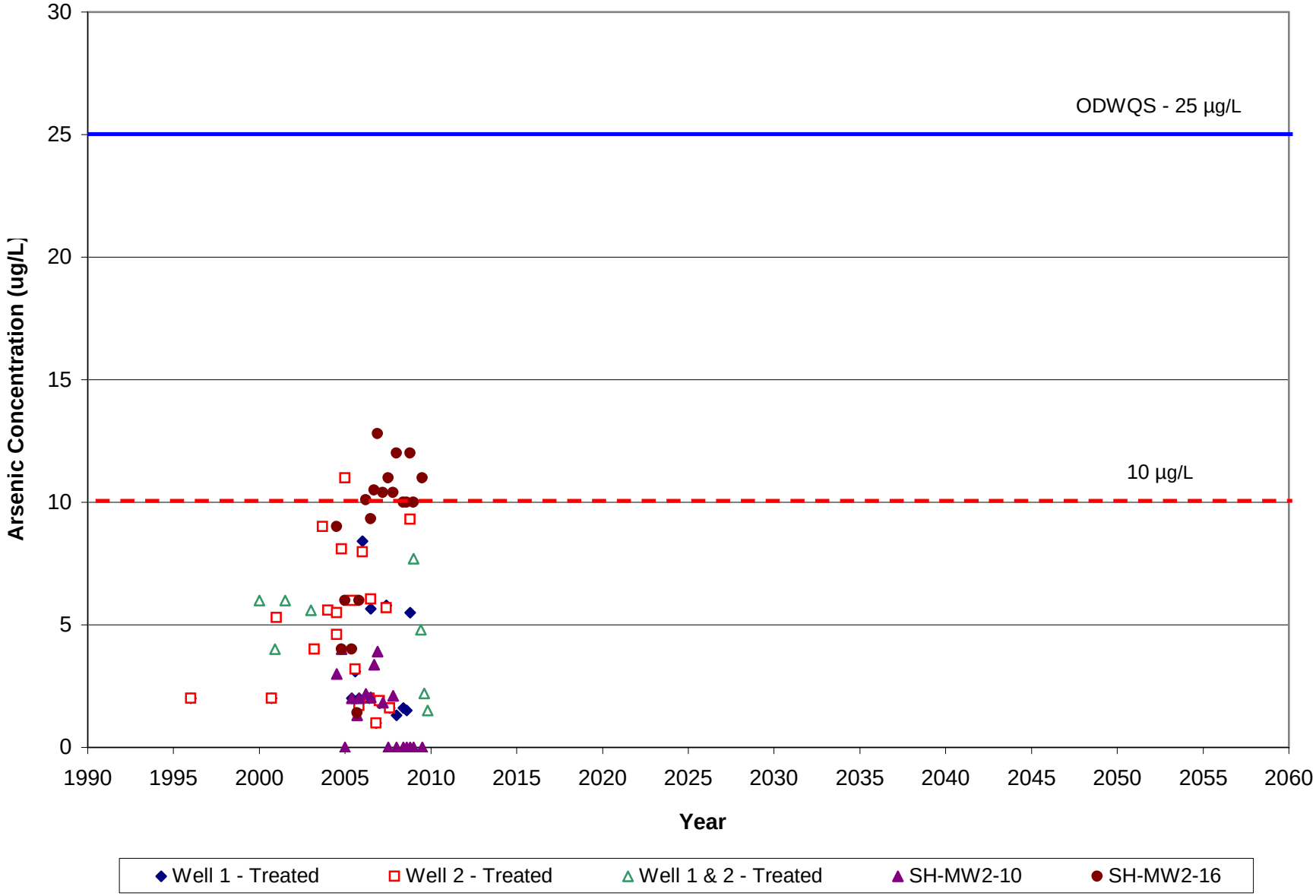


Figure E-5 Trend Analysis - Arsenic
Town of Shelburne - Well 3

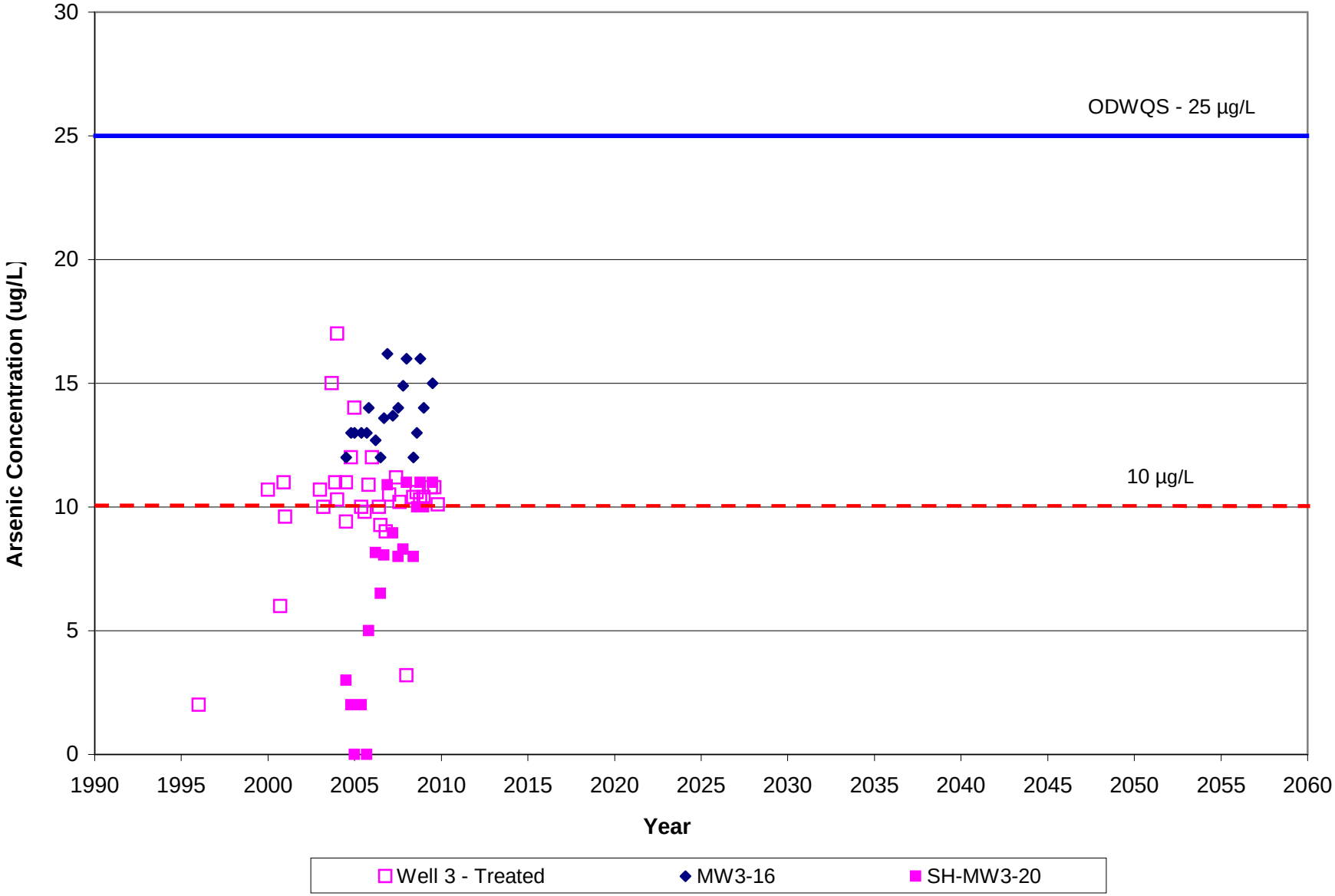
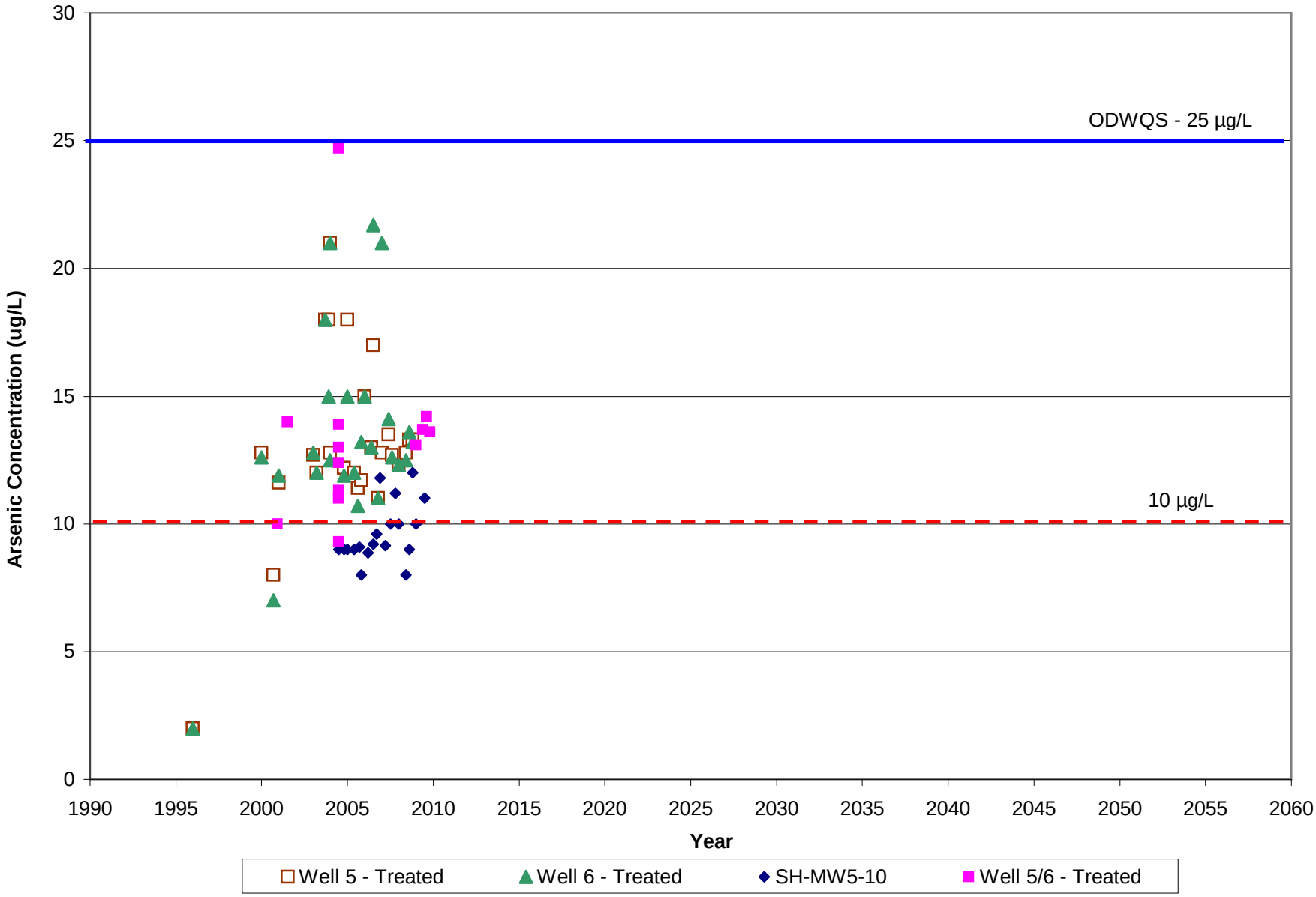


Figure E-6 Trend Analysis - Arsenic
Town of Shelburne Water Supply System - Wells 5 & 6



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Appendix F
List of Provincial Tables of Circumstances

Provincial Table Number	Table Name	Threat Type	Vulnerable Area	Vulnerability Score	Threat Risk Classification
1	CW10S	Chemical	WHPA	10	Significant
2	CW8S	Chemical	WHPA	8	Significant
3	CW10M	Chemical	WHPA	10	Moderate
4	CW8M	Chemical	WHPA	8	Moderate
5	CW6M	Chemical	WHPA	6	Moderate
6	CW10L	Chemical	WHPA	10	Low
7	CW8L	Chemical	WHPA	8	Low
8	CW6L	Chemical	WHPA	6	Low
9	DWAS	DNAPL	WHPA A, B, C, C1		Significant
10	DW6M	DNAPL	WHPA-D	6	Moderate
11	DW6L	DNAPL	WHPA-D	6	Low
12	PW10S	Pathogen	WHPA A, B	10	Significant
13	PW10M	Pathogen	WHPA A, B	10	Moderate
14	PW8M	Pathogen	WHPA A, B	8	Moderate
15	PW8L	Pathogen	WHPA A, B	8	Low
16	PW6L	Pathogen	WHPA A, B	6	Low
17	CSGRAHVA6M	Chemical	SGRA or HVA	6	Moderate
18	CSGRAHVA6L	Chemical	SGRA or HVA	6	Low
19	CIPZ10S	Chemical	IPZ	10	Significant
20	CIPZWE9S	Chemical	IPZ or WHPA-E	9	Significant
21	CIPZWE8.1S	Chemical	IPZ or WHPA-E	8.1	Significant
22	CIPZWE8S	Chemical	IPZ or WHPA-E	8	Significant
23	CIPZ10M	Chemical	IPZ	10	Moderate
24	CIPZWE9M	Chemical	IPZ or WHPA-E	9	Moderate
25	CIPZWE8.1M	Chemical	IPZ or WHPA-E	8.1	Moderate
26	CIPZWE8M	Chemical	IPZ or WHPA-E	8	Moderate
27	CIPZWE7.2M	Chemical	IPZ or WHPA-E	7.2	Moderate
28	CIPZWE7M	Chemical	IPZ or WHPA-E	7	Moderate
29	CIPZWE6.4M	Chemical	IPZ or WHPA-E	6.4	Moderate
30	CIPZWE6.3M	Chemical	IPZ or WHPA-E	6.3	Moderate
31	CIPZWE10L	Chemical	IPZ	10	Low
32	CIPZWE9L	Chemical	IPZ or WHPA-E	9	Low
33	CIPZWE8.1L	Chemical	IPZ or WHPA-E	8.1	Low
34	CIPZWE8L	Chemical	IPZ or WHPA-E	8	Low
35	CIPZWE7.2L	Chemical	IPZ or WHPA-E	7.2	Low
36	CIPZWE7L	Chemical	IPZ or WHPA-E	7	Low
37	CIPZWE6.4L	Chemical	IPZ or WHPA-E	6.4	Low
38	CIPZWE6.3L	Chemical	IPZ or WHPA-E	6.3	Low
39	CIPZWE5.6L	Chemical	IPZ or WHPA-E	5.6	Low
40	CIPZWE5.4L	Chemical	IPZ or WHPA-E	5.4	Low
41	CIPZWE4.9L	Chemical	IPZ or WHPA-E	4.9	Low
42	CIPZWE4.8L	Chemical	IPZ or WHPA-E	4.8	Low
43	CIPZWE4.5L	Chemical	IPZ or WHPA-E	4.5	Low
44	CIPZWE4.2L	Chemical	IPZ or WHPA-E	4.2	Low
45	PIPZ10S	Pathogen	IPZ	10	Significant
46	PIPZWE9S	Pathogen	IPZ or WHPA-E	9	Significant
47	PIPZWE8.1S	Pathogen	IPZ or WHPA-E	8.1	Significant
48	PIPZWE8S	Pathogen	IPZ or WHPA-E	8	Significant
49	PIPZWE10M	Pathogen	IPZ or WHPA-E	10	Moderate
50	PIPZWE9M	Pathogen	IPZ or WHPA-E	9	Moderate
51	PIPZWE8.1M	Pathogen	IPZ or WHPA-E	8.1	Moderate
52	PIPZWE8M	Pathogen	IPZ or WHPA-E	8	Moderate
53	PIPZWE7.2M	Pathogen	IPZ or WHPA-E	7.2	Moderate

Provincial Table Number	Table Name	Threat Type	Vulnerable Area	Vulnerability Score	Threat Risk Classification
54	PIPZWE7M	Pathogen	IPZ or WHPA-E	7	Moderate
55	PIPZWE6.4M	Pathogen	IPZ or WHPA-E	6.4	Moderate
56	PIPZWE6.3M	Pathogen	IPZ or WHPA-E	6.3	Moderate
57	PIPZ6M	Pathogen	IPZ	6	Moderate
58	PIPZ10L	Pathogen	IPZ	10	Low
59	PIPZWE9L	Pathogen	IPZ or WHPA-E	9	Low
60	PIPZWE8.1L	Pathogen	IPZ or WHPA-E	8.1	Low
61	PIPZWE8L	Pathogen	IPZ or WHPA-E	8	Low
62	PIPZWE7.2L	Pathogen	IPZ or WHPA-E	7.2	Low
63	PIPZWE7L	Pathogen	IPZ or WHPA-E	7	Low
64	PIPZWE6.4L	Pathogen	IPZ or WHPA-E	6.4	Low
65	PIPZWE6.3L	Pathogen	IPZ or WHPA-E	6.3	Low
66	PIPZ6L	Pathogen	IPZ	6	Low
67	PIPZWE5.6L	Pathogen	IPZ or WHPA-E	5.6	Low
68	PIPZWE5.4L	Pathogen	IPZ or WHPA-E	5.4	Low
69	PIPZ5L	Pathogen	IPZ	5	Low
70	PIPZWE4.9L	Pathogen	IPZ or WHPA-E	4.9	Low
71	PIPZWE4.8L	Pathogen	IPZ or WHPA-E	4.8	Low
72	PIPZWE4.5L	Pathogen	IPZ or WHPA-E	4.5	Low
73	PIPZWE4.2L	Pathogen	IPZ or WHPA-E	4.2	Low
74	CIPZWE5L	Chemical	IPZ or WHPA-E	5	Low
75	CIPZWE6M	Chemical	IPZ or WHPA-E	6	Moderate
76	CIPZWE6L	Chemical	IPZ or WHPA-E	6	Low

* As referenced to in the *Technical Bulletin: Threats Assessment and Issues Evaluation, Ontario Ministry of the Environment, March 2010* .

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Appendix G
Managed Lands and Livestock Density Analysis

Appendix G
Managed Lands and Livestock Density Analysis

Managed Lands and Livestock Density Analysis

The Table of Drinking Water Threats includes a number of threats that require an assessment of the percent managed lands and livestock density within vulnerable areas. The Technical Rules: Assessment Report (Clean Water Act, 2006) includes a requirement for the mapping of percent managed lands and livestock density to support the analysis of these circumstances. To complete this mapping a methodology was developed in consultation with the LSRCA based on methods proposed by the MOE in 2009. A description of the methods used in this study is described below.

To determine the location of managed lands and to calculate percentage of managed lands, Part II, rule 16(9) of the Technical Rules: Assessment Report (Clean Water Act, 2006), as amended was used. Mapping the percentage of managed lands is not required where the vulnerability score for an area is less than the vulnerability score necessary for the activity to be considered a significant threat. Based on this statement in the Technical Rules, the location and percentage of managed lands were only calculated where the vulnerability score in each WHPA was 6 or greater. This criterion was used to determine the need to calculate managed lands within the Town of Shelburne WHPAs (see Table 1).

Table 1: WHPA with Vulnerability Score of 6 or Higher

Wellfield	WHPA-A	WHPA-B	WHPA-C	WHPA-D
PW1 & PW2	Yes	Yes	Yes	Yes
PW3	Yes	Yes	Yes	No
PW 5 & 6	Yes	Yes	Yes	Yes

1.0 Methodology for Calculating Managed Land Percentage

Managed lands are lands that may receive agricultural source material (ASM), non-agricultural source material (NASM) or commercial fertilizer and can be divided into 2 categories; agricultural managed lands (AML) and non-agricultural managed lands (NAML). Agricultural managed lands include cropland, fallow and improved pasture that may receive ASM. Non-agricultural managed lands include golf courses, sports fields, residential lawns and other built-up grassed areas or turf that may have commercial fertilizers applied.

Step 1: Determining Parcels that are within the WHPA

Within each WHPA the MPAC property layer was overlaid over the WHPA's and all the properties that fell entirely or partially within the WHPA were selected for assessment.

Step 2: Removal of Natural Areas (not subject to land management)

The GIS layers for wooded areas, wetlands and drainage were used to determine the extent of these land uses and were removed from the selected areas created in the GIS process in Step 1.

Step 3: Determining Agricultural Managed Lands and Non-Agricultural Managed Lands

Agricultural managed lands (AML) were identified within the WHPAs through air photo interpretation and the field windshield surveys. AML includes cropland, improved pasture and fallow. The land area of these agricultural lands was summed then calculated as a percentage of the total area of parcels that intersect the WHPA.

Non-agricultural managed lands include golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer). Non-agricultural managed lands (NAML) were also identified through air photo interpretation, field windshield surveys and MPAC data.

All residential lands were assumed to be 50% managed lands per parcel. The area of residential parcels was multiplied by 0.5 to determine the amount of NAML in each parcel. Parks or other open green-space that were interpreted as turf or grass were all assumed to have commercial fertilizers applied and thus defined as non-agricultural managed lands.

The sum of all the NAML areas within the parcels intersecting the WHPA was divided by the total area of the parcels intersecting the WHPA to get the percentage of NAML.

Step 5: Total Managed Lands

The area of AML and the area of NAML from Step 3 were summed then divided by the total area of the parcels intersecting the WHPA to get the percentage of managed lands.

2.0 Methodology for Calculating Livestock Density

Livestock density is used as a surrogate measure of the potential for generating, storing and land applying ASM as a source of nutrients vulnerable areas. The livestock density is expressed as nutrient units per acre (NU/acre) and is calculated based on the number of animals housed, or pastured on a farm unit that generates enough manure to fertilize an area of land.

Step 1: Identifying Livestock Operations and Locating Barns

The type of farming taking place on each agricultural parcel was determined using a combination of information from MPAC, field surveys and airphoto interpretation.
A review of air photography was completed to determine whether barns were present on any parcel that fell either partially or entirely within each WHPA. The parcels that were used were the same ones identified in Step 1 of the Managed Lands Methodology above.

Step 2: Estimating Size of Livestock Barns and Nutrient Units

Once a livestock housing barn was selected, the type of livestock that was assumed to be housed in the barn was estimated with help from the MPAC farm code description, air photo interpretation, and field survey notes. In ArcGIS, a polygon was drawn to cover the

footprint of the structure to represent of the area of housing space for the livestock. The area of the barn was multiplied by the conversion factor for that livestock type, relating the area of the barn (in square metres) per Nutrient Unit, as supplied by OMAFRA in the MOE Technical Bulletin (MOE, 2009). The calculated nutrient units are assumed to be applied uniformly over the agricultural managed lands within the farm unit. A definition of a farm unit is provided in the Nutrient Management Act, 2002.

Step 3: Calculating Livestock Density in WHPA

The total NU generated by all the barns located within the WHPA intersecting parcels is divided by the total area of AML parcels that intersect the WHPA, as calculated in Step 3 of the Managed Lands Methodology, regardless of the type of farm (livestock or non-livestock). The livestock density in the WHPA is thus the sum of all NU within the parcels that intersect WHPA divided by the total AML area (in acres).

3.0 Managed Lands and Livestock Density Tables

The results of the calculations for managed lands and livestock density are provided in Tables 2 and 3 respectively.

Table 2: Managed Lands Analysis – Town of Shelburne

Wellfield	WHPA	% Managed Lands	% Agricultural Managed Lands	% Non-Agricultural Managed Lands
PW1 & PW2	WHPA-A	20%	0%	20%
	WHPA-B	47%	4%	43%
	WHPA-C	39%	2%	37%
	WHPA-D	77%	73%	4%
	WHPA-E	63%	59%	4%
PW3	WHPA-A	18%	0%	18%
	WHPA-B	21%	0%	21%
	WHPA-C	68%	57%	11%
	WHPA-D	N/A	N/A	N/A
PW 5 & 6	WHPA-A	90%	89%	1%
	WHPA-B	92%	92%	1%
	WHPA-C	92%	92%	0%
	WHPA-D	71%	69%	2%

Table 3: Livestock Density Analysis – Town of Shelburne

	Livestock Density (NU/acre)				
Wellfield	**WHPA-A**	**WHPA-B**	**WHPA-C**	**WHPA-D**	**WHPA-E**
PW1 & PW2	0	0	0	0.19	0.25
PW3	0	0	0	N/A	N/A
PW 5 & 6	0	0	0	0.04	N/A

4.0 Calculating Livestock Density for Use of Land as Livestock Grazing or Pasturing Land, an Outdoor Confinement Area or Farm-Animal Yard

For the use of land for livestock grazing or pasturing land within the vulnerable areas, the nutrient units for the farm were calculated based on the identified animal species and size of barn on the farm. The total nutrient units were then divided by the size of the livestock grazing land or pasturing land to get nutrient units per acre. For use of an outdoor confinement area or farm-animal yard the total nutrient units was divided by the size of the livestock outdoor confinement area or farm-animal yard in hectares. When a portion of the grazing and pasture, outdoor confinement area or farm animal yard fell within the vulnerable area, the entire parcel of land was factored into the calculations to create a NU/acre that applies to the portion of land within the vulnerable area.

5.0 Calculating Livestock Density Related to Agricultural Source Material Storage

Agricultural source material storage was assumed to exist at all farms with livestock and farm outbuildings. The nutrients stored and applied at an annual rate for the circumstances under the Table of Drinking Water Threats of the technical rules for ASM storage were determined by the NU stored on the farm divided by the size of the farm unit. The NU stored of the farm was calculated based on the livestock type and size of barn used for the livestock and provided MOE conversion factors.

6.0 References

Nutrient Management Protocol. Ministry of Agriculture, Food and Rural Affairs. Accessed 08/31/09.
<http://www.omafra.gov.on.ca/english/nm/regs/nmpro/nmprotcj05.htm>

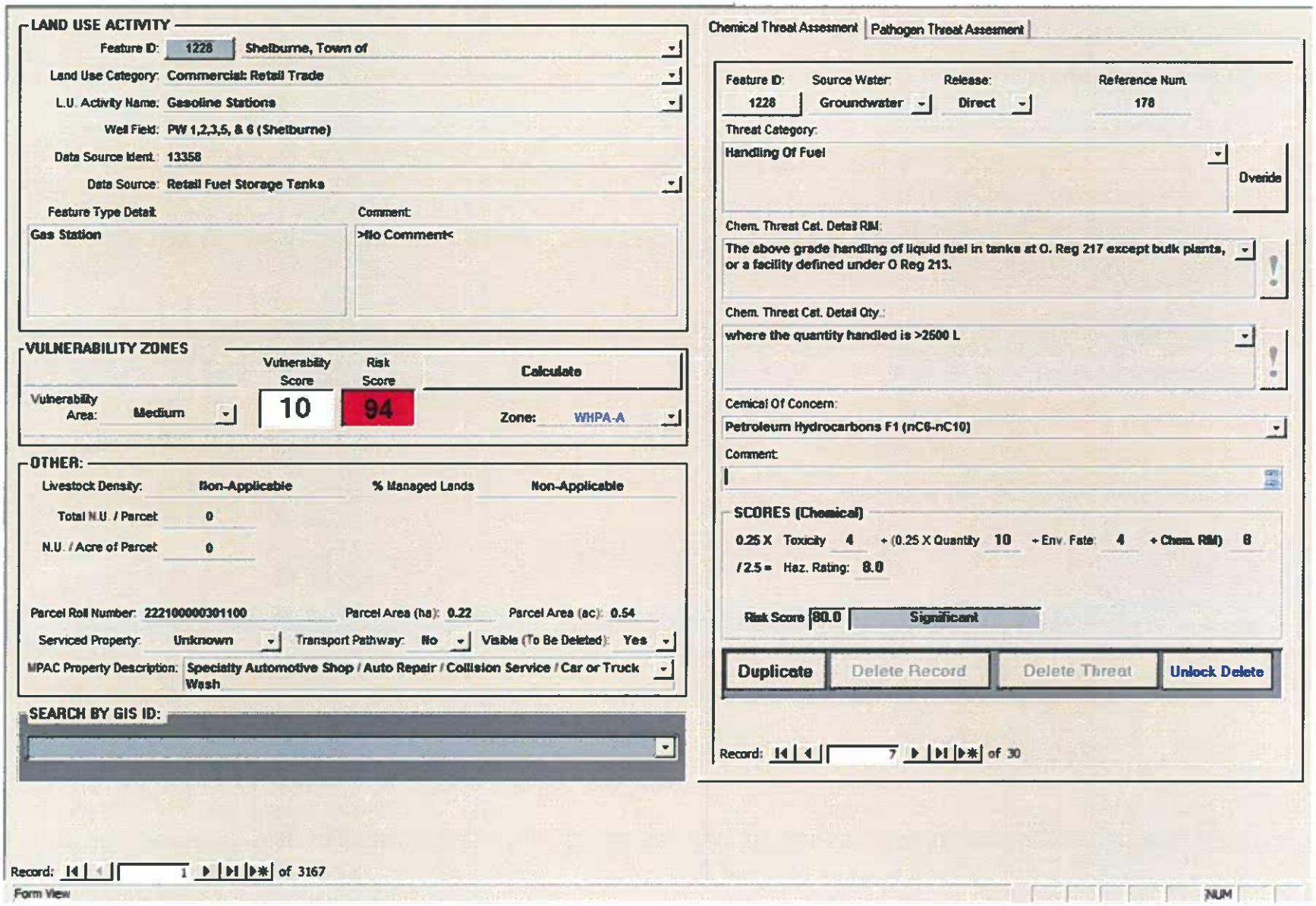
O. Reg 267/03, Nutrient Management Act, 2002.

MOE, 2009. Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers. Ontario Ministry of the Environment, December 2009.

Appendix H

Threats Database Interface

Appendix H: Threats Database Interface



Appendix I
Assumptions Used for Threat Classifications

To complete the threats classification the data fields within the database were populated using the following methods.

Land Use Activities

Land use activities were assigned based on the tables provided in the MOE Lookup Table Database v. 7.1.2 (WRIP, 2009). They were assigned a land use category and a land use activity name based on best fit with the actual land use activity.

Threats

Threats were assigned based on the land use activities and the threats listed for those activities in the MOE Lookup Tables. Because in some cases, the MOE Lookup Tables were overly conservative and included threats that in most cases were not applicable to the land use activities, some threats were eliminated. These threats were agreed on by a group of consultants to provide consistencies across different study areas and are documented in a document provided by the South Georgian Bay Lake Simcoe Region (SGBLS Region) titled “Reducing Inconsistencies in Threat Subcategory Enumeration” (May, 2010).

In addition to the assumptions provided in the SGBLS document, the following assumptions were applied to this study.

- Playing fields were assigned the land use activity name Spectator Sports. The threat application of commercial fertilizer was manually added and evaluated as part of managed lands.

- Cemeteries were assigned the land use of Religious Organizations. The threat application of commercial fertilizer was manually added and evaluated as part of managed lands.

- For agricultural land uses, if the parcel did not have any farm buildings located on it, any threats related to storage (i.e. fuel, fertilizer, pesticides) were removed.

- The threat, “Waste Disposal Site – Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste” was only applied to properties with a Certificate of Approval and/or are a registered waste generator or waste receiver.

- Threat points were placed in the area on the parcel with the highest vulnerability score except for septic systems threats which were placed within a reasonable distance of the associated building.

- One threat has been assigned per WHPA to represent the potential for residential and commercial properties to have heating fuel tanks that may be significant threats.

- Residential properties were assumed to apply commercial fertilizer to their lawns. A threat has been assigned to each parcel within the WHPAs where the application of commercial fertilizer may be a significant threat.

- A review of the Ministry of Environment biosolids database resulted in no properties within the study area receiving the application of septage or non-agricultural source material. The application of untreated septage and non-agricultural source material were not considered for agricultural lands within the study area.

Circumstances

The circumstance of a threat is comprised of two components, a quantity and Release Impact Modifier (RIM). To assign these two components some assumptions regarding typical storage practices and quantities of chemicals at a land use activity were required. Circumstances were chosen based on available mapping and database information and best knowledge of the activities on the site. When no information was available assumptions were made based on the standards provided in SGBLS Region, 2010. A conservative approach was taken throughout.

Chemicals

Chemicals of concern were taken from the MOE Lookup Tables. All chemicals were assumed to be present.

References

SGBLS Region, 2010. Reducing inconsistencies in threat subcategory enumeration: Agreed approaches for ensuring consistent standards, Outcome and decision summary, South Georgian Bay Lake Simcoe Source Protection Region, May 19, 2010.

WRIP, 2009. Threats Look-up Table Database v. 7.1.2, Water Resources Information Program (WRIP), Ministry of Natural Resources, December, 2009.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay Lake Simcoe Source Protection Region

Reducing inconsistencies in threat subcategory enumeration:
Agreed approaches for ensuring consistent standards

Outcomes and decision summary
May 19th, 2010

Compiled and lead by the SGBLS Region

Background

Reviews of draft technical reports completed for drinking water systems in the South Georgian Bay Lake Simcoe (SGBLS) Region revealed a number of inconsistencies in the manner that consultants enumerated significant threats. These inconsistencies would have led to difference in the way that a land use activities in one vulnerable area is classified (i.e. potential significant threat or not) compared to another if not resolved. Recognizing the importance of reducing these inconsistencies, and under the direction of SWP committee, an exercise was undertaken to ensure consistency in threats enumeration across the Region. As decisions made in the SGBLS region also affect how adjacent Regions undertake the enumeration process, participation in the process was extended to the TCC and CTC Regions

The process to establish consistent standards involved: 1) Identifying which threat subcategories the inconsistencies were occurring within; 2) Identifying why the inconsistencies were occurring; (3) Resolving the differences through a series of workshops and meeting, ranking evaluation and seeking further clarification from the Province. Due to the alternate approaches to identifying significant threats (i.e. threat specific database versus identifying land uses from the MOE Look-Up Tables (LUT)) it will never be possible to have complete consistency in identification of potential significant threats, moreover the approach taken was to ensure standardization in application of the LUT approach and the associated circumstance assumptions.

This document summarizes the decisions related to those threat subcategories identified as having larger inconsistencies.

Identifying threat subcategories with inconsistencies

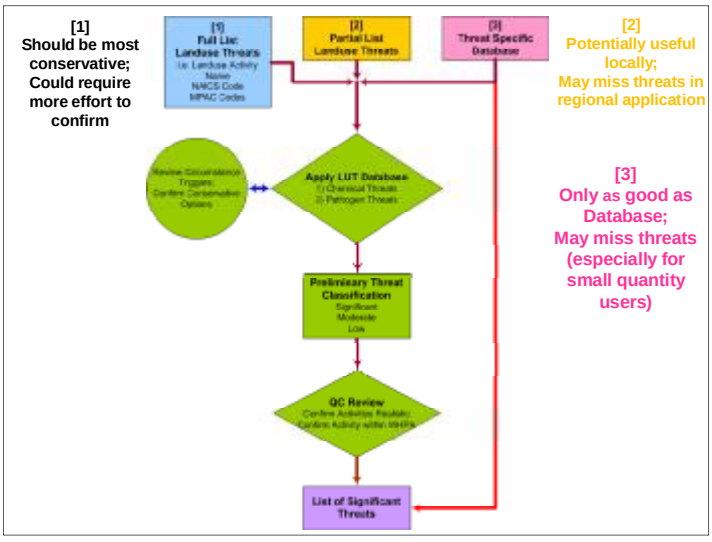
A review of draft technical reports and in discussion with various consultants the threat subcategories were classified according to the degree of inconsistence. The exercise of ensuring standard approaches focused on those threat subcategories identified as having minor and potentially larger differences. Other sources for inconsistencies arising from calculation of Managed lands and stock density have previously been resolved.

Status	Threat category / subcategory
Largely consistent	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.*
	The application of agricultural source material to land.
	The storage of agricultural source material.
	The management of agricultural source material.
	The application of road salt.
	The handling and storage of road salt.
	The storage of snow.
	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.
Minor difference	The application of non-agricultural source material to land.
	The handling and storage of non-agricultural source material.
	The application of commercial fertilizer to land.
	The handling and storage of commercial fertilizer.
	The application of pesticide to land.
	The handling and storage of pesticide.
Potential larger differences	The handling and storage of a dense non-aqueous phase liquid.
	The handling and storage of fuel.
	The handling and storage of an organic solvent.
	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
	Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste

Approach

Significant threat enumeration in the region was undertaken using one of 3 approaches, these being;

1. Assigning threats by associating land use activity to threat subcategories in LUT. Full and partial list
    - Advantage: Casts wide net
    - Disadvantage: more uncertainty & false positives
2. Using specific databases (e.g. TSSA fuel) to identify threats
    - Advantage: more certainty that a threat exists and what circumstances
    - Disadvantage: chances that significant threats missed if not in database
3. Combination of the two



Based on this summary of approaches, three areas were identified as requiring standardization, these being

1) Defendable database: Ensure threat specific databases have sufficient information (i.e. do not miss potential significant threat): default to full list approach if needed
2) Consistent Lists: Ensure consistency when assigning land use activities to threat subcategories (full or partial list approach)
3) Similar circumstances: If unknown, no local knowledge

To ensure consistent standard are applied any studies in the Region need to either defend the use of threat specific database (e.g. is it reliable and up-to-date and will therefore adequately identify potential significant threats), or use the agreed upon full or partial land use activity lists and circumstances.

Identifying a consistent list of land use activities

The full list of land use activities in the MOE LUT was identified as overly conservative and would identify many land use activities as a potential significant threat, when in reality there is a very low likelihood they would be a significant threat. To reduce the number of 'false positives' an exercise was undertaken to rationalize the LUT land use activity lists for some of the threat subcategories. The process used professional expertise of each consulting firm to rank the likelihood of the activity being a significant threat. In general those activities ranked as "must be included" or "uncertain" were included—the uncertain category was included to be more conservative. Those activities that were consistently identified as "remove from list" were not included in the final list of activities. Final list of land use activities is appended to the end of this document. Also in some instances it was noted that additional land use activities were missing and needed to be added.

Consistent Circumstances

In situations where circumstances for a land use activity was not know, it was agreed in general that the most conservative circumstances would be applied until further information becomes available – i.e. those circumstances that make the activity a significant threat were applied.

The following sections outline the outcomes and decisions for each subcategory.

Outcomes and decision

1) Application of Pesticides

1) Threat specific databases:

- Not relevant to application

2) LUT land use-threat subcategories: 12 Land use Activities

LUT Land use activity (or equivalent Parcel information)	**Action**
	Include **all agricultural managed lands** - crop and **pasture** including listed below
Forest Nurseries and Gathering of Forest Products	Include nursery
Fruit and Tree Nut Farming	Include
Golf Courses and Country Clubs	Include
Greenhouse, Nursery and Floriculture Production	Include
Oilseed and Grain Farming	Include
Other Crop Farming	Include
Power Line Corridor	Data gap
Residential Lawns	**Do not Include – Pesticide ban**
Support Activities for Crop Production	Include
Transportation Corridors	Data gap
Vegetable and Melon Farming	Include
Zoos and Botanical Gardens	Include

3) Circumstance assumptions:

Threat Sub Category	**Vulnerability to be Significant**	**Minimum Circumstances**	**Proposed assumptions**
Application of pesticides	WHPA with VS=10	Total application area >1 ha	• Agreed land use activities >1ha • Assume all pesticides in tables

Notes:

- No threats specific database available, therefore need to use identified land use activities
- Use land use activities identified in above table. Sports fields and cemeteries should not be included as they are largely covered under the cosmetic pesticide Ban
- As no one has attempted to identify power line and transport corridors as a threat, they will be treated as a data gap in the current round of the Assessment Report.
- Unless local knowledge available assume following circumstance: Application of pesticide >1ha to be significant threat

2. Handling and Storage of Pesticides

1) Threat specific databases:

- Threats specific database alone is not sufficient to identify all potential significant threats

2) LUT land use threat subcategories: 13 Land use Activities

LUT Land use activity (or equivalent Parcel information)	**Action**
	Include All agricultural managed lands - crop and **pasture** including listed below
Building Material and Supplies Dealers	Include
Forest Nurseries and Gathering of Forest Products	Include
Fruit and Tree Nut Farming	Include
Golf Courses and Country Clubs	Include
Greenhouse, Nursery and Floriculture Production	Include
Lawn and Garden Equipment and Supplies Stores	Include
Oilseed and Grain Farming	Include
Other Crop Farming	Include
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing	Include
Residential Homes	Do not Include – Pesticide ban
Support Activities for Crop Production	Include
Vegetable and Melon Farming	Include
Zoos and Botanical Gardens	Include

3) Circumstance assumptions:

Threat Sub Category	**Vulnerability to be Significant**	**Minimum Circumstances**	**Proposed assumptions**
Storage of A Pesticide	WHPA with VS=10	Activity: Manufacture, retail sale or use Quantity: 250-2500kg; >2500kg Toxicity: Type of pesticide (Mecoprop & MCPA are highest for 250-2500kg)	• Assume all listed pesticides are stored >250 kg or L - Use revised list of land use activities

Notes:

- Need to use identified land use activities (table above) or equivalent
- Unless local knowledge available assume following circumstance: quantity of Mecoprop & MCPA (2 common herbicides) are present in quantity >250kg or L

3. Handling and Storage of DNAPL

1) Threat specific databases:

- Threats specific database alone are not sufficient to identify all potential significant threats

2) LUT land use threat subcategories:

- Use revised list of land uses (see appendix)

Main LUT land use activity categories

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of DNAPL	WHPA A-C1 WHPA-D VS=6)	Activity: 139 listed Quantity: any Grade: above and below	- Use revised list of land use activities - Any quantity

Notes:

- Threats specific database alone are not sufficient to identify all potential significant threats
- The revised list of land use activities needs to be used. Modification of list based on ranked evaluation by all consultants – see appendix

4) Handling and Storage of Fuel

1) Threat specific databases:

- Use available databases if defendable e.g. TSSA fuel storage locations, Ecolog (e.g. Private fuel storage 1989-1996);

2) LUT land use-threat subcategories:

- If not using databases then use revised list of land uses (see appendix)

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of fuel	WHPA with VS=10	Use any combination of quality or storage location that would make threat significant (in the absence of local knowledge)	- For Residential – assume 250-2500L below grade fuel storage for all residences where gas line data does not suggest gas servicing? - Use revised list of land use activities

Notes:

- Existing databases should be sufficient to identify significant threats. Reports will need to provide description/support that this is the case (i.e. what data is provided, how frequently updated, requirements for information to be in database)
- Land use categories: Use revised list
- Circumstances: use any combination of quality or storage location that would make threat significant (in the absence of local knowledge)
- Domestic Fuel storage:

- Recognized that difficult to identify all potential significant threats for domestic fuel storage due to lack of available information.
- Each WHPA with vulnerability score of 10 will be assigned a single significant threat for handling and storage of fuel under the assumption that there may be residential properties present that have below grade storage of fuel >250L. This assumption would not be made in areas where there is a high probability that natural gas would be used as primary source of heating fuel. If not possible to determine if natural gas is available, then assume it is not, and apply single threat for WHPA VS=10.

5) Handling and Storage of an Organic Solvent

1) **Threat specific databases:**
   - Use threat specific databases if they can be defended
2) **LUT land use threat subcategories:**
   - If not using databases then use revised list of land uses (see appendix)
3) **Circumstance assumptions:**

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of organic solvent	WHPA with VS=10	Release: at, above, below grade Quantity: >25L	- Use revised list of land use activities - Assume >25L Below grade until actual chemicals confirmed?

Notes:

- Threats specific database alone are likely not sufficient to identify all potential significant threats. If do use, then need to provide adequate supporting information;
- Land use categories: Use revised list in appendix
- Circumstances: Unless database or local knowledge available assume >25L stored below grade.

6) Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste

1) **Threat specific databases:**
   - Must use databases to identify potential significant threats (Waste generators and Waste Receivers)
2) **LUT land use threat subcategories:**
   - Do not use LUT landuse activities. Most do not have C of A for waste disposal and therefore should not be included.
3) **Circumstance assumptions:**

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste	WHPA with VS=10	Release: at, above, below grade Any quantity	- Assume all activities in database significant threat unless local knowledge available

Notes: Following notes were drafted after clarification from the Province

The province has now provided legal advice to clarify the intent of identifying significant threats under the threat subcategory " Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste". They will be sending an official email or technical bulletin out in relation to this matter soon, but in the mean time here is a summary of the interpretation and direction for identifying associated threats.

1) Legally, a "Waste Disposal Site includes any waste disposal site with a CofA and waste generators". This defines what activities need to be considered under Column 1 of the Tables.
2) As these facilities may also receive a small amounts of hazardous waste that they may not be approved to accept, it is necessary to determine if they are a significant threat for the chemicals circumstances under the clauses of (p), (q), (r), (s), (t) or (u) of the definition hazardous waste (Column 2 of the Tables).
3) Given that the activity would require a CofA to be considered within this threat subcategory it is not appropriate to enumerate these threats using the LUT land use activity approach. Activities that are significant threats can be identified using the "waste receivers" and "waste generators" databases.
4) Given that it is not feasible to determine if the land use activity is generating or receiving the waste in accordance with clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste, we must assume that all activities within the two databases are a significant threat for this threat subcategory.

7) Application of Commercial Fertilizer

1) **Threat specific databases:** None (based on Nutrient Unit calculation)
2) **LUT land use threat subcategories:**
    - 10 Land use Activities (agreed managed lands)
3) **Circumstance assumptions:**

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Application of commercial fertilizer	WHPA with VS=10	% managed lands NU per Acre	As per Managed Lands Bulletin: Ensure 50% of residential area is managed lands

Notes:

- Ensure residential areas are identified as a significant threat if managed lands in vulnerable area exceed 80%. Assign agreed 50% area for managed lands.

8) Handling and Storage of Commercial Fertilizer

1) **Threat specific databases:**
    - No threat specific database available
2) **LUT land use threat subcategories:**
    - Use revised list of land use activities in table below

Fertilizer Storage LandUseActivityName	Stantec	Burnside	Golder	Genivar	AECOM	TRCA	comment
Fertilizer Manufacturing	1	1	1	1	1	1	Include
Forest Nurseries and Gathering of Forest Products	1	1	1	1	1	1	Include
Fruit and Tree Nut Farming	1	1	1	1	1	1	Include
Golf Courses and Country Clubs	1	1	1	1	1	1	Include
Greenhouse, Nursery and Floriculture Production	1	1	1	1	1	1	Include
Oilseed and Grain Farming	1	1	1	1	1	1	Include
Other Crop Farming	1	1	1	1	1	1	Include
Residential Lawns	3	3	3	3	3	3	Exclude
Support Activities for Crop Production	1	1	1	1	1	1	Include
Timber Tract Operations	1	1	1	1	1	1	Include
Vegetable and Melon Farming	1	1	1	1	1	1	Include
Zoos and Botanical Gardens	1	1	1	1	1	1	Include
home building supply stores	1						Recommended additional land use
Hardware Stores		1	1				Recommended additional land use
Lawn and Garden Equipment and Supplies Stores		1	1				Recommended additional land use
Grocery Stores		1					Use professional judgement as to whether a particular store should be considered
Department Stores		1					
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing			1				Recommended additional land use
Building Material and Supplies Dealers			1				Recommended additional land use

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of commercial fertilizer	WHPA with VS=10	Activity: Nitrogen >2500kg	Land use activities: >2500kg N stored?

Notes:

- Threats specific database alone are not sufficient to identify all potential significant threats
- Use revised land use activities in table above
- Only include agriculture as a potential threat if structure/building where fertilizer may be stored is within the WHPA.
- Agreed to use 2500kg N circumstance assumption if no local information available

9) Application of NASM

1) Threat specific databases:

- Biosolids database should be used to identify potential significant threats

2) LUT land use threat subcategories:

- Only include activities identified in the biosolids database

LUT Land use activity (or equivalent Parcel information)	Action
Fruit and Tree Nut Farming	Include if identified in Biosolids database (quantities based on managed land %)
Golf Courses and Country Clubs	
Greenhouse, Nursery and Floriculture Production	
Oilseed and Grain Farming	
Other Crop Farming	
Septage Waste Application	
Vegetable and Melon Farming	

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Application of NSAM (37)	WHPA with VS=10	Chemical: % managed land area nu/acre	Identified in biosolids database
	WHPA with VS=10	Pathogen: meat plant or sewage works	Identified in biosolids database

Notes:

- Application of ASM only assigned if property identified in biosolids database

10) Handling and Storage of NASM

1) Threat specific databases:

- Biosolids database not likely to include sufficient information

2) LUT land use threat subcategories:

- Use Land use activities identified in table below

NASM storage LandUseActivityName	Stantec	Burnside	Golder	Genivar	AECOM	TRCA	Min Score	#1	#2	#3	Summary	Proposed action
Sewage Treatment Facilities	1	1	2	1	0	1	1	4	1	0	Majority include or not present	Include
Animal Food Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Beverage Manufacturing (excluding 312130 Wineries)	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Converted Paper Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Dairy Product Manufacturing	0		1	1	0	1	1	3	0	0	Majority include or not present	Include
Meat Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Other Farm Product Wholesaler-Distributors	0	2	1	1	0	1	1	3	1	0	Majority include or not present	Include
Other Food Manufacturing	0	0	1	1	2	1	1	3	1	0	Majority include or not present	Include
Pulp, Paper and Paperboard Mills	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Seafood Product Preparation and Packaging	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Sugar and Confectionary Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Tobacco Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Bakeries and Tortilla Manufacturing	0	0	1	1	0	3	1	2	0	1	Mixed	Include
Food Wholesaler-Distributor	0	0	1	1	0	3	1	2	0	1	Mixed	Include
Fruit and Vegetable Preserving and Specialty Food Manufacturing	0	0	1	1	0	3	1	2	0	1	Mixed	Include
Grain and Oilseed Milling	0	3	1	1	0	2	1	2	1	1	Mixed	Include
Grocery Stores	3	3	2	1	0	3	1	1	1	3	Majority exclude or unsure	Exclude
Municipal composting facilities												Include

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of NSAM	WHPA with VS=10	Chemical: At or above grade Temporary: 0.5 to 5 T Permanent: >5 T Nitrogen	• Assume Below grade storage & > 0.5 tonnes
	WHPA with VS=10	Pathogen: Meat plants	Any quantity

Notes:

- Threats specific database alone are not sufficient to identify all potential significant threats
- Assume that the facilities for these types of activities would be permanent, and therefore need greater that 5 ton capacity for be significant. When considering if land use should be included evaluate whether it is likely to have >5 ton permanent storage.

11) <u>The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.</u>

Databases: Use appropriate databases for each sub category e.g. Municipal Sanitary Serviced Areas, Sewage Treatment Plants, Stormwater Outfalls, Stormwater Catchment areas, Sanitary Service pipes
Assumptions: Use assumptions identified in the following table

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Sewage System Or Sewage Works - Discharge Of Untreated Stormwater From A Stormwater Retention Pond	WHPA with VS=10	>10 acres (industrial lands) >100 acres (rural, residential)	Calculated from stormwater catchment layer or assume worst case
Sewage System Or Sewage Works - Sanitary Sewers and related pipes	WHPA with VS=10	Sanitary sewer with a conveyance of 10000 or more m3/d	**Assume one threat for each WHPA VS 10 where Sanitary connections exist**
Sewage System Or Sewage Works - Septic System	WHPA with VS=10	Septic system holding tank that is subject to the Building Code.	Non-serviced properties
Sewage System Or Sewage Works - Septic System Holding Tank	WHPA with VS=10	Septic system holding tank that is subject to the Building Code.	Non-serviced properties
Sewage System Or Sewage Works - Sewage Treatment Plant Effluent Discharges (Includes Lagoons)	WHPA with VS=10	Sewage Treatment Plants that discharge treated effluent ≥17,500 m3/d on an annual average	Use discharge rates if available, if not assume Highest discharge rate
Sewage System Or Sewage Works - Storage Of Sewage (E.G. Treatment Plant Tanks)	**WHPA with VS=8**	Sewage Treatment Plants that discharge treated effluent ≥2,500 m3/d and STP holding tank that is installed completely below grade, except for the access points	Use discharge rates if available, if not assume Highest discharge rate and below ground

Notes:

- Agreed that in areas with municipal sewer connection one threat per WHPA VS=10 would be applied for the threat subcategory “Sewage System Or Sewage Works - Sanitary Sewers and related pipes”.

Final threat enumeration

- In general, each threat subcategory counted once per property, unless:
    - Consider how it may be managed in future: e.g.
        - Multiple tenants per parcel (e.g. strip mall)
- An activity identified as a significant threat under both chemical and pathogen tables counted as a single threat unless
        - Considered how they would be managed differently in future

- Threats in parcel, but outside of WHPA, can be removed unless could be applied in WHPA .e.g. point source threats can be removed; application threats not
- Vacant lots and areas of future development with associated zoning are not counted as locations where an activity is or would be engaged in.

Appendix a:

Revised list of land use activities to be considered for each threat subcategory

Fuel storage
Aerospace Product and Parts Manufacturing
Agricultural, Construction and Mining Machinery Manufacturing
Alumina and Aluminum Production and Processing
Animal Aquaculture
Animal Food Manufacturing
Architectural and Structural Metals Manufacturing
Audio and Video Equipment Manufacturing
Automobile Dealers
Automotive Equipment Rental and Leasing
Automotive Parts, Accessories and Tire Stores
Bakeries and Tortilla Manufacturing
Basic Chemical Manufacturing
Beverage Manufacturing
Boiler, Tank and Shipping Container Manufacturing
Building Equipment Contractors
Building Finishing Contractors
Building Material and Supplies Dealers
Cattle Ranching and Farming
Cement and Concrete Product Manufacturing
Charter Bus Industry
Chemical (except Agricultural) and Allied Product Wholesaler-Distributors
Clay Product and Refractory Manufacturing
Clothing Accessories and Other Clothing Manufacturing
Clothing Knitting Mills
Coating, Engraving, Heat Treating and Allied Activities
Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
Commercial and Industrial Machinery and Equipment Rental and Leasing
Commercial and Service Industry Machinery Manufacturing
Communications Equipment Manufacturing
Community Colleges and C.E.G.E.P.s
Computer and Peripheral Equipment Manufacturing
Construction, Forestry, Mining, and Industrial Machinery, Equipment and Supplies Wholesaler-Distributors
Converted Paper Product Manufacturing
Cut and Sew Clothing Manufacturing
Cutlery and Hand Tool Manufacturing
Dairy Product Manufacturing
Deep Sea, Coastal and Great Lakes Water Transportation
Defence Services
Dry Cleaning and Laundry Services
Educational Support Services
Electric Lighting Equipment Manufacturing
Electric Power Generation, Transmission and Distribution
Electrical Equipment Manufacturing
Electronic and Precision Equipment Repair and Maintenance

Elementary and Secondary Schools
Engine, Turbine and Power Transmission Equipment Manufacturing
Fabric Mills
Farm, Lawn and Garden Machinery and Equipment Wholesaler-Distributors
Fibre, Yarn and Thread Mills
Fishing
Forest Nurseries and Gathering of Forest Products
Forging and Stamping
Foundation, Structure, and Building Exterior Contractors
Foundries
Fruit and Tree Nut Farming
Fruit and Vegetable Preserving and Specialty Food Manufacturing
Gasoline Stations
General Freight Trucking
General Medical and Surgical Hospitals
Glass Product Manufacturing from Purchased Glass
Grain and Oilseed Milling
Greenhouse, Nursery and Floriculture Production
Hardware Manufacturing
Hardware Stores
Highway, Street and Bridge Construction
Hog and Pig Farming
Household and Institutional Furniture and Kitchen Cabinet Manufacturing
Household Appliance Manufacturing
Industrial Gas Manufacturing
Industrial Machinery Manufacturing
Inland Water Transportation
Interurban and Rural Bus Transportation
Iron and Steel Mills and Ferro-Alloy Manufacturing
Junk / Scrap / Salvage Yards
Land Subdivision
Lawn and Garden Equipment and Supplies Stores
Lime and Gypsum Product Manufacturing
Logging
Lumber, Millwork, Hardware and Other Building Supplies Wholesaler-Distributors
Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing
Manufacturing and Reproducing Magnetic and Optical Media
Marinas
Meat Product Manufacturing
Medical and Diagnostic Laboratories
Medical Equipment and Supplies Manufacturing
Metalworking Machinery Manufacturing
Motor Vehicle Body and Trailer Manufacturing
Motor Vehicle Manufacturing
Motor Vehicle Parts Manufacturing
Motor Vehicle Wholesaler-Distributors
Municipal Fire-Fighting Services
Natural Gas Distribution
Navigational, Measuring, Medical and Control Instruments Manufacturing
Non-Ferrous Metal (except Aluminum) Production and Processing
Non-Metallic Mineral Mining and Quarrying

Non-residential Building Construction
Non-Scheduled Air Transportation
Office Furniture (including Fixtures) Manufacturing
Oil and Gas Extraction
Oilseed and Grain Farming
Other Ambulatory Health Care Services
Other Animal Production
Other Chemical Product Manufacturing
Other Crop Farming
Other Electrical Equipment and Component Manufacturing
Other Fabricated Metal Product Manufacturing
Other Food Manufacturing
Other Furniture-Related Product Manufacturing
Other General-Purpose Machinery Manufacturing
Other Heavy and Civil Engineering Construction
Other Miscellaneous Manufacturing
Other Motor Vehicle Dealers
Other Non-Metallic Mineral Product Manufacturing
Other Personal Services (812921 - Photo Finishing Laboratories (except One-Hour)), (812922 - One-Hour Photo Finishing)
Other Pipeline Transportation
Other Recyclable Material Wholesaler-Distributors
Other Schools and Instruction
Other Specialty Trade Contractors
Other Support Activities for Air Transportation
Other Support Activities for Transportation
Other Textile Product Mills
Other Transit and Ground Passenger Transportation
Other Transportation Equipment Manufacturing
Other Wood Product Manufacturing
Paint, Coating and Adhesive Manufacturing
Personal and Household Goods Repair and Maintenance
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing
Petrochemical Manufacturing
Petroleum and Coal Product Manufacturing
Petroleum Product Wholesaler-Distributors
Pharmaceutical and Medicine Manufacturing
Pipeline Transportation of Crude Oil
Pipeline Transportation of Natural Gas
Plastic Product Manufacturing
Poultry and Egg Production
Printing and Related Support Activities
Provincial Fire-Fighting Services
Psychiatric and Substance Abuse Hospitals
Pulp, Paper and Paperboard Mills
Rail Transportation
Railroad Rolling Stock Manufacturing
Recyclable Metal Wholesaler-Distributorsá(e.g. Junk/Scrap/Salvage Yards)
Remediation and Other Waste Management Services
Research and Development in the Physical, Engineering and Life Sciences
Residential Building Construction
Residential Fuel / Hydrcarbon Storage

Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing
Rubber Product Manufacturing
RV (Recreational Vehicle) Parks and Recreational Camps
Sawmills and Wood Preservation
Scenic and Sightseeing Transportation, Land
Scenic and Sightseeing Transportation, Other
Scenic and Sightseeing Transportation, Water
Scheduled Air Transportation
School and Employee Bus Transportation
Scientific Research and Development Services
Seafood Product Preparation and Packaging
Semiconductor and Other Electronic Component Manufacturing
Sheep and Goat Farming
Ship and Boat Building
Soap, Cleaning Compound and Toilet Preparation Manufacturing
Specialized Freight Trucking
Specialty (except Psychiatric and Substance Abuse) Hospitals
Spring and Wire Product Manufacturing
Steel Product Manufacturing from Purchased Steel
Sugar and Confectionary Product Manufacturing
Support Activities for Air Transportation
Support Activities for Crop Production
Support Activities for Forestry
Support Activities for Mining and Oil and Gas Extraction
Support Activities for Rail Transportation
Support Activities for Road Transportation
Support Activities for Water Transportation
Taxi and Limousine Service
Technical and Trade Schools
Textile and Fabric Finishing and Fabric Coating
Textile Furnishings Mills
Timber Tract Operations
Tobacco Manufacturing
Universities
Urban Transit Systems
Used Motor Vehicle Parts and Accessories Wholesaler-Distributors
Utility System Construction
Vegetable and Melon Farming
Veneer, Plywood and Engineered Wood Product Manufacturing
Ventilation, Heating, Air-Conditioning and Commercial Refrigeration Equipment Manufacturing
Warehousing and Storage
Waste Collection
Waste Treatment and Disposal
Water, Sewage and Other Systems

DNAPLS
Aerospace Product and Parts Manufacturing
Agricultural, Construction and Mining Machinery Manufacturing
Alumina and Aluminum Production and Processing
Animal Food Manufacturing

Architectural and Structural Metals Manufacturing
Audio and Video Equipment Manufacturing
Automobile Dealers
Automotive Parts, Accessories and Tire Stores
Automotive Repair and Maintenance
Bakeries and Tortilla Manufacturing
Basic Chemical Manufacturing
Beverage Manufacturing
Boiler, Tank and Shipping Container Manufacturing
Building Material and Supplies Dealers
Cement and Concrete Product Manufacturing
Charter Bus Industry
Coating, Engraving, Heat Treating and Allied Activities
Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
Commercial and Service Industry Machinery Manufacturing
Communications Equipment Manufacturing
Community Colleges and C.E.G.E.P.s
Computer and Peripheral Equipment Manufacturing
Converted Paper Product Manufacturing
Cutlery and Hand Tool Manufacturing
Dairy Product Manufacturing
Dry Cleaning and Laundry Services
Electric Lighting Equipment Manufacturing
Electric Power Generation, Transmission and Distribution
Electrical Equipment Manufacturing
Electronic and Precision Equipment Repair and Maintenance
Engine, Turbine and Power Transmission Equipment Manufacturing
Forging and Stamping
Foundries
Fruit and Vegetable Preserving and Specialty Food Manufacturing
Gasoline Stations
General Freight Trucking
General Medical and Surgical Hospitals
Grain and Oilseed Milling
Hardware Manufacturing
Household and Institutional Furniture and Kitchen Cabinet Manufacturing
Household Appliance Manufacturing
Industrial Machinery Manufacturing
Interurban and Rural Bus Transportation
Iron and Steel Mills and Ferro-Alloy Manufacturing
Lawn and Garden Equipment and Supplies Stores
Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing
Manufacturing and Reproducing Magnetic and Optical Media
Marinas
Meat Product Manufacturing
Medical and Diagnostic Laboratories
Medical Equipment and Supplies Manufacturing
Metalworking Machinery Manufacturing
Motor Vehicle Body and Trailer Manufacturing
Motor Vehicle Manufacturing
Motor Vehicle Parts Manufacturing

Natural Gas Distribution
Navigational, Measuring, Medical and Control Instruments Manufacturing
Non-Ferrous Metal (except Aluminum) Production and Processing
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One-Hour Photo Finishing
Other Chemical Product Manufacturing
Other Electrical Equipment and Component Manufacturing
Other Fabricated Metal Product Manufacturing
Other Food Manufacturing
Other Furniture-Related Product Manufacturing
Other General-Purpose Machinery Manufacturing
Other Heavy and Civil Engineering Construction
Other Miscellaneous Manufacturing
Other Motor Vehicle Dealers
Other Personal Services (812921 - Photo Finishing Laboratories (except One-Hour)), (812922 - One-Hour Photo Finishing)
Other Professional, Scientific and Technical Services
Other Schools and Instruction
Other Support Activities for Air Transportation
Other Transit and Ground Passenger Transportation
Other Transportation Equipment Manufacturing
Other Wood Product Manufacturing
Paint, Coating and Adhesive Manufacturing
Personal and Household Goods Repair and Maintenance
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing
Petroleum and Coal Product Manufacturing
Pharmaceutical and Medicine Manufacturing
Photo Finishing Laboratories (except One-Hour)
Photographic Services
Plastic Product Manufacturing
Printing and Duplicating
Pulp, Paper and Paperboard Mills
Rail Transportation
Railroad Rolling Stock Manufacturing
Recyclable Metal Wholesaler-Distributorsá(e.g. Junk/Scrap/Salvage Yards)
Research and Development in the Physical, Engineering and Life Sciences
Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing
Rubber Product Manufacturing
Sawmills and Wood Preservation
Scheduled Air Transportation
Scientific Research and Development Services
Seafood Product Preparation and Packaging
Semiconductor and Other Electronic Component Manufacturing
Ship and Boat Building
Soap, Cleaning Compound and Toilet Preparation Manufacturing
Specialized Freight Trucking
Spring and Wire Product Manufacturing
Steel Product Manufacturing from Purchased Steel
Sugar and Confectionary Product Manufacturing
Support Activities for Air Transportation
Support Activities for Rail Transportation

Technical and Trade Schools
Tobacco Manufacturing
Universities
Urban Transit Systems
Utility System Construction
Veneer, Plywood and Engineered Wood Product Manufacturing
Ventilation, Heating, Air-Conditioning and Commercial Refrigeration Equipment Manufacturing
Waste Collection

Solvents
Dry Cleaning and Laundry Services
Audio and Video Equipment Manufacturing
Basic Chemical Manufacturing
Communications Equipment Manufacturing
Computer and Peripheral Equipment Manufacturing
Electrical Equipment Manufacturing
Other Chemical Product Manufacturing
Other Electrical Equipment and Component Manufacturing
Pharmaceutical and Medicine Manufacturing
Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing
Rubber Product Manufacturing
Electric Lighting Equipment Manufacturing
Fruit and Vegetable Preserving and Specialty Food Manufacturing
Household Appliance Manufacturing
Industrial Injection / Waste Disposal Wells
Leather and Hide Tanning and Finishing
Manufacturing and Reproducing Magnetic and Optical Media
Meat Product Manufacturing
Navigational, Measuring, Medical and Control Instruments Manufacturing
Other Leather and Allied Product Manufacturing
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing
Petroleum and Coal Product Manufacturing
Pulp, Paper and Paperboard Mills
Semiconductor and Other Electronic Component Manufacturing
Soap, Cleaning Compound and Toilet Preparation Manufacturing
Converted Paper Product Manufacturing
Bakeries and Tortilla Manufacturing
Beverage Manufacturing
Seafood Product Preparation and Packaging
Sugar and Confectionary Product Manufacturing
Tobacco Manufacturing
Funeral Services
Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing
Other Personal Services (812921 - Photo Finishing Laboratories (except One-Hour)), (812922 - One-Hour Photo Finishing)
General Medical and Surgical Hospitals
Other Fabricated Metal Product Manufacturing
Other Food Manufacturing
Paint, Coating and Adhesive Manufacturing
Plastic Product Manufacturing

Printing and Related Support Activities
Fabric Mills
General Freight Trucking
Interurban and Rural Bus Transportation
Medical and Diagnostic Laboratories
Other Professional, Scientific and Technical Services (541940 - Veterinary Services)
Other Textile Product Mills
Other Wood Product Manufacturing (321991 - Manufactured (Mobile) Home Manufacturing)
Sawmills and Wood Preservation
Scientific Research and Development Services
Specialized Freight Trucking
Textile and Fabric Finishing and Fabric Coating
Textile Furnishings Mills
Urban Transit Systems
Veneer, Plywood and Engineered Wood Product Manufacturing
Coating, Engraving, Heat Treating and Allied Activities
Dairy Product Manufacturing
Grain and Oilseed Milling
Other Support Activities for Transportation
Other Transit and Ground Passenger Transportation
Scenic and Sightseeing Transportation, Land
Scenic and Sightseeing Transportation, Other
Support Activities for Road Transportation
Cut and Sew Clothing Manufacturing (315292 - Fur and Leather Clothing Manufacturing)
Fibre, Yarn and Thread Mills
Charter Bus Industry
School and Employee Bus Transportation
Taxi and Limousine Service
Rail Transportation

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix J

Summary Table of Significant Threats

Appendix J: Summary Table of Significant Threats - Shelburne Water Supply System

	Threat	Significant Threat Counts by Vulnerability Score						Total Significant Threats	
		VS = 10		VS = 8		WHPA-C			
		# threats	# parcels	# threats	# parcels	# threats	# parcels	# threats	# parcels
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	0	0	0	0	0	0	0	0
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	4	4	0	0	0	0	4	4
3	The application of agricultural source material to land.	2	2	0	0	0	0	2	2
4	The storage of agricultural source material.	0	0	0	0	0	0	0	0
5	The management of agricultural source material.	0	0	0	0	0	0	0	0
6	The application of non-agricultural source material to land.	0	0	0	0	0	0	0	0
7	The handling and storage of non-agricultural source material.	0	0	0	0	0	0	0	0
8	The application of commercial fertilizer to land.	3	3	0	0	0	0	3	3
9	The handling and storage of commercial fertilizer.	0	0	0	0	0	0	0	0
10	The application of pesticide to land.	2	2	0	0	0	0	2	2
11	The handling and storage of pesticide.	0	0	0	0	0	0	0	0
12	The application of road salt.	0	0	0	0	0	0	0	0
13	The handling and storage of road salt.	0	0	0	0	0	0	0	0
14	The storage of snow.	0	0	0	0	0	0	0	0
15	The handling and storage of fuel.	7	5	0	0	0	0	7	5
16	The handling and storage of dense non-aqueous phase liquid.	4	2	2	1	6	3	12	6
17	The handling and storage of an organic solvent.	0	0	0	0	0	0	0	0
18	The management of runoff that contains chemicals used in the de-icing of aircraft.	0	0	0	0	0	0	0	0
19	An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body.	0	0	0	0	0	0	0	0
20	An activity that reduces the recharge to an aquifer.	0	0	0	0	0	0	0	0
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	0	0	0	0	0	0	0
TOTAL		22	18	2	1	6	3	30	22
TOTAL NUMBER OF SIGNIFICANT THREATS:		22		2		6		30	
TOTAL PARCELS WITH SIGNIFICANT THREATS:			10		1		3		14

Note: The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel.

July 29, 2010

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Attention: Mr. Don Goodyear, Source Protection Manager

WHPA Peer Review Report

Dear Mr. Goodyear:

Dillon Consulting Limited (Dillon) was retained by the Lake Simcoe Region Conservation Authority (LSRCA) to conducted Peer Reviews of well head protection area (WHPA) mapping for 86 municipal groundwater systems. These systems are located in the South Georgian Bay Lake Simcoe Source Protection Region. External management of the project was conducted by Mr. Dave Ketcheson, P.Eng of Azimuth Environmental Consulting Inc. The results of the peer review are issued in the form of digital spreadsheet files that are attached to this letter. The project scope and peer review methodology is summarized in the letter herein.

PROJECT SCOPE

LSRCA retained Dillon to conduct a 'high level' peer review of the WHPAs that were largely delineated as part of previous WHPA or regional groundwater studies, at a time prior to the finalization of the Director Rules. In general, WHPA delineation was based on an assortment of different model types, including fixed radius, 2-D analytical solutions and numerical 3-D flow modeling. In general, more sophisticated models were applied to those systems where more data was available. The focus of the peer review was on whether the methodologies were consistent with those outlined in the Directors Rules, rather than a more traditional technical modeling critique. Evaluations also identified critical issues or deficiencies that would have implications on subsequent steps in the source protection process, so that these may be addressed as part of the Assessment Report. The review also identify long-term opportunities for improvement in subsequent rounds of the process, recognizing the various levels of effort applied in WHPA delineation across the region (i.e., analytical vs. numerical methods), and the availability of data in the various WHPA settings.

Peer reviewers were Rob Kell, M.A.Sc., P.Eng, P.Geo.; Jeff Hachey, M.Sc. and Darin Burr, M.Sc. P.Geo, all hydrogeologists with Dillon.

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Evaluation of the WHPAs was performed in a systematic fashion following a "score card" approach. The score card contained both objective and subjective criteria that were evaluated for each system. This template approach enabled reviewers to maintain a level of consistency during the reviews, and was suited to the "high level" nature of the evaluation. The criteria that were evaluated is listed below:

Objective Criteria	**Subjective Criteria**
Was modeled pumping rate appropriate?	Complexity of geological Setting
Were approved models and methods used?	Appropriateness of Flow Model
	Reasonableness of input parameters
	Adequate incorporation of natural flow field
	Model Calibration
	Incorporation of Uncertainty

For each criterion, a score between 1 and 10 was awarded. In general, a score <5 for any of the criteria would be given if a critical concern was identified that would either significantly affect the reliability of the WHPAs, or is a contravention of the elements of the Directors Rules. An exception for this rule would be the evaluation of the uncertainty criterion. Failure to adequately incorporate uncertainty into the model results was not deemed a requirement of the Director Rules and therefore would not necessarily cause the system to "fail". Details on conditions that would cause an unacceptable evaluation at the criteria level are presented in the score card sheets.

All systems were given a "pass", "fail" or "conditional pass" result, depending upon the analysis results. A "pass" ranking was given for those systems were the methodology was generally consistent with the Director Rules, and no critical deficiencies were noted. A "conditional pass" was granted, where the potential for considerable uncertainty in the results existed, but either little data was available to improve the accuracy of the results, or it was the reviewer's opinion that the uncertainty on the results would not significantly alter the enumeration of land parcels that may contain significant threats.

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Following criteria scoring, the individual scores were weighted, and summed to produce an overall system score (between 1 and 10) for the WHPA delineation. Higher the score, the more favorable are the results of the evaluation. Please note that this scoring is a relative ranking between the systems, and is not to be interpreted as any type of marking. For example, a score of 6 does not mean a 60% mark, but rather is a system whose delineated WHPAs are deemed more conservatively robust (in lieu of available data) than a system that receives a score of 5. Theoretically, a system evaluated via fixed radius that is very conservative could receive a higher system score than a detailed numerical model result that is not conservative, as the risk of under-representing the area where significant threats may be lower.

RESULTS

The results of the evaluation are presented on digital Excel™ spreadsheets for each system, and are grouped by township or separated municipality name. Rationale for the individual criteria evaluations, along with the criterion scores, overall system scores and recommendations for future improvement are presented on the individual sheets.

LIMITATIONS

This report was prepared exclusively for the purposes, project and site location(s) outlined in the report. The report is based on information provided to, or obtained by Dillon Consulting Limited ("Dillon") as indicated in the report, and applies solely to site conditions existing at the time of the assessment. Although a reasonable assessment was conducted by Dillon, Dillon's assessment was by no means exhaustive and can not be construed as a certification or acceptance of the reviewed reports. Rather, Dillon's report represents a reasonable review of available information within an agreed work scope, schedule and budget. Further review and updating of the peer review reports will be required as local and site conditions, and the regulatory and planning frameworks, change over time.

This report was prepared by Dillon for the sole benefit of our Client. The material in it reflects Dillon's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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CLOSURE

We appreciate the opportunity to work with LSCRCA on this assignment. If you have any questions about this report, please contact the undersigned.

Yours sincerely,

DILLON CONSULTING LIMITED

Darin Burr, M.Sc., P.Geo.
Project Manager

DTB:amb
Encl.

Table 1: SHELBURNE - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**SHELBURNE WELL SUPPLY**
Reviewed Report:	**Town of Shelburne, Groundwater Management Study, R.J. Burnside, 2001**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Regional 3-D Modflow**
Score:	**6.3**
Pass:	**Yes**
Critique Ref:	**Copy of Sent to Client _ Peer Review Score Card Results - 16072010**

System Characteristics

Hydrogeological Complexity	Contact bedrock aquifer underlying overburden.
Spatial variability in Aquifer Vulnerability	Medium
Known water Quality Issues	None - No human health water quality issues have been reported.

EVALUATION RESULTS

Criterion		Awarded Score	General Comments	Comments / Recommendations	
				Critical Deficiencies	Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		10	Shelburne has two well fields, the East Side well field and the West Side well field. The East Side well field has two wells, PW1 and PW2. The combined PTTW rate for these wells is 2,600 m³/day. The West Side well field has three wells, PW3, PW5 and PW6. The combined PTTW rate for these wells is 4,350 m³/day.	None	The model could be re-run at rates based on better estimates of water supply needs.
2. Were rule-approved models and methods used?		Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria					
3a. Is geological setting complex?	10	6	High complexity. A five layer model was used as follows: Layer 1, overburden aquifer/aquitard; Layer 2, contact bedrock aquifer, Layer 3, Guelph-Amabel aquifer; Layer 4, Cabot Head shale aquitard; and Layer 5, the Whirlpool aquifer..	None	If planned expansion occurs, further pumping tests and aquifer assessment is required. At that time, the appropriateness of the model to new data should be assessed.
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	Yes the geologic model requires a 3-D numerical modelling approach given the confined nature of the aquifer which has a significant spatial changes in thickness and overlying aquitard thickness. As well topography and surface drainage are important and a 3-D model incorporates these features as well.	None	Improve geological model by additional borehole construction in the future. Better documentation of the geology (e.g., cross-sections) is beneficial.
4. Is Flow Model Complexity Appropriate?	10	6	Yes - A multi-layered model was used with seven main hydrostratigraphic units represented in the model.	None	

5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	A variable recharge rates from a surface water model (GAWSER) were input into the model. The report does present a figure illustrating Layer 1 which shows the distribution of hydraulic conductivity values for this layer only. Hydraulic conductivity values were reported for each layer that was assumed to be homogeneous. Layer 1, overburden aquifer/aquitard (three zones, $4x10^{-4}$ m/s, $5x10^{-5}$ m/s and $6x10^{-8}$ m/s) ; Layer 2, contact bedrock aquifer ($8x10^{-5}$ m/s); Layer 3, Guelph-Amabel aquifer ($4x10^{-6}$ m/s); Layer 4, Cabot Head shale aquitard ($6x10^{-8}$ m/s); and Layer 5, the Whirlpool aquifer ($4x10^{-6}$ m/s).	Yes	
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	6	Boundary conditions were the Grand River and Credit River watershed boundary and the Niagara Escarpment boundary. The Grand River boundary (west) was designated as no-flow for Layers1-3 and constant head for Layer 4-5. Three recharge zones were used: a high recharge zone of 250 mm/year, a medium recharge zone of 125 mm/year and a low recharge zone of 25 mm/year.	Yes	
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10				
8. Was the Model Calibrated?	5	7	Model was calibrated to 336 wells and had a NRMS of 6.8%. The overall Orangeville and area model was calibrated to over 1000 wells and had a NRMS of 6.8% A comparison was made between the simulated base flow and the actual base flow in the Grand River (121%) and the Credit River (79%).	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale.
9. Was Uncertainty considered in the analysis?	5	5	A sensitivity assessment is documented which identified input parameters (e.g., hydraulic conductivities for certain hydrostratigraphic units) that more highly influence WHPA size. However, an uncertainty assessment was not completed and the WHPA areas are based solely on "best estimate" calibrated input parameters.	Yes	Capture zones are based on "best case" (calibrated) values. Further incorporation of sensitivity and uncertainty would be beneficial.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high.	None	