Long Point Region Source Protection Area

ASSESSMENT REPORT
Consultation Draft

Chapter 5: Norfolk County

Version 4

October 30, 2025

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5.0 NORFOLK COUNTY GROUNDWATER VULNERABILITY ASSESSMENT

Five municipal drinking water systems (**Table 5-1**) are located within the portion of the Norfolk County that falls within the Long Point Region Source Protection Area: Three~~Two~~ groundwater systems (Delhi, 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).~~ Environmental and Infrastructure Services Division.

Table 5-1~~5-15-1~~: 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[2]
220007178	Delhi Water Supply System	~~PW &~~ ES	GW~~&SW~~	Large municipal residential	6,400~~6,262~~
220000399	Port Dover Water Treatment Plant	~~PW &~~ ES	SW	Large municipal residential	7,800~~7,089~~
220000898	Port Rowan Water Treatment Plant	~~PW &~~ ES	SW	Large municipal residential	2,300~~2,312~~
220000371	Simcoe Well Supply	~~PW &~~ ES	GW	Large municipal residential	16,100~~15,040~~
220000905	Waterford Well Supply	~~PW &~~ ES	GW	Large municipal residential	4,200~~3,315~~

[1] as defined by O. Reg. 170/03 (Drinking Water Systems) made under the *Safe Drinking Water Act, 2002.*
[2] Source: Norfolk County 2022 Annual Drinking Water System Reports

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 5-25 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	532514	410444	580444	844471	647488	546102 7	664745	458506	464341	485405	431473	410425	443396
Delhi Well #2	720924	579722	668732	703710	883772	720119 5	914110 5	805132 1	654122 7	744100 1	68076 0	639741	652795
Delhi Well #3a	48-	42-	45-	21-	69-	87-	48-	44-	57-	30-	43-	65-	23-
Delhi Well #3b	93-	88-	159-	34-	95-	259-	53-	66-	95-	85-	69-	79-	39-
Simcoe Cedar St. Well #1A	00	00	00	00	00	00	00	00	00	00	00	00	00
Simcoe Cedar St Well #2A	204261	148254	149264	157183	161247	220332	281325	253326	278346	289252	233232	142170	135196
Simcoe Cedar St Well #3	444523	327436	339426	353376	357483	477645	608639	531604	595675	533583	495479	428511	289416
Simcoe Cedar St Well #4	359380	245344	239346	270302	278389	385515	512509	413455	488513	460368	372328	303228	344265
Simcoe Cedar St Well #5	397442	270389	278379	292352	290400	411535	555501	480494	563575	551486	455429	367401	250360
Simcoe Cedar St Infiltration Gallery	1408160	143642	154224	170218 5	170925 3	155113 9	135140 5	107734 5	119828 7	134762	13669	124695	137277
Simcoe Chapel St Well	16861559	15011 400	14641 447	14481 511	16031 608	17841 606	18991 615	19231 498	18661 593	19141 591	17901 605	15551 630	14821 604
Simcoe Northwest Well #1	00	00	00	00	00	00	00	00	00	00	00	00	00
Simcoe Northwest Well #2	778709	737610	761432	691549	662666	776705	925939	926999	107187 1	968861	600809	662817	552248
Simcoe Northwest Well #3	790959	722919	834102 0	831866	776741	792884	841115 1	794127 9	728115 6	684109 4	756101 2	927392	792980

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
Waterford Well #3	534485	427365	445389	475430	525481	640604	698521	662668	587533	572462	538440	393482	447436
Waterford Well #4	514498	425455	415420	395382	476403	637487	722754	536625	481600	543590	464485	485355	584421
Port Dover Intake	26892585	23042206	24622255	25902155	23232499	27172781	33333208	30913394	28713277	28752794	27722460	25322058	23951914
Port Rowan Intake	836917	760648	699671	645815	696955	10211102	11381230	10391198	914112	915102	812819	716709	679712

[1] Source: Norfolk County, based on 202316 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 I system under the Technical Rules (MECP, 2021~~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. Both W~~W~~ells 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 glaciolacustrine 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 W~~w~~ell 1 and W~~w~~ell 2. The wells were brought online in 2020. The pumping ~~2016 identified rated~~ capacity for W~~w~~ells 3a and 3b is 942 m^3/day and 2260 m^3/day, respectively.~~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); and
- 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~~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 5-2.** 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). This assessment was completed in accordance with the 2009 Technical Rules (MOE, 2009a).

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-Courtland 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). This methodology is described in Chapter 3: Water Quality Risk Assessment. ~~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 5-4** 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.

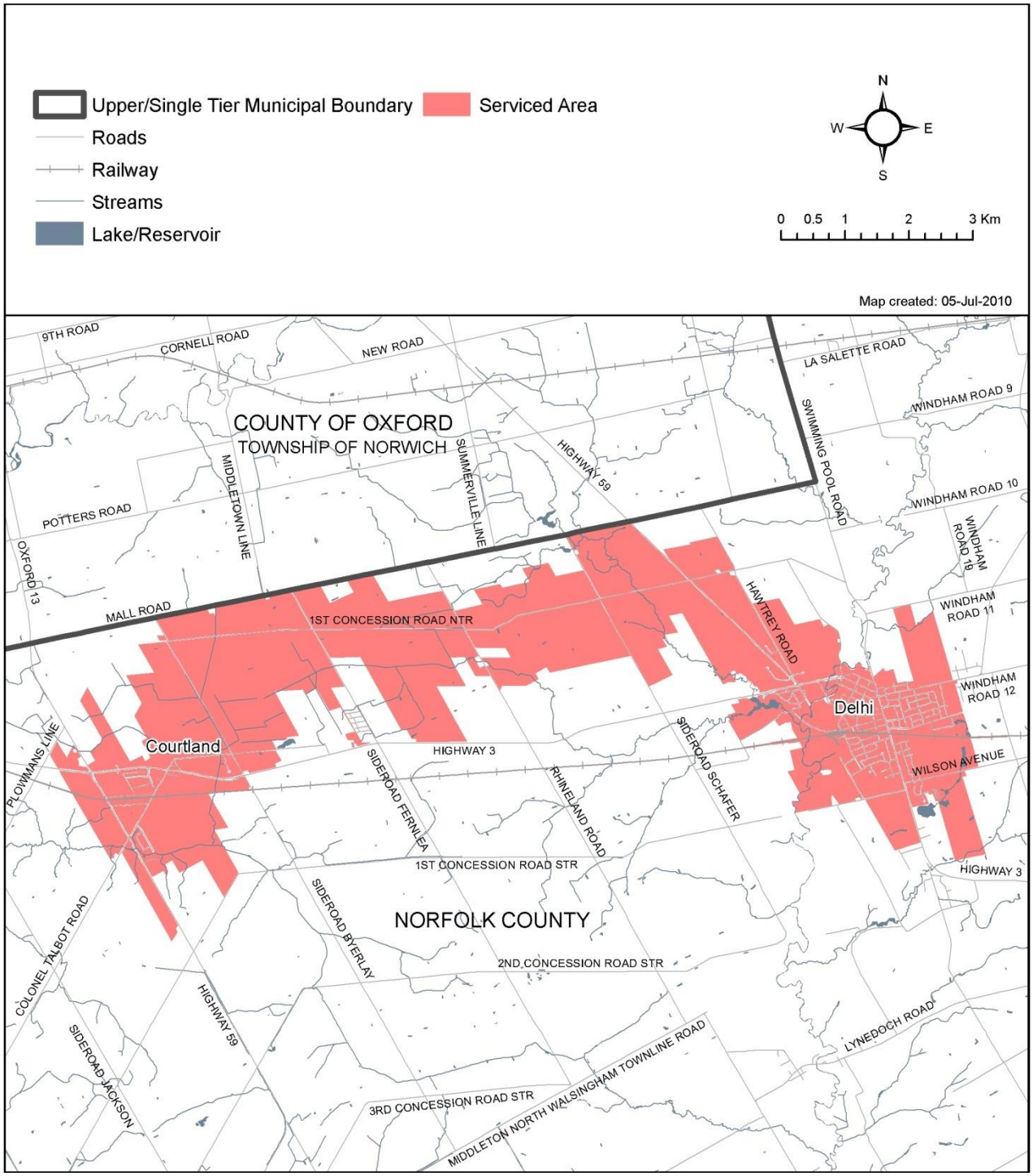
Uncertainty and Limitations in Delhi Vulnerability Scoring

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

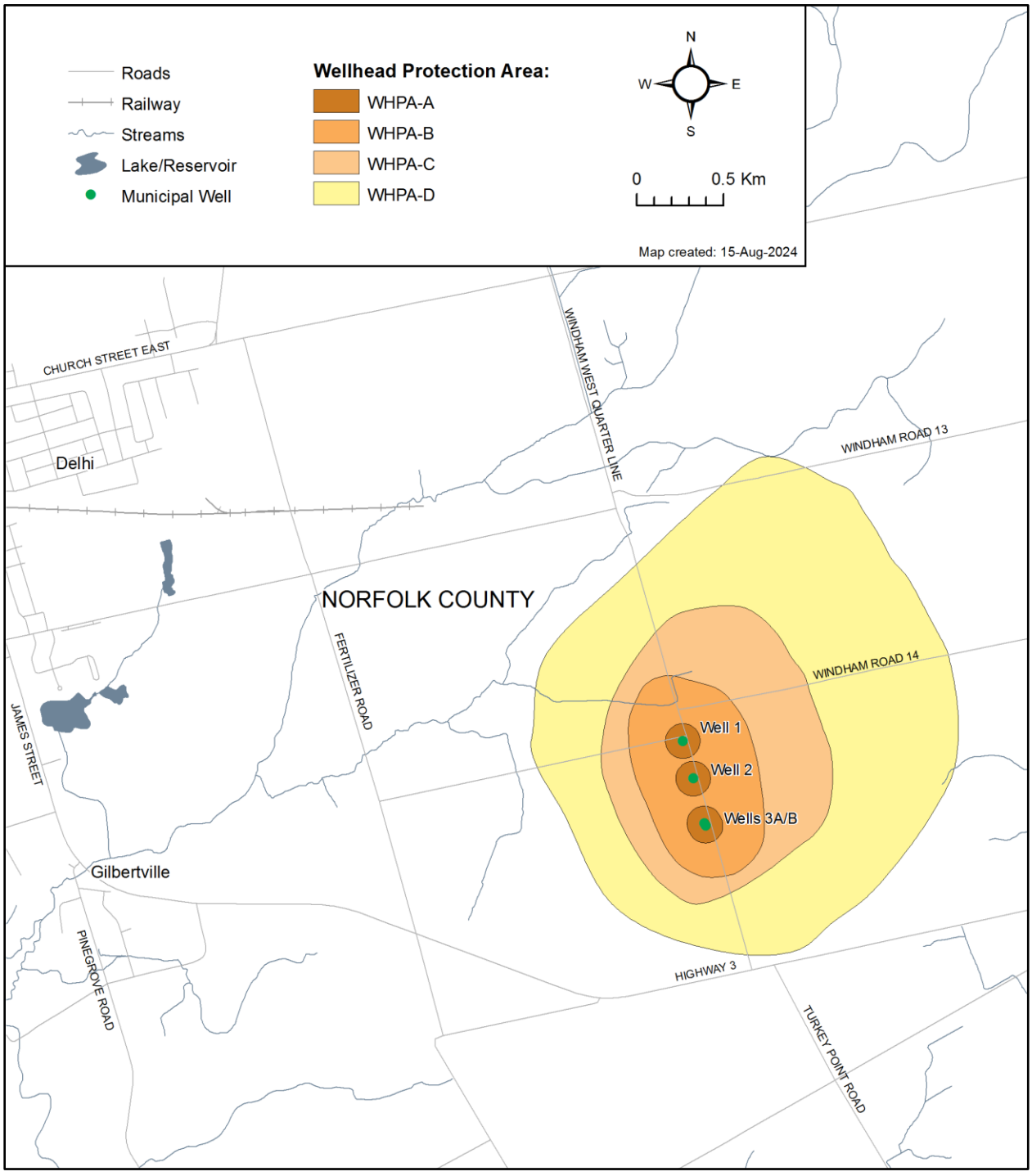
There is very little uncertainty that the water level is close to the surface and the soil material between surface and water table has a high permeability. The uncertainty of the vulnerability category areas is, therefore, considered to be low.

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.

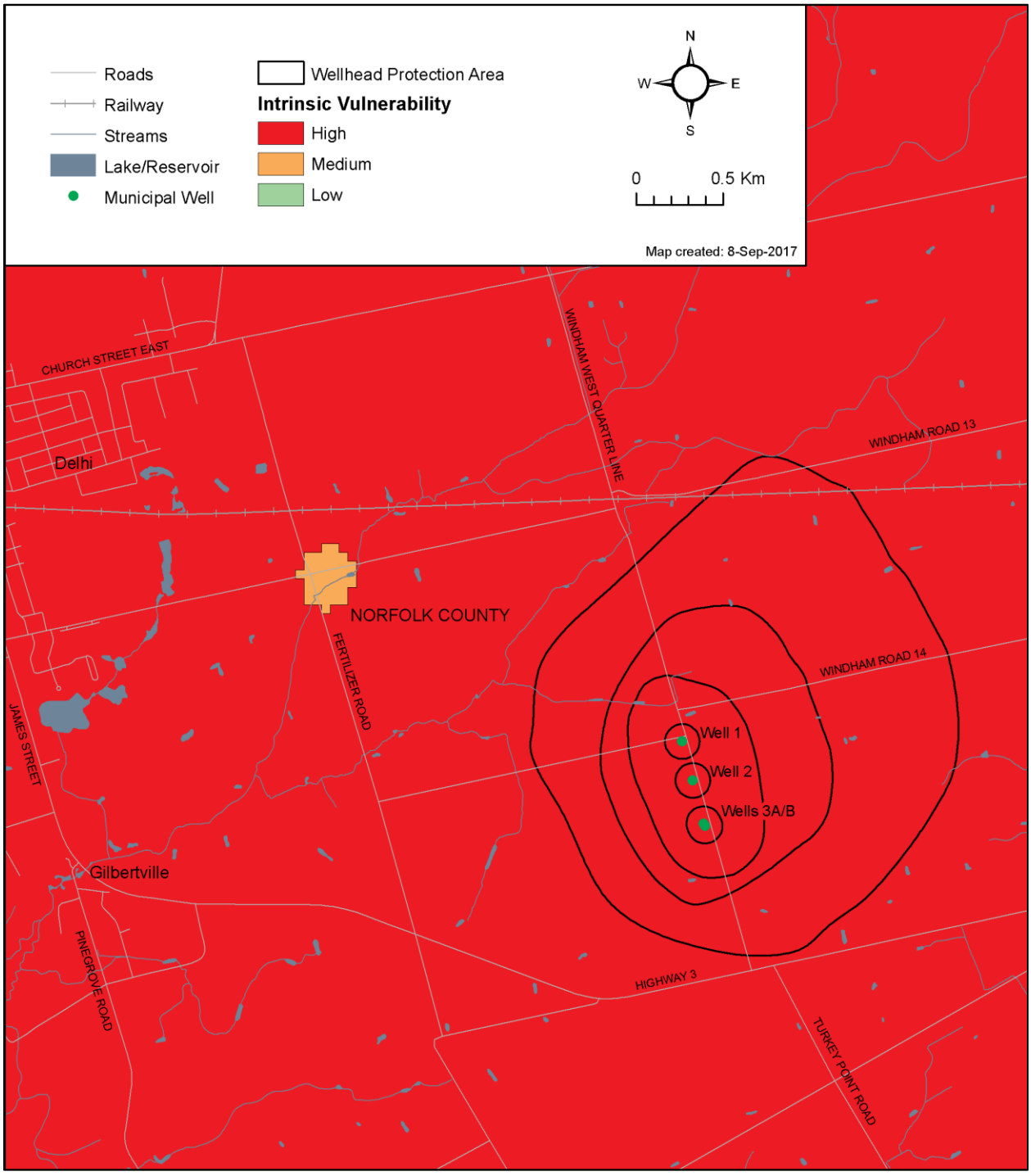
Map 5-1: Delhi-Courtland Serviced Area



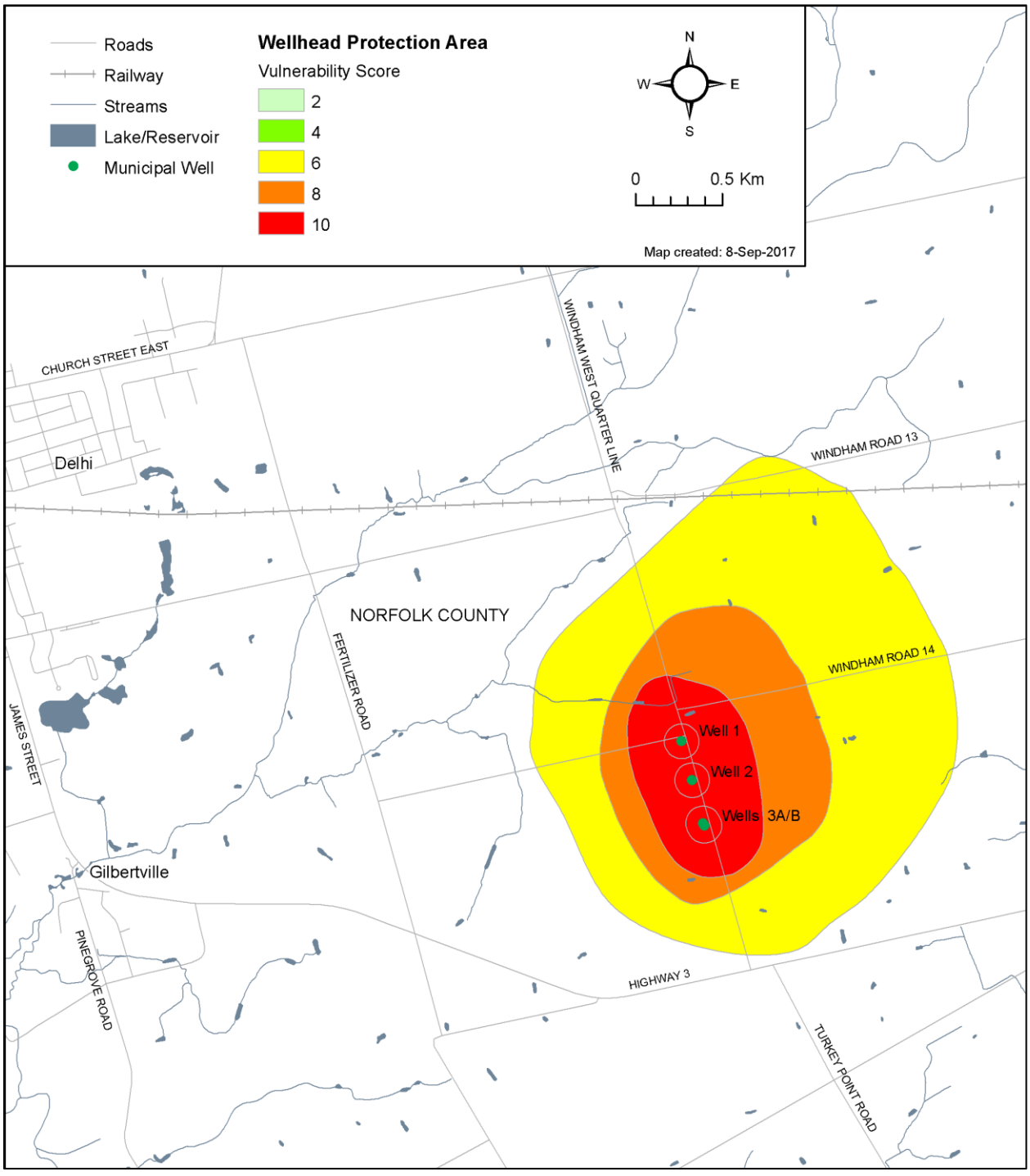
Map 5-2: Delhi-Courtland WHPA



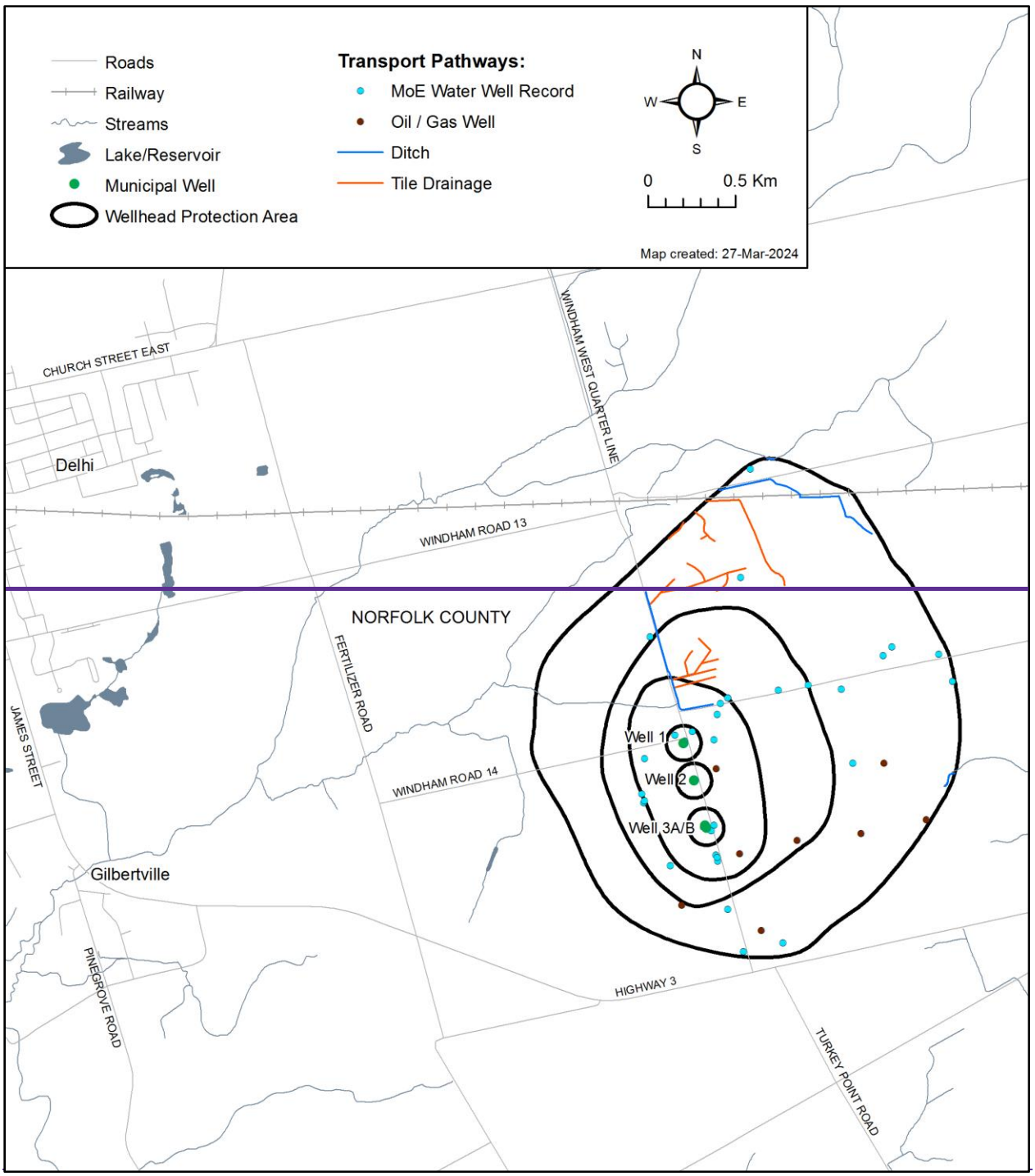
Map 5-3: Delhi-Courtland WHPA Intrinsic Vulnerability



Map 5-4: Delhi-Courtland WHPA Vulnerability Scoring~~Delhi-Courtland Transport Pathways~~



~~**Map 5-5: Delhi-Courtland WHPA Vulnerability Scoring**~~


Roads
Railway
Streams
Lake/Reservoir
Municipal Well
Wellhead Protection Area
Transport Pathways:
MoE Water Well Record
Oil / Gas Well
Ditch
Tile Drainage
N
W
E
S
0
0.5 Km
Map created: 27-Mar-2024
CHURCH STREET EAST
WINDHAM WEST QUARTER LINE
Delhi
WINDHAM ROAD 13
NORFOLK COUNTY
FERTILIZER ROAD
JAMES STREET
WINDHAM ROAD 14
Well 1
Well 2
Well 3A/B
Gilbertville
PINEGROVE ROAD
HIGHWAY 3
TURKEY POINT ROAD

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 5-4** and are shown on **Map 5-5**.

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 are presented in Table5-4 and **Map 5-6**.

Table 5-4 Percent Managed Lands (%) and Livestock Density (NU/acre) in the Dehli-Courtland Wellhead Protection Area

	WHPA-A	WHPA-B	WHPA-C	WHPA-D
Percent Managed Lands (%)	Well 1: 59% Well 2: 42% Well 3a/3b: 37%	74%	71%	72%
Livestock Density (NU/acre)	Well 1: 0 Well 2: 0 Well 3a/3b: 0	0.05 (residential hobby horse boarding)	0	0.14 (large barn, assumed mixed livestock)

A value of 0 has been assigned where no agricultural livestock barns are present to contribute nutrients. ~~Livestock Densit~~

	Table 5-8: 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

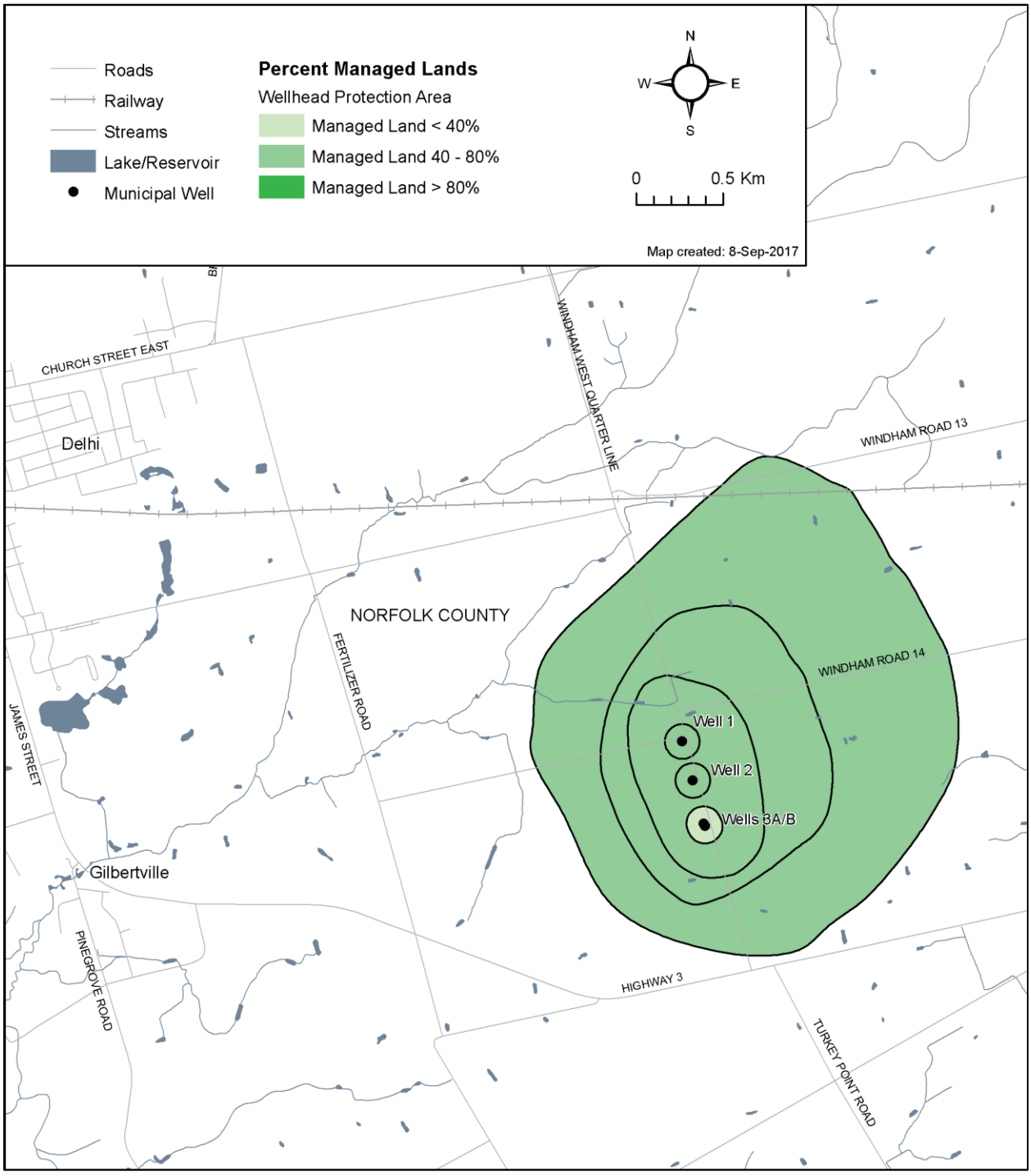
5.1.5 Percent Impervious Surface Area

Percent Impervious Surface Area in Wellhead Protection Areas

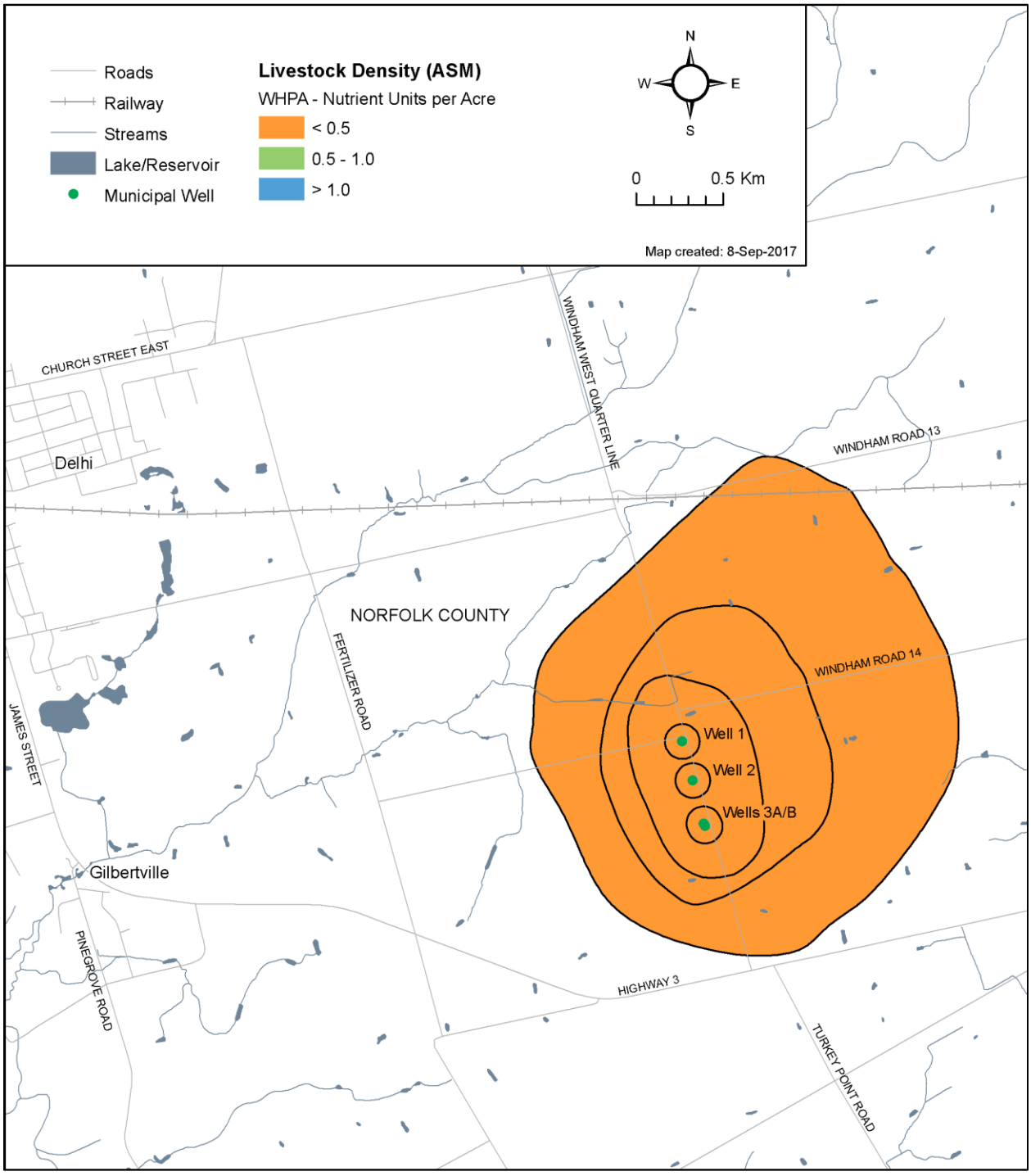
The quantification and mapping of the percentage of impervious surface area was completed to assess the potential threats related to road salt application. A 1 km x 1 km grid was overlaid and centered on the WHPAs and the percentage of impervious area for each grid cell was determined using the project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

For the Delhi area, this included the impervious area represented by roads only. **Map 5-7** presents the percentage of impervious surface for areas within the Delhi WHPAs.

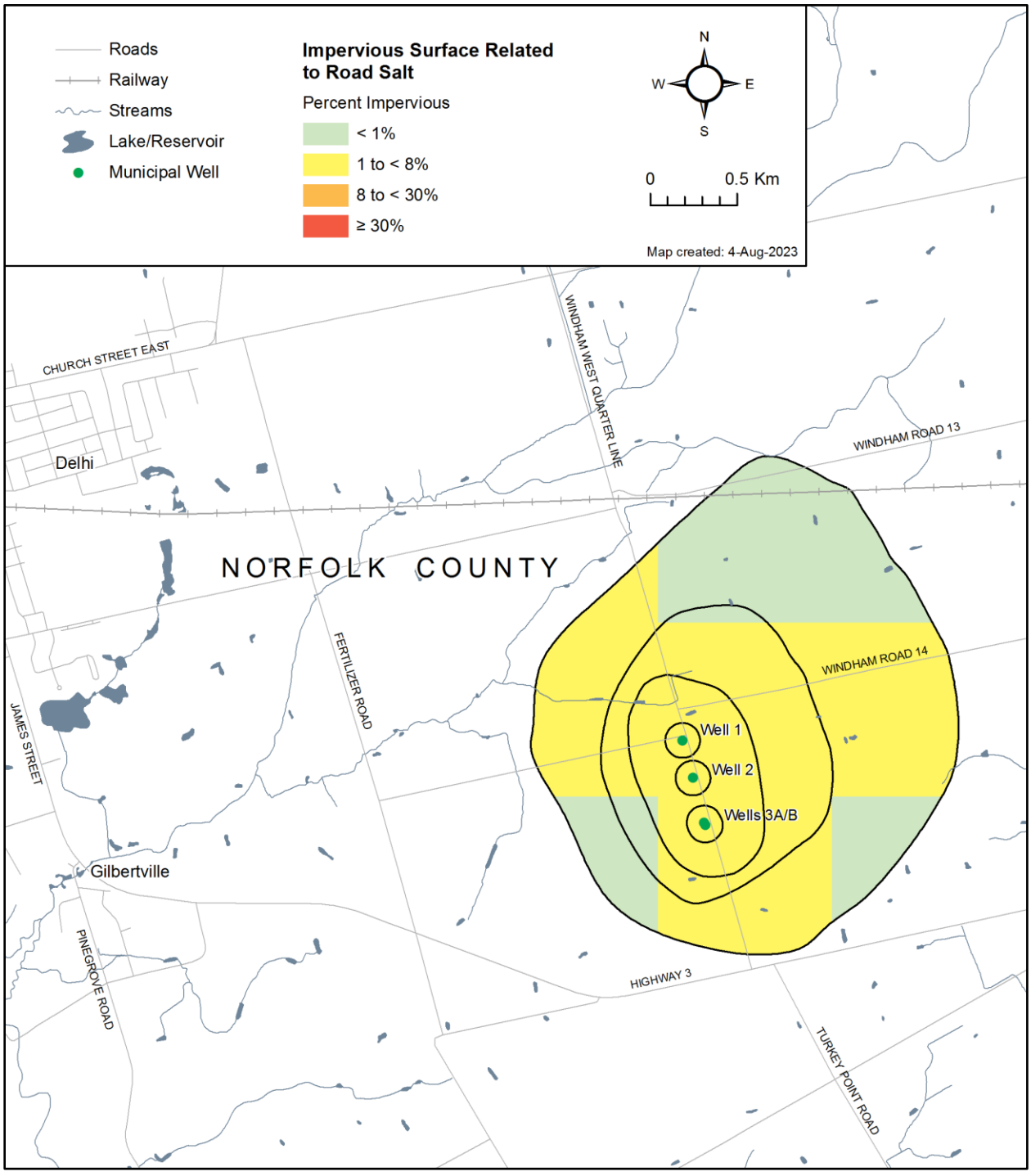
Map 5-5: Percent Managed Lands within the Delhi-Courtland WHPA



Map 5-6 Livestock Density within the Delhi-Courtland WHPA



Map 5-7: Impervious Surface within the Delhi-Courtland WHPA



5.1.6 Delhi-Courtland Water Quality Threats Assessment

The *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." Drinking water threats are described further in Chapter 3: Water Quality Risk Assessment.

Prescribed drinking water threats listed in Section 1.1 of O. Reg. 287/07 include Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogen threats. Chapter 3 provides a summary of the types of threats and their significance, based on vulnerable area and vulnerability score (as shown in the maps in this chapter).

~~**Table 5-4Table 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 5-5-9: 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 5-11: Drinking Water Quality Threats**~~

~~**Prescribed Drinking Water Quality Threats** Ontario Regulation 287/07 s.1.1.(1)~~	~~**Land Use/Activity**~~
~~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~~
~~The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.~~	~~Sewage Infrastructures Septic Systems, etc.~~
~~The application of agricultural source material to land.~~	~~e.g. manure, whey, etc.~~
~~The storage of agricultural source material.~~	~~e.g. manure, whey, etc.~~
~~The management of agricultural source material.~~	~~Aquaculture~~

Prescribed Drinking Water Quality Threats Ontario Regulation 287/07 s.1.1.(1)	Land Use/Activity
The application of non-agricultural source material to land.	Organic Soil Conditioning Biosolids
The handling and storage of non-agricultural source material.	Organic Soil Conditioning Biosolids
The application of commercial fertilizer to land.	Agriculture Fertilizer
The handling and storage of commercial fertilizer.	General Fertilizer Storage
The application of pesticide to land.	Pesticides
The handling and storage of pesticide.	General Pesticide Storage
The application of road salt.	Road Salt Application
The handling and storage of road salt.	Road Salt Storage
The storage of snow.	Snow Dumps
The handling and storage of fuel.	Petroleum Hydrocarbons
The handling and storage of a dense non-aqueous phase liquid.	DNAPLs
The handling and storage of an organic solvent	Organic Solvents
The management of runoff that contains chemicals used in the de-icing of aircraft.	De-icing
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	Agricultural Operations
The establishment and operation of a liquid hydrocarbon pipeline	Oil Pipeline

Land Use Inventory Methodology

A land use threats assessment was previously 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 werearе considered potential, requiring further review and site- specific assessments to confirm their presence. Since that time, threat assessments have relied on different sources of information. Threats are currently assessed through a combination of a desktop land use inventory, windshield surveys and local knowledge / field verification. As summarized in **Table 5-12**, a total of 38 potential threats were identified on 12 properties within the Delhi WHPAs.

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.

Enumeration of Significant Drinking Water Quality Threats in the Delhi-Courtland Wellhead Protection Areas

Significant drinking water quality threats within the Delhi-Courtland WHPAs are summarized in **Table 5-5~~Table 5-5~~.**

Table 5-5~~5-5~~: Significant Drinking Water Quality Threats in the Delhi-Courtland WHPAs (current to January 2024)

~~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~~
~~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~~	

~~PDWT #[1]~~	~~TSC #[2]~~	~~Threat Subcategory[2]~~	~~Number of Activities~~	~~Vulnerable Area~~

~~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.~~

Threat Subcategory[1]	Number of Activities	Vulnerable Area
1.1 Disposal of hauled sewage to land	3	WHPA-A WHPA-B
1.2 Application of processed organic waste to land	3	WHPA-A WHPA-B
2.2 Onsite sewage works	8	WHPA-A WHPA-B
3.1 Application of agricultural source material (ASM) to land	5	WHPA-A WHPA-B
4.1 Storage of agricultural source material (ASM)	4	WHPA-A WHPA-B
6.1 Application of non-agricultural source material (NASM) to land	4	WHPA-A WHPA-B
7.1 Handling and storage of non-agricultural source material (NASM)	1	WHPA-A WHPA-B
8.1 Application of commercial fertilizer to land	6	WHPA-A WHPA-B
9.1 Handling and storage of commercial fertilizer	4	WHPA-A WHPA-B
10.1 Application of pesticide to land	6	WHPA-A WHPA-B
11.1 Handling and storage of a pesticide	4	WHPA-A WHPA-B
15.1 Handling and storage of fuel	2	WHPA-A
21.1 Agricultural source material (ASM) generation – livestock grazing or pasturing	1	WHPA-B
21.2 Agricultural source material (ASM) generation – outdoor confinement area (OCA) or farm animal yard	1	WHPA-B
Total Number of Activities	**52**	
Total Number of Properties	**11**	

[1] Threats enumerated according to the 2021 Technical Rules (MECP, 2021)

Note: Certain types of incidental activities on residential properties may constitute significant drinking water threats but are not enumerated. These threats include the application of

commercial fertilizer and pesticides; the handling and storage of organic solvents and dense non-aqueous phase liquids; the storage of fuel (e.g., heating fuel tanks) in natural gas serviced areas; and the handling and storage of road salt that may be exposed or potentially exposed to precipitation or runoff.~~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.~~

5.1.7 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 (WHPA-ICA/IPZ-ICA) and manage these threats appropriately. ~~If at this time the WHPA-ICA 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~~ A~~a~~ll threats related to a particular Issue within the WHPA-ICA/IPZ-ICA~~s 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 s~~Sodium hypochlorite disinfection system
- UV disinfection units
- ~~A f~~Fluoridation system
- Sodium silicate (iron and manganese sequestration)
  ~~Chlorine~~

Delhi wells 3a and 3b are in a separate pump house from wells 1 and 2 but are pumped to Well 2 for treatment.

The original evaluation of raw water quality for the Delhi system (SWS, 2010) examined data from 1999-2009 and relied largely on data from the Drinking Water Surveillance Program (DWSP) as well as from field data generated by the system's SCADA data collection equipment.

Subsequent water quality analysis for the Delhi system (Matrix, 2018a) examined data up to approximately 2016. More recently, water quality has been examined up to 2023 using data from Annual Drinking Water System Reports provided by Norfolk County, supplemented by the DWSP where appropriate.

~~***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. I~~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.

2017-2023 Annual Drinking Water System Reports indicate no detections of E. coli in weekly raw water samples from Well 1, Well 2, Well 3a or~~and~~ Well 3b. However, total coliforms were detected in raw water samples from Well 2 in 2019, from Well 2 and Well 3b in 2020, and from Well 2 and Well 3b in 2021. ~~The well operator confirmed that the~~The disinfection system provides ~~the~~ appropriate treatment ~~for this low number of microbes.~~and therefore n~~N~~o Schedule 1 parameters were ~~therefore~~ noted as a concern.

~~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.~~

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 a 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.

Inorganic and organic Schedule 2 parameters examined from 2017-2023 Annual Drinking Water System Reports indicate no ODWQS exceedances in Well 1, Well 2, Well 3a and Well 3b. In relation to earlier concerns, quarterly THM concentrations have continued to decline since 2016 and remain largely below the 50% MAC (average annual concentration of 11.7 ug/L in 2023).

Schedule 3 Parameters

No elevated values of gross alpha and gross beta were found for wells 1 and 2 in the available analysis of data up to 2009 which made ~~the analysis of further~~a more detailed analysis of Schedule 3 ~~elements of Table 3 (radioactive) parameters~~radionuclides unnecessary. One tritium activity analysis was available for this time period, and the activity remained below the detection limit.

Raw water quality data available for Well 1 and Well 2 from the DWSP (2009-2019) similarly indicate no elevated values of gross alpha, gross beta or tritium.

In May 2016, ~~new~~ wells 3a and 3b were ~~also~~ sampled for gross alpha, gross beta and tritium with~~. 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. Hardness has a natural origin, does not pose a health threat and ~~However, hardness~~ has not been noted as~~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). Operational turbidity monitoring reported in 2017-2023 Annual Drinking Water System Reports indicate no exceedances of the Aesthetic Objective.

Raw water quality data from the DWSP indicates that iron and manganese occur at slightly elevated concentrations in both Well 1 and Well 2. From 2009 onwards, each parameter's half Aesthetic Objective has been exceeded at both wells. However, given the presence of appropriate treatment, these parameters have not been noted as a concern by staff at Norfolk County.

~~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 i~~was~~s not noted as a concern.

***Delhi* Issues Summary ~~- Delhi Wells~~**

No ~~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~~ i~~I~~ssues 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 5-8**.

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~~content 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); and~~.~~
- 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~~ as a part of 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~~ municipal wellfields and refined to better match new pumping rates at the wellfields.

The Northwest Wellfield draws 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.

In the area of the Cedar Street wellfield, ~~T~~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 the 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 5-6**~~**Table 5-14**~~, were used to generate WHPAs. These municipal pumping rates were ~~inititally~~initially consistent with those used in the previous WHPA study (SWS, 2010b) and then refined further in consultation with Norfolk County staff.

Table 5-6~~5-65-14~~: 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 5-9.** 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~~slightly 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~~predominantly 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)

WHPA-E delineation was completed in accordance with the 2009 Technical Rules (MOE, 2009a). 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 5-10.**

The Northwest wellfield has two GUDI wells that appear to be hydraulically connected to Patterson Creek based on previous GUDI studies. **Map 5-10** 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 5-10.** 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~~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~~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 5-10**.

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). This methodology is described in Chapter 3: Water Quality Risk Assessment. ~~The methodology is described in **Section 3.1.1**.~~

As shown on **Map 5-11,** 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 5-15: 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.~~

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 5-13**.~~

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.

Map 5-12 shows the adjusted intrinsic vulnerability while **Map 5-13** shows the resulting vulnerability scores, which represent an intersection of the capture zones and the intrinsic vulnerability categories.

As shown on **Map 5-14**~~Map 5-17~~, there was one transport pathway area of influence that increased the vulnerability score.

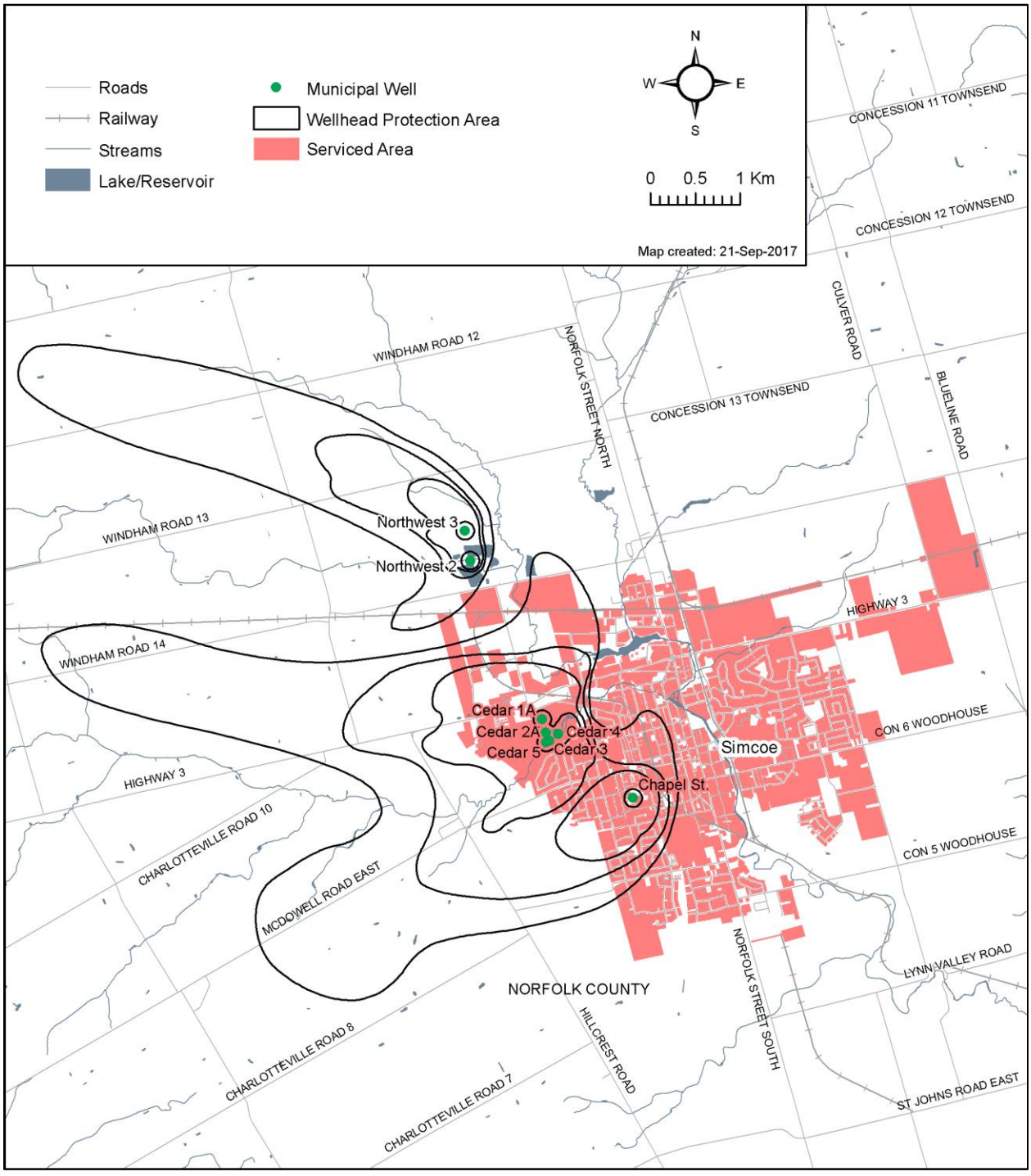
~~Vulnerability scores of 8 to 10 are found within the Chapel Street WHPAs (**Map 5-19**). Within the Cedar Street wellfield, the 2-year WHPA has a vulnerability score of 10 and the 5-year WHPA has a vulnerability score of 8. Vulnerability scores in the 25-year WHPA are mostly 6, with some 4 south of 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

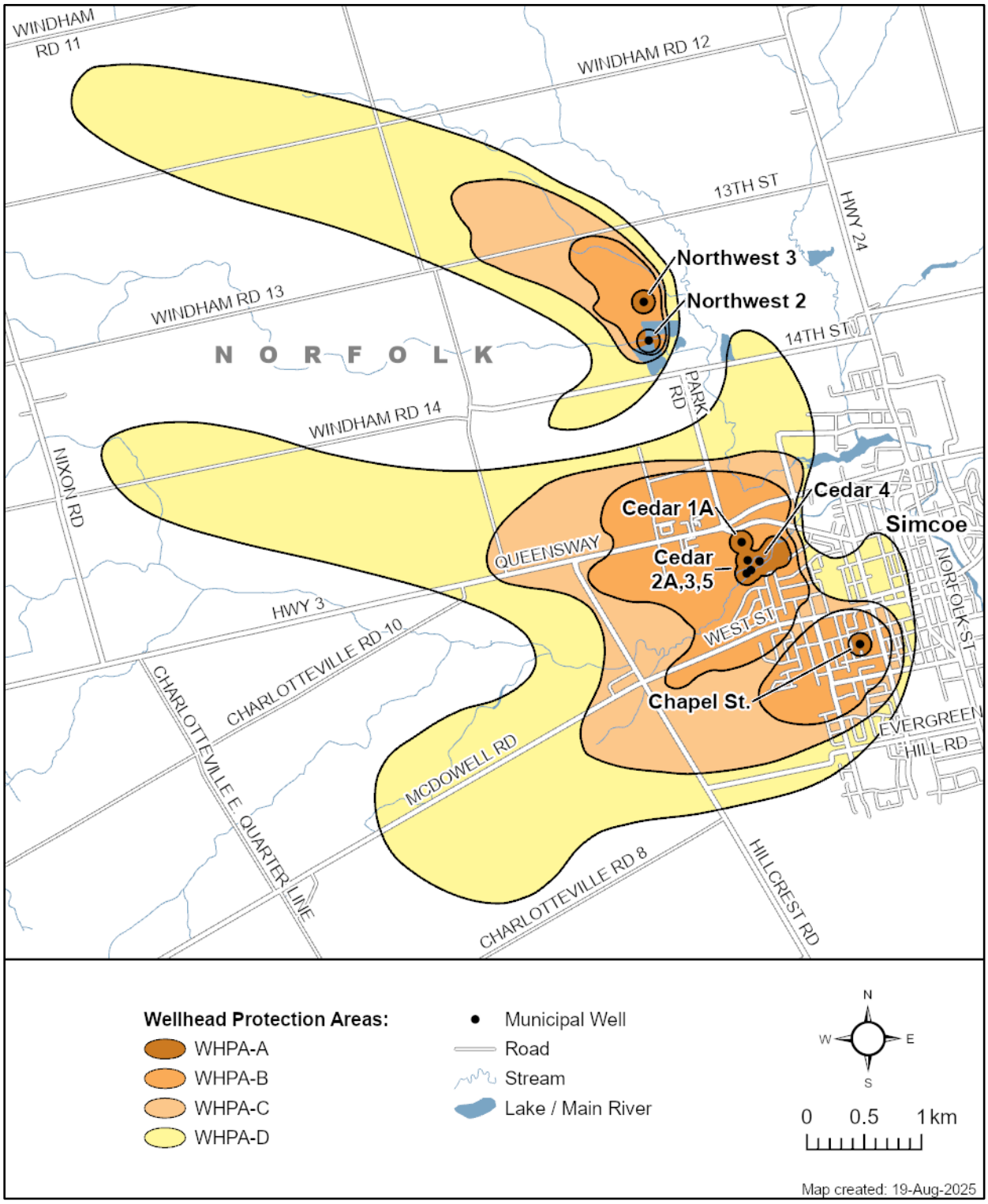
The uncertainty of the vulnerability score mapping is considered to be low, since the underlying vulnerability values are generally high.

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.

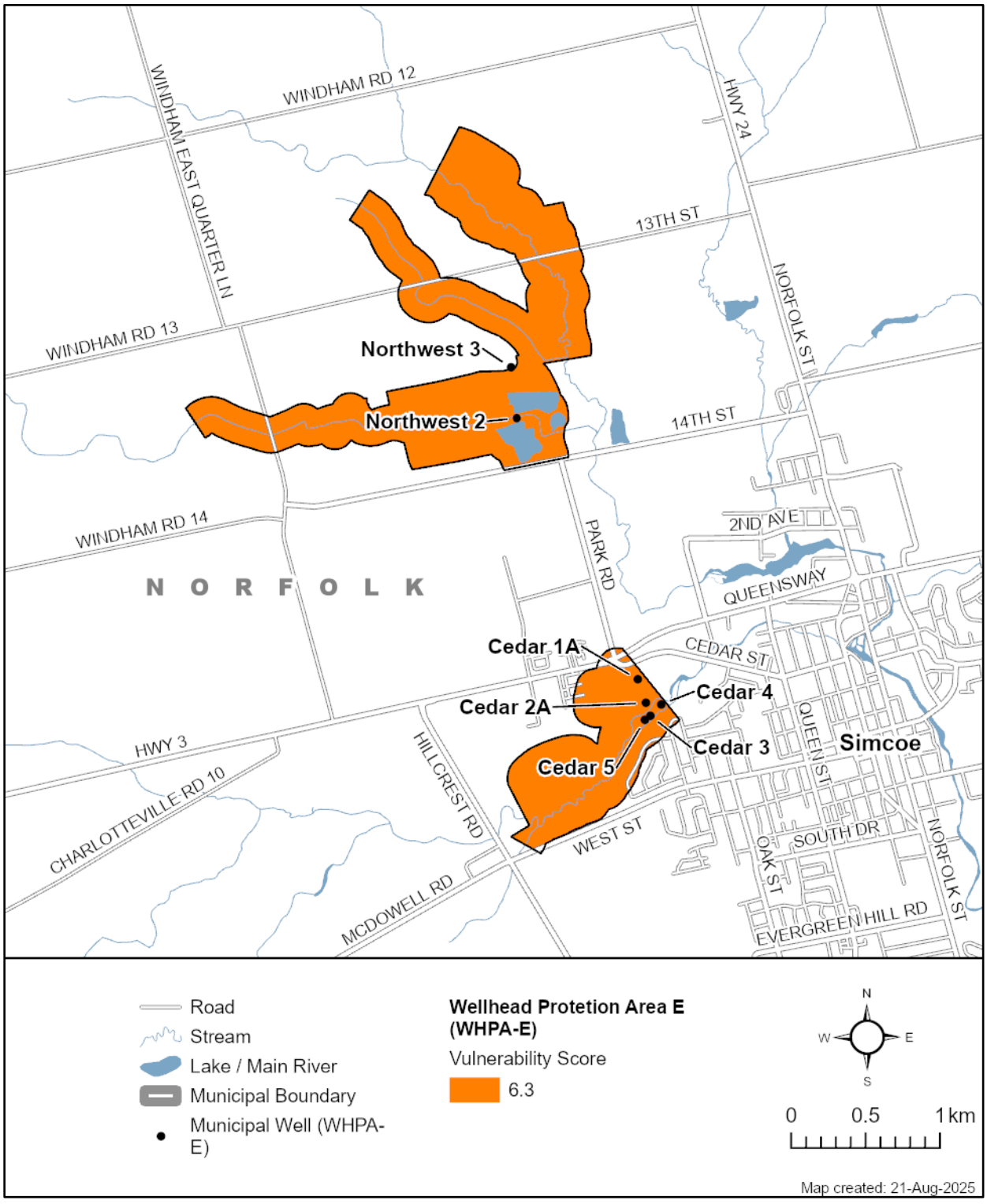
Map 5-8: Simcoe Serviced Area



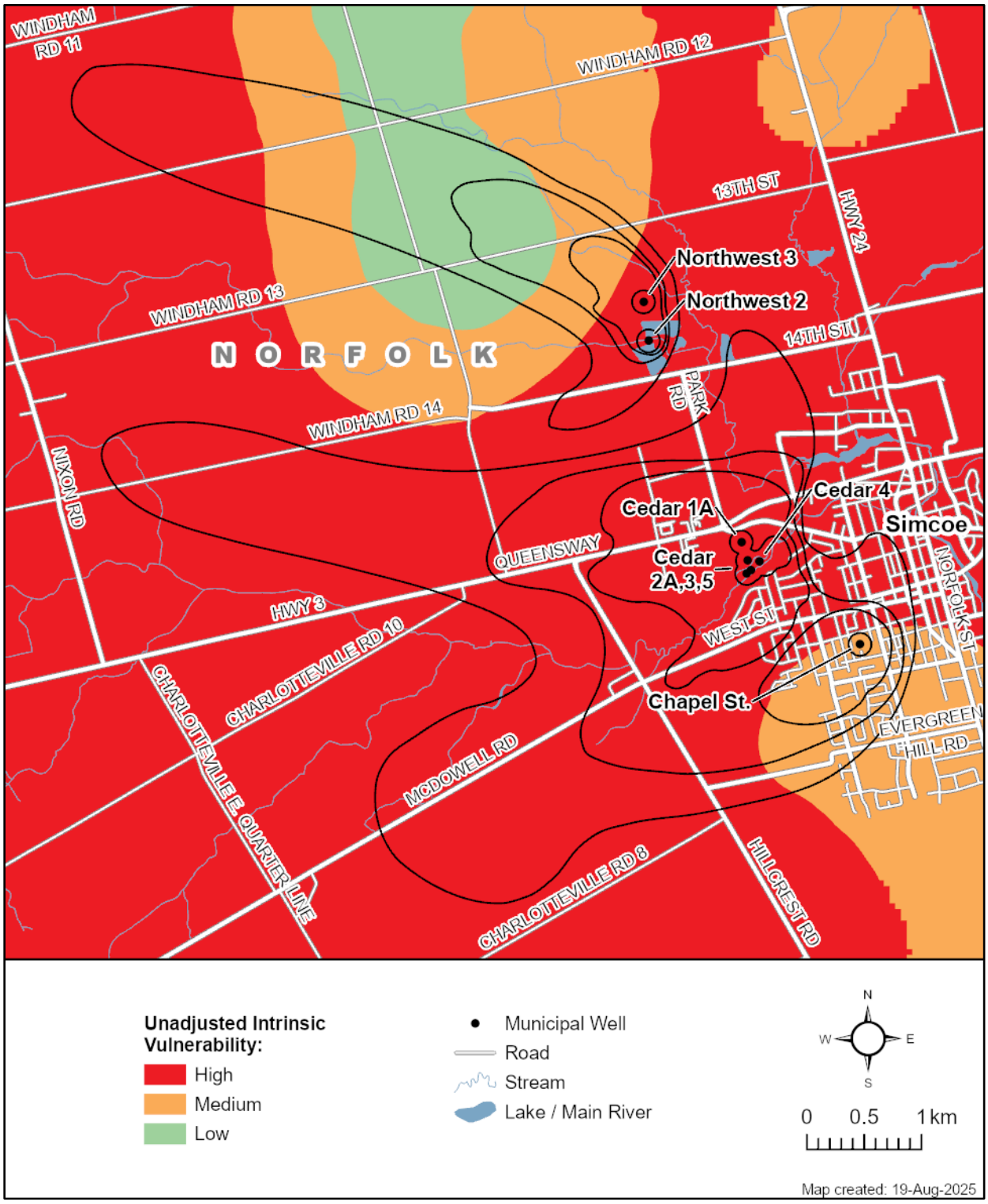
Map 5-9: Simcoe Wellhead Protection Area



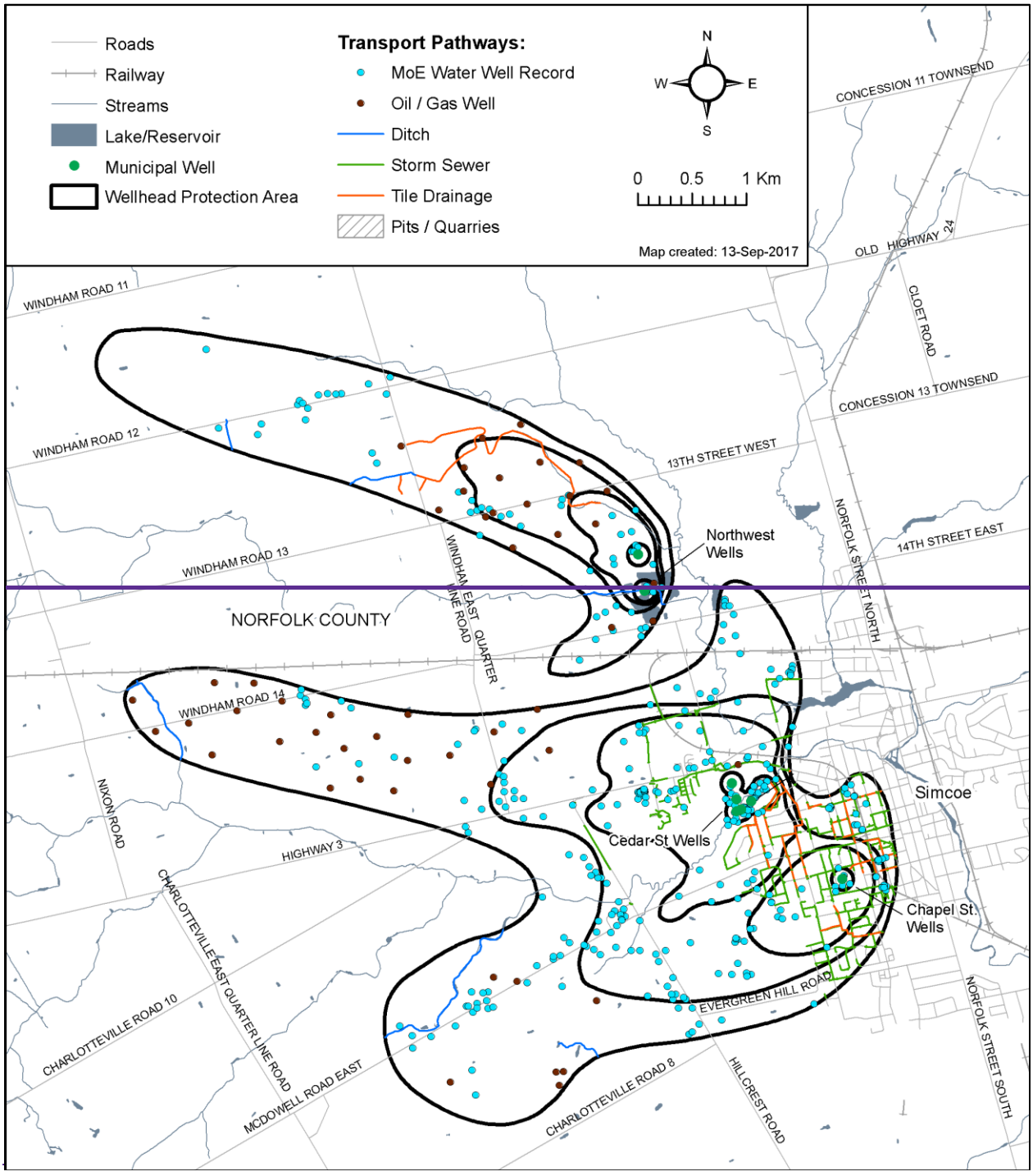
Map 5-10: Simcoe WHPA E



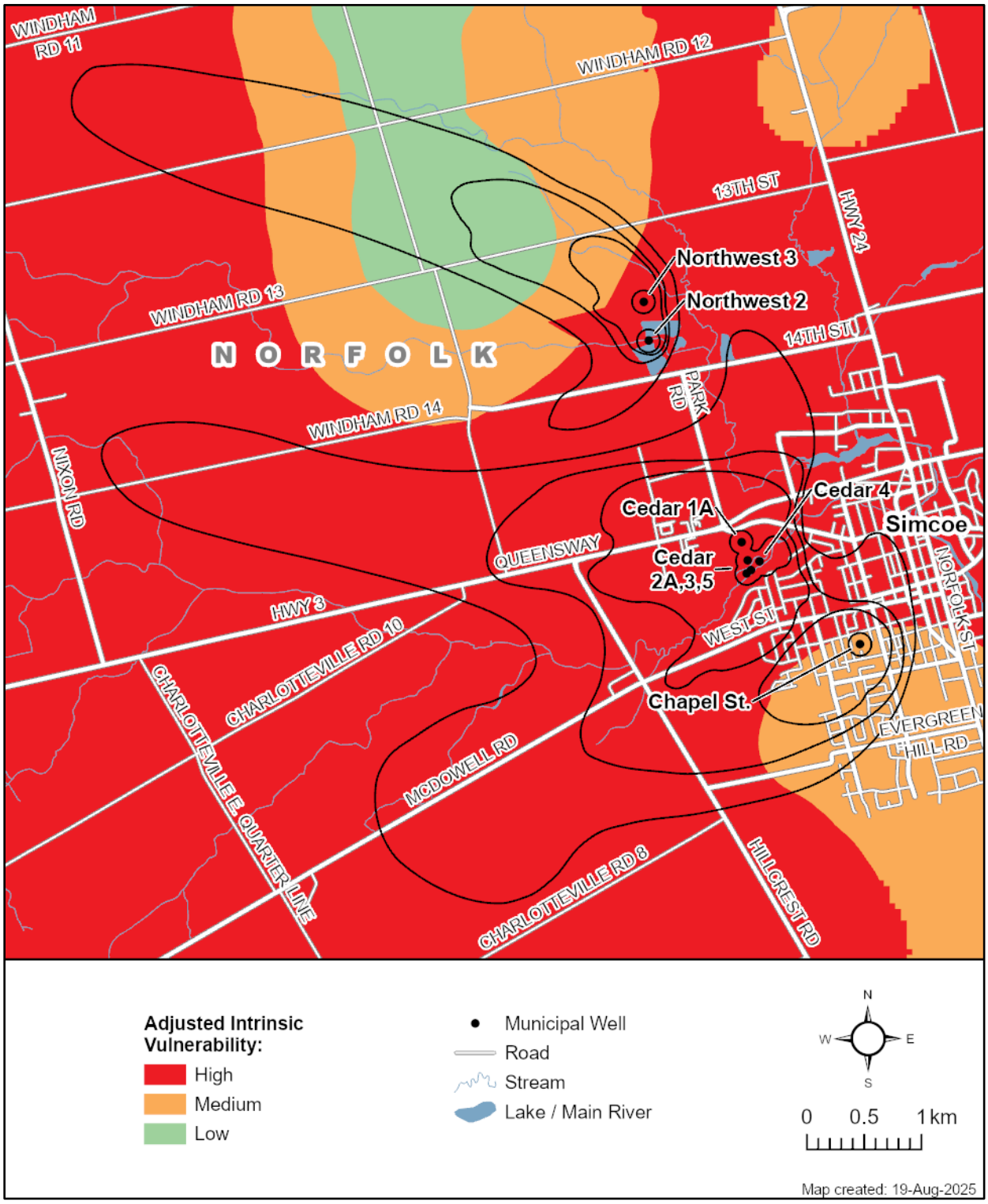
Map 5-11: Simcoe WHPA Unadjusted Intrinsic Vulnerability



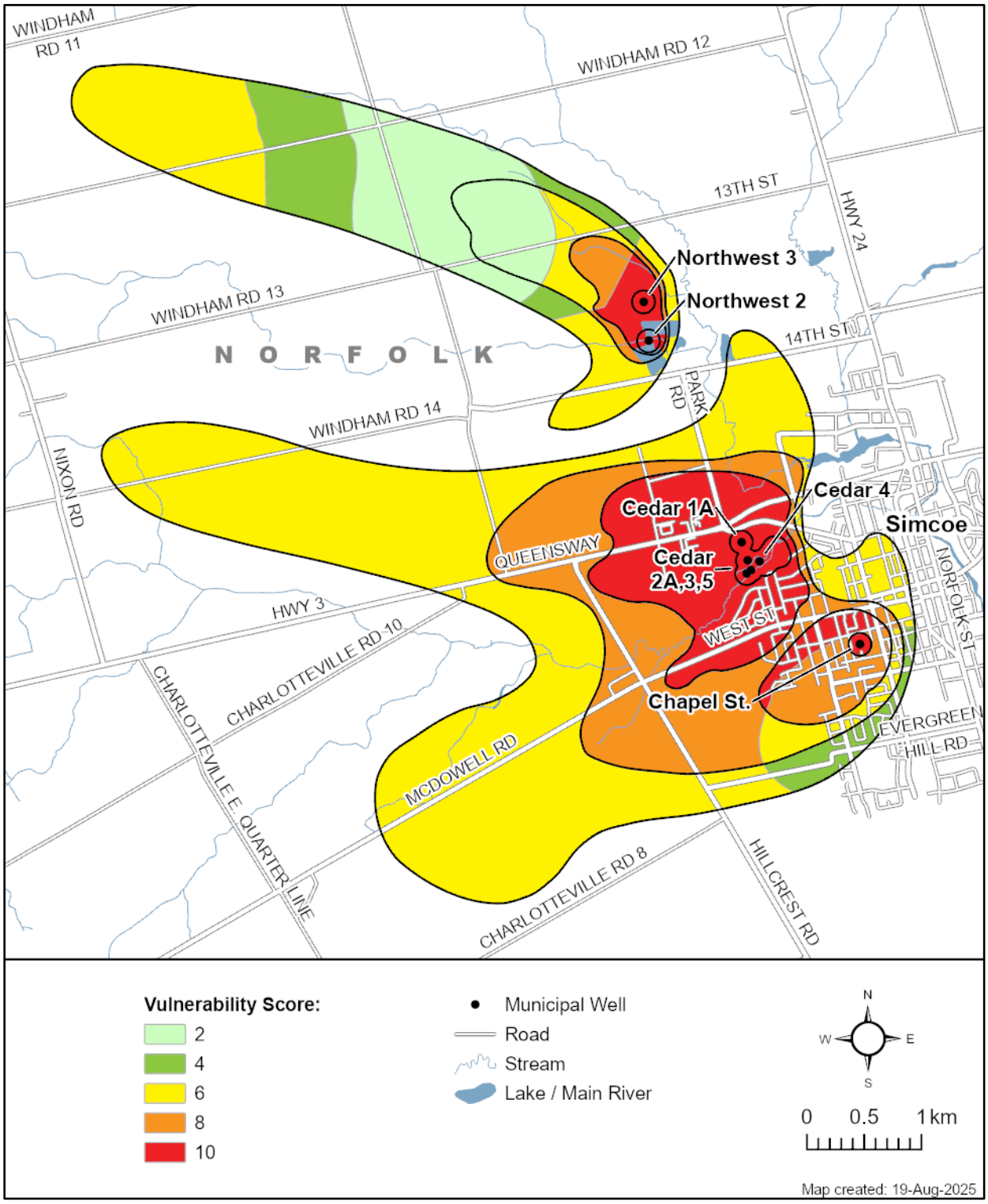
~~Map 5-13: Simcoe Transport Pathways~~



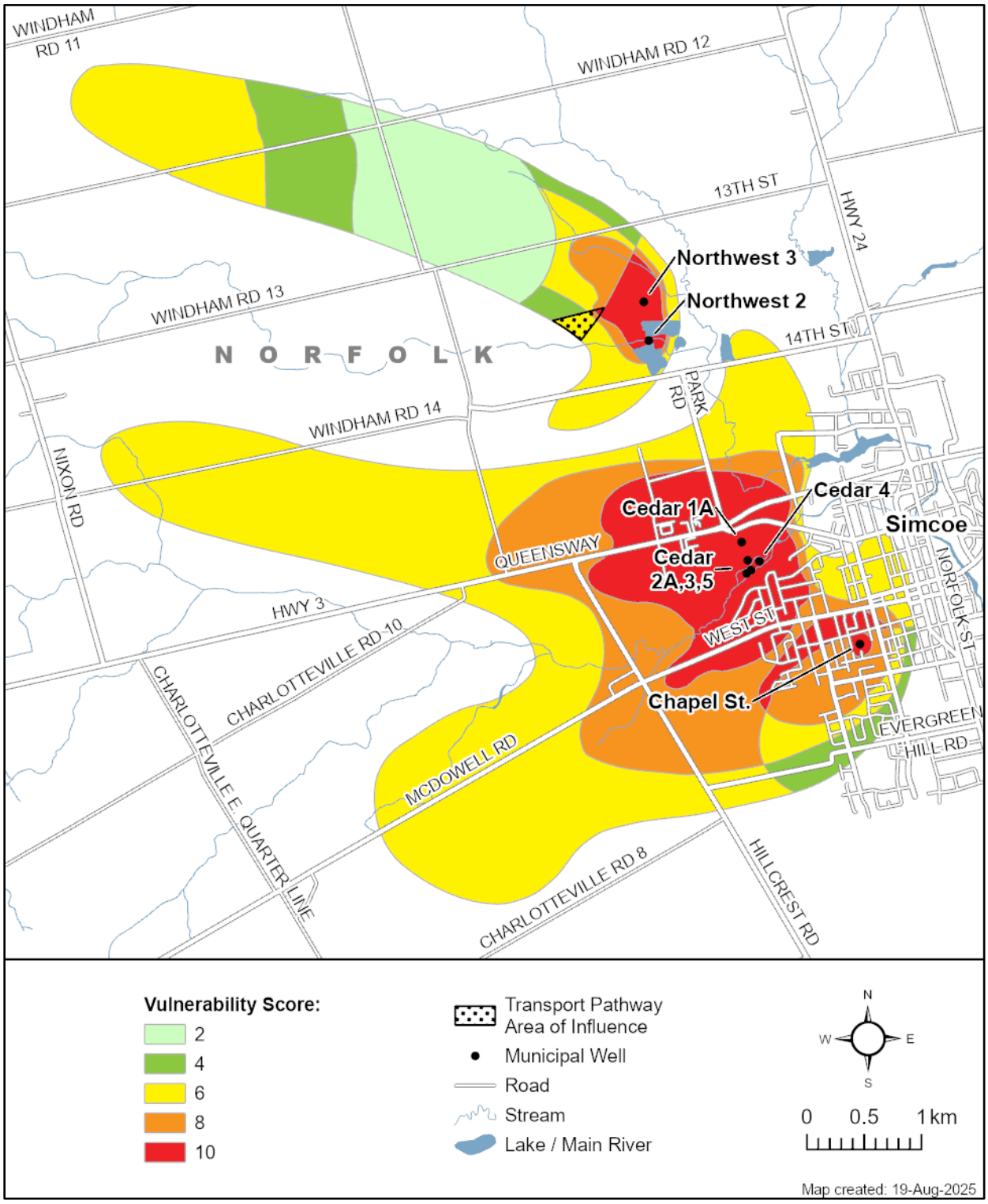
Map 5-12: Simcoe WHPA Adjusted Intrinsic Vulnerability



Map 5-13: Simcoe WHPA Vulnerability Scoring



Map 5-14: Simcoe Transport Pathways Area of Influence



5.2.3 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 5-6**).

Table 5-75-75-16: 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 5-15** and **Map 5-16**~~**Map 5-**~~.

Table 5-8: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	%
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~~Livestock density results are presented in ~~**Table 5-18,**~~ **Map 5-17** and **Map 5-18.**

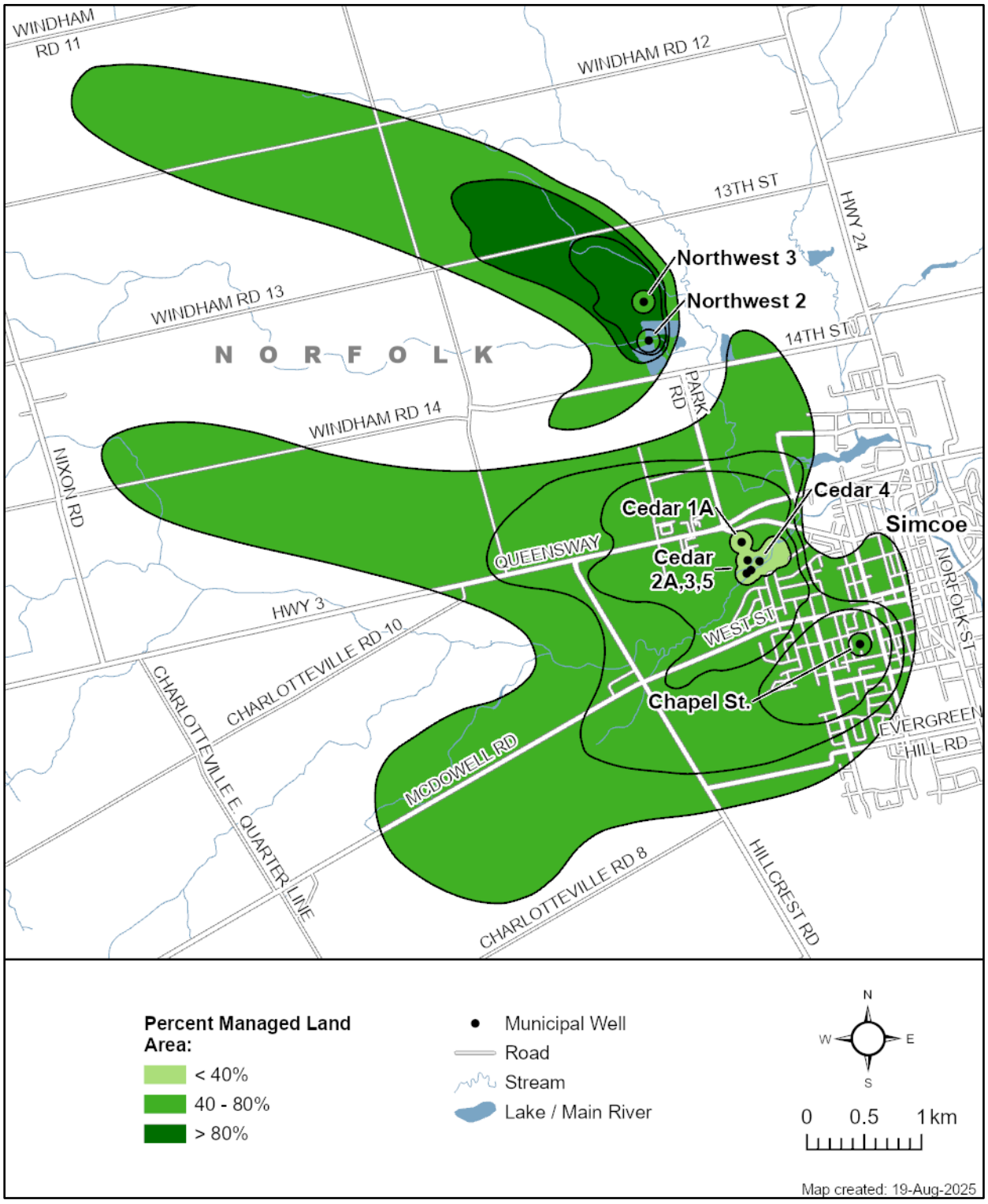
WHPA	Agricultural Managed Land Acreage	Total NU	NU/Acre	Animal Type (NU Conversion Factor)
Northwest Wellfield				
A (Well 2)	0	0.0	0.0	No animals
A (Well 3)	2	0.0	0.0	No animals
B	76	0.0	0.0	No animals
C	212	33.6	0.2	One property, assumed dairy (11 m^2/NU)
D	634	402.6	0.6	Seven properties: assumed dairy (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

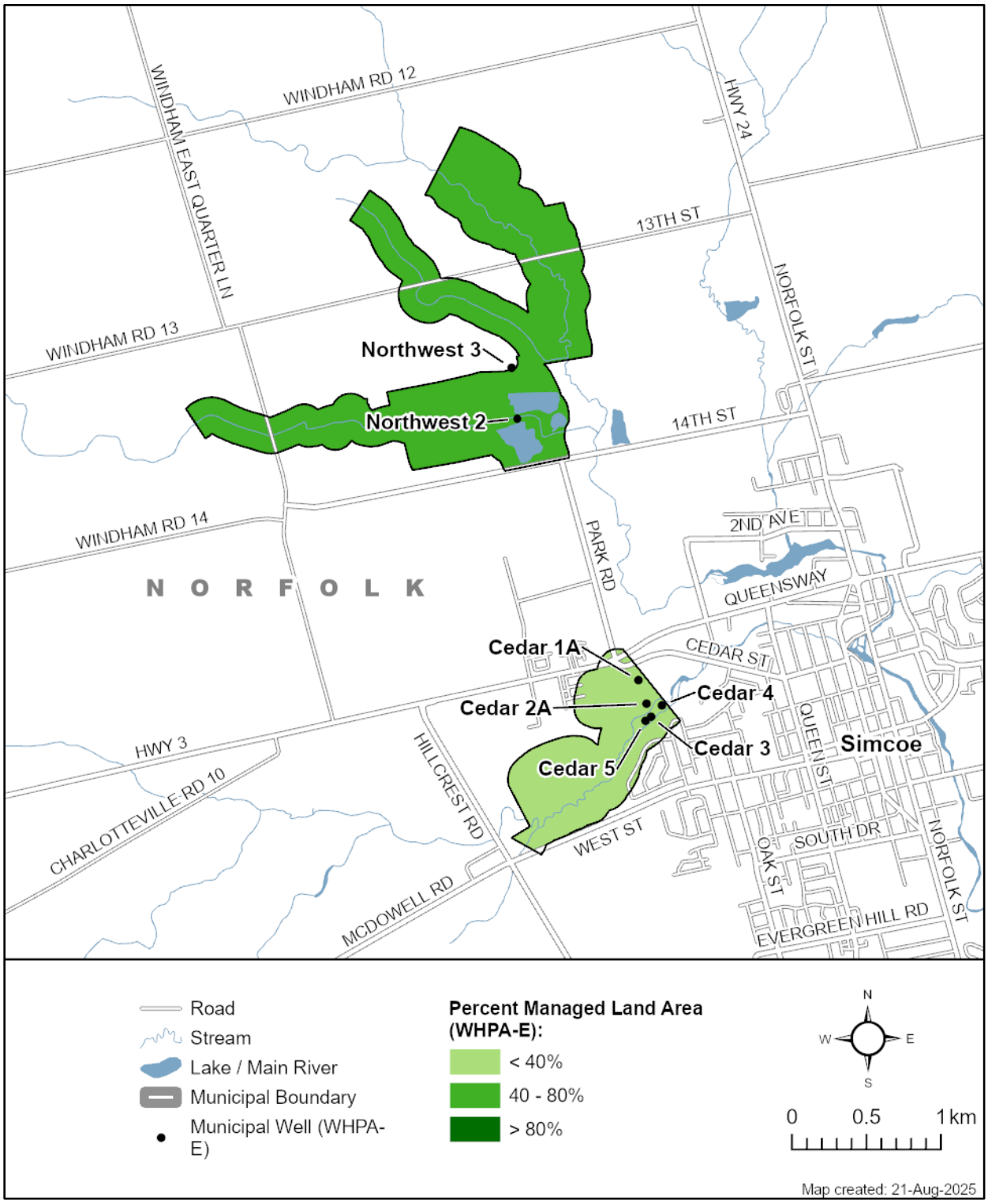
The quantification and mapping of the percentage of impervious surface area was completed to assess the potential threats related to road salt application. A 1 km x 1 km grid was overlaid and centered on the WHPAs and the percentage of impervious area for each grid cell was determined using the project GIS. For the Simcoe area, this included the impervious area represented by roads, parking lots, and sidewalks. **Map 5-19** ~~Map 5-10~~ and **Map 5-20** present~~s~~ the percentage of impervious surface area~~s~~ 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 (MOE, 2009a) 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) Technical Rules 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.~~

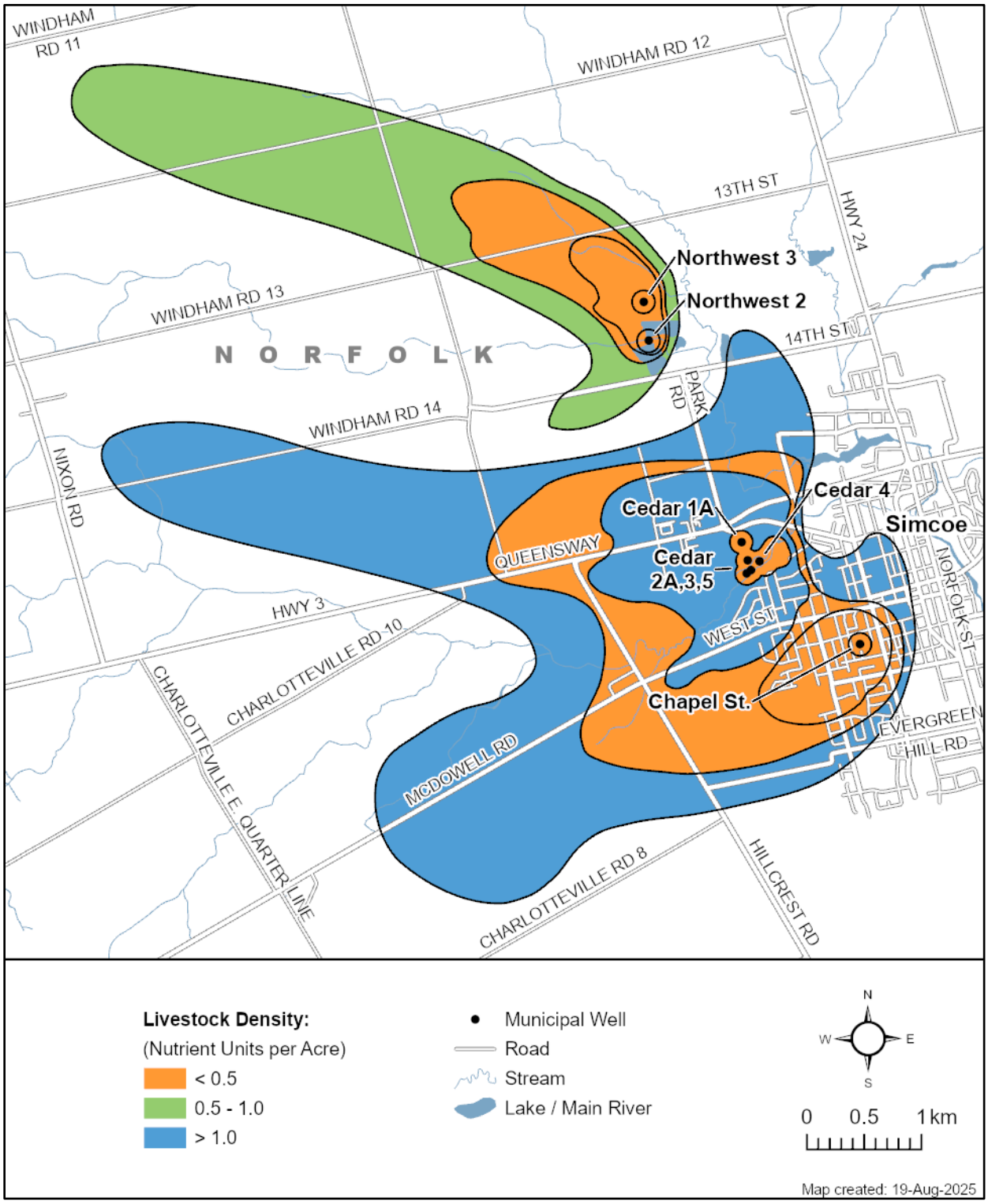
Map 5-15: Percent Managed Lands within the Simcoe WHPA



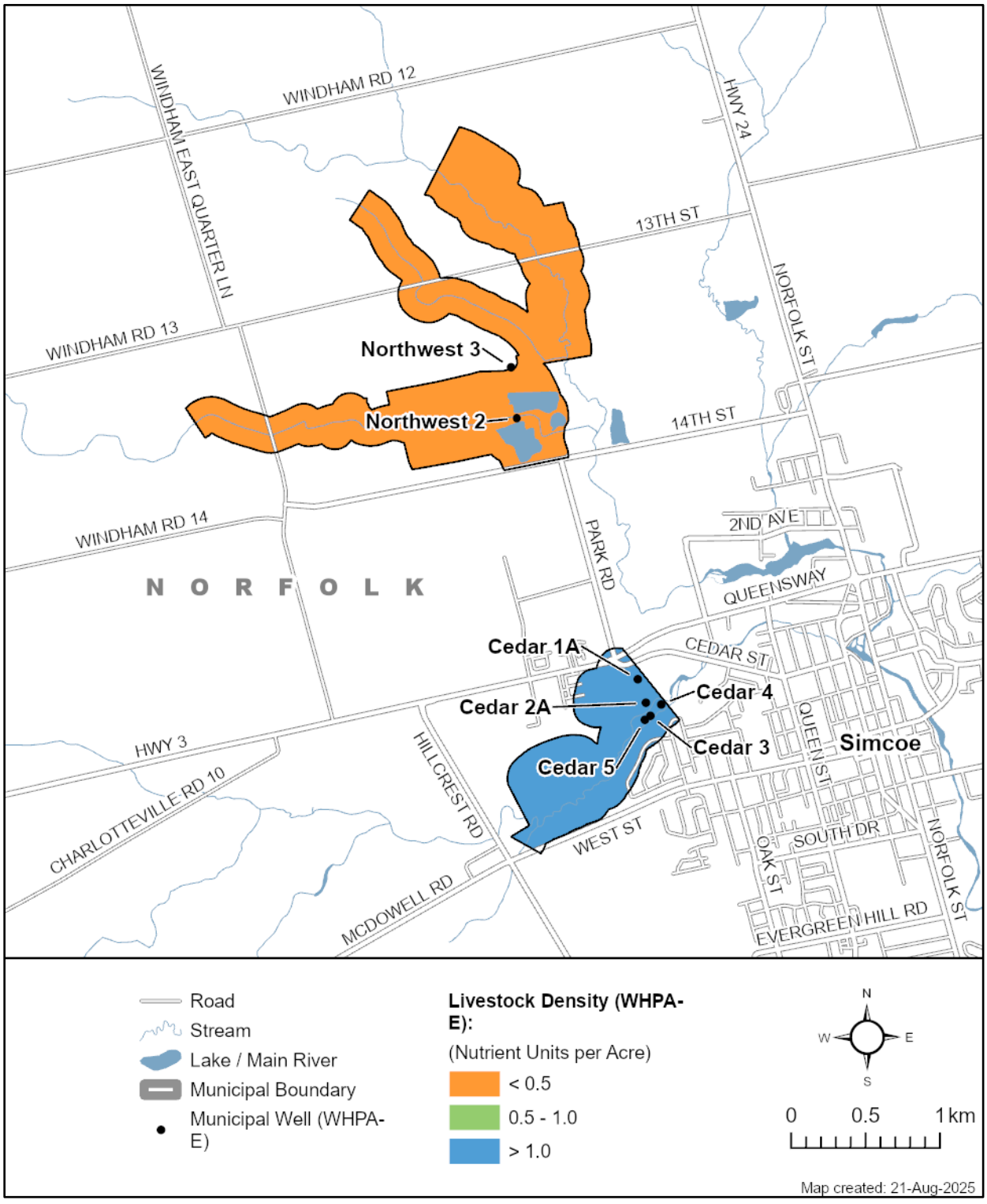
Map 5-16: Percent Managed Lands within the Simcoe WHPA-E



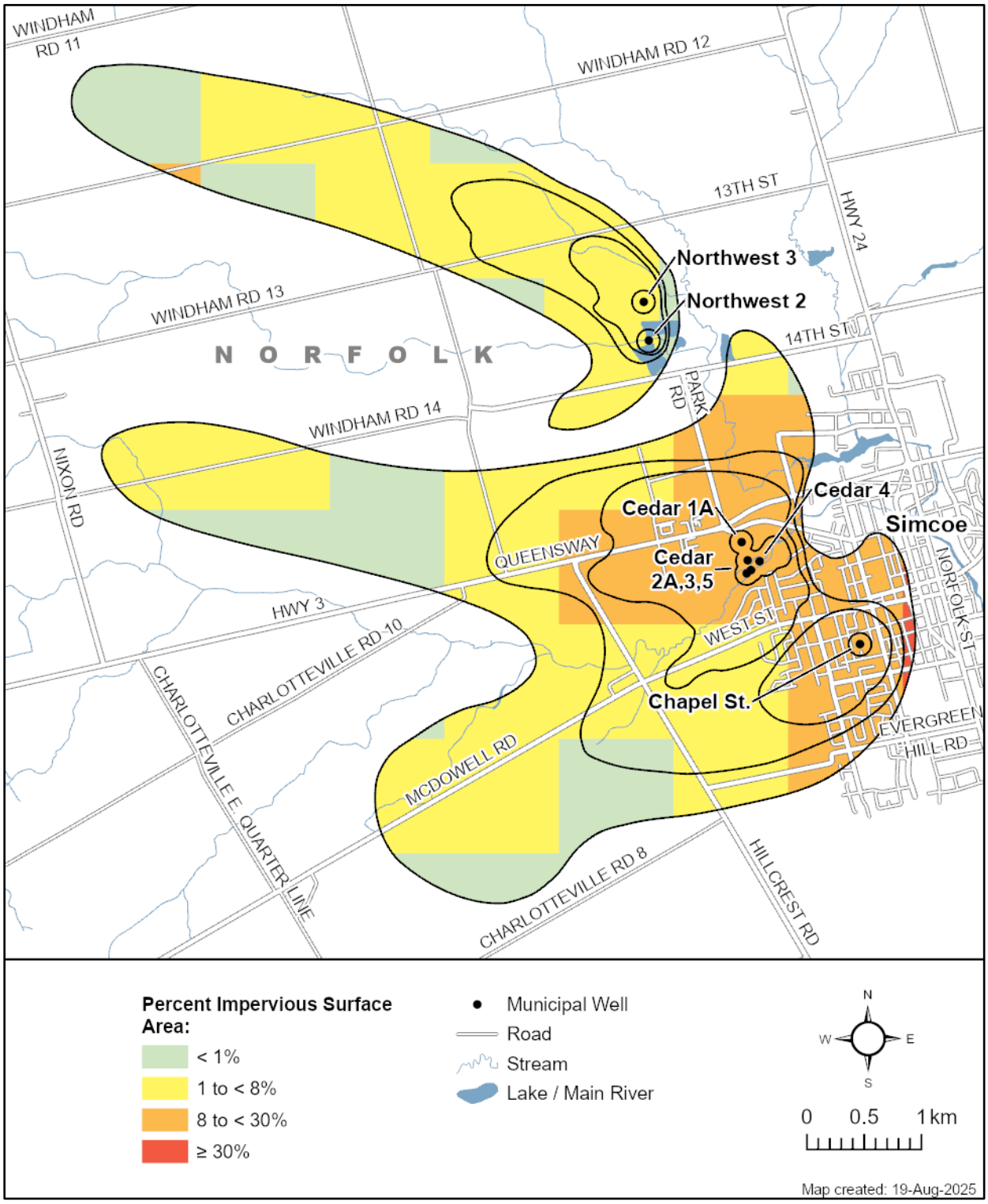
Map 5-17: Livestock Density within the Simcoe WHPA



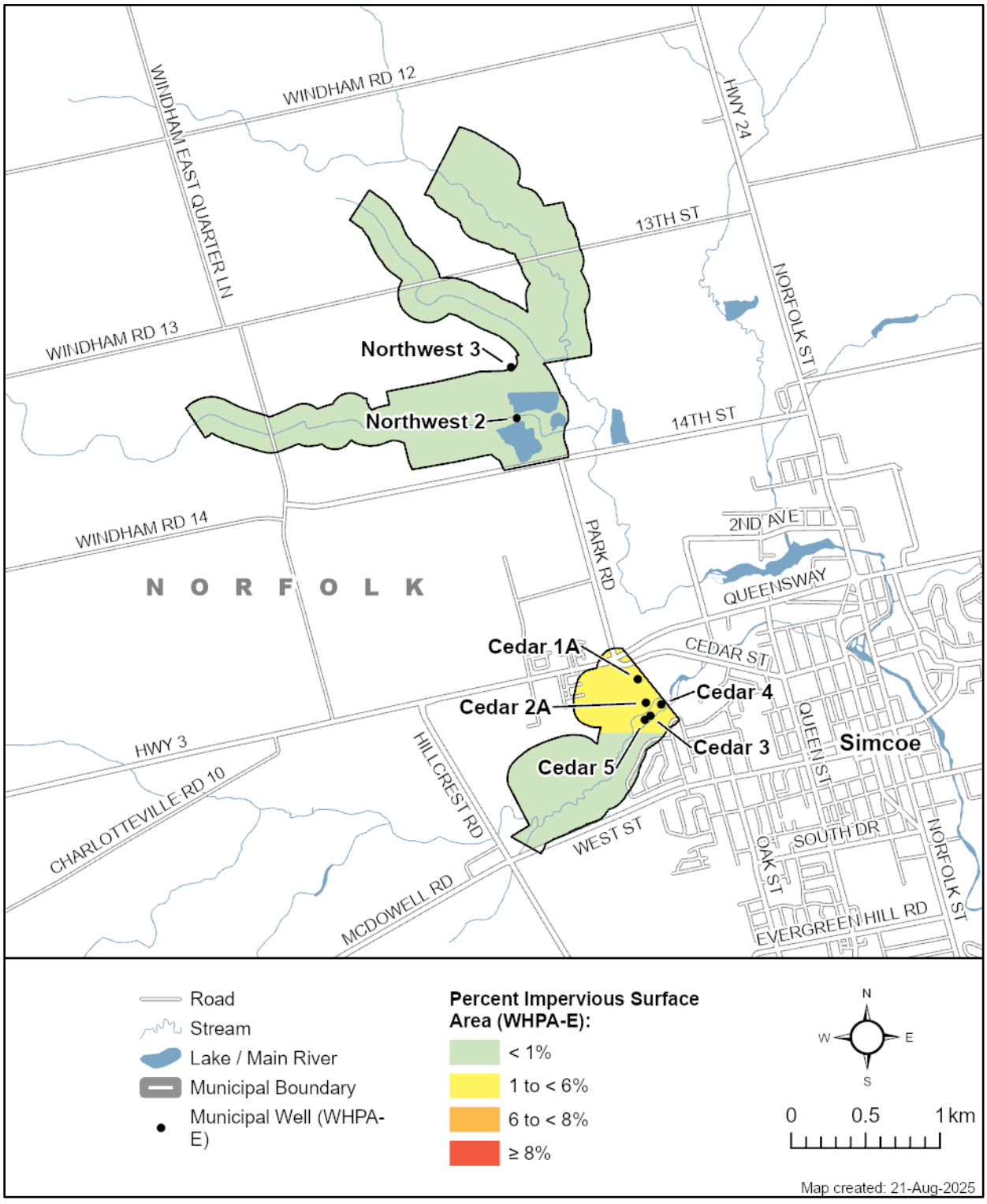
Map 5-18: Livestock Density within the Simcoe WHPA-E



Map 5-19: Impervious Surface within the Simcoe WHPA



Map 5-20: Impervious Surface within the Simcoe WHPA-E



5.2.6 Simcoe Water Quality Threats Assessment

The *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." Drinking water threats are described further in Chapter 3: Water Quality Risk Assessment.

Prescribed drinking water threats listed in Section 1.1 of O. Reg. 287/07 include Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogen threats. Chapter 3 provides a summary of the types of threats and their significance, based on vulnerable area and vulnerability score (as shown in the maps in this chapter).

~~**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 5-115-19: Identification of Drinking Water Quality Threats in the Simcoe WHPAs**~~

~~**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 previously 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. Since that time, threat assessments have relied on different sources of information. Threats are currently assessed through a combination of a desktop land use inventory, windshield surveys and local knowledge / field verification.

~~**Table 5-20: 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
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~~Drinking Water Quality Threats in the Simcoe Wellhead Protection Areas

Northwest Wellfield

~~Eleven significant prescribed drinking water threats were identified in the Northwest wellfield WHPAs. These~~ Significant prescribed drinking water threats in the Northwest wellfield WHPAs are listed in **Table 5-9**~~Table 5-21~~. Most activities identified as a potential significant threat were related to agricultural land use.

Table 5-9~~5-85-21~~: Significant Drinking Water Quality Threats in Simcoe Northwest WHPAs (current to January 2024)

~~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.*~~

Threat Subcategory[1]	Number of Activities	Vulnerable Area
1.1 Disposal of hauled sewage to land	1	WHPA-A
1.2 Application of processed organic waste to land	1	WHPA-A
3.1 Application of agricultural source material (ASM) to land	1	WHPA-A
6.1 Application of non-agricultural source material (NASM) to land	1	WHPA-A
8.1 Application of commercial fertilizer to land	1	WHPA-A
10.1 Application of pesticide to land	1	WHPA-A

16.1 Handling and storage of a dense non-aqueous phase liquid (DNAPL)	2	WHPA-B
Total Number of Activities	**8**	
Total Number of Properties	**2**	

[1] Threats enumerated according to the 2021 Technical Rules (MECP, 2021)

Note: Certain types of incidental activities on residential properties may constitute significant drinking water threats but are not enumerated. These threats include the application of commercial fertilizer and pesticides; the handling and storage of organic solvents and dense non-aqueous phase liquids; the storage of fuel (e.g., heating fuel tanks) in natural gas serviced areas; and the handling and storage of road salt that may be exposed or potentially exposed to precipitation or runoff. 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.

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 (WHPA-ICA).

Table 5-22: 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 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

PDWT #[1]	Threat Subcategory[2]	Number of Activities	Vulnerable Area
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 5-23: 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
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 Significant prescribed drinking water threats were identified within the combined Chapel and Cedar Street WHPAs. The results are summarized in **Table 5-10Table 5-24.**

Table 5-105-95-24: Significant Drinking Water Quality Threats in Combined Simcoe Cedar Street and Chapel Street WHPAs (current to January 2024)

~~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.*~~

Threat Subcategory[1]	Number of Activities	Vulnerable Area
2.2 Onsite sewage works	22	WHPA-B WHPA-ICA
3.1 Application of agricultural source material (ASM) to land	6	WHPA-B WHPA-ICA
6.1 Application of non-agricultural source material (NASM) to land	6	WHPA-B WHPA-ICA
7.1 Handling and storage of non-agricultural source material (NASM)	2	WHPA-B WHPA-ICA
8.1 Application of commercial fertilizer to land	6	WHPA-B WHPA-ICA
9.1 Handling and storage of commercial fertilizer	6	WHPA-B WHPA-ICA
10.1 Application of pesticide to land	5	WHPA-B
11.1 Handling and storage of a pesticide	6	WHPA-B
13.2 Handling and storage of road salt – potentially exposed to precipitation or runoff	49	WHPA-B
13.3 Handling and storage of road salt – not exposed to precipitation or runoff	49	WHPA-B
14.1 Storage of snow on a site	49	WHPA-B

~~PDWT #[1]~~	~~Threat Subcategory[2]~~	~~Number of Activities~~	~~Vulnerable Area~~
15.1	Handling and storage of fuel	17	WHPA-B
16.1	Handling and storage of a dense non-aqueous phase liquid (DNAPL)	35	WHPA-B
17.1	Handling and storage of an organic solvent	35	WHPA-B
21.1	Agricultural source material (ASM) generation – livestock grazing or pasturing	2	WHPA-B WHPA-ICA
21.2	Agricultural source material (ASM) generation – outdoor confinement area (OCA) or farm animal yard	2	WHPA-B WHPA-ICA
Total Number of Activities		**297**	
Total Number of Properties		**70**	

[1] Threats enumerated according to the 2021 Technical Rules (MECP, 2021)

Note: Certain types of incidental activities on residential properties may constitute significant drinking water threats but are not enumerated. These threats include the application of commercial fertilizer and pesticides; the handling and storage of organic solvents and dense non-aqueous phase liquids; the storage of fuel (e.g., heating fuel tanks) in natural gas serviced areas; and the handling and storage of road salt that may be exposed or potentially exposed to precipitation or runoff.~~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~~landowners.

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 (WHPA-ICA/IPZ-ICA) and manage these threats appropriately. All threats related to a particular Issue within the WHPA-ICA/IPZ-ICA are classified as significant drinking water threats, regardless of the vulnerability.

~~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 (WHPA-ICA) and manage these threats appropriately. If at this time the WHPA-ICA 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 WHPA-ICAsIssue Contributing Areas are classified as significant drinking water threats, regardless of the vulnerability.~~

Water treatment for the Simcoe Cedar St. Booster Station consists of the addition of hydrofluosilicic acid, UV disinfection, disinfection using sodium hypochlorite and iron sequestration using sodium silicate. Water Treatment at the Simcoe Northwest Filter Plant consists of poly aluminum chloride for coagulation prior to filtration, the addition of permanganate for oxidation of iron, and sodium hypochlorite for disinfection. Hydrofluosilicic acid is also added for dental health.~~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:~~The original evaluation of raw water quality for the Simcoe system (SWS, 2010) examined data from 1999-2009 and relied largely on data from the Drinking Water Surveillance Program (DWSP) as well as from field data generated by the system's SCADA data collection equipment.

Subsequent water quality analysis for the Simcoe system (Matrix, 2018b) examined data up to approximately 2016. More recently, water quality has been examined up to 2023 using data from Annual Drinking Water System Reports provided by Norfolk County, supplemented by the DWSP where appropriate.

Schedule 1 Parameters ~~and Pathogens~~

Weekly samples analysed for E. coli and total coliforms were available from 2005 to 2016. ~~Occurrences of~~ Ttotal coliform detections~~s~~ were ~~found to be~~ most frequent in the Cedar Street~~.~~ Wells where total coliforms were detected 329 times over the entire 12-year period of available data and E. coli 48 times. All other wells only accounted for an additional 13 detects of total coliforms and no E. coli were encountered.

Weekly raw water testing from 2017-2023 Annual Drinking Water System Reports indicate that E. coli was detected in 2018 at the Cedar Street wellfield, with no occurrences at the other wellfields. Total coliforms were detected every year throughout

this period, primarily at the Cedar Street wellfield. The ~~well operator confirmed that the~~ disinfection system provides ~~the~~ appropriate treatment and therefore no Schedule 1 Parameters were noted as a concern. ~~for this low number of microbes.~~

Schedule 2 Parameters

Chapel Street~~.~~ Wellfield

All 2009 quarterly nitrate levels were above the 50% ODWQS MAC screening benchmark and nitrate was~~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. 2017-2023 Annual Drinking Water System Reports indicate quarterly nitrate concentrations ranging from 4.69 to 5.61 mg/L (**Figure 5-1**). ~~Nitrate was therefore identified as an Issue for the Chapel St. wellfield as per Technical Rule 114.~~

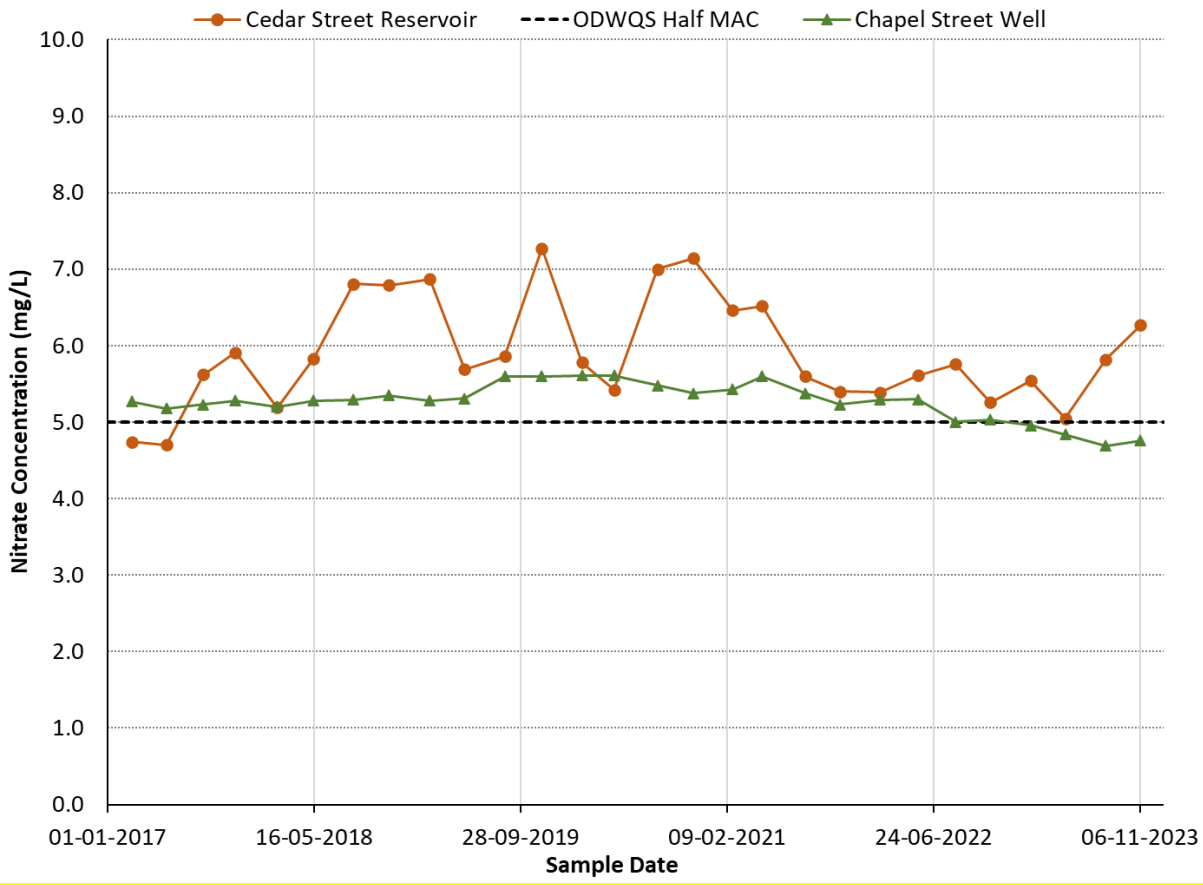


Figure 5-1: Cedar Street and Chapel Street nitrate concentrations.

Cedar Street~~.~~ Wellfield

Historically, nNitrate ~~was found to be very close~~has been observed around and above the 50% ODWQS MAC limit ~~and exceeded this benchmark limit frequently~~. 2017-2023 Annual Drinking Water System Reports indicate quarterly nitrate concentrations at the Cedar Street Reservoir ranging from 4.7 to 7.27 mg/L (**Figure 5-1**). Note that the Cedar Street Reservoir represents treated water from a combination of both well and infiltration gallery sources. ~~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 Aannual R~~r~~eporting at more than the 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.

Inorganic and organic Schedule 2 parameters examined from 2017-2023 Annual Drinking Water System Reports indicate no ODWQS exceedances.

Schedule 3 Parameters

Chapel Street~~.~~ 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 Street~~.~~ Wellfield

Between 1999-2009, t~~T~~ritium 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. Raw water quality data available for Wells 1A, 2A, and 3 from

the DWSP (2009-2018) similarly indicate no elevated values of gross alpha, gross beta or tritium.

Northwest Wellfield

No elevated values of gross alpha and gross beta were found in the available analysis from 1999-2009 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. Raw water quality data available for Wells NW2 and NW3 from the DWSP (2009-2019) similarly indicate no elevated values of gross alpha, gross beta or tritium.

Table 4 Parameters

Chapel Street~~.~~ Wellfield

The Chapel Street~~.~~ 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 S~~t~~treet in the review of raw water quality to 2009.~~.~~ 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 Street~~.~~ Wellfield

Organic nitrogen, hardness, manganese, total dissolved solids and dissolved organic carbon exceeded the ODWQS O~~o~~perational G~~g~~uidelines and A~~a~~esthetic O~~o~~bjectives at the Simcoe Cedar Street~~.~~ 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 review of raw water quality to 2009. In the absence of samples, which may have exonerated the mentioned elevated levels, all parameters were noted as a concern.

Raw water quality data between 2012-2018 available for hardness and manganese at Wells 1A, 2A, and 3 from the DWSP indicates continued ODWQS exceedances: hardness between 244 to 320 mg/L and manganese between 0.04 to 0.33 mg/L. For this same time period, dissolved organic carbon in raw water is observed to be below the ODWQS Aesthetic Objective.

Sodium has been commonly observed ~~was consistently~~ above the 20 mg/L Medical Officer of Health notification level~~Health Advisory level of 20 mg/L in the past years and this parameter was therefore noted as a concern~~. 2017-2023 Annual Drinking Water System Reports indicate elevated levels of sodium ranging between 24.8 to 90.1 mg/L in the Cedar Street Reservoir. Norfolk County will continue monitoring this parameter to determine whether an Issue under Technical Rule 114 should be identified.

Northwest Wellfield

In the review of raw water quality data up to 2009, e~~E~~xceedances of the ODWQS O~~o~~perational G~~g~~uidelines and A~~a~~esthetic O~~o~~bjectives at wells NW2 and NW3 occurred most frequently for water hardness, colour, iron and manganese, while intermittent exceedances of the A~~a~~esthetic O~~o~~bjective 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.

Raw water hardness data available from the DWSP between 2010-2016 indicates continued exceedance of the ODWQS Operational Guidelines at this wellfield (values between 248-307 mg/L). Iron and manganese concentrations reported for raw water between 2009-2018 from the DWSP indicate frequent exceedance of the ODWQS Aesthetic Objectives for iron (values between 0.25-3.05 mg/L) and consistent exceedance for manganese (values between 0.06-0.43 mg/L). Drinking water at this wellfield is treated for both iron and manganese.

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 as a concern.

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.~~

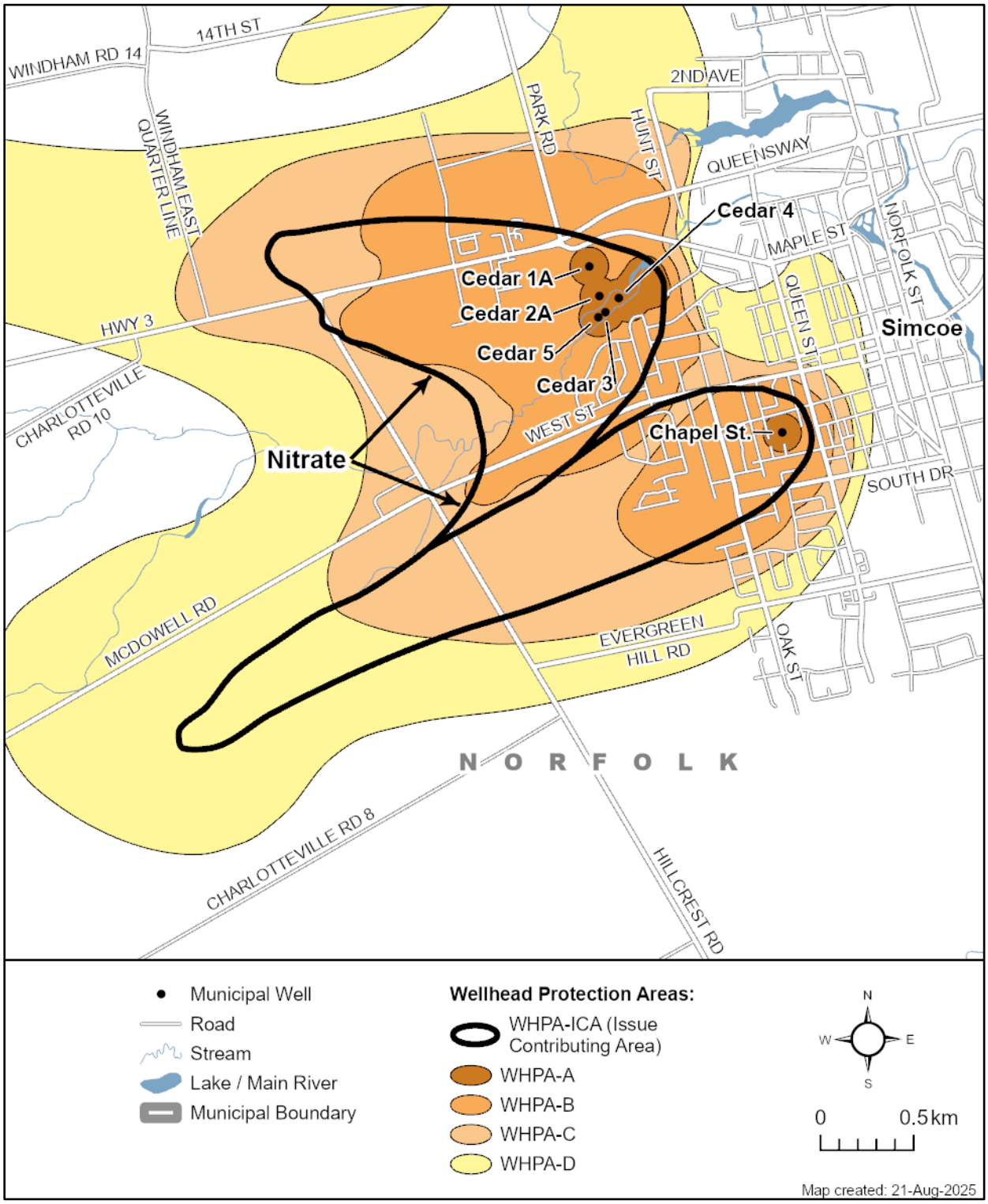
Nitrate concentrations have been~~were~~ consistently close to or above the 50% MAC threshold of 5 mg/L in the Chapel Street~~.~~ and Cedar Street~~.~~ wellfields. ~~and occasionally exceeded it.~~ In accordance with the~~Following the guidance of~~ MOE Technical Bulletin "Threats Assessment and Issues Evaluation, February 2010", a parameter can ~~also~~ be considered an Issue if half of the MAC is frequently exceeded. Given the inability to treat ~~un-treatability of~~ this parameter, nitrate was ~~therefore~~ identified as an Issue under Technical Rule 114 in the Chapel Street~~.~~ and Cedar Street~~.~~ wellfields. ~~under Technical Rule 114.~~

Issue Contributing Area (WHPA-ICA) 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 (WHPA-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 WHPA-ICAs for the Chapel Street and Cedar Street wellfields are shown on **Map 5-21**.

Chapter 3, Water Quality Risk Assessment, lists all prescribed threat activities that are associated with nitrogen and that would be identified as a significant drinking water threat if they exist within the WHPA-ICAs. Following the completion of a desktop assessment of the potential sources of nitrate in these areas, properties where nitrate could contribute to the WHPA-ICA, including where agricultural source material is applied and septic systems in WHPA-B to D, were enumerated in **Table 5-10** ~~**Table 5-22**, **Table 5-23** and **Table 5-24**~~.

Map 5-21: **Issue Contributing Area (WHPA-ICA) for 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 5-22**~~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 aggre~~a~~gate 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); and~~.~~
- Waterford WHPA Delineation, Vulnerability Scoring and Threats Assessment, Matrix Solutions, Inc. (~~2017 in progress~~2018).

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 Waterford system. 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, 2018c~~7~~).

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 5-23.** 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)

WHPA-E delineation was completed in accordance with the 2009 Technical Rules (MOE, 2009a). 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 5-24**~~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 (**Map 5-24**) 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 5-26Map 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.~~This methodology is described in Chapter 3: Water Quality Risk Assessment.

~~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 5-25: 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 5-25 shows the regional vulnerability classifications based on the SAAT methodology. ~~This is also referred to as the intrinsic vulnerability.~~ 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. **Map 5-26** 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 results in a score of 6.

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 5-29**.~~

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.

5.3.3 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 5-11~~Table 5-26~~**).

Table 5-11~~5-10~~: 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.

5.3.4 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 presented ~~summarized~~ in ~~Table 5-27,~~ **Map 5-27**~~Map 5-33,~~ and **Map 5-28** ~~Map 5-34~~**.**

Table 5-27: 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	%
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 presentedsummarized in **Table 5-28, Map 5-29Map 5-35,** and **Map 5-30 Map 5-36**.

Table 5-28: 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

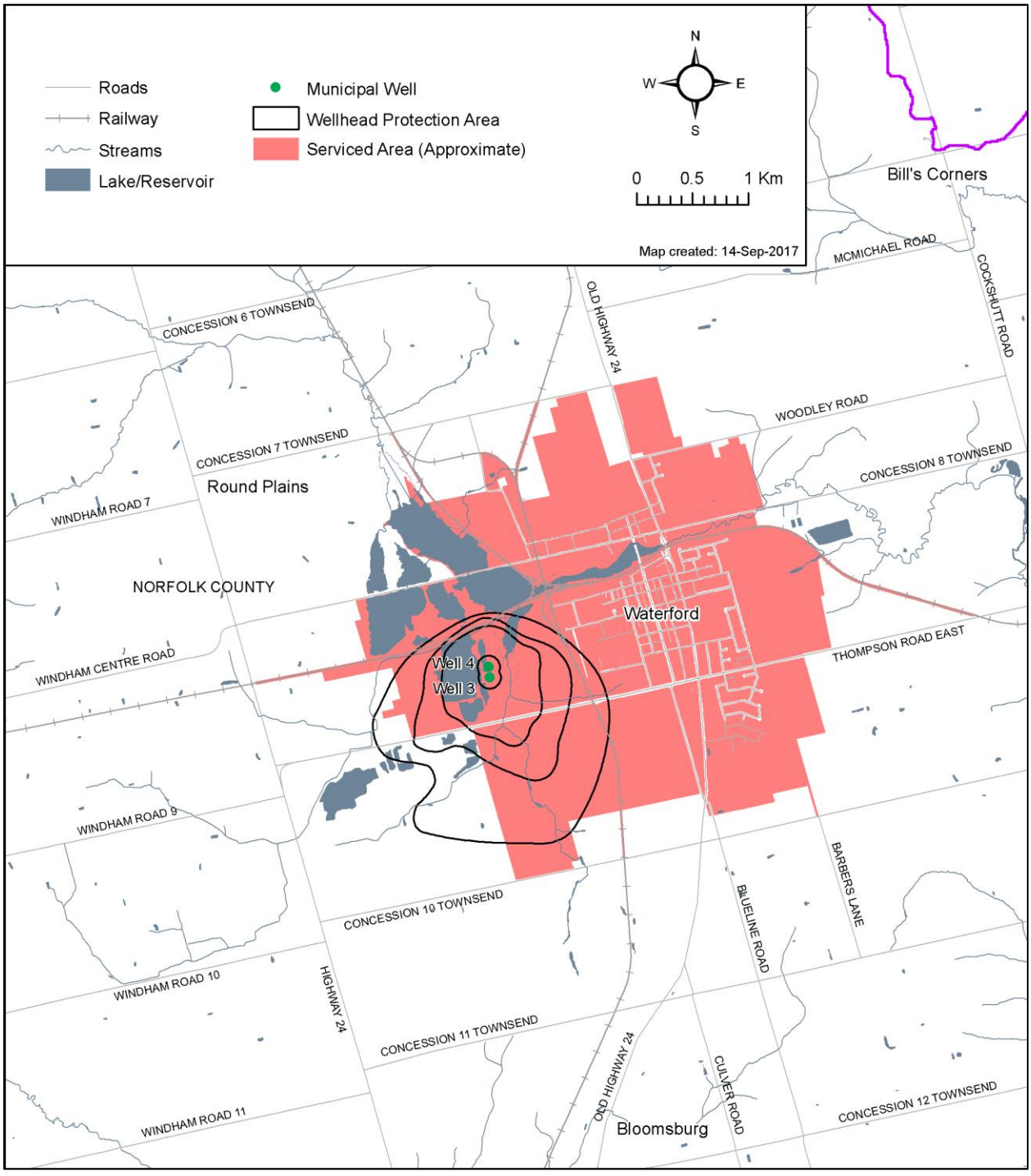
5.3.5 Percent Impervious Surface Area in WHPAs

To map impervious areas, roads, sidewalks and parking lots within the WHPAs were digitized based on the 2015 aerial photograph. A one kilometerone-kilometer square was centered on the centroid of the WHPA, and additional squares were added next to

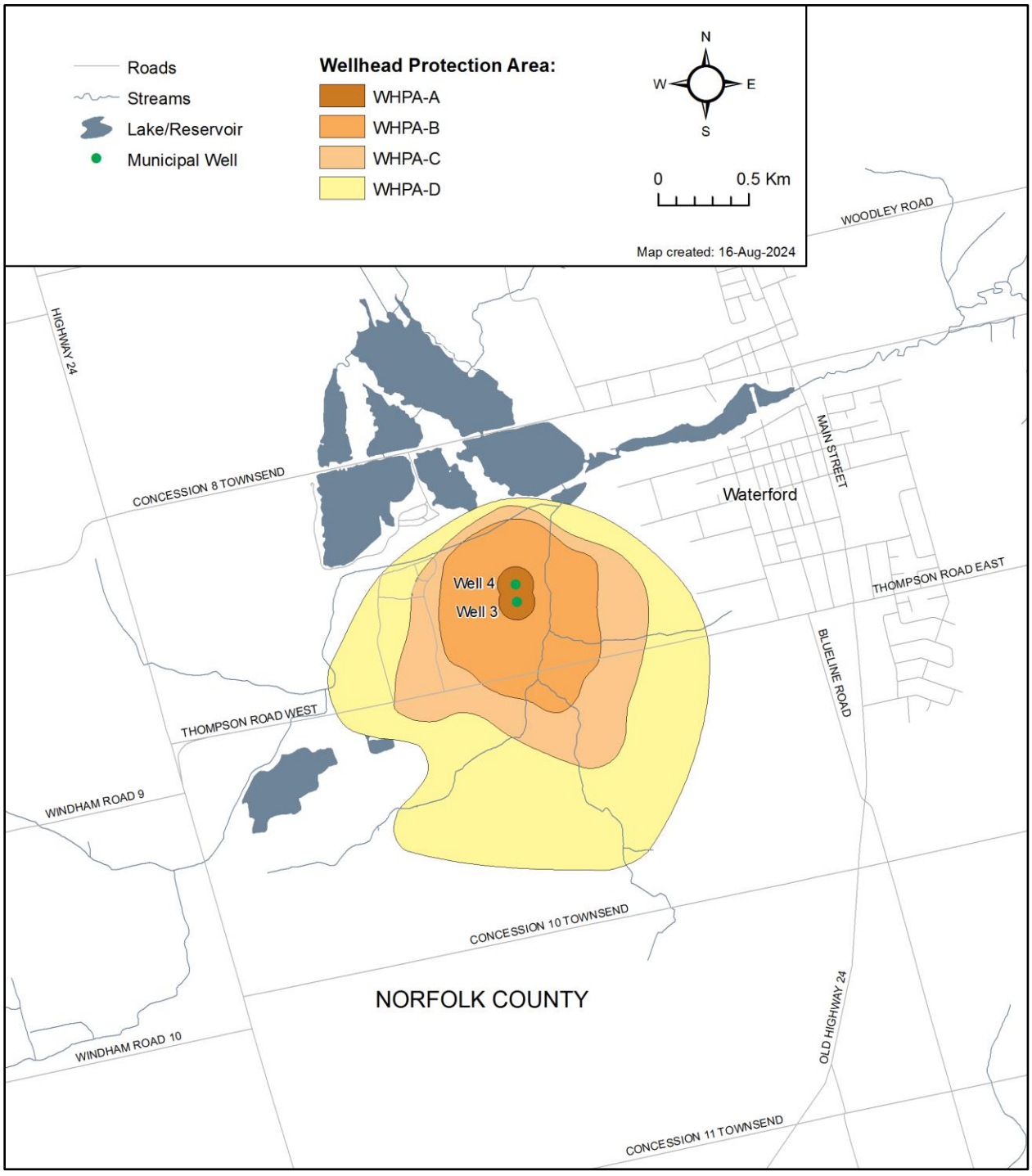
the central square, until the WHPA area was entirely covered by the grid**. Map 5-31 and Map 5-32** ~~Map 5-38~~ illustrate the percent impervious surfaces for the Waterford WHPAs. ~~Percent imperviousness ranges from 0% to just over 80%, with the majority of percentages ranging between 1 to 8% impervious 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 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.~~

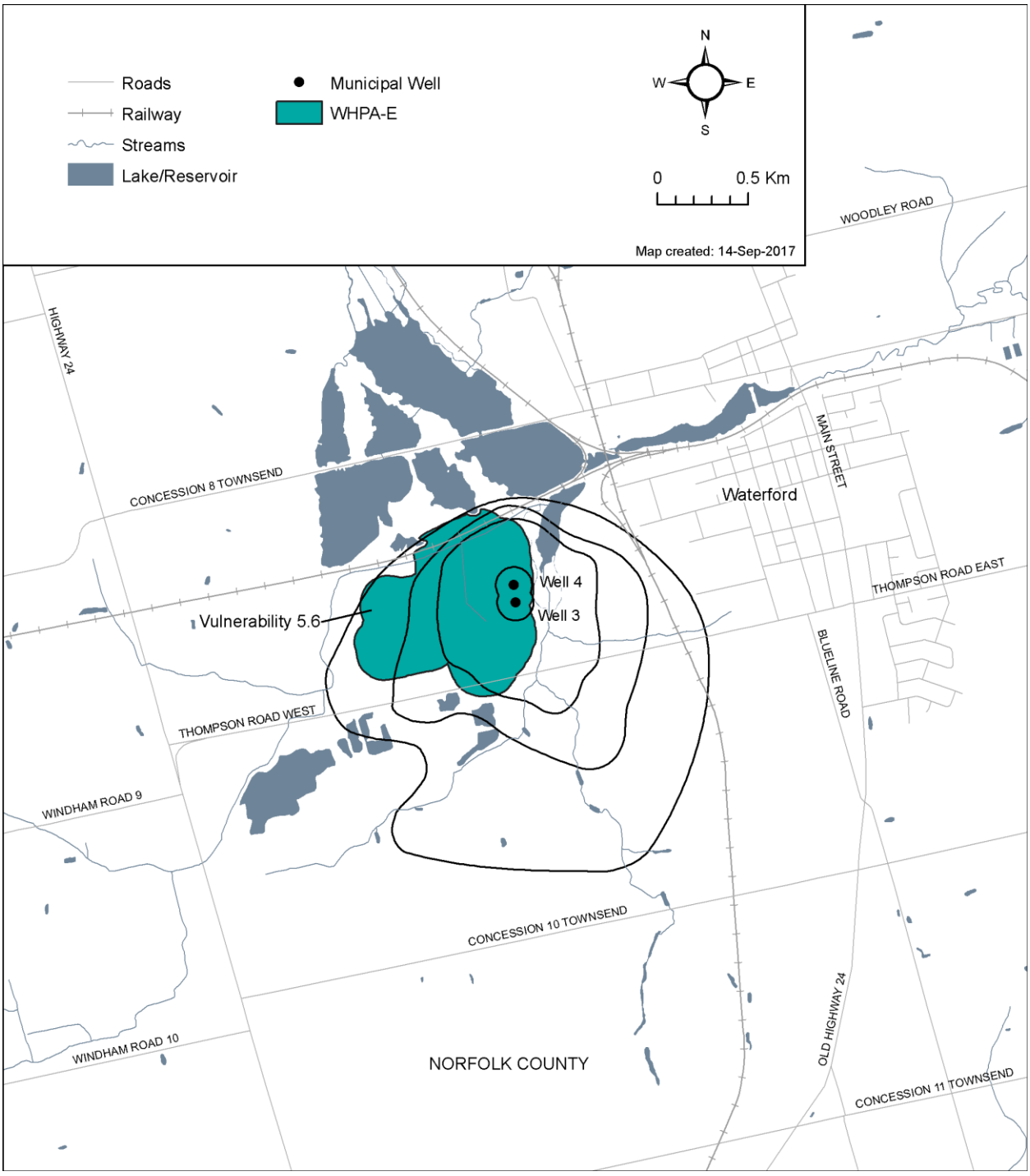
Map 5-22: Serviced Areas for the Waterford Water Supply



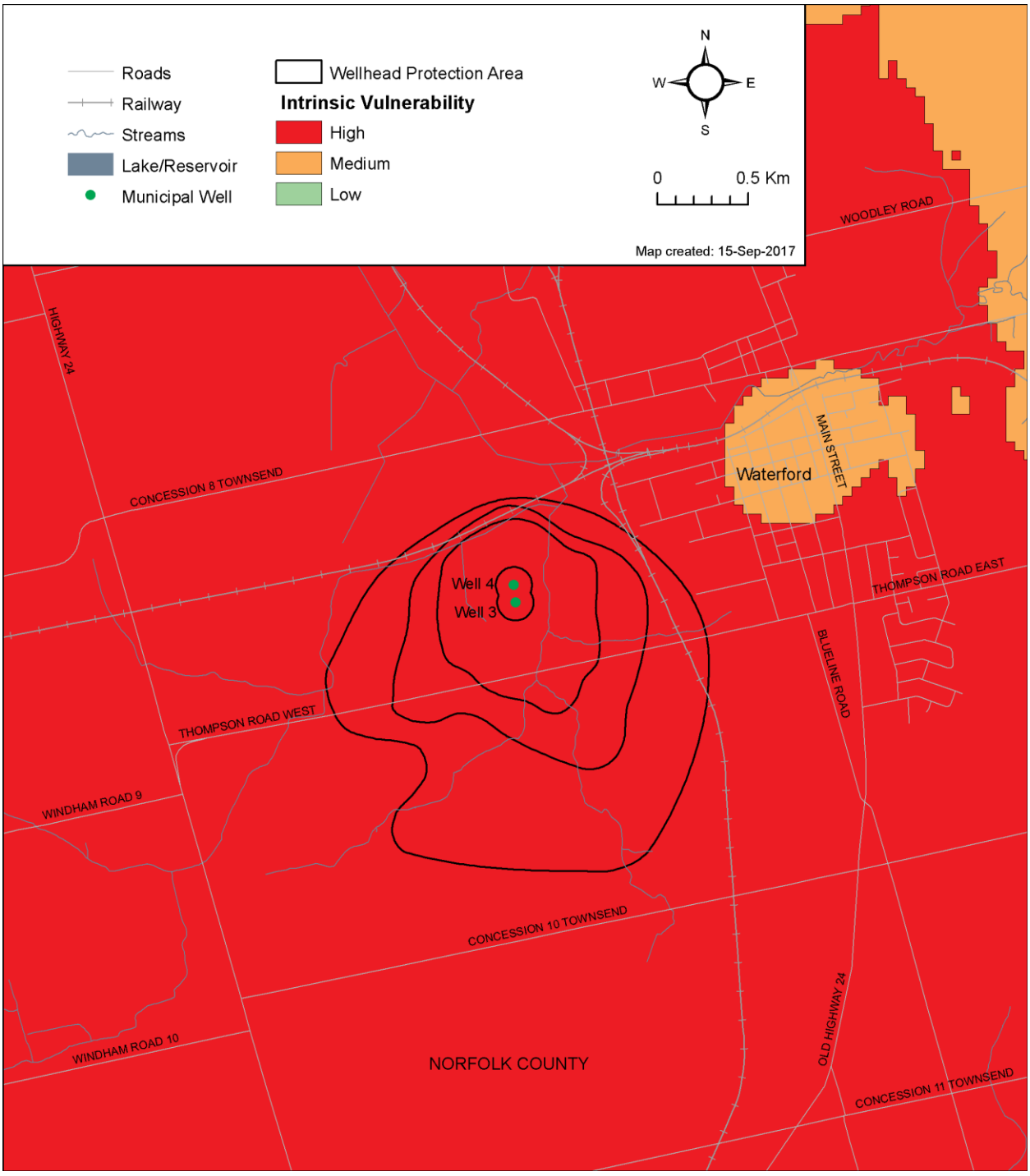
Map 5-23: Waterford WHPA



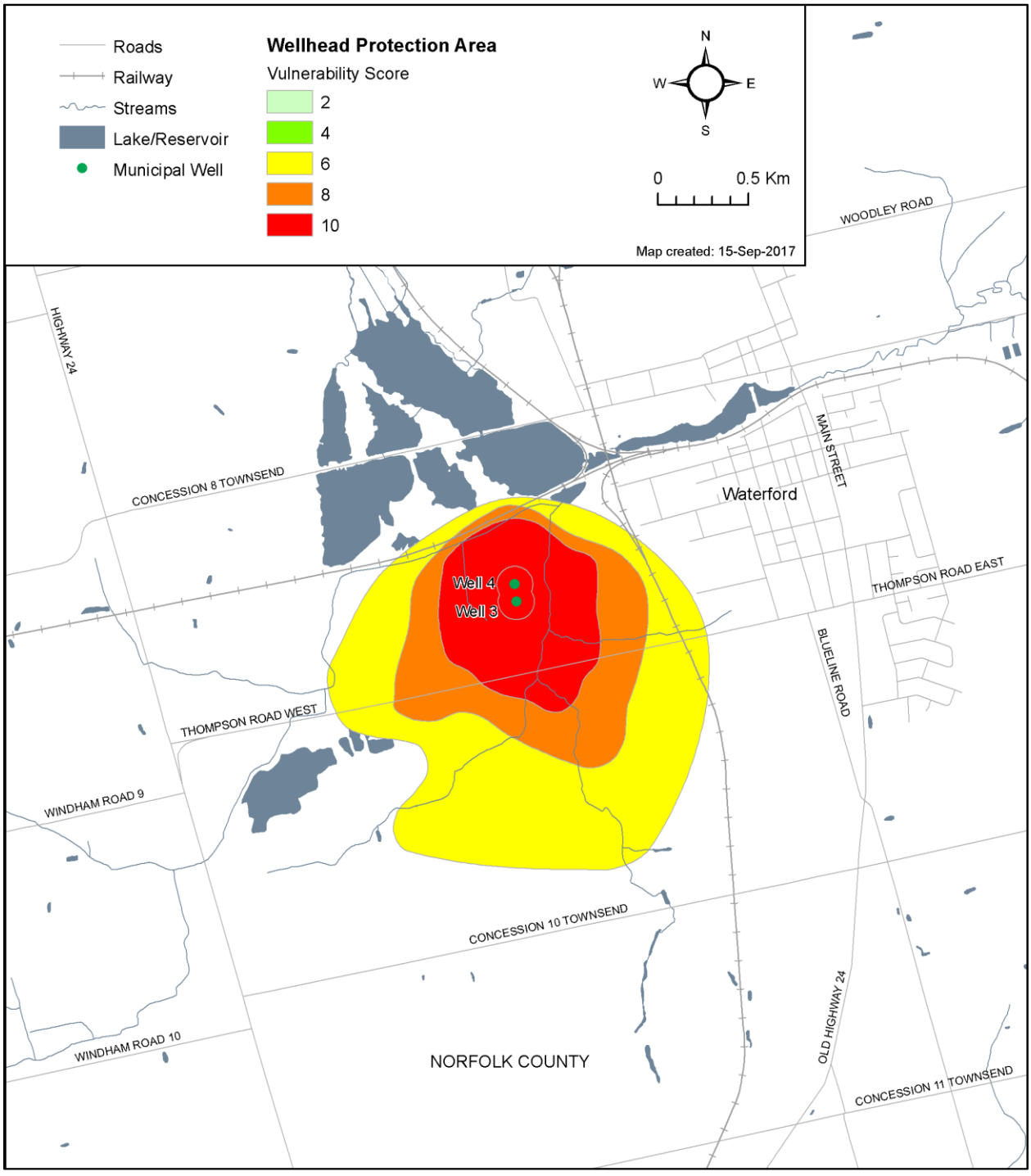
Map 5-24: Waterford WHPA E



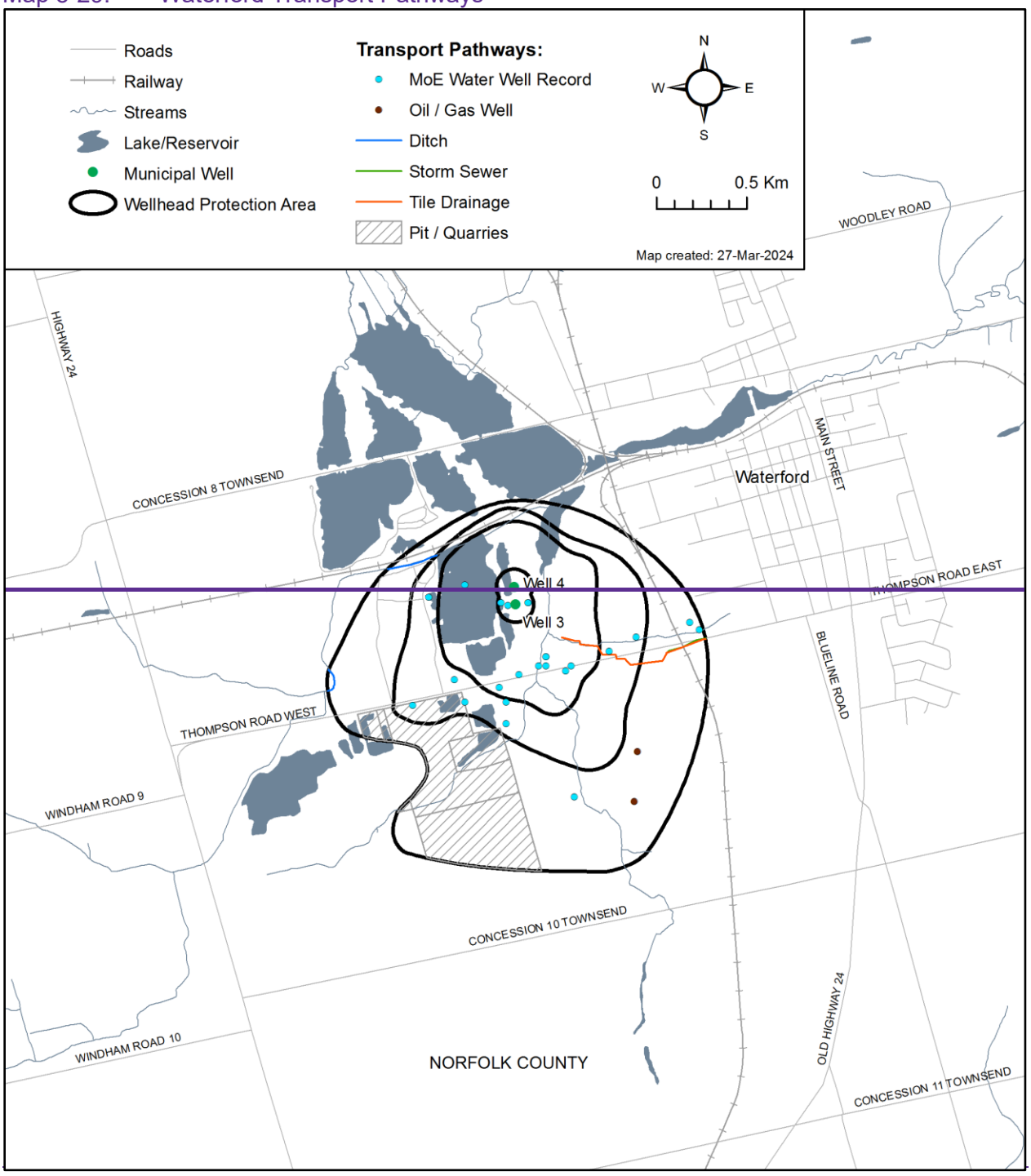
Map 5-25: Waterford WHPA Unadjusted Intrinsic Vulnerability



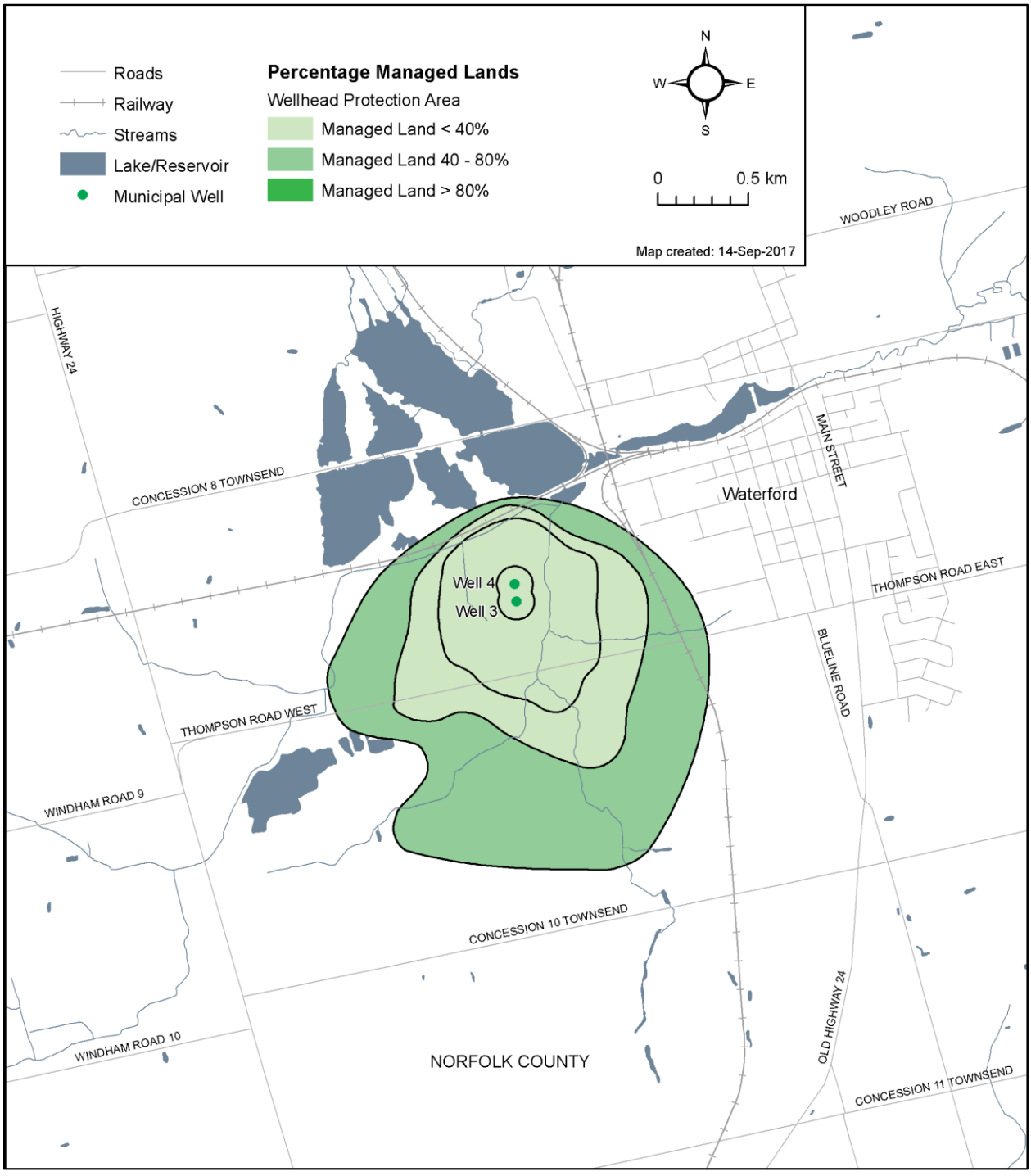
Map 5-26: Waterford WHPA Vulnerability Scoring



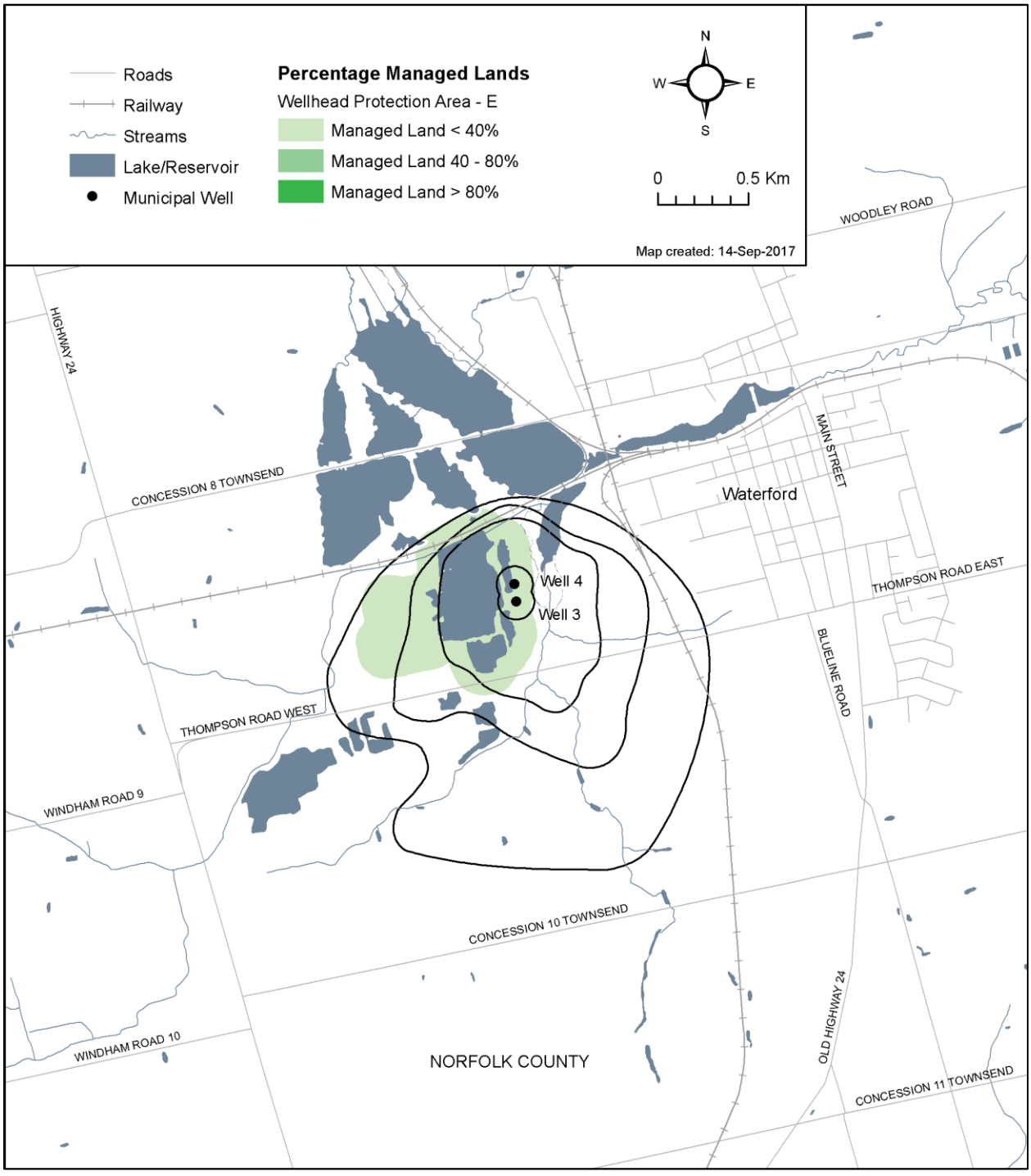
~~Map 5-29: Waterford Transport Pathways~~



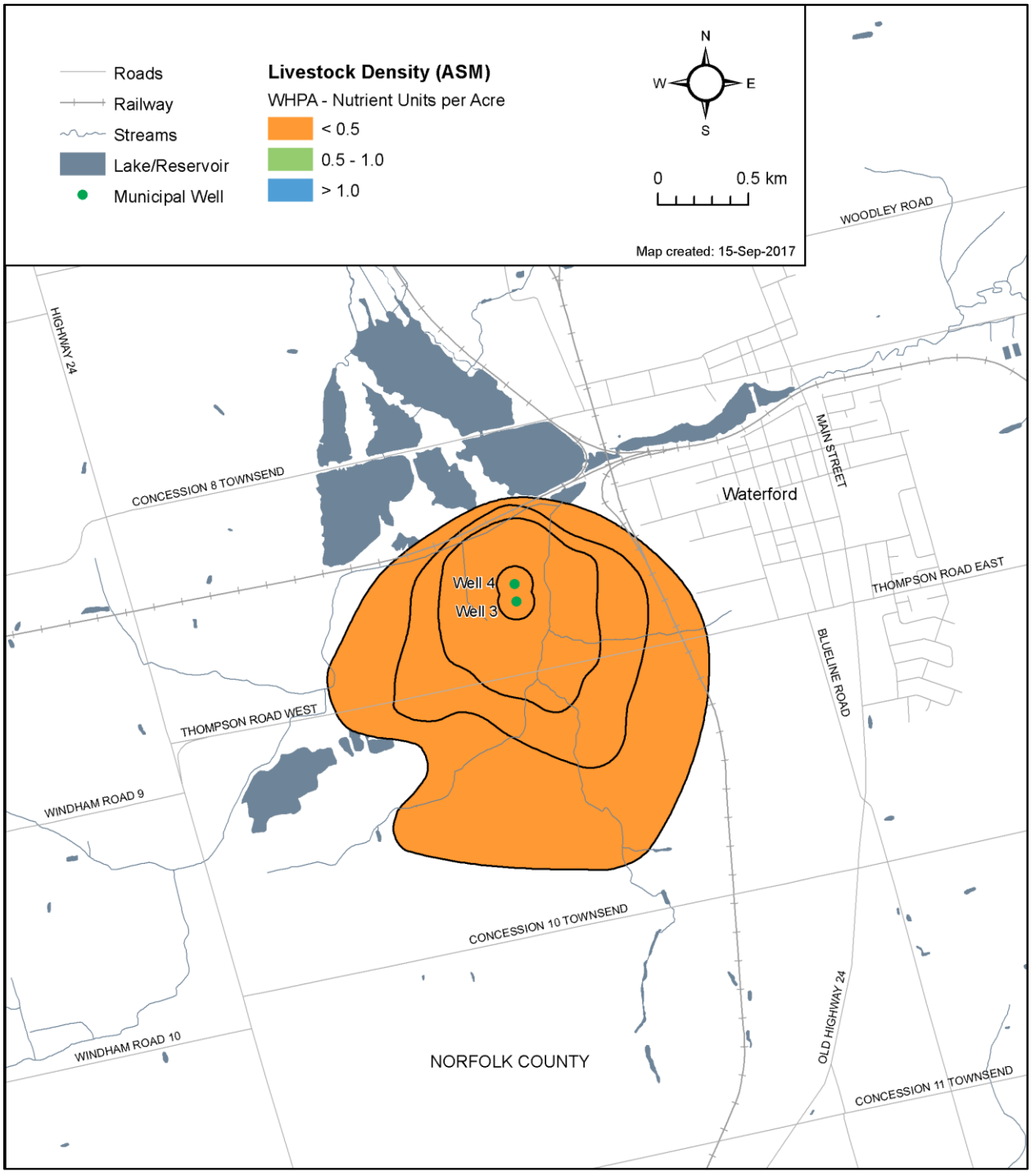
Map 5-27: Percent Managed Lands within the Waterford WHPA



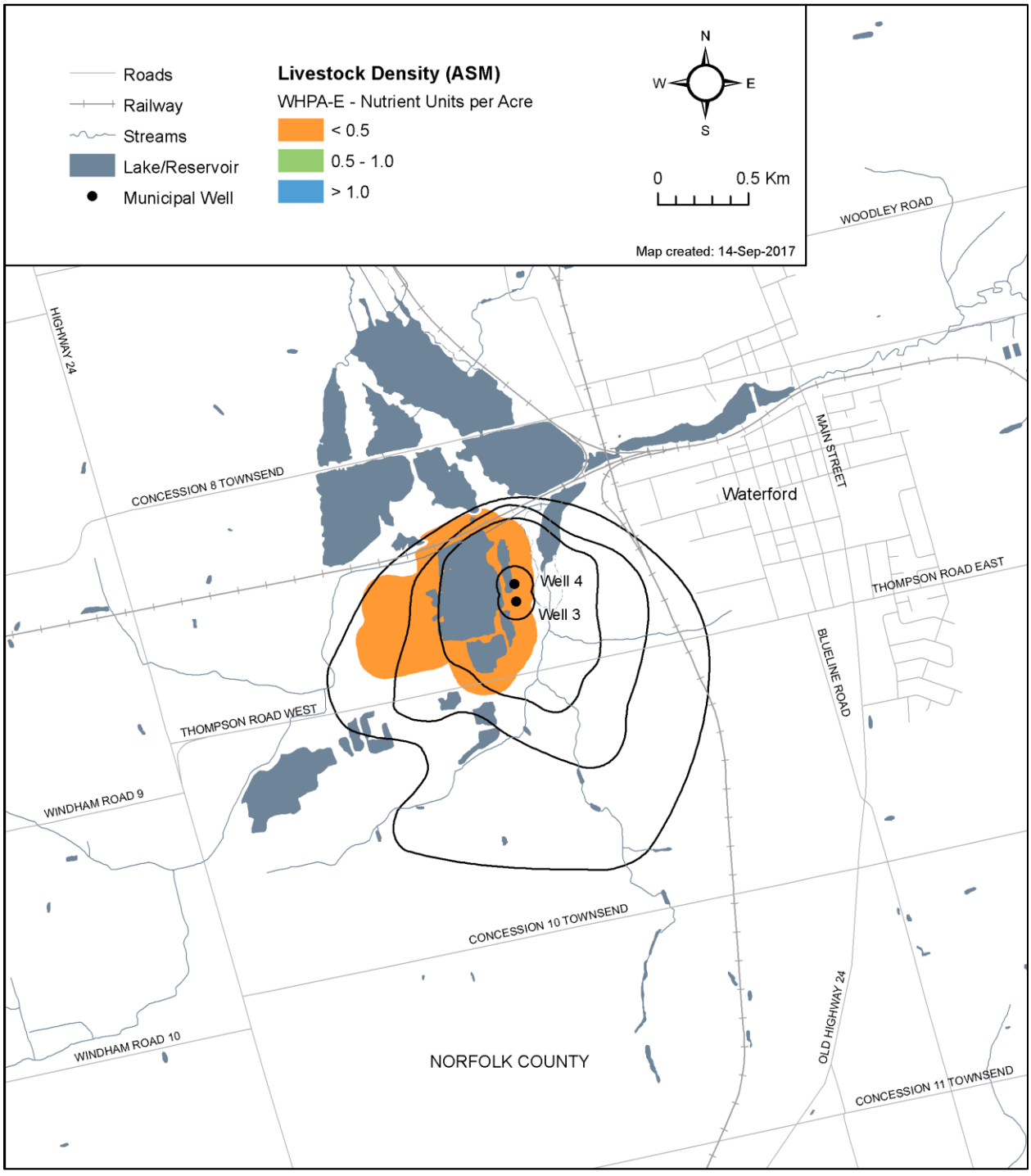
Map 5-28: Managed Lands within the Waterford WHPA E



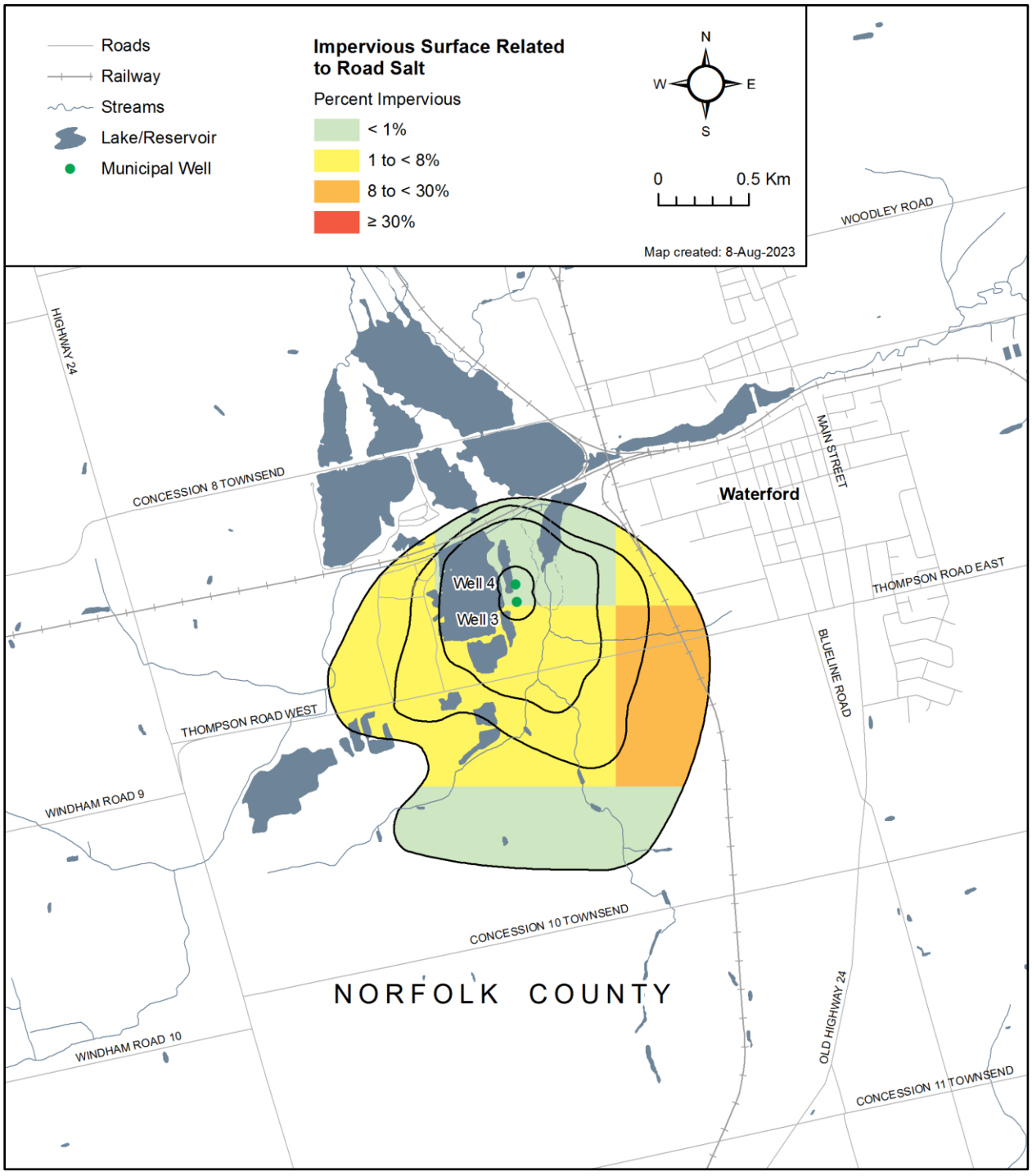
Map 5-29: Livestock Density within the Waterford WHPA



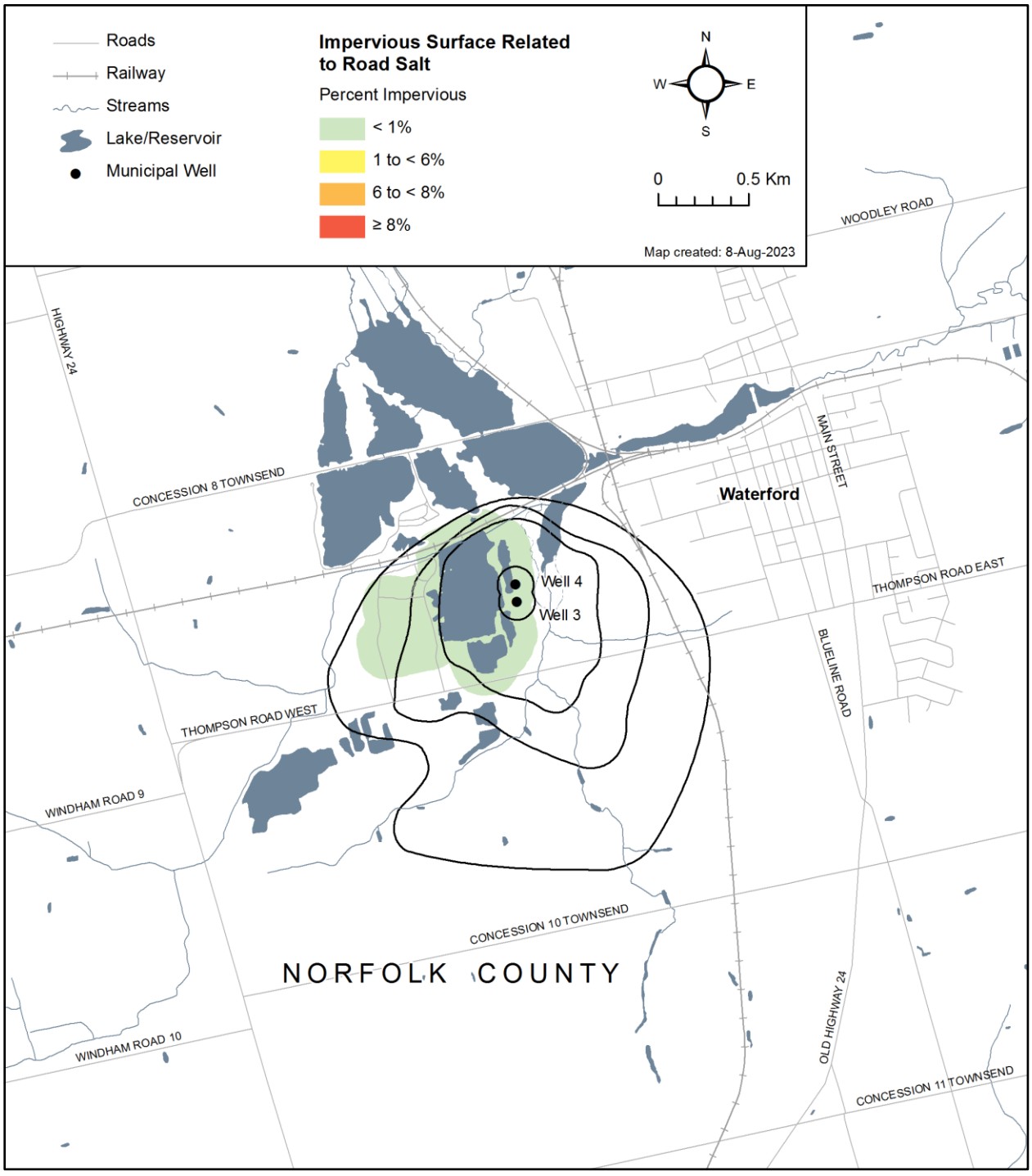
Map 5-30: Livestock Density within the Waterford WHPA E



Map 5-31: Impervious Surface within the Waterford WHPA



Map 5-32: Impervious Surface within the Waterford WHPA E



5.3.6 Waterford Water Quality Threats Assessment

The *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." Drinking water threats are described further in Chapter 3: Water Quality Risk Assessment.

Prescribed drinking water threats listed in Section 1.1 of O. Reg. 287/07 include Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogen threats. Chapter 3 provides a summary of the types of threats and their significance, based on vulnerable area and vulnerability score (as shown in the maps in this chapter).

~~**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 5-195-29: Identification of Drinking Water Quality Threats in the Waterford WHPAs**~~

~~**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 5-30** 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 previously 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. Since that time, threat assessments have relied on different sources of information. Threats are currently assessed through a combination of a desktop land use inventory, windshield surveys and local knowledge / field verification.

~~**Table 5-20: 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
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

Conditions Evaluation 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~~ Significant prescribed drinking water threats ~~were~~ identified in the Waterford WHPAs~~. These threats and their associated reference numbers~~ are listed in **Table 5-12**~~Table 5-31~~.

Table 5-12~~5-11~~5-31: Significant Drinking Water Quality Threats in Waterford WHPAs (current to January 2024)

~~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~~
~~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.*~~

Threat Subcategory[1]	Number of Activities	Vulnerable Area
2.2 Onsite sewage works	1	WHPA-B
3.1 Application of agricultural source material (ASM) to land	1	WHPA-B
6.1 Application of non-agricultural source material (NASM) to land	1	WHPA-B
8.1 Application of commercial fertilizer to land	2	WHPA-B
9.1 Handling and storage of commercial fertilizer	1	WHPA-B
10.1 Application of pesticide to land	2	WHPA-B
11.1 Handling and storage of a pesticide	1	WHPA-B
15.1 Handling and storage of fuel	1	WHPA-B
16.1 Handling and storage of a dense non-aqueous phase liquid (DNAPL)	2	WHPA-B

PDWT #[1]	Prescribed Drinking Water Threat[2]	Number of Activities	Vulnerable Area
17.1	Handling and storage of an organic solvent	1	WHPA-B
21.1	Agricultural source material (ASM) generation – livestock grazing or pasturing	1	WHPA-B
21.2	Agricultural source material (ASM) generation – outdoor confinement area (OCA) or farm animal yard	1	WHPA-B
Total Number of Activities		**15**	
Total Number of Properties		**4**	

[1] Threats enumerated according to the 2021 Technical Rules (MECP, 2021)

Note: Certain types of incidental activities on residential properties may constitute significant drinking water threats but are not enumerated. These threats include the application of commercial fertilizer and pesticides; the handling and storage of organic solvents and dense non-aqueous phase liquids; the storage of fuel (e.g., heating fuel tanks) in natural gas serviced areas; and the handling and storage of road salt that may be exposed or potentially exposed to precipitation or runoff. 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 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.

5.3.7 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 (WHPA-ICA/IPZ-ICA) and manage these threats appropriately. All threats related to a particular

Issue within the WHPA-ICA/IPZ-ICA are classified as significant drinking water threats, regardless of the vulnerability.

~~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 (WHPA-ICA) and manage these threats appropriately. If at this time the WHPA-ICAIssue 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 WHPA-ICAIssue 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.

The original evaluation of raw water quality for the Waterford system (SWS, 2010) examined data from 1999-2009 and relied largely on data from the Drinking Water Surveillance Program (DWSP) as well as from field data generated by the system's SCADA data collection equipment.

Subsequent water quality analysis for the Waterford system (Matrix, 2018c) examined data from 2010 to 2016. More recently, water quality has been examined up to 2023 using data from Annual Drinking Water System Reports provided by Norfolk County, supplemented by the DWSP where appropriate.

~~**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 coliforms 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 coliforms were detected once in 2010 at well 3 and once in 2012 in both wells 3 and 4.

Weekly raw water testing from 2017-2023 Annual Drinking Water System Reports indicates detections of E. coli and total coliforms in wells 3 and 4. The disinfection system provides appropriate treatment and therefore no Schedule 1 parameters were noted.

~~No Schedule 1 parameters were therefore noted.~~

Schedule 2 Parameters

~~Results from this data set indicated that samples~~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,~~ There have been 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 up to 2016 showed elevated nitrite levels in this wellfield, this occurrence was considered to be a single event and was not noted.

Inorganic and organic Schedule 2 parameters examined from 2017-2023 Annual Drinking Water System Reports indicate no ODWQS exceedances for the Waterford wellfield.

Schedule 3 Parameters

Few samples including radioactive parameters (gross alpha and gross beta) were available in the analysis of data up to 2009, 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. Raw water quality data available for wells 3 and 4 from the DWSP (2009-2020) similarly indicate no elevated values of gross alpha, gross beta or tritium.

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 O~~o~~perational G~~g~~uidelines with a concentration of 0.38 mg/L. No confirmatory samples were taken following this measured exceedance.

Elevated values, relative to the ODWQS, ~~in respect to the screening benchmark were frequently found for~~have been frequently observed for manganese and hardness. B~~In general,~~etween 1999-2009, manganese concentrations generally 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. From 2009-2018, raw water quality data from the DWSP indicates that concentrations of manganese continued to exceed the ODWQS Aesthetic Objective (0.05 mg/L) in both wells 3 and 4 (concentrations ranging between 0.23 to 0.45 mg/L). Note that drinking water at this system is treated for this parameter. Similarly, hardness at both wells continued to exceed the ODWQS Operational Guideline (80-100 mg/L) from 2009-2015 (values ranging between 197 to 248 mg/L). Hardness has a natural origin and does not pose a health threat.

From 1999-2009, c~~C~~onsistent exceedances of the ODWQS Aesthetic Objective (15°C) were also noted for temperature at well 4, while occasional exceedances were noted at well 3. Raw water temperature data available for 2009-2020 from the DWSP indicates occasional exceedances at both wells.

A~~A~~luminum concentrations were consistently lower than the ODWQS O~~o~~perational G~~g~~uidelines between 1999-2009 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~~. No aluminum exceedances have been noted in either well from 2009-2018 based on available DWSP data.

Sodium concentrations have~~were~~ occasionally approached~~ing~~ 20 mg/L, the point at which the local ~~a~~ M~~m~~edical O~~o~~fficer of Health should be ~~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~~. Annual Drinking Water System Reports indicate sodium concentrations of 16.9 mg/L and 17.4 mg/L in 2015 and 2020, respectively.

~~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

No ~~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 as per Technical Rule 114.

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 (MECP, 2021~~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 5-33**~~**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 5-34**) 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 5-13** outlines the data sources and purposes for which the data were used.

Table 5-135-125-32: 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 and Port Colborne	Development of hydrodynamic model to determine in-water extent of IPZ 2

Data Type	Source	Purpose
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
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 5-14** summarizes the vulnerability scores for the Port Dover WTP.

Table 5-145-135-33: Vulnerability Scoring for Port Dover WTP Intake

Intake	IPZ-1 Area Vulnerability Factor [10][1]	IPZ-2 Area Vulnerability Factor [7-9][1]	IPZ-3 Area Vulnerability Factor	Source Vulnerability Factor [0.5 – 0.7][1]	IPZ-1 Area Vulnerability Factor [5-7][1]	IPZ-2 Area Vulnerability Factor [3.5-6.3][1]	IPZ-3 Area Vulnerability Factor
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 (MECP, 2021~~MOE, 2009a~~)

5.4.6 Percent Managed Lands and Livestock Density within Intake Protection Zones

The percent managed lands in the IPZ 1 and IPZ 2 for Port Dover is shown in~~3.4% while the percent managed lands in IPZ-2 is 4.4% (see~~ **Map 5-35**~~)~~. There is no livestock in either IPZ-1 or IPZ-2 for Port Dover (see **Map 5-36**)

5.4.7 Percent Impervious Surfaces within the Intake Protection Zone

Map 5-37 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**.~~ A summary of the data inputs used in this analysis is given in **Table 5-15**.

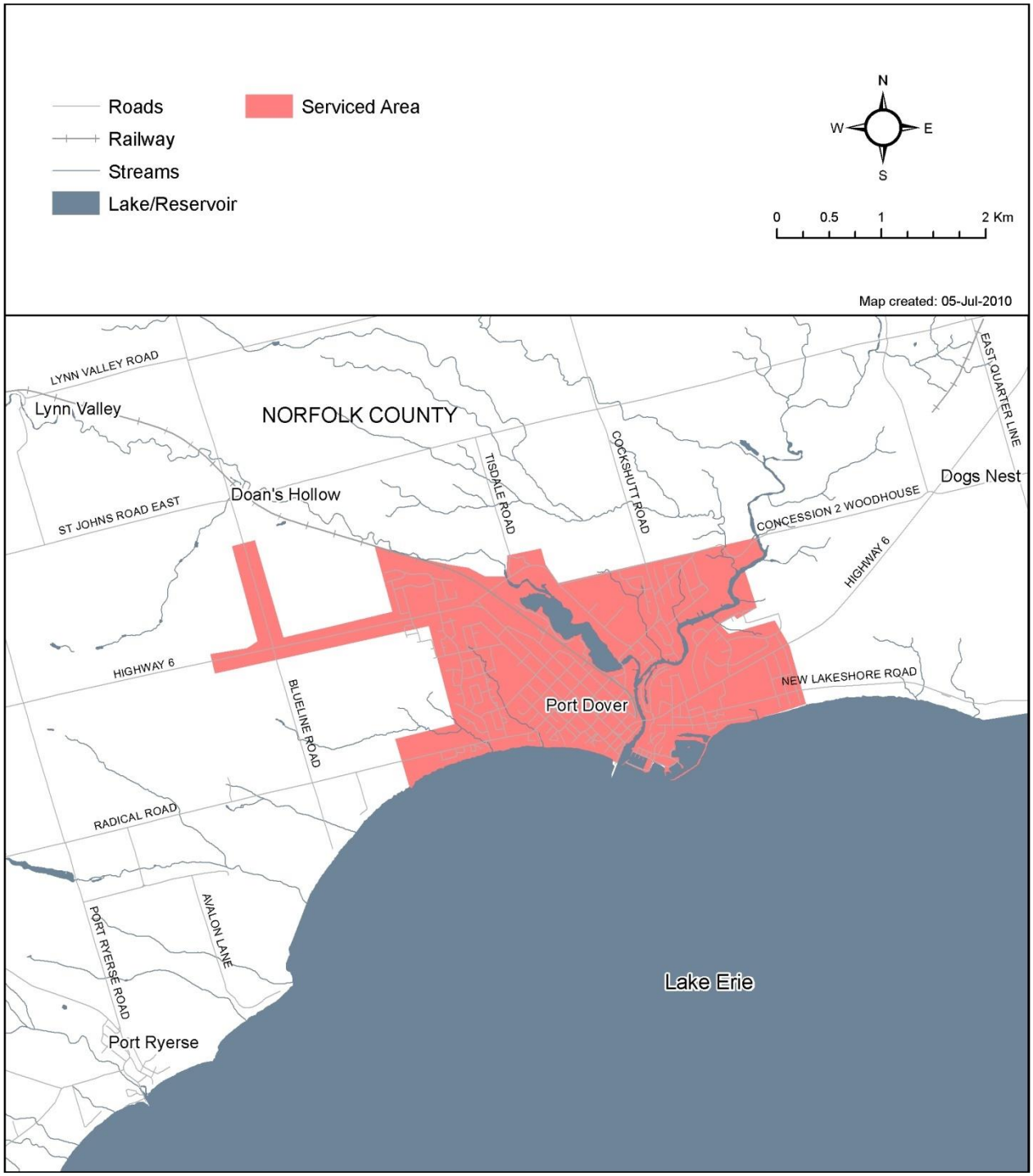
Known Limitations and Data Gaps

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.

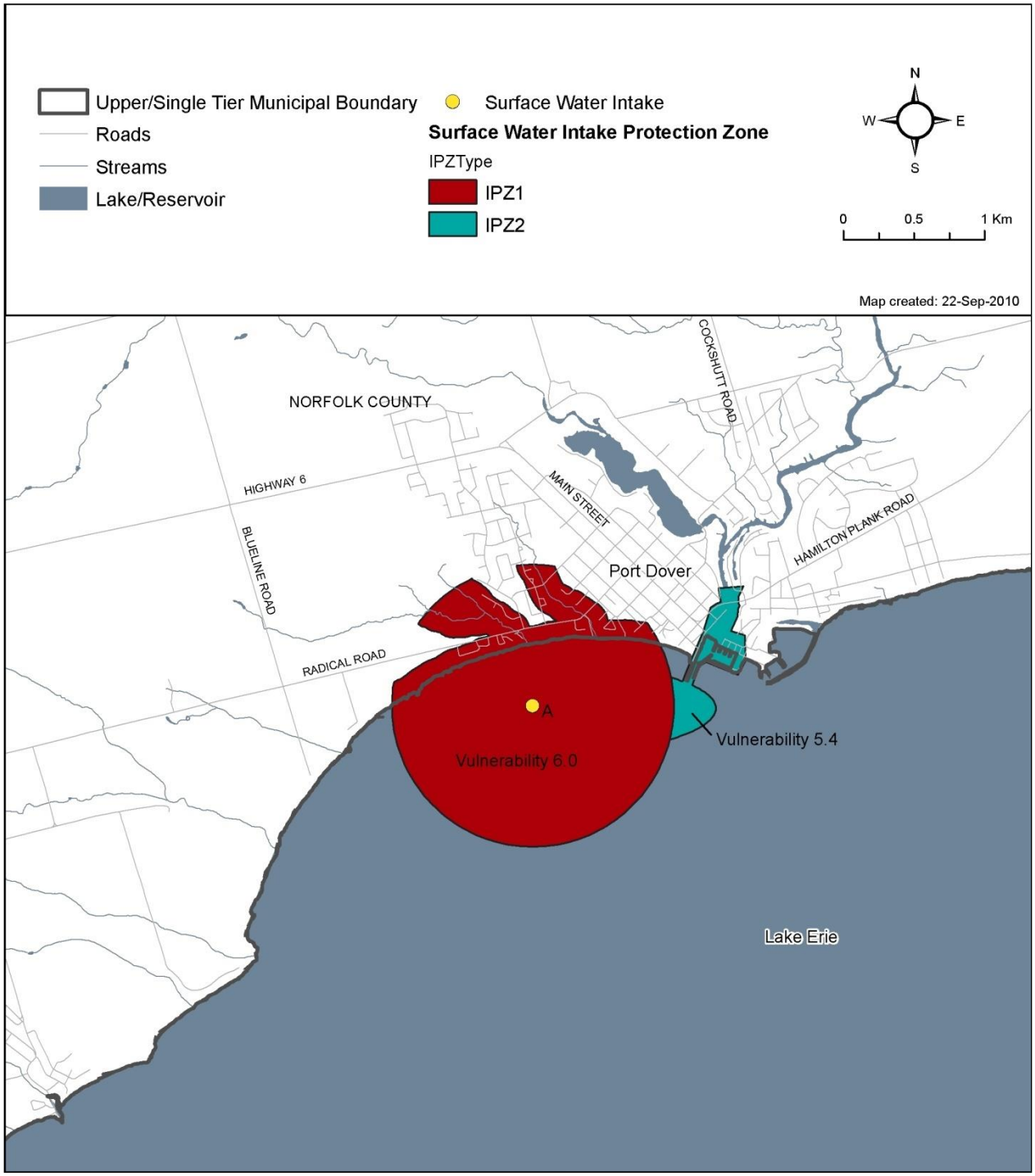
Table 5-15~~5-145-34~~: Input Data for Impervious Surfaces in Intake Protection Zones

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

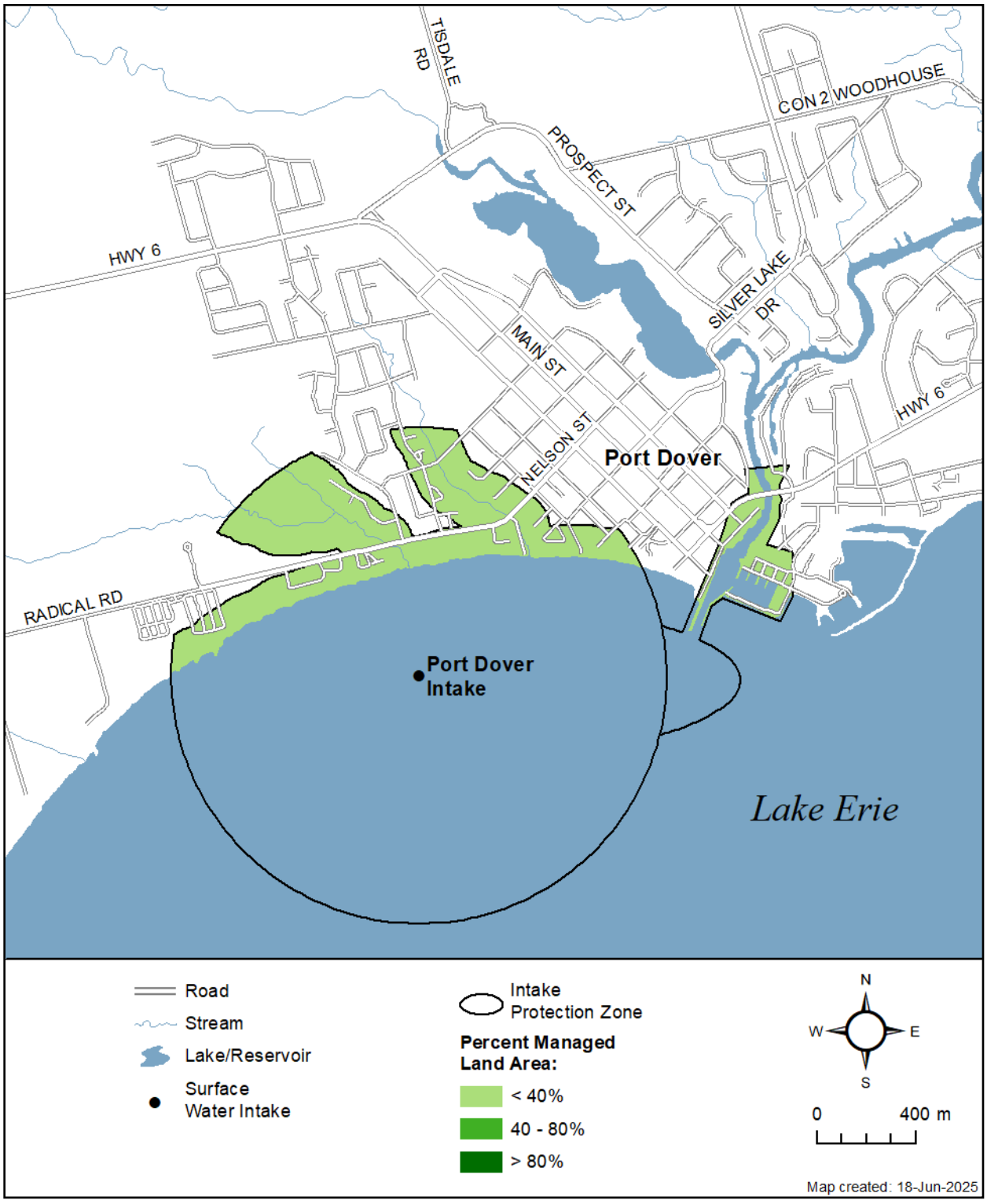
Map 5-33: Port Dover Service Area



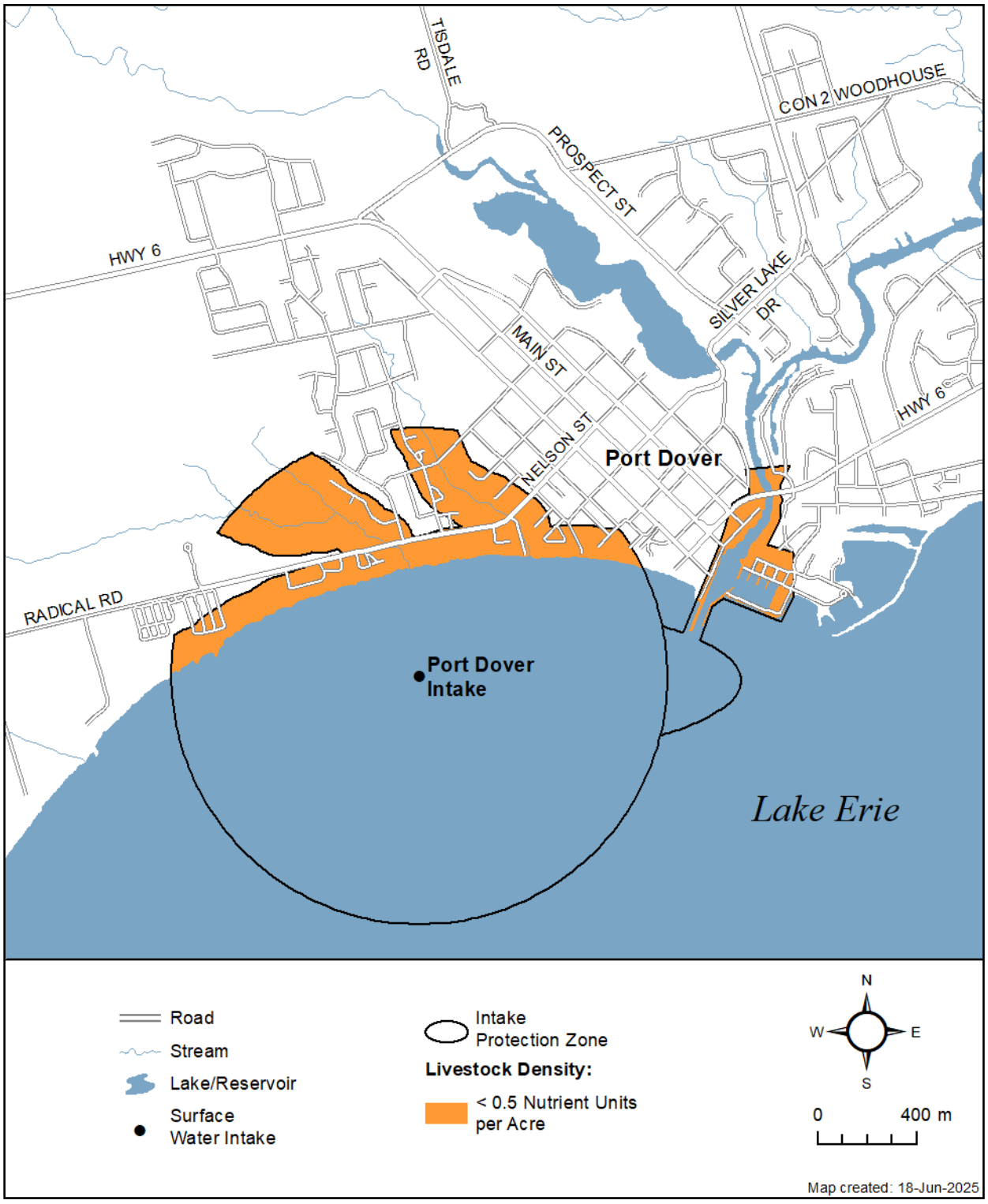
Map 5-34: Port Dover Intake Protection Zone



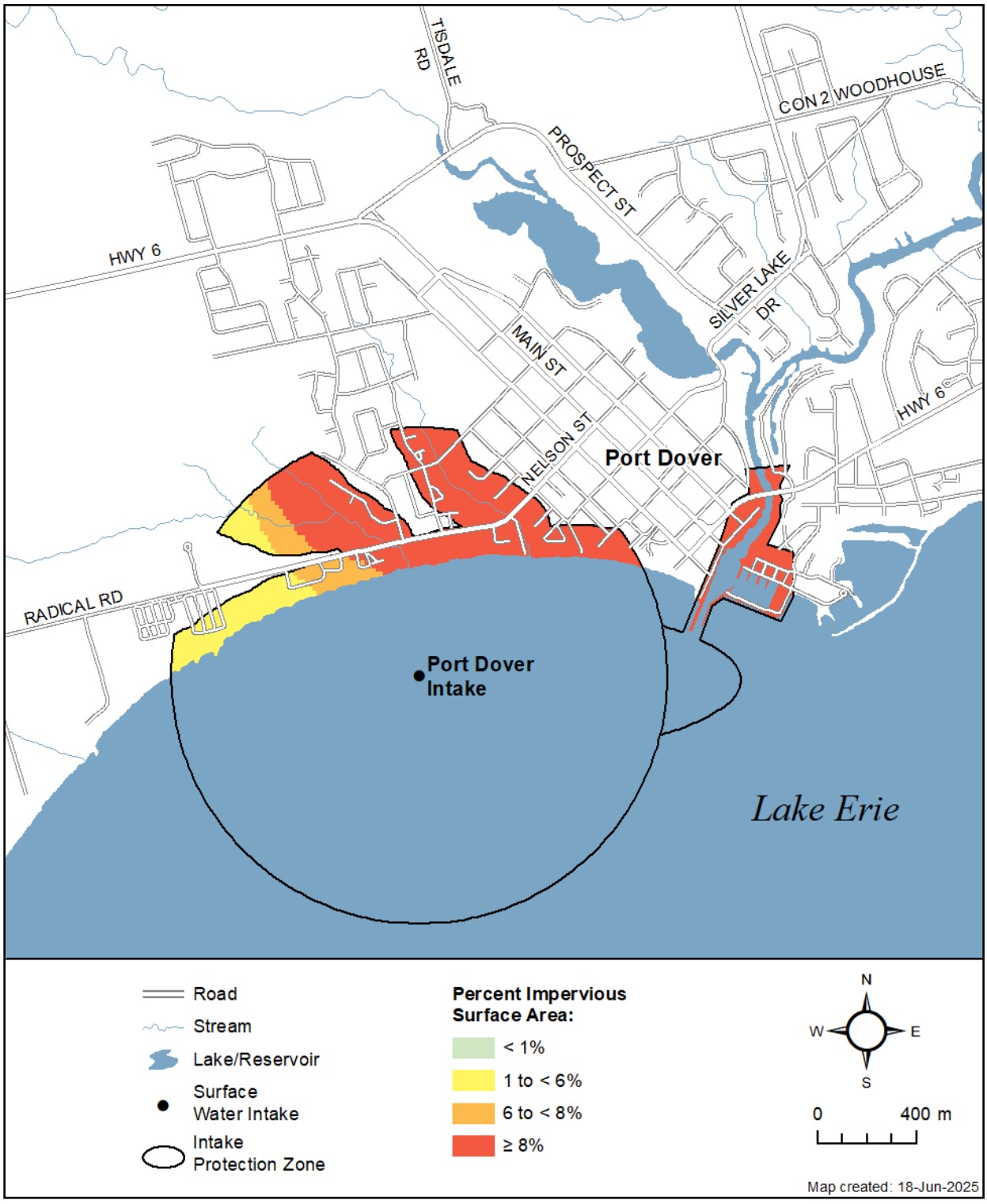
Map 5-35: Percent Managed Lands within the Port Dover Intake Protection Zone



Map 5-36: Livestock Density within the Port Dover Intake Protection Zone



Map 5-37: 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." Drinking water threats are described further in Chapter 3: Water Quality Risk Assessment.

Prescribed drinking water threats listed in Section 1.1 of O. Reg. 287/07 include Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogen threats. Chapter 3 provides a summary of the types of threats and their significance, based on vulnerable area and vulnerability score (as shown in the maps in this chapter).

~~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 for the original 2011 version of the assessment report. Since that time, threat assessments have relied on different sources of information. Threats are currently assessed through a combination of a desktop land use inventory, windshield surveys and local knowledge / field verification.

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 the www.sourcewater.caLake Erie Source Protection Region website. Information on drinking water threats is also accessible online through the Source Water Protection Threats Tool: http://swpip.caSource Water Protection Information Portal. 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.

Prescribed drinking water threats listed in Section 1.1 of O. Reg. 287/07 include Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogen threats. Chapter 3 provides a summary of the types of threats and their significance, based on vulnerable area and vulnerability score (as shown in the maps in this chapter).

Table 5-25Table 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 5-255-35: Identification of Drinking Water Threats in the Port Dover Intake Protection Zones

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~~5.4.10 Conditions Assessment

The potential presence of conditions associated with past activities was assessed based on local knowledge through discussions with Norfolk County municipal staff. MECP~~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~~5.4.11 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. 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

Subsequent review of DWSP raw water quality data between 2008-2020 indicates that all the above parameters, except Dissolved Organic Carbon, again exceeded the ODWQS in one or more samples.

Based on the preliminary assessment of DWSP data for Port Dover raw water, none of the human health-based ODWQS were exceeded. All parameters noted above relate to either Operational Gguidelines or Aesthetic Objectives. ~~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 prior to 2008 exceeded the organic nitrogen O~~o~~perational G~~g~~uideline (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 concentrations and the continued elevated concentrations beyond 2008, 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 I~~i~~ssue under Technical Rule 114.

Annual Drinking Water System Reports from Norfolk County were used to further examine water quality data from 2008-2023. These reports indicate detections of E. coli and total coliforms in raw water; however, these microbiological parameters have not been identified as Issues under Technical Rule 114 given the presence of adequate water treatment. No inorganic or organic parameters were reported to be in exceedance of the ODWQS in treated water.

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 ODWQS.

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 (MECP, 2021~~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 5-38**~~**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 5-39**)**.** 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 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.

5.5.4 Information Sources for Vulnerability Assessment

The most up-to-date information was used for determining the area and source vulnerability scores. **Table 5-16** outlines the data sources and purposes for which the data were used.

Table 5-165-155-36: 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

Data Type	Source	Purpose
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
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

5.5.5 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 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 5-17** summarizes the vulnerability for the Port Rowan WTP.

Table 5-175-165-37: Vulnerability Scoring for the Port Rowan WTP Intakes

Intake	IPZ-1 Area Vulnerability Factor [10][1]	IPZ-2 Area Vulnerability Factor [7-9][1]	IPZ-3 Area Vulnerability Factor	Source Vulnerability Factor [0.5 – 0.7][1]	IPZ-1 Vulnerability Score [5-7][1]	IPZ-2 Vulnerability Score [3.5-6.3][1]	IPZ-3 Vulnerability Score
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 (MECP, 2021MOE, 2009)

5.5.6 Managed Lands and Livestock Density within Intake Protection Zones

The percent managed lands in the IPZ 1 for Port Rowan is 4.3% (seeis shown in **Map 5-40**.) while Tthere is no livestock in the IPZ (see **Map 5-41**).

5.5.7 Percent Impervious Surfaces within the Intake Protection Zone

Map 5-42 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**. A summary of the data inputs used in this analysis is given in **Table 5-18**.

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 5-185-175-38: Input Data for Impervious Surfaces in Intake Protection Zones

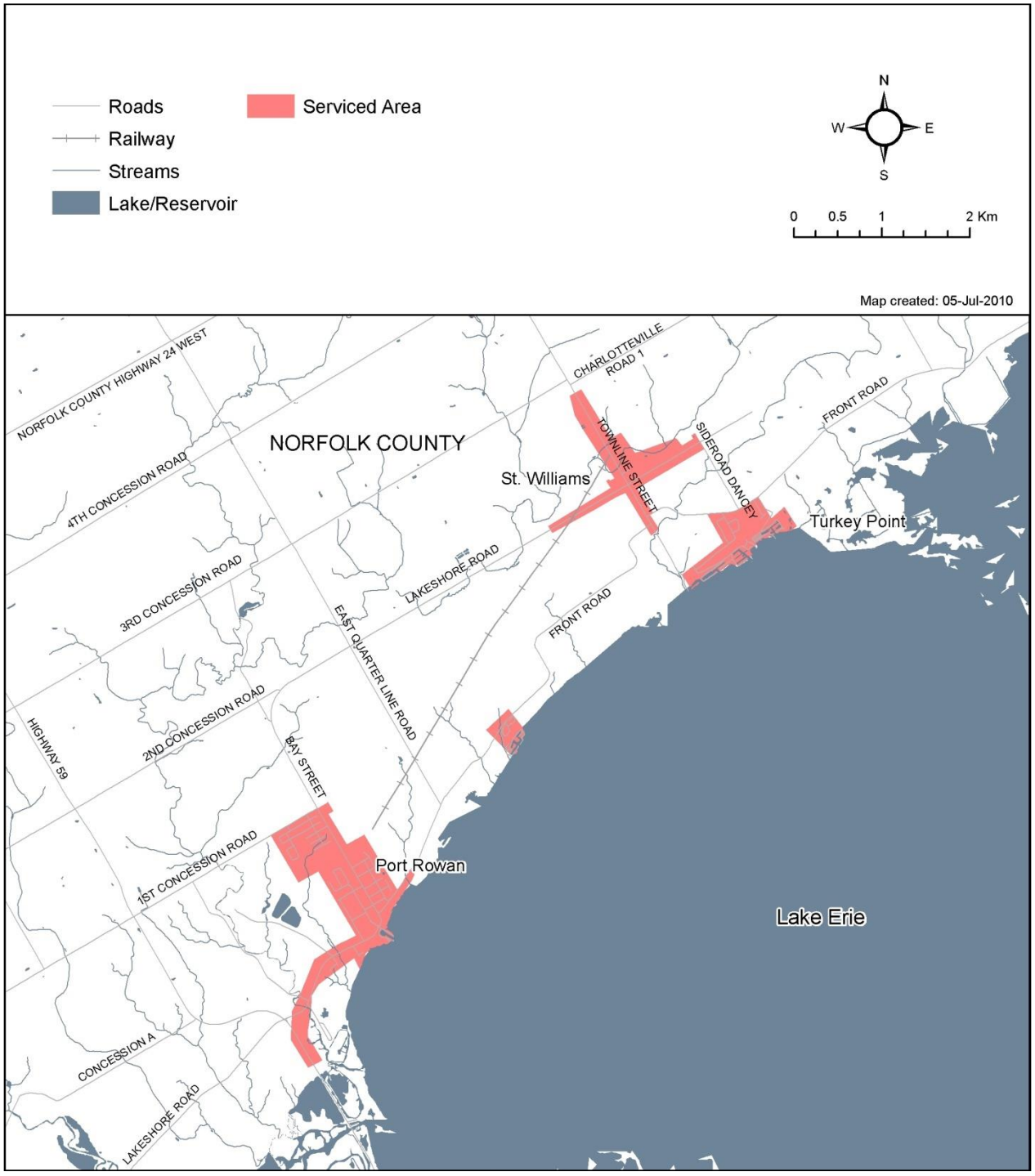
Data Input	Description	Source	Purpose
Road areas (raster)	Road and highway transportation routes as represented by the Southern Ontario Land Resource Information System (SOLRIS) version 1.2 May 2008, 15 metre raster cell format	Sub-license from Ontario Ministry of Natural Resources and Forestry (MNRF)	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

5.5.8 Uncertainty and Limitations of Data and Methods

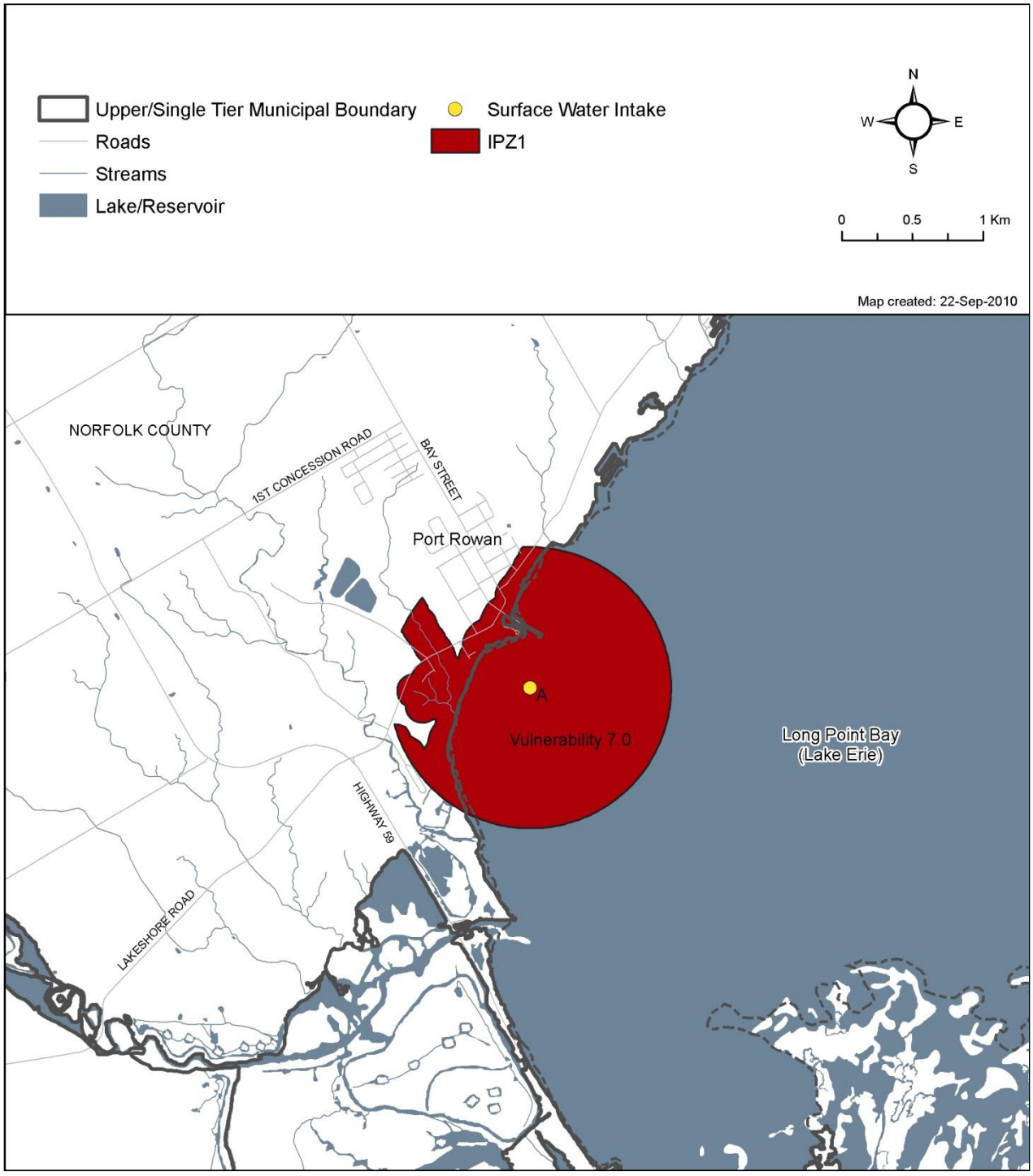
There was a high level of confidence in the datasets used to delineate the IPZ-1; therefore, a low level of uncertainty was assigned, and no limitations were identified.

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 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.

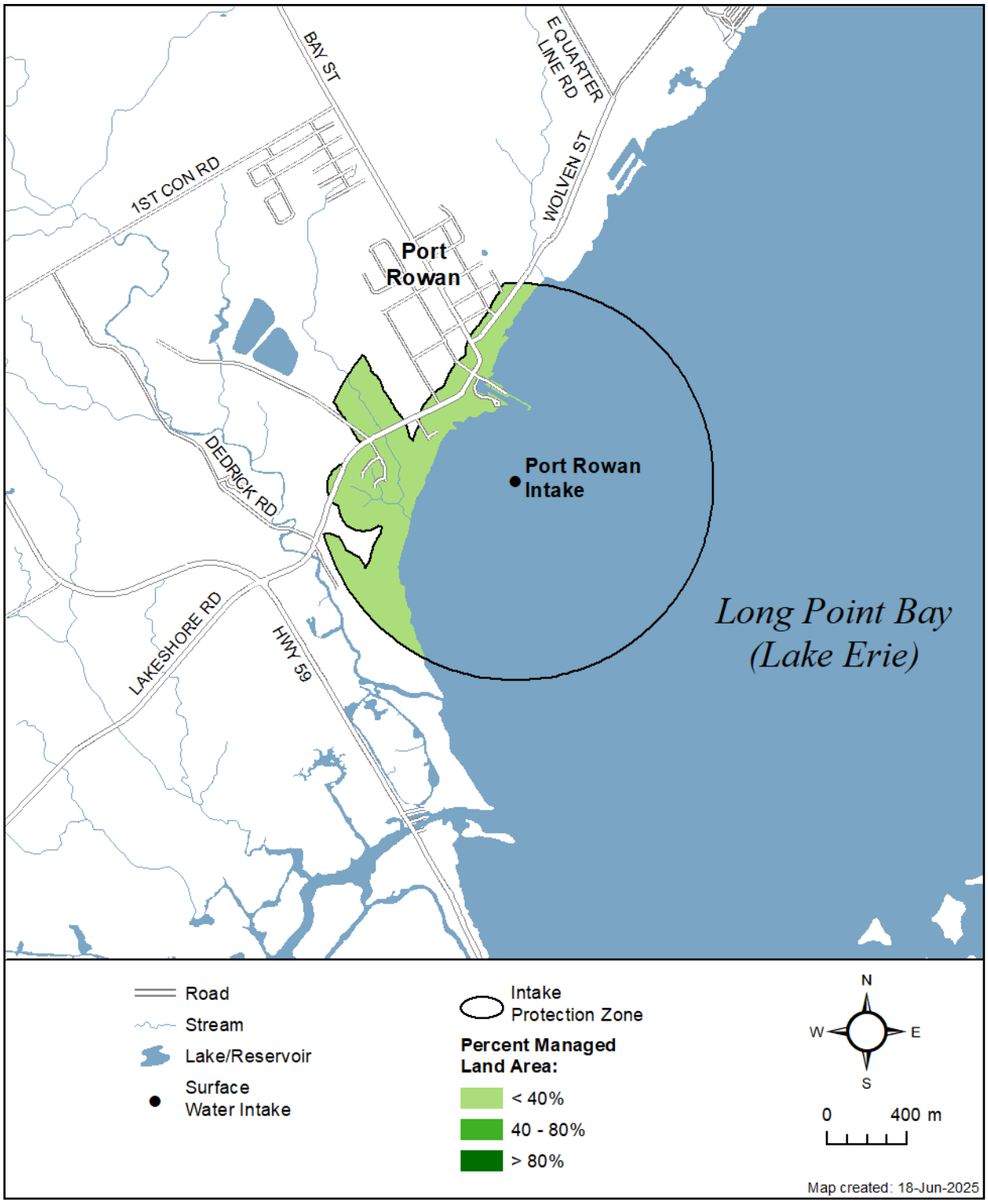
Map 5-38: Port Rowan Service Area



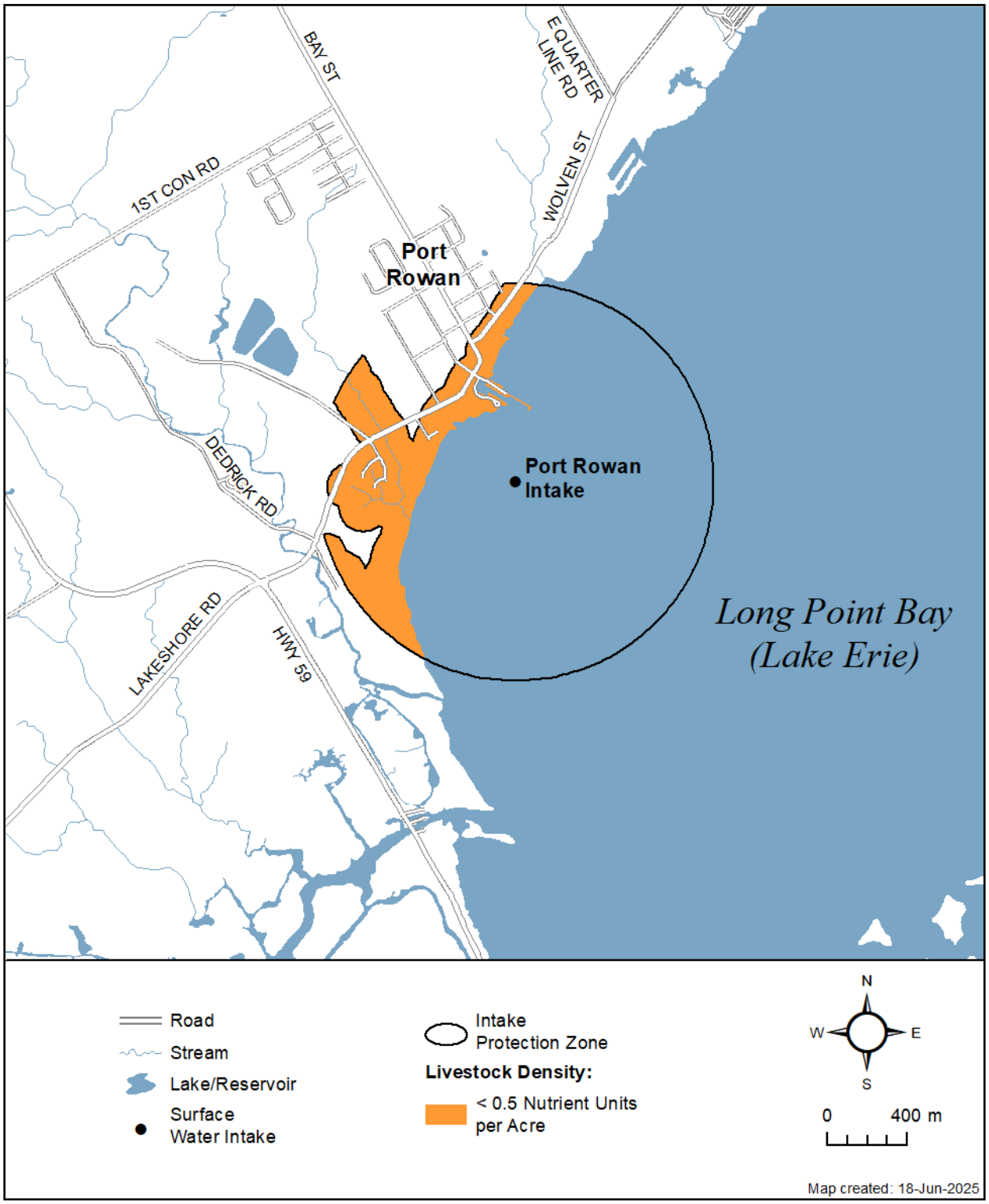
Map 5-39: Port Rowan WTP Surface Water Intake Protection Zone



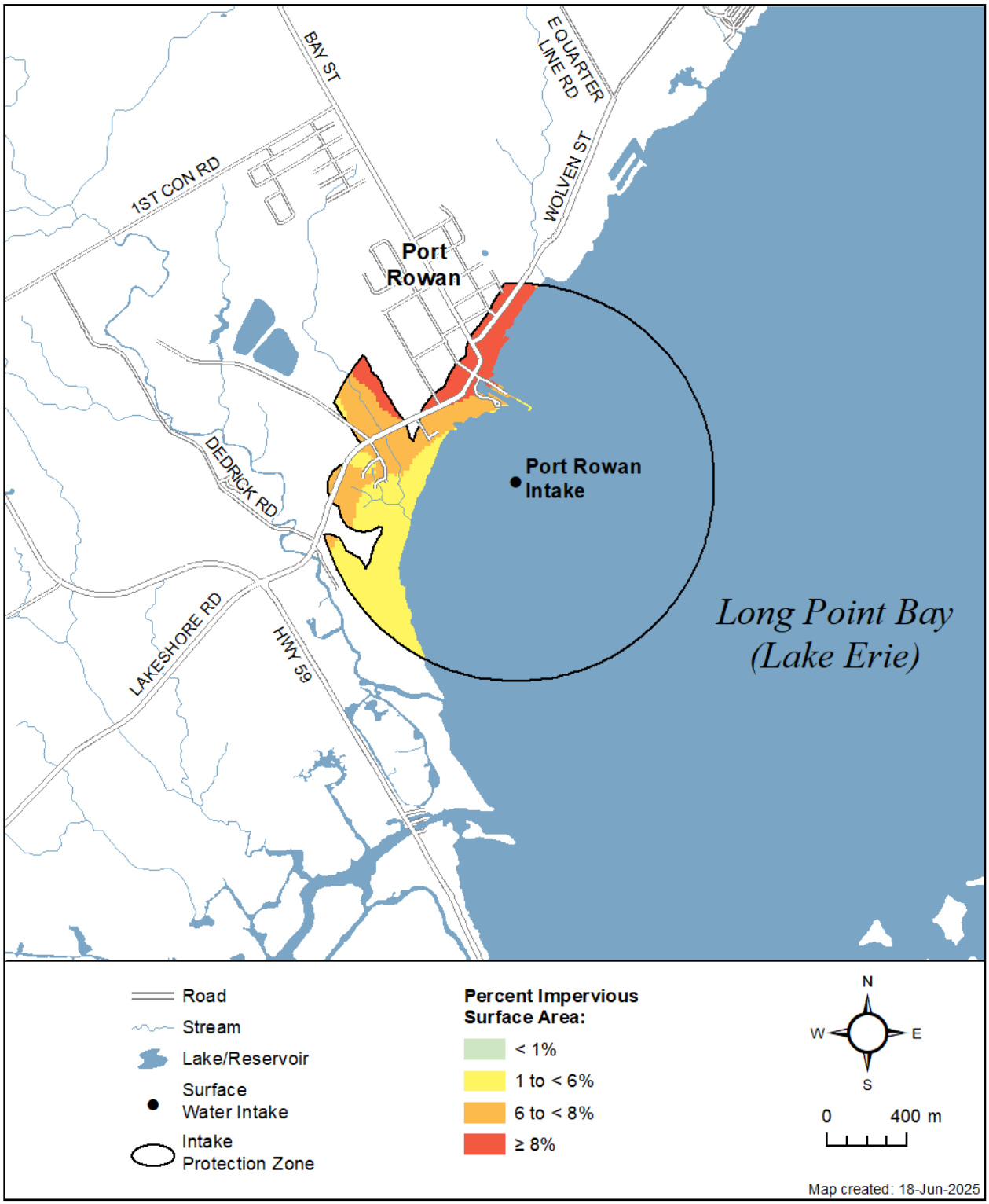
Map 5-40: Percent Managed Lands within the Port Rowan Intake Protection Zone



Map 5-41: Livestock Density within the Port Rowan Intake Protection Zone



Map 5-42: Impervious Surfaces within the Port Rowan Intake Protection Zone



5.5.9 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." Drinking water threats are described further in Chapter 3: Water Quality Risk Assessment.

Prescribed drinking water threats listed in Section 1.1 of O. Reg. 287/07 include Chemical, Dense Non-Aqueous Phase Liquid (DNAPL), and Pathogen threats. Chapter 3 provides a summary of the types of threats and their significance, based on vulnerable area and vulnerability score (as shown in the maps in this chapter).

~~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 for the original 2011 version of the assessment report. Since that time, threat assessments have relied on different sources of information. Threats are currently assessed through a combination of a desktop land use inventory, windshield surveys and local knowledge / field verification.

~~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 the . Information on~~

~~drinking water threats is also accessible online through the Source Water Protection Threats Tool: . 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 5-29****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 5-295-39: Identification of Drinking Water Threats in the Port Rowan Intake Protection Zone**~~

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

~~5.5.10 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.~~

~~5.5.11~~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.

~~5.5.12~~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 by-product 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 (expressed as a running annual average of quarterly results). From 2008-2023, Annual Drinking Water System Reports indicate annual average THM concentrations above the half MAC in 2008-2019, 2022, and 2023, with annual average THM concentrations exceeding the MAC in 2010 and 2011.

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

Subsequent review of DWSP raw water quality data between 2008-2020 indicates that all the above parameters again exceeded the ODWQS in one or more samples. Metals sampling from 2022 to 2024 (data provided by Norfolk County) agree with these findings and highlight raw water iron concentrations exceeding the ODWQS as well in more than one sample.

Based on the preliminary assessment of DWSP data for Port Rowan's raw water, none of the human health-based ODWQS were exceeded. All parameters noted above relate to either Operational Guidelines or Aesthetic Objectives. ~~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 t~~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 O~~o~~perational G~~g~~uideline (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 concentrations and the continued elevated concentrations beyond 2008, additional monitoring of the raw water is recommended before it can be decided whether organic nitrogen should be identified as an I~~i~~ssue under Technical Rule 114.

2008-2023 Annual Drinking Water System Reports indicate detections of E. coli and total coliforms in raw water; however, these microbiological parameters have not been

identified as Issues under Technical Rule 114 given the presence of adequate water treatment. Except for THMs, as noted above, no inorganic or organic parameters were reported to be in exceedance of the ODWQS in treated water.

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 ODWQS.