Grand River Source Protection Area

ASSESSMENT REPORT

Chapter 8: Region of Waterloo

July 29, 2025

CHAPTER 8: REGION OF WATERLOO SECTIONS

Chapter 8 of the Assessment Report, including each municipal well system for the Region of Waterloo, is separated into eight section documents as follows:

CURRENT DOCUMENT:

- **Section 8.3** – Kitchener Area Wellfields (Mannheim (East, West, ASR and Peaking), Greenbrook, Strange Street, Parkway, Strasburg, Pompeii, Woolner and Wilmot Centre)
- **Section 8.4** – Hidden Valley Intake

REMAINING DOCUMENTS:

- **Section 8.1** – Water Quality Risk Assessment
- **Section 8.2** – Waterloo Area Wellfields (Erb Street, William Street, and Waterloo North wells)
- **Section 8.5** – Cambridge Area Wellfields (Hespeler, Pinebush, Blair Road, Clemens Mill, Elgin Street, Middleton Street, Shades Mills, Fountain Street, and Willard)
- **Section 8.6** – Rural Area Wellfields (Ayr, Branchton Meadows, Elmira, Foxboro Green, Heidelberg, Linwood, Maryhill, New Dundee, New Hamburg, Roseville, St. Clements, Wellesley)
- **Section 8.7** – Limitations, Data Gaps and Uncertainty
- **Section 8.8** – Summary

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8.0 REGION OF WATERLOO

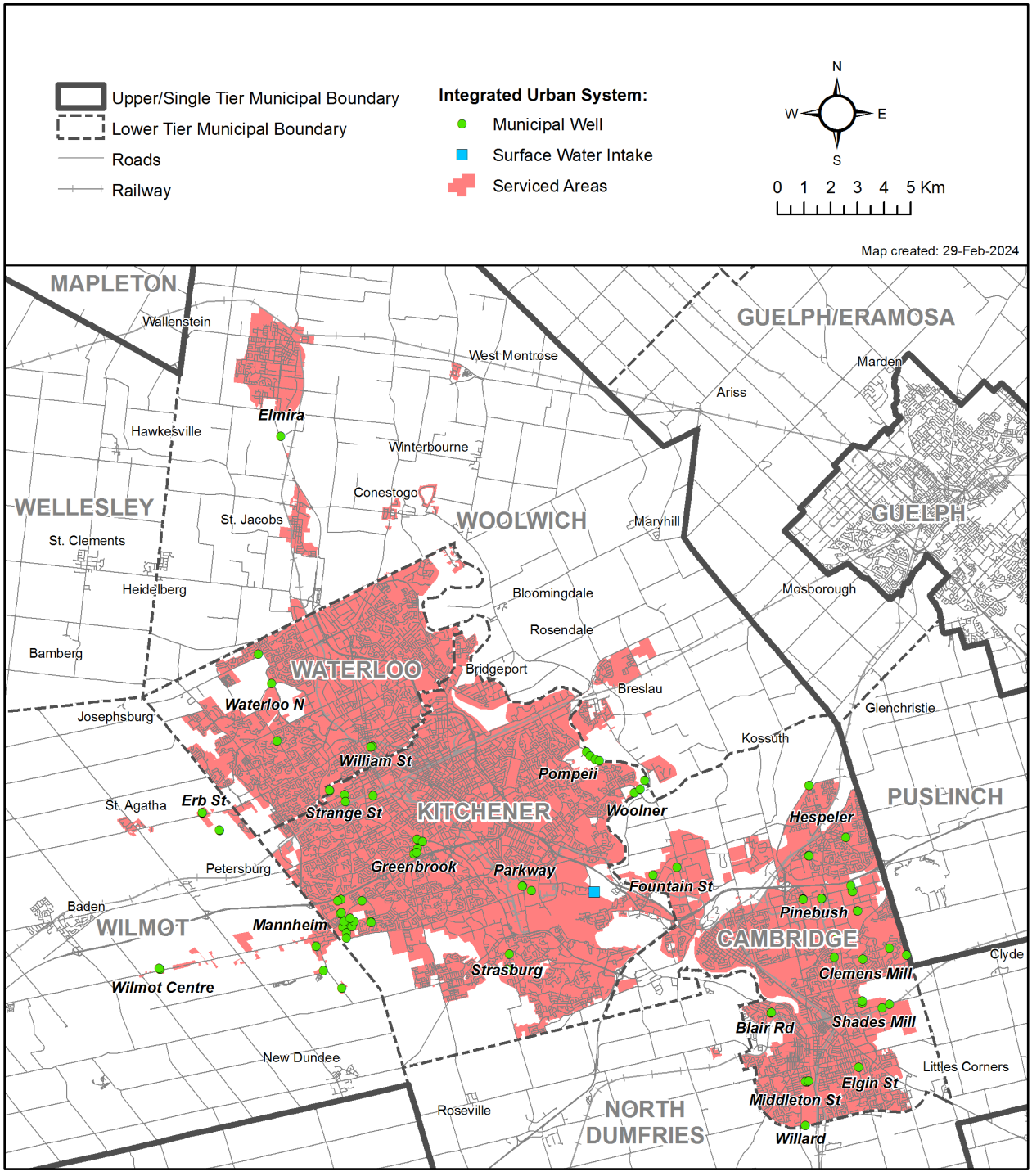
8.3 Kitchener Area Wellfields

The Kitchener Area Wellfields: Mannheim (East, West and Peaking), Greenbrook, Strange Street, Parkway, Strasburg, Pompeii, and Woolner; are described in further detail in the following subsections.

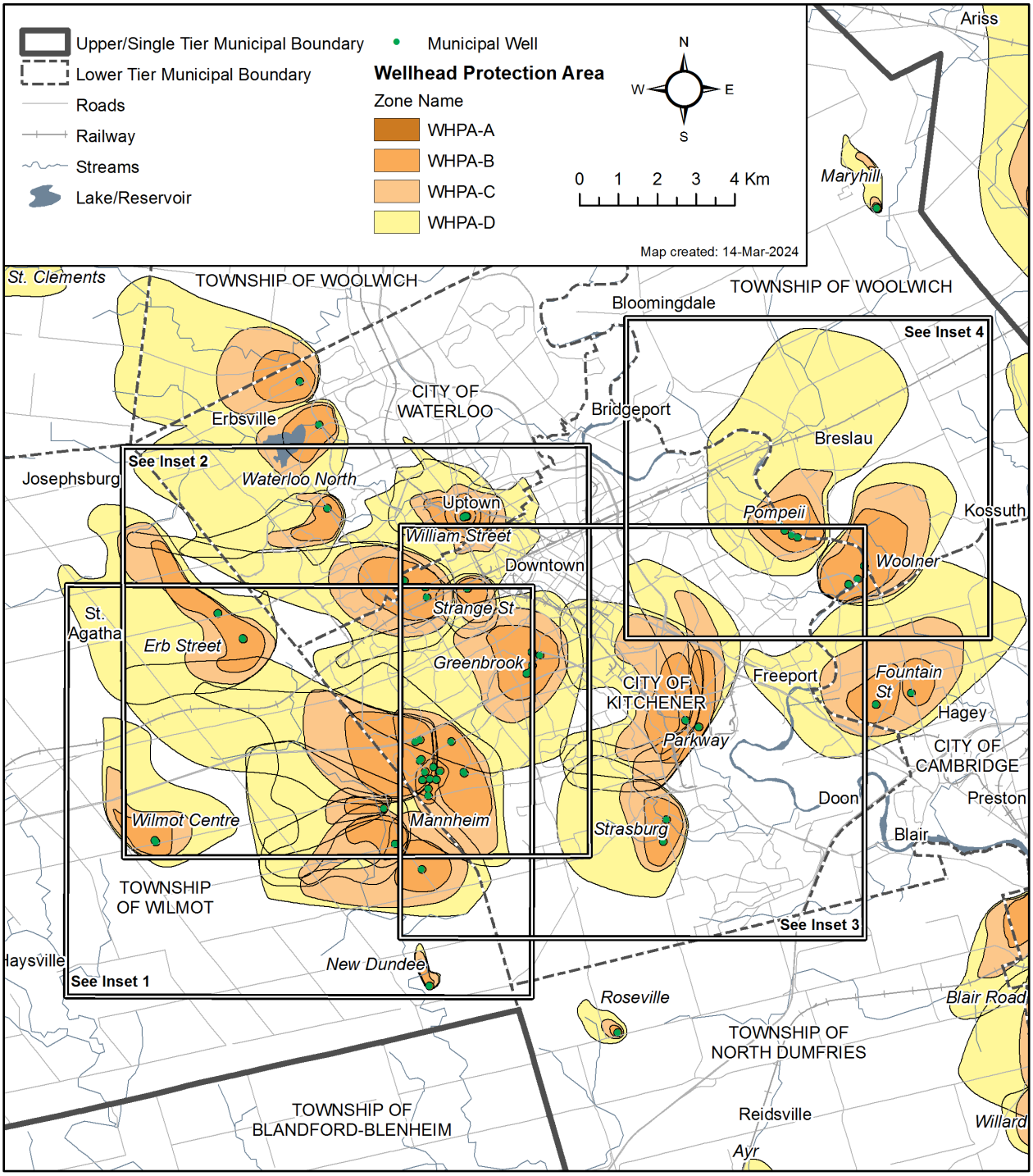
An overview of the serviced areas for both the Waterloo, Kitchener and Cambridge area wellfields (as part of the IUS) is provided in **Map 8.3—37.**

An overview of the wellhead protection areas for the Kitchener area wellfields is provided in **Map 8.3—38**.

Map 8.3—1: Integrated Urban System Serviced Areas



Map 8.3—2: Kitchener Area Well Supplies Wellhead Protection Areas Overview



8.3.1 Mannheim Wellfield (East, West, Peaking and ASR)

Water supply for the Mannheim Wellfield is obtained from the following wellfields:

- Mannheim East – Wells K21/K21A, K25 and K29 screened from 30 to 52 m BGS in AFB2;
- Mannheim Peaking – Wells K91, K92, K93, and K94 screened from 54 to 75 m BGS in AFB2;
- Mannheim West – Wells K23, K24 and K26 screened from 20 to 38 m BGS in AFB2;
- Aquifer Storage and Recovery (ASR) wells – Wells ASR1, ASR2, ASR3,ASR4, and ASR5 (previously RCW1) screened from 52 to 80 m BGS in AFB2; and,
- ASR Recovery Wells – Wells RCW2, RCW3, and RCW4 screened from 62 to 73 m BGS in AFB2.

At Mannheim East, K25 typically provides the most water followed by K29 and K21/K21A. The Peaking wells historically were primarily used in the summer months to meet peak water demands with either one of K91/K92 and K93/K94 pumping at any given time. The ASR wells were designed to inject treated water from the Grand River into the Middle Waterloo Moraine Sands (AFB2) during periods of low demand and then pump it out again when the water is needed, similar to the peaking wells. On average, more water is injected than is recovered. The ASR wells are capable of both pumping and injection whereas the RCW wells are only capable of pumping. The Mannheim wells contribute water to the IUS (**Table 8—1**).

The Mannheim wells are all constructed within the Middle Waterloo Moraine Sands (AFB2) and most have screens installed near the bottom of the aquifer, just above the Lower Maryhill Till (ATB3). AFB2 is overlain by the discontinuous, fine-grained, aquitard ATB2 throughout the Mannheim area. ATB2 is overlain by AFB1 **(Table 8.1—6)**, which outcrops in various locations throughout Mannheim. It is of note that AFB1 and AFB2 are hydraulically connected in the vicinity of the Mannheim West Wellfield and modeled particle pathlines during the capture zone assessment indicated particles extended predominantly through both aquifers (Matrix, 2017b). This was the rationale for applying AFB1 as the aquifer for intrinsic vulnerability mapping (**Table 8.1—6**).

Vulnerability and Transport Pathways

Map 8.3—39 presents the Mannheim Wellhead Protection Areas. The unadjusted intrinsic vulnerability is shown on **Map 8.3—40** and **Map 8.3—41** the adjusted intrinsic vulnerability is shown on **Map 8.3—42 and Map 8.3—43. Map 8.3—44** and **Map 8.3—45** show these transport pathways and area of influence for the Wellhead Protection Areas. **Map 8.3—46** shows the final vulnerability scoring for the Mannheim WHPA-A to D zones. Well K23 in the Mannheim West Wellfield is designated as *GUDI with effective filtration* and as such a WHPA-E capture zone has been delineated for this well **(Map 8.3—47).**

WHPAs for the ASR and RCW wells cannot be delineated in the usual way since the ASR system is water-balance neutral – i.e. the amount of water that is injected is generally removed within the same year or shortly thereafter. Accordingly, the WHPAs

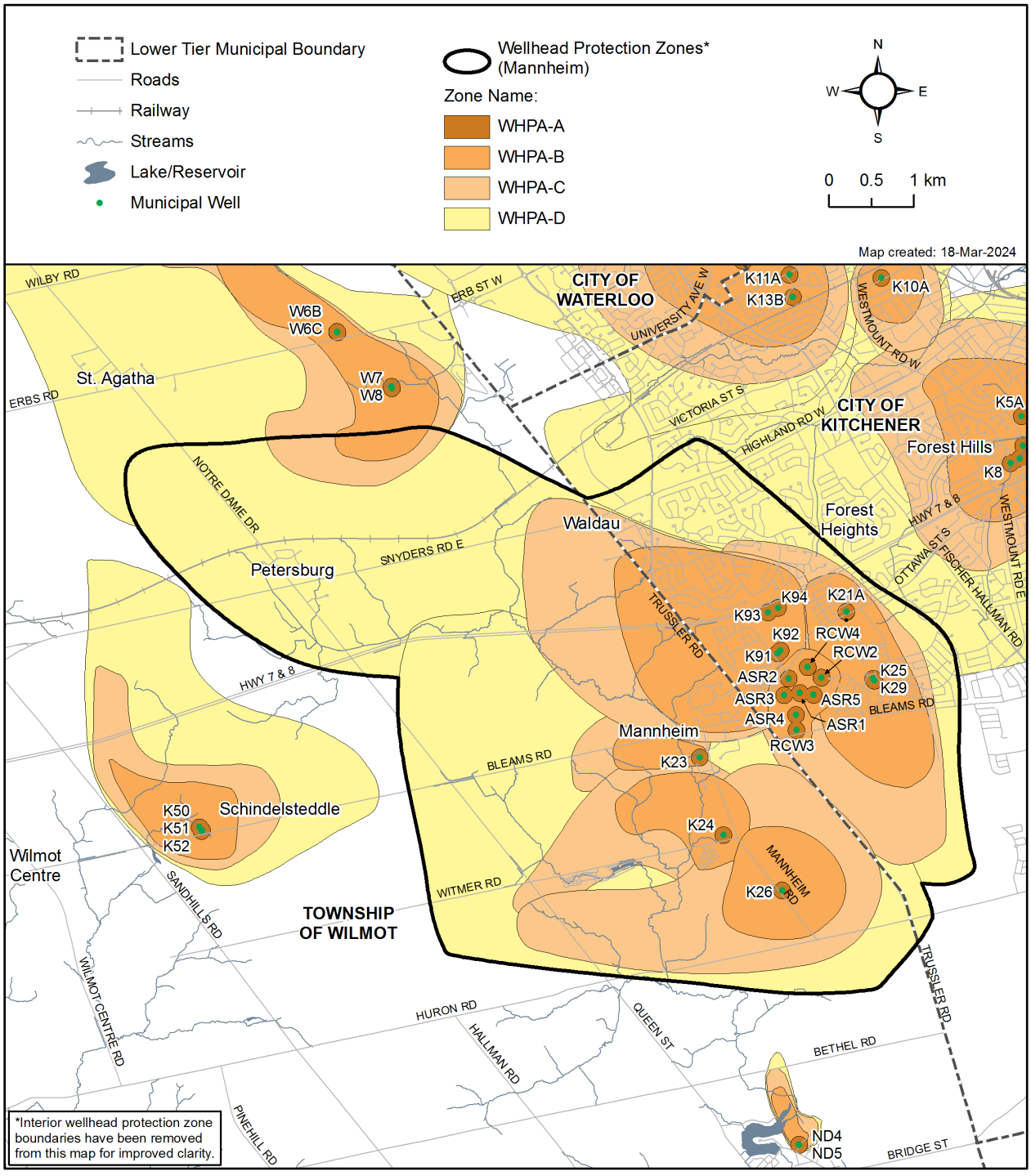
were developed based on a two-year transient simulation consisting of a progression of injection, followed by a pause and then recovery, which is considered to be maximum two-year time of travel. Only WHPA-A and WHPA-B areas were delineated for these wells.

Analysis of the attributes of each potential transport pathway found in the Mannheim WHPA identified an aggregate operation within the WHPA-C and D of wells K25 and K26 and clusters of wells, septics and underground services throughout the WHPA which warranted ISI increases.

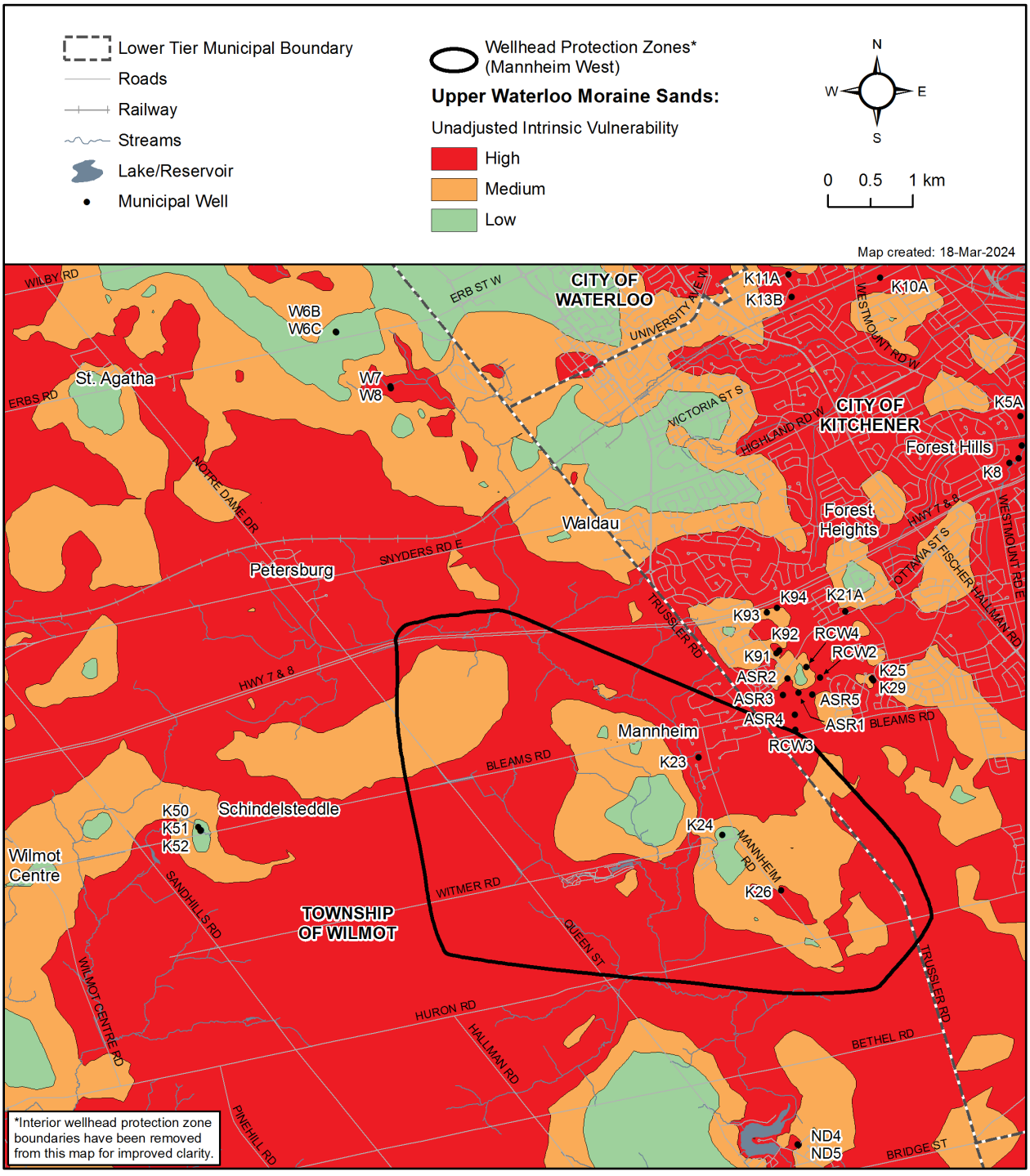
Percent Managed Land, Livestock Density and Salt Loading Potential

The calculations for determining the percent managed land, livestock density, salt loading potential and the corresponding percent impervious surfaces followed the methods outlined in **Section 8.1 Water Quality Risk Assessment. Map 8.3—48, Map 8.3—49, and Map 8.3—50** show the percent managed lands, livestock density, and percent impervious surfaces, respectively, for the Mannheim WHPA-A to D zones. **Map 8.3—49** only shows the livestock density for areas that have a vulnerability score that is greater than 4. **Map 8.3—51, Map 8.3—52, and Map 8.3—53** show the percent managed lands, livestock density, and percent impervious surfaces, respectively, for the Mannheim West WHPA-E.

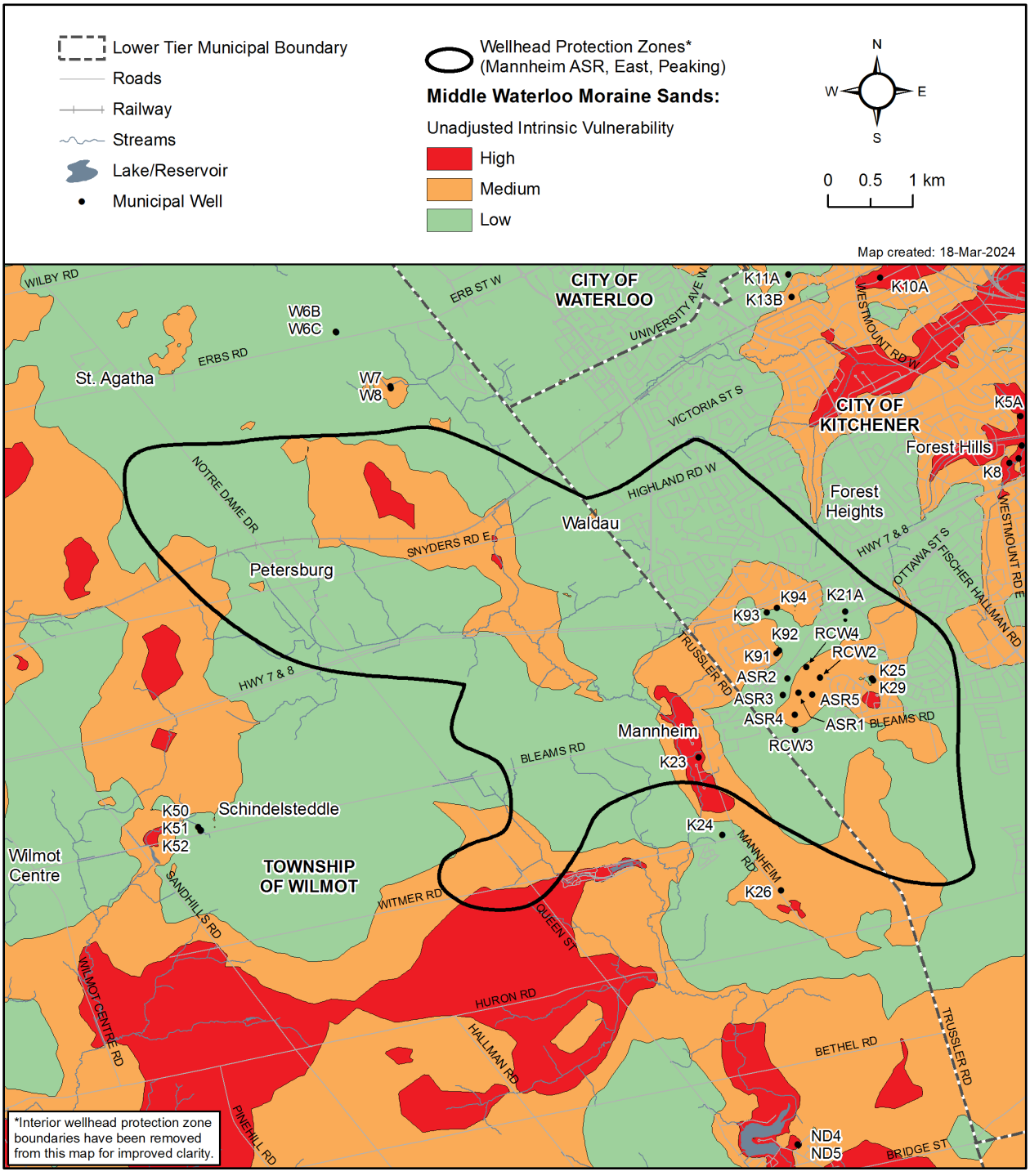
Map 8.3—3: Kitchener Area Inset 1: Mannheim (K21A, K23-26, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply



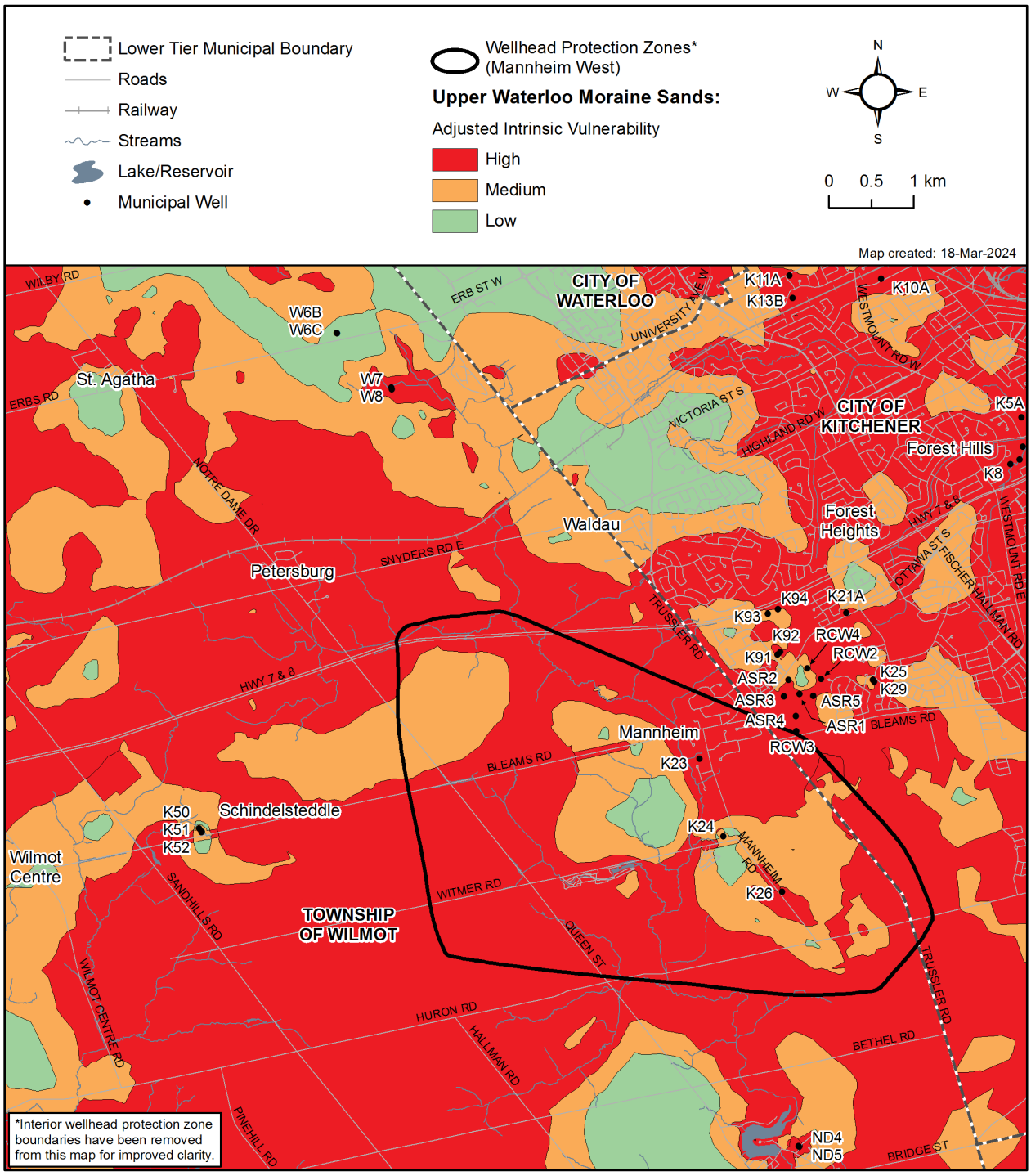
Map 8.3—4: Kitchener Area Inset 1: Mannheim (K23-26), Well Supply Wellhead Protection Area Unadjusted Intrinsic Vulnerability



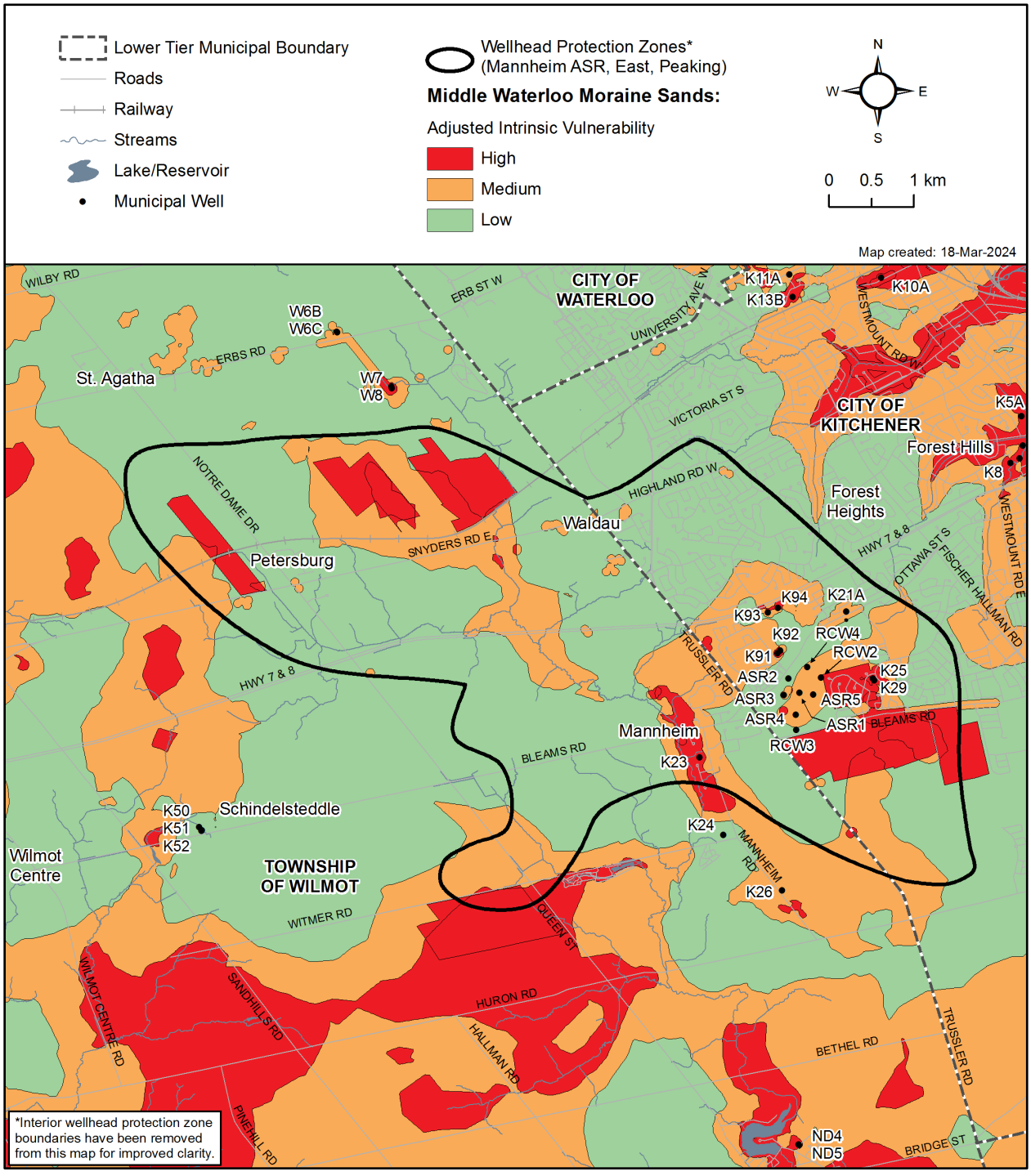
Map 8.3—5: Kitchener Area Inset 2: Mannheim (K21/K21A, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Wellhead Protection Area Unadjusted Intrinsic Vulnerability



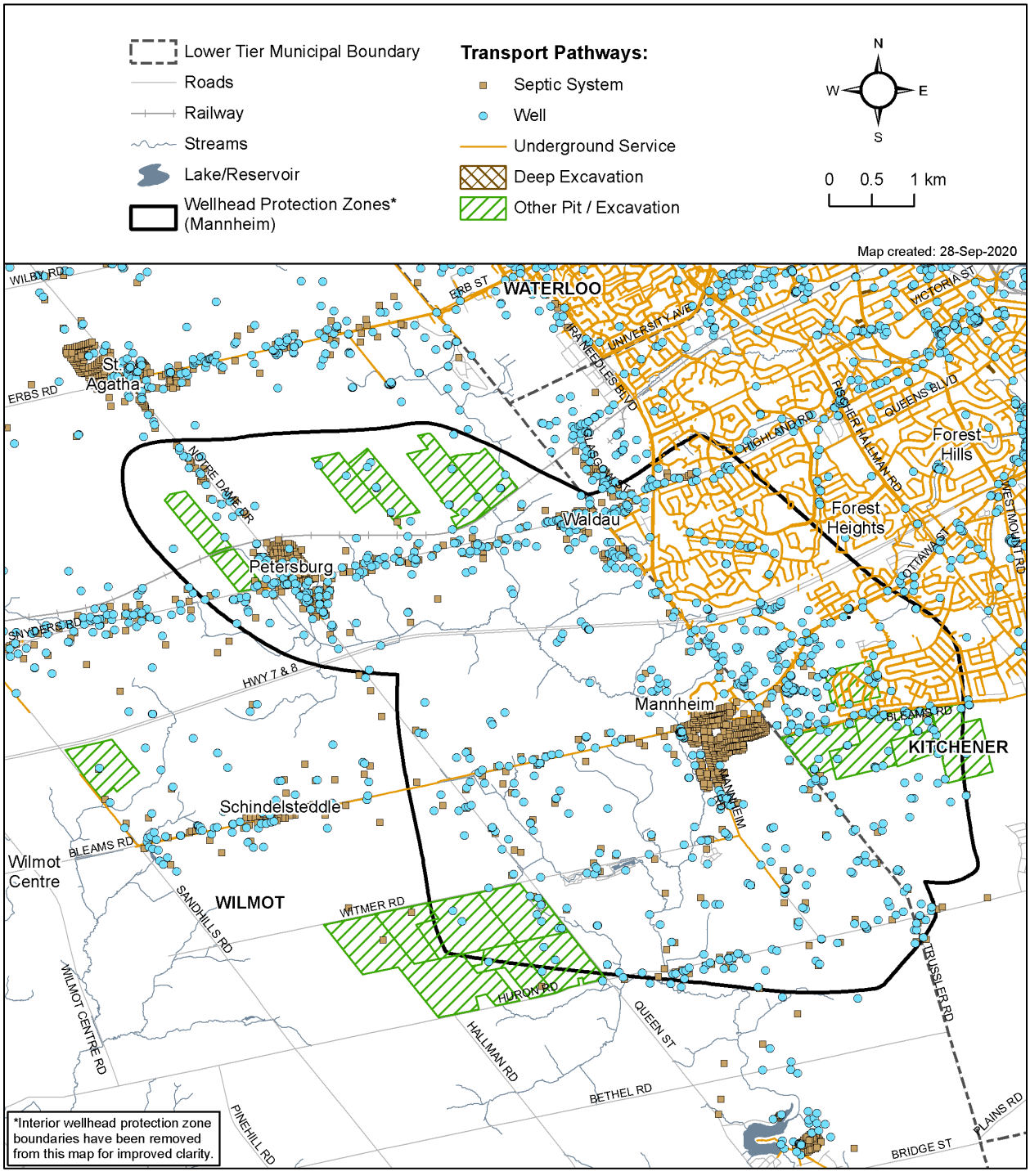
Map 8.3—6: Kitchener Area Inset 1: Mannheim (K23-26) Well Supply Wellhead Protection Area Adjusted Intrinsic Vulnerability



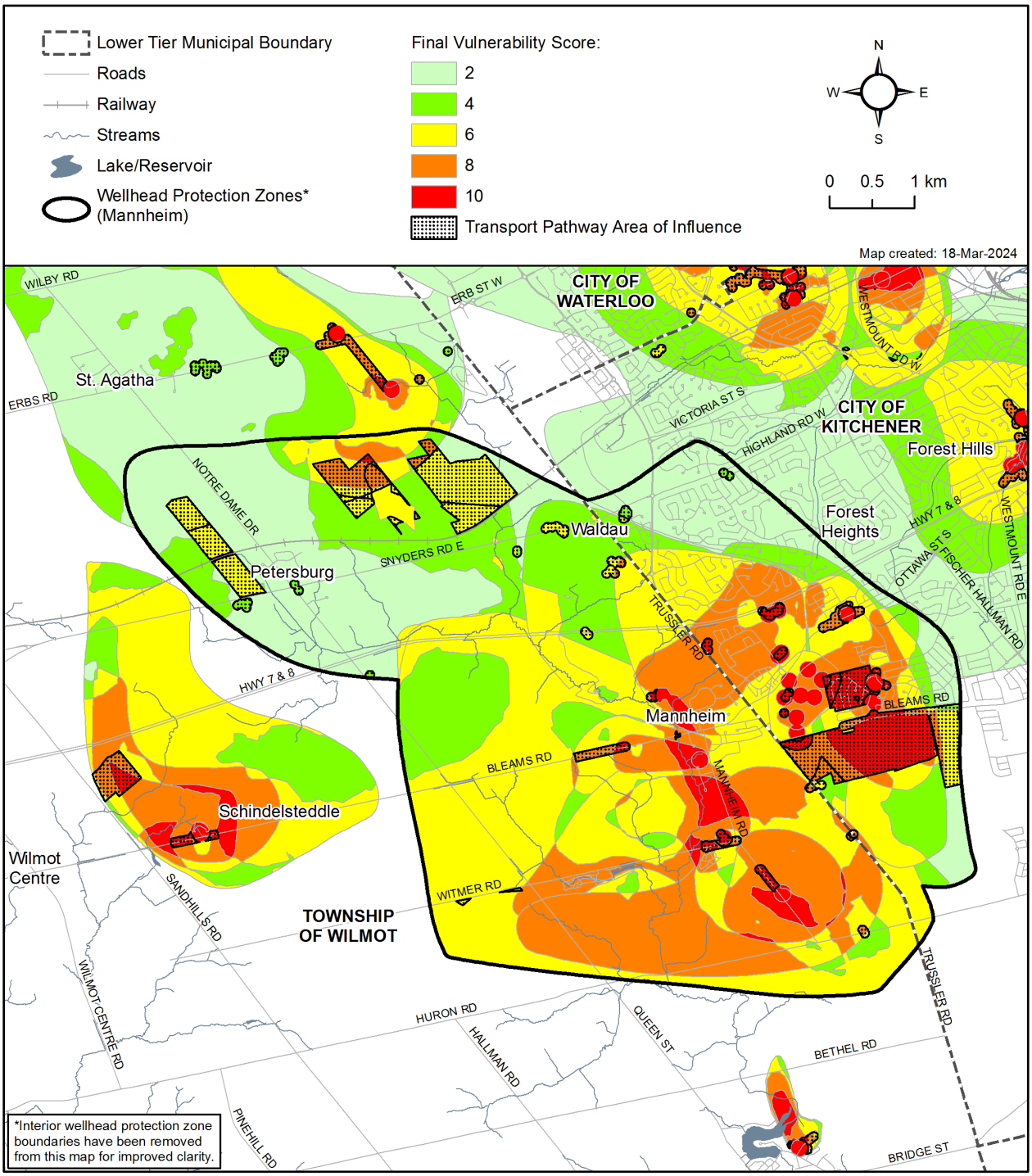
Map 8.3—7: Kitchener Area Inset 1: Mannheim (K21/K21A, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Wellhead Protection Area Adjusted Intrinsic Vulnerability



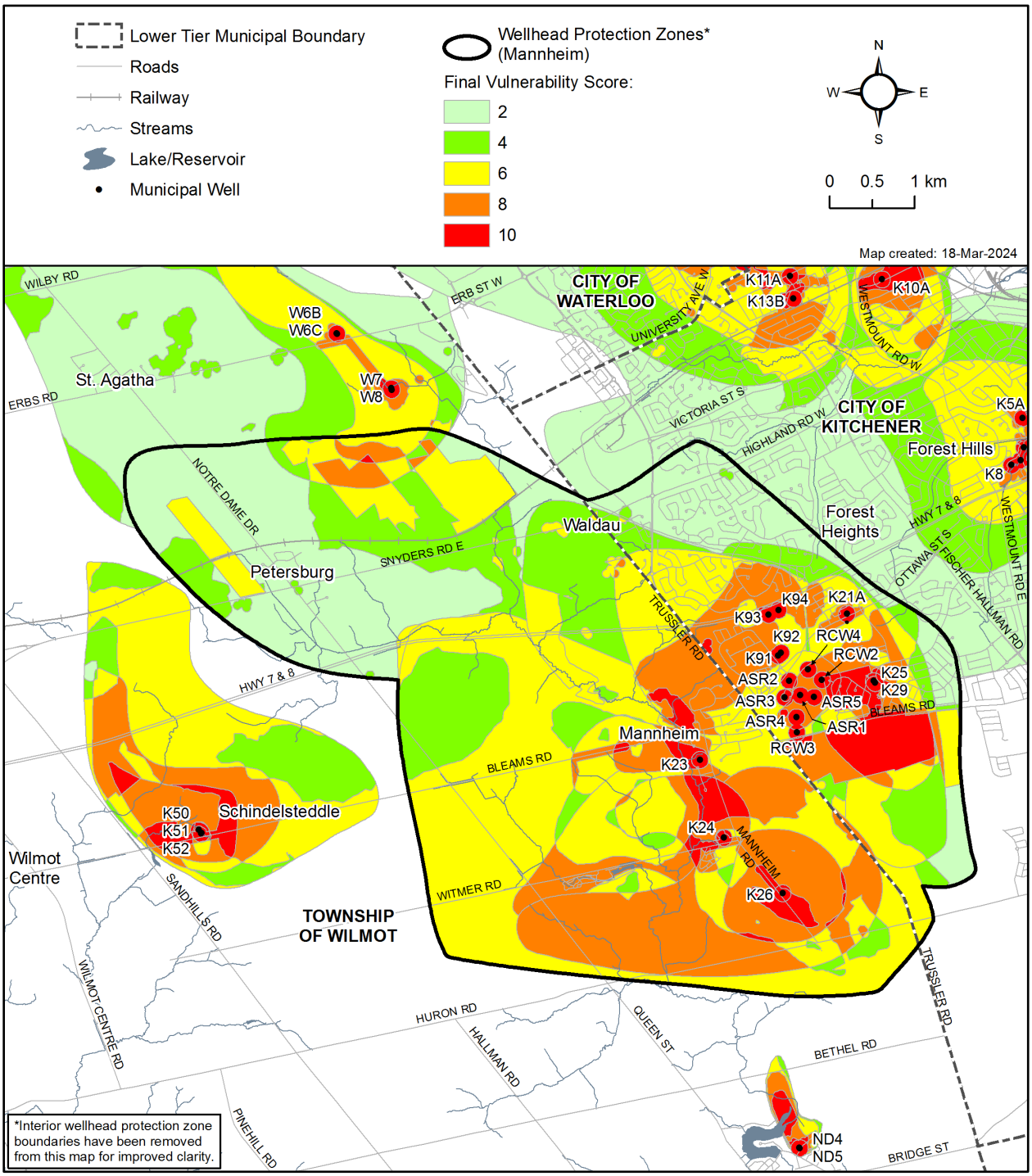
Map 8.3—8: Kitchener Area Inset 1: Mannheim (K21A, K23-26, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Transport Pathways



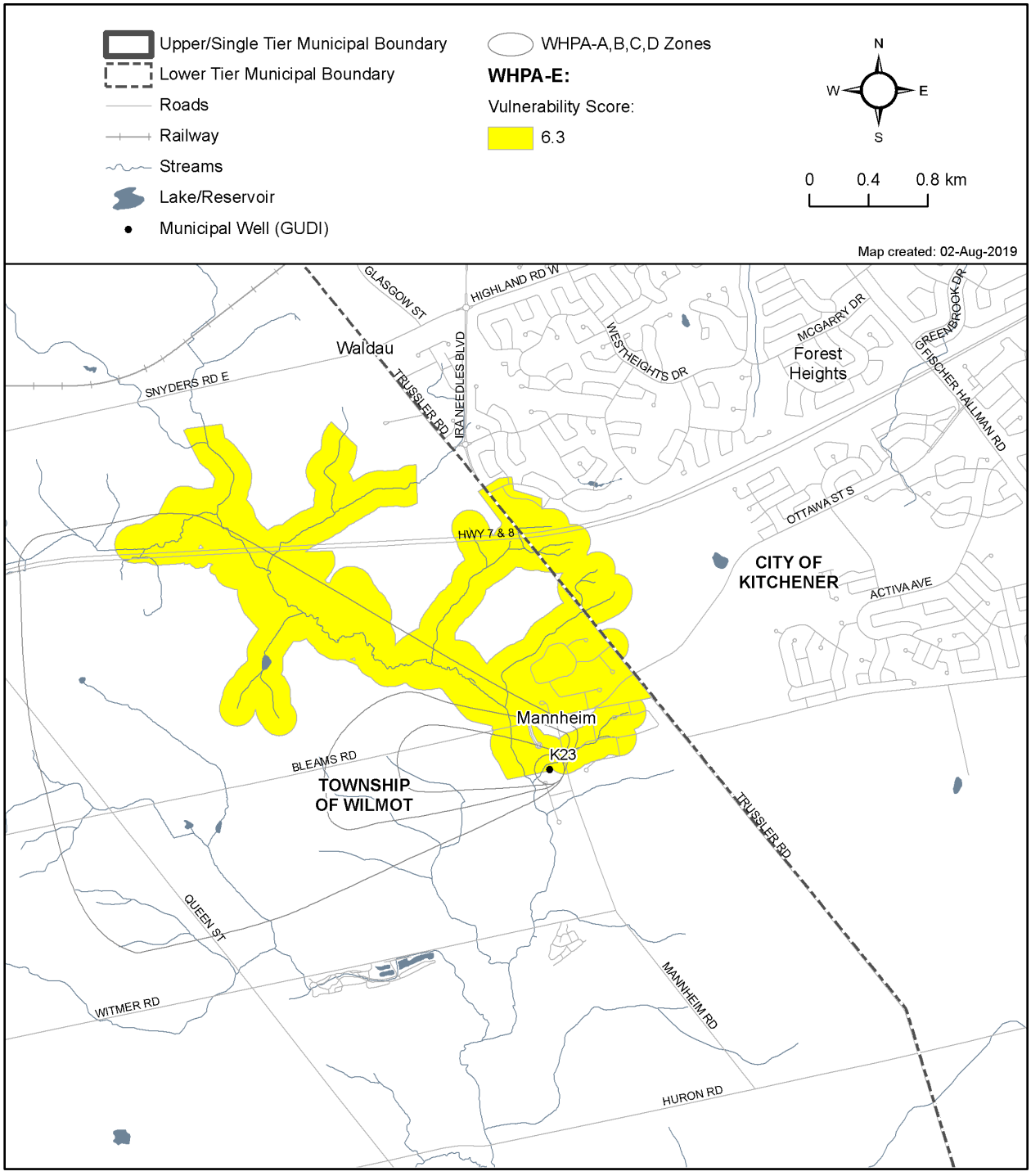
Map 8.3—9: Kitchener Area Inset 1: Mannheim (K21A, K23-26, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Transport Pathways Area of Influence



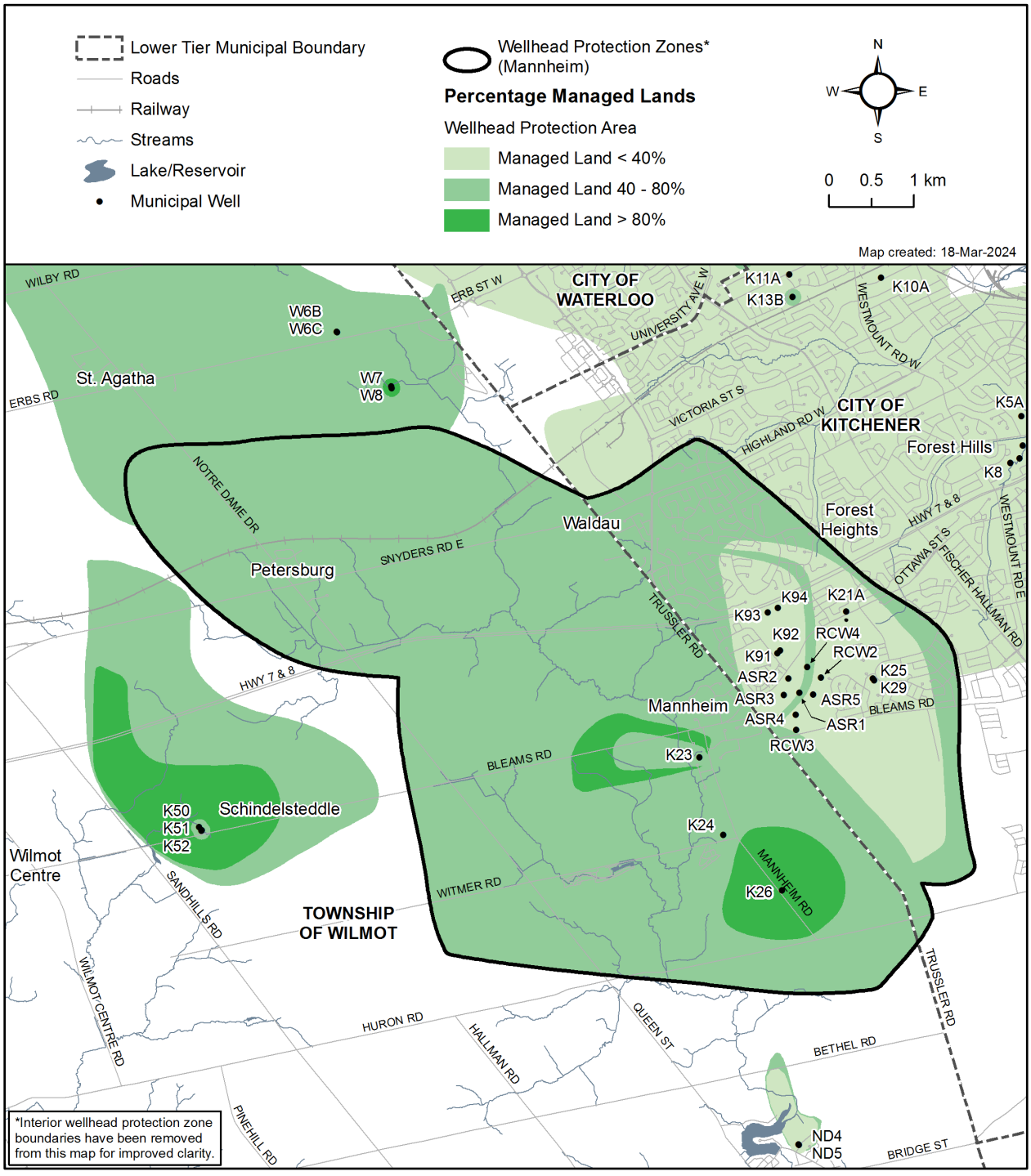
Map 8.3—10: Kitchener Area Inset 1: Mannheim (K21A, K23-26, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Wellhead Protection Area Final Vulnerability



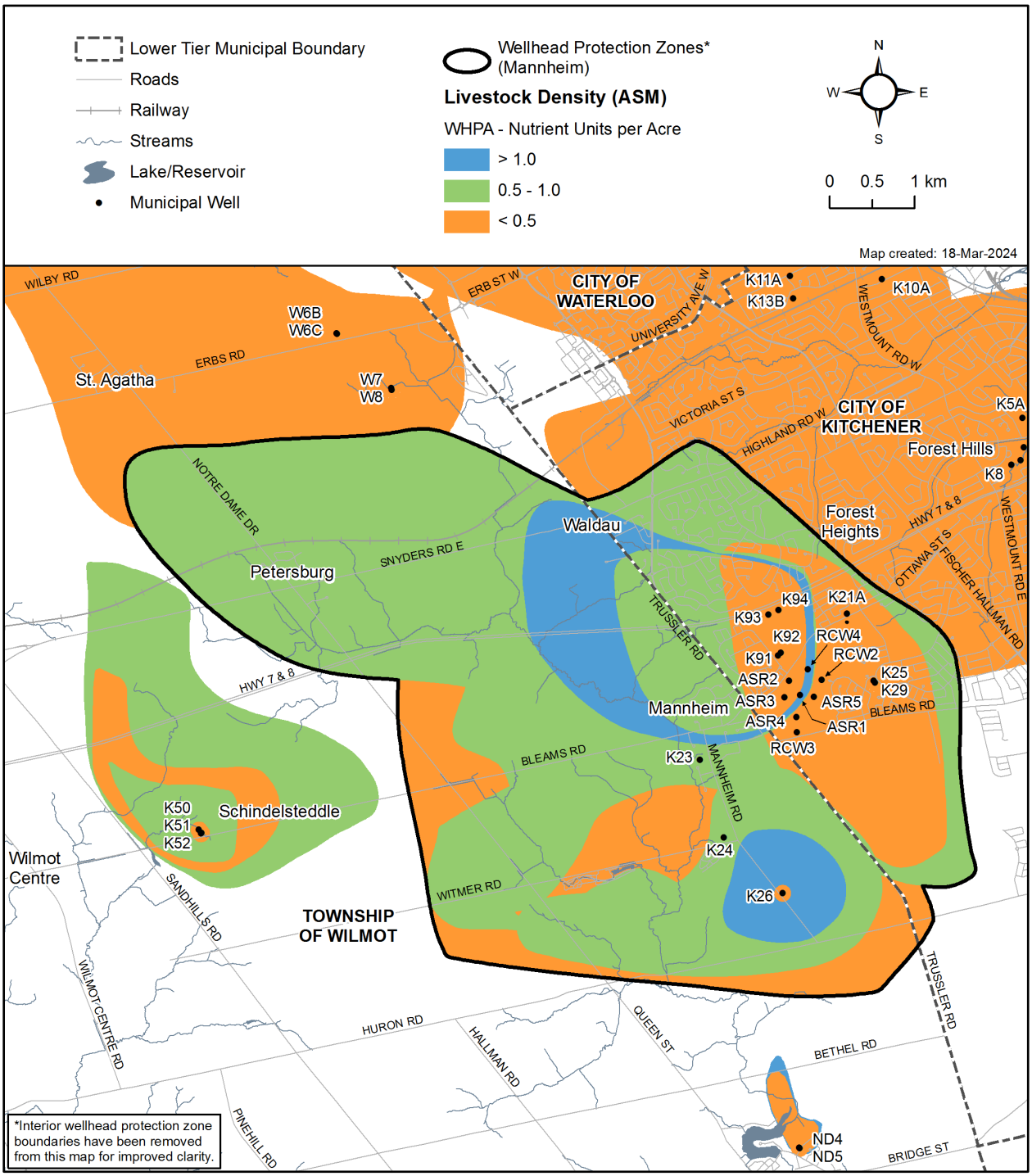
Map 8.3—11: Mannheim West (K23) Wellhead Protection Area E



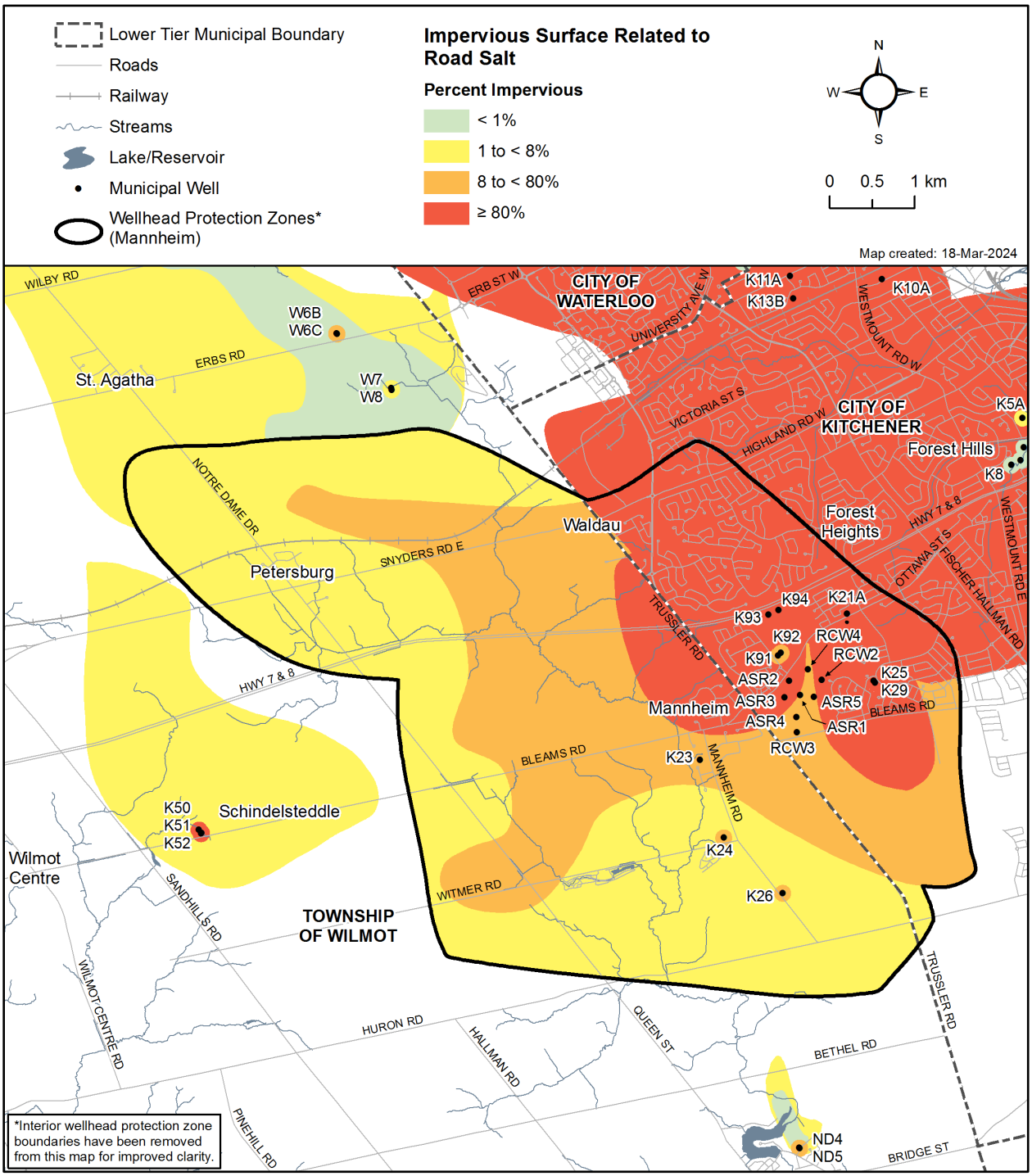
Map 8.3—12: Kitchener Area Inset 1: Mannheim (K21/K21A, K23-26, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Percent Managed Lands



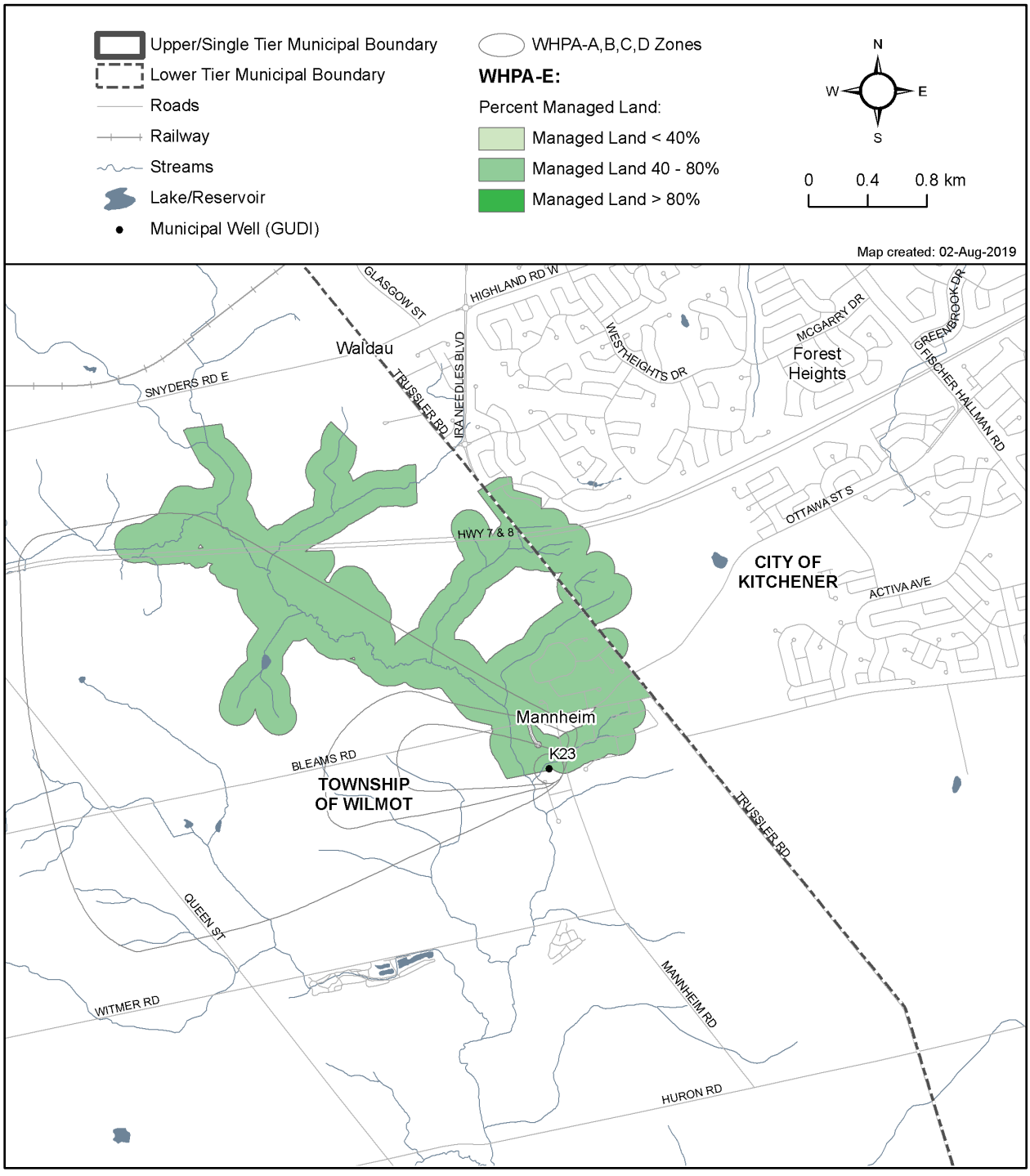
Map 8.3—13: Kitchener Area Inset 1: Mannheim (K21/K21A, K23-26, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Percent Livestock Density



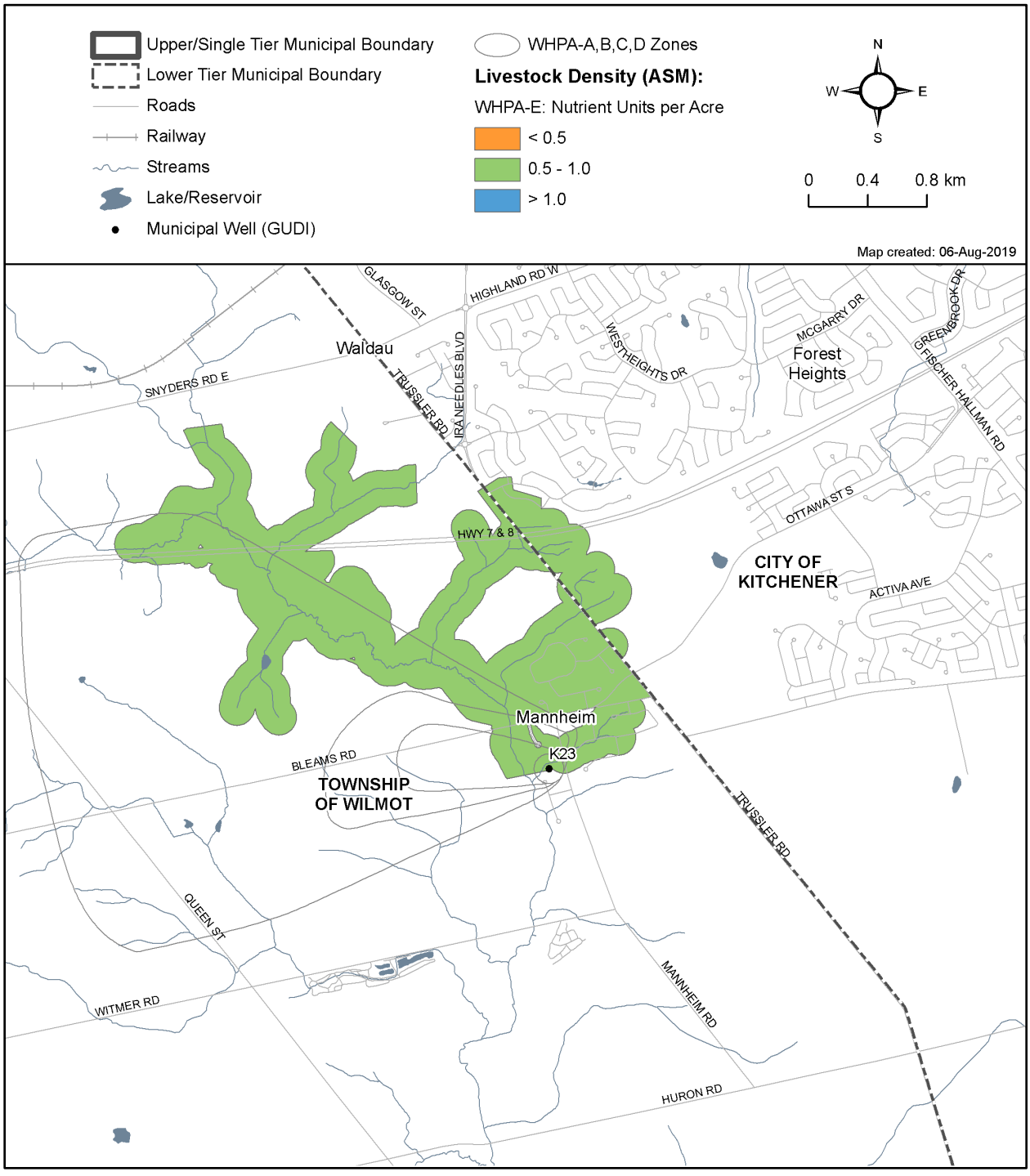
Map 8.3—14: Kitchener Area Inset 1: Mannheim (K21/K21A, K23-26, K29, K91-94, ASR1-5, RCW2, RCW3, RCW4) Well Supply Percent Impervious Surfaces



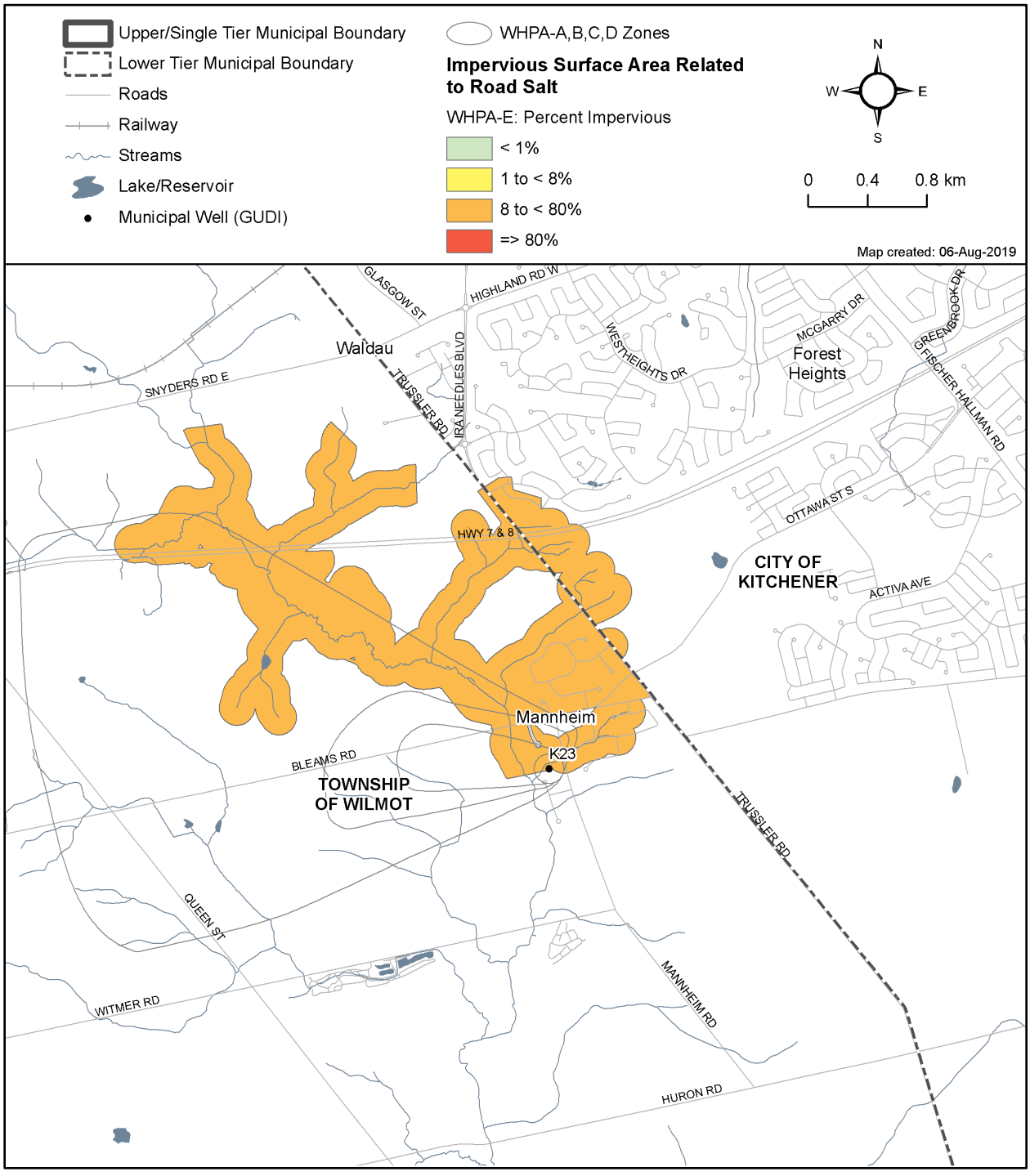
Map 8.3—15: Mannheim (K23) Well Supply Wellhead Protection Area E Percent Managed Lands



Map 8.3—16: Mannheim (K23) Well Supply Wellhead Protection Area E Percent Livestock Density



Map 8.3—17: Mannheim (K23) Well Supply Wellhead Protection Area E Percent Impervious Surfaces



Identification of Significant, Moderate and Low Drinking Water Quality Threats in the Mannheim Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—46** and **Map 8.3—47** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—17 provides a summary of the threat levels possible in the Mannheim Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. "Yes" indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; "No" indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—46** and **Map 8.3—47**.

Table 8.3—1: Identification of Drinking Water Threats in the Mannheim Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A/B	10	Yes	Yes	Yes
Chemicals	WHPA-B/C	8	Yes	Yes	Yes
Chemicals	WHPA-B/C/D	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
Chemicals	WHPA-E	6.3	No	Yes	Yes
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	6	No	Yes	Yes
DNAPLs	WHPA-D	2 & 4	No	No	No
DNAPLs	WHPA-E	6.3	No	No	Yes
Pathogens	WHPA-A/B	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes
Pathogens	WHPA-E	6.3	No	Yes	Yes

Threats and Issues Enumeration for the Mannheim Wellfield

Nitrate has been designated as an Issue for wells K23, K24 and K26 due to elevated nitrate concentrations at each well (approximately half the Ontario Drinking Water Standard) and the persistence of widespread elevated nitrate in the supply aquifer (AFB2) at wellfield monitoring wells.

The wells are located in a linear orientation over an approximately 2 kilometre long distance, and individual wells are between 400 m and 1000 m apart. Due to the distance between well locations, plus the fact that the wells do not feed a common reservoir in the water system, the *Issues* for each well have been evaluated separately.

Wells K23, K24 and K26 have shown elevated nitrate concentrations since at least 1985 (the start of available records). Nitrate concentrations at each well typically vary between 4 and 8 mg/L (as N) compared to the Ontario Drinking Water Standard of 10 mg/L (as N), (**Figure 8.3—4**).

At wells K23 and K26, nitrate concentrations appear to reduce with reduced water taking from the well, this is illustrated in **Figure 8.3—5** which shows pumped volume and nitrate concentrations for well K23.

The Region has implemented hydrogeological investigations and assessment for nitrate in the Mannheim West area, including the "Nitrate Monitoring Pilot Study- Mannheim West-South (K26)" by Water and Earth Science Ltd, November 2007. Investigations have indicated that elevated nitrate concentrations are present throughout the Mannheim West area, and the elevated nitrate is distributed through the thickness of Aquifer 1. Ongoing monitoring of four monitoring wells in the area demonstrates that nitrate levels are generally elevated over the Ontario Drinking Water Standard of 10 mg/L (as N), except in the immediate vicinity of well K24 (monitoring well WT-WM-OW3-61) (**Figure 8.3—6**).

The *Issue Contributing Areas* for wells K24 and K26 are delineated as the 25 year time-of-travel capture zone. For well K23, which is a GUDI-EF well, the *Issue Contributing Area* is set as the 25 year time-of-travel capture plus the WHPA-E zone. The WHPA-E zone was included to account conservatively for surface water within Alder Creek to be a potential source of nitrate to the well. Technical studies have documented that Alder Creek water contains elevated nitrate (i.e. nitrate is not naturally mitigated within the creek surface water environment). Technical studies also indicate that in the area of the Mannheim wells Alder Creek is a source of water to the Mannheim GUDI wells, through downward leakage from the stream bed. The combined Issue Contributing Area for wells K23, K24, and K26 is shown on **Map 8.3—54**.

The protection area for the Mannheim Wellfield overlaps with the Erb Street and Greenbrook Wellfield areas. However, threat ranking results related to the Erb Street Wellfield are presented in **Section 8.6 – Rural Area Wellfields.** Threat ranking results related to the Greenbrook Wellfield are presented in **Section 8.3 – Kitchener Area Wellfields.**

The total number of identified significant drinking water threats in this Wellfield is 630. The number of properties in this Wellfield with identified significant drinking water threats is 379. Details surrounding the types of threats and circumstances found in the Mannheim wellhead protection areas are outlined in **Table 8.3—18**.

No Significant Conditions were identified in this wellfield as per Technical Rule 126.

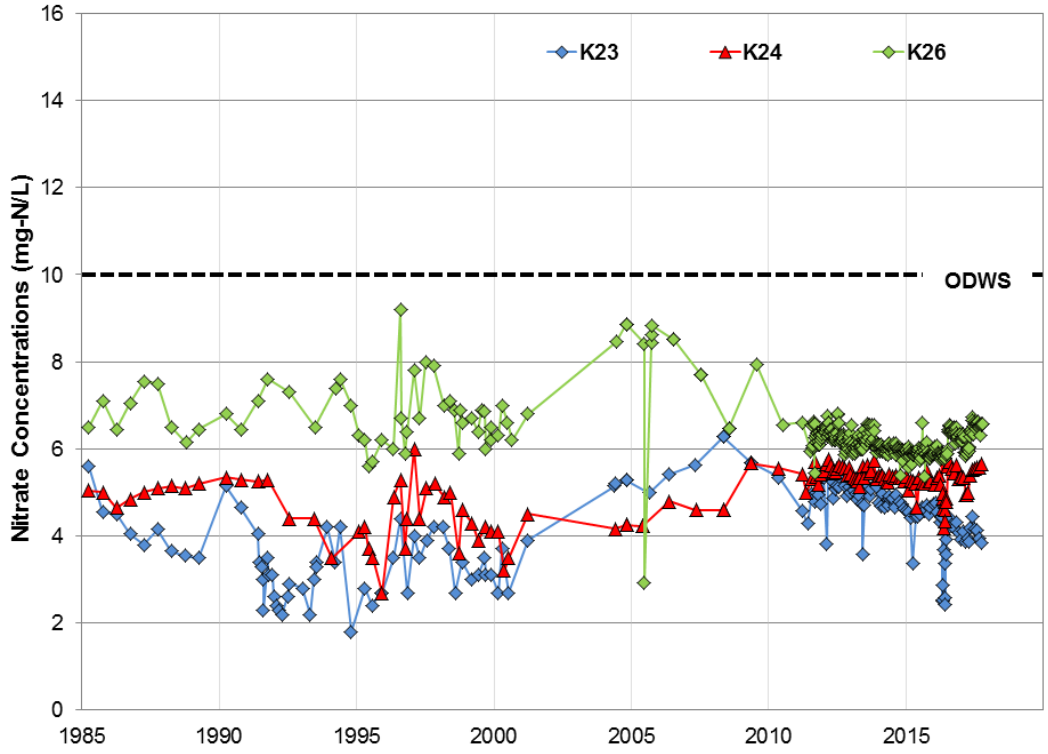


Figure 8.3—1: Nitrate Trends at the Mannheim West Supply Wells (K23, K24 & K26)

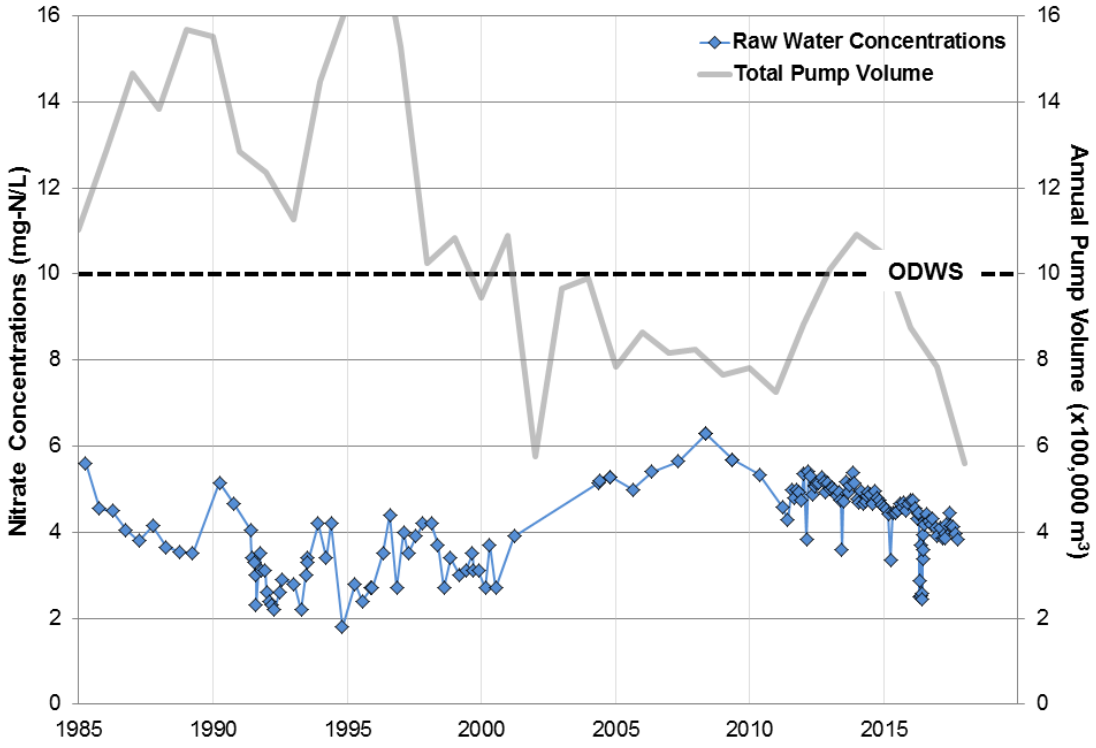


Figure 8.3—2: Nitrate Trends in K23 relative to pumping rate at the Mannheim West Supply Wells, Wilmot

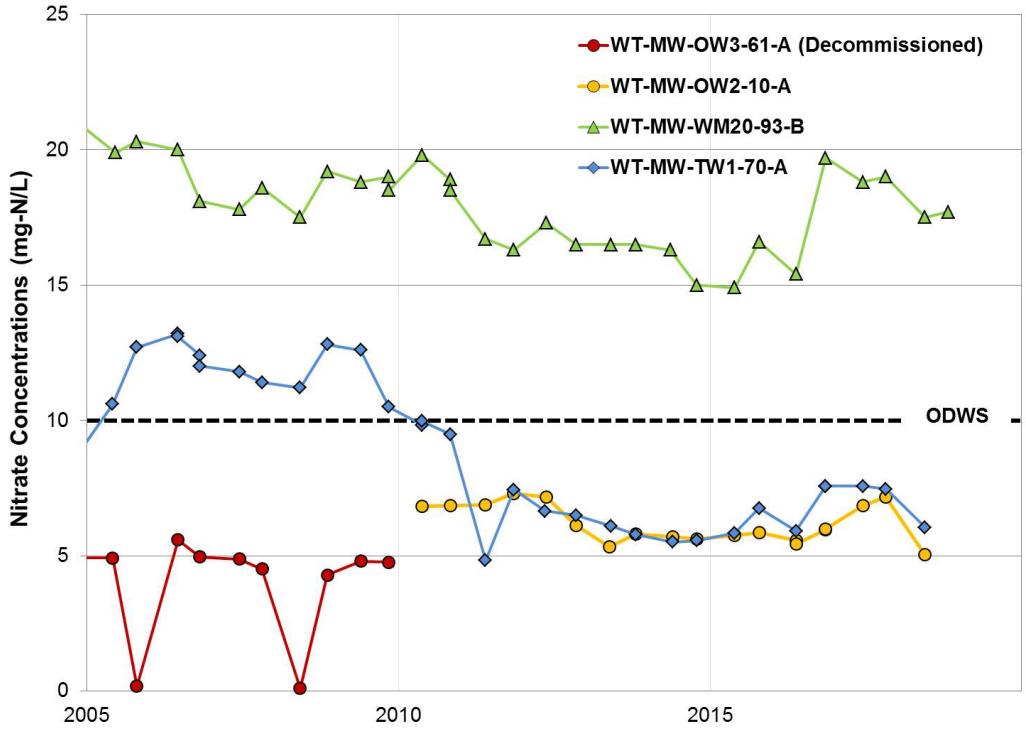


Figure 8.3—3: Nitrate Trends at the Mannheim West Monitoring Wells, Wilmot

Map 8.3—18: Mannheim Well Supply Issue Contributing Area (Wells K23, K24 and K26)

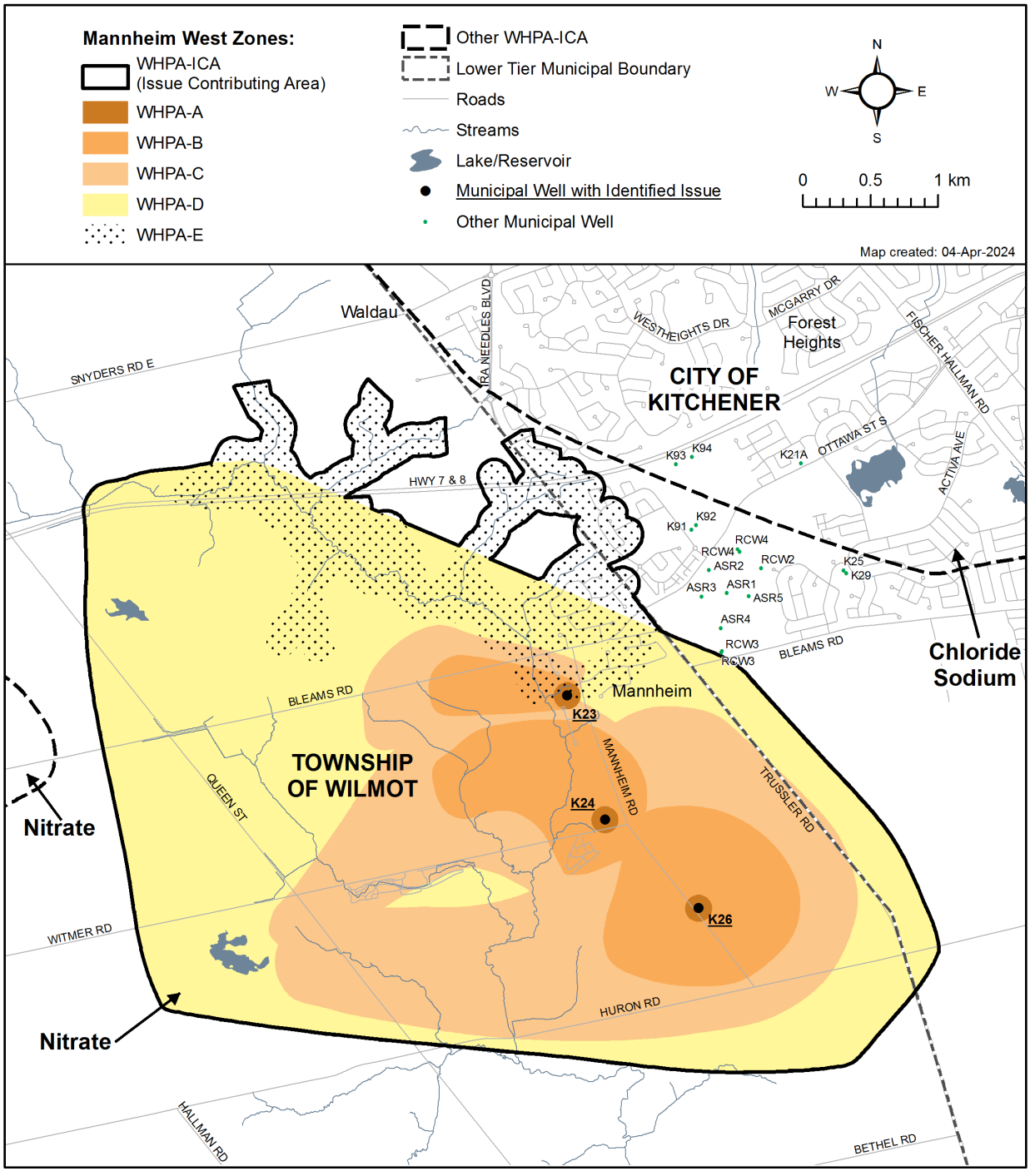


Table 8.3—2: Significant Drinking Water Quality Threats in the Mannheim Wellhead Protection Areas (current to October 2020)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
1	Storage of PCB waste at any location (generating or accepting)	1	WHPA-A
2	Sewage system or sewage works – industrial effluent discharges	1	ICA
	Sewage system or sewage works - onsite sewage systems	256	WHPA-A WHPA-B ICA
	Sewage system or sewage works - onsite sewage systems holding tanks	120	WHPA-A WHPA-B ICA
	Sewage system or sewage works - sanitary sewers and related wastewater collection systems	3	WHPA-A WHPA-B ICA
	Sewage system or sewage works - sewage storage - treatment or holding tanks	1	WHPA-A WHPA-B
	Sewage system or sewage works - storm water management facility (including storm sewers)	5	WHPA-A WHPA-B ICA
3	Application of agricultural source material (ASM) to land	40	WHPA-A WHPA-B ICA
4	Storage of agricultural source material (ASM)	30	WHPA-A WHPA-B ICA
6	Application of non-agricultural source material (NASM) or biosolids to land	3	WHPA-B ICA
7	Storage of non-agricultural source material (NASM)	4	WHPA-B ICA
8	Application of commercial fertilizer to land	59	WHPA-A WHPA-B ICA
9	Storage of commercial fertilizer	38	WHPA-A WHPA-B ICA
10	Application of pesticide to land	11	WHPA-A WHPA-B
11	Storage of a pesticide	5	WHPA-A WHPA-B
12	Application of road salt	11	WHPA-A WHPA-B

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
15	Storage and handling of fuel	6	WHPA-B
16	Storage and handling of a dense non aqueous phase liquid (DNAPL)	3	WHPA-B WHPA-C
17	Storage of an organic solvent	1	WHPA-B
21	Management or handling of agricultural source material - agricultural source material (ASM) generation (grazing and pasturing)	12	WHPA-A WHPA-B ICA
	Management or handling of agricultural source material - agricultural source material (ASM) generation (yards or confinement)	20	WHPA-A WHPA-B ICA
Total Number of Significant Threat Activities		**630**	
Total Number of Properties with Significant Threats		**379**	

[1] Prescribed Drinking Water Quality Threat 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.

8.3.2 Greenbrook and Strange Street Wellfields

Greenbrook Wellfield

The water supply for the Greenbrook Wellfield is obtained from production wells K1A, K2A, K4B/K4C, K5A, and K8 which are screened from approximately 31 to 50 m BGS. All of the production wells are completed within the Pre-Catfish Creek Aquifer (AFD1) and are overlain by an extensive aquitard unit comprised of the Maryhill and Catfish Creek Tills, with the Waterloo Moraine Sands at ground surface. K4C was constructed as a replacement well for K4B on the same property, is screened in the same aquifer, and has recently been added to the Permit to Take Water for this wellfield. The Greenbrook Wellfield supplies water to the Region's IUS system (**Table 8—1**).

Strange Street Wellfield

The water supply for the Strange Street Wellfield is obtained from production wells K10A, K11A, K13B, K18 and K19 and is pumped into the IUS (**Table 8—1**). K13B was connected to the IUS distribution system in 2023. K13B was completed as a direct replacement for K13A. The production wells are screened at depths ranging from approximately 17 m BGS to 38 m BGS within the Middle Waterloo Moraine Sands (AFB2). AFB1 is typically identified at ground surface near the site and is often separated from AFB2 by the presence of a fine-grained aquitard unit (**Table 8.1—6).** The production wells are screened below this aquitard unit, near the top of the Maryhill Till.

Vulnerability and Transport Pathways

Map 8.3—55 presents the wellhead protection areas. Replacement well K13B resulted in a slight shift to the previously delineated WHPA-A (WHPAs B, C, and D remain unchanged given no changes in depth or pumping rate relative to K13A). The unadjusted intrinsic vulnerability is shown on **Map 8.3—56** and **Map 8.3—57** and the adjusted intrinsic vulnerability is shown on **Map 8.3—58** and **Map 8.3—59** for Strange Street and Greenbrook wellfields, respectively.

Analysis of the attributes of potential transport pathways in the Greenbrook Wellfield identified several clusters of wells and underground services which warranted an increase in the ISI. Similarly, analysis of attributes of each potential transport pathway in the Strange Street WHPAs resulted in the identification of several well and underground servicing clusters within the WHPA-B to WHPA-D zones, which warranted an increased ISI. **Map 8.3—60** and **Map 8.3—61** show these transport pathways and area of influence for the WHPAs and **Map 8.3—62** shows the final vulnerability scoring.

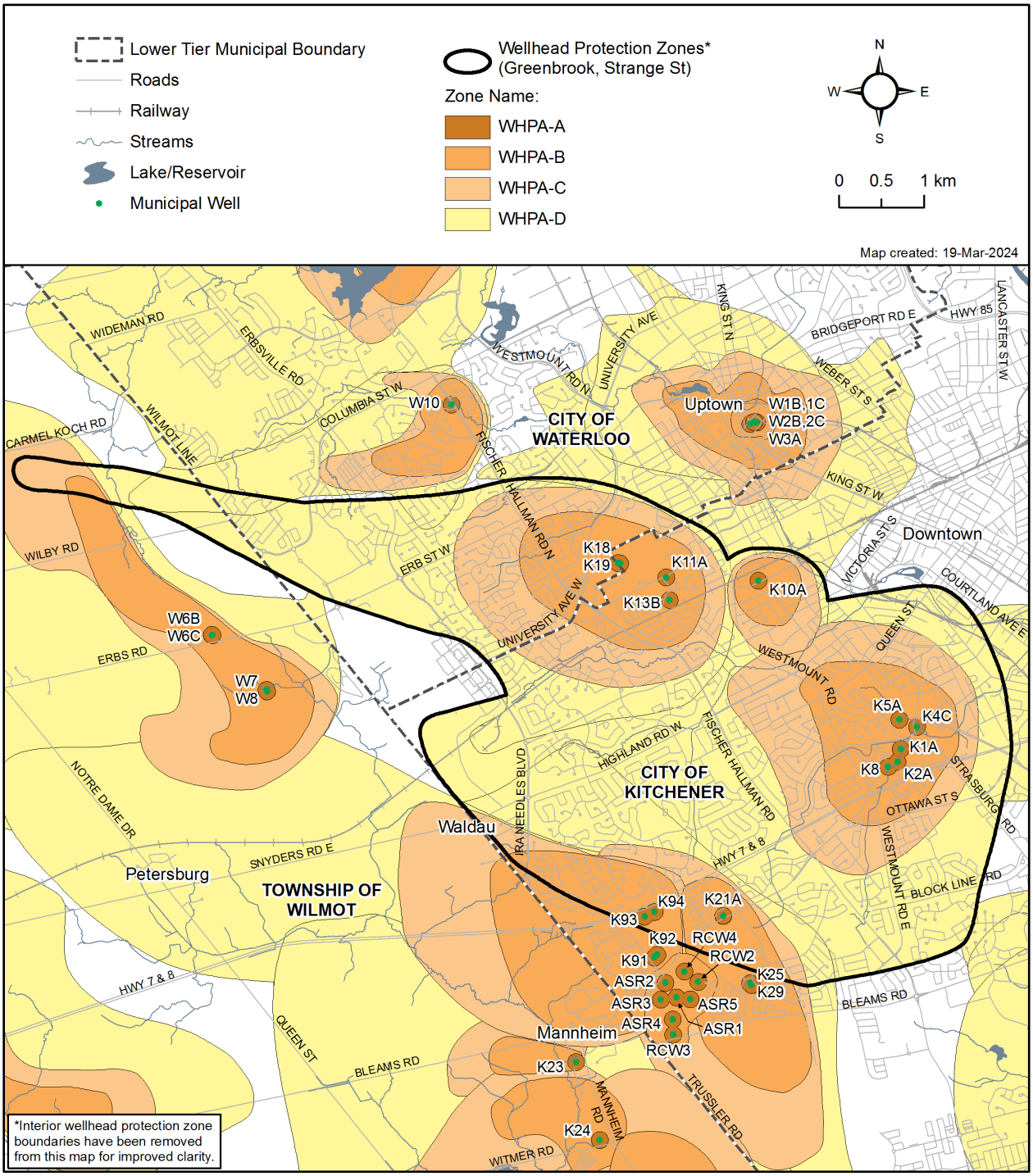
Greenbrook has been classified as a *GUDI Wellfield with effective filtration*, due to windows in the Maryhill Till identified near the production wells (Stantec, 2009b). As such the WHPA-E capture zone has been delineated for the Greenbrook Wellfield **Map 8.3—66**.

Percent Managed Land, Livestock Density, Salt Loading Potential and Percent Impervious Surface

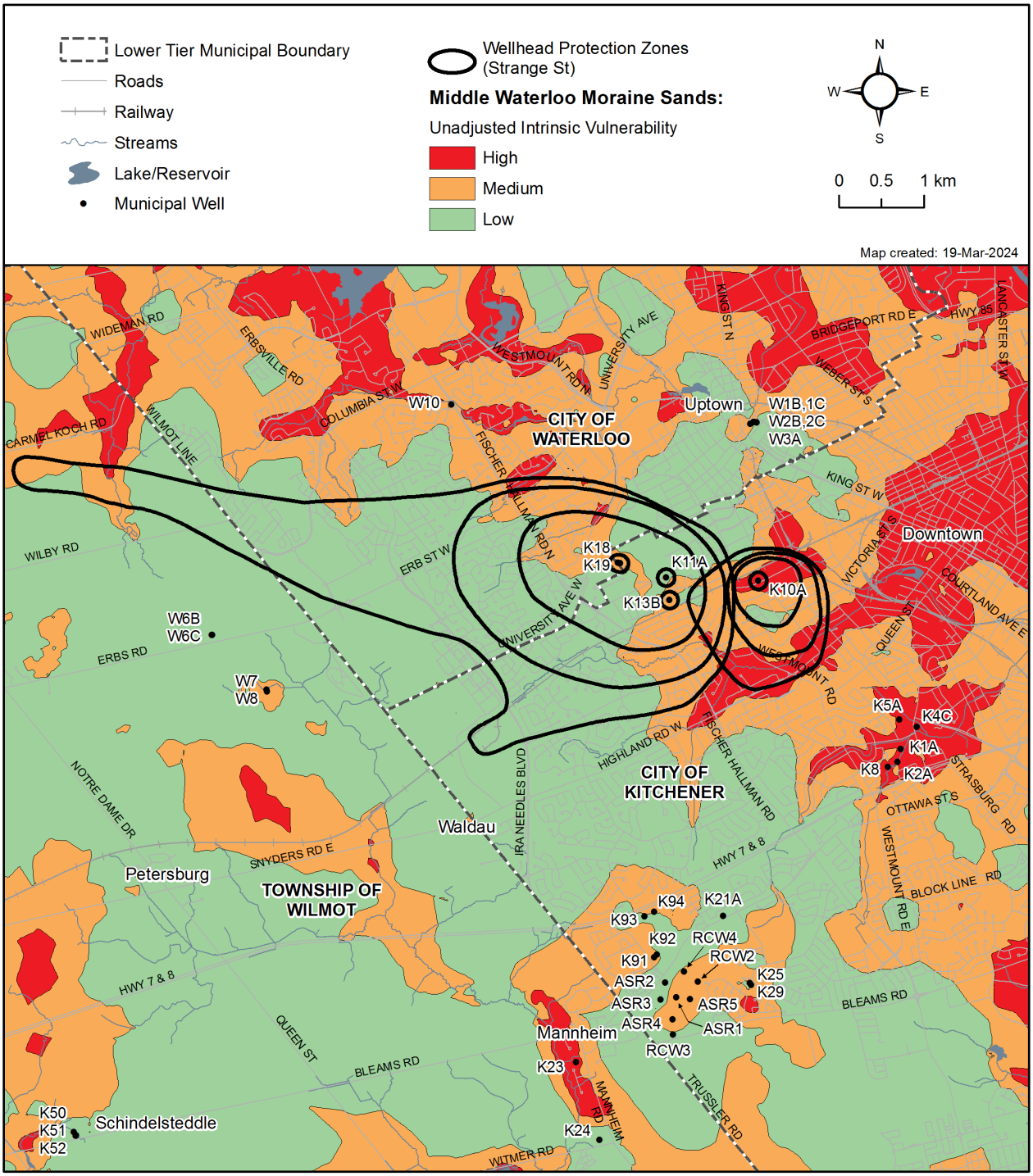
The calculations for determining the percent managed land, livestock density, salt loading potential and corresponding percent impervious surface for the Greenbrook and Strange Street Wellfields were calculated using the methods outlined in **Section 8.1 - Water Quality Risk Assessment**. A revision to the previously calculated managed lands data for the Strange Street wellfield was identified during the recent incorporation of well K13B.

Map 8.3—63, Map 8.3—64, Map 8.3—65 show the percent managed lands, livestock density and percent impervious surface, for both the Greenbrook and Strange Street Wellfields, respectively. **Map 8.3—67, Map 8.3—68**, and **Map 8.3—69** show the percent managed lands, livestock density, and percent impervious surface, respectively, for the Greenbrook WHPA-E.

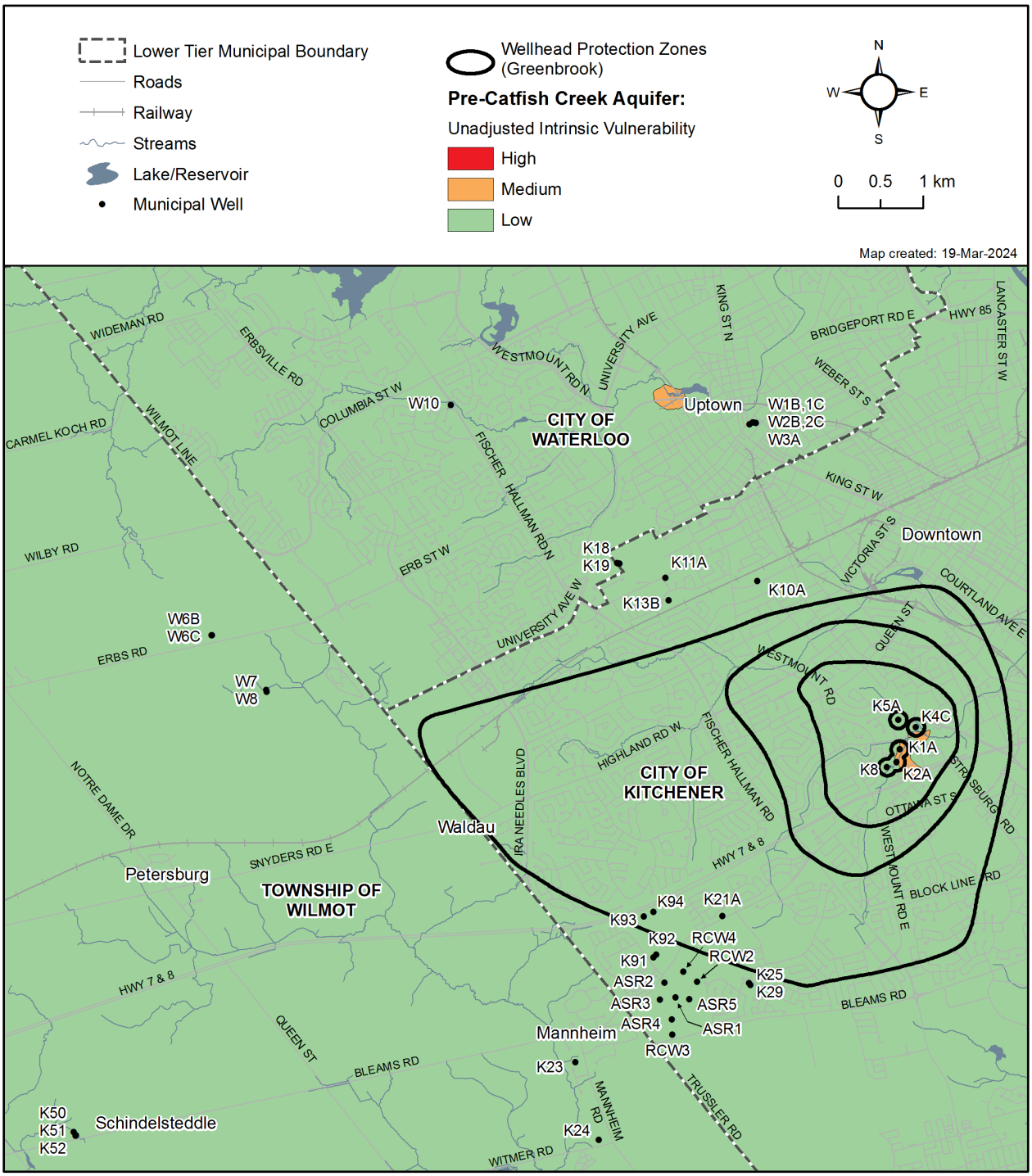
Map 8.3—19: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A, and K8) and Strange Street (K10A, K11A, K13B, K18 and K19) Well Supply Wellhead Protection Areas



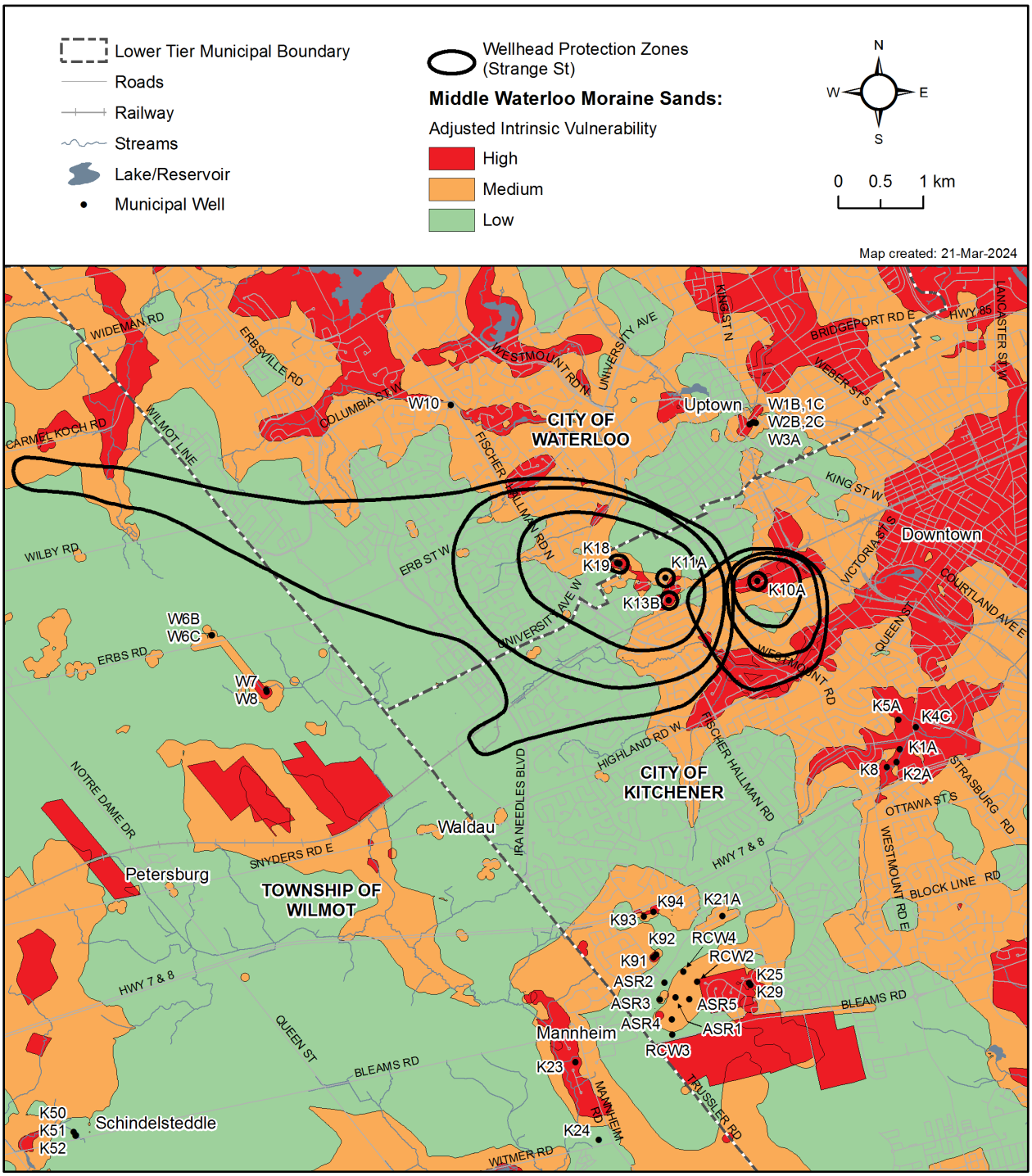
Map 8.3—20: Kitchener Area Inset 2: Strange Street (K10A, K11A, K13B, K18, and K19) Well Supply Wellhead Protection Area Unadjusted Intrinsic Vulnerability



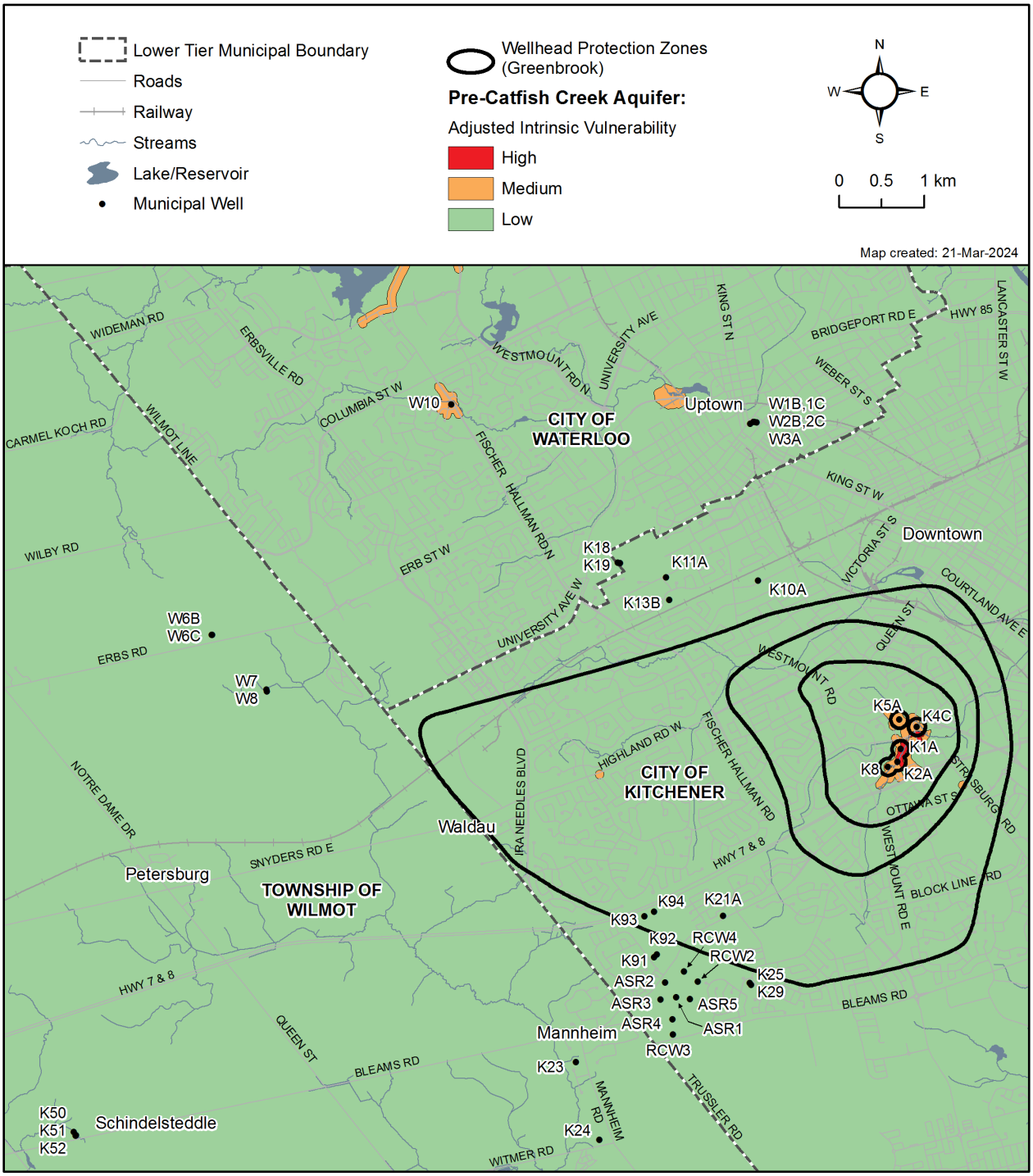
Map 8.3—21: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A and K8) Well Supply Wellhead Protection Area Unadjusted Intrinsic Vulnerability



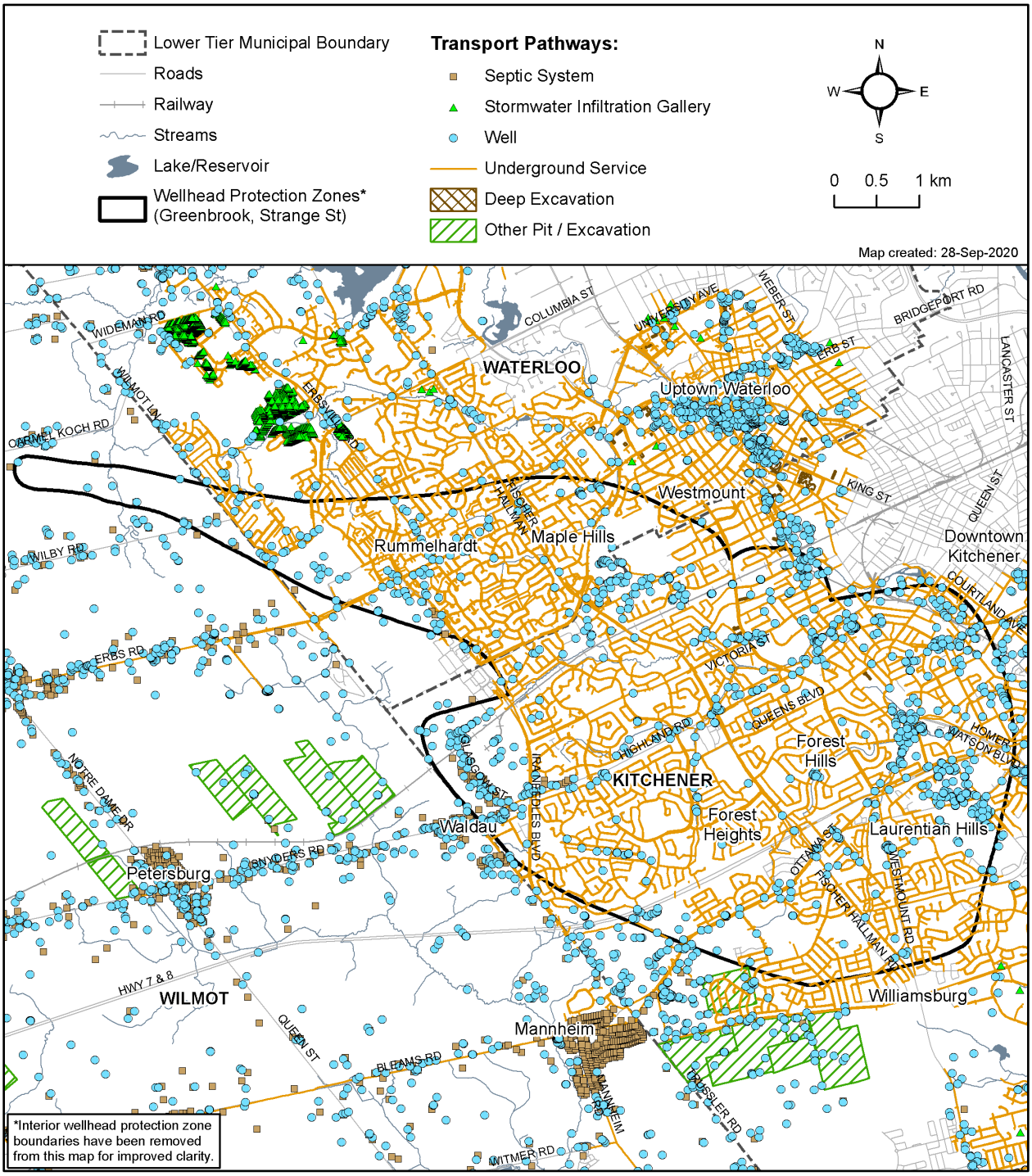
Map 8.3—22: Kitchener Area Inset 2: Strange Street (K10A, K11A, K13B, K18 and K19) Well Supply Wellhead Protection Area Adjusted Intrinsic Vulnerability



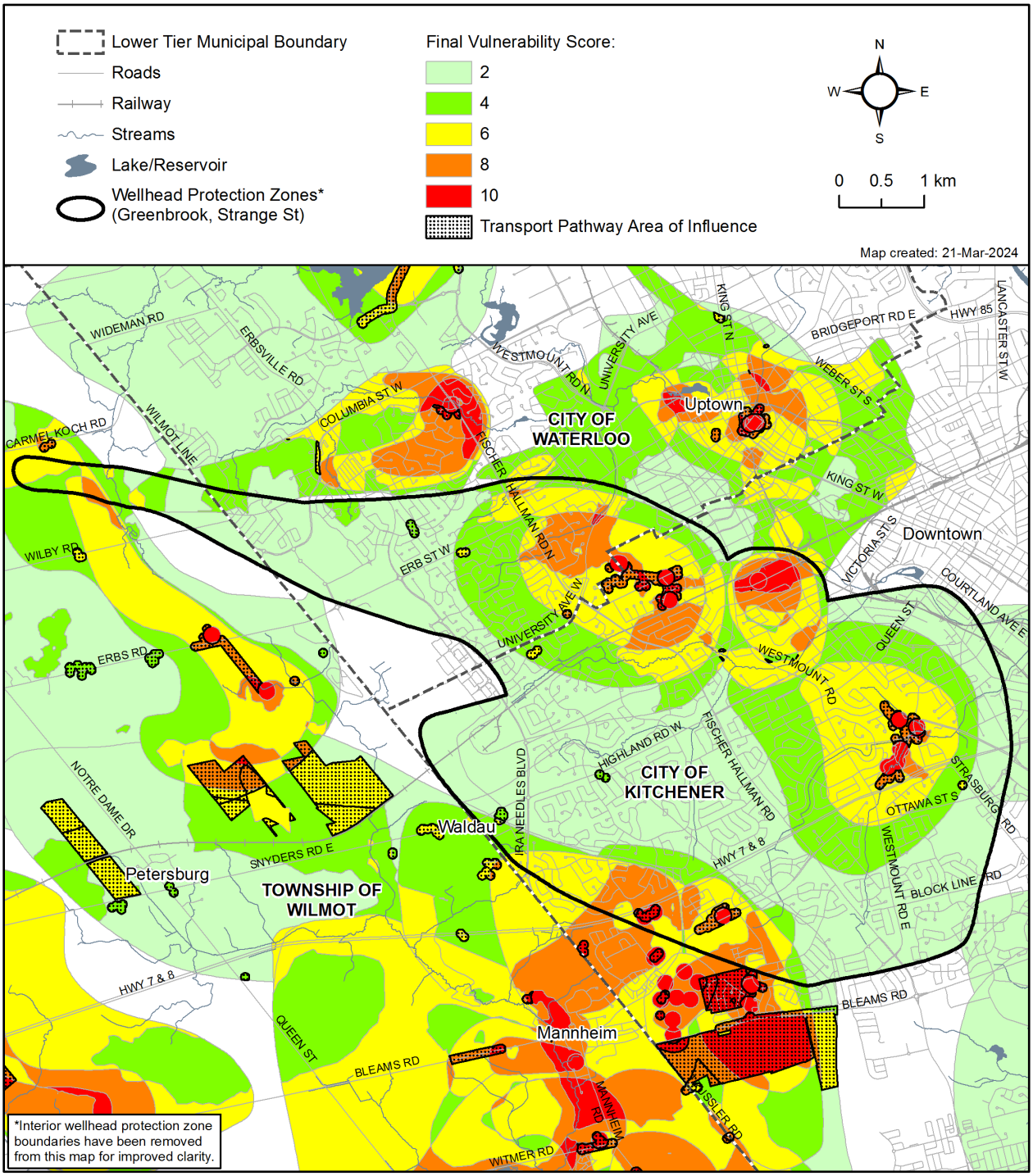
Map 8.3—23: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A and K8) Well Supply Wellhead Protection Area Adjusted Intrinsic Vulnerability



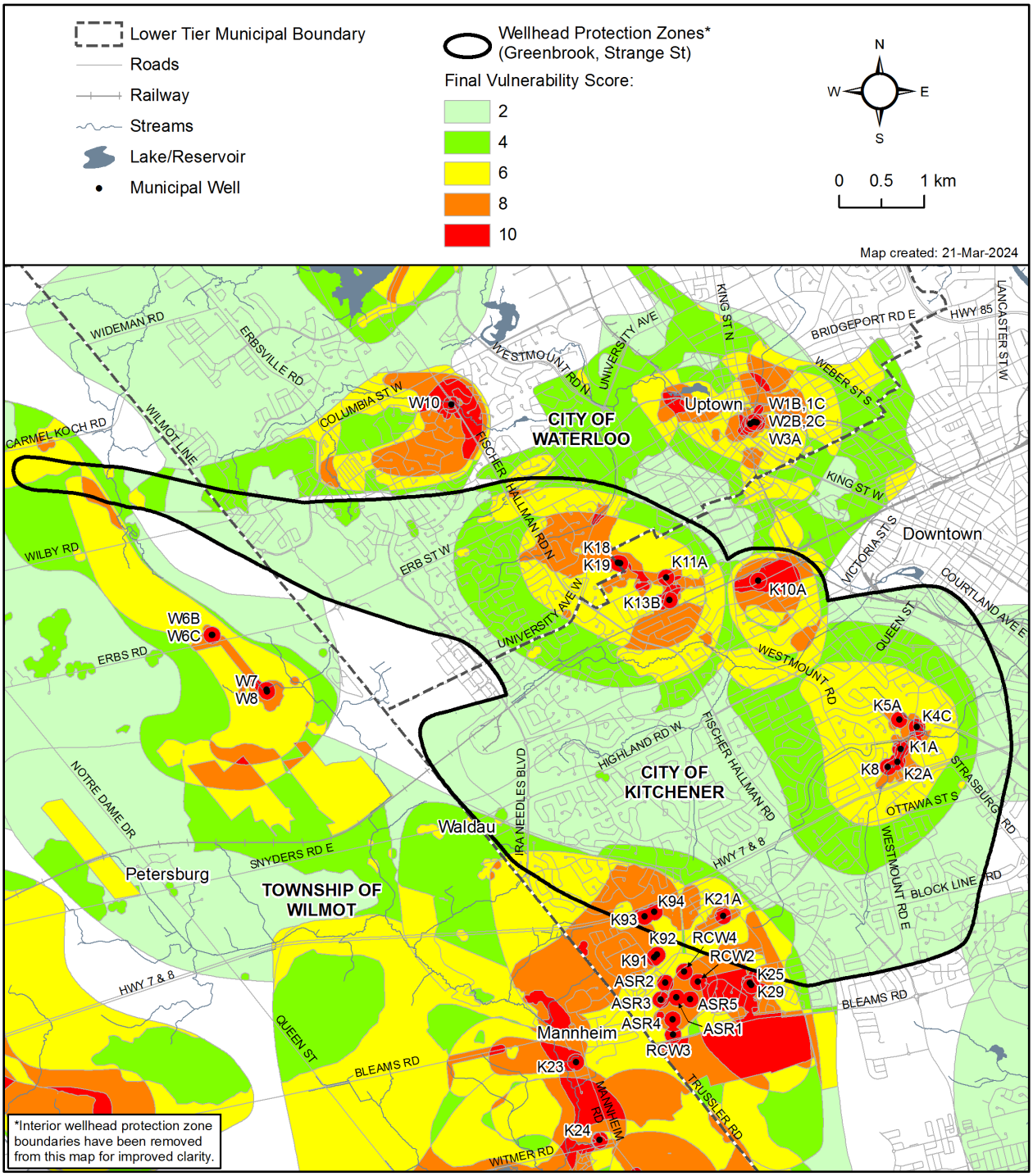
Map 8.3—24: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A, and K8) and Strange Street (K10A, K11A, K13B, K18 and K19) Well Supply Transport Pathways



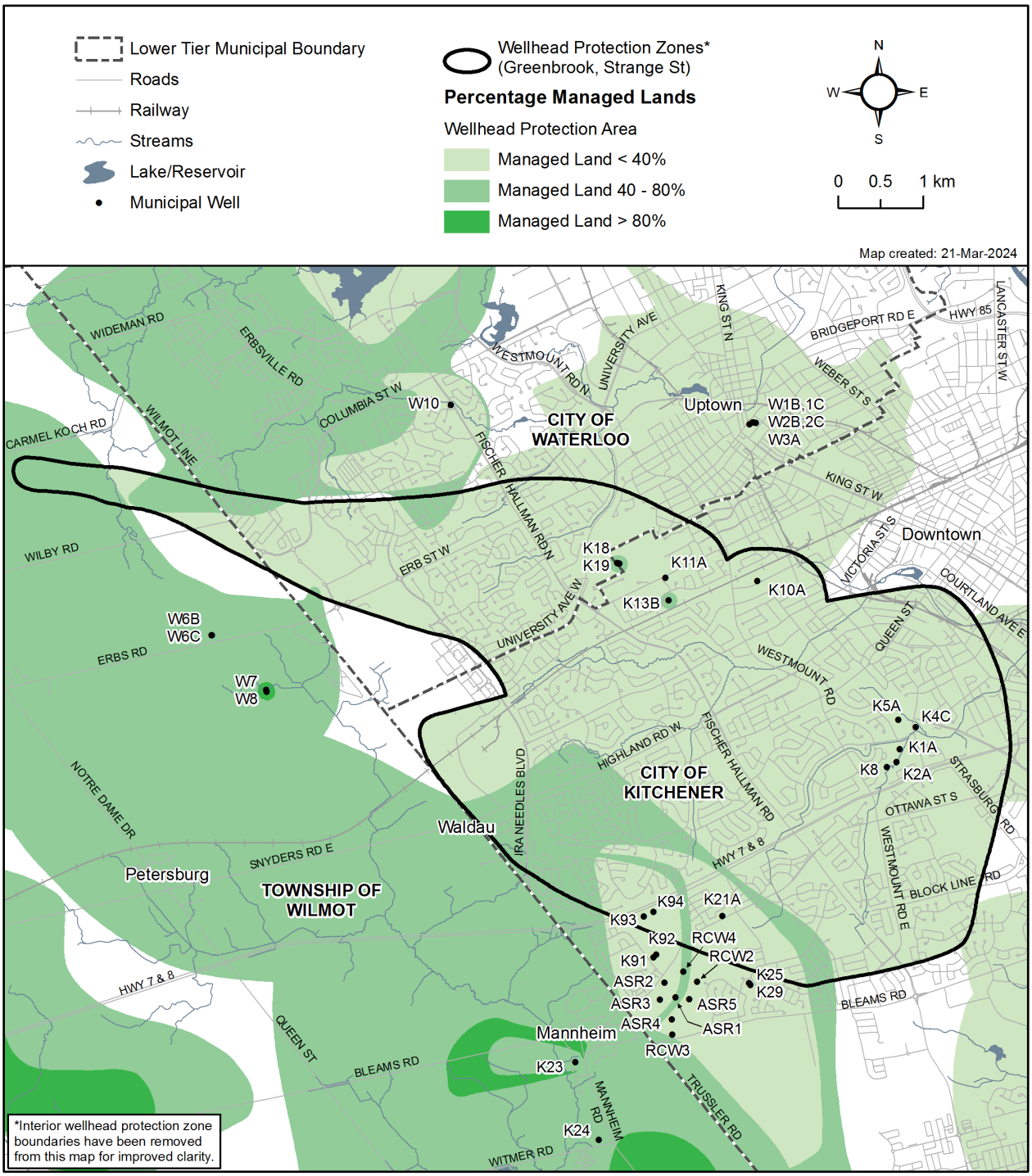
Map 8.3—25: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A, and K8) and Strange Street (K10A, K11A, K13B, K18 and K19) Well Supply Transport Pathways Area of Influence



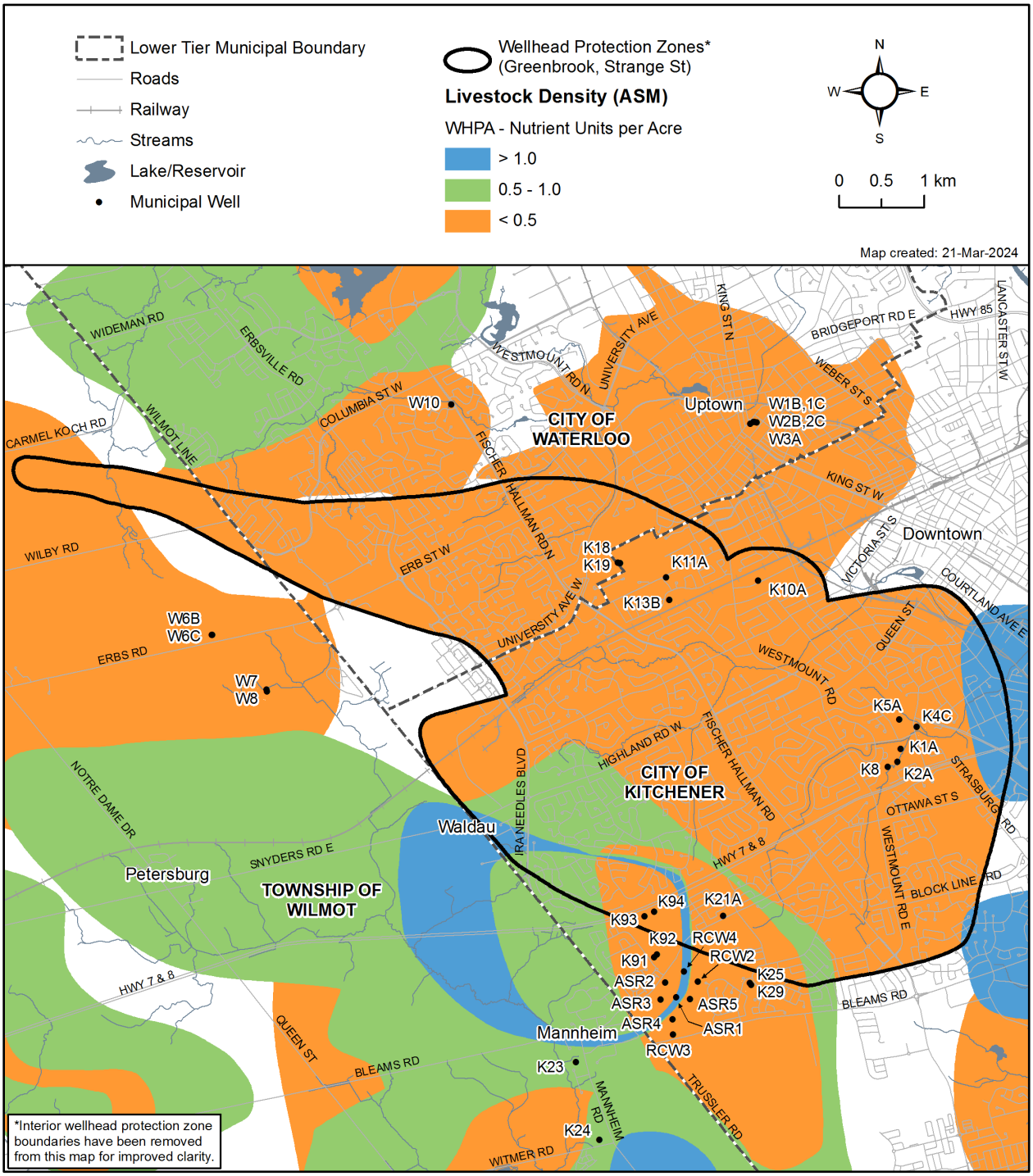
Map 8.3—26: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A, and K8) and Strange Street (K10A, K11A, K13B, K18 and K19) Well Supply Wellhead Protection Area Final Vulnerability



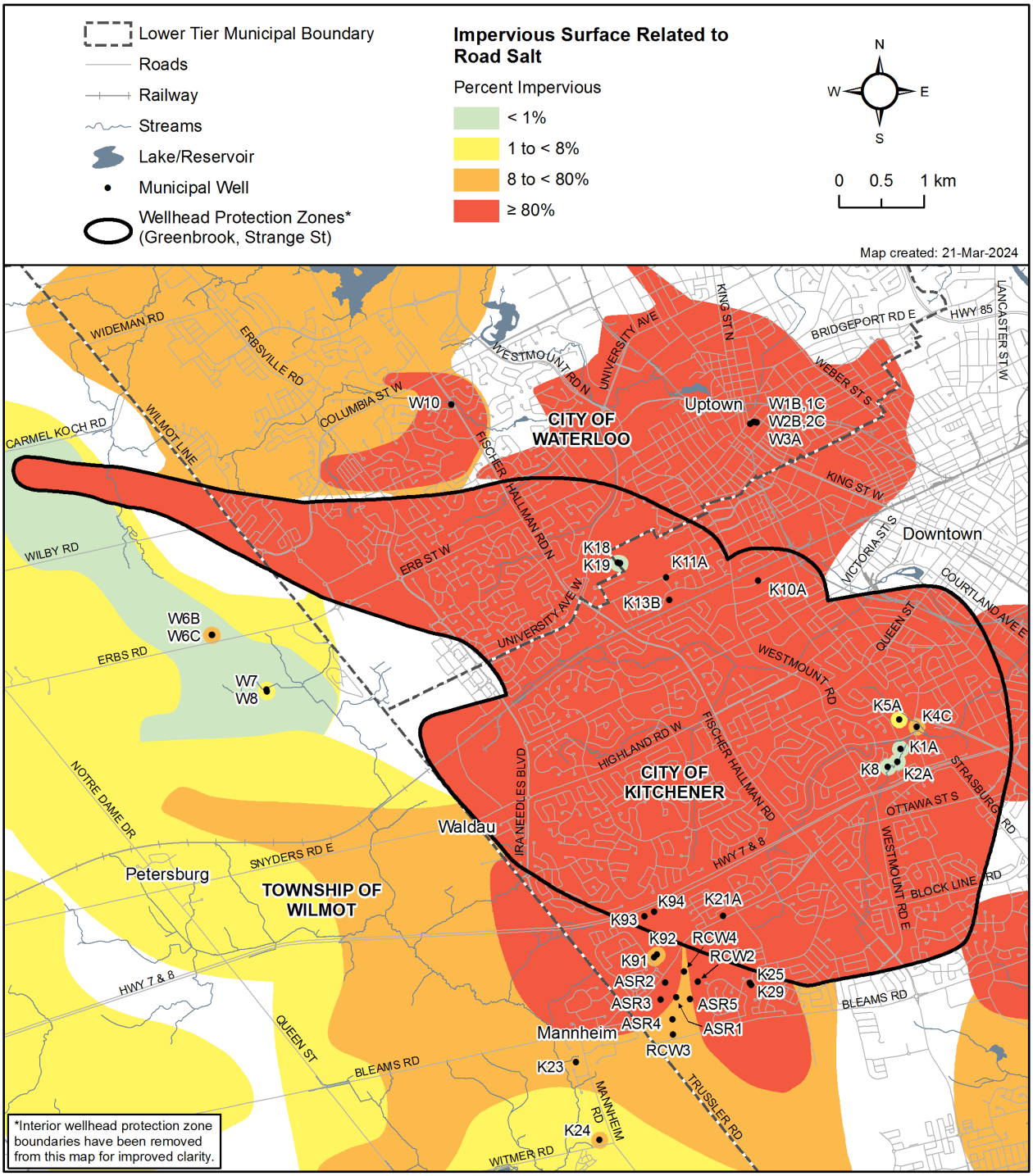
Map 8.3—27: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A, and K8) and Strange Street (K10A, K11A, K13B, K18 and K19) Well Supply Percent Managed Land



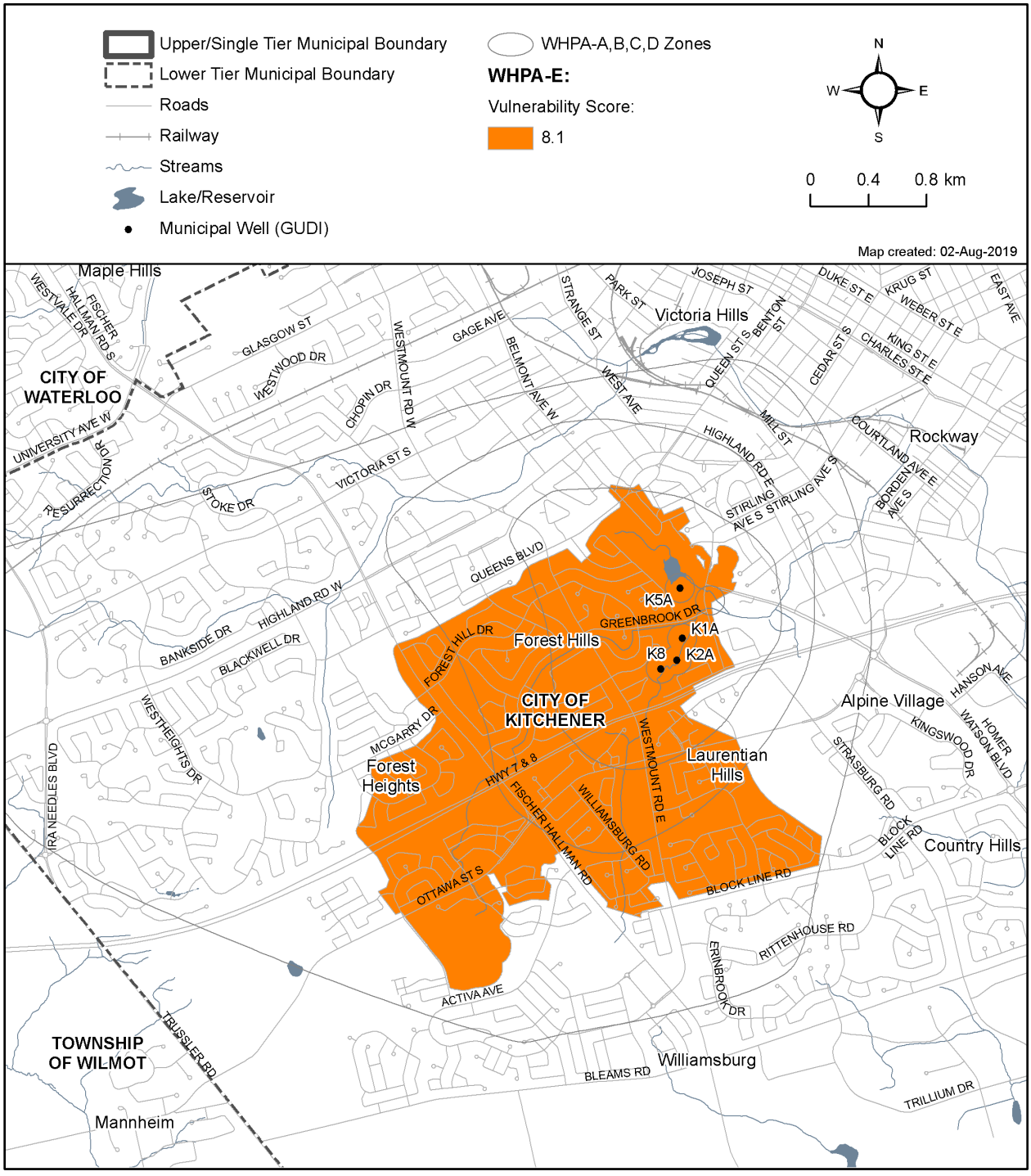
Map 8.3—28: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A, and K8) and Strange Street (K10A, K11A, K13B, K18 and K19) Well Supply Livestock Density



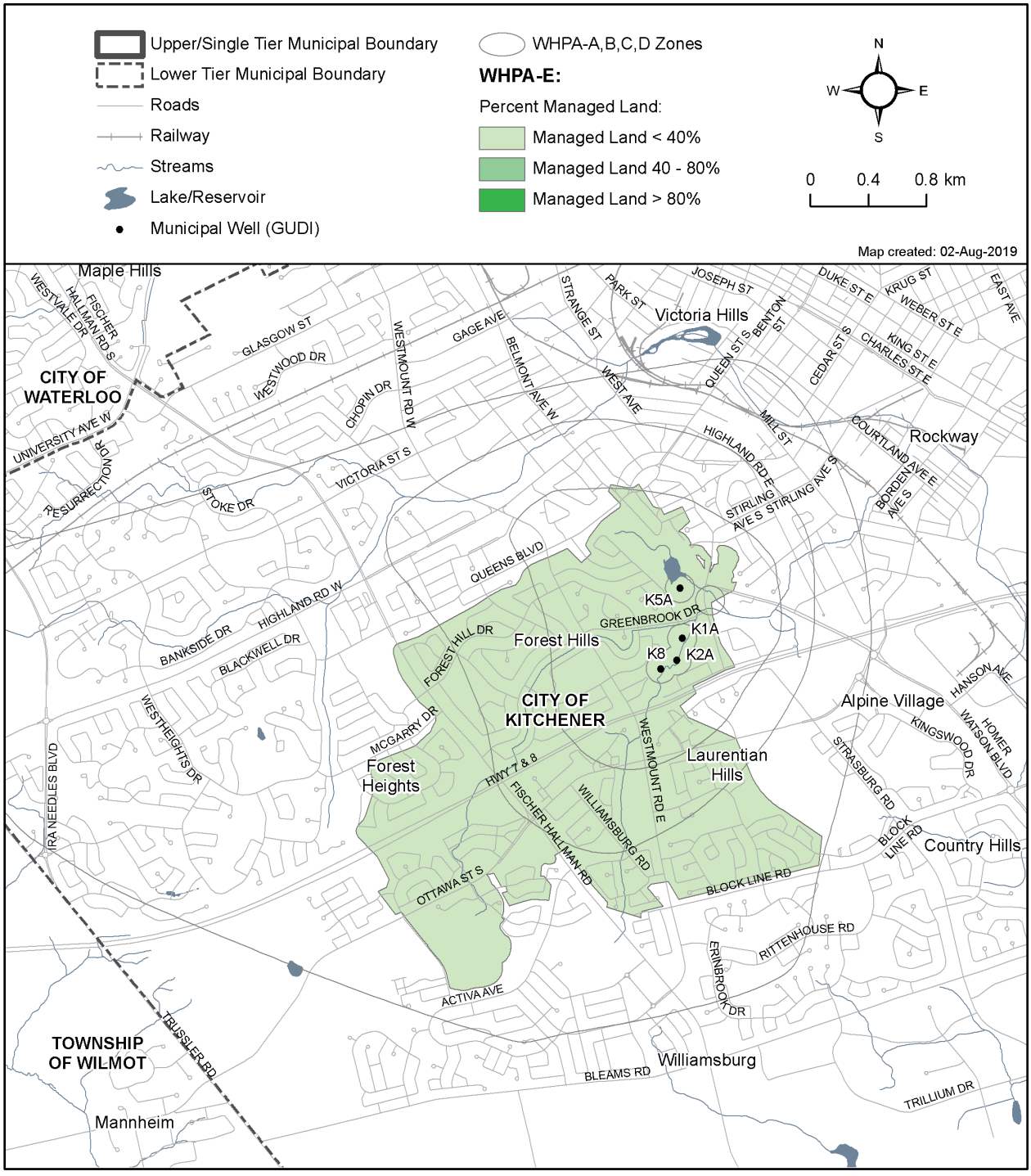
Map 8.3—29: Kitchener Area Inset 2: Greenbrook (K1A, K2A, K4C, K5A, and K8) and Strange Street (K10A, K11A, K13B, K18 and K19) Well Percent Impervious Surfaces



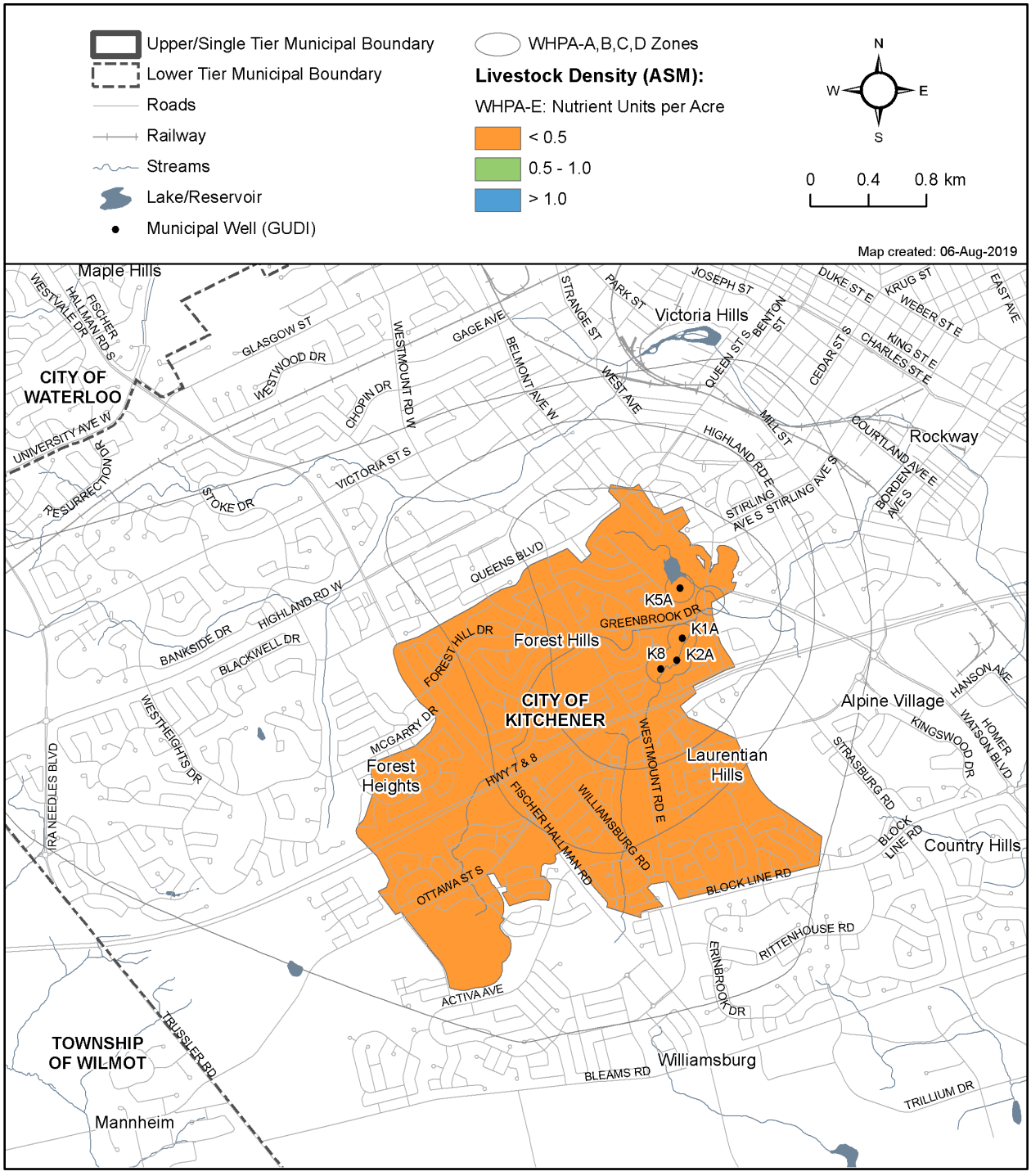
Map 8.3—30: Greenbrook Well Supply Wellhead Protection Area E Vulnerability



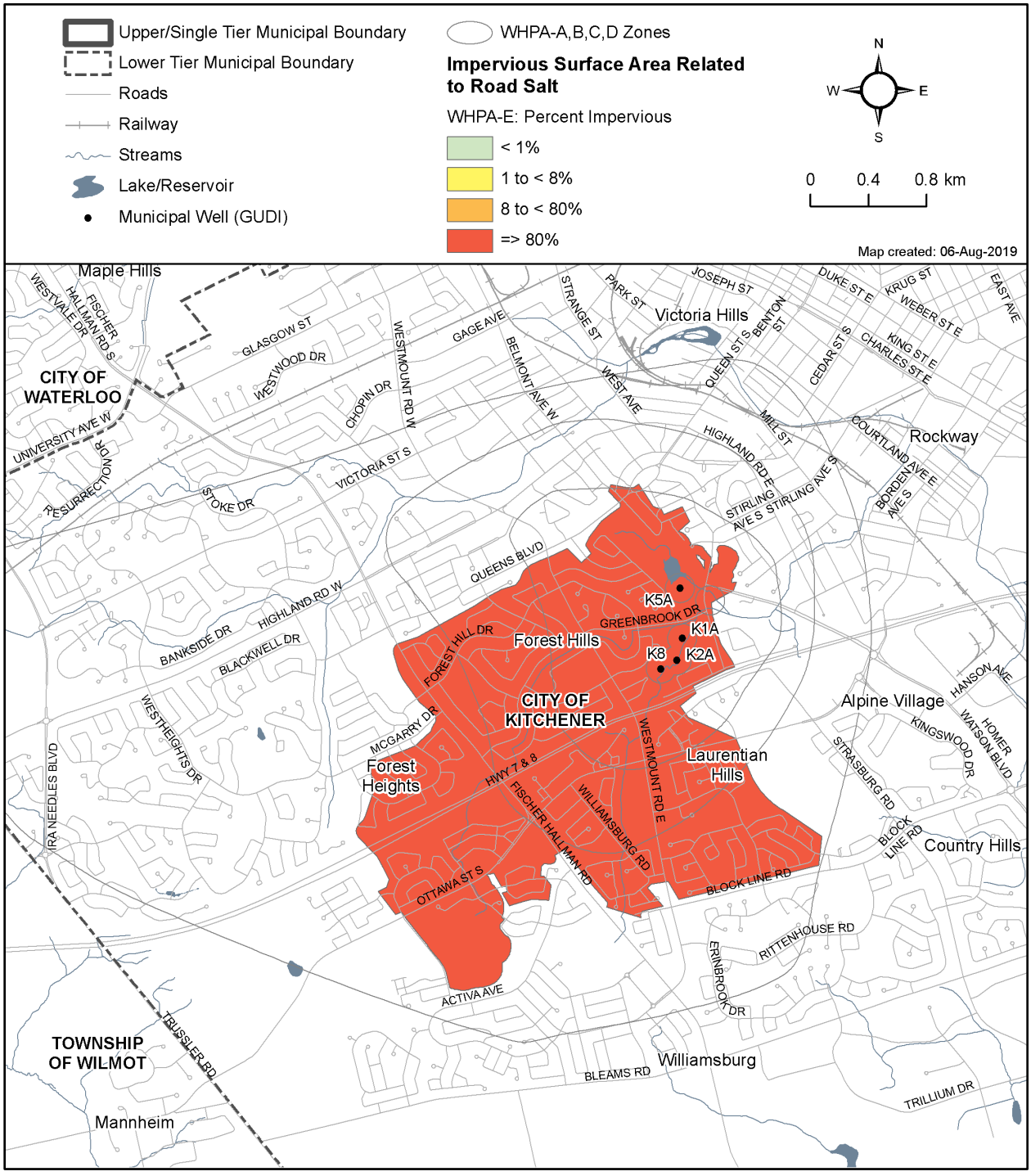
Map 8.3—31:Greenbrook Well Supply WHPA-E Percent Managed Lands



Map 8.3—32: Greenbrook Well Supply WHPA-E Livestock Density



Map 8.3—33: Greenbrook Well Supply WHPA-E Percent Impervious Surfaces



Identification of Significant, Moderate and Low Drinking Water Threats in the Greenbrook Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—62 and Map 8.3—66** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—19 provides a summary of the threat levels possible in the Greenbrook Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. "Yes" indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; "No" indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—62** and **Map 8.3—66**.

Table 8.3—3: Identification of Drinking Water Threats in the Greenbrook Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A/B	10	Yes	Yes	Yes
Chemicals	WHPA-B	8	Yes	Yes	Yes
Chemicals	WHPA-B/C	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
Chemicals	WHPA-E	8.1	Yes	Yes	Yes
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	2 & 4	No	No	No
DNAPLs	WHPA-E	8.1	No	Yes	Yes
Pathogens	WHPA-A/B	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes
Pathogens	WHPA-E	8.1	Yes	Yes	Yes

Threats and Issues Enumeration for the Greenbrook Wellfield

The protection area for the Greenbrook Wellfield overlaps with the Mannheim, Parkway, and Strange Street Wellfield areas. However, threat ranking results related to the Mannheim, Parkway, and Strange Street Wellfields are presented in **Section 8.3 – Kitchener Area Wellfields.**

Chloride and Sodium

The drinking water Issue of chloride has been identified in this Wellfield at all production wells as per Technical Rule 114. Note that well K4C was constructed as a replacement well for K4B on the same property, is screened in the same aquifer, and has recently

been added to the Permit to Take Water for this wellfield. Therefore, well K4C is expected to have the same water chemistry as well K4B and is assigned the same *Issues*.

Groundwater samples from Greenbrook wells have indicated increasing concentrations of chloride since at least 1973 (the start of available records) with raw water samples from wells K1, K4B, and K5A currently containing chloride concentrations at or over the Ontario Drinking Water Aesthetic Objective (ODW-AO) of 250 mg/L (**Figure 8.3—7**). Currently, raw water samples from wells K1A, K4B, and K5A typically contain chloride at or over the ODW-AO of 250 mg/L. Samples from wells K2A and K8 show lower values of chloride but increasing trends.

Similar to chloride trends, sodium concentrations are increasing at the Greenbrook wells, and well K5A typically exceeds the sodium AO of 200 mg/L (**Figure 8.3—8**). The chloride concentration of the blended water within the Greenbrook reservoir is typically less than the AO of 250 mg/L.

An investigation into the primary source of chloride and sodium to the Wellfield groundwater found that the concentrations observed are consistent with historical application of de-icing salt to roads and parking lots (WESA, 2013). Chloride and sodium are identified as an *Issue* for all wells, in part because past monitoring has indicated that chloride and sodium concentrations may quickly increase in individual wells if pumping is decreased at well K5A.

The parameter 1,4-dioxane is not currently listed as an Issue at the Greenbrook Wellfield; however, four of the five Greenbrook wells are impacted by elevated levels (between approximately 10 and 300 µg/L) of the organic compound and the Region operates a treatment system (ultra-violet oxidation) to reduce the impacts to acceptable levels. There is currently no Ontario Drinking Water Standard (ODWS) for this compound and the Region is currently assessing the long-term operating parameters of the treatment system.

For the Greenbrook Wellfield, the Issue Contributing Area was set at the 25 year time of travel capture zone plus the WHPA-E zone (see **Map 8.3—55** and **Map 8.3—66**). This delineation accounts for potential surface water transport of salt contamination to the well, by the surface water to groundwater pathway. The Issue Contributing Area for the Greenbrook Wellfield is shown in **Map 8.3—70**.

The total number of identified significant drinking water threats in this Wellfield is 499. The number of properties in this Wellfield with identified significant drinking water threats is 399. Details surrounding the types of threats and circumstances found in the Greenbrook wellhead protection areas are outlined in **Table 8.3—20**.

One Significant Condition was identified in the Greenbrook wellfield. The site is a former landfill located within the WHPA-C and WHPA-D, contains groundwater contamination by chloride over the standards referenced by the Technical Rules, extending off-site, and is an Issue-related Condition.

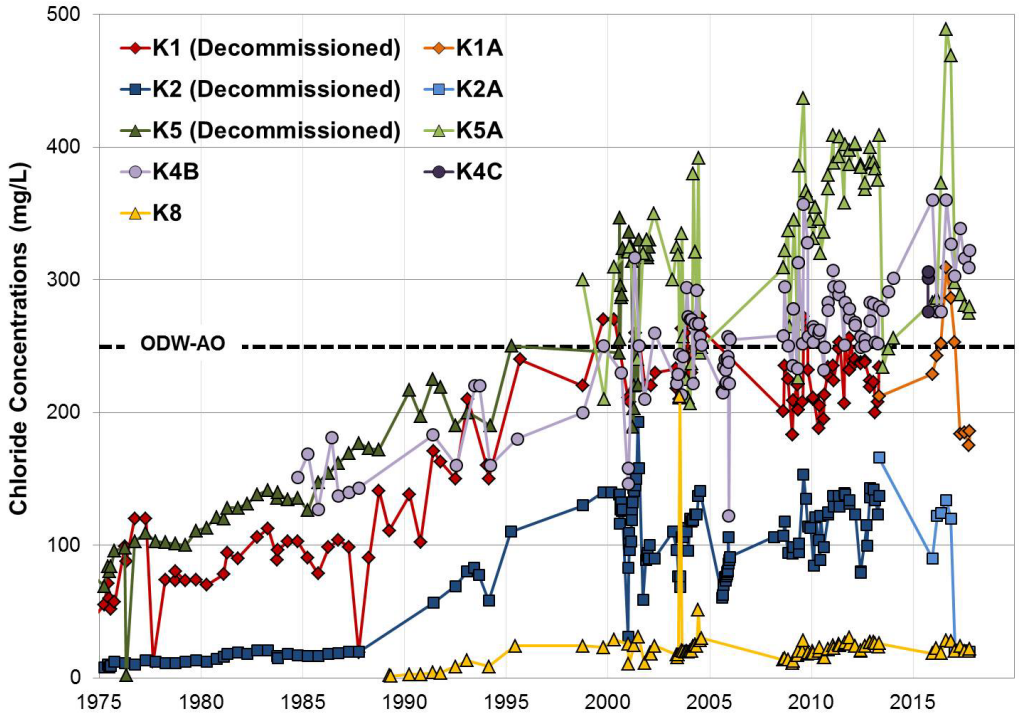


Figure 8.3—4: Chloride Trends at the Greenbrook Wellfield

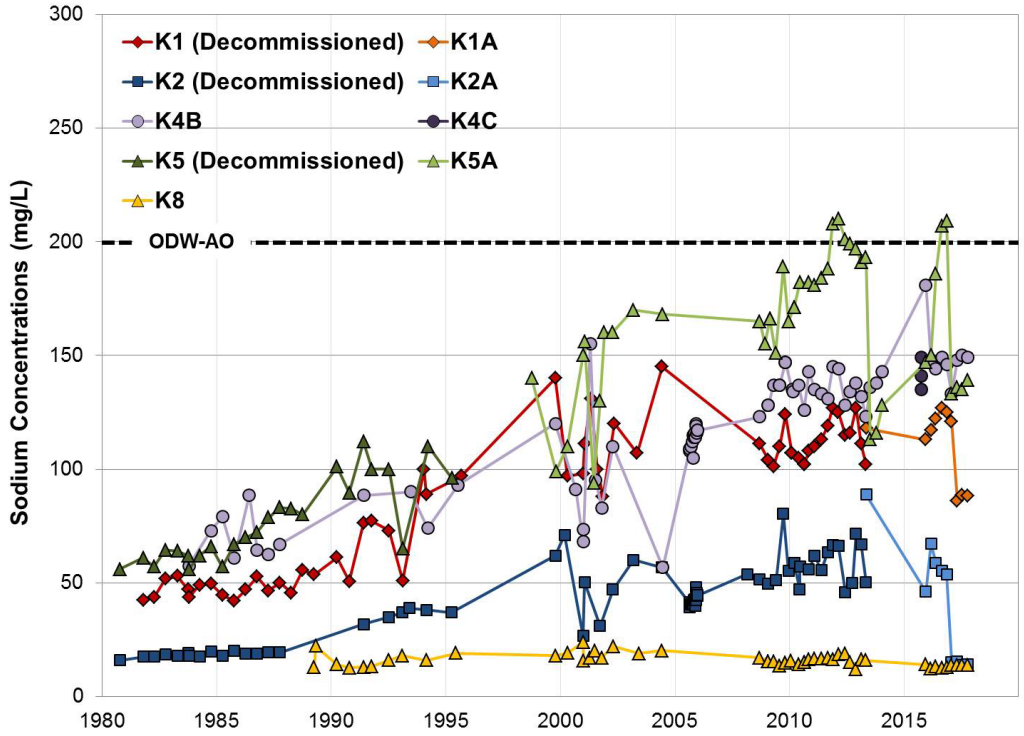


Figure 8.3—5: Sodium Trends at the Greenbrook Wellfield

Table 8.3—4: Significant Drinking Water Quality Threats in the Greenbrook Wellhead Protection Areas (current to February 2019)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
2	Sewage system or sewage works - combined sewer discharge from a storm water outlet to surface water	2	WHPA-E
	Sewage system or sewage works - industrial effluent discharges	2	ICA
	Sewage system or sewage works - storm water management facility (including storm sewers)	52	WHPA-A WHPA-E ICA
10	Application of pesticide to land	1	WHPA-E
12	Application of road salt	365	WHPA-A WHPA-B ICA
13	Storage of road salt	68	WHPA-A WHPA-B ICA
14	Storage of snow	5	WHPA-A WHPA-B ICA
16	Storage and handling of a dense non aqueous phase liquid (DNAPL)	4	WHPA-B WHPA-C
Total Number of Significant Threat Activities		**499**	
Total Number of Properties with Significant Threats		**399**	
Total Number of Significant Conditions		**1**	

[1] Prescribed Drinking Water Quality Threat 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.

Identification of Significant, Moderate and Low Drinking Water Threats in the Strange Street Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—62** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—21 provides a summary of the threat levels possible in the Strange Street Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. “Yes” indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; “No" indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—62**.

Table 8.3—5: Identification of Drinking Water Threats in the Strange Street Wellhead Protection Areas (current to February 2019)

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A/B	10	Yes	Yes	Yes
Chemicals	WHPA-B/C	8	Yes	Yes	Yes
Chemicals	WHPA-B/C/D	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	6	No	Yes	Yes
DNAPLs	WHPA-D	2 & 4	No	No	No
Pathogens	WHPA-A/B	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes

Threats and Issues Enumeration for the Strange Street Wellfield

The protection area for the Strange Street Wellfield overlaps with the Erb Street, Greenbrook, Waterloo North, and William Street Wellfield areas. However, threat ranking results related to the Erb Street Wellfield are presented in **Section 8.2 – Waterloo Area Wellfields.** Threat ranking results related to the Greenbrook Wellfield are presented in **Section 8.3 – Kitchener Area Wellfields.** Threat ranking results related to the Waterloo North and William Street Wellfields are presented in **Section 8.2 - Waterloo Area Wellfields.**

The Strange Street supply wells are located within an area approximately 1.6 kilometers in length. Due to the distance between well locations, distinct capture zones have been delineated for most wells, and the *Issues* for each well have been evaluated separately.

Chloride and sodium have been designated an *Issue* for well K10A only at this wellfield.

All the Strange Street supply wells have increasing chloride and sodium concentrations in the raw water samples, since at least 1973 when regular monitoring began. K10A has the highest chloride concentrations, currently at approximately 250 mg/L which is the ODW-AO. Sodium concentrations at well K10A have increased to approximately 150 mg/L, and linear trend analysis indicates that sodium at well K10A will reach the ODW-AO of 200 mg/L within 10 years (**Figure 8.3—9, Figure 8.3—10**).

Chloride and sodium concentrations in the remaining wells are not predicted to increase to the ODW-AO within 10 years, based on linear trend analysis.

The *Issue Contributing Area* is delineated as the 25-year time-of-travel for Strange Street well K10A is shown in **Map 8.3—70**.

The total number of identified significant drinking water threats in this wellfield is 153. No additional significant threats were identified with the recent incorporation of well K13B. The number of properties in this wellfield with identified significant drinking water threats is 114. Details surrounding the types of threats and circumstances found in the Strange Street wellhead protection areas are outlined in **Table 8.3—22**. No Significant Conditions were identified in this wellfield as per Technical Rule 126.

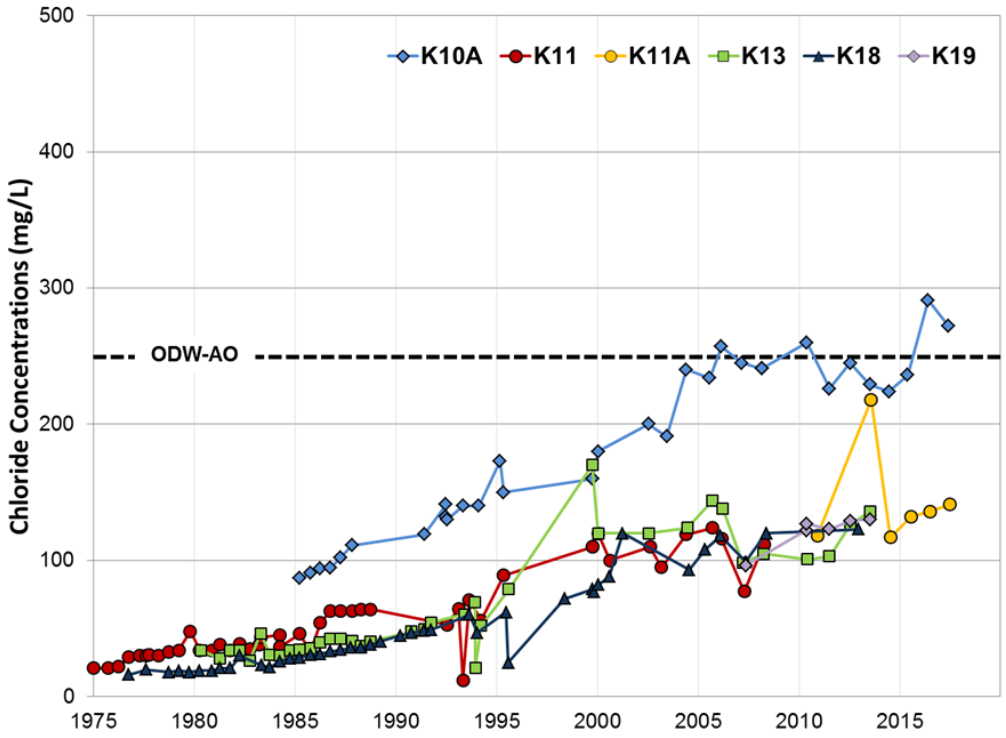


Figure 8.3—6: Chloride Trends in the Raw Water at the Strange Street Supply Wells, Kitchener

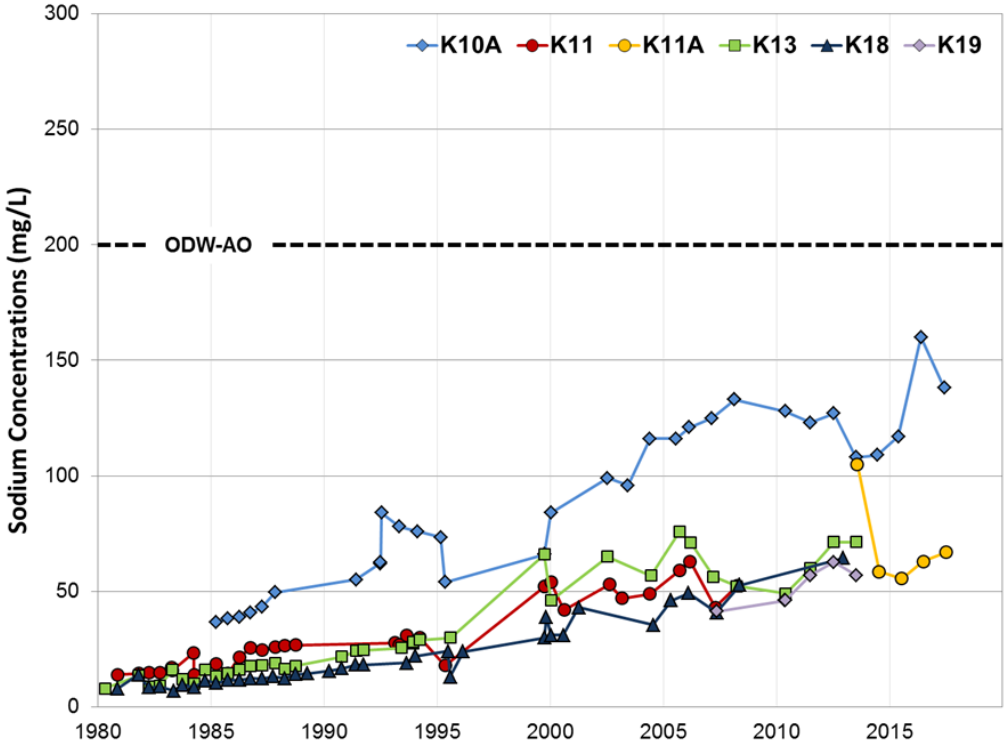


Figure 8.3—7: Sodium Trends in the Raw Water at the Strange Street Supply Wells, Kitchener

Table 8.3—6: Significant Drinking Water Quality Threats in the Strange Street Wellhead Protection Areas (current to February 2019)

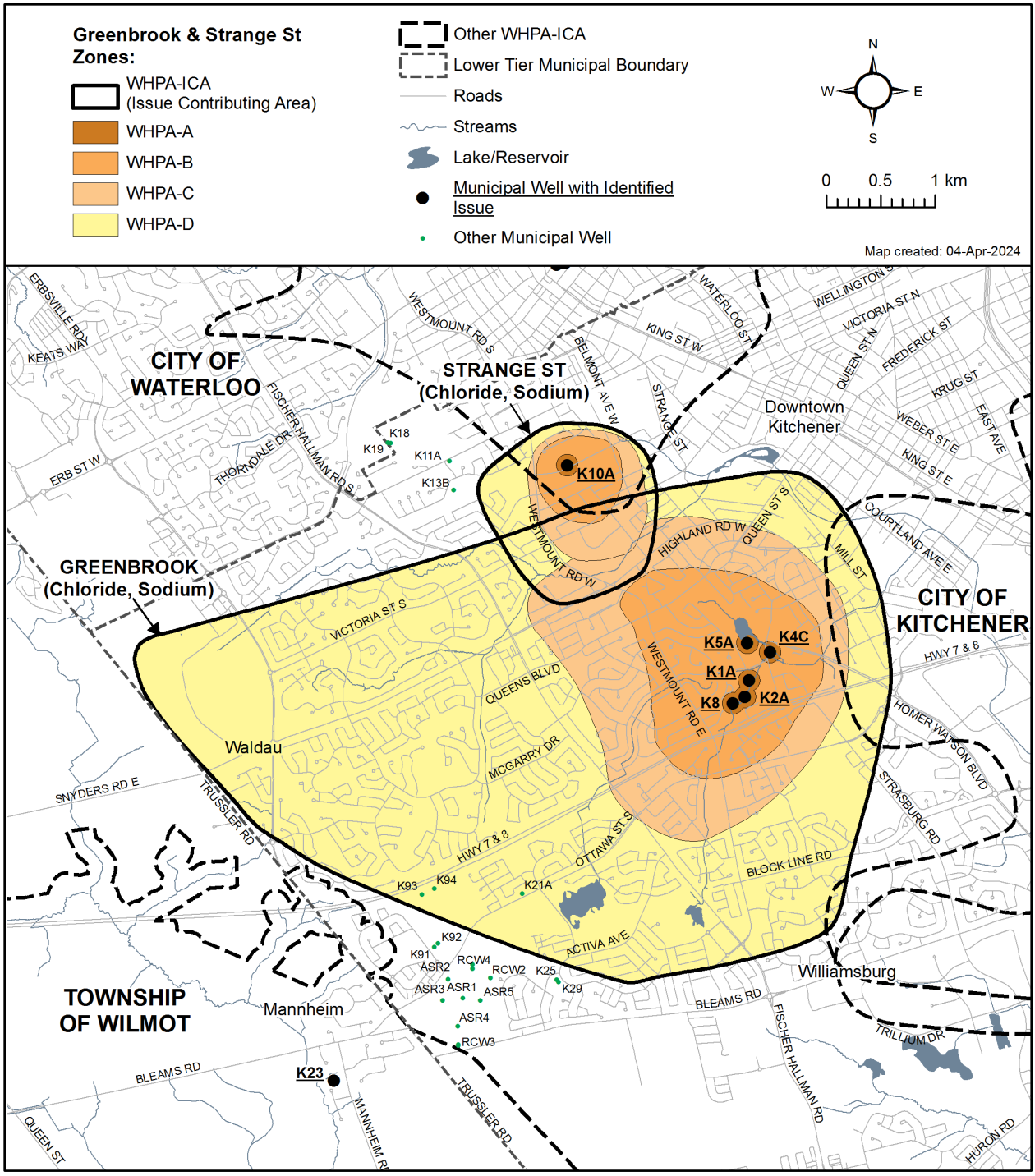
PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
1	Storage of small quantity exemptions (SQEs) of hazardous wastes or liquid industrial wastes at any type of waste disposal site including generators, receivers, and transfer/processing sites	1	WHPA-A
	Waste disposal site - storage of hazardous wastes or liquid industrial wastes subject to registration and manifesting	3	WHPA-B
2	Sewage system or sewage works - onsite sewage systems	1	WHPA-B
	Sewage system or sewage works - sanitary sewers and related wastewater collection systems	2	WHPA-A WHPA-B
	Sewage system or sewage works - storm water management facility (including storm sewers)	9	ICA

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
10	Application of pesticide to land	1	WHPA-A WHPA-B
12	Application of road salt	109	WHPA-A WHPA-B ICA
13	Storage of road salt	21	ICA
14	Storage of snow	1	ICA
15	Storage and handling of fuel	1	WHPA-B
16	Storage and handling of a dense non aqueous phase liquid (DNAPL)	3	WHPA-B WHPA-C
17	Storage of an organic solvent	1	WHPA-B
Total Number of Significant Threat Activities		**153**	
Total Number of Properties with Significant Threats		**114**	

[1] Prescribed Drinking Water Quality Threat 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.

Map 8.3—34: Greenbrook and Strange Street Well Supply Issue Contributing Area



8.3.3 Parkway and Strasburg Wellfields

Parkway Wellfield

The water supply for the Parkway Wellfield is obtained from production wells K31, K32 and K33. Each of these wells pumps at approximately the same rate. All production wells discharge to a common reservoir before water is pumped to the Region's IUS system **(Table 8—1)**. All of the production wells are screened across depths ranging from approximately 24 m below grade to 34 m below grade within the Pre-Catfish Creek Aquifer (AFD1) which is overlain by an extensive confining to semi-confining aquitard unit consisting of the Maryhill and Catfish Creek Tills, with the Upper Waterloo Moraine Sands at ground surface **(Table 8.1—6)**.

Strasburg Wellfield

The water supply for the Strasburg Wellfield is obtained from production wells K34 and K36. K34 is pumped at a higher rate and more consistently than K36. The production wells are screened from approximately 28 to 50 m below grade within the Pre-Catfish Creek Aquifer (AFD1), which is overlain by an extensive confining to semi-confining aquitard unit consisting of the Maryhill and Catfish Creek Tills, with the Upper Waterloo Moraine Sands identified at ground surface **(Table 8.1—6)**. The Strasburg Wellfield supplies water to the IUS **(Table 8—1)**.

Vulnerability and Transport Pathways

A water quality Issue for TCE was designated at well K32 but not at K31 and K33, resulting in a need to generate a WHPA for K32 separate from K31 and K33. **Map 8.3—71** presents the protection areas, **Map 8.3—72** shows the unadjusted intrinsic vulnerability and the adjusted intrinsic vulnerability is shown on **Map 8.3—73.**

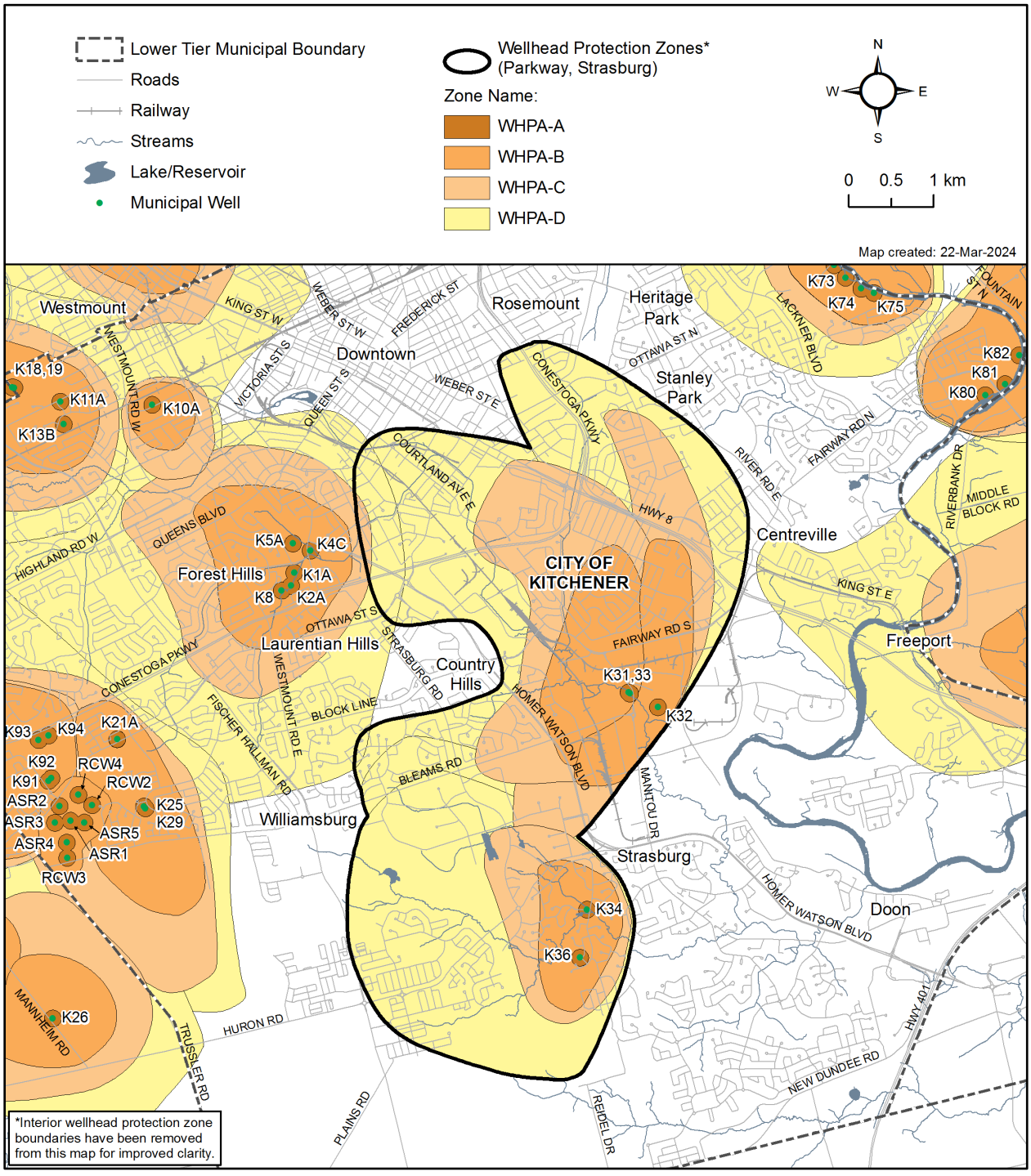
Analysis of the attributes of each potential transport pathway in the Parkway and Strasburg Wellfields resulted in the identification of several well and underground service pathway clusters situated within the WHPA-A through to WHPA-D which warranted an increase to the ISI in those areas. **Map 8.3—74** and **Map 8.3—75** show these transport pathways and area of influence for the WHPAs. **Map 8.3—76** shows the final vulnerability scoring.

Percent Managed Land, Livestock Density, Salt Loading Potential and Percent Impervious Surface

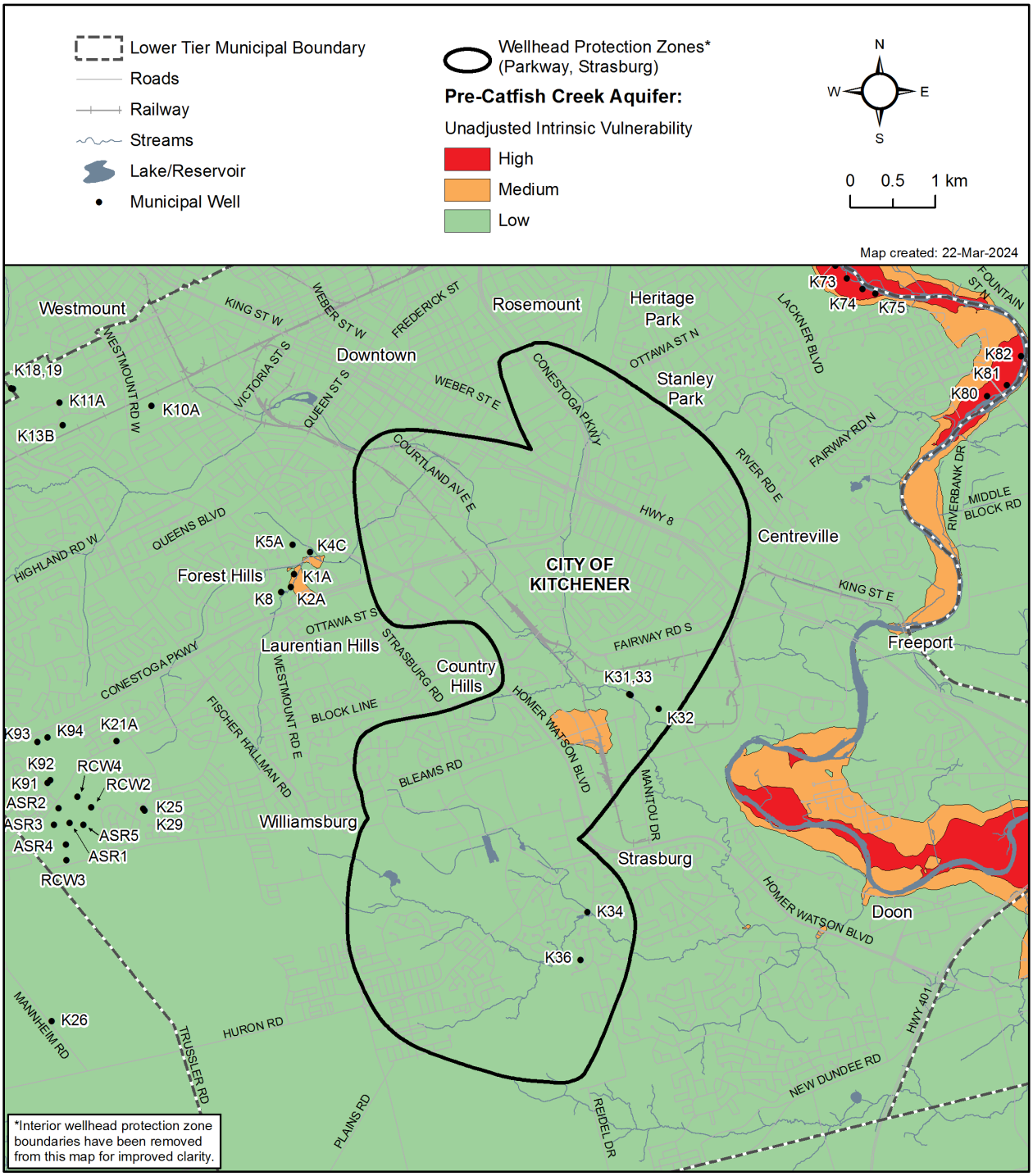
The calculations for determining the percent managed land, livestock density, salt loading potential and corresponding percent impervious surface for the Parkway and Strasburg Wellfields followed the methods outlined in **Section 8.1 - Water Quality Risk Assessment**.

Map 8.3—77, Map 8.3—78 and Map 8.3—79 show the percent managed lands, livestock density, and percent impervious surface, respectively, for both the Parkway and Strasburg Wellfields.

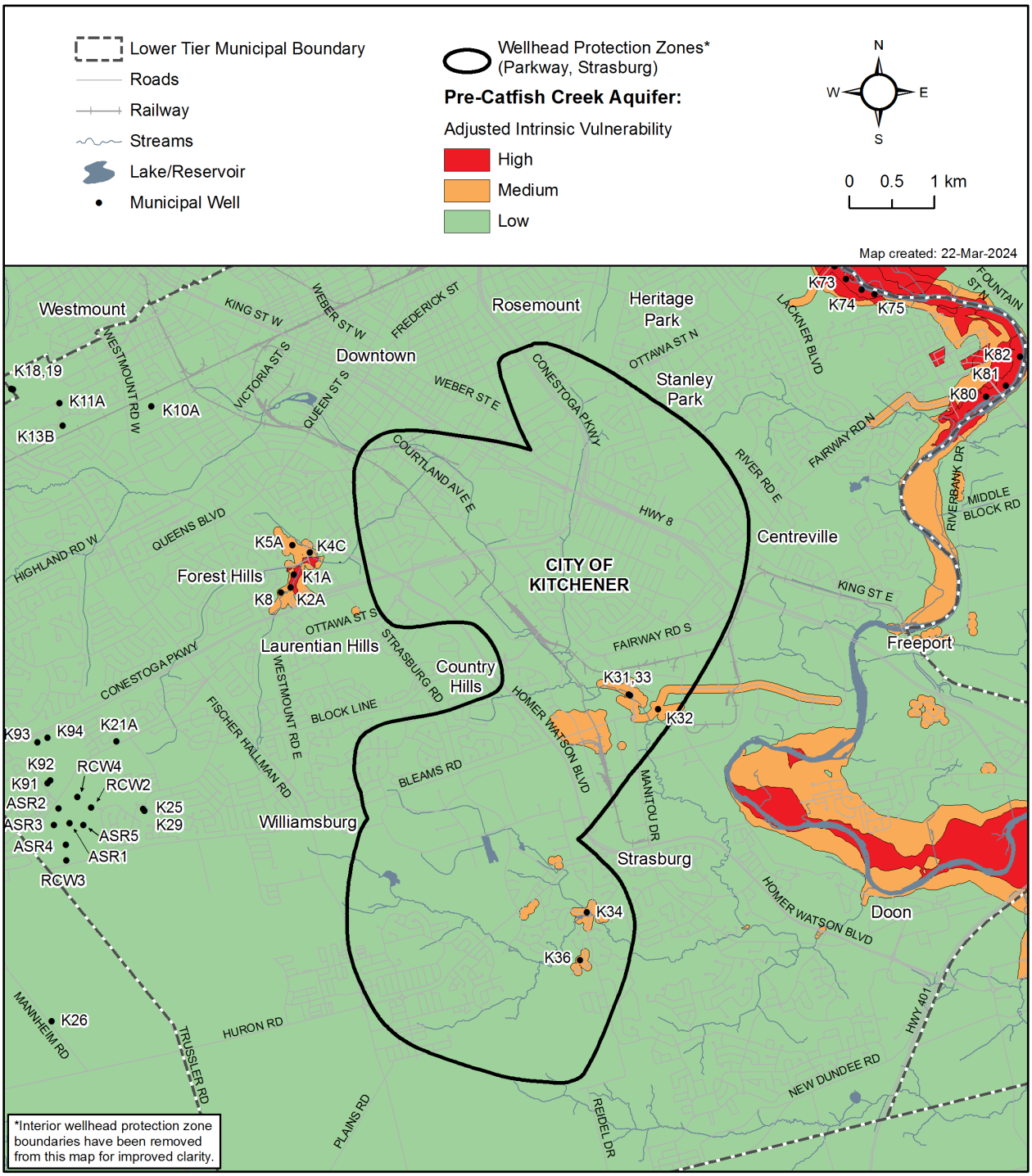
Map 8.3—35: Kitchener Area Inset 3: Parkway (K31, K32 and K33) and Strasburg (K34 and K36) Well Supply Wellhead Protection Areas



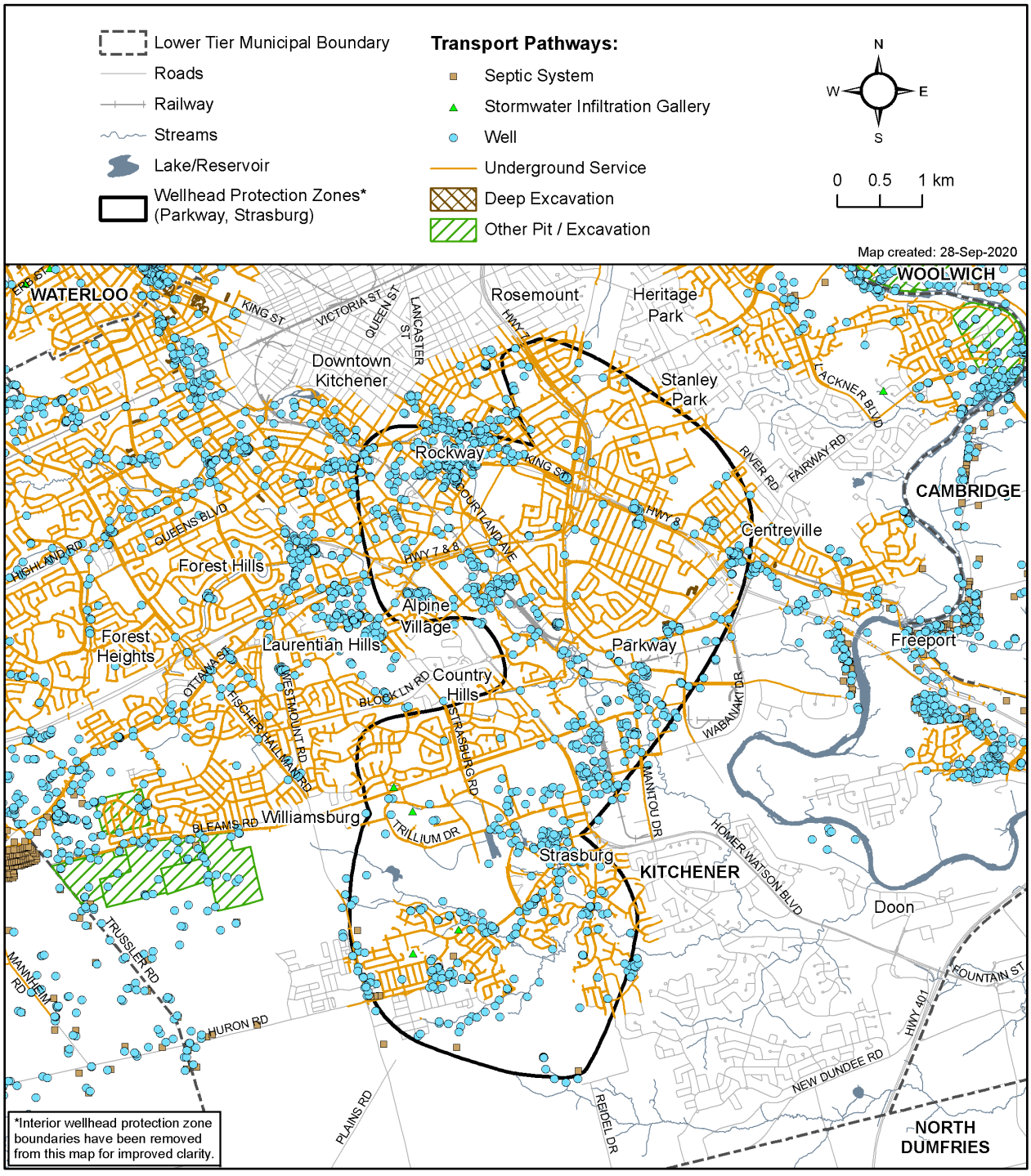
Map 8.3—36: Kitchener Area Inset 3: Parkway (K31, K32, and K33) and Strasburg (K34 and K36) Well Supply Wellhead Protection Areas Unadjusted Intrinsic Vulnerability



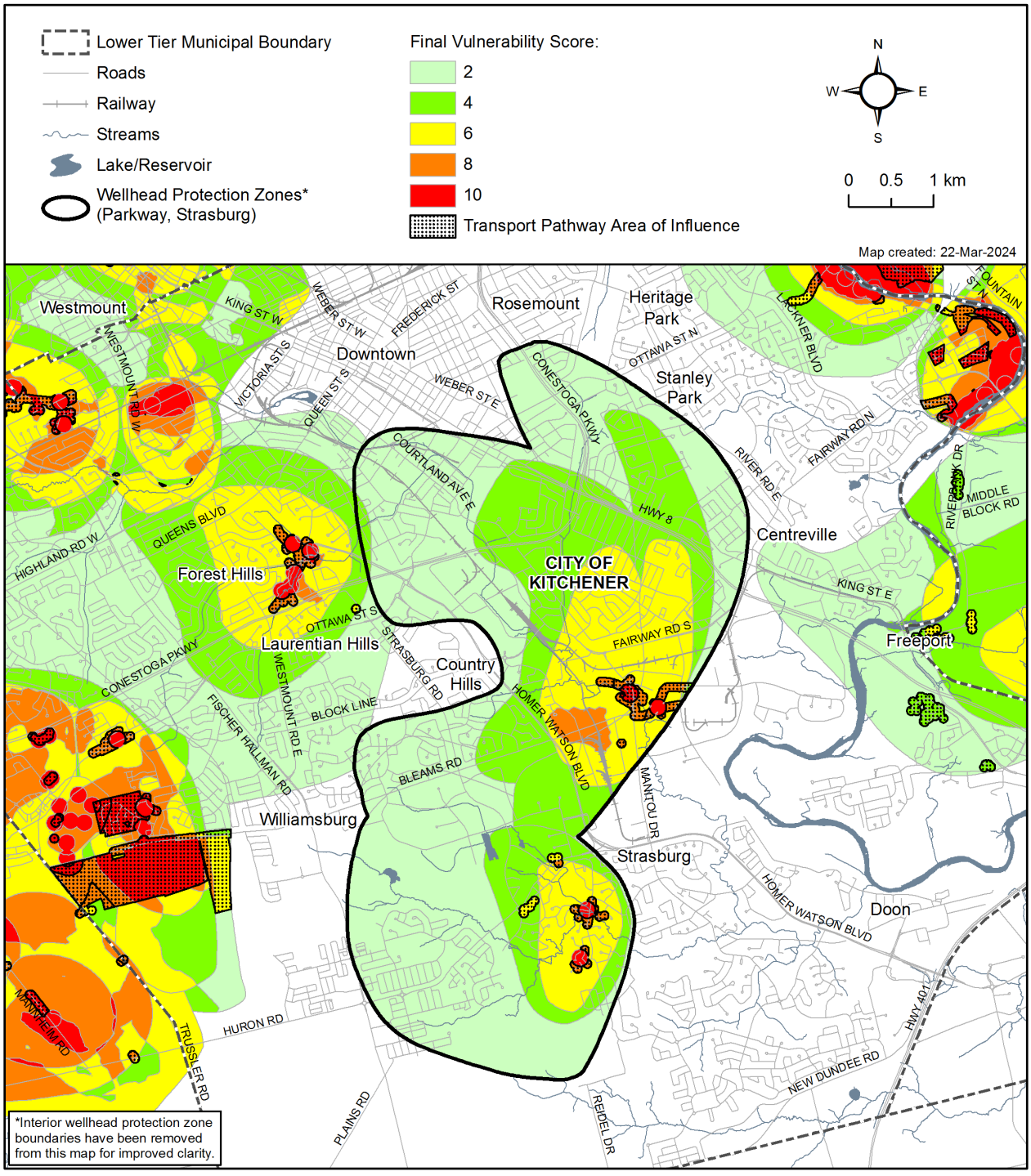
Map 8.3—37: Kitchener Area Inset 3: Parkway (K31, K32, K33) and Strasburg (K34 and K36) Well Supply Wellhead Protection Areas Adjusted Intrinsic Vulnerability



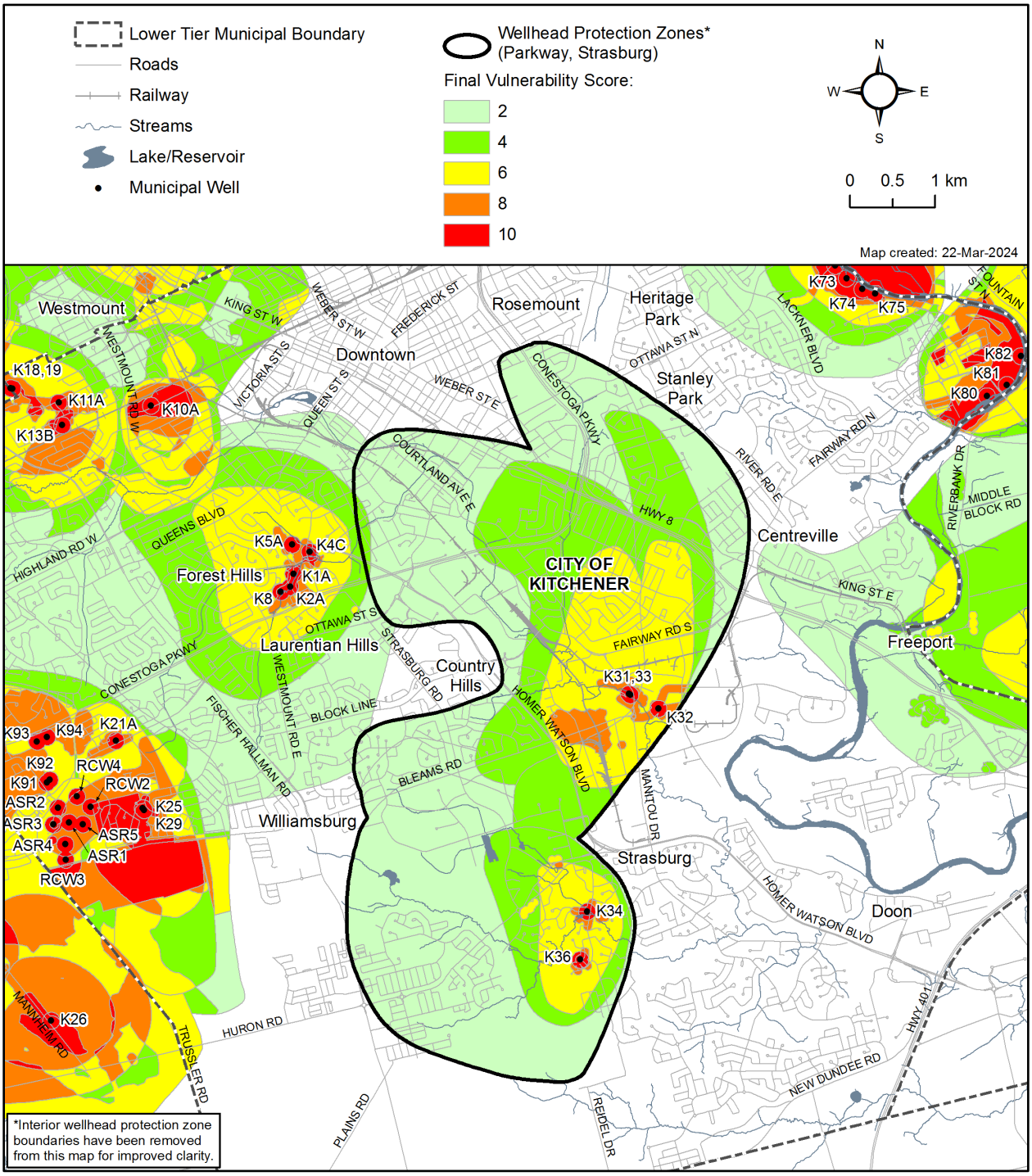
Map 8.3—38: Kitchener Area Inset 3: Parkway (K31, K32 and K33) and Strasburg (K34 and K36) Well Supply Transport Pathways



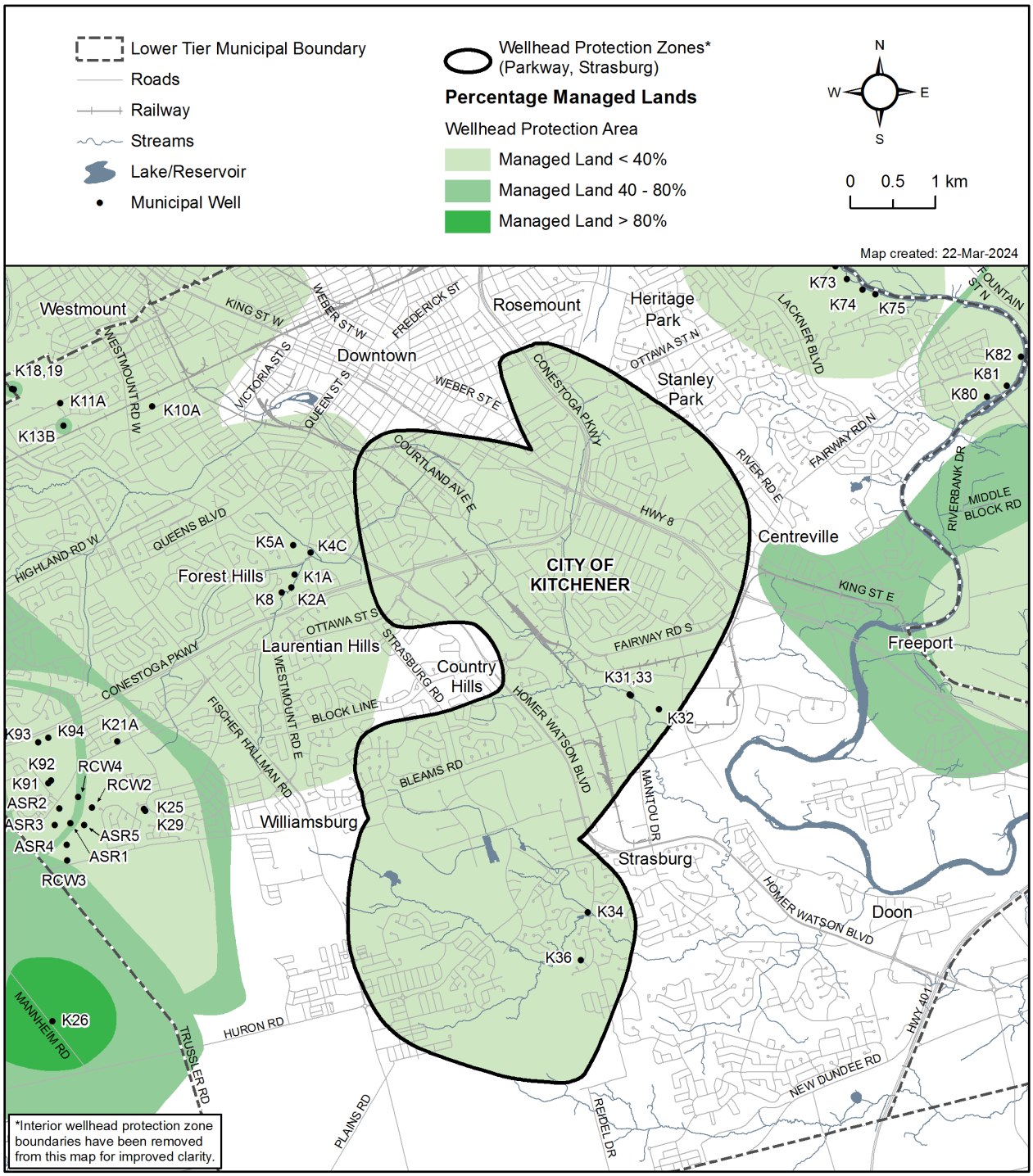
Map 8.3—39: Kitchener Area Inset 3: Parkway (K31, K32 and K33) and Strasburg (K34 and K36) Well Supply Transport Pathways Area of Influence



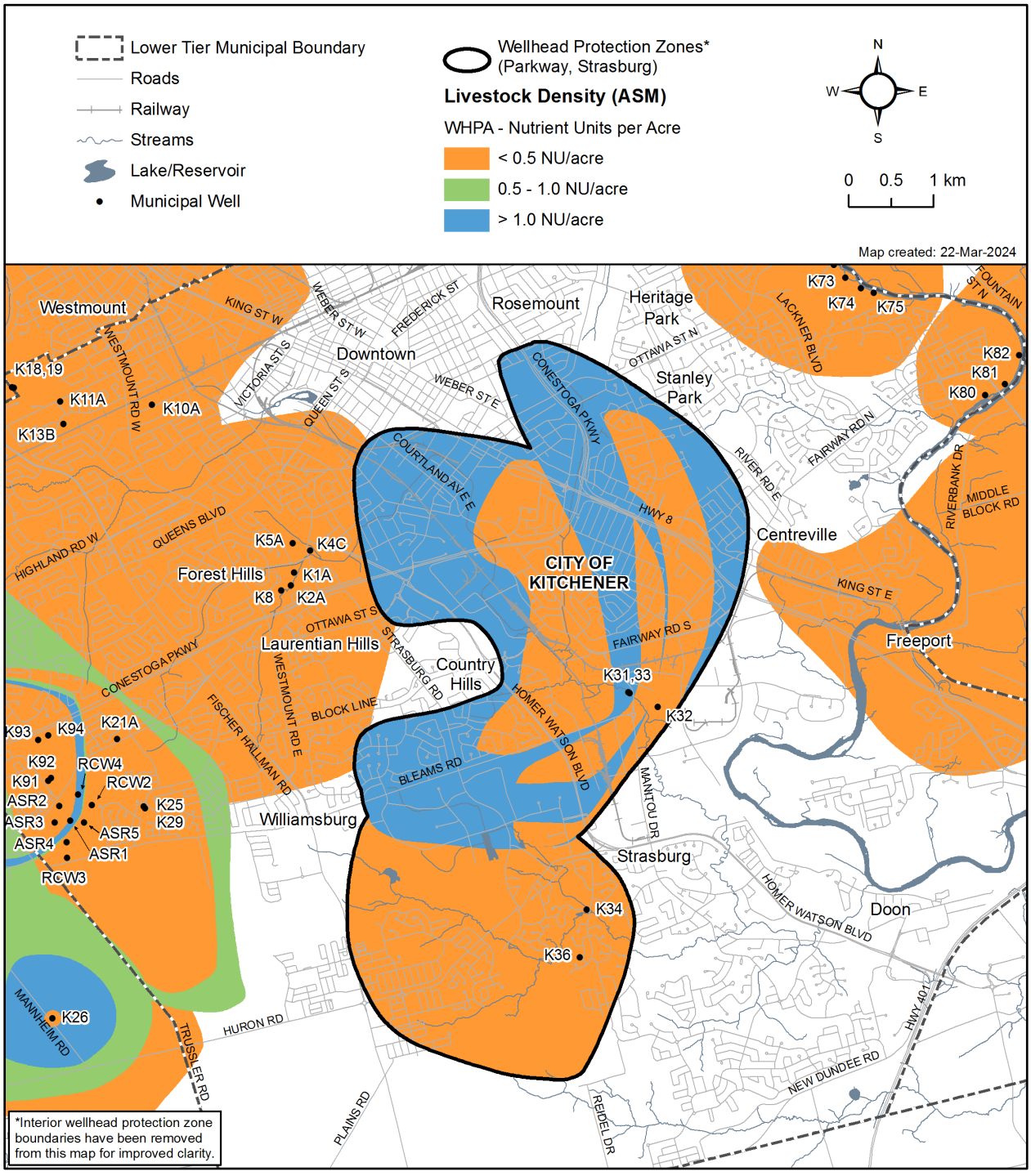
Map 8.3—40: Kitchener Area Inset 3: Parkway (K31, K32 and K33) and Strasburg (K34 and K36) Well Supply Wellhead Protection Area Final Vulnerability



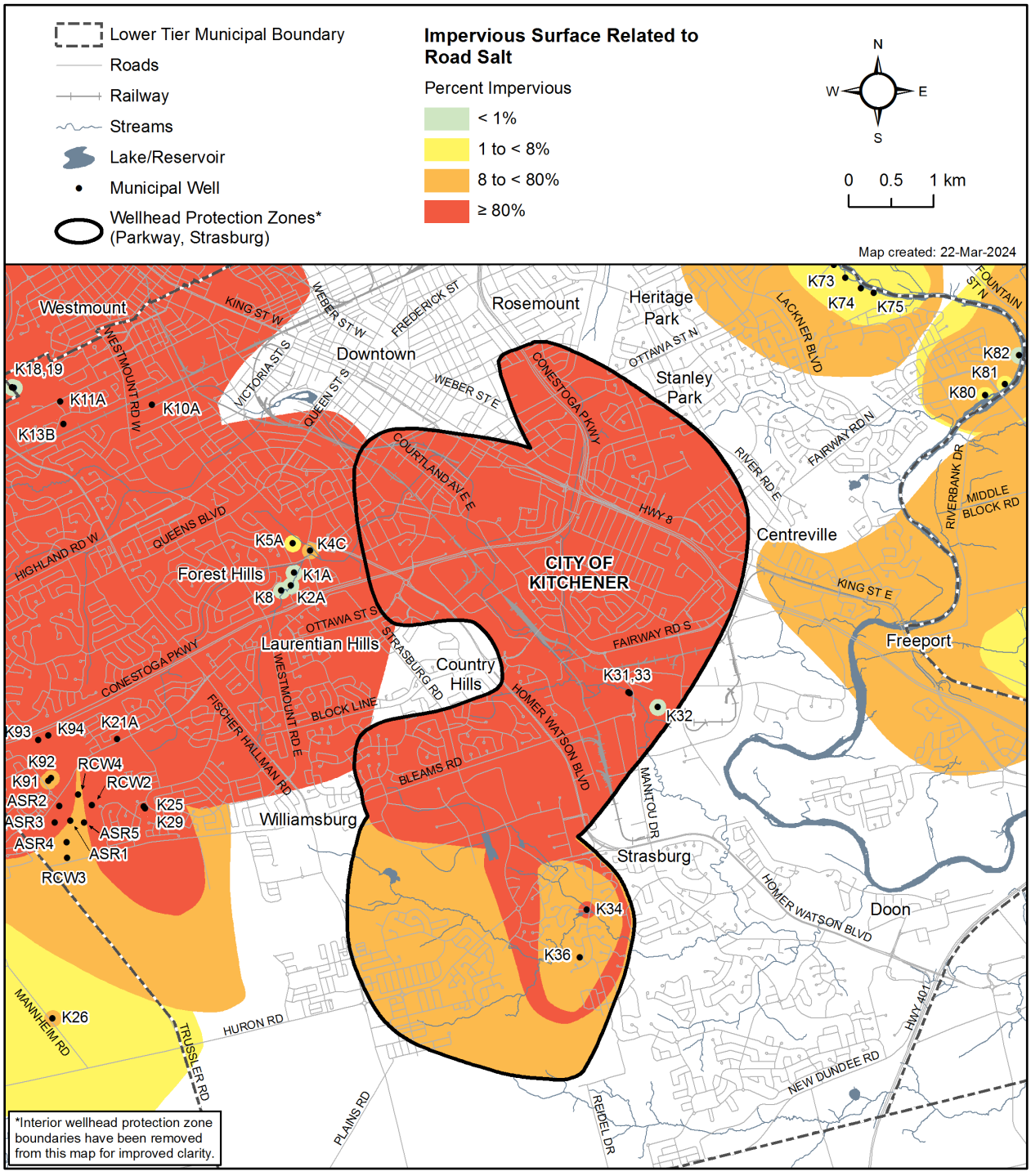
Map 8.3—41: Kitchener Area Inset 3: Parkway (K31, K32 and K33) and Strasburg (K34 and K36) Well Supply Wellhead Protection Areas Percent Managed Land



Map 8.3—42: Kitchener Area Inset 3: Parkway (K31, K32 and K33) and Strasburg (K34 and K36) Well Supply Livestock Density



Map 8.3—43: Kitchener Area Inset 3: Parkway (K31, K32 and K33) and Strasburg (K34 and K36) Percent Impervious Surfaces



Identification of Significant, Moderate and Low Drinking Water Threats in the Parkway Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—76** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—23 provides a summary of the threat levels possible in the Parkway Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. “Yes” indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; “No" indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—76**.

Table 8.3—7: Identification Drinking Water Threats in the Parkway Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A	10	Yes	Yes	Yes
Chemicals	WHPA-B	8	Yes	Yes	Yes
Chemicals	WHPA-B/C	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	2 & 4	No	No	No
Pathogens	WHPA-A	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes

Threats and Issues Enumeration for the Parkway Wells

The protection area for the Parkway Wellfield overlaps with the Greenbrook, Pompeii, Strasburg, and Woolner Wellfield areas. However, threat ranking results related to the Greenbrook, Pompeii, Strasburg, and Woolner Wellfields are presented in **Section 8.3 – Kitchener Area Wellfields.**

A chloride and a sodium Issue has been designated for all three wells in the Parkway wellfield. A TCE issue has been designated for well K32, the easternmost production well.

TCE

Low concentrations of trichloroethylene are consistently detected at well K32 (the easternmost well). Recent concentrations (since 2013) have been between 2 and 5 µg/L compared to the ODWS of 5 µg/L and the MOE guidance value of 2.5 µg/L. In addition, there were two instances where samples where concentrations were higher than the MOE guidance value. Trichloroethylene is generally not detected (< 0.5 µg/L) at wells

K31 and K33. Recent fluctuations in TCE concentrations at K32 may indicate an increasing trend (**Figure 8.3—11**). Therefore, TCE has been designated as an *Issue* for well K32.

As a detailed assessment of properties that might have used TCE has not been completed, the source of the TCE to well K32 is unknown.

Chloride and Sodium

The Parkway production wells have exhibited increasing chloride concentrations since at least 1992 when Region monitoring began. Recent chloride concentrations in raw water have risen to between 275 and 750 mg/L, compared to the ODW-AO of 250 mg/L (**Figure 8.3—12**). Sodium concentrations are currently elevated (approximately 125 to 365 mg/L) with an increasing trend, compared to the ODW-AO of 200 mg/L for sodium (**Figure 8.3—13**).

Based on the elevated concentrations at the supply wells and the increasing concentration trends, both Sodium and Chloride are designated *Issues* for the Parkway wells.

The primary source of chloride and sodium to the wellfield groundwater is consistent with historical application of de-icing salt to roads and parking lots (WESA, 2013).The *Issue Contributing Area* is delineated as the 25 year time-of-travel for the Parkway supply wells and shown in **Map 8.3—80.**

The total number of identified significant drinking water threats in this Wellfield is 889. The number of properties in this wellfield with identified significant drinking water threats is 754. Details surrounding the types of threats and circumstances found in the Parkway wellhead protection areas are outlined in **Table 8.3—24**.

No Significant Conditions were identified in this wellfield as per Technical Rule 126.

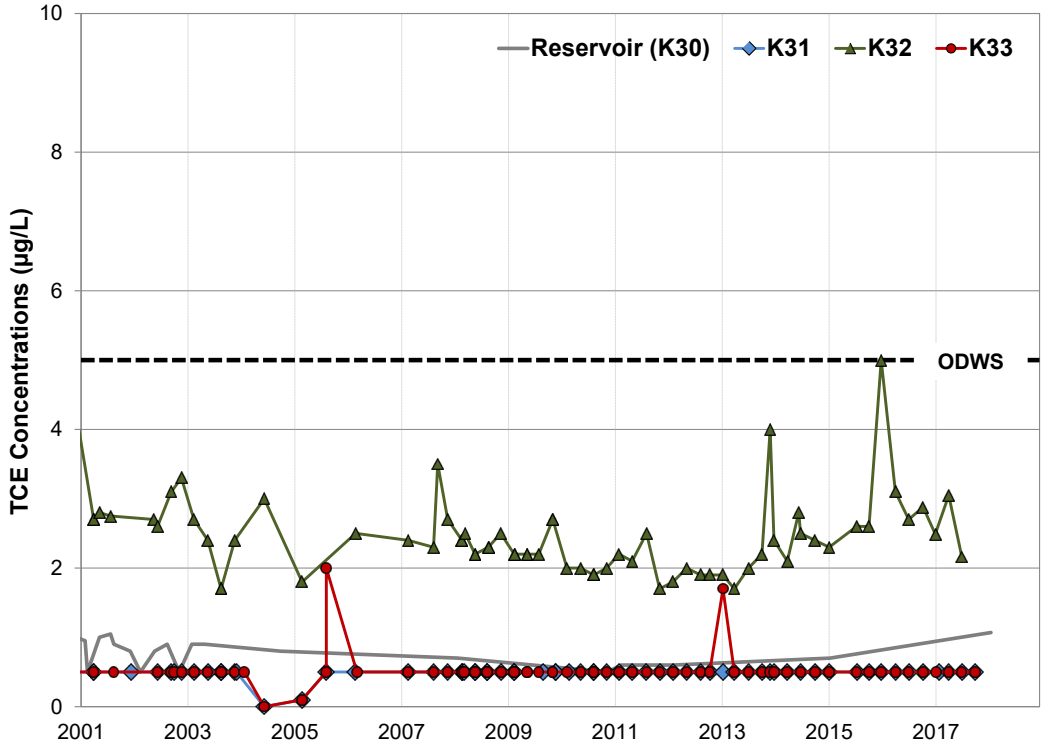


Figure 8.3—8: Trichloroethylene Trends in the Raw Water at the Parkway Supply Wells and Common Reservoir, Kitchener

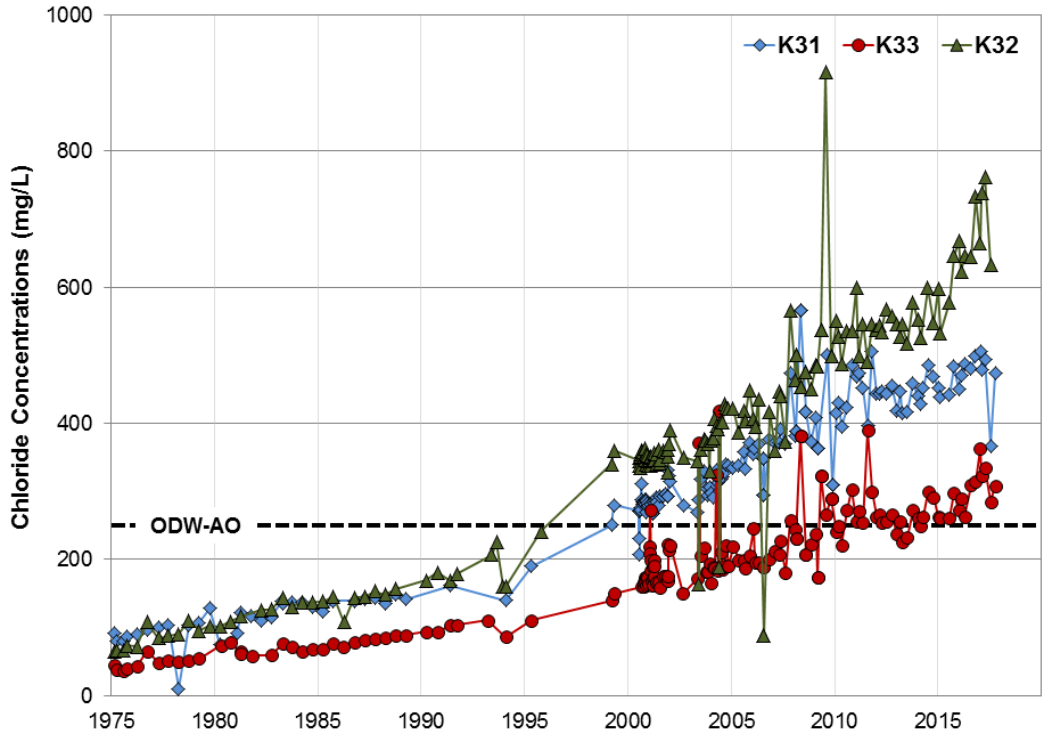


Figure 8.3—9: Chloride Trends in the Raw Water at the Parkway Supply Wells, Kitchener

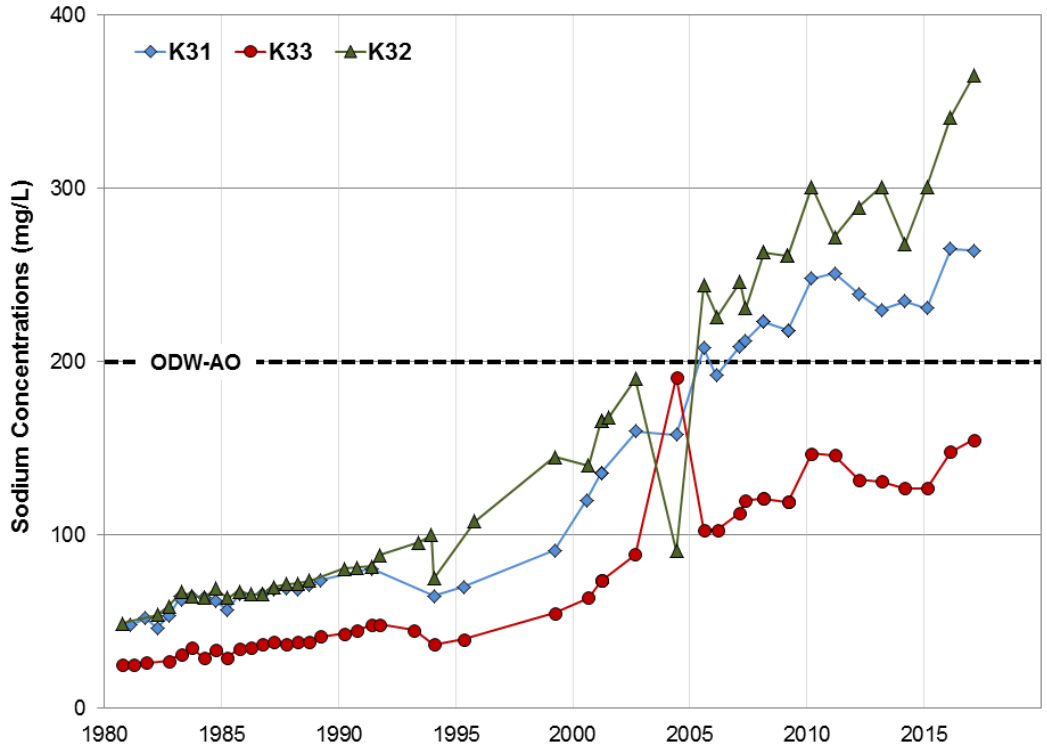


Figure 8.3—10: Sodium Trends in the Raw Water at the Parkway Supply Wells, Kitchener

Table 8.3—8: Significant Drinking Water Quality Threats in the Parkway Wellhead Protection Areas (current to February 2019)

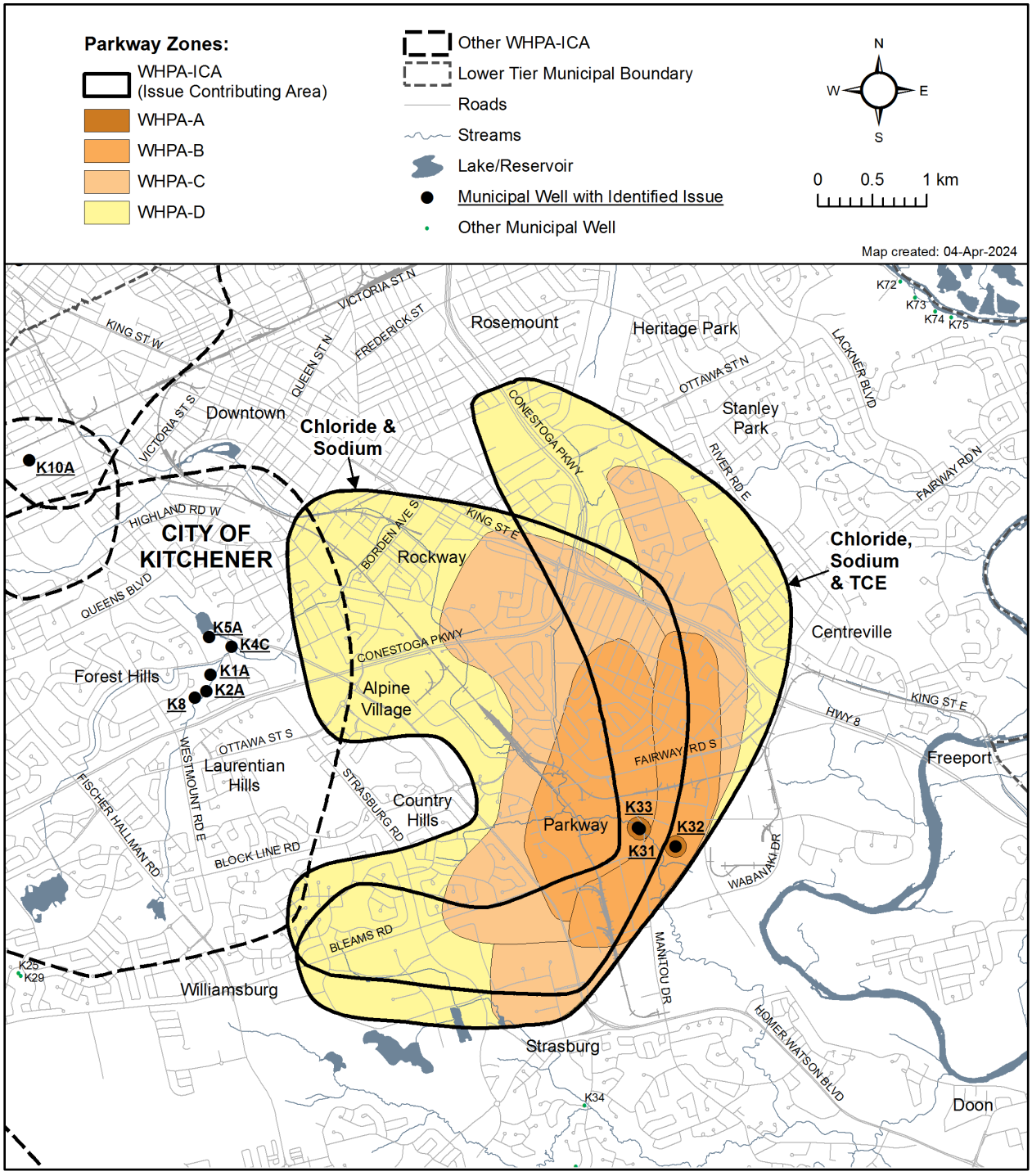
PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
1	Storage of small quantity exemptions (SQEs) of hazardous wastes or liquid industrial wastes at any type of waste disposal site including generators, receivers, and transfer/processing sites	2	WHPA-A
	The land disposal at a waste disposal site of solid non-hazardous waste generated by industrial and commercial sources	1	ICA
	Waste disposal site - storage of hazardous wastes or liquid industrial wastes subject to registration and manifesting	1	WHPA-A
2	Sewage system or sewage works - onsite sewage systems	1	WHPA-A

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
	Sewage system or sewage works - sanitary sewers and related wastewater collection systems	3	WHPA-A
	Sewage system or sewage works - sewage storage - treatment or holding tanks	3	WHPA-A ICA
	Sewage system or sewage works - storm water management facility (including storm sewers)	33	ICA
3	Application of agricultural source material (ASM) to land	1	WHPA-A
4	Storage of agricultural source material (ASM)	1	WHPA-A
9	Storage of commercial fertilizer	1	WHPA-A
10	Application of pesticide to land	1	WHPA-A
11	Storage of a pesticide	2	WHPA-A
12	Application of road salt	740	WHPA-A ICA
13	Storage of road salt	81	ICA
14	Storage of snow	11	ICA
15	Storage and handling of fuel	1	WHPA-A
16	Storage and handling of a dense non aqueous phase liquid (DNAPL)	5	WHPA-C ICA
17	Storage of an organic solvent	1	WHPA-A
Total Number of Significant Threat Activities		**889**	
Total Number of Properties with Significant Threats		**754**	
Total Number of Significant Conditions		**0**	

[1] Prescribed Drinking Water Quality Threat 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.

Map 8.3—44: Parkway Well Supply Issue Contributing Area



Identification of Significant, Moderate and Low Drinking Water Threats in the Strasburg Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—76** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—25 provides a summary of the threat levels possible in the Strasburg Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. "Yes" indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; "No" indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—76**.

Table 8.3—9: Identification of Drinking Water Threats in the Strasburg Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A	10	Yes	Yes	Yes
Chemicals	WHPA-B	8	Yes	Yes	Yes
Chemicals	WHPA-B/C	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	2	No	No	No
Pathogens	WHPA-A	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes

Threats and Issues Enumeration for the Strasburg Wellfield

The protection area for the Strasburg Wellfield overlaps with the Parkway Wellfield areas. However, threat ranking results related to the Parkway Wellfield are presented in **Section 8.3 – Kitchener Area Wellfields.**

The total number of identified significant drinking water threats in this Wellfield is 3. The number of properties in this Wellfield with identified significant drinking water threats is 2. Details surrounding the types of threats and circumstances found in the Strasburg wellhead protection areas are outlined in **Table 8.3—26**.

No Significant Conditions were identified in this wellfield as per Technical Rule 126.

No drinking water Issues were identified in this wellfield as per Technical Rule 114.

Table 8.3—10: Significant Drinking Water Quality Threats in the Strasburg Wellhead Protection Areas (current to February 2019)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
2	Sewage system or sewage works - storm water management facility (including storm sewers)	2	WHPA-A
12	Application of road salt	1	WHPA-A
Total Number of Significant Threat Activities		**3**	
Total Number of Properties with Significant Threats		**2**	

[1] Prescribed Drinking Water Quality Threat 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.

8.3.4 Pompeii and Woolner Wellfields

Pompeii Wellfield

The water supply for the Pompeii Wellfield is obtained from production wells K72, K73, K74 and K75. The Pompeii Wellfield includes production wells K72, K73, K74 and K75. None of the wells are currently connected to the IUS; however, an update to the Updated Water Supply Master Plan included these wells in long-term water supply plans (Stantec, 2015). All of the production wells are screened over depths ranging from approximately 9 m BGS to 15 m BGS within the Pre-Catfish Creek Aquifer (AFD1) in the Grand River Valley. Many of the upper moraine units, including the Upper and Middle Waterloo Moraine Sands, have been eroded away by glaciofluvial processes in the Grand River Valley, resulting in the Pre-Catfish Creek Aquifer (AFD1) being present near ground surface (**Table 8.1—6**). This is why, despite their shallow depths, the wells at the Pompeii Wellfield are screened in the Pre-Catfish Creek Aquifer (AFD1).

Woolner Wellfield

The water supply for the Woolner Wellfield is obtained from Production Wells K80, K81 and K82, which supply water to the IUS (**Table 8—1**). The production wells are screened within the Pre-Catfish Creek Aquifer (AFD1) from approximately 6 m BGS to 12 m BGS. They are located in the Grand River Valley, where many of the upper moraine units have been eroded away by glaciofluvial processes, resulting in the presence of the Pre-Catfish Creek Aquifer (AFD1) at or near the ground surface. Similar to the Pompeii wells, despite their shallow depths, the Woolner wells are also screened in the Pre-Catfish Creek Aquifer (AFD1).

Vulnerability and Transport Pathways

Map 8.3—81 presents the wellhead protection areas. The unadjusted intrinsic vulnerability is shown on **Map 8.3—82** and the adjusted intrinsic vulnerability is shown on **Map 8.3—83. Map 8.3—84** and **Map 8.3—85** show transport pathways and area of influence for the Pompeii and Woolner Wellhead Protection Areas. **Map 8.3—86** shows the final vulnerability scoring.

Analysis of the attributes of each potential transport pathway in the Pompeii Wellfield resulted in the identification of two gravel pits found adjacent to the Pompeii wells and several clusters of wells and underground services which warranted an increased ISI within WHPAs A through D. The Pompeii wells have also been classified as *GUDI with effective filtration* and as such a WHPA-E capture zone has been delineated and the *GUDI* feature has been identified for this wellfield (**Map 8.3—90**). The Grand River is a significant source of water for the Pompeii Wellfield with between 15% and 60% of its source water originating from the river (Lotowater, 1997b; Frontline and Earth*fx*, 2000). The remaining water is obtained from the unconfined sand and gravel aquifer.

Analysis of the attributes of each potential transport pathway in the Woolner WHPA resulted in the identification of a historical aggregate extraction operation within the WHPA-B to WHPA-C zones where extraction occurred below the water table. Also identified were closely spaced underground services and one cluster of wells found on the east side of the Grand River, all of which warranted an increased ISI.

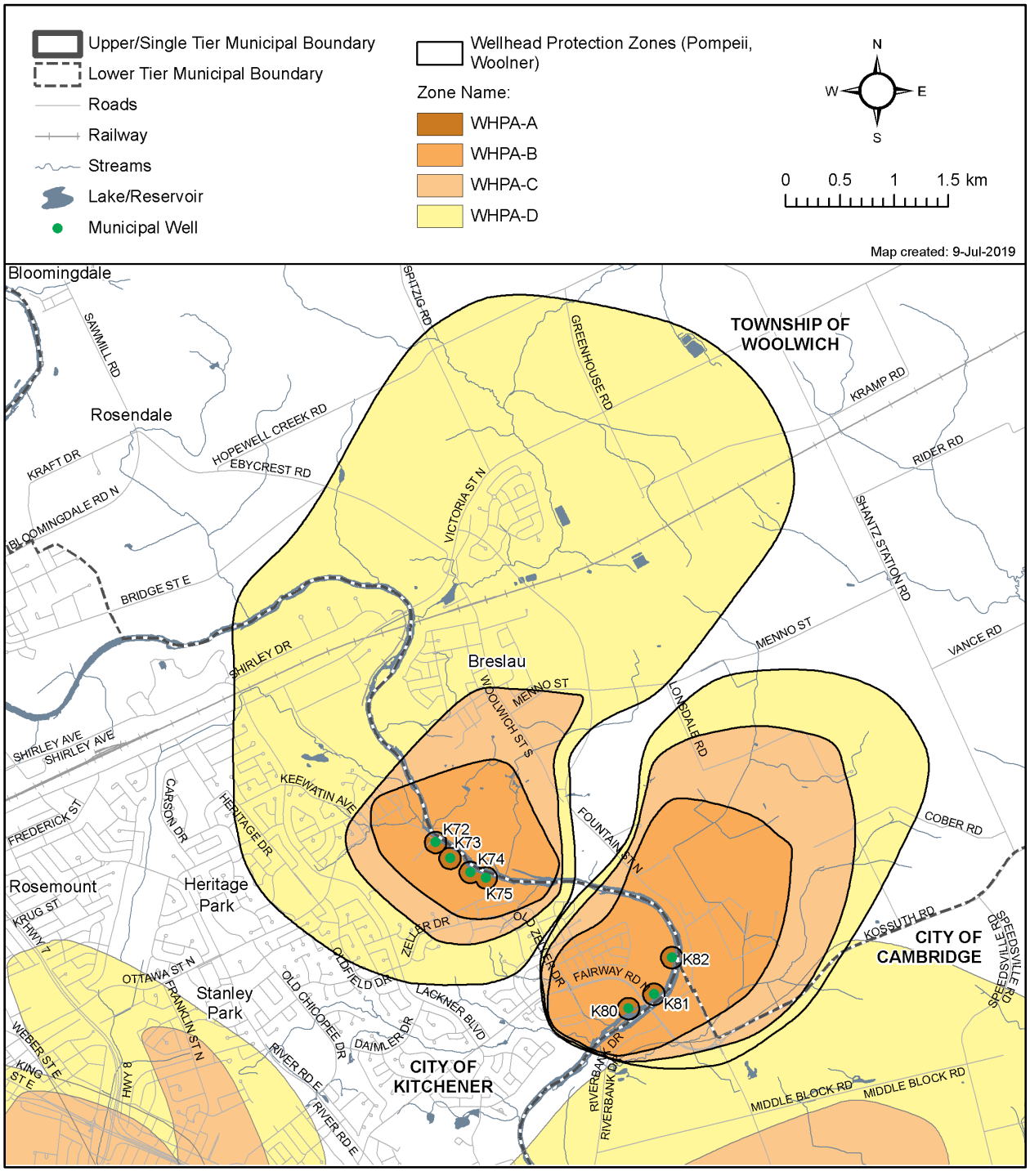
The Woolner Wellfield has been classified as *GUDI* and as such a WHPA-E capture zone has been delineated for this Wellfield **(Map 8.3—94)**. Production wells K80 and K81 have a more direct hydraulic connection with the Grand River than production well K82 does, with approximately 85% of the water obtained at K80 and K81 from the Grand River (Lotowater, 1997a). Production well K82 obtains approximately 14% of its water from the Grand River with the remaining water obtained from the lower aquifer system (Stantec, 2002b). At production well K82 the travel time for river water to reach the well has been approximated at 0.4 to 35 days, while at K80 and K81 it was estimated at 0.5 to 9.9 days (Stantec, 2002b).

Percent Managed Land, Livestock Density, Salt Loading Potential and Percent Impervious Surface

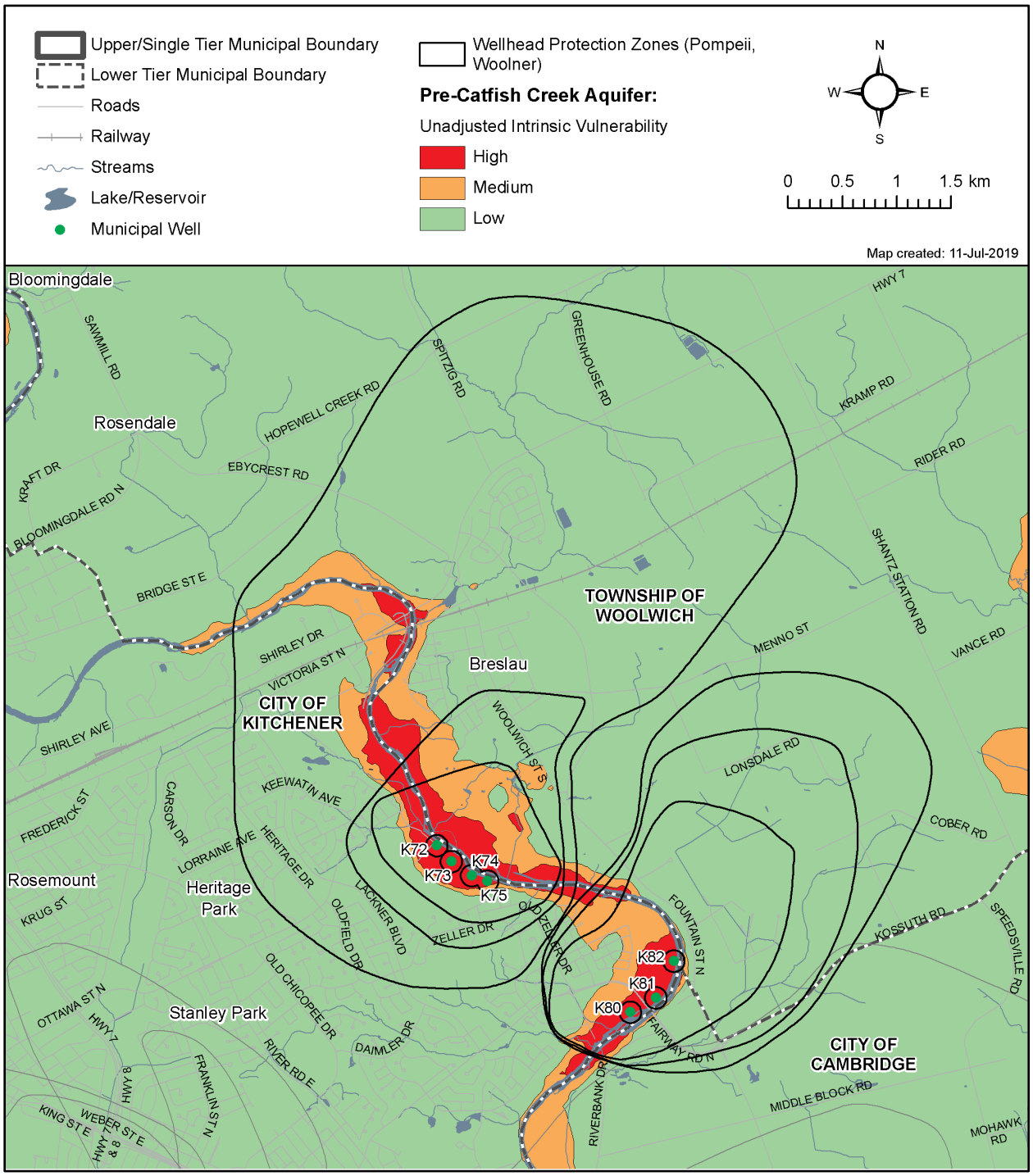
The calculations for determining the percent managed land, livestock density, salt loading potential and corresponding percent impervious surface for the Pompeii and Woolner Wellfields followed the methods outlined in **Section 8.1 – Water Quality Risk Assessment**.

Map 8.3—87, Map 8.3—88 and Map 8.3—89 show the percent managed lands, livestock density, and percent impervious surface, for both the Pompeii and Woolner Wellfields WHPA-A through D's, respectively. **Map 8.3—91, Map 8.3—92 and Map 8.3—93** show the percent managed lands, livestock density, and percent impervious surface, respectively, for the Pompeii WHPA-E. **Map 8.3—95, Map 8.3—96 and Map 8.3—97** show the percent managed lands, livestock density, and percent impervious surface, respectively, for the Woolner WHPA-E.

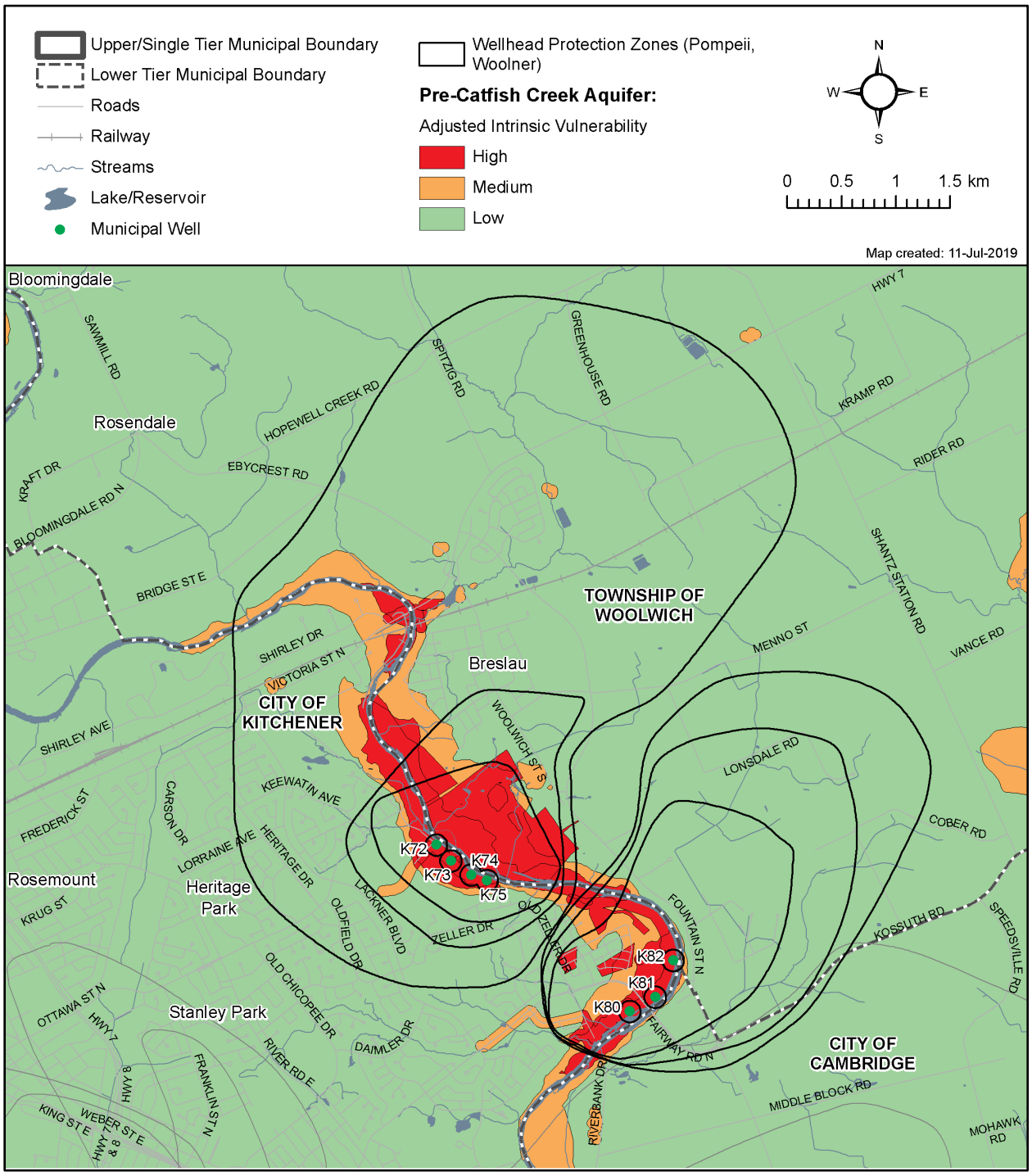
Map 8.3—45: Kitchener Area Inset 4: Pompeii Well Supply (K72-K75) and Woolner (K80-K82) Well Supply Wellhead Protection Areas



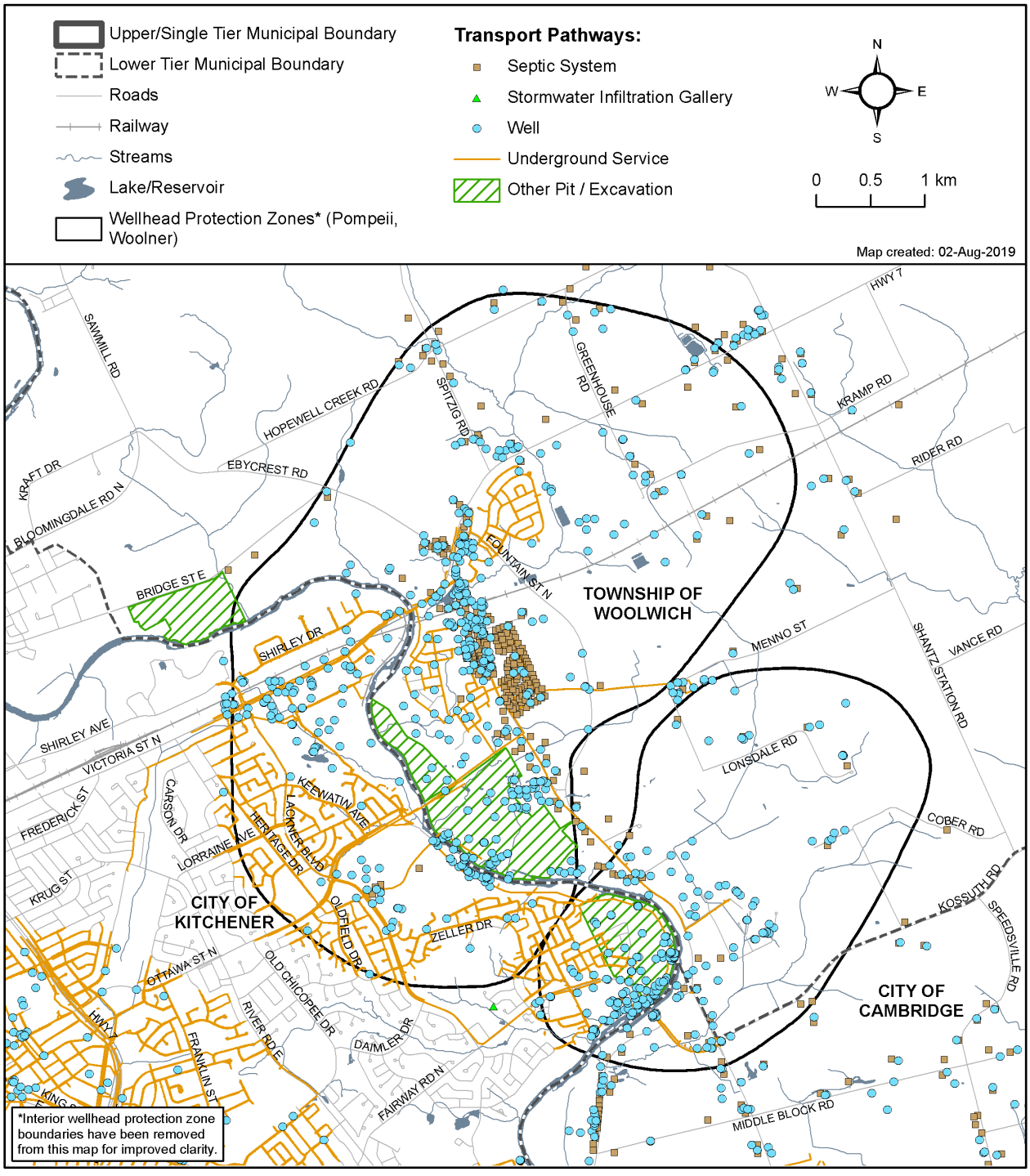
Map 8.3—46: Kitchener Area Inset 4: Pompeii Well Supply (K72-75) and Woolner (K80-82) Well Supply Wellhead Protection Areas Unadjusted Intrinsic Vulnerability



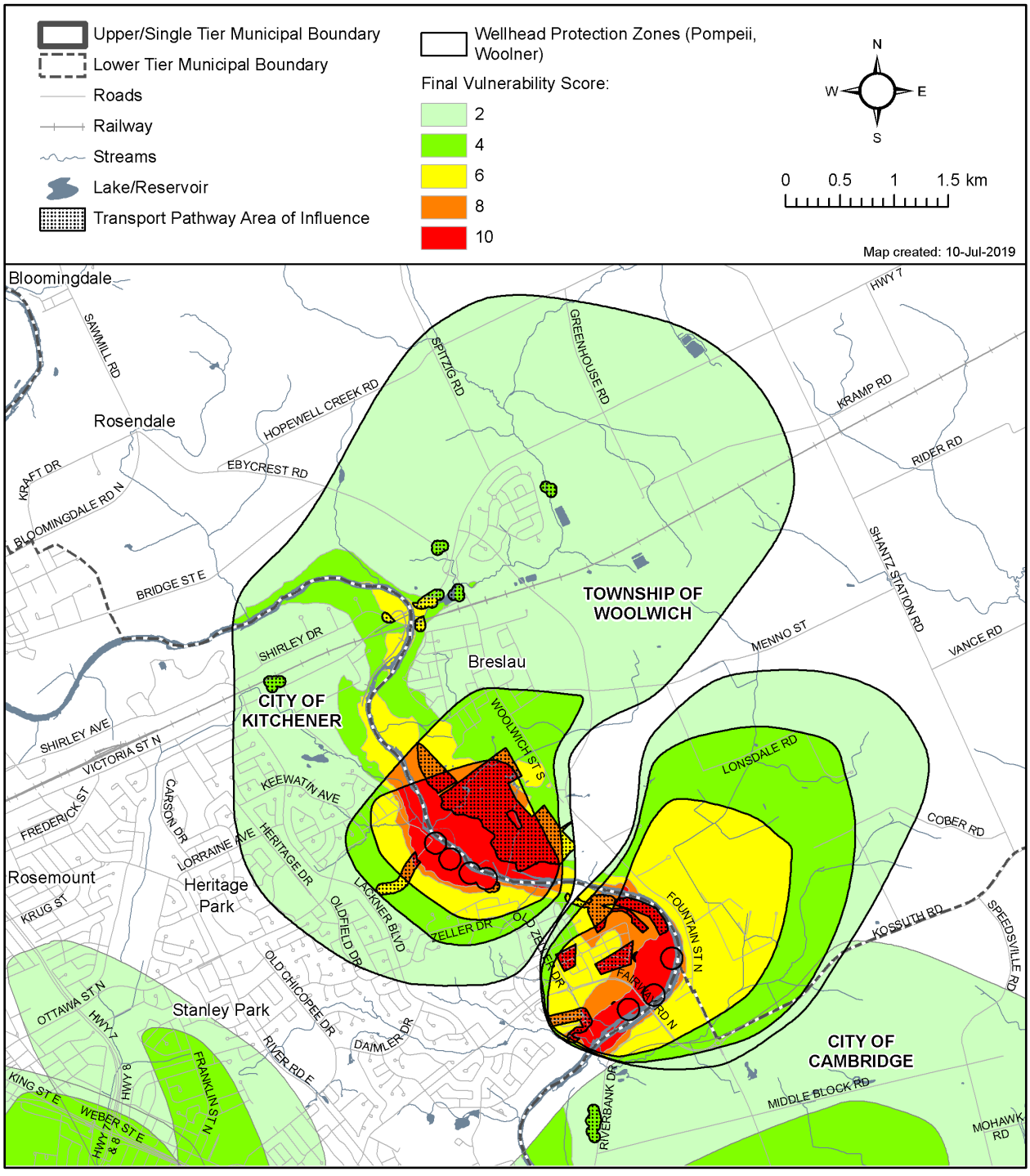
Map 8.3—47: Kitchener Area Inset 4: Pompeii Well Supply (K72-75) and Woolner (K80-82) Well Supply Wellhead Protection Areas Adjusted Intrinsic Vulnerability



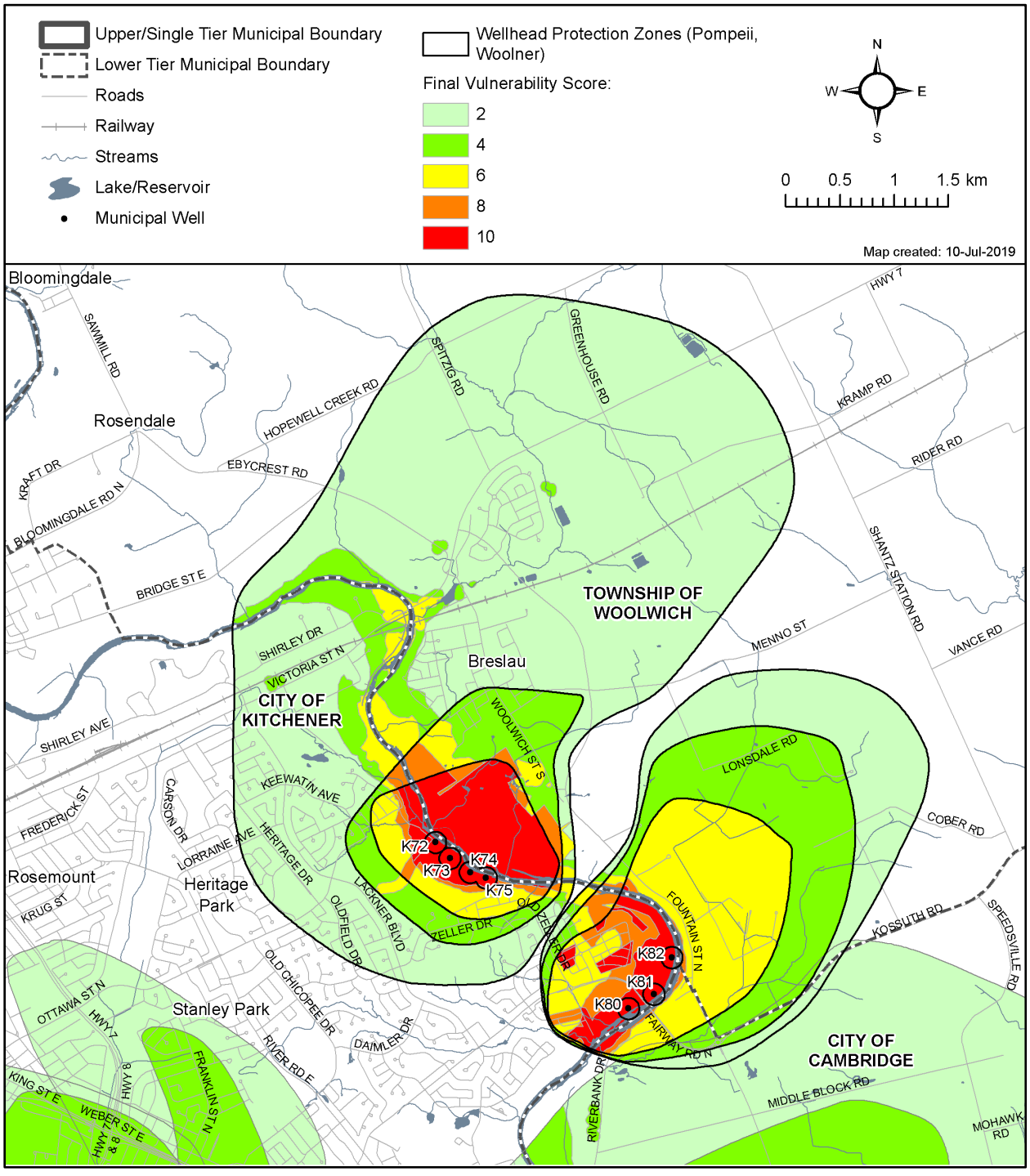
Map 8.3—48: Kitchener Area Inset 4: Pompeii Well Supply (K70-75) and Woolner (K80-82) Well Supply Transport Pathways



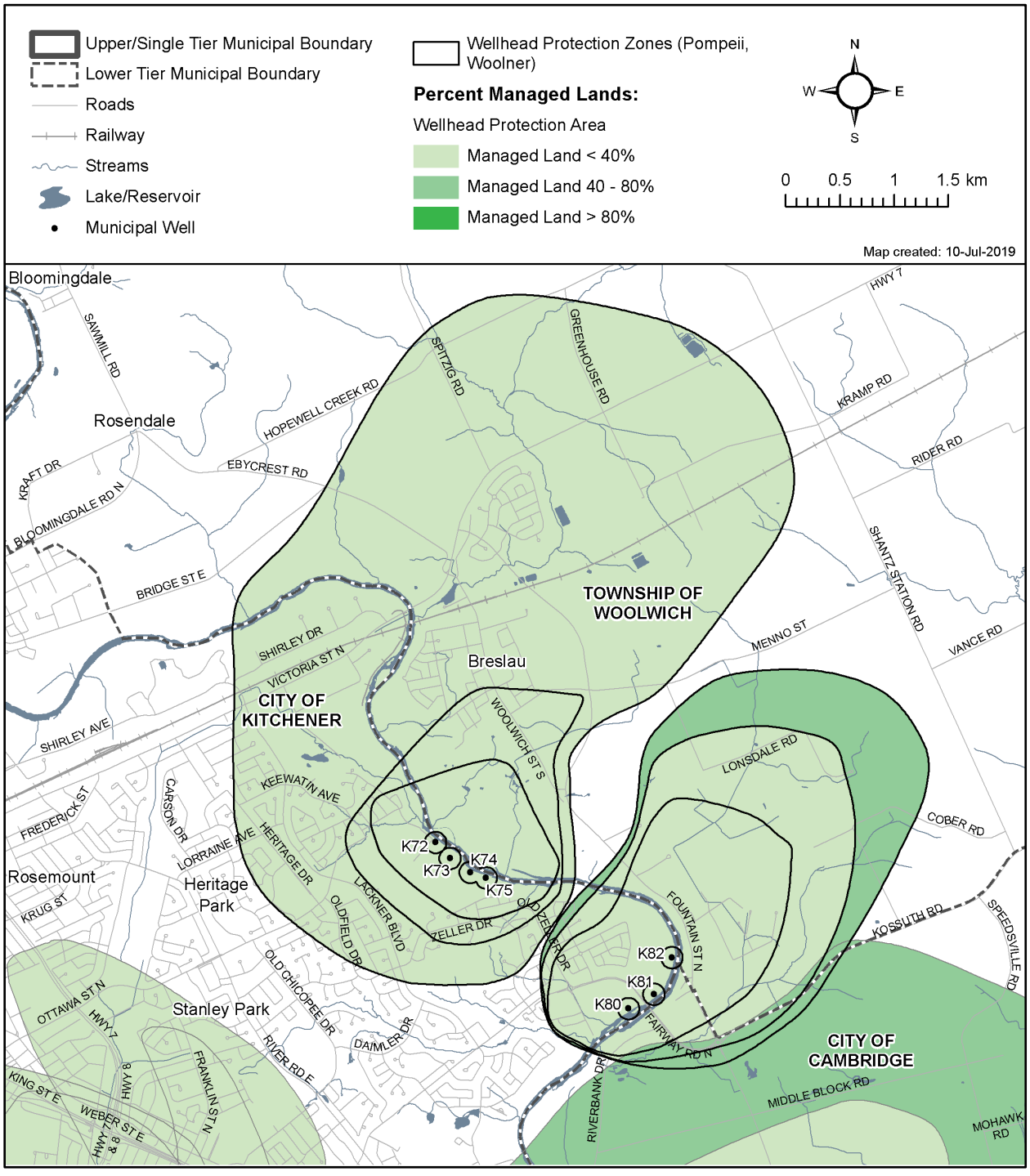
Map 8.3—49: Kitchener Area Inset 4: Pompeii Well Supply (K70-75) and Woolner (K80-82) Well Supply Transport Pathways Area of Influence



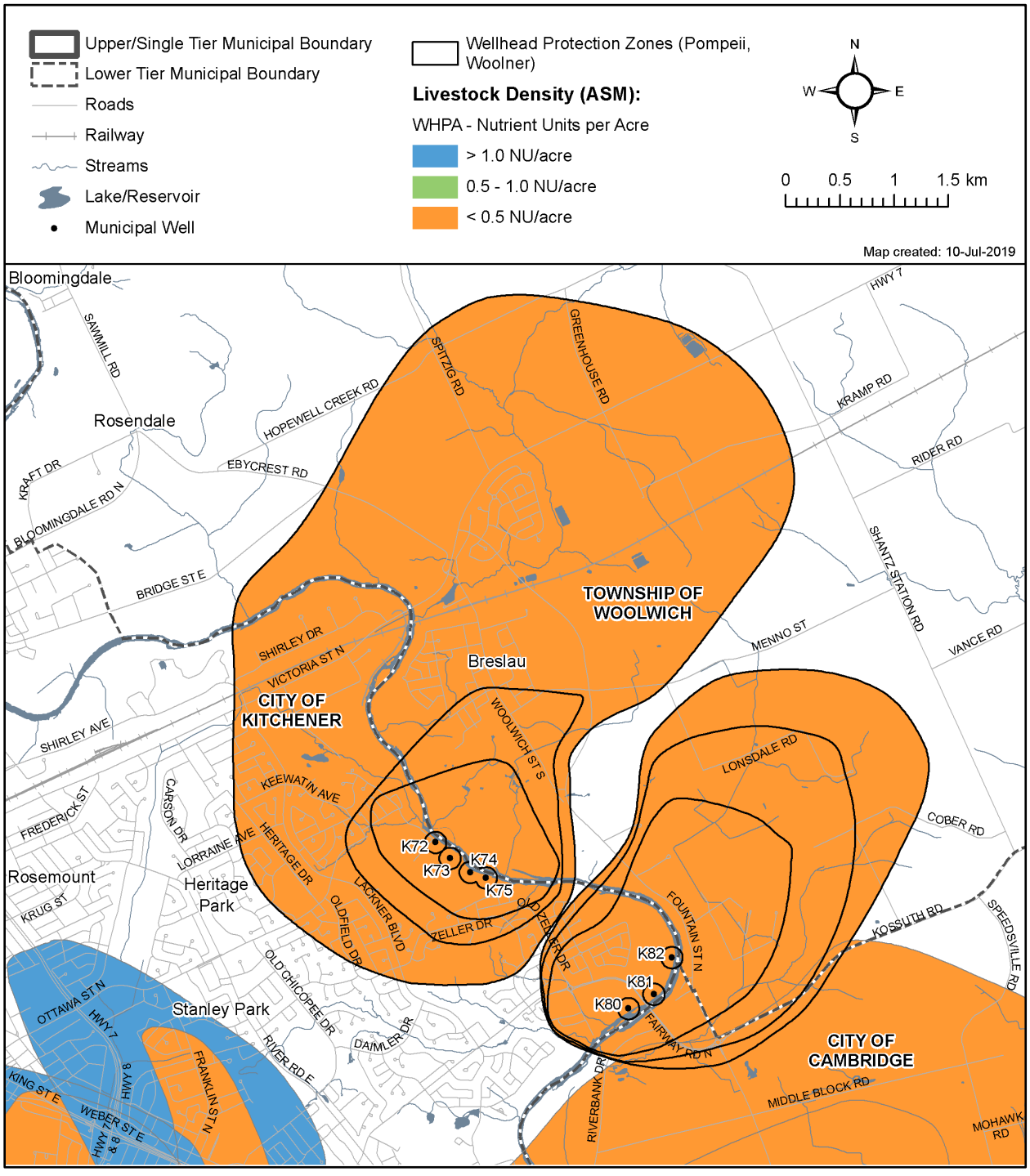
Map 8.3—50: Kitchener Area Inset 4: Pompeii Well Supply (K72-75) and Woolner (K80-82) Well Supply Wellhead Protection Area Final Vulnerability



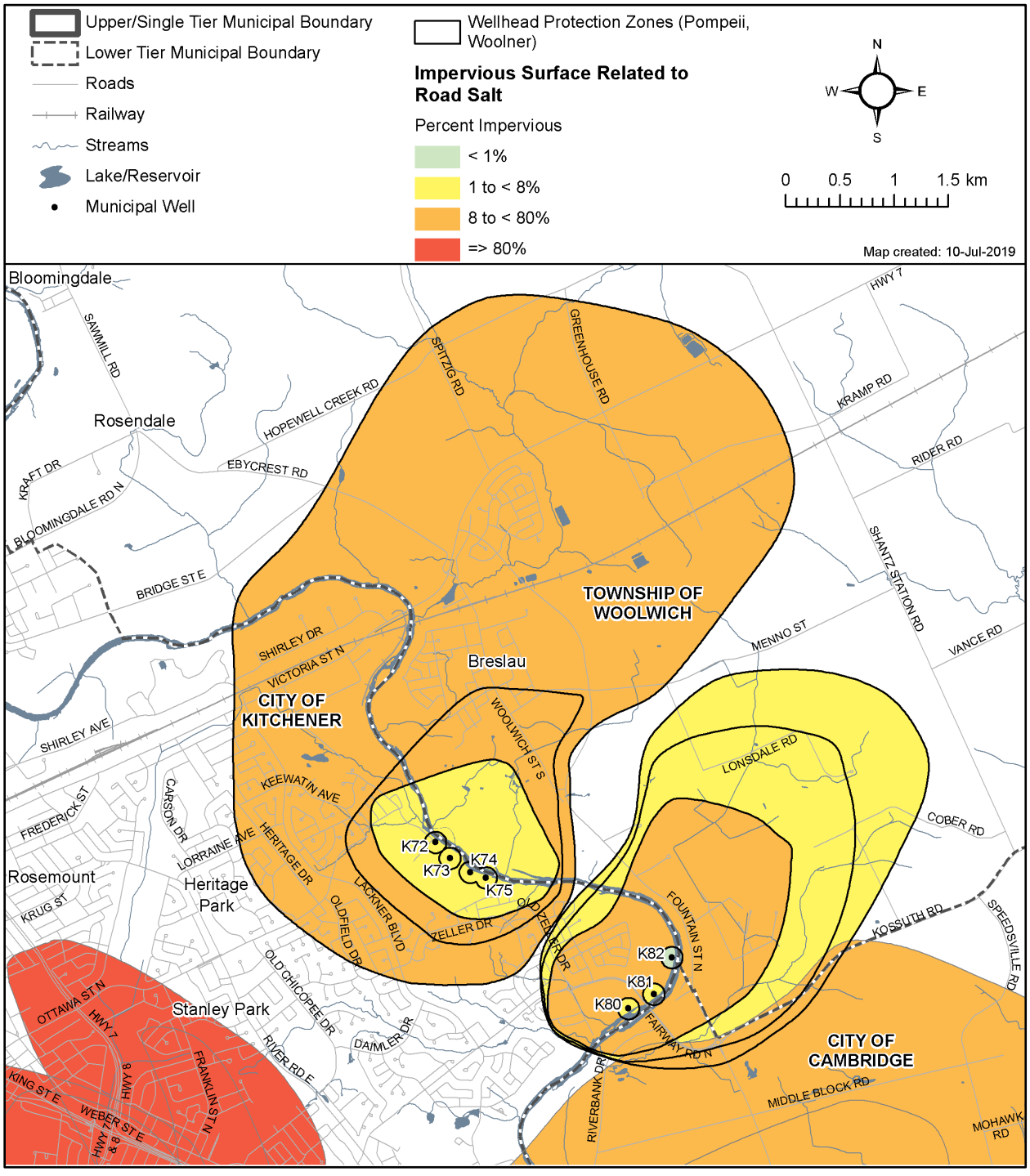
Map 8.3—51: Kitchener Area Inset 4: Pompeii Well Supply (K72-75) and Woolner (K80-82) Well Supply Percent Managed Land



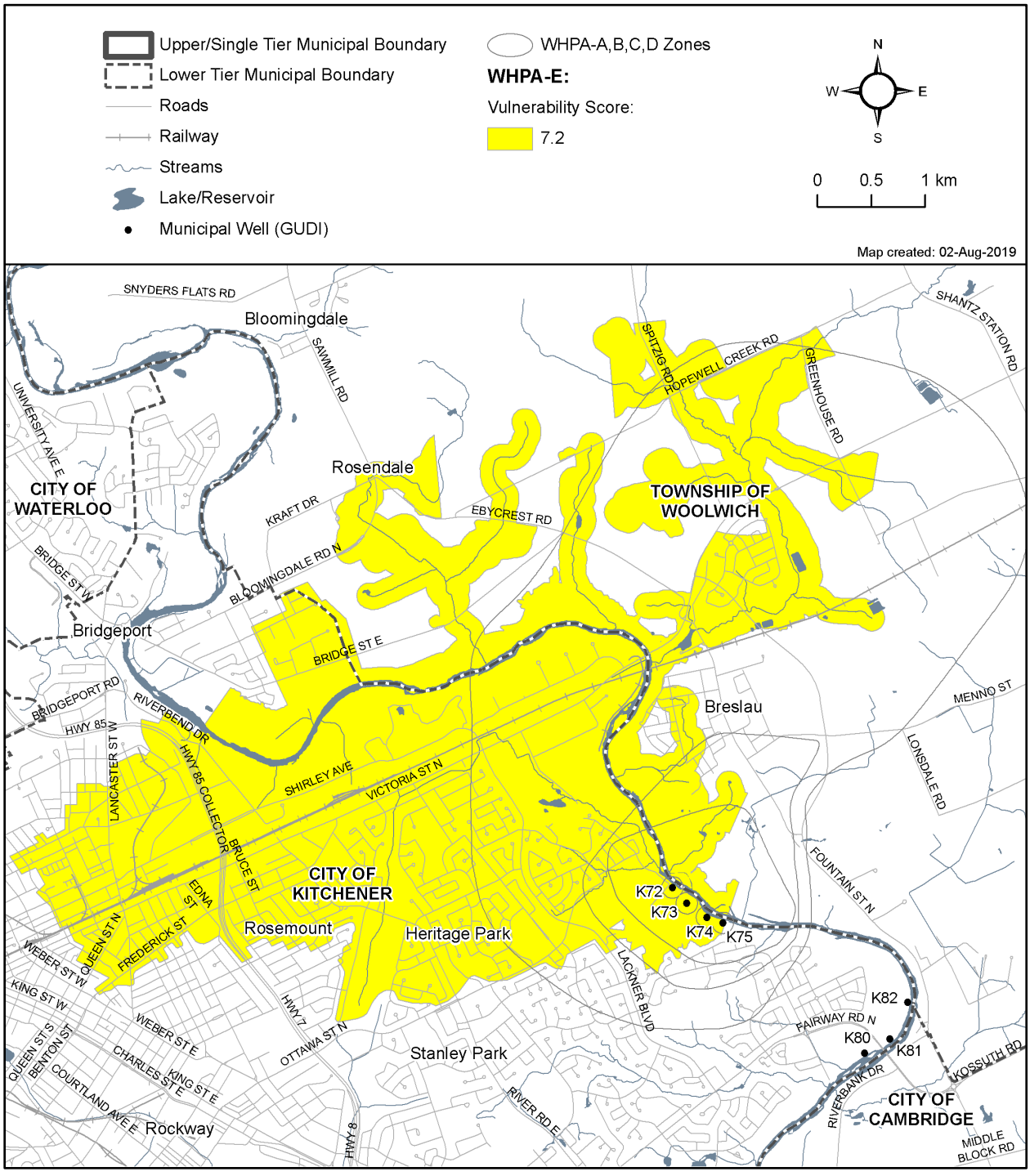
Map 8.3—52: Kitchener Area Inset 4: Pompeii Well Supply (K72-75) and Woolner (K80-82) Well Supply Livestock Density



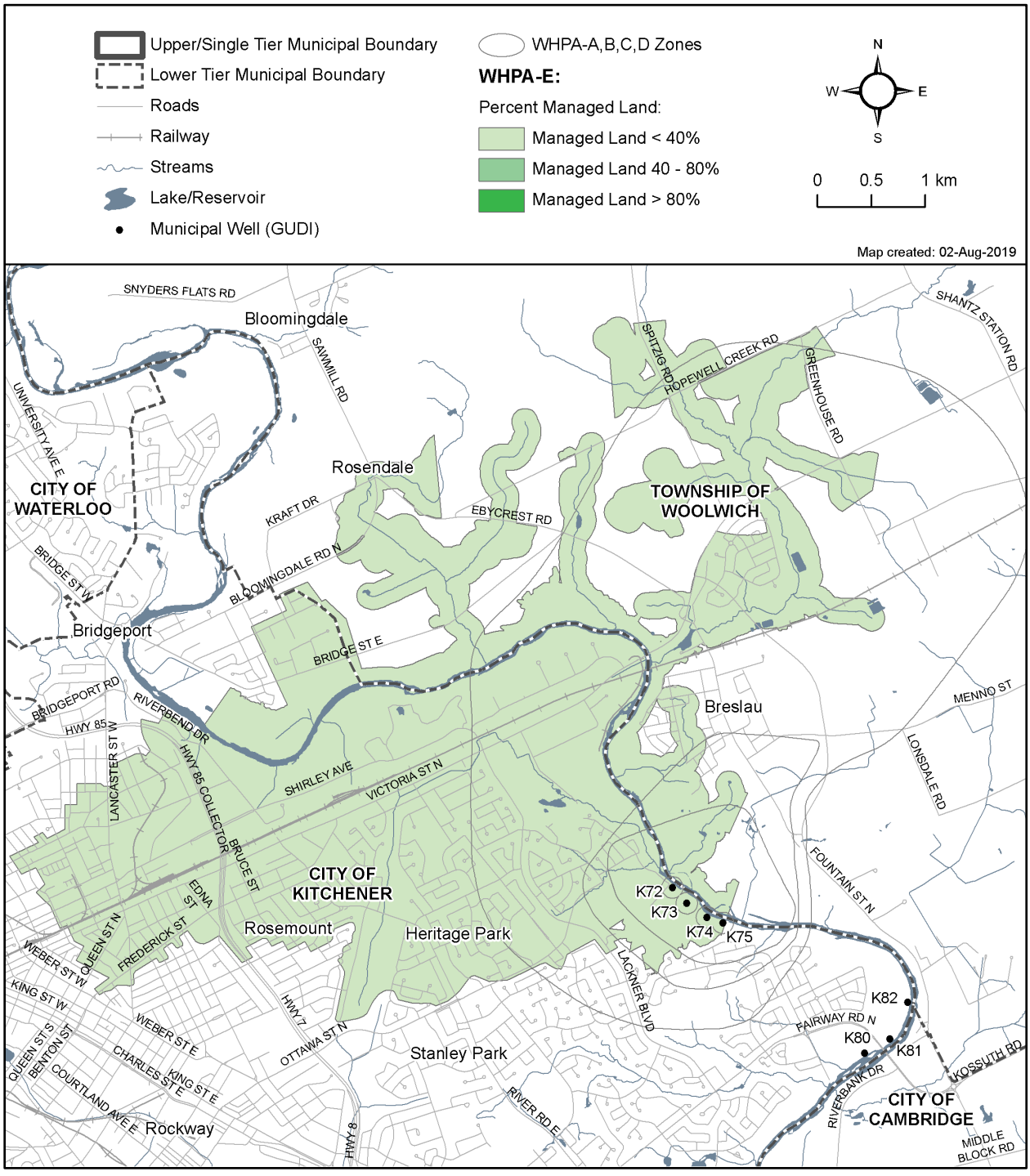
Map 8.3—53: Kitchener Area Inset 4: Pompeii Well Supply (K72-75) and Woolner (K80-82) Well Supply Percent Impervious Surfaces



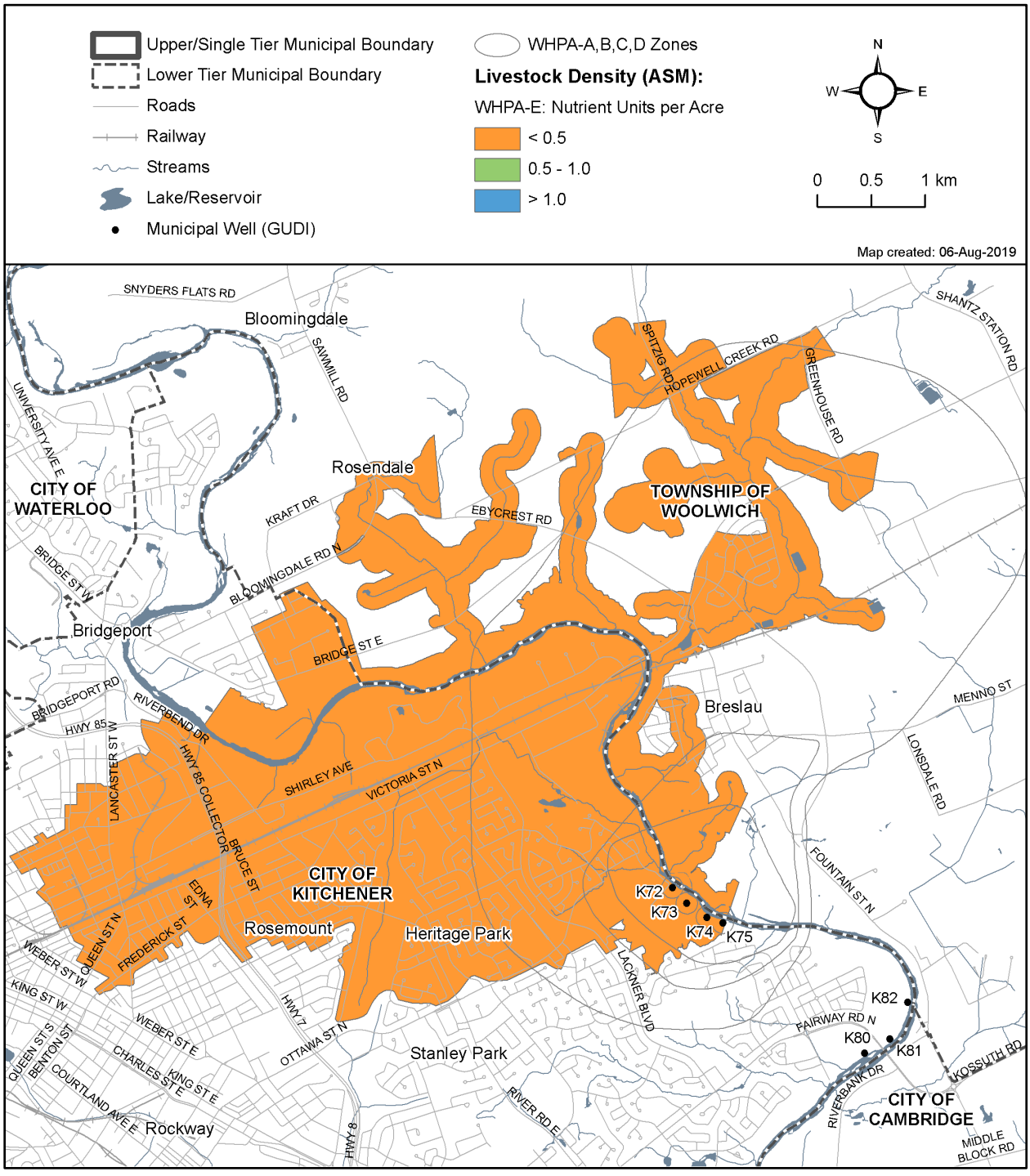
Map 8.3—54: Pompeii Well Supply (K72-75) Well Supply Wellhead Protection Area E



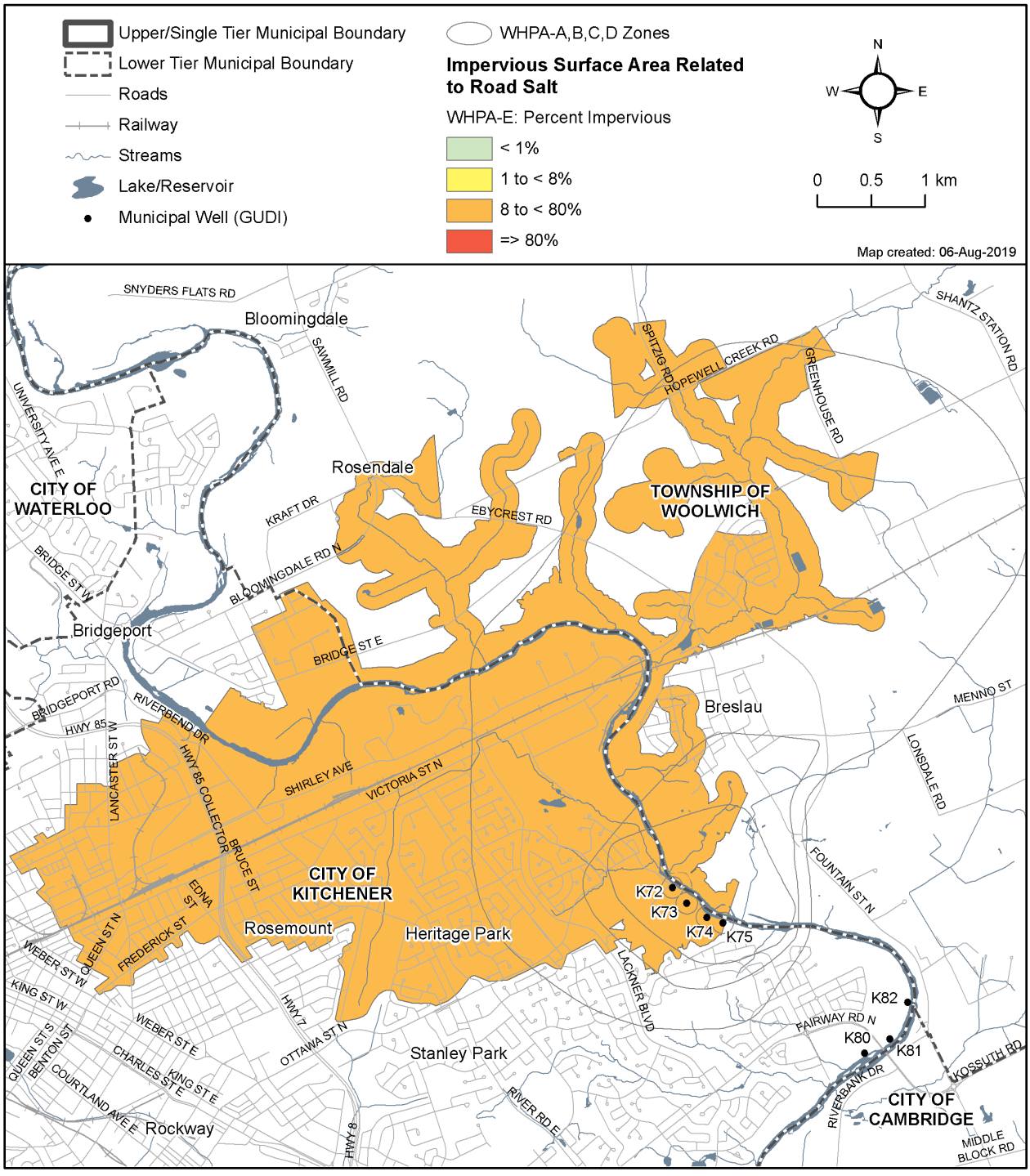
Map 8.3—55: Pompeii Well Supply (K72-75) Well Supply WHPA-E Percent Managed Lands



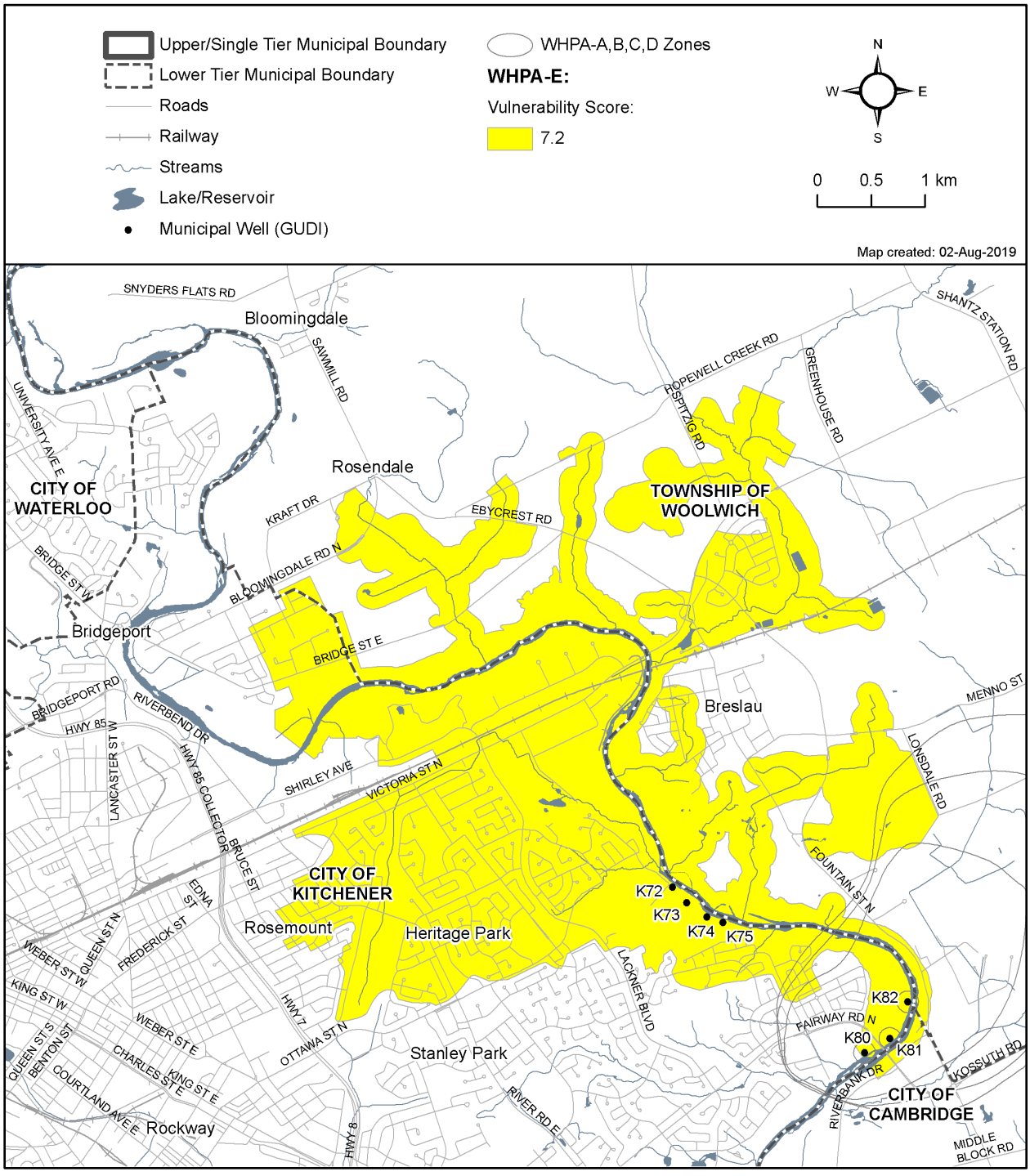
Map 8.3—56: Pompeii Well Supply (K72-75) Well Supply WHPA-E Livestock Density



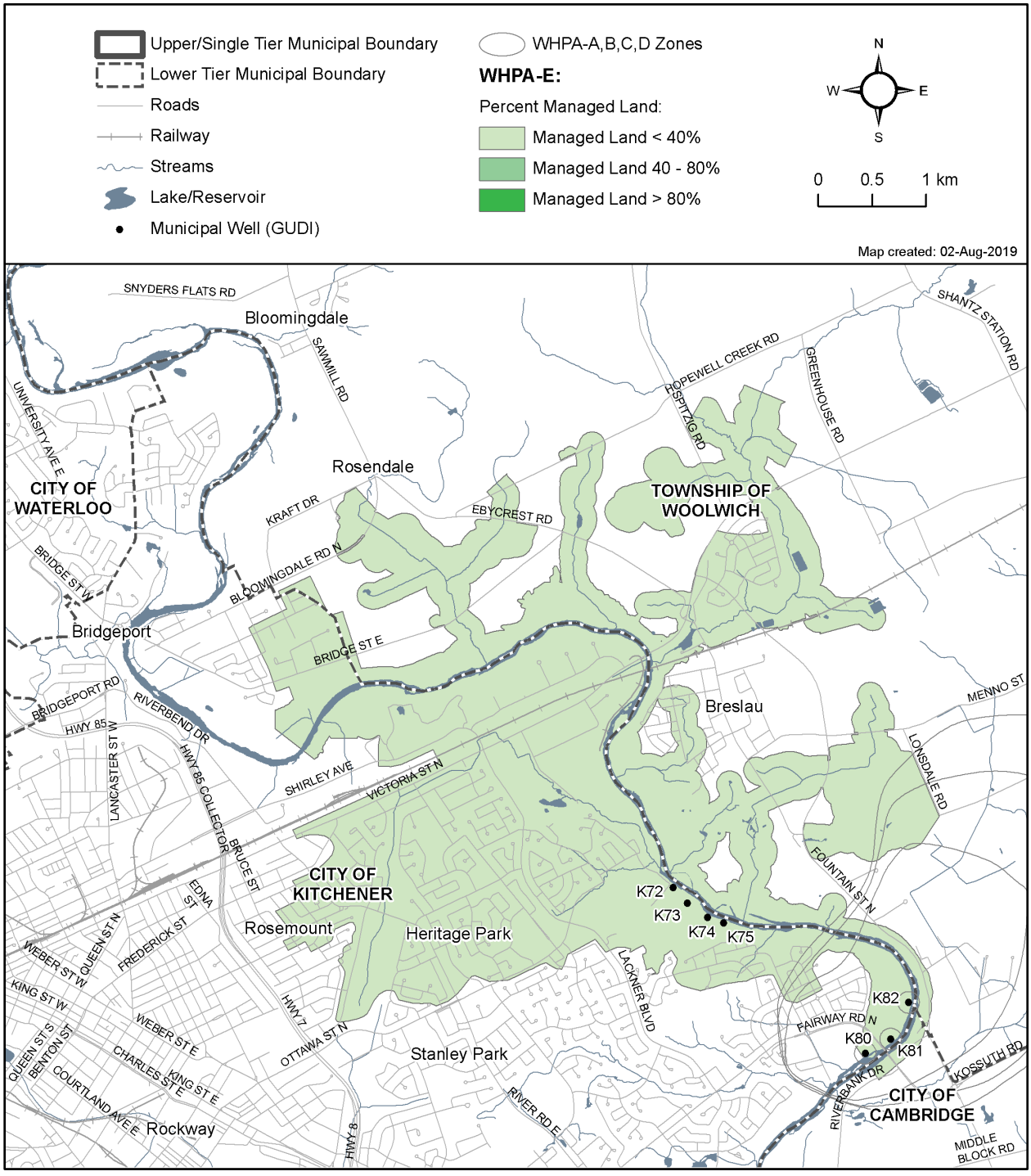
Map 8.3—57:Pompeii Well Supply (K72-75) Well Supply WHPA-E Percent Impervious Surfaces



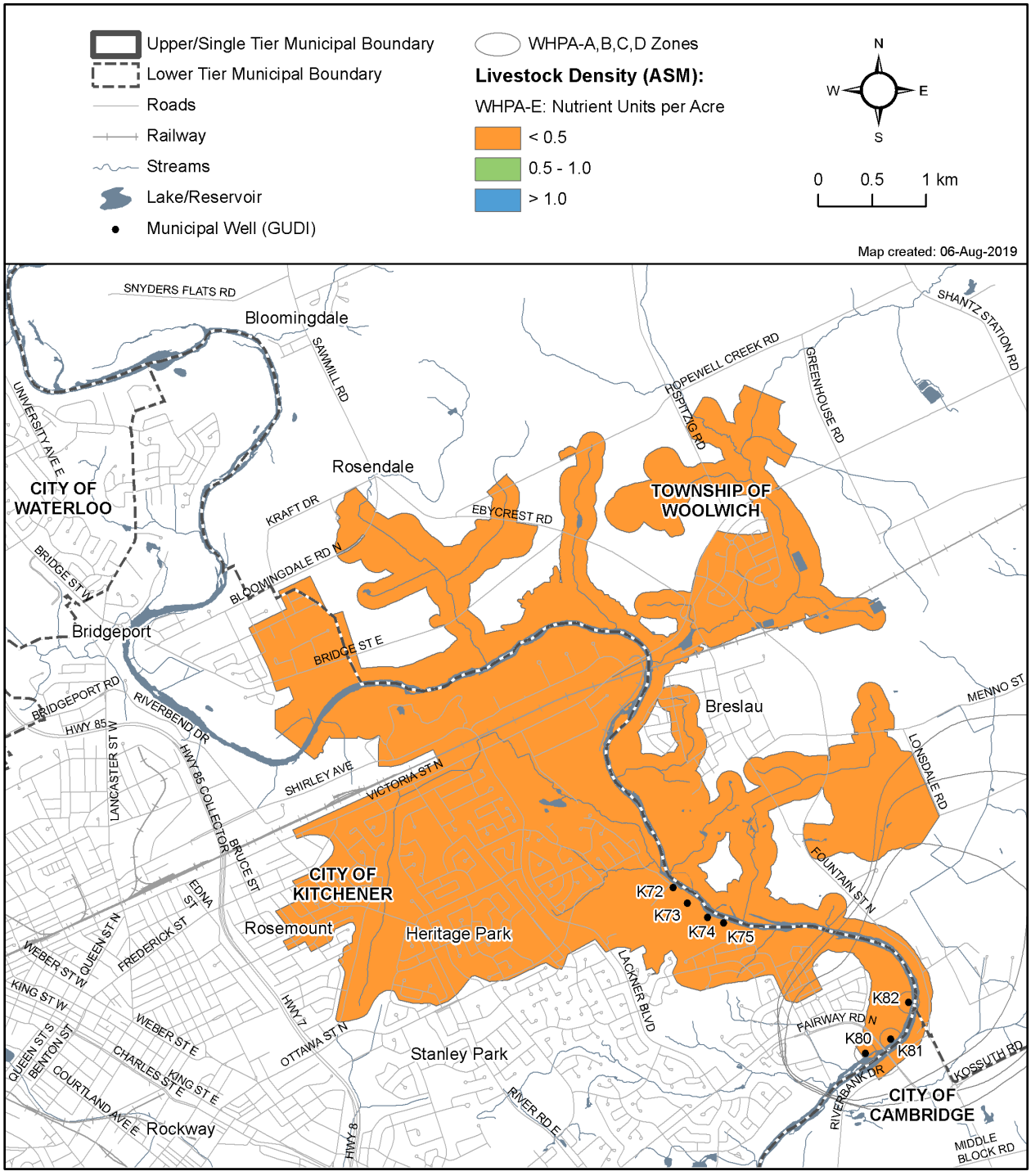
Map 8.3—58: Woolner (K80-82) Well Supply WHPA-E Well Supply Wellhead Protection Area E



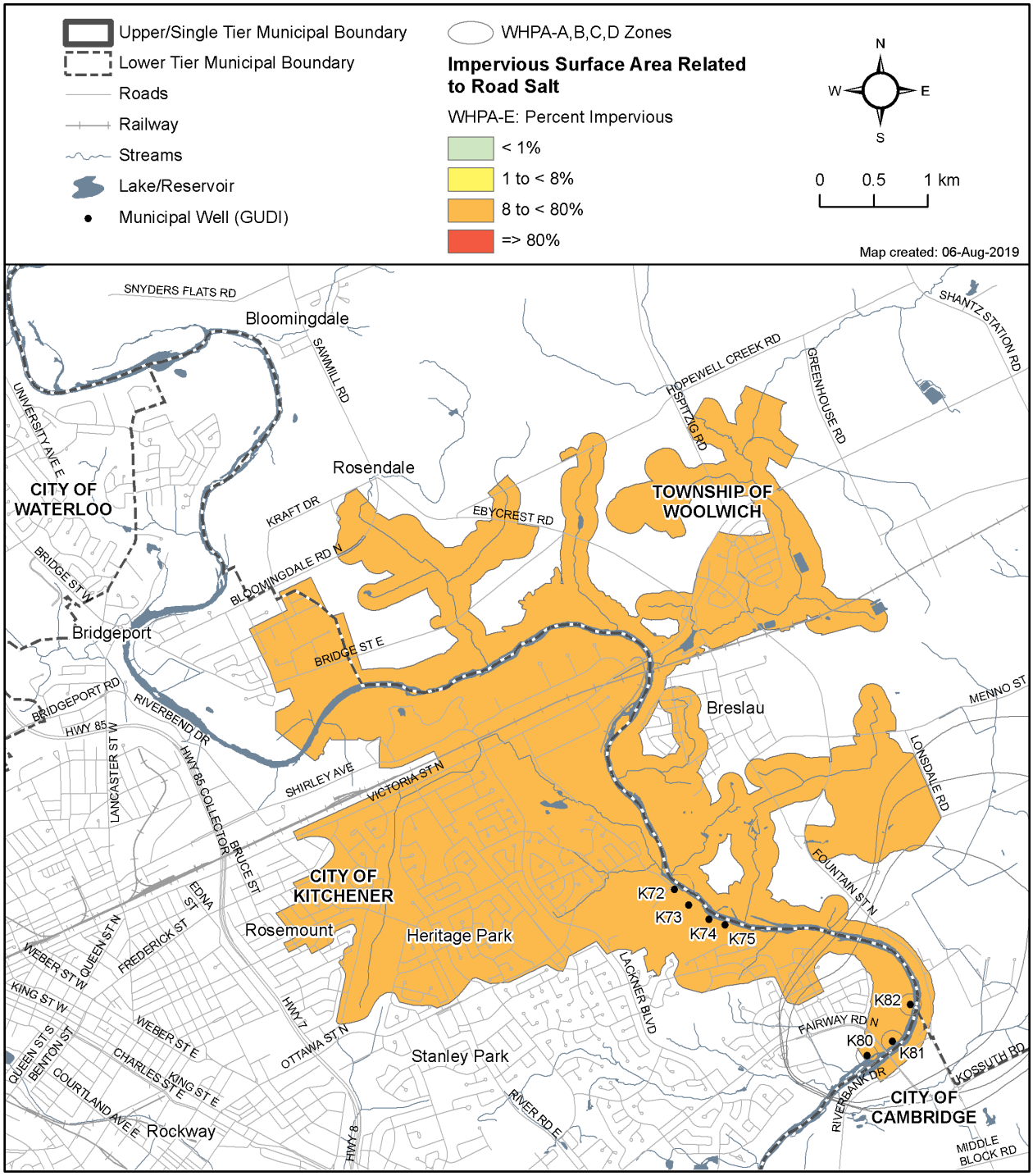
Map 8.3—59: Woolner (K80-82) Well Supply WHPA-E Percent Managed Lands



Map 8.3—60: Woolner (K80-82) Well Supply WHPA-E Livestock Density



Map 8.3—61: Woolner (K80-82) Well Supply WHPA-E Percent Impervious Surfaces



Identification of Significant, Moderate and Low Drinking Water Quality Threats in the Pompeii Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—86** and **Map 8.3—90** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—27 provides a summary of the threat levels possible in the Pompeii Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. "Yes" indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; "No" indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—86** and **Map 8.3—90**.

Table 8.3—11: Identification of Drinking Water Quality Threats in the Pompeii Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A/B	10	Yes	Yes	Yes
Chemicals	WHPA-B/C	8	Yes	Yes	Yes
Chemicals	WHPA-B/C/D	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
Chemicals	WHPA-E	7.2	No	Yes	Yes
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	6	No	Yes	Yes
DNAPLs	WHPA-D	2 & 4	No	No	No
DNAPLs	WHPA-E	7.2	No	Yes	Yes
Pathogens	WHPA-A/B	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes
Pathogens	WHPA-E	7.2	No	Yes	Yes

Threats and Issues Enumeration for the Pompeii Wellfields

The protection area for the Pompeii Wellfield overlaps with the Woolner Wellfield areas. However, threat ranking results related to the Woolner Wellfield are presented in **Section 8.3 – Kitchener Area Wellfields.**

The total number of identified significant drinking water threats in this wellfield is 19. The number of properties in this Wellfield with identified significant drinking water threats is 6. Details surrounding the types of threats and circumstances found in the Pompeii wellhead protection areas are outlined in **Table 8.3—28**.

No Significant Conditions were identified in this wellfield as per Technical Rule 126.

No drinking water Issues have been identified at the Pompeii wellfield as per Technical Rule 114.

Table 8.3—12: Significant Drinking Water Quality Threats in the Pompeii Wellhead Protection Areas (current to February 2019)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
2	Sewage system or sewage works - onsite sewage systems	1	WHPA-B
	Sewage system or sewage works - onsite sewage systems holding tanks	3	WHPA-A WHPA-B
	Sewage system or sewage works - storm water management facility (including storm sewers)	2	WHPA-B
3	Application of agricultural source material (ASM) to land	2	WHPA-A WHPA-B
4	Storage of agricultural source material (ASM)	2	WHPA-A WHPA-B
9	Storage of commercial fertilizer	2	WHPA-A WHPA-B
10	Application of pesticide to land	2	WHPA-A WHPA-B
11	Storage of a pesticide	3	WHPA-A WHPA-B
15	Storage and handling of fuel	1	WHPA-B
16	Storage and handling of a dense non aqueous phase liquid (DNAPL)	1	WHPA-C
Total Number of Significant Threat Activities		**19**	
Total Number of Properties with Significant Threats		**6**	

[1] Prescribed Drinking Water Quality Threat 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.

Identification of Significant, Moderate and Low Drinking Water Threats in the Woolner Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—86** and **Map 8.3—94** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—29 provides a summary of the threat levels possible in the Woolner Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. “Yes” indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; “No” indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—86** and **Map 8.3—94**.

Table 8.3—13: Identification of Drinking Water Threats in the Woolner Wellhead Protection Areas (current to February 2019)

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A/B	10	Yes	Yes	Yes
Chemicals	WHPA-B/C	8	Yes	Yes	Yes
Chemicals	WHPA-B/C/D	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
Chemicals	WHPA-E	7.2	No	Yes	Yes
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	6	No	Yes	Yes
DNAPLs	WHPA-D	2 & 4	No	No	No
DNAPLs	WHPA-E	7.2	No	Yes	Yes
Pathogens	WHPA-A/B	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes
Pathogens	WHPA-E	7.2	No	Yes	Yes

Threats and Issues Enumeration in the Woolner Wellfield

The protection area for the Woolner Wellfield overlaps with the Fountain Street, Parkway, and Pompeii Wellfield areas. However, threat ranking results related to the Fountain Street Wellfield are presented in **Section 8.5 – Cambridge Area Wellfields.** Threat ranking results related to the Parkway and Pompeii Wellfields are presented in **Section 8.3 – Kitchener Area Wellfields.**

The total number of identified significant drinking water threats in this wellfield is 10. The number of properties in this Wellfield with identified significant drinking water threats is 7. Details surrounding the types of threats and circumstances found in the Woolner wellhead protection areas are outlined in **Table 8.3—30**.

No Significant Conditions were identified in this wellfield as per Technical Rule 126.

No drinking water Issues have been identified in this wellfield as per Technical Rule 114.

Table 8.3—14: Significant Drinking Water Quality Threats in the Woolner Wellhead Protection Areas (current to February 2019)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
2	Sewage system or sewage works - onsite sewage systems	2	WHPA-B
	Sewage system or sewage works - onsite sewage systems holding tanks	3	WHPA-B
	Sewage system or sewage works - sanitary sewers and related wastewater collection systems	1	WHPA-B
	Sewage system or sewage works - storm water management facility (including storm sewers)	1	WHPA-B
4	Storage of agricultural source material (ASM)	1	WHPA-B
21	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 Significant Threat Activities		**10**	
Total Number of Properties with Significant Threats		**7**	

[1] Prescribed Drinking Water Quality Threat 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.

8.3.5 Wilmot Centre Wellfield

The water supply for the Wilmot Centre Wellfield is obtained from Production Wells K50, K51 which pump water to the IUS (**Table 8—1).** Well K52 was recently constructed on the same property and is planned to be connected to the supply system shortly. The three production wells are screened within the Middle Waterloo Moraine Sands (AFB2) at depths ranging from 30 m BGS to 40 m BGS. The serviced areas are presented on **Map 8.3—98.** This aquifer behaves as a semi-confined aquifer system as it is overlain by clay till in the area immediately surrounding the wells (**Table 8.1—6**). Further away, the Middle and Upper Waterloo Moraine Sands are hydraulically connected in this area through gaps in the aquitard.

Vulnerability and Transport Pathways

The WHPAs are presented on **Map 8.3—99**, the unadjusted intrinsic vulnerability is shown on **Map 8.3—100** and the adjusted intrinsic vulnerability is shown on **Map 8.3—101.** Analysis of the attributes of each potential transport pathway in the Wilmot Centre WHPA resulted in the identification of several well and septic system clusters, a length of road along Bleams Rd. with closely spaced utility services, and one aggregate licensed property within the WHPA-B through D, which warranted increases to the ISI**. Map 8.3—102** and **Map 8.3—103** show these transport pathways and area of influence for the Wellhead Protection Areas and **Map 8.3—104** show the final vulnerability scoring.

Percent Managed Land, Livestock Density, Salt Loading Potential and Percent Impervious Surface

Percent managed land, livestock density and percent impervious surface for each protection zone in this wellfield are shown in **Map 8.3—105**, **Map 8.3—106, and Map 8.3—107.**

Identification of Significant, Moderate and Low Drinking Water Quality Threats in the Wilmot Centre Wellhead Protection Areas

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal. The information above can be used with the vulnerability scores shown in **Map 8.3—104** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.3—31 provides a summary of the threat levels possible in the Wilmot Centre Wellfield for Chemicals, Dense Non-Aqueous Phase Liquids (DNAPLs), and Pathogens. “Yes” indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; “No” indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.3—104.**

Table 8.3—15: Identification of Drinking Water Quality Threats in the Wilmot Centre Wellhead Protection Areas

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A/B	10	Yes	Yes	Yes
Chemicals	WHPA-B/C	8	Yes	Yes	Yes
Chemicals	WHPA-B/C/D	6	No	Yes	Yes
Chemicals	WHPA-C/D	2 & 4	No	No	No
DNAPLs	WHPA-A/B/C	Any Score	Yes	No	No
DNAPLs	WHPA-D	6	No	Yes	Yes
DNAPLs	WHPA-D	2 & 4	No	No	No
Pathogens	WHPA-A/B	10	Yes	Yes	No
Pathogens	WHPA-B	8	No	Yes	Yes
Pathogens	WHPA-B	6	No	No	Yes

Threats and Issues Enumeration for the Wilmot Centre Wellfield

Nitrate has been designated an *Issue* for all the Wilmot Centre wells, due to persistent elevated nitrate concentrations in raw water from the supply wells, and in monitoring wells in the wellfield capture zone.

The Wilmot Centre supply wells have shown increasing nitrate concentrations since approximately 2000 (**Figure 8.3—14**). Around 2010, the nitrate concentrations at wells K50 and K51 reached a maximum of approximately 6.5 mg/L (K50) and 4 mg/L (K51), compared to the Ontario Drinking Water Standard of 10 mg/L (all values as N). Since 2010, nitrate concentrations at both wells have been decreasing and are now at approximately 4 mg/L and 1 mg/L (as N) for wells K50 and K51 respectively. The decreasing nitrate trends are likely due to increasing production at the wellfield, as illustrated in **Figure 8.3—15**.

Monitoring results at several monitoring well nests in the Wilmot Centre wellfield show relatively stable and elevated nitrate concentration in the water supply aquifer (**Figure 8.3—16**). Groundwater monitoring in the general area (completed as part of the “Wilmot Centre Monitoring Program”) indicates a continuing widespread area of elevated nitrate in the municipal aquifer. This confirms the extensive hydrogeological studies completed in the 1990s, which indicated that there is a large area of the municipal aquifer which contains elevated levels of nitrate, in an area stretching upgradient (north) from the Wilmot Centre wells to south and west of St. Agatha.

At this time, the *Issue Contributing Area* is set as the WHPA-D for this wellfield**.** Hydrogeological studies have indicated that the primary pathway for nitrate to enter the aquifer includes areas upgradient and beyond the WHPA-D (25 year time-of-travel capture zone) of the wells. The Region of Waterloo is planning technical studies to confirm where nitrate sources would be a significant threat to the aquifer and the wellfield, and will consider applying for an exception to the Technical Rules to extend the ICA beyond the WHPA-D, should this be indicated by the future studies.

The total number of identified significant drinking water threats in this wellfield is 167. The number of properties in this wellfield with identified significant drinking water threats

is 87. Details surrounding the types of threats and circumstances found in the Wilmot Centre wellhead protection areas are outlined in **Table 8.3—32**.

No Significant Conditions were identified in this wellfield as per Technical Rule 126.

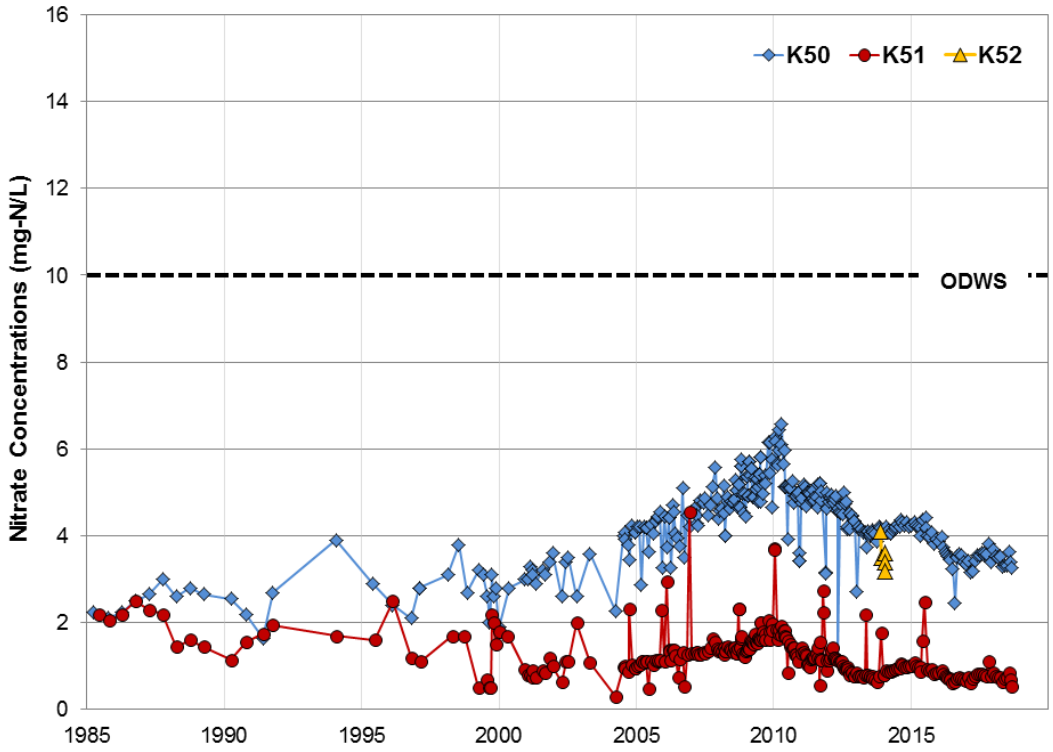


Figure 8.3—11: Nitrate Trends of Raw Water at the Wilmot Centre Supply Wells, Wilmot

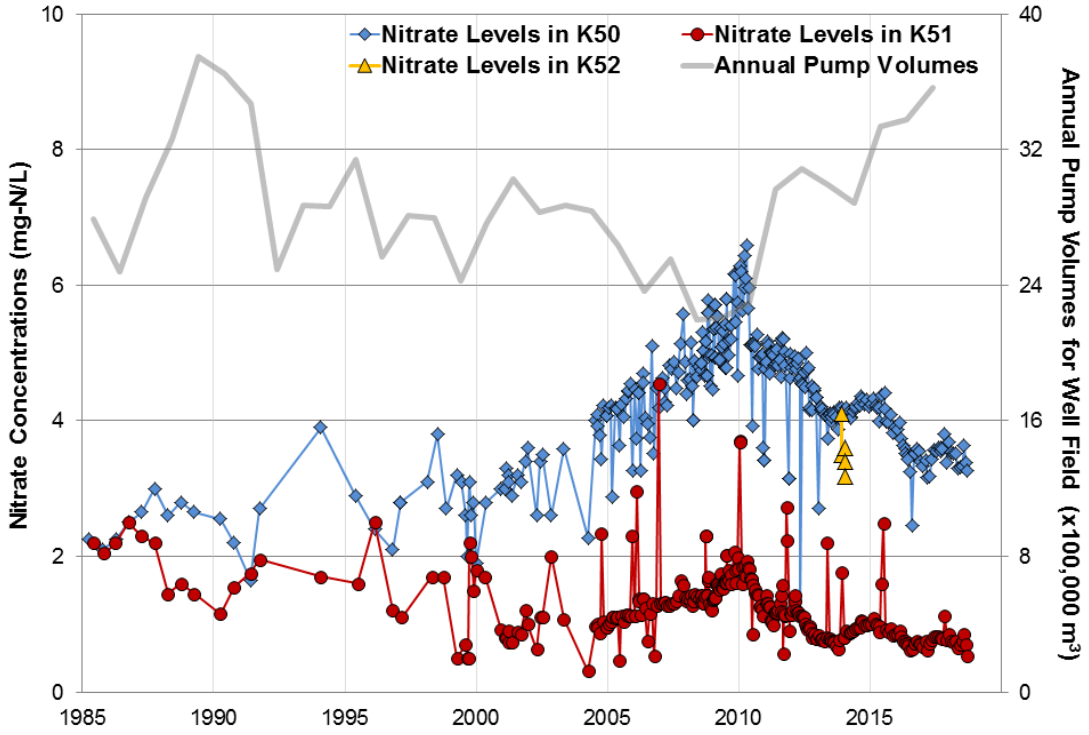


Figure 8.3—12: Nitrate Levels and Annual Production at the Wilmot Centre wells

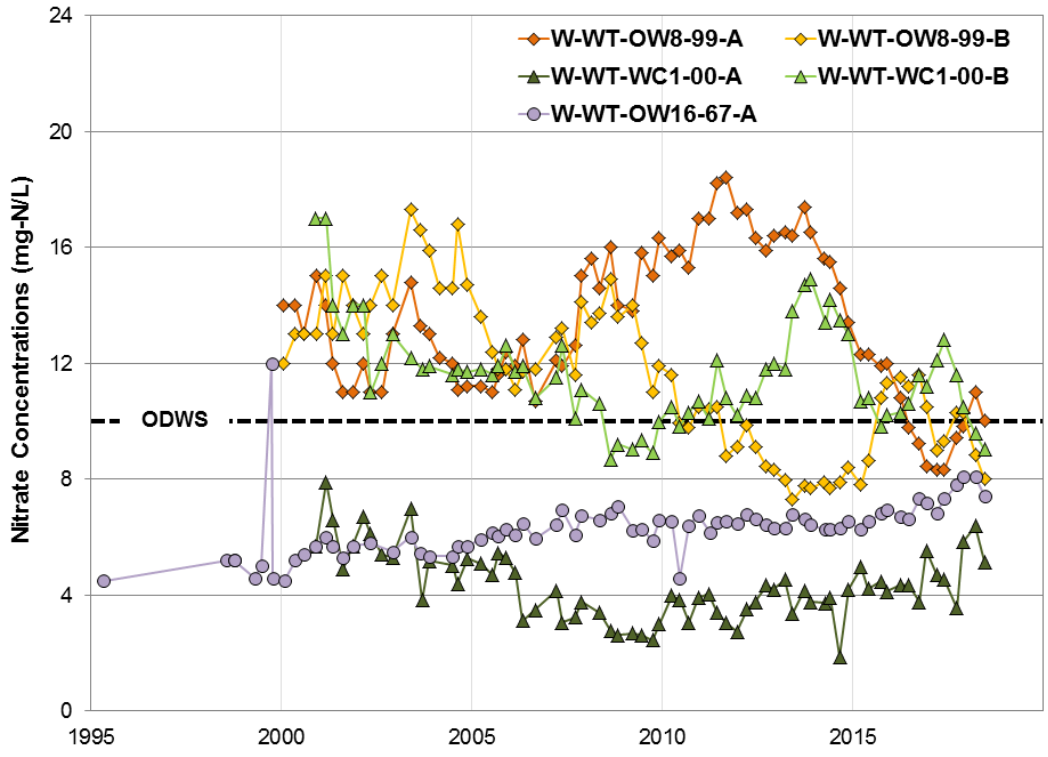


Figure 8.3—13: Nitrate Trends at some Monitoring Wells/Nests, all screened within the Municipal Supply Aquifer, near Wilmot Centre Wells, Wilmot

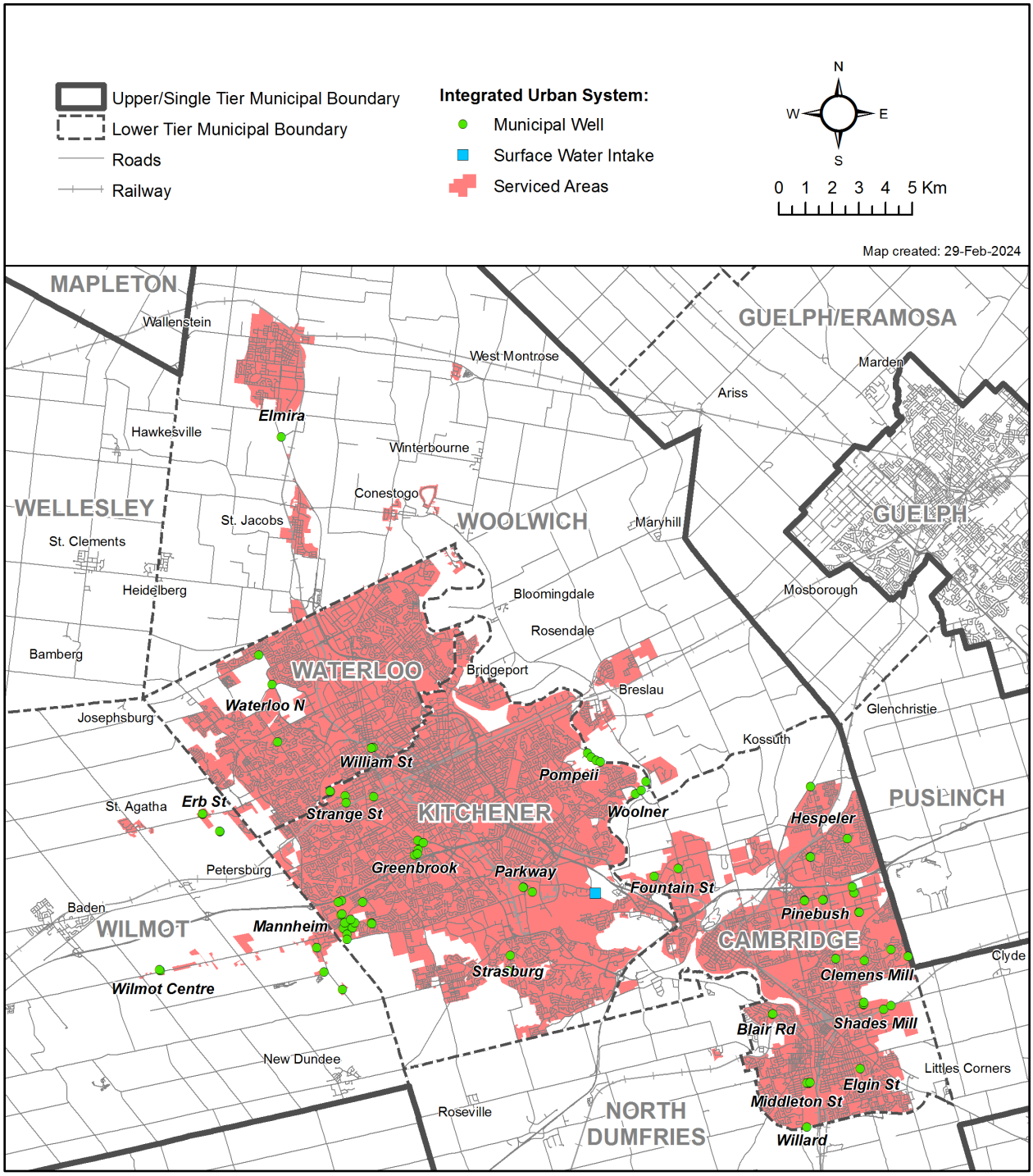
Table 8.3—16: Significant Drinking Water Quality Threats in the Wilmot Centre Wellhead Protection Areas (current to February 2019)

PDWT[1] #	Threat Subcategory[2]	Number of Activities	Vulnerable Area
1	The land disposal at a waste disposal site of solid non-hazardous waste generated by municipalities (residential)	1	WHPA-A WHPA-B WHPA-C ICA
2	Sewage system or sewage works - onsite sewage systems	82	WHPA-A WHPA-B ICA
	Sewage system or sewage works - onsite sewage systems holding tanks	13	WHPA-A WHPA-B ICA
3	Application of agricultural source material (ASM) to land	13	WHPA-A WHPA-B ICA
4	Storage of agricultural source material (ASM)	9	WHPA-A WHPA-B ICA
6	Application of non-agricultural source material (NASM) or biosolids to land	1	WHPA-A WHPA-B ICA
7	Storage of non-agricultural source material (NASM)	1	WHPA-A WHPA-B ICA
8	Application of commercial fertilizer to land	28	WHPA-A WHPA-B ICA
9	Storage of commercial fertilizer	5	ICA
10	Application of pesticide to land	6	WHPA-A WHPA-B
17	Storage of an organic solvent	1	WHPA-B
21	Management or handling of agricultural source material - agricultural source material (ASM) generation (grazing and pasturing)	2	WHPA-A WHPA-B ICA
	Management or handling of agricultural source material - agricultural source material (ASM) generation (yards or confinement)	5	WHPA-A WHPA-B ICA
Total Number of Significant Threat Activities		**167**	
Total Number of Properties with Significant Threats		**87**	

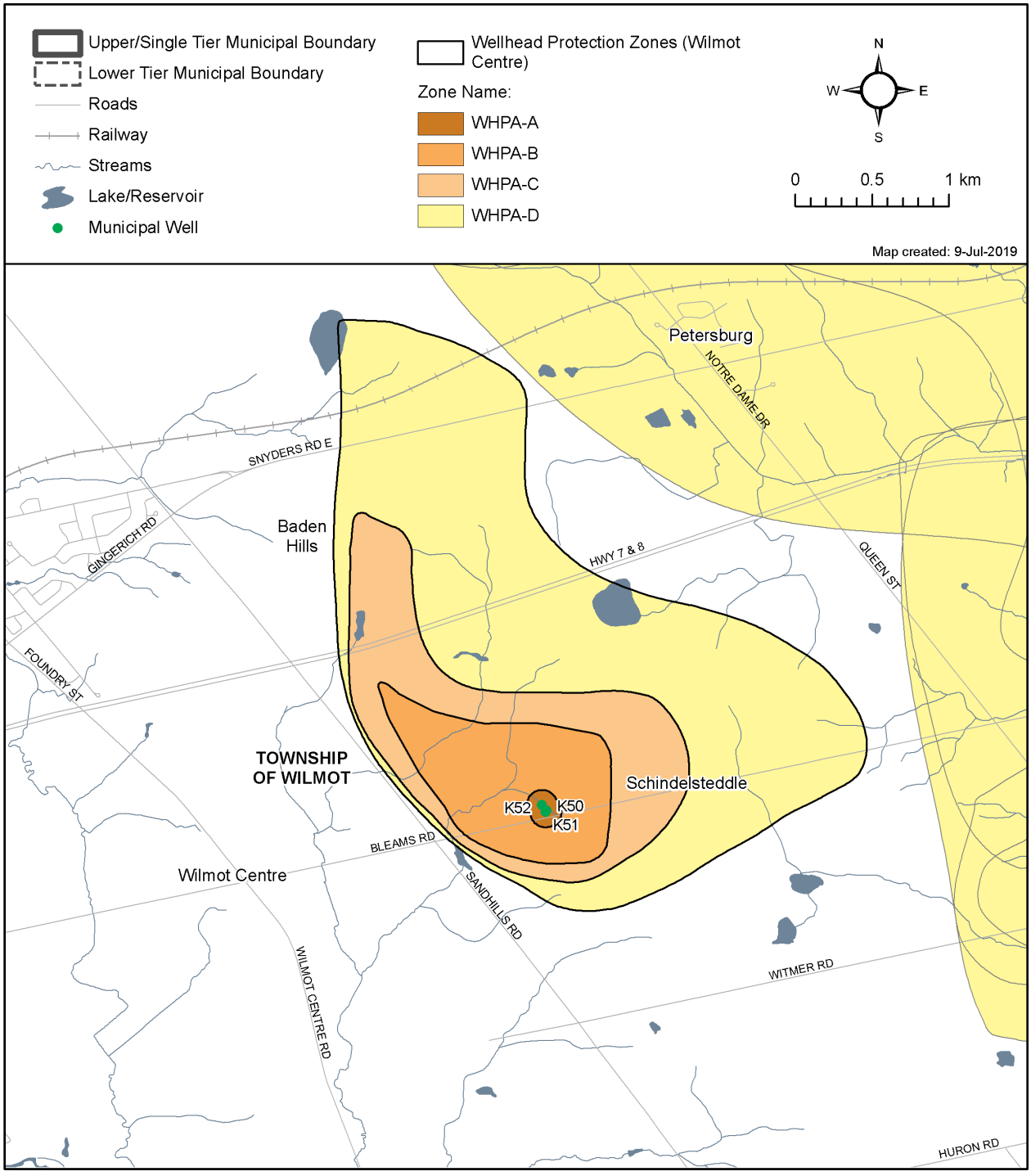
[1] Prescribed Drinking Water Quality Threat Number refers to the prescribed drinking water threat listed in O. Reg. 287/07 s.1.1 (1)

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

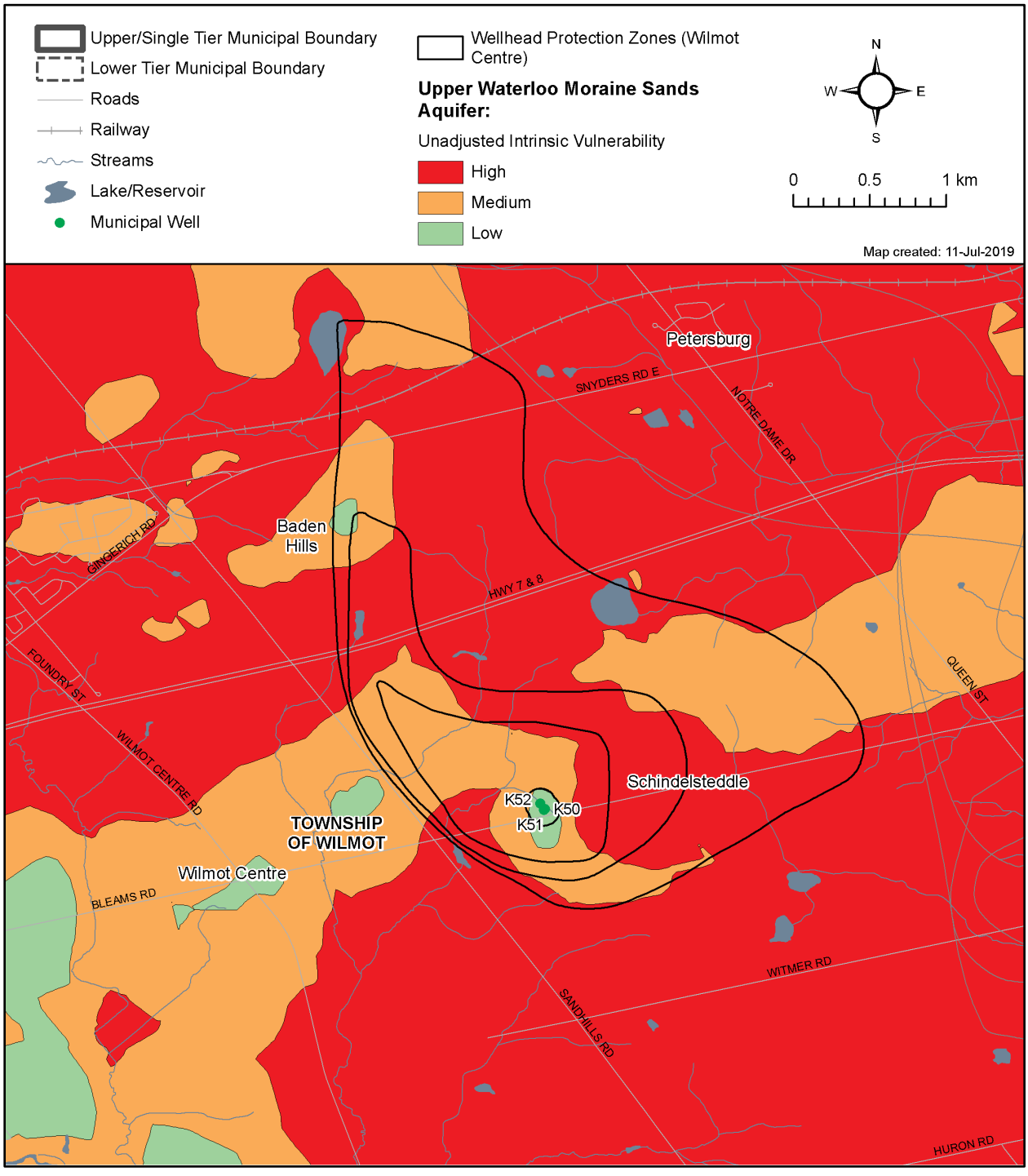
Map 8.3—62: Integrated Urban System Serviced Areas



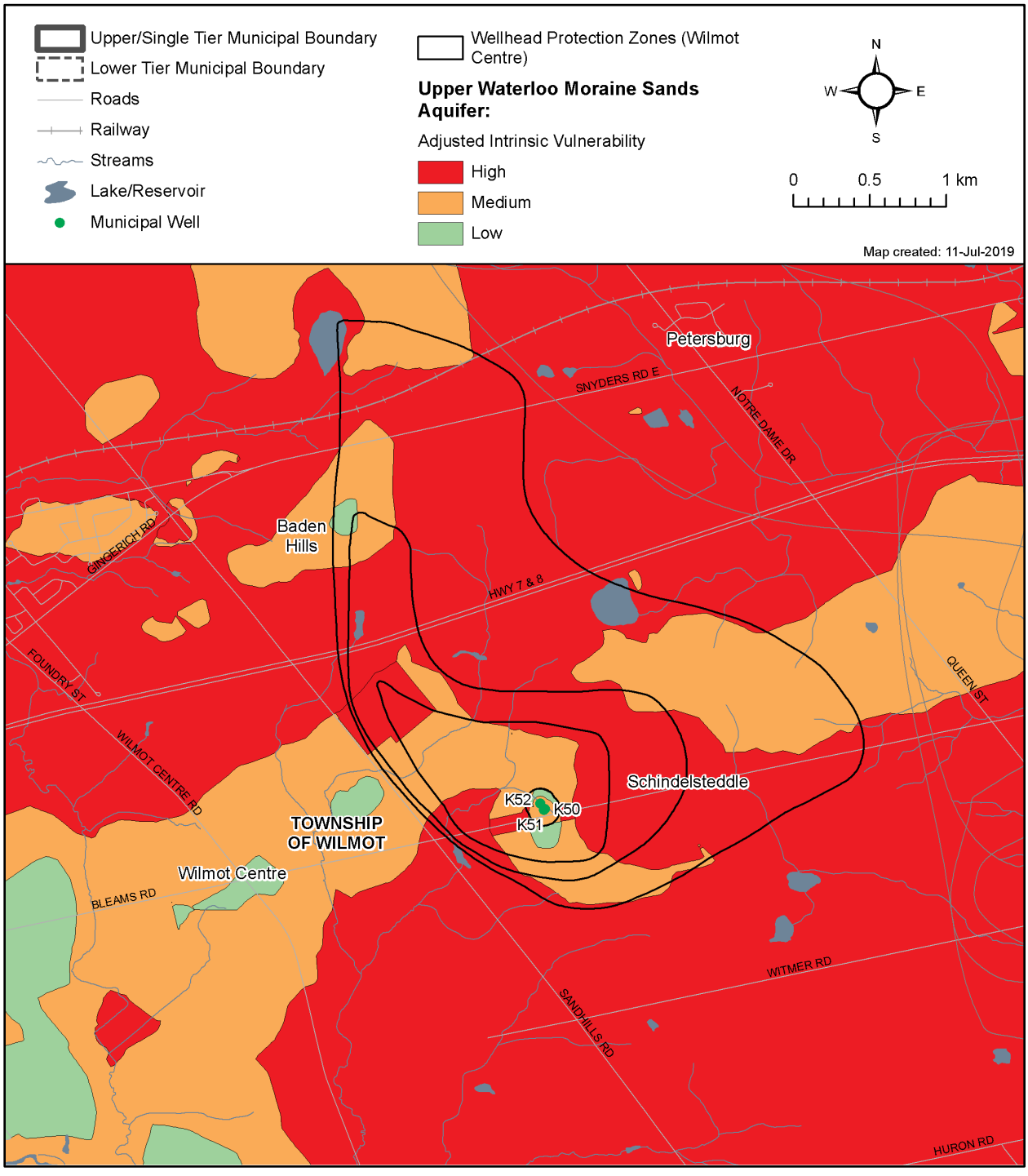
Map 8.3—63:Wilmot Centre Well Supply Wellhead Protection Areas



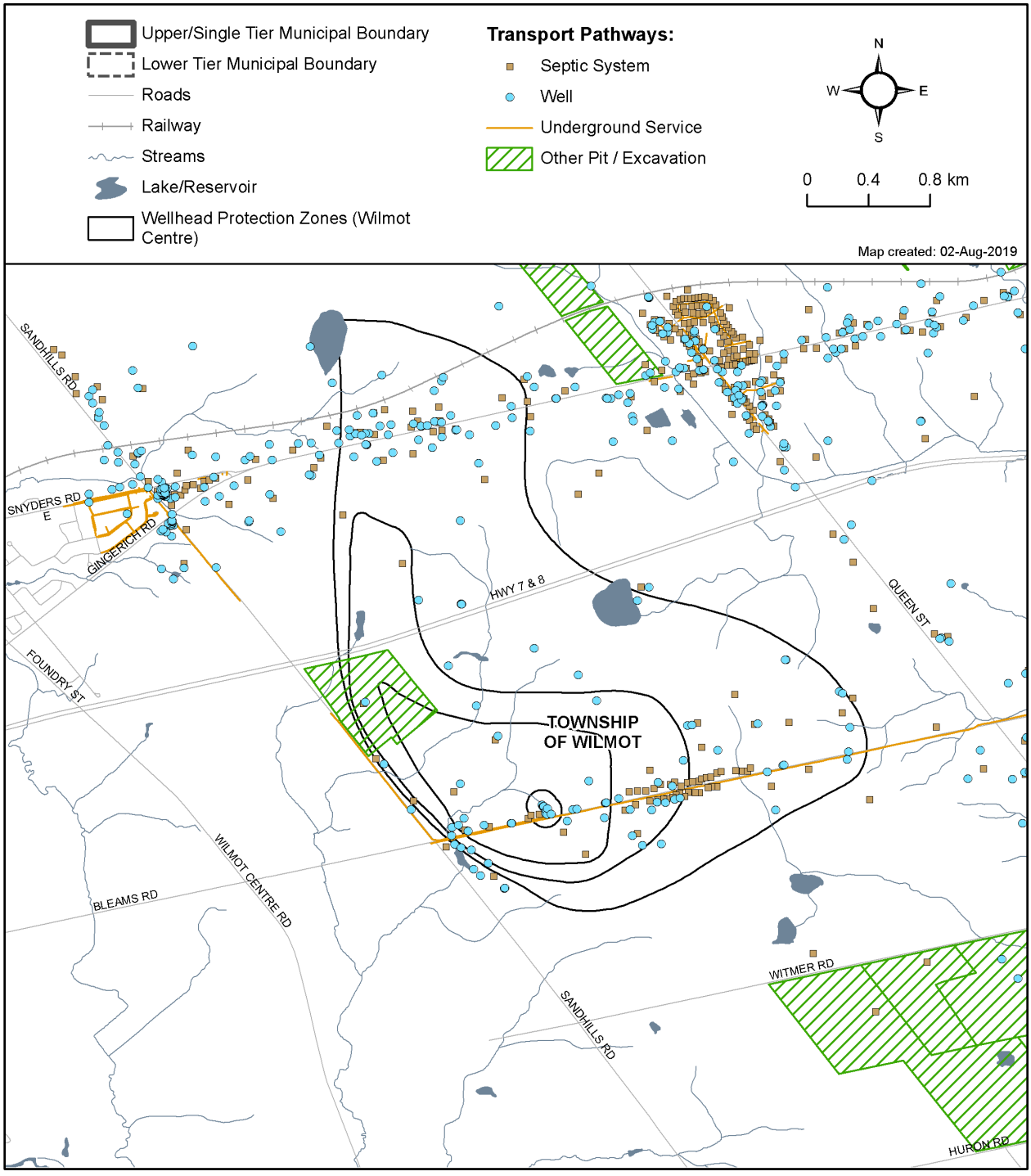
Map 8.3—64: Wilmot Centre Well Supply Wellhead Protection Area Unadjusted Intrinsic Vulnerability



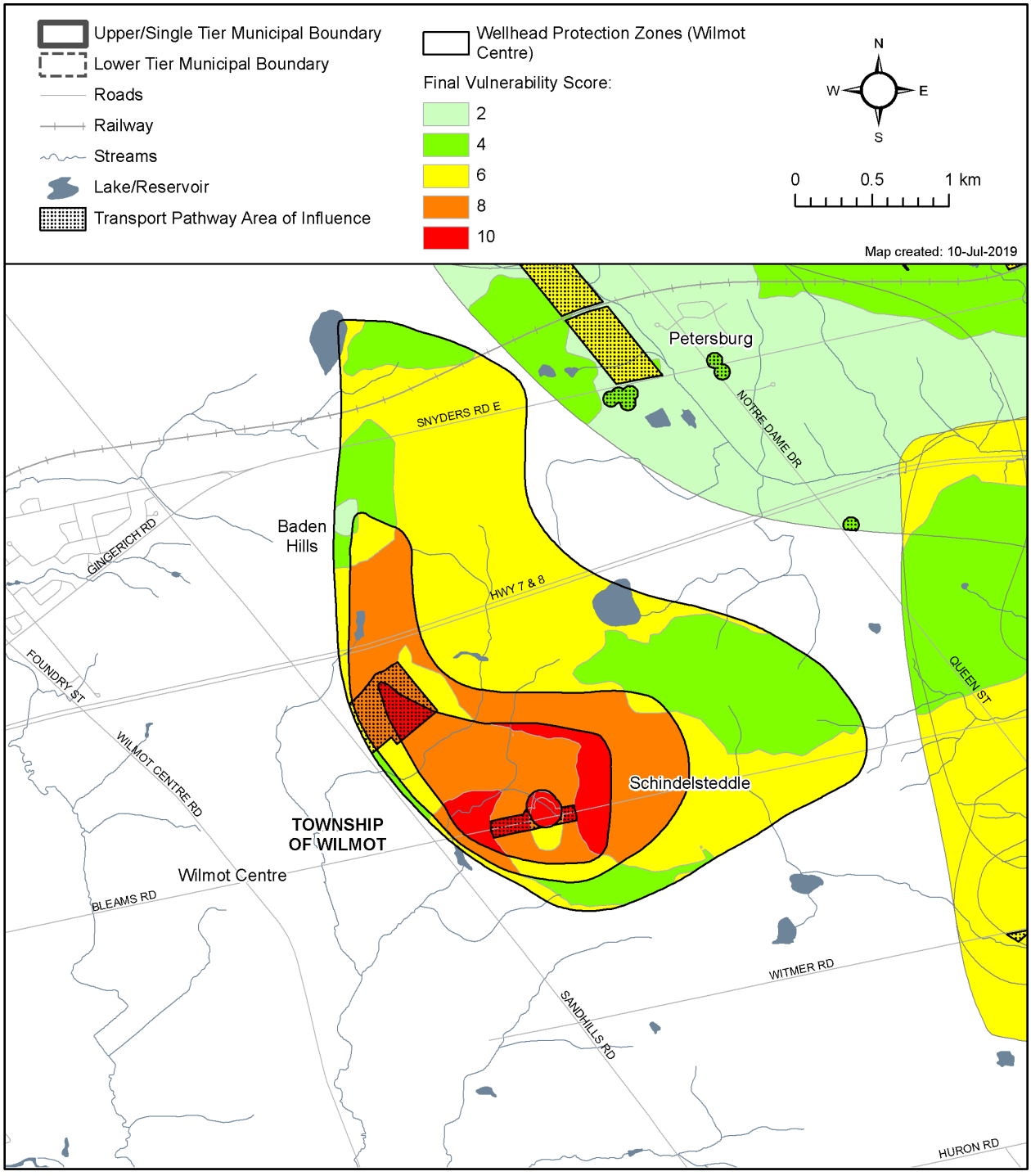
Map 8.3—65: Wilmot Centre Well Supply Wellhead Protection Area Adjusted Intrinsic Vulnerability



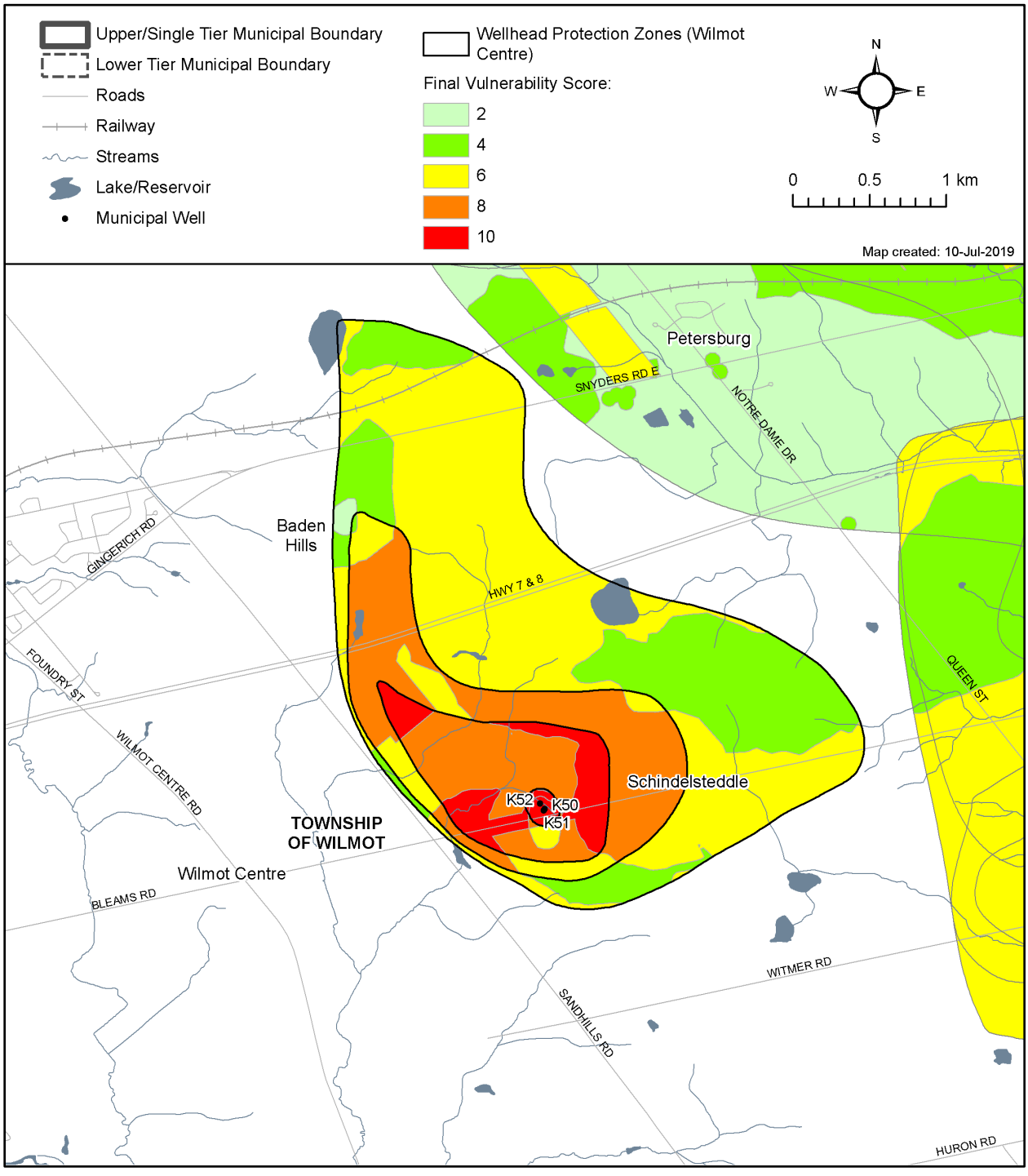
Map 8.3—66: Wilmot Centre Well Supply Transport Pathways



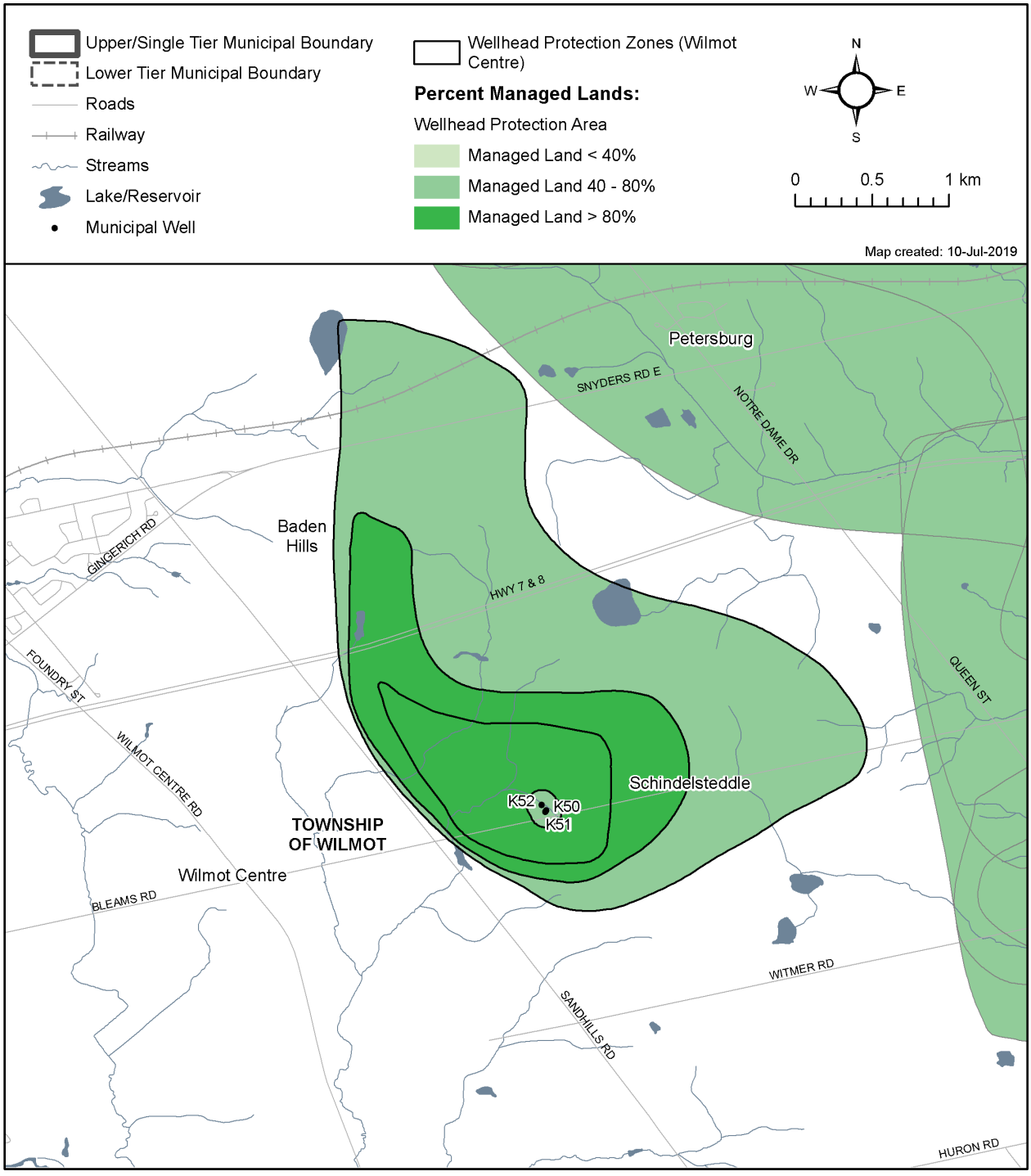
Map 8.3—67: Wilmot Centre Well Supply Transport Pathways Area of Influence



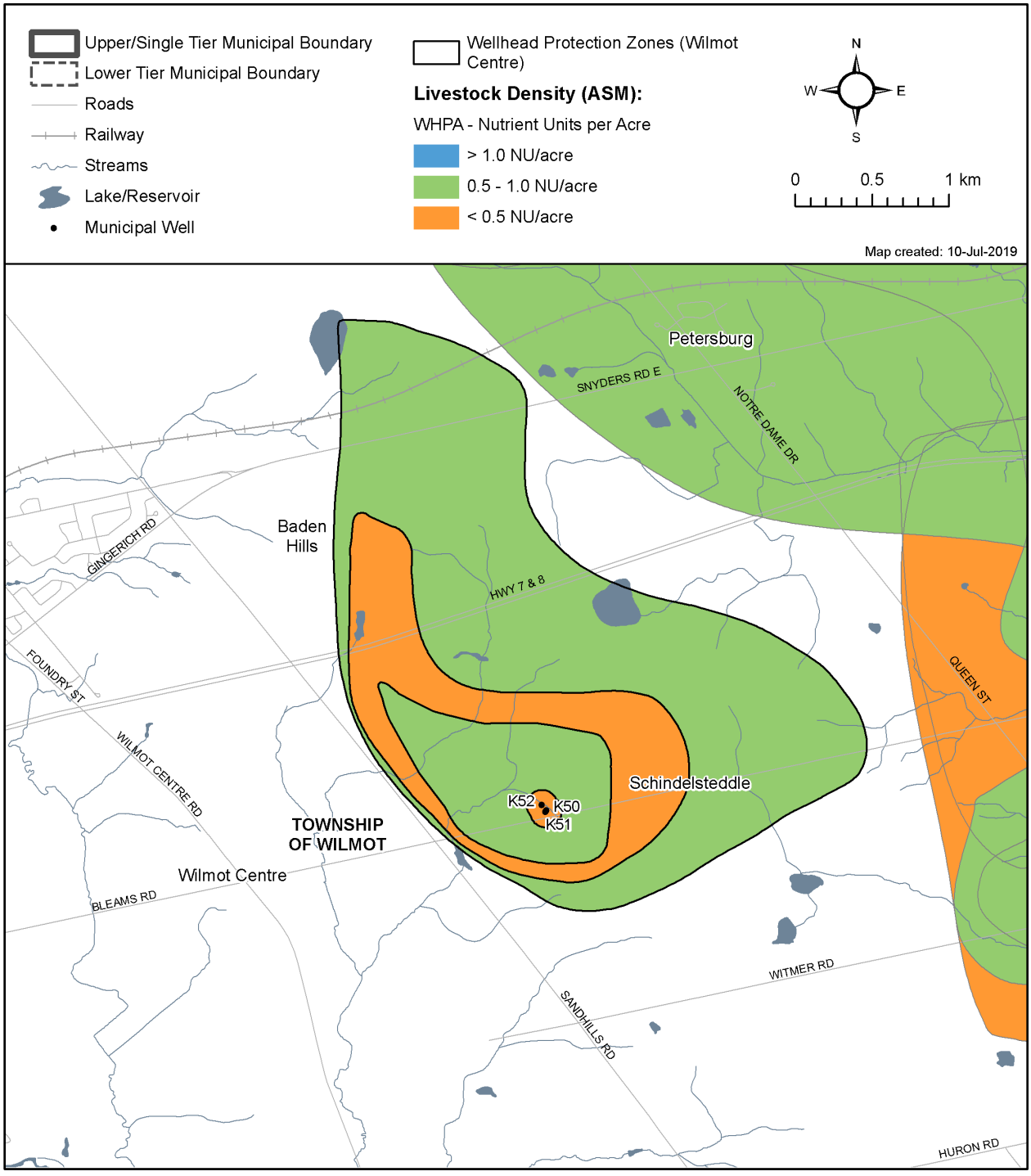
Map 8.3—68: Wilmot Centre Well Supply Wellhead Protection Area Final Vulnerability



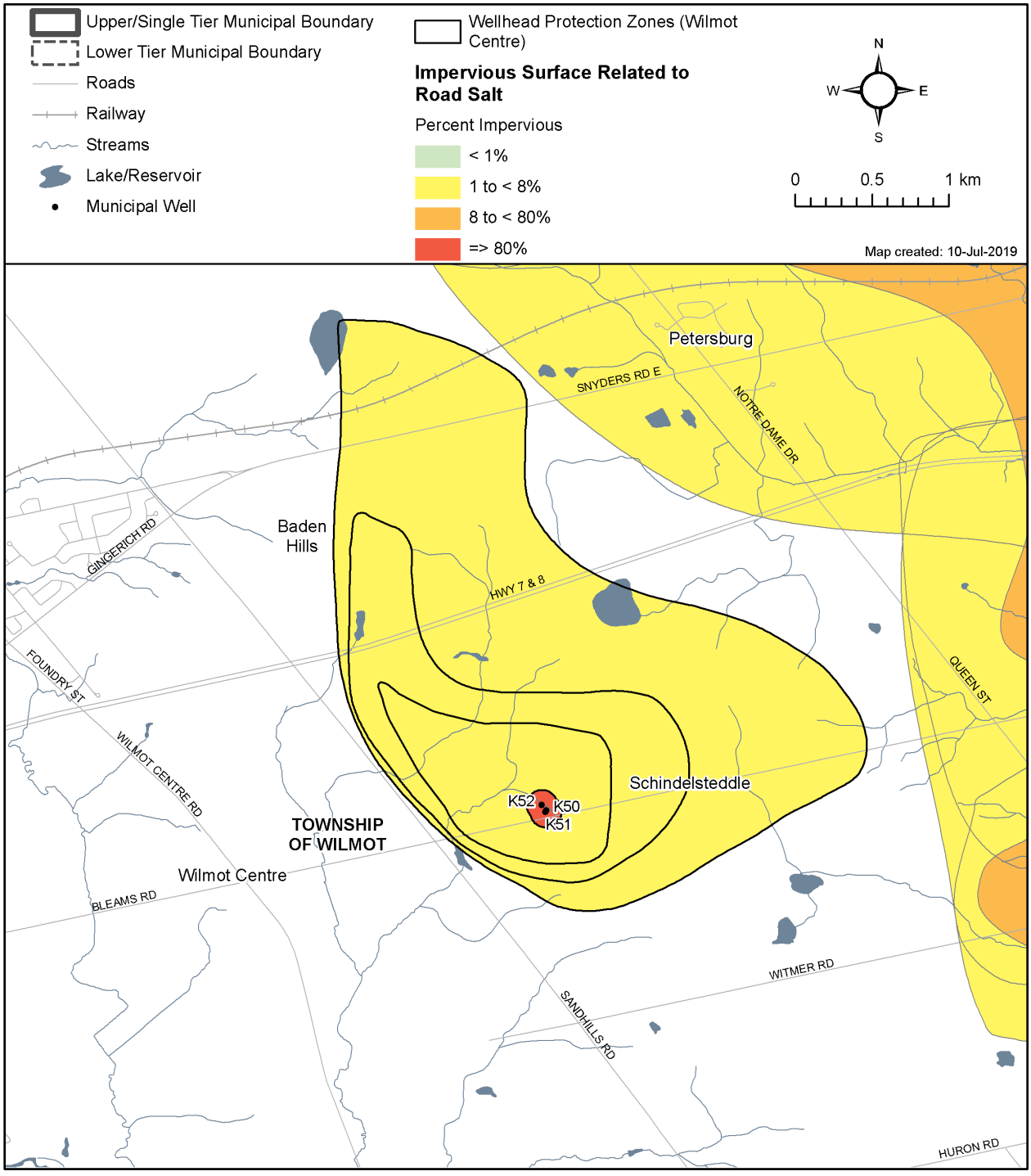
Map 8.3—69: Wilmot Centre Well Supply Percent Managed Lands



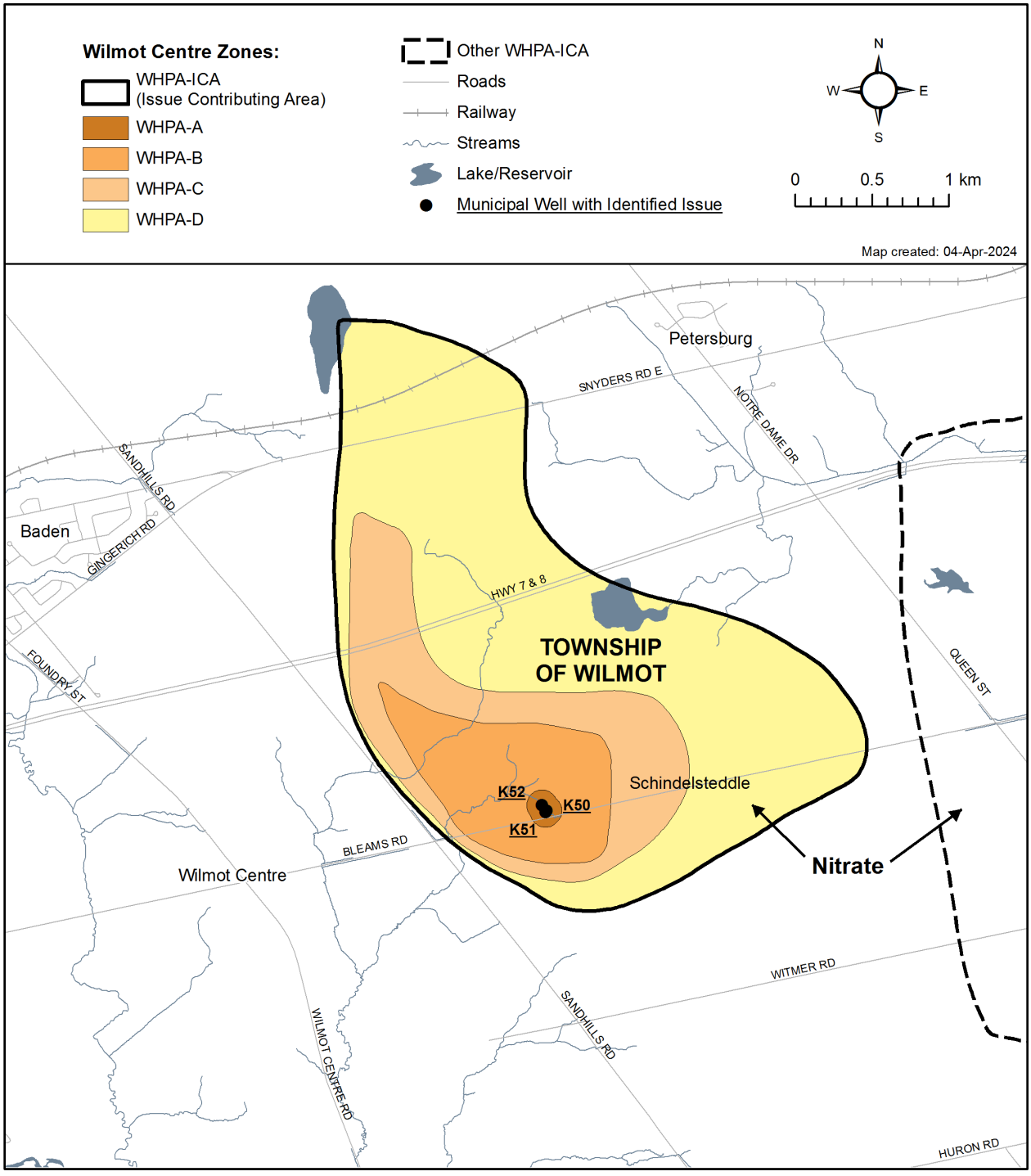
Map 8.3—70:Wilmot Centre Well Supply Livestock Density



Map 8.3—71:Wilmot Centre Well Supply Percent Impervious Surfaces



Map 8.3—72: Wilmot Centre Well Supply Issue Contributing Area



8.4 Surface Water – Hidden Valley Intake

8.4.1 Intake Protection Zone (IPZ) Delineation and Vulnerability

The Intake Protection Zones have been delineated in accordance with the Technical Rules (MOE, 2009b). A detailed description of the methods used can be found in **Section 8.1 – Water Quality Risk Assessment**. The final IPZ-1 delineation is presented on **Map 8.4—281**.

Through the extensive analysis done for the IPZ-2 delineation, a channel-bankfull design flow rate of 80 m^3/s was determined to be appropriate with an associated average maximum water velocity of 0.82 m/s. The 2-hour time of travel distance up the Grand River from the intake was estimated to be 5880 m. The on land setbacks from the high water mark were the greater of the GRCA regulation limit or 120m. For the Grand River, the high water mark was calculated as the 80^{th} percentile for the month in which the highest water level occurs. For the secondary tributaries, the high water mark was assumed to coincide with the available polygon and linework databases. The final IPZ-2 delineation is presented on **Map 8.4—281**.

The IPZ-3 delineation, which represents the upstream contributing area of the Hidden Valley intake, is presented on **Map 8.4—286**. A complete description of the results of the IPZ delineation is provided in the report entitled *Intake Protection Zone Delineation Study, Grand River Hidden Valley Intake, City of Kitchener* (Stantec, 2009b).

The vulnerability score for all properties found within the IPZ-1 is 9, while the vulnerability score for properties found within the IPZ-2 is 7.2 (**Table 8.4—76**). These vulnerability scores influence the threat ranking so that only those properties found within the IPZ-1 (vulnerability = 9) have the potential to be significant threats. The vulnerability scores for the IPZ-3 are summarized in **Table 8.4—77** and vary across the intake protection zone as follows:

- Undeveloped lands such as wetlands and forests (vulnerability score = 0.9);
- Rural lands upstream of the major reservoirs (Belwood Lake and Conestoga Lake) (vulnerability score = 2.7);
- Urban lands upstream of the major reservoirs (vulnerability = 3.6);
- Rural lands downstream of the major reservoirs (vulnerability = 3.6);
- Urban lands downstream of the major reservoirs excluding Kitchener-Waterloo (vulnerability score = 5.4); and
- Urban areas of Kitchener-Waterloo (vulnerability score = 7.2).

8.4.2 Identification of Significant, Moderate and Low Drinking Water Quality Threats in the Hidden Valley Intake Protection Zones

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. Information on drinking water threats is also accessible through the Source Water Protection Information Portal . The information

above can be used with the vulnerability scores shown in **Map 8.4—282** and **Map 8.4—286** to help the public determine where certain activities are or would be significant, moderate and low drinking water threats.

Table 8.4—75 provides a summary of the threat levels possible in the Hidden Valley Intake Protection Zones for Chemical, Dense Non-Aqueous Phase Liquid (DNAPL) and Pathogen. “Yes” indicates that the threat classification level is possible for the indicated threat type under the corresponding vulnerable area / vulnerable score; “No" indicates that it is not. The colours shown for each vulnerability score correspond to those shown in **Map 8.4—282** and **Map 8.4—286**.

Table 8.4—17: Identification of Drinking Water Quality Threats in the Hidden Valley Intake Protection Zones

Threat Type	Vulnerable Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	IPZ-1	9	Yes	Yes	Yes
Chemicals	IPZ-2 / 3	7.2	No	Yes	Yes
Chemicals	IPZ-3	5.4	No	No	Yes
Chemicals	IPZ-3	4.0 or less	No	No	No
DNAPLs	IPZ-1	9	No	Yes	No
DNAPLs	IPZ-2 / 3	7.2	No	Yes	Yes
DNAPLs	IPZ-3	5.4	No	No	Yes
DNAPLs	IPZ-3	4.0 or less	No	No	No
Pathogens	IPZ-1	9	Yes	Yes	Yes
Pathogens	IPZ-2 / 3	7.2	No	Yes	Yes
Pathogens	IPZ-3	5.4	No	No	Yes
Pathogens	IPZ-3	4.0 or less	No	No	No

8.4.3 Threats and Issues Enumeration for the Hidden Valley Intake

The Hidden Valley Intake supplies water to the IUS via the Mannheim water treatment plant. The IPZ delineated for the Intake overlaps with several Regional WHPAs including the Pompeii, Woolner and P16 Wellfield WHPA’s. Properties found within both an IPZ and a WHPA had separate rankings completed for both surface water and groundwater threats.

The percent managed land, livestock density, and percent impervious surface value for IPZ-1 and IPZ-2 are shown in **Map 8.4—283, Map 8.4—284**, **Map 8.4—285**. Values for all zones (including IPZ-3) are shown on **Map 8.4—287, Map 8.4—288**, and **Map 8.4—289**.

From a total of 440 threat surveys delivered in the intake protection zone, 220 were completed and the remaining properties were ranked without census information. The total number of identified significant drinking water threats in this protection zone is 0. The number of properties in this protection zone with identified significant drinking water

threats is 0. No significant threats were identified in the Hidden Valley Intake Protection Zone and as such a circumstance enumeration was not required for this intake.

No Significant Conditions were identified in the IPZ as per Technical Rule 126.

Table 8.4—18: Vulnerability Scores for IPZ-1 and IPZ-2 of the Hidden Valley Intake

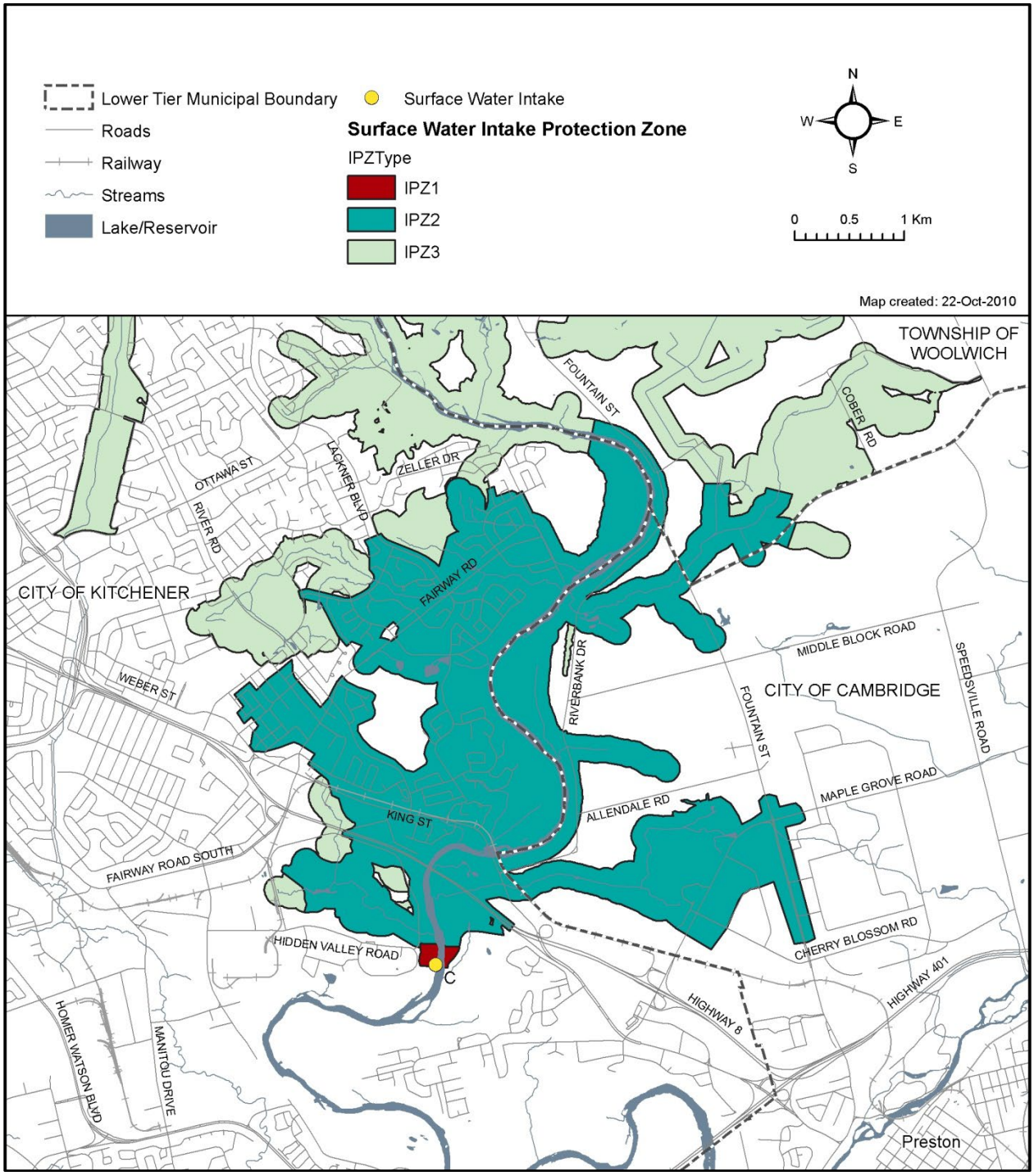
Area Vulnerability Factor (Vfa)		Source Vulnerability Factor (Vfs)	Vulnerability Score	
IPZ-1	IPZ-2		IPZ-1	IPZ-2
10	8	0.9	9	7.2

Table 8.4—19: Vulnerability Scores for the IPZ-3 of the Hidden Valley Intake[1]

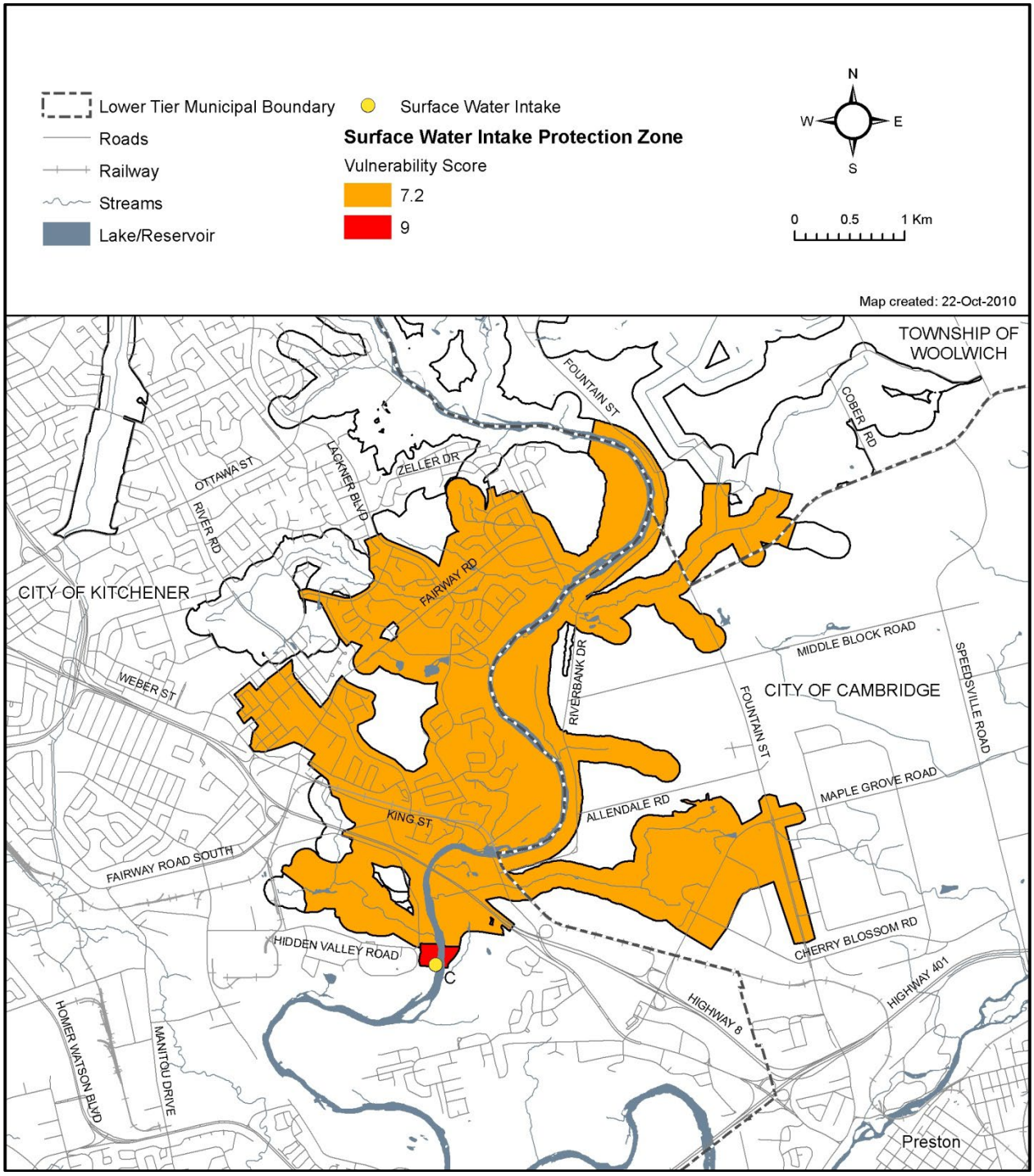
Component of IPZ-3 Zone	Area Vulnerability Factor (Vfa)	Vulnerability Score
Urban Areas of Kitchener and Waterloo outside of other IPZs	8	7.2
Urban areas downstream of Shand Dam and Conestoga Dam excluding Kitchener and Waterloo	6	5.4
Urban area upstream of Shand Dam and Conestoga Dam	4	3.6
Rural lands downstream of Shand Dam and Conestoga Dam within Regulated Area or 120 m of watercourse	4	3.6
Rural lands upstream of Shand Dam and Conestoga Dam within Regulated Area of 120 m of watercourse	3	2.7
All other agricultural lands	2	1.8
All undeveloped lands such as wetlands, forests	1	0.9

[1] Note: Source Vulnerability Factor Vfs for entire IPZ-3 is 0.9, as discussed above

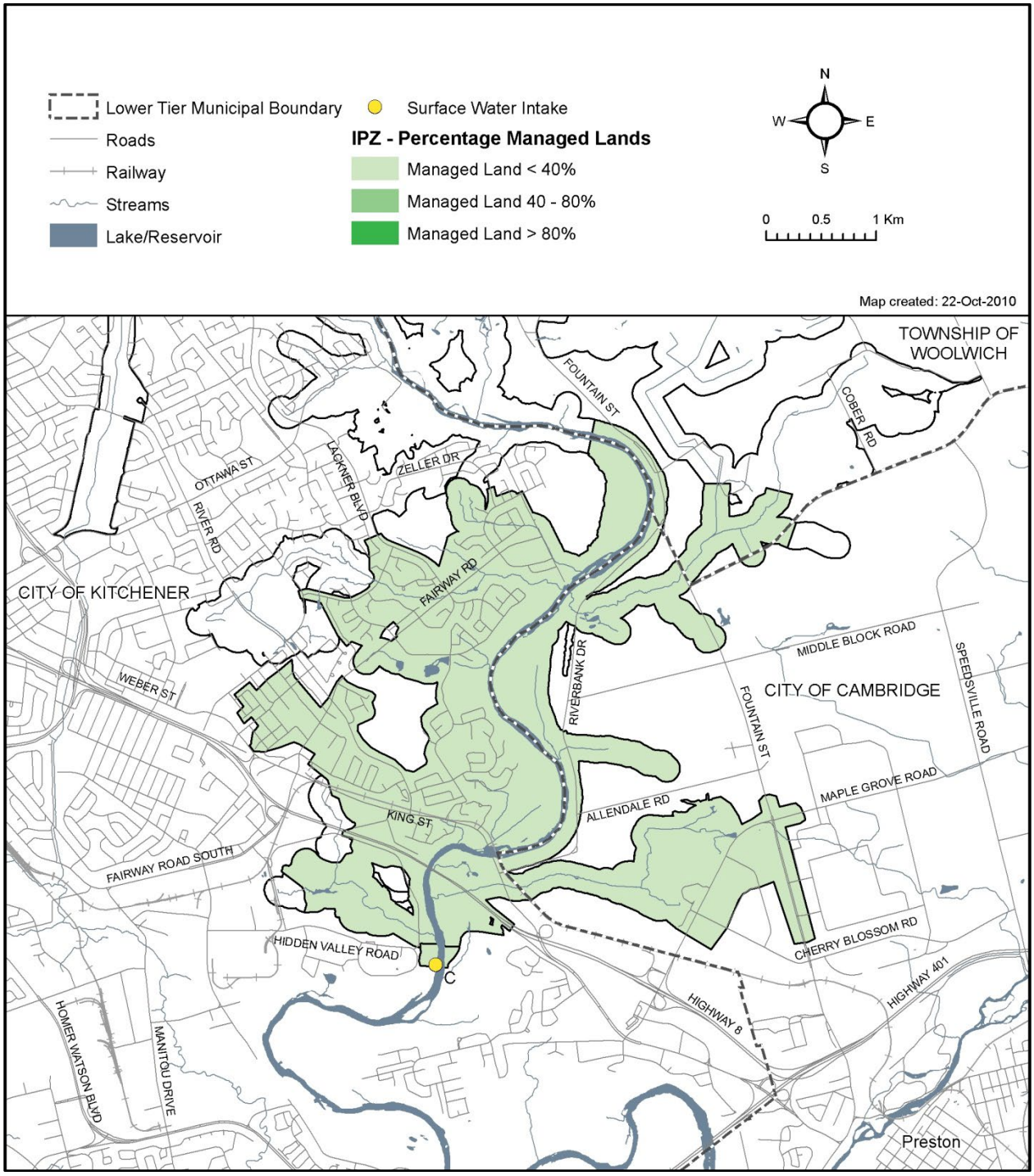
Map 8.4—73:Hidden Valley Water Supply Intake Protection Zone



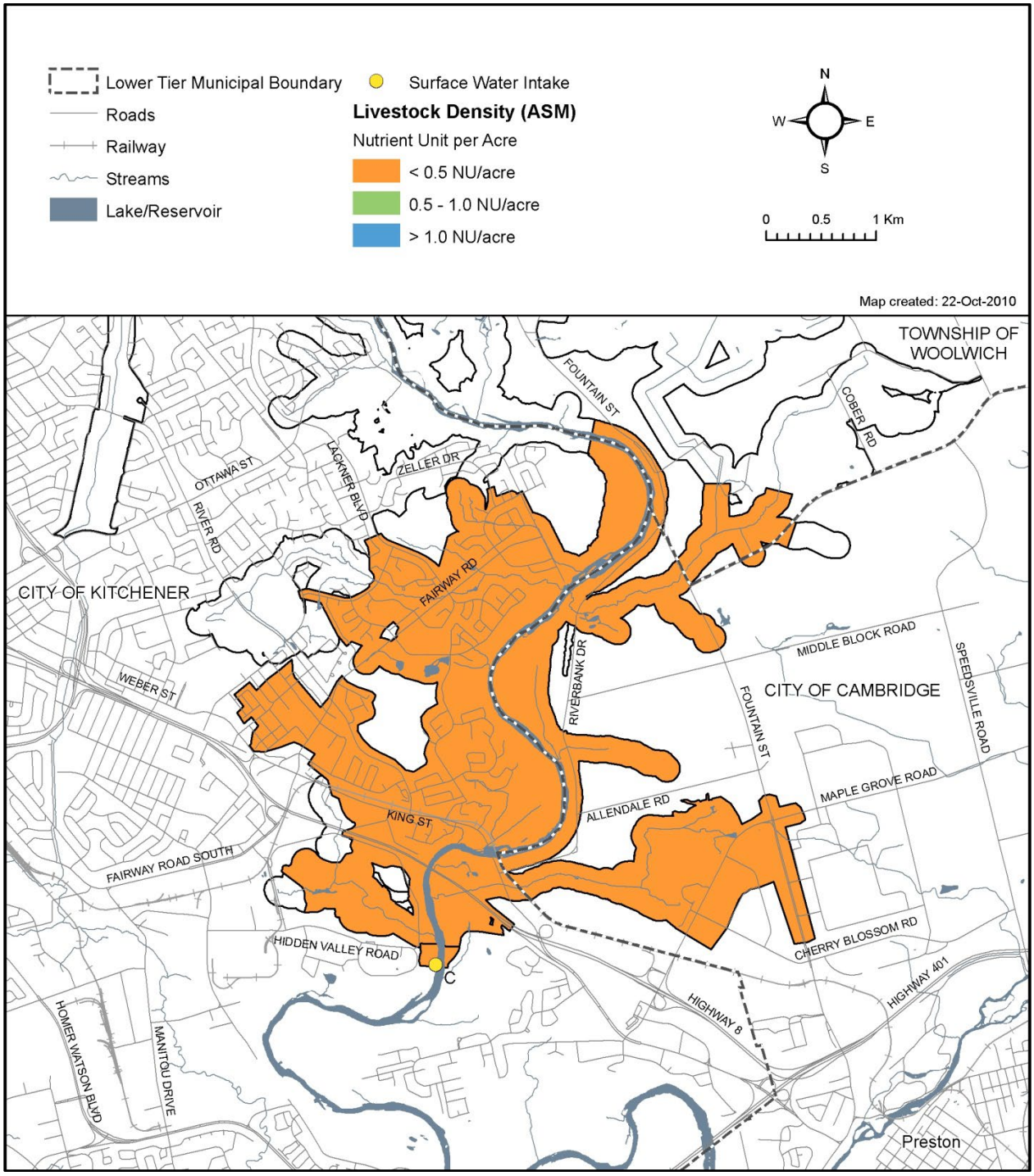
Map 8.4—74: Hidden Valley Water Supply Intake Protection Zone Vulnerability



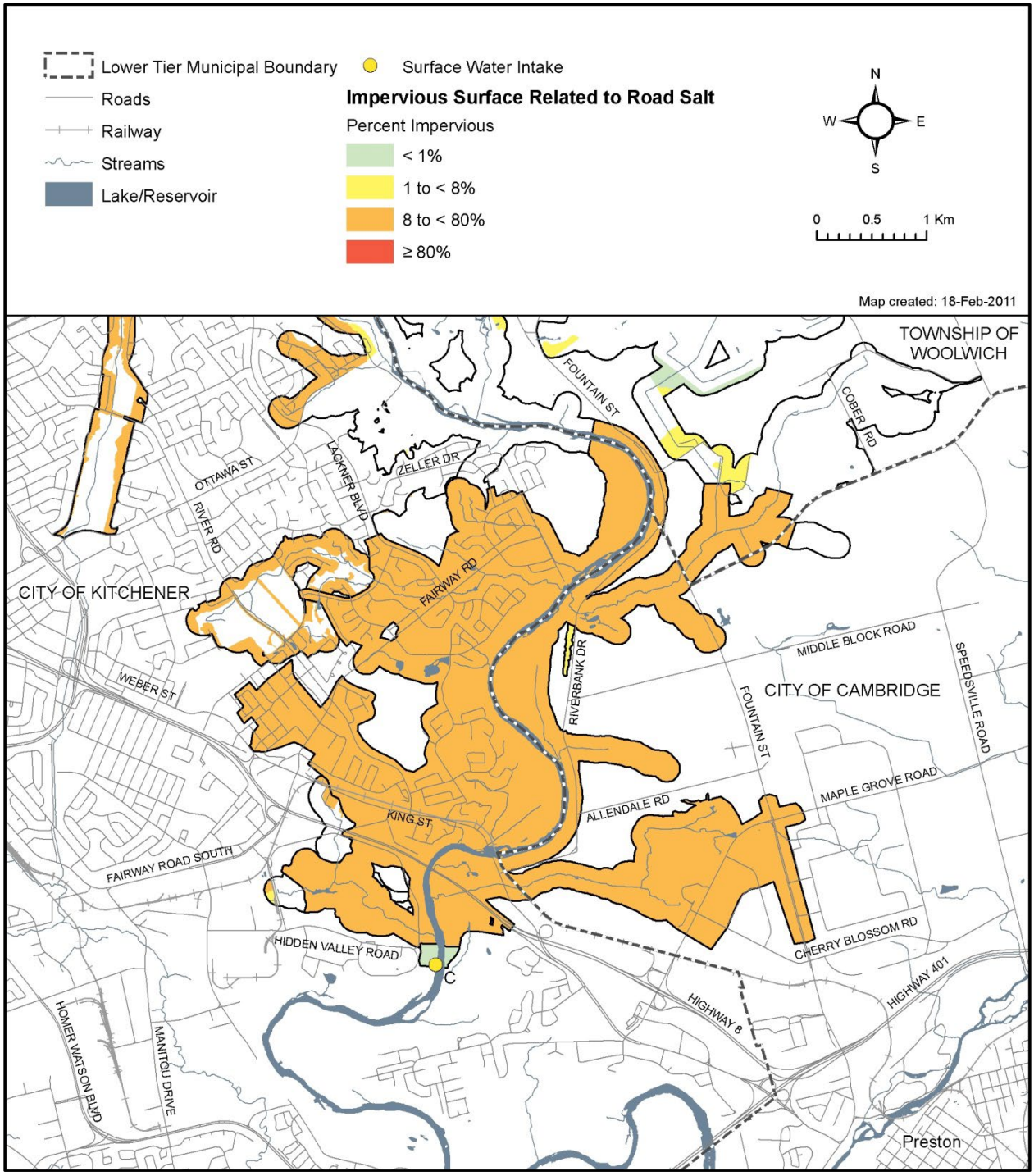
Map 8.4—75: Hidden Valley Water Supply Percent Managed Lands



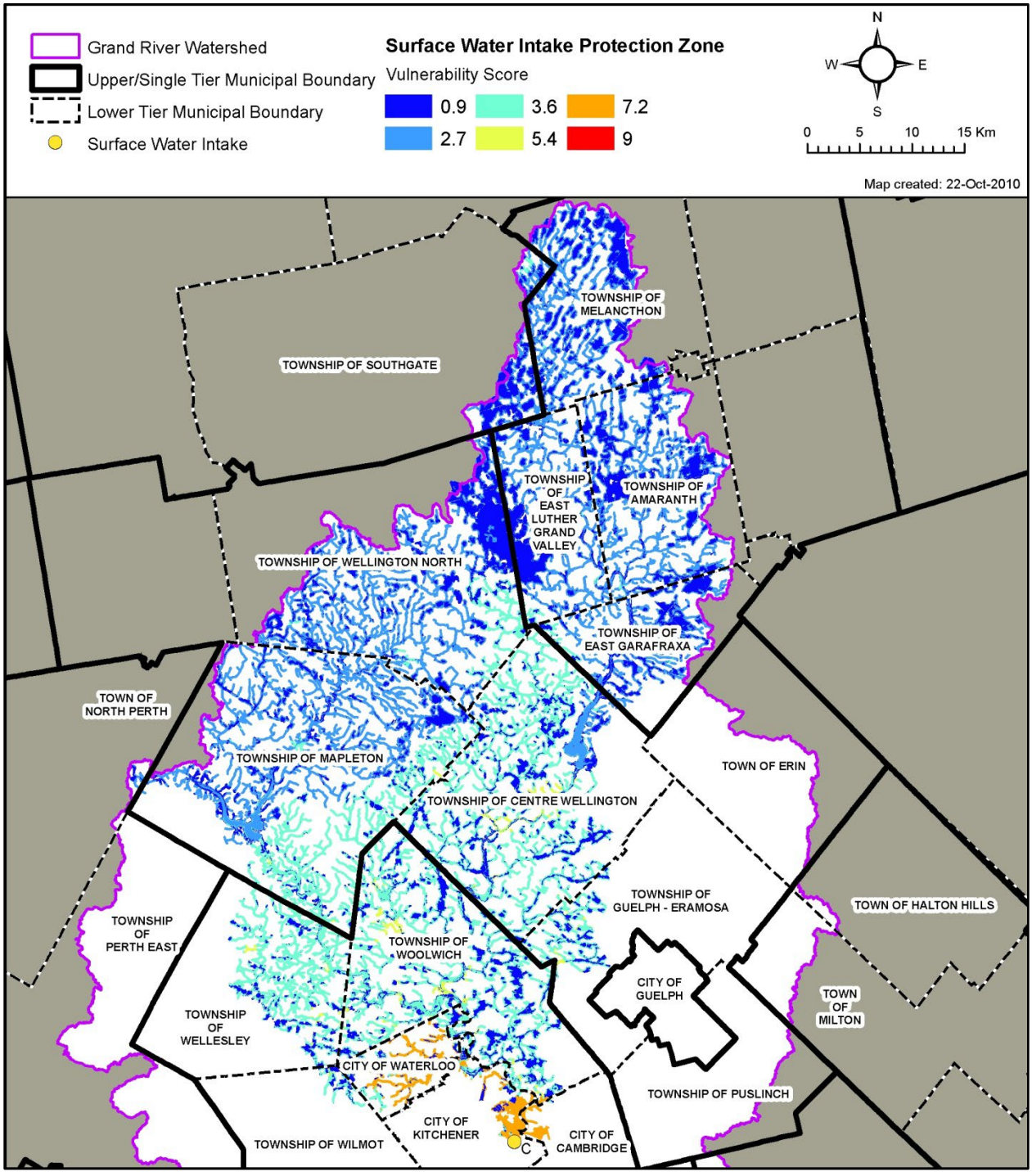
Map 8.4—76: Hidden Valley Water Supply Livestock Density



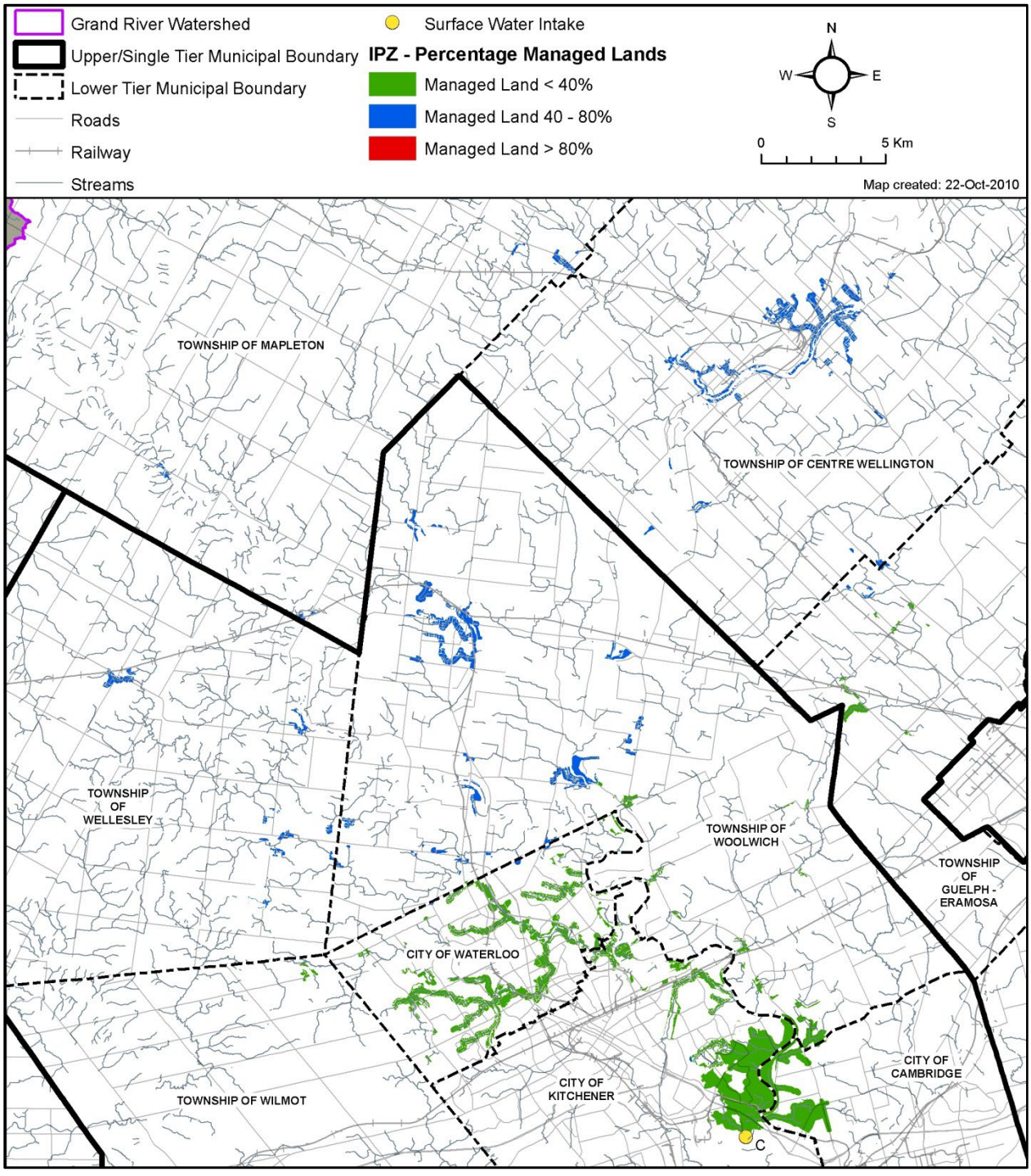
Map 8.4—77: Hidden Valley Water Supply Percent Impervious Surfaces



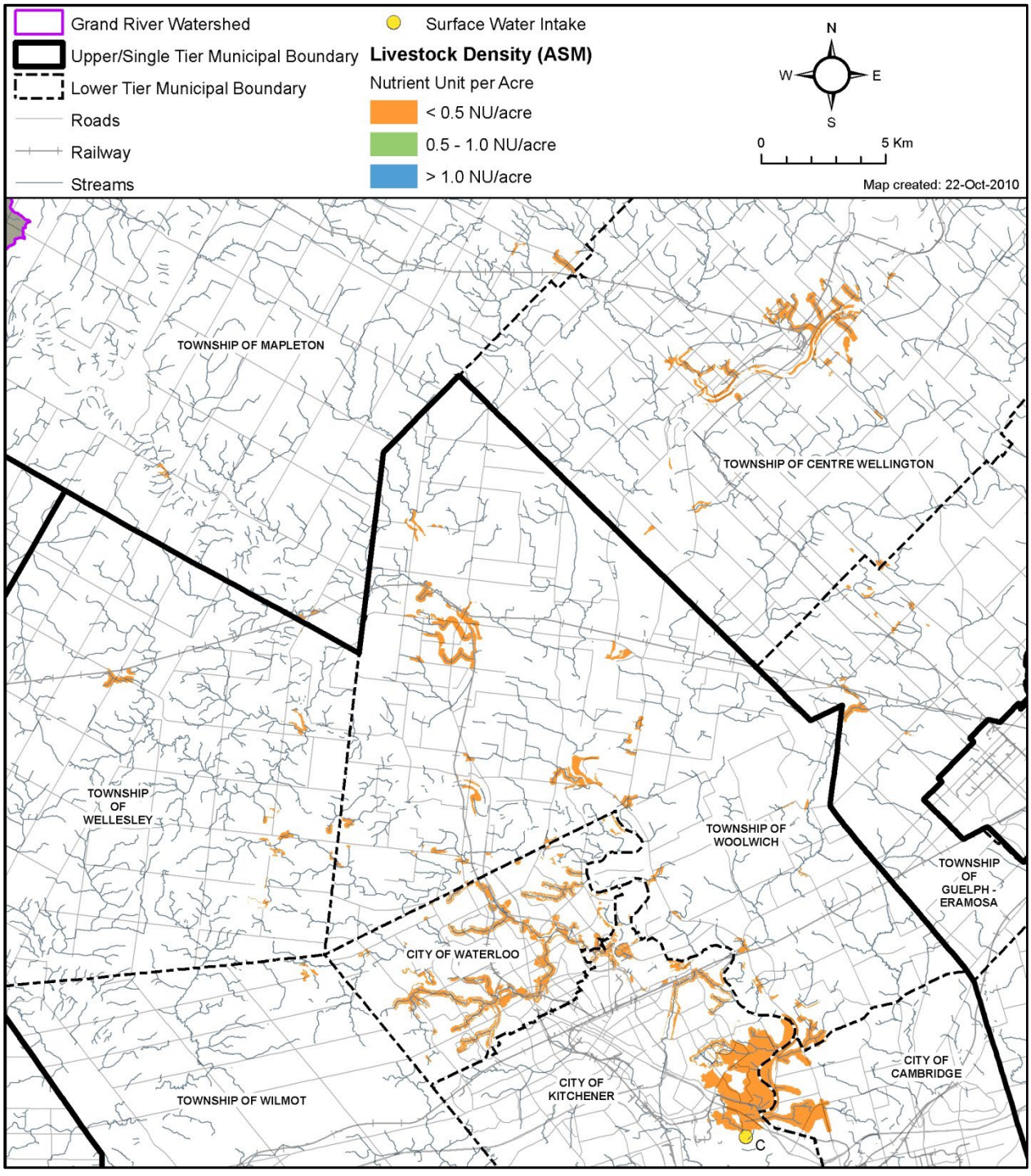
Map 8.4—78: Hidden Valley Water Supply Intake Protection Zone 3



Map 8.4—79: Hidden Valley Water Supply Intake Protection Zone 3 Percent Managed Lands



Map 8.4—80: Hidden Valley Water Supply Intake Protection Zone 3 Livestock Density



Map 8.4—81: Hidden Valley Water Supply Intake Protection Zone Percent Impervious Surfaces