2025 Biennial Groundwater Monitoring Report - Parkway Well Field (K31, K32, K33)

The Region of Waterloo

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The Region of Waterloo

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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) for the Parkway Well Field (3115-AMHHXH) requires submission of a well field specific biennial report to the Ministry of Environment, Conservation and Parks (MECP) which documents pumping volumes from production well K33 and water levels in specific monitoring wells during 2024 and 2025. The Parkway Well Field also includes production wells K31 and K32. These wells are not included in the PTTW because they are “grandfathered” wells with respect to the PTTW program. Since K31 and K32 are in close vicinity to K33 and draw from the same aquifer, the pumping of wells K31 and K32 are included in the discussions of this report. This report has been prepared to meet the reporting conditions of the PTTW for 2024 and 2025. A copy of the PTTW is included in Appendix A.

The location of the Parkway Well Field is shown on Figure 1 and the production wells in Kitchener are shown on Figure 2 with the monitoring network for K31, K32 and K33 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. 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 the Parkway Well Field which consists of the following activities:

- Measuring the daily volume pumped from production wells K31 and K32;
- Measuring the daily volume pumped from production well K33 (Condition 4.1 of the PTTW);
- Measuring the water levels in monitoring wells K-PY-PK1-95-ABC, K-PK-OW1-15-A, K-PY-OW3-12-A and K-PK-OW1-16-A (Condition 4.2 of the 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 Parkway production wells are in a predominantly industrial / commercial area near the intersection of Bleams Road and Manitou Drive in south Kitchener (Figure 3). The closest municipal well field is the Strasburg Well Field, located about 2 km to the South. The Greenbrook and Mannheim Well Fields are found about 3.5 km to the northwest and 5 km to the west respectively (Figure 2). The closest surface water feature to the Parkway Well Field is Schneider Creek located 140 m southwest of K32 and <10 m from K31 and K33. The Grand River is located 1 km southeast from the well field (Figure 3).

2.1.1 Pumping Wells

The Parkway Well Field consists of production wells K31, K32 and K33. A summary of the production well construction details is provided in Table 1 below. Well records for the production wells are found in Appendix B.

Table 1: Production Well Construction Details

Well Name	Year Built	Casing / Screen Diameter (mm)	Screened Interval (mbgs)	Aquifer
K31	1958	400	24.2 – 33.4	AFD1
K32	1960	400	25.6 – 31.7	AFD1
K33	1967	400	28.0 – 34.1	AFD1

The water taking volumes for the Parkway 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)

Well	PTTW	2024			2025		
K31	n/a	1,406	2,464	513,197	0	0	0
K32	n/a	2,580	2,742	941,587	1,399	2,663	510,476
K33	4,582	1,734	2,593	632,767	0	0	0
Total		**5,719**	**7,584**	**2,087,551**	**1,399**	**2,663**	**510,476**

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 production well, which complies with condition 4.1 of the PTTW.

The pumping volumes are presented in Appendix C as total monthly volumes. Pumping volumes from the well field ranged from 79,185 m^3/month to 215,715 m^3/month in 2024, and from 0 m^3/month to 77,184 m^3/month in 2025. In total, 2,087,551 m^3 was produced at this well field in 2024 and 510,476 m^3 was produced in 2025. The volumes pumped in 2024 were similar to volumes in the past five years. In 2025, volumes are much lower due to K31, K32 and K33 going offline for maintenance and/or infrastructure upgrades for all or a portion of the year. The total annual pumping volumes for K33 were below the permitted volume of 1,672,459 m^3 per year (Table C-1).

2.1.2 Monitoring Wells

The Region updated their well naming protocol in 2017 and as a result, the well names in EquIS (Region's Hydrogeological Database) may vary from the names listed on the PTTW. The well names on the PTTW are shown below along with the updated name that is used by the Region (Table 3). The updated Region names will be used throughout this report.

Table 3: Well Nomenclature

Monitoring well names as they appear on the PTTW	Revised well names consistent with Region nomenclature
K-PY-PK1A-95	K-PY-PK1-95-A
K-PY-PK1B-95	K-PY-PK1-95-B
K-PY-PK1C-95	K-PY-PK1-95-C
K-PK-OW1A-15	K-PK-OW1-15-A
K-PY-OW3A-12	K-PY-OW3-12-A
K-PK-OW1A-16	K-PK-OW1-16-A

Construction details for the monitoring wells are described in Table 4 below and locations of the monitoring wells are provided on Figure 3. Well records for the monitoring wells are provided in Appendix B.

Table 4: Monitoring Well Construction Details

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to K31, K33 (m)	Distance to K32 (m)
K-PY-PK1-95-A	1995	35.7- 37.2	Bedrock – Salina Formation	190	200
K-PY-PK1-95-B	1995	28.4 – 29.9	AFD1		
K-PY-PK1-95-C	1995	11.9 – 13.4	ATB3		
K-PK-OW1-15-A	2015	30.5 – 33.5	AFD1	450	10
K-PY-OW3-12-A	2012	36.9 – 38.4	AFD1	600	375
K-PK-OW1-16-A	2016	28.9 – 32.0	AFD1	6	450

2.2 Regional Geology and Hydrostratigraphy

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

Note that the cross-sections are provided as a visual aid and do not necessarily contain all wells in the monitoring program for the Parkway Well Field. The recently completed Tier Three Assessment Update Project (Aqua Insight et al, 2023) has revised the previous (Matrix 2015) stratigraphic interpretation of the lithology around the Parkway Wellfield. The lithological layers were updated in accordance with documentation provided in the Numerical Model Surface Transfer memorandum (Aqua Insight Inc, 2026).

Refinements along this cross-section A-A' (Figure 6) based on new monitoring wells in the area include the following:

- Thickening of the supply aquifer, AFD1, near K-PY-OW3-12;
- Absence of ATB2 at K-PY-OW3-12, thinning of ATC1, increase thickness of AFB1and much thicker ATB1 east of the well;
- In the northeast, between K-PY-OW3-12-AB and K-PY-OW2-12-AB, sediments that were previously mapped as AFB2 have been reinterpreted as ATB1 and ATB2 with the presence of AFB1 in some locations, and
- In the vicinity of K-PY-PK8-96, a thickening of AFD1 and a thinning of ATE1.

Refinements along cross-section B-B' (Figure 7) include the following:

- In the northwest, a thickening of AFB2, and lowering and thickening of ATB3;
- In the southeast between K32 and K-PY-OW1-10-AB, a thickening of AFB1 and a thinning of ATB2 and AFB2. Sediments previously identified as ATB1 were recharacterized as ATA1 and ATB1 is much thicker, and
- Removal of the valley in the rock at K32.

2.2.1 Surficial Geology and Conceptual Hydrostratigraphy

The surficial geology of the study area has been mapped and described by the Ontario Geological Survey (2003) and updated in Bajc and Shirota (2007). The surficial geology of the Parkway Well Field is characterized primarily by ice contact sand and gravel and silty to sandy till sediments (Figure 4). Modern alluvial and outwash deposits are present along Schneider Creek and the Grand River. In addition, the deposition of the Waterloo Moraine in this area resulted in fine to coarse-grained sand and gravel deposits at surface.

The Quaternary units typically present in the Waterloo Moraine area 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. Port Stanley Till is mapped at surface (Unit 5b on Figure 4) to the east of K33. The unit is generally less than 5 m thick where present.

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. 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. In some areas, 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. 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. AFB1 is not mapped in the area of the Parkway Well Field. AFB2 is interpreted to be continuous in the area of the Parkway production wells, ranging from 3 m to 25 m and described as fine to coarse sand, with silty sand and silt.

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. The unit ranges in thickness from 1 m to 10 m in the Parkway Well Field (Figures 6 and 7).

Aquitard ATC1 / AFC1 / 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. This unit is interpreted to be continuous in the Parkway Well Field and with ATB3 creates a vertically extensive aquitard above the production aquifer for the Parkway Well Field production wells.

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 including the Parkway Well Field. At the Parkway Well Field, AFD1 is located between 20 and 35 m depth (approximately 285 to 270 masl) and is hydraulically connected with the bedrock (Figure 7).

2.2.2 Bedrock Geology

The Paleozoic bedrock in the area consists of the Salina Formation. The Salina Formation consists of interbedded brown dolostone and grey to green shale with lenses of gypsum and anhydrite. Groundwater extracted from this unit tends to be of poor quality due to high concentrations of calcium and sulphates.

2.3 Local Geology

The following description of local geology is based on sediments reported in the production well logs and monitoring well logs in the area of the Parkway Well Field. Borehole logs of the Parkway Well Field are included in Appendix B.

Aquitard ATA1 – Whittlesey Clay - This silt and clay unit is present at surface across the well field, ATA1 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.

Port Stanley Till (ATB1) – This unit was described at K-PK-OW1-15 as clayey silty sand from surface to a depth of 6.71 m.

Upper Waterloo Moraine (AFB1 / AFB2) – ATB2 is mapped in the Parkway Well Field with varying thickness from 0 m to 15 m. This unit was present at K-PK-OW1-16 from surface to a depth of 4.57 mbgs and at K-PY-OW3-12 from surface to a depth of 21.64 mbgs.

Lower Maryhill Till (ATB3) – This unit was described as a silty clay to clay unit at K-PK-OW1-15 from 6.71 m to 16.76 mbgs, at K-PK-OW1-16 from 4.57 m to 14.63 mbgs and at K-PY-PK1-95 from about 7.4 m to 15.5 mbgs.

Catfish Creek Till (ATC1/AFC1/ATC2) – This unit was present at K-PK-OW1-16 from 14.6 m to 21.0 mbgs and at K-PY-PK1-95 from about 15.5 m to 19.2 mbgs. In the K33 drillers log, it is described as clay with gravel and boulders from 20.4 m to 23.2 mbgs. A sand and gravel aquifer (AFC1) was identified at K-PY-OW3-12 from 35.0 m to 39.8 m below ground.

Pre-Catfish Creek Sand and Gravel (AFD1) – This unit was encountered at K-PK-OW1-16 from 21.03 m to a depth of 35.66 mbgs and at K-PY-PK1-95 from about 19.2 m to 34 mbgs. AFD1 is the production aquifer for the Parkway Well Field production wells. In the driller's log for K33, the unit is described as gravel with sand and boulders encountered from 23.2 m to 34.6 m bgs.

Bedrock – Bedrock was identified at K-PY-PK1-95 at a depth of 34 mbgs as dolostone and shale (Salina Formation).

3.0 2024 / 2025 Results

The following sections summarize groundwater levels at monitoring wells in relation to precipitation and water taking from the aquifer (in accordance with condition 4.3 of the PTTW).

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 (U of W) and Environment Canada station located closest to the production wells are used. The closest weather station relative to the Parkway Well Field is the U of W station located 10.9 km from the well field. The closest Environment Canada station is Roseville located about 7.1 km 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 U of W and Roseville are shown on Figures D.1 and D.2, Appendix D. At the U of W station, the long-term average was calculated from 1998 until the end of 2025. The Roseville station has “Climate Normals” calculated by Environment Canada for 1981 to 2010.

Annual 2024 / 2025 precipitation data for the U of W and Environment Canada meteorological stations closest to the Parkway Well Field are presented in Table 5 below. In 2024, Roseville was missing 5 days of data and 20 days in 2025. As a result, the precipitation totals may be under reported at this location.

Table 5: Summary of Precipitation Data

Station	2024 Precipitation (mm)	2024 Deviation (mm)	Long-Term Average (mm)	2025 Precipitation (mm)	2025 Deviation (mm)
Roseville Station (1)	856	-63	919(A)	786	-133
University of Waterloo (2)	763	-108	871(B)	943	+72

Sources: Environment Canada (1), University of Waterloo (2)
A 1981 to 2010 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 the U of W station was 763 mm, which is 108 mm below the long-term average, indicating 2024 was drier-than-average near the well field. A similar below long-term average trend is noted at the Roseville station. The GRCA March 1, 2024 snow survey indicated a snowpack across the Region that was low compared to normal.

In 2025, the total precipitation at U of W was 943 mm, which is 72 mm above the long-term average. Whereas the total precipitation at the Roseville station was 133 mm below the long-term average, indicating 2025 was a drier-than-average year. However, Roseville was missing 20 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.

K-PY-PK1-95-ABC

Monitoring well nest K-PY-PK1-95 is located 190 m southeast of K31 and K33 and 200 m northwest of K32.

The A screen is installed in the shallow bedrock 4 m beneath AFD1 and water levels were recorded with a datalogger. The B screen is installed in the production aquifer AFD1 and water levels were collected manually from 2012 to 2020 and a datalogger was installed in April 2021. Water levels in screens A and B display similar patterns with a clear response to pumping at the well field. Fluctuations up to 5 m occur due to on / off pump cycles. Water levels in both screens recovered up to 8 m when the well field was offline between April and August 2021 and when K31 and K33 were offline October 2024 to December 2025. Water levels in 2024 and 2025 were within the historical range of water levels since 2016.

Water levels in the C Screen are collected with a datalogger. Screen C is in the aquitard ATB3 and is separated from AFD1 by about 18 m of lacustrine clay (AFC1) and the Catfish Creek Till (ATC2). Abrupt, stepwise drops in water levels, observed at regular intervals over time, correspond to water quality sampling events. Due to the fine-grained nature of ATB3, the water level is slow to recover between sampling events. Water

levels in 2024 and 2025 were within the historical range of water levels since 2016. Water levels in 2025 were higher than normal when K31 and K33 were offline.

K-PK-OW1-15-A

Monitoring well K-PY-OW1-15-A is located 10 m from K32 and 450 m southeast of K31 and K33. The monitoring well is screened in a sand and gravel overburden unit interpreted to be AFD1 and water levels have been recorded at the well with a datalogger since April 2015. The water levels indicate a response to pumping at the Parkway production wells with daily fluctuations of up to 1.5 m occuring due to on / off pump cycles. A recovery of approximately 8 m occurred in 2021 when the well field was offline between April to August 2021 and between October 2024 to December 2025 when K31 and K33 were offline. Water levels in 2024 and 2025 were within the historical range of water levels since 2014.

K-PY-OW3-12-A

K-PY-OW3-12-A is located 600 m east of production wells K31 and K33 and 400 m northeast of K32. The well is screened in a sand and gravel overburden unit (AFD1) located below ATC1. Monitoring of K-PY-OW3-12-A started in January 2016 and a datalogger was installed in July 2018. Water levels show a response to pumping that is much more subdued than observed at K-PY-OW1-15-A. A recovery of approximately 6.5 m occurs in 2021 when the wellfield is shut down between April and August 2021. K-PY-OW3-12-A was decommissioned in April 2024 due to construction of the Bleams Road extension.

K-PK-OW1-16-A

K-PK-OW1-16-A is located 6 m from K33 and K31 and 450 m northwest of K32 and is screened in the production aquifer AFD1. Manual water level monitoring of K-PK-OW1-16-A started in March 2017 and a datalogger was installed in April 2018. Monitoring results indicate that water levels are influenced by pumping of the well field with daily fluctuations of up to 3 m due to on / off pump cycles. A recovery of approximately 9 m occured in 2021 when the well field was offline between April to August 2021 and between October 2024 to December 2025 when K31 and K33 were offline. Water levels in 2024 and 2025 were within the historical range of water levels since 2017.

4.0 Impact Assessment

4.1 Well Interference

The Parkway Well Field is located in a municipally serviced industrial / commercial 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 2022 / 2023 Biennial Groundwater Monitoring Report – Multiple Well Fields (Burnside, 2024). There

were no well interference complaints related to pumping at the Parkway Well Field 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 6.

Table 6: PTTWs in Vicinity of Parkway Well Field

Permit Number	Permit Holder	Purpose	Source - Max Liters per Day	Distance (km) from Production Wells	Expiry Date
5841-BS6M62	Kuntz Electroplating Inc.	Cooling Water	Well 1 – 1,090,080 Well 2 – 1,634,000 Well 3 – 1,090,080	200 m – K32 450 m – K33	08/31/2030
0533-9U9Q4P	Deer Ridge Golf Club	Recreational	Grand River – 381,840	1350 m – K32 1,550 m – K33	02/28/2025

Kuntz Electroplating Inc., located 200 m southeast of K32, has a permit to take water for three cooling water supply wells. It is believed that the wells are completed in the bedrock. Deer Ridge Golf Club has a surface water taking PTTW with the source being the Grand River. These takings are not anticipated to be impacted by / or to impact the Parkway Well Field.

4.2 Aquifer Response to Pumping and Precipitation

Water levels in the main supply aquifer at the Parkway Well Field (K-PY-PK1-95-B, K-PY-OW3-12-A, K-PY-OW1-15-A and K-PK-OW1-16-A), AFD1, are influenced by pumping and respond to changes in pumping rates and on / off pumping cycles. Resuming pumping at the production wells in August 2021 results in decreasing water levels in the aquifer until January 2023 when water levels stabilize. From January 2023 to October 2024 water levels in the aquifer are stable within historical ranges under pumping conditions. Water levels in the aquifer quickly recover in October 2024 when K31 and K33 go offline. The shallow bedrock which underlies AFD1 (also shows a response to pumping. Water levels in the aquitard ATB3 are higher than historical ranges under pumping conditions in 2025 when K31 and K33 are offline.

Seasonal fluctuations and precipitation trends are not observed in the AFD1, bedrock or ATB3 wells.

5.0 Conclusions

Impacts from pumping the municipal production wells at the Parkway 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 3115-AMHHXH;
- 2024 and 2025 pumping volumes were within the permitted range;
- There were no reported well interference complaints arising from water taking at the Parkway Well Field; and
- Monitoring wells show a response to well field pumping that dominates over seasonal fluctuations.

6.0 References

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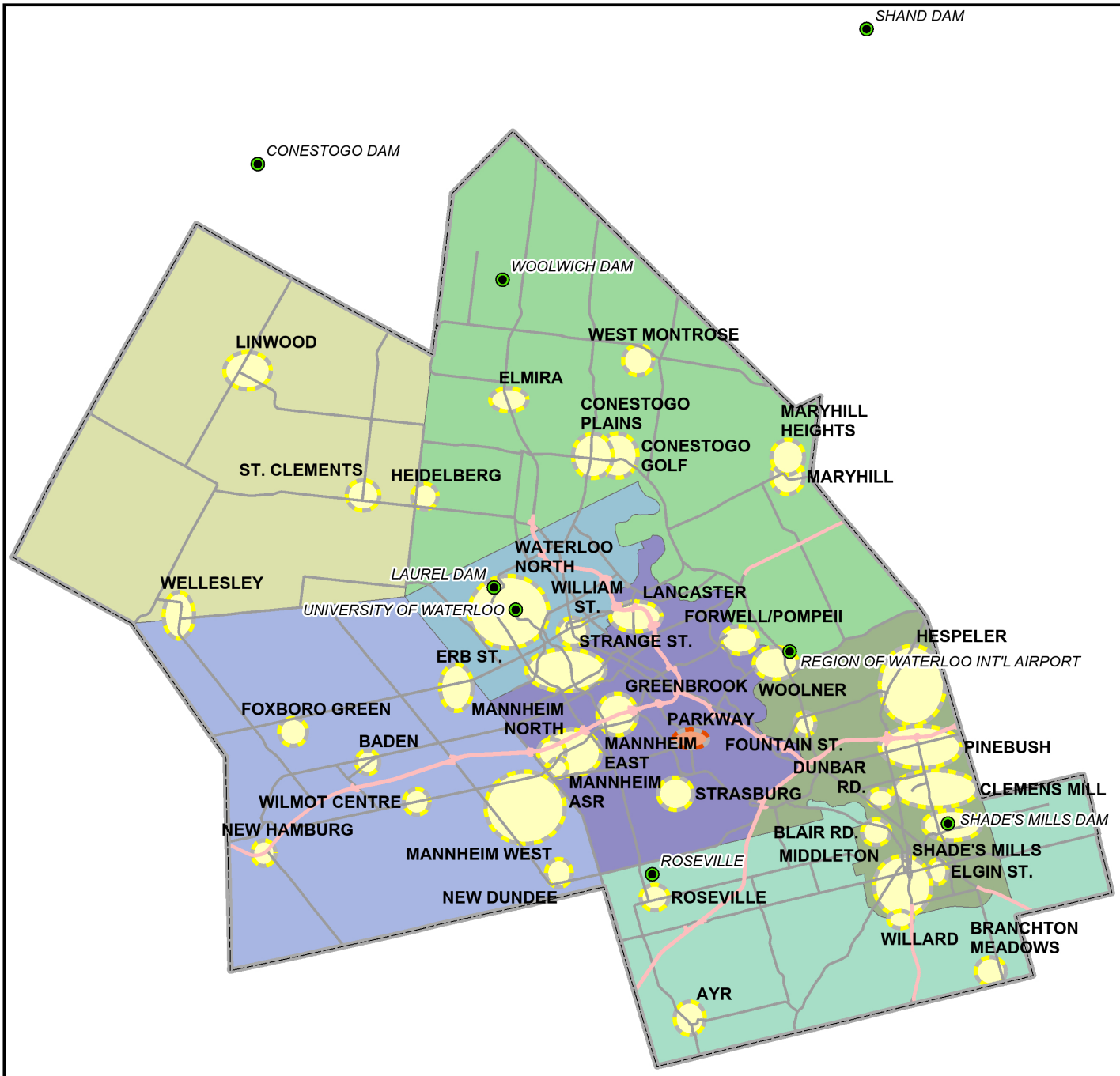
[THE DIFFERENCE IS OUR PEOPLE]

Figures



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Map Title

2025 GROUNDWATER MONITORING REPORT - PARKWAY WELL FIELD

WELL FIELD LOCATION MAP

Client

REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	February 2026	1
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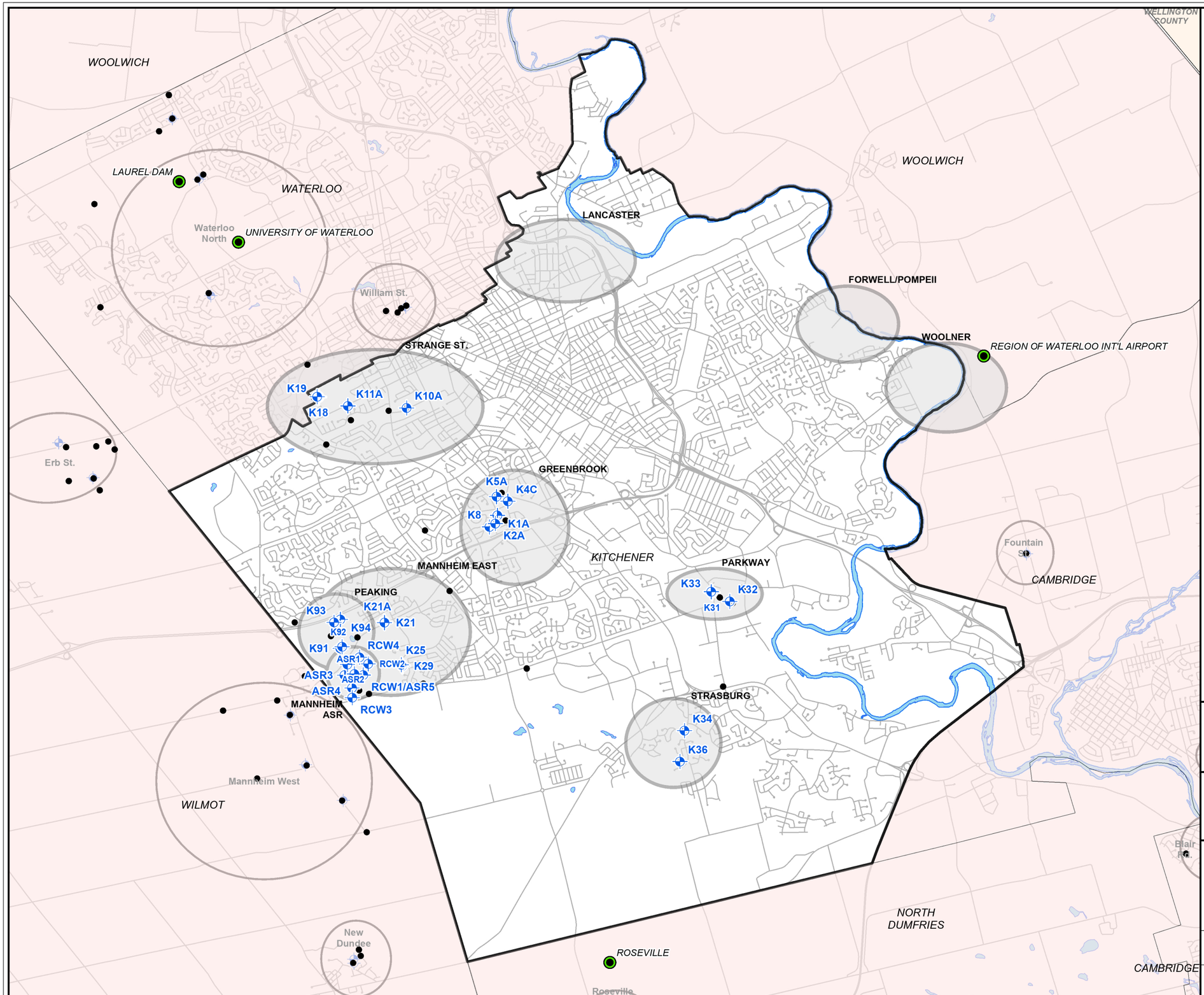


LEGEND

- Production Well Location
- Monitoring Well Location
- Kitchener 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.

Datum: North American 1983 CSRS

Coord. System: NAD 1983 CSRS UTM Zone 17N

N

0 1 2 3 4 5

Kilometers

BURNSIDE

Client

REGION OF WATERLOO

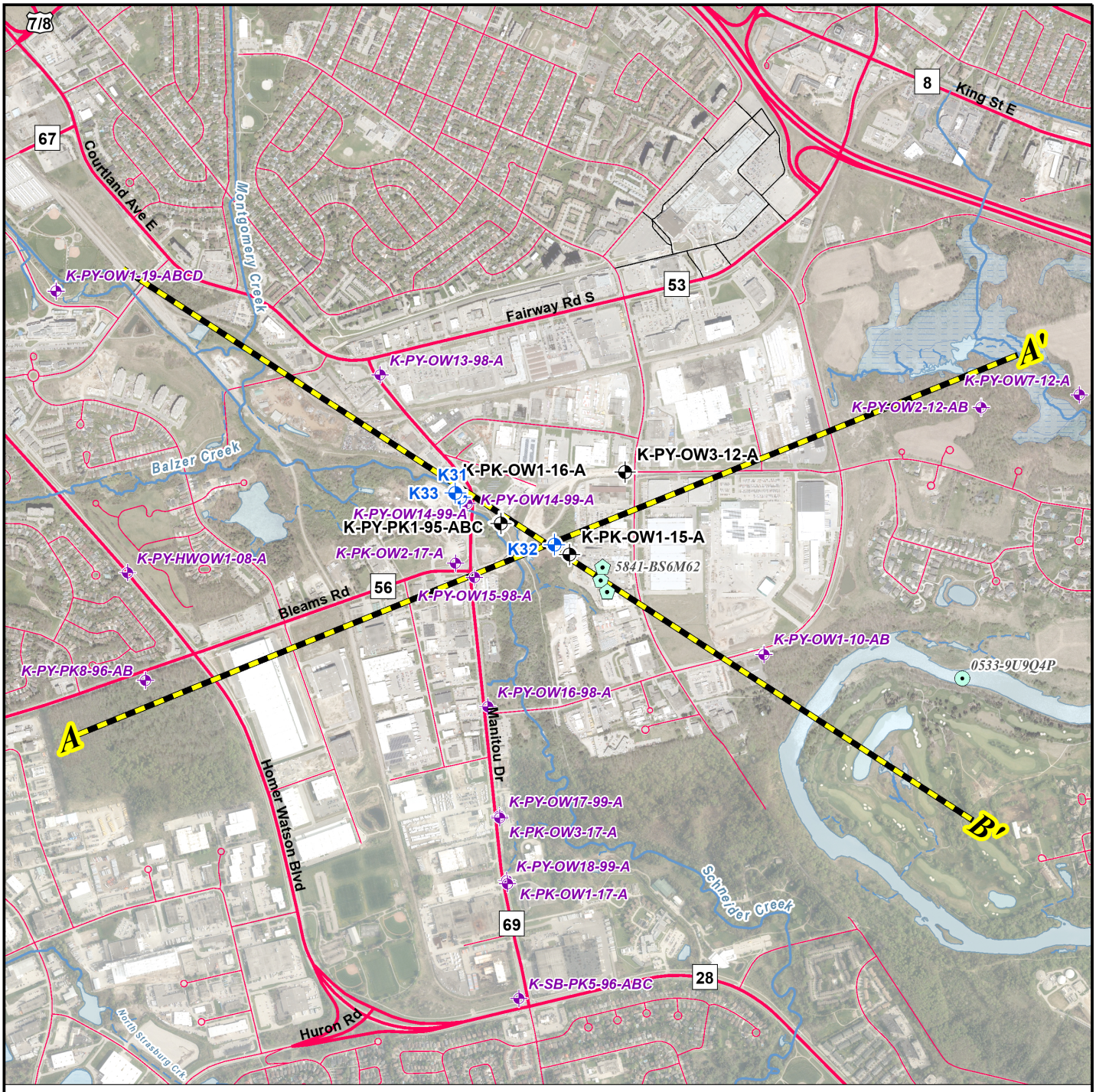
Figure Title

2025 GROUNDWATER MONITORING REPORT - PARKWAY WELL FIELD

KITCHENER WELL FIELDS AND MONITORING NETWORK

Drawn	Checked	Date	Figure No.
HN	SQ	April 2026	2
Scale		Project No.	
1:70,000		HA0464020	

File Path: \\elmo\gis\project\H Jobs\HA 04 6402 (Waterloo)\Reporting\Groundwater Level Monitoring Program\2025 Groundwater Report Figures\Parkway\Pro\Parkway\Parkway.aprx Print Date: 2026/04/24 Time: 02:10 PM



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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.

0 150 300 450 600 750 900 1,050 1,200 1,350

Metres

PTTW Monitoring Well Location
Production Well Location
Nearby Monitoring Well Location

Additional MECP PTTW Locations
Groundwater
Surface and Ground Water
Cross Section Orientation

Intermittent Creek
Creek
Waterbody
Provincially Significant Wetland (MNR)

Provincial Highway
Regional Road
Local Road
Private / Other Road

BURNSIDE

Map Title

2025 GROUNDWATER MONITORING REPORT - PARKWAY WELL FIELD

WELL LOCATION MAP

Client

REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	April 2026	3
Scale		Project No.	
1:20,000		HA0464020	

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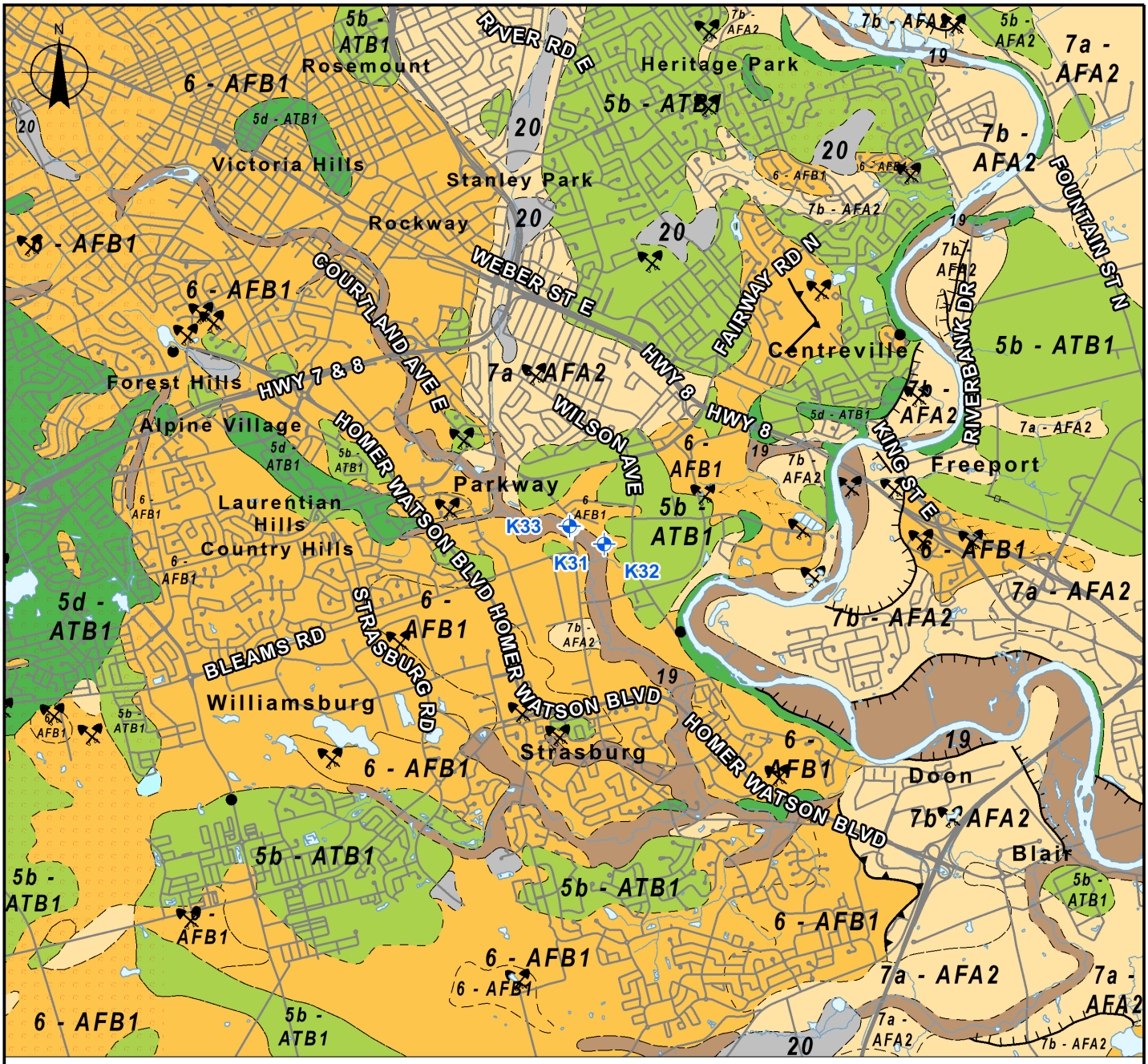

Data Source:
1. Ontario Geological Survey 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.
2. Region of Waterloo GIS

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
- Esker: Direction of Flow Known
- Ice-Contact Slope
- Terrace
- Drumlin or drumlinoid ridges (point)
- Sample Location
- Hummocky Topography
- Unit Contact Boundary

BURNSIDE

Map Title
2025 GROUNDWATER MONITORING REPORT - PARKWAY 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	

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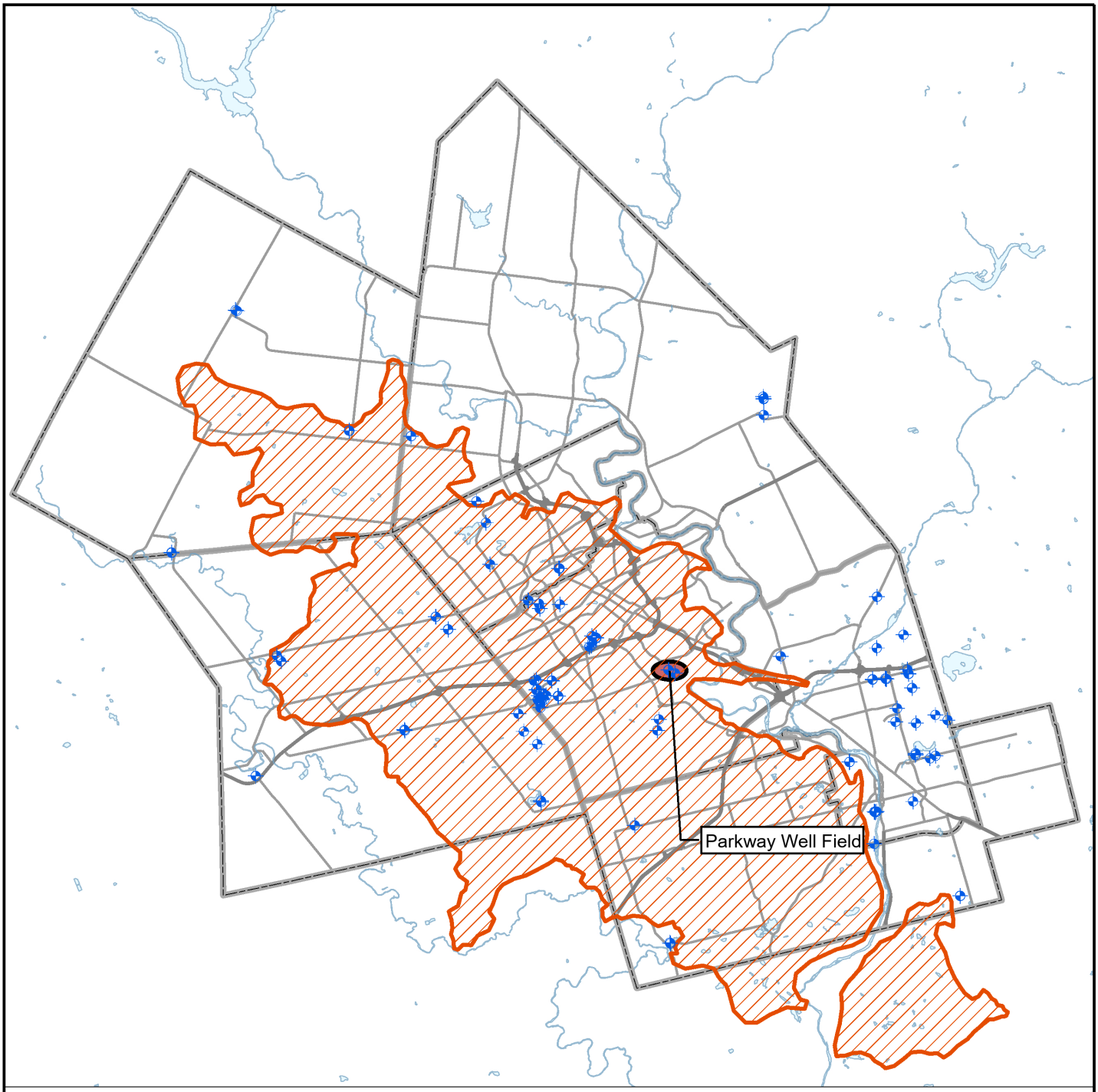

N

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)
Parkway Well Field
Waterbody
Regional Municipal Boundaries

BURNSIDE

Map Title

2025 GROUNDWATER MONITORING REPORT - PARKWAY 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	

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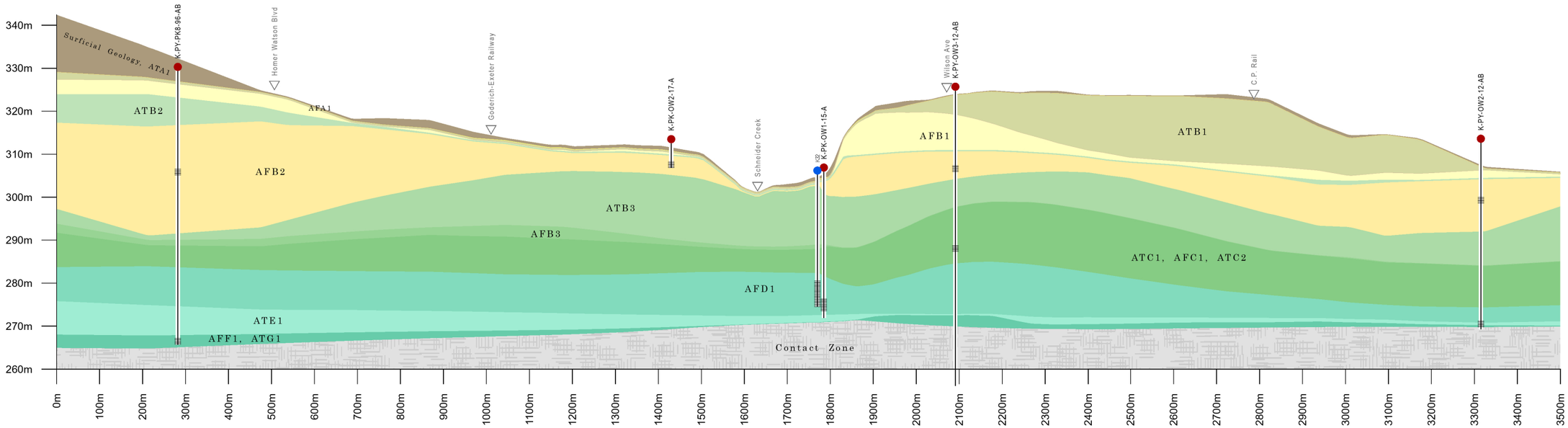
A

A'



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

Parkway

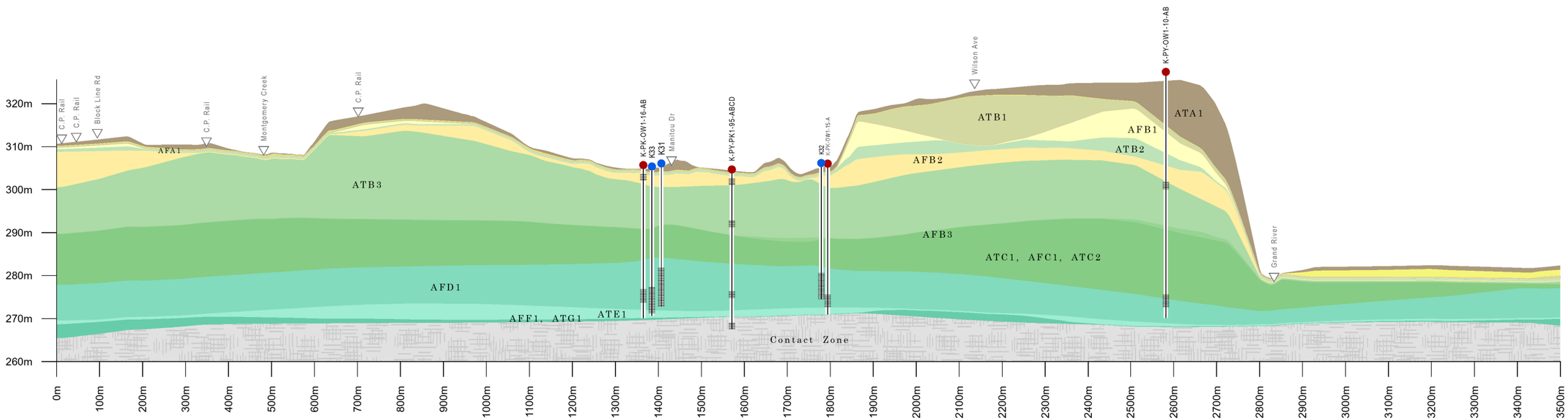
Cross Section A - A'

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/11	6
Horizontal Scale 1:10,000		Project No.	
Vertical Ex.:10x		HA046402	

File Path: F:\GIS Working\Projects\ROW_Cross_Sections\ROW_Cross_Sections.aprx Print Date: 2026/06/11 Time: 04:43 PM

B

B'



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

Parkway

Cross Section B - B'

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/16	7
Horizontal Scale 1:10,000		Project No.	
Vertical Ex.:10x		HA046402	

File Path: F:\GIS Working\Projects\ROW_Cross_Sections\ROW_Cross_Sections.aprx Print Date: 2026/06/16 Time: 07:13 PM

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Permit To Take Water

PERMIT TO TAKE WATER
Ground Water
NUMBER 3115-AMHHXH

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

The Regional Municipality of Waterloo
150 Frederick St.
Kitchener, Ontario
N2G 4J3

For the water taking from: Well K33

Located at: 33 Manitou Dr
Kitchener, Regional Municipality of Waterloo

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 and Climate Change.

(d) "District Office" means the Guelph District Office.

(e) "Permit" means this Permit to Take Water No. 3115-AMHHXH including its Schedules, if any, issued in accordance with Section 34.1 of the OWRA.

(f) "Permit Holder" means The 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, dated February 23, 2017 and signed by Richard Wootton, 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 **May 31, 2027**. 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

	Source Name / Description:	Source: Type:	Taking Specific Purpose:	Taking Major Category:	Max. Taken per Minute (litres):	Max. Num. of Hrs Taken per Day:	Max. Taken per Day (litres):	Max. Num. of Days Taken per Year:	Zone/ Easting/ Northing:
1	K33	Well Drilled	Municipal	Water Supply	3,182	24	4,582,080	365	17 544523 4807049
						Total Taking:	4,582,080		

3.3 The Permit Holder shall ensure that the taking complies with the requirements of the *Safe Drinking Water Act S.O. 2002* and all pertinent regulations thereunder.

4. Monitoring

4.1 Under section 9 of O. Reg. 387/04, and as authorized by subsection 34(6) of the *Ontario Water Resources Act* , the Permit Holder shall, on each day water is taken under the authorization of this Permit, record the date, the volume of water taken on that date and the rate at which it was taken. 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. The Permit Holder shall keep all records required by this condition current 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. 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 Water Taking Reporting System.

4.2 The Permit Holder shall measure and record water levels once a month in the following monitoring wells:
K-PY-PK1A-95
K-PY-PK1B-95
K-PY-PK1C-95
K-PK-OW1A-15
K-PY-OW3A-12
K-PK-OW1A-16

4.3 The Permit Holder shall prepare and submit a report to the Director every two years by June 30 commencing June 30, 2018, that presents the results of the well field water level monitoring for the two preceding calendar years, assesses changes in water levels in the supply aquifer in relation to the precipitation and the water taking from the aquifer, and 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 and 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 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

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).

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.

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 Environmental Review 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 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

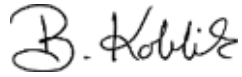
The Director, Section 34.1, Ministry of the Environment and Climate Change
12th Floor
119 King St W
Hamilton ON L8P 4Y7
Fax: (905) 521-7820

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 Permit cancels and replaces Permit Number 7731-78QJ44, issued on 2007/11/28.

Dated at Hamilton this 31st day of May, 2017.



Belinda Koblik
Director, Section 34.1
Ontario Water Resources Act , R.S.O. 1990

Schedule A

This Schedule “A” forms part of Permit To Take Water 3115-AMHHXH, dated May 31, 2017.

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Well Records

UTM Z 17 E 544530 N 4806800

Elev. R 1004

Basin 23

40P8e

K31

ONTARIO

The Water-well Drillers Act, 1954

Department of Mines

GROUND WATER BRANCH
NOV 20 1958
ONTARIO WATER RESOURCES COMMISSION

65 No 292

Water-Well Record

County or Territorial District Waterloo Township, Village, Town or City KITCHENER

Con. — Lot — Street and Number (if in Village, Town or City)

Owner Kitchener Water Commission Address Kitchener Ont.

Date completed 18th Sept 1958
(day) (month) (year)

Pipe and Casing Record

Casing diameter(s) 26" 16"

Length(s) 70' 79.5'

Type of screen Louvre stainless steel

Length of screen 30

Pumping Test

Static level Flows

Pumping rate 1010 I.G.M.

Pumping level 20.3'

Duration of test 70 hrs.

Well Log

Parkway well

Overburden and Bedrock Record	From ft.	To ft.
Top soil	0	2
sticky clay sand	2	5
Boulders coarse gravel clay	5	12
clay sand gravel	12	14
sticky clay gravel	14	16
sticky clay small amount of gravel showing	16	40
clay gravel	40	61
Gravel clay	61	64
Boulders gravel clay	64	71
coarse gravel sand boulders	71	103
hard packed coarse sand boulders gravel	103	105
Boulders coarse sand gravel	105	107-6"

Water Record

Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
		Fresh.

For what purpose(s) is the water to be used? Municipal

Is water clear or cloudy? Yes

Is well on upland, in valley, or on hillside? Valley

Drilling firm International Water Supply

Address London Ont.

Name of Driller C. W. Collens

Address 17 Maitland St. London Ont.

Licence Number 65

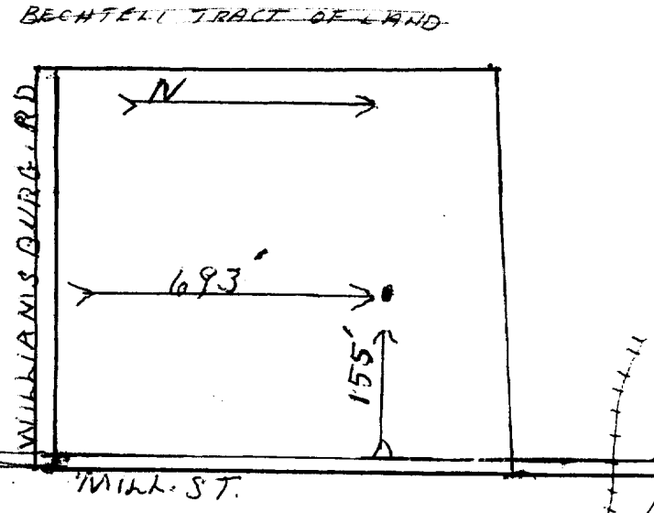
I certify that the foregoing statements of fact are true.

Date Oct 14th/58 C. W. Collens
Signature of Licensee

Test 4-58

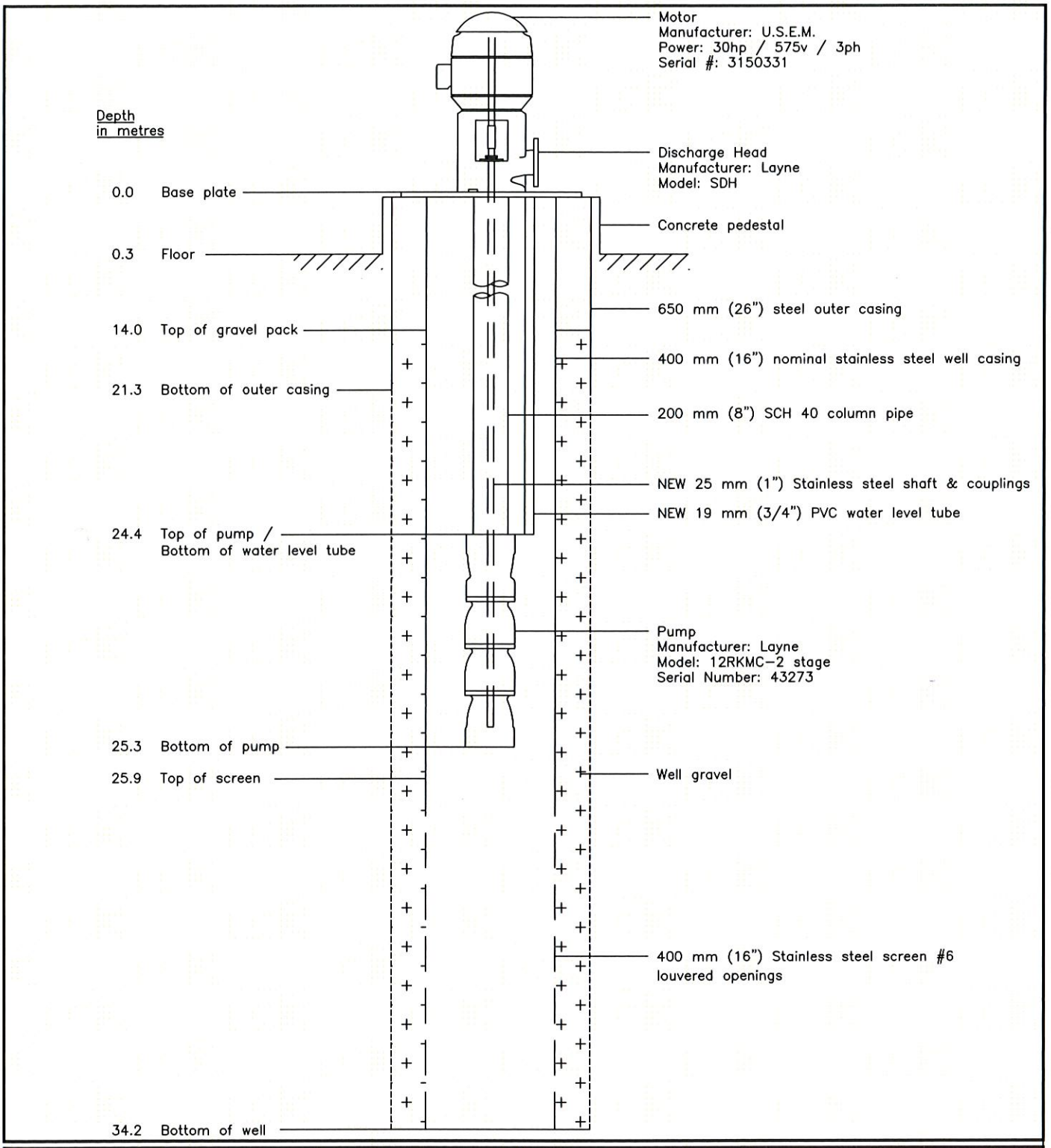
Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 5

CSS.S8



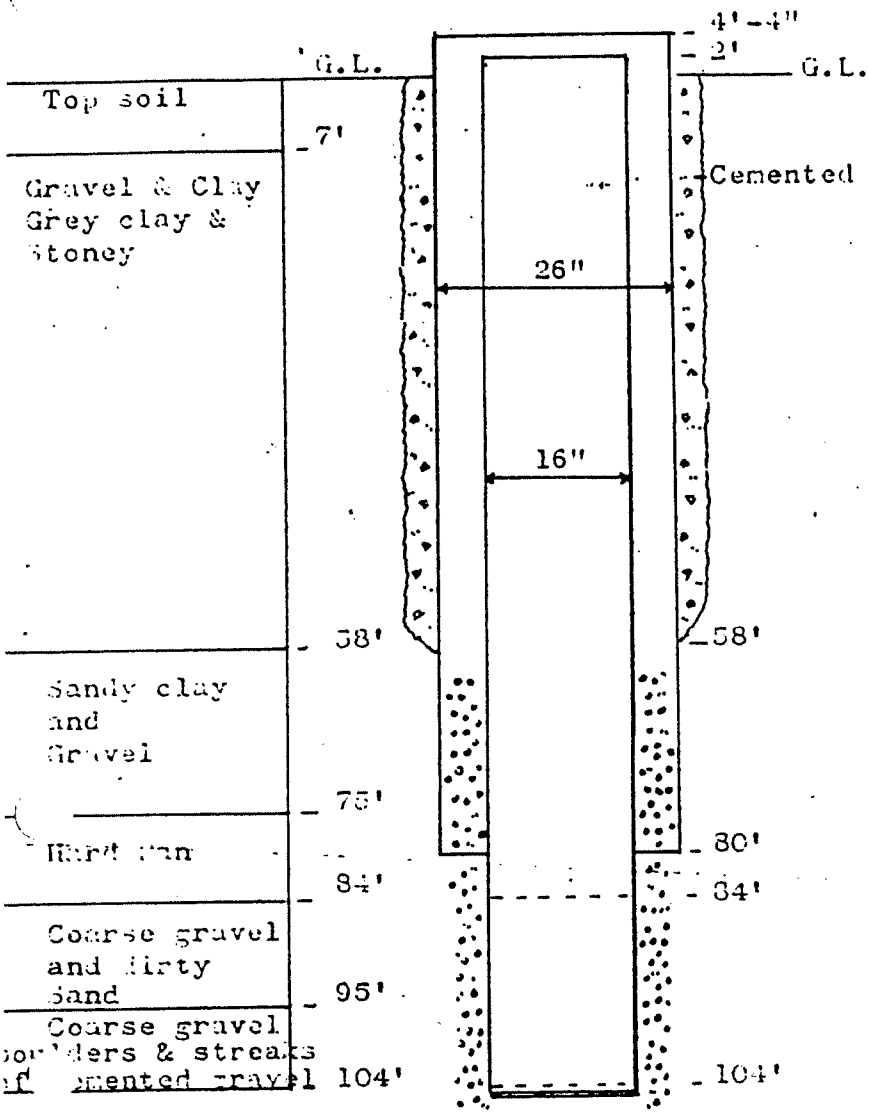
Lotowater
TECHNICAL SERVICES INC.

CLIENT
Regional Municipality of Waterloo

TITLE
K31
Pump Installation Drawing

PROJECT No. 006-384			G:\Lotowater Projects\006 Region of Waterloo\384 K31\ Lineshaft Pump Installation.dwg		FIGURE
DESIGN					
DRAWN	EH	2017-01-25	REVISION No. 2017-01-25	SCALE N.T.S.	2
CHECKED					

K32



Well Material

Outer Casing	84'-4" of 26" casing
Inner Casing	86' of 16" s.s. casing
Screen	20' of s.s. No. 6 opening
Plug	s.s. plate
Gravel	

Pump

No.	43274	Setting BP-MB	80'
No. Stages	2	Length Bowl	5'-7"
Bowl	12" RUMC	Size & Lgth. Suction	--
Head	SDH	Size Column	8" x 1"

Materials or setting details other than standard

Impellers: Trim

Motor

Make	U.S.	Phase	3
H. P.	50	Cycles	60
R. P. M.	1800	Volts	550
Type	HC	Amps.	29.6
Frame	326 UP	Serial	5150882

Bearing Nos. Upper Brg. 1-7220H
Lower Brg. 1-6211 J.

Special Equipment

32
#2
K32

Well No. 2 Parkway

B. P. referred to original ground level +3'-10"

Clear depth below B. P. 107'-10"

Started Oct. 14/60 Final Test

Preliminary Test Oct. 17 Static Level 3'-3"

Final Test /60 Pumping Level 40'-11"

Guarantee IGPM Capacity 1403 IGP

Contract Pressure # Pressure Pump

Length Air Line 81' Main

INTERNATIONAL WATER SUPPLY LTD.

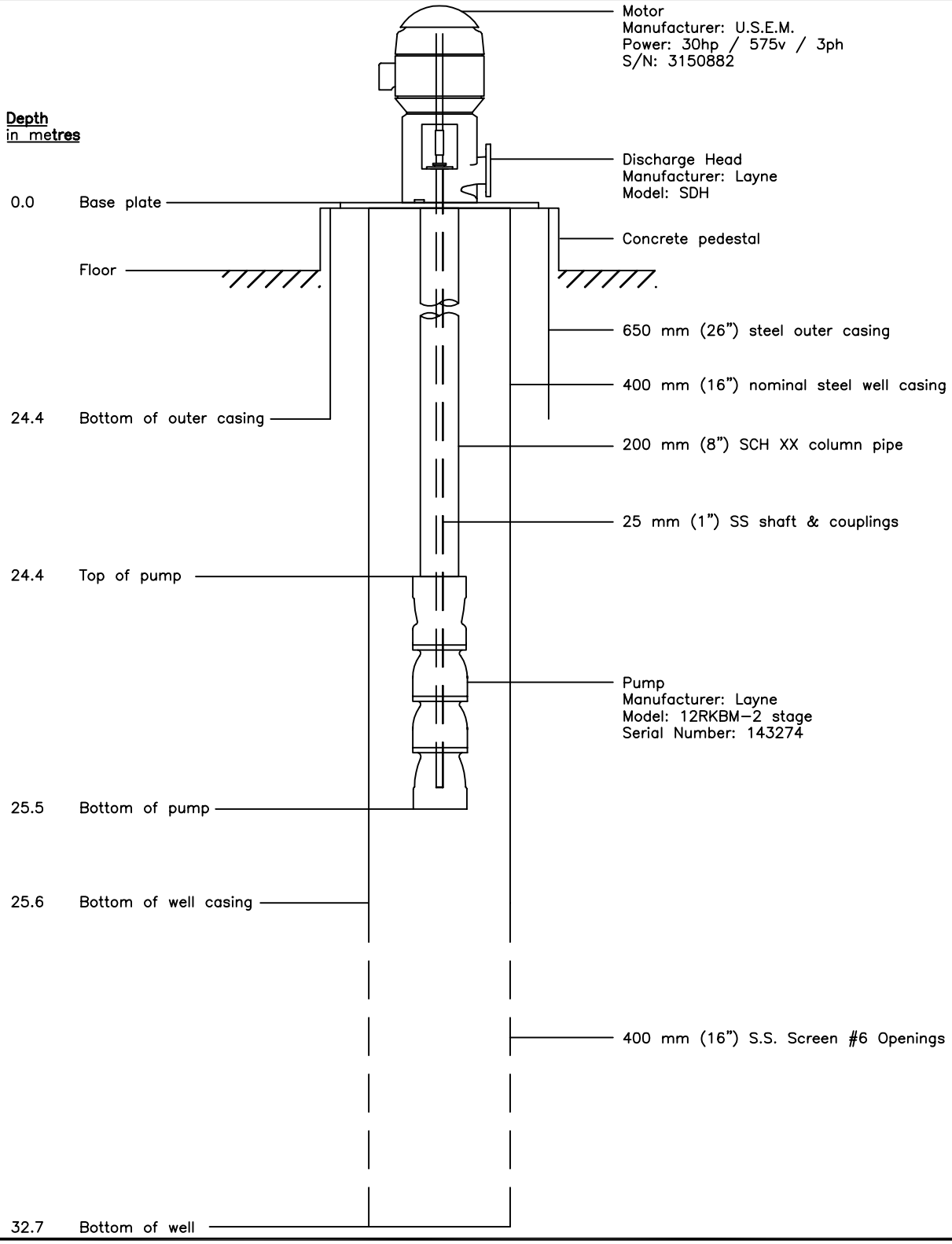
MONTREAL OAKVILLE LONDON, CANADA WATER SUPPLY CONTRACTORS SASKATO VANCOUV

KITCHENER WATER COMMISSION

KITCHENER, ONTARIO

DRILLED BY T. Kyle DRAWN BY sa

INSTALLED BY G. Keyes APPROVED BY



Lotowater
TECHNICAL SERVICES INC.

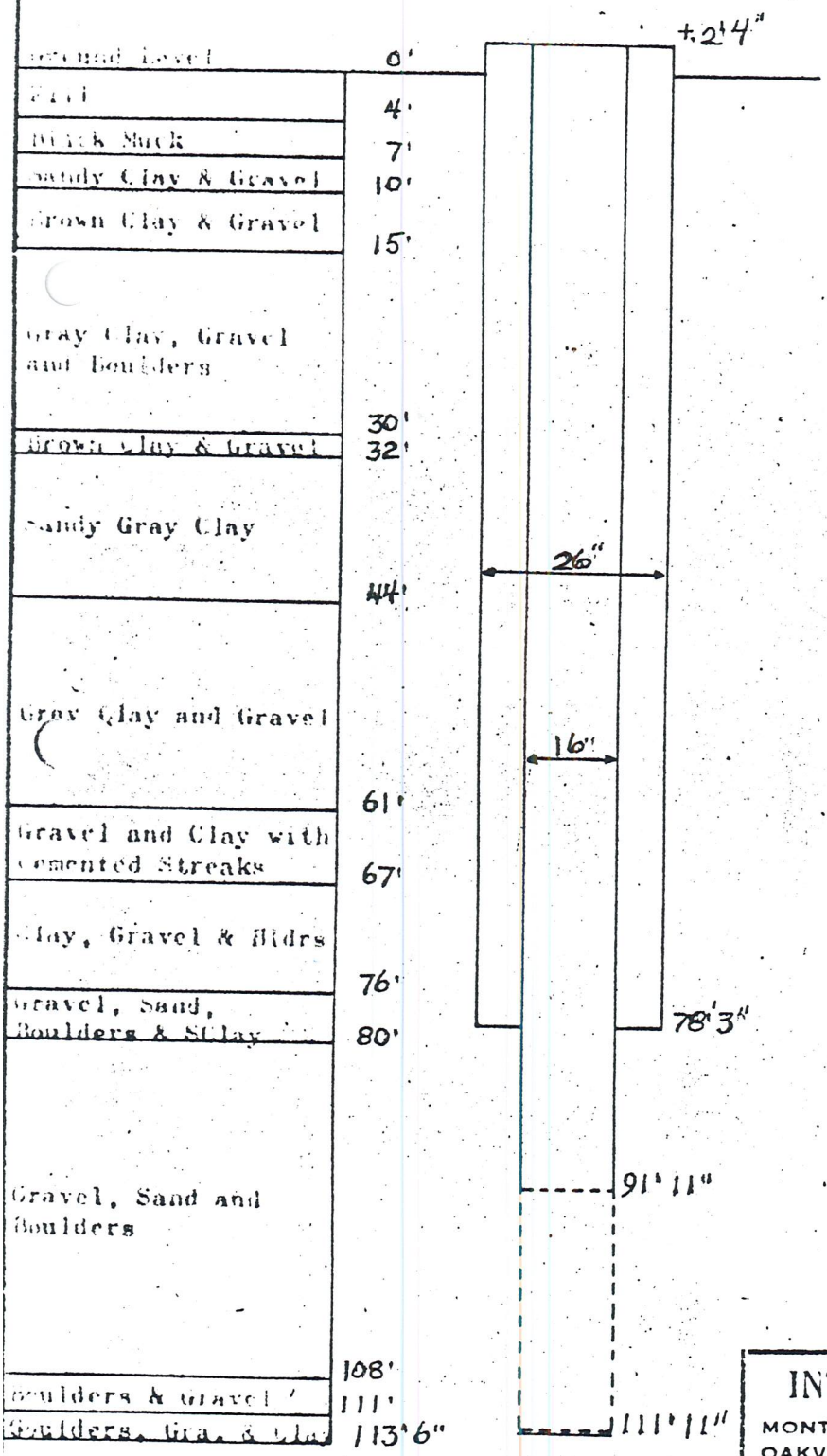
CLIENT
Regional Municipality of Waterloo

TITLE
K32
Pump Installation Drawing

PROJECT No.	006-182	G:\Lotowater Projects\006 Region of Waterloo\182 K32\Lineshaft Pump Installation.dwg			APPENDIX
DESIGN					
DRAWN	EH	2010/10/12	REVISION No. 2010/10/12	SCALE N.T.S.	2D
CHECKED					

K33

K # 33



This 30 H.P. motor was originally on Pump No. 17986, Metzloff.

Well Material

Outer Casing 80'7" of 26"

Inner Casing 94'3 of 16"
Screen 20' of 16" Layne S.S. #4
Plug S.S. Plate
Gravel 37 tons 3/8" x 3/16"; 10 tons sand

Pump

No.	56647	Setting BP-MB	80'
No. Stages	2	Length Bowl	3'7"
Bowl	12" RKAM	Size & Lgth. Suction	10' x 8"
Head	TF818	Size Column	8" x 1"

Materials or setting details other than standard:
Impellers: Trim

Motor

Make	U.S E.M.	Phase	3
H. P.	30	Cycles	60
R. P. M.	1800	Volts	550
Type	CFU	Amps.	29.6
Frame	951	Serial	500272

Bearing Nos., Upper - 7222
Lower - 6215

Special Equipment

Well No. 33

B.P. referred to original ground level 2'4"
Clear depth below B.P. 113'3'
Started Jan. 31/67 Final Test April 19/67
Preliminary Test 28 Feb. Static Level 29'5"
Final Test Pumping Level 45'
Guarantee 700 I G P M Capacity 800 I G P M
Contract Pressure = Pressure Pump =
Length Air Line 90' Main =

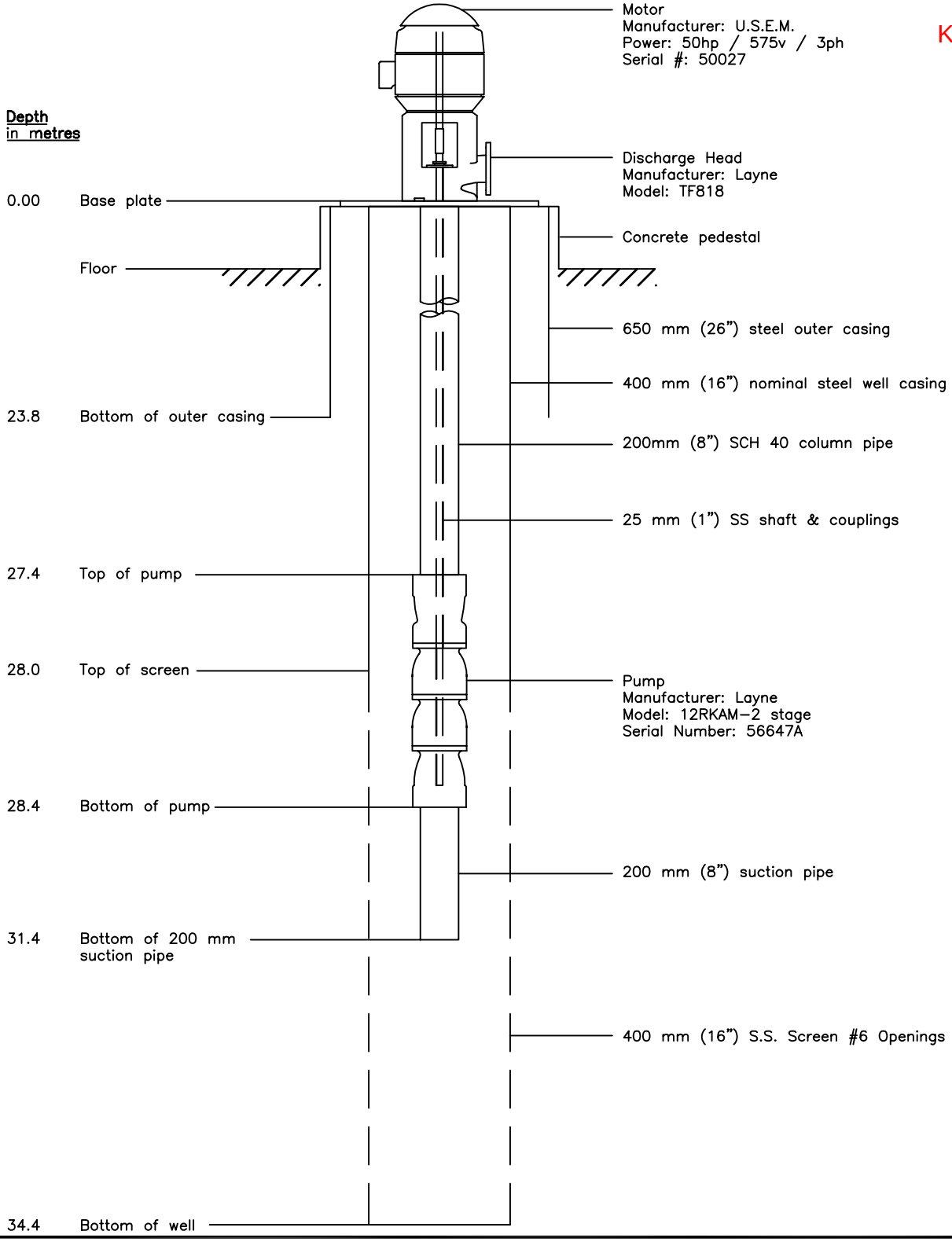
INTERNATIONAL WATER SUPPLY LTD.
MONTREAL LONDON, CANADA SASKATOON
OAKVILLE WATER SUPPLY CONTRACTORS VANCOUVER

KITCHENER WATER COMMISSION

PAKKAY NO. 33

DRILLED BY E. J. Bernhardt DRAWN BY
INSTALLED BY J. Hartman APPROVED BY

K33



Lotowater TECHNICAL SERVICES INC.

CLIENT
Regional Municipality of Waterloo

TITLE
K33
Pump Installation Drawing

PROJECT No. 006-182			G:\Lotowater Projects\006 Region of Waterloo\182 K33\Lineshaft Pump Installation.dwg		APPENDIX
DESIGN			REVISION No. 2010/10/12	SCALE N.T.S.	3D
DRAWN	EH	2010/10/12			
CHECKED					

Terraqua Investigations Ltd.

BOREHOLE NO. : PK1

6508 000 (4 000 429) PK 1

PROJECT – CLIENT : Parkway Area Hydrogeological Study - R.M.O.W.

PROJECT NO. : TA516

CONTRACTOR : All Terrain Drilling Ltd.

METHOD : Refer to page 2

DATE : November 3 to November 21, 1995

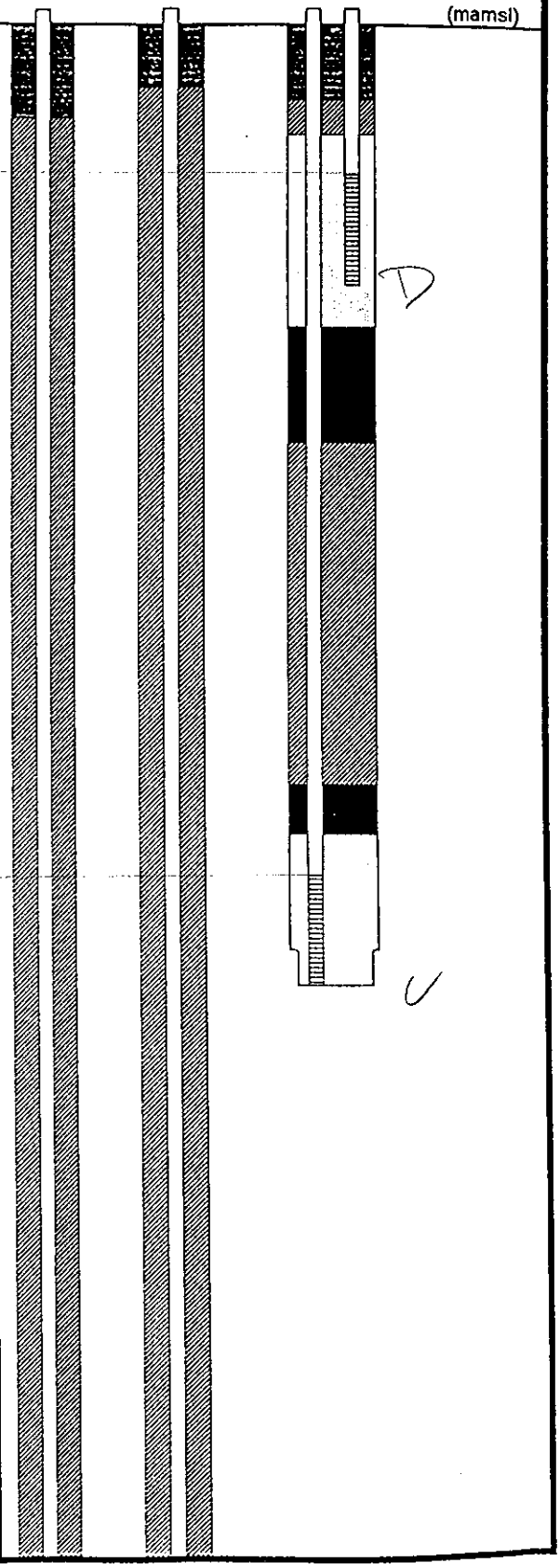
SUPERVISOR : W. Best

K-PY-PK1-95-(A-B-C-D)

GEOLOGIC DESCRIPTION	DEPTH ft	DEPTH m	ELEV. (mAMSL)	SAMPLES #	type	rec ft	interval ft
	0	0	304.760				
TOPSOIL			(surveyed) 304.61				
FINE SAND - light brown, minor silt, minor fine to medium gravel, soft	5	2		1	CS	3'1"	4'1"
			302.35	2	CS	2'8"	5'
SAND and GRAVEL - grey-brown, fine to medium gravel, loose	10	4	300.95	3	CS	1'9"	5'
CLAY TILL - grey, trace fine gravel, dense, silt partings at 17'2", 17'9", 18'6"	15	6		4	CS	5'	5'
	20			5	CS	5'5"	5'
			297.90				
LAYERED CLAY & SAND / SILT			297.41				
CLAY TILL **(probable Maryhill Till)** - grey, dense, trace very fine to fine gravel, occasional medium gravel	25	8		6	CS	5'2"	5'
	30	10		7	CS	5'3"	5'
	35	12		8	CS	5'2"	5'
	40			9	CS	5'	5'
- 48'3" to 49'1": mottled with minor to some silt	45	14		10	CS	5'4"	5'
- 49'1" to 50'9": intensely mottled / layered w light brown clay and silt	50		289.28				
SILT and SAND TILL **(probable Catfish Creek Till)** - grey, some fine to medium gravel, occasional coarse gravel, predominantly soft but occasional denser more till-like zones	55	16		11	CS	5'	5'
		18		12	CS	1'6"	5'
	60			13	CS	2'11"	5'
			285.56				
SAND and GRAVEL - brown, fine to medium sand, fine to medium gravel	65	20					
			284.52	14	CS	3'3"	5'
Alternating SILT and SILT TILL	70						

GROUND WATER MONITOR

PK1-1	PK1-2	PK1-3	PK1-4	
305.60	305.42	305.53	305.52	TOC elev (mamsl)



Terraqua Investigations Ltd.

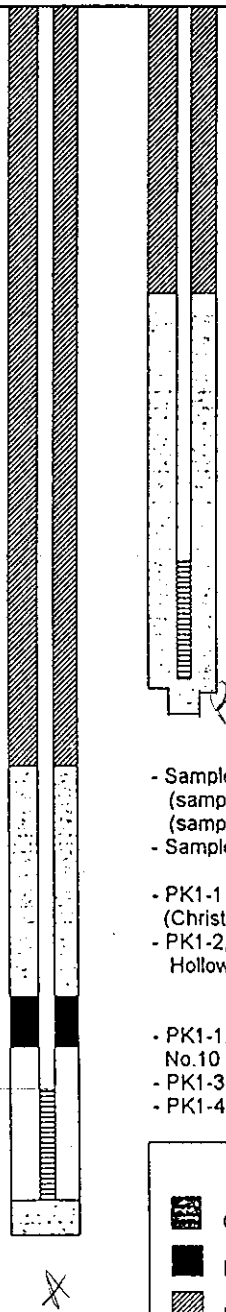
BOREHOLE NO. : PK1

PROJECT – CLIENT : Parkway Area Hydrogeological Study - R.M.O.W.
PROJECT NO. : TA516
CONTRACTOR : All Terrain Drilling Ltd.
METHOD : Refer to page 2

DATE : November 3 to November 21, 1995
SUPERVISOR : W. Best

GEOLOGIC DESCRIPTION	DEPTH ft	DEPTH m	ELEV. (mAMSL)	SAMPLES #	type	rec ft	interval ft
	70						
		22	282.75				
SAND and GRAVEL - medium to coarse sand, fine to coarse gravel	75			15	CS	4'5"	5'
				16	CS	2'10"	3'5"
		24					
	80						
		26		17	SS	3"	3"
	85						
				18	SS	1"	1"
	90						
		28					
- predominantly gravel from about 95'	95			19	SS	1"	1"
				24	PQ	2'	2'
		30		20			
				21			
	100			22	PQ	2'	5'
				23			
		32		26	PQ	5'	5'
	105						
				27	PQ	5'	5'
	110						
		34	270.77				
BEDROCK - Dolostone with Shale interbeds to 117'	115			28	PQ	5'	5'
117' - Shale with Dolostone interbeds to 122'		36					
	120			29	PQ	5'	5'
			267.57				
Bottom of Hole: 122'		38					
	125						
	130	40					
	135						
		42					
	140						

GROUND WATER MONITOR



- Samples 1 to 23 taken from PK1-2 (samples 20, 21 were SS samples) (samples 22,23 were NQ samples)
- Samples 24 to 29 taken from PK1-1

- PK1-1 drilled using Mud Rotary (Christensen Wireline Method)
- PK1-2, -3, -4 drilled using 4 1/4" I.D. Hollow Stem Augers

- PK1-1, -2: 2" PVC Riser Pipe and No.10 Slot Well Screen
- PK1-3: 1 1/2" PVC Riser Pipe, Screen
- PK1-4: 1 1/4" PVC Riser Pipe, Screen

LEGEND

- Cement
- Bentonite Holeplug
- Benseal Grout
- Graded Silica Sand
- Native Material
- PVC Well Screen
- CS Continuous Sample (Hollow Stem Auger Method)
- PQ Continuous Sample (Christensen Method)

Monitoring Well: K-PK-OW1-15

Project:	RMOW Well Replacement	**Drilling method:**	Air Rotary
Client:	Regional Municipality of Waterloo	**Date started/completed:**	09-Mar-2015
Location:	Cambridge, ON	**Ground surface elevation:**	306.06 m AMSL
Number:	160900798	**Top of casing elevation:**	306.93 m AMSL
Field investigator:	C.Davis	**Easting:**	544880
Contractor:	Gerrits Well Drilling Inc.	**Northing:**	4806874

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Diagram / Description
				306.92					
-2	-0.5								Above Ground Casing 0.87 m
0	0.0		Ground Surface	306.06					
			CLAYEY SILTY SAND light orangey brown (7YR 4/6), fine to coarse sand, some clay and silt, fine gravel, subrounded, moist	0.00					
1	0.5								
2	1.0								
3	1.5								
4	2.0								
5	2.5								
6	3.0								
7	3.5								
8	4.0								
9	4.5						0.5	GB	
10	5.0								
11	5.5								
12	6.0								
13	6.5			299.35					
14	7.0		CLAY TILL light grey brown (7.5R 4/1), trace silt, trace fine sand, dry to moist	6.71					
15	7.5								
16	8.0								
17	8.5								
18	9.0								
19	9.5								
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									

Above Ground Casing 0.87 m

48.5 mm ID Schedule 80 PVC casing 0.87 m AGS to 30.48 m BGS

254 mm Diameter Borehole 0 - 6.1 m BGS

155.5 mm ID steel casing 1 m AGS to 16.76 m BGS

Bentonite Grout 0 to 16.45 m

Screen Interval: 30.48 - 33.53 m BGS
Sand Pack Interval: 29.56 - 35.05 m BGS
Well Seal Interval: 0.00 - 29.56 m BGS

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

WRAS No. 9207188

Stantec

Drawn By/Checked By: CD/LV

Monitoring Well: K-PK-OW1-15

Project:	RMOW Well Replacement	**Drilling method:**	Air Rotary
Client:	Regional Municipality of Waterloo	**Date started/completed:**	09-Mar-2015
Location:	Cambridge, ON	**Ground surface elevation:**	306.06 m AMSL
Number:	160900798	**Top of casing elevation:**	306.93 m AMSL
Field investigator:	C.Davis	**Easting:**	544880
Contractor:	Gerrits Well Drilling Inc.	**Northing:**	4806874

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Diagram / Description
33	10.0		CLAY TILL light grey brown (7.5R 4/1), trace silt, trace fine sand, dry to moist		Possible ATB3	Possible Lower Maryhill Till and Equivalents	1	GB	
34	10.5								
35	11.0								
36	11.5								
37	12.0								
38	12.5								
39	13.0								
40	13.5								
41	14.0								
42	14.5								
43	15.0								
44	15.5		silt content increasing at 15.2 m BGS				2	GB	
45	16.0								
46	16.5			289.29					
47	17.0		SILT TILL grey-brown (5YR 5/1), some fine to coarse sand, some fine gravel, subangular to angular, some clay	16.76			3	GB	
48	17.5								
49	18.0								161 mm Borehole 6.1 - 35.05 m
50	18.5								
51	19.0								
52	19.5								
53	20.0						4	GB	
54									
55									
56									
57									
58									
59									
60									
61									
62									
63									
64									
65									
66									

Screen Interval: 30.48 - 33.53 m BGS
Sand Pack Interval: 29.56 - 35.05 m BGS
Well Seal Interval: 0.00 - 29.56 m BGS

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

WRAS No. 9207188

Stantec

Drawn By/Checked By: CD/LV

Monitoring Well: K-PK-OW1-15

Project:	RMOW Well Replacement	**Drilling method:**	Air Rotary
Client:	Regional Municipality of Waterloo	**Date started/completed:**	09-Mar-2015
Location:	Cambridge, ON	**Ground surface elevation:**	306.06 m AMSL
Number:	160900798	**Top of casing elevation:**	306.93 m AMSL
Field investigator:	C.Davis	**Easting:**	544880
Contractor:	Gerrits Well Drilling Inc.	**Northing:**	4806874

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Diagram / Description
68	21.0		SILT TILL grey-brown (5YR 5/1), some fine to coarse sand, some fine gravel, subangular to angular, some clay clay content decreasing at 20.7 m BGS		Possible ATC1	Possible Upper/Main Catfish Creek Till			
69									
70									
71	21.5		becomes very hard at 21.3 m BGS						
72	22.0								
73									
74	22.5								
75									
76	23.0								Bentonite Holeplug 16.45 to 29.56 m
77									
78	23.5								
79	24.0								
80				281.67					
81	24.5		SILTY GRAVELLY SAND grey, fine to coarse sand, fine to coarse gravel	24.38			5	GB	
82	25.0								
83									
84	25.5								
85									
86	26.0								
87	26.5								
88									
89	27.0								
90	27.5		trace clay beginning at 27.4 m BGS		Possible AFC1	Possible Catfish Stratified Deposits			
91									
92	28.0								
93									
94	28.5								
95	29.0		producing orange-brown water beginning at 28.9 m BGS some clay coarse gravel decreasing				6	GB	
96									
97	29.5								
98									
99	30.0								No. 2 Silica Sand 29.56 to 35.05 m
100	30.5			275.58					
101			SAND AND GRAVEL mottled grey/black, fine to coarse sand, fine gravel, subrounded to rounded, wet, producing more water	30.48					
	31.0								

Screen Interval: 30.48 - 33.53 m BGS
Sand Pack Interval: 29.56 - 35.05 m BGS
Well Seal Interval: 0.00 - 29.56 m BGS

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

WRAS No. 9207188

Stantec

Drawn By/Checked By: CD/LV

Monitoring Well: K-PK-OW1-15

Project:	RMOW Well Replacement	**Drilling method:**	Air Rotary
Client:	Regional Municipality of Waterloo	**Date started/completed:**	09-Mar-2015
Location:	Cambridge, ON	**Ground surface elevation:**	306.06 m AMSL
Number:	160900798	**Top of casing elevation:**	306.93 m AMSL
Field investigator:	C.Davis	**Easting:**	544880
Contractor:	Gerrits Well Drilling Inc.	**Northing:**	4806874

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Diagram	Description
103	31.5		SAND AND GRAVEL mottled grey/black, fine to coarse sand, fine gravel, subrounded to rounded, wet, producing more water							
104										
105	32.0									
106										
107	32.5									
108										
109	33.0									
110	33.5			272.53						
111			GRAVELLY CLAY grey brown, some sand, poor recovery	33.53			7	GB		
112	34.0									
113										
114	34.5									
115	35.0			271.00						
116			End of Borehole	35.05						
117	35.5									
118										
119	36.0									
120										
121	36.5									
122	37.0									
123										
124	37.5									
125										
126	38.0									
127										
128	38.5									
129	39.0									
130										
131	39.5									
132										
133	40.0									
134										
135	40.5									
136	41.0									
	41.5									

No.10 Slot
PVC Screen
60 mm OD Diameter
30.48 to 33.5 m

Screen Interval: 30.48 - 33.53 m BGS
Sand Pack Interval: 29.56 - 35.05 m BGS
Well Seal Interval: 0.00 - 29.56 m BGS

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

WRAS No. 9207188

Stantec

Drawn By/Checked By: CD/LV

STANTEC BOREHOLE AND WELL V2 160900798_20150309_CD.GPJ STANTEC - DATA TEMPLATE.GDT 7/30/15 NSPINA

K-PY-OW3-12-(A-B)

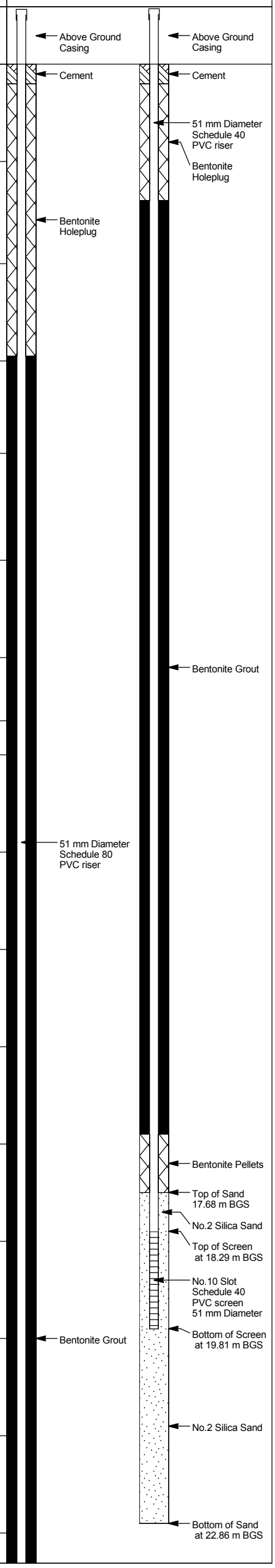
Monitoring Well: K-PY-OW3-12

Project: Hydrogeology Study for River Road Extension
Client: Regional Municipality of Waterloo
Location: Kitchener, Ontario; 03
Number: 160900687
Field investigator: AM / AV / EH / RD
Contractor: Aardvark Drilling Inc.
Drilling method: CME 850 track mount and Continuous PQ
Date started/completed: 12-Mar-2012 / 21-Mar-2012

Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
				325.56					
0	0		Ground Surface	324.67					
			TOPSOIL sand and silt, fine gravel, grass, roots, organics, dark greyish-brown (10Yr, 3/2), loose, moist	0.00 324.44					
			SAND fine, trace cobbles, yellowish-brown (10Yr, 5/4), loose, moist	0.23			1	CC	57
			becomming finer at 1.01 m BGS	323.15					
5			SAND and GRAVEL fine and medium sand, trace to little coarse sand, coarse gravel	1.52			2	CC	32
	2			321.62					
10			SAND fine and medium, trace to little coarse sand, little to some gravel and cobbles, brown (10Yr, 4/3), loose, moist	3.05			3	CC	15
	4								
15			colour change to light yellowish-brown at 4.57 m BGS				4	CC	60
20	6						5	CC	60
25									
	8						6	CC	60
30							7	CC	39
	10		wet at 10.29 m BGS		AFB1/ AFB2	Upper/Middle Waterloo Moraine stratified sediments and equivalents	8	PQ	18
35							9	PQ	52
40	12								
							10	PQ	54
45	14						11	PQ	52
50									
	16		increasing cobbles beginning at 15.95 m BGS, subrounded				12	PQ	24
55							13	PQ	24
60	18								
							14	PQ	0
65	20						15	PQ	12
70				303.03					
	22		SANDY SILT TILL some fine sand, brown, stiff, wet	21.64			16	PQ	18
75			trace clay, colour change to grey at 23.32 m BGS						

WELL DETAILS

	K-PY-OW3A-12	K-PY-OW3B-12
Name:	K-PY-OW3A-12	K-PY-OW3B-12
GS Elev:	324.67 m AMSL	324.69 m AMSL
TOC Elev:	325.59 m AMSL	325.61 m AMSL
Easting:	545112	545115
Northing:	4807124	4807124
Stick-up:	0.92 m	0.92 m



Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
CC - continuous core sample
PQ - wireline continuous core sample
n/a - not available

Spatial coordinates were estimated using aerial photography
Ground surface elevation estimated based on Region Digital Elevation Model (DEM)

Drawn By/Checked By: EH / SB

Stantec

Monitoring Well: K-PY-OW3-12

Project: Hydrogeology Study for River Road Extension
Client: Regional Municipality of Waterloo
Location: Kitchener, Ontario; 03
Number: 160900687

Field investigator: AM / AV / EH / RD
Contractor: Aardvark Drilling Inc.
Drilling method: CME 850 track mount and Continuous PQ
Date started/completed: 12-Mar-2012 / 21-Mar-2012

Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Recovery
			SUBSURFACE PROFILE		HYDROGEOLOGY		SAMPLE DETAILS		
80	24		SANDY SILT TILL some fine sand, brown, stiff, wet		ATC1	Catfish Creek Till	17	PQ	53
85	26		increasing cobbles, gravel and sand in till at 26.06 m BGS				18	PQ	55
90	28						19	PQ	48
95				295.56			20	PQ	60
	30		SANDY SILT TO SILTY SAND TILL little to some fine and coarse gravel, trace to little cobbles, greyish-brown to grey, stiff	29.11			21	PQ	60
100				293.53					
			SAND and GRAVEL little silt, greyish-brown, loose, subangular to well rounded	31.14 293.20			22	PQ	58
105	32		SAND to SILTY SAND fine sand, some silt, greyish-brown, irregular horizontal features, well sorted, stiff	31.47	ATC1	Upper Catfish Creek Till			
				292.03			23	PQ	46
110	34		SANDY SILT TILL gravel and cobbles, wet	32.64			24	PQ	n/a
115				289.62					
	36		GRAVEL some sand, little cobble, loose, well rounded	35.05	AFD1	Pre-Catfish Creek sand and gravel	25	PQ	26
120									
	38						26	PQ	24
125				286.42					
			SAND and GRAVEL medium, little coarse sand, trace cobbles, greyish-brown, rounded gravel	38.25			27	PQ	24
130				284.90					
	40		End of Borehole	39.78					
135									
	42								
140									
	44								
145									
150	46								
155									

WELL DETAILS

Name:	K-PY-OW3A-12	Name:	K-PY-OW3B-12
GS Elev:	324.67 m AMSL	GS Elev:	324.69 m AMSL
TOC Elev:	325.59 m AMSL	TOC Elev:	325.61 m AMSL
Easting:	545112	Easting:	545115
Northing:	4807124	Northing:	4807124
Stick-up:	0.92 m	Stick-up:	0.92 m

- Bentonite Pellets
- Top of Sand 36.27 m BGS
- No.2 Silica Sand
- Top of Screen at 36.88 m BGS
- No.10 Slot Schedule 80 PVC screen 51 mm Diameter
- Bottom of Screen at 38.41 m BGS
- No.2 Silica Sand
- Bottom of Sand at 39.78 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing
CC - continuous core sample
PQ - wireline continuous core sample
n/a - not available

Spatial coordinates were estimated using aerial photography
Ground surface elevation estimated based on Region Digital Elevation Model (DEM)

Drawn By/Checked By: EH / SB

Stantec

K-PK-OW1-16-A

Monitoring Well: K-PK-OW1-16

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Kitchener, ON
Number: 160900798

Field investigator: C.Davis
Contractor: Gerrits Drilling and Engineering Inc.
Drilling method: Air Rotary/Badger Daylighting
Date started/completed: 12-Oct-2016 / 21-Oct-2016

Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	WELL DETAILS
				306.29					Name: K-PK-OW1A-16 Location: Parkway Well Field GS Elev: 305.34 m AMSL TOC Elev: 306.29 m AMSL Easting: 544527.81 Northing: 4807057.36 Stick-up: 0.95 m Name: K-PK-OW1B-16 Location: Parkway Well Field GS Elev: 305.25 m AMSL TOC Elev: 306.33 m AMSL Easting: 544529.46 Northing: 4807058.31 Stick-up: 1.07 m
-3 to -1	-1.0 to -0.5								Above Ground Casing 0.95 m stick-up Above Ground Casing 1.07 m stick-up
0	0.0		Ground Surface	305.34					
0 to 15	0.0 to 4.5		SAND AND GRAVEL compact, brown, fine to coarse sand, fine gravel, cobbles, moist to wet	0.00	Possible AFB2	Upper/Middle Waterloo Moraine Stratified Sediments and equivalents	1 2 3	GB	Bentonite Holeplug 0 to 0.6 m Cement 0.6 to 3.05 m 155 mm ID steel casing 0 to 2.4 m Cement 0.6 to 1.52 m Schedule 40 PVC Riser 0 to 2.1 m No.3 Silica sand 1.8 to 3.66 m 356 mm diameter borehole No. 10 slot Schedule 40 PVC Screen 51 mm Diameter 2.13 to 3.66 m
15 to 31	4.5 to 9.5		CLAY TO SILTY CLAY stiff, dark grey brown (10 yr 3/2), trace sand, trace to some fine gravel, rounded, trace rock fragments sand content and rock fragments decrease with depth	300.77 4.57	ATB3	Lower Maryhill Till	4 5 6	GB	152.4 mm Diameter Borehole

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

K-PK-OW1A-16 WRAS No. 9207313
K-PK-OW1B-16 WRAS No. 9207314

Clay/silty clay encountered at 12' in shallow borehole

Stratigraphy based on observations of deep borehole

Drawn By/Checked By: CD/LV

Monitoring Well: K-PK-OW1-16

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Kitchener, ON
Number: 160900798

Field investigator: C.Davis
Contractor: Gerrits Drilling and Engineering Inc.
Drilling method: Air Rotary/Badger Daylighting
Date started/completed: 12-Oct-2016 / 21-Oct-2016

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE 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	Name: K-PK-OW1A-16 Location: Parkway Well Field GS Elev: 305.34 m AMSL TOC Elev: 306.29 m AMSL Easting: 544527.81 Northing: 4807057.36 Stick-up: 0.95 m Name: K-PK-OW1B-16 Location: Parkway Well Field GS Elev: 305.25 m AMSL TOC Elev: 306.33 m AMSL Easting: 544529.46 Northing: 4807058.31 Stick-up: 1.07 m
32	10.0		CLAY TO SILTY CLAY stiff, dark grey brown (10 yr 3/2), trace sand, trace to some fine gravel, rounded, trace rock fragments				7	GB	
33									
34	10.5								
35									
36	11.0						8	GB	
37									
38	11.5								
39									
40	12.0				ATB3	Lower Maryhill Till			
41	12.5								
42									
43	13.0						9	GB	Bentonite Holeplug 3.05 to 22.9 m
44									
45	13.5								
46									
47	14.0								
48	14.5			290.71			10	GB	
49			CLAY AND GRAVEL hard, light brown (10 yr 6/2), some fine to coarse sand, fine to coarse gravel and cobbles, subangular to angular, rock fragments, limestone - dolostone composition	14.63					
50	15.0								
51	15.5								
52							11	GB	
53	16.0								
54	16.5		clast size increases, silt and sand content increase with depth		ATC1	Upper/Main Catfish Creek Till			
55									
56	17.0								
57	17.5						12	GB	
58									
59	18.0								
60									
61	18.5								
62	19.0						13	GB	
63									
64	19.5				ATC1	Upper/Main Catfish Creek Till			
65									
66	20.0								

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

K-PK-OW1A-16 WRAS No. 9207313
K-PK-OW1B-16 WRAS No. 9207314

Clay/silty clay encountered at 12' in shallow borehole

Stratigraphy based on observations of deep borehole

Drawn By/Checked By: CD/LV

Monitoring Well: K-PK-OW1-16

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Kitchener, ON
Number: 160900798

Field investigator: C.Davis
Contractor: Gerrits Drilling and Engineering Inc.
Drilling method: Air Rotary/Badger Daylighting
Date started/completed: 12-Oct-2016 / 21-Oct-2016

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE 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	Name: K-PK-OW1A-16 Location: Parkway Well Field GS Elev: 305.34 m AMSL TOC Elev: 306.29 m AMSL Easting: 544527.81 Northing: 4807057.36 Stick-up: 0.95 m Name: K-PK-OW1B-16 Location: Parkway Well Field GS Elev: 305.25 m AMSL TOC Elev: 306.33 m AMSL Easting: 544529.46 Northing: 4807058.31 Stick-up: 1.07 m
67	20.5		CLAY AND GRAVEL hard, light brown (10 yr 6/2), some fine to coarse sand, fine to coarse gravel and cobbles, subangular to angular, rock fragments, limestone - dolostone composition				14	GB	
68									
69	21.0			284.31					
			SAND AND GRAVEL compact, light tan brown (10 yr 1/7), trace clay in clumps, little silt, fine to coarse sand, fine to coarse gravel, subrounded to rounded, wet	21.03					
70									
	21.5		clay and silt decrease with depth, color change to grey						
71									
72	22.0						15	GB	
73									
74	22.5								
75									
	23.0								
76									
77	23.5						16	GB	
78									
79	24.0				AFD1	Pre-Catfish Sand and Gravel			
80									
	24.5		heaving sands during drilling						
81									
82	25.0						17	GB	
83									
84	25.5								
85									← No. 3 silica sand 22.9 to 35.7 m
	26.0								
86									
87	26.5						18	GB	
88									
89	27.0								
90									
	27.5								
91									
92	28.0						19	GB	
93									
94	28.5								
95									
	29.0								
96									
97	29.5						20	GB	
98									
99	30.0								
100									← No. 10 slot Schedule 80 PVC screen 51 mm OD 28.9 to 32 m
	30.5								
101									

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

K-PK-OW1A-16 WRAS No. 9207313
K-PK-OW1B-16 WRAS No. 9207314

Clay/silty clay encountered at 12' in shallow borehole

Stratigraphy based on observations of deep borehole

Drawn By/Checked By: CD/LV

Monitoring Well: K-PK-OW1-16

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Kitchener, ON
Number: 160900798

Field investigator: C.Davis
Contractor: Gerrits Drilling and Engineering Inc.
Drilling method: Air Rotary/Badger Daylighting
Date started/completed: 12-Oct-2016 / 21-Oct-2016

Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type
102	31.0		SAND AND GRAVEL compact, light tan brown (10 yr 1/7), trace clay in clumps, little silt, fine to coarse sand, fine to coarse gravel, subrounded to rounded, wet		AFD1	Pre-Catfish Sand and Gravel	21	GB
103	31.5							
104								
105	32.0							
106							22	GB
107	32.5							
108	33.0							
109								
110	33.5							
111								
112	34.0							
113	34.5						23	GB
114								
115	35.0		brown limestone/dolostone boulder or potentially bedrock at 35.7 m					
116								
117	35.5			269.68				
			End of Borehole	35.66				
118	36.0							
119								
120	36.5							
121								
122	37.0							
123	37.5							
124								
125	38.0							
126								
127	38.5							
128	39.0							
129								
130	39.5							
131								
132	40.0							
133	40.5							
134								
135	41.0							
136	41.5							

WELL DETAILS

	K-PK-OW1A-16	K-PK-OW1B-16
Location:	Parkway Well Field	Parkway Well Field
GS Elev:	305.34 m AMSL	305.25 m AMSL
TOC Elev:	306.29 m AMSL	306.33 m AMSL
Easting:	544527.81	544529.46
Northing:	4807057.36	4807058.31
Stick-up:	0.95 m	1.07 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

K-PK-OW1A-16 WRAS No. 9207313
K-PK-OW1B-16 WRAS No. 9207314

Clay/silty clay encountered at 12' in shallow borehole

Stratigraphy based on observations of deep borehole

Drawn By/Checked By: CD/LV

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Appendix C

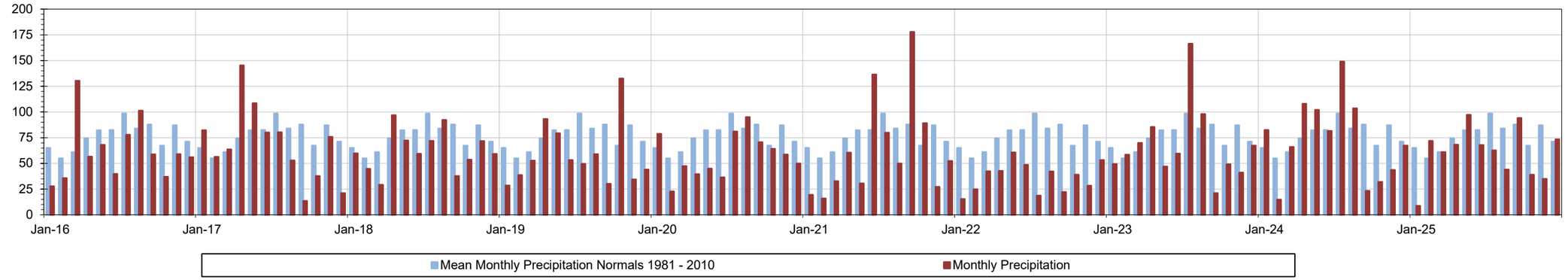
Monitoring Data
(Pumped Volumes and Hydrographs)

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

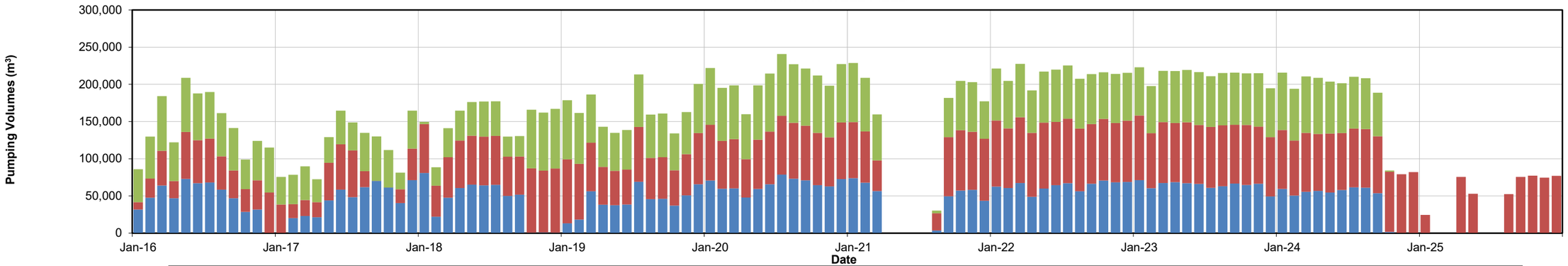
Well Field	Major or Minor Supply	Production Well Name	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
			MOE Permit Number	Permitted Capacity (total m^3/year)*	Permitted Rate (L/s)*	Total 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)
Parkway	Major	K31	Not Required - well installed prior to Ontario Water Resource			410,733	1,125	13.0	761,760	2,087	24.2	772,776	2,117	24.5	513,197	1,406	16.3	0	0	0.0
		K32	Not Required - well installed prior to Ontario Water Resource			530,617	1,454	16.8	1,013,736	2,777	32.1	962,216	2,636	30.5	941,587	2,580	29.9	510,476	1,399	16.2
		K33	3115-AMHHXH	**1,672,459**	**53.0**	452,814	1,241	14.4	799,509	2,190	25.4	824,115	2,258	26.1	632,767	1,734	20.1	0	0	0.0
			Well Field Total	***N/A***	***N/A***	***1,394,164***	***3,820***	***44.2***	***2,575,005***	***7,055***	***81.7***	***2,559,107***	***7,011***	***81.1***	***2,087,551***	***5,719***	***66.2***	***510,476***	***1,399***	***16.2***

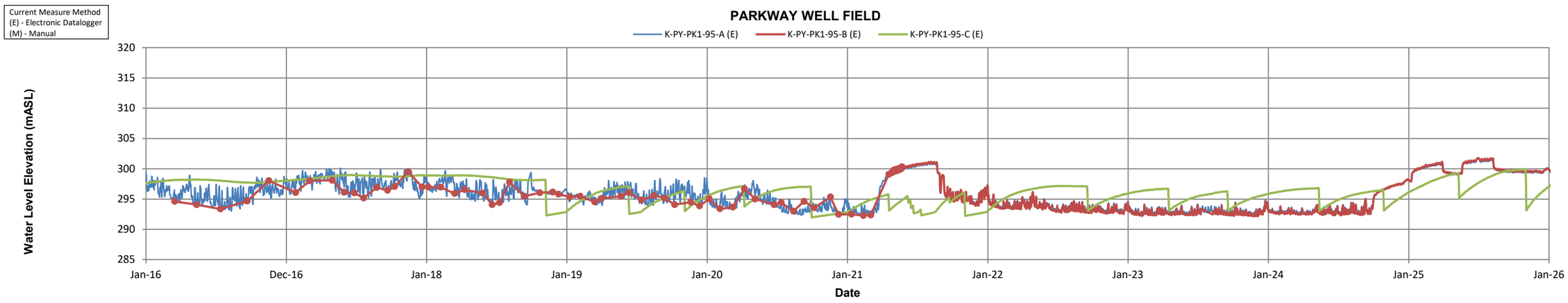
Notes:
- = no applicable data
n/a = data not available
* = rates and volumes based on permitted L/day

Actual versus Mean Monthly Precipitation
Weather Station - Region of Waterloo International Airport

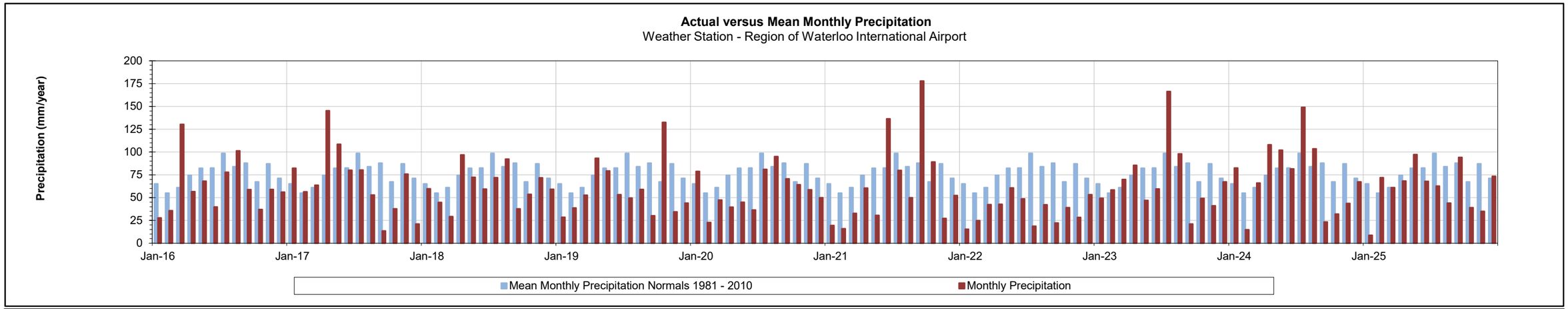


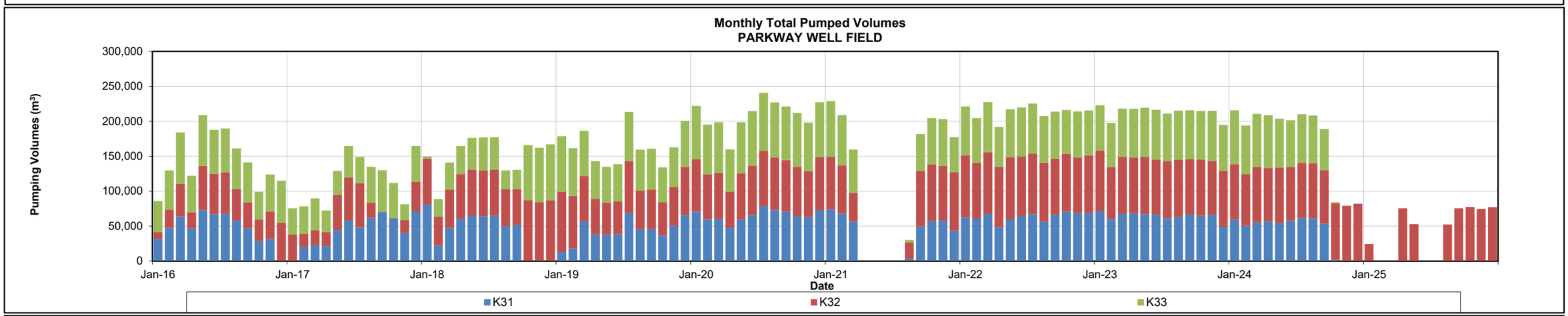
Monthly Total Pumped Volumes
PARKWAY WELL FIELD

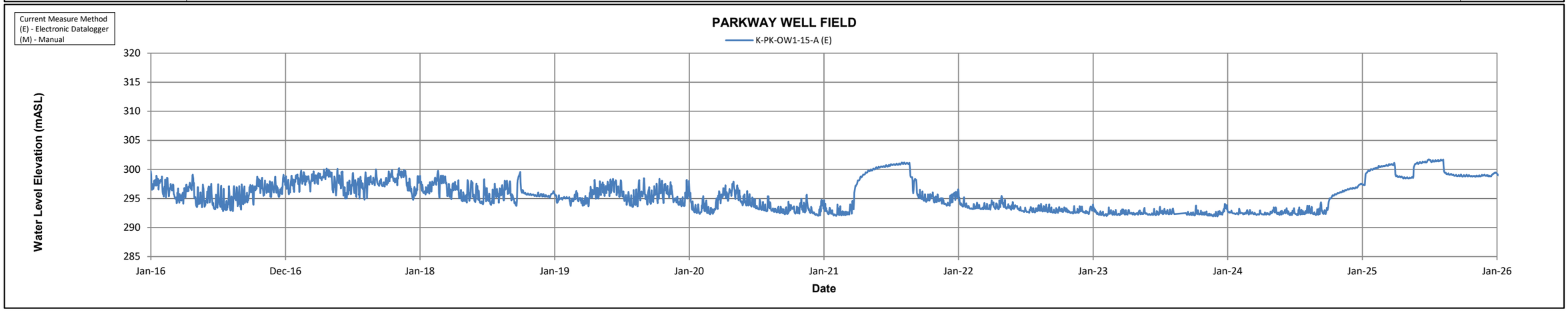




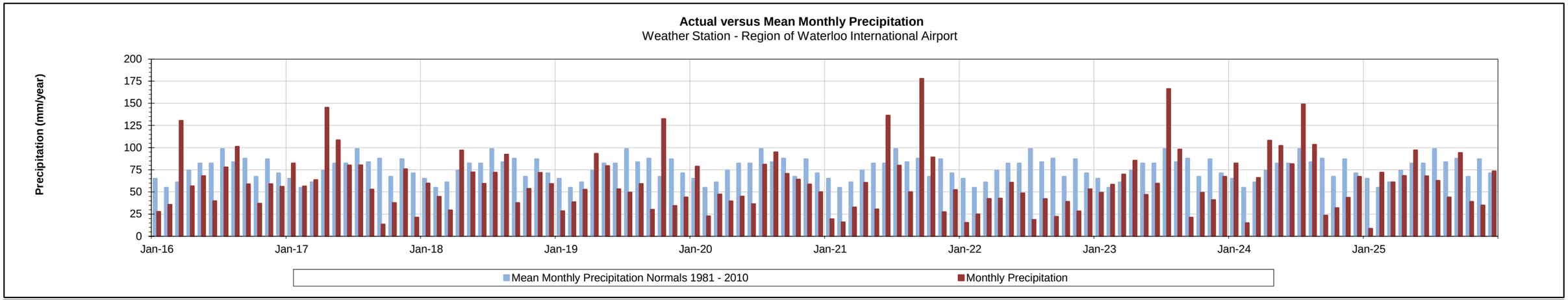
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
PARKWAY

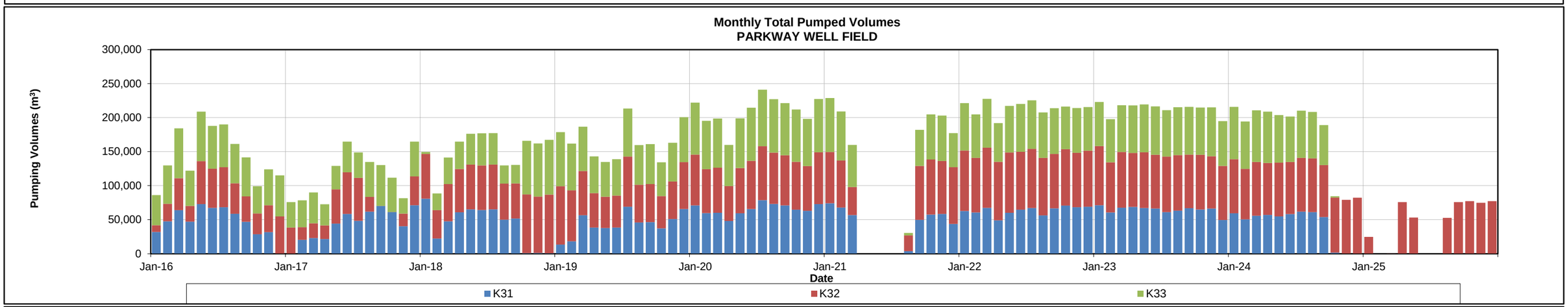


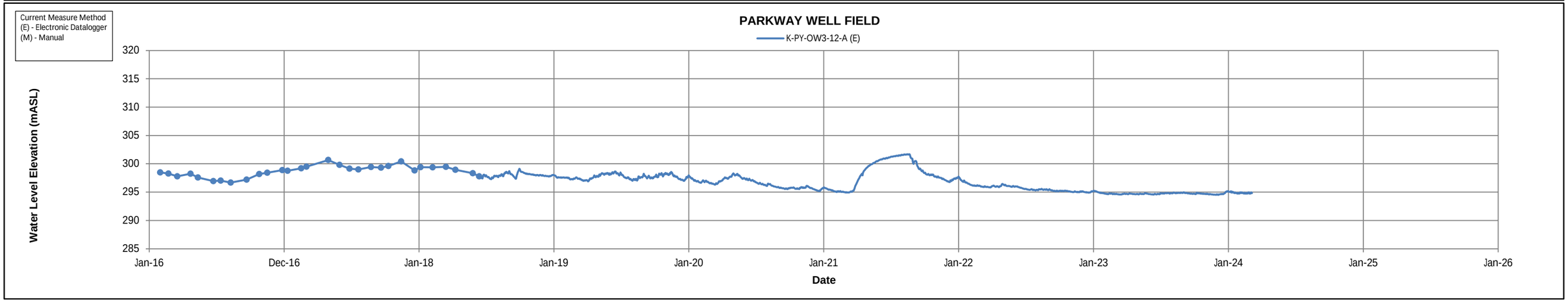


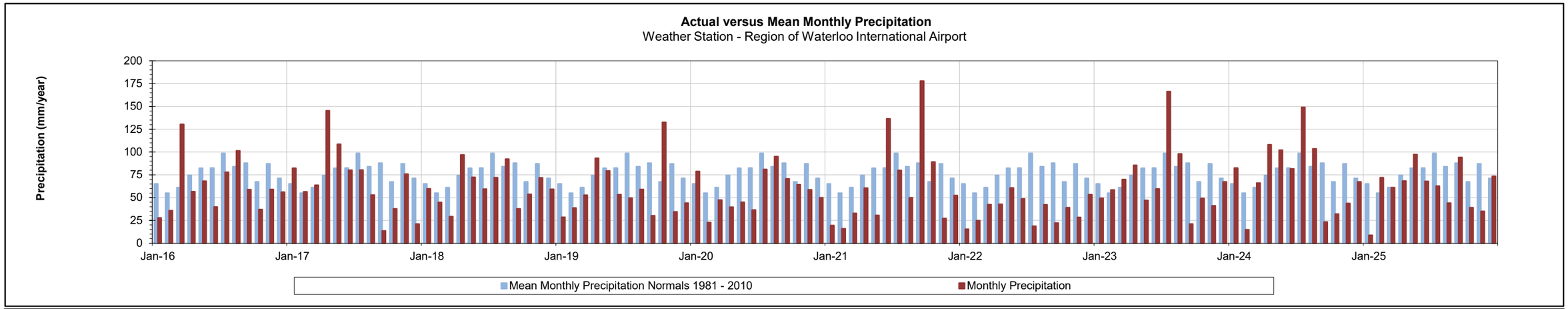


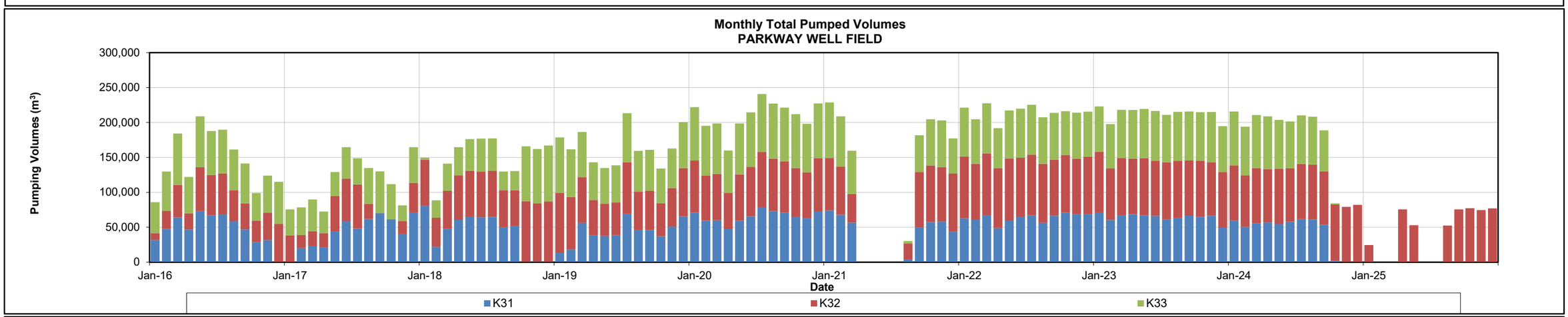
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
PARKWAY

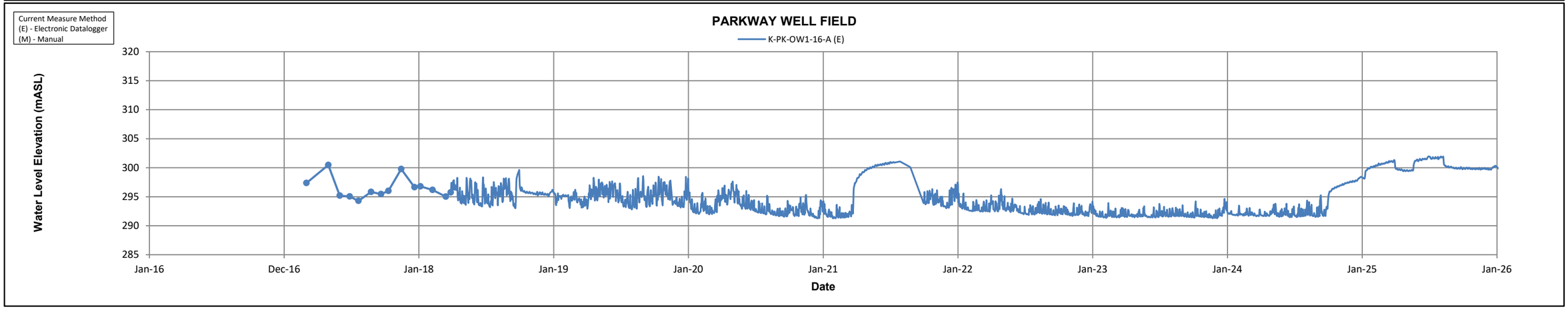







Actual versus Mean Monthly Precipitation
Weather Station - Region of Waterloo International Airport
Precipitation (mm/year)
200
175
150
125
100
75
50
25
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Mean Monthly Precipitation Normals 1981 - 2010
Monthly Precipitation


Monthly Total Pumped Volumes
PARKWAY WELL FIELD
Pumping Volumes (m³)
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
K31
K32
K33


Current Measure Method
(E) - Electronic Datalogger
(M) - Manual
PARKWAY WELL FIELD
K-PK-OW1-16-A (E)
Water Level Elevation (mASL)
320
315
310
305
300
295
290
285
Jan-16
Dec-16
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Jan-26
Date

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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

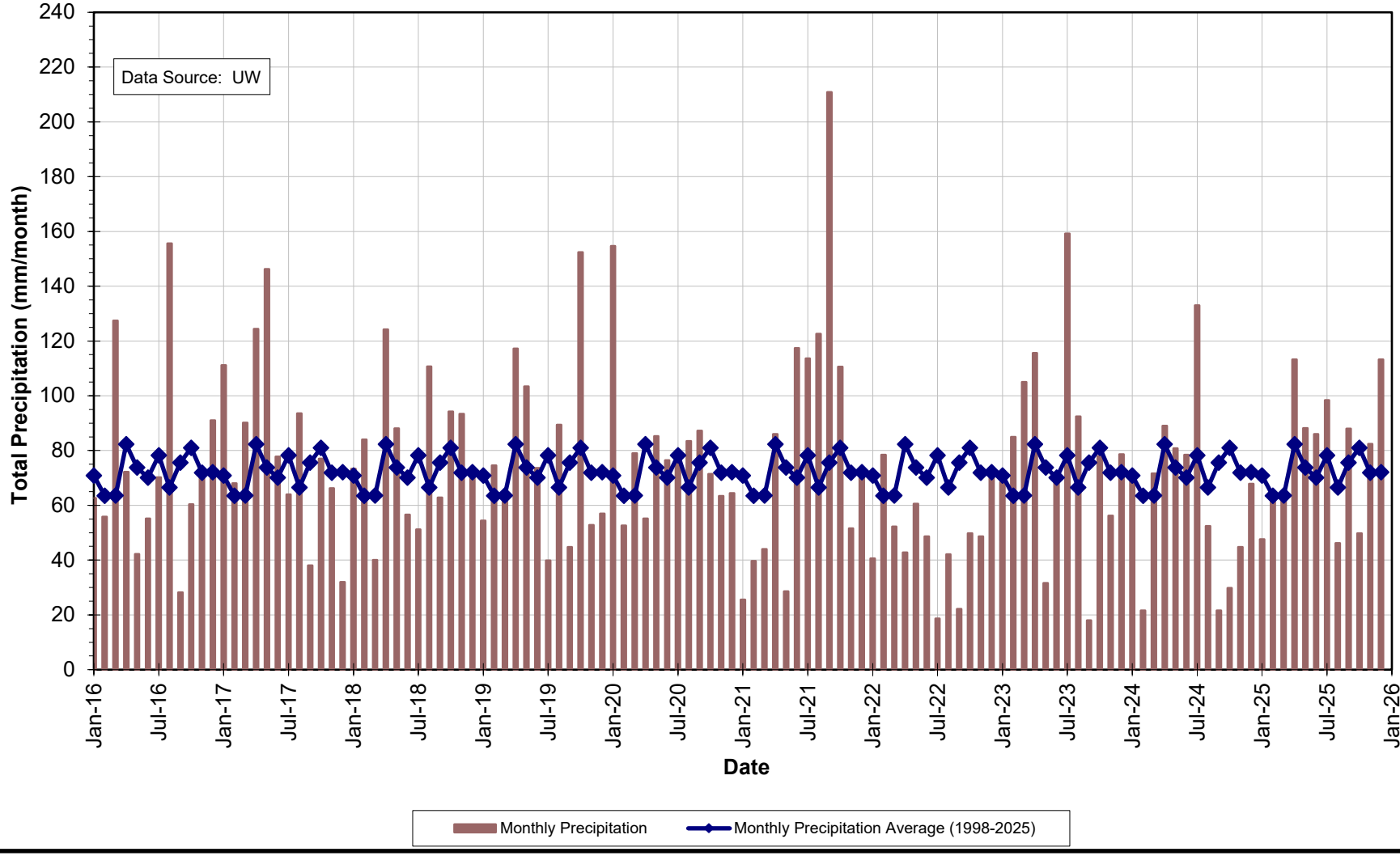
Year	Laurel Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	985	938	47
2017	1062	938	124
2018	1071	938	133
2019	940	938	2
2020	938	938	0
2021	1027	938	89
2022	689	938	-249
2023	921	938	-17
2024	907	938	-31
2025	894	938	-44

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



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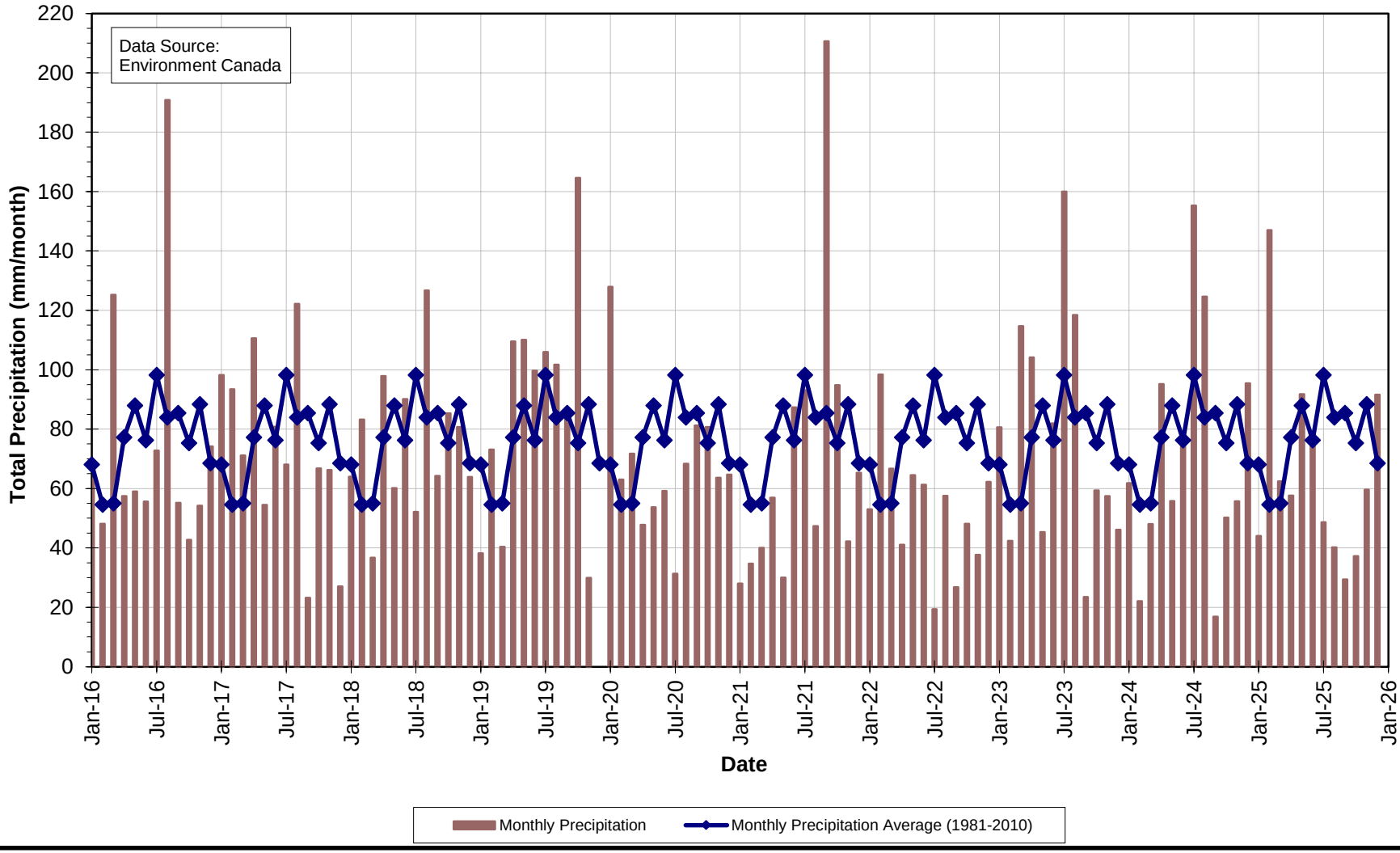
Prepared By: C.D.
Printed On: 2/13/2026
File: Appendix D Precipitation Data/Monthly UW

Figure D.2
Roseville Weather Station
Monthly Precipitation



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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