2025 Biennial Groundwater Monitoring Report - William Street Well Field (W1B, W2B, W1C, W2, W2C, W2A, W3, W3A)

The Region of Waterloo

2025 Biennial Groundwater Monitoring Report - William Street Well Field (W1B, W2B, W1C, W2, W2C, W2A, W3, W3A)

The Region of Waterloo

R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 20
Guelph ON N1H 1C4 CANADA

June 2026
HA0464020.2024

Distribution List

No. of Hard Copies	PDF	Email	Organization Name
0	Yes	Yes	The Ministry of Environment, Conservation and Parks (MECP)
0	Yes	Yes	The Region of Waterloo

Record of Revisions

Revision	Date	Description
0	April 2026	Submission to the Region of Waterloo
1	June 2026	Submission to MECP

R.J. Burnside & Associates Limited

Report Prepared By:



Stephanie Charity, P.Geo.
Hydrogeologist
SC:js

Report Reviewed By:



Dave Hopkins, P.Geo.
Senior Hydrogeologist
DH:js

Table of Contents

1.0 Introduction 1
1.1 Scope of Work 1
2.0 Site Setting 2
2.1 Well Field Description 2
2.1.1 Pumping Wells 2
2.1.2 Monitoring Wells 4
2.2 Regional Geology and Hydrostratigraphy 5
2.2.1 Surficial Geology and Conceptual Hydrostratigraphy 5
2.2.2 Bedrock Geology 7
2.3 Local Geology 7
3.0 2024 / 2025 Results 8
3.1 Precipitation 8
3.2 Monitoring Results 10
4.0 Impact Assessment 11
4.1 Well Interference 11
4.2 Aquifer Response to Pumping and Precipitation 12
5.0 Conclusions 13
6.0 References 14

Tables

Table 1: Production Well Construction Details 2
Table 2: Annual Water Taking 2024 / 2025 3
Table 3: Monitoring Well Construction Details 4
Table 4: Summary of Precipitation Data 9
Table 5: PTTWs in Vicinity of William Street Well Field 12

Figures

Figure 1: Well Field Location Map
Figure 2: Waterloo Well Fields and Monitoring Network
Figure 3: Well Location Map
Figure 4: Surficial Geology
Figure 5: Location of the Waterloo Moraine
Figure 6: William Street Well Field Cross Section A – A’
Figure 7: William Street Well Field Cross Section B – B’
Figure 8: William Street Well Field Cross Section C – C’

Appendices

Appendix A Permit To Take Water
Appendix B Well Records
Appendix C Monitoring Data (Pumped Volumes and Hydrographs)

Appendix D Precipitation Data
Appendix E Monitoring Program Overview

1.0 Introduction

The Regional Municipality of Waterloo (the Region) is unique in Ontario in that it is the largest urban municipality to rely almost exclusively on groundwater supplies for its drinking-water (Region of Waterloo, 2015). Figure 1 shows the location of municipal well fields within the Region.

The Permit to Take Water (PTTW P-300-5049623280, Version 1.0 and Version 2.0)) for the William Street Well Field requires submission of a well field specific biennial report to the Ministry of Environment, Conservation and Parks (MECP) which documents production well pumping volumes and water levels in specific monitoring wells during 2024 and 2025. PTTW P-300-5049623280 Version 2.0 was issued on September 12, 2024 replacing the PTTW P-300-5049623280 Version 1.0. The current and previous permits are provided in Appendix A. This report has been prepared to meet the reporting conditions of the PTTW for 2024 and 2025. Since no pumping occurred at the well field in 2024 under the previous permit, this report only refers to the current permit.

The location of the William Street Well Field is shown on Figure 1 and the production wells in Waterloo are shown on Figure 2 with the monitoring network for the William Street Well Field shown on Figure 3. Well records for the production and monitoring wells are found in Appendix B.

1.1 Scope of Work

The Region records water levels on a regular basis within a network of monitoring wells to satisfy the requirements of their Permits to Take Water (PTTW) and to confirm that water taking is sustainable in the long term. The monitoring wells are concentrated near the production wells but are also located in known aquifer recharge areas. The data from these wells and regular measurements of pumping volume obtained from the production wells are used to evaluate the impact of Region pumping on aquifers and potential impacts to private wells, other water takers and the natural environment.

The Region has developed a monitoring program for William Street Well Field in accordance with PTTW P-300-5049623280 which consists of the following activities:

- Measuring the daily volume pumped from the W1B, W2A, W2B, W2C and W3A production wells (Condition 4.1 of PTTW);
- Measuring the water levels in monitoring wells W-WS-OW5-87-A, W-WS-OW10-87-A and W-WS-SGMSOW1-07-AB, and W-WS-OW2-17-ABCD (Condition 4.2 of PTTW);
- Review of precipitation data from the nearest GRCA / Environment Canada weather station; and

- Completion of a biennial report (every 2 years) that presents data in compliance with condition 4.3 of the PTTW.

The Monitoring data (pumped volumes and hydrographs) are found in Appendix C with precipitation data in Appendix D. The monitoring program procedures and methodology are included in Appendix E.

2.0 Site Setting

2.1 Well Field Description

The William Street Well Field is located in a fully developed area, in the City of Waterloo's commercial core. The well field is located at the intersection of Regina Street and William Street. The closest municipal well field is the Strange Street Well Field, located 2 km southwest, with the Waterloo North Well Field located 3 km to the northwest (Figure 2). The closest surface water feature to the wellfield site is Laurel Creek, located approximately 200 m north of the production wells (Figure 3).

2.1.1 Pumping Wells

Well records for the production wells are found in Appendix B. The William Street Well Field consists of production wells W1B, W1C, W2, W2A, W2B, W2C, W3 and W3A. The current permit (Version 2) includes production wells W1B, W2B, W2C and W3A. The locations of the production wells are shown on Figure 3. A summary of the production well construction details is provided in Table 1 below.

Table 1: Production Well Construction Details

Well Name	Year Built	Casing / Screen Diameter (mm)	Screened Interval (mbgs)	Aquifer	Status
W1B	1978	150/300	20.4 – 29.9	AFB2	Active
W1C	1984	300	28.9 – 34.7	AFB2	Disconnected
W2	1952	400	28.0 – 32.6	AFB2	Disconnected
W2A	1971	406	28.0 – 36.6	AFB2	Disconnected
W2B	2019	305	28.19 – 32.69	AFB2	Active

Well Name	Year Built	Casing / Screen Diameter (mm)	Screened Interval (mbgs)	Aquifer	Status
W2C	2019	305	28.04 – 32.61	AFB2	Active
W3	1952	254	49.1 - 103.9	Bedrock	Decommissioned
W3A	2023	305	50.3 – 61.9	Bedrock	Active

The water taking volumes for the William Street Well Field are regulated by Condition 3.2 of the PTTW and are summarized in Table 2 below.

Table 2: Annual Water Taking 2024 / 2025

Well	PTTW	2024			2025		
	Permitted Max. Daily Water Taking (m^3)	Avg. Daily Water Taking (m^3)	Max Taken per Day (m^3)	Total Volume Pumped (m^3)	Avg. Daily Water Taking (m^3)	Max Taken per Day (m^3)	Total Volume Pumped (m^3)
W1B	5,288	0	0	0	1,160	3,420	423,392
W2B	5,288	0	0	0	1,540	5,150	562,145
W2C	5,288	0	0	0	1,141	5,149	416,397
W3A	2,203	0	0	0	502	1,901	183,282
Total	14,100	0	0	0	4,343	12,160	1,585,216

Condition 3.3 of the PTTW specifies that the combined volume of water taking from wells W1B, W2B and W2C must not exceed 11,897.28 m^3/day. This requirement was also met in 2024 (no pumping) and 2025. The maximum combined daily volume of water taking from wells W1B, W2B and W2C in 2024 was 0 m^3/day and 10,282.54 m^3/day in 2025.

Condition 3.4 of the PTTW specifies that the combined volume of taking from the well field must not exceed an annual daily average of 11,721.024 m^3/day. As shown in Table 2, this requirement was met in both 2024 (no pumping) and 2025 (4,343 m^3/day).

The Region of Waterloo's SCADA system records total daily water taking volumes including the dates and times of water takings, the rates of pumping, and calculations of the total amounts of water pumped per day for each supply well, which complies with condition 4.1 of the PTTW.

The pumping volumes are presented in Appendix C as total monthly volumes. There was no pumping from the well field in 2024. In 2025, pumping started at W2B in April, at W2C in July and at W1B and W3A in August. Pumping volumes from the well field ranged from 0 m^3/month to 344,366 m^3/month in 2025. In total, 0 m^3 was produced at this well field in 2024 and 1,585,216 m^3 was produced in 2025. The volumes in 2025 are within the historical range of volumes in 2021 and 2022 and higher than the 2023 volumes. Both years are well below the permitted volume of 4,278,174 m^3 per year (Table C-1).

2.1.2 Monitoring Wells

Water level monitoring is completed at observation wells W-WS-OW5-87-A, W-WS-OW10-87-A, W-WS-SGMSOW1-07-AB and W-WS-OW2-17-ABCD. The locations of the wells are shown on Figure 3. Construction and monitoring details of the monitoring wells are described in the table below. Well records for the monitoring wells are provided in Appendix B.

Table 3: Monitoring Well Construction Details

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to Closest Production Wells (m)
W-WS-OW5-87-A	1987	27.05 – 27.81	AFB2	87 m (W1B) 51 m (W2C)
W-WS-OW10-87-A	1987	41.76 – 42.67	AFD1	180 m (W1B) 153 m (W2C)
W-WS-SGMSOW1-07-A	2007	51.21 – 54.25	AFD1	370 m (W1B) 334 m (W2C)
W-WS-SGMSOW1-07-B	2007	34.62 – 38.10	AFB2	
W-WS-OW2-17-A	2017	51.25 – 52.75	Bedrock	30 m (W1B) 47 m (W3A)
W-WS-OW2-17-B	2017	46.1 – 47.6	AFF1/ATG1	
W-WS-OW2-17-C	2017	36.5 – 38.0	AFD1	
W-WS-OW2-17-D	2017	26.5 – 28.0	AFB2	

2.2 Regional Geology and Hydrostratigraphy

The following sections provide a brief overview of the regional geology and hydrogeology of the William Street Well Field. The surficial geology based on regional OGS mapping is provided on Figure 4. The William Street Well Field is located in northeast portion of the Waterloo Moraine (Figure 5). Representative cross-sections showing the stratigraphy in the vicinity of the William Street Well Field are included as Figures 6, 7 and 8. The cross-section locations are provided on Figure 3.

The cross-sections are provided as a visual aid and do not necessarily contain all wells in the monitoring program for the William Street Well Field. The conceptual hydrostratigraphy of the William Street Well Field and model was updated in 2020 based on new investigations and borehole drilling (Stantec, 2020 and Matrix, 2020). These updates were reflected in the 2023 Biennial Report (R.J Burnside, 2024). Only a few updates were made as part of the Region of Waterloo Tier Three Assessment Project (Aqua Insight Inc et al, 2023). The minor updates which appear on in the cross-sections provided as Figures 6, 7 and 8 include:

- New hydrostratigraphic picks at Well W2B, W-WS-BH1-18, and Well W2C lower the elevation of the top of ATB2 by approximately 3.4 m at Well W2C, 3.7 m at Well W2B, and 2.9 m at W-WS-BH1-18;
- As a results of lowering the top of ATB2, AFB1 is mapped at or near ground surface;
- The thickness and elevation of ATB3 was adjusted by approximately 1.6 m at Well W2C and increased in elevation by approximately 1.4 m at Well W2;
- Aquitard ATB3 thinned at Well W2C as the top of ATB3 was lowered by approximately 1.6 m. Aquitard ATB3 thickened at Well 2 as the top of ATB3 increased in elevation by approximately 1.4 m;
- ATB1 is thinner to the east of the production wells on Section A-A” (Figure 6) and AFA1 is now mapped at surface;
- At K-SS-OW1-19ABCD (Figure 7), AFB1 is thicker and ATB1 is overlain by AFA1 at surface, and
- On C-C” AFA1 is now mapped at surface southeast of the production wells.

2.2.1 Surficial Geology and Conceptual Hydrostratigraphy

The surficial geology of the area has been mapped and described by the Ontario Geological Survey (2003) and updated in Bajc and Shirota (2007). The surficial geology of the William Street Well Field is characterized primarily by ice contact sand and gravel (Figure 4). Modern alluvial deposits are present along Laurel Creek.

The Quaternary units typically associated with the Waterloo Moraine are briefly described below, in order from youngest to oldest.

Aquitard ATB1 – Port Stanley Till

The Port Stanley Till is a sandy silt to silty sand till, with occasional stony texture, that is predominantly found along the flanks of the Waterloo Moraine. The Port Stanley Till was deposited by ice advancing from the Erie-Ontario ice lobe. In other parts of the Region, Bajc and Shirota (2007) have also used unit ATB1 to represent Tavistock, Mornington and Upper Maryhill Tills. This unit is considered an aquitard and, where present, acts to restrict recharge to the lower aquifers. ATB1 is interpreted to be thin or absent to the east of Fischer Hallman Road (Stantec, 2009) and in the area of the William Street Wellfield.

Aquifer AFB1 / ATB2 / AFB2 – Upper Waterloo Moraine Stratified Sediments and Equivalents

Aquifer AFB1 / AFB2 represents the main water supply aquifer in the core areas of the Waterloo Moraine, including the William Street Well Field production wells. These units are generally comprised of layered silt and fine sand to coarse sand and gravel. Throughout the core areas of the Moraine (Figure 5), the unit typically exceeds 45 m in thickness. This aquifer is the most prolific aquifer in the Waterloo Region due to its high hydraulic conductivity and transmissivity, lateral extent, and high recharge rate. In some areas, including the William Street Well Field area, the Upper Waterloo Moraine is interpreted to be bisected by the middle Maryhill Till (ATB2), effectively separating the aquifer into two units, AFB1 and AFB2. In the area of the William Street production wells (Figures 6, 7, 8) AFB1 pinches out and AFB2 is the main aquifer, and ATB2 the overlying confining unit (Stantec, 2020).

Aquitard ATB3 – Lower Maryhill Till

The Lower Maryhill Till is described as a clayey silt to silty clay till. This unit represents one of the primary regional aquitards due to its strong influence on the groundwater flow system within the Waterloo Moraine. This unit is extensive within the core area of the Waterloo Moraine, and along the eastern flank tends to be thin, discontinuous, or re-worked and re-deposited as glaciofluvial sediments. ATB3 is interpreted to be discontinuous or absent near the William Street Well Field (Stantec, 2020).

Aquitard ATC1 / ATC2 – Catfish Creek Till

The Catfish Creek Till was deposited by a major glacial advance from the north to northeast that covered all of southern Ontario. It is a dense, stony, sandy silt to silty sand till with little clay content. The hydrogeologic properties of the Catfish Creek Till are variable, ranging from a good aquitard to a poor aquifer, depending on local lithology, degree of compaction, and the presence of overlying aquitard units. The

Catfish Creek Till is typically thickest in the core area of the Waterloo Moraine, and thin or absent along the eastern flank.

Aquifer AFD1 – Pre-Catfish Creek Sand and Gravel

Pre-Catfish Creek Till aquifer corresponds to sands and gravel re-worked from Catfish Creek and Pre-Catfish Creek Tills and represents the main supply aquifer in several production wells in the Cities of Kitchener and Waterloo. This unit is spatially discontinuous throughout much of the core areas of the Waterloo Moraine but is about 6m thick in the vicinity of the William Street Well Field (Stantec, 2020).

Aquitard ATE1 – Canning Drift

The Canning Drift is comprised of till and associated fine-textured lake deposits. It is typically found at depths greater than 70 mbgs in the Waterloo Moraine area and is identified to be discontinuous and limited in lateral extent and thickness. Where it is absent, a hydraulic connection is present between the deep overburden aquifers and the underlying bedrock.

Aquifer AFF1 – Pre-Canning Till

The Pre-Canning aquifer is characterized by coarse-grained sand and gravel sediments and is typically found within bedrock depressions. This unit is discontinuous throughout the Region, and where present is hydraulically connected with the upper weathered portion of the bedrock aquifer.

2.2.2 Bedrock Geology

The Paleozoic bedrock in the area consists of the Salina Formation underlain by the Guelph Formations.

2.3 Local Geology

The following description of local geology is based on drilling investigations for the installation of the production wells and monitoring wells of the William Street Well Field. Borehole logs are included in Appendix B.

Whittlesey Sand (AFA1) - This very fine to coarse sand unit is encountered just below surface. mainly to the east and southeast of the production wells. AFA1 extends from a depth of a few metres below ground surface and is a few metres thick.

Upper Maryhill Till and Equivalents (ATB1) – This silt and clay unit is present immediately below ATA1 across the section area. ATB1 extends from ground surface to

a depth of a few metres below ground surface. Silt and clay were described at surface at several well records.

Upper Waterloo Moraine (AFB1) – This unit was described as sand and gravel at W-WS-SGSOW1-07 from 0 to 12 metres below ground surface (mbgs).

Middle Maryhill Till (ATB2) – This unit consisting of clayey silt sediments was identified in the area of the well field with thicknesses ranging from 3 m to 25 m. The unit was identified at W2C from 0 to 19.5 mbgs, at W3A from 0 to 18.3 m, at W-WS-OW5-87-A from 11 m to 14 m and at W-WS-SGSOW1-07 from 12 to 22 mbgs.

Lower Waterloo Moraine (AFB2) – This unit consisting of sand and gravel is interpreted to be the overburden production aquifer for the William Street Well Field production wells W1B, W2B and W2C (Matrix, 2020). This unit was identified at W2C from 19.5 m to 33.5 mbgs, at W3A from 18.3 m to 33.5 m and at W-WS-SGMSOW1-07 from 21.6 m to 41.4 mbgs.

Lower Maryhill Till (ATB3) – This unit is noted to be thin to absent in the area of the William Street Wellfield (Stantec, 2020). It was identified at W-WS-OW10-87-A as clay till from 29.5 m to 33.5 mbgs. ATB3 was also identified at W2B and W2C consisting of clayey till with a thickness of 2 m extending from 33 m to 35 mbgs (Stantec, 2020).

Catfish Creek Till (ATC1) – This unit consisting of silty sand till was identified at W-WS-OW10-87-A from 33.5 m to 40 m bgs and at W2B and W2C from 35.4 mbgs to the base of boreholes at 42.1 mbgs (Stantec, 2020).

Pre-Catfish Creek Sands and Gravels (AFD1) –This unit was identified at W-WS-OW10-87 from 40 m to 43 mbgs and at W-WS-SGSOW1-07 from 41.4 m to 54.2 mbgs.

Bedrock – This unit was identified at a depth of 54 m at W-WS-SGMSOW1-07, 48.2 m at W-WS-OW2-17 and at 48 m at W3A. Production well W3A is completed in the dolomitic shale bedrock aquifer (interpreted to be Salina Formation) from 48.2 to 61.9 mbgs.

3.0 2024 / 2025 Results

3.1 Precipitation

Longer term precipitation trends can have an impact on water levels in the supply aquifer. To assess the potential influence, monthly precipitation is plotted for comparison to water levels and pumping and presented in Appendix C.

Since variations in precipitation totals can occur throughout the Region due to localized events, monthly precipitation data from the University of Waterloo climate station and the Environment Canada station located closest to the production wells are used. The closest weather station relative to the William Street well field is the University of Waterloo station located 3.3 km from the well field. The closest Environment Canada station is Waterloo International Airport (WIA) located about 11.4 km east from the well field. The locations of the meteorological stations are shown on Figure 1. Annual precipitation data from the past 10 years for all stations are compared with long term averages in Table D.1, Appendix D. Monthly precipitation data for the past 10 years at Shades Mills Dam are shown on Figure D.1, Appendix D. At the University of Waterloo station, the long-term average was calculated from 1998 to the end of 2025. The Region of Waterloo International Airport (WIA) has “Climate Normals” calculated by Environment Canada for 1991 to 2020.

Annual 2024 / 2025 precipitation data for the University of Waterloo and Environment Canada meteorological station closest to the William Street Well Field are presented in Table 4 below. In 2024 WIA was missing 6 days of data and 6 days in 2025. As a result, the precipitation totals may be under reported at this location.

Table 4: Summary of Precipitation Data

Station	2024 Precipitation (mm)	2024 Deviation (mm)	Long-Term Average (mm)	2025 Precipitation (mm)	2025 Deviation (mm)
Region of Waterloo International Airport (1)	874	+23	851(A)	723	-128
University of Waterloo (2)	763	-108	871(B)	943	+72

Sources: Environment Canada (1), University of Waterloo (2)
A 1991 to 2020 Normal
B 1998-2025 data

Water levels typically follow a seasonal trend with highest levels occurring in the spring with the depth and water content of the snowpack having a significant influence on water levels. Lowest levels occurring in July / August. Widespread synoptic rainfall events can also result in Region-wide water level responses. Summer thunderstorms tend to be short lived and occur over a smaller area resulting in short term, localized water level rises not typically seen in the monitoring wells.

The 2024 total precipitation at University of Waterloo station was 763 mm, which is 108 mm below the long-term average, indicating 2024 was drier-than-average at the well field. An above long-term average total was recorded at the WIA station. The March 1

GRCA snow survey indicated a snowpack across the Region that was low compared to normal. In 2025, the total precipitation at the University of Waterloo station was 943 mm, which is 72 mm above the long-term average. The total precipitation at the WIA station was 128 mm below the long-term average, indicating 2025 was a drier-than-average year. However, WIA was missing 6 days of data in 2025 and as a result, precipitation totals may be under reported. The snow survey conducted by the GRCA on March 15, 2025, showed that the stations in the Region had a high to very high measured snow water equivalent.

3.2 Monitoring Results

Hydrographs showing the results of water level monitoring over the past 10 years are provided in Appendix C. The method used to collect the water levels (manual or electronic) is indicated on the graphs in Appendix C.

W-WSW-OW10-87-A

Groundwater level monitoring at W-WSW-OW10-87-A (located 153 m southwest of production well W2C and 180 m from production well W1B) was completed with monthly manual measurements. The A screen is located in the production aquifer AFD1 and water levels responde to pumping of the production wells. Groundwater levels rose about 5 m between April 2023 and July 2025 when the pumping wells were offline. A pumping test at W1B resulted in the lower water level reading in October 2023. Water levels decreased by 6.7 m between August 2025 and the end of December 2025 when the wells were commissioned. At the end of December 2025, water levels are slighly below historical levels observed 2016 to 2019.

W-WSW-OW5-87-A

Groundwater levels in W-WSW-OW5-87-A (located less than 100 m west of production well W1C) are monitored with an electronic water level meter (data logger). This well is screened in the overburden aquifer (AFB2) at a similar elevation to the production wells W1B, W2B and W2C (Figure 6) and shows a response to daily pumping at the well field. At the end of December 2025, water levels are slightly below historical levels observed from 2016 to 2019. Water levels increased 5.5 m from May 2023 to July 2025 when the pumping wells were offline.. Water levels decreased by 7.2 m between August 2025 and December 2025, in response to the wells going back online.

W-WSW-SGMOW1-07-AB

Groundwater levels in the well nest W-WSW-SGMOW1-07-AB (located 370 m northeast of production well W1B and 334 m from W2C) are collected by data loggers. Screen A is located at the overburden / bedrock contact in AFD1 and Screen B is located in the

production aquifer (AFB2). Water levels at the end of December 2025 are slightly below historical levels observed from 2016 to 2019.

Groundwater levels in both the A and B screens follow the same trends with water levels responding to pumping at the well field. This is notable when water levels decreased about 7.5 m between July 2025 and the end of December 2025 when the wells are commissioned.

W-WS-OW2-17-ABCD

Monitoring well nest W-WS-OW2-17-ABCD is located 30 m north of W1B and 47 m from W3A and groundwater levels in all screens are monitored with dataloggers. The A screen is located in the bedrock aquifer and the B screen is located in the AFF1 aquifer, and both screens respond to pumping. Water levels recover 2 m in the A screen and 4 m in the B screen between June 2023 and August 2025 while the well field was offline. When the well field is commissioned in August 2025, water levels dropped 8 m in the A screen and 6 m in the B screen.

The C screen is located in AFD1 and the D screen is located in the AFB2 aquifer and both wells respond to pumping at the well field. This is notable when water levels recovered 2.5 m in the C and D screens between June 2023 and August 2025 while the well field was offline. When the well field was commissioned in August 2025, water levels declined and at the end of the year are lower than historical levels observed. With the commissioning of new wells and increased takings at the William Street well field, a decrease in water levels is expected to occur. Water levels should continue to be monitored to record the response the pumping wells have on the screened aquifers.

4.0 Impact Assessment

4.1 Well Interference

PTTW Condition 5.1 states, "The Permit Holder shall immediately notify the local District Office of any complaint arising from the taking of water authorized under this Permit and shall report any action which has been taken or is proposed with regard to such complaint. The Permit Holder shall immediately notify the local District Office if the taking of water is observed to have any significant impact on the surrounding waters. After hours, calls shall be directed to the Ministry's Spills Action Centre at 1-800-268-6060."

PTTW Condition 5.2 states: “For Groundwater Takings - If the taking of water is observed to cause any negative impact to other water supplies obtained from any adequate sources that were in use prior to initial issuance of a Permit for this water taking, the Permit Holder shall take such action necessary to make available to those

affected, a supply of water equivalent in quantity and quality to their normal takings, or shall compensate such persons for their reasonable costs of so doing, or shall reduce the rate and amount of taking to prevent or alleviate the observed negative impact. Pending permanent restoration of the affected supplies, the Permit Holder shall provide to those affected temporary water supplies adequate to meet their normal requirements or shall compensate such persons for their reasonable costs of doing so. If permanent interference is caused by the water taking, the Permit Holder shall restore the water supplies of those permanently affected."

The William Street Well Field is in a municipally serviced urban area. When a well interference complaint is received, the Region has a Well Interference Policy in place. A copy of the policy is presented in Appendix F of the 2019 Biennial Groundwater Monitoring Report – Multiple Well Fields (Burnside, 2020). There were no well interference complaints related to pumping of W1B, W2B, W2C and W3A received in 2024 and 2025.

Other groundwater takings registered in the MECP PTTW database within 2 km of the wellfield are mapped on Figure 3 and summarized below in Table 5.

A review of PTTWs within the vicinity of the well field as shown on Figure 3 indicates that the closest permits are for a remediation well (W14) owned by the Region of Waterloo and for two remediation wells operated by ivari.

Table 5: PTTWs in Vicinity of William Street Well Field

Permit Number	Permit Holder	Purpose	Sources, Max Liters per Day (Source)	Distance from Well Field	Expiry Date
7300-BCPJ4Q	Region of Waterloo	Remediation	W14, 4,546,000	430 m	05/31/2029
6377-ACWRQF	ivari	Remediation	Two wells, 72,000 L each	1,000 m	08/31/2025

4.2 Aquifer Response to Pumping and Precipitation

Water levels in monitoring wells screened in the production aquifer AFB2 respond to pumping at the production wells. Water levels in monitoring wells screened in AFD1 also show an identical response to pumping at the well field indicating that there may be minimal aquitard material (ATC1) separating AFB2 from AFD1 (Blackport Hydrogeology Inc., June 2011). Water levels in AFB2 and AFD1 show an increasing trend in 2024 to

July 2025 while the well field is offline and then a decrease in water levels once the production wells begin pumping again with water levels at the end of 2025 slightly below historical levels and not stabilized yet. Water levels in monitoring wells in AFF1 and the bedrock (W-WS-OW2-17-AB) show an immediate response to pumping at W3A in the bedrock but also respond to pumping from the AFB2 aquifer. Water levels in AFF1 and the bedrock also show a decrease in water levels to lower than historical levels at the end of 2025. Further monitoring will capture when the aquifer stabilizes in response to pumping at the production wells.

Due to the monitoring wells being screened in the deep overburden aquifer and bedrock, responses to precipitation are not observed.

5.0 Conclusions

Impacts from pumping the municipal wells at the William Street Well Field were evaluated through implementation of the Groundwater Monitoring Program. Based on the information contained in the report, Burnside offers the following conclusions:

- The information presented in this report satisfies condition 4.3 of PTTW
- 2024 and 2025 pumping volumes were within the permitted range;
- There were no reported well interference complaints arising from water taking at the William Street well field; and
- Water levels in monitoring wells indicate that current pumping rates have not resulted in any adverse impacts to water levels in the monitoring wells.

6.0 References

Aqua Insight Inc., Technical Memorandum Numerical Model Surface Transfer, March 2026.

Aqua Insight Inc., Stantec Consulting Ltd, S.S. Papadopulos and Associates Inc. and WSP Canada Inc., 2023. Hydrogeologic Characterization and Conceptual Model Updates, Region of Waterloo Tier Three Update Project. Final Report, June 2023.

Aqua Insight Inc., Stantec Consulting Ltd, S.S. Papadopulos and Associates Inc., 2024. Updates to the Moraine and Cambridge Model following Model Calibration Reporting, July 2024.

Bajc, A.F. and Shirota J., 2007. Three-dimensional mapping of surficial deposits in the Regional Municipality of Waterloo, southwestern Ontario; report in Ontario Geological Survey, Groundwater Resources Study 3, p. 42.

Blackport Hydrogeology Inc., June 2011, revised January 2012. Tier 3 Water Budget and Local Area Risk Assessment, Waterloo North, William Street and Lancaster Well Fields Characterization Study, Final Report.

Karrow, P.F., 1993. Quaternary Geology of the Stratford-Conestogo Area, Southern Ontario. Ontario Geologic Survey Report 283.

Matrix Solutions Inc., 2015. Technical Memorandum: Numerical Model Surfaces Data Transfer, Region of Waterloo, June 5, 2015.

Matrix Solutions Inc., 2020. William Street Wellfield Trichloroethylene (TCE) Modelling Study, Matrix Solutions Inc., September 2020.

R.J. Burnside & Associates Limited, 2024. Region of Waterloo 2022/2023 Biennial Groundwater Monitoring Report.

Stantec, 2020. Construction and Testing of Production Wells W2B/W2C, William Street Well Field, Regional Municipality of Waterloo, Stantec Consulting Ltd, April 21, 2020.

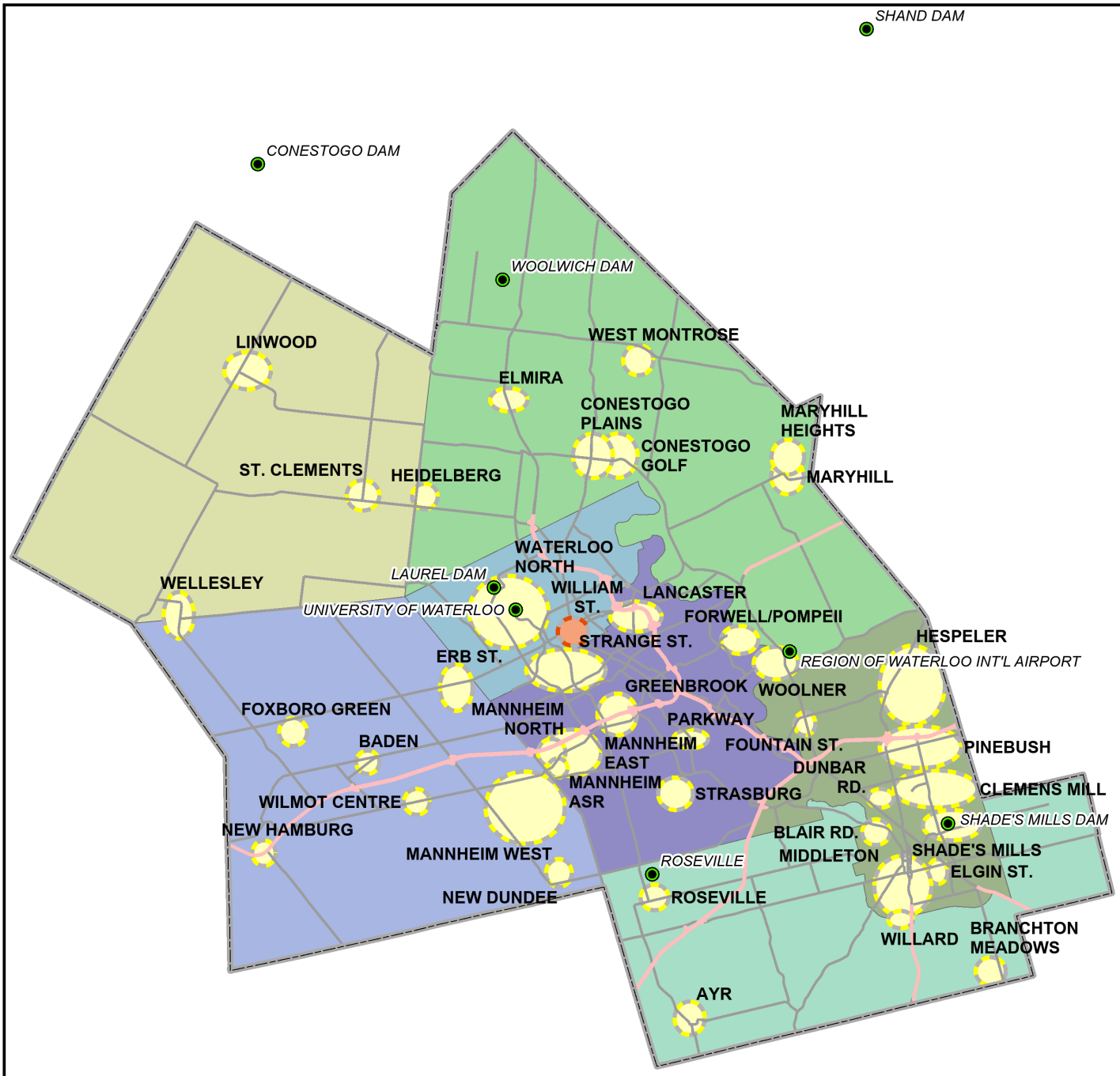
Terraqua Investigations Ltd.,1997. William Street and Seagram Water Supply Systems Background Hydrogeology Report

Terraqua Investigations Ltd., 1995. The Study of the Hydrogeology of the Waterloo Moraine. Regional Municipality of Waterloo Water Services Division Report. (Four volumes: Executive Summary, Text, Figures, Appendices).

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Figures



N

Data Source:
Region of Waterloo; Includes material © 2012 of the Queen's Printer for Ontario. All rights reserved.

0 5 10 15 20
Kilometers

- Well Field Location
- Well Fields
- Regional Municipal Boundaries
- City of Cambridge
- City of Kitchener
- City of Waterloo
- Township of North Dumfries
- Township of Wellesley
- Township of Wilmot
- Township of Woolwich
- Meteorological Monitoring Locations

BURNSIDE

Map Title

2025 GROUNDWATER MONITORING REPORT - WILLIAM STREET WELL FIELD

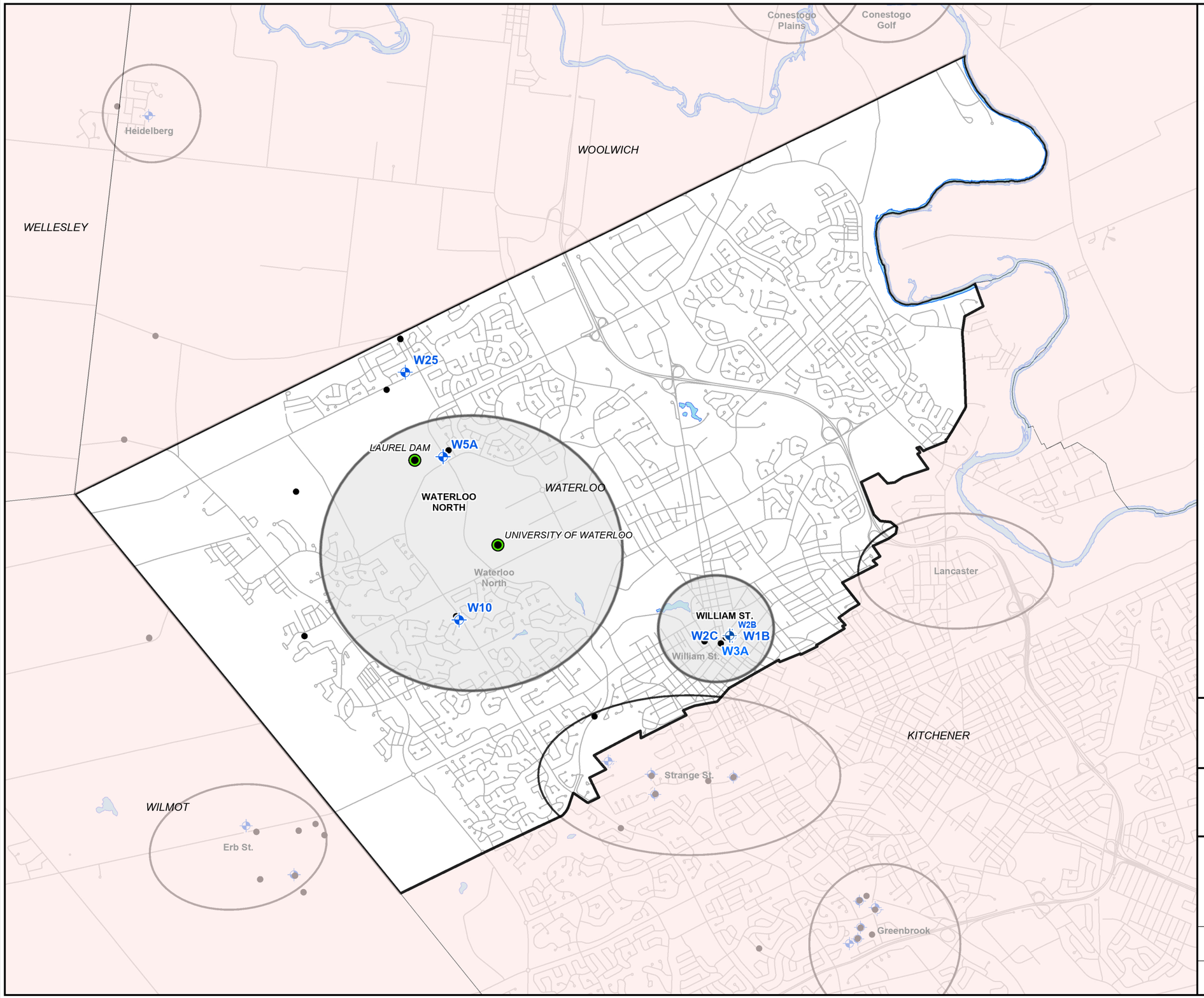
WELL FIELD LOCATION MAP

Client

REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	February 2026	1
Scale		Project No.	
1:300,000		HA0464020	

File Path: \\elmo\gis\Project\H Jobs\HA 04 6402 (Waterloo)\Reporting\Groundwater Level Monitoring Program\2025 Groundwater Report Figures\ALL Well Fields General Figures 2025\Pro\General Figures 2025.aprx Print Date: 2026/02/18 Time: 08:58 AM



LEGEND

- Production Well Location
- Monitoring Well Location
- Waterloo Municipal Boundary
- Well Fields
- Meteorological Monitoring Locations

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Region of Waterloo

Datum: North American 1983 CSRS

Coord. System: NAD 1983 CSRS UTM Zone 17N

N

0 1 2 3 4

Kilometers

BURNSIDE

Client

REGION OF WATERLOO

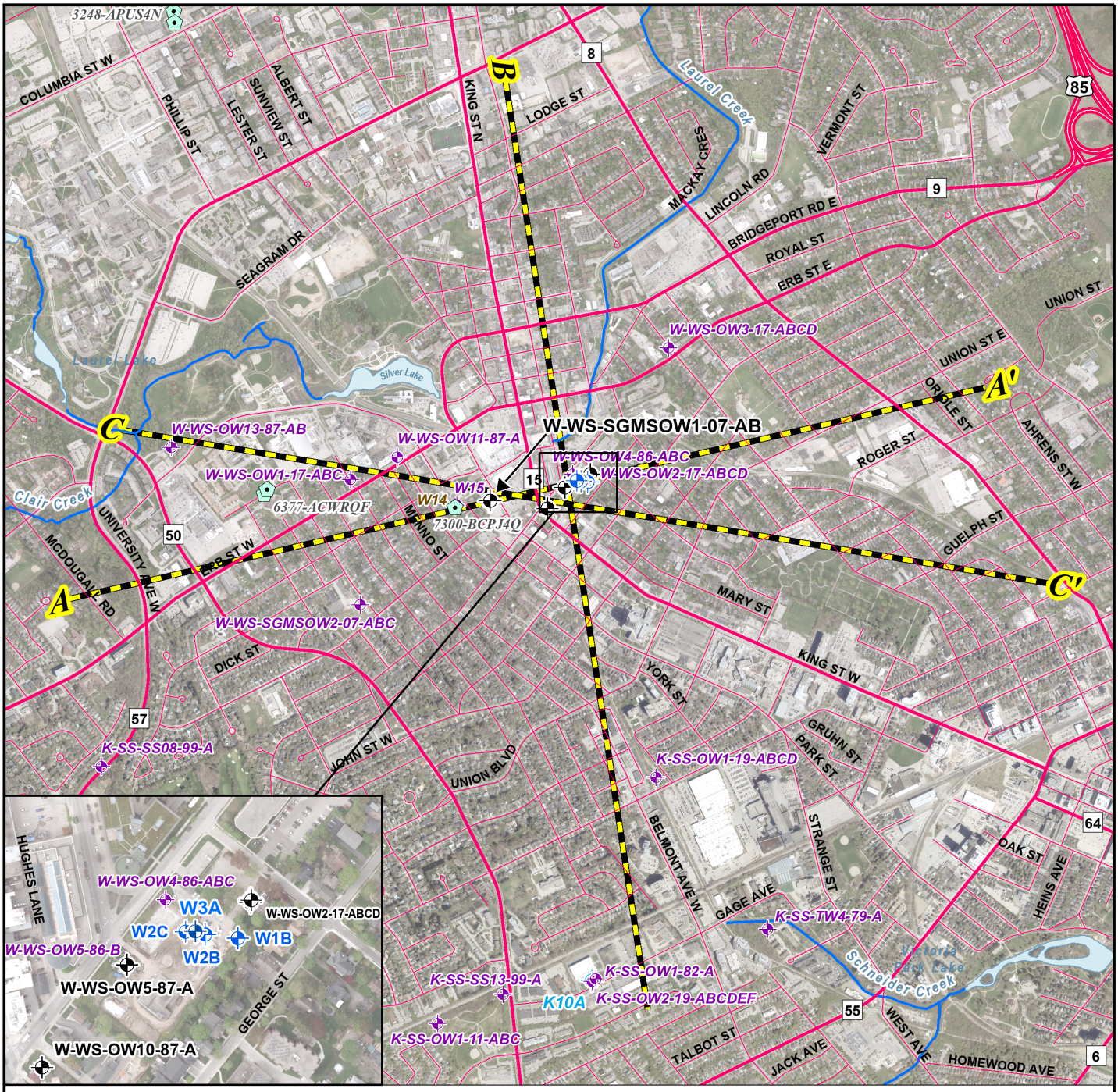
Figure Title

2025 GROUNDWATER MONITORING REPORT - WILLIAM STREET WELL FIELD

WATERLOO WELL FIELDS AND MONITORING NETWORK

Drawn	Checked	Date	Figure No.
HN	SQ	April 2026	2
Scale		Project No.	
1:50,000		HA0464020	

File Path: \\elmo\gis\project\H Jobs\HA 04 6402 (Waterloo)\Reporting\Groundwater Level Monitoring Program\2025 Groundwater Report Figures\William Street\Pro\William Street\William Street.aprx Print Date: 2026/04/24 Time: 01:43 PM



N

Data Source:
Region of Waterloo GIS Data; Background 2020 Air Photo: ArcGIS Image Service Region of Waterloo; Ministry of Natural Resources, © Queen's Printer for Ontario; Natural Resources Canada © Her Majesty the Queen in Right of Canada.

0 200 400 600 800 1,000 1,200
Metres

- PTTW Monitoring Well Location
- Production Well Location
- Containment Well Location
- Nearby Monitoring Well Location
- Nearby Production Well Location

Additional MECP PTTW Locations
- Groundwater
- Cross Section Orientation

- Provincial Highway
- Regional Roads
- Municipal Roads
- Stream: Permanent (OHN)
- Waterbody: Permanent (OHN)

BURNSIDE

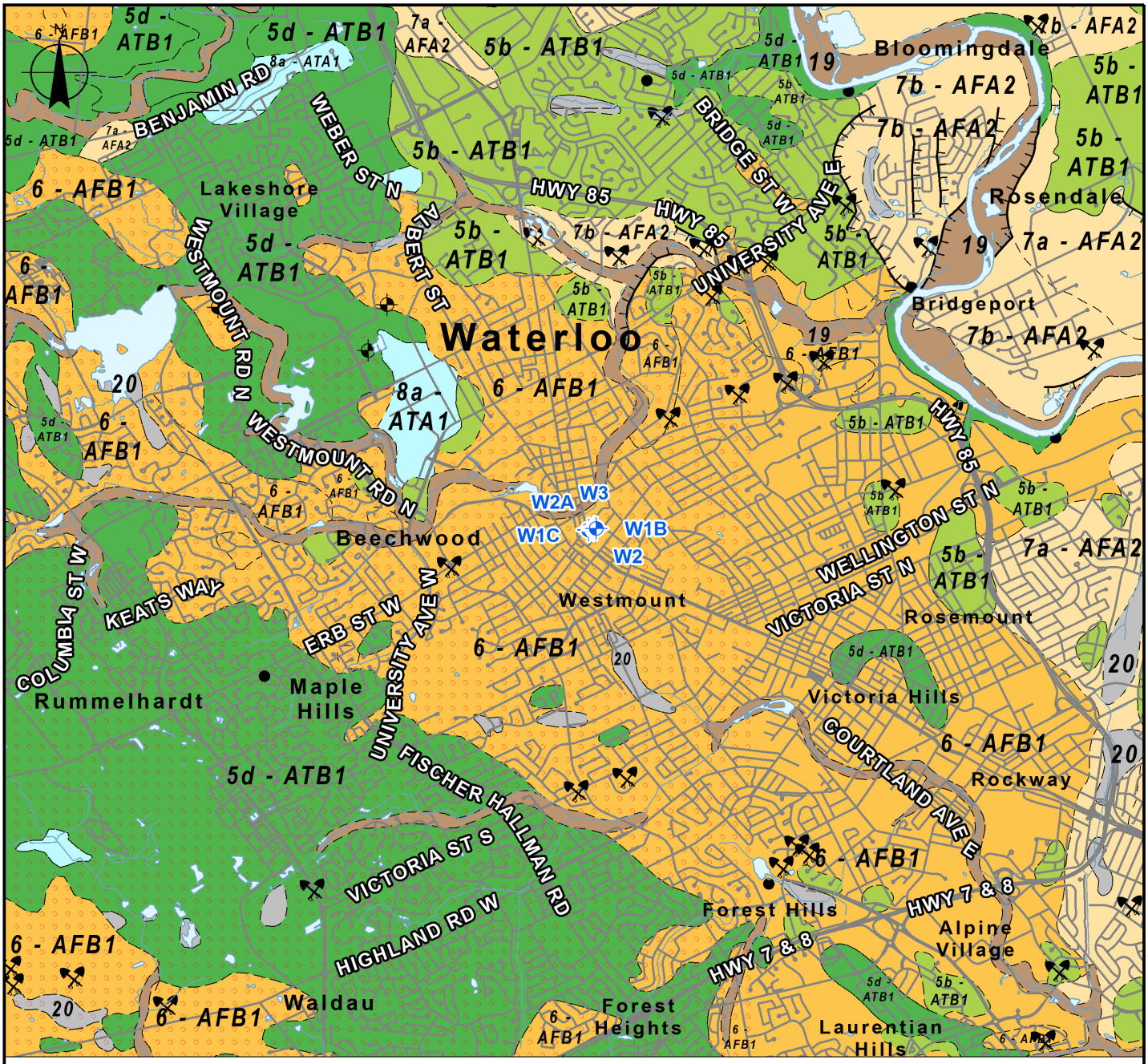
Map Title
2025 GROUNDWATER MONITORING REPORT - WILLIAM STREET WELL FIELD

WELL LOCATION MAP

Client
REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	April 2026	3
Scale		Project No.	
1:22,000		HA0464020	

File Path: \\elmo\gis\project\H Jobs\HA 04 6402 (Waterloo)\Reporting\Groundwater Level Monitoring Program\2025 Groundwater Report Figures\William Street\Pro\William Street\William Street.aprx Print Date: 2026/04/24 Time: 01:53 PM



Data Source:
1. Ontario Geological Survey 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.
2. Region of Waterloo GIS

0 1,000 2,000 3,000 4,000 5,000
Meters

- RMOW Supply Well
- Watercourse
- Waterbody

Surficial Geology

- 5b: Stone-poor, carbonate-derived silty to sandy till (ATA2/ATB1 - Aquitard)
- 5d: Glaciolacustrine-derived silty to clayey till (ATB1 - Aquitard)
- 6: Ice-contact stratified deposits (AFB1 - Aquifer)
- 7a: Glaciofluvial deposits: Sandy deposits (AFA2 - Aquifer)
- 7b: Glaciofluvial deposits: Gravelly deposits (AFA2 - Aquifer)
- 8a: Fine-textured glaciolacustrine deposits: Massive-well laminated (ATA1)
- 19: Modern alluvial deposits
- 20: Organic deposits
- Sand and Gravel Pit
- Terrace
- Drill Hole
- Sample Location
- Hummocky Topography
- Unit Contact
- Boundary

BURNSIDE

Map Title

2025 GROUNDWATER MONITORING REPORT - WILLIAM STREET WELL FIELD

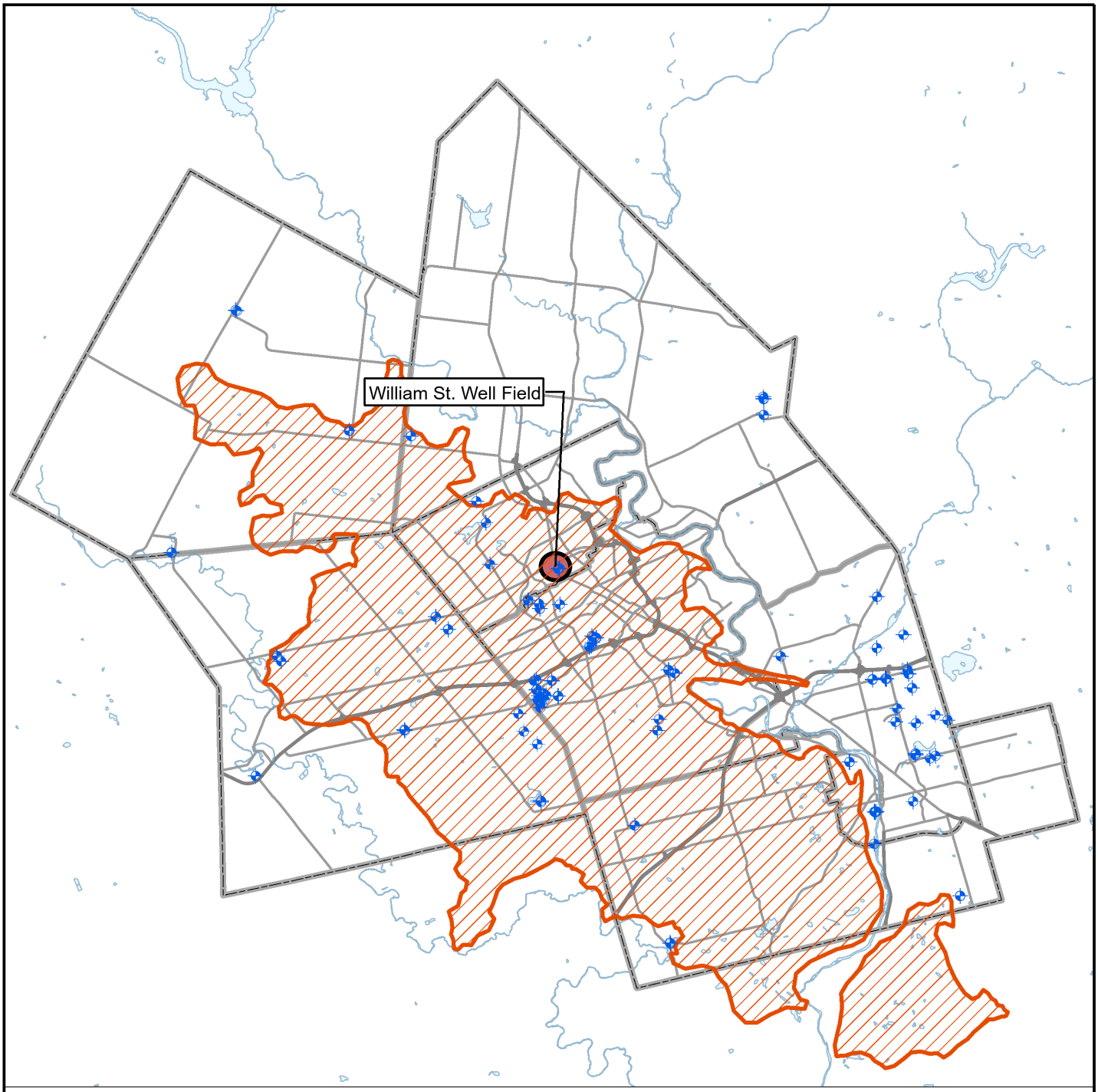
SURFICIAL GEOLOGY

Client

REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	February 2026	4
Scale		Project No.	
1:60,000		HA0464020	

File Path: \\elmo\gis\Project\H Jobs\HA 04 6402 (Waterloo)\Reporting\Groundwater Level Monitoring Program\2025 Groundwater Report Figures\New Dundee\Pro\New Dundee\New Dundee.aprx Print Date: 2026/02/05 Time: 03:16 PM



N

Data Source:
1. Andy F. Bajc, Hazen A.J. Russell and David R. Sharpe (2014) A three-dimensional hydrostratigraphic model of the Waterloo Moraine area, Southern Ontario, Canada, Canadian Water Resources Journal / Revue canadienne des ressources hydriques, 39:2, 95-119
2. Region of Waterloo; Includes material © 2019 of the Queen's Printer for Ontario. All rights reserved.

0 5 10 15 20 25
Kilometers

RMOW Supply Well
Waterloo Moraine (2014)
William Street Well Field
Waterbody
Regional Municipal Boundaries

BURNSIDE

Map Title

2025 GROUNDWATER MONITORING REPORT - WILLIAM STREET WELL FIELD

LOCATION OF THE WATERLOO MORAINE

Client

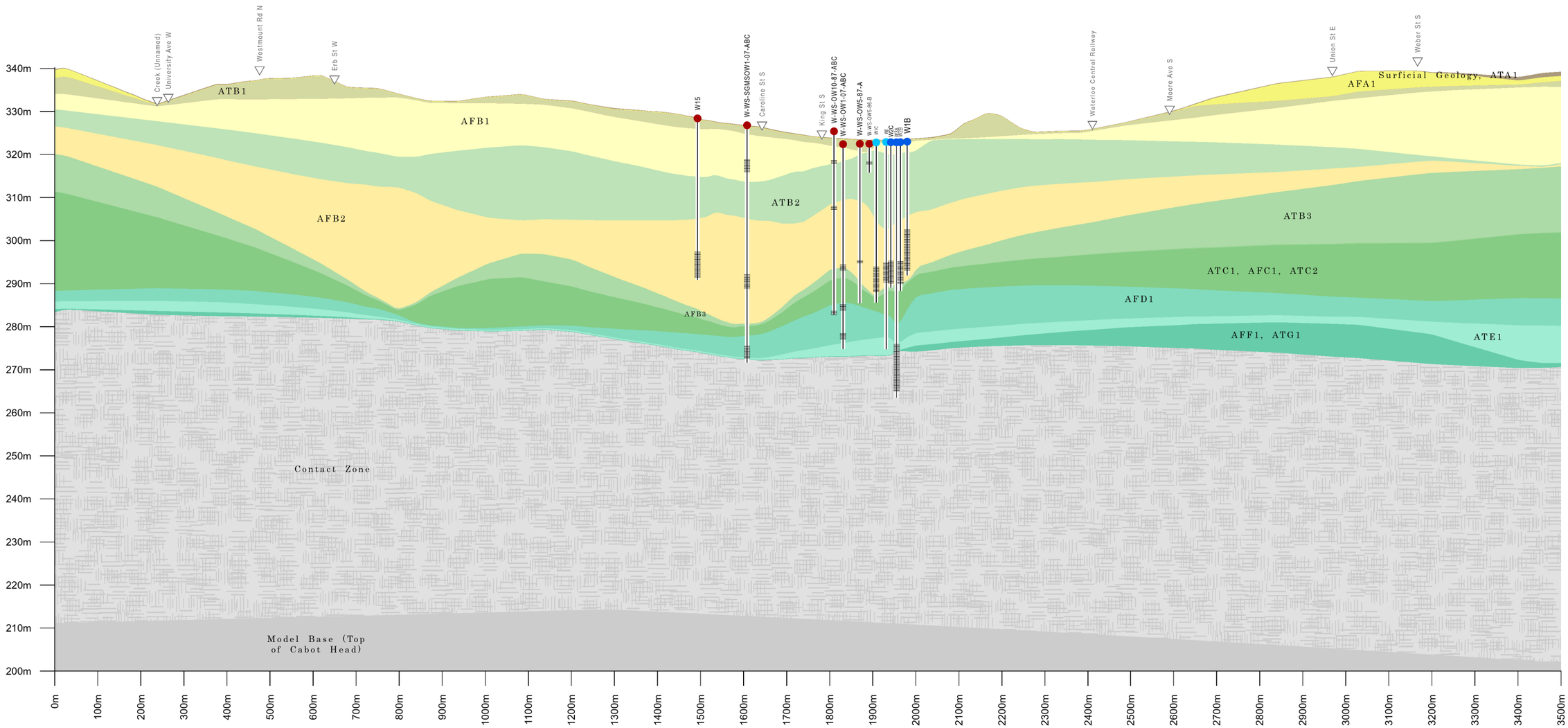
REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	April 2026	5
Scale		Project No.	
1:300,000		HA0464020	

File Path: \\elmo\gis\project\H Jobs\HA 04 6402 (Waterloo)\Reporting\Groundwater Level Monitoring Program\2025 Groundwater Report Figures\William Street\Pro\William Street\William Street.aprx Print Date: 2026/04/17 Time: 03:55 PM

A

A'

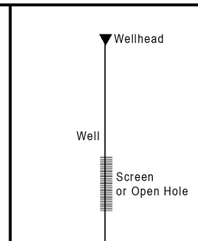


Wells

- Production Well (Active)
- Production Well (Inactive)
- Monitoring Well

Moraine Model Full 2026

- Surficial Geology, Whittlesey Clay (ATA1)
- Whittlesey Sand (AFA1)
- Upper Maryhill, Port Stanley, Tavistock, Mornington, & Stratford Tills (ATB1)
- Upper Waterloo Moraine Stratified Sediments & Equivalents (AFB1)
- Middle Maryhill Till & Equivalents (ATB2)
- Middle Waterloo Moraine Stratified Sediments & Equivalents (AFB2)
- Lower Maryhill Till & Stratified Equivalents (ATB3)
- Lower Waterloo Moraine Stratified Sediments or Catfish Creek Till Outwash (AFB3)
- Upper/Main Catfish Creek Till (ATC1), Middle Catfish Creek Stratified Deposits (AFC1), Lower Catfish Creek Till (ATC2)
- Pre-Catfish Creek Coarse-Grained Glaciofluvial/ Lacustrine Deposits (AFD1)
- Canning Drift, Till & Fine Textured Glaciolacustrine Deposits (ATE1)
- Pre-Canning Coarse Textured Glaciofluvial / Glaciolacustrine Deposits (AFF1), Pre-Canning Coarse Textured Till (ATG1)
- Weathered Bedrock
- Model Base (Top of Cabot Head)



BURNSIDE

Client

REGION OF WATERLOO

Figure Title

GEOLOGIC CROSS SECTION REGION OF WATERLOO

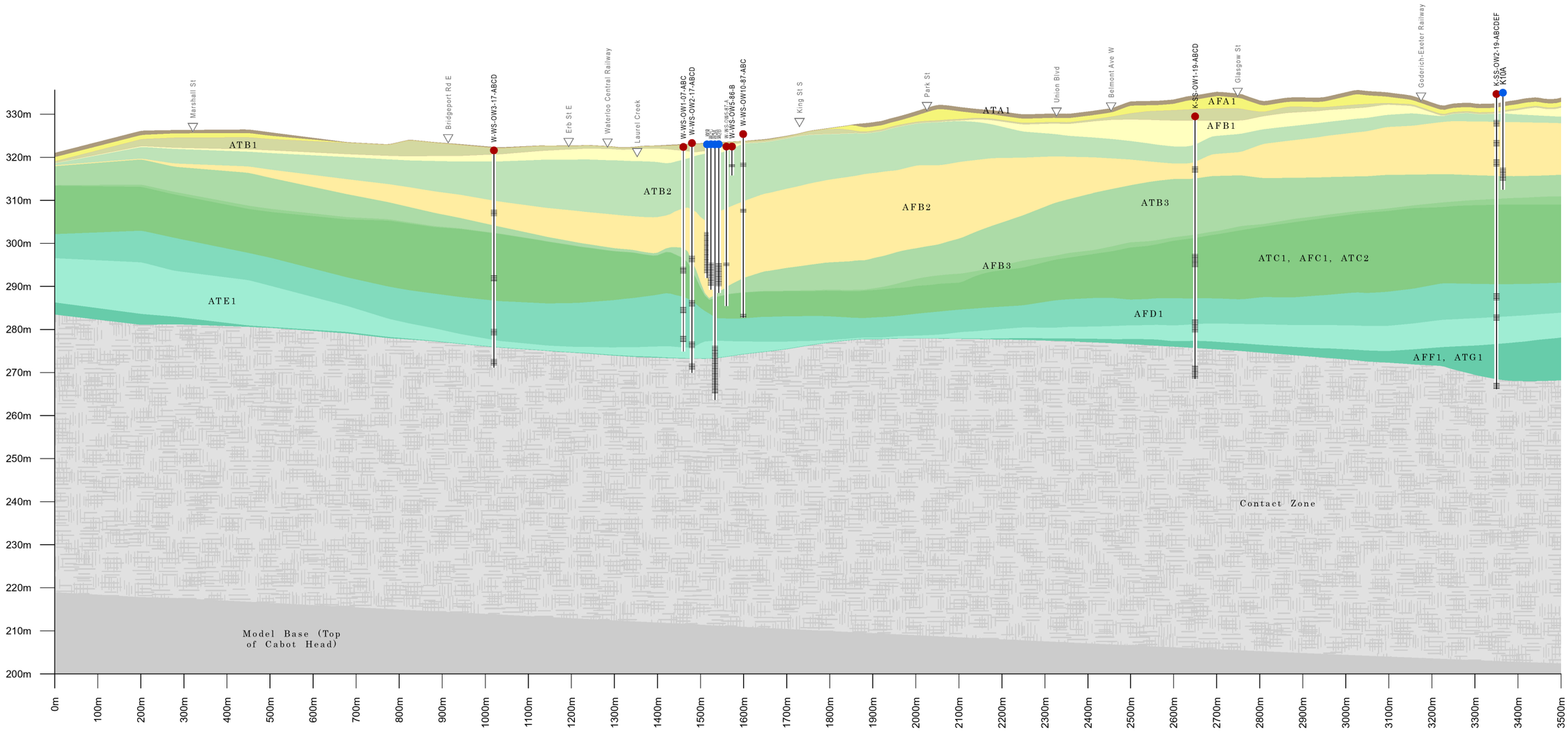
William Street
Cross Section A - A'

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/15	6
Horizontal Scale 1:9,600		Project No.	
Vertical Ex.:10x		HA046402	

File Path: F:\GIS Working\Projects\ROW_Cross_Sections\ROW_Cross_Sections.aprx Print Date: 2026/06/15 Time: 04:42 PM

B

B'



Wells

● Production Well (Active) ● Monitoring Well

Moraine Model Full 2026

- Surficial Geology, Whittlesey Clay (ATA1)
- Whittlesey Sand (AFA1)
- Upper Maryhill, Port Stanley, Tavistock, Mornington, & Stratford Tills (ATB1)
- Upper Waterloo Moraine Stratified Sediments & Equivalents (AFB1)
- Middle Maryhill Till & Equivalents (ATB2)
- Middle Waterloo Moraine Stratified Sediments & Equivalents (AFB2)
- Lower Maryhill Till & Stratified Equivalents (ATB3)
- Lower Waterloo Moraine Stratified Sediments or Catfish Creek Till Outwash (AFB3)
- Upper/Main Catfish Creek Till (ATC1), Middle Catfish Creek Stratified Deposits (AFC1), Lower Catfish Creek Till (ATC2)
- Pre-Catfish Creek Coarse-Grained Glaciofluvial/ Lacustrine Deposits (AFD1)
- Canning Drift, Till & Fine Textured Glaciolacustrine Deposits (ATE1)
- Pre-Canning Coarse Textured Glaciofluvial / Glaciolacustrine Deposits (AFF1), Pre-Canning Coarse Textured Till (ATG1)
- Weathered Bedrock
- Model Base (Top of Cabot Head)

Wellhead

Well

Screen or Open Hole

BURNSIDE

Client

REGION OF WATERLOO

Figure Title

GEOLOGIC CROSS SECTION REGION OF WATERLOO

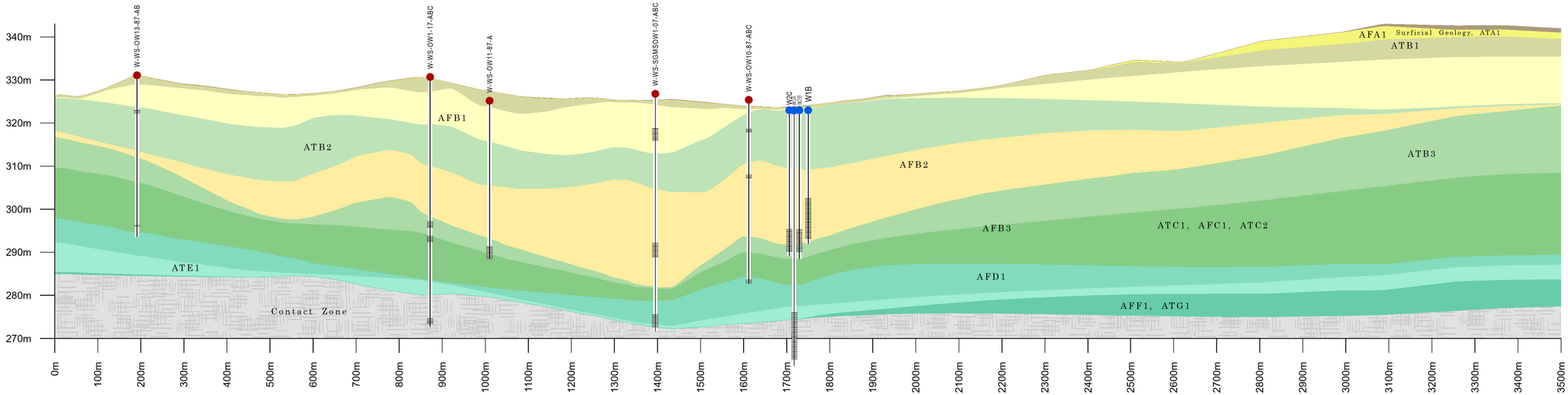
William Street
Cross Section B - B'

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/17	7
Horizontal Scale 1:9,600		Project No.	
Vertical Ex.:10x		HA046402	

File Path: F:\01S Working\Projects\ROW_Crocs_Sections\ROW_Crocs_Sections.aprx Print Date: 2026/06/17 Time: 04:47 PM

C

C'



Wells

- Production Well (Active)
- Monitoring Well

Moraine Model 2026

- Surficial Geology, Whittlesey Clay (ATA1)
- Whittlesey Sand (AFA1)
- Upper Maryhill, Port Stanley, Tavistock, Mornington, & Stratford Tills (ATB1)
- Upper Waterloo Moraine Stratified Sediments & Equivalents (AFB1)
- Middle Maryhill Till & Equivalents (ATB2)
- Middle Waterloo Moraine Stratified Sediments & Equivalents (AFB2)
- Lower Maryhill Till & Stratified Equivalents (ATB3)
- Lower Waterloo Moraine Stratified Sediments or Catfish Creek Till Outwash (AFB3)
- Upper/Main Catfish Creek Till (ATC1), Middle Catfish Creek Stratified Deposits (AFC1), Lower Catfish Creek Till (ATC2)
- Pre-Catfish Creek Coarse-Grained Glaciofluvial/ Lacustrine Deposits (AFD1)
- Canning Drift, Till & Fine Textured Glaciolacustrine Deposits (ATE1)
- Pre-Canning Coarse Textured Glaciofluvial / Glaciolacustrine Deposits (AFF1), Pre-Canning Coarse Textured Till (ATG1)
- Weathered Bedrock

Wellhead
Well
Screen or Open Hole

BURNSIDE

Client
REGION OF WATERLOO

Figure Title
GEOLOGIC CROSS SECTION REGION OF WATERLOO
William Street
Cross Section C - C'

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/15	8
Horizontal Scale 1:9,600 Vertical Ex.:10x		Project No. HA046402	

File Path: F:\GIS Working\Projects\ROW_Cross_Sections\ROW_Cross_Sections.aprx Print Date: 2026/06/15 Time: 09:21 PM

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Permit To Take Water

Ontario

Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

PERMIT TO TAKE WATER
Ground Water
NUMBER P-300-5049623280
Version: 1.0
Effective Date: September 13, 2019
Expiry Date: April 1, 2029

Pursuant to Section 34.1 of the Ontario Water Resources Act, R.S.O. 1990 this Permit To Take Water is hereby issued to:

REGIONAL MUNICIPALITY OF
WATERLOO

150 Frederick Street
6th Floor
KITCHENER
KITCHENER
ONTARIO
Canada
N2G 4J3

For the water taking from

W3

W2A

W1C

W1B

W2

Located at:

23 William Street East, Waterloo, WATERLOO CITY, ONTARIO,
CANADA, N2J 1T3

For the purposes of this Permit, and the terms and conditions specified below, the following definitions apply:

DEFINITIONS

a. "Director" means any person appointed in writing as a Director pursuant to section 5 of the OWRA for the purposes of section 34.1, OWRA.

b. "Provincial Officer" means any person designated in writing by the Minister as a Provincial Officer pursuant to section 5 of the OWRA.

c. "Ministry" means Ontario Ministry of the Environment, Conservation and Parks.

d. "District Office" means the Guelph District Office

e. "Permit" means this Permit to Take Water No. P-300-5049623280 including its Schedules, if any, issued in accordance with Section 34.1 of the OWRA.

f. "Permit Holder" means REGIONAL MUNICIPALITY OF WATERLOO.

g. "OWRA" means the Ontario Water Resources Act, R.S.O. 1990, c. O. 40, as amended.

You are hereby notified that this Permit is issued subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1 **Compliance with Permit**

1.1 Except where modified by this Permit, the water taking shall be in accordance with the application for this Permit To Take Water, attested to by Richard Wootton, on March 25, 2019, and all Schedules included in this Permit.

1.2 The Permit Holder shall ensure that any person authorized by the Permit Holder to take water under this Permit is provided with a copy of this Permit and shall take all reasonable measures to ensure that any such person complies with the conditions of this Permit.

1.3 Any person authorized by the Permit Holder to take water under this Permit shall comply with the conditions of this Permit.

1.4 This Permit is not transferable to another person.

1.5 This Permit provides the Permit Holder with permission to take water in accordance with the conditions of this Permit, up to the date of the expiry of this Permit. This Permit does not constitute a legal right, vested or otherwise, to a water allocation, and the issuance of this Permit does not guarantee that, upon its expiry, it will be renewed.

1.6 The Permit Holder shall keep this Permit available at all times at or near the site of the taking, and shall produce this Permit immediately for inspection by a Provincial Officer upon his or her request.

1.7 The Permit Holder shall report any changes of address to the Director within thirty days of any such change. The Permit Holder shall report any change of ownership of the property for which this Permit is issued within thirty days of any such change. A change in ownership in the property shall cause this Permit to be cancelled.

2 **General Conditions and Interpretation**

2.1 Inspections
The Permit Holder must forthwith, upon presentation of credentials, permit a Provincial Officer to carry out any and all inspections authorized by the OWRA, the Environmental Protection Act, R.S.O. 1990, the Pesticides Act, R.S.O. 1990, or the Safe Drinking Water Act, S. O. 2002.

2.2 Other Approvals
The issuance of, and compliance with this Permit, does not:
(a) relieve the Permit Holder or any other person from any obligation to comply with any other applicable legal requirements, including the provisions of the Ontario Water Resources Act, and

the Environmental Protection Act, and any regulations made thereunder; or
(b) limit in any way any authority of the Ministry, a Director, or a Provincial Officer, including the authority to require certain steps be taken or to require the Permit Holder to furnish any further information related to this Permit.

2.3 Information
The receipt of any information by the Ministry, the failure of the Ministry to take any action or require any person to take any action in relation to the information, or the failure of a Provincial Officer to prosecute any person in relation to the information, shall not be construed as:
(a) an approval, waiver or justification by the Ministry of any act or omission of any person that contravenes this Permit or other legal requirement; or
(b) acceptance by the Ministry of the information's completeness or accuracy.

2.4 Rights of Action
The issuance of, and compliance with this Permit shall not be construed as precluding or limiting any legal claims or rights of action that any person, including the Crown in right of Ontario or any agency thereof, has or may have against the Permit Holder, its officers, employees, agents, and contractors.

2.5 Severability
The requirements of this Permit are severable. If any requirements of this Permit, or the application of any requirements of this Permit to any circumstance, is held invalid or unenforceable, the application of such requirements to other circumstances and the remainder of this Permit shall not be affected thereby.

2.6 Conflicts
Where there is a conflict between a provision of any submitted document referred to in this Permit, including its Schedules, and the conditions of this Permit, the conditions in this Permit shall take precedence.

3 **Water Takings Authorized by This Permit**

3.1 Expiry
This Permit expires on April 1, 2029. No water shall be taken under authority of this Permit after the expiry date.

3.2 Amounts of Taking Permitted
The Permit Holder shall only take water from the source, during the periods and at the rates and amounts of taking specified in Table A. Water takings are authorized only for the purposes specified in Table A.

Table A (litres)

	Source Name / Description	Source Type	Purpose Category	Specific Purpose	Activity	Max. Taken per minute	Max. No. of Hrs Taken per day	Max. volume per Day	Max. days in a year	Zone / Easting / Northing
1	W1B (W1B)	Well	Public administration	Municipal Supply	Water Supply	3636	24	5236992	365	17 / 538895 / 4812298
2	W1C (W1C)	Well	Public administration	Municipal Supply	Water Supply	2273	24	3274000	365	17 / 538817 / 4812280
3	W2 (W2)	Well	Public administration	Municipal Supply	Water Supply	5000	24	5246000	365	17 / 538871 / 4812289
4	W2A (W2A)	Well	Public administration	Municipal Supply	Water Supply	3660	24	5270400	365	17 / 538875 / 4812292
5	W3 (W3)	Well	Public administration	Municipal Supply	Water Supply	2100	24	3024000	365	17 / 538875 / 4812300
Total Taking								**22051392**		

3.3 Not withstanding the Maximum Taken per Day specified in Table A of Condition 3.2, the combined taking from wells WIB, W1C, W2 and W2A shall not exceed an annual daily average

of 7,650,000 litres per day, and the taking from well W3 shall not exceed an annual daily average of 1,577,000 litres per day.

4 **Monitoring**

4.1 The Permit Holder shall maintain a record of all water takings. This record shall include the dates and times of water takings, the rates of pumping, and an estimated calculation of the total amounts of water pumped per day for each day that water is taken under the authorization of this Permit. A separate record shall be maintained for each source. The Permit Holder shall keep all required records up to date and available at or near the site of the taking and shall produce the records for inspection by a Provincial Officer upon his or her request.

4.2 The Permit Holder shall measure and record water levels once a month in the following monitoring wells:

W-WS-OW5-87-A
W-WS-OW5-87-B
W-WS-OW10-87-A
W-WS-OW10-87-B
W-WS-OW10-87-C
W-WS-SGMSOW1-07-A
W-WS-SGMSOW1-07-B
W-WS-SGMSOW1-07-C

5 **Impacts of the Water Taking**

5.1 Notification

The Permit Holder shall immediately notify the local District Office of any complaint arising from the taking of water authorized under this Permit and shall report any action which has been taken or is proposed with regard to such complaint. The Permit Holder shall immediately notify the local District Office if the taking of water is observed to have any significant impact on the surrounding waters. After hours, calls shall be directed to the Ministry's Spills Action Centre at 1-800-268-6060.

5.2 Impacts for Water Situation Type

For Groundwater Takings

If the taking of water is observed to cause any negative impact to other water supplies obtained from any adequate sources that were in use prior to initial issuance of a Permit for this water taking, the Permit Holder shall take such action necessary to make available to those affected, a supply of water equivalent in quantity and quality to their normal takings, or shall compensate such persons for their reasonable costs of so doing, or shall reduce the rate and amount of taking to prevent or alleviate the observed negative impact. Pending permanent restoration of the affected supplies, the Permit Holder shall provide, to those affected, temporary water supplies adequate to meet their normal requirements, or shall compensate such persons for their reasonable costs of doing so.

If permanent interference is caused by the water taking, the Permit Holder shall restore the water supplies of those permanently affected.

6 **Director May Amend Permit**

6.1 The Director may amend this Permit by letter requiring the Permit Holder to suspend or reduce the taking to an amount or threshold specified by the Director in the letter. The suspension or reduction in taking shall be effective immediately and may be revoked at any time upon otification by the Director. This condition does not affect your right to appeal the suspension or reduction in taking to the Environmental Review Tribunal under the Ontario Water Resources Act, Section 100 (4).

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is included to ensure that the conditions in this Permit are complied with and can be enforced.

2. Condition 2 is included to clarify the legal interpretation of aspects of this Permit.

3. Conditions 3 through 6 are included to protect the quality of the natural environment so as to safeguard the ecosystem and human health and foster efficient use and conservation of waters. These conditions allow for the beneficial use of waters while ensuring the fair sharing, conservation and sustainable use of the waters of Ontario. The conditions also specify the water takings that are authorized by this Permit and the scope of this Permit.

Appeal Provisions

In accordance with Section 100 of the Ontario Water Resources Act, R.S.O. 1990, you may by written notice served upon me, the Environmental Review Tribunal and the Minister of the Environment, Conservation and Parks, within 15 days after receipt of this Notice, require a hearing by the Tribunal. The Minister of the Environment, Conservation and Parks will place notice of your appeal on the Environmental Registry. Section 101 of the Ontario Water Resources Act, as amended provides that the Notice requiring a hearing shall state:

1. The portions of the Permit or each term or condition in the Permit in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

In addition to these legal requirements, the Notice should also include:

a. The name of the appellant;
b. The address of the appellant;
c. The Permit to Take Water number;
d. The date of the Permit to Take Water;
e. The name of the Director;
f. The municipality within which the works are located

This notice must be served upon:

The Secretary *Environmental Review Tribunal* *655 Bay Street, 15th Floor* *Toronto ON* *M5G 1E5* *Fax: (416) 326-5370* *Email:* *ERTTribunalsecretary@ontario.ca*	*AND*	*Minister of the Environment, Conservation and Parks* *777 Bay Street, 5th Floor* *Toronto, Ontario* *M7A 2J3*	*AND*	*The Director, Section 34.1,* *Ministry of the Environment, Conservation and Parks* *119 King St W, 12th Floor* *Hamilton, ON L8P 4Y7* *Fax: (905) 521-7820*

Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal:

by Telephone at	*by Fax at*	*by e-mail at*
(416) 212-6349	*(416) 326-5370*	*www.ert.gov.on.ca*
Toll Free 1(866) 448-2248	*Toll Free 1(844) 213-3474*	

*This instrument is subject to Section 38 of the **Environmental Bill of Rights** that allows residents of Ontario to seek leave to appeal the decision on this instrument. Residents of Ontario may seek to appeal for 15 days from the date this decision is placed on the Environmental Registry. By accessing the Environmental Registry, you can determine when the leave to appeal period ends.*

This Permit cancels and replaces Permit Number 3208-8VPRY5, issued on June 29, 2012.

Dated at Hamilton this 12th day of September, 2019



Daniel Dobrin

Director, Section 34.1

Ontario Water Resources Act , R.S.O. 1990

CC Information

Recipient Name	Organization	Email ID
Richard Wootton	Region of Waterloo	rwootton@regionofwaterloo.ca

PERMIT TO TAKE WATER
Ground Water
NUMBER P-300-5049623280
Version: 2.0
Effective Date: September 12, 2024
Expiry Date: April 1, 2029

Pursuant to Section 34.1 of the Ontario Water Resources Act, Revised Statutes of Ontario (R.S.O.) 1990 this Permit To Take Water is hereby issued to:

REGIONAL MUNICIPALITY OF WATERLOO

150 Frederick Street
6th Floor
KITCHENER
ONTARIO
Canada
N2G 4J3

For the water taking from

W1B

W2B

W2C

W3A

Located at:

23 William Street East, Waterloo, WATERLOO CITY, ONTARIO, CANADA, N2J 1T3

This Permit cancels and replaces Permit Number P-300-5049623280 Version 1.0, issued on September 12, 2019.

DEFINITIONS

For the purposes of this Permit, and the terms and conditions specified below, the following definitions apply:

a. "Director" means any person appointed in writing as a director pursuant to section 5 of the OWRA for the purposes of section 34.1 of the OWRA.

b. "Provincial Officer" means any person designated in writing by the Minister as a provincial officer pursuant to section 5 of the OWRA.

c. "Ministry" means the ministry of the government of Ontario responsible for the administration of the OWRA, currently named the Ministry of the Environment, Conservation and Parks.

d. "District Office" means the Guelph District Office of the Ministry.

e. "Permit" or "PTTW" means this Permit to Take Water No. P-300-5049623280 including its Schedules, if any, issued in accordance with Section 34.1 of the OWRA, as may amended.

f. "Permit Holder" means REGIONAL MUNICIPALITY OF WATERLOO.

g. "OWRA" means the *Ontario Water Resources Act,* R.S.O. 1990, c. O. 40.

TERMS AND CONDITIONS

You are hereby notified that this Permit is issued subject to the terms and conditions outlined below:

1. **Compliance with Permit**

1.1. Except where modified by this Permit, the water taking shall be in accordance with the application for this Permit To Take Water, attested to by Frank Kosa, on July 8, 2024, and all Schedules included in this Permit.

1.2. The Permit Holder shall ensure that any person authorized by the Permit Holder to take water under this Permit is provided with a copy of this Permit and shall take all reasonable measures to ensure that any such person complies with the conditions of this Permit.

1.3. Any person authorized by the Permit Holder to take water under this Permit shall comply with the conditions of this Permit.

1.4. This Permit is not transferable to another person without the Director's written consent.

1.5. This Permit provides the Permit Holder with permission to take water in accordance with the conditions of this Permit, up to the date of the expiry of this Permit. This Permit does not constitute a legal right, vested or otherwise, to a water allocation, and the issuance of this Permit does not guarantee that, upon its expiry, it will be renewed.

1.6. The Permit Holder shall keep this Permit available at all times at or near the site of the taking, and shall produce this Permit immediately for inspection by a Provincial Officer upon his or her request.

1.7. The Permit Holder shall report any changes of address to the Director within thirty days of any such change. The Permit Holder shall report any change of ownership of the property for which this Permit is issued within thirty days of any such change.

2. **General Conditions and Interpretation**

2.1. Inspections

The Permit Holder must forthwith, upon presentation of credentials, permit a Provincial Officer to carry out any and all inspections authorized by the OWRA, the Environmental Protection Act, R.S.O. 1990, the Pesticides Act, R.S.O. 1990, or the Safe Drinking Water Act, S. O. 2002.

2.2. Other Approvals

The issuance of, and compliance with this Permit, does not:
(a) relieve the Permit Holder or any other person from any obligation to comply with any other applicable legal requirements, including the provisions of the Ontario Water Resources Act, and the Environmental Protection Act, and any regulations made thereunder; or
(b) limit in any way any authority of the Ministry, a Director, or a Provincial Officer, including the authority to require certain steps be taken or to require the Permit Holder to furnish any further information related to this Permit.

2.3. Information

The receipt of any information by the Ministry, the failure of the Ministry to take any action or require any person to take any action in relation to the information, or the failure of a Provincial Officer to prosecute any person in relation to the information, shall not be construed as:
(a) an approval, waiver or justification by the Ministry of any act or omission of any person that contravenes this Permit or other legal requirement; or
(b) acceptance by the Ministry of the information's completeness or accuracy.

2.4. Rights of Action

The issuance of, and compliance with this Permit shall not be construed as precluding or limiting any legal claims or rights of action that any person, including the Crown in right of Ontario or any agency thereof, has or may

have against the Permit Holder, its officers, employees, agents, and contractors.

2.5. Severability
The requirements of this Permit are severable. If any requirements of this Permit, or the application of any requirements of this Permit to any circumstance, is held invalid or unenforceable, the application of such requirements to other circumstances and the remainder of this Permit shall not be affected thereby.

2.6. Conflicts
Where there is a conflict between a provision of any submitted document referred to in this Permit, including its Schedules, and the conditions of this Permit, the conditions in this Permit shall take precedence.

3. **Water Takings Authorized by This Permit**

3.1. Expiry
This Permit expires on April 1, 2029. No water shall be taken under authority of this Permit after the expiry date.

3.2. Amounts of Taking Permitted
The Permit Holder shall only take water from the source, during the periods and at the rates and amounts of taking specified in Table A. Water takings are authorized only for the purposes specified in Table A.

Table A (litres)

	Source Name / Description	Source Type	Purpose Category	Specific Purpose	Activity	Maximum Taken per minute	Maximum Number of Hours Taken per day	Maximum volume per Day	Maximum days in a year	Zone / Easting / Northing
1	W1B (W1B)	Well	Public administration	Municipal Supply	Water Supply	3672	24	5287680	365	17 / 538894 / 4812296
2	W2B (W2B)	Well	Public administration	Municipal Supply	Water Supply	3672	24	5287680	365	17 / 538870 / 4812299
3	W2C (W2C)	Well	Public administration	Municipal Supply	Water Supply	3672	24	5287680	365	17 / 538855 / 4812301
4	W3A (W3A)	Well	Public administration	Municipal Supply	Water Supply	1530	24	2203200	365	17 / 538862 / 4812302
Total Taking								**14100480**		

3.3. Notwithstanding Table A, the combined volume of water taking from **Sources 1, 2 and 3** (Production Wells W1B, W2B and W2C, respectively) shall not exceed **11,897,280 litres per day**.

3.4. Notwithstanding Table A and Condition 3.3, the combined volume of water taking from all sources listed in Table A shall not exceed an annual daily average of **11,721,024** litres per day.

4. **Monitoring**

4.1. The Permit Holder shall maintain a record of all water takings. The daily volume of water taken shall be measured by a flow meter or calculated in accordance with the method described in the application for this Permit, or as otherwise accepted by the Director. This record shall include the dates and times of water takings, the rates of pumping, and the total measured amounts of water pumped per day for each day that water is taken under the authorization of this Permit. A separate record shall be maintained for each source. The Permit Holder shall keep all required records up to date and available at or near the site of the taking and shall produce the records immediately for inspection by a Provincial Officer upon his or her request. The Permit Holder, unless otherwise required by the Director, shall submit, on or before March 31st in every year, the records required by this condition to the Ministry's Regulatory Self Reporting System.

4.2. The Permit Holder shall measure and record water levels once a month in the following monitoring wells:

i. W-WS-OW5-87-A

ii. W-WS-OW10-87-A

iii. W-WS-SGMSOW1-07-A

iv. W-WS-SGMSOW1-07-B

v. W-WS-OW2-17-A

vi. W-WS-OW2-17-B

vii. W-WS-OW2-17-C

viii. W-WS-OW2-17-D

The Permit Holder shall keep all monitoring records available for inspection and review upon request by the Ministry.

4.3. The Permit Holder shall prepare and submit a report to the Director and the Guelph District Office every two years by March 31st, commencing March 31, 2026 that:

i. presents the results of the well field water level monitoring for the two preceding calendar years,

ii. assesses changes in water levels in the supply aquifer(s) in relation to precipitation and water taking from the aquifer(s), and

iii. provides a summary for all interference complaints received by the Permit Holder related to this Permit and reported in the District Office in accordance with Condition 5.1, including the manner in which the Permit Holder has dealt with the complaint.

5. **Impacts of the Water Taking**

5.1. Notification

The Permit Holder shall immediately notify the local District Office of any complaint arising from the taking of water authorized under this Permit and shall report any action which has been taken or is proposed with regard to such complaint. The Permit Holder shall immediately notify the local District Office if the taking of water is observed to have any significant impact on the surrounding waters. After hours, calls shall be directed to the Ministry's Spills Action Centre at 1-800-268-6060.

5.2. Impacts for Water Situation Type

For Surface-Water Takings

The taking of water (including the taking of water into storage and the subsequent or simultaneous withdrawal from storage) shall be carried out in such a manner that streamflow is not stopped and is not reduced to a rate that will cause interference with downstream uses of water or with the natural functions of the stream.

For Groundwater Takings

If the taking of water is observed to cause any negative impact to other water supplies obtained from any adequate sources that were in use prior to initial issuance of a Permit for this water taking, the Permit Holder shall take such action necessary to make available to those affected, a supply of water equivalent in quantity and quality to their normal takings, or shall compensate such persons for their reasonable costs of so doing, or shall reduce the rate and amount of taking to prevent or alleviate the observed negative impact. Pending permanent restoration of the affected supplies, the Permit Holder shall provide, to those affected, temporary water supplies adequate to meet their normal requirements, or shall compensate such persons for their reasonable costs of doing so.

If permanent interference is caused by the water taking, the Permit Holder shall restore the water supplies of those permanently affected.

6. **Director May Amend Permit**

6.1. The Director may amend this Permit by letter requiring the Permit Holder to suspend or reduce the taking to an amount or threshold specified by the Director in the letter. The suspension or reduction in taking shall be effective immediately and may be revoked at any time upon notification by the Director. This condition does not affect your right to appeal the suspension or reduction in taking to the Environmental Review Tribunal under the

Ontario Water Resources Act, Section 100 (4).

REASONS

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is included to ensure that the conditions in this Permit are complied with and can be enforced.
2. Condition 2 is included to clarify the legal interpretation of aspects of this Permit.
3. Conditions 3 through 6 are included to protect the quality of the natural environment so as to safeguard the ecosystem and human health and foster efficient use and conservation of waters. These conditions allow for the beneficial use of waters while ensuring the fair sharing, conservation and sustainable use of the waters of Ontario. The conditions also specify the water takings that are authorized by this Permit and the scope of this Permit.

APPEAL PROVISIONS

In accordance with Section 100 of the *Ontario Water Resources Act, R.S.O. 1990*, you may by written notice served upon me and the Ontario Land Tribunal within 15 days after receipt of this notice, require a hearing by the Tribunal. Section 101 of the *Ontario Water Resources Act, R.S.O. 1990*, as amended, provides that the notice requiring the hearing ("the Notice") shall state:

1. The portions of the Permit or each term or condition in the Permit in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

In addition to these legal requirements, the Notice should also include:

a. The name of the appellant;

b. The address of the appellant;

c. The permit to take water number;

d. The date of the permit to take water;

e. The name of the Director;

f. The municipality within which the works are located;

This Notice must be served upon:

Registrar* Ontario Land Tribunal 655 Bay Street, Suite 1500 Toronto ON M5G 1E5 OLT.Registrar@ontario.ca	and	The Director, Section 34.1, Ministry of the Environment, Conservation and Parks 5775 Yonge Street, 8th Floor Toronto, ON M2M 4J1 Fax: (416) 325-6347

*** Further information on the Ontario Land Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349 or 1 (866) 448-2248, or www.olt.gov.on.ca**

Dated at Toronto this 11th day of September, 2024



Matthew Corriveau

Director, Section 34.1

Ontario Water Resources Act , R.S.O. 1990

c: Frank Kosa
Karl Belan, REGIONAL MUNICIPALITY OF WATERLOO

SCHEDULE 1

This Schedule "1" forms part of Permit To Take Water P-300-5049623280 Version Number 2.0, dated September 11, 2024.

1. Stantec Consulting Ltd. 2024. Construction of Production Well W3A and Well Field Testing, William Street Well Field, Regional Municipality of Waterloo, signed by Lesley Veale, P.Geo., and Roger Freymond, P.Eng., dated May 29, 2024.

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

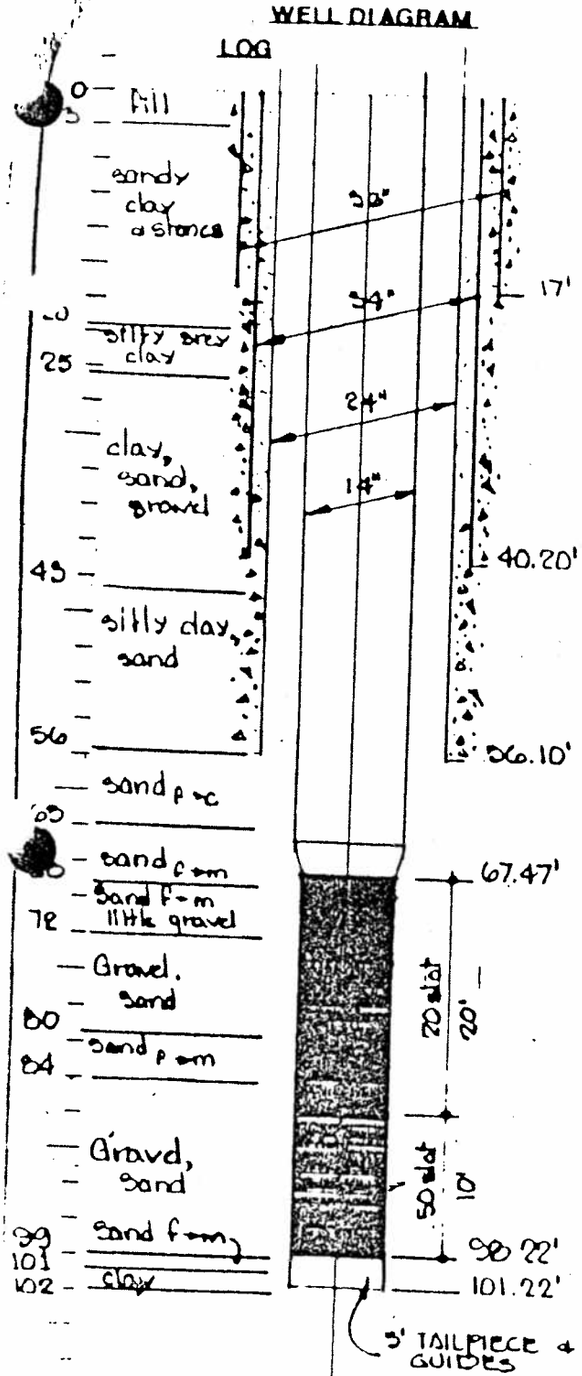
Well Records

W1B

W1B

WELL DIAGRAM

LOG



WELL MATERIAL

Outer Casing 24 " dia .375 " Wall Thk Matl steel
Cemented from 0 ' " to 56 ' 10 "
Inner Casing 14 " dia .375 " Wall Thk Matl steel
Screen Make Smith 12 " dia., Opening & Matl. 30 slot - P. 20 slot - P.
Plug: Type plate , Matl stain. steel Other:
Gravel Type silica , Size 1/8 x 10 Quantity 3.55T 5.15T

WELL TEST DATA

Preliminary Test Date: Jan 25-26 / 78 by J H
Static Level 34.06' " below M.P. GL
Pumping Rate IGM: 1000 IGM
Pumping Duration: 24 hrs. 0 min.
Pumping Level at Test End: ' "
Performance Plots: dd-t Dwg. A 78024-5
dd-r Dwg. A 78026
Step Test Dwg B-78020 A-78021-1

Final Test: Date by
Rated Well Capacity IGM
Pumping Rate IGM Static level ' "
Pumping level ' " at hrs. min.
Pump pressure: psi: Main pressure psi
Shut off: AGH psi; W.L. ' "
Clear Well Depth from B.P. ' " Air Line ' "

PUMP & MOTOR DATA

Pump Make LAYNE Rating 800 IGM @ 105 ' TH
Head: Type TF 8/8 S.N. 13062A
Column: 70 ' X 8 " X 1 ": Shaft Mtl: S.S.
Bowl: 10" THC Stage 3 : Curve:
Suction 8 " dia. 10 ' - 0 - " Long
Special: Zinc Sleeves ✓ : Taped Oil Line
Other
Motor Make: U.S. Frame: 404-1 SN: 2254299
40 HP, 3 ph, 60 hz, 1750 rpm
Bearing No. Upper
Lower

Special Equipment

WELL REVISIONS AND REHABILITATION

DATE	WORK DONE	BY

International Water Supply Limited
SASKATOON - BARRIE - MONTR

CLIENT WATERLOO
WELL NO W1-B

FIGURE A.88

DRILLED BY J. GRAY DATE Sept 77 DRA

W1B

The Ontario Water Resources Act

WATER WELL RECORD

Ontario

INTERNATIONAL WATER SUPPLY LTD.

1 PRINT ONLY IN SPACES PROVIDED
2 CHECK (✓) CORRECT BOX WHERE APPLICABLE

COUNTY OR DISTRICT	TOWN OR BOROUGH OR TOWNSHIP	CON.	BLOCK	TRACT	SURVEY	LOT
WATERLOO	Waterloo					

OWNER (SURNAME FIRST) — ADDRESS — DATE COMPLETED

Regional Municipality of Waterloo — Blueland Dr., Waterloo, Ont. — DAY 22 MO Sept. YR 72

Well W 1 B

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH FEET FROM	DEPTH FEET TO
Black	Fill			0	3
Brown	Sandy clay	Stones	Soft	3	20
Grey	Silty clay		Soft	20	25
Grey	Silty clay	Gravel, Sand	Soft	25	56
Brown	Sand	Fine-Course,	Loose	56	72
Grey	Gravel	Sand	Loose	72	80
Brown	Sand	Fine - Med	Loose	80	84
Grey	Gravel	Sand	Loose	84	99
Brown	Sand	Fine - Med	Loose	99	101
Grey	Clay		Firm	101	102

WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
56 - 72	☒ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL

CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH FEET FROM	DEPTH FEET TO
34"	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	.375	40'	0
24"	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	.375	56'	0
14"	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	.375	67'	0

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
50 Slot 20 Slot	12" INCHES	30.75 FEET
MATERIAL AND TYPE: Howard Smith WW + SS	DEPTH TO TOP OF SCREEN: 67.47 FEET	

PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER ETC.)
	98'	12" SS Plate
0	3.1	concrete surface outer casing

PUMPING TEST

PUMPING TEST METHOD: ☒ PUMP ☐ BAILER — PUMPING RATE: 100 GPM — DURATION OF PUMPING: 24 HOURS — MINS

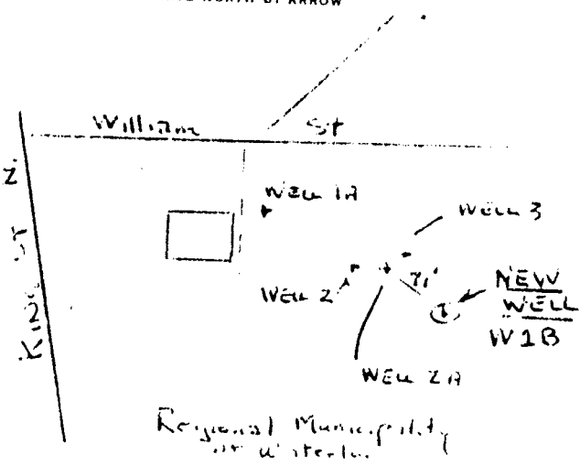
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: ☒ PUMPING ☐ RECOVERY — 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
54.64 FEET	52.44 FEET	51.95 FEET	51.69 FEET	-- FEET	52.00 FEET

IF FLOWING GIVE RATE — GPM — PUMP INTAKE SET AT — FEET — WATER AT END OF TEST: ☒ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP — RECOMMENDED PUMP SETTING: 65 FEET — RECOMMENDED PUMPING RATE: 100 GPM

LOCATION OF WELL W1-B

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE — INDICATE NORTH BY ARROW



Regional Municipality of Waterloo

Waterloo William St Pumping Station

DRILLERS REMARKS

FINAL STATUS OF WELL

☒ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☐ UNFINISHED

WATER USE

☒ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ OTHER ☒ COMMERCIAL ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

METHOD OF DRILLING

☐ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☒ ROTARY (REVERSE) ☐ ROTARY (AIR) ☐ AIR PERCUSSION ☐ BORING ☐ DIAMOND ☐ JETTING ☐ DRIVING

NAME OF WELL CONTRACTOR: I W S — LICENCE NUMBER: 2201

ADDRESS: Box 310 Barrie Ont

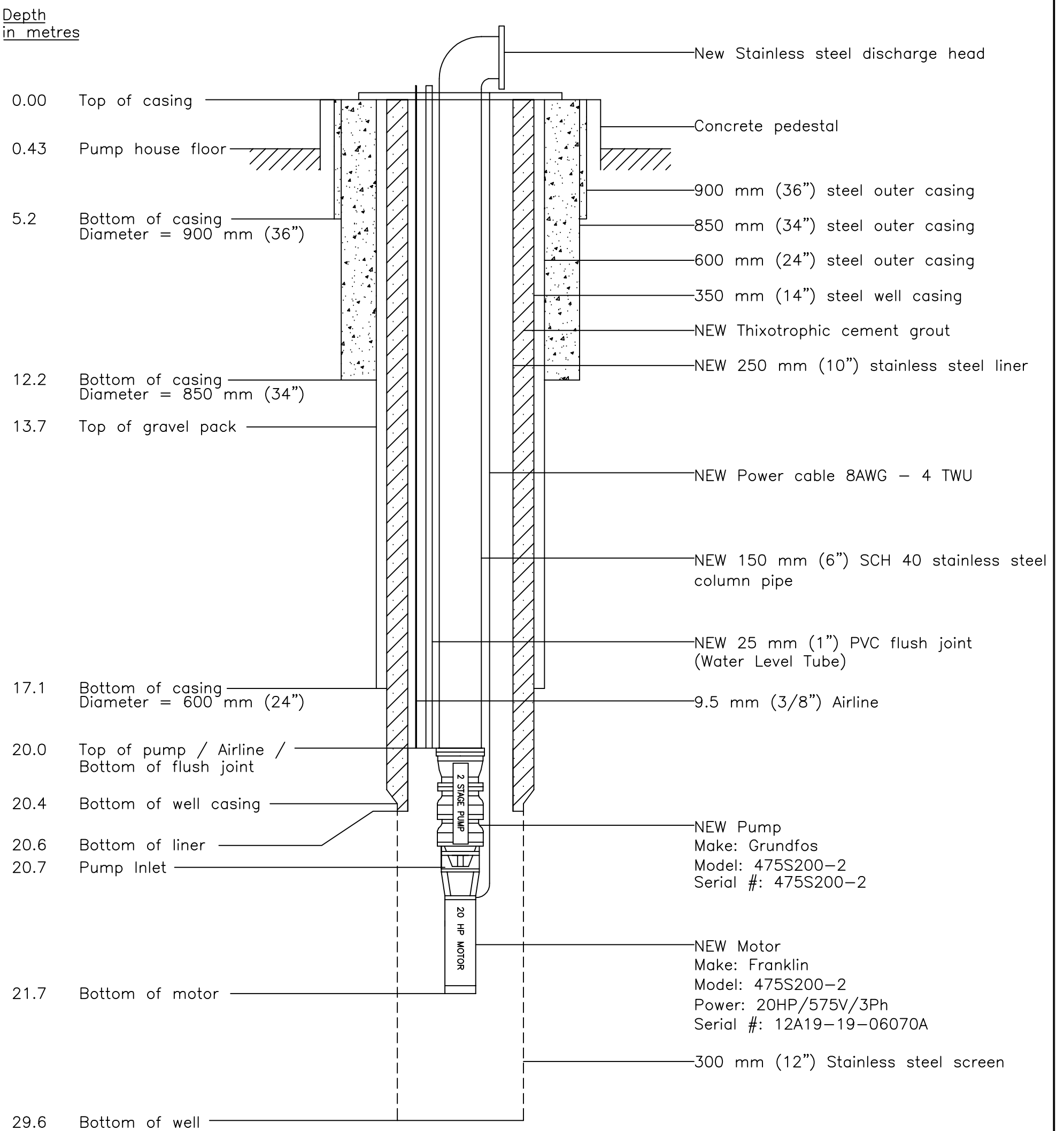
NAME OF DRILLER OR BORER: J G Gray — LICENCE NUMBER:

SIGNATURE OF CONTRACTOR — SUBMISSION DATE: DAY 22 MO Oct YR 72

CONTRACTOR'S COPY

OFFICE USE ONLY

FORM 7 MOE 07-091



NOTES

(1) All measurements below top of base plate which is 0.43 m above pumphouse floor.

(2) New pump installed November 7, 2012.
New motor installed November 7, 2012.

(3) Static water level = 6.76 m below top of base plate measured November 8, 2012.

(4) MOE well tag #A054408, installed Nov 11, 2012.

(5) All existing components, unless otherwise specified.

Lotowater TECHNICAL SERVICES INC.

CLIENT Regional Municipality of Waterloo

TITLE Well W1B
Pump and Liner Installation

PROJECT No. 006-245			G:\Lotowater Projects\006 Region of Waterloo\245 W1B Emergency Service\Proposed Liner Installation.dwg		
DESIGN	EH	2012/10/15	REVISION No. 2012-11-09	SCALE N.T.S.	FIGURE 3
DRAWN	EH	2012/10/15			
CHECKED					

Production Well: W2B

Project: William Street Well Field
Client: Regional Municipality of Waterloo
Location: Waterloo, ON
Number: 160900892

Field Investigator: S. Baer
Contractor: Well Initiatives
Drilling method: Mud Rotary
Date started/completed: 10-May-2018 / 14-Jan-2019

Ground surface elevation: 322.51 m AMSL
Top of casing elevation: 323.24 m AMSL
Easting: 538870
Northing: 4812299

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		GEOPHYSIC DETAILS			WELL DETAILS
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Caliper (cm) 20 30 40 50 60	Gamma (cps) 20 40 60 80 100	Resistivity (Ohm.m) 50 100 150 200	
0	0		Ground Surface	322.51								
			FILL	0.00								
				318.85								
			CLAYEY SILT some sand, trace fine gravel	3.66								
				311.84								
			increased silt content	10.67	ATB2	Middle Maryhill Till and Equivalents						
				303.61								
			SAND fine sand, some medium sand, trace silt	18.90								
			increasing coarse sand and gravel content below 24.4 m		AFB2	Middle Waterloo Moraine stratified sediments and Equivalents	1	GB				
							2	GB				
							3	GB				
							4	GB				
							5	GB				
							6	GB				
				295.38								
			GRAVEL fine gravel, some fine to coarse sand	27.13								
			losing water during drilling 28.0 to 29.0 m									
				289.50								
			CLAY TILL some silt	33.01	ATB3	Lower Maryhill Till	7	GB				
				287.15			8	GB				
			SAND TILL fine to medium sand, some fine gravel, some silt. hard	35.36								
			very hard drilling noted from 39 to 42.1 m		ATC1	Upper/Main Catfish Creek Till						
				280.45								
			End of Borehole	42.06								

Cement Seal
0 to 28.2 m

Type 316 Stainless Steel Casing
304 mm I.D.
0.9 m AGS to 28.2 m BGS

457 mm Borehole
0 to 28.2 m

K-packer at 27.3 m

305 mm Borehole
28.2 m to 32.7 m

Natural Cave
28.2 m to 32.7 m

Telescopic Type 316 Stainless Steel Screen and tight wind
286 mm OD
27.3 m to 32.7 m

156 mm borehole
32.7 to 42.0 m

No. 2 Silica Sand/Natural Cave
32.7 to 36.6 m

Bentonite Pellets
36.6 to 42.1 m

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
GB - grab sample
n/a - not available/applicable

The borehole was temporarily abandoned in May 2018 and overdrilled beginning on December 10, 2018 for production well construction
m AGS - meters above ground surface

Telescopic screen includes:
tight wind 27.3 m to 28.2 m
80 slot screen 28.2 m 32.7 m

Stantec

Drawn By/Checked By: CD/LV/KM

STANTEC BOREHOLE AND WELL - MASTER 17X11 160900892_20180516_CD_AH.GPJ DATA TEMPLATE_ENVS_CA_140725.GDT 1/13/20 AHEALEY

Production Well: W2C

Project: William Street Well Field
Client: Regional Municipality of Waterloo
Location: Waterloo, ON
Number: 160900892

Field Investigator: S. Rixon
Contractor: Well Initiatives
Drilling method: Mud Rotary
Date started/completed: 16-Jan-2019 / 06-Mar-2019

Ground surface elevation: 322.42 m AMSL
Top of casing elevation: 323.12 m AMSL
Easting: 538855
Northing: 4812301

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		GEOPHYSIC DETAILS			WELL DETAILS
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Caliper (cm) 20 30 40 50 60	Gamma (cps) 20 40 60 80 100	Resistivity (Ohm.m) 50 100 150 200	
			Ground Surface	322.42								
			FILL sand and gravel	0.00 321.20								
5	2		CONCRETE Drillable concrete associated with historic reservoir	1.22 318.76								
10	4		CLAYEY SILT some sand, trace fine gravel, grey	3.66								
15	6											
20	8											
25	10											
30	12		decreased sand and gravel content beginning at 11.6 m	310.84 11.58	ATB2	Middle Maryhill Till and Equivalents						
35	14			302.91								
40	16											
45	18											
50	20		SAND fine sand, some medium sand, trace silt, brown	19.51 301.69	AFB2	Middle Waterloo Moraine stratified sediments and Equivalents						
55	22		SAND fine and medium sand, trace coarse sand, brown	20.73 297.43			1	GB				
60	24		trace to some fine gravel beginning at 25.0 m	24.99 294.68			2	GB				
65	26						3	GB				
70	28		SAND AND GRAVEL medium and coarse sand, fine gravel, some fine sand	27.74			4	GB				
75	30		trace fine sand beginning at 29.9 m fine gravel from 30.2 to 30.8 m large loss of water during drilling from 30.5 to 32.0 m				5	GB				
80	32						6	GB				
85	34		some fine sand beginning at 32.9 m	288.89			7	GB				
90	36		SILTY CLAY TILL some fine to coarse sand	33.53 287.06	ATB3	Lower Maryhill Till	8	GB				
95	38		SAND TILL fine to medium sand, some silt and clay, greyish brown, hard drilling	35.36	ATC1	Upper/Main Catfish Creek Till	9	GB				
100	40		some coarse sand and fine gravel, yellowish brown, very hard drilling beginning at 39.6 m									
105	42		End of Borehole	280.36 42.06								

WELL DETAILS:
- 457 mm Borehole 0 to 28.0 m
- Bentonite-Cement Grout 0 to 28.0 m
- Type 316 Schedule 40 Stainless Steel Casing 304 mm I.D. 0.7 m AGS to 28.0 m BGS
- K-packer at 27.1 m
- 305 mm Borehole 28.0 m to 32.6 m
- Telescopic Type 316 Stainless Steel screen and tight wind 290 mm I.D. 27.1 m to 32.6 m
- Natural Cave 28.0 m to 32.6 m
- 156 mm borehole filled with bentonite pellets 32.6 m to 42.1 m

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
GB - grab sample
n/a - not available/applicable

m AGS - meters above ground surface

Telescopic screen includes:
tight wind 27.1 m to 28.0 m
16 slot screen 28.0 m to 29.0 m
40 slot screen 29.0 m to 30.5 m
80 slot screen 30.5 m to 32.6 m

Stantec

Drawn By/Checked By: SB/

STANTEC BOREHOLE AND WELL - MASTER 17X11 160900892_20180516_CD_AH.GPJ DATA TEMPLATE_ENVS_CA_140725.GDT 1/13/20 AHEALEY

Production Well: W3A

Project: W3A
Client: Region of Waterloo
Location: William St Well Field
Number: 160900970

Field Investigator: R. Baker
Contractor: Well Initiatives
Drilling method: Dual Rotary
Date started/completed: 10-Aug-2023 / 08-Sep-2023

SUBSURFACE PROFILE				HYDROGEOLOGY		GEOPHYSIC DETAILS		WELL DETAILS
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Caliper (cm) 20 30 40 50 60	Gamma (cps) 55 110 165 220 275	
			Ground Surface	322.97 322.41					Name: W3A GS Elev: 322.41 m AMSL TOC Elev: 322.97 m AMSL Easting: 538862 Northing: 4812302 Stick-up: 0.56 m
0	0		FILL Coarse-grained.	0.00 321.80					Stick up 0.56 m AGS
5	2		CEMENT Medium-grained, grey.	0.61 318.76					
10	4		SANDY CLAY Soft, brown.	3.66					
30	10			312.36	ATB2	Middle Maryhill Till and Equivalents			
35	10		SILTY CLAY Soft, grey.	10.06					
60	18			304.13					
65	20		SAND Fine-grained, brown.	18.29 300.47					
75	22		SAND Medium-grained, brown.	21.95					
85	26			295.90	AFB2	Middle Waterloo Moraine stratified sediments and Equivalents			Bentonite-Cement Grout 0 m to 50.3 m BGS
90	28		GRAVEL Coarse-grained, some cobbles, brown.	26.52					457.2 mm Borehole 0 m to 50.3 m BGS
110	34			288.89					
110	34		GRAVEL TILL Some cobbles, brown, hard. Adjacent boreholes suggest clay till within the top 1 m to 2 m of this unit: however, significant clayey material not observered during drilling.	33.53					Type 316 Schedule 40 Stainless Steel Casing 304.8 mm I.D. 0.56 m AGS to 50.3 m BGS
155	48			274.26	ATC1 / AFD1 / ATE1	Upper/Main Catfish Creek Till / Pre-Catfish Creek sand and gravel / Canning Drift (pre-Catfish Creek Till)			
160	48		BEDROCK Limestone with thin layers of white calcite. Interpretted as Salina Formation.	48.16					
205	62			260.54	Bedrock	Salina Formation			301.6 mm Borehole 50.3 m to 61.9 m BGS Open Hole 50.3 m to 61.9 m BGS
			End of Borehole	61.87					

DRAFT

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
n/a - not available/applicable

m AGS - meters above ground surface
Sys_Loc_Code = 9207933
Well Tag = A382067
Gamma log was completed through the groutedcasing and therefore data is only presented within the open beedrock borehole

Stantec

Drawn By/Checked By: R.B. / L.V.

STANTEC BOREHOLE AND WELL - MASTER 17X11 160900970_W3A_DRAFT_RB.GPJ DATA TEMPLATE_ENVS_CA_140725.GDT 2/13/24 RACBAKER

Ontario — Ministry of the Environment, Conservation and Parks

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below): A382067

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	Region of Waterloo		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
150 Frederick St 6th Floor	Kitchener	Ont	N2G4J3	5197574570

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
24 William street E			

County/District/Municipality	City/Town/Village	Province	Postal Code
waterloo	Waterloo	Ontario	N2J1K6

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	17	538622	4811230 1		

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Br	fill		Course	0	2
Grey	Cement		Med	2	12
Br	clay	Sandy	Soft	12	33
grey	clay	silt	Soft	33	60
Br	Sand		Fine	60	72
Br	Sand		Med	72	87
Br	Gravel	stones	Course	87	110
Br	gravel	Till stones	Hard	110	158
Br	Limestone		Hard	158	203

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
165	0	Cement	3 meters

Method of Construction

☐ Cable Tool ☐ Diamond
☑ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☐ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
12"	steel	.375	+2	165
11 3/4	Open		165	203

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water	Other, specify
	☐	☐ Fresh ☑ Untested	169-172-174
	☐	☐ Fresh ☑ Untested	178
	☐	☐ Fresh ☑ Untested	183-188

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	165	8 3/4
0	165	18
165	203	11 3/4

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft): 43

Pumping rate (l/min / GPM): 1499

Duration of pumping: 48 hrs + ____ min

Final water level end of pumping (m/ft): 27.78

If flowing give rate (l/min/GPM): —

Recommended pump depth (m/ft): 43

Recommended pump rate (l/min/GPM): 1499

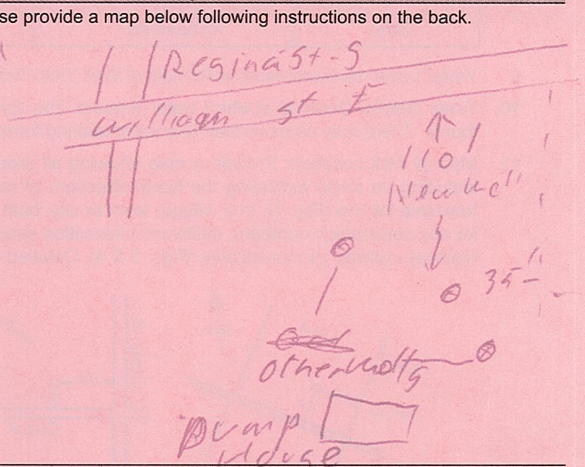
Well production (l/min/GPM): 1499

Disinfected? ☑ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	4.34		27.76
1	18.14	1	17.59
2	20.48	2	14.67
3	27.36	3	13.20
4	23.13	4	12.25
5	23.78	5	11.56
10	26.20	10	9.90
15	27.18	15	9.08
20	27.50	20	8.79
25	27.84	25	8.52
30	26.74	30	8.35
40	26.57	40	8.10
50	26.65	50	7.93
60	26.74	60	7.78

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Well Initiatives	7221

Business Address (Street Number/Name)	Municipality
15 Townline	Orangeville

Province	Postal Code	Business E-mail Address
Ont	L9W3R4	info@wellinitiatives.com

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
5004378276	Fenton Doug

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
7203	Doug Fenton	2020/06/26

Well owner's information package delivered: ☐ Yes ☑ No

Date Package Delivered: ____

Date Work Completed: 2020/06/26

Ministry Use Only

Audit No. Z410885

Received

0506E (2020/06) © Queen's Printer for Ontario, 2020

Well Owner's Copy

W-WS-OW5-87-A

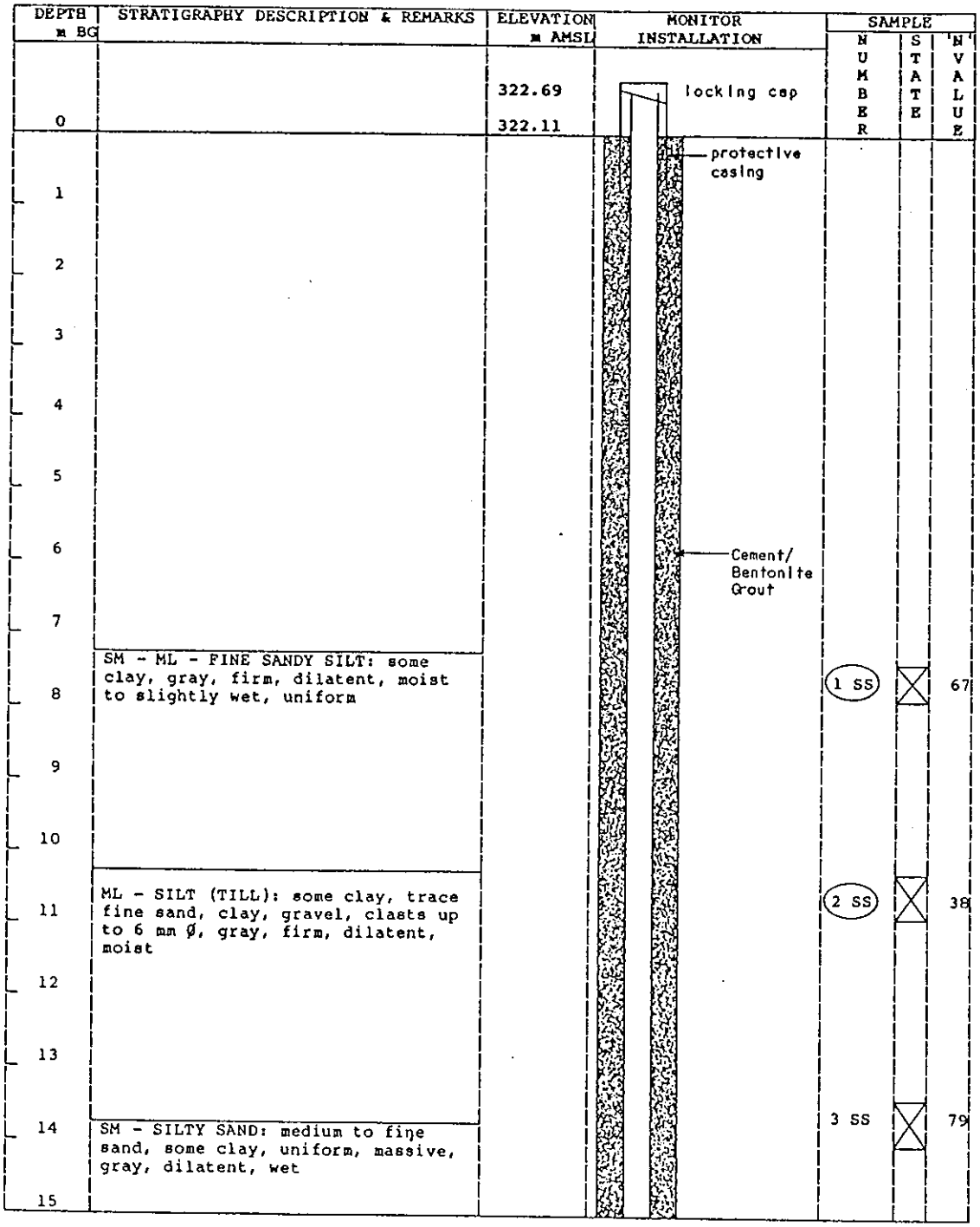
STRATIGRAPHIC AND INSTRUMENTATION LOG

(OVERBURDEN)

PROJECT NAME: WILLIAM ST. PUMPING STATION
PROJECT NO.: 1931
CLIENT: REGIONAL MUNICIPALITY OF WATERLOO
LOCATION: WILLIAM STREET, WATERLOO

HOLE DESIGNATION: OW5A-87

DATE COMPLETED: MAY 25, 1987
DRILLING METHOD: 4-1/4" ID HSA
CRA SUPERVISOR: CHRIS GALINSKI



NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS (◯) WATER FOUND STATIC WATER LEVEL

STRATIGRAPHIC AND INSTRUMENTATION LOG

(OVERBURDEN)

PROJECT NAME:	WILLIAM ST. PUMPING STATION	HOLE DESIGNATION:	OW5A-87
PROJECT NO.:	1931	DATE COMPLETED:	MAY 25, 1987
CLIENT:	REGIONAL MUNICIPALITY OF WATERLOO	DRILLING METHOD:	4-1/4" ID HSA
LOCATION:	WILLIAM STREET, WATERLOO	CRA SUPERVISOR:	CHRIS GALINSKI

DEPTH m BG	STRATIGRAPHY DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
15						
16			Cement/ Bentonite Grout			
17	- sand tending to pile up in auger, must use thick mud for hole to remain stable			4 SS		94
18						
19						
20	- medium sand, dense, wet			5 SS		97
21			Natural Sand Pack			
22						
23				6 SS		100
24						
25						
26	- medium to coarse sand (GM-SM) trace silt			7 SS		54
27						
28		294.30				
29	- medium to fine sand, slightly dilatent, uniform, wet		cave-in	8 SS		142
30						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ◯ WATER FOUND STATIC WATER LEVEL

STRATIGRAPHIC AND INSTRUMENTATION LOG

(OVERBURDEN)

PROJECT NAME: WILLIAM ST. PUMPING STATION
HOLE DESIGNATION: OW5A-87

PROJECT NO.: 1931
DATE COMPLETED: MAY 25, 1987
CLIENT: REGIONAL MUNICIPALITY OF WATERLOO
DRILLING METHOD: 4-1/4" ID HSA
LOCATION: WILLIAM STREET, WATERLOO
CRA SUPERVISOR: CHRIS GALINSKI

DEPTH m BG	STRATIGRAPHY DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
30						
31						
32						
	GM - SM - GRAVELLY SAND: medium to coarse sand, some gravel, silt, trace clay, very dense, moist to wet			9 SS	☒	240/0.305
33						
34	SM - SAND		cave-in			
35	GM - SM - GRAVELLY SAND: coarse to medium sand, some gravel, interbedded with fine sand, very wet, very dilatent					
36						
37				10 SS	☒	162
	END OF HOLE AT 37.03 m BGS		Screen Details: Set screen to 27.81 m (Elev. 294.30) Length - 0.76 m Diameter - 50 mm No. 10 slot			
38	Notes: 1. See log of OW5B-86 for geology of upper 7 m. 2. Switched to mud auger drilling at 9.14 m bgs. 3. Thick mud required to maintain stability of hole. Sand tends to pile up in augers. 4. Pulling back augers to 15.24 m bgs causes hole to slough to 25.29 m bgs. Water jetted through 25 mm poly pipe to allow setting of screen of selected depth.					
39						
40						
41						
42						
43						
44						
45						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ◯ WATER FOUND STATIC WATER LEVEL

STRATIGRAPHIC AND INSTRUMENTATION LOG

(OVERBURDEN)

PROJECT NAME: WILLIAM ST. PUMPING STATION
HOLE DESIGNATION: OW5-86

PROJECT NO.: 1931
DATE COMPLETED: AUGUST 15, 1986

CLIENT: REGIONAL MUNICIPALITY OF WATERLOO
DRILLING METHOD: 4-1/4" ID HSA

LOCATION: WILLIAM STREET, WATERLOO
CRA SUPERVISOR: L. LEMON

DEPTH m BG	STRATIGRAPHY DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
0		323.19	locking cap; protective casing			
		323.11				
1	SW - SAND (FILL): fine to coarse, trace gravel, silt, compact, brown, coarsens downward, wet		50 mmØ black iron pipe; cement/bentonite grout	1 SS		18
2						
3	CL - SILTY CLAY: trace very fine sand, massive, uniform, gray, very moist		bentonite seal			
4	SM - FINE SAND: little to some silt, trace medium sand, uniform, gray, slightly dilatent, very wet		silica sand pack; screen	2 SS		30
5				3 SS		23
6	ML - SILT: little very fine sand, clay, firm, gray, trace bedding, occasional sandy layer, friable, moist					
		315.4		4 SS		24
7	END OF HOLE AT 6.71 M. BGS					
8			Screen Details: Set screen to 4.87 m (Elev. 317.24) Length - 0.76 m Diameter - 50 mm no. 6 slot			
9						
10						
11						
12						
13						
14						
15						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE: REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS WATER FOUND STATIC WATER LEVEL

W-WS-OW10-87-A

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

E 538800
N 4811900

PROJECT NAME: TCE – WATERLOO
PROJECT NO.: 1973
CLIENT: R.M.W.
LOCATION: KING AND WILLIAM ST. PARKETTE

~~Qu300683~~

HOLE DESIGNATION: OW10A–87 (PAGE 1 OF 2)
DATE COMPLETED: 13/09/87
DRILLING METHOD: 152 mm I.D. W.R.
CRA SUPERVISOR: S. CROSSMAN

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
	REFERENCE ELEVATION GROUND ELEVATION	325.648 324.63	105 mm ϕ LOCKABLE PROTECTIVE CASING			
2.0 4.0 6.0 8.0 10.0	For Stratigraphic detail refer to log of OW10C–87		CEMENT 152 mm ϕ BOREHOLE BENTONITE GROUT SEAL 50 mm ϕ S.L. PIPE			
12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0	SILT (ML) – some very fine sand, occasional clay seams, hard, layered, dilatent, non–plastic, grey–brown, wet – Possible soft zone from 12.80 – 14.02 m bgs	312.74		1SS		58

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS (○) WATER FOUND ▽ STATIC WATER LEVEL ▼

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: TCE – WATERLOO
PROJECT NO.: 1973
CLIENT: R.M.W.
LOCATION: KING AND WILLIAM ST. PARKETTE

HOLE DESIGNATION: OW10A–87 (PAGE 2 OF 2)
DATE COMPLETED: 13/09/87
DRILLING METHOD: 152 mm I.D. W.R.
CRA SUPERVISOR: S. CROSSMAN

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
26.0						
28.0	SILT (ML) – some very fine sand, occasional clay seams, hard, layered, dilatent, non–plastic, grey–brown, wet					
		295.07				
30.0	CLAY (CL) TILL – some silt, little sand, little gravel, stiff, low plasticity, grey–brown, moist					
32.0	– hard, medium plasticity					
		291.10				
34.0	SAND (SW) – some silt, some fine gravel, dense, well graded, fine to coarse, angular, grey, water bearing	290.49	SAND PACK			
36.0	CLAY (CL) – little silt, trace sand, seams of gravel throughout, hard, layered, medium plasticity, grey, very moist	288.06	50 mm ø SLOTTED PIPE	2SS		>75
38.0	ALTERNATING LAYERS OF SAND (SW) & CLAY (CL)					
40.0		284.40				
42.0	GRAVEL (GW) – some sand, little silt, dense, well graded, fine to coarse, water bearing					
		281.96	WELL SCREEN			
44.0	End of Hole at 42.67 m. bgs					
46.0						
48.0						
50.0						
52.0						

SCREEN DETAILS:
Screened Interval:
281.96 to 282.87 AMSL
Length – 0.91 m
Diameter – 5.1 cm I.D.
Slot # 10
Material– STAINLESS STEEL

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS (oval) WATER FOUND ▽ STATIC WATER LEVEL ▼

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

E 538800
N 4811900

PROJECT NAME: TCE – WATERLOO
PROJECT NO.: 1973
CLIENT: R.M.W.
LOCATION: KING AND WILLIAM ST. PARKETTE

HOLE DESIGNATION: OW10B–87
DATE COMPLETED: 15/09/87
DRILLING METHOD: 152 mm I.D. W.R.
CRA SUPERVISOR: S. CROSSMAN

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
	REFERENCE ELEVATION GROUND ELEVATION	325.596 324.62	105 mm ϕ LOCKABLE PROTECTIVE CASING			
2.0 4.0 6.0 8.0	For Stratigraphic detail to 10.06 m, refer to the log of OW10C–87	324.62	CEMENT 152 mm ϕ BOREHOLE BENTONITE GROUT SEAL			
10.0	– sand seam		50 mm ϕ BL PIPE			
12.0	SILT – some ~~clay~~, some ~~fine~~ sand, cobbles, very stiff, dilatent, layered, occasional layer of clay (CL), sand seams, grey–brown moist	313.95		1SS		45
14.0 16.0			SAND PACK			
18.0	End of Hole at 18.29 m. bgs	306.33	WELL SCREEN			
20.0 22.0 24.0 26.0			SCREEN DETAILS: Screened Interval: 306.33 to 307.25 AMSL Length – 0.91 m Diameter – 5.1 cm I.D. Slot # 10 Material– STAINLESS STEEL			

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

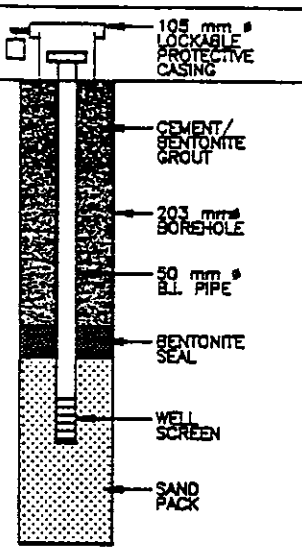
E 538600
N 491900

PROJECT NAME: TCE – WATERLOO
PROJECT NO.: 1973 ~~90500-64~~
CLIENT: R.M.W.
LOCATION: KING AND WILLIAM ST. PARKETTE

HOLE DESIGNATION: OW10C-87
DATE COMPLETED: 04/08/87
DRILLING METHOD: HSA
CRA SUPERVISOR: S. CROSSMAN

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL
	REFERENCE ELEVATION GROUND ELEVATION	325.634 324.66
	CLAY (CL) – some silt, layered, stiff, medium plasticity, mottled grey–brown, moist	323.74
2.0	SAND (SP) – trace to little silt, dense, fine grained, uniform, light brown, wet	322.37
4.0	SILT (ML) – some sand, stiff, layered, low to non plastic, dilatent, light grey, wet – inclusions of silt(TILL) at 3.66 m. – clay seam at 4.02 to 4.20 m b.g.s.	
6.0	– trace clay, massive – occasional pebble inclusions	
8.0	CLAY (CL) – some silt, stiff, layered, grey–brown – wet sand seam (SP) from 7.16 to 7.35 m.	317.80 317.31
10.0	SILT (ML) – some clay, little sand, very hard, low plastic, grey–brown, slightly moist, occassional wet seam of SP	314.91
	End of Hole at 9.75 m bgs	
12.0		
14.0		
16.0		
18.0		
20.0		
22.0		
24.0		
26.0		

MONITOR INSTALLATION



SCREEN DETAILS:
Screened Interval:
317.04 to 317.95 AMSL
Length – 0.91 m
Diameter – 5.1 cm I.D.
Slot # 10
Material– STAINLESS STEEL

SAMPLE NUMBER	STATE	'N' VALUE
1SS	☒	30
2SS	☒	18
3SS	☒	12
4SS	☒	14
5SS	☒	27
6SS	☒	33
7SS	☒	43
8SS	☒	25
9SS	☒	36
10SS	☒	41

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

RECORD OF DRILLHOLE: SGMSOW1A-07

PROJECT: 05-1112-010(8000)

LOCATION: N 4812226.3 ;E 538532.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 11-13, 2007

DRILL RIG: PQ Wireline

DRILLING CONTRACTOR: Aardvark Drilling Inc.

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m
0		GROUND SURFACE		326.20			
		Gravel with some silt and construction debris (FILL)		0.00	1		
				324.37			
2		SAND and GRAVEL, fine to coarse gravel with occasional layer of gravel and coarse sand, clean, gravel subangular to subrounded		1.83	2		
4					3		
6					4		
					5		
8					6		
10	Mud Rotary				7		
12					8		
				313.70			
		Grey, fine sandy SILT		12.50	9		
				312.18			
14		Dense, brown to grey, SILTY CLAY, trace very fine gravel (TILL)		14.02	10		
16					11		
18					12		
				307.00			
		Grey, CLAYEY SILT, moderate to low density		19.20	13		
20							

CONTINUED NEXT PAGE

GEOPHYSICAL RECORD

GAMMA (cps): 20 40 60 80

CONDUCTIVITY (mS/m): 10 20 30 40

NOTES
WATER LEVELS
INSTRUMENTATION

DEPTH SCALE

1 : 100

LOGGED: AP

CHECKED: RB

Golder Associates

MIS-GEO 001 05-1112-010_2.GPJ GAL-MISS.GDT 4/1/08

PROJECT: 05-1112-010(8000)

RECORD OF DRILLHOLE: SGMSOW1A-07

SHEET 2 OF 3

LOCATION: N 4812226.3 ;E 538532.5

DRILLING DATE: September 11-13, 2007

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: PQ Wireline

DRILLING CONTRACTOR: Aardvark Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80 / CONDUCTIVITY (mS/m) 10 20 30 40	NOTES WATER LEVELS INSTRUMENTATION
20		*--- CONTINUED FROM PREVIOUS PAGE ---*							
		Grey, CLAYEY SILT, moderate to low density			14				
				304.56					
22		Grey, silty fine SAND to sandy SILT, moderate to low density		21.64	15				
24					16				Bentonite Grout over Hole Plug (0-49.68m)
					17				
26					18				
28					19				
				296.94					
30	Mud Rotary	Fine to coarse GRAVEL, subrounded, in fine sand matrix, some silt		29.26	20				
				295.42					
32		Brown, fine to medium SAND with minor silt, well graded		30.78	21				
				293.28					
34		Fine to coarse GRAVEL and STONEs, clean, subrounded, sand matrix		32.92	22				
					23				
36					24				
					25				
38					26				
40		*CONTINUED NEXT PAGE*							

DEPTH SCALE

1 : 100

LOGGED: AP

CHECKED: RB

MIS-GEO 001 05-1112-010_2.GPJ GAL-MISS.GDT 4/1/08

PROJECT: 05-1112-010(8000)

RECORD OF DRILLHOLE: SGMSOW1A-07

SHEET 3 OF 3

LOCATION: N 4812226.3 ;E 538532.5

DRILLING DATE: September 11-13, 2007

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: PQ Wireline

DRILLING CONTRACTOR: Aardvark Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD: CONDUCTIVITY (mS/m) 10 20 30 40	NOTES WATER LEVELS INSTRUMENTATION
40		*--- CONTINUED FROM PREVIOUS PAGE ---*								
		Fine to coarse GRAVEL and STONEs, clean, subrounded, sand matrix		284.75	27					
		Brown, fine to medium SAND, well graded, minor silt		41.45	28					
42					29					
44					30					
46					31					
48	Mud Rotary	Dense silt layer at 48m depth		277.00	32					
		Coarse GRAVEL, STONEs and COBBLEs, subrounded, in sand matrix		49.20	33					Sand (49.68-55.17m)
50					34					
52					35					Screen (51.21-54.25m)
54				271.95						
		Dark greyish black, SHALE, possibly dolomitic		54.25	36					
				271.03						
		END OF BOREHOLE		55.17						
56										
58										
60										

DEPTH SCALE

1 : 100

LOGGED: AP

CHECKED: RB

Golder Associates

MIS-GEO 001 05-1112-010_2.GPJ GAL-MISS.GDT 4/1/08

RECORD OF DRILLHOLE: SGMSOW1B-07

PROJECT: 05-1112-010(8000)

LOCATION: N 4812224.9 ;E 538530.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 24-29, 2007

DRILL RIG: PQ Wireline

DRILLING CONTRACTOR: Aardvark Drilling Inc.

SHEET 1 OF 2

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80 / CONDUCTIVITY (mS/m) 10 20 30 40	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		326.22					
0	Mud Rotary	Gravel with some silt and construction debris (FILL)		0.00	1				
				324.39					
2		SAND and GRAVEL, fine to coarse gravel with occasional layer of gravel and coarse sand, clean, gravel subangular to subrounded		1.83	2				
4					3				
6					4				
					5				
8					6				
10					7				
					8				
12				313.72					
		Grey, fine sandy SILT		12.50	9				
14				312.20					
		Dense, brown to grey, SILTY CLAY, trace very fine gravel (TILL)		14.02	10				
16					11				Bentonite Grout over Hole Plug (0-33.07m)
					12				
18									
				307.02	13				
		Grey, CLAYEY SILT, moderate to low density		19.20					
20									
		CONTINUED NEXT PAGE							

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: AP

CHECKED: RB

MIS-GEO 001 05-1112-010_2.GPJ GAL-MISS.GDT 4/1/08

PROJECT: 05-1112-010(8000)

RECORD OF DRILLHOLE: SGMSOW1B-07

SHEET 2 OF 2

LOCATION: N 4812224.9 ;E 538530.4

DRILLING DATE: August 24-29, 2007

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: PQ Wireline

DRILLING CONTRACTOR: Aardvark Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD: CONDUCTIVITY (mS/m) 10 20 30 40	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---								
20	Mud Rotary	Grey, CLAYEY SILT, moderate to low density		304.58	14					
22		Grey, silty fine SAND to sandy SILT, moderate to low density		21.64	15					
24					16					
26					17					
28					18					
30				296.96	19					
		Fine to coarse GRAVEL, subrounded, in fine sand matrix, some silt		29.26	20					
		Brown, fine to medium SAND with minor silt, well graded		295.44 30.78	21					
32				293.30						
34		Fine to coarse GRAVEL and STONEs, clean, subrounded, sand matrix		32.92	22					Sand (33.07-38.1m)
36					23					
					24					Screen (34.62-37.67m)
38					25					
		END OF BOREHOLE		288.12 38.10						
40										

DEPTH SCALE

1 : 100

LOGGED: AP

CHECKED: RB

Golder Associates

MIS-GEO 001 05-1112-010_2.GPJ GAL-MISS.GDT 4/1/08

BOREHOLE ID: W-WS-OW2-17A

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.20 m*
TOP: *323.23 m*
UTM (Zone 17): 4812323.400 N 538904.447 E

Depth (m)	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm)	Construction	Notes
-1										Stickup is 0.940 m
0	Ground Surface	0.00 / 322.20								Concrete
1	Daylighted not logged									Holeplug
2		2.40 / 319.80								
3	**Silty clay** Light brownish grey silty clay, minor gravel (0.5-1.0 cm), saturated at 4 m, pliable.					92%				
4						100%				51 mm Schedule 80 PVC
5						100%				GW = 316.95 m (6.28m bgs)
6										
7						100%				Grout
8										
9						93%				
10						93%				
11						100%				
12										
13						100%				
14	**Sandy clay** Light brownish grey fine sandy clay; saturated	13.70 / 308.50				100%				

Drill Date: July 28, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: PQ coring
Logged By: HH
Hole Diameter: 0.127 m (OD)
Checked By: MLD

Notes: CORE SAMPLE

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17A

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.20 m*
TOP: *323.23 m*
UTM (Zone 17): 4812323.400 N 538904.447 E

Depth (m)	Description	Depth (m) / Elev. (m.a.s.l.)	Recovery (%)	Notes
15–18			99%, 100%	
18		18.30		
18–22	**Sand** Fine to medium grain medium brown sand (red and black flecks - mixed origin); very wet	303.90	100%, 96%	
22		21.95		
22–28	**Gravel** 1-10 cm rounded gravel (mixed origin), medium grain brown sand unit present as a matrix material but dominantly washed away during drilling, very wet.	300.25	97%, 58%, 39%, 95%	51 mm Schedule 80 PVC; Grout
28		28.30	69%	
28–29	**Clay with gravel** Dark brownish grey stiff clay with minor gravel (0.2 - 1.0 cm); dry to moist.	293.90		
29		29.70	88%	
29–30	**Clay with gravel** Light brown to beige silty/sandy clay with gravel (1 - 7 cm), saturated.	292.50		

Headspace Vapour Level (ppm): 10 – 100

Drill Date: July 28, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: PQ coring
Hole Diameter: 0.127 m (OD)
Logged By: HH
Checked By: MLD

Notes: CORE SAMPLE

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17A

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.20 m*
TOP: *323.23 m*
UTM (Zone 17): 4812323.400 N 538904.447 E

Depth (m)	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm)	Construction	Notes
31						13%				
32										51 mm Schedule 80 PVC
33						0%				
34		34.30 / 287.90								Grout
34	**Sand and gravel** Grey/light brown sand and subangular gravel (0.5 -2.0 cm) , wet.					0%				
35										
36						0%				
37						87%				
38										
39						87%				
40						80%				
41		41.15 / 281.05								
41	**Silty sand and gravel** Grey/light brown silty sand and subangular gravel (0.5 -3.0 cm), wet. Silty matrix material fined downhole from above unit					67%				
42										
43		43.40 / 278.80				100%				
43	**Clay with gravel** Dark brownish grey sandy/silty clay with minor subangular gravel (0.5-15 cm), stiff, dry to moist									
44										
45						90%				
46										
46		46.55 / 275.65				79%				

Drill Date: July 28, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: PQ coring
Hole Diameter: 0.127 m (OD)
Logged By: HH
Checked By: MLD

Notes: CORE SAMPLE

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17A

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.20 m*
TOP: *323.23 m*
UTM (Zone 17): 4812323.400 N 538904.447 E

Depth (m)	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm)	Construction	Notes
47	**Gravel** Gravel with silty/sandy matrix (mostly washed away by drilling)									Grout
48		48.20 / 274.00				59%				51 mm Schedule 80 PVC
49	**Bedrock** Dominantly grey vuggy limestone, strong laminar bedding, minor 1-2 cm beds of clastic sediments, highly fractured.					97%				bentonite seal
50										
51						100%				silica sand
52										51 mm Schedule 80 slot .010 PVC screen
53		53.36 / 268.84				100%				End cap
54	End of borehole at 53.36 m Well Completion Details: Screened interval from 51.25 m to 52.75 m below surface Elevation at top of pipe (TOP) = 323.23 m									
55										
56										
57										
58										
59										
60										
61										
62										

Drill Date: July 28, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: PQ coring
Logged By: HH
Hole Diameter: 0.127 m (OD)
Checked By: MLD

Notes: CORE SAMPLE

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17B

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.23 m*
TOP: *323.27 m*
UTM (Zone 17): 4812326.127 N
538904.691 E

Depth (m)	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm)	Construction	Notes
-1										Stickup is 0.990 m
0	Ground Surface	0.00 / 322.23								
	Daylighted not logged									Concrete
1										Holeplug
2		2.40 / 319.83								
	Silty clay Light brownish grey silty clay, minor gravel (0.5-1.0 cm), saturated at 4 m, pliable.									
3										
4										
5										GW = 316.68 m (6.59m bgs)
6										
7										51 mm Schedule 40 PVC
8										Grout
9										
10										
11										
12										
13		13.70 / 308.53								
	Sandy clay Light brownish grey fine sandy clay; saturated									
14										

Drill Date: August 3, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.152 m (OD)
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17B

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.23 m*
TOP: *323.27 m*
UTM (Zone 17): 4812326.127 N 538904.691 E

SUBSURFACE PROFILE			SAMPLE							WELL COMPLETION	
Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
15											
16											
17											
18			18.30 303.93								
19		**Sand** Fine to medium grain medium brown sand (red and black flecks - mixed origin); very wet									
20											
21			21.95 300.28								51 mm Schedule 40 PVC
22		**Gravel** 1-10 cm rounded gravel (mixed origin), medium grain brown sand unit present as a matrix material but dominantly washed away during drilling, very wet.									Grout
23											
24											
25											
26											
27											
28			28.30 293.93								
29		**Clay with gravel** Dark brownish grey stiff clay with minor gravel (0.2 - 1.0 cm); dry to moist.	29.70 292.53								
30		**Clay with gravel** Light brown to beige silty/sandy clay with gravel (1 - 7 cm), saturated.									

Drill Date: August 3, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.152 m (OD)
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17B

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.23 m*
TOP: *323.27 m*
UTM (Zone 17): 4812326.127 N 538904.691 E

SUBSURFACE PROFILE				SAMPLE						WELL COMPLETION	
Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
31											
32											Grout
33											51 mm Schedule 40 PVC
34			34.30 287.93								
35		**Sand and gravel** Grey/light brown sand and subangular gravel (0.5 -2.0 cm) , wet.									
36											
37											
38											
39											
40											
41			41.15 281.08								
42		**Silty sand and gravel** Grey/light brown silty sand and subangular gravel (0.5 -3.0 cm), wet. Silty matrix material fined downhole from above unit									
43			43.40 278.83								
44		**Clay with gravel** Dark brownish grey sandy/silty clay with minor subangular gravel (0.5-15 cm), stiff, dry to moist									bentonite seal
45											
46			46.55 275.68								silica sand

Drill Date: August 3, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.152 m (OD)
Checked By: MLD

Notes:

Sheet 3 of 4

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17B

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.23 m*
TOP: *323.27 m*
UTM (Zone 17): 4812326.127 N 538904.691 E

SUBSURFACE PROFILE			SAMPLE							WELL COMPLETION	
Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
47		**Gravel** Gravel with silty/sandy matrix (mostly washed away by drilling)									51 mm Schedule 40 slot .010 PVC screen
48			48.20 274.03								End cap
		End of borehole at 48.20 m									
49		Well Completion Details: Screened interval from 45.10 m to 47.60 m below surface Elevation at top of pipe (TOP) = 323.27 m									
50		Lithography inferred from borehole W-WS-OW2-17A.									
51											
52											
53											
54											
55											
56											
57											
58											
59											
60											
61											
62											

Drill Date: August 3, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.152 m (OD)
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17C

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.21 m*
TOP: *323.32 m*
UTM (Zone 17): 4812325.140 N
538904.069 E

Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
-1											Stickup is 1.069 m
0		Ground Surface	0.00 322.21								
1		Daylighted not logged									Concrete
2			2.40 319.81								Holeplug
3		**Silty clay** Light brownish grey silty clay, minor gravel (0.5-1.0 cm), saturated at 4 m, pliable.									
4											
5											51 mm Schedule 40 PVC
6											GW = 316.08 m (7.24m bgs)
7											
8											Grout
9											
10											
11											
12											
13			13.70 308.51								
14		**Sandy clay** Light brownish grey fine sandy clay; saturated									

Drill Date: August 2, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.152 m (OD)
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17C

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.21 m*
TOP: *323.32 m*
UTM (Zone 17): 4812325.140 N
538904.069 E

SUBSURFACE PROFILE				SAMPLE						WELL COMPLETION	
Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
15											
16											
17											Grout
18			18.30								
19		**Sand** Fine to medium grain medium brown sand (red and black flecks - mixed origin); very wet	303.91								51 mm Schedule 40 PVC
20											
21			21.95								
22		**Gravel** 1-10 cm rounded gravel (mixed origin), medium grain brown sand unit present as a matrix material but dominantly washed away during drilling, very wet.	300.26								
23											
24											
25											
26											
27											
28			28.30								
29		**Clay with gravel** Dark brownish grey stiff clay with minor gravel (0.2 - 1.0 cm); dry to moist.	293.91								
30		**Clay with gravel** Light brown to beige silty/sandy clay with gravel (1 - 7 cm), saturated.	29.70 292.51								

Drill Date: August 2, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.152 m (OD)
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17C

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.21 m*
TOP: *323.32 m*
UTM (Zone 17): 4812325.140 N 538904.069 E

SUBSURFACE PROFILE			SAMPLE							WELL COMPLETION	
Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
31											51 mm Schedule 40 PVC
32											Grout
33											
34			34.30 287.91								bentonite seal
35		**Sand and gravel** Grey/light brown sand and subangular gravel (0.5 -2.0 cm) , wet.									
36											
37											silica sand 51 mm Schedule 40 slot .010 PVC screen
38			38.60 283.61								End cap
39		End of borehole at 38.60 m Well Completion Details: Screened interval from 36.50 m to 38.00 m below surface Elevation at top of pipe (TOP) = 323.32 m Lithography inferred from borehole W-WS-OW2-17A.									
40											
41											
42											
43											
44											
45											
46											

Drill Date: August 2, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.152 m (OD)
Checked By: MLD

Notes:

Sheet 3 of 3

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17D

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.34 m*
TOP: *323.18 m*
UTM (Zone 17): 4812325.140 N 538905.150 E

SUBSURFACE PROFILE				SAMPLE						WELL COMPLETION	
Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
-1											Stickup is 0.890 m
0		Ground Surface	0.00								
		Daylighted not logged	322.34								Concrete
1											Holeplug
2			2.40								
		Silty clay Light brownish grey silty clay, minor gravel (0.5-1.0 cm), saturated at 4 m, pliable.	319.94								
3											
4											
5											
6											
7											GW = 315.35 m (7.83m bgs)
8											
9											
10											51 mm Schedule 40 PVC
11											
12											Grout
13											
			13.70								
		Sandy clay Light brownish grey fine sandy clay; saturated	308.64								
14											

Drill Date: July 31, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Logged By: HH
Hole Diameter: 0.203 m (OD)
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17D

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.34 m*
TOP: *323.18 m*
UTM (Zone 17): 4812325.140 N 538905.150 E

Depth (m)	Description	Depth (m) / Elev. (m.a.s.l.)	Notes
18		18.30	51 mm Schedule 40 PVC Grout
19	**Sand** Fine to medium grain medium brown sand (red and black flecks - mixed origin); very wet	304.04	
22		21.95	
23	**Gravel** 1-10 cm rounded gravel (mixed origin), medium grain brown sand unit present as a matrix material but dominantly washed away during drilling, very wet.	300.39	bentonite seal
27			silica sand 51 mm Schedule 40 slot .010 PVC screen
28			End cap
29	End of borehole at 28.60 m Well Completion Details: Screened interval from 26.50 m to 28.00 m below surface Elevation at top of pipe (TOP) = 323.18 m	28.60 293.74	

SUBSURFACE PROFILE | SAMPLE | WELL COMPLETION

Sample ID | Type | Blow Counts | Recovery (%) | Lab Analysis | Headspace Vapour Level (ppm) 10 100 | Construction

Drill Date: July 31, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Hole Diameter: 0.203 m (OD)
Logged By: HH
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BOREHOLE ID: W-WS-OW2-17D

Project No.: 160043
Client: Region of Waterloo
Report: Assessment of Chlorinated Ethenes, William Street Well Field
Site Address: 153 Herbert St. Waterloo, ON

Elevation Ground: *322.34 m*
TOP: *323.18 m*
UTM (Zone 17): 4812325.140 N 538905.150 E

SUBSURFACE PROFILE			SAMPLE							WELL COMPLETION	
Depth (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Sample ID	Type	Blow Counts	Recovery (%)	Lab Analysis	Headspace Vapour Level (ppm) 10 100	Construction	Notes
31		Lithography inferred from borehole W-WS-OW2-17A.									
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											
46											

Drill Date: July 31, 2017
Drilled By: Aardvark Drilling Inc.
Drilling Method: Mud rotary
Hole Diameter: 0.203 m (OD)
Logged By: HH
Checked By: MLD

Notes:

BH MW OB LOGV1.0 160043 HERBERT ST OW2-17 A-D.GPJ VL TEMPLATE.GDT 2/2/18

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

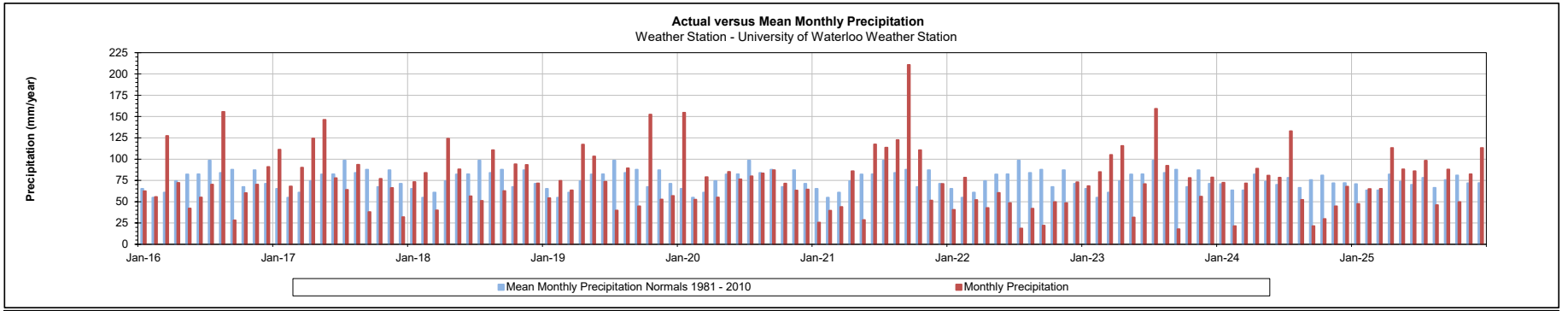
Monitoring Data
(Pumped Volumes and Hydrographs)

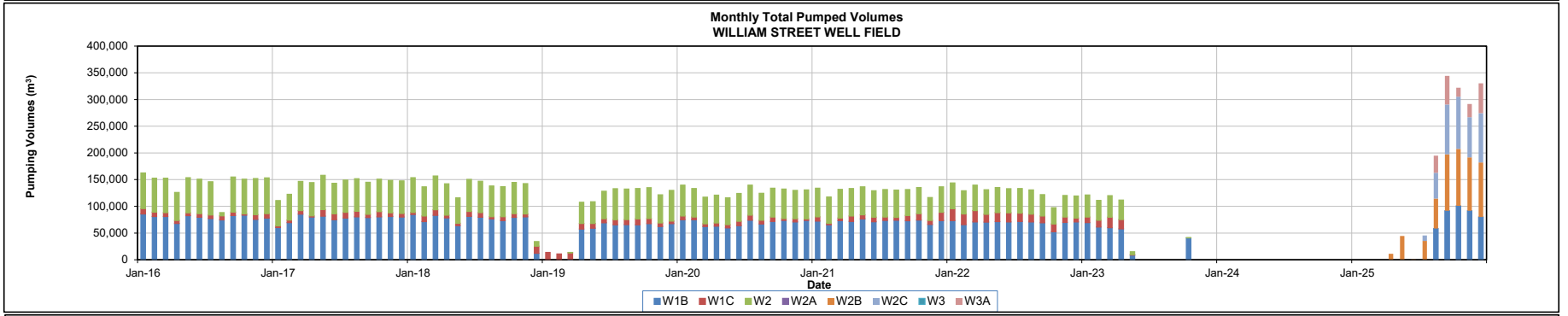
TABLE C-1
WELL FIELD WATER PRODUCTION SUMMARY
REGION OF WATERLOO - 2025 GROUNDWATER MONITORING REPORT

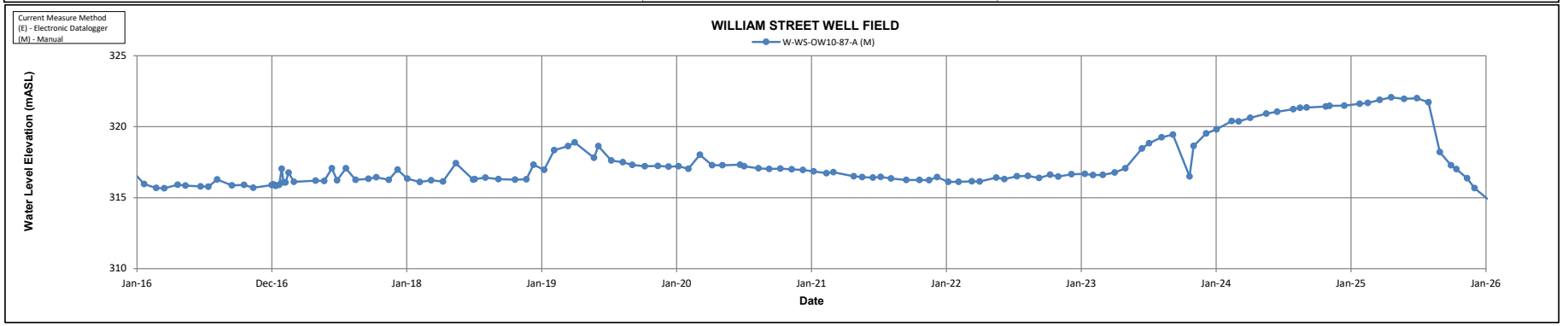
Well Field	Major or Minor Supply	Production Well Name	Status	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
				MOE Permit Number[1]	Permitted Capacity (total m^3/year)*	Permitted Rate (L/s)*	Total Production Well Volume (total m^3/year)	Average Daily Rate (m^3/day)	Average Rate (L/s)	Total Production Well Volume (total m^3/year)	Average Daily Rate (m^3/day)	Average Rate (L/s)	Total Production Well Volume (total m^3/year)	Average Daily Rate (m^3/day)	Average Rate (L/s)	Total Production Well Volume (total m^3/year)	Average Daily Rate (m^3/day)	Average Rate (L/s)	Total Production Well Volume (total m^3/year)	Average Daily Rate (m^3/day)	Average Rate (L/s)
William Street	Major	W1B	Supply	P-300-5049623280	1,930,003	61.2	865,788	2,372	27.5	827,199	2,266	26.2	298,699	818	9.5	0	0	0.0	423,392	1,160	13.4
		W1C	Disconnected	P-300-5049623280			99,076	271	3.1	187,168	513	5.9	60,988	167	1.9	0	0	0.0	0	0	0.0
		W2	Disconnected	P-300-5049623280			599,722	1,643	19.0	520,988	1,427	16.5	160,723	440	5.1	0	0	0.0	0	0	0.0
		W2A	Disconnected	P-300-5049623280			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
		W2B	Supply	P-300-5049623280	1,930,003	61.2													562,145	1,540	17.8
		W2C	Supply	P-300-5049623280	1,930,003	61.2													416,397	1,141	13.2
		W3	Disconnected	P-300-5049623280			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
		W3A	Supply	P-300-5049623280	804,168	25.5													183,282	502	5.8
				Well Field Total	***4,278,174***	***209.1***	***1,564,586***	***4,287***	***49.6***	***1,535,355***	***4,206***	***48.7***	***520,410***	***1,426***	***16.5***	***0***	***0***	***0.0***	***1,585,216***	***4,343***	***50.3***

*Combined taking from W1B, W2B and W2C shall not exceed 11,897,280 L/day. The taking from W1B, W2B, W2C and W3A shall not exceed an annual daily average of 11,721,024 L/day.

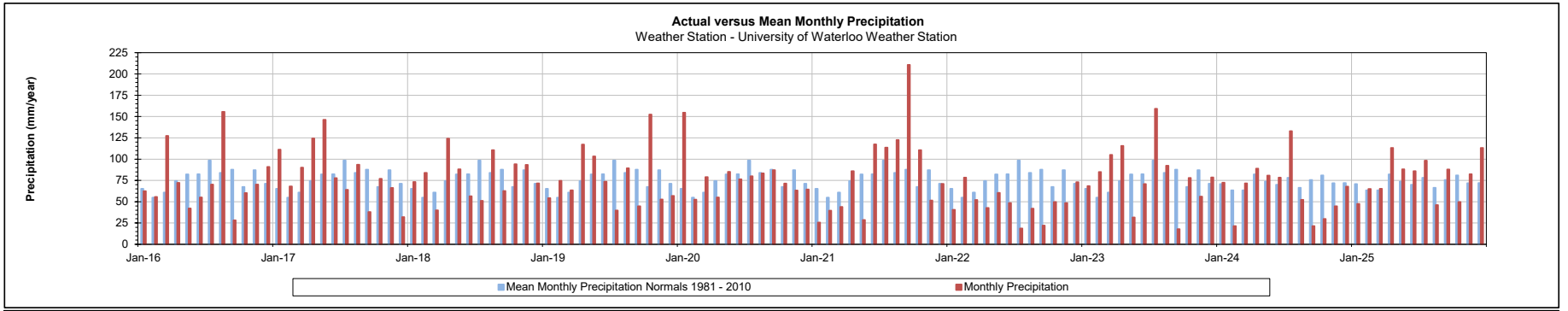
Notes:
- = no applicable data
n/a = data not available
*** = rates and volumes based on permitted L/day**
[1] = Current Permit

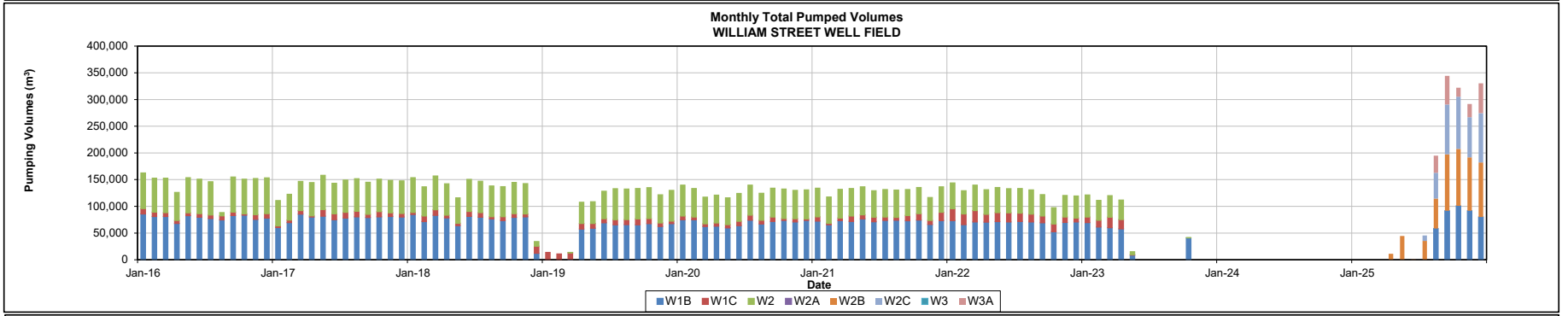

Actual versus Mean Monthly Precipitation
Weather Station - University of Waterloo Weather Station
Precipitation (mm/year)
225
200
175
150
125
100
75
50
25
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Mean Monthly Precipitation Normals 1981 - 2010
Monthly Precipitation

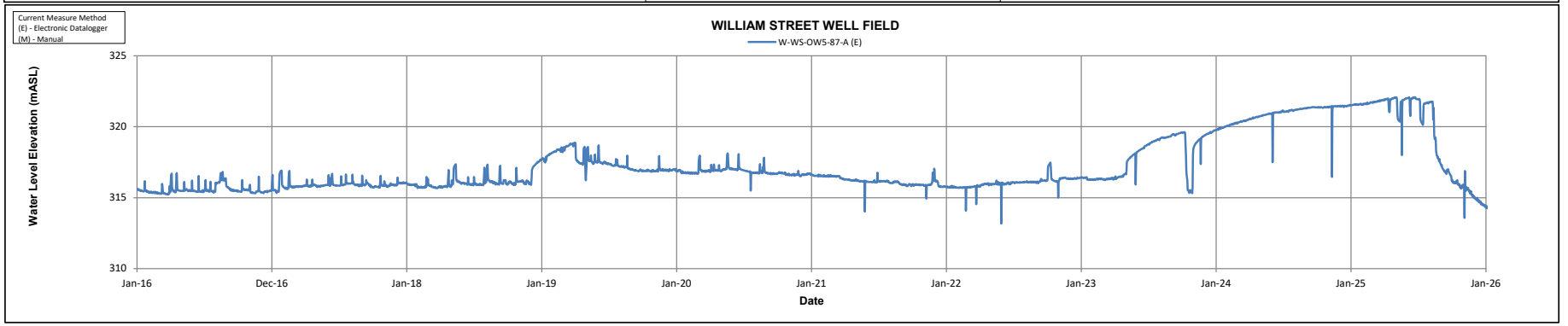

Monthly Total Pumped Volumes
WILLIAM STREET WELL FIELD
Pumping Volumes (m³)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Date
W1B
W1C
W2
W2A
W2B
W2C
W3
W3A


Current Measure Method
(E) - Electronic Datalogger
(M) - Manual
WILLIAM STREET WELL FIELD
W-WS-OW10-87-A (M)
Water Level Elevation (mASL)
325
320
315
310
Jan-16
Dec-16
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Jan-26
Date

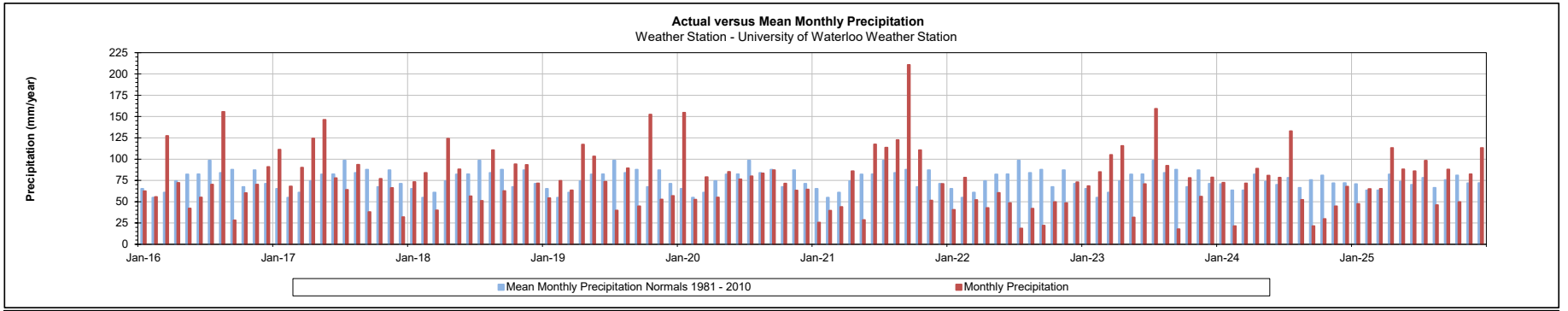
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
WILLIAM STREET

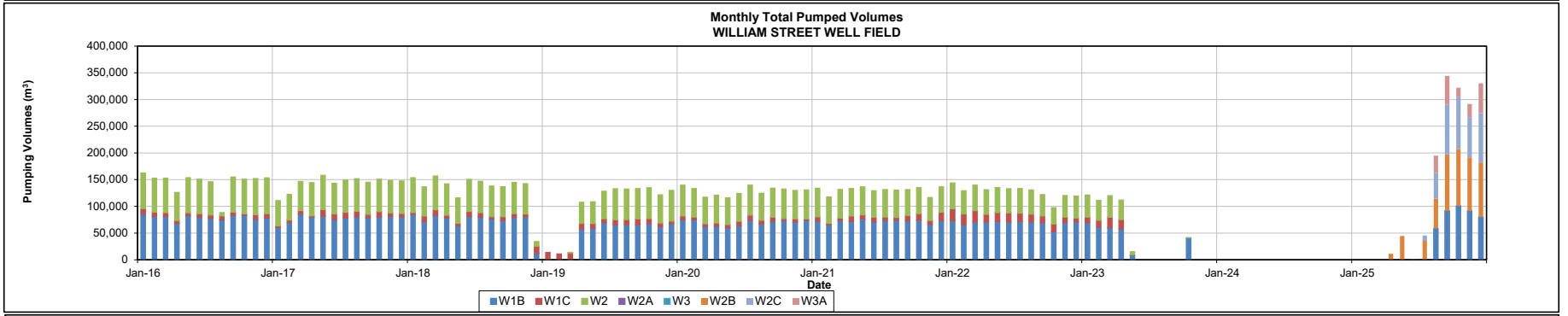


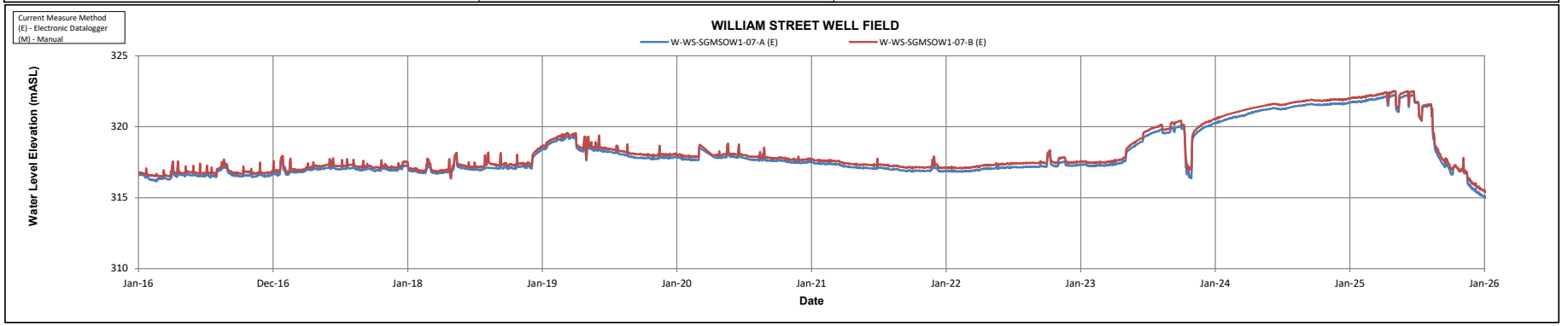


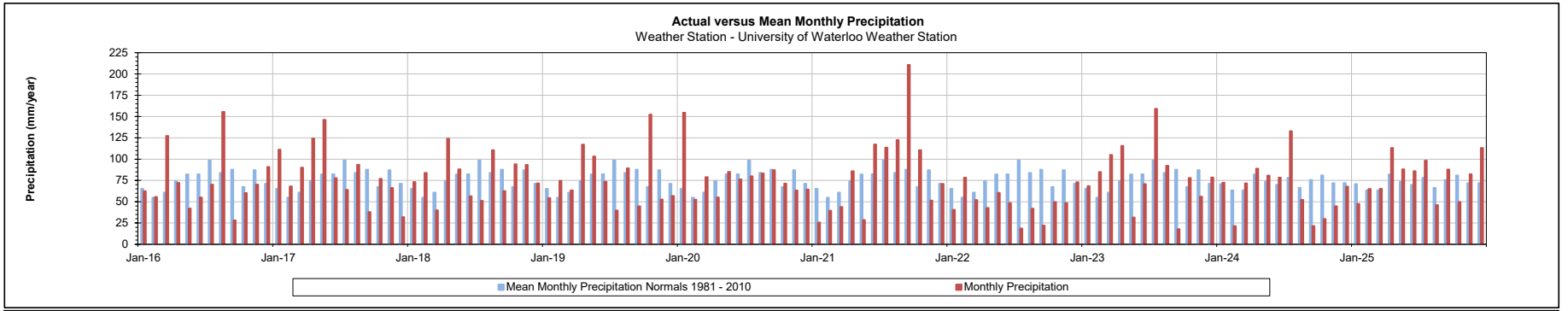


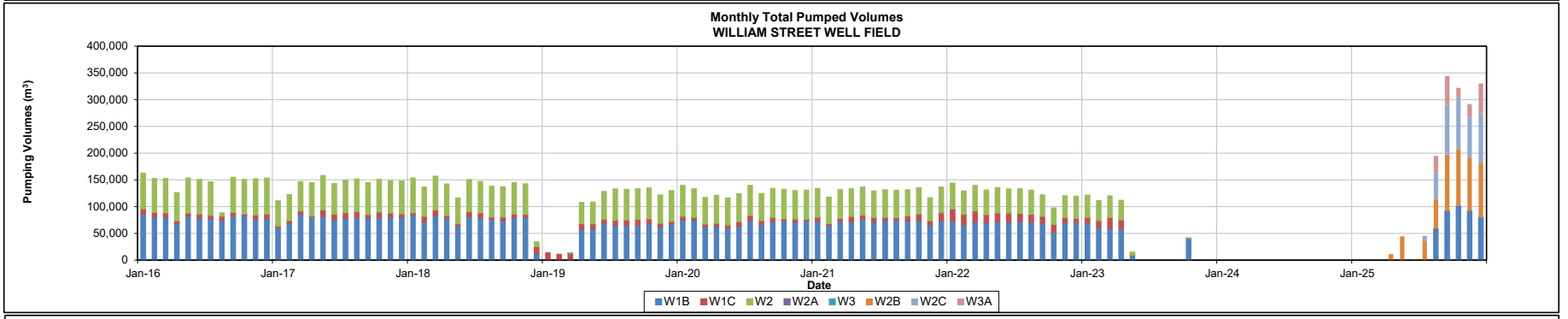
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
WILLIAM STREET

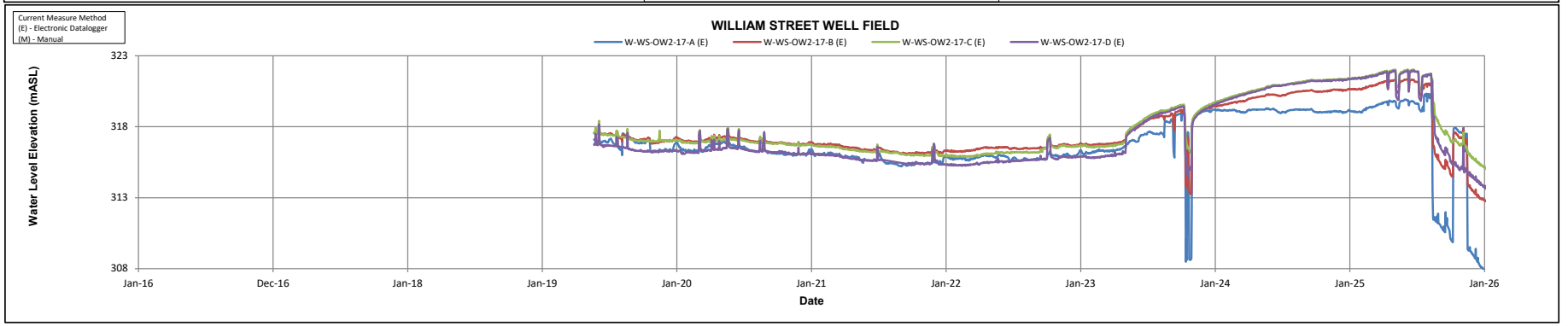







Actual versus Mean Monthly Precipitation
Weather Station - University of Waterloo Weather Station
Precipitation (mm/year)
225
200
175
150
125
100
75
50
25
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Mean Monthly Precipitation Normals 1981 - 2010
Monthly Precipitation


Monthly Total Pumped Volumes
WILLIAM STREET WELL FIELD
Pumping Volumes (m³)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Date
W1B
W1C
W2
W2A
W3
W2B
W2C
W3A


Current Measure Method
(E) - Electronic Datalogger
(M) - Manual
WILLIAM STREET WELL FIELD
W-WS-OW2-17-A (E)
W-WS-OW2-17-B (E)
W-WS-OW2-17-C (E)
W-WS-OW2-17-D (E)
Water Level Elevation (mASL)
323
318
313
308
Jan-16
Dec-16
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Jan-26
Date

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix D

Precipitation Data

Table D-1
Precipitation Variation from Average
Region of Waterloo - 2025 Groundwater Monitoring Report

Year	Kitchener/Waterloo Weather Station Established 1966		
	Annual Precipitation (mm)	30-yr NORMAL Precipitation 1981-2010 (mm)	Difference (mm)
2016	748	851	-103
2017	818	851	-33
2018	749	851	-102
2019	695	851	-156
2020	689	851	-162
2021	772	851	-79
2022	438	851	-413
2023	813	851	-38
2024	874	851	23
2025	723	851	-128

Year	University of Waterloo Station Established 1988		
	Annual Precipitation (mm)	Average Precipitation 1998-2024 (mm)	Difference (mm)
2016	891	871	20
2017	989	871	118
2018	950	871	79
2019	923	871	52
2020	953	871	82
2021	1022	871	151
2022	578	871	-293
2023	959	871	88
2024	763	871	-108
2025	943	871	72

Year	Shand Dam Established 1939		
	Annual Precipitation (mm)	Average Precipitation 1940-2025 (mm)	Difference (mm)
2016	976	926	50
2017	1093	926	167
2018	849	926	-77
2019	1081	926	155
2020	1017	926	91
2021	876	926	-50
2022	798	926	-128
2023	1015	926	89
2024	994	926	68
2025	995	926	69

Year	Conestogo Dam Established 1961		
	Annual Precipitation (mm)	Average Precipitation 1961-2025 (mm)	Difference (mm)
2016	983	990	-7
2017	1210	990	220
2018	962	990	-28
2019	992	990	2
2020	1021	990	31
2021	975	990	-15
2022	907	990	-83
2023	1053	990	63
2024	972	990	-18
2025	1025	990	35

Year	Woolwich Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	844	835	9
2017	986	835	151
2018	869	835	34
2019	824	835	-11
2020	862	835	27
2021	649	835	-186
2022	668	835	-167
2023	859	835	24
2024	793	835	-42
2025	732	835	-103

Year	Shade's Mills Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	934	909	24
2017	1092	909	183
2018	1042	909	133
2019	1059	909	150
2020	848	909	-62
2021	1020	909	111
2022	682	909	-227
2023	982	909	73
2024	976	909	67
2025	895	909	-14

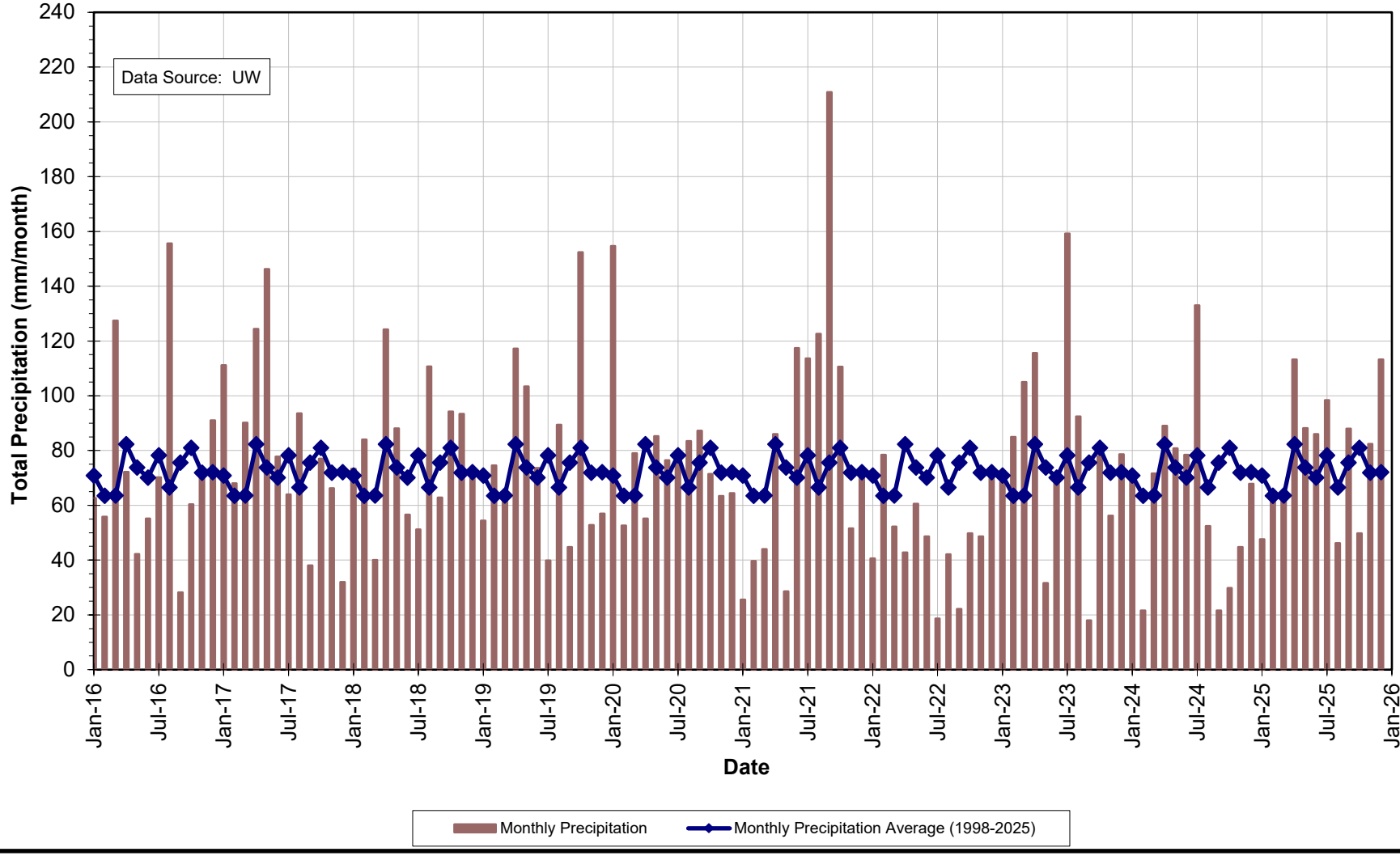
Year	Laurel Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	985	938	47
2017	1062	938	124
2018	1071	938	133
2019	940	938	2
2020	938	938	0
2021	1027	938	89
2022	689	938	-249
2023	921	938	-17
2024	907	938	-31
2025	894	938	-44

Year	Roseville Weather Station Established 1972		
	Annual Precipitation (mm)	30-yr NORMAL Precipitation 1981-2010 (mm)	Difference (mm)
2016	899	919	-20
2017	882	919	-37
2018	905	919	-14
2019	957	919	38
2020	817	919	-102
2021	832	919	-87
2022	637	919	-282
2023	945	919	26
2024	856	919	-63
2025	786	919	-133

NOTES:

WIA station data is not subject to review by the National Climate Archives, therefore, undergoes very limited quality checking.
GRCA Dam stations data is not reviewed extensively and undergoes limited quality checking.

Figure D.1
University of Waterloo Weather Station
Monthly Precipitation



BURNSIDE
Prepared By: C.D.
Printed On: 2/13/2026
File: Appendix D Precipitation Data/Monthly UW

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix E

Monitoring Program Overview

GROUNDWATER LEVEL MONITORING PROGRAM PROCEDURES

E.1 Overview

The Region of Waterloo (Region) collects water level measurements at specific monitoring wells to ensure sustainable long-term water supply and to meet monitoring and reporting requirements for the Region's water-taking permits. The goal of the program is to manage and protect the Region's groundwater supply and to assess the potential impact of municipal pumping on the groundwater and surface water resources in the Region. The ongoing collection and assessment of groundwater level data is integral to assess any changes to the water resources that may occur due to pumping.

E.1.1 Production Well Pumping and Water Levels

In 2023 the Region managed approximately 132 production wells with status defined as:

- Commissioned – Active wells
- New Not-Commissioned – Well are inactive or locked out until future demand or repairs/maintenance of other wells requires activating them

The well fields are referred to as Urban (Kitchener, Waterloo, and Cambridge) and Rural (North Dumfries, Woolwich, Wilmot, and Wellesley). Well fields in Kitchener, Waterloo, and Cambridge are referred to as the Integrated Urban System (IUS).

The Region's active production wells are monitored through the Region's SCADA (Supervisory Control and Data Acquisition) system, which reads and records the volume pumped on a daily basis. A few wells do not have their own meter but are combined with other nearby well(s) in the well field and the combined flow is divided into a record for each source. Water level measurements are obtained from the production wells where required. All manual measurements are obtained using either an air line or a water level tape.

E.1.2 Monitoring Wells and Surface Water levels

Water levels are measured at monitoring wells and at some surface water features. The objective of this monitoring is to collect data to ensure that the Region's water taking has minimal impact on the environment and on private water takers.

Water levels in the Region's monitoring wells are measured either electronically or manually. Most of the wells that are monitored electronically use datalogger equipment manufactured by *In-Situ Inc.*® LevelTROLLs® and RuggedTROLLs®; as well as, by *Van Essen Instruments (formerly Schlumberger Water Services)* Mini-Divers®, Micro-Divers®, and TD-Divers®; or by *Solinst*® Leveloggers®. The datalogger pressure sensor models used may be either vented (gauged) or non-vented (absolute) for *In-Situ Inc.*®; whereas, for *Van Essen Instruments* and for *Solinst,*® non-vented (absolute) models are used. Barometric dataloggers by each manufacturer suspended in select well locations are also used with the non-vented (absolute) models to provide the required barometric pressure compensation necessary in producing the water level data. Manual monitoring is done using a *Solinst*® and/or *Heron Instruments Inc.* electronic water level meter with both visual and audio indicators.

The electronically monitored wells are typically measured every hour, with increased frequency as required. At the hourly frequency, the following trends can be distinguished in an individual monitoring well:

- Seasonal climate trends;
- Water level changes in the aquifer that is being pumped;
- Water level changes in aquifers connected to the pumped aquifer; and
- Individual precipitation events in unconfined aquifers.

The manually monitored wells are measured once per month. At this frequency only the first three responses listed above can be distinguished.

E.1.3 Climatological Data

To evaluate the reaction of water levels to changes in climatic conditions, precipitation data are monitored at various locations throughout the Region. Within the Region of Waterloo, climate data is collected by Environment Canada at the Region of Waterloo International Airport (WIA) and the Roseville weather station, by the Grand River Conservation Authority (GRCA) at various Dam locations and by the University of Waterloo at a weather station located on the north campus.

E.2 Groundwater Level Collection Protocols

E.2.1 Groundwater Level Monitoring Network Summary Well Checklist

A well checklist and data entry spreadsheet are prepared of all the measuring points where water levels will be collected on a monthly basis. The checklist and spreadsheet are organized by well field so wells in close proximity are grouped together and indicates whether locations are measured with electronic dataloggers or manual measurements only. Once a well is visited, data is entered in the spreadsheet and the well is checked off the list; thus, the checklist and spreadsheet provides an obvious indication that work is unfinished if a location is unchecked and has no data.

E.2.2 Well Inspection

Upon visiting a well for the first time, the well/casing/equipment details are noted, photos taken, and GPS coordinates are recorded in a field book and/or in the monthly data entry spreadsheet. Well/casing/equipment details includes: location, access, condition, materials, diameters, casing security, surface seal condition, requiring repair or not, well/casing stickup measurements from ground level, well total depth, and the type of datalogger and/or sampling equipment installed. Any notable deficiencies, concerns, problems, or changes in the well condition are recorded in a field book and/or in the monthly data entry spreadsheet, as well as, photos are taken. Also, any observed activities taking place around or near the well that are worth noting are recorded in a field book and/or in the monthly data entry spreadsheet.

E.2.3 Monitoring Well Manual Water Level Measurement Procedure

- Unlock well casing and open well casing lid.
- Remove well cap (if present).
- Use an Electronic Water Level meter and lower the probe down the well until the meter beeps to indicate the probe has encountered water.
- The probe is raised up until the beep of the meter stops, indicating the probe is now above the water.
- Then the probe is slowly lowered down until the probe just contacts the water level surface causing the meter to beep.
- At this point the depth (in meters) is read off the water level meter tape from the measuring point of the well (in most cases is the top of the casing or pipe) and this provides the water level depth below the measuring point.
- The date, time, and water level depth measured is recorded in a field book and/or in the monthly data entry spreadsheet.
- This procedure is repeated for each of the well screens inside the well casing.

- Replace well caps.
- Close well casing lid and lock well casing.

E.2.4 Downloading of Water Levels from Electronic Dataloggers Procedure

For Non-Vented (Absolute) Datalogger Models:
In-Situ Inc.® LevelTROLLs® and RuggedTROLLs®, *Van Essen Instruments* Divers®, and *Solinst*® Leveloggers®

- Prior to downloading data from the datalogger, a manual water level is measured in each well screen containing a datalogger.
- The datalogger is pulled out of the well, unthreaded from the cap that is attached to a wire cable and connected to (or placed in) the corresponding datalogger communication device. The communication device is connected to a laptop/tablet PC or a RuggedReader® Handheld PC and the associated datalogger software is started.
- Water level data stored in the datalogger is subsequently downloaded and viewed using the datalogger software and saved on the hard drive/memory.
- Note: downloading data from the datalogger does not automatically stop the datalogger from recording.
- The status of the datalogger is viewed and checked for correct operation and to confirm that the datalogger is hanging in the well water within its operating range.
- Select datalogger details such as the battery level and free/used memory are recorded in a field book and/or in the monthly data entry spreadsheet.
- If the datalogger does not require restarting to free up memory or to change the sample rate, then the datalogger is removed from the communication device and is threaded back onto its cap and lowered back down the well on the wire cable.
- If the datalogger does require restarting to free up memory or to change the sample rate, then the datalogger is stopped, reprogrammed, and restarted using the datalogger software and, as a result, erases the previous data stored in memory on the datalogger.
- This procedure is repeated for each datalogger within each of the well screens inside the well casing.
- After all the non-vented (absolute) dataloggers have been downloaded then the Barometric dataloggers are downloaded following the same procedure as above.

For Vented (Gauged) Datalogger Models:
In-Situ Inc.® LevelTROLLs®

- Prior to downloading data from the datalogger, a manual water level is measured in each well screen containing a datalogger.
- The desiccant tube is unconnected from the datalogger cable.
- The datalogger cable is connected to a communication cable device that is connected to a laptop/tablet PC or a RuggedReader® Handheld PC and the datalogger software is started.
- Water level data stored in the datalogger is subsequently downloaded and viewed using the datalogger software and saved on the hard drive/memory.
- Note: downloading data from the datalogger does not automatically stop the datalogger from recording.
- The status of the datalogger is viewed and checked for correct operation and to confirm that the datalogger is hanging in the well water within its operating range.
- Select datalogger details such as the battery level, free/used memory, and desiccant condition (colour) are recorded in a field book and/or in the monthly data entry spreadsheet.
- The desiccant tube condition is checked and replaced if necessary.
- If the datalogger does not require restarting to free up memory or to change the sample rate, then the communication cable device is disconnected from the datalogger cable and the desiccant tube is reconnected.
- If the datalogger does require restarting to free up memory or to change the sample rate, then the datalogger is stopped, reprogrammed, and restarted using the datalogger software and, as a result, erases the previous data stored in memory on the datalogger.
- This procedure is repeated for each datalogger within each of the well screens inside the well casing.

E.2.5 Data Entry and Processing into the Burnside MS ACCESS/SQL® Database

- All field data collected (i.e. date, time, manual water level depth measured, comments) and recorded for each well screen and datalogger in a field book is entered into the monthly data entry spreadsheet, unless already entered in the field using a laptop/tablet PC.
- The monthly data entry spreadsheet is checked and reviewed prior to importing the data into a database table using Burnside Water Level Data Tools software. Manual water level depth values are converted into water level elevation values using the software during this import process.
- Any associated well notes, comments, and datalogger details are entered into a database table under the appropriate well and screen.

- Water level data from the dataloggers downloaded to a laptop/tablet PC or a RuggedReader® Handheld PC are transferred to Burnside file folder network upon returning to the office.
- These datalogger water level data files are subsequently read and the data is imported into a database table using Burnside Water Level Data Tools software.
- Using Burnside Water Level Data Tools software, the datalogger water level data are reviewed and processed (as described below) resulting in corrected water level depth values and corrected water level elevation values that are stored in a database table.
- *For Non-Vented (Absolute) Datalogger Models:*
  Datalogger water level data is first barometric pressure compensated using selected Barometric datalogger data, then a manual water level depth value measured at the time of the most recent download is applied and used to convert the barometric compensated water level data into corrected water level depth values, which are converted into water level elevation values that are appended to a database table.
- *For Vented (Gauged) Datalogger Models:*
  A manual water level depth value measured at the time of the most recent download is applied to the datalogger water level data to convert the water level data into corrected water level depth values, which are converted into water level elevation values that are appended to a database table.
- Temperature data recorded by the dataloggers are also imported into a database table.
- Hydrographs are subsequently created for each well and screen from the water level elevation data in the database for review and presentation. If there are some data points that are erroneous, then these data points are marked as non-reportable (invalid) within the database and/or are removed resulting in them not being plotted on the hydrographs.
- An updated data file is provided to the Region on a quarterly basis for upload into their eWRAS EQuIS database.

R.J. Burnside & Associates Limited