2025 Biennial Groundwater Monitoring Report - Middleton Well Field (G1, G1A, G2, G3, G14)

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 7214-AMGR5G) for the Middleton Well Field requires submission of a well field specific biennial report to the Ministry of Environment, Conservation and Parks (MECP) which documents production well pumping volumes and water levels in specific monitoring wells every two years. 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 Middleton Well Field is shown in Figure 1 and the production wells in Cambridge are shown in Figure 2 with the monitoring network for G1, G1A, G2, G3 and G14 shown in Figure 3. Well records for the production and monitoring wells are found in Appendix B.

1.1 Scope of Work

The Region regularly records water levels from a network of monitoring wells to satisfy the requirements of their PTTW and to confirm that the Region's 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 Middleton Well Field (G1, G1A, G2, G3, G14) in accordance with PTTW 7214-AMGR5G which consists of the following activities:

- Measuring the daily volume of water pumped from the G1, G1A, G2, G3 and G14 production wells (Condition 4.1 of the PTTW);
- Measuring water levels in monitoring wells C-MS-BH4-94-AB, C-MS-BH2B-93-AB, C-MS-BH1-93-ABC, C-MS-OW104-90-A, C-MS-OW2-92-AB and C-MS-MW1-08-AB (Condition 4.2 of the PTTW);
- Review of precipitation data from the nearest GRCA / Environment Canada weather station (Condition 4.3 of the PTTW); 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 Middleton Well Field is located north of First Avenue and West of Middleton Street in the southern portion of the City of Cambridge. The closest municipal well field is the Willard Well Field which is located about 1.5 km to the south (Figure 2). The closest surface water feature to the G1, G1A, G2, G3 and G14 site is the Grand River located 200 m to the east of G14 (Figure 3).

2.1.1 Pumping Wells

Well records for the production wells are found in Appendix B. The Middleton Well Field has been used for water supply since the late 1880's. Initially, seepage was collected at the base of the riverbanks. In the early 1900's, wells were installed which flowed naturally and were later pumped. Records of water level measurements are available for the production wells since 1975 and for observation wells since 1993.

A summary of the production well construction details is provided in Table 1 below.

Table 1: Production Well Construction Details

Well Name	Year Built	Casing Diameter (mm)	Open Hole Diameter (mm)	Open Hole interval (mbgs)	Aquifer
G1	NA	350	350	29.3-59.4	Lower Guelph / Eramosa / Upper Gasport
G1A	1951	300	500	28.46-59.7	Lower Guelph / Eramosa / Upper Gasport
G2	NA	500	500	29.7-49.1	Lower Guelph / Eramosa
G3	1951	508	508	38.2-52.5	Lower Guelph / Eramosa

Well Name	Year Built	Casing Diameter (mm)	Open Hole Diameter (mm)	Open Hole interval (mbgs)	Aquifer
G14	1951	508	457	29.9-54.2	Eramosa / Upper Gasport

The water taking volumes for the Middleton G1, G1A, G2, G3 and G14 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

	PTTW Details	2024			2025		
Well	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)
G1	24,000	4,079	7,776	1,489,008	5,772	7,777	2,106,682
G1A	24,000	2,026	4,050	739,363	3,492	3,889	1,274,414
G2	24,000	3,019	7,777	1,101,821	2,184	7,777	797,219
G3	24,000	6,531	7,780	2,383,644	5,508	8,101	2,010,307
G14	24,000	110	1,562	40,083	799	4,114	291,643
Combined	24,000	15,764	19,643*	5,753,919	17,754	22,595*	6,480,265

Note: *Combined maximum taken per day occurred on May 21, 2024 and June 1, 2025.

In each calendar year the Permit Holder may increase the amount of taking up to 30,000 m^3/day for a maximum of 100 days (not necessarily consecutive) and up to 35,000 m^3/day for a maximum of 15 additional days (not necessarily consecutive) provided that the average annual daily taking remains at or below 24,000 m^3/day.

Production wells G1, G1A and G3 are typically pumped every day, while G2 and G14 are pumped less fequently (434 days and 375 days respectively over the past two years). The pumping volumes are based on the total daily volumes as recorded by the Region's SCADA system and are presented in Appendix C as total monthly volumes. Pumping volumes from the well field ranged from 452,000 m^3/month to 510,333 m^3/month in 2024, and from 460,709 m^3/month to 622,633 m^3/month in 2025.

In total, 5,753,919 m^3 was produced at this well field in 2024 and 6,480,265 m^3 was produced in 2025. These volumes are similar to the previous three years and below the permitted volume of 8,760,000 m^3 per year (Table C-1).

2.1.2 Monitoring Wells

The Region recently updated their well naming protocol in 2017 and as a result, the well names in EQuIS 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. 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
C-MS-BH4A-94	C-MS-BH4-94-A
C-MS-BH4B-94	C-MS-BH4-94-B
C-MS-BH2BA-93	C-MS-BH2B-93-A
C-MS-BH2BB-93	C-MS-BH2B-93-B
C-MS-BH1A-93	C-MS-BH1-93-A
C-MS-BH1B-93	C-MS-BH1-93-B
C-MS-BH1C-93	C-MS-BH1-93-C
C-MS-OW104A-90	C-MS-OW104-90-A
C-MS-OW2A-92	C-MS-OW2-92-A
C-MS-OW2B-92	C-MS-OW2-92-B
C-MS-MW1A-08	C-MS-MW1-08-A
C-MS-MW1B-08	C-MS-MW1-08-B

Observation wells C-MS-BH1-93-ABC and C-MS-OW2-92-AB are located adjacent to wells G1, G1A, G2, G3 and G14. C-MS-BH4-94-AB is located to the west, C-MS-OW104-90-A is located to the north and C-MS-BH2B-93-AB and C-MS-MW1-08-AB are located to the east (Figure 3).

Construction details and the locations of C-MS-BH4-94-AB, C-MS-BH2B-93-AB, C-MS-BH1-93-ABC, C-MS-OW104-90-A, C-MS-OW2-92-AB and C-MS-MW1-08-AB are described in Table 4 below. 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 closest production well (m)
C-MS-BH4-94-A	1994	78.5-84.6	Eramosa	758 (G3)

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to closest production well (m)
C-MS-BH4-94-B	1994	55.4-58.5	Lower Guelph	758 (G3)
C-MS-BH2B-93-A	1993	43.0-49.0	Upper Gasport	310 (G14)
C-MS-BH2B-93-B	1993	28.4-34.4	Upper Gasport	310 (G14)
C-MS-BH1-93-A	1993	89.8-97.5	Middle Gasport	59 (G3)
C-MS-BH1-93-B	1993	69.2-75.2	Upper Gasport	59 (G3)
C-MS-BH1-93-C	1993	51.1-57.2	Eramosa	59 (G3)
C-MS-OW104-90-A	1990	86.0-107.0	Gasport	1310 (G3)
C-MS-OW2-92-A	1992	41.7-44.8	Eramosa	89 (G1A)
C-MS-OW2-92-B	1992	26.5-31.1	Lower Guelph	89 (G1A)
C-MS-MW1-08-A	2008	48.5-53.0	Upper Gasport	120 (G14)
C-MS-MW1-08-B	2008	32.0-35.1	Upper Gasport	120 (G14)

2.2 Regional Geology and Hydrostratigraphy

The following sections provide a brief overview of the regional geology and hydrogeology of the Middleton Well Field. The surficial geology based on regional OGS mapping is provided in Figure 4. Representative cross-sections showing the stratigraphy in the vicinity of the Middleton Well Field are included as Figures 5 and 6 to visualize the stratigraphy described in this section. The cross-section locations are provided in Figure 3.

The cross-sections are provided as a visual aid and do not necessarily contain all wells in the monitoring program for the Middleton Well Field. It should be noted that the deep A series wells were not included in the modelling. The layers displayed were generated from results of the Hydrogeological Characterization and Conceptual Model Tier 3 Assessment Update Project (Aqua Insight et al, 2023) and associated hydrogeological modelling work. Updates to the conceptual model were informed by drilling programs completed in 2017 and 2018 (Geofirma and Geosyntec, 2020). The most notable revisions involve the interpreted upper elevations of the Reformatory Quarry Member and the Gasport Formation. The top of the Reformatory Quarry Member is now estimated to be approximately 2 to 5 m lower than previously interpreted, and its thickness has been reduced by roughly 5 to 10 m. No additional geological picks have been identified to further refine the hydrostratigraphic framework.

2.2.1 Surficial Geology and Conceptual Hydrostratigraphy

The surficial geology of the Study Area has been mapped and described by Karrow (1987). The surficial geology (Figure 4) in the area on either side of the Grand River largely consists of sand and gravel outwash deposits (Units 7a and 7b), Ice-contact kame stratified sands and gravels (Unit 6), modern alluvial deposits (Unit 19) and sone-poor, carbonate-derived silty to sandy till (Unit 5b).

The Middleton well field is located within the Grand River Valley, and is mapped as primarily exposed Paleozoic bedrock (Figure 4). Overburden present within the vicinity of the Grand River ranges from less than 2 m to 20 m in thickness. Adjacent to the Grand River and at the Middleton Well Field, a thin (<2 m) layer of overburden is present at surface and lies unconformably on top of the bedrock (Stantec, 2011).

The Quaternary Geology of the Cambridge area includes the following units (Lotowater 1997, Karrow 1987 and Bajc and Shirota, 2007). These units are described in more detail below.

Aquitard ATA1 / ATA2 - Wentworth Till

The Wentworth Till was deposited by the last glacier to advance in the area. It is described as a stony, sandy silt to sand textured till, and is often inter-bedded with sand and gravel. In the Cambridge area, the Wentworth Till is generally less than 10 m thick. Due to the loose, coarse-grained nature of the till, the unit behaves as a leaky aquitard or poor aquifer that is readily recharged from precipitation.

Aquifer AFA2 / ATA3 - Outwash Deposits

The outwash sand and gravel sediments of AFA2 are present within the Grand River Valley and vicinity, however extensive deposits have also been identified underlying the Wentworth Till in the Paris and Galt moraines. These outwash deposits are interpreted as the main production aquifer for the Shade's Mills municipal wells.

Aquitard ATB3 / AFB3 / ATC1 / AFC1 / ATC2 - Lower Maryhill Till

Fine grained till and glaciolacustrine deposits of the Lower Maryhill Till ATB3 generally separate AFB1 from the underlying Catfish Creek Till. The Lower Maryhill Till is described as a dense, dark brown, clayey silt to silty clay till and is interpreted to be present in the Fountain Street (Well P16) well field area above the Catfish Creek and below the Port Stanley Till. Aquitard ATB3 can be difficult to distinguish from ATB1 throughout most of the study area due to the similar lithologies of these units. Lotowater (1997) grouped the Port Stanley and Maryhill Tills as a single aquitard hydrostratigraphic unit, which is a reasonable approach where no significant thickness of sand and gravel separate these units.

Aquifer AFD1 / ATE1 / AFF1 / ATG1 - Pre-Catfish Sand and Gravel

The Pre-Catfish sand and gravel aquifer is present below the Ice-Contact Stratified Deposits in the Willard and Fountain Street Well Fields but is not a significant unit elsewhere in the Cambridge area. This unit is the main municipal aquifer for the Fountain Street Well Field. The Pre-Catfish sand and gravel is found directly overlying bedrock in the Willard and Fountain Street Well Field area. In these areas it is hydraulically connected with the upper weathered portion of the bedrock aquifer. Aquifer AFD1 corresponds to sand and gravel deposits reworked from Catfish Creek and Pre-Catfish Creek Tills.

2.2.2 Bedrock Geology and Conceptual Hydrostratigraphy

The bedrock stratigraphy discussed below is consistent with the revised stratigraphic framework described by the OGS (Brunton, 2009) and is also used in the Tier 3 Study of the area (Golder, 2011). A brief description (from Stantec, 2013) of each bedrock formation and conceptual hydrostratigraphic units typically present in Cambridge is provided below (from youngest to oldest). The formations present in the vicinity of Middleton are shown on the cross sections in Figures 5 and 6.

Guelph Formation

The Guelph Formation is a cream-coloured fossiliferous dolostone that represents an important aquifer in the Cambridge and Guelph area, where it is most often the uppermost bedrock unit.

Eramosa Formation

The Upper Eramosa Formation is described by Brunton (2009) as light brown to cream coloured, pseudonodular, thickly bedded and coarsely crystalline dolostone. The formation consists of the Reformatory Quarry Member, and the Vinemount Member.

The Reformatory Quarry Member is susceptible to karstification due to its uniform fine dolomite crystallinity (Brunton, 2009), and also often contains mud-rich and microbial mat-bearing lithofacies. As a result, this unit generally represents a poor aquifer or poor aquitard. This unit was described as either the Guelph Formation or Eramosa Member in previous studies within the Region.

The Vinemount Member is comprised of thinly bedded, fine crystalline dolostone with shaley beds that give off a distinctive petroliferous odour when broken (Brunton, 2009). This unit represents an aquitard when present within the Cambridge and Guelph areas.

Goat Island Formation

The Goat Island Formation consists of the upper Ancaster Member and lower Niagara Falls Member. The Ancaster Member is a chert rich, finely crystalline dolostone that is medium to ash grey in colour. The Niagara Falls Member is a finely crystalline and cross laminated crinoidal grainstone with small reef mounds. The finely crystalline nature of these Members results in a lower hydraulic conductivity and transmissivity compared to the underlying Gasport Formation (Brunton, 2009). Conceptually, the two members of the Goat Island Formation are treated as a single hydrostratigraphic unit.

Gasport (Amabel) Formation

The Gasport Formation is a cross-bedded crinoidal grainstone-packstone with sequences of reef mound and coquina (shell bed) lithofacies. This unit has commonly been referred to as the Amabel Formation in previous studies in the Region. Upper, middle and lower hydrostratigraphic units of the Gasport have been defined to allow for general representation of the vertical distribution of the more transmissive reef mound and coquina bed lithofacies. Highly transmissive reef mounds, crinoidal grainstones and coquina beds are generally present in the upper and middle portions of the formation, and are largely absent from the lower 10 m to 20 m.

The lower portion of the Gasport Formation has been grouped with the Rochester, Irondequoit, Rockway, and Merriton Formations due to the difficulty in distinguishing the various units from available borehole data and geophysical logs. All four formations, as well as the base of the Gasport Formation, are relatively less permeable than the upper sections of the Gasport Formation.

2.3 Local Geology

The following description of local geology is based on drilling investigations at the Middleton Well Field. Borehole logs are included in Appendix B.

The well field is located in the Grand River Valley where there is limited overburden overlying the bedrock. Increasing thicknesses of overburden sands, silts and clay (up to 60 m) have been observed toward the east and west of the valley. At the site, the overburden consists of inter-bedded layers of sand, silty sand deposits of the Maryhill Till, and is approximately 2.0 m to 4.0 m thick.

Based on the results of drilling investigations at the site, the bedrock surface is encountered at approximately 3 mbgs (Appendix B). C-MS-BH1-93-ABC is the deepest well nest in the immediate vicinity of the production wells. Here, the Guelph formation is about 42 m thick and is present between 262 masl and 220 masl, the Eramosa Formation is 22 m thick from 220 to 198 masl and the Gasport is present from about 198 masl to the end of the borehole at about 103 masl.

3.0 2024 / 2025 Results

3.1 Precipitation

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

Since variations in precipitation totals can occur throughout the Region due to localized events, the closest GRCA and Environment Canada climate station to each wellfield is used for monthly precipitation data. The closest GRCA weather station relative to the Middleton well field is the Shades Mills Dam station located approximately 3.8 km northeast of the well field. The closest Environment Canada station is the Roseville weather station located about 12.6 km west of 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 the Shades Mills Dam station are shown on Figure D.1, Appendix D. At the Shades Mills Dam station, the long-term average was calculated from when measurements started until the end of 2025. The Roseville “Climate Normals” calculated by Environment Canada for 1981 to 2010.

Annual 2024 / 2025 precipitation data for the GRCA and Environment Canada meteorological stations closest to the Shades Mills well field are presented in Table 5 below. The Roseville Station was missing 5 days of data in 2024, and 20 days of data 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)
Shades Mills Dam (2)	976	+67	909(B)	895	-14
Roseville Station (1)	856	-63	919(A)	786	-133

Sources: Environment Canada (1), GRCA (2),
A 1981 to 2010 Normal B Average annual precipitation since monitoring began to the end of 2025

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 tend to occur 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 all the monitoring wells.

The 2024 total precipitation at Shades Mills station was 976 mm, which is 67 mm above the long-term average, whereas the Roseville station recorded 856 mm of precipitation, which is 63 mm below the long-term average. The March 1 GRCA snow survey indicated a snowpack across the Region that was low compared to normal. In 2025, the total precipitation was 895 mm at Shades Mills station which is 14 mm below the long-term average. Similarly, the total precipitation at the Roseville station was 133 mm below the long-term average, indicating 2025 was a drier-than-average year. Note that the Roseville station was missing 25 days of data in 2024 / 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.

C-MS-BH1-93

C-MS-BH1-93 is located within the Middleton Production Well site and has been monitored since April 2002. Monthly manual water level monitoring is conducted at C-MS-BH1-93-ABC. Screens A and B are completed in the Gasport Formation below the open hole portion of the production wells; screen C is in the Eramosa Formation at similar elevation to the bottom of G2 and G3.

The water levels in all three screens fluctuate within a range of approximately 8.5 m in response to pumping. During 2024, groundwater elevations remained within the established historical range. Pumping increased from an average of 479,493 m^3/month in 2024 to 540,022 m^3/month in 2025. In 2025, monthly pumping in July and August (average 619,137 m^3/month) was the highest in the past 10 years and water levels declined to the lowest levels seen in the last 10 years with several measurements approaching minimums last observed in 2007 when pumping was elevated (approximately 600,000 m^3/month).

C-MS-BH2B-93

C-MS-BH2B-93 is located on the east side of the Grand River approximately 500 m from the production wells and has been monitored since November 2001. Water level monitoring was completed using an electronic data logger at C-MS-BH2B-93-A and monthly manual water level monitoring was conducted at C-MS-BH2B-93-B. Both

C-MS-BH2B-93 monitoring wells are screened in the Upper Gasport Formation as indicated in Figure 5.

Water levels in the two monitored screens exhibited closely aligned responses to pumping, with an overall fluctuation of approximately 9 m. Throughout 2024, groundwater elevations remained within the established historical range. In 2025, water levels declined during the summer with the lowest levels seen in July / August when pumping volumes were the highest. Several measurements in July / August approached the historical minimums which occurred prior to 2007 when pumping was generally greater than 600,000 m^3/month.

C-MS-BH4-94

C-MS-BH4-94 is located approximately 750 m west of the production wells with water level monitoring starting in November 2001. Water level monitoring was completed using an electronic data logger at C-MS-BH4-94-A. C-MS-BH4-94-A is screened in the Eramosa Formation at a similar elevation to the lower open hole portion of G2 and G3 and the upper open hole interval of G1, G1A and G14 (Figure 5). The daily water level fluctuation at C-MS-BH4-94-A due to production well pumping is approximately 3 m. Water levels begin to decline after July 2024 with August 2025 levels the lowest in the past 10 years.

Monthly manual water level monitoring is conducted at the B screen which is screened in the Lower Guelph Formation and constructed opposite the upper open hole portion of production wells G1, G1A and G2. The daily water level fluctuation at C-MS-BH4-94-B due to production well pumping is approximately 1 m. Water levels declined approximately 10 m from January 2022 to the lowest levels in the past 10 years in August 2025 when well field pumping was highest.

C-MS-MW1-08

C-MS-MW1-08 is located approximately 200 m east of the production well site with water level monitoring starting in November 2008. Water level monitoring was completed using an electronic data logger at well nest C-MS-MW1-08. The A and B screens are in the Gasport Formation and at similar elevations to open hole intervals in G1, G1A and G14.

Since 2014 water levels in both the A and B screens have varied within a 4 m range due to pumping with water levels about 0.5 m higher in the B screen. In 2025, water levels declined during the summer, with several measurements during peak pumping in July / August approaching previously observed minimums which occurred 2007 when pumping was generally greater than 600,000 m^3/month.

C-MS-OW104-90-A

C-MS-OW104-90-A is located approximately 1.3 km northeast of the production wells site with monitoring starting in May 1993. C-MS-OW104-90-A is screened in the Gasport Formation about 4 m below the production wells. Water levels are measured electronically and do not show any correlation with pumping. Water levels during 2025 declined during the summer, with measurements approaching low levels which were last observed in 2007, when pumping was elevated to 600,000 m^3 per month.

C-MS-OW2-92

C-MS-OW2-92 is located within the Middleton Production Well site located approximately 90 m south from G1A and G2, with monitoring starting in April 1992. Monthly manual water level data is collected from C-MS-OW2-92-A to monitor the Eramosa Formation. Water level data is collected with an electronic data logger at C-MS-OW2-92-B to monitor the Lower Guelph Formation.

Water levels in the A and B screens show a similar response to pumping with fluctuations up to 9 m. Water levels during 2025 declined during the summer, with measurements approaching similar levels which were last observed in July 2005, when pumping was elevated to 713,461 m^3 for the month.

4.0 Impact Assessment

4.1 Well Interference

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

PTTW Condition 5.2 states: “For Groundwater Takings - if the taking of water is observed to cause any negative impact to other water supplies obtained from any adequate sources that were in use prior to initial issuance of a Permit for this water taking, the Permit Holder shall take such action necessary to make available to those affected, a supply of water equivalent in quantity and quality to their normal takings, or shall compensate such persons for their reasonable costs of so doing, or shall reduce the rate and amount of taking to prevent or alleviate the observed negative impact. Pending permanent restoration of the affected supplies, the Permit Holder shall provide, to those affected, temporary water supplies adequate to meet their normal requirements, or shall compensate such persons for their reasonable costs of doing so. If permanent

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

All properties within 500 m of the Middleton wells are serviced with municipal water. The well field has been in operation for over a century and current water taking is similar or less than annual takings over the past several decades. Therefore, domestic well interference is very unlikely. When a well interference complaint is received, the Region has a Well Interference Policy in place. A copy of the policy is presented in Appendix F of the 2019 Biennial Groundwater Monitoring Report – Multiple Well Fields (Burnside, 2020). There were no well interference complaints related to pumping of G1, G1A, G2, G3 and G14 received in 2024 and 2025. There are no other active PTTWs within 2 km of the well field.

4.2 Aquifer Response to Pumping and Precipitation

Monthly pumping in July / August 2025 was the highest seen in the past 10 years. Resultant water levels in all monitoring wells in July and August were the lowest seen in the past 10 years. Water levels in the Lower Guelph Formation were monitored using monitoring wells C-MS-BH4-94-B and C-MS-OW2-92-B. The water level response to pumping varies from 1 m at C-MS-BH4-94-B to 7.5 m at C-MS-OW2-92-B which is screened at a depth similar to the top of the open hole intervals at G1, G1A, G2 and G14. The groundwater levels in Lower Guelph Formation did not display a correlation with precipitation events.

Water levels in the Eramosa Formation were monitored using monitoring wells C-MS-BH4-94-A, C-MS-BH1-93-C and C-MS-OW2-92-A. Water levels indicate a clear response to pumping with drawdowns between 3 and 9 m. The greatest drawdown in the Eramosa formation is observed in C-MS-OW2-92-A (9 m). The groundwater levels in Eramosa Formation did not display a correlation with precipitation events.

Water levels in the Gasport Formation were monitored using monitoring wells C-BH-2B-93-AB, C-MS-BH1-93-AB, C-MS-OW104-90-A and C-MS-MW1-08-AB. C-MS-OW104-90-A, which is 1.3 km from the production wells, did not respond to pumping. The water levels in C-MS-MW1-08-AB vary by up to 4 m in response to pumping, with a response of about 9 m at C-MS-BH2B-93-AB and C-MS-BH1-93-AB. The groundwater levels in Guelph Formation did not display a correlation with precipitation events.

The 2024 / 2025 precipitation data from the Shades Mill weather station did not demonstrate a clear correlation with observed groundwater level responses. A seasonal pattern was observed across all monitoring wells during 2024 and 2025, characterized by higher groundwater levels in the spring, lower levels during the summer months, and partial recovery in the fall.

5.0 Conclusions

Impacts from pumping the municipal wells at the Middleton Well Field (G1, G1A, G2, G3, G14) 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 7214-AMGR5G;
- 2024 and 2025 pumping volumes were within the permitted range;
- There were no reported well interference complaints arising from water taking at the Middleton well field;
- Water levels in monitoring wells screened in the Guelph, Eramosa and Upper and Middle Gasport Formations show a measurable response to pumping; and,
- In August 2025 during peak well field pumping, water levels in all monitoring wells were the lowest seen in the past 10 years. Water levels in this period are similar to when pumping was elevated above 600,000 m^3/month, which occurred in 2005.

6.0 References

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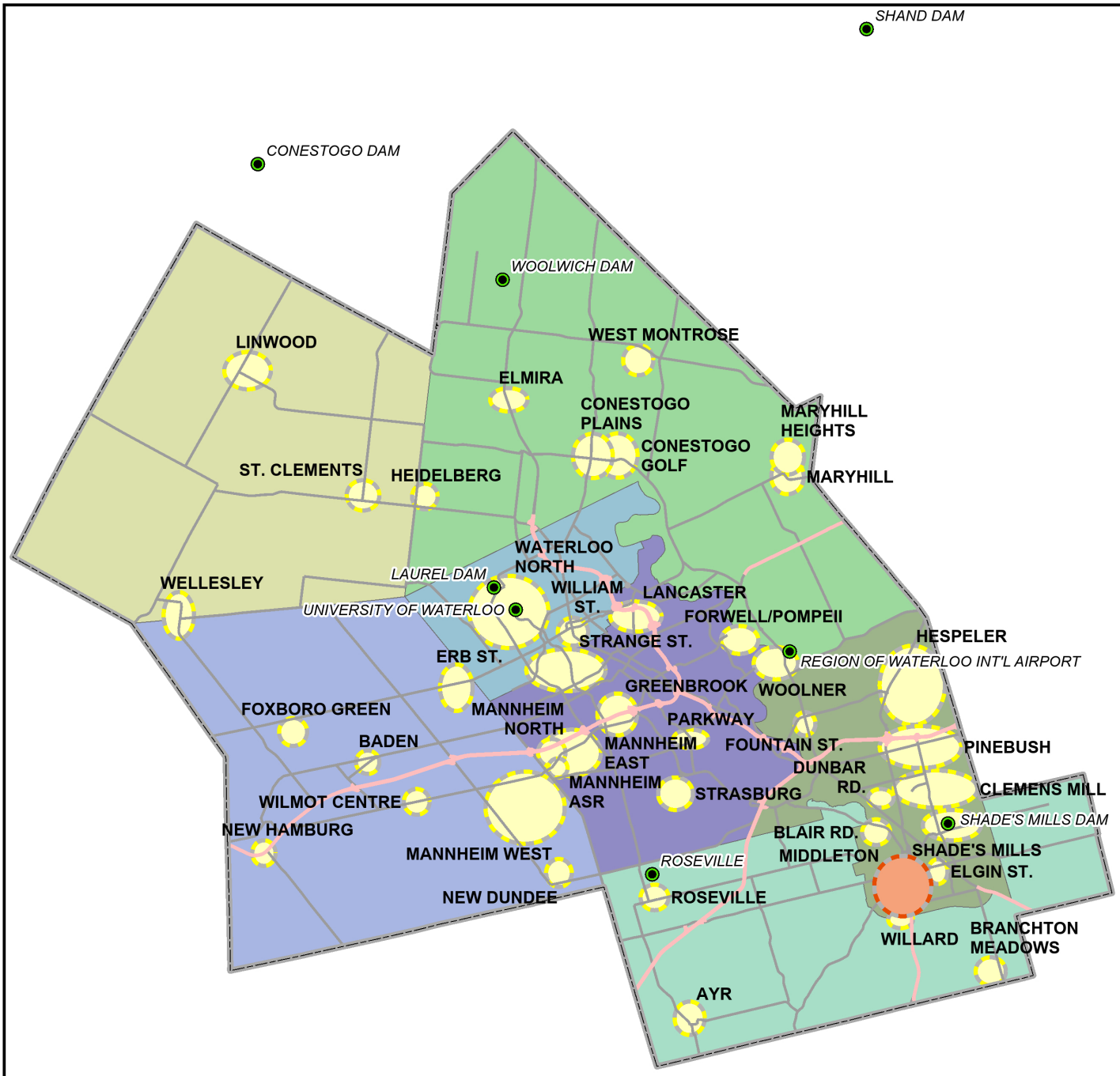
Figures



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

0 5 10 15 20
Kilometers

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

BURNSIDE

Map Title

2025 GROUNDWATER MONITORING REPORT - MIDDLETON WELL FIELD

WELL FIELD LOCATION MAP

Client

REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	February 2026	1
Scale		Project No.	
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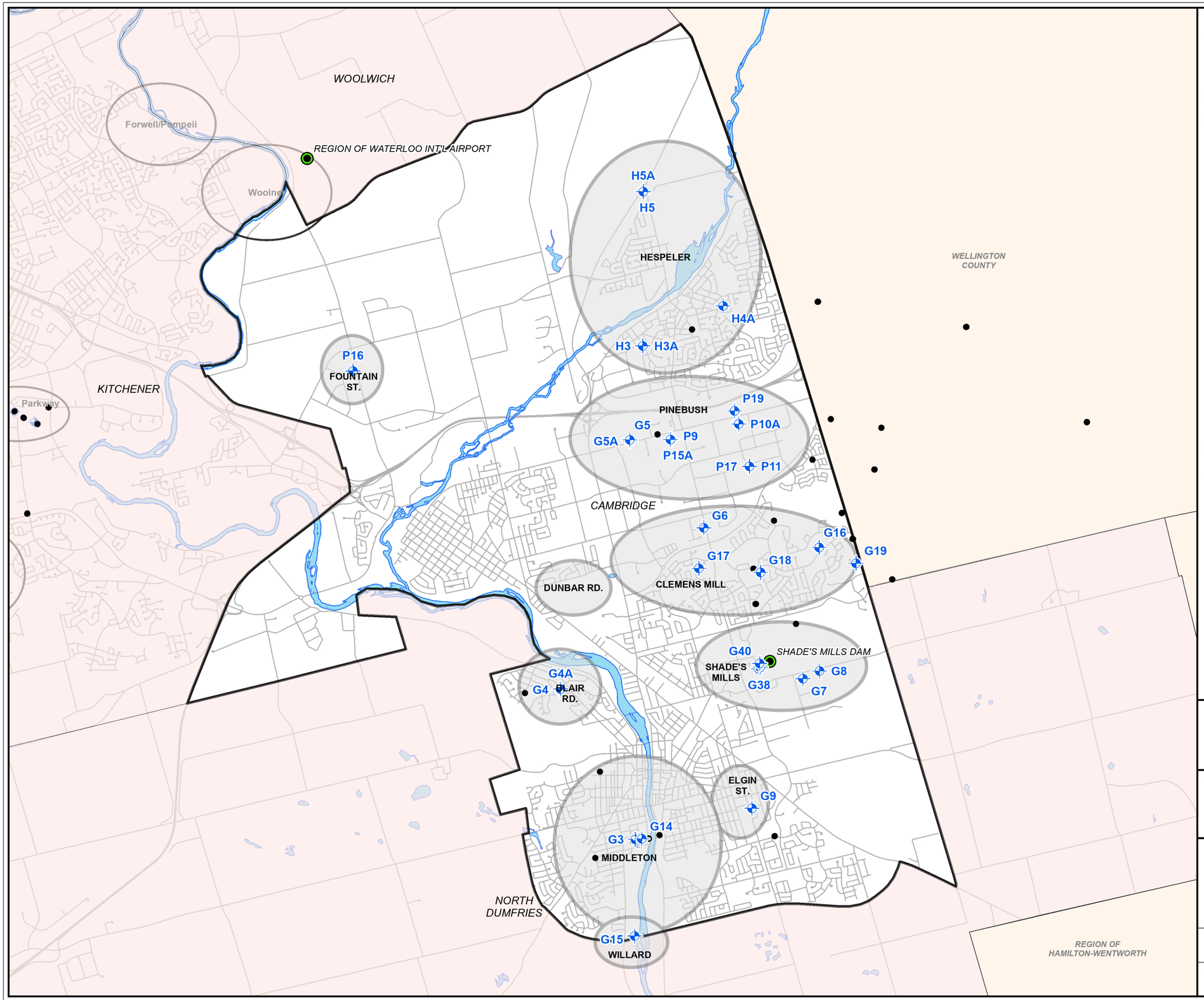

LEGEND

- Production Well Location
- Monitoring Well Location
- Well Fields
- Cambridge Municipal Boundary
- 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 - MIDDLETON WELL FIELD

CAMBRIDGE WELL FIELDS AND MONITORING NETWORK

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HN	SQ	March 2026	2
Scale		Project No.	
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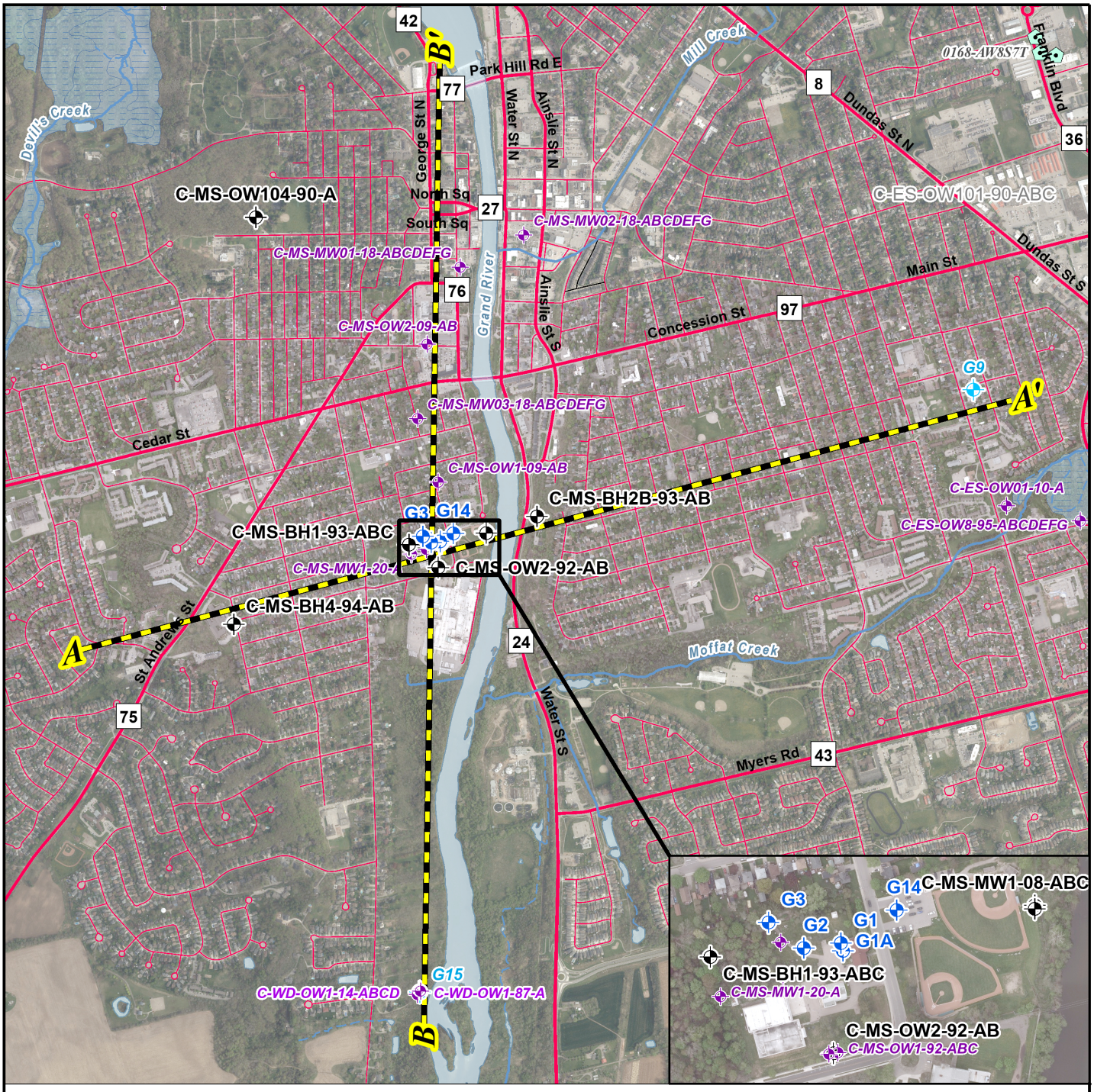

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Data Source:
Region of Waterloo GIS Data; Background 2018 Air Photo: ArcGIS Image Service Region of Waterloo; Ministry of Natural Resources, © Queen's Printer for Ontario; Natural Resources Canada © Her Majesty the Queen in Right of Canada.

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

Metres

- PTTW Monitoring Well Location
- Nearby Monitoring Well Location
- Nearby Production Well Location
- Decommissioned Production Well Location

Additional MECP PTTW Locations
- Groundwater
- 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 - MIDDLETON WELL FIELD

WELL LOCATION MAP

Client

REGION OF WATERLOO

Drawn	Checked	Date	Figure No.
HN	SQ	March 2026	3
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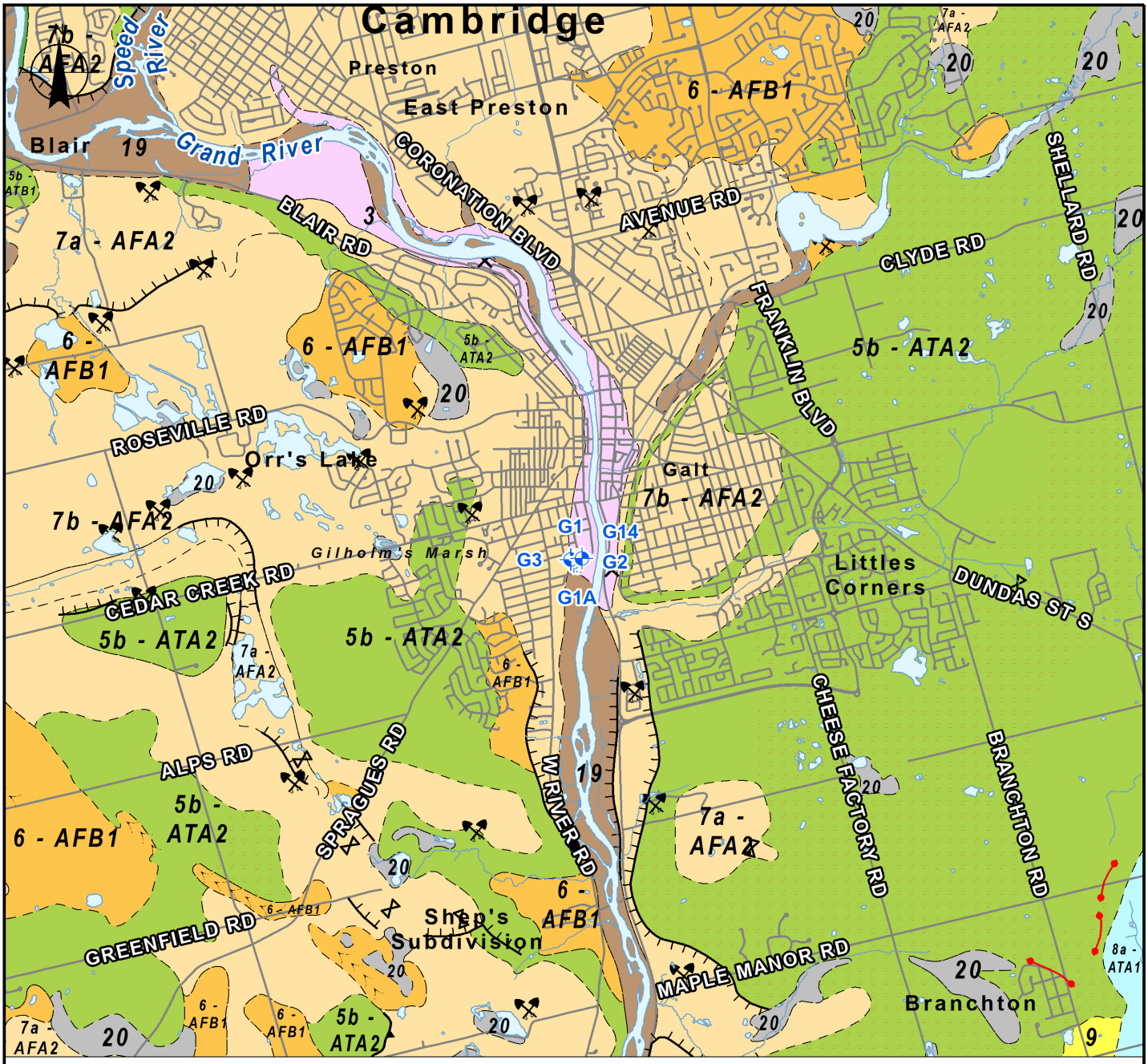

Data Source:
1. Ontario Geological Survey 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.
2. Region of Waterloo GIS

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

- RMOW Supply Well
- Watercourse
- Waterbody

Surficial Geology

- 3: Paleozoic bedrock
- 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)
- 9: Coarse-textured glaciolacustrine deposits
- 19: Modern alluvial deposits
- 20: Organic deposits
- Quarry (Point)
- Sand and Gravel Pit
- Beach
- Esker: Direction of Flow Known
- Ice-Contact Slope
- Terrace
- Delta, glaciolacustrine
- Sample Location
- Hummocky Topography
- Unit Contact Boundary

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Map Title

2025 GROUNDWATER MONITORING REPORT - MIDDLETON WELL FIELD

SURFICIAL GEOLOGY

Client	Drawn	Checked	Date	Figure No.
REGION OF WATERLOO	HN	SQ	May 2026	4
	Scale		Project No.	
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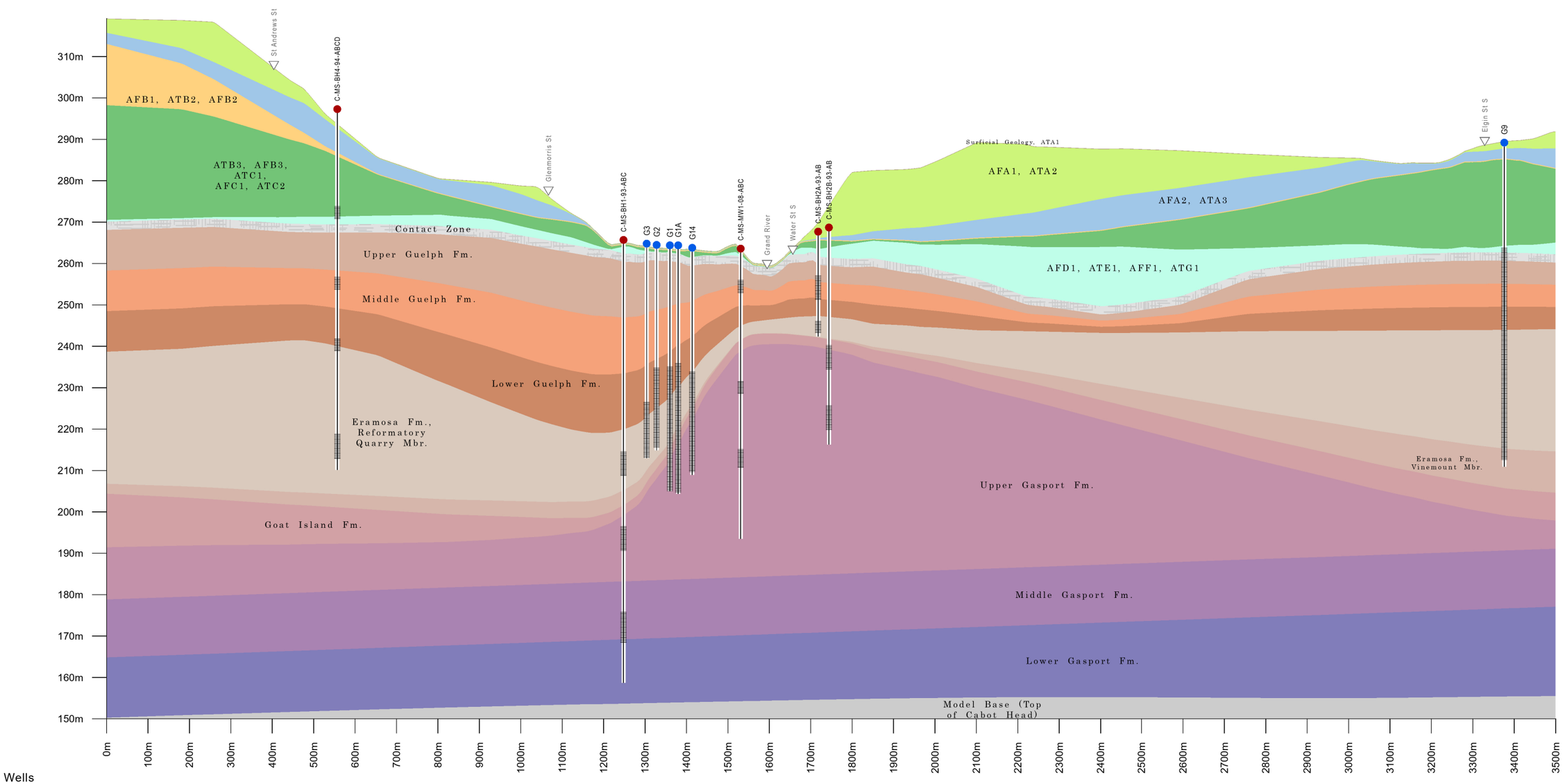
A

A'



Wells

● Production Well (Active) ● Monitoring Well

Cambridge Model 2026

- Surficial Geology, Whittlesey Clay (ATA1)
- Whittlesey Sand (AFA1), Wenthworth Till (ATA2)
- Grand River Valley Outwash Deposits (AFA2), Fine Grain Deposits in the Grand River Valley (ATA3)
- 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
- Bedrock: Upper Guelph Fm.
- Bedrock: Middle Guelph Fm.
- Bedrock: Lower Guelph Fm.
- Bedrock: Eramosa Fm., Reformatory Quarry Mbr.
- Bedrock: Eramosa Fm., Vinemount Mbr.
- Bedrock: Goat Island Fm.
- Bedrock: Lower Gasport Fm.
- Bedrock: Upper Gasport Fm.
- Bedrock: Middle Gasport Fm.
- Model Base (Top of Cabot Head)

Wellhead

Well

Screen or Open Hole

BURNSIDE

Client

REGION OF WATERLOO

Figure Title

GEOLOGIC CROSS SECTION REGION OF WATERLOO

Middleton

Cross Section A - A'

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/01	5
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Vertical Ex.:10x		HA046402	

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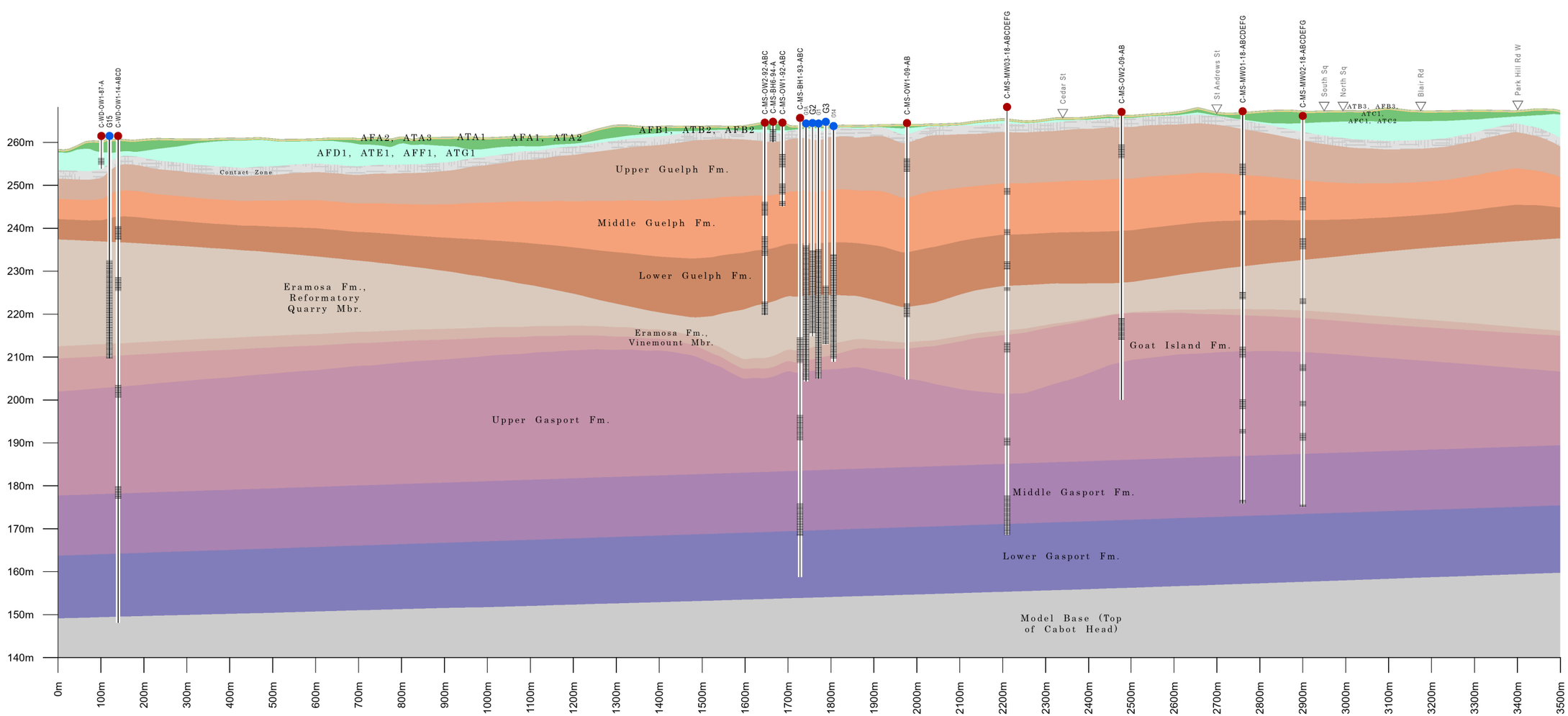
B

B'



Wells

- Production Well (Active)
- Monitoring Well

Cambridge Model 2026

- Surficial Geology, Whittlesey Clay (ATA1)
- Whittlesey Sand (AFA1), Wenthworth Till (ATA2)
- Grand River Valley Outwash Deposits (AFA2), Fine Grain Deposits in the Grand River Valley (ATA3)
- 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
- Bedrock: Upper Guelph Fm.
- Bedrock: Middle Guelph Fm.
- Bedrock: Lower Guelph Fm.
- Bedrock: Eramosa Fm., Reformatory Quarry Mbr.
- Bedrock: Eramosa Fm., Vinemount Mbr.
- Bedrock: Goat Island Fm.
- Bedrock: Lower Gasport Fm.
- Bedrock: Upper Gasport Fm.
- Bedrock: Middle Gasport Fm.
- Model Base (Top of Cabot Head)

Wellhead

Well

Screen or Open Hole

BURNSIDE

Client

REGION OF WATERLOO

Figure Title

GEOLOGIC CROSS SECTION REGION OF WATERLOO

Middleton

Cross Section B - B'

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Appendix A

Permit To Take Water

PERMIT TO TAKE WATER
Ground Water
NUMBER 7214-AMGR5G

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: Middleton Street Well Field
(Municipal Bedrock Wells: G1, G1A, G2, G3 and G14)

Located at: 60 Middleton St Lot 2 West of Grand River Concession 10
Cambridge, 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. 7214-AMGR5G 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 22, 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	G1, G1A, G2, G3, G14	Well Drilled	Municipal	Water Supply	25,200	24	24,000,000	365	17 555241 4799693
						Total Taking:	24,000,000		

3.3 Notwithstanding Table A daily amounts, in each calendar year the Permit Holder may increase the amount of taking up to 30,000,000 L/day for a maximum of 100 days (not necessarily consecutive) and up to 35,000,000 L/day for a maximum of 15 additional days (not necessarily consecutive) provided that the average annual daily taking remains at or below 24,000,000 L/day.

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:

C-MS-BH4A-94
C-MS-BH4B-94
C-MS-BH2BA-93
C-MS-BH2BB-93
C-MS-BH1A-93
C-MS-BH1B-93
C-MS-BH1C-93
C-MS-OW104A-90
C-MS-OW2A-92
C-MS-OW2B-92
C-MS-MW1A-08
C-MS-MW1B-08

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

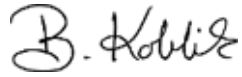
The Director, Section 34.1, Ministry of the Environment and Climate Change
12th Floor
119 King St W
Hamilton ON L8P 4Y7
Fax: (905) 521-7820

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 7006-7BJS39, issued on 2008/02/19.

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 7214-AMGR5G, dated May 31, 2017.

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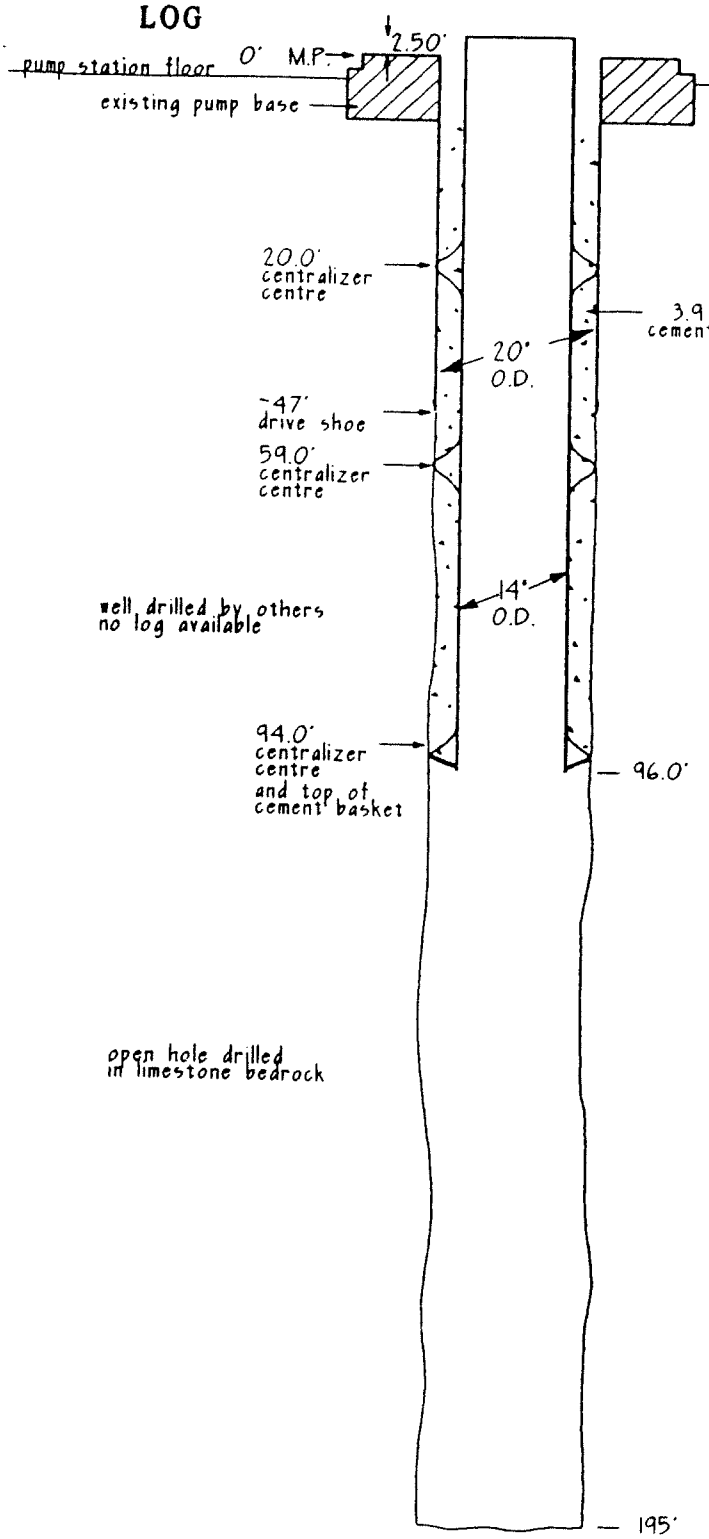
Appendix B

Well Records

FILE - G1

LOG



WELL MATERIAL

Inner Casing: 14 " dia. 0.375 " Wall Thk. Mat'l Steel
Cemented from 0 ' 0 " to 95 ' 0 "
Outer Casing: 20 " dia. _____ " Wall Thk. Mat'l Steel
Screen: Make: _____ " dia. Opening & Mat'l: _____
Plug: Type: _____ Mat'l _____ Other _____
Gravel: Type: _____ Size: _____ Quantity: _____

AQUIFER TEST DATA

Date: _____ By: _____
Static Level _____ below M.P. _____
Pumping Rate I.G.M.: _____
Pumping Duration: _____ hrs. _____ min.
Pumping Level at Test End: _____
Performance Plots: dd-t Dwg. _____
dd-r Dwg. _____
Step Test _____

EQUIPPED WELL DATA

Date: _____ By: _____
Rated Well Capacity IGM _____
Pumping Rate IGM _____ Static Level _____ ' _____ "
Pumping Level _____ ' _____ " at _____ hrs. _____ min.
Pump Pressure: _____ psi Main Pressure _____ psi
Shut Off: AGH _____ psi W.L. _____ ' _____ "
Clear Well Depth from B.P _____ ' _____ " Air Line _____ ' _____ "

PUMP & MOTOR DATA

Pump Make: _____ Rating: _____ I.G.M. @ _____ ' T.H
Head: Type: _____ S.N. _____
Column: _____ ' X _____ " X _____ " X _____ " Shaft Mat'l _____
Bowl: _____ Stage: _____ Curve: _____
Suction: _____ " dia. _____ ' _____ " Long
Special: Zinc Sleeves _____ Taped Oil Line _____
Other _____
Motor Make: _____ Frame: _____ S.N. _____
_____ H.P _____ phase _____ hz _____ rpm _____ Volts
Bearing No. Upper _____
Lower _____

Special Equipment

Dec 13/95 - 98.5 feet of 14" O.D. liner installed

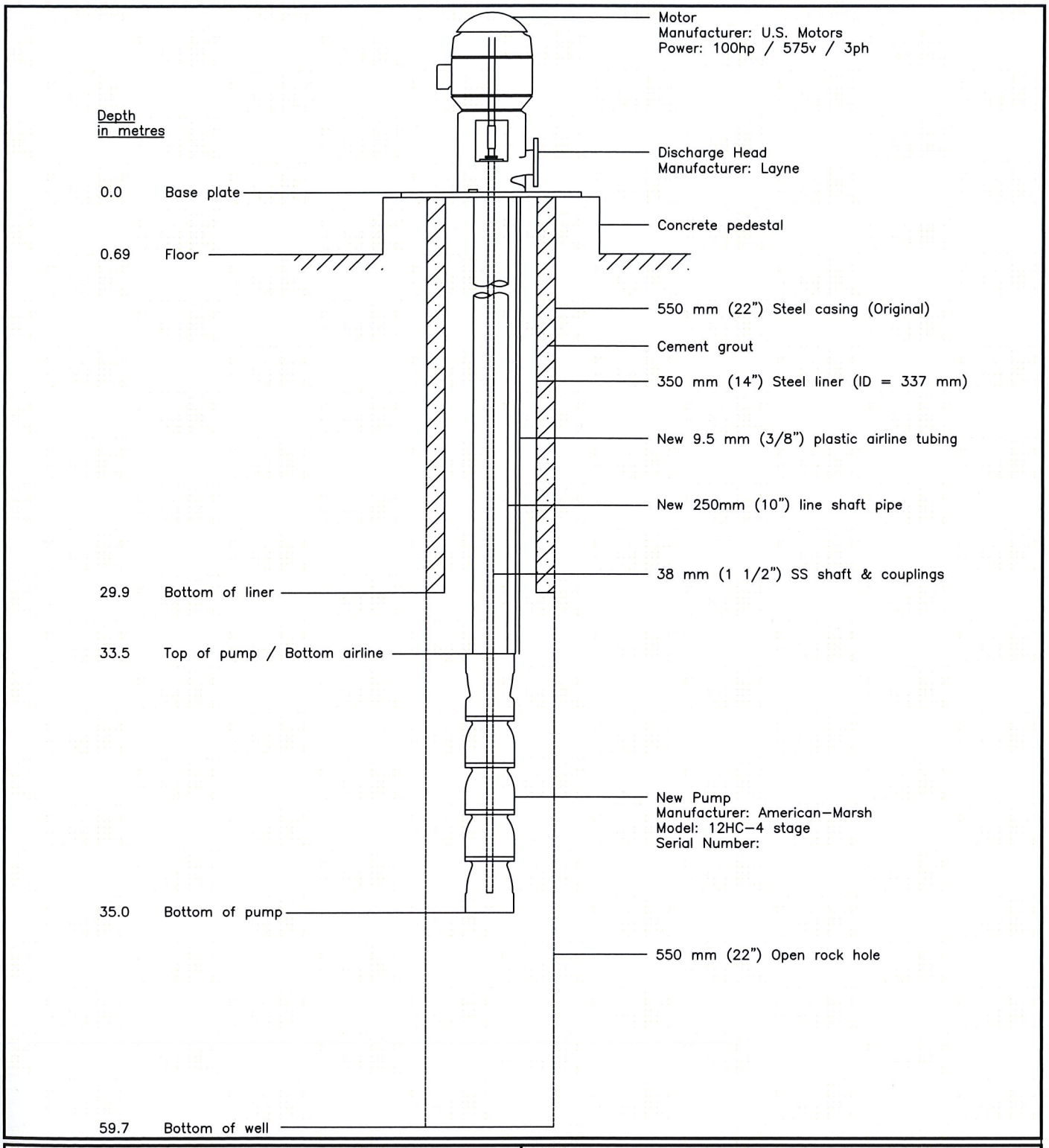
		BY

International Water Supply Ltd.
MONTREAL - BARRIE - SASKATOON

CLIENT: REGIONAL MUNICIPALITY OF WATERLOO
WELL No: MIDDLETON WELL GI

DRILLED BY: Others DATE:
INSTALLED BY: DATE:
DRAWN: T. Brown
DATE: Jan. 3/96

G1



Lotowater
TECHNICAL SERVICES INC.

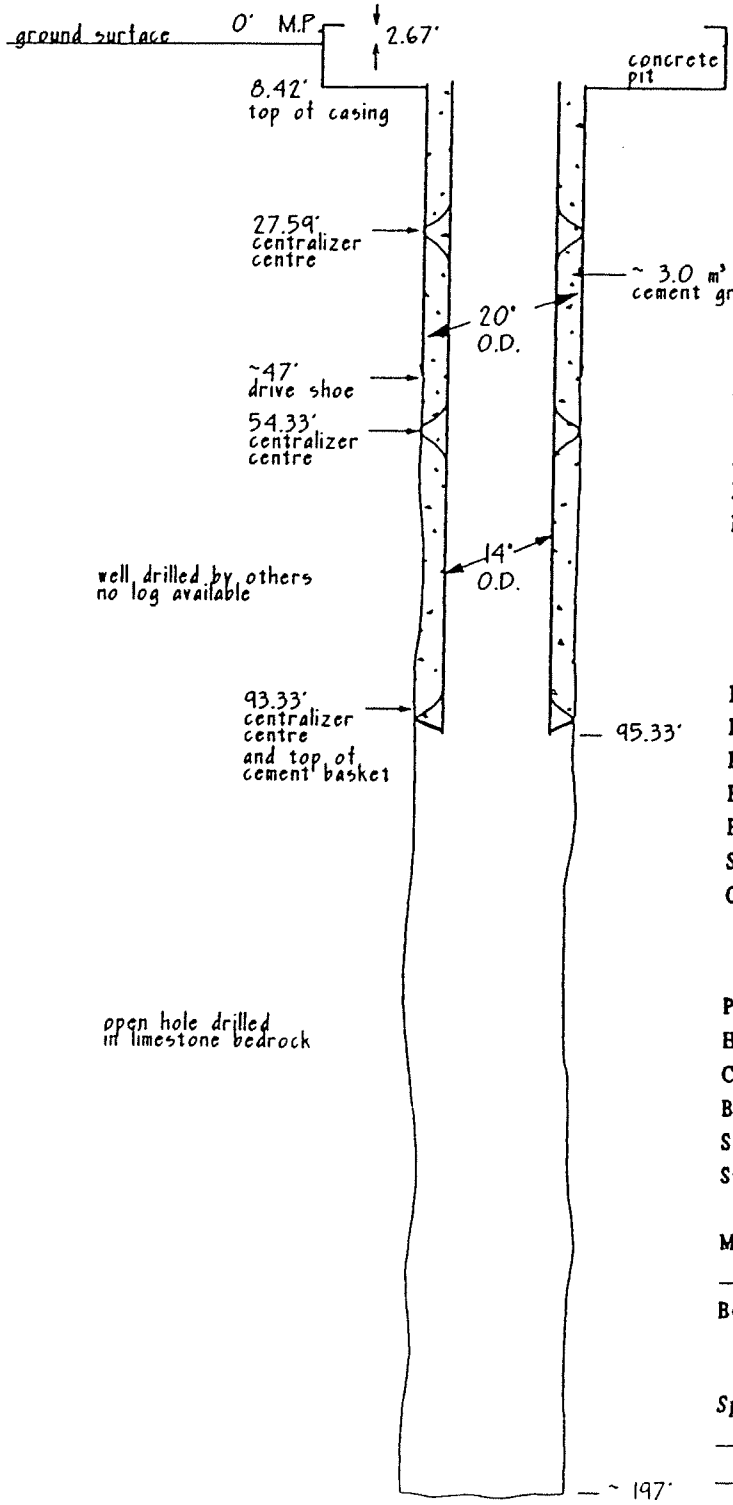
CLIENT
Regional Municipality of Waterloo

TITLE
Well G1
Pump Installation Drawing

PROJECT No. 006-331			G:\Lotowater Projects\006 Region of Waterloo\331 Well G1\Pump Install.dwg		FIGURE 4
DESIGN			REVISION No. 2015-03-25	SCALE N.T.S.	
DRAWN	EH	2015/03/25			
CHECKED					

G1A

LOG



WELL MATERIAL

Inner Casing: 14 " dia. 0.375 " Wall Thk. Mat'l Steel
Cemented from 85 ' 0 " to 94.3 ' 0 "
Outer Casing: 20 " dia. _____ " Wall Thk. Mat'l Steel
Screen: Make: _____ " dia. Opening & Mat'l: _____
Plug: Type: _____ Mat'l _____ Other _____
Gravel: Type: _____ Size: _____ Quantity: _____

AQUIFER TEST DATA

Date: _____ By: _____
Static Level _____ below M.P. _____
Pumping Rate I.G.M.: _____
Pumping Duration: _____ hrs. _____ min.
Pumping Level at Test End: _____
Performance Plots: dd-t Dwg. _____
dd-r Dwg. _____
Step Test _____

EQUIPPED WELL DATA

Date: _____ By: _____
Rated Well Capacity IGM _____
Pumping Rate IGM _____ Static Level _____ ' _____ "
Pumping Level _____ ' _____ " at _____ hrs. _____ min.
Pump Pressure: _____ psi Main Pressure _____ psi
Shut Off: AGH _____ psi W.L. _____ ' _____ "
Clear Well Depth from B.P _____ ' _____ " Air Line _____ ' _____ "

PUMP & MOTOR DATA

Pump Make: _____ Rating: _____ I.G.M. @ _____ ' T.H
Head: Type: _____ S.N. _____
Column: _____ ' X _____ " X _____ " X _____ " Shaft Mat'l _____
Bowl: _____ Stage: _____ Curve: _____
Suction: _____ " dia. _____ ' _____ " Long
Special: Zinc Sleeves _____ Taped Oil Line _____
Other _____
Motor Make: _____ Frame: _____ S.N. _____
_____ H.P. _____ phase _____ hz _____ rpm _____ Volts
Bearing No. Upper _____
Lower _____

Special Equipment
Aug 29/95 - 87.74 feet of 14" O.D. liner installed

		BY

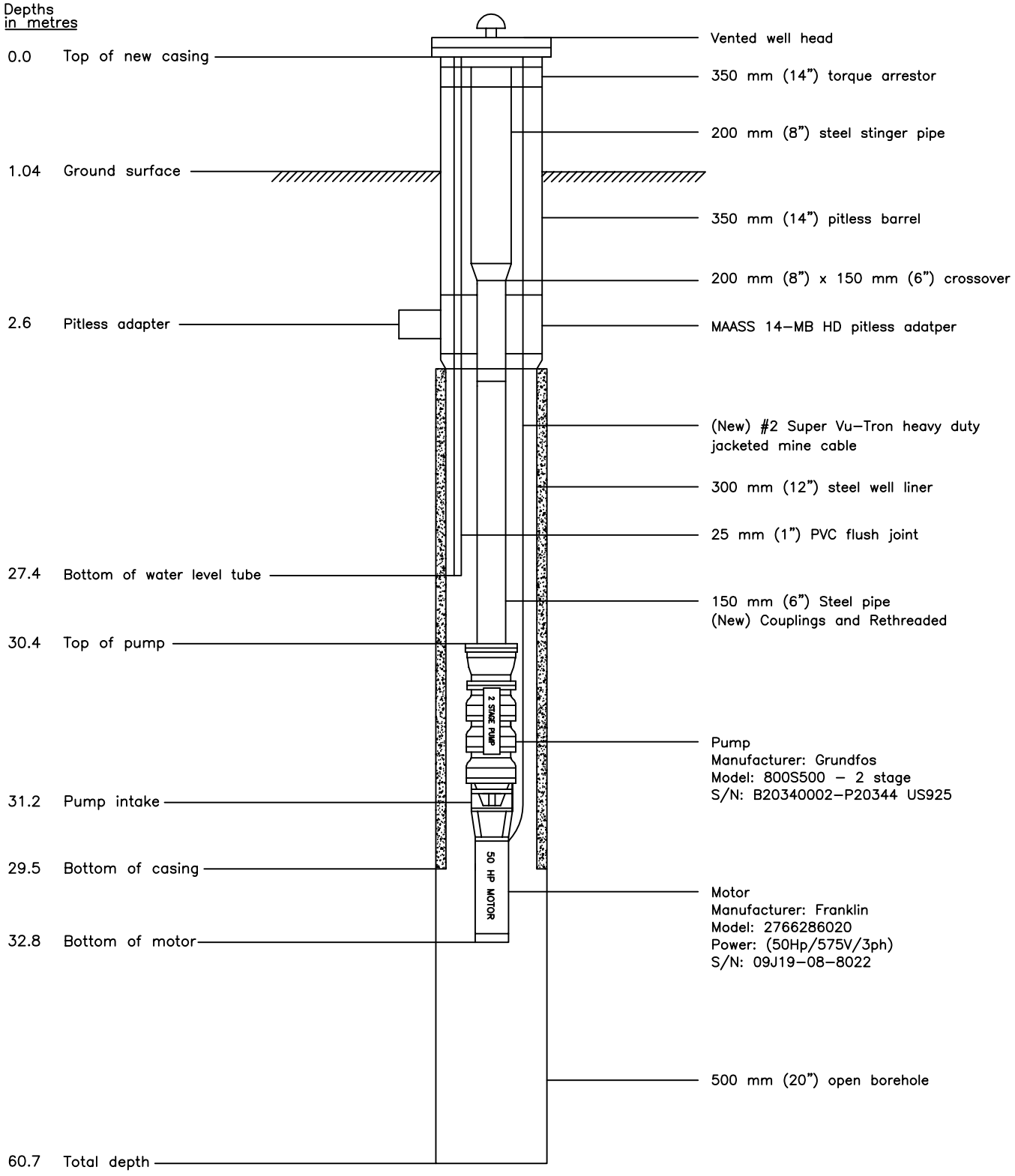
International Water Supply Ltd.

MONTREAL - BARRIE - SASKATOON

CLIENT: REGIONAL MUNICIPALITY OF WATERLOO
WELL No: MIDDLETON WELL GIA

DRILLED BY: Others	DATE:	DRAWN: T. Brown
INSTALLED BY:	DATE:	DATE: Sept 29/95

G1A



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CLIENT
REGIONAL MUNICIPALITY OF WATERLOO

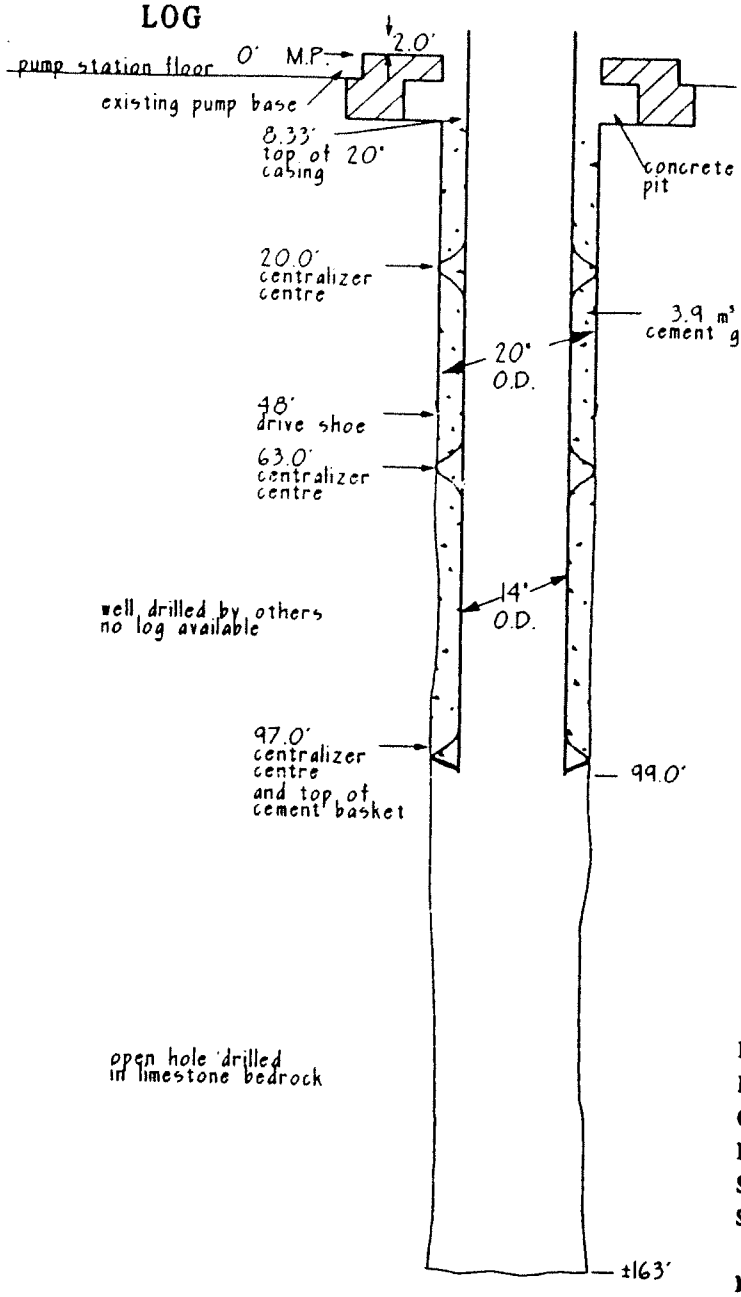
TITLE
Well G1A
Pump Installation Drawing

PROJECT No. 006-223			G:\Lotowater Projects\006 Region of Waterloo\223 G1A Repair\Pump Install.dwg		FIGURE 1
DESIGN					
DRAWN	EH	2012/02/17	REVISION No. 2012/02/17	SCALE N.T.S.	
CHECKED					

File G2

G2

LOG



WELL MATERIAL

Inner Casing: 14 " dia. 0.375 " Wall Thk. Mat'l Steel
Cemented from 8 ' 4 " to 98 ' 0 "
Outer Casing: 20 " dia. _____ " Wall Thk. Mat'l Steel
Screen: Make: _____ " dia. Opening & Mat'l: _____
Plug: Type: _____ Mat'l _____ Other _____
Gravel: Type: _____ Size: _____ Quantity: _____

AQUIFER TEST DATA

Date: _____ By: _____
Static Level _____ below M.P. _____
Pumping Rate I.G.M.: _____
Pumping Duration: _____ hrs. _____ min.
Pumping Level at Test End: _____
Performance Plots: dd-t Dwg. _____
dd-r Dwg. _____
Step Test _____

EQUIPPED WELL DATA

Date: _____ By: _____
Rated Well Capacity IGM _____
Pumping Rate IGM _____ Static Level _____ ' _____ "
Pumping Level _____ ' _____ " at _____ hrs. _____ min.
Pump Pressure: _____ psi Main Pressure _____ psi
Shut Off: AGH _____ psi W.L. _____ ' _____ "
Clear Well Depth from B.P _____ ' _____ " Air Line _____ ' _____ "

PUMP & MOTOR DATA

Pump Make: _____ Rating: _____ I.G.M. @ _____ ' T.H
Head: Type: _____ S.N. _____
Columns: _____ ' X _____ " X _____ " X _____ " Shaft Mat'l _____
Bowl: _____ Stage: _____ Curve: _____
Suction: _____ " dia. _____ ' _____ " Long
Special: Zinc Sleeves _____ Taped Oil Line _____
Other _____
Motor Make: _____ Frame: _____ S.N. _____
_____ H.P _____ phase _____ hz _____ rpm _____ Volts
Bearing No. Upper _____
Lower _____

Special Equipment

Feb 6/96 - 101.0 feet of 14" O.D. liner installed

		BY

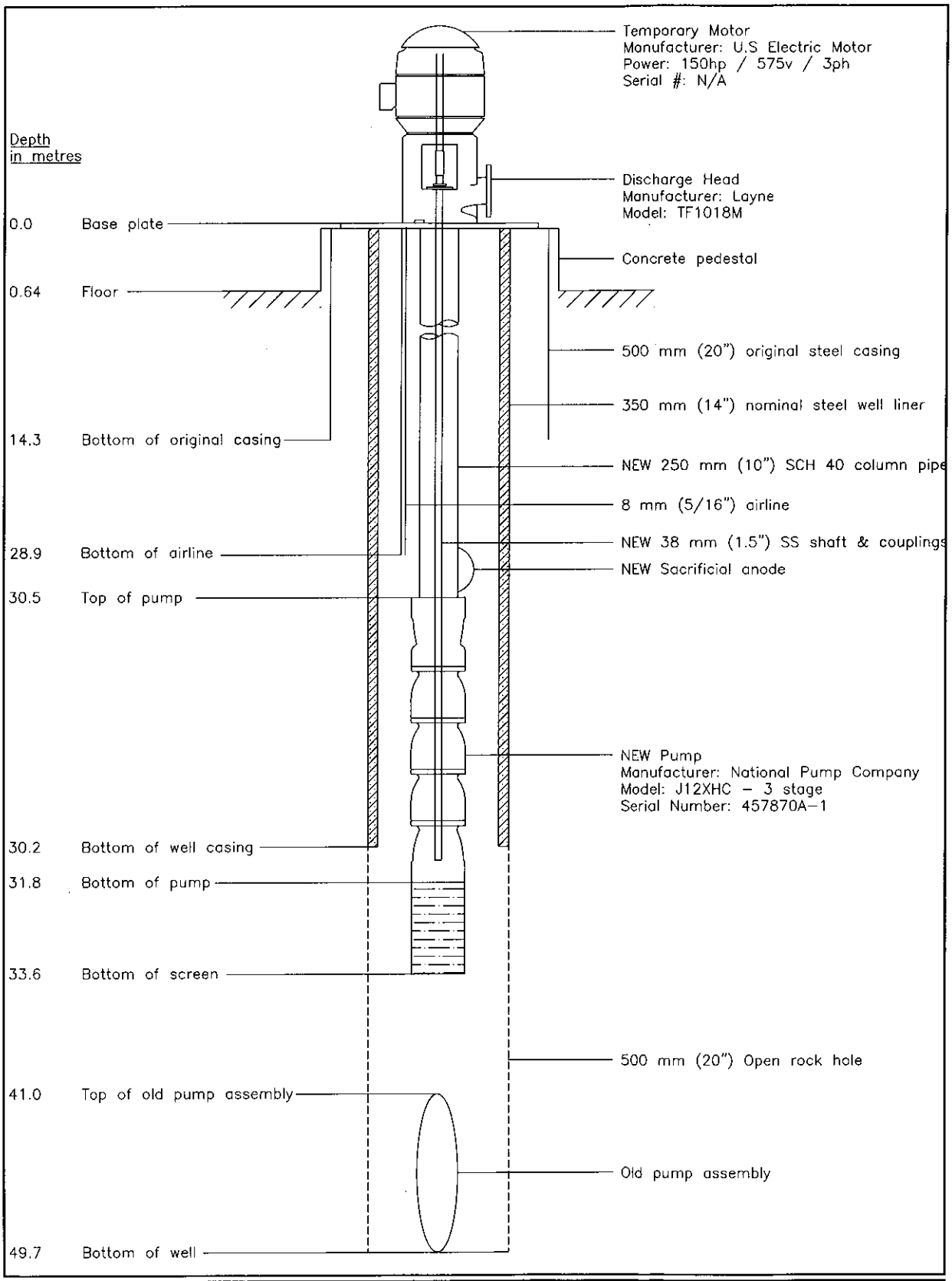
International Water Supply Ltd.

MONTREAL - BARRIE - SASKATOON

CLIENT: REGIONAL MUNICIPALITY OF WATERLOO

WELL No: MIDDLETON WELL G2

DRILLED BY: Others	DATE:	DRAWN: T. Brown	
INSTALLED BY:	DATE:	DATE: Feb. 14/96	



NOTES

(1) All measurements below top of base plate which is 0.64 m above pumphouse floor.

(2) New pump installed December 5, 2013.

(3) Static water level = 10.67 m below top of base plate measured December 6, 2013.

Lotowater
GROUND WATER SERVICES INC.

CLIENT: Regional Municipality of Waterloo

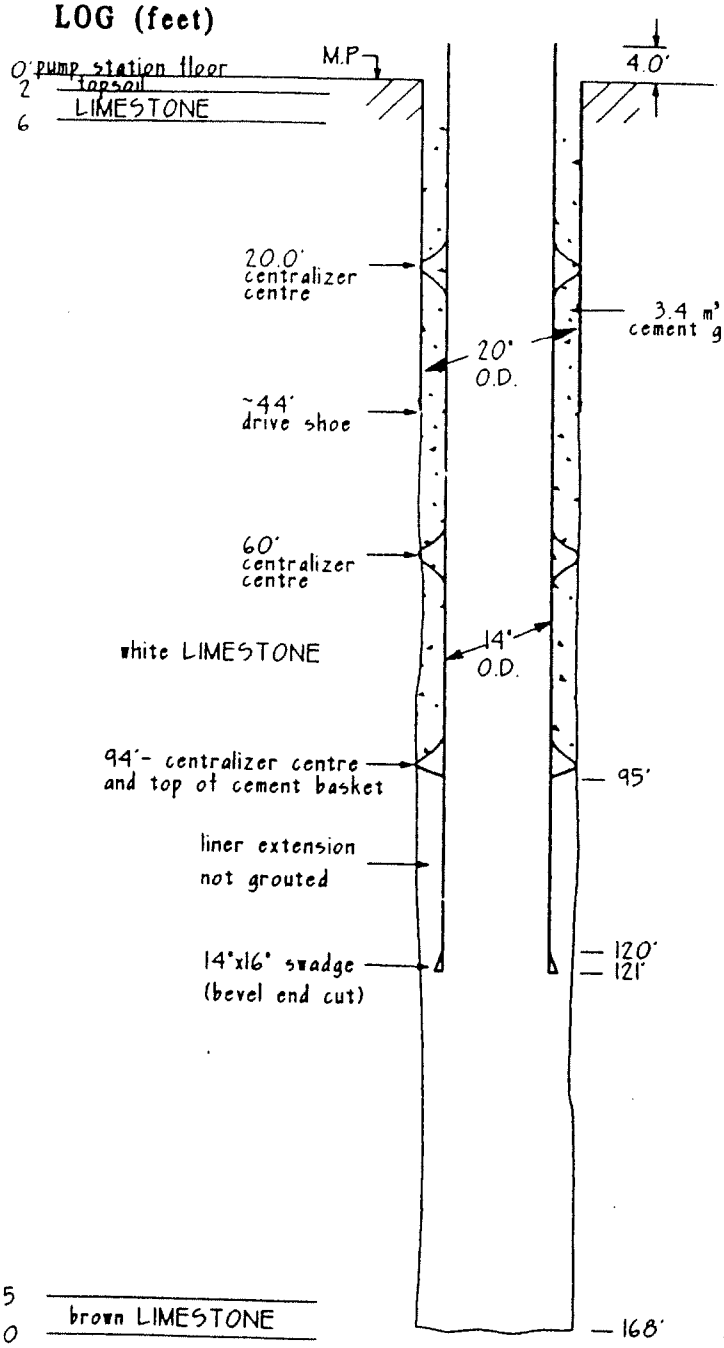
TITLE: Well G2
Pump Installation Details

PROJECT No. 006-289			G:\Lotowater Projects\006 Region of Waterloo\289 Middleton\Lineshaft Pump Installation.dwg		
DESIGN			REVISION No. 2013/10/23	SCALE N.T.S.	FIGURE 4
DRAWN	BH	2013/10/23			
CHECKED					

G3

File G3

LOG (feet)



WELL MATERIAL

Inner Casing: 14 " dia. 0.375 " Wall Thk. Mat'l Steel
Cemented from 0 ' 0 " to 95 ' 0 "
Outer Casing: 20 " dia. _____ " Wall Thk. Mat'l Steel
Screen: Make: _____ " dia. Opening & Mat'l: _____
Plug: Type: _____ Mat'l _____ Other _____
Gravel: Type: _____ Size: _____ Quantity: _____

AQUIFER TEST DATA

Date: _____ By: _____
Static Level _____ below M.P. _____
Pumping Rate I.G.M.: _____
Pumping Duration: _____ hrs. _____ min.
Pumping Level at Test End: _____
Performance Plots: dd-t Dwg. _____
dd-r Dwg. _____
Step Test _____

EQUIPPED WELL DATA

Date: _____ By: _____
Rated Well Capacity IGM _____
Pumping Rate IGM _____ Static Level _____ ' _____ "
Pumping Level _____ ' _____ " at _____ hrs. _____ min.
Pump Pressure: _____ psi Main Pressure _____ psi
Shut Off: AGH _____ psi W.L. _____ ' _____ "
Clear Well Depth from B.P 168 ' 2 1/2 " Air Line ____ ' ____ "

PUMP & MOTOR DATA

Pump Make: Layne Rating: 1490 I.G.M. @ 167 ' T.H
Head: Type: TF 1227 S.N. _____
Column: 115 ' X 10 " X --- " X 1 1/2" Shaft Mat'l S.S
Bowl: 12 THC Stage: 3 Curve: _____
Suction: 10 " dia. 5 ' 0 " Long
Special: Zinc Sleeves 13 Taped Oil Line _____
Other _____
Motor Make: USEM Frame: 404TP S.N. _____
100 H.P. 3 phase 60 hz 1780 rpm 575 Volts
Bearing No. Upper _____
Lower _____

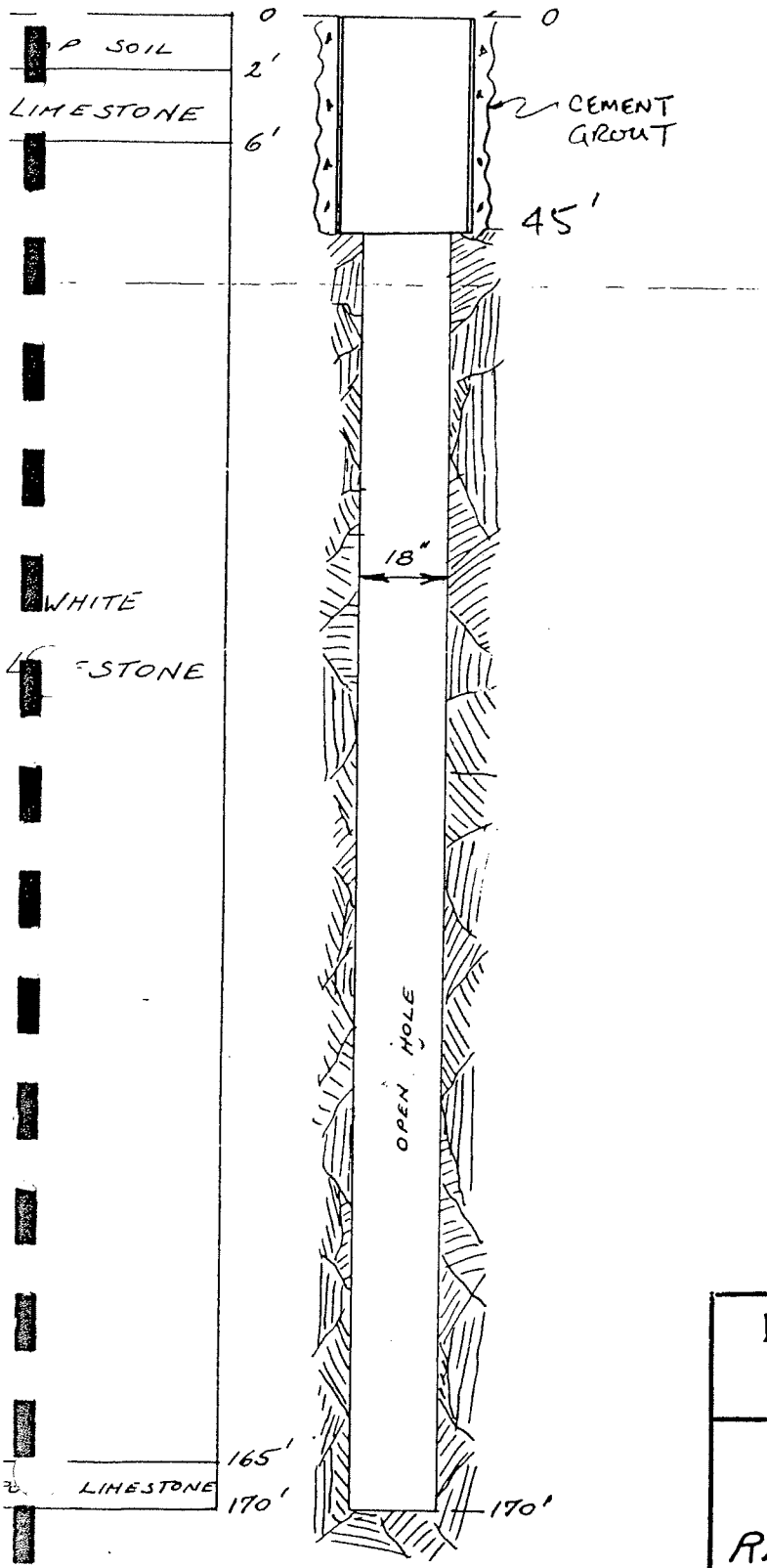
Special Equipment
Aug 21/96 - 124.0 feet of 14" O.D. liner installed

		BY

International Water Supply Ltd.
MONTREAL - BARRIE - SASKATOON

CLIENT: REGIONAL MUNICIPALITY OF WATERLOO
WELL No: MIDDLETON WELL G3

DRILLED BY: J. McGeachy	DATE: Apr/51	DRAWN: T. Brown	
INSTALLED BY: G. Keyes	DATE: Jun/52	DATE: Sept 5/96	



Well Material

Outer Casing }	20" ex app ~~20~~ 45'
Inner Casing }	
Screen	–
Plug	–
Gravel	–

Pump

No. 24114	Setting BP-MB 40'
No. Stages 6	Length Bowl 9'-2"
Bowl 18" RKLC	Size & Lgth. Suction 10' x 12"
Head TF 1227	Size Column 12" x 3½" x 2 7/16"

Materials or setting details other than standard:

Motor

Make US	Phase 3
Shaft VHS	Cycles 60
H. P. 200	Volts 550
R. P. M. 1200	Amps. 192
Type CFU	Base
Frame 587-9	Serial 9/5194

Special Equipment

JOHNSON RIGHT ANGLE GEAR DRIVE
18832 - H250 - RATIO 3-2
SRC 50 size 14 BLH Clutch

Well G-3

B. P. referred to original Ground Level	APP GL
Started MARCH 14, 1951	Clear Depth 167'-6"
Preliminary Test Apr 30/51	Length Air Line 60'
Final Test	Static Level 12'-9"
P. Guarantee 2000 IGM @	Pumping Level
Pressure 270' TDH	Capacity

Driller: J. McGEACHY (No OR)

Installer: G KEYES 6/16/52

INTERNATIONAL WATER SUPPLY LTD.
LONDON, CANADA
WATER SUPPLY CONTRACTORS

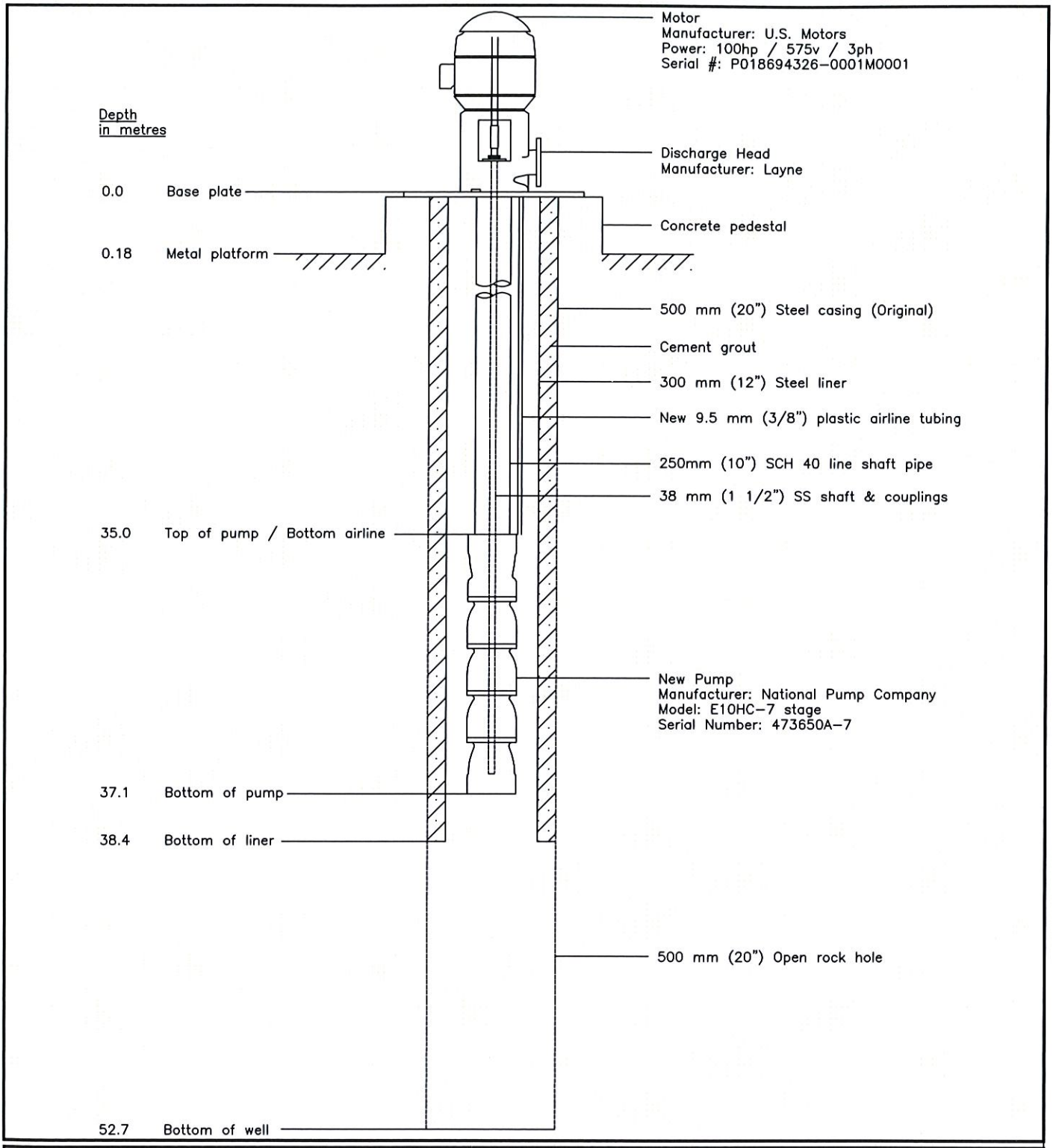
P.U.C. GALT, ONT.

REAR OF PUMPING STN. MIDDLETON ST.

DRAWN BY CHL APPROVED BY

WELL NO. 3 (Nov 1, 1951)

G3



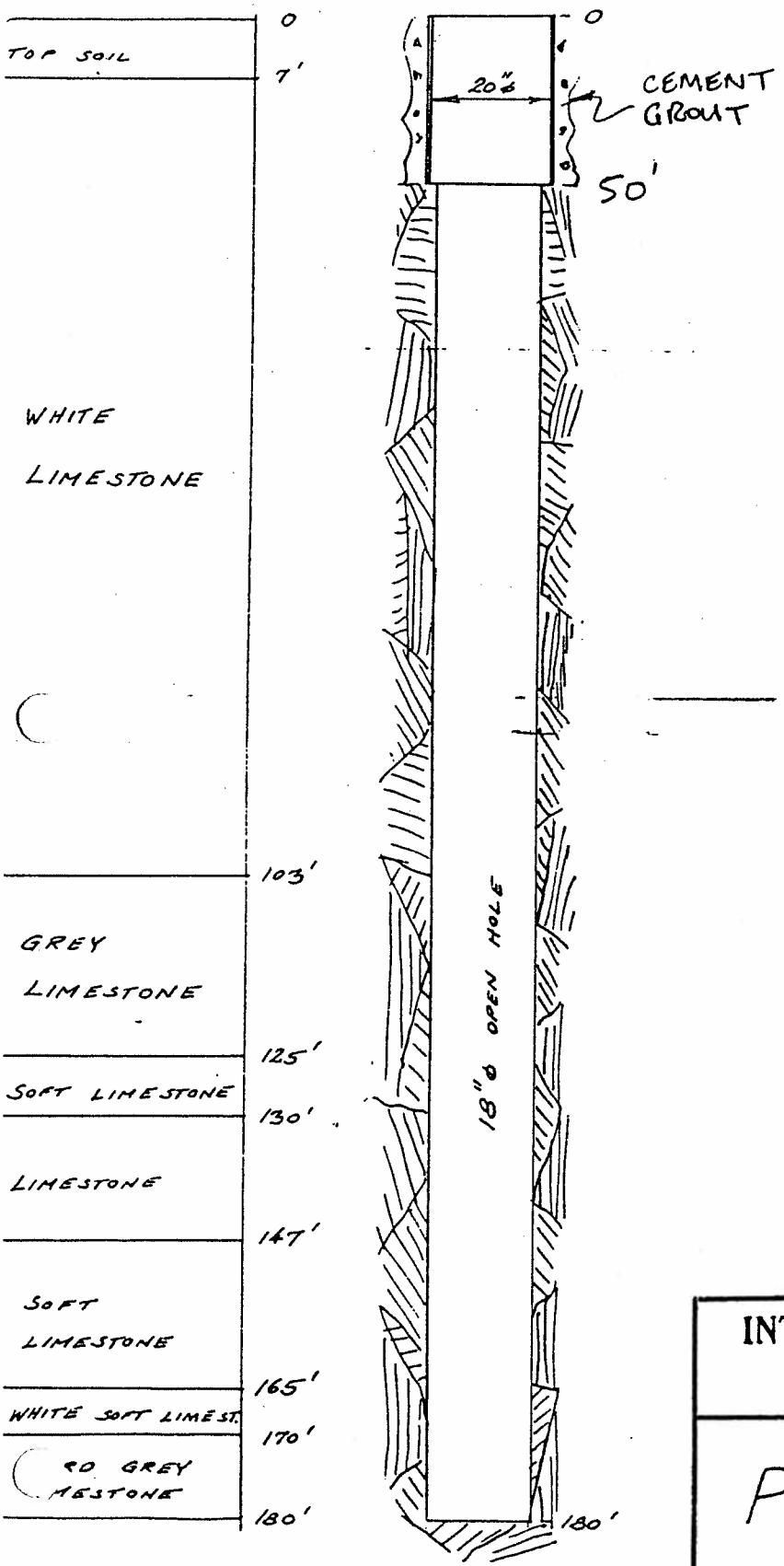
Lotowater
TECHNICAL SERVICES INC.

CLIENT
Regional Municipality of Waterloo

TITLE
Well G3
Pump Installation Drawing

PROJECT No. 006-327			G:\Lotowater Projects\006 Region of Waterloo\327 Well G3\Pump Install.dwg		FIGURE
DESIGN					
DRAWN	EH	2014/12/22	REVISION No. 2014-12-22	SCALE N.T.S.	4
CHECKED					

G14



JWH 8/11/51: The chemical quality of this water is questionable & the production is Low.

Well Material

Outer Casing }	20"ø × app 20' 50'	
Inner Casing }		
Screen	-	
Plug	-	
Gravel	-	

Pump

No.		Setting BP-MB
No. Stages	NONE	Length Bowl
Bowl		Size & Lgth. Suction
Head		Size Column

Materials or setting details other than standard -

Motor

Make		Phase
Shaft		Cycles
H. P.		Volts
R. P. M.	NONE	Amps.
Type		Base
Frame		

CDN. GENERAL TOWER

NOW CALLED

G-14

Well

B. P. referred to original Ground Level

Started MAY 18, 1951	Clear Depth
Preliminary Test	Length Air Line
Final Test	Static Level
Guarantee	Pumping Level 46
Pressure	Capacity 1185 IGI Recovery slow.

Driller: J MS GEACHY (No O.R.)

Installer:

INTERNATIONAL WATER SUPPLY LTD.
LONDON, CANADA
WATER SUPPLY CONTRACTORS

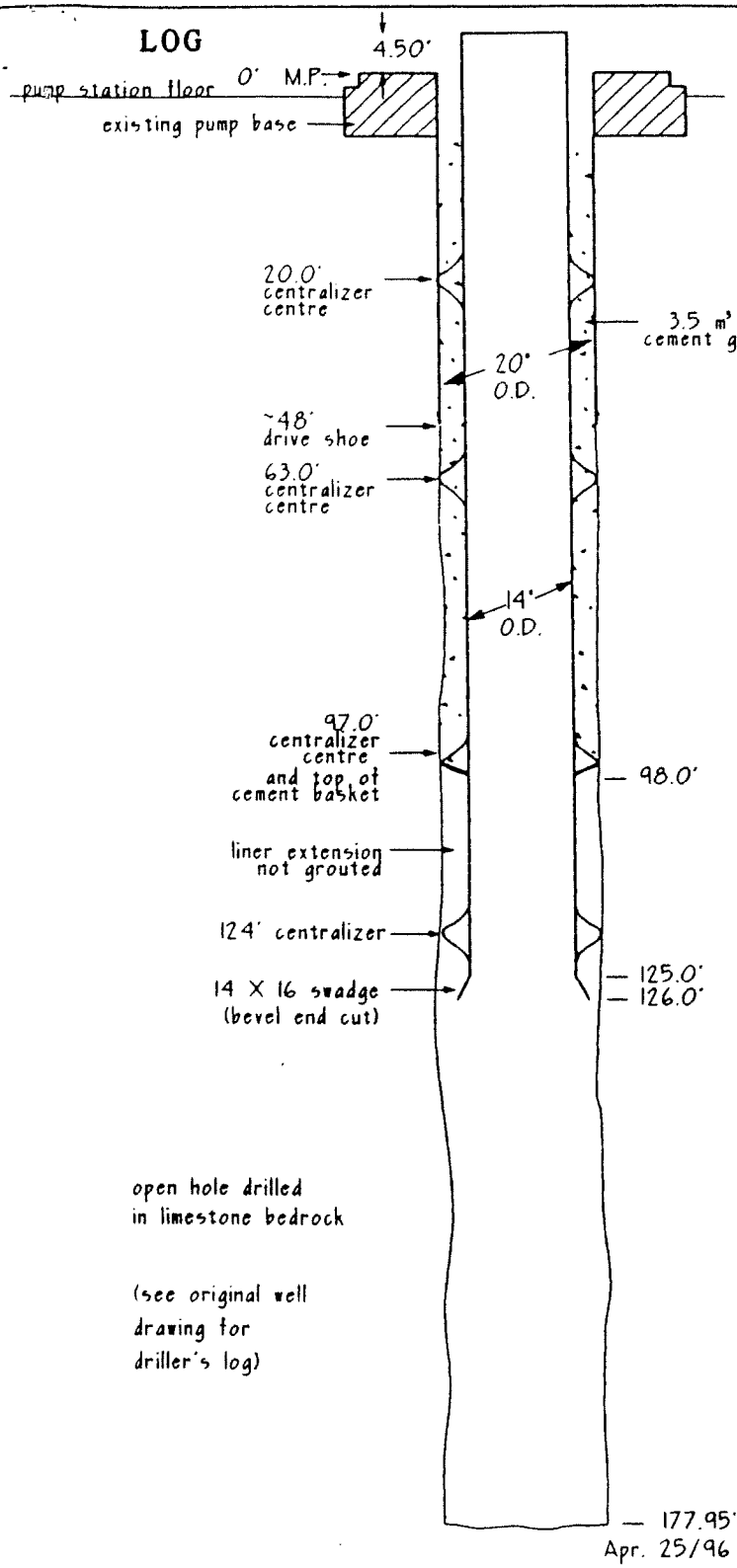
PUC. GALT. ONTARIO.

DRAWN BY CNL APPROVED BY G-14

WELL NO. 4 (our No2, 1951)

File G14

LOG



open hole drilled in limestone bedrock

(see original well drawing for driller's log)

WELL MATERIAL

Inner Casing: 14 " dia. 0.375 " Wall Thk. Mat'l Steel
Cemented from 0 ' 0 " to 98 ' 0 "
Outer Casing: 20 " dia. _____ " Wall Thk. Mat'l Steel
Screen: Make: _____ " dia. Opening & Mat'l: _____
Plug: Type: _____ Mat'l _____ Other _____
Gravel: Type: _____ Size: _____ Quantity: _____

AQUIFER TEST DATA

Date: _____ By: _____
Static Level _____ below M.P. _____
Pumping Rate I.G.M.: _____
Pumping Duration: _____ hrs. _____ min.
Pumping Level at Test End: _____
Performance Plots: dd-t Dwg. _____
dd-r Dwg. _____
Step Test _____

EQUIPPED WELL DATA

Date: _____ By: _____
Rated Well Capacity IGM _____
Pumping Rate IGM _____ Static Level _____ ' _____ "
Pumping Level _____ ' _____ " at _____ hrs. _____ min.
Pump Pressure: _____ psi Main Pressure _____ psi
Shut Off: AGH _____ psi W.L. _____ ' _____ "
Clear Well Depth from B.P _____ ' _____ " Air Line _____ ' _____ "

PUMP & MOTOR DATA

Pump Make: _____ Rating: _____ I.G.M. @ _____ ' T.H
Head: Type: _____ S.N. _____
Column: _____ ' X _____ " X _____ " X _____ " Shaft Mat'l _____
Bowl: _____ Stage: _____ Curve: _____
Suction: _____ " dia. _____ ' _____ " Long
Special: Zinc Sleeves _____ Taped Oil Line _____
Other _____
Motor Make: _____ Frame: _____ S.N. _____
_____ H.P. _____ phase _____ hz _____ rpm _____ Volts
Bearing No. Upper _____
Lower _____

Special Equipment

May 2/96 - 129.6 feet of 14" O.D. liner installed
- 1' X 14" X 16" swadge

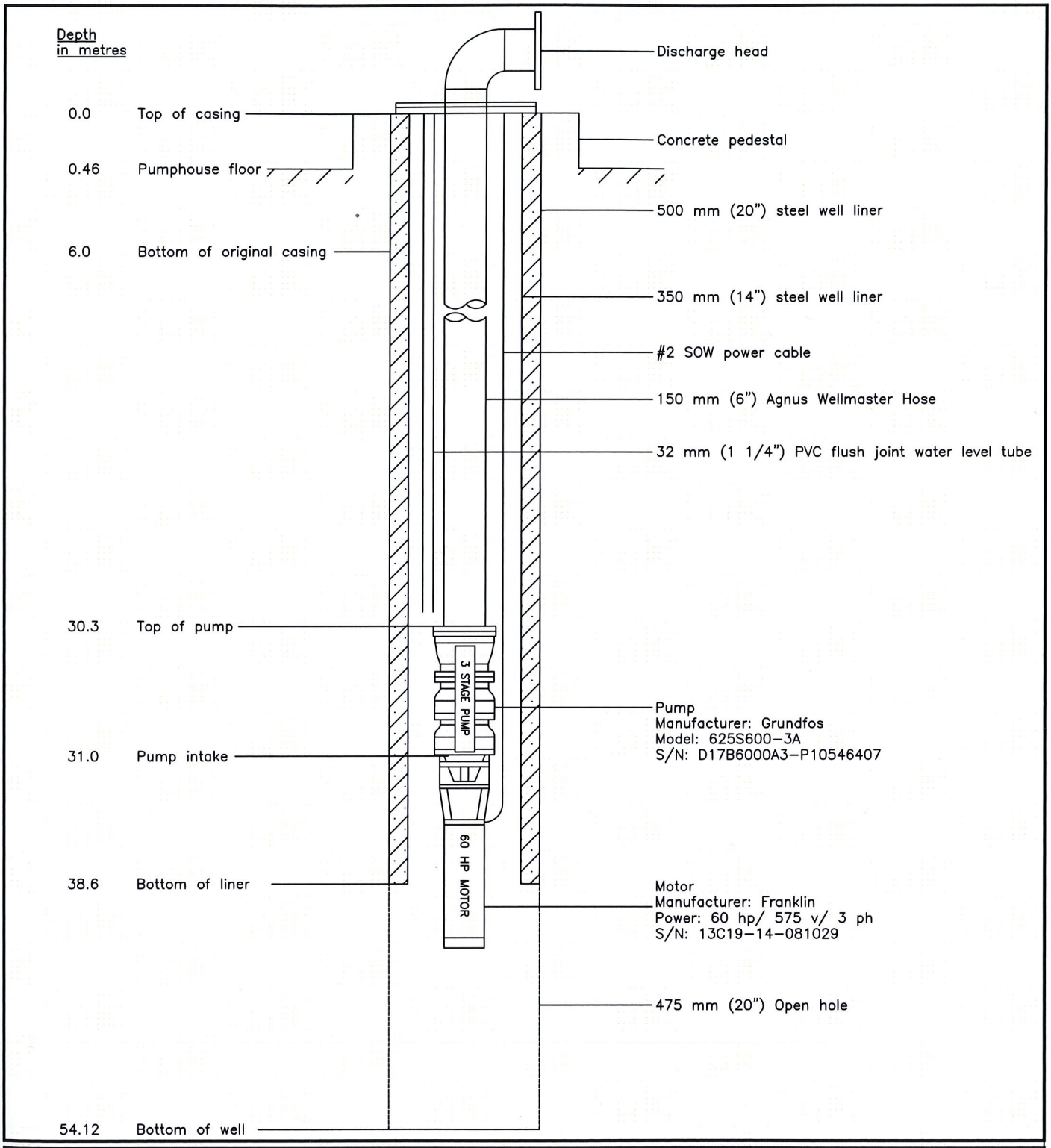
		BY

International Water Supply Ltd.

MONTREAL - BARRIE - SASKATOON

CLIENT: REGIONAL MUNICIPALITY OF WATERLOO
WELL No: MIDDLETON WELL G14

DRILLED BY: J. McGeachy	DATE: May/51	DRAWN: T. Brown	
INSTALLED BY:	DATE:	DATE: May 9/96	



Lotowater
TECHNICAL SERVICES INC.

CLIENT
Regional Municipality of Waterloo

TITLE
Well G14
Pump Installation Drawing

PROJECT No. **006-325**			\\Poweredge\sharedfolders\...\006 Region of Waterloo\325 G14 Service\Pump Install.dwg		FIGURE **4**
DESIGN			REVISION No. 2015/01/30	SCALE **N.T.S.**	
DRAWN	**EH**	**2015/01/30**			
CHECKED					

Borehole Chip Sample Description

Well I.D. BH-1

Project: Middleton Street Well Field Study

Logged by: R.A. Trevail ORION RESOURCES CONSULTING LIMITED FOR BEAK

Depth Interval (m bgs)	Description
Guelph Fm. @ 2 metres	
2-5	DOLOSTONE, lt brn, bu, f-m xln, pr, pch ϕ, intxln, p.p. Vug, sml Vug
5-8	DOLOSTONE (75%), m brn, f-m xln, pr, pch ϕ, intxln, p.p. Vug, ti DOLOSTONE (25%), lt gry-brn, vf-m xln, pr, pch ϕ, intxln pp. Vug, ti
8-11	DOLOSTONE, lt brn-gry, f-crs xln, pr-fr, pch ϕ,intxln p.p. Vug, sml Vug, vugs lined w/ dol Xls
11-14	DOLOSTONE, lt brn-gry, m-crs xln, fr, uni intxln ϕ, Tr sml vug
14-17	DOLOSTONE, lt brn-gry, m-crs xln, fr, uni intxln ϕ, Tr sml vug, incr intxln ϕ, p.p. Vug
17-20	DOLOSTONE, lt brn-gry, m-crs xln, fr uni intxln ϕ, Tr small vug
20-24	DOLOSTONE, lt brn, Tr gry, vf-m xln, pr, pch ϕ, intxln, p.p. Vug, sml Vug
24-27	DOLOSTONE, lt gry-brn, vf-m, pr, pch ϕ, intxln, p.p. Vug, ti
27-30	DOLOSTONE, lt brn (incr gry), vf-m xln, pr, pch ϕ, intxln, p.p. Vug, ti

Depth Interval (m bgs)	Description
	Guelph Fm. @ 2 metres (cont'd.)
30-33	DOLOSTONE (80%), lt gry, vf-f xln, ti, occ. intxln, p.p. Vug DOLOSTONE (20%), lt brn, vf-f xln, ti, Tr plugged p.p. Vug, sml Vug (dol rhombs lining some vugs)
33-36	DOLOSTONE, ltd gry-brn & gry, f-m xln, ti, occ. intxln, p.p. Vug, sml Vug
36-39	DOLOSTONE, lt gry-brn & gry, vf-m xln, ti, occ. intxln, p.p. Vug, sml Vug
39-42	DOLOSTONE, lt gry-brn & gry, vf-f xln, pr, pch ϕ, ti, intxln, p.p. Vug, sml Vug
42-45	DOLOSTONE (50%), lt brn, m xln, ti, occ. intxln, p.p. Vug DOLOSTONE (50%), lt-m gry, mott, micro-f xln, ti, Tr intxln, p.p. Vug, sml Vug
45-48	DOLOSTONE (95%), lt gry-brn, micro-f xln, ti, occ. pp.p. Vug, sml Vug DOLOSTONE (5%), lt-m gry, mott, micro-f, ti, Tr intxln, p.p. Vug, sml Vug
48-51	DOLOSTONE, lt gry-brn, micro-f xln, pr, pch ϕ, intxln, p.p. Vug, sml Vug, vugs lined w/ dol Xls
51-54	DOLOSTONE, lt brn, vf-m xln, pr-fr pch ϕ, intxln, p.p. Vug, sml Vug, possible flowstone? on fracture surface
54-58	DOLOSTONE (25%), lt brn, vf-m xln, pr-fr pch ϕ, intxln, p.p. Vug, sml Vug DOLOSTONE (75%), lt-m gry & gry-wh mott, f-crs xln, fr ϕ, intxln, p.p. Vug, sml Vug, (tp of bioh)
58-61	DOLOSTONE, lt-m gry & gry-wh, mott, vf-crs xln, fr, pch ϕ, intxln, p.p. Vug, sml Vug, fractured?, Tr Pyr, slily arg
61-64	DOLOSTONE, lt-m gry & gry-wh, mott, vf-crs xln, good, pch to uni ϕ, intxln, p.p. Vug, sml Vug, slily arg

Depth Interval (m bgs)	Description
	Lockport Fm. - Eramosa Mbr. @ 64 metres
64-67	DOLOSTONE (10%), lt-m gry & gry-wh, mott, vf-crs xln, good, pch to uni ϕ, intxln, p.p. Vug, sml Vug, slily arg DOLOSTONE (90%), m brn, micro-f xln, suc tex, fr, unit ϕ, intxln, Tr p.p. Vug, fnt alg Lam
	Lockport Fm. - Gasport Member @ 67 metres
67-70	DOLOSTONE (10%), m brn, micro-f xln, suc tex, fr, uni ϕ, intxln, Tr p.p. Vug, fnt alg Lam DOLOSTONE (90%), lt-m wh-gry crypto-crs xln, fr, pch ϕ, intxln, p.p. Vug, sml Vug, Tr Pyr
70-73	DOLOSTONE, lt-m gry, vf-m xln, ti, pr, pch ϕ, intxln, p.p. Vug, sml Vug, Tr Pyr
73-76	DOLOSTONE, m gry, micro xln, ti, Tr p.p. Vug, Tr Pyr
76-79	DOLOSTONE, m gry, micro xln, ti, Tr p.p. Vug, Tr Pyr
79-82	DOLOSTONE (90%), m gry, micro xln, ti, Tr p.p. Vug, Tr Pyr DOLOSTONE (10%), lt brn, f-m xln, fr, pch ϕ, intxln, p.p. Vug, sml Vug
82-85	DOLOSTONE, lt brn-gry, micro xln, ti, Tr intxln, p.p. Vug
85-88	DOLOSTONE, lt brn-gry, micro xln, ti, Tr intxln, p.p. Vug, Tr gyp in vugs
88-91	DOLOSTONE, lt-m gry mott, & lt brn, micro-m xln, fr, pch ϕ, intxln, p.p. Vug, sml Vug, Tr Pyr
91-94	DOLOSTONE, lt-m gry mott, micro-m xln, pr, pch ϕ, intxln, p.p. Vug

Depth Interval (m bgs)	Description
94-97	DOLOSTONE, lt-m gry mott, micro-m xln, fr, pch ϕ, intxln, p.p. Vug, sml Vug
97-100	DOLOSTONE, lt-m gry mott, micro-m xln, pr, pch ϕ, intxln, p.p. Vug, sml Vug
100-103	DOLOSTONE, lt-m gry mott, micro-m xln, pr, pch ϕ, intxln, p.p. Vug, sml Vug, Tr Pyr, slily arg
Rochester Fm. @ 104 metres	
103-106	DOLOSTONE (10%), lt-m gry mott, micro-m xln, pr, pch ϕ, intxln, p.p. Vug, sml Vug, Tr Pyr, slily arg SHALE (90%), m-dk gry, dol, Tr Glauc, slily pyr
Reynales Fm. @ 106 metres	
106-107	DOLOSTONE, lt brn, m gry, mott, micro-m xln, pr, pch ϕ, intxln p.p. Vug, sml Vug, Tr Pyr, Tr shale a.a.

Notes:

m bgs - metres below ground surface

beak consultants limited
42 Arrow Road,
Guelph, Ontario N1K 1S6
telephone: (519) 763-2325
facsimile: (519) 763-2378

CORE LOG FORM

C-MS-BH2B-93-(A-B)

Date: 29 November 1993
Project Number: 7209.1
Project Name: Middleton Street Well Field Study
Location: **BH-2B**
Core Size: 76mm/3"

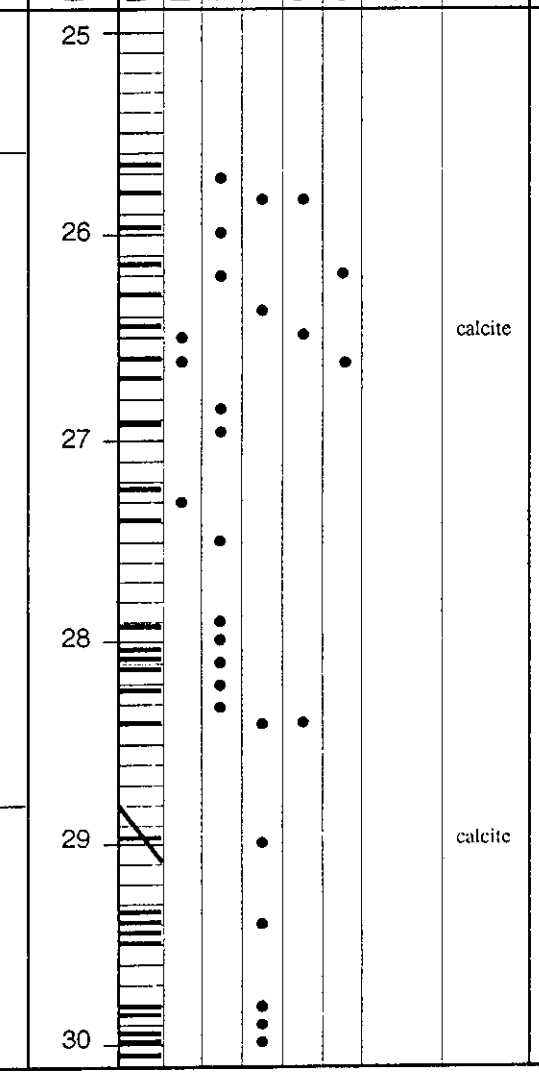
Drilling Co.: Davidson Environmental
Logged by: R.A. Sweezey/R.A. Trevail
Core Box: 1, 2

Lithology

3.66-25.60m
DOLOSTONE, lt gry
-triconed no core recovered

25.60-32.75m
DOLOSTONE, lt gry, intbd w/ lt gry-brn, vf-f xln, pr, pch ø. intxln, p.p. Vug, sml Vug, lge Vug, Frac, foss, solitary corals, small brachiopods, bryozoa,-cephalopods (mudstone)

-competent zone 25.60-28.80 metres



Remarks

fracture
fracture zone
Vug

rubble zone

beak consultants limited
42 Arrow Road,
Guelph, Ontario N1K 1S6
telephone: (519) 763-2325
facsimile: (519) 763-2378

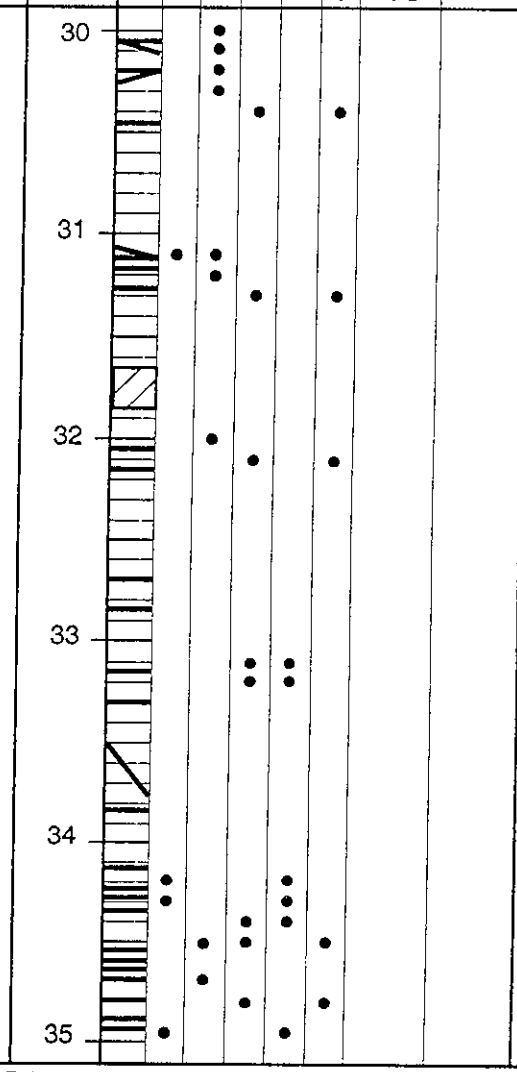
CORE LOG FORM

Date: 29,30 November 1993
Project Number: 7209.1
Project Name: Middleton Street Well Field Study
Location: **BH-2B**
Core Size: 76mm/3"

Drilling Co.: Davidson Environmental
Logged by: R.A. Sweezey/R.A. Trevail
Core Box: 2, 3

Lithology

32.75-42.10
-flowstone at 32.80 metres
DOLOSTONE, lt gry to lt gry-brn, vf-f xln, pr pch ø, intxln, p.p. Vug, sml Vug, foss, smaller tabulate corals, stromatoporoid fragments, gastropods, small brachiopods (wackestone)



Remarks

fracture
fracture zone
Vug

rubble zone

rubble zone

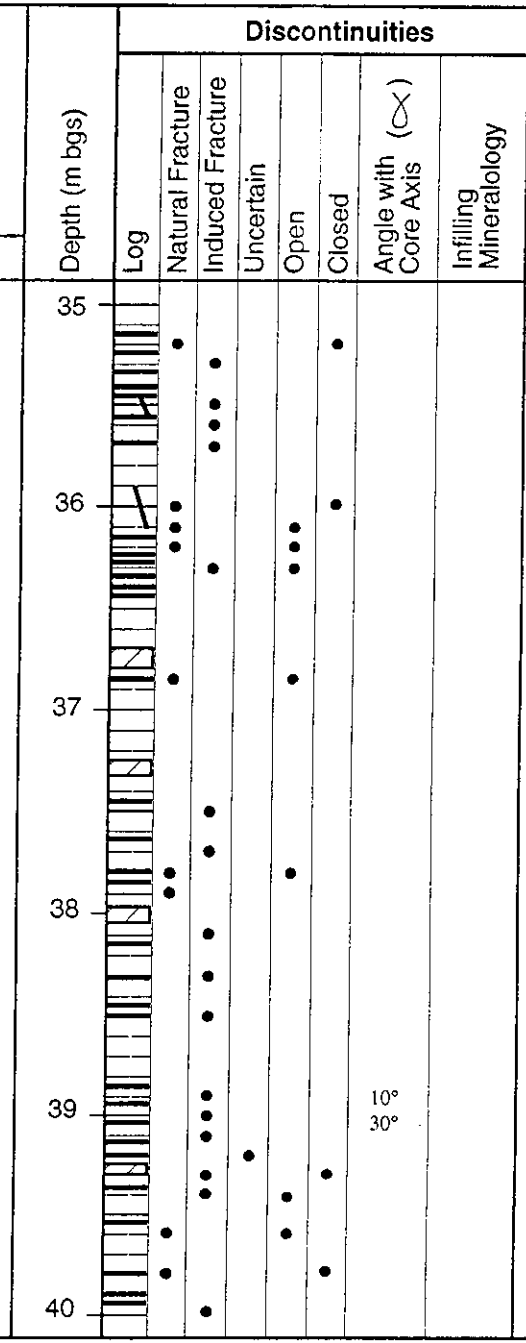
fracture zone

beak consultants limited
42 Arrow Road,
Guelph, Ontario N1K 1S6
telephone: (519) 763-2325
facsimile: (519) 763-2378

CORE LOG FORM

Date: 29 November 1993
Project Number: 7209.1
Project Name: Middleton Street Well Field Study
Location: **BH-2B**
Core Size: 76mm/3"

Drilling Co.: Davidson Environmental
Logged by: R.A. Sweezey/R.A. Trevail
Core Box: 4, 5, 6



Remarks

rubble zone
rubble zone

fracture
fracture zone
Vug

fracture zone
rubble zone

rubble zone

rubble zone

rubble zone

fracture zone

beak consultants limited
42 Arrow Road,
Guelph, Ontario N1K 1S6
telephone: (519) 763-2325
facsimile: (519) 763-2378

CORE LOG FORM

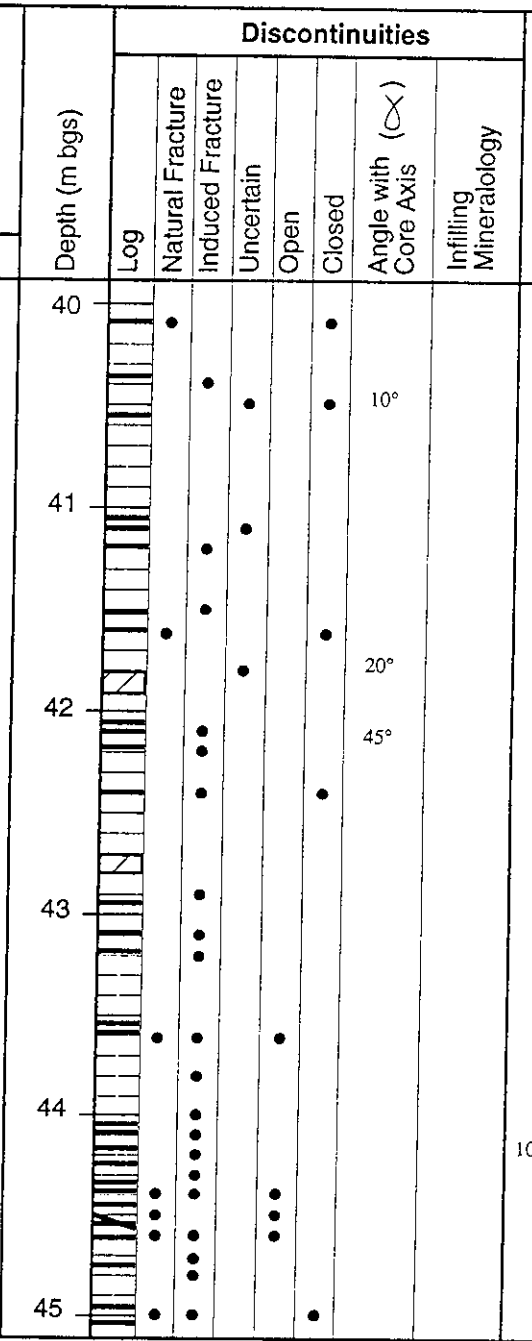
Date: 29 November 1993
Project Number: 7209.1
Project Name: Middleton Street Well Field Study
Location: **BH-2B**
Core Size: 76mm/3"

Drilling Co.: Davidson Environmental
Logged by: R.A. Sweezey/R.A. Trevail
Core Box: 6, 7

Lithology

42.10-52.43m
DOLOSTONE, gry to lt gry-brn mott, vf-f xln, pr-gd, pch ø, intxln, p.p. Vug, sml Vug, lge Vug, Frac, foss, Stroms, tab Cor, Gast, bioherm assemblage (wackestone - packstone)

-lower horizontal fracture surface coated with carbonate precipitate at 44.38 metres



Remarks

fracture
fracture zone
Vug

fracture zone

fracture zone

fracture zone

beak consultants limited
42 Arrow Road,
Guelph, Ontario N1K 1S6
telephone: (519) 763-2325
facsimile: (519) 763-2378

CORE LOG FORM

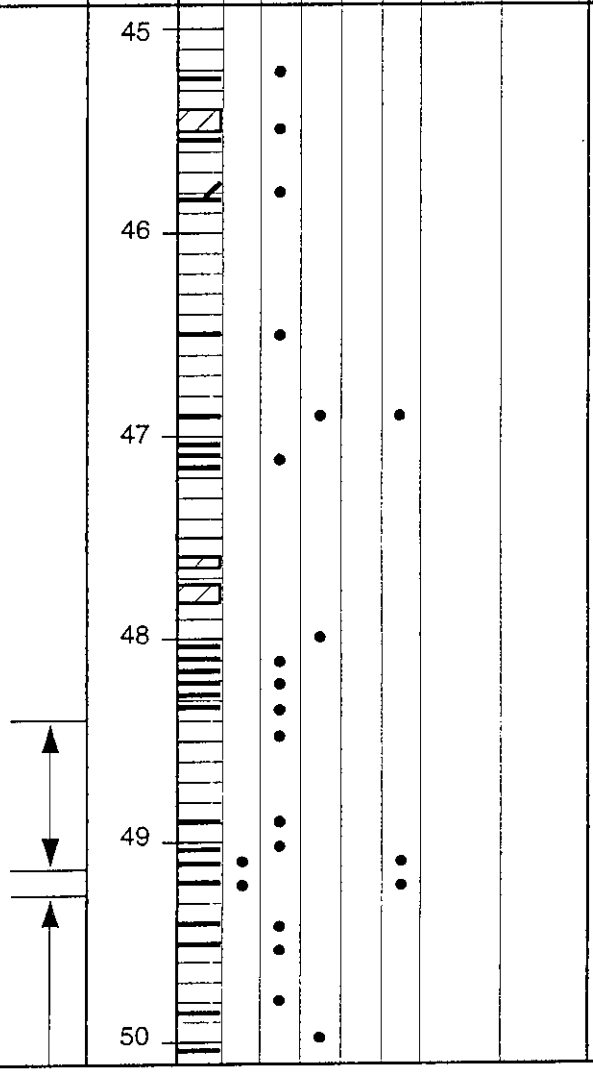
Date: 29 November 1993
Project Number: 7209.1
Project Name: Middleton Street Well Field Study
Location: **BH-2B**
Core Size: 76mm/3"

Drilling Co.: Davidson Environmental
Logged by: R.A. Sweezey/R.A. Trevail
Core Box: 7, 8, 9

Lithology

-competent zone 48.40-49.13 metres

-competent zone 49.27-52.43 metres



Remarks

fracture
fracture zone
Vug

fracture zone

rubble zone
rubble zone
fracture zone

beak consultants limited
42 Arrow Road,
Guelph, Ontario N1K 1S6
telephone: (519) 763-2325
facsimile: (519) 763-2378

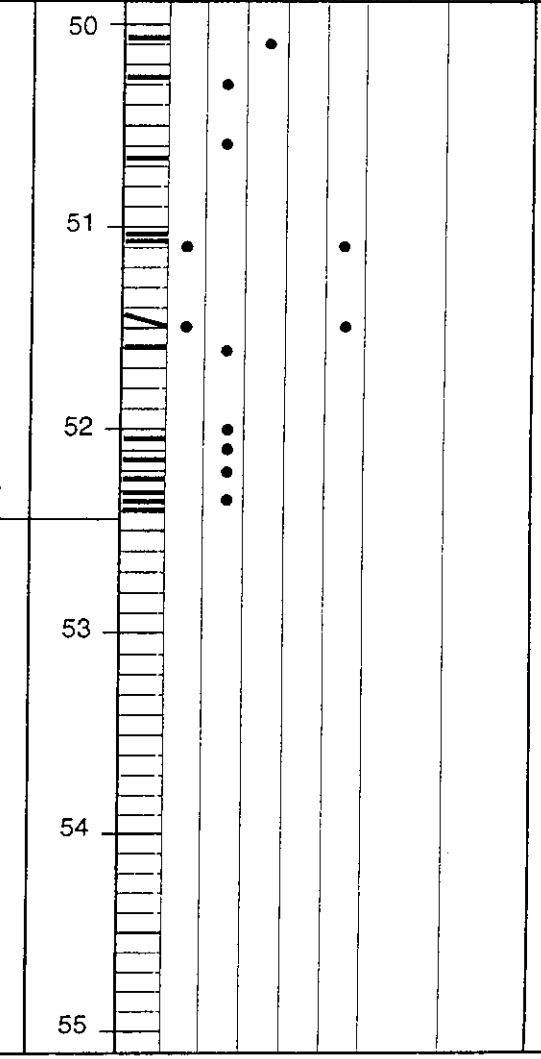
CORE LOG FORM

Date: 29 November 1993
Project Number: 7209.1
Project Name: Middleton Street Well Field Study
Location: **BH-2B**
Core Size: 76mm/3"

Drilling Co.: Davidson Environmental
Logged by: R.A. Sweezey/R.A. Trevail
Core Box: 9, 10

Lithology

End of Borehole at 52.43 metres



Remarks

fracture
fracture zone
Vug

C-MS-BH4-94-(A-B)

beak consultants limited

Borehole No: BH-4 **page 1 of** 3 **Borehole Log**

Project No: 7209.1
Client: RMOW Cambridge
Geologist: R. Sydor
Drilling Co.: Davidson Environmental
Completion Date: 29 March 1994

Project Name: RMOW Cambridge
Location: Borden Street and 1st Avenue
Drilling Method: Mud Rotary

Depth feet	Depth metres	Depth waterlevel	Stratigraphy	Lithologic Description	Geologic Samples: unified soils classification	recovery %	blow counts/ft	PID reading	subsamples
				fine sand with some coarse sand, brown, moderately well graded, trace fine gravel	SW				
5	1			fine gravel with sand, brown, well-graded, mostly fine gravel and coarse sand, little fine and medium sand	GW				
10	3			coarse sand with gravel, brown to medium grey, well-graded, little fine gravel, angular, few medium sand	SW				
15	4			fine gravel with sand, medium grey, well graded, gravel angular, little coarse gravel, little medium and coarse sand	GW				
20	6			fine gravel with some coarse sand, light brown, well graded, little fine sand, trace clay					
25	7			coarse gravel, light brown, well-graded, subangular, trace clay					
	8								

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Borehole No: BH-4 **page 2 of** 3 **Borehole Log**

Depth feet	Depth metres	waterlevel	Stratigraphy	Lithologic Description	Geologic Samples: unified soils classification	recovery %	blow counts/ft	PID reading	subsamples
					GW				
30	9			clay, grey to light brown with some coarse sand and fine gravel	CL				
	10								
35				silty or clayey fine sand, grey to light brown, little coarse sand, subangular	SM				
	11								
	12			silty or clayey fine sand, grey to light brown, little coarse sand, subangular, trace fine gravel					
40									
	13			driller noted colour change at 13.4m					
45				silty fine sand, light grey, some silt, little coarse sand					
	14								
	15								
50				silty fine sand, light grey, some silt, little coarse sand, few clay, firm					
	16								
55				silty fine sand, light grey, some silt, little coarse sand, few clay, firm					
	17								

beak consultants limited

Borehole No: BH-4 **page 3 of** 3 **Borehole Log**

Depth feet	Depth metres	Depth waterlevel	Stratigraphy	Lithologic Description	Geologic Samples: unified soils classification	recovery %	blow counts/ft	PID reading	subsamples
60	18			silty fine sand, light grey, some silt, few coarse sand, few clay, firm	SM				
	19								
65	20			silty fine sand, light grey, more silt than previous unit, few to little coarse sand, few clay, firm	ML				
	21								
70	22								
				bedrock - medium grey limestone and well-graded coarse sand, angular cuttings	BDRK				
75	23			core chip samples collected from 24 to 87m below ground surface					
	24								
80	25								
	26								
85	27								

C-MS-MW1-08-(A-B-C)

Monitoring Well: C-MS-MW1-08

Project:	Middleton Monitoring Well Installation and Upgrades	**Drillrig:**	CME75	**Casing Diameter:**	HW (102 mm ID x 114 mm OD)
Client:	Region of Waterloo	**Bit Type:**	Christiansen PQ Coring	**Inclination:**	90°
Location:	Water Works Park	**Flush:**	Potable water- Brethren Water Service	**Azimuth:**	n/a
Number:	1609-00492	**Feed:**	Potable water- Brethren Water Service	**Date Started:**	Aug-11-2008
Field investigator:	L.Kennell	**Core Diameter:**	85 mm		
Contractor:	Noll Drilling Inc./Durl Hopper Ltd.				

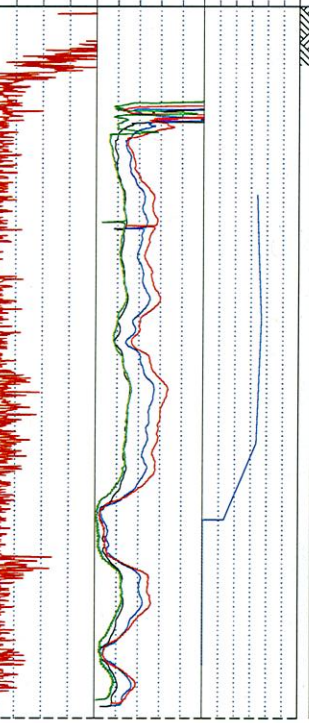
SUBSURFACE PROFILE

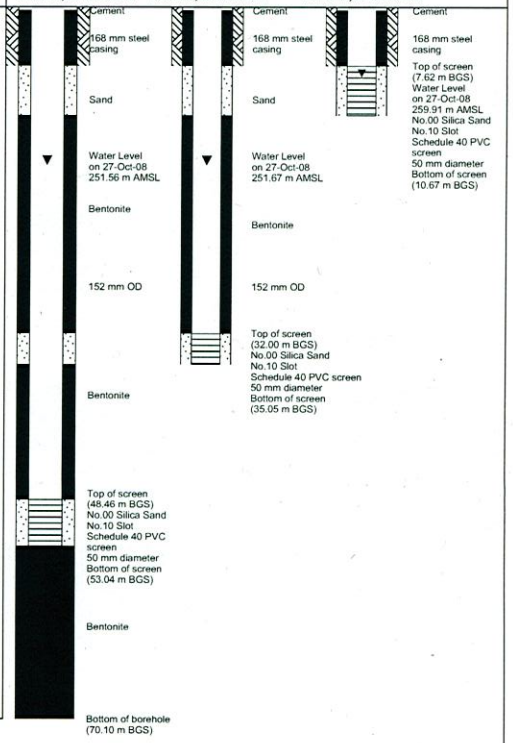
Depth (ft)	Depth (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)
			Ground Surface	265.90 0.00
			FILL silty sand with gravel and some clay	261.93 3.96
			UPPER BEDROCK AQUIFER light brown, dolostone, medium crystalline, wackestone, vuggy, megalodontid bivalves highly weathered with iron staining from 0-12 m pyrite crystals at 10.15 m BGS	250.05 15.85
			UPPER BEDROCK AQUIFER brown, dolostone, fine to medium crystalline, wackestone, megalodontid bivalves, digitate coral, stromatoporoids, brecciated pyrite crystals between 17.4 to 18.3 m BGS	245.78 20.12
			UPPER BEDROCK AQUITARD brown, dolostone, fine crystalline, laminar stromatoporoids, sponges	242.58 23.32
			UPPER BEDROCK AQUITARD white/light grey, dolostone, fine crystalline, crinoidal grainstone	239.45 26.44
			LOWER BEDROCK AQUIFER dolostone, fine to medium crystalline, vuggy, microbial reef, mound and coquina sequence Microbial Crinoidal Reef Mound dark blue grey, some weathered sections	216.69 49.20
			Brachiopool-Bryozoan-Crinoid Coquina white, highly weathered	212.71 53.19
			Microbial Crinoidal Reef Mound dark blue grey	203.18 62.71
			Brachiopod-Bryozoan-Crinoid Coquina white, weathered	202.24 63.65
			Microbial Crinoidal Reef Mound dark blue grey	198.74 67.16
			Brachiopod-Bryozoan-Crinoid Coquina white, weathered	195.79 70.10
			End of Borehole	

FOTO VIEW

CORE RECOVERY DATA

Run Number	TCR	SCR	RQD	Fractures per 1.52 m	Surface Description	Rock Strength
1	100%	70%	33%	9	iron staining irregular fractures	
2	96%	90%	68%	5	iron staining	
3	100%	82%	78%	7	irregular	
4	98%	94%	75%	1	irregular	
5	100%	98%	87%	2	irregular step-wise	
6	95%	90%	89%	2	undulating fracture orientation ~30°	R4
7	100%	100%	100%	2	irregular	R4
8	100%	97%	94%	2	irregular	R4
9	97%	94%	93%	2	undulating	R5
10	100%	100%	99%	1	irregular	R5
11	94%	93%	92%	3	irregular undulating fractures	R4
12	100%	100%	100%	0		R4
13	100%	100%	100%	1	irregular	R4
14	97%	94%	89%	2	irregular weathered	R4
15	99%	95%	93%	3	undulating	R4
16	97%	91%	93%	1	irregular	R4
17	100%	100%	100%	0		R3
18	100%	100%	109%	1	irregular	R3
19	100%	100%	100%	1	irregular	R4
20	100%	100%	98%	1	undulating	
21	97%	97%	97%	1	smooth curved	R4-R5
22	98%	98%	98%	0		R5
23	99%	99%	99%	0		R5
24	100%	100%	100%	2		
25	97%	97%	97%	0		R4
26	100%	100%	100%	0		R4
27	96%	96%	96%	0		R4
28	93%	93%	93%	0		R5
29	76%	56%	53%	4	large fracture	R4
30	82%	82%	82%	>10		R4
31	96%	93%	93%	1	undulating	R4
32	93%	88%	83%	2	undulating	R5
33	100%	100%	100%	0		R5
34	98%	98%	98%	0		R5
35	99%	99%	99%	0		R3-R4
36	99%	99%	99%	0		
37	99%	99%	99%	0		
38	98%	98%	98%	1	irregular	
39	98%	98%	98%	1	irregular	
40	98%	98%	98%	0		R4
41	100%	100%	100%	0		
42	100%	100%	100%	0		





NOTES:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
mAMSL - metres above mean sea level
mBGS - metres below ground surface

Electrode spread
No.8
No.16
No.32
No.64

WRAS - Water Resource Analysis System Plus Database

Stantec

RECORD OF DRILLHOLE 104-90

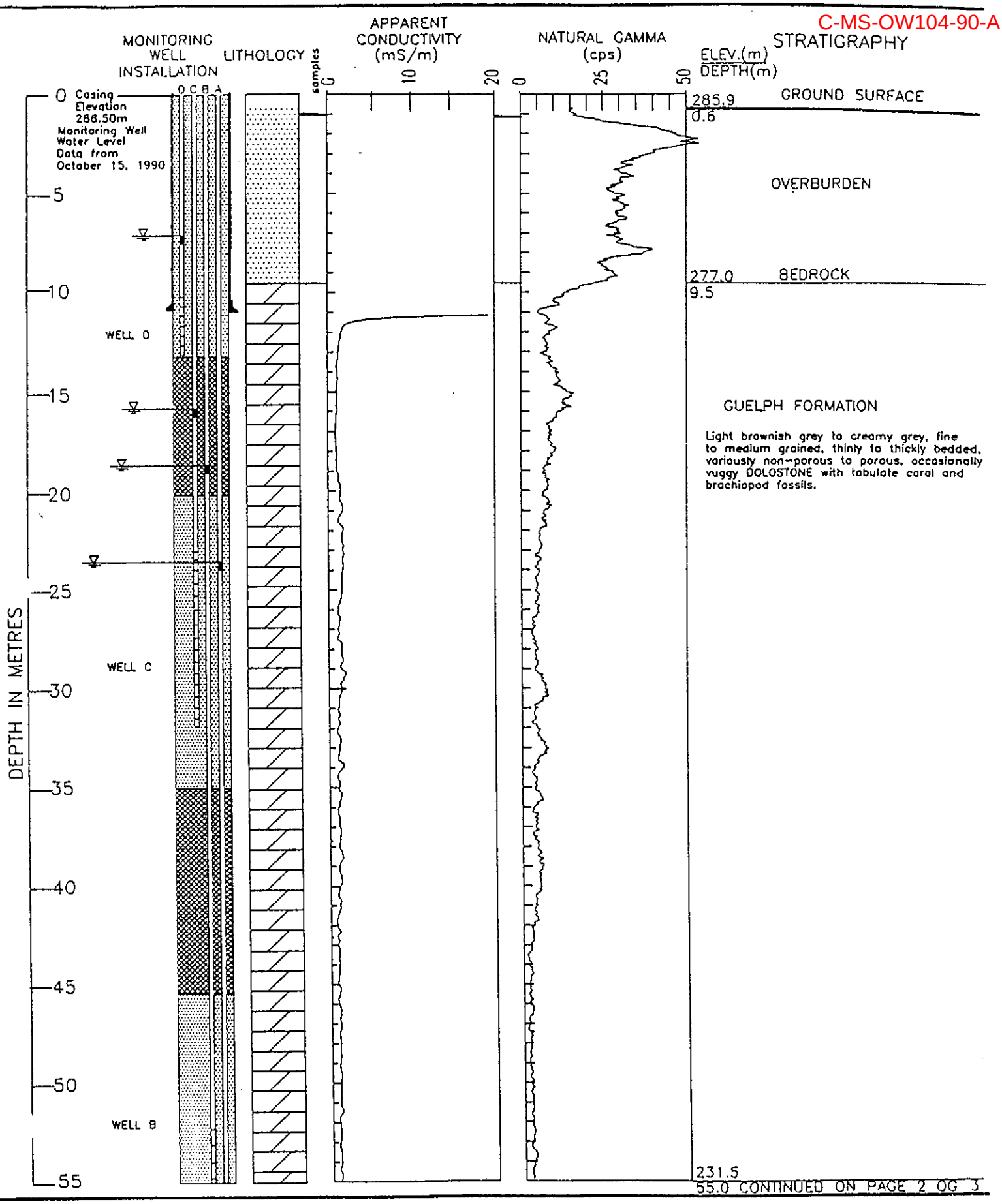
9070064

Location 554650E 4800640N (UTM COORD.)
Datum GEODETIC

Drilling Contractor LUNNEY WELL DRILLING
Drilling Method AIR ROTARY PERCUSSION

Dated Drilled July 23, 199(
Date Installed Aug. 30-31

C-MS-OW104-90-A



CONTINUED ON PAGE 2 OF 3

Project No. 891-1582

Scale 1:250

Golder Associates

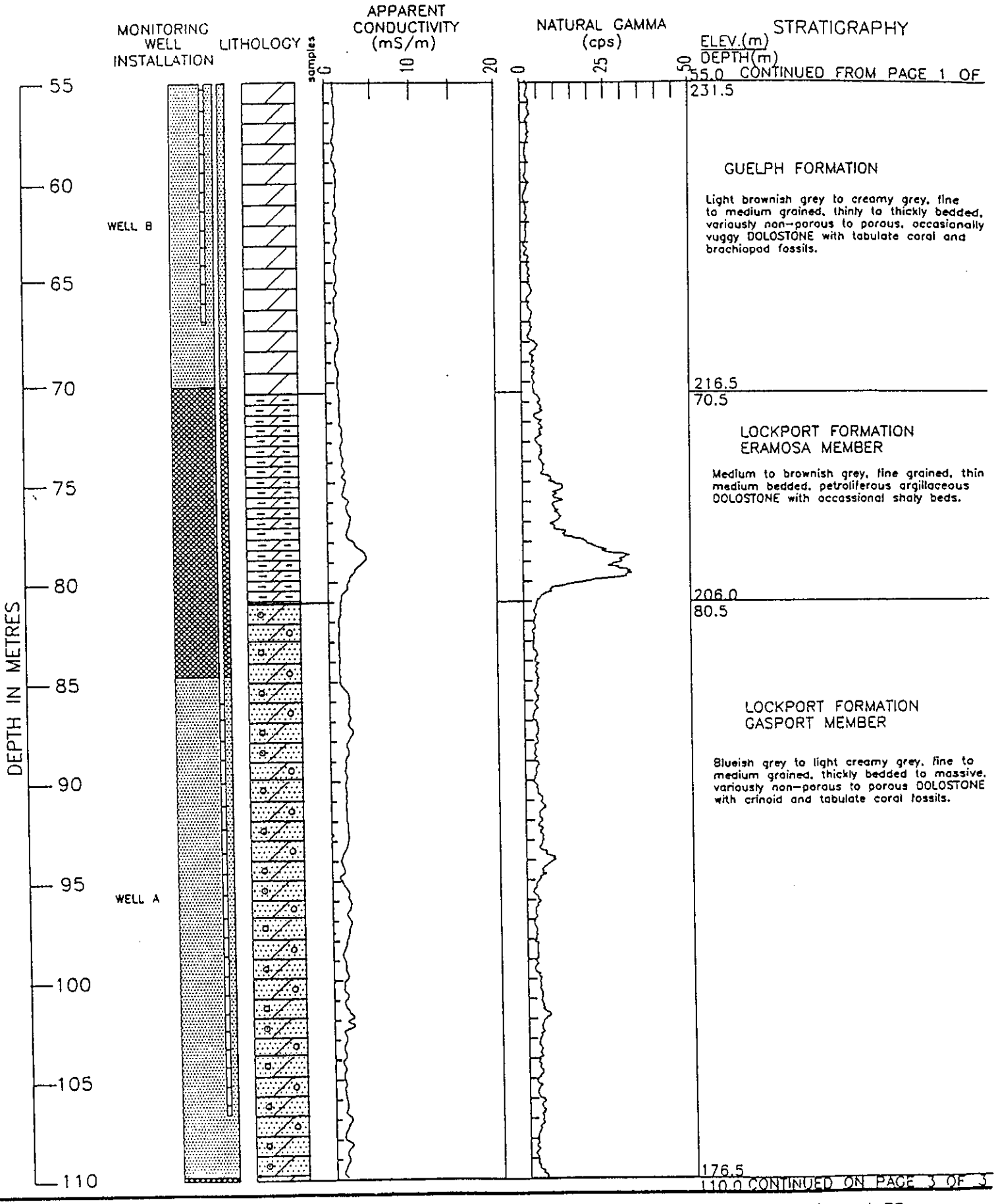
Logged RB
Checked RB

RECORD OF DRILLHOLE 104-90

Location 554650E 4800640N (UTM COORD.)
Datum GEODETIC

Drilling Contractor LUNNEY WELL DRILLING
Drilling Method AIR ROTARY PERCUSSION

Dated Drilled July 23, 199
Date Installed Aug. 30-31



Scale 1 : 250

Golder Associates

Logged RB
Checked RB

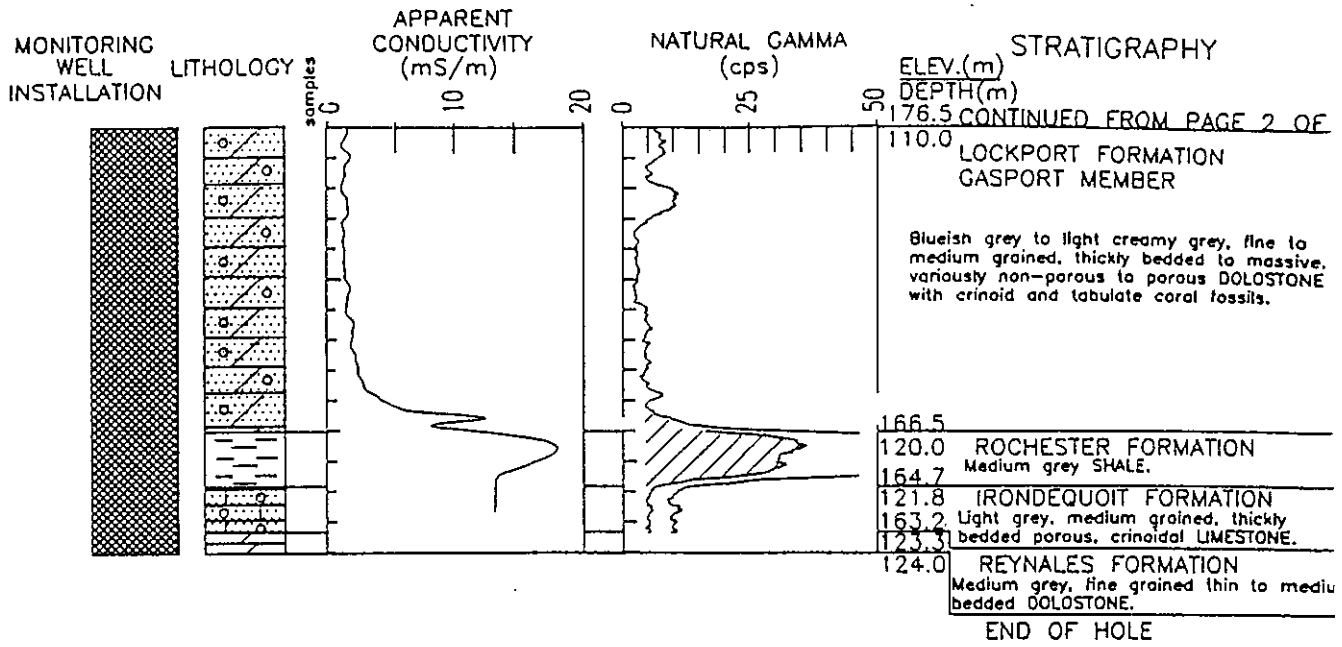
Project No 891-1532

RECORD OF DRILLHOLE 104-90

Location 554650E 4800640N (UTM COORD.)
Datum GEODETIC

Drilling Contractor LUNNEY WELL DRILLING
Drilling Method AIR ROTARY PERCUSSION

Dated Drilled July 23, 199
Date Installed Aug. 30-31



DEPTH IN METRES

110
115
120
125
130
135
140
145
150
155
160
165

NOTE

▨ DENOTES A 100% SCALE OVERLAP IN GEOPHYSICAL RESULTS

1. Record of cumulative water production during drilling
   2.27 l/sec between 29.0 and 29.6m
   additional water at 96.6m and 100.6m

2. Open drillhole was developed with a submersible pump at a rate of 5.1 /sec (limit of pump capacity) for 3 hours with 7.6m of drawdown on August 9, 1990.

3. Water level data (October 15, 1990)

Well OW104D-90	279.41m
104C-90	270.70m
104B-90	267.90m
104A-90	262.96m

Project No.891-1582

Scale 1:250

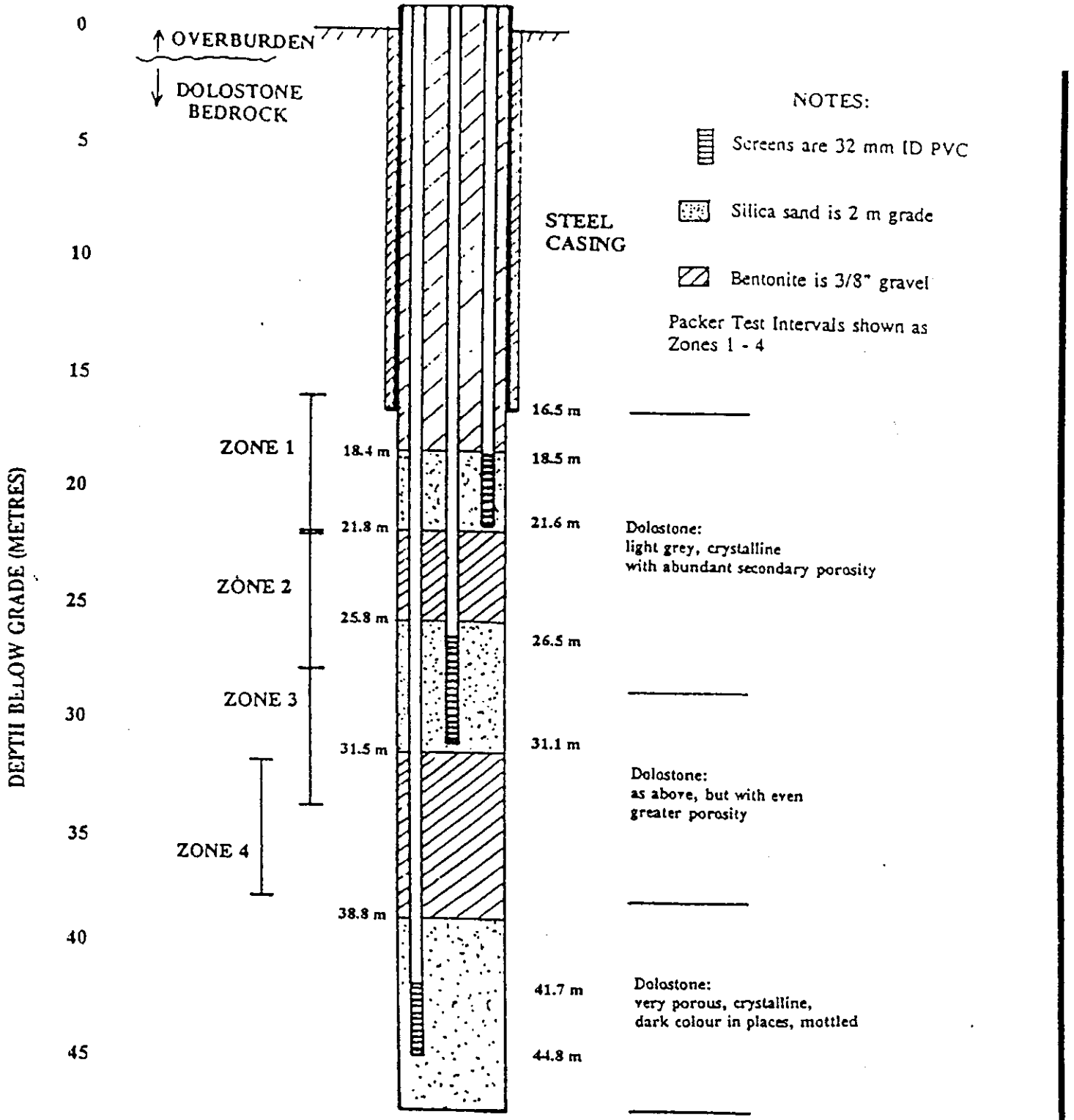
Golder Associates

Logged RB
Checked RB

a200048

MI-OW2/92

C-MS-OW2-92-(A-B)



LOTOWATER LTD.

THE REGION OF WATERLOO
Middleton Street Well Field
Hydrogeologic Investigation and Installation of Sentry Wells
MI-OW2/92 PIEZOMETER DETAILS
Project: 006-026 May 1993 FIGURE 3

TRANSPORTATION AND ENVIRONMENTAL SERVICES
Water Services
150 Frederick Street
Kitchener ON Canada N2G 4J3
Telephone: (519) 575-4426
Fax: (519) 575-4452
www.region.waterloo.on.ca
Region of Waterloo

C-MS-BH1-93-(A-B)

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

BH-1-93

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON. BLOCK, TRACT, SURVEY, ETC.	LOT
Region of Waterloo	City of Cambridge		

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Regional Mun. of Waterloo	c/o Beak Consultants Limited 42 Arrow Rd., Guelph, ON N1K 1S6	DAY 24 MO Nov. YR 93.

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Brown	~~Broken~~ Limestone	Silt	Soft	0	4
Lt.Brown	Limestone		Hard	4	189
Grey	Limestone		Med.	189	200
Grey,Brn.	Limestone		Hard	200	244
Grey	Limestone		Hard	244	351

RECEIVED
DEC 10 1997
WATER SERVICES

WATER RECORD

WATER FOUND AT FEET	KIND OF WATER	
92	☒ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
114 135	☒ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
139 143	☒ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
154 159 166	☒ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
175 240 286,303,343	☒ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS

CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE ☐ PLASTIC	.188	+ 3	21
6	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☒ OPEN HOLE ☐ PLASTIC		21	351
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE ☐ PLASTIC			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
0	21	Holeplug

PUMPING TEST

PUMPING TEST METHOD: ☐ PUMP ☐ BAILER

PUMPING RATE: 400 GPM

DURATION OF PUMPING: ____ HOURS ____ MINS

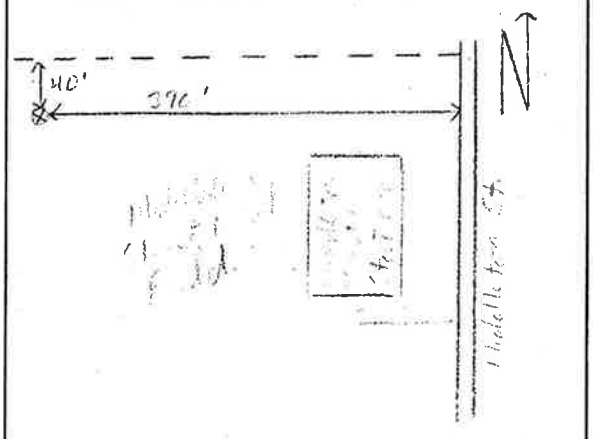
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING ☐ PUMPING ☐ RECOVERY			
		15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
50 FEET	FEET	FEET	FEET	FEET	FEET

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

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☐ DEEP	FEET	GPM

LOCATION OF WELL

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



DRILLERS REMARKS

132410

FINAL STATUS OF WELL	☐ WATER SUPPLY ☐ ABANDONED, INSUFFICIENT SUPPLY ☒ OBSERVATION WELL ☐ ABANDONED, POOR QUALITY ☐ TEST HOLE ☐ UNFINISHED ☐ RECHARGE WELL ☐ DEWATERING
WATER USE	☐ DOMESTIC ☐ COMMERCIAL ☐ STOCK ☐ MUNICIPAL ☐ IRRIGATION ☐ PUBLIC SUPPLY ☐ INDUSTRIAL ☐ COOLING OR AIR CONDITIONING ☒ OTHER Water quality U sampling ☐ NOT USED
METHOD OF CONSTRUCTION	☐ CABLE TOOL ☐ BORING ☒ ROTARY (CONVENTIONAL) ☐ DIAMOND ☐ ROTARY (REVERSE) ☐ JETTING ☒ ROTARY (AIR) ☐ DRIVING ☐ AIR PERCUSSION ☐ DIGGING ☐ OTHER

CONTRACTOR

WELL CONTRACTOR	WELL CONTRACTOR'S LICENCE NUMBER
Davidson Well Drilling Limited	1737

ADDRESS: Box 486, Wingham, Ontario. N0G 2W0

NAME OF WELL TECHNICIAN	WELL TECHNICIAN'S LICENCE NUMBER
G. Reavie	10156

SIGNATURE OF TECHNICIAN/CONTRACTOR

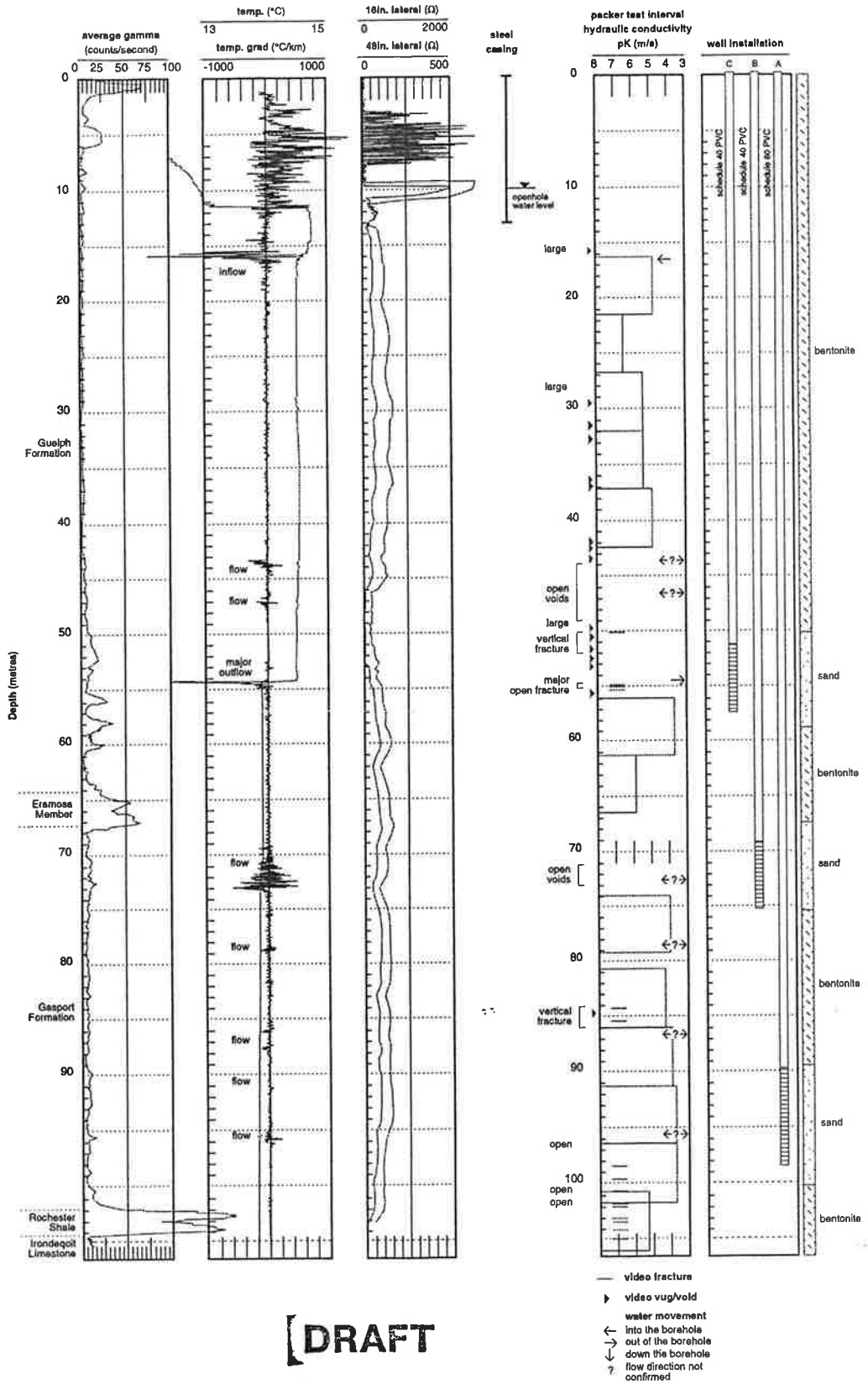
SUBMISSION DATE: DAY 9 MO Dec. YR 93.

OFFICE USE ONLY

OWNER'S COPY

FORM NO. 0506 (11/86) FORM 9

C-MS-BH1-93-(A-B)



[DRAFT

BH-1 Log and Casing Summary
Middleton Street Well Field Study
Cambridge, Ontario

beak consultants limited	Figure BH-1	February 1994 Rev. 00

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Appendix C

Monitoring Data
(Pumped Volumes and Hydrographs)

Region of Waterloo

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

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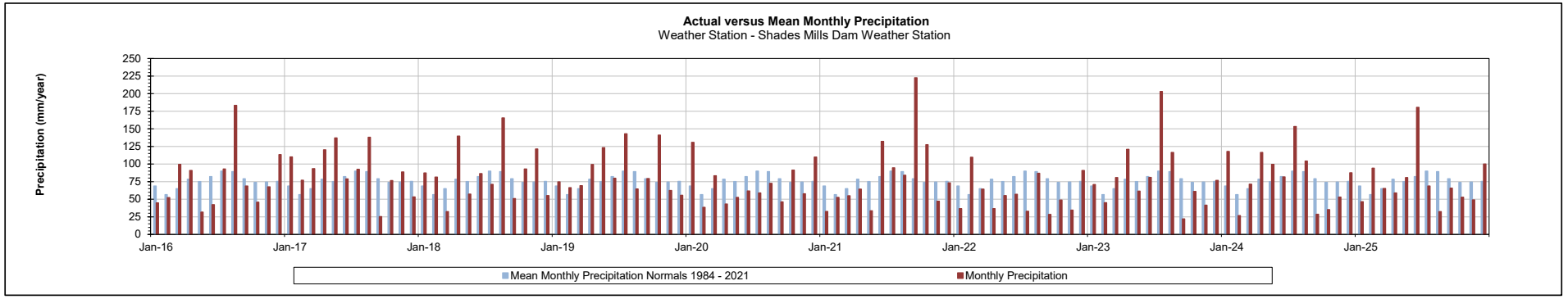
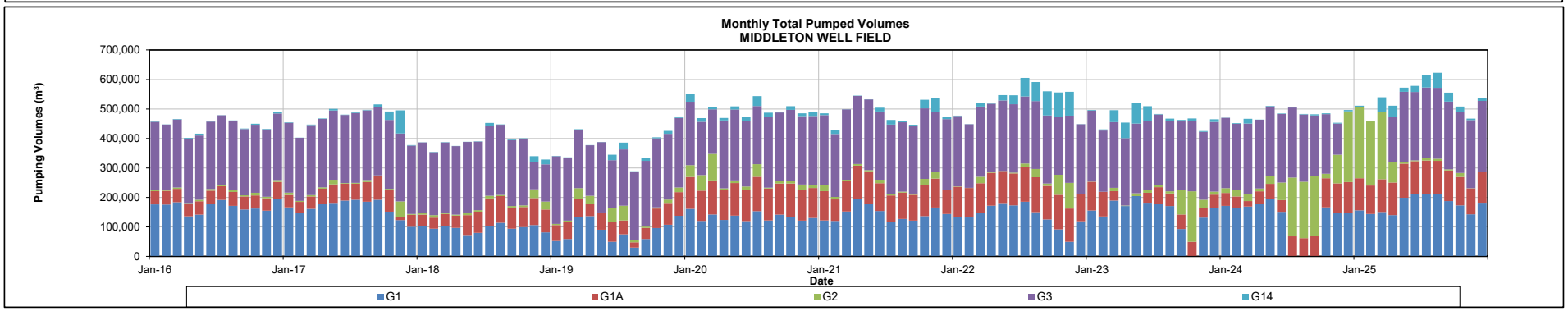
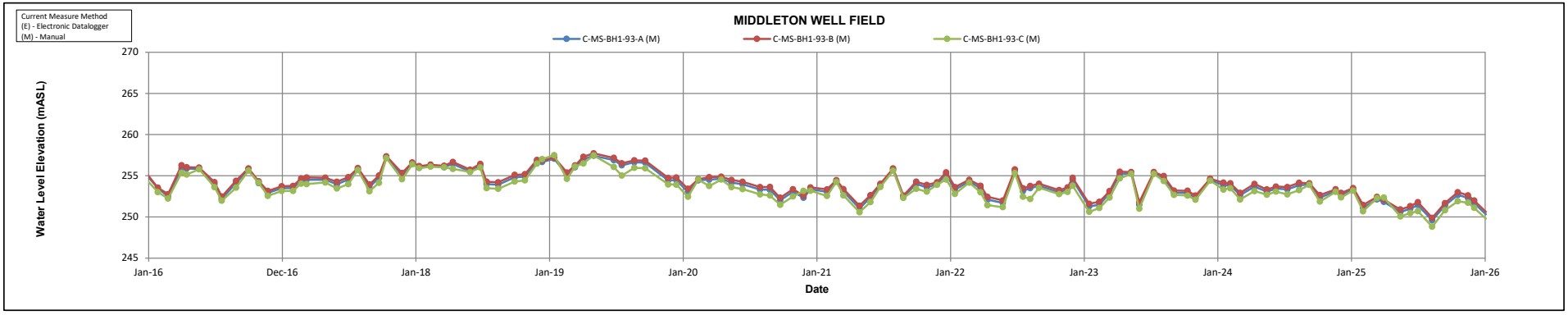
Well Field	Major or Minor Supply	Production Well Name	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
			MOE Permit Number	Permitted Capacity (total m^3/year)*	Permitted Rate (L/s)*	Total 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)
Middleton	Major	G1	7214-AMGR5G	Combined rate of PTTW 7214-AMGR5G		1,731,606	4,744	54.9	1,659,836	4,547	52.6	1,775,254	4,864	56.3	1,489,008	4,079	47.2	2,106,682	5,772	66.8
		G1A	7214-AMGR5G			1,147,490	3,144	36.4	1,304,453	3,574	41.4	520,879	1,427	16.5	739,363	2,026	23.4	1,274,414	3,492	40.4
		G2	7214-AMGR5G			116,807	320	3.7	230,532	632	7.3	343,298	941	10.9	1,101,821	3,019	34.9	797,219	2,184	25.3
		G3	7214-AMGR5G			2,774,431	7,601	88.0	2,746,267	7,524	87.1	2,781,482	7,620	88.2	2,383,644	6,531	75.6	2,010,307	5,508	63.7
		G14	7214-AMGR5G			145,573	399	4.6	438,235	1,201	13.9	256,355	702	8.1	40,083	110	1.3	291,643	799	9.2
			Well Field Total	***8,760,000***	***420.0***	***5,915,907***	***16,208***	***187.6***	***6,379,323***	***17,478***	***202.3***	***5,677,268***	***15,554***	***180.0***	***5,753,919***	***15,764***	***182.5***	***6,480,265***	***17,754***	***205.5***

* Maximum taken per day from all wells shall not exceed annual daily average of 24,000,000 L/day

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


Actual versus Mean Monthly Precipitation
Weather Station - Shades Mills Dam Weather Station
Precipitation (mm/year)
250
225
200
175
150
125
100
75
50
25
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Mean Monthly Precipitation Normals 1984 - 2021
Monthly Precipitation


Monthly Total Pumped Volumes
MIDDLETON WELL FIELD
Pumping Volumes (m³)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Date
G1
G1A
G2
G3
G14


Current Measure Method
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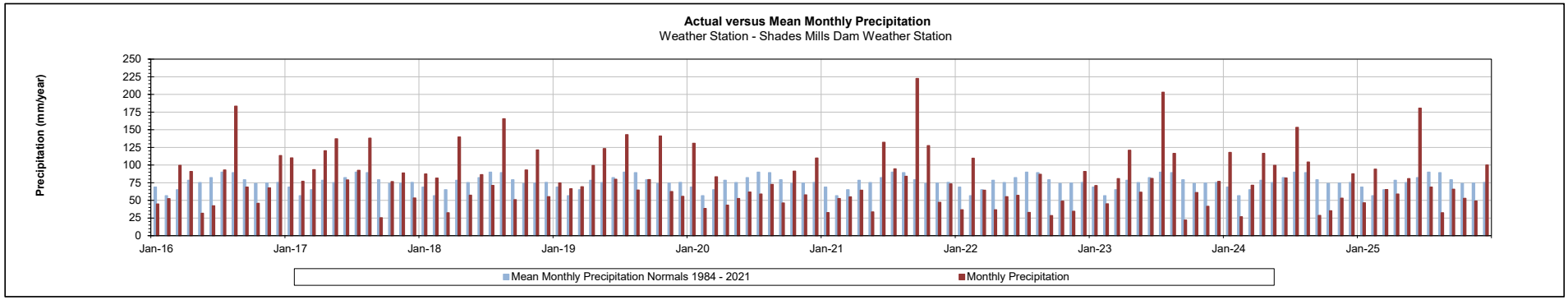
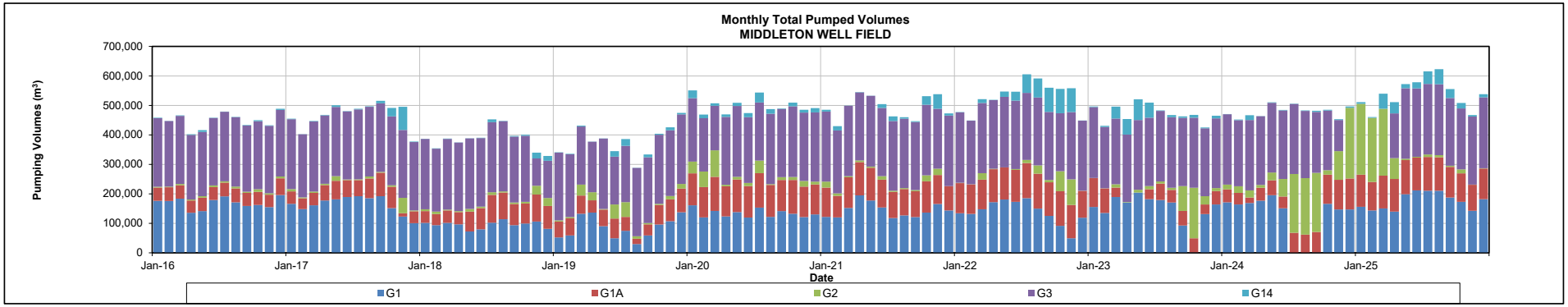
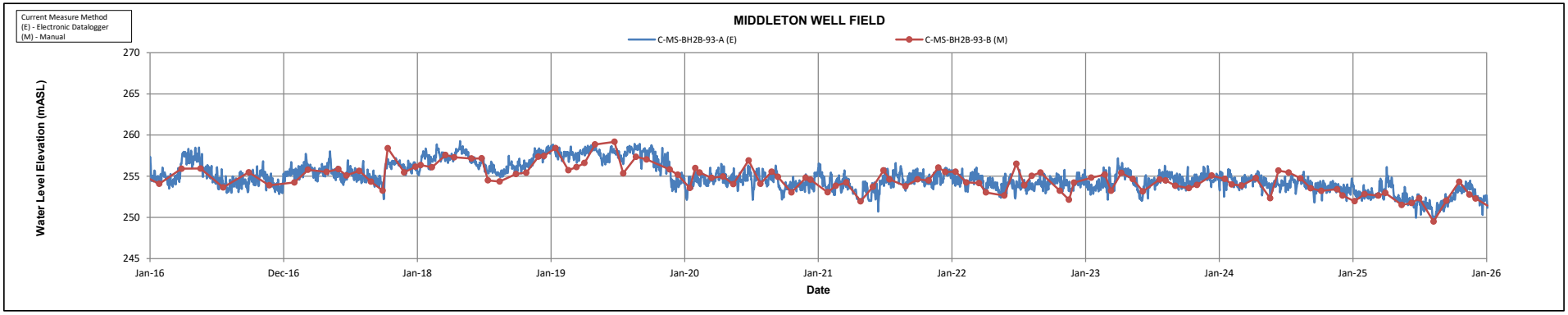
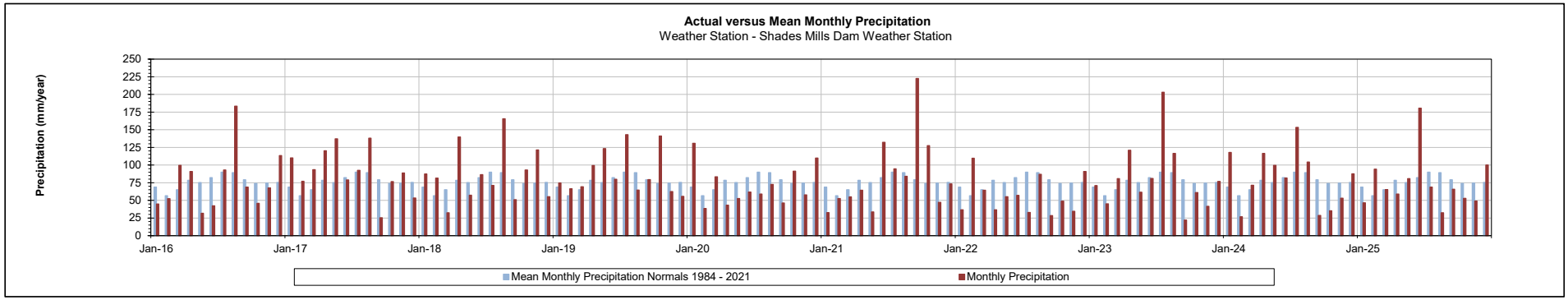
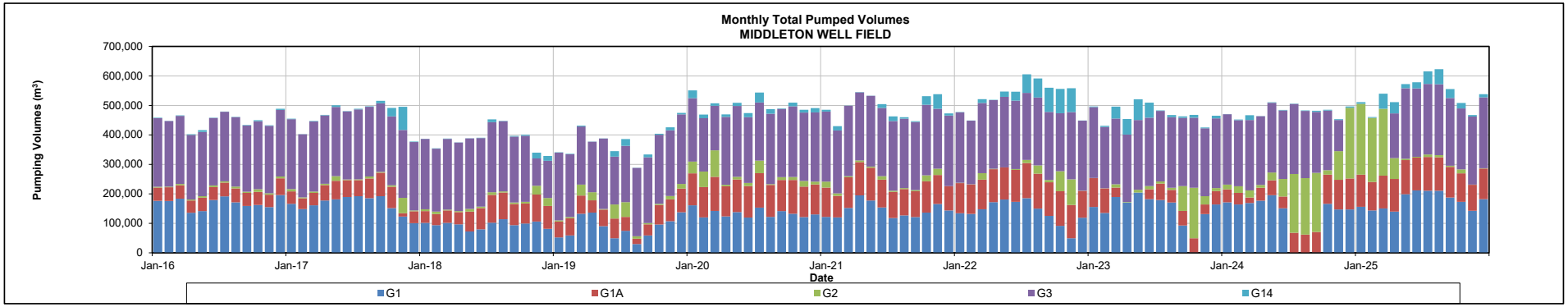
(M) - Manual
MIDDLETON WELL FIELD
C-MS-BH1-93-A (M)
C-MS-BH1-93-B (M)
C-MS-BH1-93-C (M)
Water Level Elevation (mASL)
270
265
260
255
250
245
Jan-16
Dec-16
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Jan-26
Date

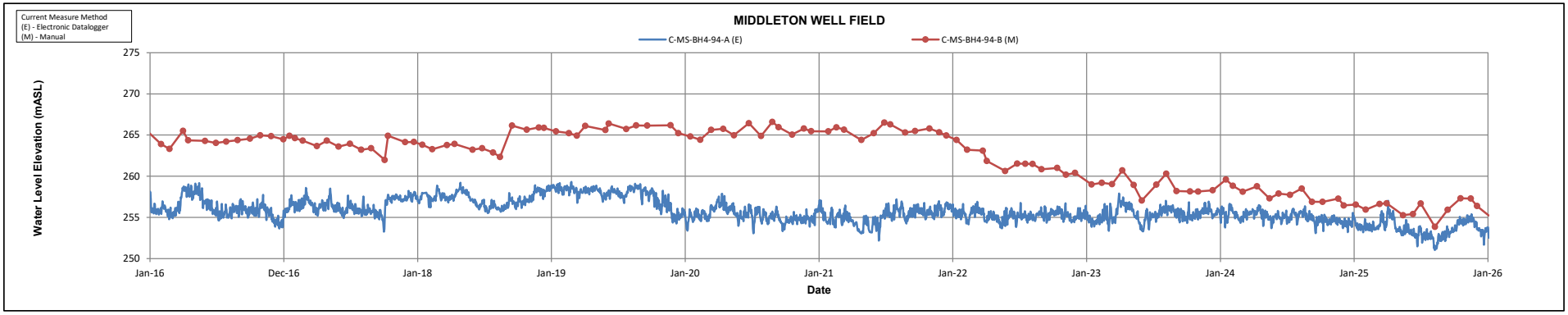

Actual versus Mean Monthly Precipitation
Weather Station - Shades Mills Dam Weather Station
Precipitation (mm/year)
250
225
200
175
150
125
100
75
50
25
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Mean Monthly Precipitation Normals 1984 - 2021
Monthly Precipitation


Monthly Total Pumped Volumes
MIDDLETON WELL FIELD
Pumping Volumes (m³)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Date
G1
G1A
G2
G3
G14

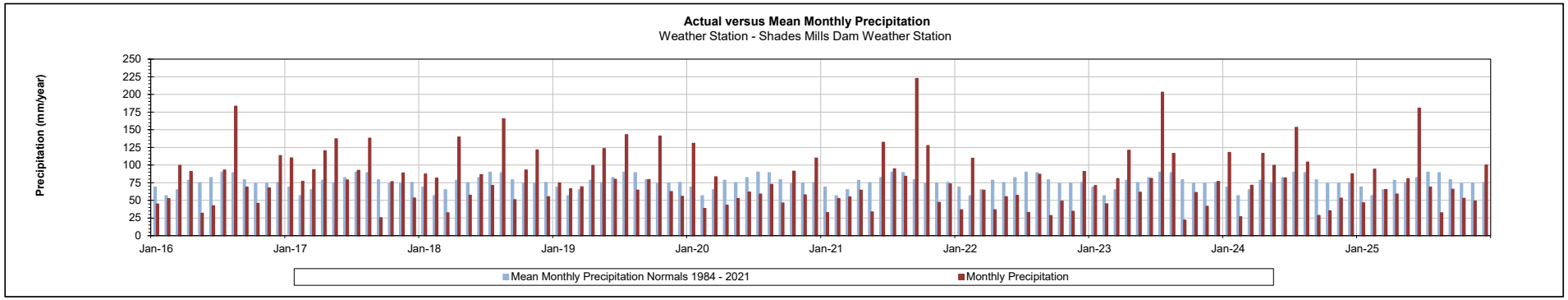

Current Measure Method
(E) - Electronic Datalogger
(M) - Manual
MIDDLETON WELL FIELD
C-MS-BH2B-93-A (E)
C-MS-BH2B-93-B (M)
Water Level Elevation (mASL)
270
265
260
255
250
245
Jan-16
Dec-16
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Jan-26
Date

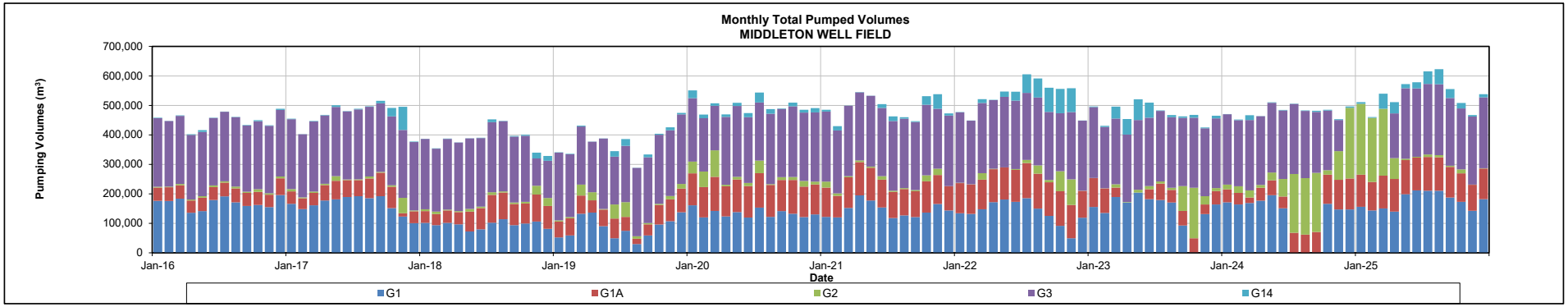

Actual versus Mean Monthly Precipitation
Weather Station - Shades Mills Dam Weather Station
Precipitation (mm/year)
250
225
200
175
150
125
100
75
50
25
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Mean Monthly Precipitation Normals 1984 - 2021
Monthly Precipitation

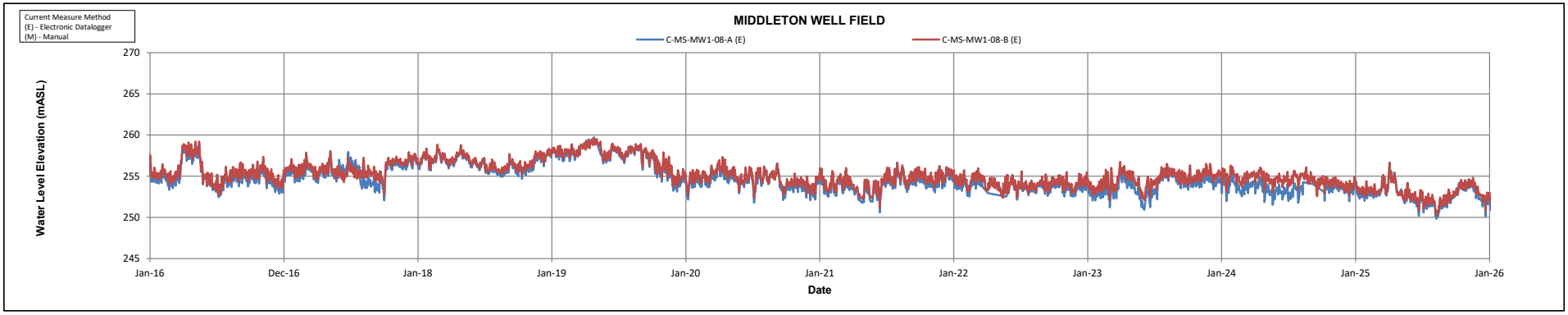

Monthly Total Pumped Volumes
MIDDLETON WELL FIELD
Pumping Volumes (m³)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Date
G1
G1A
G2
G3
G14

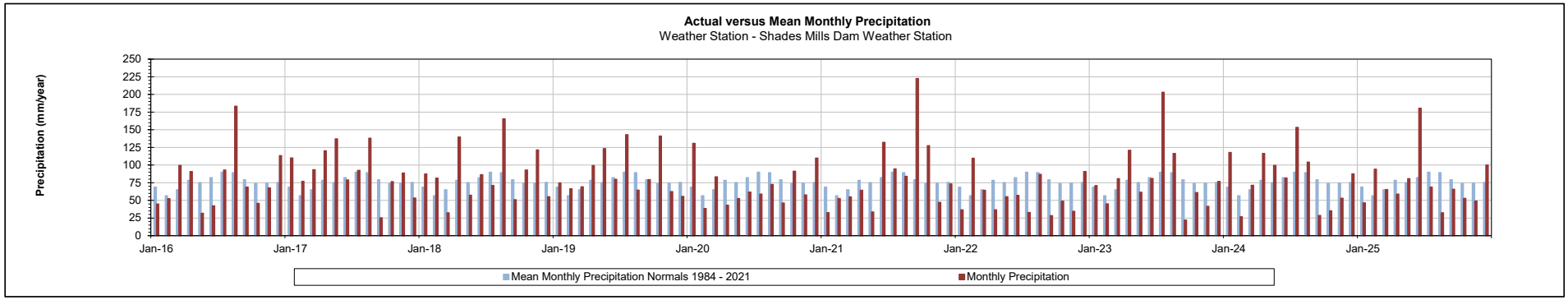

Current Measure Method
(E) - Electronic Datalogger
(M) - Manual
MIDDLETON WELL FIELD
C-MS-BH4-94-A (E)
C-MS-BH4-94-B (M)
Water Level Elevation (mASL)
275
270
265
260
255
250
Jan-16
Dec-16
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Jan-26
Date

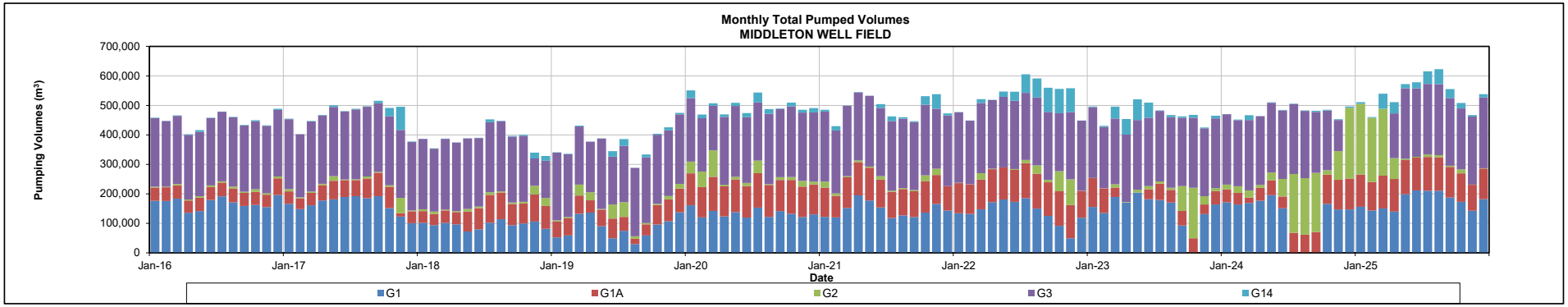
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
MIDDLETON








Actual versus Mean Monthly Precipitation
Weather Station - Shades Mills Dam Weather Station
Precipitation (mm/year)
250
225
200
175
150
125
100
75
50
25
0
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Mean Monthly Precipitation Normals 1984 - 2021
Monthly Precipitation


Monthly Total Pumped Volumes
MIDDLETON WELL FIELD
Pumping Volumes (m³)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-16
Jan-17
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Jan-21
Jan-22
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Jan-24
Jan-25
Date
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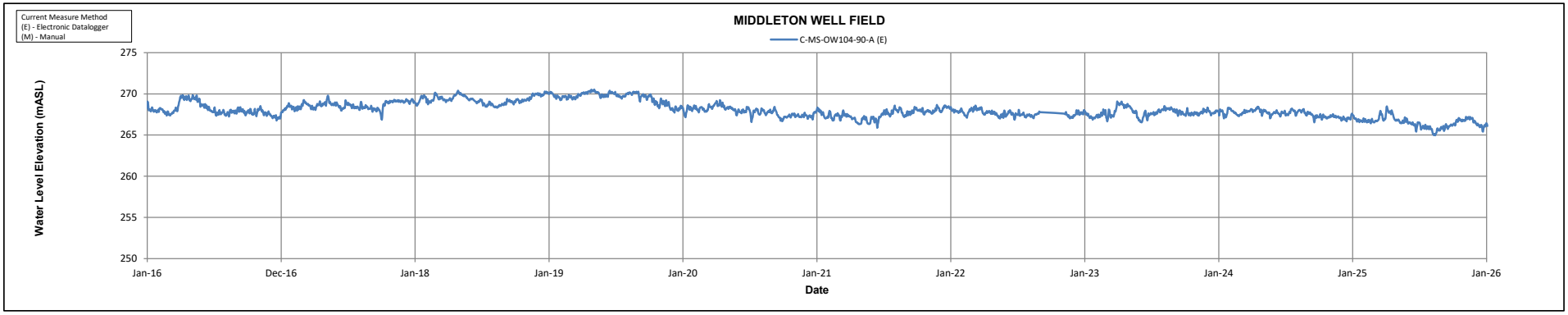
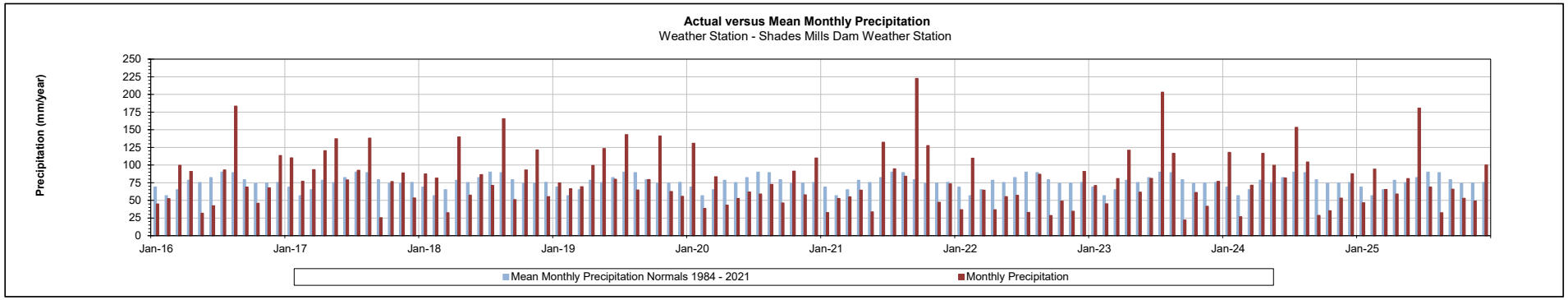
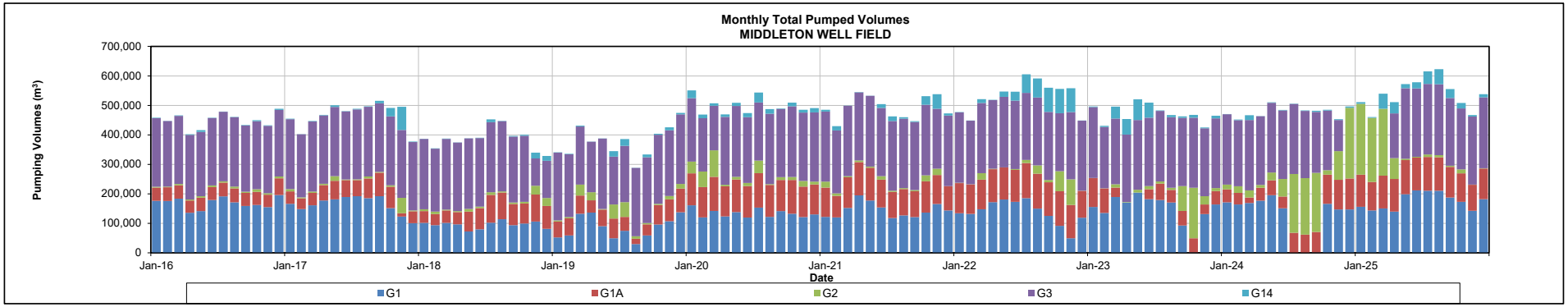
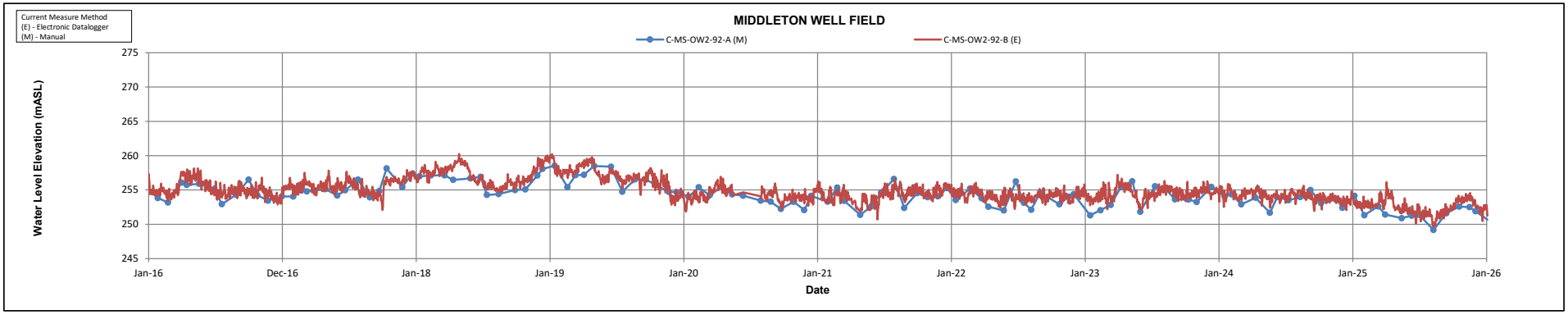
G3
G14


Current Measure Method
(E) - Electronic Datalogger
(M) - Manual
MIDDLETON WELL FIELD
C-MS-OW104-90-A (E)
Water Level Elevation (mASL)
275
270
265
260
255
250
Jan-16
Dec-16
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Jan-26
Date

REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
MIDDLETON







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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

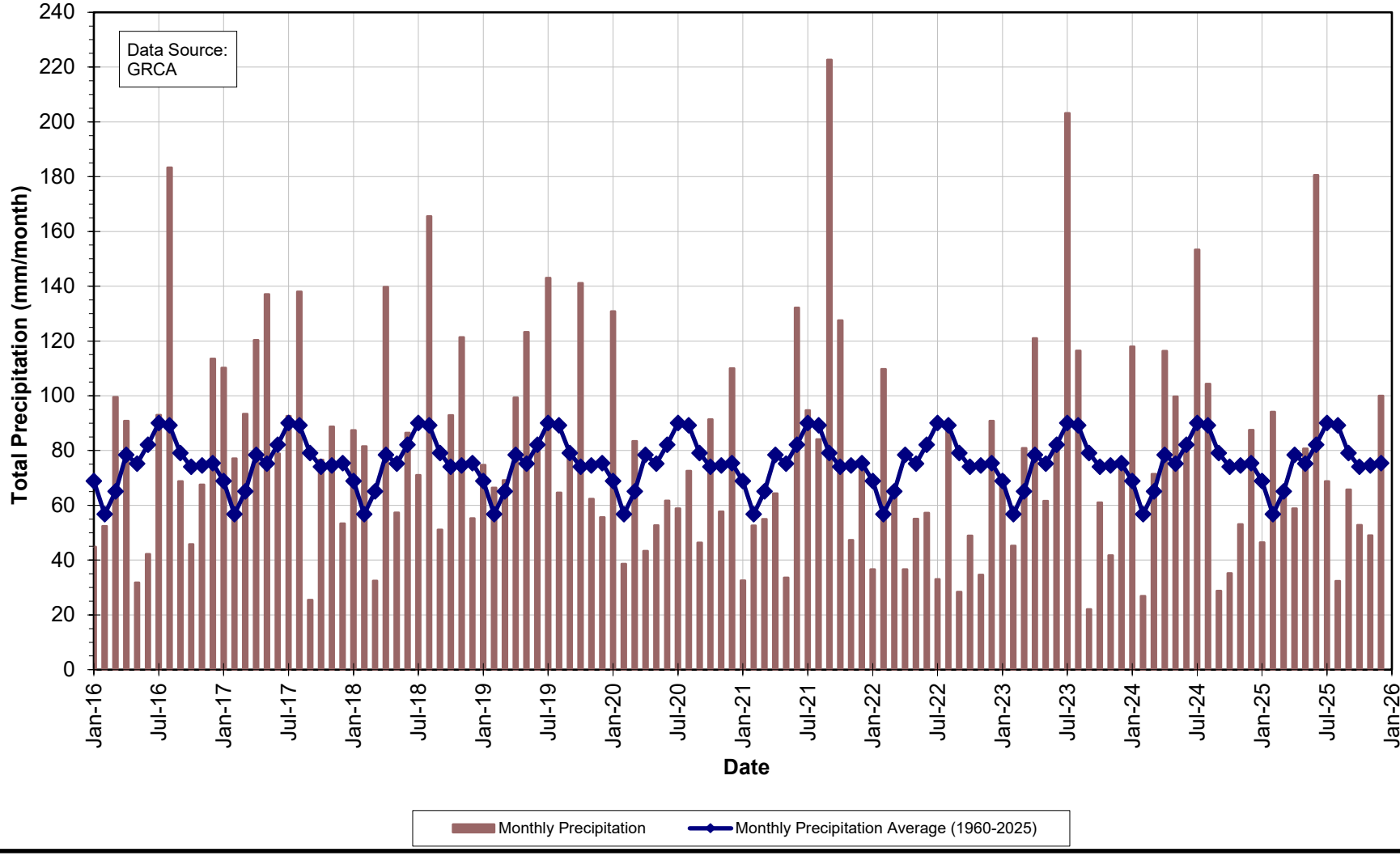
Year	Laurel Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	985	938	47
2017	1062	938	124
2018	1071	938	133
2019	940	938	2
2020	938	938	0
2021	1027	938	89
2022	689	938	-249
2023	921	938	-17
2024	907	938	-31
2025	894	938	-44

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
Shade's Mills Dam
Monthly Precipitation



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Prepared By: S.Q.
Printed On: 2/13/2026
File: Appendix D Precipitation Data/Monthly Shades Mills

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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