7.0 Threats and Risk Assessment – Water Quality

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

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

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

The *Threats* and *Risk* Assessment studies involved the operating authorities of the drinking water systems and were undertaken through partnerships involving the Conservation Authorities

in the region. Dillon Consulting Ltd. was the primary consultant who completed the *threats* and *risk* assessment work for these groundwater systems.

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

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

Drinking Water Systems	Technical Study on Threats and Risk Assessment
City of London back up wells (Fanshawe and Hyde Park wellfields), Birr, Melrose, Kilworth-Komoka, Dorchester and Thorndale	London, Middlesex Centre and Thames Centre Wellfield Source Protection Study. Water Quality Threats and Risk Assessment Final Report.June 4, 2010. Dillon Consulting Limited.
Embro, Lakeside, Mount Elgin (existing wells) and Tavistock	Upper Thames River Source Protection Area. Embro, Lakeside, Mount Elgin and Tavistock Well Systems Threats Assessment. March 23, 2010. County of Oxford.
Ingersoll	Upper Thames River Source Protection Area. Ingersoll Well Systems Threats Assessment. April 23, 2010. County of Oxford.
Beachville, Hickson, Innerkip, Thamesford	Upper Thames River Source Protection Area. Beachville, Hickson, Innerkip and Thamesford Well Systems Threats Assessment. April 27, 2010. County of Oxford.
Woodstock (urban wellfield)	Upper Thames River Source Protection Area. Woodstock Urban Well Systems Threats Assessment. May 19, 2010. County of Oxford.
Mount Elgin (existing and planned wells)	Upper Thames River Source Protection Area. Mount Elgin Threats Assessment. June 10, 2010. County of Oxford.
Woodstock (rural wellfield including planned wells)	Upper Thames River Source Protection Area. Woodstock Rural Well Systems Threats Assessment. June 24, 2010. County of Oxford.
Mitchell, Sebringville, St. Pauls, Stratford, St. Marys	Draft Threat Assessment – Perth County Municipal Drinking Water Systems. Schlumberger Water Services. June 21, 2010.
Shakespeare	Draft Threat Assessment –Milverton and Shakespeare Municipal Drinking Water Systems. Schlumberger Water Services. May 6, 2010.

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

7.1 Drinking Water Quality Threat Identification and Risk Assessment Methodology

Drinking water quality *threats* in *vulnerable areas* must be identified and assessed as to their *risk* to the drinking water source. The *vulnerable areas* are *Intake Protection Zone (IPZ), Wellhead Protection Area (WHPA), Highly Vulnerable Aquifers (HVA)* and *Significant Groundwater Recharge Areas (SGRA)*. *IPZ* are comprised of *IPZ-1, IPZ-2* and *IPZ-3*, while *WHPA* are comprised of *WHPA-A, WHPA-B, WHPA-C, WHPA-D, WHPA-E* and *WHPA-F*. The vulnerability assessment (including delineation and assignment of vulnerability scores) of these *vulnerable areas* is described in Section 4 - Vulnerability Assessment of this Assessment Report. In the Upper Thames River Source Protection Area, there are no surface water intakes. While the *WHPA-A, WHPA-B, WHPA-C* and *WHPA-D* are delineated, work related to *WHPA-E* and *WHPA-F* is yet to be completed. In the Upper Thames River Source Protection Area, 22 drinking water systems draw their source water from groundwater aquifers. Map 4-1 shows the location of the *WHPA* around municipal wellheads. Map 4-7 shows the delineated *HVA*, while Map 4-8 shows the delineated *SGRA* in the Upper Thames River Source Protection Area.

The drinking water quality *threats* that may be considered in the identified *vulnerable areas* are those due to: *prescribed activities*, *other activities*, *conditions* (past *activities*) and *activities* contributing to identified drinking water quality *issues*. The *Technical Rules: Assessment Report* Part XI describes the listing of drinking water quality *threats*. In the Thames-Sydenham and Region, a local guidance document was developed to provide clarification and local interpretation of the relevant sections in the Clean Water Act, its regulations and the associated *technical rules* pertaining to the *threats* and *risk* assessment. The methodology is included in Appendix 10.

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

7.1.1. Prescribed Drinking Water Threats

Through the Clean Water Act and General Regulation 287/07, a list of 21 *prescribed* drinking water *threats* is provided. That list is reproduced in Table 7-2.

Table 7-2 Activities Prescribed as Drinking Water Threats

1. The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.
2. The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
3. The application of agricultural source material to land.
4. The storage of agricultural source material.
5. The management of agricultural source material.
6. The application of non-agricultural source material to land.
7. The handling and storage of non-agricultural source material.
8. The application of commercial fertilizer to land.
9. The handling and storage of commercial fertilizer.
10. The application of pesticide to land.
11. The handling and storage of pesticide.
12. The application of road salt.
13. The handling and storage of road salt.
14. The storage of snow.
15. The handling and storage of fuel.
16. The handling and storage of a dense non-aqueous phase liquid.
17. The handling and storage of an organic solvent.
18. The management of runoff that contains chemicals used in the de-icing of aircraft.
19. An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body.
20. An activity that reduces the recharge of an aquifer.
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.

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

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

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

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

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

Risk = Vulnerability X Hazard

Table 7-3 shows the relationship between the *risk* score calculated and the resulting *threat* level. The highest possible *risk* score is 100. A *risk* score of 80 or greater results in a *significant threat* level. Some exceptions include *issue*-based *threats* which are deemed *significant* regardless of the vulnerability area and score, and *activities* related to *Dense Non-Aqueous Phase Liquids* (*DNAPLs*) which are *significant threats* in *WHPA-A* (100 m radius), *WHPA-B* (2 year capture zone excluding A), and *WHPA-C* (2 to 5 year capture zone) regardless of the vulnerability score. In *WHPA-D* (5 to 25 year capture zone), *WHPA-E* and *WHPA-F*, *dense non-aqueous phase liquids* (*DNAPLs*) are considered under chemical *threats*. *Pathogens* are not

viewed as *threats*, outside of *WHPA-A, WHPA-B, WHPA-E* and *IPZ-1* and *IPZ-2*. *WHPA-E* and *WHPA-F* are delineated for drinking water systems designated to be *groundwater under the direct influence of surface water* (*GUDI*).

Table 7-3 Threat Level Determination

Risk Score	Threat Level
80 or more	Significant
60 or greater, but less than 80	Moderate
Greater than 40, but less than 60	Low
40 or less than 40	No threat

As mentioned earlier, the *vulnerable areas* are *IPZ, WHPA, HVA* and *SGRA*. As there are no surface water intakes in the Upper Thames River SPA, there are no *IPZ*s. According to the *Technical Rules: Assessment Report*, vulnerability scores for *WHPA* range from 2 to 10 (depending on whether it is for *WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*). An *activity* can only be identified as a *threat* if it is occurring in a *vulnerable area* and the vulnerability score of the area is greater than 4. In an area where the vulnerability score is 8 or greater, the *threat* may be *significant* (dependent on the *circumstances* associated with *activity*). *WHPA-A*, *WHPA-B* and *WHPA-C* can have vulnerability scores of 8 or greater. As a result, possible to have *significant threats* in *WHPA-A, WHPA-B* and *WHPA-C*, dependent upon the assigned vulnerability score. *HVA* are assigned a vulnerability score of 6 while *SGRA* are assessed a vulnerability score of 6 or less, as described in Section 4 – Vulnerability Assessment. Hence there can be no *significant threats* in *HVA* and *SGRA*. Further, in *SGRA* with vulnerability scores of 4 and 2, no *threats* can be identified, as discussed above.

In order to assess the *risks* due to the *prescribed* drinking water quality *threats*, the Ministry of Environment (*MOE*) has developed '*Tables of Drinking Water Threats*' based on the 21 *prescribed threats*. The *MOE tables of drinking water threats* include the results of the *risk* score calculation and identify the *threat* level associated with an *activity* based on the vulnerability

score of the area in which the *activity* is being undertaken. The *MOE tables of drinking water threats* provide the *circumstances* under which an *activity* may be categorized as a low, moderate or *significant threat*. Hence, the *circumstances* of the *activity* are considered to determine the level of *risk* associated with a water *threat*. The *circumstances* to be considered include the type of material, the quantity of material and whether it might be released to surface water or groundwater. Each combination of *circumstances* for an *activity* is assigned a hazard score. The hazard score ranges between 4.1 to 10 for chemical *threats*, 5 to 10 for *pathogens*, and 8.3 to 10 for *DNAPLs*. There are two separate tables in the *tables of drinking water threats* for *activities* related to chemicals and for *activities* related to pathogens.

See Maps 7-3-1 to 7-3-23 for activities related to chemicals, *DNAPLs* and pathogens that are low, moderate or *significant threats*. These maps also contain tables indicating the possible level of threat dependent on the *WHPA* zone and the vulnerability score. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Chemicals

Chemicals include, but are not limited to, nitrogen and phosphorus (related to the prescribed drinking water threat of application of commercial fertilizers, and *agricultural source material and non-agricultural source material* to land), atrazine, dicamba, glyphosate (related to the application of pesticide on land), *BTEX*, certain petroleum hydrocarbons (related to the handling and storage of fuel), chloroform (related to the handling and storage of organic solvent), sodium and copper (related to the storage of snow). In the *tables of drinking water threats*, *dense non-aqueous phase liquids* (*DNAPLs*) such as trichloroethylene and vinyl chloride are considered as chemicals but only in *WHPA-D*, *WHPA-E* and *WHPA-F*. The consideration of *DNAPLs* in *WHPA-A, WHPA-B* and *WHPA- C* is described below.

Dense Non-Aqueous Phase Liquids

Dense non-aqueous phase liquids (*DNAPLs*) are considered separately from other chemical related *activities* in *WHPA-A, WHPA-B* and *WHPA-C*. *DNAPLs* are heavier than water and do not mix with water. They are of concern in groundwater since they sink into the ground, settle at the bottom of and contaminate an aquifer. Examples of *activities* or products containing

DNAPLs include: dry cleaning, wood preservation, asphalt operations, machining, pesticides, brake cleaners, glues, varnishes, production and repair of automobiles, aviation equipment (source of information: http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=6A7FB7B2-1#sub3). The *activities* related to the handling and storage of *Dense Non-Aqueous Phase Liquids* (*DNAPLs*) are deemed *significant threats* in *WHPA-A*, *WHPA-B* and *WHPA-C*, regardless of the vulnerability score. In *WHPA-D*, *WHPA-E* and *WHPA-F*, *dense non-aqueous phase liquids* (*DNAPLs*) are considered under chemical *threats*.

Pathogens

Pathogens are disease-causing microorganisms. In the *tables of drinking water threats*, they are not limited to a specific list of types of pathogens. *Activities* that may cause the presence of pathogens include, but are not limited to, the application of *agricultural source material and non-agricultural source material* to land, livestock grazing, and sewage discharge. *Pathogens* are not viewed as *threats*, outside of *WHPA-A, WHPA-B, WHPA-E* and *IPZ-1* and *IPZ-2*.

Locations at which Significant Threats Occur

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

Mapping of Impervious Area, Managed Lands and Livestock Density

As part of the identification of certain *prescribed* chemical drinking water *threats*, an intermediate step involving the creation of maps showing impervious area (see Maps 7-1-1 to 7-1-23), managed lands and livestock density (see Maps 7-2-1 to 7-2-23) is necessary. A determination of the percentage of impervious area is needed to determine the level of *threat* associated with the application of road salt. Also, the percentage of managed lands is required, as this is related to the level of *threat* for the application of *agricultural source material* (*ASM*), commercial fertilizer or *non-agricultural source material* (*NASM*). The *technical rules* also require that the livestock density for an area, expressed in terms of nutrient units/acre, be

determined as a means of estimating the potential for the generation, storage and application of *agricultural source materials* (*ASM*) in an area.

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

Impervious Area

For determining the *risk* level associated with the application of road salt, the percentage of impervious area must be determined. Impervious areas related to application of road salt include roads, parking areas and sidewalks. The percentage of impervious surface areas must be calculated within each square kilometre of *vulnerable areas* (Rule 16). The extent of each square kilometre is determined by overlaying a 1 kilometre by 1 kilometre grid over the *vulnerable area* with a node of the grid located at the centroid of the Source Protection Area. Geographic Information System (*GIS*) tools were used to undertake this calculation for each grid which touched a *vulnerable area*. Within the WHPAs, on-screen digitizing was performed using colour orthophotography from 2006 to delineate areas of paved road, parking lots, driveways and sidewalks. In the case of *HVA*s and *SGRA*s, the Southern Ontario Land Resource Information System (SOLRIS) land classification was used to delineate roads and, in conjunction with the orthophotography, was use to delineate parking lots, driveways and sidewalks. The area of paved surface within each of the grid cells described above was divided by the area of *vulnerable area* within that same grid cell to determine the percentage of impervious surface area.

Managed Lands

In determining the percentage of managed lands, Source Protection committees must determine the areas where there may be application of *agricultural source material* (*ASM*), commercial fertilizer, or *non-agricultural source material* (*NASM*). These areas are expressed as percentages of the total area being evaluated. Mapping the percentage of managed lands is not required where the vulnerability score for an area is less than the vulnerability score necessary for the *activity* to be considered a *threat* in the Table of Drinking Water *Threats*. Managed lands can be broken into two types: agricultural managed land and non-agricultural managed land.

Agricultural managed land includes areas of cropland, fallow and improved pasture that may receive nutrients. Non-agricultural managed lands include golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer). Both managed land and agricultural managed lands are to be delineated within each of the *vulnerable areas* (individually for each *WHPA-A*, *WHPA-B*, *WHPA-C*, *WHPA-D*, *WHPA-E*, *WHPA-F*, well as for *HVA* and *SGRA*). Within the *WHPA*s, on-screen digitizing was performed using colour orthophotography from 2006 to delineate agricultural managed lands. In the case of *HVA*s and *SGRA*s, Municipal Property Assessment Corporation (MPAC) information and the SOLRIS land classification was used delineate agricultural managed lands. Within the *WHPA*s, non-agricultural managed lands were determined using the MPAC information and the orthophotography to select areas of green from commercial, industrial and residential properties. In the case of *HVA*s and *SGRA*s, the SOLRIS land classification was used with the orthophotography to select areas of green from commercial, industrial and residential properties.

The percentage of managed land area within a *vulnerable area* is the sum of agricultural managed land and non-agricultural managed land, divided by the total area of all land within a *vulnerable area*, multiplied by 100. This was undertaken for each part of the *WHPA* which have been delineated and for the *HVA*s and *SGRA*s as a whole. Where a parcel of managed land is partially within a *vulnerable area*, only the portion of the parcel within the *vulnerable area* is used in the calculations.

Livestock Density

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

1. Estimate the number of each category of animals present within the specified area,
2. Convert the number of each category of poultry and livestock present into nutrient units (NU), to enable all livestock to be compared on an equivalent unit of measure in terms of the nutrients produced by each type,

3. Sum the total NU of all categories of poultry and livestock within the specified area and then divide this NU value by the area of agricultural managed land within the same specified area.

The determination of the agricultural managed land is described above. The NUs within a *vulnerable area* were determined using the MPAC data to screen for livestock operations, the orthophotography to determine livestock barn size and the table provided in a MOE Technical Bulletin to convert the barn area into NUs.

Risk Assessment using Managed Lands and Livestock Density

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

Chemical Threats Related to the Land Application of Nutrients

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

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

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

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

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

- *Vulnerable Areas* scoring 9 if the livestock density is sufficient to generate nutrients at an annual rate that is more than 1.0 Nutrient Units per acre (NU/acre); or
- *Vulnerable Areas* scoring 10 if the livestock density is sufficient to generate nutrients at an annual rate that is at least 0.5 NU/acre for surface water (in an *IPZ*) or more than 1.0 NU /acre for groundwater; and

- if the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater. The *tables of drinking water threats* refer to Phosphorus in groundwater, but do not identify any *threats* associated with it in a *WHPA*.

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

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

Chemical Threats Related to Agricultural Source Material Storage

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

7.1.2. Other Activities

The Clean Water Act also allows the Source Protection Committee to include *activities* that they consider being drinking water *threats* but are not *prescribed* drinking water *threats*. These are

called *other activities* (Rule 119). The Source Protection Committee can also identify additional *circumstances* (not already in the *tables of drinking water threats*) under which they consider the *activity* to be a *prescribed* drinking water *threat*. The Source Protection Committee is considering a few such *other activities*, as discussed in Section 7.3. These include geothermal systems (harnessing underground temperature) and transportation corridors (shipping or road transport of materials).

Other activities may be listed as *threats* only if the Source Protection Committee identifies them as drinking water *threats*, and similar to the *prescribed threats*, if the hazard score is greater than 4 and the *risk* score calculated is greater than 40. The hazard score must be calculated based on certain criteria set out in the *technical rules*, and further must be agreed upon by the Director (*MOE*).

7.1.3. Threats Arising from Conditions

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

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

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

If *Conditions* (resulting from past *activities*) are identified, the hazard score is either 6 or10 depending on certain factors (Rule 139). There are additional scenarios where, regardless of the *risk* score, a *condition* is a *significant threat*. These scenarios are when a *condition* is related to a drinking water quality *issue* or an *IPZ-3*. For more information, refer to Section 6 – Conditions Assessment of this Assessment Report.

7.1.4. Threats Arising from Issues

A drinking water *issue* is a *parameter* (a substance) or *pathogen* (a disease-causing microorganism) which is shown to deteriorate, or trends towards a deterioration of raw (untreated) water quality for the purposes of drinking. The *issues* identified in the Upper Thames River Source Protection Area are summarized in the Section 5 - Issues Evaluation of the Assessment Report.

According to Rule 131, *activities* in *vulnerable areas* that contribute to drinking water quality *issues* are deemed *significant* drinking water *threats* regardless of assigned vulnerability scores. These *activities* may be *prescribed* or *other threats* (according to Rule 115(3)), or they may be *conditions* (Rule 141). If an *issue* is identified, the *activities* that contribute to the identified *issue* and the areas where they occur must also be identified. Since the *activities* contributing to *issues* are deemed to be *significant threats*, the *risks* these *activities* (if identified) pose must be reduced through the source protection plan.

7.1.5. Local Guidance and Technical Studies

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

For the *threats* analysis in the *WHPAs*, an inventory of land use *activities* that may be associated with *prescribed* drinking water *threat* was conducted. The inventory was based on a review of multiple data sources including public records, data provided through questionnaires completed by municipal officials, previous contaminant/historical land use information, and data collected during windshield surveys. Very little specific information was collected; therefore, all *prescribed* drinking water *threat activities* are considered potential rather than confirmed. In summary, evaluation followed a multi-step process including:

- assigning land use *activity*
- assigning vulnerability scores

- relating land use *activity* to *threat* category
- relating land use *activity* to *prescribed* drinking water *threat* and
- determining applicable *circumstances*.

Determining the applicable *circumstances* is based on a combination of site-specific knowledge of *activities* on the property, available information on local/regional characteristics, and on professional opinion. Where possible, site-specific data from information provided through available public records and interviews are considered. In many cases, selection of the relevant *circumstance* is based largely on professional opinion as to the likelihood of a *circumstance* being applicable, as site inspections have not been conducted to date.

A tier 2, or site-specific, *risk* assessment is planned for 2011 to confirm the number of locations at which *significant threats* occur.

7.2 Drinking Water Quality Threats and Risk Assessment

From the *prescribed* list of *activities*, the drinking water *threats* and their *circumstances* are identified in *vulnerable areas* of each drinking water system. They are described further in this section.

The Source Protection Committee has not identified any '*other*' (not *prescribed*) *activities* or *circumstances* (not in the *tables of drinking water threats*) at this point. However, the Source Protection Committee has expressed a concern to the *MOE* over the *risks* associated with the transportation of materials through pipelines or other corridors. The Source Protection Committee has also expressed a concern over the potential *risk* that geothermal systems pose to groundwater sources of drinking water. The Source Protection Committee will give further consideration to these *activities* and may include them in an amended Assessment Report if they cannot be adequately addressed through other means.

The investigation to determine if there are any *conditions* (*threats* resulting from past *activities*) is yet to be completed at the time of drafting this Assessment Report. However, a couple of potential *conditions* in the Upper Thames River Source Protection Area are being considered for further work. More studies will be undertaken on identifying and assessing *conditions* and the

Assessment Report will be amended if necessary. These are discussed in Section 6 – Conditions Assessment.

Activities that contribute to *issues* are deemed a *significant risk* by the Clean Water Act. The area and *activities* contributing to a drinking water quality *issue* must both be identified. This work has yet to be completed and will be part of an amended Assessment Report. A work plan to conduct this work is included in the Section 5 - Issues Evaluation of the Assessment Report.

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

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

The maps indicating impervious surfaces, managed lands and livestock density in the region were updated based on *MOE* guidance received during the drafting of this Assessment Report. The identification of the *threats* related to these mapped areas is completed. The *threats* related to these mapping products are the application of *agricultural source material and non-agricultural source material* to land, the application of commercial fertilizer to land, and the application of road salt. They are identified as chemical related threats in the description on each drinking water system below. Due to the vulnerability scoring of *HVA* and *SGRA*, the analysis will not result in the identification of any *significant threats* in these *vulnerable areas*.

7.2.2. Number of Locations of Significant Threats

Table 7-5, 7-6, 7-7 and 7-8 provide the number of locations where *significant threats* are thought to occur, based on current land use, within the *vulnerable areas* of the Upper Thames River Source Protection Area. These numbers include *threats* due to chemical and pathogen-related *activities*. As can be seen from Table 7-8, there are no locations of *activities* that 'are or would be' *significant threats* within the *HVA* and *SGRA*. This is due to the range of vulnerability scores allowed for *HVA* and *SGRA* as discussed in Section 7.1.1. There are however locations where

significant threats 'are or would' occur in the *WHPA-A*, *WHPA-B* and *WHPA-C*. There are no surface water intakes in this Source Protection Area, therefore no *IPZ*s.

Table 7-5 : Number of Locations of Significant Drinking Water Threats in Middlesex County and City of London

System - wellfield	Vulnerable Area	Vulnerability Score	Number of Locations of Significant Threats
Birr	WHPA - A	10	13
	WHPA - B	6	0
	WHPA - C	4	0
	WHPA - D	2	0
Melrose	WHPA - A	10	16
	WHPA - B	10	10
	WHPA - C	6, 8	0
	WHPA - D	2, 4, 6	0
Kilworth-Komoka	WHPA - A	10	1
	WHPA - B	6, 8, 10	0
	WHPA - C	4	0
	WHPA - D	2	0
Dorchester	WHPA - A	10	5
	WHPA - B	10	64
	WHPA - B	6	0
	WHPA - C	4, 8	0
	WHPA - D	2, 6	0
Thorndale	WHPA - A	10	6
	WHPA - B	6	1
	WHPA - C	4	0
	WHPA - D	2	0
City of London-Fanshawe wells	WHPA - A	10	6
	WHPA - B	10	1
	WHPA - C	8	0
	WHPA - D	Not applicable*	Not applicable
City of London-Hyde Park wells	WHPA - A	10	2
	WHPA - B	10	1
	WHPA - B	6, 8	0
	WHPA - C	6	1
	WHPA - C	4, 8	0
	WHPA - D	2, 4, 6	0

*WHPA reaches steady state in WHPA-C, therefore there is no WHPA-D

Table 7-6 : Number of Locations of Significant Drinking Water Threats in Oxford County

System - wellfield	Vulnerable Area	Vulnerability Score	Number of Locations of Significant Threats
Beachville	WHPA - A	10	6
	WHPA - B	6, 8	0
	WHPA - C	4, 8	1
	WHPA - D	2, 4, 6	0
Embro	WHPA - A	10	21
	WHPA - B	6	2
	WHPA - C	4	0
	WHPA - D	2	0
Hickson	WHPA - A	10	10
	WHPA - B	8	0
	WHPA - C	4	0
	WHPA - D	2	0
Ingersoll	WHPA - A	10	18
	WHPA - B	6, 8, 10	16
	WHPA - C	2, 4, 6	9
	WHPA - D	2, 4, 6	0
Innerkip	WHPA - A	10	2
	WHPA - B	8	0
	WHPA - C	6, 8	0
	WHPA - D	2, 4	0
Lakeside	WHPA - A	10	6
	WHPA - B	6	0
	WHPA - C	4	0
	WHPA - D	2	0
Mount Elgin	WHPA - A	10	15
	WHPA - B	6	1
	WHPA - C	4	0
	WHPA - D	2	0
Tavistock	WHPA - A	10	4
	WHPA - B	6	8
	WHPA - C	4	1
	WHPA - D	2	0
Thamesford	WHPA - A	10	4
	WHPA - B	6, 8, 10	4
	WHPA - C	4, 8, 10	0
	WHPA - D	2, 8	0
Woodstock – urban wells	WHPA - A	10	4
	WHPA - B	6	20
	WHPA - C	2	28
	WHPA - D	4, 2	0
Woodstock - Thornton wellfield and Tabor wellfield	WHPA - A	10	10
	WHPA - B	6	196
	WHPA - C	6, 2	0
	WHPA - D	2	0

Table 7-7 : Number of Locations of Significant Drinking Water Threats in Perth County, City of Stratford and Town of St. Marys

System - wellfield	Vulnerable Area	Vulnerability Score	Number of Locations of Significant Threats
Mitchell	WHPA - A	10	1
	WHPA - B	6	2
	WHPA - C	4	0
	WHPA - D	2	0
Shakespeare	WHPA - A	10	1
	WHPA - B	6	0
	WHPA - C	4	0
	WHPA - D	2	0
Sebringville	WHPA - A	10	0
	WHPA - B	10	0
	WHPA - C	4	0
	WHPA - D	2	0
St. Pauls	WHPA - A	10	1
	WHPA - B	6	0
	WHPA - C	4	0
	WHPA - D	2	0
Stratford	WHPA - A	10	5
	WHPA - B	6	4
	WHPA - C	4	1
	WHPA - D	2	0
St. Marys	WHPA - A	10	3
	WHPA - B	8, 10	14
	WHPA - C	6	0
	WHPA - D	4	0

Table 7-8 : Number of Locations of Significant Drinking Water Threats in HVA and SGRA

System - wellfield	Vulnerable Area	Vulnerability Score	Number of Locations of Significant Threats
(Not applicable)	HVA	6.0	0
(Not applicable)	SGRA	6.0, 4.0 and 2.0	0

7.2.3. Threats in Birr Wellhead Protection Areas

Table 7-9 indicates the number of locations where *significant threats* could occur in the Birr *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A.* The land use within the Birr *WHPA* is mainly agricultural, residential and commercial. Map 7-3-1 shows areas in the Birr *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-9 Significant Threats in the Birr WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	11	A
The application of agricultural source material to land	Pathogen	1	A
The application of non-agricultural source material to land	Pathogen	1	A
The handling and storage of fuel	Chemical	12	A
Total number of locations of significant threats		13*	

*some parcels may have more than one activity occuring

7.2.4. Threats in Dorchester Wellhead Protection Areas

Table 7-10 indicates the number of locations where *significant threats* could occur in the Dorchester *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Dorchester *WHPA* is mainly residential, agricultural, commercial and park/open space. The Dorchester Swamp is a natural feature that spans the *WHPA*. Map 7-3-2 shows areas in the Dorchester *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat*

is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-10 Significant Threats in the Dorchester WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	1	A
	Pathogen	54	B
The application of agricultural source material to land	Pathogen	5	A
	Pathogen	16	B
The storage of agricultural source material	Pathogen	1	A
	Pathogen	1	B
The application of non-agricultural source material to land	Pathogen	5	A
	Pathogen	16	B
The handling and storage of commercial fertilizer	Chemical	1	A
	Chemical	2	B
The application of pesticide to land	Chemical	4	A
	Chemical	9	B
The handling and storage of pesticide	Chemical	2	B
The handling and storage of fuel	Chemical	2	A
	Chemical	54	B
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.	Pathogen	1	A
	Pathogen	1	B
Total number of locations of significant threats		64*	

*some parcels may have more than one activity occuring

7.2.5. Threats in Kilworth-Komoka Wellhead Protection Areas

Table 7-11 indicates the number of locations where *significant threats* could occur in the Kilworth-Komoka *WHPA* of the Upper Thames River Source Protection Area based on current

land use. The *significant threats* occur in *WHPA-A*. The land use within the Kilworth-Komoka *WHPA* is mainly agricultural, park/open space, industrial and residential. Map 7-3-3 shows areas in the Kilworth-Komoka *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-11 Significant Threats in the Kilworth-Komoka WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The handling and storage of fuel	Chemical	2	A
Total number of locations of significant threats		2*	

*some parcels may have more than one activity occuring

7.2.6. Threats in City of London Wellhead Protection Areas

Table 7-12 and Table 7-13 indicate the number of locations where *significant threats* could occur in the City of London *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A, WHPA-B* and *WHPA-C*. The land use within the City of London Fanshawe *WHPA* is mainly park/open space, industrial and residential. The general land use within the City of London Hyde Park *WHPA* is mainly residential, commercial, park/open spaces and institutional. Map 7-3-4 and Map 7-3-5 (Fanshawe and Hyde Park wellfields) show areas in the City of London *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-12 Significant Threats in the City of London-Fanshawe WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	2	A
The application of pesticide to land	Chemical	2	A
The handling and storage of fuel	Chemical	5	A
	Chemical	1	B
Total number of locations of significant threats		6*	

*some parcels may have more than one activity occuring

Table 7-13 Significant Threats in the City of London-Hyde Park WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	1	A
	Pathogen	1	B
The handling and storage of fuel	Chemical	1	A
The handling and storage of a dense non-aqueous phase liquid	DNAPL	1	C
Total number of locations of significant threats		3*	

*some parcels may have more than one activity occuring

7.2.7. Threats in Melrose Wellhead Protection Areas

Table 7-14 indicates the number of locations where *significant threats* could occur in the Melrose *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Melrose *WHPA* is mainly residential and agricultural. Map 7-3-6 shows areas in the Melrose *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is

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

Table 7-14 Significant Threats in the Melrose WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	13	A
	Pathogen	8	B
The application of agricultural source material to land	Chemical	2	B
The application of non-agricultural source material to land	Chemical	2	B
The application of commercial fertilizer to land	Chemical	2	B
The handling and storage of fuel	Chemical	16	A
	Chemical	8	B
The handling and storage of a dense non-aqueous phase liquid	DNAPL	3	A
Total number of locations of significant threats		26*	

*some parcels may have more than one activity occuring

7.2.8. Threats in Thorndale Wellhead Protection Areas

Table 7-15 indicates the number of locations where *significant threats* could occur in the Thorndale *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Thorndale *WHPA* is mainly agricultural, residential and industrial. Map 7-3-7 shows areas in the Thorndale *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-15 Significant Threats in the Thorndale WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	5	A
The application of agricultural source material to land	Pathogen	2	A
The application of non-agricultural source material to land	Pathogen	2	A
The handling and storage of commercial fertilizer	Chemical	1	A
The application of pesticide to land	Chemical	2	A
The handling and storage of pesticide	Chemical	1	A
The handling and storage of a dense non-aqueous phase liquid	DNAPL	1	B
Total number of locations of significant threats		64*	

*some parcels may have more than one activity occuring

7.2.9. Threats in Beachville Wellhead Protection Areas

Table 7-16 indicates the number of locations where *significant threats* could occur in the Beachville *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Beachville *WHPA* is mainly agricultural, residential and industrial. Map 7-3-8 shows areas in the Beachville *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-16 Significant Threats in the Beachville WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	6	A
The handling and storage of a dense non-aqueous phase liquid	DNAPL	1	B
Total number of locations of significant threats		7*	

*some parcels may have more than one activity occuring

7.2.10. Threats in Embro Wellhead Protection Areas

Table 7-17 indicates the number of locations where *significant threats* could occur in the Embro *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Embro *WHPA* is mainly agricultural, residential and commercial. Map 7-3-9 shows areas in the Embro *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-17 Significant Threats in the Embro WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	19	A
The application of agricultural source material to land	Pathogen	1	A
The handling and storage of fuel	Chemical	1	A
The handling and storage of a dense non-	DNAPL	2	A

aqueous phase liquid	DNAPL	2	B
Total number of locations of significant threats		23*	

*some parcels may have more than one activity occuring

7.2.11. Threats in Hickson Wellhead Protection Areas

Table 7-18 indicates the number of locations where *significant threats* could occur in the Hickson *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Hickson *WHPA* is mainly agricultural and residential. Map 7-3-10 shows areas in the Hickson *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-18 Significant Threats in the Hickson WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	19	A
The application of agricultural source material to land	Pathogen	1	A
The handling and storage of fuel	Chemical	1	A
The handling and storage of a dense non-aqueous phase liquid	DNAPL	2	A
	DNAPL	2	B
Total number of locations of significant threats		23*	

*some parcels may have more than one activity occuring

7.2.12. Threats in Ingersoll Wellhead Protection Areas

Table 7-19 indicates the number of locations where *significant threats* could occur in the Ingersoll *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A*, *WHPA-B* and *WHPA-C*. The land use within the Ingersoll *WHPA* is mainly agricultural, industrial, park/open space and commercial. Map 7-3-11 shows areas in the Ingersoll *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-19 Significant Threats in the Ingersoll WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	Chemical	3	A
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	11	A, B
The application of agricultural source material to land	Chemical, Pathogen	6	A, B
The storage of agricultural source material	Chemical, Pathogen	1	B
The application of commercial fertilizer to land	Chemical	5	A, B
The handling and storage of commercial fertilizer	Chemical	2	A, B
The application of pesticide to land	Chemical	1	B
The handling and storage of pesticide	Chemical	2	A, B
The handling and storage of fuel	Chemical	4	A, B
The handling and storage of a dense non-aqueous phase liquid	DNAPL	27	A, B, C
The handling and storage of an organic solvent	Chemical	1	A
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.	Pathogen	1	A

Total number of locations of significant threats	43*	

*some parcels may have more than one activity occuring

7.2.13. Threats in Innerkip Wellhead Protection Areas

Table 7-20 indicates the number of locations where *significant threats* could occur in the Innerkip *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A*. The land use within the Innerkip *WHPA* is mainly agricultural, residential and park/open space. Map 7-3-12 shows areas in the Innerkip *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-20 Significant Threats in the Innerkip WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The application of agricultural source material to land	Pathogen	2	A
The application of pesticide to land	Chemical	1	A
Total number of locations of significant threats		2*	

*some parcels may have more than one activity occuring

7.2.14. Threats in Lakeside Wellhead Protection Areas

Table 7-21 indicates the number of locations where *significant threats* could occur in the Lakeside *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A*. The land use within the Lakeside *WHPA* is mainly agricultural with some residential and industrial use. Map 7-3-13 shows areas in the Lakeside *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the

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

Table 7-21 Significant Threats in the Lakeside WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	5	A
The application of agricultural source material to land	Chemical, Pathogen	1	A
The application of commercial fertilizer to land	Chemical	6	A
The application of pesticide to land	Chemical	1	A
Total number of locations of significant threats		6*	

*some parcels may have more than one activity occuring

7.2.15. Threats in Mount Elgin Wellhead Protection Areas

Table 7-22 indicates the number of locations where *significant threats* could occur in the Mount Elgin*WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A*. The land use within the Mount Elgin *WHPA* is mainly agricultural, residential and institutional. Map 7-3-14 shows areas in the Mount Elgin *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-22 Significant Threats in the Mount Elgin WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	Pathogen	1	A
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	12	A
The application of agricultural source material to land	Pathogen	3	A
The application of pesticide to land	Chemical	1	A
The handling and storage of fuel	Chemical	13	A
The handling and storage of a dense non-aqueous phase liquid	DNAPL	2	A
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.	Pathogen	1	A
Total number of locations of significant threats		16*	

*some parcels may have more than one activity occuring

7.2.16. Threats in Tavistock Wellhead Protection Areas

Table 7-23 indicates the number of locations where *significant threats* could occur in the Tavistock *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A*, *WHPA-B* and *WHPA-C*. The land use within the Tavistock *WHPA* is mainly agricultural, residential and institutional. Map 7-3-15 shows areas in the Tavistock *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-23 Significant Threats in the Tavistock WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	1	A
The handling and storage of fuel	Chemical	2	A
The handling and storage of a dense non-aqueous phase liquid	DNAPL	12	A, B, C
The handling and storage of an organic solvent	Chemical	2	A
Total number of locations of significant threats		12*	

*some parcels may have more than one activity occuring

7.2.17. Threats in Thamesford Wellhead Protection Areas

Table 7-24 indicates the number of locations where *significant threats* could occur in the Thamesford *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Thamesford *WHPA* is mainly agricultural and residential with some industrial use. Map 7-3-16 shows areas in the Thamesford *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-24 Significant Threats in the Thamesford WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	3	A, B
The application of agricultural source material to land	Pathogen	4	A, B
The handling and storage of a dense non-	DNAPL	1	A, B

aqueous phase liquid			
The application of pesticide to land	Chemical	2	A
Total number of locations of significant threats		6*	

*some parcels may have more than one activity occuring

7.2.18. Threats in Woodstock Wellhead Protection Areas

Table 7-25 and Table 7-26 indicate the number of locations where *significant threats* could occur in the Woodstock *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A*, *WHPA-B* and *WHPA-C*. The land use within the Woodstock *WHPA* is mainly agricultural, residential, industrial and commercial. Map 7-3-17 and Map 7-3-18 show areas in the Woodstock *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-25 Significant Threats in the Woodstock WHPA (Urban well system)

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	Chemical	2	A
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	2	A
The handling and storage of fuel	Chemical	3	A
The handling and storage of a dense non-aqueous phase liquid	DNAPL	71	A, B, C
Total number of locations of significant threats		71	

*some parcels may have more than one activity occuring

Table 7-26 Significant Threats in the Woodstock WHPA (Rural well system)

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Pathogen	187	A, B
The application of agricultural source material to land	Chemical, Pathogen	18	A, B
The application of commercial fertilizer to land	Chemical	3	A
The application of pesticide to land	Chemical	10	A, B
The storage of pesticides	Chemical	2	A, B
The handling and storage of fuel	Chemical	13	A, B
The handling and storage of a dense non-aqueous phase liquid	DNAPL	2	B
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.	Chemical	2	B
Total number of locations of significant threats		206*	

*some parcels may have more than one activity occuring

7.2.19. Threats in Mitchell Wellhead Protection Areas

Table 7-27 indicates the number of locations where *significant threats* could occur in the Mitchell *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Mitchell *WHPA* is mainly agrcultural, industrial, commercial and residential. Map 7-3-19 shows areas in the Mitchell *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-27 Significant Threats in the Mitchell WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The handling and storage of fuel	Chemical	1	A
	Chemical	2	B
The handling and storage of a dense non-aqueous phase liquid	DNAPL	1	A
	DNAPL	2	B
Total number of locations of significant threats		3*	

*some parcels may have more than one activity occuring

7.2.20. Threats in Shakespeare Wellhead Protection Areas

Table 7-28 indicates the number of locations where *significant threats* could occur in the Shakespeare *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A* and *WHPA-B*. The land use within the Shakespeare *WHPA* is mainly agricultural, industrial and residential. Map 7-3-20 shows areas in the Shakespeare *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-28 Significant Threats in the Shakespeare WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The application of agricultural source material to land	Chemical, Pathogen	1	A, B
The application of commercial fertilizer to land	Chemical	1	A, B
The application of pesticide to land	Chemical	1	A, B
Total number of locations of significant threats		1*	

*some parcels may have more than one activity occuring

7.2.21. Threats in Sebringville Wellhead Protection Areas

Table 7-29 indicates the number of locations where *significant threats* could occur in the Sebringville *WHPA* of the Upper Thames River Source Protection Area based on current land use. No *significant threats* occur in the Sebringville *WHPA*. Map 7-3-21 shows areas in the Sebringville *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-29 Significant Threats in the Sebringville WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
None identified		0	
Total number of locations of significant threats		0	

7.2.22. Threats in St. Pauls Wellhead Protection Areas

Table 7-30 indicates the number of locations where *significant threats* could occur in the St. Pauls *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threat* occurs in *WHPA-A*. The land use within the St. Pauls *WHPA* is mainly agricultural and residential. Map 7-3-22 shows areas in the St. Pauls *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-30 Significant Threats in the St. Pauls WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The application of agricultural source material to land	Chemical, Pathogen	1	A
The application of commercial fertilizer to land	Chemical	1	A
The application of pesticide to land	Chemical	1	A
Total number of locations of significant threats		1*	

*some parcels may have more than one activity occuring

7.2.23. Threats in Stratford Wellhead Protection Areas

Table 7-31 indicates the number of locations where *significant threats* could occur in the Stratford *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A, WHPA-B* and *WHPA-C*. The land use within the Stratford *WHPA* is mainly agricultural, commercial, industrial and residential. Map 7-3-23 shows areas in the Stratford *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-31 Significant Threats in the Stratford WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The handling and storage of a dense non-aqueous phase liquid	DNAPL	5	A
	DNAPL	4	B
	DNAPL	1	C
The application of commercial fertilizer to land	Chemical	1	A
The handling and storage of commercial fertilizer	Chemical	1	A
The application of pesticide to land	Chemical	1	A

The handling and storage of pesticide	Chemical	1	A
Total number of locations of significant threats		10*	

*some parcels may have more than one activity occuring

7.2.24. Threats in St. Marys Wellhead Protection Areas

Table 7-32 indicates the number of locations where *significant threats* could occur in the St. Marys *WHPA* of the Upper Thames River Source Protection Area based on current land use. The *significant threats* occur in *WHPA-A, WHPA-B* and *WHPA-C*. The land use within the St. Marys *WHPA* is mainly industrial, commercial and agricultural. Map 7-3-24 shows areas in the St. Marys *WHPA* where *activities* 'are or would be' low, moderate or *significant threats*. The level of *threat* is dependent upon the *vulnerable area* (*WHPA-A, WHPA-B, WHPA-C* or *WHPA-D*) where the *activity* is occurring, the vulnerability score and the *circumstances* associated with the *activity*. Refer to Appendix 10 for detailed lists of low, moderate or *significant threats* and the *circumstances* under which they occur.

Table 7-32 Significant Threats in the St. Marys WHPA

Prescribed Drinking Water Threat	Type (Chemical, Pathogen or DNAPL)	Number of Locations at which threat is significant	WHPA
The application of agricultural source material to land	Chemical*, Pathogen	3	B
The application of commercial fertilizer to land	Chemical	1	B
The handling and storage of commercial fertilizer	Chemical	1	B
The application of pesticide to land	Chemical	1	B
The handling and storage of pesticide	Chemical	1	B
The handling and storage of fuel	Chemical	2	B
The handling and storage of a dense non-aqueous phase liquid	DNAPL	3	A
	DNAPL	5	B
The handling and storage of an organic solvent	Chemical	3	B
Total number of locations of significant threats		17**	

*Analysis of livestock density, managed lands and impervious lands yet to be completed

**some parcels may have more than one activity occuring

7.2.25. Threats in HVA and SGRA

Table 7-5 to Table 7-8 indicate the number of locations where *significant threats* could occur in the *vulnerable areas* of the Upper Thames River Source Protection Area based on current land use. Due to the low to moderate vulnerability scoring of the *HVA* and *SGRA*, it is not possible to have *significant threats* in these *vulnerable areas*. It is possible however to have low and moderate levels of chemical *threats*, including *dense non-aqueous phase liquids* (*DNAPLs*), for a vulnerability score of 6 in *HVA* and *SGRA*. Map 4-7 and 4-8 show the *HVA* and *SGRA* delineations respectively in the Upper Thames River Source Protection Area. Map 4-9 shows the vulnerability scores of the delineated *SGRA*. Table 7-33 shows the levels of *threats* that could occur in these *vulnerable areas*. Refer to Appendix 10 for detailed lists of moderate or low *threats* and the *circumstances* under which they occur.

Table 7-33 Levels of Threats Related to Pathogens, Chemicals and DNAPLs in HVAs and SGRAs

Vulnerable Area	Vulnerability Score	Level of Threat for Activities Related to Pathogens			Level of Threat for Activities Related to Chemicals			Level of Threat for Activities Related to DNAPLs		
		Significant	Moderate	Low	Significant	Moderate	Low	Significant	Moderate	Low
HVA	6	No	No	No	No	Yes	Yes	No	Yes	Yes
SGRA	6	No	No	No	No	Yes	Yes	No	Yes	Yes
SGRA	4	No	No	No	No	No	No	No	No	No
SGRA	2	No	No	No	No	No	No	No	No	No

7.3 Tier 2 Risk Assessment

A tier 2, or site-specific, *risk* assessment is planned for 2011 to confirm the number of locations at which *significant threats* occur. As part of the consultation on this assessment report, those who are believed to be engaging in a *significant threat* will be notified. This will allow their participation in the tier 2 *risk* assessment. The tier 2 work involves the examination of land use *activities* and the *circumstances* under which they are undertaken, through site visits and discussions with the landowners. The outcome of the tier 2 *risk* assessment will be part of an amended Assessment Report.

7.4 Data Gaps

The delineation and vulnerability assessment of *IPZ-3* as well as *WHPA-E* and *WHPA-F* for *GUDI* (*groundwater under the direct influence of surface water*) drinking water systems are yet to be complete. It is estimated to complete this work in 2010-2011. Thereafter, the impervious, managed lands and livestock density calculations and associated *threats* identification and *risk* assessment will be completed for these *vulnerable areas* in 2011, to be a part of an amended Assessment Report.

A preliminary investigation has been completed to determine if there are any *conditions*. A couple of potential *conditions* in the Upper Thames River Source Protection Area are being considered. More work will be undertaken on identifying and assessing *conditions* for potential *threats*, and the Assessment Report will be amended if necessary.

Work to identify the areas and the *activities* contributing to identified drinking water quality *issues* has yet to be completed and will be part of an amended Assessment Report. A work plan to conduct this work is included in Section 5 - Issues Evaluation, of the Assessment Report.