6. WELLAND WATER TREATMENT PLANT

The Welland Water Treatment Plant (WTP) is located in Welland, Ontario and obtains raw water from Lake Erie via the Welland Canal and Welland Recreational Canal (Old Welland Canal). The 'Old Welland Canal' is a name commonly used for the portion of the Welland Canal which was superseded by the Welland Canal By-pass that was completed in 1973 (See Section 2.2.1 for more details on the Welland Canal). With a total capacity of 102.3 million litres per day, the plant services a population of approximately 50,000 in the City of Welland and a portion of the Town of Pelham. A map showing the local setting of the Welland WTP and its intake is shown in Figure 6.1.

A surface water vulnerable area and water quality threats assessment has been completed for the Welland WTP intake. The methodology used for this assessment is described in Chapter 5 and specific results are outlined in Sections 6.1 through 6.7. Data sources used for each task are listed in Appendix B.

6.1 Classification of Intake

According the Ministry of Environment (MOE) Assessment Report Technical Rules (TR), the Welland Canal is defined as a Great Lakes Connecting Channel. Since the Welland Recreational Canal is directly connected to the Welland Canal and is essentially the same water body, the Welland WTP intake is classified as **Type B – Connecting Channel**.

TR 55, TR 1(1)

6.2 Delineation of Surface Water Intake Protection Zones

The following sections describe the delineation of the primary (IPZ-1) and secondary (IPZ-2) Intake Protection Zones.

6.2.1 Primary Zone (IPZ-1) Delineation

The IPZ-1 (Figure 6.2) for the Welland WTP was delineated in accordance with the TR. The delineation extends 1,000 m upstream of the intake and the downstream limit is a straight line transecting the Welland Recreational Canal 100 m downstream of the intake.

As required by the TR, where the IPZ touches land a setback of the Conservation Authority Regulation Limit or 120 m, is applied. The area of the Conservation Authority Regulation Limit for the Welland Recreational Canal is significantly smaller than 120 m and therefore was not used. Topography was used to determine direction of overland flow. As a result, the northwest portion has been truncated as the topography reflected overland flow within that area discharges north of the Welland WTP IPZ-1.

TR 61-64

6.2.2 Secondary Zone (IPZ-2) Delineation

The IPZ-2 for the Welland WTP was delineated in three components: in-water, upland, and up-tributary. The development of each of these components is described in further detail below.

6.2.2.1 In-water

The in-water component of IPZ-2 (Figure 6.3) was established using a moderately conservative analysis to determine the two hour Time Of Travel (TOT) to the intake. The in-water IPZ-2 component for the intake was modelled using the hydraulic model ECOMSED under normal conditions, meaning intake water is being drawn exclusively from the old canal. The conservative modelled flow conditions were of low stage combined with 10-year peak flow.

Based on the modelling, it was found that the extents of the 2- hour TOT are fully included within IPZ-1. There are portals connecting the Welland River to the Welland Recreational Canal at the siphon. It has been determined that the possibility of reverse flow from the Welland River exceeds the 1 in 10 year probability. Therefore the Welland WTP has only one vulnerable area (IPZ-1).

TR 65-66

6.2.2.2 Upland – Transport Pathways

The TR state that where an IPZ-2 includes a setback, the area may be extended to include an area that contributes water to the IPZ-2 through a transport pathway. As identified above, the 2-hour TOT is contained entirely within IPZ-1. Therefore there is no IPZ-2 for the Welland WTP and no corresponding transport pathways have been included.

One storm sewer outlet, at McCormick Street, is within the Welland WTP IPZ-1 and is illustrated in Figure 6.4 for information purposes.

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) tile drained area data (OMAFRA, 2009a) were reviewed and it was determined that no tile drains exist along the extents of watercourses delineated in the up-tributary analysis, or along the shoreline. Therefore tile drained areas were not included in the upland delineation.

TR 65(2), 72-75

6.2.2.3 Up-Tributary

There are no natural watercourses within the Welland WTP IPZ-1 and thus, an up-tributary analysis was not required.

TR 72-75

6.2.3 Tertiary Zone (IPZ-3) Delineation

An IPZ-3 was delineated between Clarence Street in Port Colborne and the existing Welland WTP IPZ-1 according to Technical Rule 68, incorporating appropriate set-backs (Stantec Consulting Limited, 2012, and NPCA, 2013). The delineation is shown in Figure 6.5. However significant threat policies addressing diesel fuel storage, handling and transportation in the IPZ-3 also apply downstream in the IPZ-1 where attenuation of contaminants would be less.

This delineation was based upon thirteen modelled scenarios of diesel spills from either Clarence Street (Port Colborne), Regional Road 3 (Port Colborne) or Highway 406 (at Welland Recreational Canal) exceeding the ODWQS for benzene at the Welland WTP intake. The scenarios included summer and winter conditions, varying winds and spills of 1,000 or 10,000 litres. The most severe intake impacts were identified for a 10,000 litre spill from Highway 406 at the Welland Recreational Canal under low wind conditions, however under high wind conditions even 1,000 litres of diesel at Highway 406 could also impact the intake. Modelled scenarios resulting in significant drinking water threat (SDWT) identification (i.e. benzene concentration exceeded 5 µg/L at the intake) are summarized in Table 6.1.

Table 6.1: Summary of Welland SDWT Event-based Modelling

Welland Canal Spill Location	Spill Size (litres)	Season	Wind (m/s, direction)	Intake Concentration (µg/L)
Clarence Street, Port Colborne	10,000*	Summer	0	94
	1,000			7
Regional Road #3, Port Colborne	10,000*			114
	1,000			9
Highway 406, Welland Recreational Canal	10,000*	Winter	0	460
			4 NNE	320
			17 NNE	85
		Summer	0	387
			4 NNE	300
			17 NNE	80
	1,000	Winter	0	17
			17 NNE	5.4
		Summer	0	15

Note: * - concentrations are sufficiently high for these scenarios as to also be applicable to a spill of gasoline (NPCA, 2013)

TR 68-70, 72-75, 130

6.3 Assignment of Vulnerability Scores

A vulnerability score must be determined for each IPZ to represent the susceptibility of the intake to contaminants. The vulnerability score is calculated using the area and source vulnerability factors using the methodology described in Section 5.3.

TR 8(2), 9(1)(c)(iv), 86-96

6.3.1 Area Vulnerability Factor

The TR prescribe an IPZ-1 area vulnerability factor of 10 for all intake types. Therefore, the IPZ-1 area vulnerability factor for Welland is 10.

TR 88

6.3.2 Source Vulnerability Factor

The source vulnerability factor is based on intake properties. The TR require that the source vulnerability factor be between 0.7 to 0.9 for Type B intakes (refer to Table 5.3).

TR 95

A source vulnerability factor of 0.7 was determined for the Welland intake, as summarized in Table 6.2.

Table 6.2: Welland WTP Source Vulnerability Factor

Factor	Description	Supports a Source Vulnerability Factor of :
Depth of intake	4.3 m average depth	Moderate to Low
Distance of intake from land	Terminates at the wall of the Welland Recreational Canal which is a protected environment	Low
Historical raw water quality concerns	Excellent historical raw water quality recorded at the intake	Low
Overall Source Vulnerability Factor		**Low (=0.7)**

6.3.3 Overall Vulnerability Scores

The calculated vulnerability score was determined to be 7.0 for IPZ-1 (Table 6.3).

Table 6.3: Welland WTP Vulnerability Score Summary

Intake Type	Area Vulnerability Factor (Vf_a)		Source Vulnerability Factor (Vf_s)	Vulnerability Score (V)	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
Type B	10	N/A	0.7	10 x 0.7 = **7.0**	N/A

6.4 Identification of Threats

Surface water quality threats are defined as activities or conditions that pose a potential risk to source water quality. Threats may be identified by an activity or condition. An activity is a land use; for example the storage, application or discharge of a substance including chemicals and pathogens. A condition is an existing situation as a result of 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 were evaluated and described in detail in Sections 6.4.1 through 6.4.4, respectively.

6.4.1 Prescribed Activities

Section 5.4.1 lists the activities that are prescribed as drinking water threats for a vulnerable area in paragraphs 1 through 18 and paragraph 21 of subsection 1.1(1) of O.Reg. 287/07.

TR 7(3), 118

To determine the number of activities that constitute significant, moderate or low drinking water threats (if they were to occur) within the Welland IPZ, the Tables of Drinking Water Threats (TDWT) were truncated by vulnerability score, as described in Section 5.4.1. Table 6.4 provides Appendix reference numbers for the Provincial Tables of Circumstances corresponding with significant, moderate and low threats for each IPZ (both chemical and pathogen).

Table 6.4: Welland WTP References for Provincial Tables of Circumstances

IPZ	Vulnerability Score	Provincial Table Reference - Chemical Threats			Provincial Table Reference - Pathogen Threats		
		Sig.	Moderate	Low	Sig.	Moderate	Low
1	7.0	--	Appendix C.7	Appendix C.12	--	Appendix C.21	Appendix C.26
2	N/A (no IPZ-2)	--	--	--	--	--	--

There are no potential significant threats because of the vulnerability score for the Welland IPZ-1 is less than 8.

TR 118.1

Figure 6.5 illustrates areas where activities are or would be significant, moderate or low drinking water quality threats. These figures should be viewed in conjunction with the appendices referenced in Table 6.4 to determine specific activities within an IPZ that would be significant, moderate or low drinking water quality threats. For example, if one wants to determine activities that would be moderate threats within Welland's IPZ-1, one should reference Appendices C.7 and C.21.

TR 8(4), 9(1)(c)(ix), 127-129, 132-137

6.4.2 Non-Prescribed Activities

The NPSPC has included additional (locally based) activities other than those already identified as prescribed threats (Section 5.4.2).

Transportation threats were enumerated by cross-referencing the IPZ-1 intake vulnerability score with Table 1 (Appendix E, MOE letter May, 2011) and then identifying roads, railways and marine transport pathways within the IPZ where these transport corridors could be significant or moderate threats (Stantec Consulting Limited, 2010).

Table 6.5: Welland WTP Reference for Non-Prescribed (Transportation) Activities

IPZ	Vulnerability Score	Appendix E - Chemical Threats			Appendix E - Pathogen Threats		
		Sig.	Mod.	Low	Sig.	Mod.	Low
1	7.0	--	--	Table 1	--	Table 1	

TR 7(3), 119-122, 125

6.4.3 Conditions

The TR state that conditions may exist in a vulnerable area if the presence of a single mass of more than 100 litres of dense non-aqueous phase liquids occurs in the surface water of an IPZ and/or if there is the presence of a contaminant in the surface soil or sediment.

TR 126

The following contaminated sites registries were reviewed to assist with identification of conditions within the WTP vulnerable area:

- Provincial Brownfield Sites Registry (MOE, 2009c);
- Federal Contaminated Sites Inventory (TBCS, 2009);
- MOE IPZ-1 Threats Database for Niagara Region (MOE, 2009d);
- MOE Spills Database for Niagara Region (WHI, 2005);
- Brownfield site GIS layer (NPCA, 2009c); and
- Closed landfill GIS layer (WHI, 2005).

After reviewing the available data sources listed above, no conditions were identified that result from past activities.

The collection of additional soil and sediment data is noted as a future consideration in Section 5.9.

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

6.4.4 Significant Threats Identified by Event-based Modelling

Significant threats were enumerated during the Event-Based Modelling process, when contaminant concentrations (i.e. benzene) that were modelled and exceeded the Maximum Acceptable Criteria (MAC) drinking water criteria at the Welland WTP intake (Section 6.2.1).

TR 68-70, 72-75, 130

6.5 Enumeration/Listing of Existing Threats

The TR require the enumeration/listing of locations at which:

- A person is engaging in an activity that is or would be a <u>significant</u> threat; and
- A condition resulting from a past activity is a <u>significant</u> drinking water threat.

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

Existing moderate threats have also been enumerated as these may be addressed in the Source Protection Plan. Enumeration of each of these threat types is described in further detail in Sections 6.5.1 and 6.5.2.

6.5.1 Activities

As described in Section 5.5, land use information and other data were obtained from various sources and compared with threat circumstances from the TDWT to determine existing threats within each IPZ-1 and IPZ-2.

For this analysis, existing threats are defined as activities that could occur because infrastructure is in place. For example if there are two livestock enterprises 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.

With a vulnerability score of 7.0, no activities representing significant drinking water threats exist or could exist within Welland's IPZ-1. There is the potential for moderate threats; however, after examining land use information, no existing moderate drinking water threats were identified.

6.5.2 Conditions

As described in Section 6.4.3, no conditions were identified that result from past activities. Therefore, no conditions represent a significant drinking water threat.

6.5.3 Non-Prescribed Activities

Two transportation corridor roadway threats were identified as moderate pathogen threats in the Welland IPZ-1 (Figure 6.7), transportation of:

- Agricultural source material; and
- Non-agricultural source material (sewage biosolids).

6.5.4 Significant Threats Identified by Event-Based Modelling

The handling, storage and transportation of diesel fuel in quantities of 1,000 L or greater are enumerated as significant drinking water threats (SDWT) along the Welland Canal from Clarence Street (Port Colborne) to the WTP intake (Figure 6.5). Diesel fuel along these waterways was identified as a SDWT from three locations. From upstream to downstream the locations are: (i) Clarence Street, Port Colborne, (ii) Highway 3, Port Colborne, and (iii) Highway 406 in Welland (see Section 6.2.3 for more detail). Spills from these locations have been modelled and the activities at these locations deemed to be SDWT (Stantec Consulting Limited, 2012 and NPCA, 2013). The areas that are subject to source protection policies have been extended beyond the three modelled locations, i.e. beyond the IPZ-3 into IPZ-1 (Figure 6.5). This is because a spill within this hatched area would result in similar or greater water column benzene concentrations than provided in Table 6.1 due to typical flow characteritics and behaviour in a water system driven in one direction. This also applies to a small portion of the Welland WTP IPZ-1 southwest of the intake as it is under similar hydrodynamic conditions (i.e. it is also flowing to the intake and at an even faster velocity), although not explicitly modelled in the event-based exercise (Figure 6.3).

Diesel handling, storage and transportation activities for quantities of 1,000 L or more, are elevated from moderate or low threat status (based on either the TDWT or Table 1 – Appendix E) to significant as EBM identified the activity as having a potential to degrade the water quality at the intake (Stantec Consulting Limited, 2012, and NPCA, 2013). Gasoline handling, storage and transportation activities for quantities of 10,000 L or more (Section 6.2.3), are elevated from moderate or low threat status (based on either the TDWT or Table 1 – Appendix E) to significant as EBM identified the activity as having a

potential to degrade the water quality at the intake (Stantec Consulting Limited, 2012, and NPCA, 2013).

6.6 Evaluation of Drinking Water Quality Issues

To determine if any drinking water issues exist, the methodology described in Section 5.6 was applied for the Welland WTP raw water quality data.

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 the Welland WTP intake.

2. **Establish issues benchmarks**
   Issues benchmarks established by the NPSPC are listed in Table 5.7.

3. **Identify "parameters of interest"**
   As described in Section 5.6, parameters of interest are those that consistently measure above 10% of their regulatory criteria and often above 25%. The following parameters of interest were identified were identified for the Welland WTP intake:
   - Antimony
   - Colour;
   - Temperature;
   - Turbidity
   - Aluminum;
   - Hardness;
   - pH; and
   - Organic nitrogen.

4. **Identify "potential water quality issues"**
   Parameters of interest were plotted and analyzed to determine if they were regularly present at their benchmark values and/or trending upwards toward their benchmarks. Based on an analysis of the above parameters of interest, only four non health related potential water quality issues were identified for the Welland WTP vulnerable area. Colour and pH were identified based upon upward trends approaching the drinking water quality issue benchmark (Table 5.7). Hardness and organic nitrogen were also identified as potential water quality issues because of consistent concentrations above the benchmark.

5. **Identify "issues"**
   The potential water quality issues were further evaluated to determine if they are directly related to human health considerations and/or can be attributed to artificial source(s). It was found that none of the potential water quality issues are directly related to human health considerations. Furthermore, colour, hardness and pH have been attributed to naturally occurring processes and characteristics. For these reasons, colour, hardness and pH are not considered drinking water quality issues.

In the case of organic nitrogen, the information available does not clearly indicate an absolute source(s) and therefore further investigation should be undertaken. Information related to the source(s) of organic nitrogen is identified as an item for future consideration in Section 5.9.

In summary, no water quality issues were identified for the Welland WTP IPZ-1. The high quality of raw water received at the Welland WTP combined with its diligent operation ensures a safe supply of treated drinking water.

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

6.7 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

Descriptions of the sources of uncertainty considered for each major task are outlined in Table 6.6. As indicated in Table 6.6, the overall level of uncertainty for the Welland WTP surface water vulnerability assessment is low.

Welland Recreational Canal (looking north / upstream)

Table 6.6: Evaluation of Sources of Uncertainty for Welland WTP		
Task	Description of Uncertainty	Uncertainty
Section 6.1: Classification of Intake		
Intake classification	TR prescribe the Welland Canal to be a Connecting Channel	Low
Section 6.2: Delineation of IPZs		
IPZ-1 Delineation	Dimensions for the IPZ-1 delineation are prescribed by the TR. Setbacks from shore were determined using topography data from the NPCA and has low uncertainty associated with the accuracy of the information.	Low
IPZ-2 Delineation	Data acquired for modelling was of sufficient quality to conceptualize the in-water time of travel. There were no adjoining tributaries or storm sewersheds to the modelled in-water IPZ-2 and thus an IPZ-2 upland uncertainty analysis was not required.	Low
IPZ-3 Delineation	Data reliable for delineation as the steady-state system was modelled using flows and water levels from the St. Lawrence Seaway Management Corporation similar to process for the IPZ-2.	Low
Section 6.3: Assignment of Vulnerability Scores		
Vulnerability Scores	Data contributing to the area and source vulnerability factors are from reliable provincial and federal monitoring programs, Niagara Region Water Operations staff, and City of Welland staff.	Low
Section 6.4: Identification of Threats		
EBM Significant Threats	Uncertainty of results estimated as +/- 50%, however even a 50% reduction in modelled results exceed the MAC at the intake making the uncertainty of diesel fuel being a significant threat low.	Low
Section 6.5: Enumeration/Listing of Existing Threats		
Identification of Land Use Activities	The data used to find specific parcels were provided by government resources and were of a sufficient quality. Multiple resources were used to identify the land use activities present on parcels within the vulnerable areas. The quality and quantity of these resources was also sufficient.	Low
Section 6.6: Evaluation of Issues		
Issues Evaluation	The issues evaluation was based upon raw water quality data provided by the MOE. The data spanned 17 years; but frequency of sampling for each parameter varied. The methodology was tailored for the quality and quantity of available data and was appropriate for the issues evaluation.	Low