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5.0 NORFOLK COUNTY GROUNDWATER VULNERABILITY ASSESSMENT

Five municipal drinking water systems are located within the portion of the Norfolk County that falls within the Long Point Region Source Protection Area: Two groundwater systems (Simcoe and Waterford), two surface water systems (Port Dover and Port Rowan), and one combined groundwater and surface water system (Delhi). These systems are operated by the County's Public Works and Environmental Services (PW & ES) Department).

Table 5-1: Norfolk County Municipal Residential Drinking Water Systems in the Long Point Region

DWS Number	DWS Name	Operating Authority	GW or SW	System Classification[1]	Number of Users served
220007178	Delhi Water Supply System	PW & ES	GW&SW	Large municipal residential	6,262
220000399	Port Dover Water Treatment Plant	PW & ES	SW	Large municipal residential	7,089
220000898	Port Rowan Water Treatment Plant	PW & ES	SW	Large municipal residential	2,312
220000371	Simcoe Well Supply	PW & ES	GW	Large municipal residential	15,040
220000905	Waterford Well Supply	PW & ES	GW	Large municipal residential	3,315

[1] as defined by O. Reg. 170/03 (Drinking Water Systems) made under the *Safe Drinking Water Act, 2002.*

A description of each of these systems and the methods used for the water quality risk assessment are included in **Section 5.1 to 5.5**. **Table 5-2** provides a summary of the annual and monthly average pumping rates for each well and intake associated with these systems.

Table 5-2: Annual and Monthly Average Pumping Rates for Norfolk County Municipal Residential Drinking Water Systems in the Long Point Region

Well or Intake	Annual Avg. Taking[1] (m^3/d)	Monthly Average Taking[1] (m^3/d)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Delhi Well #1	514	444	444	471	488	1027	745	506	341	405	473	425	396
Delhi Well #2	924	722	732	710	772	1195	1105	1321	1227	1001	760	741	795
Delhi Well #3a	-	-	-	-	-	-	-	-	-	-	-	-	-
Delhi Well #3b	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5-2: Annual and Monthly Average Pumping Rates for Norfolk County Municipal Residential Drinking Water Systems in the Long Point Region

Well or Intake	Annual Avg. Taking[1] (m^3/d)	Monthly Average Taking[1] (m^3/d)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Simcoe Cedar St. Well #1A	0	0	0	0	0	0	0	0	0	0	0	0	0
Simcoe Cedar St Well #2A	261	254	264	183	247	332	325	326	346	252	232	170	196
Simcoe Cedar St Well #3	523	436	426	376	483	645	639	604	675	583	479	511	416
Simcoe Cedar St Well #4	380	344	346	302	389	515	509	455	513	368	328	228	265
Simcoe Cedar St Well #5	442	389	379	352	400	535	501	494	575	486	429	401	360
Simcoe Cedar St Infiltration Gallery	160	42	24	185	253	139	405	345	287	62	9	95	77
Simcoe Chapel St Well	1559	1400	1447	1511	1608	1606	1615	1498	1593	1591	1605	1630	1604
Simcoe Northwest Well #1	0	0	0	0	0	0	0	0	0	0	0	0	0
Simcoe Northwest Well #2	709	610	432	549	666	705	939	999	871	861	809	817	248
Simcoe Northwest Well #3	959	919	1020	866	741	884	1151	1279	1156	1094	1012	392	980
Waterford Well #3	485	365	389	430	481	604	521	668	533	462	440	482	436
Waterford Well #4	498	455	420	382	403	487	754	625	600	590	485	355	421
Port Dover Intake	2585	2206	2255	2155	2499	2781	3208	3394	3277	2794	2460	2058	1914
Port Rowan Intake	917	648	671	815	955	1102	1230	1198	1112	1026	819	709	712

[1] Source: Norfolk County, based on 2016 monitoring data

5.1 Delhi-Courtland Water Quality Risk Assessment

Norfolk County provides municipal drinking water to approximately 6,262 residents in the communities of Delhi and Courtland (see **Table 5-1**) via the Delhi-Courtland water supply system. This is an existing large municipal residential drinking water system, defined as a Type 1 system under the Technical Rules (2009a). **Map 5-1** shows the serviced area for Delhi and Courtland.

The Delhi-Courtland water supply is sourced from four groundwater supply wells located to the east of Delhi.

Wells 1 and 2 have a planned pumping capacity of 2,300 m^3/day. The annual average raw water takings in 2016 from wells 1 and 2 were 514 m^3/day and 924 m^3/day, respectively.

Wells 1 and 2 are 39 m deep and screened in an extensive unconfined aquifer consisting of glaciolacutrine sands and gravels that are part of an intermediate aquifer. Wells 1 and 2 are classified as groundwater under the direct influence of surface water (GUDI) as previous analyses have shown a potential hydraulic connection between the intermediate municipal aquifer and the shallow surficial aquifer (Stantec, 2010a).

Norfolk County had identified a need for increased capacity for the Delhi-Courtland system and completed a Schedule B Class Environmental Assessment (EA) in March of 2012. The Class EA process identified the preferred solution as the construction of two new wells at the Delhi wellfield. Municipal wells 3a and 3b were drilled in 2016 with the purpose of providing increased capacity. Both wells are screened within the same unconfined aquifer as well 1 and well 2. The wells were brought online in 2020. The 2016 identified rated capacity for wells 3a and 3b is 1,145 m^3/day.

Technical studies to support the vulnerable area delineation, threat assessment and issue identification for the Delhi-Courtland system are described in the following reports:

- *Norfolk County Source Water Protection Team Vulnerability Report, Schlumberger Water Services (Canada) Inc. (November 2009);*
- *Delhi, Simcoe and Waterford Source Protection Study Preliminary Threats Assessment and Issues Identification Report #2, Schlumberger Water Services (Canada) Inc. (May 2010);*
- *Wellhead Protection Area E Delineation and Vulnerability Scoring for GUDI Wells in Norfolk County, Stantec (March 2010);*
- *Draft Delhi WHPA Delineation, Vulnerability Scoring and Threats Assessment, Matrix Solutions, Inc. (October, 2017)*

5.1.1 Delhi-Courtland Wellhead Protection Areas

In the early 2000s, a local scale Visual MODFLOW (Harbaugh 2005) groundwater flow model was developed to delineate groundwater quality WHPAs for Delhi municipal wells 1 and 2. Later in 2009, a regional scale FEFLOW (DHI 2012a) groundwater flow model was developed for all of Long Point Region for the Tier Two Water Budget Study (Matrix, 2009a). In 2015, the Long Point Region Tier Three Water Budget and Local Area Risk Assessment was completed (Matrix 2015) which included a water quantity evaluation of the Delhi system. This work included the local refinement of areas around Delhi, Simcoe, and Waterford within the Tier Two regional scale groundwater flow model and the development of a new integrated groundwater/surface-water model using MikeSHE (DHI 2012b).

WHPAs have been re-delineated for the existing wells 1 and 2, and new WHPAs have been delineated for Delhi wells 3a and 3b. The existing Long Point Tier Three groundwater flow model has been updated to represent the new production wells and refined to better match new pumping test results at the wellfield (Matrix, 2017).

The production aquifer for the Delhi municipal wells consists of fine to coarse grained sand, overlain by approximately 17 metres of Wentworth Drift and 18 m of sand/gravel material at surface. Hydrogeologic characterization work completed by Matrix (2015) has suggested potential for hydraulic connection between the production aquifer and the surficial shallow sand.

Delhi's WHPAs were delineated using pumping rates that correspond to the "identified capacity" of the existing wells 1 and 2, and the combined target capacity of the two new wells, wells 3a and 3b (from *Schedule 'B' Class Environmental Assessment Delhi Water System,* Vallee 2012). The total proposed pumping of 6,870 m^3/day satisfies the Maximum Day demand of 6,021 m^3/d predicted to the year 2026 in the Norfolk County Master Plan (November 2007).

The rates are summarized in **Table 5-3**.

Table 5-3: Delhi Municipal Pumping Rates for WHPA Delineation

Well ID	Pumping Rate (m^3/day)
Delhi 1	2,290
Delhi 2	2,290
Delhi 3a (New)	1,145
Delhi 3b (New)	1,145
Total Wellfield Pumping	**6,870**

The resulting WHPAs for Delhi are shown on **Map 5-1.** Wells 1, 2, 3a and 3b are located close to each other and exhibit a single capture zone. The WHPAs extend predominantly eastward aligned to the east-west directed local groundwater flow. The 25-year WHPA has an area of 4.96 km^2 and intersects two tributaries of Stoney Creek.

WHPA-E Delineation for Wells Under the Direct Influence of Surface Water (GUDI)

Although well 1 is among several wells in Norfolk County that have been identified as GUDI, there is no evidence of a connection to, or interaction with, a surface waterbody that would decrease the time of travel of water to the well. Well 1 is GUDI due to the presence of a shallow water table within 4 metres of the ground surface. Based on this rationale, a WHPA-E was not delineated for this well (Stantec, 2010a).

Data Gaps and Uncertainty in Wellhead Protection Area Delineation

As a part of the Tier 3 Water budget, Delhi's WHPAs were updated to reflect current knowledge of the area. The uncertainty related to the WHPA delineation was assessed by looking at the match between the model's geological layers and well logs from the modelled area, and incorporated the uncertainty related to estimating groundwater recharge for the area. The assessment concluded that the uncertainty of the Delhi WHPAs is considered to be low.

5.1.2 Delhi Vulnerability Scoring in Wellhead Protection Areas

A vulnerability assessment using the surface to aquifer advection time (SAAT) method was completed to identify the vulnerability of the groundwater resources to surficial sources of contamination (SWS, 2010b; EarthFx, 2008). The SAAT time of travel values were used to create mapped vulnerability categories of low (value > 25 years), medium (5 < value ≤ 25 years) and high (value ≤ 5). The methodology is described in **Section 3.1.1**.

The water table is approximately 4 m bgs within the WHPAs, accounting for a travel time of approximately 3 years. The vulnerability was therefore classified as high, as shown in **Map 3-2.**

Vulnerability scores within the WHPAs were assigned following Part VII.2 of the Technical rules, and are summarized in **Table 5-4**.

Table 5-4: WHPA Vulnerability Scores

Intrinsic Vulnerability Category	Time of Travel Capture Zone			
	100-m	2-year	5-Year	25-year
High	10	10	8	6
Medium	10	8	6	2
Low	10	6	4	2

Map 5-3 shows the SAAT vulnerability classifications (also referred to as intrinsic vulnerability) across Delhi and the surrounding area, while **Map 5-5** shows the resulting vulnerability scores within the WHPAs that were also summarized in **Table 5-4**.

Delhi Transport Pathways and Adjusted Vulnerability Score

Constructed or natural preferential pathways such as improperly abandoned boreholes or breaches in aquitards may be present within the WHPAs. These pathways may allow contaminants to move rapidly from the ground surface to the underlying aquifer. Other preferential pathways may include pits and quarries, large diameter subsurface infrastructure such as storm and sanitary pipelines, and ditches.

Potential transport pathways within the Delhi Capture zones were identified using various databases and GIS layers, including MECP Water Well Records, oil and gas wells, tile drainage, constructed drains, storm sewers and pits and quarries. All identified potential features are mapped on **Map 5-4.**

The MECP Technical Rules note that the low vulnerability areas can be increased to medium or high vulnerability or a medium vulnerability area can be increased to high due to the presence of one of the above noted anthropogenic transport pathways. Professional judgment is used to increase the vulnerability score based on the hydrogeological conditions, the type and nature of the pathway, and the potential cumulative impact of the pathways. However, because the vulnerability in the Delhi WHPAs is already high, additional preferential pathways could not further increase the vulnerability.

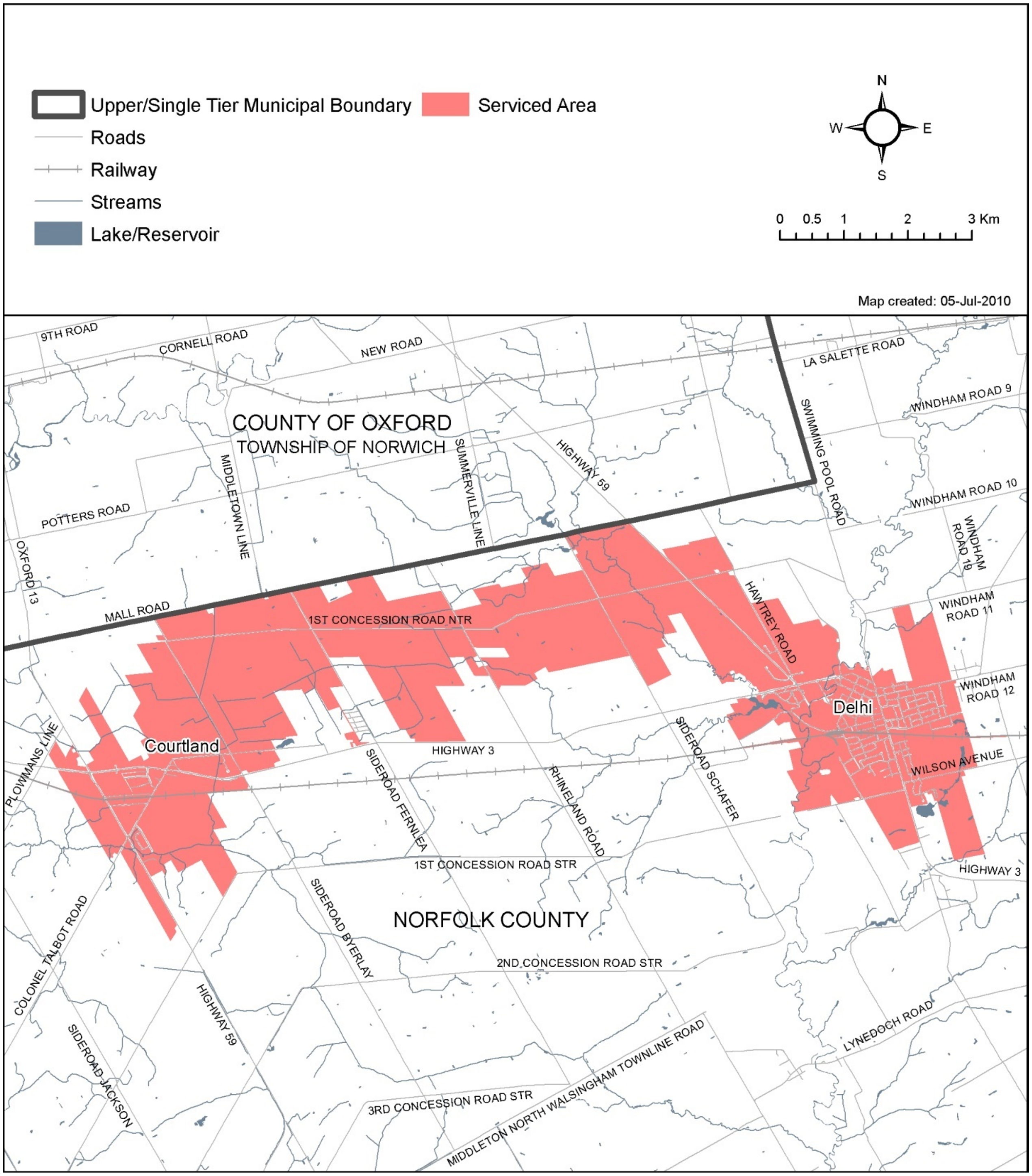
Uncertainty and Limitations in Delhi Vulnerability Scoring

The uncertainty of the vulnerability score mapping is considered to be low, since the underlying vulnerability values are uniformly high.

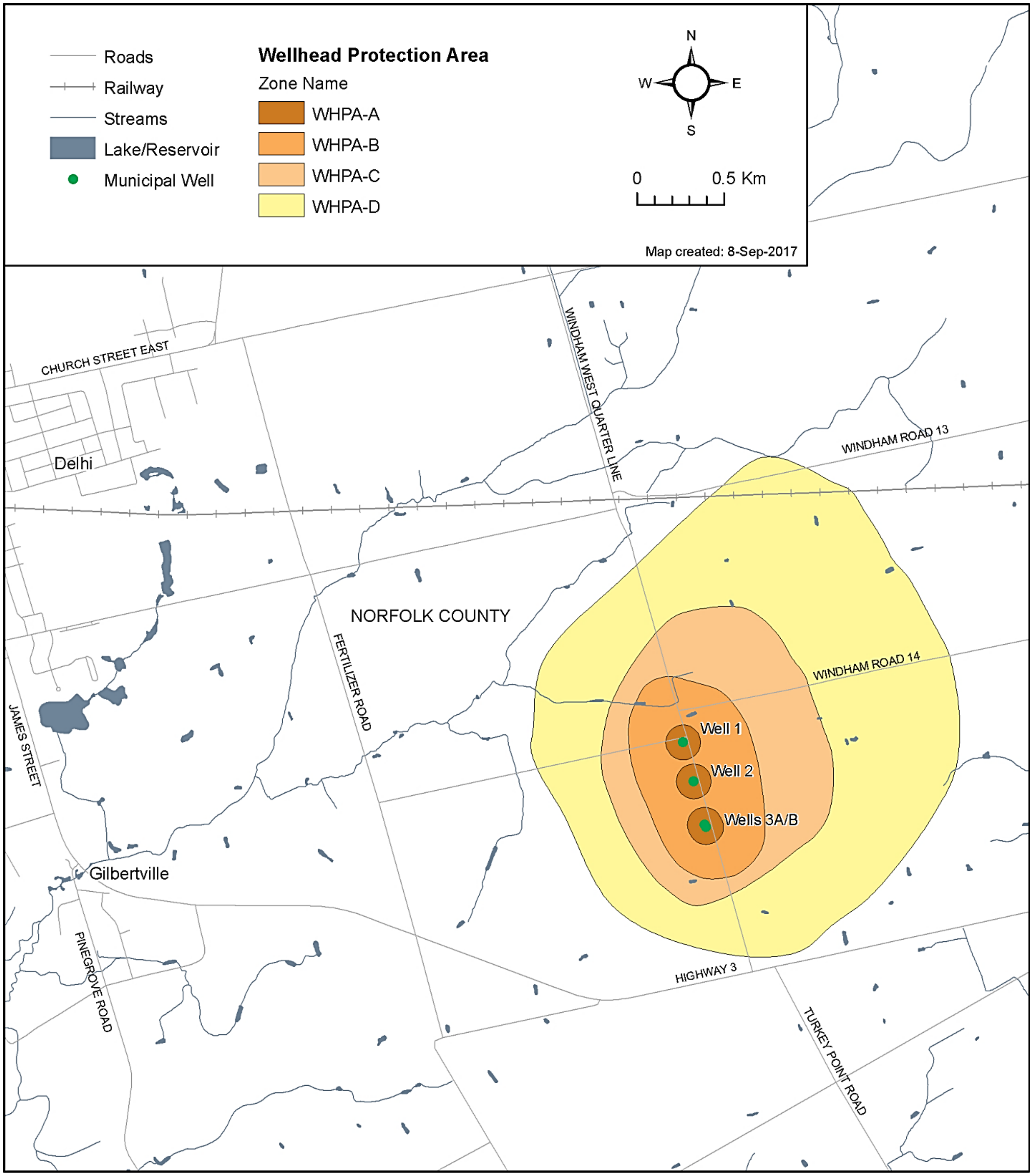
There is very little uncertainty that the water level is close to the surface and the soil material between surface and water table has a high permeability. The uncertainty of the vulnerability category areas is, therefore, considered to be low.

Except for the four municipal wells, there are no nearby deep wells that provide additional insight regarding the continuity of clay and silt lenses assumed to be present throughout the model. Additional well logs or geophysical information would improve the analysis of the presence and continuity of the aquitard formation.

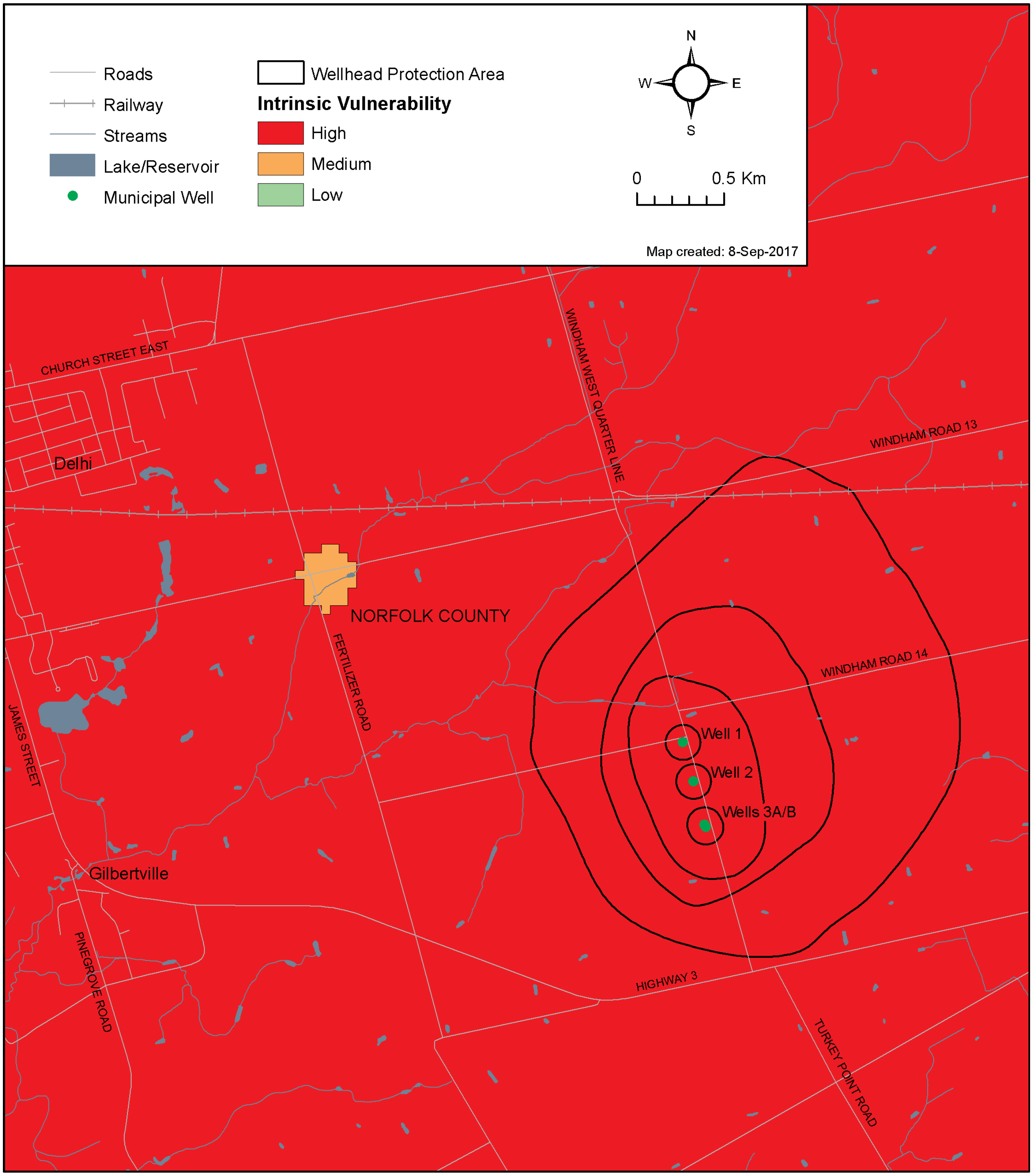
Map 5-1: Delhi-Courtland Serviced Area



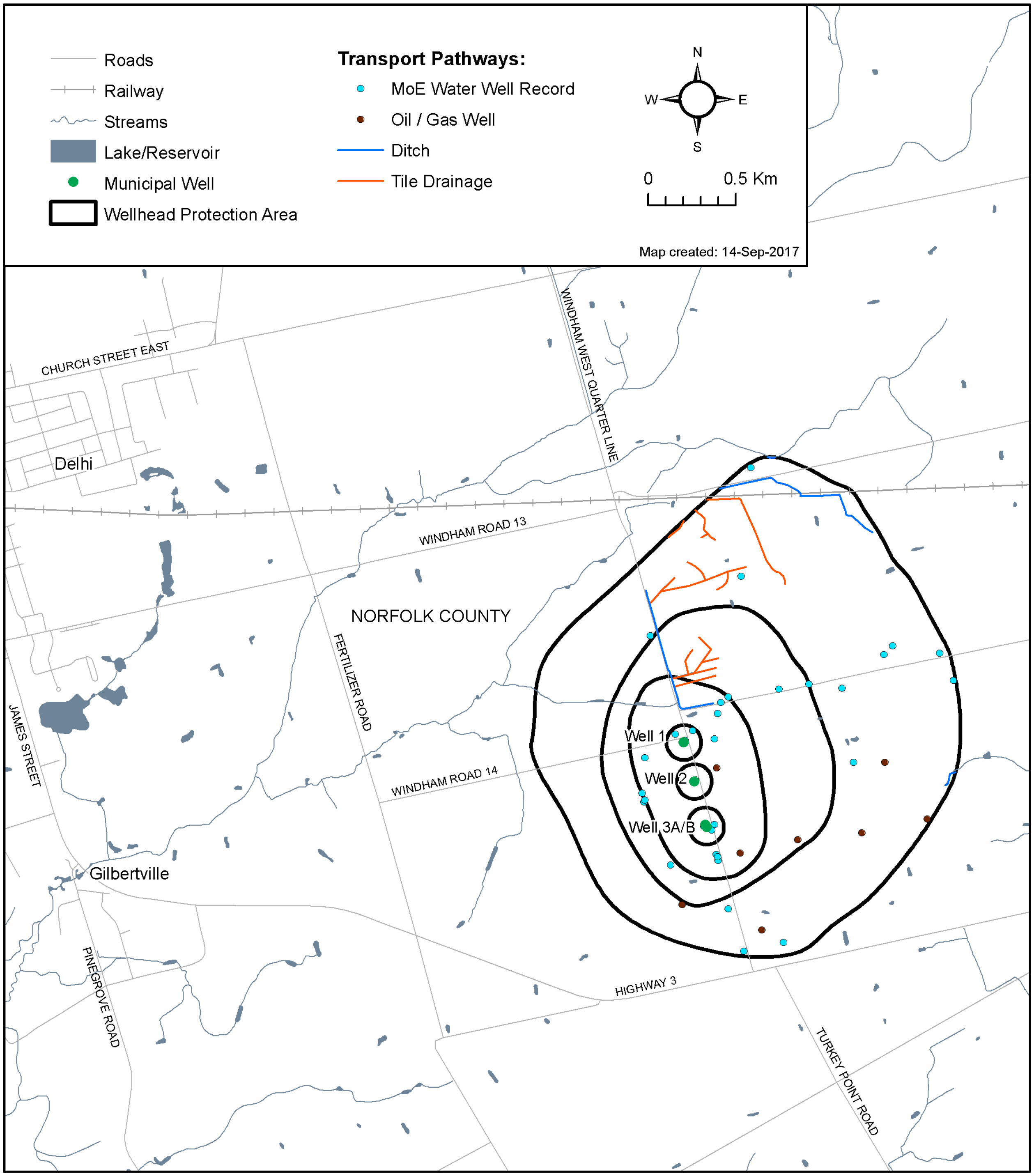
Map 5-2: Delhi-Courtland WHPA



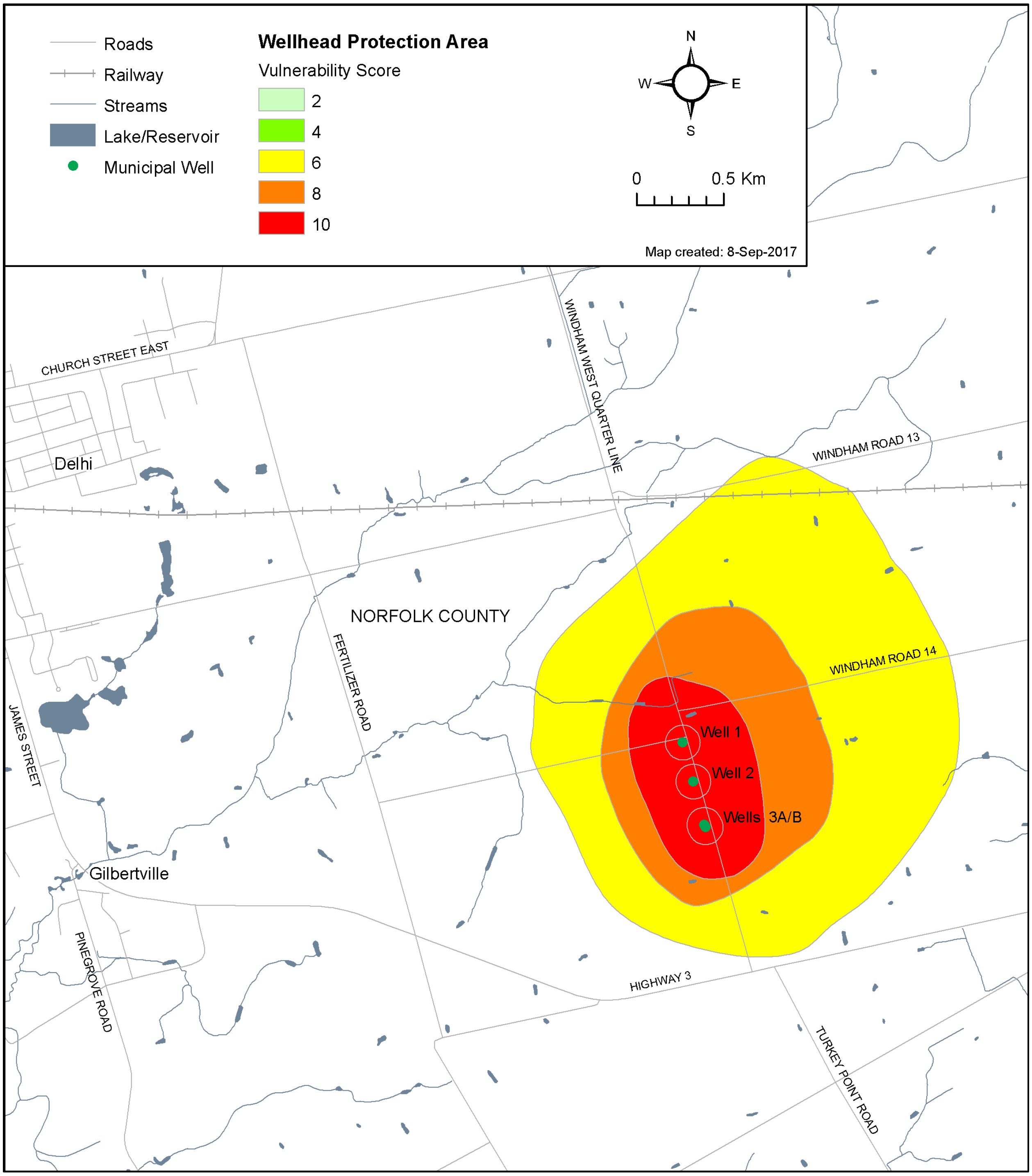
Map 5-3: Delhi-Courtland WHPA Intrinsic Vulnerability



Map 5-4: Delhi-Courtland Transport Pathways



Map 5-5: Delhi-Courtland WHPA Vulnerability Scoring



5.1.3 Lehman Dam Reservoir Surface Water Intake

Lehman Dam Reservoir is located just west of the community of Delhi. It was built in 1963 by constructing an earthen dam and flooding the existing river valley. The Lehman Dam Reservoir is fed by two creeks, North Creek and South Creek, with a total contributing watershed area of about 54 km^2.

The vulnerable areas and associated drinking water threats for the Lehman Dam surface water intake have been removed from the Long Point Region Source Protection Plan and Assessment Report because the reservoir has been decommissioned and is no longer used as a drinking water supply.

5.1.4 Percent Managed Lands and Livestock Density

Percent Managed Lands in the Wellhead Protection Areas

Managed Lands are lands to which nutrients are applied. Managed lands can be categorized into two groups: 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 land includes golf courses, sports fields, lawns and other grassed areas that may receive nutrients (primarily commercial fertilizer).

Managed lands within the Delhi WHPAs are summarized in **Table 57** and are shown on **Map 58**.

Table 5-5: Percent Managed Land Calculations Within Delhi WHPAs and IPZs

WHPA	WHPA Area		Agricultural Managed Land Area		Non-agricultural Managed Land Area		Managed Land Area		Managed Land
	Acres	**m^2**	**Acres**	**m^2**	**Acres**	**m^2**	**Acres**	**m^2**	**%**
WHPA-A (Well 1)	7.7	31,214	2.0	8,167	2.6	10,373	4.6	18,540	59%
WHPA-A (Well 2)	7.7	31,214	2.3	9,133	0.9	3,955	3.2	13,088	42%
WHPA-A Wells 3a/ 3b	8.5	34,331	1.9	7,511	1.3	5,331	3.2	12,842	37%
WHPA-B	145.3	587,908	93.0	376,433	15.1	61,053	108.1	437,486	74%
WHPA-C	245.7	994,207	152.7	617,849	21.9	88,686	174.6	706,535	71%
WHPA-D	811.2	3,282,695	559.9	2,265,999	20.6	83,367	580.5	2,349,366	72%

Livestock Density

Livestock density is defined as nutrient units per acre of agricultural managed land within a vulnerable area. A nutrient unit is defined as the number of animals that will give the fertilizer replacement value of the lesser of 43 kilograms of nitrogen or 55 kilograms of phosphate per year as nutrients.

Livestock density was calculated using the MOE 2009 guidance "Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land

Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers" for calculating Livestock Density in the WHPAs.

Results presented in **Table 5-8** concluded with a NU/Acre of 0.05 for WHPA-B, and a NU/Acre of 0.14 for WHPA-D.

A classification of "less than 0.5 NU/acre" is presented on **Map 5-9.**

Table 5-6: Livestock Density (NU/Acre) Calculations

Scenario	Agricultural Managed Land Acreage	**Total NU**	**Livestock Density (NU/Acre)**	**Notes**
WHPA-A (Well 1)	2.0	0	0	No Animals
WHPA-A (Well 2)	2.3	0	0	No Animals
WHPA-A (Well 3A & 3B)	1.9	0	0	No Animals
WHPA-B	93.2	5.04	0.05	Residential hobby horse boarding
WHPA-C	152.7	0	0	No Animals
WHPA-D	559.9	76.3	0.14	Large barn, assumed mixed livestock

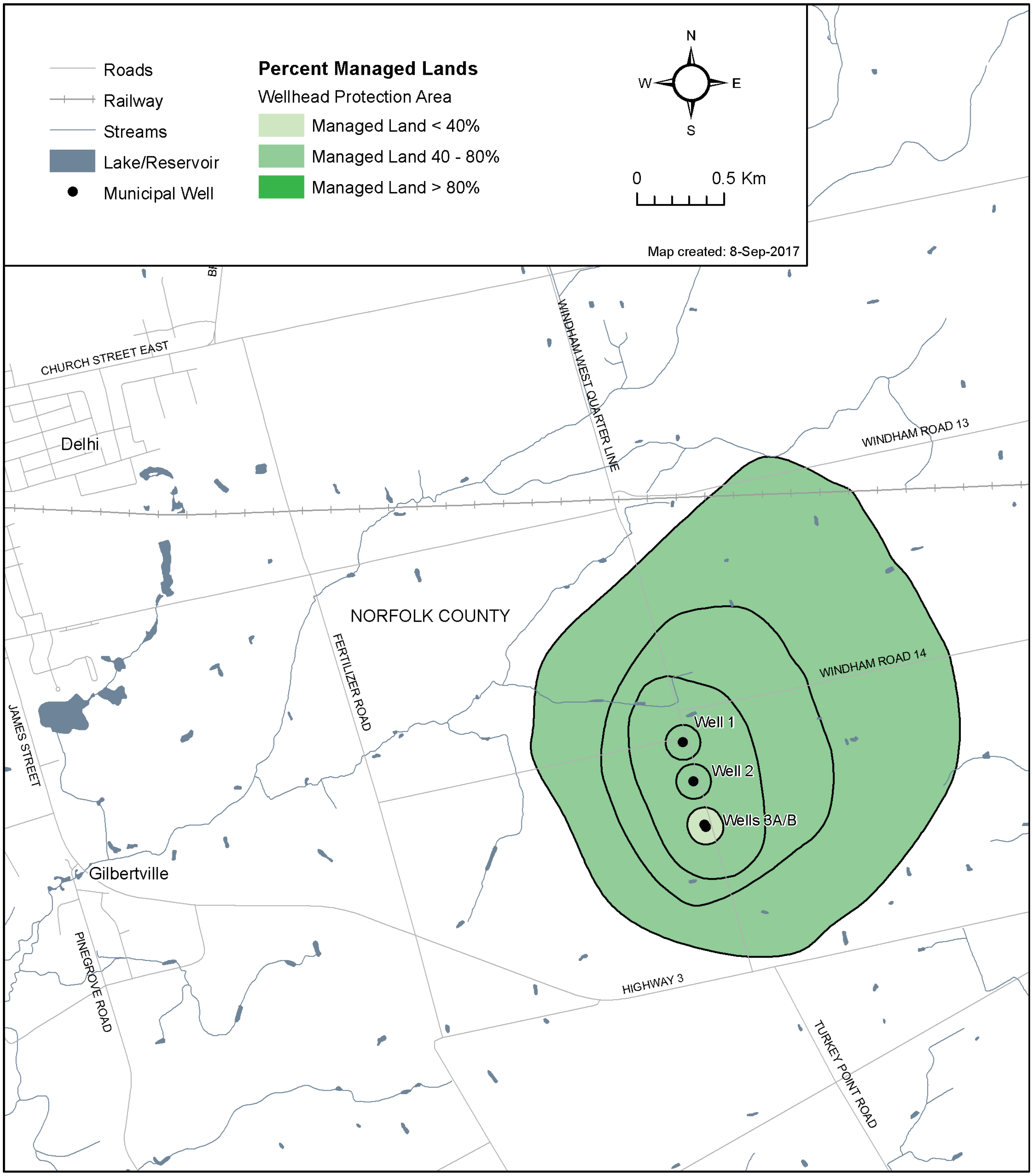
5.1.5 Percent Impervious Surface Area

Percent Impervious Surface Area in Wellhead Protection Areas

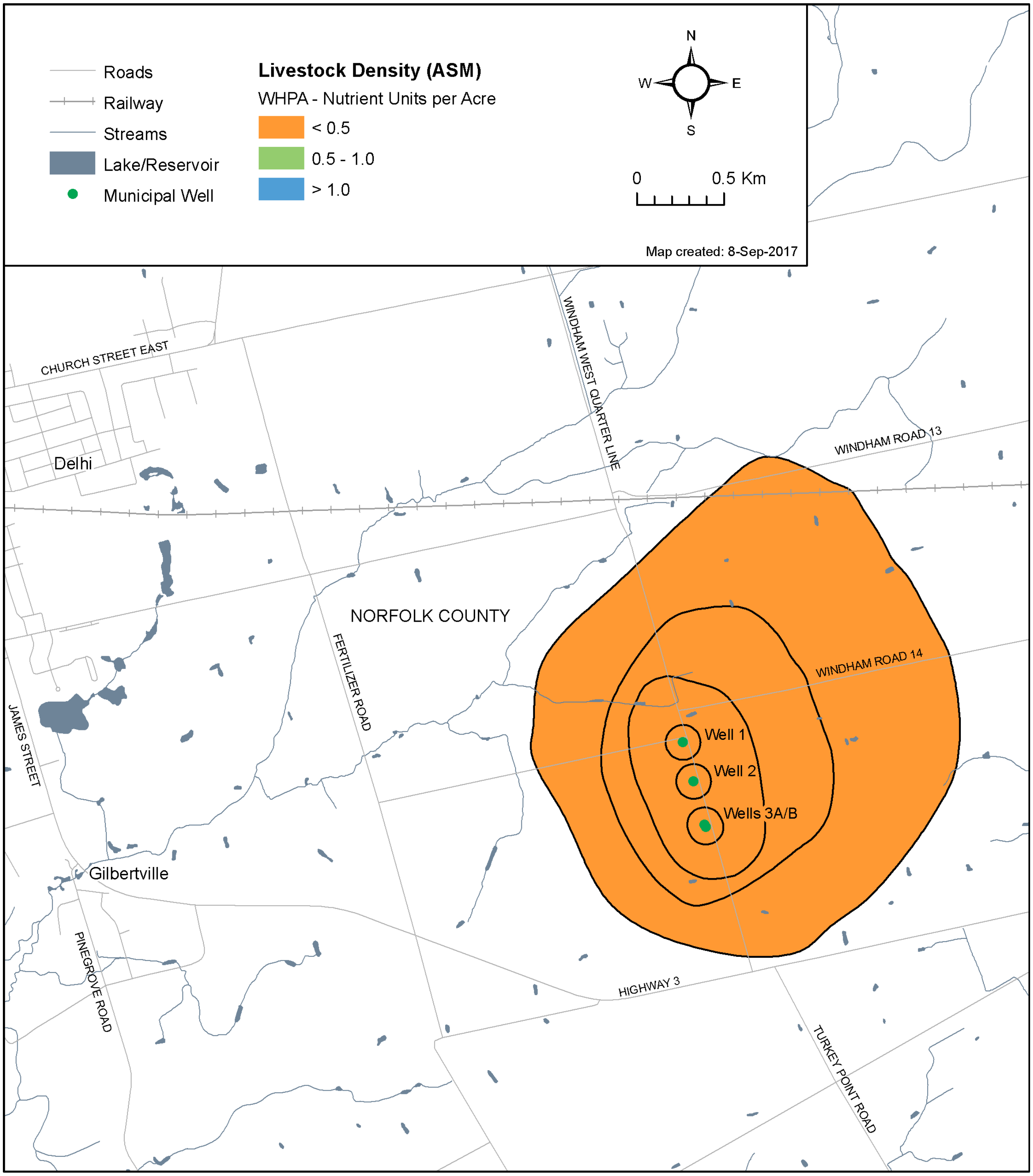
The quantification and mapping of the percentage of impervious surface area was completed to assess the potential threats related to road salt application. A 1 km x 1 km grid was overlaid and centered on the WHPAs and the percentage of impervious area for each grid cell was determined using the project GIS.

For the Delhi area, this included the impervious area represented by roads only. **Map 5-10** presents the percentage of impervious surface for areas within the Delhi WHPAs. As the percentage of impervious surfaces ranged from 0 % to 6.1% across the WHPAs, the application of road salt was not considered a significant threat to the Delhi municipal wells.

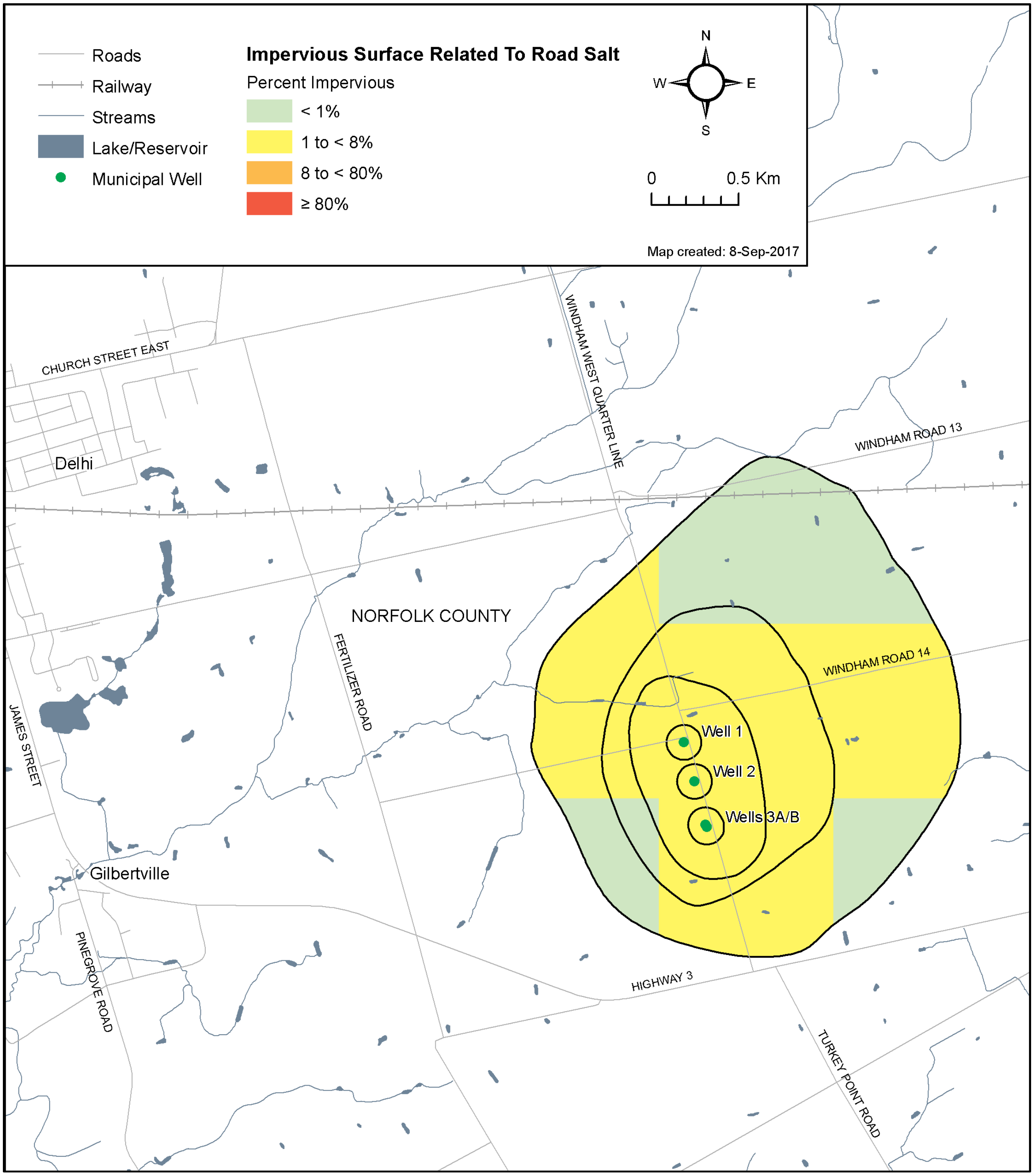
Map 5-6: Percent Managed Lands within the Delhi-Courtland WHPA



Map 5-7: Livestock Density within the Delhi-Courtland WHPA



Map 5-8: Impervious Surface within the Delhi-Courtland WHPA



Delhi Water Quality Threats Assessment
Table 5-9 provides a summary of the threat levels possible in the Delhi-Courtland water supply system for chemicals, dense non-aqueous phase liquids (DNAPLs), and pathogens. A checkmark in the following tables indicates the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; a blank cell indicates that it is not. The colours shown for each vulnerability score correspond to those shown in the maps.

Table 5-7: Identification of Drinking Water Quality Threats in the Delhi Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals	WHPA-A/B	10	✔	✔	✔
	WHPA-C	8	✔	✔	✔
	WHPA-D	6		✔	✔
Handling / Storage of DNAPLs	WHPA-A/B/C	Any Score	✔		
	WHPA-D	6		✔	✔
Pathogens	WHPA-A/B	10	✔	✔	

Table 5-11 lists the activities that are prescribed drinking water quality threats (as identified under Ontario Regulation 287/09) and local identified threats. Typical land use activities are listed beside the drinking water quality threats.

Table 5-8: Drinking Water Quality Threats

Prescribed Drinking Water Quality Threats Ontario Regulation 287/07 s.1.1.(1)		**Land Use/Activity**
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	Landfills – Active, Closed Hazardous Waste Disposal Liquid Industrial Waste
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage Infrastructures Septic Systems, etc.
3	The application of agricultural source material to land.	e.g. manure, whey, etc.
4	The storage of agricultural source material.	e.g. manure, whey, etc.
5	The management of agricultural source material.	aquaculture
6	The application of non-agricultural source material to land.	Organic Soil Conditioning Biosolids
7	The handling and storage of non-agricultural source material.	Organic Soil Conditioning Biosolids
8	The application of commercial fertilizer to land.	Agriculture Fertilizer
9	The handling and storage of commercial fertilizer.	General Fertilizer Storage
10	The application of pesticide to land.	Pesticides
11	The handling and storage of pesticide.	General Pesticide Storage

Table 5-8: Drinking Water Quality Threats		
Prescribed Drinking Water Quality Threats Ontario Regulation 287/07 s.1.1.(1)		**Land Use/Activity**
12	The application of road salt.	Road Salt Application
13	The handling and storage of road salt.	Road Salt Storage
14	The storage of snow.	Snow Dumps
15	The handling and storage of fuel.	Petroleum Hydrocarbons
16	The handling and storage of a dense non-aqueous phase liquid.	DNAPLs
17	The handling and storage of an organic solvent	Organic Solvents
18	The management of runoff that contains chemicals used in the de-icing of aircraft.	De-icing
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	Agricultural Operations
22	The establishment and operation of a liquid hydrocarbon pipeline	Oil Pipeline

Land Use Inventory Methodology

A land use threats assessment was completed through the review of existing data within Delhi's WHPAs (Matrix, 2017). Limited site specific information was collected as a part of this assessment and most identified threats are considered potential, requiring further review and site specific assessments to confirm their presence.

As summarized in **Table 5-12**, a total of 38 potential threats were identified on 12 properties within the Delhi WHPAs.

Table 5-9: Potential Significant Drinking Water Quality Threats in the Delhi Courtland WHPAs (Matrix, 2017)

PDWT #[1]	TSC #[2]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
1	10	Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste	1	WHPA-A WHPA-B
2	15	Sewage System Or Sewage Works - Onsite Sewage Systems	8	WHPA-A WHPA-B
3	20	Application Of Agricultural Source Material (ASM) To Land	7	WHPA-A WHPA-B
4	21	Storage Of Agricultural Source Material (ASM)	1	WHPA-B

Table 5-9: Potential Significant Drinking Water Quality Threats in the Delhi Courtland WHPAs (Matrix, 2017)

PDWT #[1]	TSC #[2]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
9	26	Storage Of Commercial Fertilizer	3	WHPA-A WHPA-B
10	27	Application Of Pesticide To Land	5	WHPA-B
11	28	Storage Of A Pesticide	3	WHPA-A WHPA-B
15	32	Handling Of Fuel	4	WHPA-A WHPA-B
15	33	Storage Of Fuel	4	WHPA-A WHPA-B
21	38	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation (Grazing and pasturing)	1	WHPA-B
	39	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation (Yards or confinement)	1	WHPA-B
	Total number of activities		**38**	
	Total number of properties		**12**	

1: Prescribed Drinking Water Threat Regulation Reference Number refers to the prescribed drinking water threat listed in O. Reg 287/07 s. 1.1.(1).

2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category.

Note: Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facilty.

Conditions Evaluation

To identify potential threats from conditions within the Delhi WHPAs (refer to Technical Rules, Part XI.3), multiple data sources were reviewed including aerial and roadside imagery, an ERIS database report, interviews with municipal staff, and the historic 2003 Norfolk County Threats Database.

No significant, conditions-based threats were identified in this review, and thus no conditions resulting from past activities in the Delhi WHPAs were identified as per Technical Rule 126.

5.1.6 Delhi-Courtland Drinking Water Quality Issues Evaluation

Issues Evaluation - Delhi Wells

The objective of the Issues evaluation was to identify drinking water Issues where the existing or trending concentration of a parameter or pathogen at an intake, well or monitoring location would result in the deterioration of the quality of water for use as a source of drinking water. The parameter or pathogen must be listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards (ODWQS) or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (Technical Rules XI.1 (114 – 117)).

Once a drinking water Issue is identified, the objective is to identify all sources and threats that may contribute to the issue within an Issue Contributing Area (ICA) and manage these threats appropriately. If at this time the Issue contributing area can not be identified or the Issue can not be linked to threats then a work plan must be provided to assess the possible link.

If an Issue is identified for an intake, well or monitoring location, then all threats related to a particular Issue within the Issue Contributing Areas are classified as significant drinking water threats, regardless of the vulnerability.

Delhi wells 1 and 2 have separate pump houses including the following equipment for water treatment:

- A sodium hypochlorite disinfection system
- UV disinfection units
- A fluoridation system
- Sodium silicate (iron and manganese sequestration)
- Chlorine

Wells 3a and 3b were put into production in 2020.Schedule 1 Parameters

Weekly samples analysed for E. coli and total coliforms were available from 2005 to 2016. For Well 1, raw and treated samples were available for the entire time period. For Well 2, only analyses of raw water were available from 2005 to 2009 and both raw and treated water from 2010 to 2016.

In Well 1, total coliforms were found in 7 raw water samples and in 2 treated water samples over the available record. In Well 2 total coliforms were detected in 7 raw water samples and 1 treated water sample. E. coli was detected in a single raw water sample in Well 2 indicating fecal contamination.

One instance of E.coli and total coliform was found at the water treatment plant (WTP) in 2014; however, additional sampling was completed and results were within applicable guidelines. Similarly, total coliform was detected in the distribution system in 2015 but additional sampling showed results within applicable guidelines.

The well operator confirmed that the disinfection system provides the appropriate treatment for this low number of microbes. No Schedule 1 parameters were therefore noted.

Schedule 2 Parameters

No occurrences of inorganic Schedule 2 parameters were observed in the raw water of Delhi wells 1 and 2; however, in 2016 a fluoride residual was found leaving the WTP at more than the standard of 1.5 mg/L. As remedial action, the WTP was backwashed, hydrants were flushed, the fluoride pump was reprogrammed and operators received training on pump controls.

Among the organic Schedule 2 parameters, one exceedance of the ODWQS maximum acceptable concentration was noted at Delhi Well 1 for benzo(a)pyrene on November 21, 2001 with a concentration of 0.03 ug/L (MAC = 0.01 ug/L). All other available concentrations extracted from the annual drinking water reports 2003 to 2009 (treated water) and 2010 to 2016 (raw water) were below the detection limit of 0.004 ug/L. The elevated concentration was, therefore, considered to be a single occurrence and this parameter was not noted as a concern.

From 2010 to 2013, the annual quarterly average concentrations of trihalomethanes (THM) exceeded 50% of MAC (100 ug/L) at wells 1 and 2. Annual average concentrations ranged from 51.5 to 78.5 ug/L during these 4 years. The quarterly THM has consistently been declining since 2013 to well below the 50% MAC (32.3 ug/L) in 2016. Therefore THM is not considered an Issue.

In 2012, N-Nitrosodimethylamine (NDMA) was found in the Delhi WTP at 0.054 ug/L and 0.057 ug/L at sample station 4 Gage St. (MAC is 0.009 ug/L). The source of NDMA is attributed to land application and run-off into surface water supply. Subsequent samples from the drinking water system were found to be within guidelines and no further action was required.

In 2015, the fungicide, Mefenoxam, was detected in the WTP at a concentration of 0.2 ug/L. Additional samples were retrieved and found to be within guidelines and no further action was required. Note that this parameter is not listed in Schedule 1, 2, or 3 of the ODWQS, Table 4 of the Technical Support Document, or Table 2 of the Soil, Ground Water and Sediment Standards.

In May 2016, new wells 3a and 3b were sampled for dioxins and furans and all analyses were below detection limits.

Schedule 3 Parameters

No elevated values of gross alpha and gross beta were found for wells 1 and 2 in the available analysis which made the analysis of further elements of Table 3 (radioactive) parameters unnecessary. One tritium activity analysis was available and the activity remained below the detection limit.

In May 2016, new wells 3a and 3b were also sampled for gross alpha, gross beta and tritium. Similar to earlier analysis, the results were below the reportable detection limits.

Table 4 Parameters

Hardness is elevated at Delhi Well 1 with available data between 1999 and 2015 exceeding the Operational Guideline (OG; 80 to 100 mg/L) with a maximum concentration of 224 mg/L. Hardness at Well 2 was also analyzed in 2012 and was found to also exceed the OG. However, hardness is not a concern for staff at Norfolk County.

Turbidity occurred above the screening benchmark at Delhi Well 2 on July 27, 2004 with a value of 36 NTU. Available sample results obtained after this date remained below the benchmark level indicating that this exceedance may have been an isolated event or more likely a transcription error (omission of decimal separator).

Iron and manganese concentrations were available for raw water at Well 1 in Delhi from February 2017 at values below each parameter's aesthetic objective. These parameters were not noted as a concern by staff at Norfolk County.

No complaints in respect to odours in the drinking water of Delhi were mentioned in the drinking water reports or by the well operator and therefore this parameter was not noted as a concern.

Issues Summary - Delhi Wells

Iron and manganese are frequently above the ODWQS Aesthetic Objective; however, the drinking water is already treated for these constituents. Both parameters were therefore identified as elevated parameters.

Hardness is frequently above the ODWQS Operational Guideline Objective. Given the natural origin and the lack of a health threat associated with this parameter, it was identified as an elevated parameter. Therefore no Issues were identified in Delhi as per Technical Rule 114.

5.2 Simcoe Water Quality Risk Assessment

The community of Simcoe, which is serviced by three separate overburden wellfields, has a population of approximately 15,040 residents. The serviced area is shown on **Map 5-12**.

The Cedar Street wellfield consists of five groundwater wells (Cedar St. wells 1A, 2A, 3, 4, and 5) and a shallow infiltration gallery. The municipal wells are located along the banks of Kent Creek and the infiltration gallery is located immediately east of Cedar St. well 4. The infiltration gallery is a series of shallow perforated pipes that are connected by 10 manholes within the sandy sediment present along Kent Creek. The infiltration gallery collects and conveys water to a central pumping station where the water is pumped on a reoccurring, but variable, basis as the infiltration gallery becomes flooded.

The Northwest wellfield consists of two water supply wells (Northwest wells 2 and 3) that lie near a former sand and gravel extraction operation that extended below the water table. The extraction of sand and gravel and subsequent infill of the extraction areas with groundwater left behind three large ponds approximately 10 m from the municipal wells.

The Chapel Street wellfield is a single well that supplies approximately 30% of the town's water. The Chapel Street well is far removed from surface water bodies.

The municipal production aquifer consists of fine to medium grained sand with variable gravel and silt conent and ranges in thickness up to 30 m. The aquifer thins to the south towards the Chapel Street wellfield and extents to bedrock in the Northwest wellfield. The surficial confining unit (Wentworth Till) is interpreted to be discontinuous and windows in this till are interpreted to lead to a direct connection between the surface water features and the municipal production aquifer (Matrix, 2017).

Technical studies to support vulnerable area delineation, threat assessment and issue identification for the Simcoe municipal drinking water system are described in the following reports:

- *Norfolk County Source Water Protection Team Vulnerability Report, Schlumberger Water Services (Canada) Inc. (November 2009);*

- *Delhi, Simcoe and Waterford Source Protection Study Preliminary Threats Assessment and Issues Identification Report #2, Schlumberger Water Services (Canada) Inc. (May 2010); and*

- *Wellhead Protection Area E Delineation and Vulnerability Scoring for GUDI Wells in Norfolk County, Stantec (March 2010).*

- *Town of Simcoe WHPA Delineation, Vulnerability Scoring and Threats Assessment, Matrix Solutions, Inc. (2017)*

5.2.1 Simcoe Wellhead Protection Areas

In the early 2000s, a local scale Visual MODFLOW (Harbaugh, 2005) model was developed to delineate groundwater quality WHPAs for Simcoe municipal wells. Later in 2009, a regional scale groundwater flow model was developed for all of Long Point Region for the Tier Two Water Budget Study (Matrix, 2009a) using FEFLOW (DHI, 2012a). In 2015, the Long Point Region Tier Three Water Budget and Local Area Risk Assessment was completed (Matrix, 2015) which included a water quantity evaluation of the Simcoe system. This work included the local refinement of areas around Delhi, Simcoe, and Waterford within the Tier Two regional scale groundwater flow model and the development of a new integrated groundwater/surface-water model using MikeSHE (DHI, 2012b).

WHPAs have been re-delineated for all existing wells at the Cedar Street, Chapel Street and Northwest wellfields. The existing Long Point Tier Three groundwater flow model was updated to represent the updated wellfields and refined to better match new pumping at the wellfields.

The Northwest Wellfield draw its water from the bottom of a 15 to 30 m thick fine to medium-grained sand aquifer that is overlain in the north by a discontinuous and thin (<2 m) layer of fine-grained Wentworth Till. South of Northwest well 2, the till is absent and the aquifer lies at ground surface and is therefore, is considered unconfined. The municipal aquifer thins from the Northwest wellfield to the south towards the Chapel Street wellfield. Boreholes logs in the area note that the Wentworth Till is absent in some areas, leading to connections between shallow ponds created from historic aggregate extraction operations, and the deeper municipal production aquifers.

Three overburden aquifers located in the Cedar Street wellfield area are separated by aquitards. The uppermost surficial sand aquifer is part of the Norfolk Sand Plain and locally is approximately 6 m thick. It is underlain by a discontinuous layer of Wentworth Till. The Wentworth Till is not present at Cedar Street Well 1A, Cedar Street Infiltration Gallery, or areas west of Cedar Street Wells 2A and 3. Where the Wentworth Till is absent, the sand aquifer and intermediate aquifer are connected with a total thickness of approximately 12 m at the production wells. Underlying the intermediate aquifer is a thick unit of Wentworth and Port Stanley tills.

In the area surrounding Chapel Street well 3, the municipal well obtains water from a 5 m thick aquifer that is overlain by approximately 10 m of fine-grained Wentworth Drift. The well is located far from sensitive surface water features.

Pumping rates, as shown in **Table 5-14**, were used to generate WHPAs. These municipal pumping rates were inititally consistent with those used in the previous WHPA study (SWS, 2010b) and then refined further in consultation with Norfolk County staff.

Table 5-10: Simcoe Municipal Pumping Rates

Well ID	Pumping Rate (m^3/day)
Chapel St.	3,437
Cedar 1A	1,806
Cedar 2A	1,305
Cedar 3	1,305
Cedar 4	984
Cedar 5	1,305
Infiltration Gallery	742

Northwest 2	1,725
Northwest 3	2,292
Total Wellfield Pumping	14,901

The WHPAs for Simcoe are shown on **Map 5-13.** The Cedar and Chapel Street wellfields are located close to each other and exhibit a single capture zone. The WHPAs extend predominantly westward with two individual lobes that point slighty northwestward and southwestward, aligned to the local westward groundwater flow. The 25-year WHPA for the Cedar and Chapel Street wellfield has an area of 15.80 km^2. The Northwest wellfield WHPA extends in a perdominatly westward direction, similar to the other Simcoe wellfields. The 25-year WHPA for the Northwest wellfield has an area of 6.03 km^2.

WHPA-E for Wells Under the Direct Influence of Surface Water (GUDI)

Delineation of additional WHPAs may be required for each well or wellfield that has been identified as groundwater under the direct influence of surface water under subsection 2(2) of O. Reg. 170/03 (referred to as GUDI wells). A WHPA-E is required for GUDI wells where the interaction between surface and groundwater has the effect of decreasing the travel time of water to the well. WHPA-F may also be delineated for GUDI wells where a drinking water issue has been identified and is believed to originate from a source outside of any other WHPA.

The Cedar Street wellfield in Simcoe contains five overburden wells pumping from an unconfined aquifer and an infiltration gallery. The GUDI study for this wellfield identified a hydraulic connection between the wells, infiltration gallery and Kent Creek. The well locations relative to Kent Creek are shown on **Map 5-14.**

The Northwest wellfield has two GUDI wells that appear to be hydraulically connected to Patterson Creek based on previous GUDI studies. **Map 5-14** shows the location of the GUDI wells in the Northwest wellfield.

WHPA-E delineations for the Cedar Street and Northwest wellfields in Simcoe were based on a 2 hour time of travel under estimated high flow conditions and included appropriate setbacks on land, according to the Technical Rules. A 2 hour response time, the minimum required by the Technical Rules, was deemed appropriate given the ability to respond quickly to spills or other contamination events by shutting down the wells remotely through the county's SCADA system.

The 2 hour time of travel distance in Kent Creek upstream of the Cedar Street wellfield was based on a statistical analysis of continuous flow monitoring data combined with dye tracer studies carried out at bankfull or near bankfull flow conditions. Continuous flow records on Kent Creek were available from Schroeter and Associates for the period from July 2005 to June 2009 and were used to calculate the 95th percentile of flow. Experience has shown that 95th percentile flow and bankfull conditions are not substantially different for natural watercourses. Dye tracer studies were carried out at flows similar to the 95th percentile flow calculated for Kent Creek and field observations indicated that water levels were at or near the top of bank (i.e. bankfull flow conditions). Based on the dye tracer study, the peak velocity in Kent Creek under bankfull conditions is 0.19 m/s, which corresponds to a 2 hour time of travel distance of 1,358 m upstream of the Cedar Street wellfield. WHPA-E for the Cedar Street wellfield was delineated to this distance from the presumed intake location, which is the point in Kent Creek nearest to the most upstream GUDI well, as shown on **Map 5-14.** According to the Technical Rules, WHPA-E also includes a setback on land to include the Conservation Authority Regulation Limit or 120 m, whichever is greater. According to the Technical Rules, the 120 m setback is to be measured from the high water mark, however this GIS layer is not readily available. The Water Virtual Flow

– Seamless Provincial Data Set and Water Poly Segment data layers from the Ontario Land Information Warehouse were used to identify the extent of waterbodies for the purpose of defining the 120 m setback. For in-land rivers, it is unlikely that there will be significant change in the wetted perimeter of the watercourse under high water conditions compared to this layer and therefore, this approach is considered to be appropriate.

There was no historical flow data available for Patterson Creek upstream of the Northwest wellfield in Simcoe and consequently, the 2 hour time of travel distance was based on a dye tracer study conducted at elevated flow conditions. Dye injections were carried out on two branches of Patterson Creek upstream of the Northwest wellfield in April 2009. Field observations during the dye tracer study suggested that Patterson Creek was not at bankfull flow and water levels were approximately 15 cm below the top of bank. A hydraulic model analysis was used to scale up the measured flow velocity to bankfull conditions by correcting for changes in velocity and depth over a range of flows in each branch of the creek. The estimated 2 hour time of travel at bankfull flow conditions includes an upstream distance of 2,315 m for the West branch of Patterson Creek and 2,018 m for the Main branch of Patterson Creek. WHPA-E for the Northwest wellfield was delineated to these distances from the presumed intake locations (i.e. the point in each branch of Patterson Creek closest to the most upstream well), as shown on **Map 5-14**.

A natural transport pathway, i.e. a small tributary to the Main branch of Patterson Creek, was identified as contributing water to the WHPA-E. WHPA-E was extended to include this tributary assuming it is hydraulically similar to the Main branch. WHPA-E for the Northwest wellfield also includes a setback on land to include the Conservation Authority Regulation Limit or 120 m, whichever is greater. According to the Technical Rules, the 120 m setback is to be measured from the high water mark, however this GIS layer is not readily available. The Water Virtual Flow – Seamless Provincial Data Set and Water Poly Segment data layers from the Ontario Land Information Warehouse were used to identify the extent of waterbodies for the purpose of defining the 120 m setback. For in-land rivers, it is unlikely that there will be significant change in the wetted perimeter of the watercourse under high water conditions compared to this layer and therefore, this approach is considered to be appropriate.

Data Gaps and Uncertainty in Wellhead Protection Area Delineation

As a part of the Tier 3 Water budget, Simcoe's WHPAs were updated to reflect current knowledge of the area. Based on differences between the model layers and the well logs, and on the uncertainty of the recharge, the uncertainty of the resulting Simcoe WHPAs is considered to be low.

5.2.2 Simcoe Vulnerability Scoring in Wellhead Protection Areas

A vulnerability assessment using the surface to aquifer advection time (SAAT) method was completed to identify the vulnerability of the groundwater resources to surficial sources of contamination (SWS, 2010b; EarthFx, 2008). The SAAT time of travel values were used to create mapped vulnerability categories of low (value > 25 years), medium (5 < value ≤ 25 years) and high (value ≤ 5). The methodology is described in **Section 3.1.1**.

As shown on **Map 5-15,** the areas within and surrounding the Simcoe wellfields are mapped as predominantly highly vulnerable. One area of medium vulnerability area encompasses parts of the Chapel Street 2-year WHPA. A larger area of medium and low vulnerability is located to the northwest, covering most of the Northwest wellfield.

Vulnerability scores within the WHPAs were assigned following Part VII.2 in the Technical rules as summarized in **Table 5-15**.

Table 5-11: WHPA Vulnerability Scores

Intrinsic Vulnerability Category	Time of Travel Capture Zone			
	100-m	2-year	5-Year	25-year
High	10	10	8	6
Medium	10	8	6	4
Low	10	6	2	2

Map 5-17 shows the intrinsic vulnerability while **Map 5-18** shows the vulnerability scores, which represent an intersection of the capture zones and the vulnerability categories.

5.2.3 Simcoe Transport Pathways and Adjusted Vulnerability Score

Constructed or natural preferential pathways such as improperly abandoned boreholes or breaches in aquitards may be present within the WHPAs, and these pathways may allow contaminants to move rapidly from the ground surface to the underlying aquifer. Other preferential pathways may include pits and quarries, large diameter subsurface infrastructure such as storm and sanitary pipelines, and ditches.

Various potential transport pathways within the Simcoe wellfield capture zones were identified using various databases and GIS layers, including MECP Water Well Records, oil and gas wells, tile drainage, constructed drains, storm sewers and pits and quarries. All identified potential features are mapped on **Map 5-16**.

The MECP Technical Rules note that the low vulnerability areas can be increased to medium or high vulnerability or a medium vulnerability area can be increased to high due to the presence of one of the above noted anthropogenic transport pathways. Professional judgment is used to increase the vulnerability score based on the hydrogeological conditions, the type and nature of the pathway, and the potential cumulative impact of the pathways.

As shown on **Map 5-17,** there was one area of influence that increased the vulnerability score.

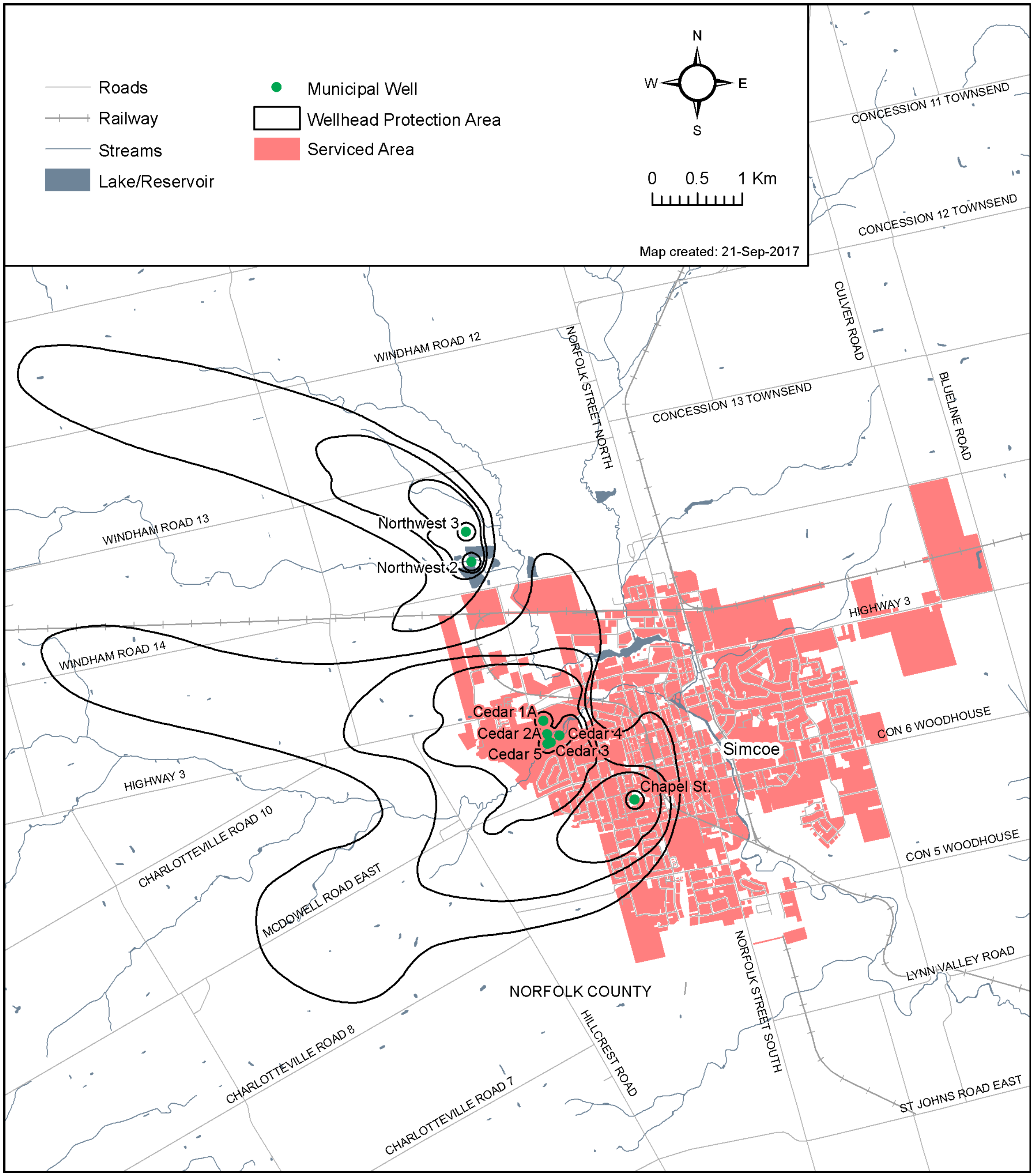
Vulnerability scores of 8 to 10 are found within the Chapel Street WHPAs (**Map 5-19**). Within the Cedar Street wellfield, the 2-year WHPA has a vulnerability score of 10 and the 5-year WHPA has a vulnerability score of 8. Vulnerability scores in the 25-year WHPA are mostly 6, with some 4 south of the Chapel St. wellfield. In the Northwest wellfield, the 2-year WHPA has a vulnerability score of 8 to 10 and the 5-year WHPA ranges from 8 to 2 with the majority of its area associated with a score of 2. The 25-year WHPA has a vulnerability score of 2 to 6.

Uncertainty and Limitations in Simcoe Vulnerability Scoring

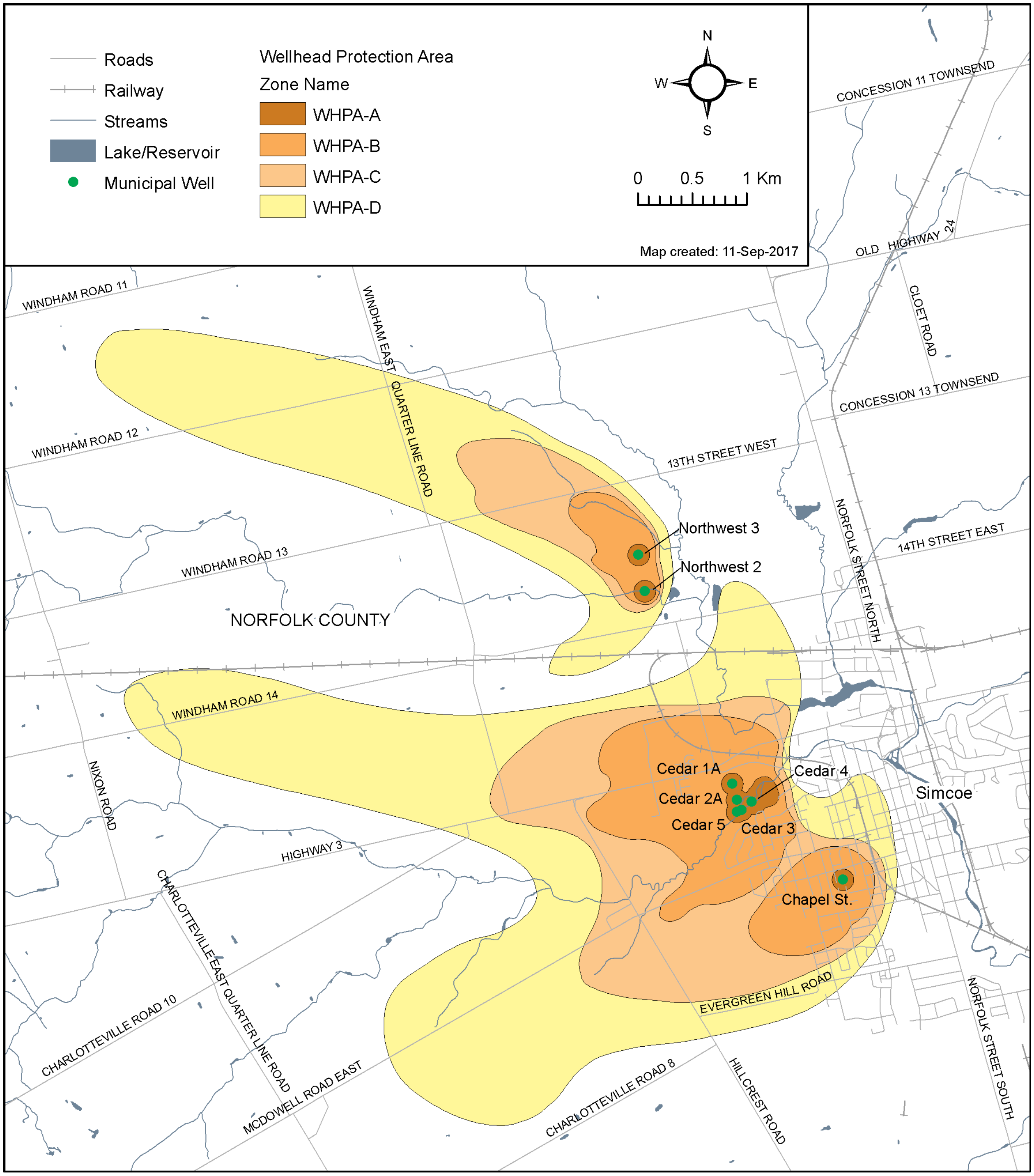
The uncertainty of the vulnerability score mapping is considered to be low, since the underlying vulnerability values are generally high.

There is very little uncertainty that the water level is close to the surface and the soil material between surface and water table has a high permeability. The uncertainty of the vulnerability category areas is, therefore, considered to be low.

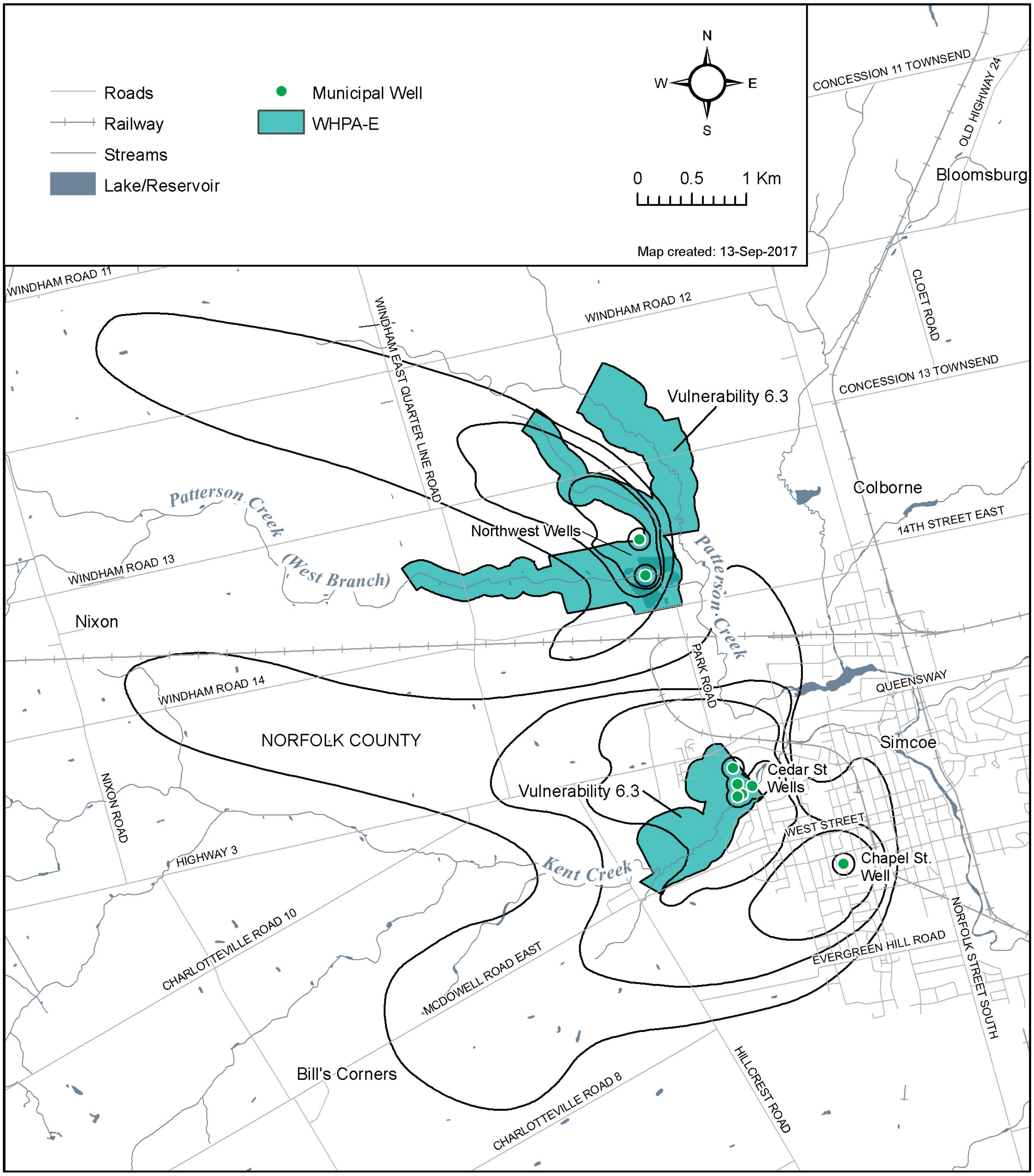
Map 5-9: Simcoe Serviced Area



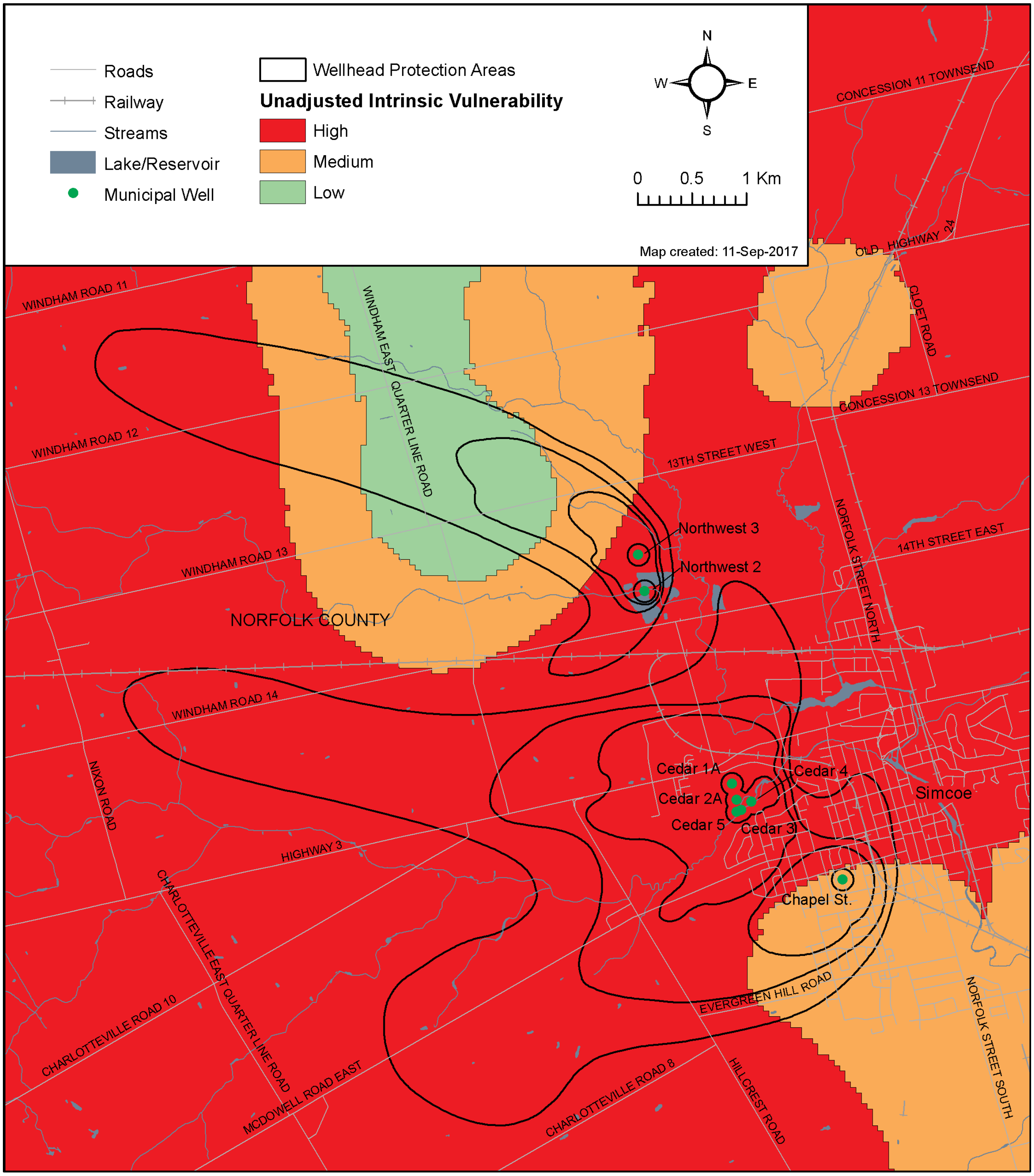
Map 5-10: Simcoe Wellhead Protection Area



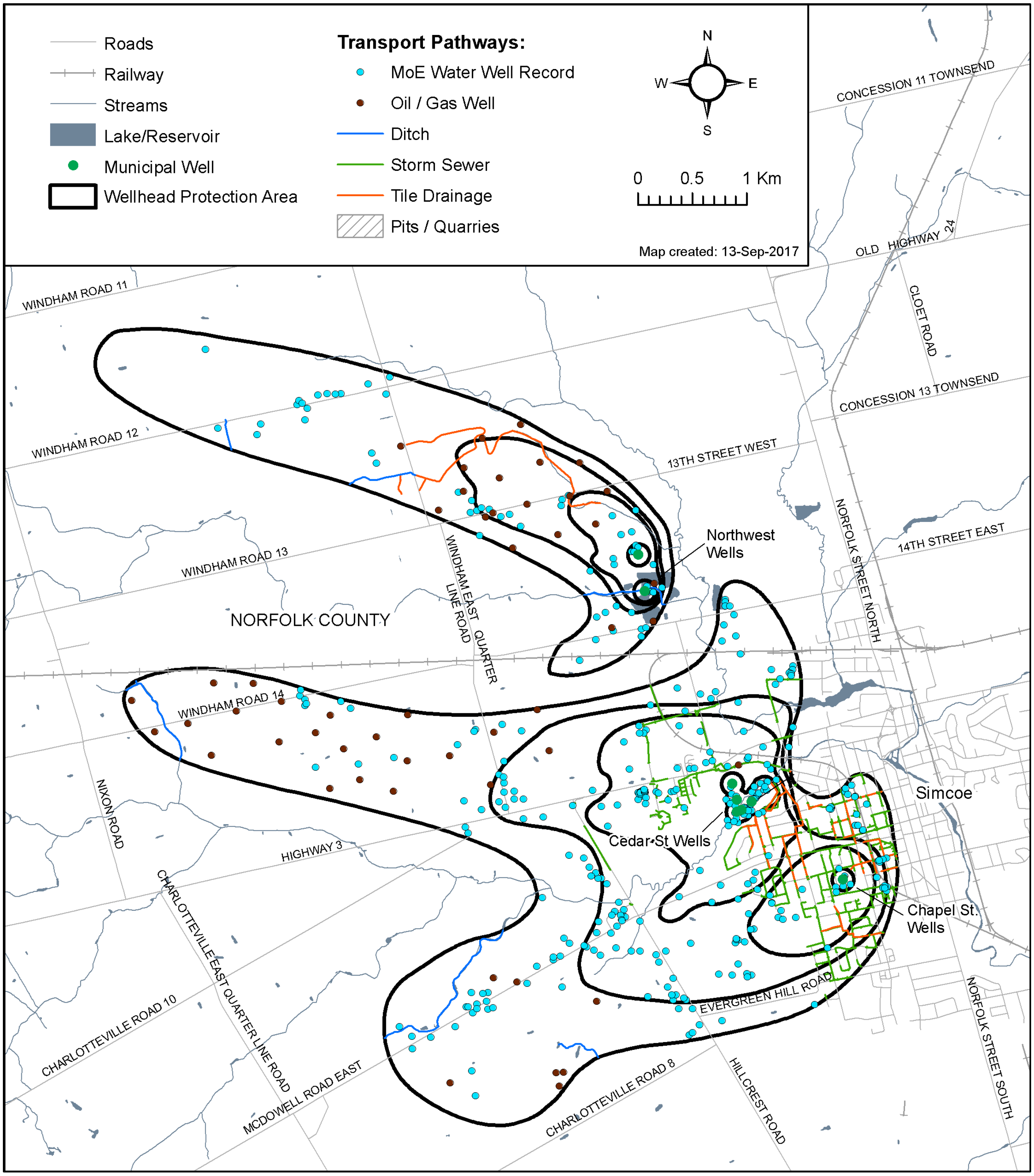
Map 5-11: Simcoe WHPA E



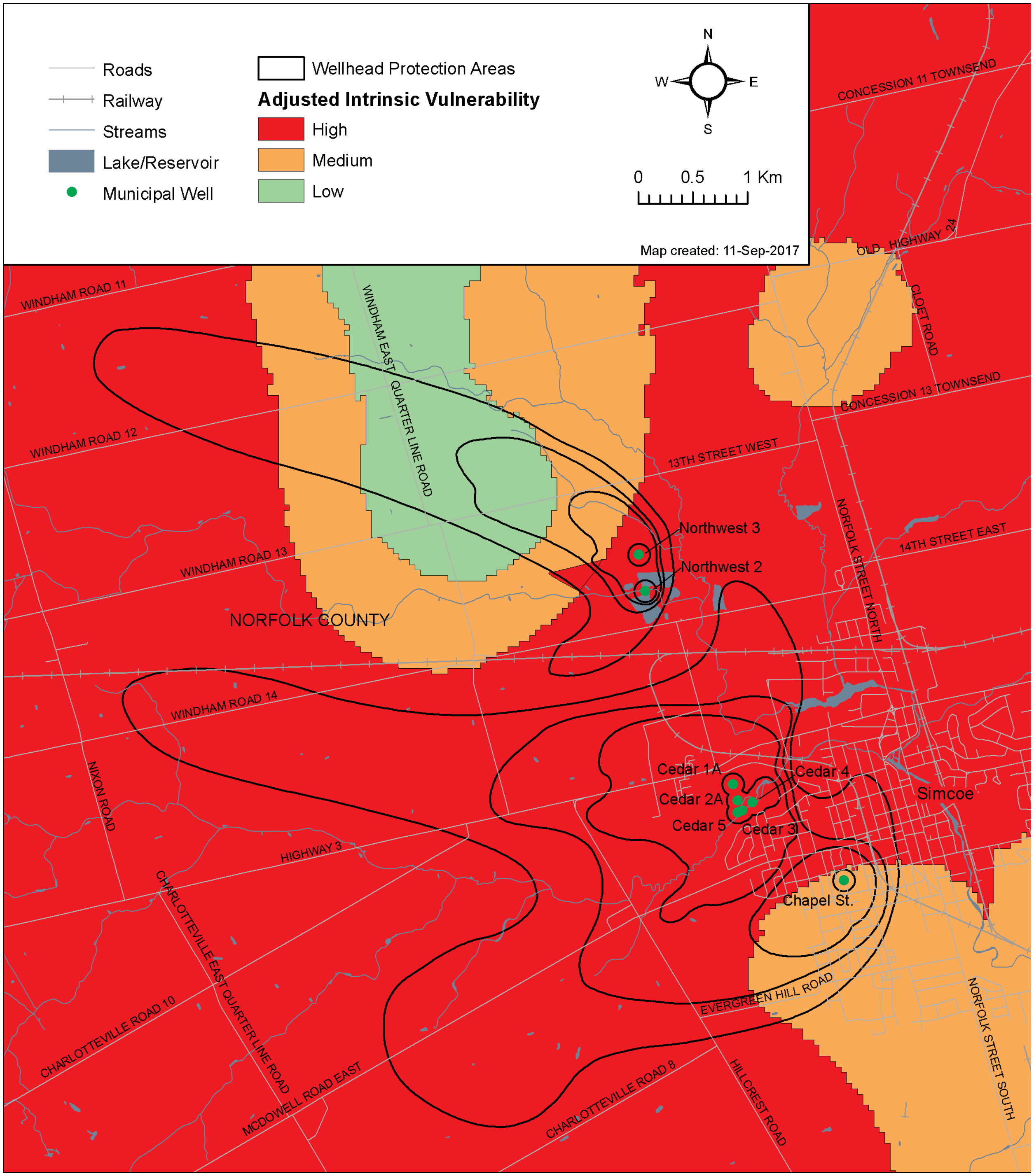
Map 5-12: Simcoe WHPA Unadjusted Intrinsic Vulnerability



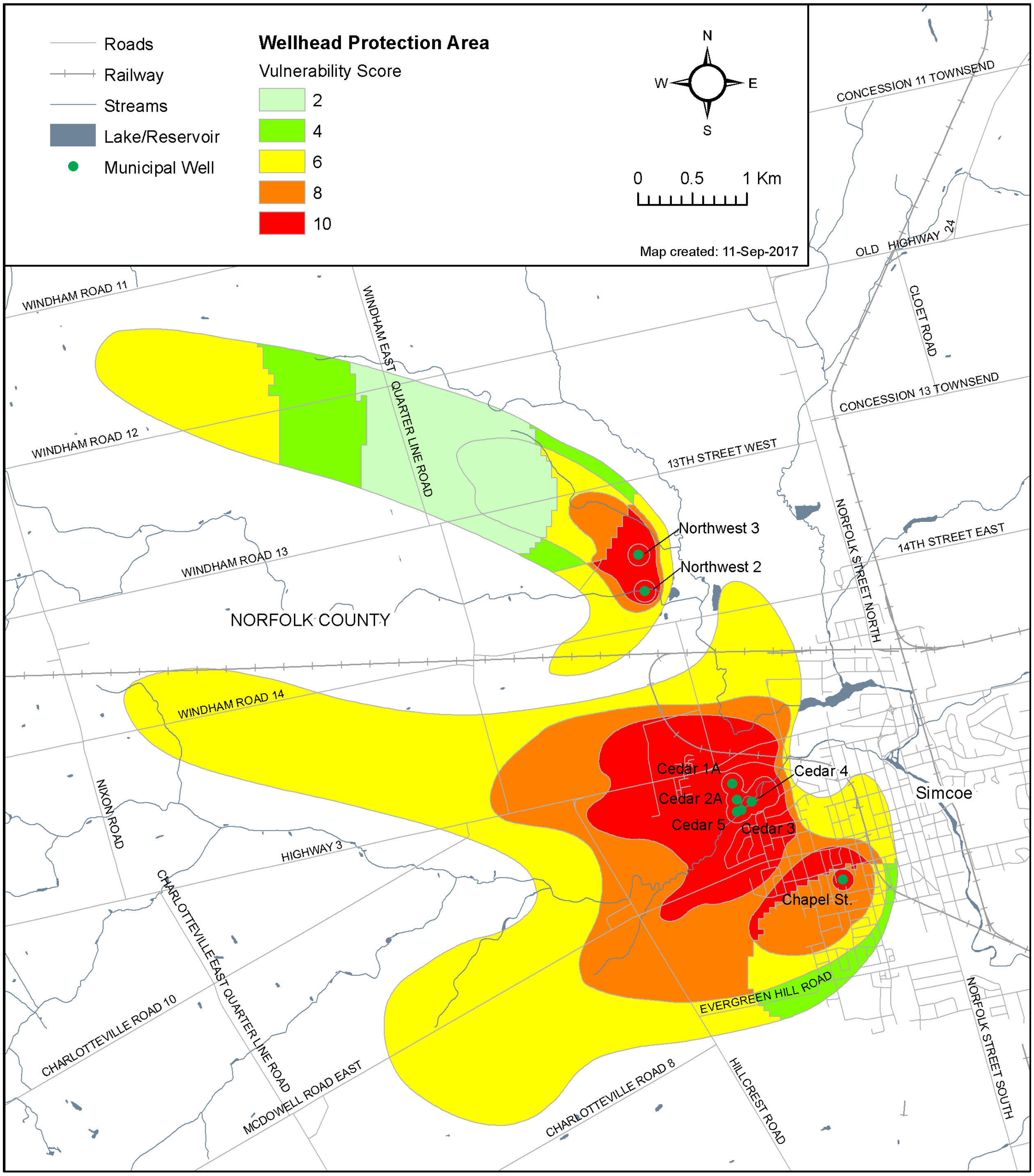
Map 5-13: Simcoe Transport Pathways



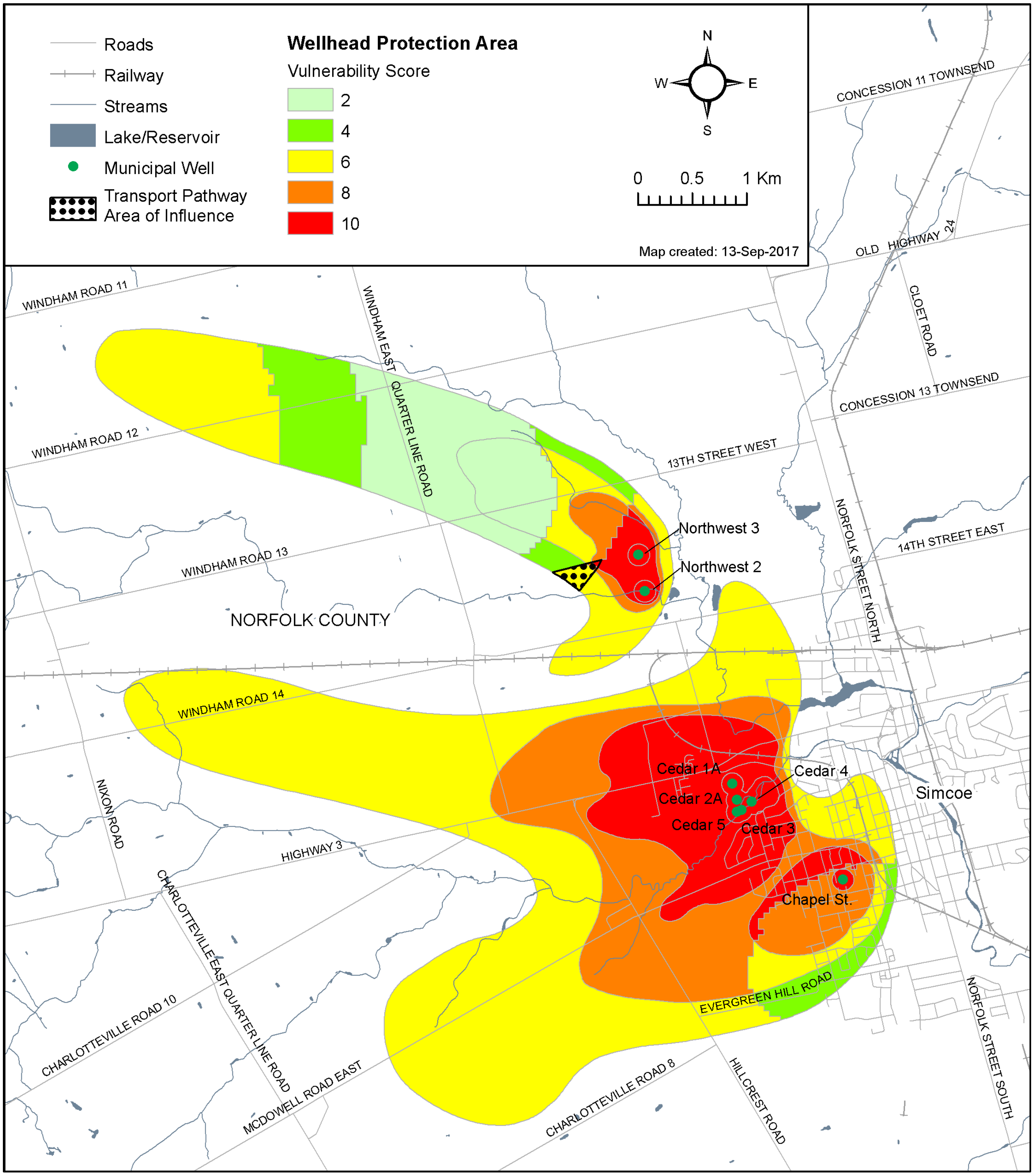
Map 5-14: Simcoe WHPA Adjusted Intrinsic Vulnerability



Map 5-15: Simcoe WHPA Vulnerability Scoring



Map 5-16: Simcoe Transport Pathways Area of Influence



WHPA-E Vulnerability Scoring

Vulnerability analysis of WHPA-E includes consideration for both the area and the source as described in the Technical Rules. The area vulnerability factor for a WHPA-E is prescribed to be the same as IPZ 2, i.e. between 7 and 9. The source vulnerability factors for GUDI wells in the Simcoe Northwest and Cedar Street wellfields have been assessed on the basis of Type C intake (i.e. the wellfields are hydraulically connected to in-land creeks) and therefore were assumed to be in the range of 0.9 to 1.0.

The area vulnerability factors for the WHPA-E zones in Simcoe were assigned a value of 7 based on the following:

- Land area within the two WHPA-E zones is largely rural and undeveloped, much of the undeveloped areas are forested.
- There is a small area of low density residential development within 120 m of Kent Creek in the WHPA-E for the Cedar Street wellfield in Simcoe but stormwater infrastructure mapping indicates that this area drains to a point downstream of the wellfield.
- Soils within the two WHPA-E zones are typical of the Norfolk Sand Plain and are composed of sand and gravel deposits making them highly permeable.
- There are only three minor road crossings of Patterson Creek within WHPA-E for the Northwest wellfield. There are no road crossings over Kent Creek within WHPA-E for the Cedar Street wellfield.
- No transport pathways were identified for the WHPA-E for the Cedar Street wellfield. One natural transport pathway was identified for the Northwest wellfield.

These factors, taken together, suggest a low vulnerability of the source to contamination from spills and therefore, the lowest score was assigned to each WHPA-E.

According to the Technical Rules, the source vulnerability factor for a surface water intake takes into consideration the depth of the intake from the water surface, the distance from land and historical water quality concerns. For a WHPA-E, the first two factors do not apply as there is no particular relevance to a GUDI well that is likely drawing surface water from a distributed area, rather than a point and only a small portion of the water getting to the well originates from surface water. There were no historical water quality concerns raised for any of the GUDI wells during the technical study. In addition, groundwater wells are known to be less vulnerable than surface water intakes to spills and other adverse conditions by virtue of the time delay between the surface water feature to the well, in-situ filtration through the soil and dilution of the surface water by groundwater from the rest of the well capture zone. For these reasons, the source vulnerability factor for the two GUDI wellfields in Simcoe was assigned the lowest value.

Combining the area and source vulnerability scores, the overall vulnerability score for Northwest and Cedar Street WHPA-E zones is 6.3 (see **Table 5-16**).

Table 5-12: Vulnerability Score Summary for the Simcoe WHPA-E Zones.

Location	Intake Protection Zone	Area Vulnerability Factor	Source Vulnerability Factor	Vulnerability Score
Simcoe Northwest wellfield	WHPA-E	7	0.9	6.3
Simcoe Cedar Street wellfield	WHPA-E	7	0.9	6.3

Limitations of Data and Methods used in the WHPA-E Vulnerability Assessment

Determination of the hydrologic and hydraulic characteristics of the surface water systems associated with each wellfield represented the most significant analytic component of the WHPA-E delineation, and arguably the largest potential source of error. Given the lack of available hydrologic or hydraulic models for the watercourse systems under investigation, an independent understanding of design flow conditions was developed. In-situ dye tracer analysis completed at bankfull or near bankfull conditions, statistical analysis of historic flow data, and simple single-section hydraulic analysis were all employed in the generation of design flow rates, the associated velocities, and the resultant 2-hour travel distances.

The comparable results for design flow conditions predicted by the dye tracer fieldwork results, under conditions observed to be at or near bankfull conditions, and the statistical flow analysis completed on historic Kent Creek data lends confidence to both sets of results. Further, the hydraulic modeling analysis completed to assess the relationship between various flow regimes and the associated water velocities confirmed a relative insensitivity on the velocity parameter. In other words, it was determined that a relatively large error in selection of a design flow regime translated into a relatively small impact on design velocities and, by association, the 2-hour travel distances.

Given the good agreement between the various analytic approaches, it is concluded that the hydrologic and hydraulic analysis represents a relatively low uncertainty.

5.2.4 Percent Managed Lands and Livestock Density

Percent Managed Lands

Managed Lands are lands to which nutrients are applied. Managed lands are categorized into two groups: 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 land includes golf courses, sports fields, lawns and other grassed areas that may receive nutrients (primarily commercial fertilizer).

To determine the location and percentage of agriculturally managed lands, parcels with agricultural land use were identified on the aerial photography and digitized. All areas with wooded land, wetlands and water were cut out of these surfaces.

To assess the percentage of non-agricultural managed land, all non-agricultural parcels were first delineated. The green space area was then digitized in this zone and the percentage of green space of the total area was calculated.

Managed lands within the Simcoe WHPAs are summarized in **Table 5-17** and shown on **Map 5-20.**

Table 5-13: Managed Land Calculations

WHPA	WHPA Area		Agricultural Managed Land Area		Non-agricultural Managed Land Area		Managed Land Area		Managed Land
	m²	Acres	m²	Acres	m²	Acres	m²	Acres	%
Northwest Wellfield									
A (Well 2)	31,354	8	0.0	0.0	19,806	5	19,806	5	63%
A (Well 3)	31,354	8	9,282	2	13,699	3	22,981	6	75%
B	442,001	109	306,463	76	68,435	17	374,898	93	85%
C	991,996	245	859,660	212	80,823	20	940,484	232	95%
D	4,536,773	1,121	2,565,137	634	527,628	130	3,092,765	764	68%
Cedar St.									
A	156,033	39	0.0	0.0	35,966	9	35,966	9	23%
B	2,201,825	544	367,703	91	921,142	228	1,288,845	319	59%
Chapel St.									
A	31,075	8	0.0	0.0	19,009	5	19,009	5	63%
B	764,375	189	83,336	21	312,997	77	396,333	98	52%
Cedar St. / Chapel St. Combined									
C	3,422,342	846	1,700,469	420	880,189	218	2,580,658	638	75%
D	9,221,662	2,279	5,599,120	1,384	1,110,479	274	6,709,600	1,658	73%

Livestock Density

Livestock density is defined as nutrient units per acre of agricultural managed land within a vulnerable area. A nutrient unit is defined as the number of animals that will give the fertilizer replacement value of the lesser of 43 kilograms of nitrogen or 55 kilograms of phosphate per year as nutrients.

Livestock density was calculated using the MOE 2009 guidance “Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers” for calculating Livestock Density in the WHPAs. Using aerial photography, livestock buildings were identified and square metre areas were measured for each structure. Each category of livestock was calculated into Nutrient Units as per the Barn/Nutrient Unit Relationship Table provided by the MOE (2009) and area weighted given the amount of Agricultural Managed Land that fell within each WHPA zone. The sum of the total Nutrient Units for each WHPA zone was then divided by the agricultural managed land area acreage to arrive at the NU/acre density for each WHPA zone.

In Simcoe, eight barns were identified in the Northwest wellfield that likely are used for dairy, beef, horses, and/or chickens. These barns are located in WHPA-C and WHPA-D, with seven within WHPA-D. Livestock densities were 0.2 to 0.6 in WHPA-C and WHPA-D, respectively. In the Cedar Street wellfield, three properties were identified with an estimated livestock density of 1.9 in the WHPA–B. WHPA-C and WHPA-D for Cedar and Chapel wellfields combined had 4 properties in total with livestock densisties of 0.1 and 1.9 as presented on **Table 5-18, Map 5-22** and **Map 5-23.**

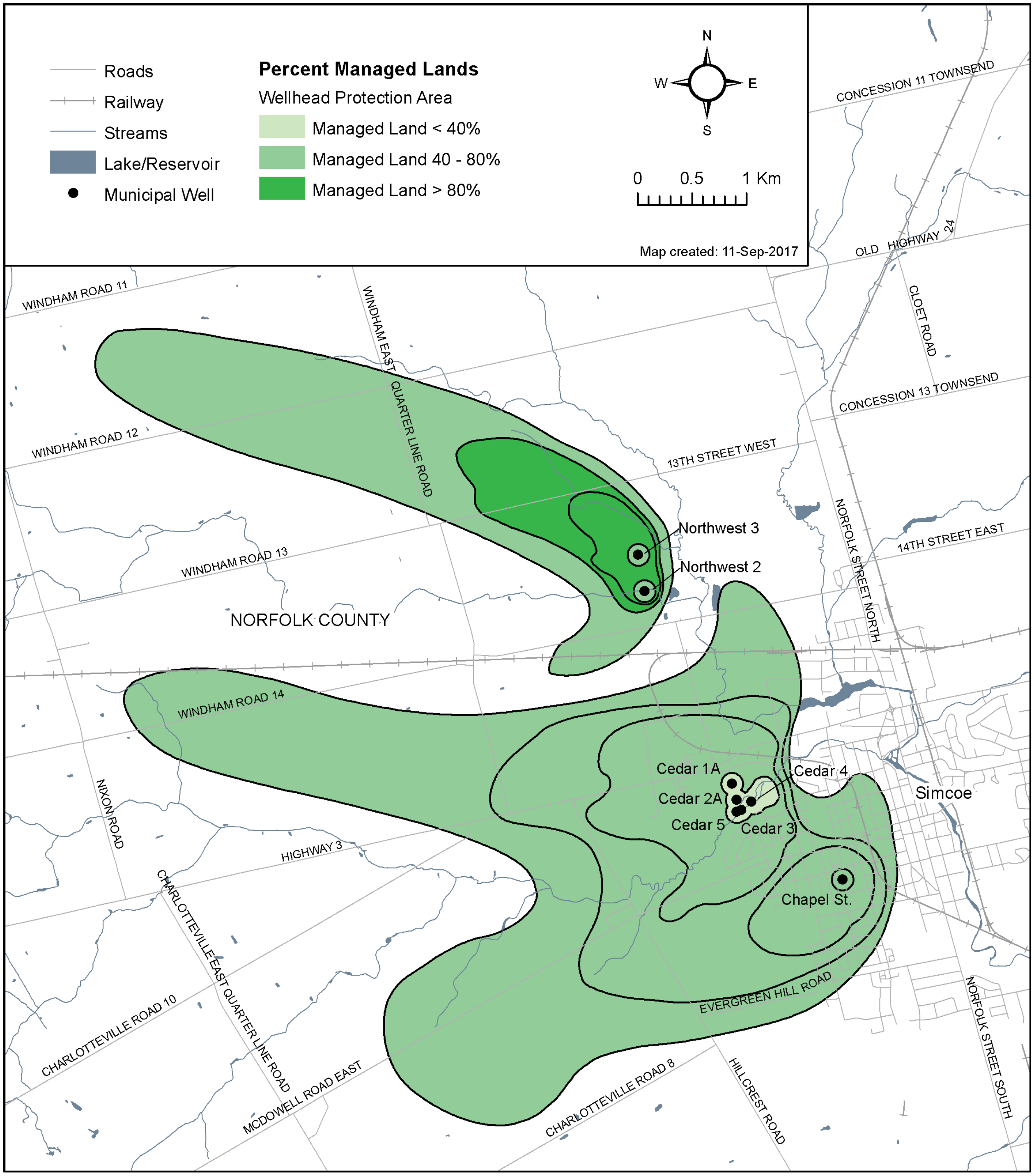
Table 5-14: Livestock Density Calculations				
WHPA	Agricultural Managed Land Acreage	Total NU	NU/Acre	Animal Type (NU Conversion Factor)
Northwest Wellfield				
A (Well 2)	0	0.0	0.0	No animals
A (Well 3)	2	0.0	0.0	No animals
B	76	0.0	0.0	No animals
C	212	33.6	0.2	One property, assumed dairy (11 m^2/NU)
D	634	402.6	0.6	Seven properties: assumed dairy (11 m^2/NU), beef (9 m^2/NU), horses (26 m^2/NU) and chickens (25 m^2/NU)
Cedar St.				
A	0	0.0	0.0	No animals
B	91	169.4	1.9	Three properties: assumed chicken (25 m^2/NU) and mixed livestock (13 m^2/NU)
Chapel St.				
A	0	0.0	0.0	No animals
B	21	0.0	0.0	No animals
Cedar St. / Chapel St. Combined				
C	420	35.7	0.1	One property, assumed mixed livestock (13 m^2/NU)
D	1,384	2,574.2	1.9	Three properties: assumed swine (7 m^2/NU) and dairy (11 m^2/NU)

5.2.5 Percent Impervious Surface Area in Wellhead Protection Areas

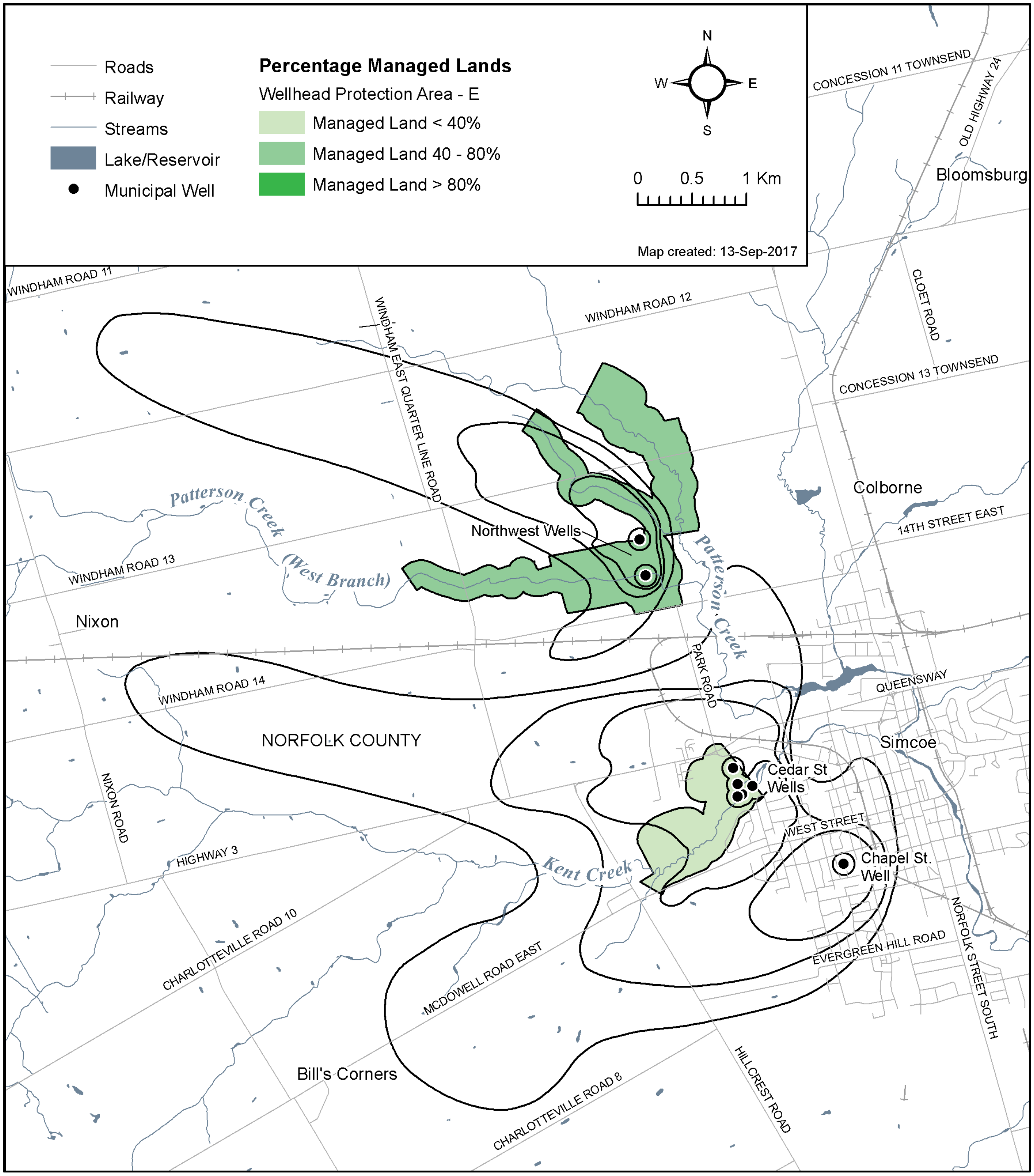
The quantification and mapping of the percentage of impervious surface area was completed to assess the potential threats related to road salt application. A 1 km x 1 km grid was overlaid and centered on the WHPAs and the percentage of impervious area for each grid cell was determined using the project GIS. For the Simcoe area, this included the impervious area represented by roads, parking lots, and sidewalks. **Map 5-10** and **Map 5-25** presents the percentage of impervious surface areas for the Simcoe WHPAs. In order for the application of road salt to be considered a significant threat in the Simcoe area, the percentage impervious area must be greater than 80% within WHPA-A or WHPA-B where the vulnerability score is 10. Impervious percentage ranged from 0 % to 12.9% across the Northwest wellfield WHPAs and 0.0 to 46.2% across the Cedar St./Chapel St. WHPAs, therefore the application of road salt is not considered a significant threat.

This methodology departs from Technical Rule 17 as the grid was centered on the centroid of the WHPA rather than the source protection area. The rationale for this departure is that the previous percent impervious surface was calculated prior to the release of the current Technical Rules (November 16th, 2009) and was consistent with the previous version of the Technical Rules (November 20th, 2008). The method of centering the grid on the vulnerable area is considered to be an equivalent approach. As per Technical Rule 15.1, the Director has provided confirmation agreeing to the departure. The Director’s letter of confirmation can be found in **Appendix B**. This method was retained for the current update to be consistent with the previous work.

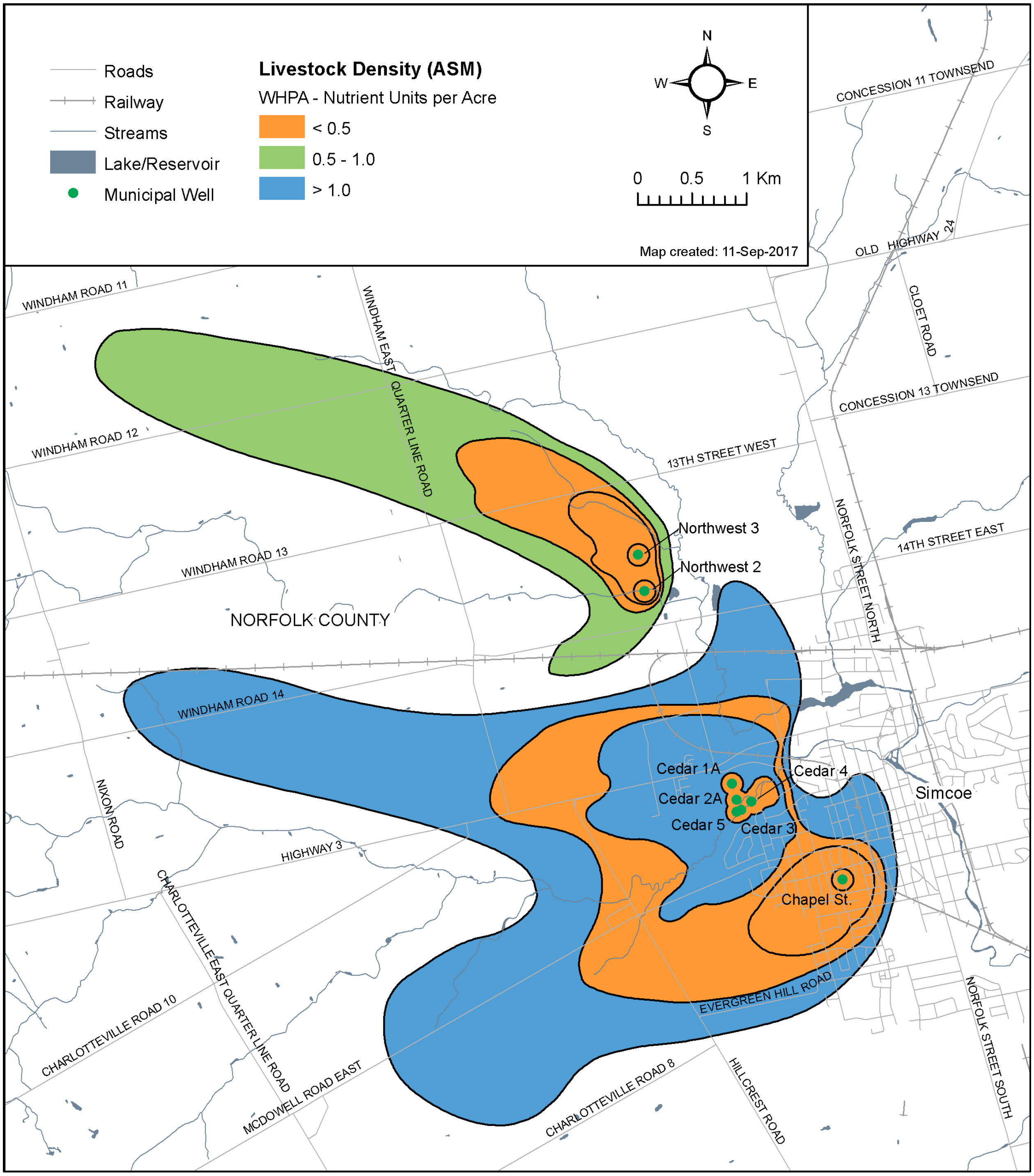
Map 5-17: Percent Manage d Lands within the Simcoe WHPA



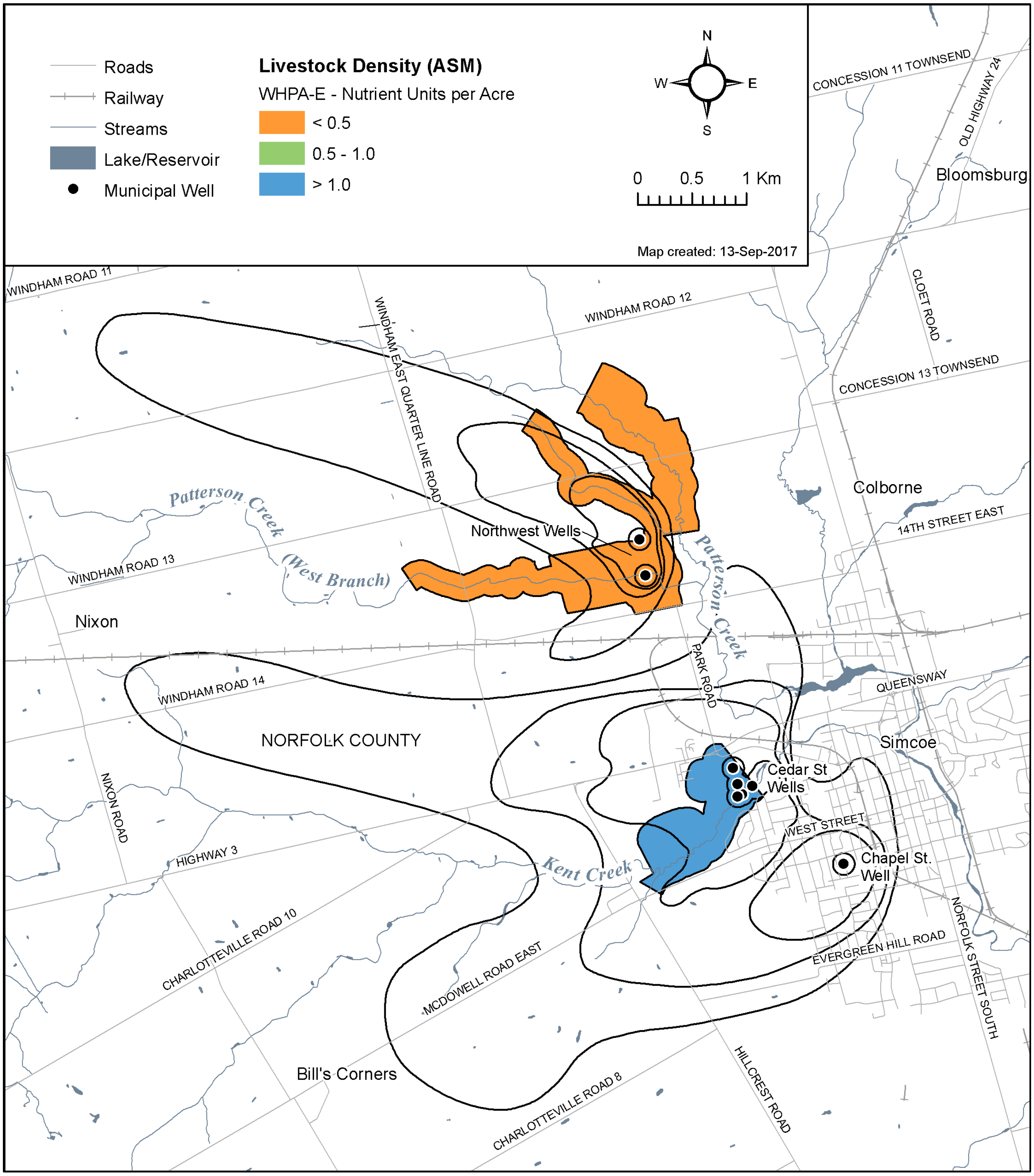
Map 5-18: Percent Managed Lands within the Simcoe WHPA E



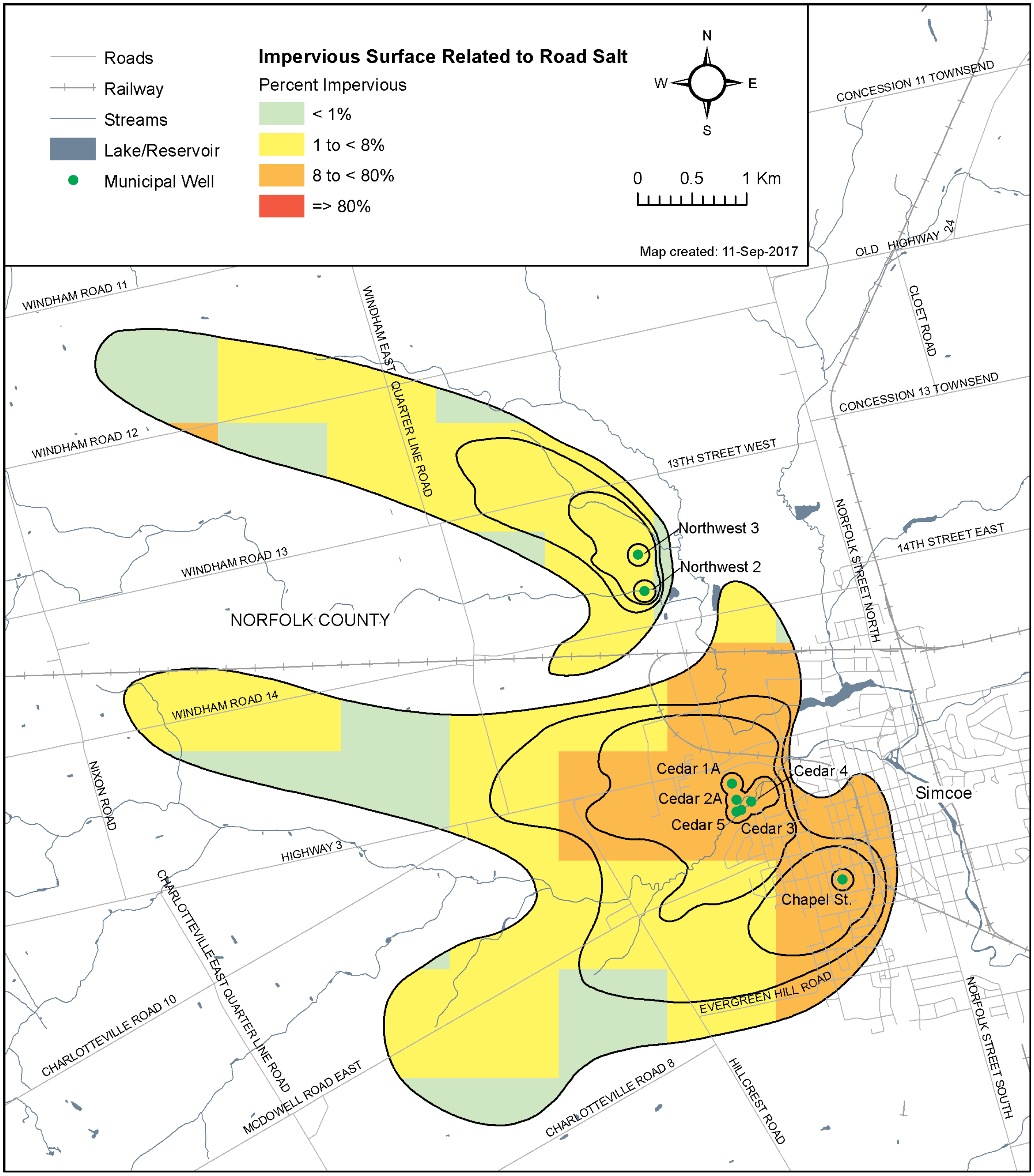
Map 5-19: Livestock Density within the Simcoe WHPA



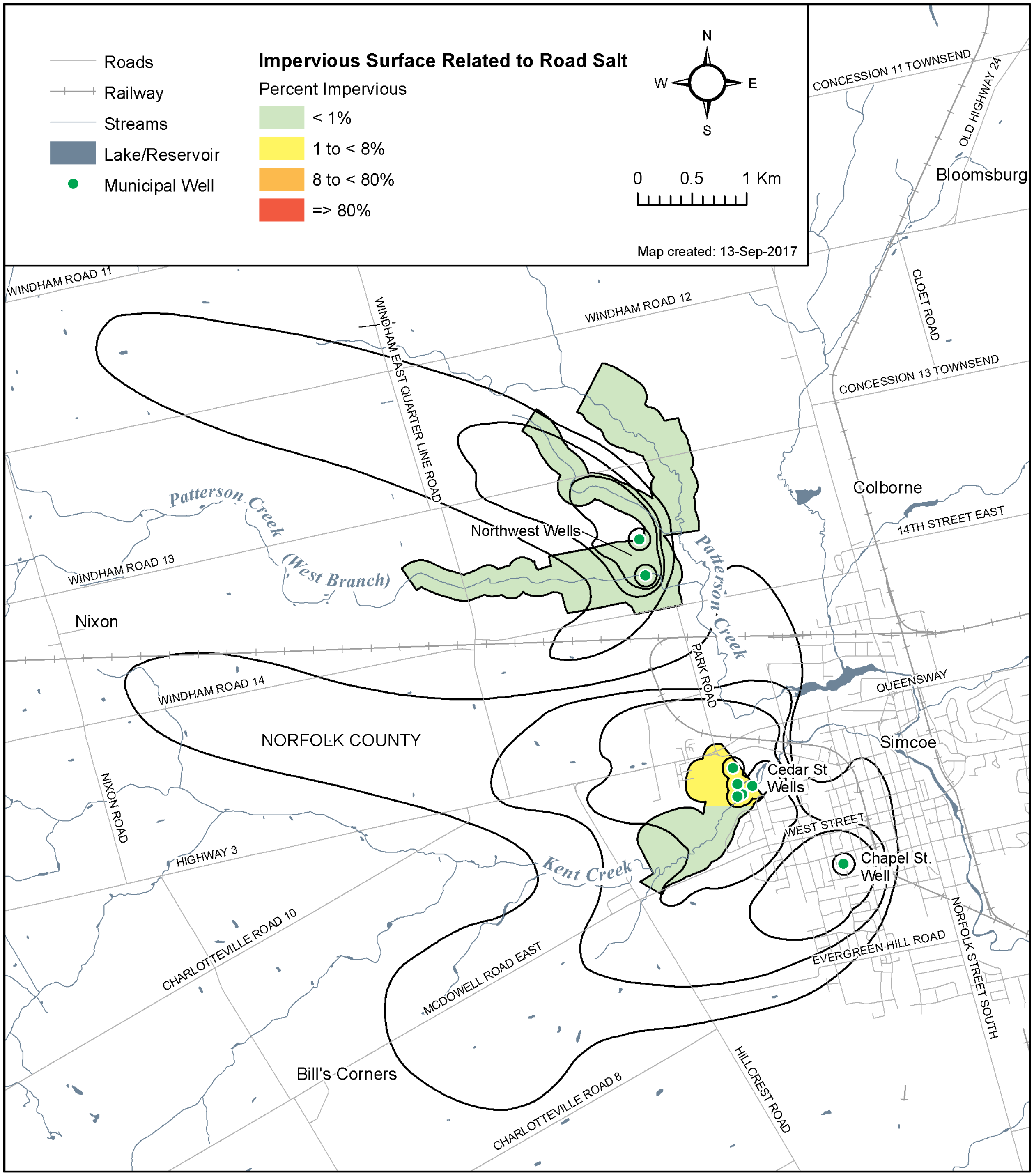
Map 5-20: Livestock Density within the Simcoe WHPA E



Map 5-21: Impervious Surface within the Simcoe WHPA



Map 5-22: Impervious Surface within the Simcoe WHPA E



5.2.6 Simcoe Water Quality Threats Assessment

Table 5-19 provides a summary of the threat levels possible in the Simcoe Well Supply for chemicals, dense non-aqueous phase liquids (DNAPL), and pathogens. A checkmark indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; a blank cell indicates that it is not. The colours shown for each vulnerability score correspond to those shown in the maps.

Table 5-15: Identification of Drinking Water Quality Threats in the Simcoe WHPAs

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals	WHPA-A/B	10	✔	✔	✔
	WHPA-B/C	8	✔	✔	✔
	WHPA-B/C/D	6		✔	✔
	WHPA-C/D	2 & 4			
	WHPA-E	6.3		✔	✔
Handling / Storage of DNAPLs	WHPA-A/B/C	Any Score	✔		
	WHPA-D	6		✔	✔
	WHPA-D	2 & 4			
	WHPA-E	6.3			✔
Pathogens	WHPA-A/B	10	✔	✔	
	WHPA-B	8		✔	✔
	WHPA-B	6			✔
	WHPA-E	6.3		✔	✔

Activities that Are or Would be Drinking Water Threats in the Wellhead Protection Areas and Intake Protection Zones

Table 5-20 lists the activities that are prescribed drinking water quality threats. Typical land use activities that are associated with the threat are also listed.

Land Use Inventory Methodology

A land use threats assessment was completed through the review of existing data within Simcoe's WHPAs (Matrix, 2017) and summarized in **Table 5-20**. Limited site specific information was collected as a part of this assessment and most identified threats were considered potential, requiring further review and site specific assessments to confirm their presence.

Table 5-16: Drinking Water Quality Threats

Prescribed Drinking Water Quality Threats Ontario Regulation 287/07 s.1.1.(1)		**Land Use/Activity**
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	Landfills – Active, Closed Hazardous Waste Disposal, Liquid Industrial Waste

Table 5-16: Drinking Water Quality Threats		
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage Infrastructures Septic Systems, etc.
3	The application of agricultural source material to land.	e.g. manure, whey, etc.
4	The storage of agricultural source material.	e.g. manure, whey, etc.
5	The management of agricultural source material.	Aquaculture
6	The application of non-agricultural source material to land.	Organic Soil Conditioning Biosolids
7	The handling and storage of non-agricultural source material.	Organic Soil Conditioning Biosolids
8	The application of commercial fertilizer to land.	Agriculture Fertilizer
9	The handling and storage of commercial fertilizer.	General Fertilizer Storage
10	The application of pesticide to land.	Pesticides
11	The handling and storage of pesticide.	General Pesticide Storage
12	The application of road salt.	Road Salt Application
13	The handling and storage of road salt.	Road Salt Storage
14	The storage of snow.	Snow Dumps
15	The handling and storage of fuel.	Petroleum Hydrocarbons
16	The handling and storage of a dense non-aqueous phase liquid.	DNAPLs
17	The handling and storage of an organic solvent	Organic Solvents
18	The management of runoff that contains chemicals used in the de-icing of aircraft.	De-icing
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	Agricultural Operations
22	The establishment and operation of a liquid hydrocarbon pipeline	Oil Pipelines

Conditions Evaluation

To identify potential threats from Conditions (Technical Rules, Part XI.3) within the WHPAs, multiple data sources were reviewed including aerial and roadside imagery; interviews with municipal staff; historical and current federal, provincial and private environmental databases; and the historic 2003 Norfolk County Threats Database.

A total of 17 potential non-aqueous phase liquid (NAPL) contaminant releases were found in WHPA-B, C, or D. Three of these NAPL releases, which resulted from past activities, were identified as potentially impacting groundwater and should therefore be further assessed as Condition-based threats according to Technical Rule 126. The remainder of the releases may potentially be considered Condition-based threats if the contaminants are also found in groundwater, or if the contaminant is listed in the applicable tables of the Soil, Groundwater and Sediment Standards, and present at a concentration that exceeds the applicable standards.

These circumstances could not be determined from the data available at the time of the conditions-based threats assessment and therefore the remaining contaminant releases cannot formally be considered Conditions. This is noted as a data gap that requires more refinement.

Simcoe - Enumeration of Significant Threats

Northwest Wellfield

Eleven significant prescribed drinking water threats were identified in the Northwest wellfield WHPAs. These threats are listed in **Table 5-21**. Most activities identified as a potential significant threat were related to agricultural land use.

Table 5-17: Significant Drinking Water Quality Threats in Simcoe Northwest WHPAs

PDWT #[1]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
3	Application Of Agricultural Source Material (ASM) To Land	4	WHPA-A WHPA-B
8	Application Of Commercial Fertilizer to Land	4	WHPA-B
10	Application of Pesticide to Land	3	WHPA-B
Total number of Activities		**11**	
Total number of properties		**4**	

1: Prescribed Drinking Water Threat Number refers to the prescribed drinking water threats listed in O. Reg 287/07 s.1.1.(1).

2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category.

Note: Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facilty.

Cedar Street Wellfield

Two hundred and twenty five activities for sixty eight prescribed drinking water threats were identified in the Cedar Street WHPAs as listed in **Table 5-22**. The majority of the activities identified as potentially significant threats were agricultural and related to the identified Cedar Street wellfield's nitrate Issue Contributing Area.

Table 5-18: Significant Drinking Water Quality Threats in Simcoe Cedar Street WHPAs

PDWT #[1]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
1	Waste Disposal Site – Storage of wastes described in clauses (p), (q), (r), (s), (t), or (u) of the definition of hazardous wastes	15	WHPA-B
2	Sewage System Or Sewage Works – Sanitary Sewers and related pipes	2	WHPA-A WHPA-B ICA
	Sewage System Or Sewage Works - Onsite Sewage Systems	50	WHPA-B ICA
	Sewage System Or Sewage Works - Septic System Holding Tank	2	WHPA-B ICA
3	Application Of Agricultural Source Material (ASM) To Land	15	WHPA-B

Table 5-18: Significant Drinking Water Quality Threats in Simcoe Cedar Street WHPAs			
PDWT #[1]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
			ICA
4	Storage of Agricultural Source Material (ASM)	6	WHPA-B ICA
8	Application of Commercial Fertilizer to Land	20	WHPA-B ICA
9	Storage of Commercial Fertilizer	10	WHPA-B ICA
10	Application Of Pesticide To Land	6	WHPA-B
11	Storage of A Pesticide	6	WHPA-B
15	Handling of Fuel	14	WHPA-B
	Storage of Fuel	15	WHPA-B
16	Handling Of A Dense Non Aqueous Phase Liquid (DNAPL)	21	WHPA-B
	Storage Of A Dense Non Aqueous Phase Liquid (DNAPL)	21	WHPA-B
17	Storage of an Organic Solvent	22	WHPA-B
Total Number of Activities		**225**	
Total Number of Properties		**68**	

1: Prescribed Drinking Water Threats Number refers to the prescribed drinking water threat listed in O. Reg 287/07 s.1.1.(1).

2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category.

Note: Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facilty.

Chapel Street Wellfield

Thirty one activities for twenty one prescribed drinking water threats were identified within the Chapel Street WHPAs. The results are summarized in **Table 5-23.**

Table 5-19: Significant Drinking Water Quality Threats in Simcoe Chapel Street WHPAs			
PDWT #[1]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
1	Waste Disposal Site – Storage of wastes described in clauses (p), (q), (r), (s), (t), or (u) of the definition of hazardous wastes	2	WHPA-B
2	Sewage System Or Sewage Works – Sanitary Sewers and related pipes	2	WHPA-A WHPA-B ICA
	Sewage System Or Sewage Works - Septic System	10	ICA
3	Application Of Agricultural Source Material (ASM) To Land	8	WHPA-B

Table 5-19: Significant Drinking Water Quality Threats in Simcoe Chapel Street WHPAs

PDWT #[1]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
8	Application of Commercial Fertilizer to Land	9	ICA
Total Number of Activities		**31**	
Total Number of Properties		**21**	

1: Prescribed Drinking Water Threats Number refers to the prescribed drinking water threat listed in O. Reg 287/07 s.1.1.(1).

2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category.

Note: Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facilty.

Chapel and Cedar Street Wellfields Combined

Thirty one activities for fourteen prescribed drinking water threats were identified within the combined Chapel and Cedar Street WHPAs. The results are summarized in **Table 5-24.**

Table 5-20: Significant Drinking Water Quality Threats in Combined Simcoe Cedar Street and Chapel Street WHPAs

PDWT #[1]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
3	Application Of Agricultural Source Material (ASM) To Land	2	ICA
8	Application of Commercial Fertilizer to Land	2	ICA
15	Handling of Fuel	1	WHPA-B
	Storage of Fuel	1	WHPA-B
16	Handling Of A Dense Non Aqueous Phase Liquid (DNAPL)	12	WHPA-B WHPA-C
	Storage Of A Dense Non Aqueous Phase Liquid (DNAPL)	12	WHPA-B WHPA-C
17	Storage of an Organic Solvent	1	WHPA-B
Total Number of Activities		**31**	
Total Number of Properties		**14**	

1: Prescribed Drinking Water Threats Number refers to the prescribed drinking water threat listed in O. Reg 287/07 s.1.1.(1).

2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category.

Note: Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facility.

Data Gaps and Uncertainty in Threats Assessment

In many cases the results of the desktop inventory did not include all required information to determine whether the circumstances for the drinking water threats were met. Where information was missing to determine the circumstances under which a threat occurred, a conservative assumption was used. This led to a significant number of threats, many of which need to be confirmed by a more detailed analysis including interviews with land owners.

Given the conservative approach that was chosen in this study, the uncertainty that current land uses posing a threat to the drinking water were missed is low. At the same time it is likely that many of the threats that were identified as significant are not a threat in reality. The uncertainty of the current threats assessment of land uses based on the desktop inventory is high.

5.2.7 Simcoe Drinking Water Quality Issues Evaluation

The objective of the Issues evaluation is to identify drinking water Issues where the existing or trending concentration of a parameter or pathogen at an intake, well or monitoring location would result in the deterioration of the quality of water for use as a source of drinking water. The parameter or pathogen must be listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards (ODWQS) or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (Technical Rules XI.1 (114 – 117)).

Once a drinking water Issue is identified, the objective is to identify all sources and threats that may contribute to the issue within an Issue contributing area and manage these threats appropriately. If at this time the Issue contributing area can not be identified or the Issue can not be linked to threats then a work plan must be provided to assess the possible link.

If an Issue is identified for an intake, well or monitoring location, then all threats related to a particular Issue within the Issue Contributing Areas are classified as significant drinking water threats, regardless of the vulnerability.

Water treatment for the Simcoe municipal wells consists of addition of hydrofluosilicic acid, UV disinfection, disinfection using sodium hypochlorite and iron and manganese removal using sodium permanganate and sodium silicate.

The following is a summary of the analytical results with respect to water quality for the Simcoe municipal wells:

Schedule 1 Parameters and Pathogens

Weekly samples analysed for *E. coli* and total coliforms were available from 2005 to 2016. Occurrences of total coli detects were found to be most frequent in the Cedar St. Wells where total coli were detected 329 times over the entire 12 year period of available data and E. coli 48 times. All other wells only accounted for additional 13 detects of total coli and no E. coli were encountered. The well operator confirmed that the disinfection system provides the appropriate treatment for this low number of microbes.

Schedule 2 Parameters

<u>*Chapel St. Wellfield*</u>

All 2009 quarterly nitrate levels were above the 50% MAC screening benchmark and nitrate also occasionally was above the same benchmark in the previous years. Similarly, from 2010 to 2016, nitrate exceeded the 50% MAC in all quarterly sampling, except in 2010 where 3 of the 4 sampling events showed exceedances above the 50% MAC. Nitrate was therefore identified as an Issue for the Chapel St. wellfield as per Technical Rule 114.

Cedar St. Wellfield

Nitrate was found to be very close and above the 50% MAC limit and exceeded this benchmark limit frequently. Nitrate was therefore identified as an Issue as per Technical Rule 114.

Nofolk County staff identified trichloroethylene (TCE) and chloroform as two parameters that have been detected at Cedar St. Well 3 and Well 2, respectively. TCE concentrations at Well 3 have ranged from 0.6 to 0.8 ug/L since March 2017, which is under the MAC of 5 ug/L (Schedule 2). Chloroform at Well 2 has ranged from 0.6 to 1.4 ug/L since May 2016. While chloroform is not a parameter in Schedule 2 or 3 of the ODWQS, or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines, it has a prescribed potable groundwater site condition standard of 2.4 ug/L under Table 2 of the Soil, Ground Water and Sediment Standards. Both parameters are currently being sampled on a monthly basis.

Northwest Wellfield

Water quality results from the NW3 Well exceeded the ODWQS standards for benzo(a)pyrene and dichloromethane on December 19, 2001. Both parameters have not been detected since, and the elevated concentrations were therefore considered to be a single event.

In 2015, lead was detected on one occasion in the distribution system at a concentration of 17.5 ug/L (MAC = 10 ug/L). After the system was flushed, all subsequent samples were within guidelines.

Nitrate was documented in annual reporting at more than 50% MAC at the northwest booster or reservoir POE on 4 occasions in 2011 and 1 occasion in 2015; however, Norfolk County staff indicate that they have not had nitrate issues in the Northwest wellfield and the results were likely erroneous.

Schedule 3 Parameters

Chapel St. Wellfield

Tritium and gross alpha and gross beta activity information was available from a single sample collected in 2001. All activities were close to or below the detection limit indicating that no further analysis of Schedule 3 parameters was required.

Cedar St. Wellfield

Tritium activity was available from one sample, and gross alpha and gross beta activity information was available from three samples. All activities were close to below the detection limit indicating that no further analysis of Schedule 3 parameters was required.

Northwest Wellfield

No elevated values of gross alpha and gross beta were found in the available analysis which made the analysis of further elements of Schedule 3 (radioactive) parameters unnecessary. Three samples with tritium activity analysis were available and the activity remained below the detection limit of 1,000 Becquerel/L.

Table 4 Parameters

Chapel St. Wellfield

The Chapel St. Well exceeded ODWQS standards for hardness, manganese and dissolved organic carbon on December 19, 2001. Only this one set of sampling results was provided for hardness and dissolved organic carbon results at Chapel St. The dissolved organic carbon peak was also found in other wells such as the Northwest and the former First Avenue Wellfields. Organic carbon was therefore noted as a concern. Hardness and manganese were also considered to be above the screening benchmark frequently and were also noted as a concern.

Cedar St. Wellfield

Organic nitrogen, hardness, manganese, total dissolved solids and dissolved organic carbon exceeded the ODWQS operational guidelines and aesthetic objectives at the Simcoe Cedar St. wells on December 19, 2001. Only this one set of sampling results was provided for organic nitrogen, hardness, manganese, dissolved organic carbon and total dissolved solids. In the absence of samples, which may have exonerated the mentioned elevated levels, all parameters were noted as a concern.

Sodium was consistently above the Health Advisory level of 20 mg/L in the past years and this parameter was therefore noted as a concern.

Northwest Wellfield

Exceedances of the operational guidelines and aesthetic objectives at wells NW2 and NW3 occurred most frequently for water hardness, colour, iron and manganese, while intermittent exceedances of the aesthetic objective for dissolved organic carbon and turbidity and organic nitrogen were also observed at NW2. The parameters hardness, iron and manganese were therefore noted as a concern.

Dissolved organic nitrogen, organic carbon and turbidity at NW1 and NW2 also rarely exceeded the ODWQS standards with all samples from March 2003 to 2009 falling below the acceptable limit and these parameters where therefore not noted as a concern.

No complaints in respect to odours in the drinking water of Simcoe were mentioned in the drinking water reports or by the well operator and therefore this parameter was not noted.

Simcoe Issues Summary

Iron and manganese are constantly above the ODWQS Aesthetic Objective; however, the drinking water is already treated for these constituents. Both parameters were therefore identified as elevated parameters but they were not identified as Issues under Technical Rule 114.

TCE and Chloroform have both been detected in the Cedar St. wellfield. TCE concentrations were detected well below the 50% MAC threshold and do not appear to be increasing. As a result, TCE is not considered an Issue. Chloroform is also not increasing and is not a parameter of interest from Schedule 1, 2 or 3 of the ODWQS or Table 4 of the Technical Support Document. It is a parameter in Table 2 of the Soil, Ground Water and Sediment Standards with a standard of 2.4 ug/L for potable groundwater; however, observed concentrations only exceed 50% of this standard on one occasion. Therefore chloroform is not considered an Issue.

Nitrate concentrations were consistently close to the 50% MAC threshold of 5 mg/L in the Chapel St. and Cedar St. wellfields and occasionally exceeded it. Following the guidance of MOE

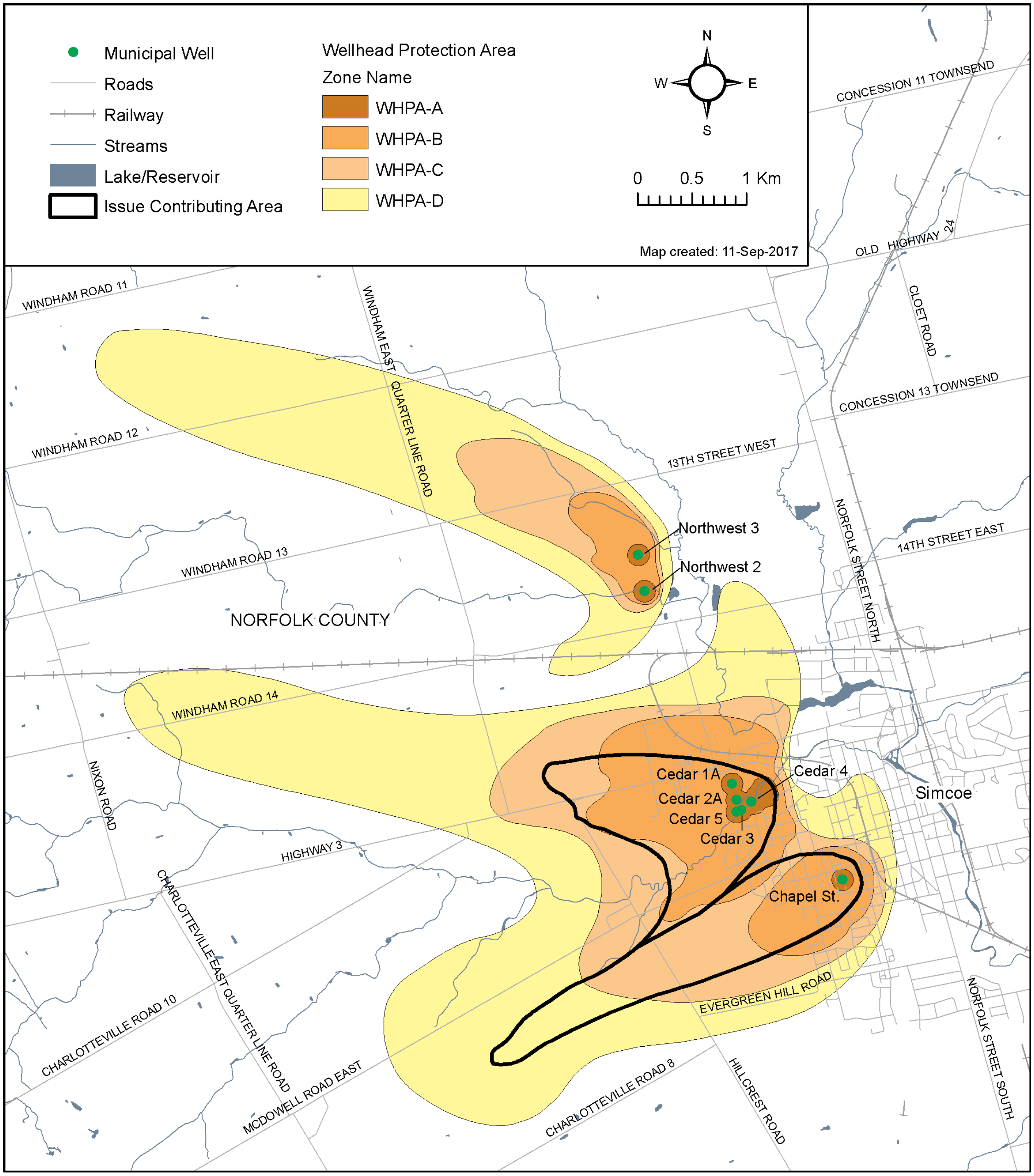
Technical Bulletin “Threats Assessment and Issues Evaluation, February 2010”, a parameter can also be considered an Issue if half of the MAC is frequently exceeded. Given the un-treatability of this parameter, nitrate was therefore identified as an Issue in the Chapel St. and Cedar St. wellfields under Technical Rule 114.

Issue Contributing Area for Nitrate for Chapel St. and Cedar St. Wellfields

There are many potential natural and anthropogenic sources of nitrate within the delineated WHPAs. The Issue Contributing Area (ICA) for both of these wellfields was defined as the area within the WHPAs that is currently contributing water to the wells, i.e., using current pumping rates, as opposed to the future rates used to delineate the WHPAs (Matrix, 2017). The ICAs for the Chapel Street and Cedar Street wellfields are shown on **Map 5-26**.

Following the completion of a desktop assessment of the potential sources of nitrate in these areas, properties where nitrate could contribute to the ICA, including where agricultural source material is applied and septic systems in WHPA-B to D were enumerated in **Table 5-22**, **Table 5-23** and **Table 5-24**.

Map 5-23: Simcoe Well Supply Issue Contributing Areas (Chapel St. and Cedar St.)



5.3 Waterford Well Supply

Waterford is a small community of approximately 3,315 located to the northeast of Simcoe. The serviced area is shown on **Map 5-24**.The municipal water supply for Waterford consists of two shallow groundwater wells (Thompson Road Wells 3 and 4). The primary aquifer supplying the Waterford wells consists of local unconfined gravel and sand deposits surrounding the community. The thickness of the aquifer ranges from 4 to 8 m. The wells are located adjacent to the former aggreagate extraction pits that have filled with water creating ponds. The Waterford supply wells are classified as groundwater under the influence of surface water (GUDI) (Lotowater, 2002).

Technical studies to support vulnerable area delineation, threat assessment and issue identification for the Waterford municipal drinking water system are described in the following reports:

- *Norfolk County Source Water Protection Team Vulnerability Report, Schlumberger Water Services (Canada) Inc. (November 2009);*
- *Delhi, Simcoe and Waterford Source Protection Study Preliminary Threats Assessment and Issues Identification Report #2, Schlumberger Water Services (Canada) Inc. (May 2010); and*
- *Wellhead Protection Area E Delineation and Vulnerability Scoring for GUDI Wells in Norfolk County, Stantec (March 2010).*
- *Waterford WHPA Delineation, Vulnerability Scoring and Threats Assessment, Matrix Solutions, Inc. (2017 in progress)*

5.3.1 Waterford Wellhead Protection Areas

In the early 2000s, a local scale Visual MODFLOW (Harbaugh 2005) model was developed to delineate groundwater quality WHPAs for Waterford municipal wells. Later in 2009, a regional scale groundwater flow model was developed for all of Long Point Region for the Tier Two Water Budget Study (Matrix, 2009a) using FEFLOW (DHI 2012a). In 2015, the Long Point Region Tier Three Water Budget and Local Area Risk Assessment was completed (Matrix 2015) which included a water quantity evaluation of the Waterfordsystem. This work included the local refinement of areas around Waterford within the Tier Two regional scale groundwater flow model and the development of a new integrated groundwater/surface-water model using MikeSHE (DHI 2012b).

WHPAs have been re-delineated for the existing Thompson Road wells 3 and 4. The existing Long Point Tier Three groundwater flow model was updated to incorporate the latest data available on the Waterford wellfield (Matrix, 2017).

The Waterford municipal production wells are completed in a 6 m thick discontinuous sand and gravel aquifer that is part of the Norfolk Sand Plain. The aquifer is overlain by Wentworth Till. The till is absent in some areas resulting in a hydraulic connection between the municipal supply aquifer and the nearby Waterford Ponds. The municipal production aquifer thins in the areas north and south of the wellfield and pinches out to the west where the Wentworth Till thickens. Underlying the production aquifer is a 15 m thick unit of fine-grained silty clay to sand interpreted as the Port Stanley Till (Matrix, 2015).

The Waterford WHPAs are based on municipal pumping rates consistent with those used in the previous WHPA study (SWS 2010b). These values were discussed with Norfolk County staff and represent the maximum permitted pumping rate for each well. Well 3 was assigned a pumping rate of 3,270 m^3/day and Well 4 was assigned a pumping rate of 2,946 m^3/day.WHPAs for the Waterford municipal wells are shown on **Map 5-28.** The WHPAs extend predominantly westward and extend beneath a tributary of Nanticoke Creek and local wetlands that run along the river course. The WHPAs also overlap the Waterford ponds located to the north and west of the wells. The 25-year WHPA has an area of 3.27 km^2.

WHPA-E for Wells under the Direct Influence of Surface Water (GUDI)

The Waterford wells are drilled into overburden and the GUDI study for these wells suggests that there is a hydraulic connection between the wells and surface waterbodies (nearby ponds). The municipal supply wells for Waterford and the nearby ponds are shown in **Map 5-30**.

The Assessment Report Technical Rules state that WHPA-E is to be delineated in accordance with the rules for delineating an IPZ-2, as though the intake for the system were located at the point of interaction between surface and groundwater (if known) or a point within the waterbody closest to the well.

In the case of the Waterford wells, the GUDI connection appears to be to one or more surface water ponds near the wells. Since these waterbodies are not flowing, defining a 2 hour time of travel is complex. Although they are relatively small, the surface area and volume of the ponds are sufficient enough to offer at least 2 hours time of travel to the wells. The WHPA-E for the Waterford GUDI wells was therefore conservatively delineated by including the area of all four ponds immediately west of the wells and setbacks on land. As the groundwater flow direction in the vicinity of the Waterford wells is west to east, only the surface water ponds to the west of the wells are expected to contribute to the wells (Stantec, 2010a).

The Technical Rules require a setback on land around the ponds to include either the Conservation Authority Regulation Limit or 120 m, whichever is greater. This approach did not seem appropriate for the Waterford ponds due to the complex nature of the Regulation Limit, relatively flat topography and general direction of drainage from the north and west. For this reason, a setback of up to 120 m was applied to include areas that are thought to drain toward the ponds. The setback on land was extended out to the Conservation Authority Regulation Limit on the west side of the ponds to include areas that may drain toward the ponds, as shown on **Map 5-30**. As per Technical Rule 15.1, the Director has provided confirmation agreeing to the departure. The Director's letter of confirmation is found in **Appendix B**.

5.3.2 Waterford Vulnerability Scoring in Wellhead Protection Areas

A vulnerability assessment using the surface to aquifer advection time (SAAT) method was completed to classify aquifer vulnerability (SWS, 2010b; EarthFx, 2008). The SAAT time of travel values were used to create mapped categories of low (> 25 years), medium (5 to 25 years) and high (≤ 5) vulnerability. The SAAT methodology is described in Section 3.1.1.

As shown on **Map 5-29**, the entire Waterford area has been mapped as highly vulnerable. In this area of Norfolk County, the water table is shallow, leading to less geologic protection of the aquifer.

Vulnerability scores within the WHPAs were assigned following Part VII.2 in the Technical rules as summarized in **Table 5-25.**

Table 5-21: WHPA Vulnerability Scores

Intrinsic Vulnerability Category	Time of Travel Capture Zone			
	100-m	2-year	5-Year	25-year
High	10	10	8	6
Medium	10	8	6	2
Low	10	6	4	2

Map 5-30 shows the regional vulnerability classifications based on the SAAT methodoelogy. This is also referred to as the intrinsic vulnerability. **Map 5-31** shows the vulnerability scores within the WHPAs, which represent the intersection of the capture zones and the vulnerability categories. Since the vulnerability category is uniform, the vulnerability scores follow the capture zone delineations, where the 2-year capture zone results in a score of 10 (high), and the 5-year capture zone results in a score of 8 and the 25-year capture zone in a score of 6.

5.3.3 Waterford Transport Pathways and Adjusted Vulnerability Score

Potential transport pathways within the Waterford WHPAs were identified using various databases and GIS layers, including MECP Water Well Records,oil and gas wells, tile drainage, constructed drains, storm sewers and pits and quarries. All identified potential features are mapped on **Map 5-32**.

The MECP Technical Rules note that the low vulnerability areas can be increased to medium or high vulnerability or a medium vulnerability area can be increased to high due to the presence of one of the above noted anthropogenic transport pathways. Professional judgment is used to increase the vulnerability score based on the hydrogeological conditions, the type and nature of the pathway, and the potential cumulative impact of the pathways. However, because the vulnerability in the Waterford WHPAs is already high, additional preferential pathways cannot increase the vulnerability any further.

Uncertainty and Limitations in Waterford Vulnerability Scoring

The uncertainty of the vulnerability score mapping is considered to be low, since the underlying vulnerability values are generally high.

There is very little uncertainty that the water level is close to the surface and the soil material between surface and water table has a high permeability. The uncertainty of the vulnerability category areas is, therefore, considered to be low.

5.3.4 WHPA-E Vulnerability Scoring

The WHPA-E vulnerability analysis includes consideration for both the area and the source as described in the Technical Rules. The area vulnerability factor for a WHPA-E is prescribed to be the same as IPZ 2, i.e. between 7 and 9. The source vulnerability factor for the Waterford wellfield was assessed based on a Type D intake, as it is under the influence of one or more small ponds. A Type D intake may have a source vulnerability factor between 0.8 and 1.0.

The area vulnerability factor for the WHPA-E zones in Waterford was assigned a value of 7 based on the following:

- Land area within the WHPA-E zone is largely rural and undeveloped, much of the undeveloped areas are forested.

- Soils within the WHPA-E zone are typical of the Norfolk Sand Plain and are composed of sand and gravel deposits making them highly permeable.
- There are no road crossings within WHPA-E for the ponds near the Waterford wells.
- No transport pathways were identified for the WHPA-E for the Waterford wellfield.

These factors, taken together, suggest a low vulnerability of the source to contamination from spills and therefore, the lowest score was assigned to each WHPA-E.

According to the Technical Rules, the source vulnerability factor for a surface water intake takes into consideration the depth of the intake from the water surface, the distance from land and historical water quality concerns. For a WHPA-E, the first two factors do not apply as there is no particular relevance to a GUDI well that is likely drawing surface water from a distributed area, rather than a point and only a small portion of the water getting to the well originates from surface water. There were no historical water quality concerns raised for any of the GUDI wells during the technical study. In addition, groundwater wells are known to be less vulnerable than surface water intakes to spills and other adverse conditions by virtue of the time delay between the surface water feature to the well, in-situ filtration through the soil and dilution of the surface water by groundwater from the rest of the well capture zone. For these reasons, the source vulnerability factor for all three GUDI wellfields in Norfolk County was assigned the lowest value. The source vulnerability factor for the Waterford wellfield was given a source vulnerability score of 0.8.

Combining the area and source vulnerability scores, the overall vulnerability score for Waterford is 5.6 (**Table 5-26**).

Table 5-22: Vulnerability Score Summary for the Waterford WHPA-E Zone

Location	Intake Protection Zone	Area Vulnerability Factor	Source Vulnerability Factor	Vulnerability Score
Waterford wellfield	WHPA-E	7	0.8	5.6

Limitations of Data and Methods used in the WHPA-E Vulnerability Assessment

The methods used to delineate the WHPA-E zones were generally consistent with MOE guidance and the Technical Rules, with the exception noted for the Waterford wellfield. The WHPA-E for Waterford did not include all areas within the Conservation Authority Regulation Limit, because this would have included a large area that does not have any connection to the wellfield.

Determination of the hydrologic and hydraulic characteristics of the surface water systems associated with the wellfield represented the most significant analytic component of the WHPA-E delineation, and arguably the largest potential source of error. Given the lack of available hydrologic or hydraulic models for the watercourse systems under investigation, an independent understanding of design flow conditions was developed.

Given the low sensitivity to error with the other approach taken for delineating the WHPA-E in Waterford, it is concluded that the hydrologic and hydraulic analysis represents a relatively low uncertainty.

5.3.5 Percent Managed Lands and Livestock Density

Percent Managed Lands

Managed Lands are lands to which nutrients are applied. Managed lands can be categorized into two groups: 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 land includes golf courses, sports fields, lawns and other grassed areas that may receive nutrients (primarily commercial fertilizer).

The results for managed lands within the Waterford WHPAs are summarized in **Table 5-27**, **Map 5-33,** and **Map 5-34.**

Table 5-23: Managed Land Calculations

WHPA	WHPA Area		Agricultural Managed Land Area		Non-agricultural Managed Land Area		Managed Land Area		Managed Land
	m^2	Acres	m^2	Acres	m^2	Acres	m^2	Acres	%
A	49,654	12.3	0	0.0	5,045	1.2	5,045	1.2	10%
B	686,398	169.6	17,499	4.3	40,629	10.1	58,128	14.4	8%
C	724,173	178.9	129,809	32.1	111,069	27.4	240,878	59.5	33%
D	1,808,160	446.8	1,007,621	249.0	99,928	24.7	1,107,549	273.7	61%

Livestock Density

Livestock density is defined as nutrient units per acre of agricultural managed land within a vulnerable area. A nutrient unit is defined as the number of animals that will give the fertilizer replacement value of the lesser of 43 kilograms of nitrogen or 55 kilograms of phosphate per year as nutrients.

Livestock density was calculated using the MOE 2009 guidance "Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers" for calculating Livestock Density in the WHPAs.

In Waterford, one horse barn was identified in WHPA C, and a livestock density of 0.41 NU/acre was determined. In WHPA D, two barns were identified and assumed to be mixed livestock, with a livestock density of 0.08 NU/acre. The livestock densities for all WHPAs are summarized in **Table 5-28, Map 5-35,** and **Map 5-36.**

Table 5-24: Livestock Density (NU/Acre) Calculations

Waterford				
WHPA	Agricultural Managed Land Acerage	Total NU	Livestock Density (NU/Acre)	Notes
WHPA A (100 Meter)	0	0	0	No Animals
WHPA B (2 Year)	4.3	0	0	No Animals
WHPA C (5 Year)	32.1	13.3	0.41	One barn, assume horses

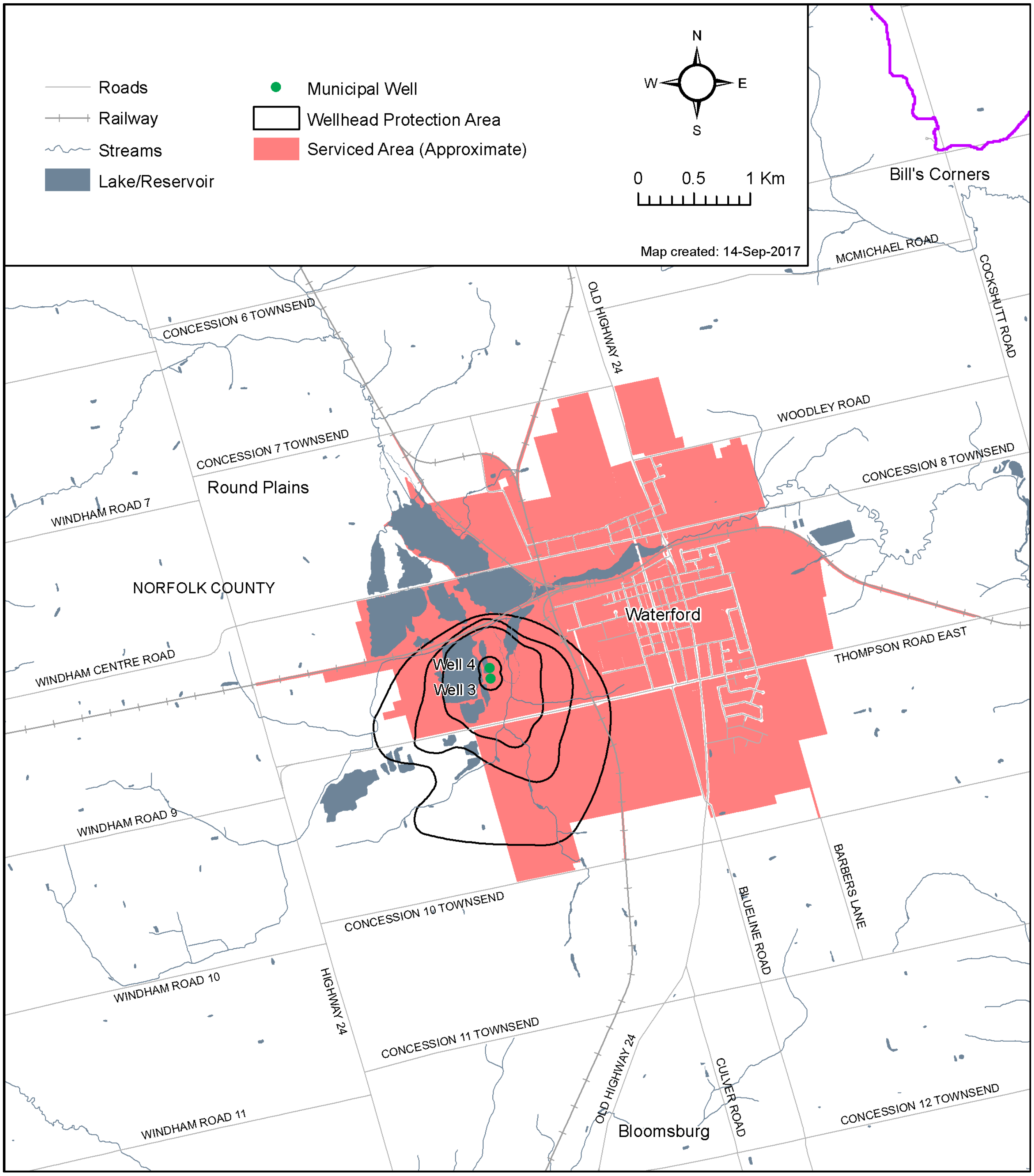
WHPA D (25 Year)	249.0	18.9	0.08	Two barns, assume mixed livestock
WHPA-E	3.7	0	0	No Animals

5.3.6 Percent Impervious Surface Area in WHPAs

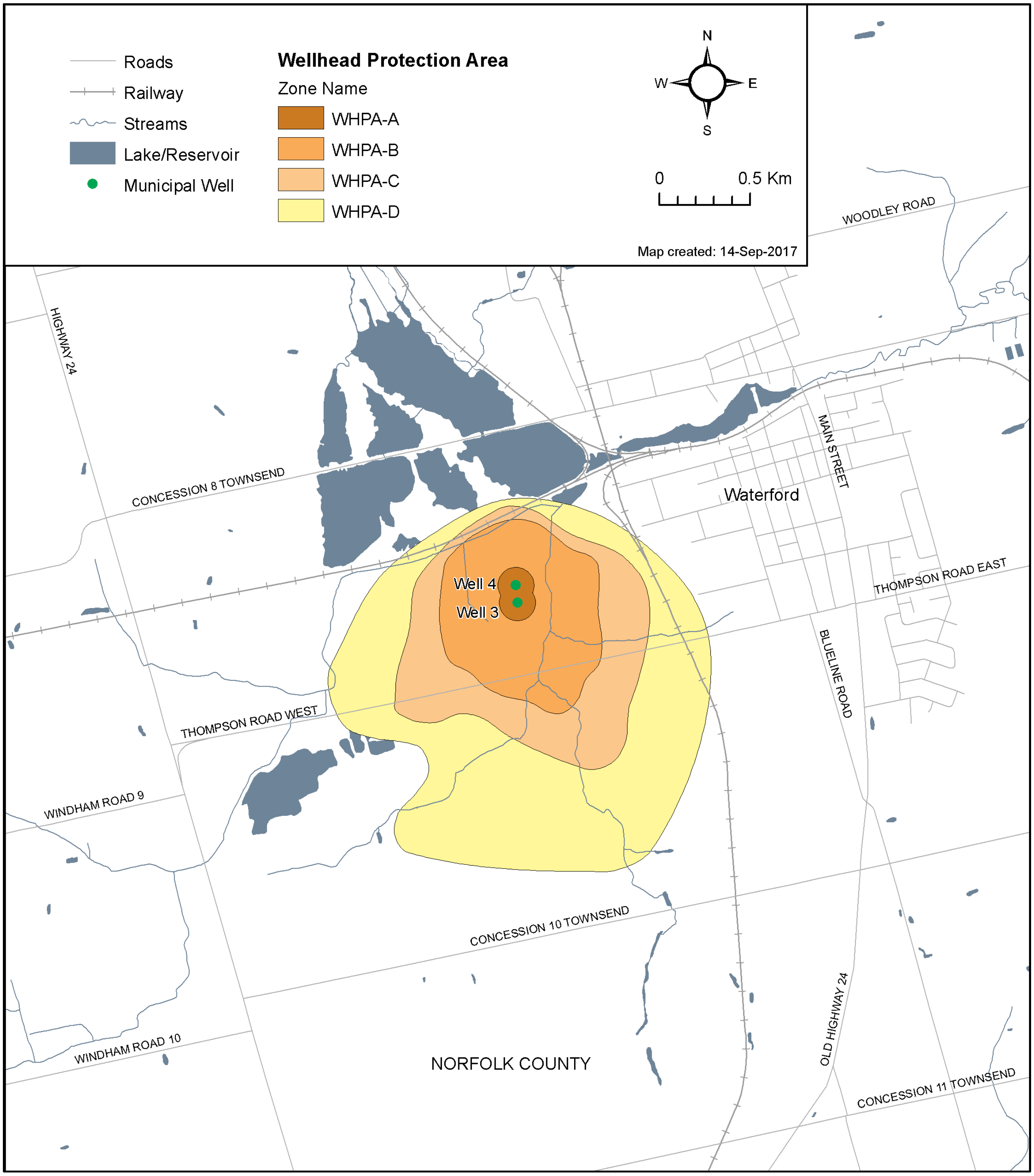
To map impervious areas, roads, sidewalk and parking lots within the WHPAs were digitized based on the 2015 aerial photograph. A one kilometer square was centered on the centroid of the WHPA and additional squares were added next to the central square, until the WHPA area was entirely covered by the grid**. Map 5-37 and Map 5-38**Map 5-38 illustrate the percent impervious surfaces for the Waterford WHPAs. Percent imperviousness ranges from 0% to just over 80%, with the majority of percentages ranging between 1 to 8% impervious surface cover. WHPA E percent imperviousness is all less than 1%.

This methodology departs from Technical Rule 17 as the grid was centered on the centroid of the WHPA rather than the source protection area. The rationale for this departure is that the previous percent impervious surface was calculated prior to the release of the current Technical Rules (November 16^{th}, 2009) and was consistent with the previous version of the Technical Rules (November 20^{th}, 2008). The method of centering the grid on the vulnerable area is considered to be an equivalent approach. As per Technical Rule 15.1, the Director has provided confirmation agreeing to the departure. The Director's letter of confirmation can be found in **Appendix B**. This method was retained for the current update to be consistent with the previous work.

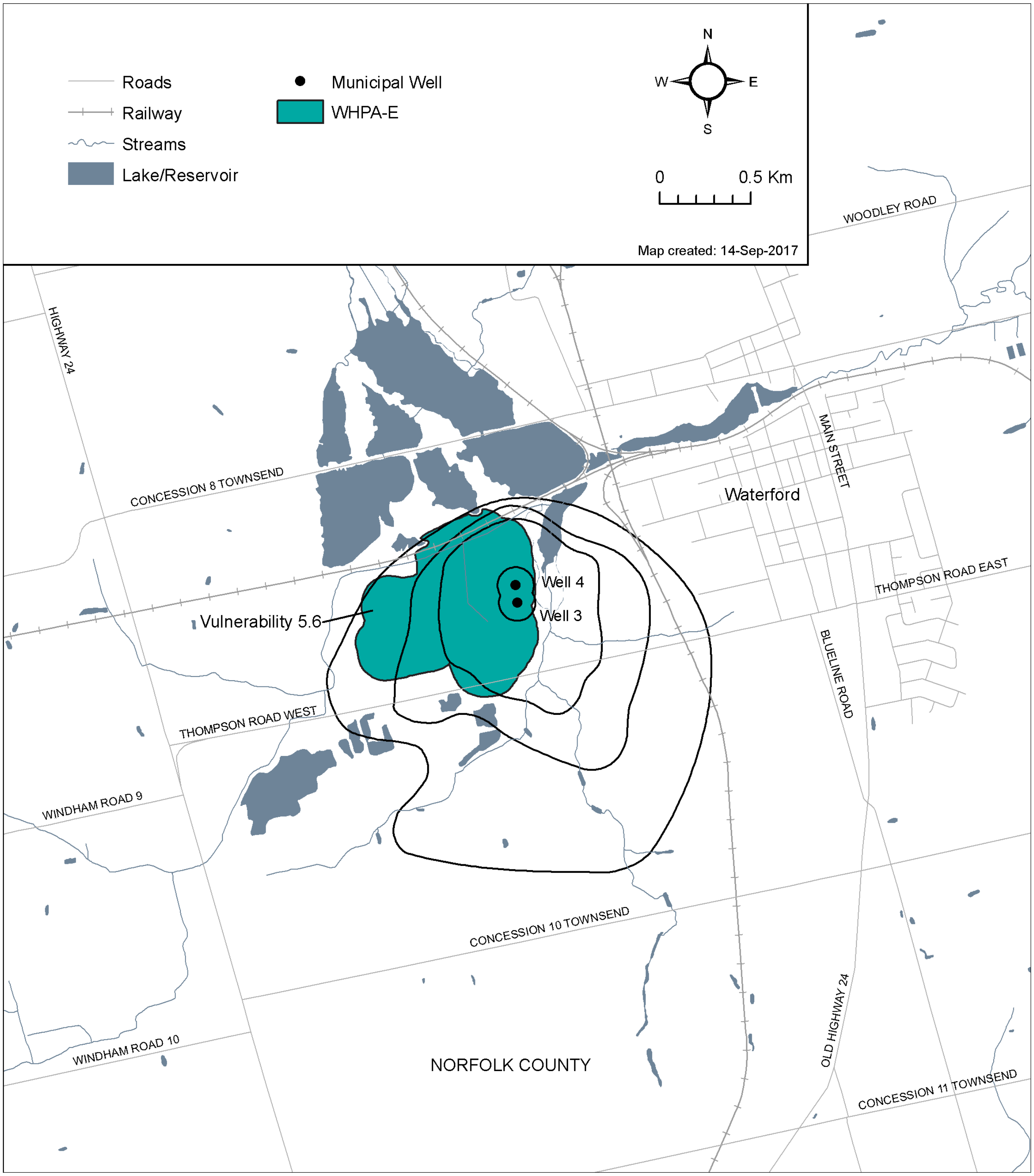
Map 5-24: Serviced Areas for the Waterford Water Supply



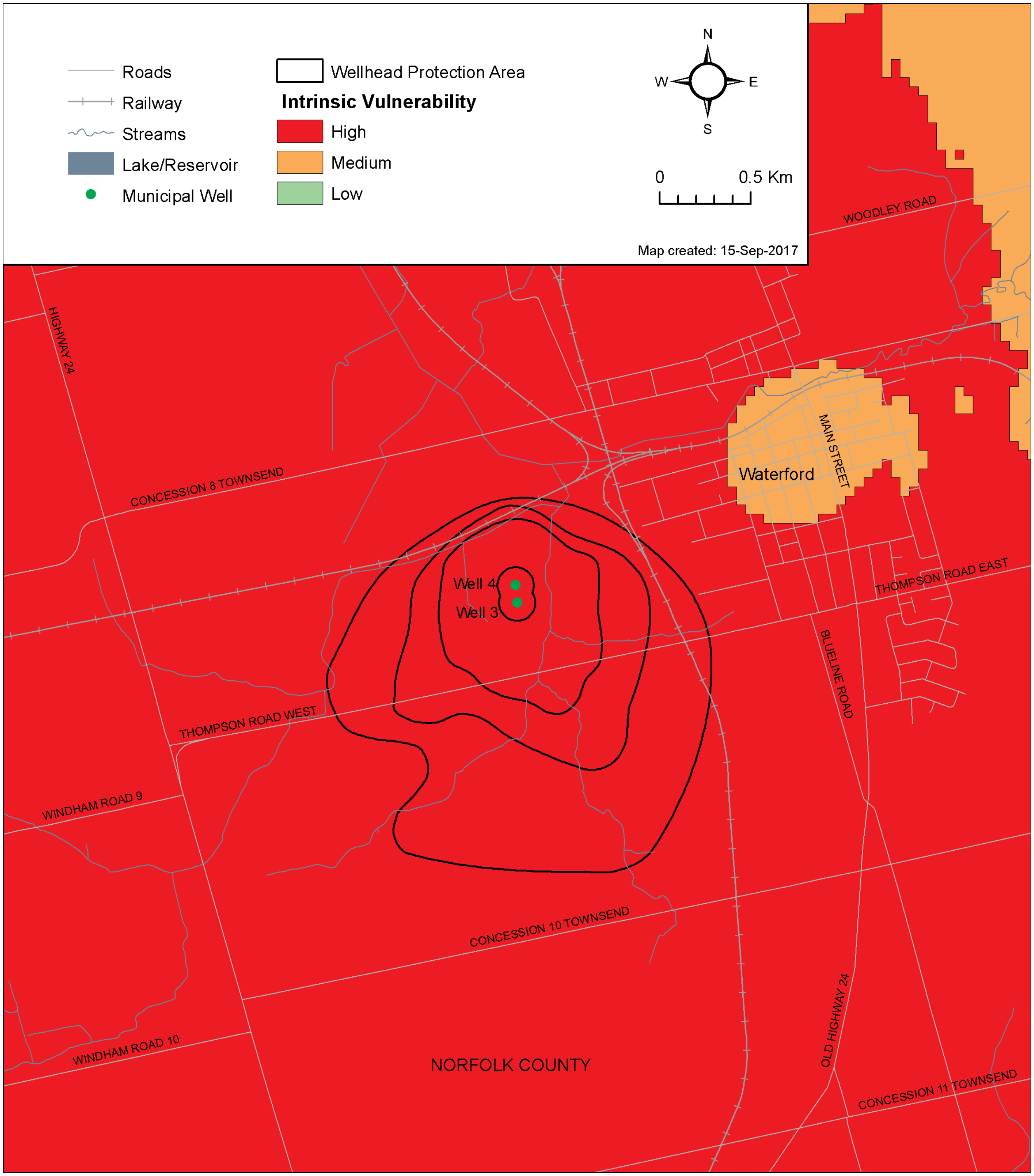
Map 5-25: Waterford WHPA



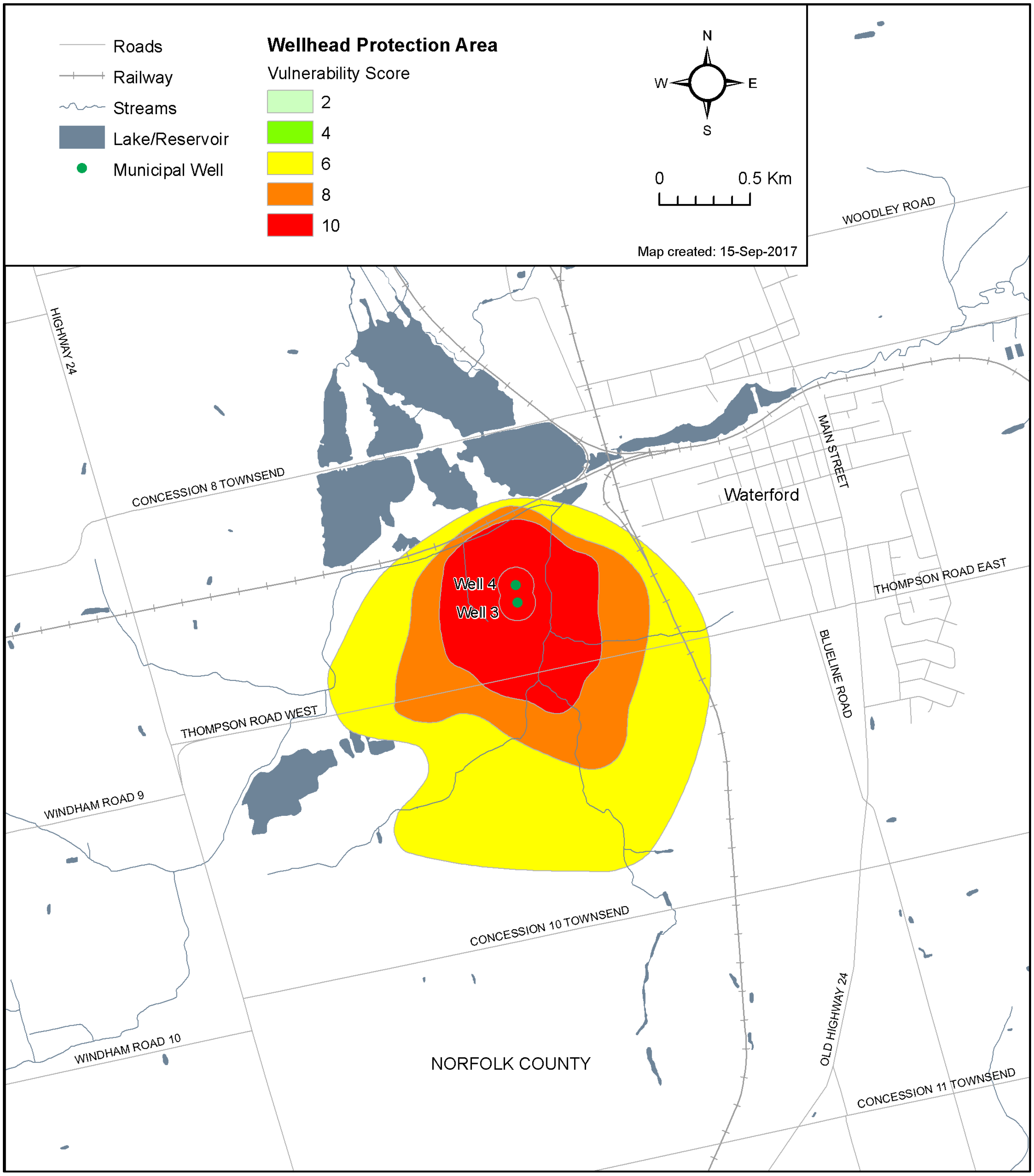
Map 5-26: Waterford WHPA E



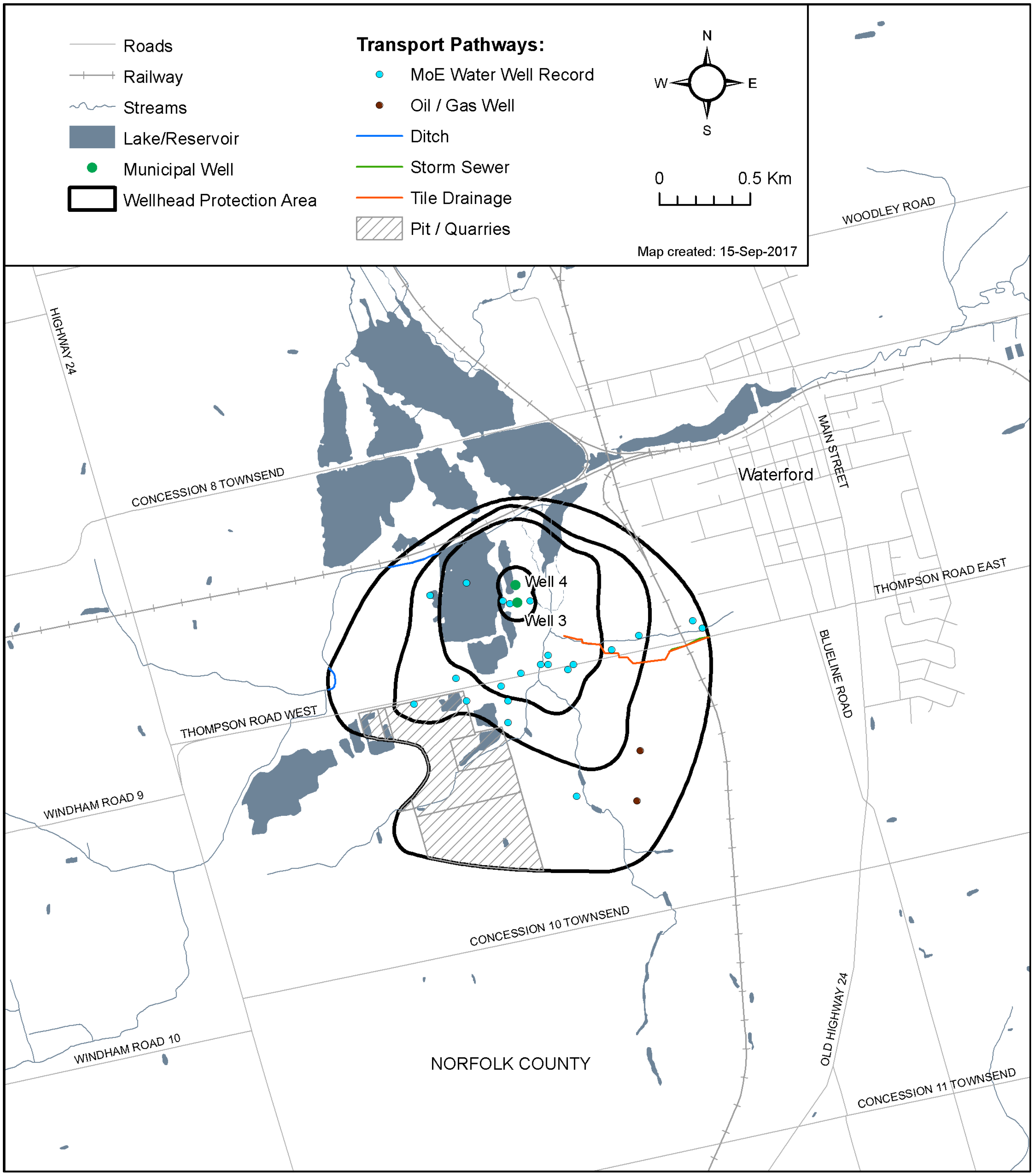
Map 5-27: Waterford WHPA Unadjusted Intrinsic Vulnerability



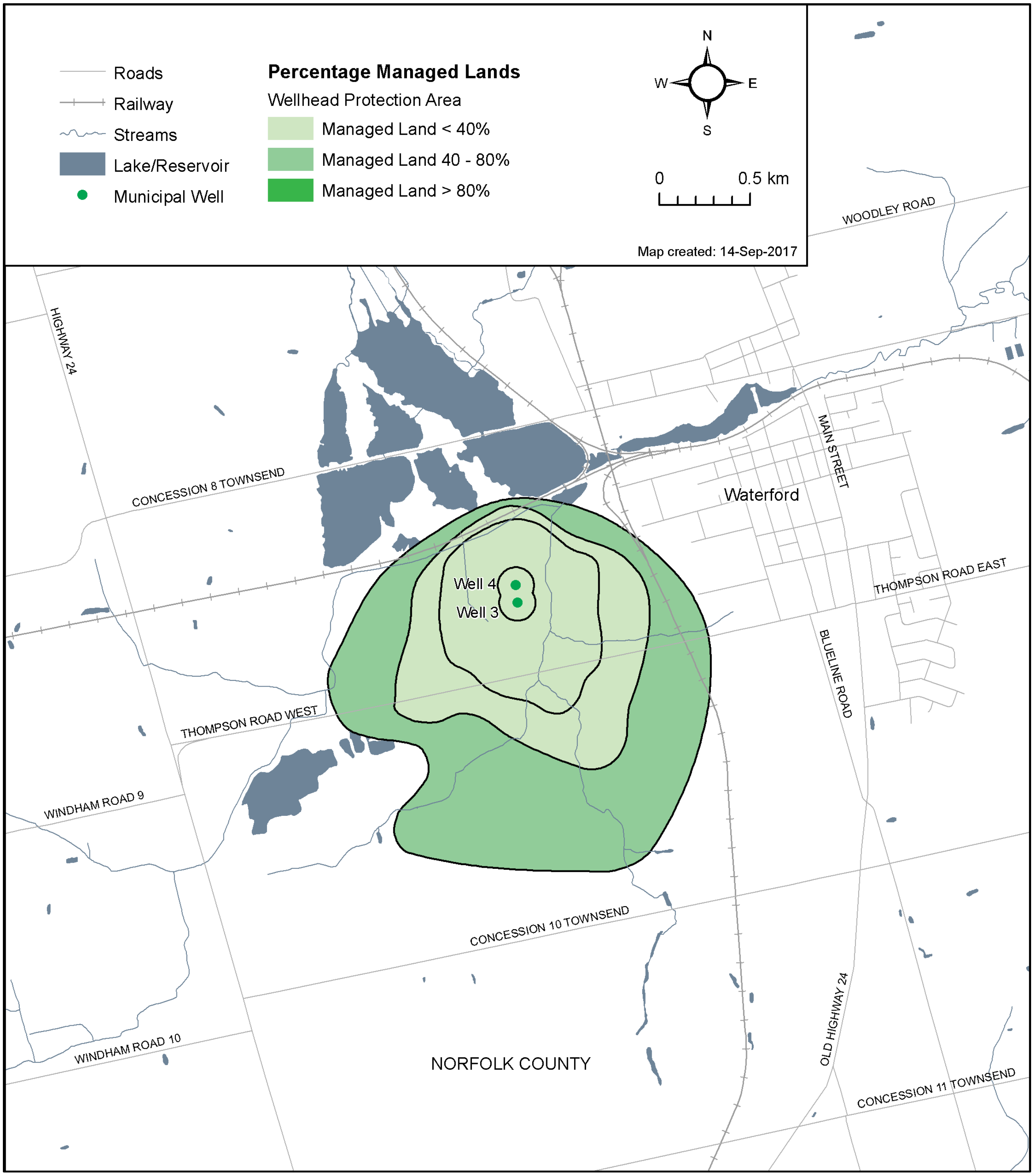
Map 5-28: Waterford WHPA Vulnerability Scoring



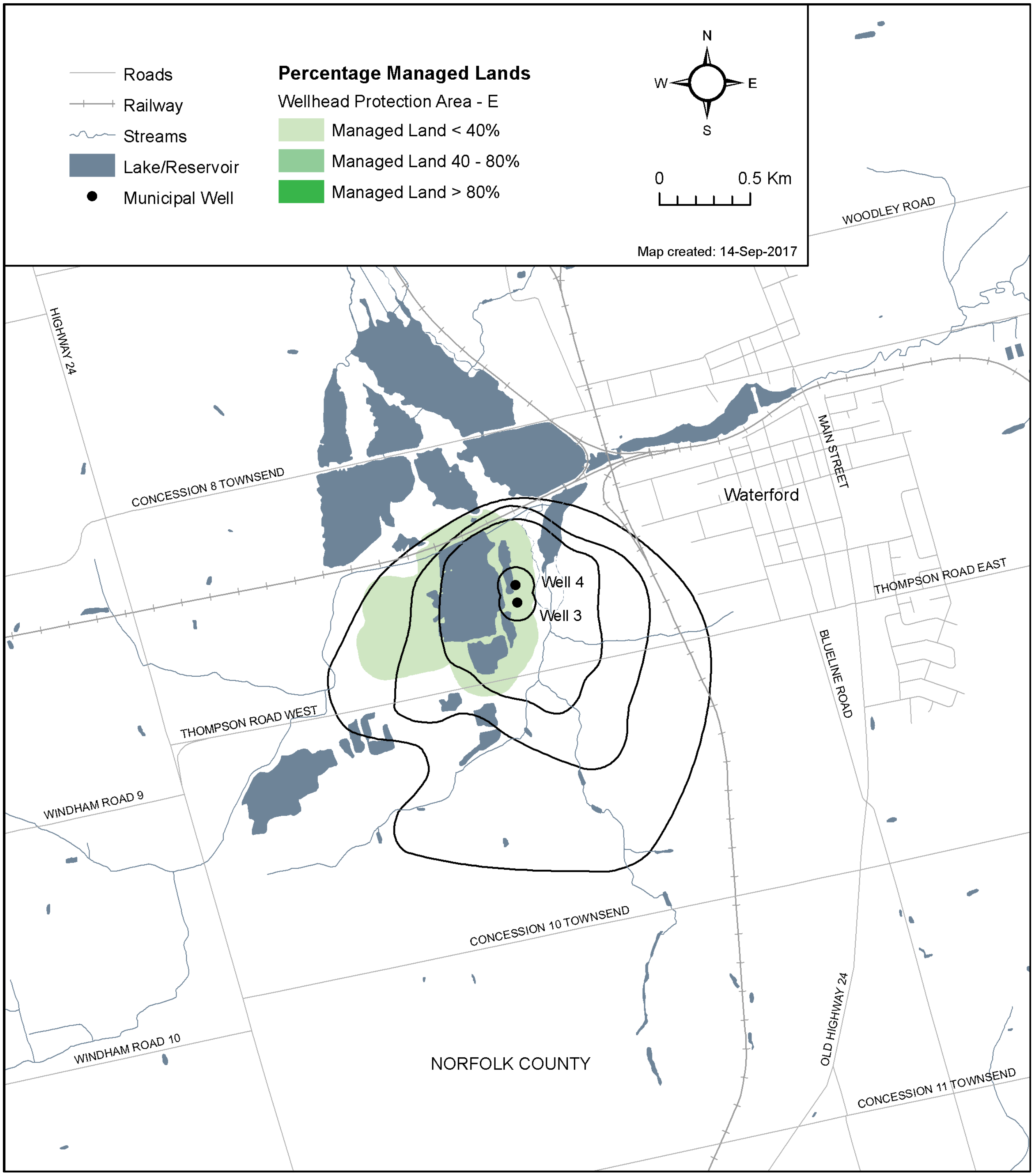
Map 5-29: Waterford Transport Pathways



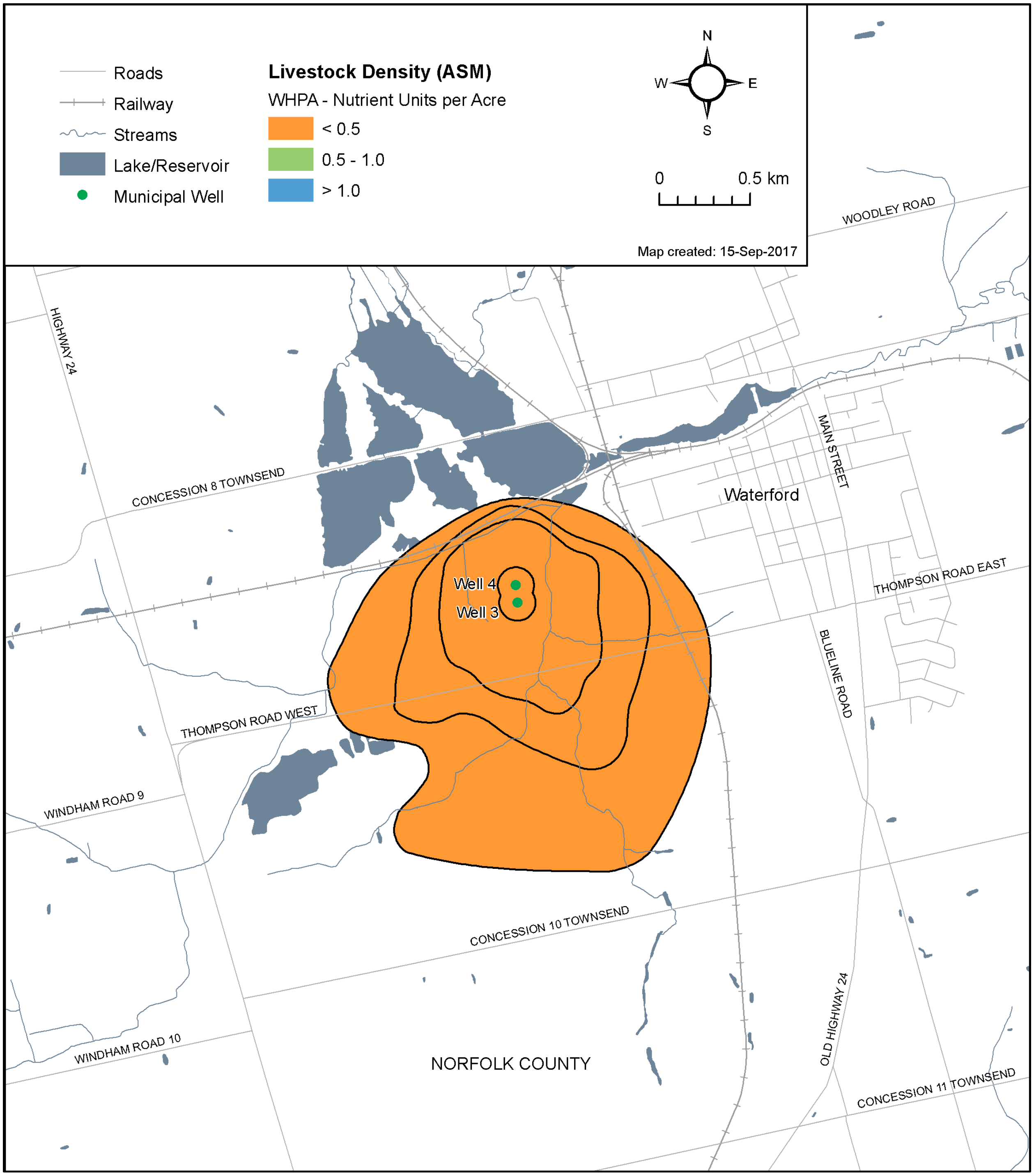
Map 5-30: Percent Managed Lands within the Waterford WHPA



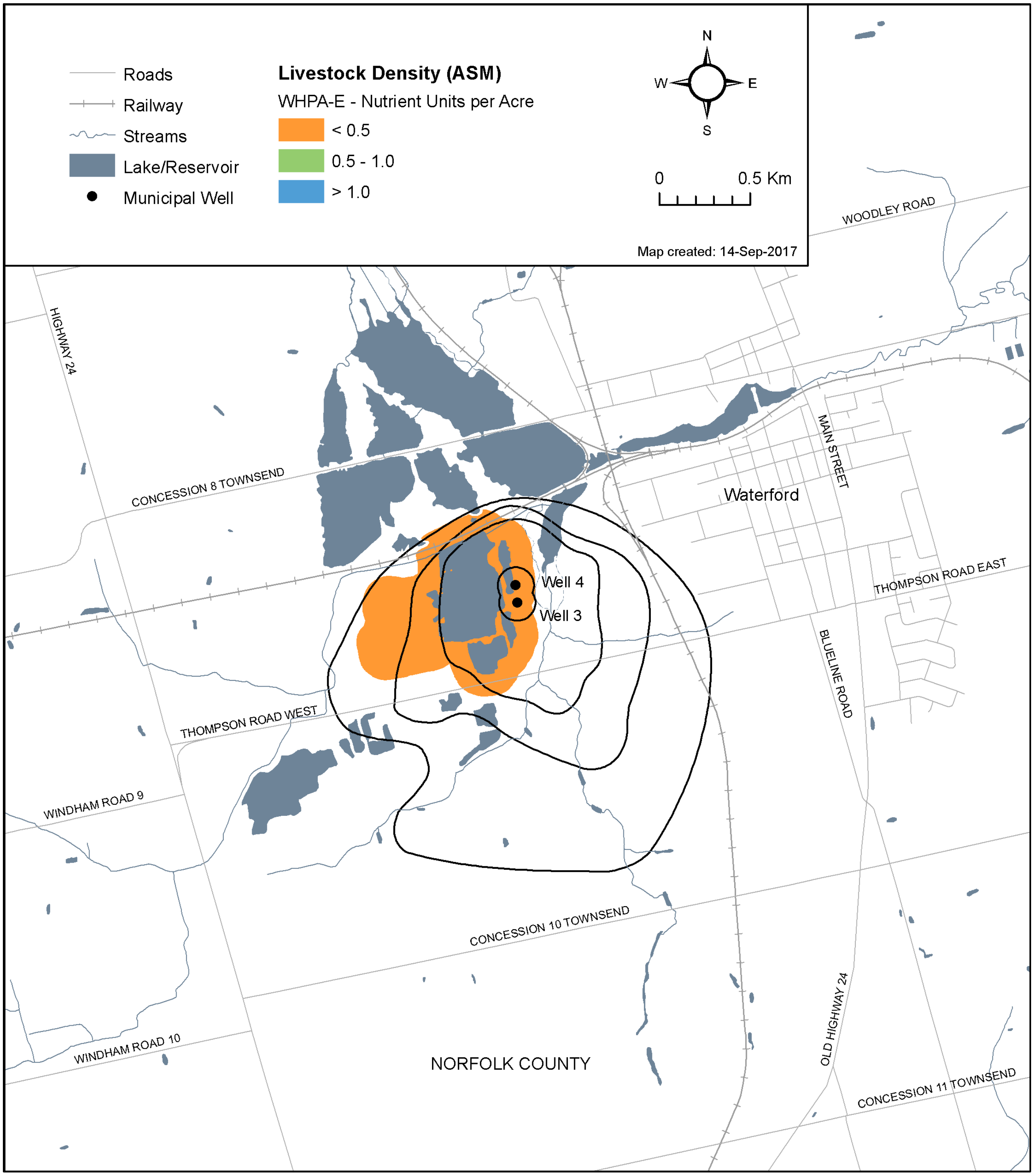
Map 5-31: Managed Lands within the Waterford WHPA E



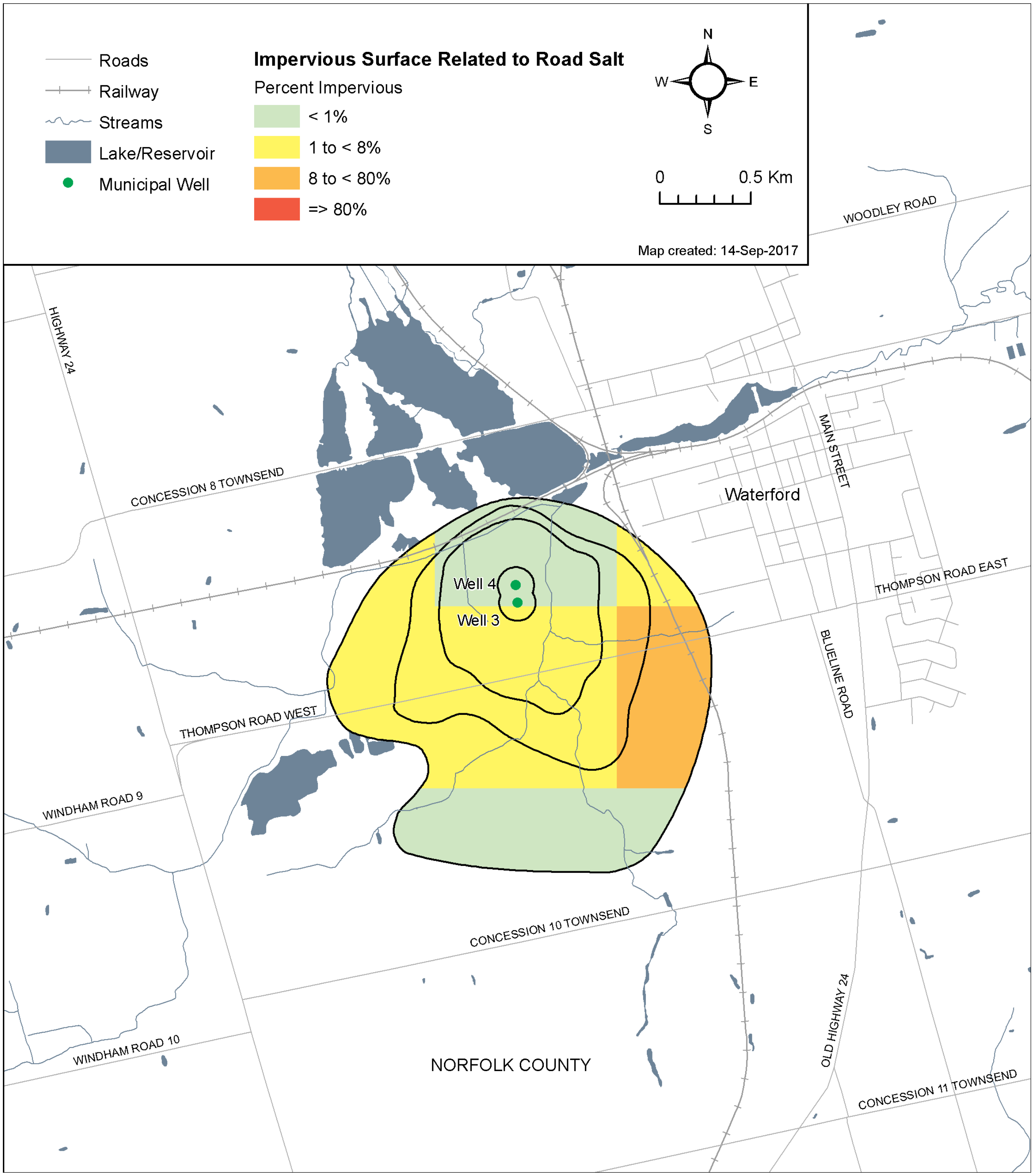
Map 5-32: Livestock Density within the Waterford WHPA



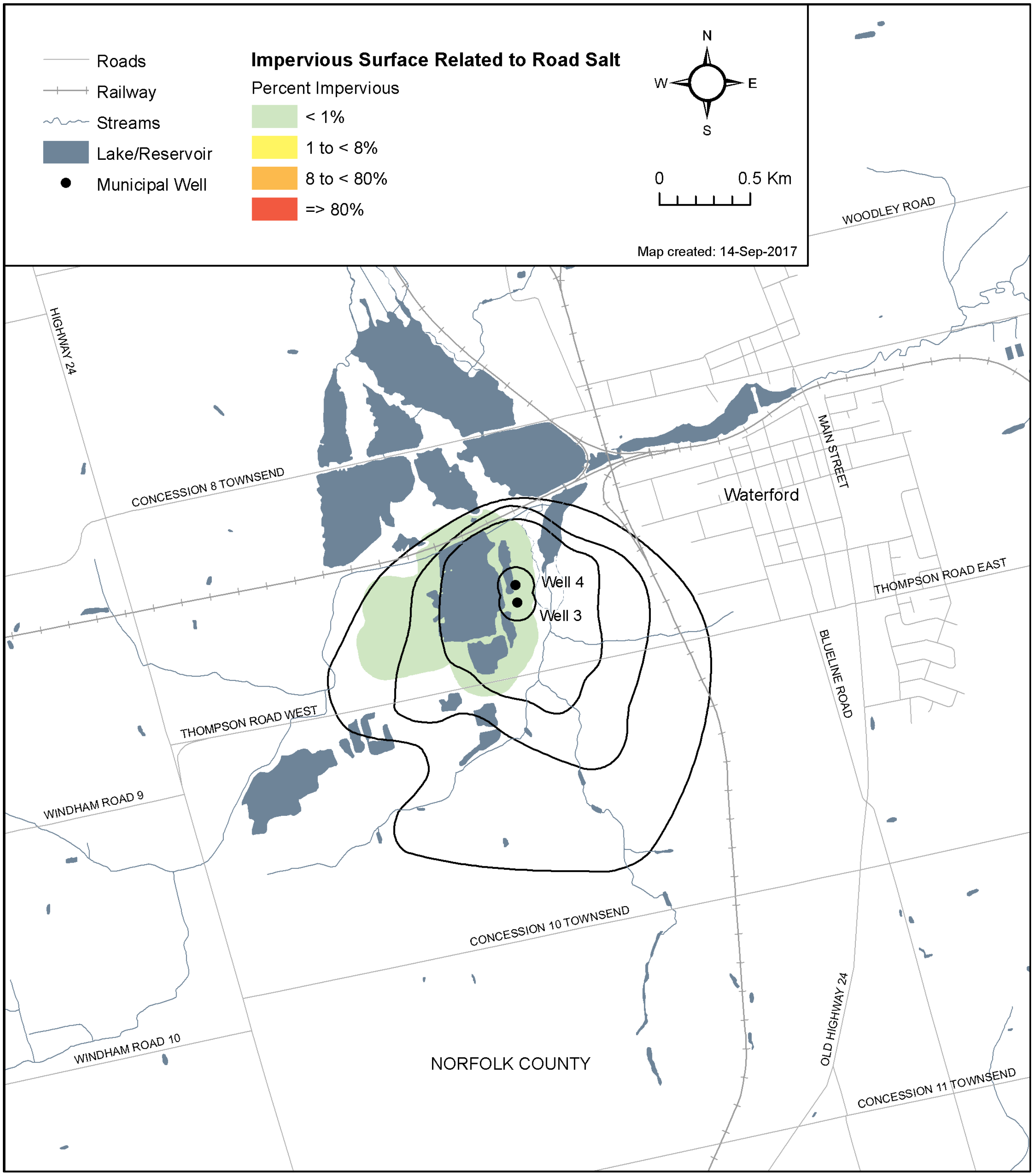
Map 5-33: Livestock Density within the Waterford WHPA E



Map 5-34: Impervious Surface within the Waterford WHPA



Map 5-35: Impervious Surface within the Waterford WHPA E



5.3.7 Waterford Water Quality Threats Assessment

Table 5-29 provides a summary of the threat levels possible in the Waterford Well Supply for Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogens. A checkmark indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; a blank cell indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 5-31**.

Table 5-25: Identification of Drinking Water Quality Threats in the Waterford WHPAs

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals	WHPA-A/B	10	✔	✔	✔
	WHPA-C	8	✔	✔	✔
	WHPA-D	6		✔	✔
	WHPA-E	5.6			✔
Handling / Storage of DNAPLs	WHPA-A/B/C	Any Score	✔		
	WHPA-D	6		✔	✔
	WHPA-E	5.6			✔
Pathogens	WHPA-A/B	10	✔	✔	
	WHPA-E	5.6			✔

Activities that Are or Would be Drinking Water Threats in the Wellhead Protection Areas and Intake Protection Zones

Ontario Regulation 287/07, pursuant to the *Act*, provides a list of prescribed drinking water threats that could constitute a threat to drinking water sources.

Table 5-30Error! Reference source not found. lists the activities that are prescribed drinking water quality threats. Typical land use activities associated with the threat are also listed.

Land Use Inventory Methodology

A land use threats assessment was completed through the review of existing data within Waterford's WHPAs (Matrix, 2017).Limited site specific information was collected as a part of this assessment and most identified threats were considered potential, requiring further review and site specific assessments to confirm their presence.

Table 5-26: Drinking Water Quality Threats

Prescribed Drinking Water Quality Threats Ontario Regulation 287/07 s.1.1.(1)		**Land Use/Activity**
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	Landfills – Active, Closed Hazardous Waste Disposal Liquid Industrial Waste
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage Infrastructures Septic Systems, etc.
3	The application of agricultural source material to land.	e.g. manure, whey, etc.

Table 5-26: Drinking Water Quality Threats

4	The storage of agricultural source material.	e.g. manure, whey, etc.
5	The management of agricultural source material.	aquaculture
6	The application of non-agricultural source material to land.	Organic Soil Conditioning Biosolids
7	The handling and storage of non-agricultural source material.	Organic Soil Conditioning Biosolids
8	The application of commercial fertilizer to land.	Agriculture Fertilizer
9	The handling and storage of commercial fertilizer.	General Fertilizer Storage
10	The application of pesticide to land.	Pesticides
11	The handling and storage of pesticide.	General Pesticide Storage
12	The application of road salt.	Road Salt Application
13	The handling and storage of road salt.	Road Salt Storage
14	The storage of snow.	Snow Dumps
15	The handling and storage of fuel.	Petroleum Hydrocarbons
16	The handling and storage of a dense non-aqueous phase liquid.	DNAPLs
17	The handling and storage of an organic solvent	Organic Solvents
18	The management of runoff that contains chemicals used in the de-icing of aircraft.	De-icing
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	Agricultural Operations
22	The establishment and operation of a liquid hydrocarbon pipeline	Liquid Hydrocarbon Pipelines

Condition-based Threats

To identify potential conditions within the WHPAs, multiple data sources were reviewed including aerial and roadside imagery; historical and current federal, provincial and private environmental databases; interviews with municipal staff; and the historic 2003 Norfolk County Threats Database. No significant, condition-based threats were identified in this review, and therefore no conditions resulting from past activities in the WHPAs were identified as per Technical Rule 126.

Enumeration of Significant Drinking Water Quality Threats in the Waterford Wellhead Protection Areas

Twelve activities for seven prescribed drinking water threats were identified in the Waterford WHPAs. These threats and their associated reference numbers are listed in **Table 5-31**.

Table 5-27: Significant Drinking Water Quality Threats in Waterford WHPAs

PDWT #[1]	Prescribed Drinking Water Threat[2]	Number of Activities	Vulnerable Area
2	Sewage System Or Sewage Works - Sanitary Sewers and related pipes	1	WHPA-A WHPA-B
	Sewage System Or Sewage Works - Onsite Sewage Systems	4	WHPA-B
	Sewage System Or Sewage Works - Septic System Holding Tank	1	WHPA-B
3	Application Of Agricultural Source Material (ASM) To Land	2	WHPA-C
16	Handling of a Dense Non Aqueous Phase Liquid (DNAPL)	1	WHPA-C
	Storage of a Dense Non Aqueous Phase Liquid (DNAPL)	1	WHPA-B

Table 5-27: Significant Drinking Water Quality Threats in Waterford WHPAs

PDWT #[1]	Prescribed Drinking Water Threat[2]	Number of Activities	Vulnerable Area
19	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation (Grazing and pasturing)	1	WHPA-B
	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation (Yards or confinement)	1	WHPA-B
Total Number of Activities		**12**	
Total Number of Properties		**7**	

1: Prescribed Drinking Water Threat Number refers to the prescribed drinking water threats listed in O. Reg 287/07 s.1.1.(1).

2: Where applicable, waste, sewage, and livestock threat numbers are reported by sub-threat; fuel and DNAPL by Prescribed Drinking Water Threat category.

Note: Certain types of activities on residential properties that are incidental in nature and that are significant drinking water threats are not enumerated. These threats include the application of commercial fertilizer on residential properties, the storage of organic solvents (dense non-aqueous phase liquids) on residential properties, and the storage of fuel (e.g., heating fuel tanks) on residential properties in natural gas serviced areas.

Note: Storm sewer piping is not considered to be part of a storm water management facilty.

Data Gaps and Uncertainty in Threats Assessment

In many cases the results of the desktop inventory did not include all required information to determine whether the circumstances for the drinking water threats were met. Where information was missing, to determine the circumstances under which a threat occurred, a conservative assumption was used. This led to a number of threats that need to be confirmed by a more detailed analysis including interviews with land owners. Given the conservative approach that was chosen in this study, the uncertainty that current land uses, posing a threat to the drinking water, were missed, is low. At the same time it is likely that some of the threats that were identified as significant may not be a significant threat in reality. The uncertainty of the current threats assessment of land uses based on the desktop inventory is high.

5.3.8 Waterford Drinking Water Quality Issues Evaluation

The objective of the Issues evaluation is to identify drinking water Issues where the existing or trending concentration of a parameter or pathogen at an intake, well or monitoring location would result in the deterioration of the quality of water for use as a source of drinking water. The parameter or pathogen must be listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards (ODWQS) or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (Technical Rules XI.1 (114 – 117)).

Once a drinking water Issue is identified, the objective is to identify all sources and threats that may contribute to the issue within an Issue contributing area and manage these threats appropriately. If at this time the Issue contributing area can not be identified or the Issue can not be linked to threats then a work plan must be provided to assess the possible link.

If an Issue is identified for an intake, well or monitoring location, then all threats related to a particular Issue within the Issue Contributing Areas are classified as significant drinking water threats, regardless of the vulnerability.

The drinking water system serving the Community of Waterford consists of two wells, well 3 and well 4, and two pump houses. Water treatment consists of sodium hypochlorite and sodium permanganate addition for iron and manganese treatment and the addition of a poly aluminum chloride coagulant to reduce particulate matter.

No issues have been identified for the Waterford drinking water system.

Schedule 1 Parameters and Pathogens

Weekly samples analysed for E. coli and total coliforms were available from 2005 to 2009. Total coli were detected only two times in each of the wells 3 and 4 and no E. coli was detected. The well operator confirmed that the disinfection system easily treats this low number of microbes.

Weekly sample analytical results were also available from 2010 to 2016. During this time E. coli and total coli were detected once in 2010 at well 3 and once in 2012 in both wells 3 and 4.

No Schedule 1 parameters were therefore noted.

Schedule 2 Parameters

Results from this data set indicated that samples were taken on two dates from Waterford well 4 (February 21, 2001 and May 23, 2001) for dichloromethane. Of these two samples, the later sample collected on May 23, 2001 was above the ODWQS maximum acceptable concentration. No confirmatory sampling for dichloromethane was evident in the current data set following this exceedance. However, no further detects for dichloromethane was found in either well up to this date.

In the sample collected on May 23, 2001, nitrite was found at the MAC level of 0.5 mg/L. Since organic nitrogen was also high in this sample, but nitrate was found to be below detection limit, the elevated nitrite level appears to indicate the beginning oxidation process of the organic nitrogen to nitrite. Since none of the following samples showed elevated nitrite levels in this wellfield, this occurrence was considered to be a single event and was not noted.

Schedule 3 Parameters

Few samples including radioactive parameters (gross alpha and gross beta) were available, and all of them were from treated water (Reservoir). All activities were below or close to the detection limit of these parameters which made a more detailed analysis of Schedule 3 parameters unnecessary.

Table 4 Parameters

One sample was also analyzed for organic nitrogen at Waterford well 4 on May 23, 2001. This sample was found to exceed ODWQS operational guidelines with a concentration of 0.38 mg/L. No confirmatory samples were taken following this measured exceedance.

Elevated values in respect to the screening benchmark were frequently found for manganese and hardness. In general, manganese concentrations varied from 0.08 to 0.36 mg/L, while hardness varied from 191 to 488 mg/L. Concentrations of both manganese and hardness at well 4 were relatively consistent, while more variability was noted in the results from well 3.

Consistent exceedances were also noted for temperature at well 4, while occasional exceedances were noted at well 3.

Aluminum concentrations were consistently lower than the ODWQS operational guidelines at well 3, with the exception of one exceedance on May 23, 2001. This occurrence was interpreted as a single occurrence and was not noted.

Sodium concentrations were occasionally approaching 20 mg/L, the point at which a medical officer would be notified so that doctors can advise patients on sodium restricted diets, but still much less than the aesthetic objective of 200 mg/L.

The temperature was elevated repeatedly in well 4 and was therefore noted.

No complaints in respect to odours in the drinking water of Waterford were mentioned in the drinking water reports or by the well operator and therefore this parameter was not noted.

Waterford Drinking Water Quality Issues Evaluation Summary

The levels of iron and manganese both exceed the ODWQS Aesthetic Objective; however, the drinking water is already treated for these constituents. Both parameters were therefore identified as an elevated parameter.

Hardness is frequently above the ODWQS Operational Guidelines. Given the natural origin and the lack of a health threat, the parameter was identified as an elevated parameter. Therefore, no Issues were identified in Waterford.

5.4 Port Dover Water Treatment Plant

The Port Dover Water Treatment Plant (WTP) is a large municipal residential drinking water system, and as such is a Type I system as defined by the Technical Rules (2009a).

Port Dover has one Type A (Great Lakes) intake located 457 m offshore at a depth of 2.9 m.

The Port Dover WTP withdraws raw water from Lake Erie and provides drinking water to the community of Port Dover and the municipal bulk water depot, serving a population of approximately 7,089 (**Map 5-39**). The WTP has a design capacity of 11,400 cubic metres per day. Water treatment includes chlorine disinfection, coagulation, flocculation, sedimentation, filtration, zebra Mussel control and taste / odour control.

The vulnerability assessment, threats assessment and issues identification is based on the following report "*CH2MHILL. 2010. Updated Surface Water Vulnerability Assessments and Initial Threats Inventory for the Port Dover and Port Rowan Water Treatment Plants*".

5.4.1 Intake Protection Zone 1

Intake protection zones (IPZ) 1 and 2 (**Map 5-40**) were delineated for the intake in accordance with Part VI of the Technical Rules set by the Ministry of the Environment (November 2009).

An IPZ 1 represents the most vulnerable and immediate area around an intake and, for a type A intake, is defined as a circle that has a radius of 1,000m centred on the crib of the intake. Where the 1,000m circle intersected land, only the portion of the land within the Conservation Authority Regulation Limit or within 120m, whichever was greater, was included.

5.4.2 Intake Protection Zone 2

An IPZ-2 is defined as an area surrounding the intake that takes into account characteristics of the local conditions including local water currents, shoreline features and local tributaries. An IPZ 2 accommodates the following:

- The area within each surface water body that may contribute water to the intake where the time to the intake is sufficient for operator response to an adverse condition, the minimum time of travel requirement is 2 hours.
- Areas within storm sewersheds and other drainages that drain toward the intake; and
- A setback of not more than 120m inland or the Conservation Authority Regulation Limit whichever is greater if the area abuts land.

An IPZ-2 was delineated for the Port Dover WTP intake using a time of travel of 2 hours. A 2 hour time of travel was deemed sufficient for operators to respond to an adverse situation based on: interviews with water treatment plant operators, a 24 hour-a-day, 7-day-a-week alarm answering system that notifies County staff when there is an adverse water quality condition and the ability to remotely shut down the water treatment plant. The County also indicated that operators strive to respond to alarms or emergency situations within one hour. Based on these factors, the County felt that the Intake Protection Zone (IPZ) 2 should be delineated for 2 hours, which is the minimum time allowed under the Technical Rules.

The DHI (Danish Hydraulic Institute) software MIKE-3, a three dimensional (3-D) hydrodynamic and water quality model, was used to simulate the currents in Lake Erie. Wind speed and current data were collected from an Acoustic Doppler Current Profiler (ADCP) from April to December 2006 to capture seasonal variation. This dataset, along with other Environment Canada data from several buoys in Lake Erie near Long Point and Port Colborne, was used to calibrate the model and select representative high wind and current speed events for modelling. Three high wind/current events were chosen as representative and used to delineate the IPZ in an easterly direction: July, October and December and two events in May were chosen to delineate the IPZ in a westerly direction. Current speeds in the selected representative events ranged from 0.06 to 0.18 m/s and plotted on a compass rose diagram to describe the lake current movement about the intake. The distance required for a two-hour time of travel was then determined based on these modeled current events.

Hydrodynamic lake modeling showed that the shoreline was beyond the two hour time limit given the strong along-shore currents in the vicinity of Port Dover and therefore, it was not necessary to investigate upland transport pathways (e.g. sewersheds, streams etc.). However, one event that was modeled showed one 2 hour time-of-travel estimate extend eastward just beyond the IPZ-1 boundary and south (offshore) of the mouth of the Lynn River. Upon closer inspection using aerial photography, the discharge plume from the Lynn River was evident and it was assumed that under certain river hydrologic events the discharge from the Lynn River may enter the IPZ-1 and influence the intake. Given these circumstances and the high uncertainty due to the lack of river hydraulic modeling, a precautionary approach was taken to delineate an IPZ-2 for Port Dover that extends up the Lynn River. Further investigation is needed to confirm the delineation of the IPZ-2 for Port Dover.

5.4.3 Intake Protection Zone 3

Investigation and modeling of an identified threat within the upland area indicated that it does not pose a threat to the Port Dover WTP intake and therefore, an IPZ-3 was not delineated for the

Port Dover WTP. Currently, the Source Protection Committee is not aware of any additional potential drinking water threats beyond IPZ-1 and IPZ-2 that could impact the Port Dover intake and would necessitate the delineation of an IPZ-3.

5.4.4 Information Sources for Vulnerability Assessment

The most up-to-date information was used for determining the area and source vulnerability scores. **Table 5-32** outlines the data sources and purposes for which the data were used.

Table 5-28: Summary of Data Sources Used in the Delineation of the Vulnerable Areas and the Vulnerability Assessment

Data Type	Source	Purpose
Lake Erie bathymetry	Raw depth sounding released by US National Oceanic and Atmospheric Administration (NOAA) in 1999	Development of hydrodynamic model to determine in-water extent of IPZ 2
Location of Lake Erie shoreline GIS dataset	Ontario Ministry of Natural Resources (MNR) Ontario Base Map theme	Development of hydrodynamic model to determine in-water extent of IPZ 2
Wind speed and direction	Atmospheric Environment Service (AES) station at Long Point and Port Colborne	Development of hydrodynamic model to determine in-water extent of IPZ 2
Climate data (air temperature, relative humidity, and cloud cover)	Erie International Airport	Input for hydrodynamic modeling
Lake current data	Acoustic Doppler Current Profiler (ADCP)	ADCP deployed at 80°12’12”; 42°45’48” as part of study for calibration of hydrodynamic model from November 2, 2006 to December 19, 2006
Lake Erie water levels, shoreline erosion characteristics, wave, sediment, erosion rates	Long Point Region Conservation Authority Shoreline Management Plan	Vulnerability characterization
Drawings, technical information regarding intake; Engineering reports	Norfolk County	Describes location, depth of intake
Watercourse mapping	MNR	Identify watercourses/ transport pathways that may impact IPZ
Conservation Area Regulation Limit GIS dataset	Long Point Region Conservation Authority	Determine land area to be included in IPZ
2006 orthoimagery with 30 cm resolution	Norfolk County	General mapping and identification of surface features
Water treatment plant operator interviews; spill reporting process; plant shut down process; shut down response time; treatment Issues/complaints etc.	Water treatment plant operator	Identify operational concerns and obtain local knowledge

Table 5-28: Summary of Data Sources Used in the Delineation of the Vulnerable Areas and the Vulnerability Assessment

Data Type	Source	Purpose
Sediment Sampling information	Sediment Sampling Report – Binational Toxics Strategy 2002; Environment Canada report	Assessment of Issues and conditions
Raw water quality	MOE Drinking Water Surveillance Program, Norfolk County	Assess vulnerability of intake and identify concerns
Lot fabric information	Norfolk County / MNR	Available through Land Information Ontario
National Pollutant Release Inventory (NPRI) data	Environment Canada	Identify potential threats

5.4.5 Vulnerability Assessment

Vulnerability analysis of the IPZ-1 includes consideration for both the area and the source as described in the Technical Rules. The area vulnerability factor for an IPZ-1 is prescribed as 10.

The Port Dover IPZ-2 area vulnerability factor was scored a 9 given the following rationale:

- High sloping banks along Lake Erie at the WTP;
- The IPZ-2 area contains approximately 20% land which has been considered a small percentage;
- High level of impermeability along shoreline increasing the potential for runoff; and
- Identified storm sewer transport pathways

In addition to the physical location, land cover/runoff potential, and transport pathways that are evaluated for scoring the area vulnerability, consideration was also given for the 27 hours of available storage that the County has for the town of Port Dover.

The Port Dover WTP intake is located 457 m offshore at a depth of 2.9 m. The length and depth of the intake is relatively near and shallow, respectively, when compared to other Great Lake intakes. Relatively few water quality concerns have been raised by operators. Occasional high turbidity, aluminum and organic nitrogen levels have been flagged as concerns in the raw water requiring further monitoring. These factors result in a source vulnerability score of 0.6. **Table 5-33** summarizes the vulnerability scores for the Port Dover WTP.

Table 5-29: Vulnerability Scoring for Port Dover WTP Intake

Intake	Area Vulnerability Factor			Source Vulnerability Factor [0.5 – 0.7][1]	Vulnerability Score		
	IPZ-1 [10][1]	IPZ-2 [7-9][1]	IPZ-3		IPZ-1 [5-7][1]	IPZ-2 [3.5-6.3][1]	IPZ-3
Port Dover WTP	10	9	n/a	0.6	6	5.4	n/a

[1] Represents range of potential scoring for Great Lakes water source –Technical Rules (MOE, 2009a)

5.4.6 Percent Managed Lands and Livestock Density within Intake Protection Zones

The percent managed lands in the IPZ 1 for Port Dover is 3.4% while the percent managed lands in IPZ-2 is 4.4% (see **Map 5-41**). There is no livestock in either IPZ-1 or IPZ-2 for Port Dover (see **Map 5-42**)

5.4.7 Percent Impervious Surfaces within the Intake Protection Zone

Map 5-43 shows the percent impervious surfaces in IPZ-1 and IPZ-2 for Port Dover.

Methodology

To calculate the percent impervious surface, information on land cover classification from the Southern Ontario Land Resource Information system (SOLRIS) was used. This provided land use information, including road and highway transportation routes, as continuous 15x15 metre grid cells across the entire Source Protection Area. All the cells that represent highways and other impervious surfaces used for vehicular traffic were re-coded with a cell value of 1 and all other land cover classifications were given a value of 0, to identify impervious surface areas.

Then, a focal sum moving window average was applied using the Spatial Analyst module of the ArcGIS software. For each 15x15 metre cell, the total number of neighbouring grid cells coded as impervious, within a 1x1 kilometre search area, was calculated. This total was then converted into the percentage of impervious surface by land area, using the area of each cell (225 sq. m) and the area of the moving window (1 sq. km). This provides a 1x1 kilometre moving window calculation of percent impervious surface, represented in 15x15 metre spatial increments. This dataset was calculated for the entire Source Protection Area, but was clipped to show those results only in the WHPAs and Intake Protection Zones. The analysis is more representative of road density and is better than the method described in the Technical Rules. As per Technical Rule 15.1, the Director has confirmed their agreement with the departure. The Director's letter of confirmation can be found in **Appendix B**.

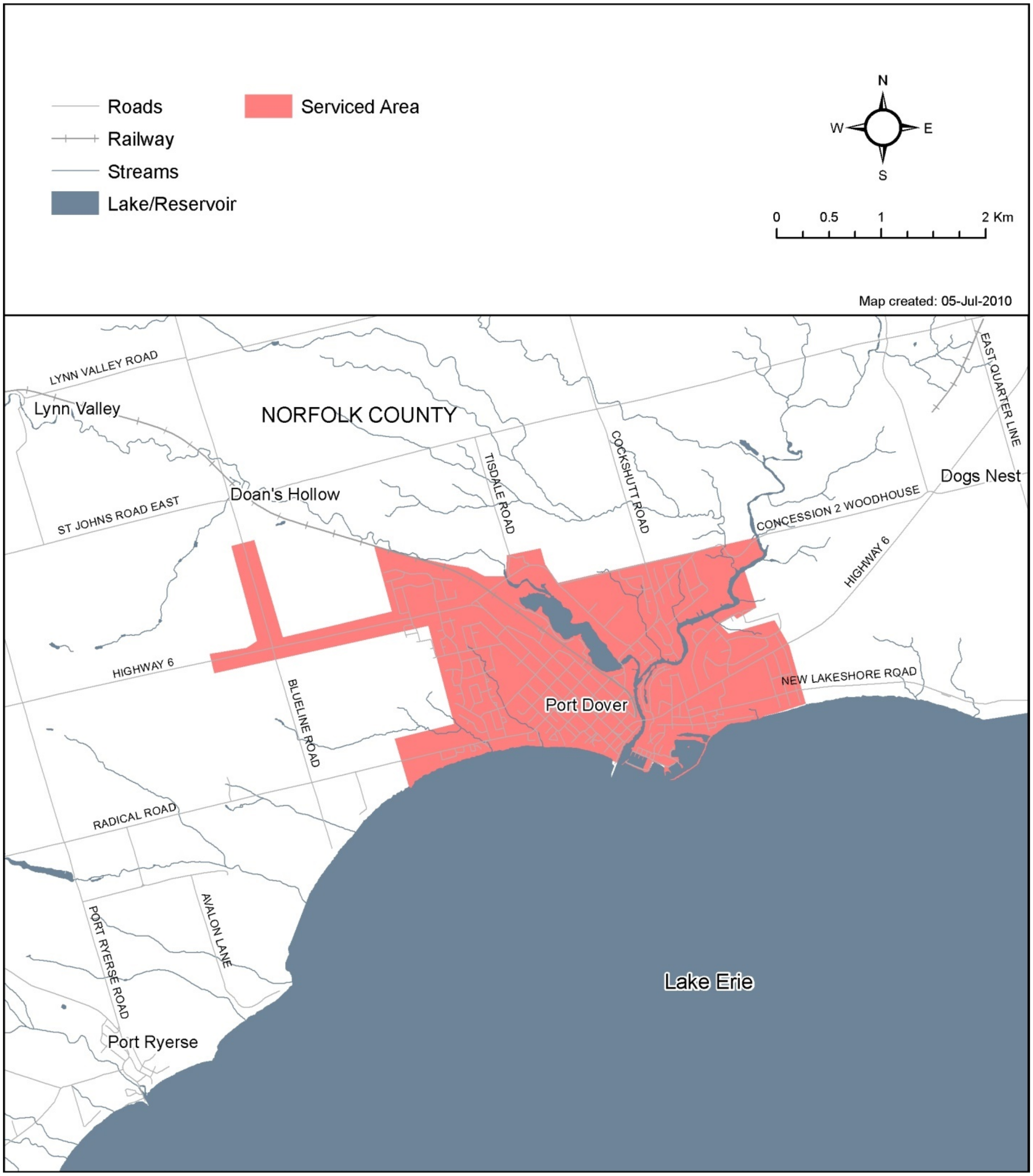
Known Limitations and Data Gaps

Impervious surfaces such as parking lots, pedestrian walkways and other related surfaces that may receive salt application were not considered as data was not available for these features within the study area.

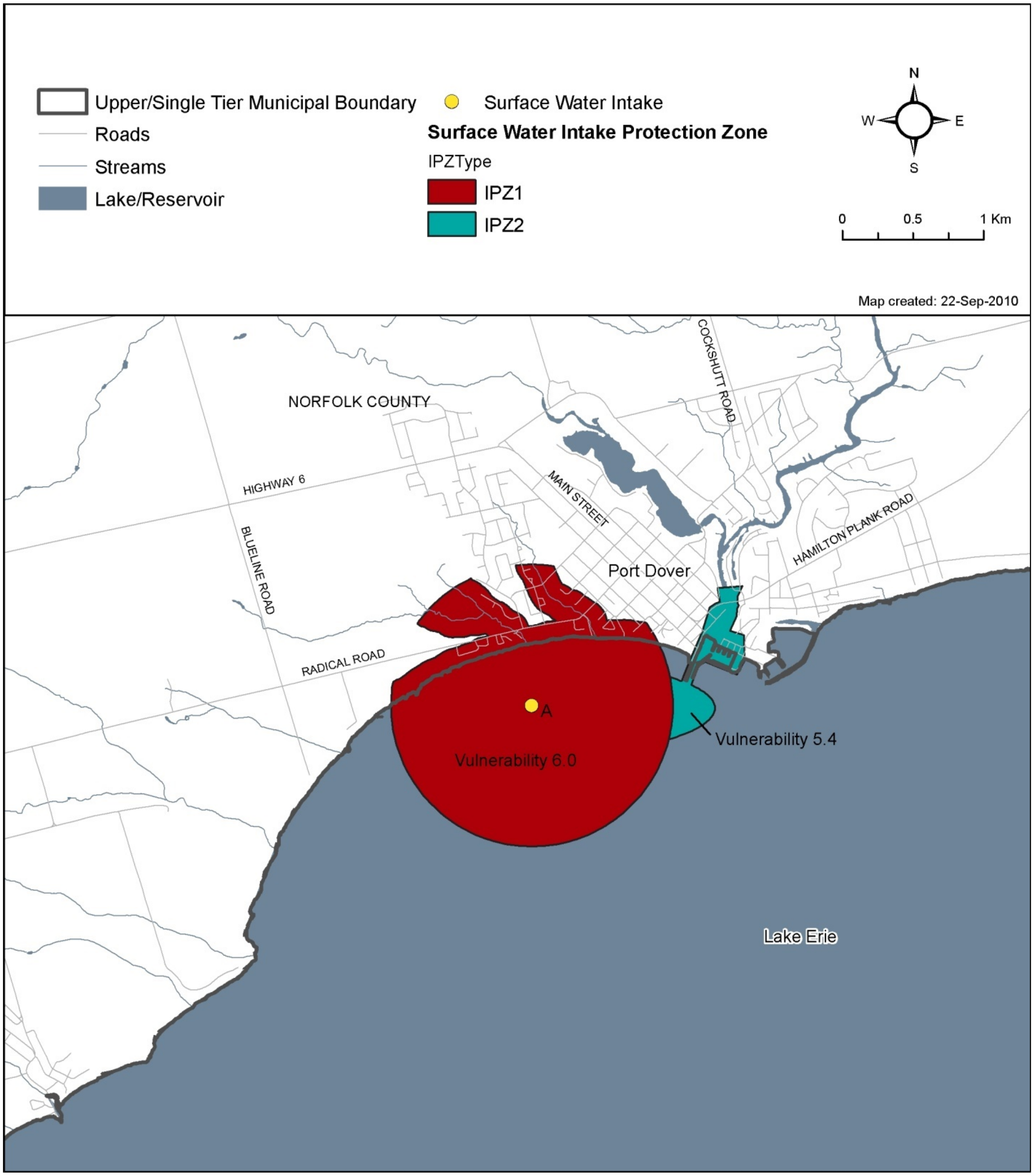
Table 5-30: Input Data for Impervious Surfaces in Intake Protection Zones

Data Input	Description	Source	Purpose
Road areas (raster)	Road and highway transportation routes as represented by the Southern Ontario Land Resource Information System (SOLRIS) version 1.2 May 2008, 15 metre raster cell format	Sub-license from Ontario Ministry of Natural Resources (MNR)	Continuous 15 x 15 metre cells represent surface areas of all highways and other impervious land surfaces used for vehicular traffic
IPZ (polygon)	Intake Protection Zone	Lake Erie Source Protection Region	Boundary of reporting unit

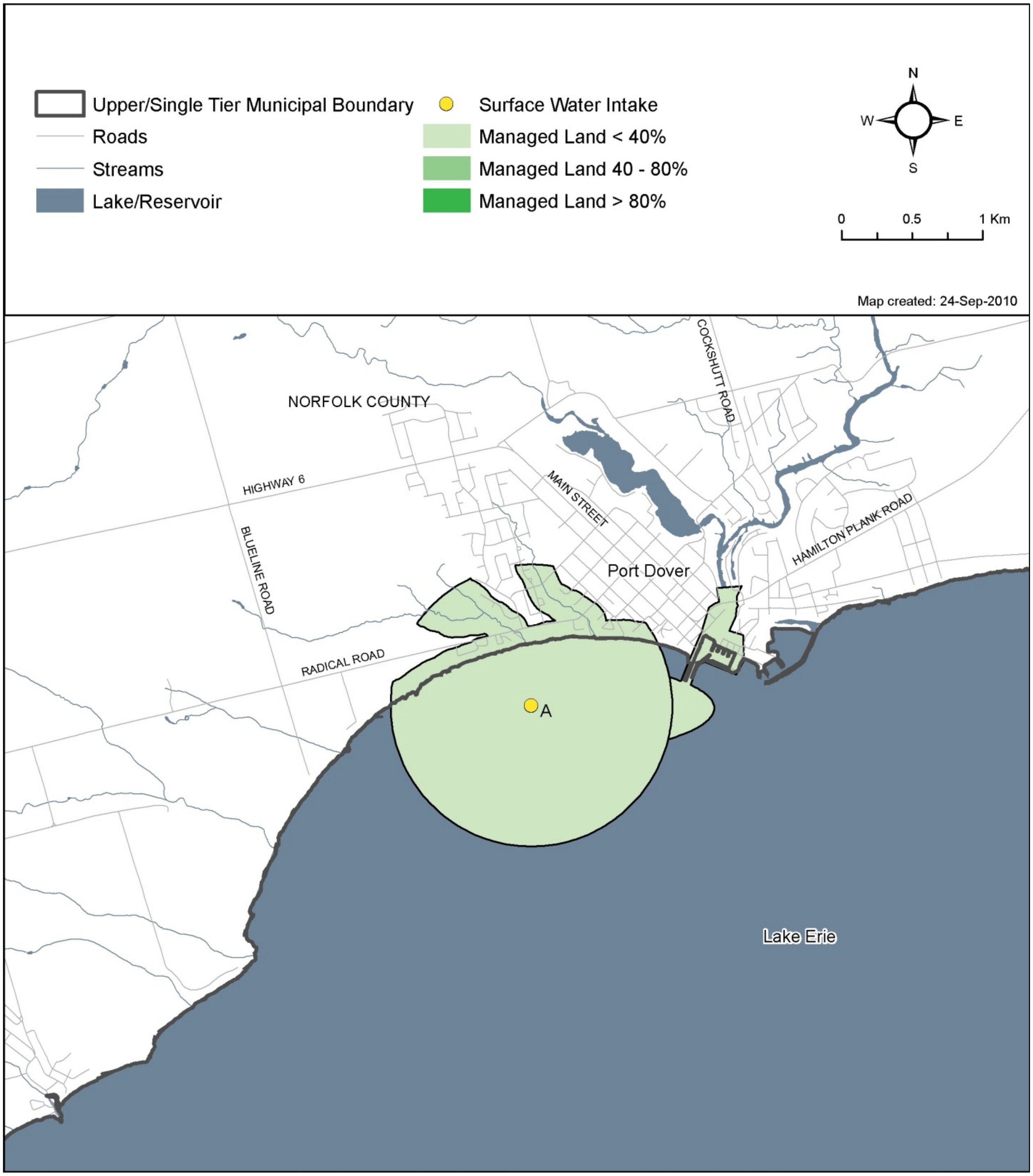
Map 5-36: Port Dover Service Area



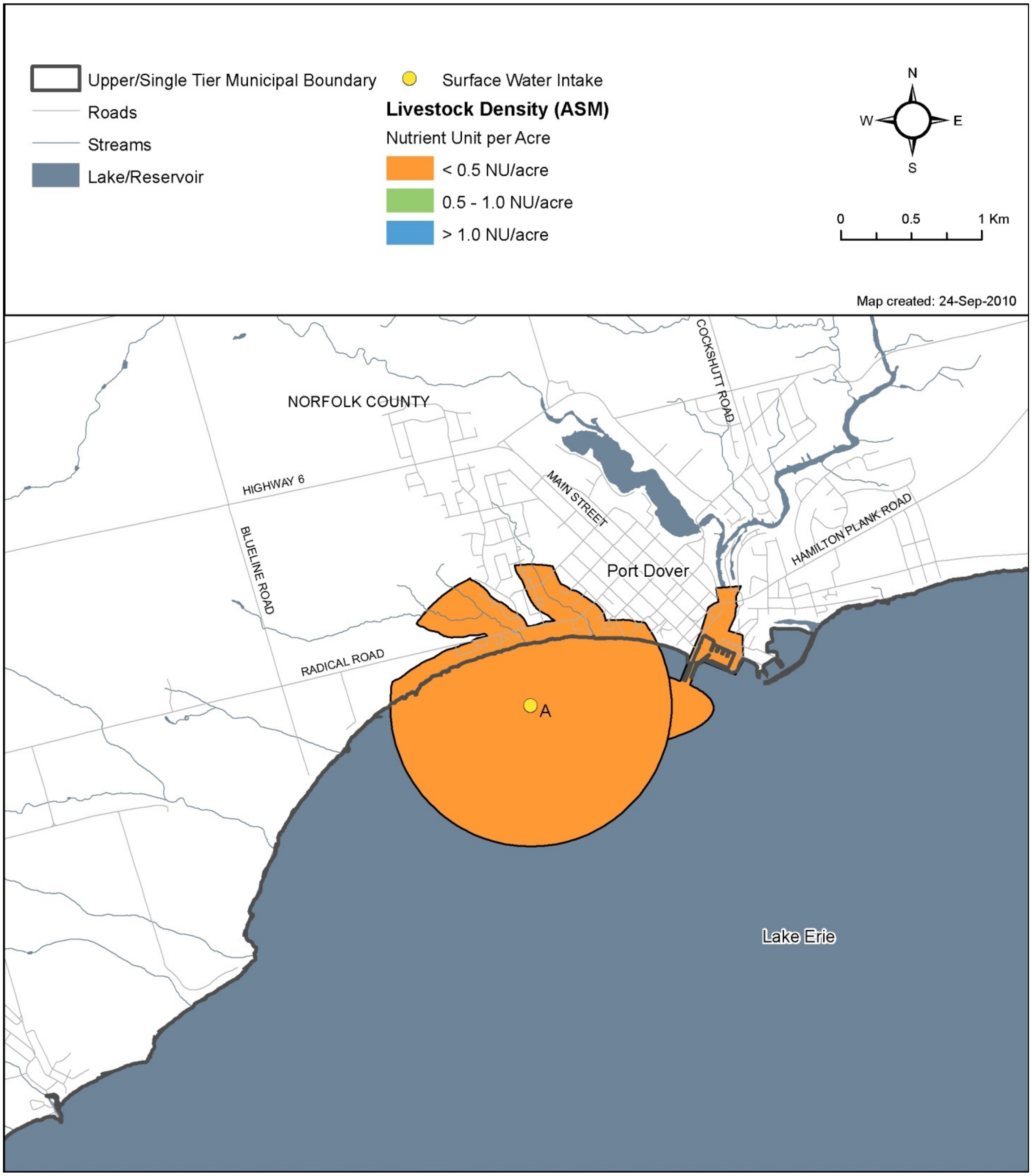
Map 5-37: Port Dover Intake Protection Zone



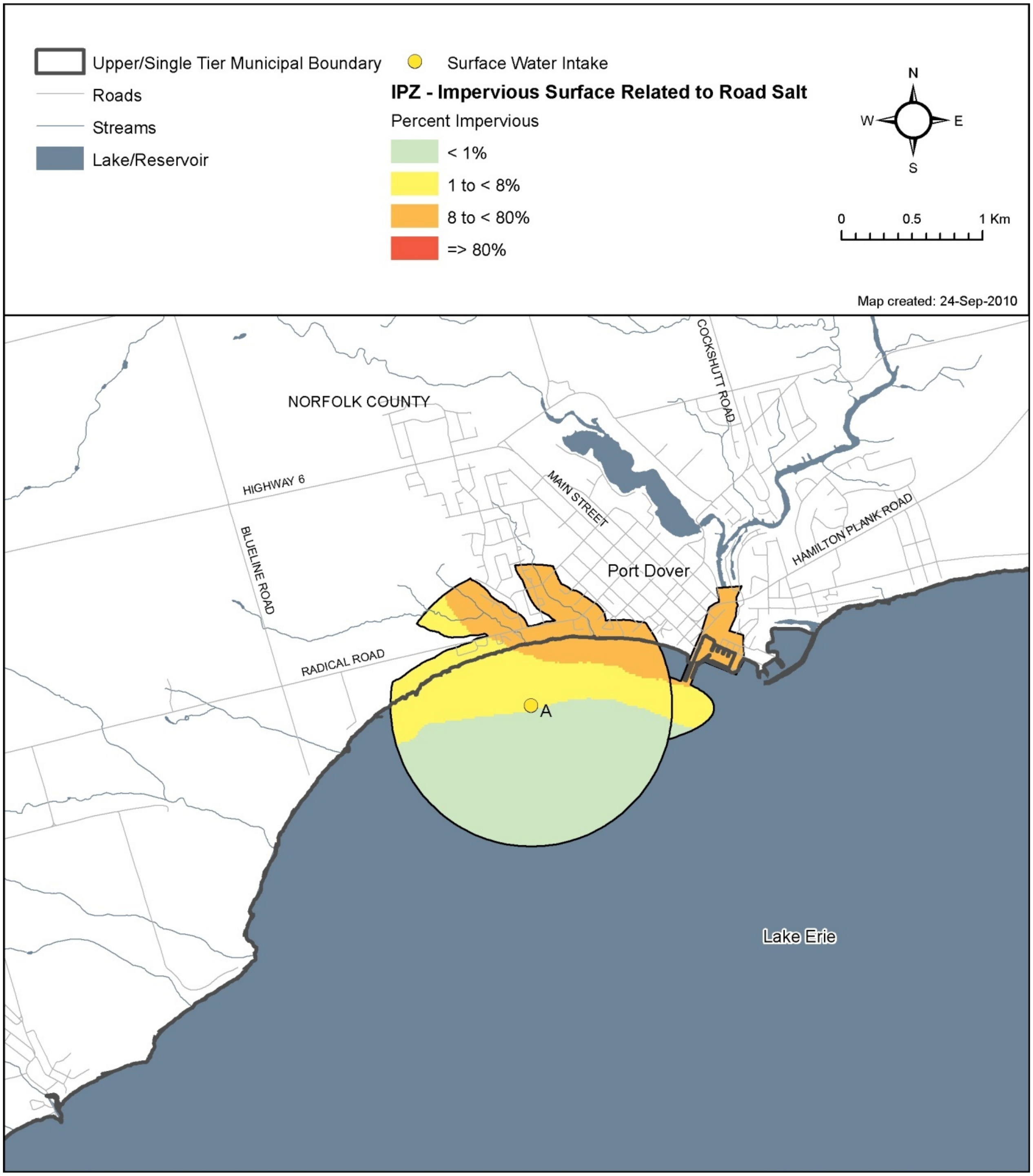
Map 5-38: Percent Managed Lands within the Port Dover Intake Protection Zone



Map 5-39: Livestock Density within the Port Dover Intake Protection Zone



Map 5-40: Impervious Surfaces within the Port Dover Intake Protection Zone



5.4.8 Uncertainty and Limitations of Data and Methods

There was a high level of confidence in the datasets used to delineate the IPZ-1; therefore, a low level of uncertainty was assigned and no limitations were identified.

Hydrodynamic modeling was used for the delineation of the IPZ-2 and although there is inherent uncertainty with large in-lake modeling, an overall low level of uncertainty was assigned to the modeling which identified one modeling event that extended outside the IPZ-1 and the resulting need for an IPZ-2. A precautionary approach was used to delineate an IPZ-2 that took into consideration the modeling event that fell outside the IPZ-1 along with the assumed influence of the Lynn River as seen on aerial photographs. Given the lack of in-river hydrodynamic modeling completed to understand the influence of the Lynn River on the IPZ-1 and IPZ-2, an overall high level of uncertainty was assigned to the IPZ-2 for Port Dover.

5.4.9 Threat Assessment

The Ontario Clean *Water Act, 2006* defines a Drinking Water Threat as “an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, and includes an activity or condition that is prescribed by the regulation as a drinking water threat.”

The Technical Rules (MOE, 2009a) list five ways in which to identify a drinking water threat:

a) Through an activity prescribed by the Act as a Prescribed Drinking Water Threat;
b) Through an activity identified by the Source Water Protection Committee as an activity that may be a threat and (in the opinion of the Director) a hazard assessment confirms that the activity is a threat;
c) Through a condition that has resulted from past activities that could affect the quality of drinking water;
d) Through an activity associated with a drinking water issue; and
e) Through an activity identified through the events based approach (this approach has not been used in this Assessment Report).

Threats can fall into one of the following four categories:

- Chemical threats can include toxic metals, pesticides, fertilizers, petroleum products and industrial solvents;
- Pathogenic threats are microorganisms that could cause illness; and
- Dense non-aqueous phase liquids (DNAPLs) are chemicals which are denser than water and do not dissolve in water, such as chlorinated solvents.
- Through a condition that has resulted from past activities that could affect the quality of drinking water.

Significant threats to the Port Dover water supply were assessed through the development of a desktop land use inventory.

The identification of a land use activity as a significant, moderate, or low drinking water threat depends on its risk score, determined by considering the circumstances of the activity and the type and vulnerability score of any underlying protection zones, as set out in the Tables of Drinking Water Threats available through www.sourcewater.ca. Information on drinking water threats is also accessible through the Source Water Protection Threats Tool: http://swpip.ca. The information above can be used with the vulnerability scores shown in **Map 5-40** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 5-35 provides a summary of the threat levels possible in the Port Dover Intake Protection Zones for Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogens. A checkmark indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; a blank cell indicates that it is not. The colours shown for each vulnerability score correspond to those shown in the map.

Table 5-31: Identification of Drinking Water Threats in the Port Dover Intake Protection Zones

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals	IPZ-1	6		✔	✔
	IPZ-2	5.4			✔
Handling & Storage of DNAPLs	IPZ-1	6			✔
	IPZ-2	5.4			✔
Pathogens	IPZ-1	6		✔	✔
	IPZ-2	5.4			✔

Because the highest vulnerability score is 6, no significant drinking water threats are possible in the Port Dover Intake Protection Zones.

5.4.10 Intake Protection Zone 3

No IPZ-3 has been delineated for the Port Dover WTP. The Source Protection Committee is currently not aware of any potential drinking water threats beyond IPZ-1 and IPZ-2 that could impact the Port Dover intake and would necessitate the delineation of an IPZ-3. If modelling is completed and shows this could be the case this information would be included in an updated Assessment Report.

5.4.11 Conditions Assessment

The potential presence of conditions associated with past activities was assessed based on local knowledge through discussions with Norfolk County municipal staff. MOE datasets related to past spills, Records of Site Condition and potentially contaminated sites were not assessed and this is noted as a data gap. There were no conditions identified for the Port Dover WTP intake.

5.4.12 Preliminary Issues Identification and Parameters of Concern

Municipal water treatment plant operators have indicated very few concerns regarding the operation of the water treatment plant. Although the Ontario Drinking Water Quality Standards (ODWQS) are for treated water, they can be used to flag parameters that could be a concern. A preliminary assessment of the Drinking Water Surveillance Program (DWSP) data indicates that the following parameters exceeded the ODWQS in one or more samples for the period between 1998 and 2007:

- Aluminum
- Dissolved Organic Carbon

- Hardness
- Iron
- Manganese
- Organic Nitrogen
- pH
- Temperature
- Turbidity

Based on DWSP data for Port Dover raw water, none of the human health-based ODWQS were exceeded. Operational guidelines were exceeded for aluminum, hardness, organic nitrogen, and pH on one or more occasion based on the DWSP dataset. Aesthetic objectives for dissolved organic carbon, manganese, temperature and turbidity were also exceeded in one or more raw water sample. All of these parameters are associated with naturally occurring processes in Lake Erie, although in some cases, anthropogenic activities may play a role in the elevated levels observed. All raw water samples taken for the DWSP exceeded the organic nitrogen operational guideline (for treated water) of 0.150 mg/L. These levels may be related to algae blooms, agricultural runoff and/or wastewater inputs to Lake Erie. Given the high frequency of elevated concentrations of organic nitrogen, organic nitrogen has been identified as a preliminary issue that may be attributed to both natural and anthropogenic sources. Additional monitoring of the raw water is recommended before it can be decided whether organic nitrogen is identified as an issue under Technical Rule 114.

5.4.13 Uncertainty/Limitations of Data and Methods Used for Issues Evaluation

In general, the available data were of sufficient quality and quantity to evaluate Issues. Raw water quality data for parameters listed on schedule 1, 2 and 3 and Table 4 of the Ontario Drinking Water Standards were provided for the years 1998-2007. Although there were data for most of the parameters from the schedules and Table, some parameters were not sampled for. The analysis may benefit from improved frequency and consistency of sampling data as well as a more complete scan for all parameters on the schedules of the ODWS.

5.5 Port Rowan Water Treatment Plant

The Port Rowan Water Treatment Plant (WTP) is a large municipal residential drinking water system and, as such, is a Type I system as defined by the Technical Rules (2009a).

The Port Rowan WTP has one Type A (Great Lakes) intake located approximately 365m off-shore into the Long Point inner Bay. The intake crib is at a depth of 0.9m.

The Port Rowan WTP is located on the shores of Lake Erie in the town of Port Rowan. The WTP has a design capacity of 3,000 cubic metres per day that serves a population of approximately 2,312 from the towns of Port Rowan and St. Williams. The distribution system is shown in **Map 5-44.**

The Port Rowan WTP is a conventional treatment plant (package plant) that receives raw water from Lake Erie. The treatment process consists of prescreening, chlorine and ultra violet disinfection, pH adjustment, coagulation, flocculation, sedimentation, filtration, zebra mussel control, and taste and odour control.

The vulnerability assessment, threats assessment and Issues identification is based on the following report “*CH2MHILL 2010. Updated Surface Water Vulnerability Assessments and Initial Threats Inventory for the Port Dover and Port Rowan Water Treatment Plants,*”

5.5.1 Intake Protection Zone 1

Intake protection zones (IPZ) 1 and 2 were delineated for the intake in accordance with Part VI of the Technical Rules set by the Ministry of the Environment (November 2009).

An IPZ-1 represents the most vulnerable and immediate area around an intake and, for a type A intake, is defined as a circle that has a radius of 1,000m centred on the crib of the intake (**Map 5-45**)**.** Where the 1,000m circle intersected land, only the portion of the land within the Conservation Authority Regulation Limit or within 120m, whichever was greater, was included.

5.5.2 Intake Protection Zone 2

An IPZ-2 is defined as an area surrounding the intake that takes into account characteristics of the local conditions including local water currents, shoreline features and local tributaries. An IPZ-2 accommodates the following:

- The area within each surface water body that may contribute water to the intake where the time to the intake is sufficient for operator response to an adverse condition, the minimum time of travel requirement is 2 hours.
- Areas within storm sewersheds and other drainages that drain toward the intake; and
- A setback of not more than 120m inland or the Conservation Authority Regulation Limit, whichever is greater, if the area abuts land.

An IPZ-2 was delineated for the Port Rowan WTP intake using a time of travel of 2 hours. A 2 hour time of travel was deemed sufficient for operators to respond to an adverse situation based on: interviews with water treatment plant operators, a 24 hour a day, 7-day a week alarm answering system that notifies County staff when there is an adverse water quality condition and the ability to remotely shut down the water treatment plant. The County also indicated that operators strive to respond to alarms or emergency situations within one hour. Based on these factors, the County felt that the Intake Protection Zone (IPZ) 2 should be delineated for 2 hours, which is the minimum time allowed under the Technical Rules.

The DHI software MIKE-3, a three dimensional (3-D) hydrodynamic and water quality model, was used to simulate the currents in Lake Erie. Wind speed and current data were collected from an Acoustic Doppler Current Profiler (ADCP) from April to December 2006 to capture seasonal variation. This dataset, along with other Environment Canada data from several buoys in Lake Erie near Long Point and Port Colborne, was used to calibrate the model and select representative high wind and current speed events for modelling. The location of the Port Rowan intake is in the inner Long Point bay where there were very different current patterns than Port Dover. There is neither evidence of an eddy nor any dominant current direction. Nonetheless, three high wind/current events were chosen as representative and used to delineate the IPZ in an easterly direction: July, October and December and two events in May were chosen to delineate the IPZ in a westerly direction. Current speeds in the selected representative events ranged from 0.01 to 0.05 m/s and plotted on a compass rose diagram to describe the lake current movement about the intake. The distance required for a two-hour time of travel was then determined based on these modeled current events.

Lake hydrodynamic modelling showed that the two hour time of travel about the intake did not reach the shoreline and therefore, it was not necessary to investigate upland transport pathways (e.g. sewersheds, streams etc.). Further, the modeling showed that the two-hour travel time fell completely within the IPZ-1. Since the Technical Rules state that an IPZ-2 shall not include an area of land or water that lies within an IPZ-1 that has been delineated for that surface water intake, an IPZ-2 for Port Rowan was not delineated.

5.5.3 Information Sources for Vulnerability Assessment

The most up-to-date information was used for determining the area and source vulnerability scores. **Table 5-36** outlines the data sources and purposes for which the data were used.

Table 5-32: Summary of Data Sources Used in the Delineation of the Vulnerable Areas and the Vulnerability Assessment.

Data Type	Source	Purpose
Lake Erie bathymetry	Raw depth sounding released by US National Oceanic and Atmospheric Administration (NOAA) in 1999	Development of hydrodynamic model to determine in-water extent of IPZ-2
Location of Lake Erie shoreline GIS dataset	Ontario Ministry of Natural Resources (MNR) Ontario Base Map theme	Development of hydrodynamic model to determine in-water extent of IPZ-2
Wind speed and direction	Atmospheric Environment Service (AES) station at Long Point	Development of hydrodynamic model to determine in-water extent of IPZ-2
Climate data (air temperature, relative humidity, and cloud cover)	Erie International Airport	Input for hydrodynamic modeling
Lake current data	Acoustic Doppler Current Profiler (ADCP)	ADCP deployed at 80°12’12”; 42°45’48” as part of study for calibration of hydrodynamic model from November 2, 2006 to December 19, 2006
Lake Erie water levels, shoreline erosion characteristics, wave, sediment, erosion rates	Long Point Region Conservation Authority Shoreline Management Plan	Vulnerability characterization
Drawings, technical information regarding intake; Engineering reports	Norfolk County	Describes location, depth of intake
Watercourse mapping	MNR	Identify watercourses/ transport pathways that may impact IPZ
Conservation Area Regulation Limit GIS dataset	Long Point Region Conservation Authority	Determine land area to be included in IPZ
2006 orthoimagery with 30 cm resolution	Norfolk County	General mapping and identification of surface features
Water treatment plant operator interviews; spill reporting process; plant shut down process; shut down response time; treatment Issues/complaints etc.	Water treatment plant operator	Identify operational concerns and obtain local knowledge

Table 5-32: Summary of Data Sources Used in the Delineation of the Vulnerable Areas and the Vulnerability Assessment.

Data Type	Source	Purpose
Sediment Sampling information	Sediment Sampling Report – Binational Toxics Strategy 2002; Environment Canada report	Assessment of Issues and conditions
Raw water quality	MOE Drinking Water Surveillance Program, Norfolk County	Assess vulnerability of intake and identify concerns
Lot fabric information	Norfolk County / MNR	Available through Land Information Ontario
National Pollutant Release Inventory (NPRI) data	Environment Canada	Identify potential threats

5.5.4 Vulnerability Assessment

Vulnerability analysis of the IPZ-1 includes consideration for both the area and the source as described in the Technical Rules. The area vulnerability factor for an IPZ-1 is prescribed to be 10.

The Port Rowan WTP intake is located 365 m off the shore line at a depth of 0.9 m. The length and depth of the intake is relatively near and very shallow, respectively, when compared to other Great Lake intakes. During summer months, the shallow water in the vicinity of the intake has resulted in higher temperatures and pH in the raw source water. The warmer water temperatures, in combination with available nutrients such as phosphorus also promotes algae growth which has clogged the intake cribs on a regular basis. Occasional high turbidity, aluminum and organic nitrogen levels have been flagged as concerns in the raw water requiring further monitoring. These factors result in a source vulnerability score of 0.7. **Table 5-37** summarizes the vulnerability for the Port Rowan WTP.

Table 5-33: Vulnerability Scoring for the Port Rowan WTP Intakes

Intake	Area Vulnerability Factor			Source Vulnerability Factor	Vulnerability Score		
	IPZ-1 [10][1]	IPZ-2 [7-9][1]	IPZ-3	[0.5 – 0.7][1]	IPZ-1 [5-7][1]	IPZ-2 [3.5-6.3][1]	IPZ-3
Port Rowan WTP	10	n/a	n/a	0.7	7	n/a	n/a

[1] Represents range of potential scoring for Great Lakes water source –Technical Rules (MOE, 2009a)

5.5.5 Managed Lands and Livestock Density within Intake Protection Zones

The percent managed lands in the IPZ 1 for Port Rowan is 4.3% (see **Map 5-46**) while there is no livestock in the IPZ (see **Map 5-47**).

5.5.6 Percent Impervious Surfaces within the Intake Protection Zone

Map 5-48 shows the percent impervious surfaces in IPZ-1 for Port Rowan.

Methodology

To calculate the percent impervious surface, information on land cover classification from the Southern Ontario Land Resource Information system (SOLRIS) was used. This provided land use information, including road and highway transportation routes, as continuous 15x15 metre grid cells across the entire Source Protection Area. All the cells that represent highways and other impervious surfaces used for vehicular traffic were re-coded with a cell value of 1 and all other land cover classifications were given a value of 0, to identify impervious surface areas.

Then, a focal sum moving window average was applied using the Spatial Analyst module of the ArcGIS software. For each 15x15 metre cell, the total number of neighbouring grid cells coded as impervious, within a 1x1 kilometre search area, was calculated. This total was then converted into the percentage of impervious surface by land area, using the area of each cell (225 sq. m) and the area of the moving window (1 sq. km). This provides a 1x1 kilometre moving window calculation of percent impervious surface, represented in 15x15 metre spatial increments. This dataset was calculated for the entire Source Protection Area, but was clipped to show those results only in the Wellhead Protection Areas and Intake Protection Zones. The analysis is more representative of road density and is better than the method described in the Technical Rules. As per Technical Rule 15.1, the Director has confirmed their agreement with the departure. The Director's letter of confirmation can be found in **Appendix B**.

Known Limitations and Data Gaps

Impervious surfaces such as parking lots, pedestrian walkways and other related surfaces that may receive salt application were not considered as data was not available for these features within the study area.

Table 5-34: Input Data for Impervious Surfaces in Intake Protection Zones

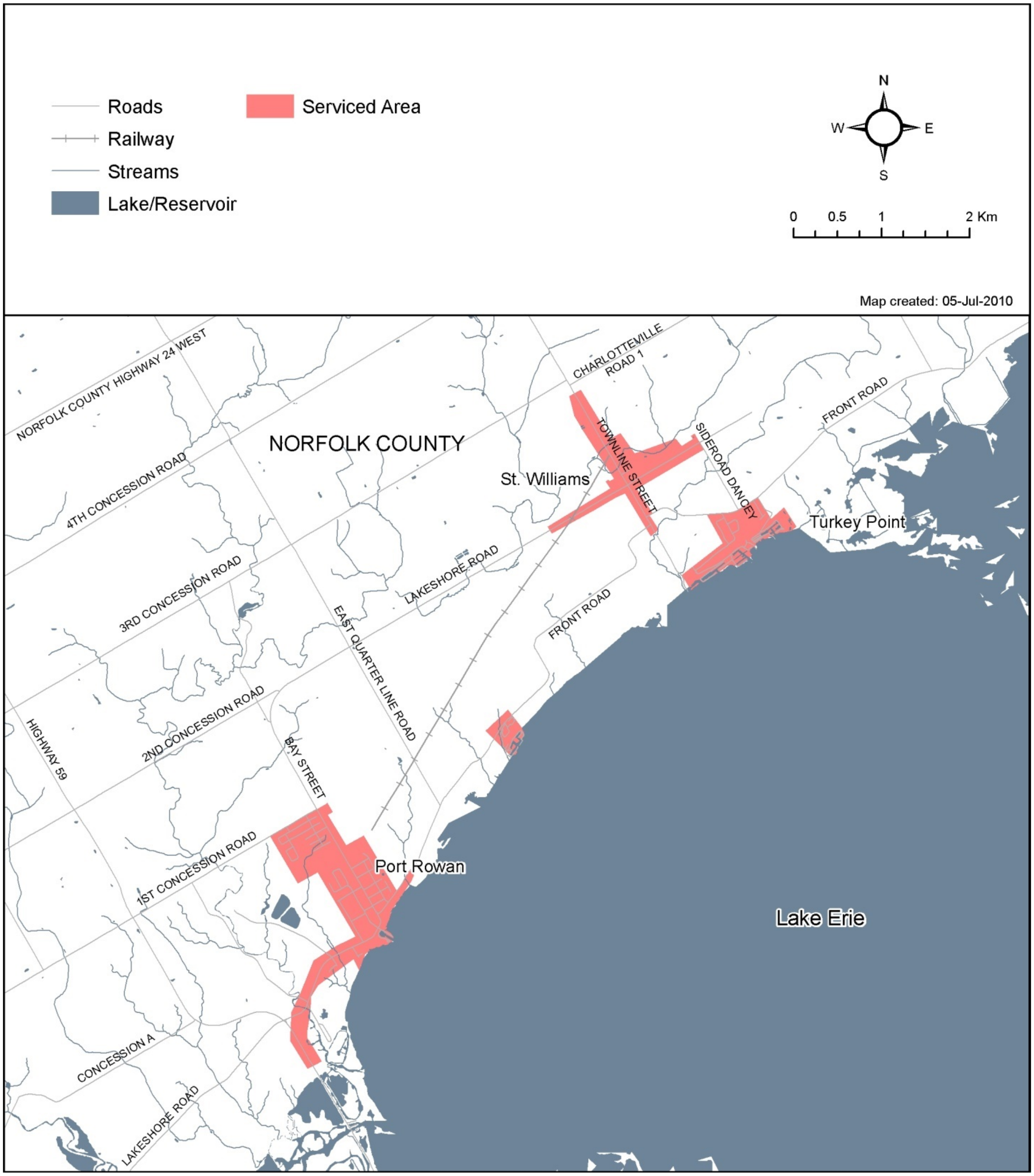
Data Input	Description	Source	Purpose
Road areas (raster)	Road and highway transportation routes as represented by the Southern Ontario Land Resource Information System (SOLRIS) version 1.2 May 2008, 15 metre raster cell format	Sub-license from Ontario Ministry of Natural Resources (MNR)	Continuous 15 x 15 metre cells represent surface areas of all highways and other impervious land surfaces used for vehicular traffic
IPZ (polygon)	Intake Protection Zone	Lake Erie Source Protection Region	Boundary of reporting unit

5.5.7 Uncertainty and Limitations of Data and Methods

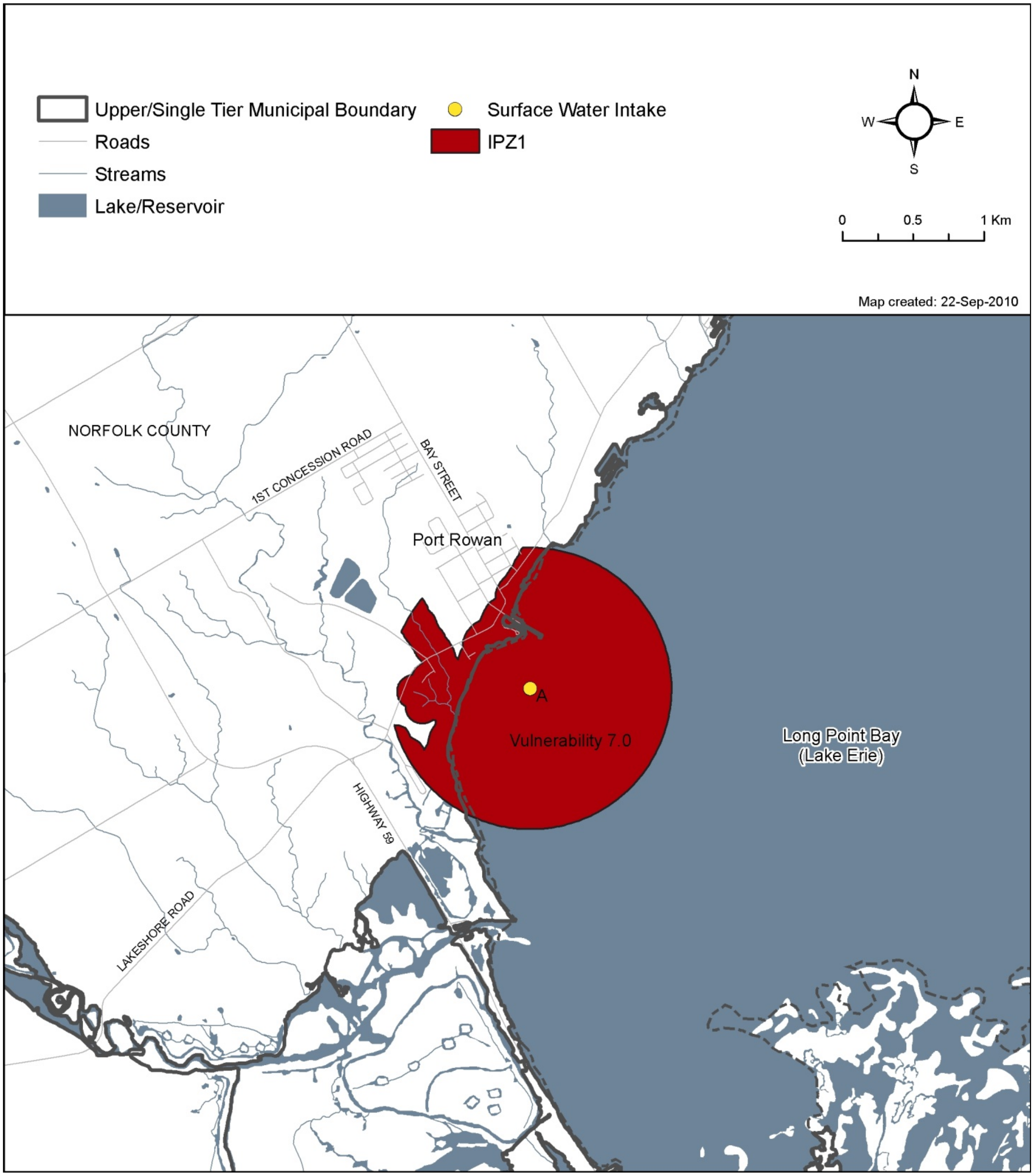
There was a high level of confidence in the datasets used to delineate the IPZ-1; therefore, a low level of uncertainty was assigned and no limitations were identified.

Hydrodynamic modeling was used for the delineation of the IPZ-2 and although there is inherent uncertainty with large in-lake modeling, an overall low level of uncertainty was assigned to the modeling which delineated the extent of the 2 hour time of travel about the intake. Since the modeling showed that the IPZ-2 was wholly contained within the IPZ-1, there is no IPZ-2 for the Port Rowan WTP.

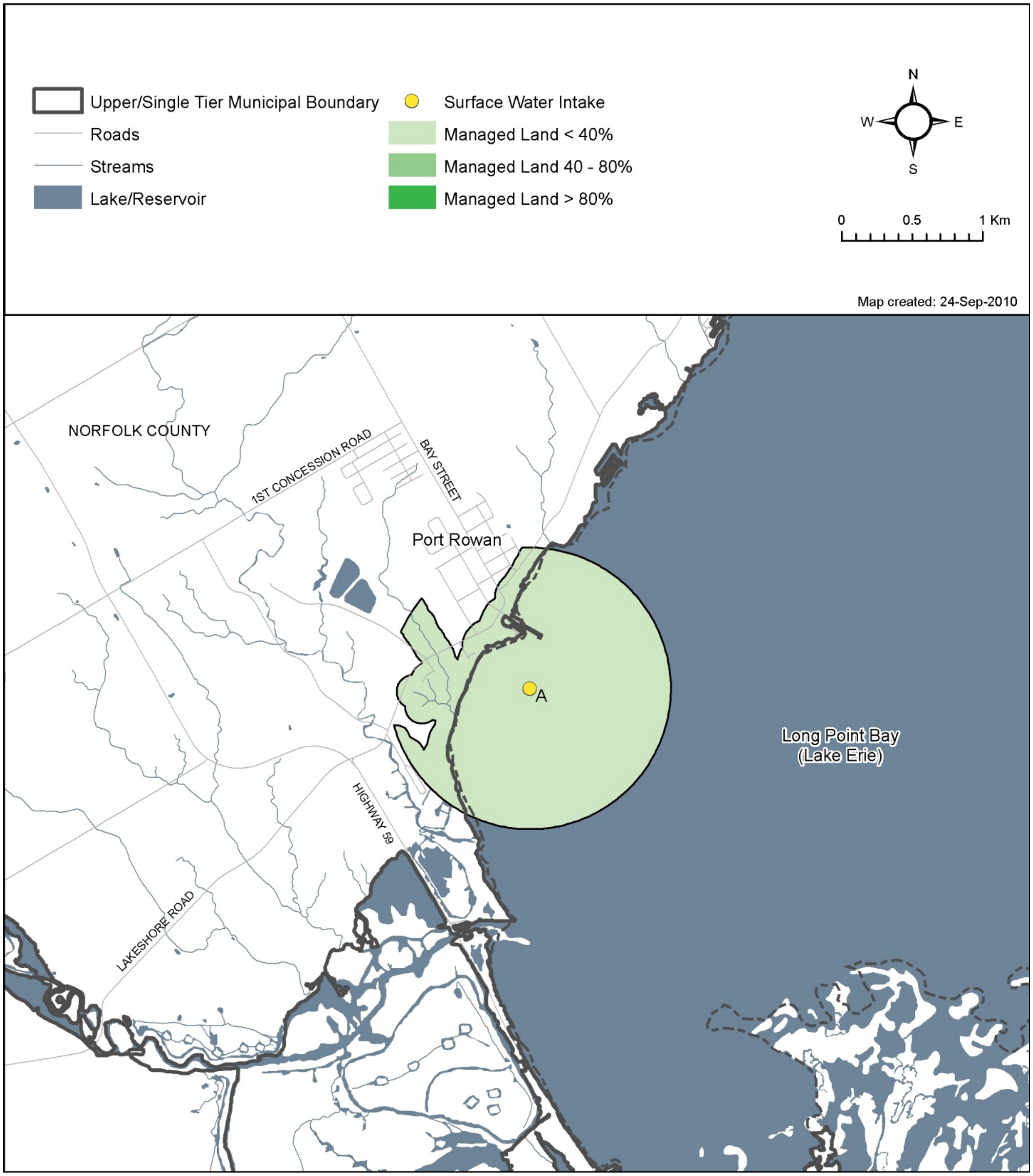
Map 5-41: Port Rowan Service Area



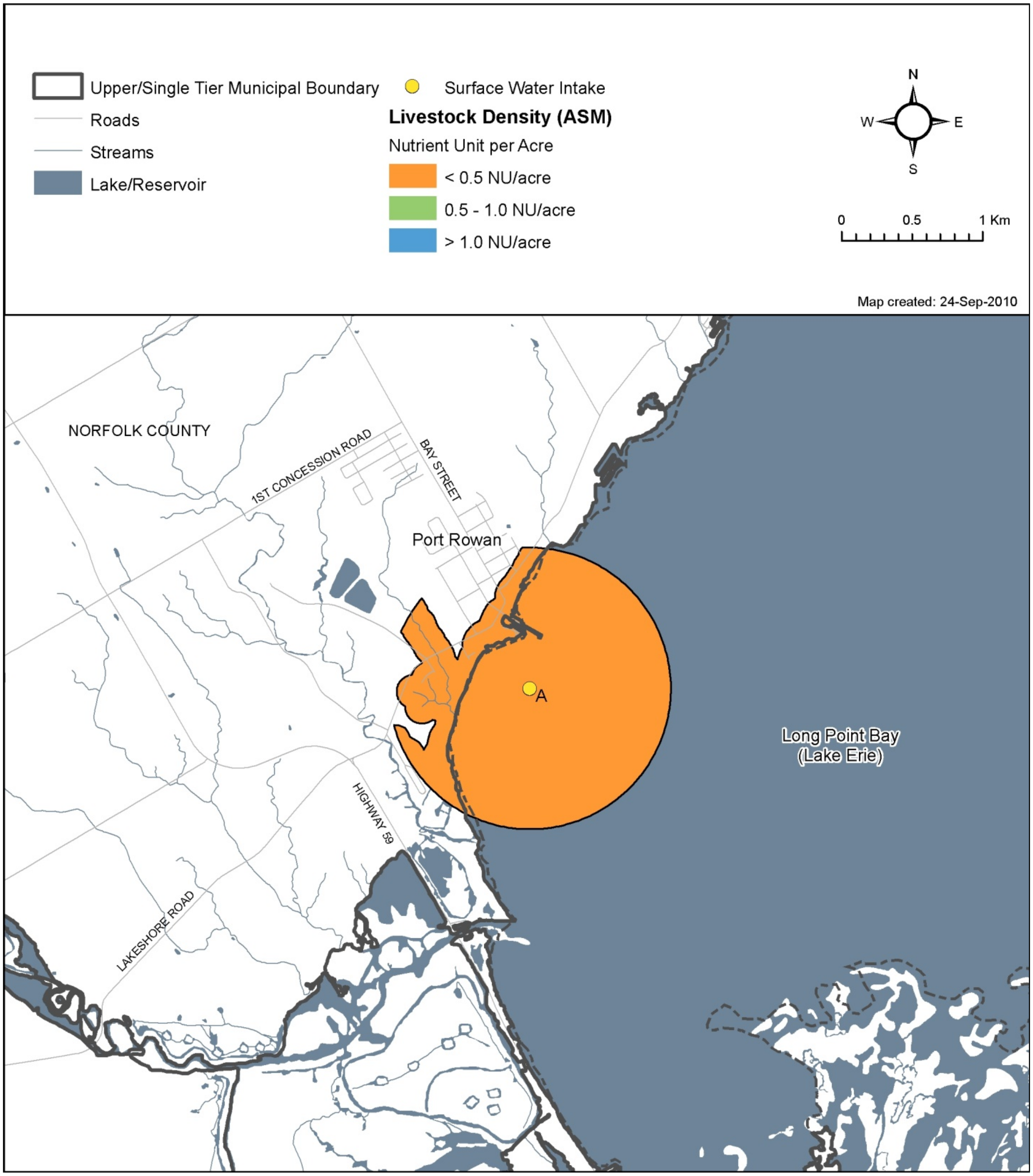
Map 5-42: Port Rowan WTP Surface Water Intake Protection Zone



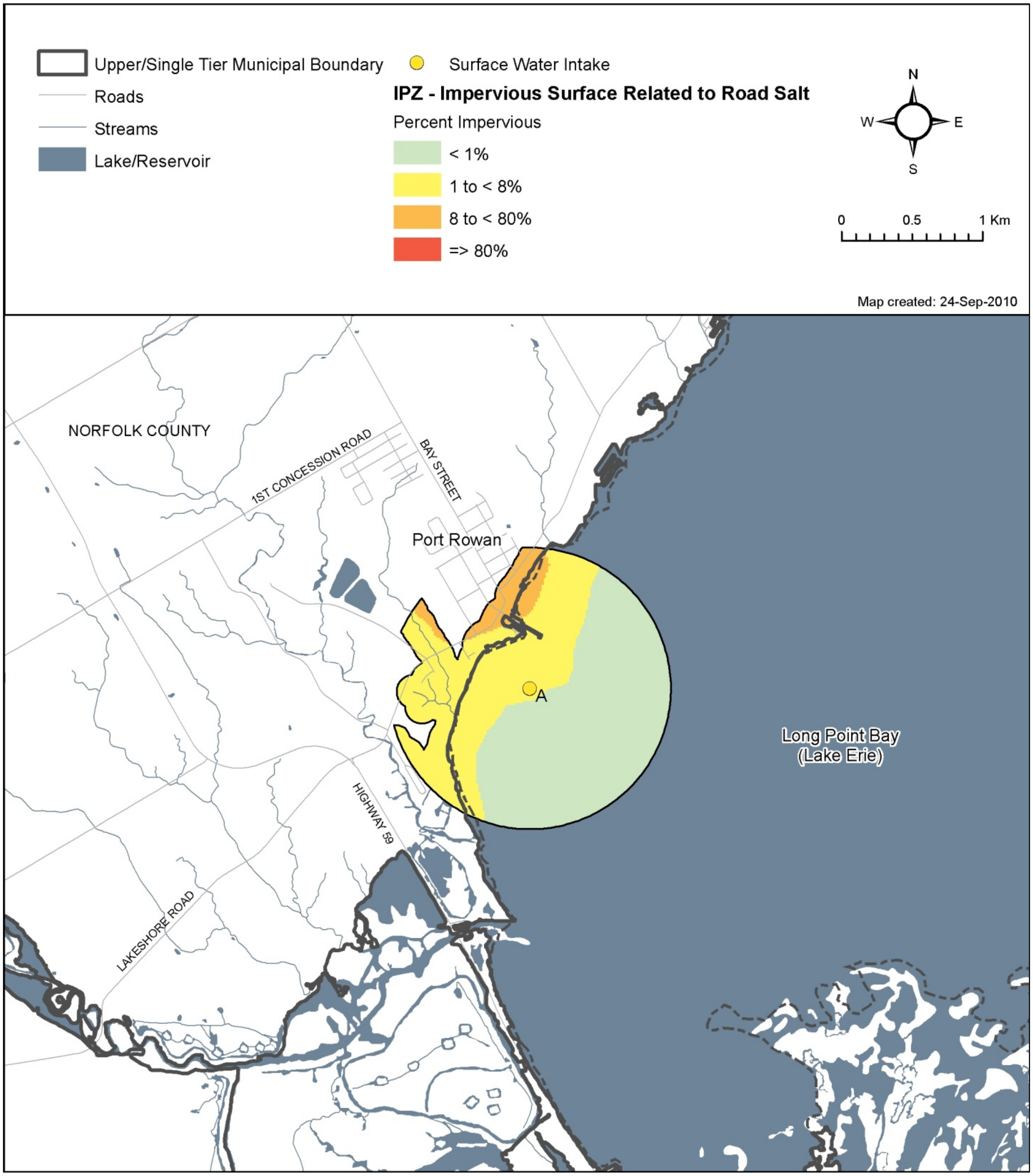
Map 5-43: Percent Managed Lands within the Port Rowan Intake Protection Zone



Map 5-44: Livestock Density within the Port Rowan Intake Protection Zone



Map 5-45: Impervious Surfaces within the Port Rowan Intake Protection Zone



5.5.8 Threat Assessment

The Ontario *Clean Water Act, 2006* defines a Drinking Water Threat as “an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, and includes an activity or condition that is prescribed by the regulation as a drinking water threat.”

The Technical Rules (MOE, 2009a) list five ways in which to identify a drinking water threat:

a) Through an activity prescribed by the Act as a Prescribed Drinking Water Threat;
b) Through an activity identified by the Source Water Protection Committee as an activity that may be a threat and (in the opinion of the Director) a hazard assessment confirms that the activity is a threat;
c) Through a condition that has resulted from past activities that could affect the quality of drinking water;
d) Through an activity associated with a drinking water issue; and
e) Through an activity identified through the events based approach (this approach has not been used in this Assessment Report).

Threats can fall into one of the following four categories:

- Chemical threats can include toxic metals, pesticides, fertilizers, petroleum products and industrial solvents;
- Pathogenic threats are microorganisms that could cause illness; and
- Dense non-aqueous phase liquids (DNAPLs) are chemicals which are denser than water and do not dissolve in water, such as chlorinated solvents.
- Through a condition that has resulted from past activities that could affect the quality of drinking water.

Significant threats to the Port Rowan water supply were assessed through the development of a desktop land use inventory.

The identification of a land use activity as a significant, moderate, or low drinking water threat depends on its risk score, determined by considering the circumstances of the activity and the type and vulnerability score of any underlying protection zones, as set out in the Tables of Drinking Water Threats available through www.sourcewater.ca. Information on drinking water threats is also accessible through the Source Water Protection Threats Tool: http://swpip.ca. The information above can be used with the vulnerability scores shown in **Map 5-45** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 5-39 provides a summary of the threat levels possible in the Port Rowan Intake Protection Zone for Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogens. A checkmark indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; a blank cell indicates that it is not. The colours shown for each vulnerability score correspond to those shown in the map.

Table 5-35: Identification of Drinking Water Threats in the Port Rowan Intake Protection Zone

Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification Level		
			Significant 80+	Moderate 60 to <80	Low >40 to <60
Chemicals / Handling & Storage of DNAPLs	IPZ-1	7		✔	✔
Pathogens	IPZ-1	7		✔	✔

Because the highest vulnerability score is 7, no significant drinking water threats are possible in the Port Rowan Intake Protection Zones.

5.5.9 Intake Protection Zone 3

A complete failure of the Port Rowan municipal sewage treatment lagoons was identified as a possible threat on the landscape to the Port Rowan WTP intake. The Port Rowan municipal sewage lagoons are located outside the IPZ-1 limits and therefore, hydrodynamic modeling was completed of the catastrophic failure of these lagoons to determine whether this land use activity is a threat to the WTP intake.

The MIKE-3 hydrodynamic and water quality model was employed to determine whether E. coli levels from the catastrophic failure of the lagoons reached the WTP intake at levels that posed a threat to the intake. Modeling results illustrated elevated E. coli levels at the Port Rowan intake; however, the levels at the intake were within the current range experienced at the water treatment plant. Norfolk County staff indicated that these levels did not pose a treatability concern. Therefore, it was concluded that the municipal sewage treatment lagoons are not a threat to the water treatment plant and no IPZ-3 needed to be delineated.

5.5.10 Conditions Assessment

The potential presence of conditions associated with past activities was assessed based on local knowledge through discussions with Norfolk County municipal staff. MOE datasets related to past spills and potentially contaminated sites were not assessed and this is noted as a data gap. There were no conditions identified for the Port Rowan WTP intake.

5.5.11 Preliminary Issues Identification and Parameters of Concern

Municipal water treatment plant operators have indicated very few concerns regarding the operation of the water treatment plant with the exception of detections of trihalomethanes (THM) in the treated water supply. Trihalomethanes are a disinfection byproduct that is produced when chlorine or bromine is used to treat water with elevated organic matter. THM have been reported in the treated water, with some samples exceeding the Maximum Allowable Concentration (MAC) of 0.100 mg/L.

Although the Ontario Drinking Water Standards (ODWS) are for treated water, they can be used to flag parameters that could be a concern. A preliminary assessment of the Drinking Water

Surveillance Program (DWSP) data indicates that the following parameters exceeded the ODWS in one or more samples for the period between 1998 and 2007:

- Aluminum
- Dissolved Organic Carbon
- Colour
- Hardness
- Manganese
- Organic Nitrogen
- pH
- Temperature
- Turbidity

Based on DWSP data for Port Rowan's raw water, none of the human health-based ODWS were exceeded. Operational guidelines were exceeded for aluminum, hardness, organic nitrogen, and pH on one or more occasion based on the DWSP dataset. Aesthetic objectives for dissolved organic carbon, colour, manganese, temperature and turbidity were also exceeded in one or more raw water sample. All of these parameters are associated with naturally occurring processes in Lake Erie, although in some cases, anthropogenic activities may play a role in the elevated levels observed. All raw water samples taken for the DWSP exceeded the organic nitrogen operational guideline (for treated water) of 0.150 mg/L. These levels may be related to algae blooms, agricultural runoff and/or wastewater inputs to Lake Erie. Given the high frequency of elevated concentrations of organic nitrogen, additional monitoring of the raw water is recommended before it can be decided whether organic nitrogen should be identified as an issue under Technical Rule 114.

5.5.12 Uncertainty/Limitations of Data and Methods Used for Issues Evaluation

In general, the available data were of sufficient quality and quantity to evaluate Issues. Raw water quality data for parameters listed on schedule 1, 2 and 3 and Table 4 of the Ontario Drinking Water Standards were provided for the years 1998-2007. Although there were data for most of the parameters from the schedules and Table, some parameters were not sampled. The analysis may benefit from improved frequency and consistency of sampling data as well as a more complete scan for all parameters on the schedules of the ODWS.

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