Grand River Source Protection Area

ASSESSMENT REPORT
Submission Draft

Chapter 12: City of Hamilton

January 30, 2025

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12.0 CITY OF HAMILTON

12.1 Lynden Communal Well System

The City of Hamilton operates a groundwater water supply and distribution system located in the Lynden Rural Settlement Area. The system consists of two pumping wells (FDL1R and FDL03). Both wells are screened in a confined overburden aquifer between 50 and 55 metres below ground surface. The aquifer is locally confined by a thick deposit of clay and silt. Neither well meets the requirements to be considered groundwater under the direct influence of surface water (GUDI) (Burnside, 2024; WSP, 2016). FDL1R is a replacement for FDL01, which was decommissioned in 2023.

The location of the existing well sites and serviced area is shown on **Map 12-1**. The system operates under Permit to Take Water (PTTW No. 0634-ASERU8) and has a capacity of 518.4 m^3/day. **Table 12-1** and **Table 12-2** summarize the system characteristics. The raw water at this system passes through a two-stage treatment process to remove naturally occurring hydrogen sulphide and provide disinfection. The treatment facility includes an air stripper, a cartridge filter and a carbon dioxide injection system for pH adjustment prior to the aeration tank. The reservoir acts as a free chlorine contact chamber to ensure disinfection of the water.

Table 12-1: Municipal Residential Drinking Water System Information for the City of Hamilton in the Grand River Source Protection Area (Lynden Communal Well System)

DWS Number	DWS Name	Operating Authority	GW or SW	System Classification[1]	Number of Users served[2]
250001830	Lynden Communal Well System	City of Hamilton	GW	Large Municipal Residential System	393

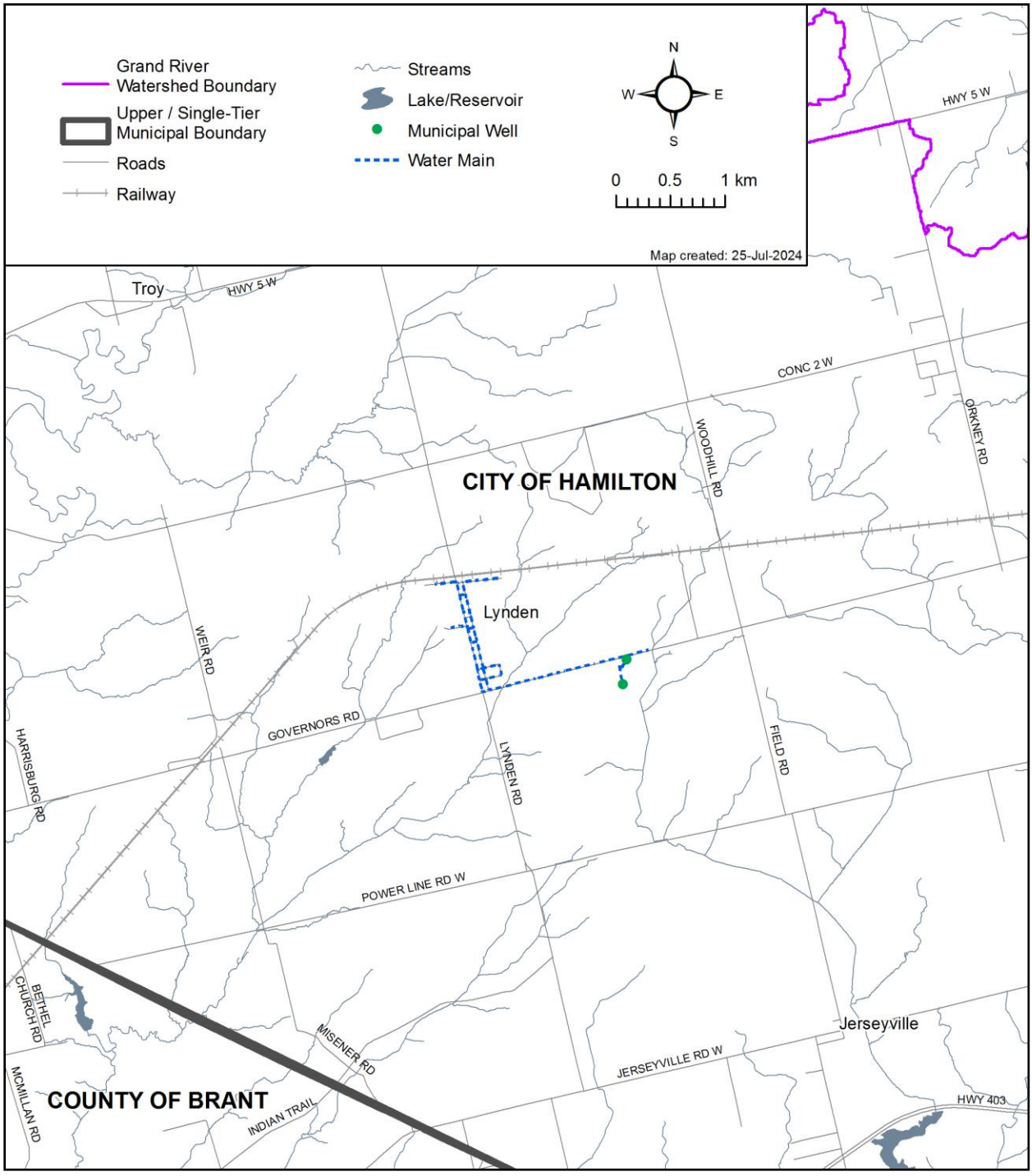
[1] as defined by O. Reg. 170/03 (Drinking Water Systems) made under the *Safe Drinking Water Act, 2002.*
[2] Drinking Water System Regulation 170/03, 2023

Table 12-2: Annual and Monthly Average Pumping Rates for the Lynden Communal Well System

Well or Intake	Annual Avg. Taking[1] (m^3/d)	Monthly Average Taking[1] (m^3/d)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FDL03	88.67	76	79	78	81	97	124	90	84	85	92	88	90

[1] City of Hamilton 2023 annual summary report (FDL1R not online as of this reporting period)

Map 12-1: Lynden Communal Well System Serviced Areas



12.1.1 Delineation of Wellhead Protection Areas for Lynden Communal System

A numerical groundwater flow model and a hydrologic model for the Fairchild Creek subwatershed were developed to delineate wellhead protection areas for the Lynden Communal Wells System (Earthfx, 2018d). Five different pumping configurations were tested in order to simulate a wide range of operational conditions. The most conservative and/or most realistic WHPA was delineated based on the different capture zones generated under different pumping configurations.

Groundwater recharge rates for the study area were estimated using a new hydrologic model developed for this study area using the USGS PRMS hydrologic modelling code. The model was calibrated to match observed streamflow at Water Survey of Canada gauges on Fairchild and Spencer creeks. In addition, updated conceptual geologic and hydrostratigraphic models were developed as part of this study, which incorporated geologic datasets from the OGS and a previous study by Earthfx (2010).

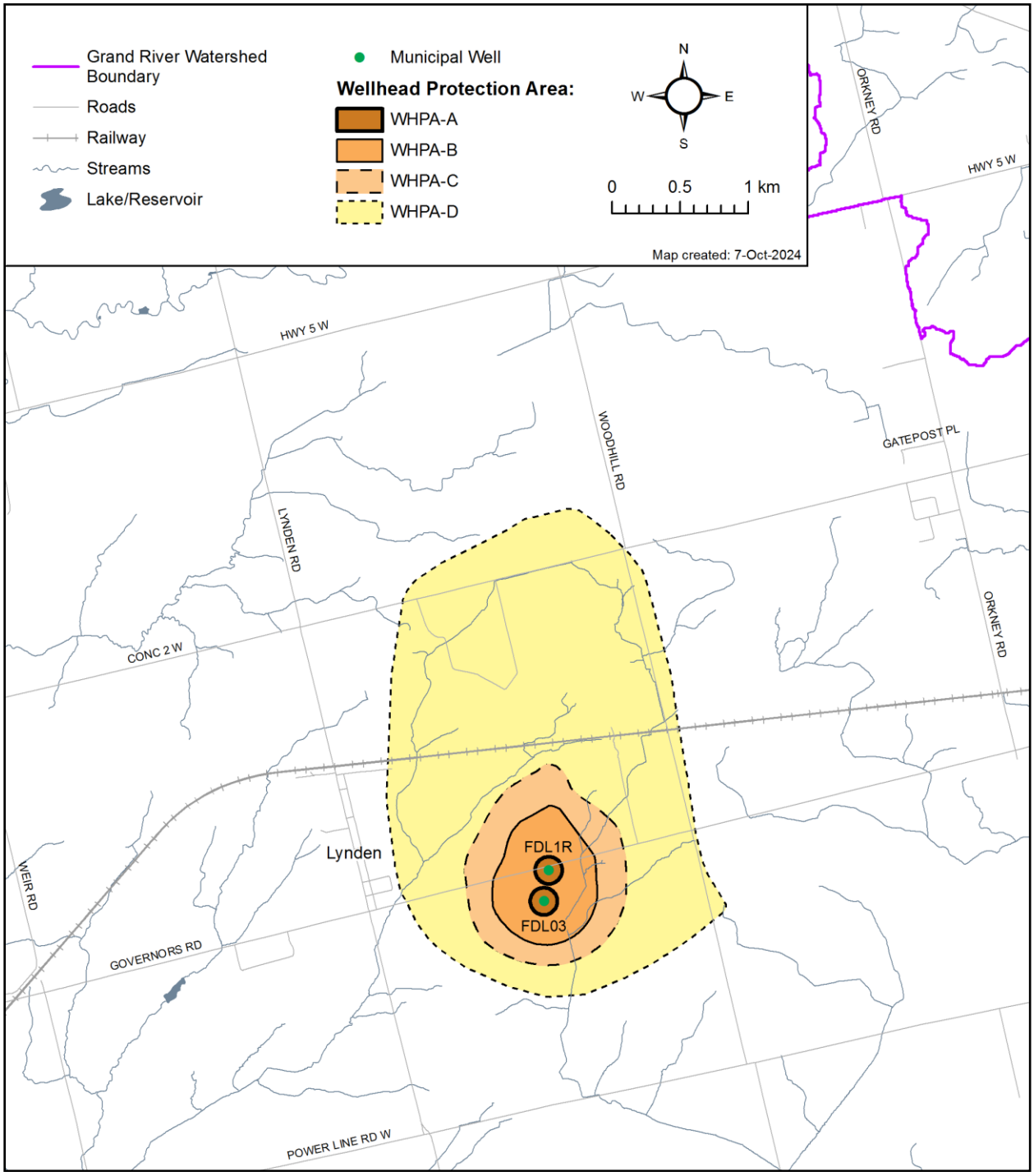
A single WHPA was delineated for the two Lynden supply wells (originally FDL01 and FDL03) because of their close proximity to one another and because they both draw from the same deep sand and gravel aquifer. Pumping was distributed 2:1 in favour of FDL03, with a total wellfield production equal to the maximum permitted rate of 6 L/s. The WHPA is oriented in the northern direction and does not appear to be influenced by any major hydrogeologic features. Replacement well FDL1R resulted in a slight shift of 3.5 m west to the previously delineated FDL01 WHPA-A (the combined WHPAs B, C, and D remain unchanged given no changes in depth or pumping rate relative to FDL01). The Lynden Communal System WHPA is presented on **Map 12-2**.

Vulnerability Scoring in Wellhead Protection Areas

Aquifer vulnerability was mapped using the Surface to Well Advection Time (SWAT) method which utilizes the groundwater flow model by tracking particles forward in the model to estimate their time of travel from ground surface to the municipal wells.

Vulnerability scores were calculated by combining the WHPAs with the vulnerability indices (High, Medium, and Low) from the SWAT analysis. The Lynden supply wells are screened beneath a thick deposit of clay till and simulated water levels indicate relatively little connection with the shallow groundwater system. Accordingly, the intrinsic vulnerability scores are low. The intrinsic vulnerability of the Lynden Communal Well System is shown on **Map 12-3.**

Map 12-2: Lynden Communal Well System Wellhead Protection Areas



Identification of Transport Pathways and Vulnerability Adjustment

Adjustments to the vulnerability scores are needed to account for the presence of transport pathways (i.e., constructed preferential pathways) that might bypass the natural protective geologic layers. Unsaturated zone travel times were not considered in the analysis of SWAT times. Therefore, constructed pathways that could reduce unsaturated zone travel times, such as stormwater ponds and pipeline bedding, would not result in an increase in the vulnerability scores already assigned. The focus, therefore, was to identify constructed pathways that could reduce travel times in the saturated zone. This included a review of:

- Wells that may leak or have been improperly abandoned;
- Pits and quarries that breech the upper confining unit;
- Lakes in connection with the municipal aquifer system;
- Landfills located in former pits or quarries that may breach the upper confining unit; or
- Other deep excavations.

Transport Pathways in the Lynden Wellhead Protection Areas

The discharge of contaminants to deep wells could provide a pathway to the underlying confined aquifer. As an initial screening, all wells that penetrated the bedrock aquifers were identified. Of these, the wells that were installed after 1990, when Ontario Regulation 903 (Wells) under the *Ontario Water Resources Act*), set out minimum standards for the construction and proper decommissioning of all types of wells, were assumed to be less likely to have failures of the casing or annular seals.

A total of 68 wells were identified within the delineated WHPA-A through WHPA-D areas for the Lynden supply wells. Of these, 13 wells were considered high risk by potentially not meeting the current MECP well standards and are in connection with the aquifer used for municipal supply.

Adjusted Vulnerability Scoring for the Lynden Wellhead Protection Areas

No adjustments due to transport pathways were made to the vulnerability scores for the Lynden WHPAs. It was recommended that the high-risk wells be investigated further before making any adjustments to address concerns such as well location accuracy (Earthfx, 2018d).

The vulnerability scoring is presented in **Map 12-4.** The WHPA-A has vulnerability score of 10, the WHPA-B has a vulnerability score of 6, and the WHPA-C and WHPA-D have a vulnerability score of 2.

Limitations and Uncertainty in the Wellhead Protection Area Delineation and Vulnerability Scoring for the Lynden Communal Well System

Uncertainty associated with WHPAs must be identified as either High or Low. There are uncertainties and limitations related to both the WHPA modeling, the aquifer vulnerability assessment and the mapping of transport pathways. Results of the final

uncertainty factors for the WHPA delineation and vulnerability scoring are summarized in **Table 12-3**.

Table 12-3: Summary of Uncertainty Analysis

Uncertainty Element	Uncertainty for WHPA Delineation	Uncertainty for Vulnerability Scoring
Distribution, variability, quality and relevance of data	Low	Low
Ability of the methods and models used to accurately reflect the flow processes in the hydrogeological system	High	High
Quality assurance and quality control procedures applied	Low	Low
Extent and level of calibration and validation achieved for models used or calculation or general assessments completed.	Low	Low
Accuracy to which the groundwater vulnerability categories effectively assess the relative vulnerability of the underlying hydrogeological features.	Not applicable	High
Overall	**High**	**High**

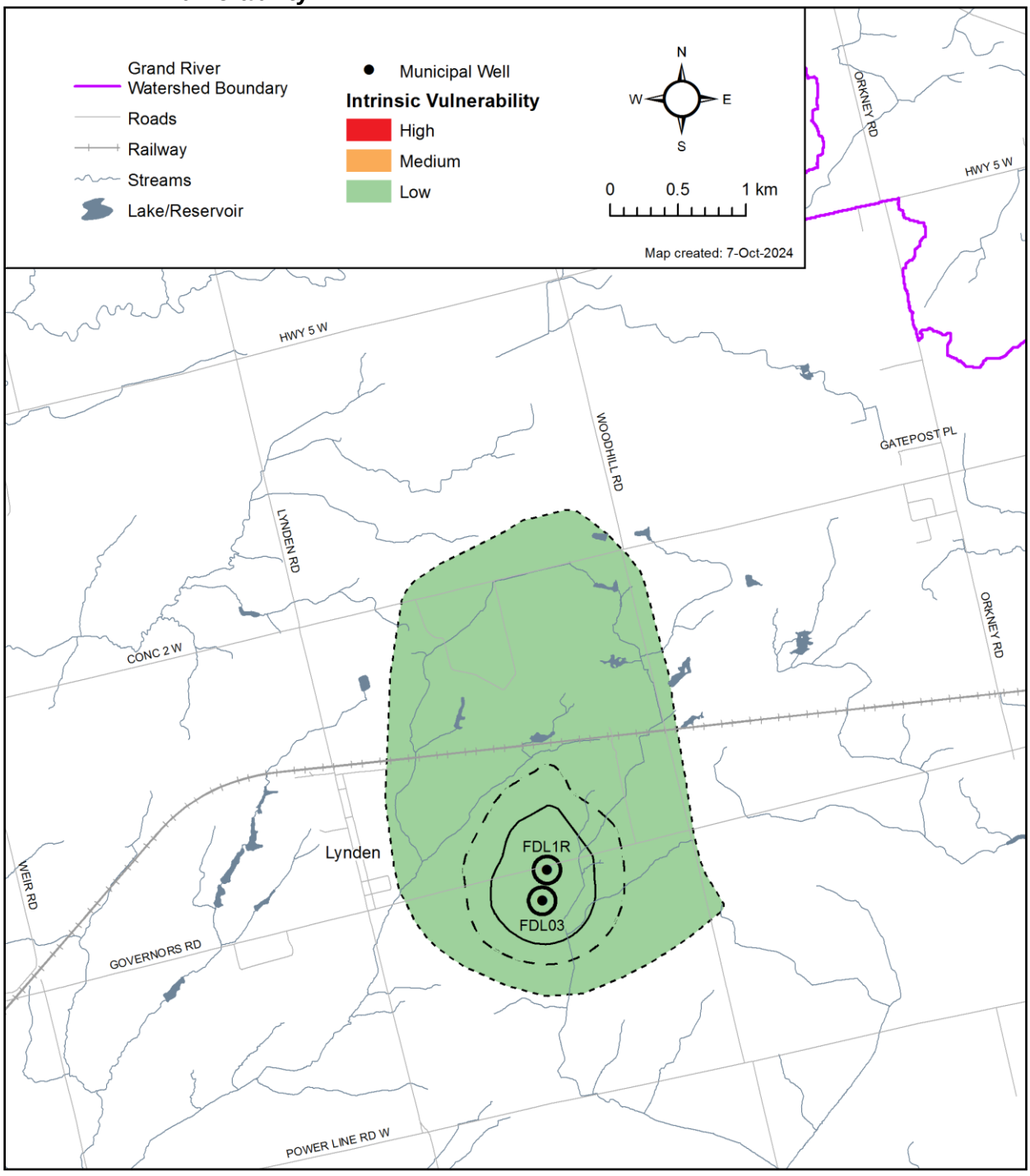
While a good overall calibration was achieved, we recognize that the Fairchild Creek model may be overpredicting drawdown and underpredicting water levels. For that reason, the model uncertainty is considered to be high.

Average groundwater recharge, a common source of uncertainty in groundwater models, was estimated by developing and calibrating a separate hydrologic model (PRMS). The uncertainty and limitations associated with PRMS include the absence of field measured values for groundwater recharge, limited ability to represent groundwater feedback using an uncoupled surface model, and uncertainty in the input and calibration target data.

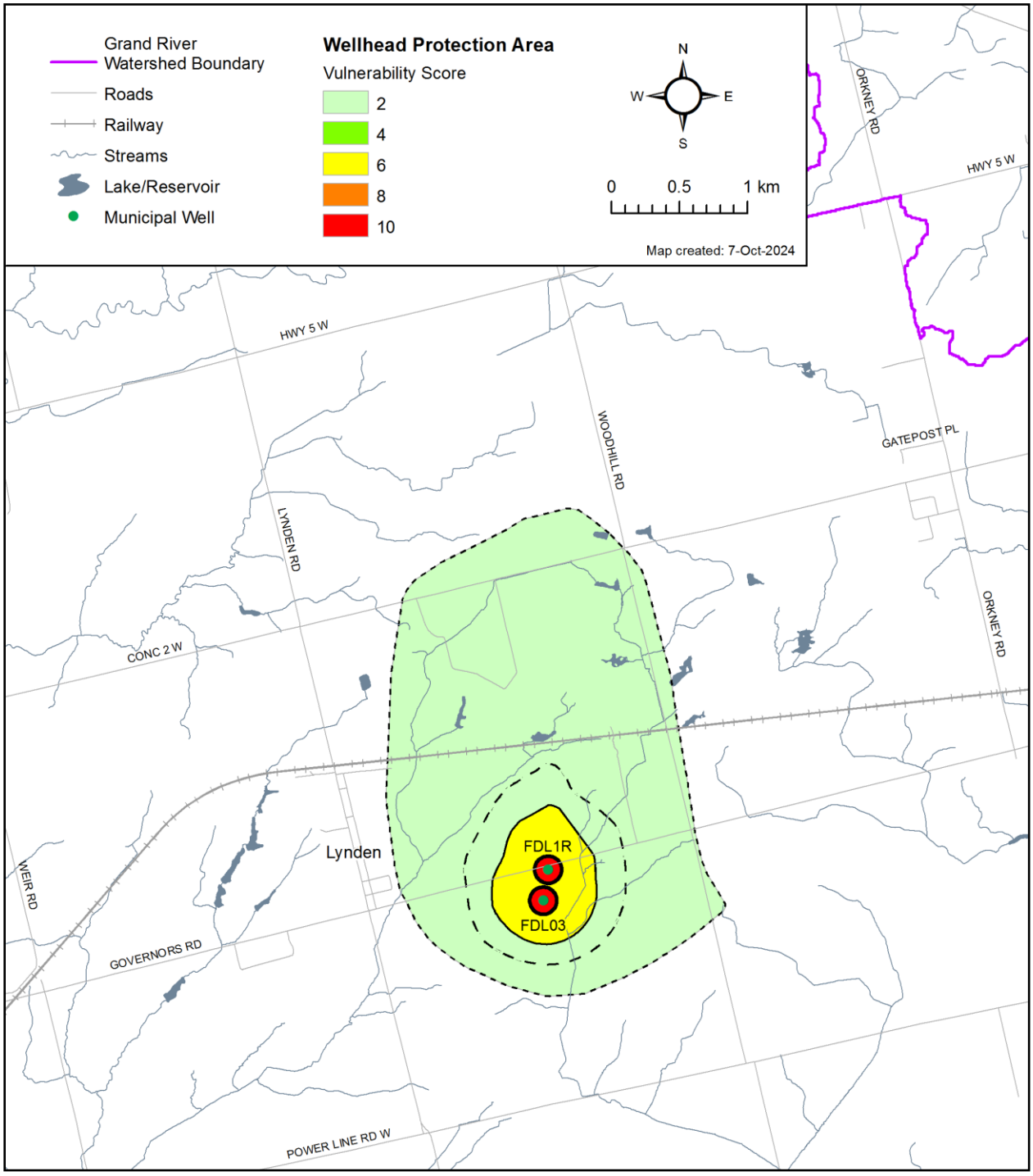
While the application of a calibrated numerical groundwater model to delineate the WHPAs is considered to be the most robust and precise of the options available for determining the time of travel to a well, sources of uncertainty are introduced from both the groundwater flow model and the time of travel analysis itself. Subtle variations in the flow directions near the wells caused by local variation in aquitard or aquifer thickness, aquifer and aquitard hydraulic conductivity values, and/or recharge rates can lead to significant changes in the flow paths of the particles. For this study, the uncertainty in the groundwater flow patterns was relatively low due to the uniformity of the municipal aquifer system.

Based on the discussion above, the uncertainty associated with the vulnerability assessment is deemed “High”, as defined by the Technical Rules.

Map 12-3 Lynden Communal Well System Wellhead Protection Area Intrinsic Vulnerability



Map 12-4: Lynden Communal Well System Wellhead Protection Area Vulnerability



12.1.2 Managed Lands within the Lynden Wellhead Protection Area

The percent managed lands analysis identifies lands to which nutrients are applied. The analysis categorizes managed lands into two groups: agricultural managed lands and non-agricultural managed lands. Agricultural managed lands include areas of cropland, fallow, and improved pasture that may receive nutrients. Non-agricultural managed lands include golf courses, sports fields, lawns and other built-up areas that may have received nutrients such as commercial fertilizers. The assessment of managed lands is only necessary for areas within a WHPA that have a vulnerability score of 6 or greater.

The percentage of managed lands in the Lynden WHPA is high given the rural location of the wellfield. Managed lands were completed using the methodology outlined in Chapter 3, Water Quality Threat Assessment Methodology, with results of the managed lands calculations presented in **Map 12-5.**

12.1.3 Livestock Density within the Lynden Wellhead Protection Area

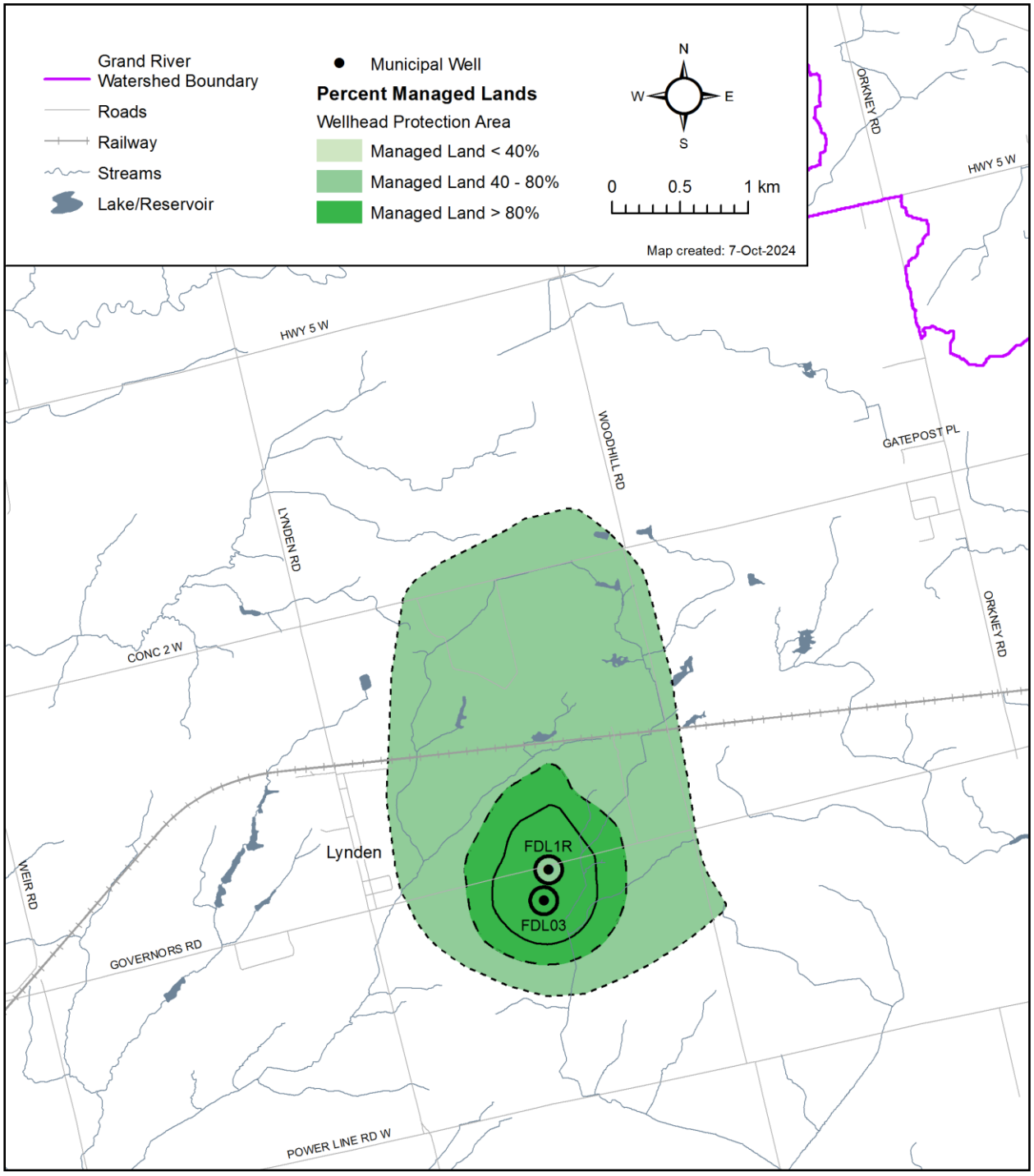
The Livestock Density analysis determines the intensity of livestock animals and is a surrogate measure of the potential for gathering, storing and applying agricultural source materials (ASM) as a nutrient source within vulnerable areas.

After a review of the air photos and *Street Views,* properties with potential livestock were identified in the Lynden WHPA. Livestock densities were calculated for each of the applicable WHPA zones and are presented in **Map 12-6**. Note that while the livestock density was calculated for the WHPA-D of the Lynden WHPA, it was not evaluated for potential threats since the vulnerability score was below 6 (Earthfx, 2018d). Note that confirmation of the properties with livestock requires site visits and interviews with property owners.

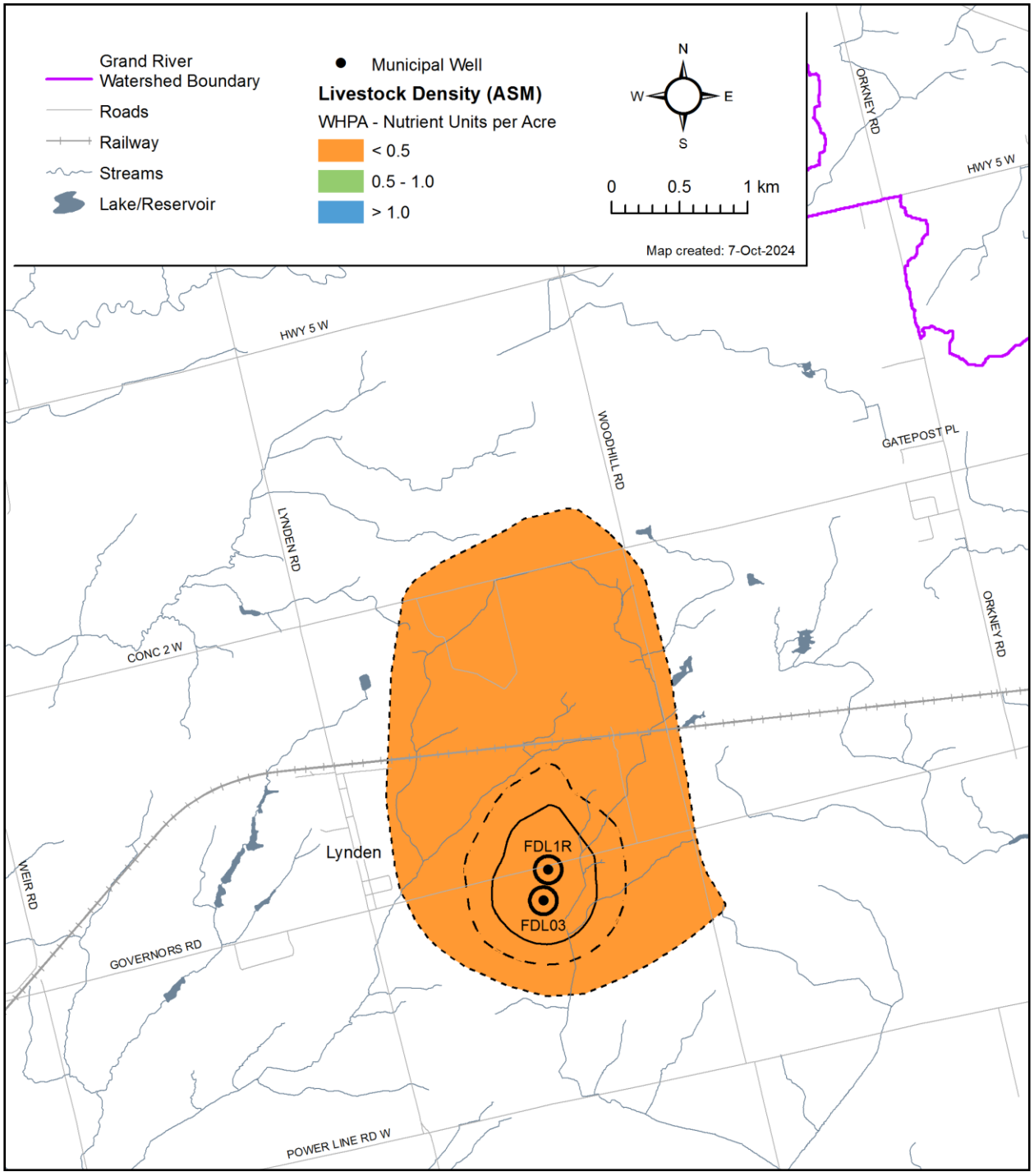
12.1.4 Percentage of Impervious Surface Area within the Lynden Wellhead Protection Areas

The Technical Rule 16(11) requires the calculation and mapping of the percentage of total impervious surface area where road salt can be applied per square kilometre in each of the vulnerable areas. The resulting impervious surface area maps are used in the water quality risk scoring and the assessment of threat circumstances relating to road salt application. Total impervious surface area is defined in the Technical Rules as the surface area of all highways and other impervious land surfaces used for vehicular traffic and parking, and all pedestrian paths. The method used to calculate impervious surfaces for the Lynden WHPAs is the 1x1 km grid and detailed in Chapter 3. The results of the assessment are presented on **Map 12-7.** Overall, the error associated with the analysis is deemed low since the lands are predominantly agricultural in use with few impervious surface features.

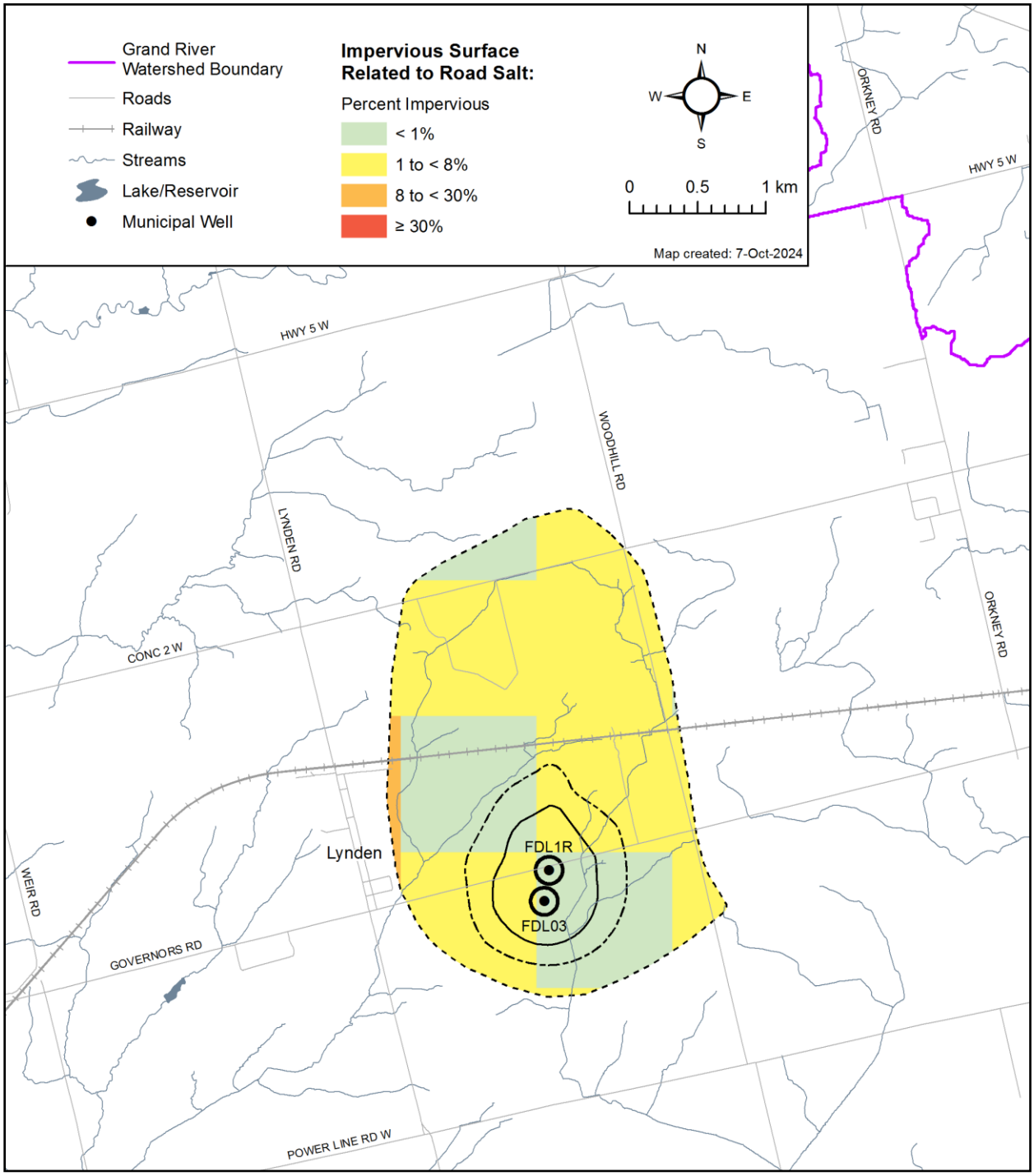
Map 12-5: Lynden Communal Well System Percent Managed Lands



Map 12-6: Lynden Communal Well System Livestock Density



Map 12-7: Lynden Communal Well System Percent Impervious Surfaces



12.1.5 Lynden Drinking Water Quality Threats Assessment

The *Clean Water Act, 2006* defines a Drinking Water Threat as "an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, and includes an activity or condition that is prescribed by the regulation as a drinking water threat." A Prescribed Drinking Water Threats table in Chapter 3 lists all possible drinking water threats.

Identification of Significant, Moderate and Low Drinking Water Quality Threats for the Lynden Communal Well System

Table 12-4 provides a summary of the threat levels possible in the Lynden WHPAs 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 12-4.**

Table 12-4: Identification of Drinking Water Quality Threats in the Lynden Wellhead Protection Areas

Threat Type	Wellhead Protection Area	Vulnerability Score	Significant Threats	Moderate Threats	Low Threats
Chemicals	WHPA-A	10	Yes	Yes	Yes
Chemicals	WHPA-B	6	No	Yes	Yes
Chemicals	WHPA-C & D	2	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	6	No	No	Yes
Pathogens	WHPA-C & D	Any Score	No	No	No

Enumeration of Significant Drinking Water Quality Threats for the Lynden Communal Well System

The number of significant Prescribed Drinking Water Threats are presented in **Table 12-5**. Significant threats are associated with agricultural activities in the area.

Table 12-5: Significant Drinking Water Quality Threats for the Lynden Communal Well System (current to July 2024)

Threat Subcategory[1]	Number of Activities	Vulnerable Area
3.1 Application of agricultural source material (ASM) to land	2	WHPA-A
Total Number of Activities	2	
Total Number of Properties	**2**	

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

Note: Certain types of incidental activities on residential properties may constitute significant drinking water threats but have not yet been identified.

Conditions Evaluation for the Lynden Communal Well Supply

After review of several databases and a discussion with municipal staff, there is no evidence of a Condition for the Lynden Communal Well Supply. It is possible that condition-related drinking water threats do exist; however, no data is available to either confirm or refute this possibility.

Limitations and Uncertainty of the Enumeration of Significant Drinking Water Quality Threats for the Lynden Communal Well System

No significant data gaps were encountered during the identification of significant drinking water quality threats. There was a general lack of information on the presence/absence of contamination associated with historical land uses. As a result, no condition-related drinking water threats (if present) were identified.

The level of uncertainty associated with the threats assessment can be considered low. City staff conducted interviews and site visits with the owners of the properties within the WHPA to confirm storage and application quantities and to identify any mitigation or containment measures that may be in place to reduce potential impacts to drinking water quality.

12.1.6 Water Quality Issues Evaluation for the Lynden Communal Well Supply

The Issues evaluation focused on the water quality parameter groupings outlined in the Ontario Drinking Water Quality Standards (ODWQS). These include: a) Pathogens, b) Schedule 1 parameters, c) Schedule 2 and 3 parameters and, d) Table 4 parameters. In addition to these parameters, the Source Protection Committee may identify other parameters that are to be evaluated; however, to date, no additional parameters have been selected.

Earthfx (2018d) evaluated drinking water issues for the Lynden Communal Well System by reviewing available water quality data up to 2017. This has been supplemented by a subsequent review of 2018 to 2023 water quality data provided by the City of Hamilton. Note that as of 2024, FDL1R is not yet in use; therefore, the review of water quality data presented below focuses largely on FDL01 and FDL03.

Between the period of 2003 and 2017, there were 756 reported raw water samples collected and analyzed for *E. coli*, total coliforms, and background colonies. There were no instances of *E. coli* or total coliforms in any of the reported raw water samples. Similarly, between 2018-2023, there were no detections of *E. coli* reported in the weekly raw water samples. However, total coliforms were detected in raw water sampled from FDL03 in 2021. Given the presence of adequate treatment for microbiological parameters, this is not a concern.

No Schedule 2 or 3 parameters were identified as potential or actual Issues based on a review of available raw water quality information up to 2017. Between 2018 to 2023, available water quality data for FDL01 (offline as of 2020) and FDL03 indicate that

Schedule 2 and 3 parameters have not exceeded respective ODWQS Maximum Acceptable Concentrations (MAC). However, elevated concentrations of barium (MAC = 1.0 mg/L) and total trihalomethanes (MAC = 0.100 mg/L) in treated water have been observed. The half MAC was exceeded for barium in FDL01 between 2018-2020 (and in FDL1R during a long-term pumping test in February 2024). While still below the half MAC, barium concentrations appear to be increasing in FDL03. Barium is naturally occurring and will continue to be monitored to assess the need for added treatment. In the distribution system, the half MAC was exceeded for total trihalomethanes between 2018-2023. Note that trihalomethanes are a disinfection by-product and not a property of the source water.

Since 2005, sodium concentrations have not exceeded the 200 mg/L ODWQS Aesthetic Objective (AO) but have been largely above the 20 mg/L Medical Officer of Health (MOH) notification level in both FDL01 and FDL03. Concentrations greater than 20 mg/L were reported in 2005 and consistently between 2007 and 2023. A maximum reported sodium concentration of 67 mg/L occurred in FDL01 in 2005 and again in 2007. Water quality samples collected during a long-term pumping test in February 2024 indicate that sodium concentrations in FDL1R are also above the 20 mg/L MOH reporting level. Sodium has been historically stable at this system and is deemed to be naturally occurring in the groundwater; therefore, an Issue has not been identified under Technical Rule 114.

The maximum reported raw water turbidity values for the ranges reported between 2003 and 2017 never exceeded the ODWQS AO of 5 NTU (as measured at point of consumption). However, values elevated above the half AO have been observed. High reported values prior to 2006 may be related to reporting protocol at the time that required reporting of all turbidity spikes including those noted during well startup. The maximum reported turbidity value for the ranges reported between 2018 to 2023 is 2.68 NTU (observed in FDL03 raw water). This parameter should continue to be monitored; however, as filtration is incorporated in this water system, increasing turbidity is not a concern for the disinfection process.

Raw groundwater sourced from this wellfield is characterized by high levels of naturally occurring hydrogen sulphide (AO = 0.05 mg/L) and methane (AO = 3 L/m^3). Historically, hydrogen sulphide concentrations in FDL03 have consistently exceed the ODWQS AO, with levels up to 2 mg/L observed in 2024. Methane concentrations in FDL03 have similarly been observed to exceed the ODWQS AO. Water quality samples collected during a long-term pumping test in February 2024 indicate that hydrogen sulphide and methane concentrations in FDL1R are also above the ODWQS AO. To minimize aesthetic impacts, the treatment process at this wellfield is designed to remove both hydrogen sulphide and methane.

Summary of Water Quality Issues Evaluation of the Lynden Communal Well System

There are no identified Issues for the Lynden Communal Well Supply.

Sodium concentrations regularly exceeded the local MOH notification level of 20 mg/L but have not been reported to be above 50% of the ODWQS AO. The sodium present in the Lynden Communal Well System is deemed to be naturally occurring in the groundwater and is not identified as an Issue.

Limitations and Uncertainty of the Water Quality Issues Evaluation

The results of this evaluation are based on the review of data available at the time of assessment. Historically, this was generally limited to water system annual reports. However, as of 2017, raw water is sampled quarterly which provides improved certainty in the assessment of drinking water quality at the Lynden Communal Well System.

Since sampling and analysis is not part of this review, the analysis and conclusions drawn herein can only be based on previous data obtained by others. This analysis can also not comment on the method by which these samples were obtained or as to the laboratories used in the analysis. Any errors in data reporting or analysis associated with the referenced reports will be unknowingly carried forward through this analysis.

Data for the years between 2003 and 2023 were reviewed. Therefore, the analysis of any trends in the data was limited to this time span. Nevertheless, the reviewed data was deemed adequate for the purpose of this assessment, and no significant data gaps were identified.