5. Surface Water Vulnerable Areas and Water Quality Threats Analysis

The primary focus of the *Clean Water Act, 2006 (CWA)* and the Source Protection Program is the protection of *municipal* drinking water sources. As mentioned previously (Section 2.7), there are six municipal Water Treatment Plants (WTPs) located within the Niagara Peninsula Source Protection (NPSP) Area, two use Great Lakes surface water as their raw water source and the other four, Great Lakes Connecting Channels.

The location, source water and population serviced by each WTP within the NPSP Area are listed in Table 5.1 and illustrated in Figure 5.1.

Table 5.1: WTPs in NPSP Area

WTP	Source Water	Service Population (2008)
Welland WTP	Welland Recreational Canal	50,587
DeCew Falls WTP	Welland Canal	166,557
Port Colborne WTP	Welland Canal	15,092
Niagara Falls WTP	Niagara River	78,000
Rosehill (Fort Erie) WTP	Lake Erie	27,000
Grimsby WTP	Lake Ontario	54,177

The *CWA*, its associated regulations and the Assessment Report Technical Rules (TR) define the process used to assess existing and potential surface water quality threats that could impact the source water for the WTPs. This process involves a number of tasks for each WTP intake including:

1. Classification of the **intake**;
2. Delineation of the vulnerable areas around the intake known as Intake Protection Zones or **IPZs**;
3. Assignment of **vulnerability scores** for IPZ-1 and IPZ-2;
4. Identification of **activities** and **conditions** that are or would be drinking water quality threats within each IPZ;
5. Enumeration/listing of **existing drinking water quality threats**;
6. Evaluation of raw water quality for each intake to determine if there are current **issues** or 'challenges' with the source water;
7. Evaluation of sources of **uncertainty**;
8. Identification of **knowledge and data gaps;** and
9. Identification of items for **future consideration**.

This chapter describes the methodology and approaches related to each of the steps listed above. The progression of tasks is outlined in Figures 5.2 and 5.3, and described in Sections 5.1 to 5.9. Chapters 6 to 11 provide the specific results of the surface water quality threats analysis, using the methodology described in this chapter, for each WTP intake. Data sources used for each task are listed in Appendix B.

TR 9(2)(a)(b)

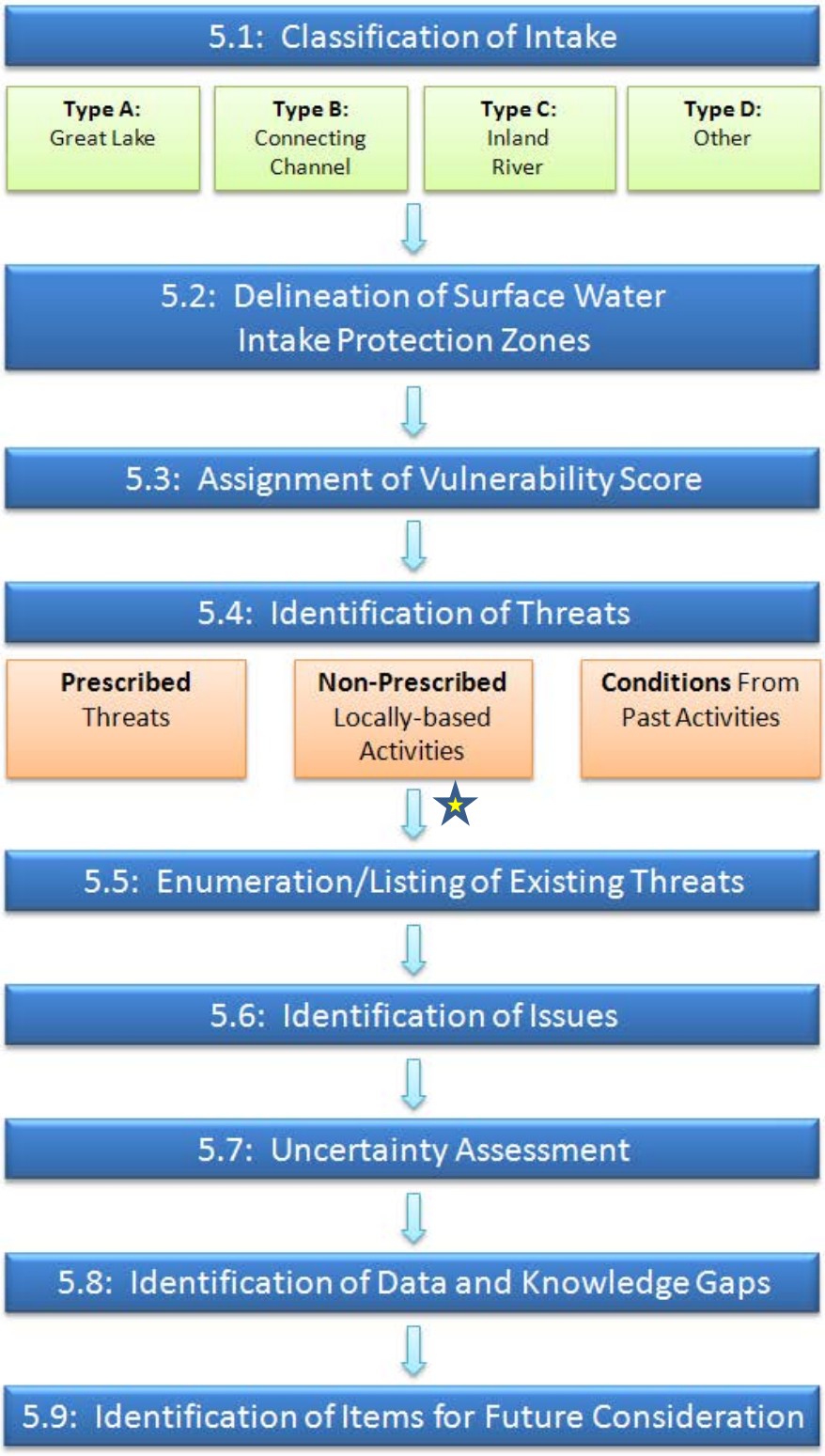

Figure 5.2: Primary Process Chart (Note ★ see Figure 5.3)

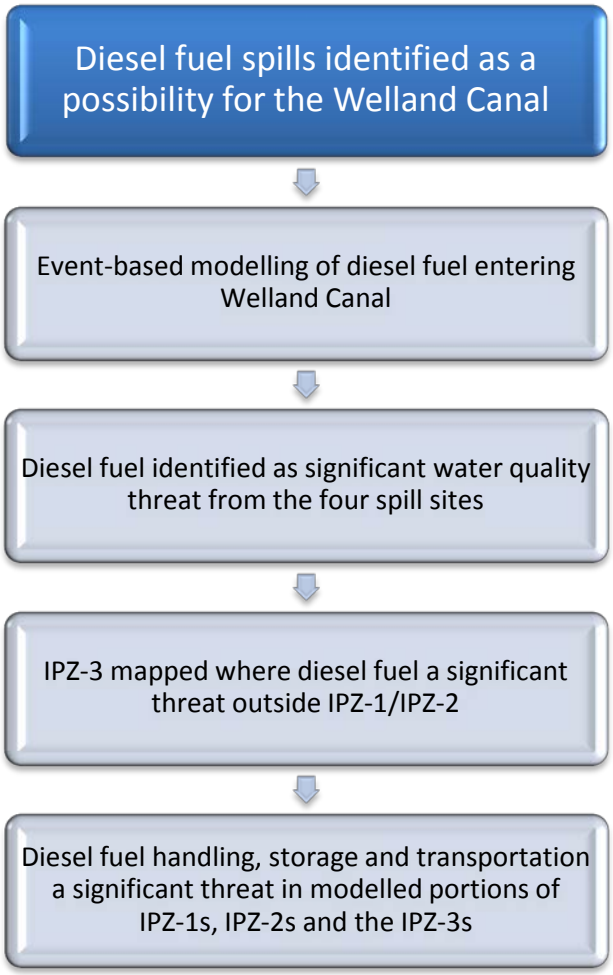

Figure 5.3: Event-based Modelling Threat Process Chart

5.1 Classification of Intake

The TR require classification of each surface water intake into one of the following four categories:

1. **Type A** intakes are located in a Great Lake.
2. **Type B** intakes are located in a Great Lakes Connecting Channel or River (such as the Welland Canal, Niagara River and St. Clair River).
3. **Type C** intakes are located in a smaller (inland) river where neither the direction nor flow rate at the intake are affected by a water impoundment structure (such as a dam).
4. **Type D** intakes are anything not classified as a Type A, B, or C intake. Type D intakes are typically located in smaller Inland Lakes (such as Lake Simcoe).

The classification of an intake determines how its IPZs are developed and assessed. The classification of each intake within the NPSP Area is listed in Table 5.2 and the intake locations are shown in Figure 5.1.

Table 5.2: WTP Intake Classifications		
WTP	**Source Water**	**Intake Classification**
Welland WTP	Welland Recreational Canal (Old Welland Canal)	Type B – Connecting Channel
DeCew Falls WTP	Welland Canal	Type B – Connecting Channel
Port Colborne WTP	Welland Canal	Type B – Connecting Channel
Niagara Falls WTP	Niagara River	Type B – Connecting Channel
Rosehill (Fort Erie) WTP	Lake Erie	Type A – Great Lake
Grimsby WTP	Lake Ontario	Type A – Great Lake

While the DeCew and Niagara Falls intakes could also be classified as Type C or D intakes, the Ministry of Environment (MOE) indicated these two intakes are to be classified as Type B intakes, as outlined in its letter of May 6, 2010 (Appendix E). Further details about each intake classification are contained in Chapters 6 through 11.

TR 55

5.2 Delineation of Surface Water Intake Protection Zones (IPZ)

After the WTP intake is classified as a Type A, B, C or D, the TR require that surface water IPZs be identified. Surface water IPZs are the designated protection areas around WTP intakes. They include the surrounding water and land area which may contribute contamination to an intake. The primary, secondary and tertiary IPZs and their delineation are described in Sections 5.2.1 to 5.2.3, respectively.

TR 5(1)

5.2.1 Primary Zone (IPZ-1) Delineation

The primary zone or IPZ-1 represents the most vulnerable area immediately surrounding the intake. The IPZ-1 for Type A (Great Lakes) intakes is a circle with a fixed radius of 1,000 m from the centre of the intake.

The IPZ-1 for Type B intakes (on Great Lakes Connecting Channels) is a semi-circle that has a radius of 1,000 m extending upstream from the intake and 100 m downstream. In both of these cases, the IPZ-1 may be modified to reflect local conditions. For example, IPZ-1 could be reduced if it was improbable that water could flow to the intake, such as up the Niagara Escarpment.

For both intake classifications, where an IPZ-1 touches land, the zone is extended onto land by 120 m from the shore or the Conservation Authority Regulation Limit, whichever is greater, unless otherwise indicated by surface water drainage.

TR 61-64

Examples of Type A and Type B IPZs are shown in Figures 5.4 and 5.5, respectively.

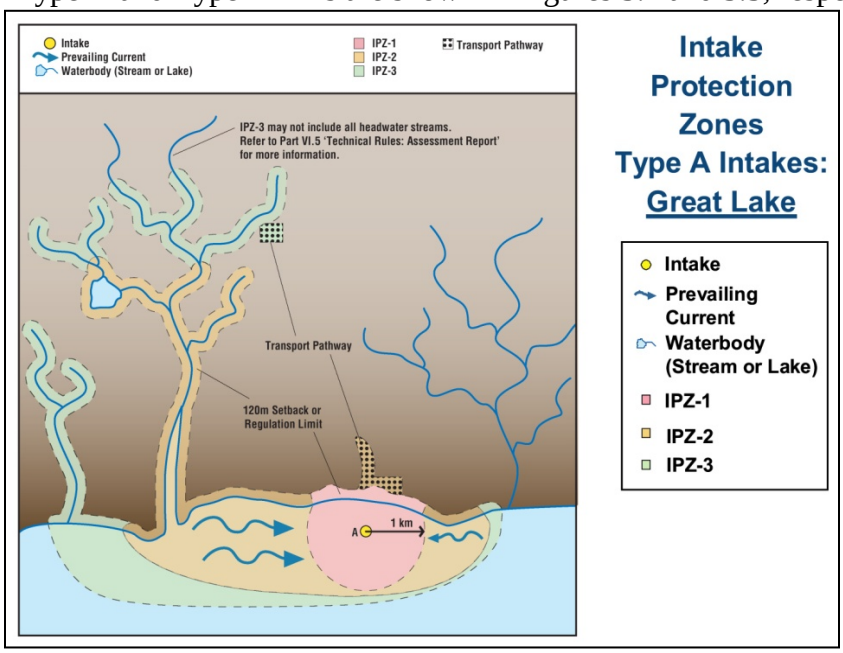

Figure 5.4: Type A Intake Protection Zones

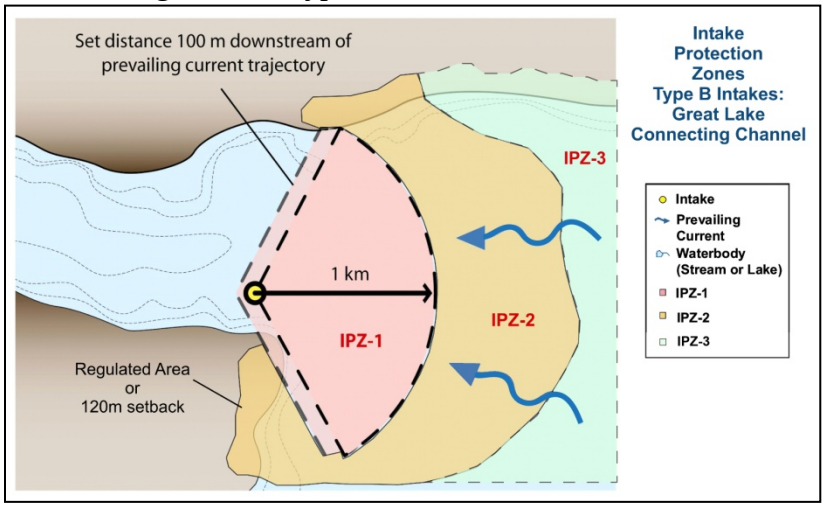

Figure 5.5: Type B Intake Protection Zones

5.2.2 Secondary Zone (IPZ-2) Delineation

The secondary zone (IPZ-2) is delineated based on the amount of time that is sufficient to allow a WTP Operator to respond to an event that may impair the quality of the water at the intake (i.e. a spill) or 2 hours, whichever is greater. In the NPSP Area, a 2 hour Time Of Travel (TOT) was adopted.

Delineation of an IPZ-2 involves modelling three components: in-water, upland and up-tributary. Each of these components is described in further detail below and examples of Type A and B IPZ-2s are illustrated in Figures 5.4 and 5.5. The complete set of NPSP Area delineated IPZs for are shown on Figure 5.6.

TR 65-66

5.2.2.1 In-water

Determining the portion of an IPZ-2 in-water for Type A (Great Lakes) intakes requires modelling lake flows and currents using lake-wide computer models to determine the two hour TOT to the intake.

The in-water component of IPZ-2 for Type B intakes is established using two moderately conservative analyses. These analyses determine the two hour TOT to the intake and are conducted with various hydraulic flow models, e.g. HEC-RAS™ and ECOMSED™. The conservative modelled flow conditions are of low stage combined with 10-year peak flow.

TR 9(2)(b)

5.2.2.2 Upland

Where an IPZ-2 touches land, the zone is extended to include a setback distance of 120 m from shore or the Conservation Authority Regulation Limit, whichever is greater, unless a surface water drainage divide indicates otherwise.

In addition to the required setbacks, the upland component of an IPZ-2 must also include transport pathways. A transport pathway is a natural or manufactured structure, land alteration or condition which would increase the probability of a contaminant reaching a drinking water source. For example, a storm sewer is considered a transport pathway.

Transport pathways were identified within each IPZ from information provided by sources such as the municipalities, Niagara Region and the Niagara Peninsula Conservation Authority.

5.2.2.3 Up-Tributary

Natural transport pathways, such as rivers and tributaries, also have the potential to transport contaminants to the source water. As required by the TR, any natural pathway that could contribute water to the intake within the designated TOT (2-hours), must be included as part of IPZ-2.

For each IPZ-2, local tributaries were modelled to identify the area that could contribute contaminants to the intake within a 2-hour TOT. This was done using bankfull (1:2 year) velocity and residual TOTs, to calculate the up-tributary distances. The residual TOT is the total TOT (2 hours) less the in-water travel time. If the calculated up-tributary extent exceeded the actual length of the tributary, the delineations were terminated at the headwaters of the watercourse with a circular cap radius of 120 m. Appropriate setback distances of 120 m or the Conservation Authority Regulation Limit were also applied around each watercourse. However, where the subwatershed boundaries indicated that overland flow traveled away from the watercourse, the 120 m watercourse setback was truncated

5.2.3 Tertiary Zone (IPZ-3) Delineation

The tertiary zones (IPZ-3) are areas where contaminants could be released and transported to the intake. They are delineated using event-based modelling that considers

particular contaminants of concern and spill volumes (MOE, 2009h and 2010b). The modelling determines if the contaminant can be expected to exceed the maximum acceptable criteria (MAC) drinking water standard at the intake. If it is found that the contaminant reaches the intake at a concentration above the MAC benchmark the activity is identified as a significant drinking water threat (SDWT), and an IPZ-3 is delineated (where the flowpath to the intake is outside an existing IPZ-1 or IPZ-2). This identification as a SDWT applies not only in the IPZ-3 but also downstream where modelled in the IPZ-2 and IPZ-1.

The Source Protection Committee affirmed the need to study potential diesel fuel impacts to Welland Canal WTPs (i.e. Port Colborne, Welland and DeCew Falls) in fall 2010. This decision followed a diesel fuel spill in Port Colborne (June 2010) which caused a 12-hour shutdown of the Port Colborne WTP. IPZ-3 studies were completed for the Welland, DeCew Falls, Port Colborne WTPs along the Welland Canal and the Grimsby WTP on Lake Ontario (Stantec Consulting Limited, 2012, Dewey, R., 2011 and NPCA, 2013). Future activities may also be considered where it is known that an activity will be taking place or is expected to take place in the future.

IPZ-3s extend from the IPZ-2, or in the case of Welland and Port Colborne, from the IPZ-1, to include all rivers and tributaries where modelling demonstrates that contaminant spills may reach the intake. If that boundary abuts land, the area includes the following setbacks along the abutted land: (i) Regulation Limit and (ii) a setback up to 120 meters from the high water mark where overland flow drains into the surface water body. It is important to note that the activity is not only a significant threat in the IPZ-3 but also where modelled as such downstream in the IPZ-2 or IPZ-1. This means an activity that was previously a moderate or low threat (as a prescribed or local drinking water threat) is upgraded to significant threat status where the modelling shows this risk.

The IPZ-3 related to Type A or Type B intakes are not assigned vulnerability scores.

5.2.3.1 Welland Canal

The modelling completed for the Welland Canal considered four spill locations (Stantec Consulting Limited 2012, and NPCA, 2013). These locations were:

A. Clarence Street Refueling Station (Port Colborne);
B. Highway 3 (Port Colborne);
C. Highway 406 (Welland); and
D. Allanburg/Highway 20.

Two spill volumes of diesel were considered 1,000 litres and 10,000 litres. These amounts were chosen after considering the spill at Port Colborne in June 2010 (~1,000 litres) and after consulting with the Lake Ontario Collaborative Project Manager (personal communication, Rodney Bouchard). Benzene was the contaminant of concern modelled for impact at the WTP intakes because it would present the highest risk to the water quality.

The event-based modelling considered a number of attenuation processes, these included advection, dispersion, volatilization and diffusion. All spill scenarios were evaluated using a 3-D convective transport and diffusion model (McCorquodale, 1985). In some cases the scenarios were also evaluated using ECOMSED to accommodate wind effects and other hydrodynamic boundary conditions.

5.2.3.2 Lake Ontario

Event-based modelling of potential significant threats to the Grimsby Intake on Lake Ontario was completed by the Lake Ontario Collaborative (LOC) (Dewey, R., 2011). The LOC group was formed by the Credit Valley, Toronto and Region and Central Lake Ontario (CTC) Source Protection Region to collaborate with other Source Protection Regions/Areas to study potential threats to Lake Ontario Drinking water. The LOC included Quinte, Trent Conservation Coalition, CTC, Halton-Hamilton and Niagara Peninsula.

Two scenarios were modelled by the LOC for Grimsby, (i) a diesel spill into the Burlington Ship Canal (benzene impacts) and (ii) a disinfection by-pass at the Grimsby Wastewater Treatment Plant (high E.coli levels). Both were identified by the LOC as significant drinking water threats to the Grimsby intake; (i) benzene at 35 µg/L and (ii) E.coli at 3100 counts/100 ml. However these have not been included as significant drinking water threats because:

A. The location of the modelled diesel spill is outside of the Niagara Peninsula SPA, making significant threat policies the responsibility of the Halton-Hamilton SPR. Further modelling that was completed for Halton-Hamilton SPC indicated a diesel spill at Burlington Lift Bridge is unlikely to adversely affect the Hamilton Woodward WTP or Grimsby WTP (Yerubandi and Zhao, Environment Canada, 2013). While it is difficult to compare results from different models, the differing results between the LOC and the EC models indicates some uncertainty. The SPC may further investigate this in the future.
B. Niagara Region has indicated a maximum concentration of 3,000,000 counts/ml in the event of a disinfection by-pass while the LOC modelling used 5,000,000 counts/ml.

IPZ-3s were not prepared as part of the LOC report. The SPC may choose to re-assess these potential threats and map their associated IPZ-3s in a future UAR.

TR 68-70, 72-75, 130

5.3 Assignment of Vulnerability Scores

After delineating the IPZ-1 and IPZ-2 (if present) for each intake, a vulnerability score must be determined to represent a numerical expression of the susceptibility of an intake to contaminants. The vulnerability score is a unitless value that is based on intake properties and attributes of the surrounding area. The vulnerability score is calculated from the following formula as provided in O.Reg 385/08:

$$V = Vf_a \times Vf_s$$

Where:

- V is the vulnerability score;
- Vf_a is the area vulnerability factor; and
- Vf_s is the source vulnerability factor.

The area vulnerability factor (Vf_a) is based on:

- The percentage of the area of IPZ that is composed of land;
- The land cover, soil type, permeability of land, slope of setbacks; and
- Any hydrological and hydrogeological conditions in the area that contribute water through transport pathways, as shown below in Table 5.3.

Table 5.3: Area Vulnerability Factor Methodology Matrix

Factors	Component	Criteria		
		7 (Low)	**8 (Moderate)**	**9 (High)**
% Land	N/A	<33%	33% to 66%	>66%
Land Characteristics	Land Cover	Mainly forested	Agriculture and/or mixed vegetated & developed	Mainly developed
	Soil Type	Sandy	Silty Clay	Clay
	Percent impervious	<33%	33% to 66%	>66%
	% Slope	<2%	2% to 5%	>5%
Transport Pathways	Storm catchment area	<33%	33% to 66%	>66%
	# of storm outfalls, watercourses & drains	0 to 8	9 to 19	>19
	% tile drain area	<33%	33% to 66%	>66%

Area vulnerability factors are determined for each IPZ by evaluating the factors listed in Table 5.3. Each of the factors (% land, land characteristics and transport pathways) are equally weighted. However in one case, the Lake Gibson intake, the land characteristics strongly supported a lower area vulnerability factor, and so the land characteristics were more heavily weighted reflecting the complexity and importance of its several components (i.e. land cover, soil type, permeability and % slope).

The source vulnerability factor (Vf_s) is based on:

- Depth of the intake from the top of the water surface,

- Distance of the intake from land, and
- Number of recorded drinking water issues related to the intake, if any, as shown in Table 5.4.

Table 5.4: Source Vulnerability Factor Methodology Matrix

Factor	Criteria		
	(Low)	**(Medium)**	**(High)**
Depth of Intake	> 4 m	3 to 4 m	< 3 m
Distance from Land	Beyond wave breaking zone or in a protected area	Moderate	Within wave breaking zone or negligible distance from shore
History of raw water quality concerns	Excellent historical raw water quality at intake	Occasional historical raw water quality concerns at intake	Frequent historical raw water quality concerns at intake

Source vulnerability factors are determined for each IPZ by evaluating the factors listed in Table 5.4. Each of the three factors (depth of intake, distance from land and raw water quality at the intake) are equally weighted to produce an overall source vulnerability factor. Ranges of values for the vulnerability scores for Type A and B intakes are prescribed by the MOE in the TR. These values are summarized in Table 5.5.

Table 5.5: Vulnerability Score Ranges

Type of Intake	Source Vulnerability Factor	Area Vulnerability Factor		Overall Vulnerability Score	
		IPZ-1	**IPZ-2**	**IPZ-1**	**IPZ-2**
A (Great Lake)	0.5 – 0.7	10	7 – 9	5 -7	3.5 – 6.3
B (Connecting Channel)	0.7 – 0.9	10	7 – 9	7 – 9	4.9 – 8.1

Using the results of the area and source vulnerability factor analysis described above, and the prescribed ranges shown in Table 5.5, an overall vulnerability score is calculated for each IPZ.

5.4 Identification of Threats

Surface water quality threats are defined as activities or conditions that pose a potential risk to source water quality. An activity is a land use; for example the storage,

application or discharge of a harmful substance including chemicals and pathogens. A condition is an existing situation resulting from a past activity; for example, contaminated sediment.

The TR require consideration of the following activities and conditions:

- Activities that are prescribed as drinking water threats in O.Reg. 287/07,
- Non-prescribed, locally based activities, and
- Conditions resulting from past land use activities.

The TR also allow for the identification of significant threats by way of the event-based modelling approach (which may result in mapping IPZ-3s).

Each of the above are identified and described in further detail in Sections 5.4.1 through 5.4.4, respectively.

5.4.1 Prescribed Activities

The following activities are prescribed to be drinking water threats in paragraphs 1 through 18 and paragraph 21 of subsection 1.1(1) of O.Reg. 287/07.

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 (DNAPL).
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.

TR 7(3), 118

The (above) prescribed activities are further detailed in the MOE's Tables of Drinking Water Threats (TDWT). The TDWT is an extensive document that outlines 1920 different circumstances related to prescribed activities 1 through 18 and 21, as set out by the CWA. Activities 19 and 20 are not included because they do not relate to surface water quality.

The TDWT also define the threat level of each circumstance based on the vulnerability score of a given IPZ. To determine if a particular activity constitutes a significant, moderate or low drinking water threat, the related circumstance is cross-referenced to the vulnerability score of the IPZ using the TDWT.

TR 118.1

For example, in an IPZ with a vulnerability score of 8, circumstance #317 (refer to Table 5.6) represents a moderate threat <u>if this activity were to occur in the IPZ-1 or IPZ-2</u>.

Table 5.6: Example of TDWT Circumstance #317

Threat	Under the following circumstance:	Significant	Moderate	Low
		Threat level given a vulnerability score of:		
The handling and storage of fuel	1. The storage of liquid fuel in a tank, a part of which, but not all, is below grade and at a bulk plant as defined in section 1 of O. Reg. 217/01 (Liquid Fuels) made under the Technical Standards and Safety Act, 2000, or a facility that manufacturers or refines fuel. 2. The fuel is stored in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of BTEX in groundwater or surface water.	10	7 - 9	4.8 - 6.4

For municipal planning purposes it is necessary to determine which of the 1920 prescribed circumstances constitute significant, moderate, or low drinking water threats, if they were to occur in the IPZ. To complete this task, the MOE's *Provincial Tables of Circumstances* were used.

The *Provincial Tables of Circumstances* list potential circumstances that represent significant, moderate or low drinking water threats (chemical or pathogen) for a given vulnerability score (e.g. Appendix C.4 lists moderate chemical threats in an IPZ-1 or IPZ-2 with a vulnerability score of 9). Provincial Tables of Circumstances related to each IPZ are referenced in Chapters 6 to 11 and included in Appendices C.1 through C.30.

It is important to note that the threats identification methodology described above is only a function of the vulnerability score; the actual land use has no impact on the number of identified threats. In other words, circumstance #317 would be identified as a moderate threat for *any* IPZ in the province with a vulnerability score of 8. The methodology with

which land uses are considered and existing threats enumerated/listed is outlined in Section 5.5.

5.4.2 Non-Prescribed Activities

The NPSPC has the ability to include additional (locally based) activities other than those already identified as prescribed threats if it believes the activities are a threat and the Director has approved the inclusion of a local threat. The NPSPC requested the MOE add transportation threats as locally based activities for the NPSPA in October 2010. Transportation threats are the transportation of specific substances along certain routes that pose a threat to local source waters. The MOE Director of Source Protection Programs allowed the addition of transportation threats as locally based activities in a letter received May 2011 (Appendix E).

The SPC believes transportation threats (road, waterway and railways) can be risks to Niagara Region's WTPs, particularly along the Welland Canal, and there are multiple transportation crossings of the Welland Canal from Port Colborne to Allanburg.

The MOE letter of May 2011 has identified eleven categories of locally-based transportation threats (Appendix E). Similar to the prescribed activities the threat level (significant, moderate, low) is a function of the intake vulnerability score. The eleven categories include chemical threats (1 through 8) and pathogen threats (9 to 11):

1. Transportation of Organic Solvents
2. Transportation of DNAPLS
3. Transportation of Fuels
4. Transportation of Pesticides/Herbicides
5. Transportation of Other Chemicals
6. Transportation of Agricultural Source Material
7. Transportation of Non-Agricultural Source Material – Sewage Biosolids
8. Transportation of Non-Agricultural Source Material – Pulp and Paper Waste
9. Transportation of Agricultural Source Material
10. Transportation of Non-Agricultural Source Material – Sewage Biosolids
11. Transportation of Non-Agricultural Source Material – Pulp and Paper Waste

TR 7(3), 119-122, 125

5.4.3 Conditions

Conditions resulting from past land use activities may also be considered drinking water threats. As described in the TR, the following conditions are considered drinking water threats:

- The presence of a single mass of more than 100 litres of one or more dense non-aqueous phase liquids in a surface water IPZ.
- The presence of a contaminant in surface soil in a surface water IPZ if, the contaminant is listed in Table 4 of the Soil, Ground Water and Sediment Standards

(MOE, 2004) and is present at a concentration that exceeds the surface soil standard for industrial/commercial/community property used set out for the contaminant in that Table

- The presence of a contaminant in sediment, if the contaminant is listed in Table 1 of the Soil, Ground Water and Sediment Standards (MOE, 2004) and is present at a concentration that exceeds the sediment standard set out for the contaminant in that Table.
    - Comparison of sediment to soil criteria (Table 4) is an alternative method approved by the MOE under Assessment Report Technical Rule 15.1 with respect to Technical Rule 126 (I. Smith, 2010b). The rationale for this departure is provided by the MOE: "Sediment standards generally pertain to aquatic life whereas soil standards pertain to human health. Therefore soil standards are a more appropriate standard for defining a condition." (M. McHugh, e-mail 29-March-2010).

To determine if any of the above conditions exist, an inventory of past land use activities is conducted. This involves comparing available soil and sediment data to the Soil, Ground Water and Sediment Standards. In addition, various data sources (refer to Appendix B), are examined to determine if any dense non-aqueous phase liquids, such as Polychlorinated Biphenyls (PCBs), may exist within the IPZ.

A risk score is determined for all identified conditions, which is based on the hazard rating of the condition and the vulnerability score of the IPZ in which it is located:

Hazard Rating x Vulnerability Score = Risk Score.

The hazard rating of a condition which results from a past activity is either 10 or 6. The hazard rating is 10 if either of two criteria are met: (i) there is evidence that the condition is causing off-site contamination and/or (ii) the condition is on a property where the intake to the drinking water system is located. If either of these two criteria are not met the hazard rating is 6.

Using the methodology described by the TR, a condition is determined to represent a significant threat if it has a risk score greater than or equal to 80. A condition is determined to represent a moderate threat if it has a risk score greater than 60 and less than 80 and a low threat if it has a risk score greater than 40 but less than 60. A condition is also considered significant if it is associated with a drinking water quality issue or if there is evidence that it may be causing off-site contamination.

TR 7(4), 9(3)(c), 126, 138, 139, 140

5.4.4 Significant Threats Identified by Event-Based Modelling (EBM)

Diesel fuel storage, handling and transportation are not identified as significant threats under either the prescribed activities approach (Section 5.4.1) or approved locally-based

activities approach (Section 5.4.2, i.e. transportation threats). However the NPSPC was concerned about potential diesel fuel impacts to Welland Canal WTPs.

Under the TR an SPC can complete event-based modelling to assess if a particular activity is a significant drinking water threat (Figure 5.3). The NPSPC chose to do this along the Welland Canal for diesel fuel storage, handling and transportation (Section 5.2.3). Event-based modelling was completed for spills of 1,000 and 10,000 litres of diesel fuel (Stantec Consulting Limited, 2012), and diesel/gasoline fuel handling, storage and transportation were identified as significant drinking water quality threats. IPZ-3 (and where modelled downstream in the IPZ-2s and IPZ-1s) identifies where these three activities are significant drinking water threats for the Port Colborne, Welland and DeCew Falls WTPs. Significant threat policies addressing diesel/gasoline fuel storage, handling and transportation in the IPZ-3s also apply downgradient in the portions of the IPZ-2s and IPZ-1s where modelled.

TR 68-70, 72-75, 130

5.5 Enumeration/Listing of Existing Threats

Section 5.4 outlines the methodology used to determine activities and threats that would be significant, moderate or low drinking water threats, if they were to occur in an IPZ.

The TR also require the enumeration/listing of existing significant threats, or locations at which:

- A person is engaging in an activity that is or could be a significant threat; and
- A condition resulting from past activity is a significant drinking water threat.

TR 9(1)(e) and (f)

Existing moderate drinking water threats have also been enumerated as these may be addressed in the Source Protection Plan.

For this analysis, existing threats are defined as activities that could occur because infrastructure is in place. For example if two livestock enterprises are in operation and a third has an empty barn with no livestock, then three livestock enterprises are counted because the third barn could have livestock brought in the next day.

5.5.1 Activities

Enumeration/listing of locations at which a person is known to be engaging in an activity that is or would be a significant or moderate threat is accomplished by identifying the following land use activities that correspond with circumstances listed in the TDWT:

- Agricultural
- Industrial
- Commercial relating to fuel, fertilizer, pesticide, solvents and dense non-aqueous phase liquids

- Utility
- Residential not connected to municipal sanitary services
- Storm, sanitary and industrial sewer networks
- Landscape activities such as road salt application and storage of snow

The land use activities listed above are identified and then further considered with respect to the TDWT and Provincial Tables of Circumstances (Appendices C.1 through C.30) using available databases and maps. The output of this task is a list of existing activities that are or could be significant or moderate drinking water quality threats within each IPZ.

5.5.2 Conditions

As described in Section 5.4.3, a condition is determined to represent a significant threat if it has a risk score greater than or equal to 80 and a moderate threat if it has a risk score greater than 60 and less than 80. A condition is also considered significant if it is associated with a drinking water quality issue or if there is evidence that it may be causing off-site contamination. The output of this task is a list of conditions that are or would be significant or moderate drinking water quality threats within each IPZ (as included in Chapters 6 through 11).

5.5.3 Non-Prescribed Activities

Enumeration of significant and moderate transportation threats involved cross-referencing IPZ vulnerability scores with Table 1 (Appendix E, MOE letter May, 2011) and then identifying roads, railways and marine transport pathways within those IPZs where these transport corridors could be significant or moderate threats. IPZs where significant or moderate threats were enumerated included : Port Colborne IPZ-1/IPZ-2, DeCew Falls Main, Hwy 406 and Lake Gibson IPZ-1s, Niagara Falls IPZ-1, Welland IPZ-1 and Rosehill IPZ-1.

5.5.4 Significant Threats Identified by Event-Based Modelling (EBM)

Significant threats were enumerated during the EBM process when contaminant concentrations (i.e. benzene) that were modelled, exceeded the MAC drinking water criteria at a WTP intake. Diesel/gasoline handling, storage and transportation were enumerated as significant threats at four locations along the Welland Canal. Significant threat status of these activities in the IPZ-3 also applies downstream of the modelled locations where attenuation of contaminants would be less, and in portions of IPZ-2s and IPZ-1s where modelled.

Diesel/gasoline handling, storage and transportation activities are elevated from moderate or low threat status (based on either the TDWT or Table 1 – Appendix E) to significant where the EBM identified the activity as having a potential to degrade the water quality at an intake.

5.6 Evaluation of Drinking Water Quality Issues

A drinking water quality issue is present if a parameter is at a concentration or increasing towards a concentration that may adversely affect drinking water quality. The TR require that the parameters listed the Ontario Drinking Water Quality Standards (ODWQS) be evaluated for potential issues. These include microbiological, chemical and radiological parameters, as well as aesthetic characteristics of the water, such as temperature.

The steps used in the issues evaluation are described below:

1. **Collect raw water quality data**
   Drinking Water Information System (DWIS) data for the years 2003-2008 and Drinking Water Surveillance Program (DWSP) data for the years 1990-2007 was collected from the MOE for each of the intakes within the NPSP Area.

2. **Establish issues benchmarks**
   To identify drinking water quality issues for each intake, raw water sampling data must be compared to established benchmarks. Since no regulatory standards exist for source water, the issues benchmarks are established based on treated water standards and guidelines as outlined in the Tables of the MOE (2006) Technical Support Document for ODWQS (Appendix D). This represents a conservative approach as raw water data are compared with stringent treated water regulatory values.

   The issues benchmarks used by the NPSPC are listed in Table 5.7.

Table 5.7: Benchmarks for Drinking Water Quality Issues

Parameters	Issues Benchmark Threshold
Microbiological Parameters	MOE standards for recreational waters (MOE, 1999)
Chemical Parameters (Appendix D Table 2)	50% of maximum allowable concentration as documented in ODWQS
Radiological Parameters (Appendix D Table 3)	50% of maximum allowable concentration as documented in ODWQS
Aesthetic Characteristics (Appendix D Table 4)	Objective/guideline value as documented in ODWQS

3. **Identify "parameters of interest"**
   Parameters of interest are identified by evaluating the raw water quality data to determine those parameters that consistently measured above 10% of their regulatory value and often above 25% and/or 50%.

4. **Identify "potential water quality issues"**
   Parameters of interest are plotted and further analyzed to determine if they are regularly present at the benchmark values and/or trending upwards towards the

benchmarks. Those that meet this designation are classified as potential water quality issues.

5. **Identify "Issues"**
   Each potential water quality issue is then examined further to determine if it results from natural or artificial sources and/or if it is directly related to human health considerations. The presence of dissolved minerals represents a natural source that could contribute to a potential issue and the discharge of pollution from a local industry represents an artificial source. Potential water quality issues that are identified to have naturally occurring source(s) are not considered to be issues.

TR 6, 9(1)(c)(xii), 114-115, 131, 134.1

5.7 Evaluation of Uncertainty

The TR require a description of every uncertainty analysis conducted as part of the surface water quality assessment.

TR 9(2)(f), 13-14

The following sources of uncertainty are examined and described further in Chapters 6 through 11:

- IPZ-1, IPZ-2 and IPZ-3 delineations
- Vulnerability scores
- Threats identification
- Conditions inventory
- Issues evaluation
- Identification of land use activities to enumerate significant threats

5.8 Identification of Data and Knowledge Gaps

Data gaps exist if information is not available in sufficient quantity or quality to provide a reasonably informed decision at the time of submission of the Assessment Report to the Ministry (MOE, 2009e). In general, the available data were of sufficient quality and quantity to complete the surface water quality assessment for all of the intakes within the NPSP Area.

5.9 Items for Future Consideration

Suggestions for continued improvement of future versions of the Assessment Report have been identified. These future considerations are summarized in Table 5.8 (below).

Table 5.8: Future Considerations for Improving Assessment Report	
Consideration	**Purpose**
Event-based modelling of contaminant releases during extreme events including storm event sampling (DeCew Falls Highway 406 and Lake Gibson Alternate Intakes, Niagara Falls and Fort Erie)	To determine if contaminants can reach the intake during extreme events (to delineate IPZ-3), e.g. existing oil pipelines beneath Niagara Falls IPZ-2, and upstream of the DeCew Falls IPZ-2s for the Highway 406 and Lake Gibson Alternate Intakes
Additional surface soil data	For some IPZ areas, additional data would be helpful to conduct a more comprehensive condition assessment (e.g. Welland IPZ-1)
Additional sediment data	
Raw water quality data recorded at Highway 406 and Lake Gibson intakes	To assist with issues identification at these intakes.
Organic Nitrogen information and source data	To determine the source of organic nitrogen and whether it should be included as a drinking water issue

5.10 Technical Advisory Groups and Peer Review

The Technical Advisory Group for intake protection zone studies (Chapter 5 through 11) completed by Stantec Consulting Limited consisted of staff from Niagara Region and NPCA. Peer review of the intake protection zone 1 and 2 delineations was completed by Dillon Consulting Limited. The intake protection zone studies were revised accepting the recommendations of the technical advisory group. The intake protection zone delineations were accepted and endorsed by the peer review team.