

APPENDIX 'D'

W.L. GIBBONS AND ASSOCIATES GROUNDWATER REPORT



November 12, 2013

File: Plessis Underpass

AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, MB R3P 0Y7

Attention: Mr. Andy Nagy, P.Eng.

Dear Mr. Nagy:

**RE: City of Winnipeg Plessis Road Underpass
Potential Bedrock Groundwater Concerns
Hydrogeologic Investigation Report and Recommendations**

W.L. Gibbons & Associates Inc. (WLG) is pleased to provide the following report documenting the results of the hydrogeologic investigations undertaken at the proposed Plessis Road Underpass site. The purpose of this work program was to verify the hydrogeologic conditions beneath the Plessis Road Underpass site, particularly with regards to the groundwater contained within the upper portion of the limestone bedrock. Based on discussions with AECOM personnel and other information provided by AECOM, the following is the current understanding of the situation:

- Geotechnical investigations by AECOM have identified that the bedrock groundwater pressures beneath the proposed site are in the 223 (+/-) m range (approximately 10.5 m below grade). Review of the long term groundwater monitoring record for the area (Appendix A) indicates that bedrock groundwater pressures in this area can vary from 219 to 226 meters.
- The proposed underpass will require the installation of a lift station to provide drainage of water from the underpass. As currently designed, the lift station will require an excavation to a depth of 220 meters. Based on estimates by AECOM geotechnical personnel, a potential risk of bedrock groundwater problems during construction has been identified, and that in order to achieve a factor of safety against base heave of 1.5, the bedrock groundwater pressures would need to be approximately 3 meters lower than has been measured at the site.
- AECOM personnel have indicated that the disposal of large volumes of water in the project area is problematic due to limitations to the drainage system. It is understood that the maximum practical limit that the drainage system can accommodate is a discharge of approximately 11.4 Lps (150 Igpm). This 11.4 Lps (150 Igpm) rate has been used as a design constraint in the review of the potential options to address the bedrock groundwater concerns.

Activities completed as part of this work program include the following:

- Review of the available information on the hydrogeology of the area, including the geotechnical test hole logs completed by AECOM personnel. The relevant geotechnical test holes are included in Appendix B with the locations shown on Figure C.8.

- Application for and receipt of a Groundwater Exploration Permit from the MB Water Use Licensing Section authorizing the completion of a groundwater exploration program. (Copy in Appendix C)
- The installation of two 125 mm (5 inch) test wells at locations proximate to the proposed lift station, and the subsequent enlargement of the test wells to 200 mm (8 inch) diameter.
- The completion of pumping tests on the test wells at rates of up to 37.9 Lps (500 Igpm)
- Data assessment and reporting.

1.0 Site Setting

Physical Setting

The project site is located at the northwest corner of Plessis Road and Dugald Road within the City of Winnipeg. Surrounding land uses include:

- Northwest – CN Mainline followed by residential
- Northeast – CN Mainline followed by industrial (food processing)
- Southwest – Industrial (food processing) followed by Dugald Road and residential
- Southeast – Dugald Road followed by the Transcona Golf Course and commercial

Geologic/Hydrogeologic Setting

The subsurface geology at the proposed lift station site consists of clay to a depth of approximately 16.8 meters (55 feet, +/-) followed by 1 to 1.5 meters (3 to 5 feet) of either till or rubbled limestone. Limestone bedrock is encountered at a depth of 18.3 to 18.7 meters (60 to 61.5 feet). The available information indicates that the upper approximately 3 meters (10 feet) of the bedrock is fractured, with generally competent carbonate bedrock below (to the maximum depth of drilling of 30.78 meters (101 feet, test hole TH 13-B04)).

Groundwater in significant quantities is found within the upper fractured carbonate aquifer zone, as well as from fractured carbonate rock below a depth of 91 meters (300 feet). This assessment is primarily concerned with the potential impacts associated with the groundwater in the upper aquifer zone, as this groundwater pressure is acting directly on the base of the overburden profile.

The provincial government maintains a network of groundwater level monitoring stations across the city. The compiled data from two of the closest stations are included in Appendix A. This includes Station OH-004 located at Mazonod Road and Camiel Sys Street, approximately 1.9 kms southwest of the site, and Station OJ-030 located at Dugald Road and McFadden Avenue, approximately 2.2 kms east of the site. Based on this compiled information, the following is noted:

- Groundwater levels in the bedrock aquifer have been rising since the early 1970's. This rise is attributed to an overall decline in the consumptive use of groundwater in the Winnipeg area which is resulting in a gradual return of groundwater levels towards the natural predevelopment levels.
- The highest groundwater levels were recorded in the spring of 2011 at both stations. This significant rise in groundwater levels coincides with the overall high precipitation and flooding that occurred in the early part of that year. Since the spring of 2011, groundwater levels have been declining and are currently in the 223 meter range (+/- 1 meter). The decline in water levels in 2011 and 2012 primarily starts in late April to early May and ends in late August to September. Such a decline is typically associated with a consumptive geothermal cooling system which only operate in the summer months. The information suggests that increasing consumptive use of groundwater in the area is occurring and may be resulting in a reversal of the long term rising trend that has been the norm since the early 1970's.
- The groundwater monitoring record exhibits a seasonal variation in groundwater levels with the highest levels in any given year generally in the late winter to early spring, and the lowest levels occurring in the summer. Both monitoring records indicate that groundwater levels are influenced by the consumptive use of groundwater in the area, as is evidenced by the low levels that occur in most summers when consumptive use is highest.
- The monitoring records clearly show that groundwater levels have varied from a low of approximately 219 meters to a high of 226 meters, depending on the precipitation patterns and changes in consumptive groundwater use. For the short term (ie: the next year), it is reasonable to expect that groundwater levels will be in the 223 (meter (+/- 1 meter)) range, with the highest levels most likely to occur in early spring.

Groundwater flow in the bedrock aquifer occurs within the fractures and joint sets in the rock. The size, extent and interconnectivity of these openings in the rock determine the degree of transmissivity (ie: the ability to transmit water) of the aquifer. As the transmissivity is a function of the degree of fracturing, the transmissivity and the well yield can vary substantially over short distances. Published maps of the transmissivity distribution in the area (Baracos, Shields and Kjartanson, 1983) indicate that the transmissivity is in excess of $7 \times 10^{-3} \text{ m}^2/\text{s}$ (50,000 USgpd/ft) in the Plessis Underpass site area. Site specific investigations since the 1983 report was published have identified locations in the area where the transmissivity is significantly higher. This includes an estimate of transmissivity in the 1.8×10^{-3} to $2.2 \times 10^{-3} \text{ m}^2/\text{s}$ (125,000 to 150,000 USgpd/ft) range at the Freshwater Fish Marketing Corporation site (KGS, 2009), as well as an estimate of transmissivity in the 1.0×10^{-2} to $2.5 \times 10^{-2} \text{ m}^2/\text{s}$ (70,000 to 175,000 USgpd/ft) range at the Granny's Poultry Cooperative site (Friesen, 2008).

Standard practice when depressurization of the bedrock aquifer is required to facilitate construction is to install a pumping system with sufficient pumping capacity to achieve the required depressurization for the length of time required to complete construction. However, in this case, there is a significant design constraint that the discharge rate from the pumping system could not exceed 11.4 Lps (150 Igpm) due to limitations to the drainage system in the area. The pumping rate needed to achieve the require drawdown is a direct function of the transmissivity



of the aquifer. Therefore, a preliminary analysis was done to determine what the transmissivity of the aquifer would need to be at this specific site to achieve a drawdown of 3 meters with a pumping rate limitation of 11.4 Lps (150 Igpm). It was found that the transmissivity of the aquifer would need to be on the order of $7 \times 10^{-3} \text{ m}^2/\text{s}$ (50,000 USgpd/ft) or less. This transmissivity is at the lower range of the estimates for regional transmissivity provided in Baracos, Shields and Kjartanson, 1983, and well below the estimates of transmissivity from the site specific investigations at Freshwater Fish Marketing Corporation and the Granny's Poultry Cooperative sites. It was therefore recognized early on that determining the transmissivity at the Plessis Underpass site was a key first step, and that if it exceeded $7 \times 10^{-3} \text{ m}^2/\text{s}$ (50,000 USgpd/ft), it would be necessary to artificially lower the transmissivity in this area by some means in order to achieve the required depressurization within the pumping rate limit imposed by drainage constraints.

2.0 Site Specific Hydrogeologic Investigations

A hydrogeologic investigation was undertaken at the Plessis Underpass site to obtain site specific information to verify the hydrogeologic conditions, and specifically to obtain estimates of transmissivity at this site.

Specific details of the design of the investigation are as follows:

- As the intention was to control groundwater levels in the immediate area of the proposed lift station, two test wells were to be drilled as close as practical to the proposed lift station. It was intended that the test wells would remain for subsequent use as either monitoring or pumping locations. Therefore, AECOM personnel marked the location of the lift station and the likely location of the shoring required for construction. The test wells were then drilled 4 meters outside the shoring limits at the locations shown on Figure C.8.
- The investigation followed the standard protocol for investigations of this nature, including the drilling of an initial 125 mm (5 inch) diameter test well to verify that fractured bedrock was present at that location, and that the location would produce a significant volume of water. This was followed by the enlargement of the test hole and the installation of a 200 mm (8 inch) test well. The 200 mm (8 inch) test well size was selected as it allowed the aquifer to be pump tested at rates of up to 37 Lps (500 Igpm), and in recognition of the fact that pumping during construction in excess of 11.4 Lps (150 Igpm) was not an option due to the drainage constraint.
- Prior to the start of drilling, AECOM personnel obtained underground utility clearances for the area and copies were provided to WLG personnel.
- A constraint on the investigation was that the construction of new sewer and water lines were proceeding immediately to the west of the test well locations and it was necessary to limit the production of water to avoid flooding the trench excavation. As a result, development of the test wells was limited to the degree necessary to allow the test pumping to proceed. If these wells are to be used in future as pumping wells, further development will be required to remove the residual sediment and ensure that the wells can be pumped clear and free of sediment.

2.1 Test Well Installation

Test Well TW 13-01 - Test well TW 13-01 was drilled at the southeast corner of the lift station shoring (Figure C.8) on August 7 and 8, 2013. A copy of the Driller's Report outlining the stratigraphy encountered and the final well construction details are included in Appendix D. The stratigraphy consists of 16.8 m (55 feet) of clay followed by 1.5 m (5 feet) of clay till. All drill returns were lost from a depth of 17.7 to 18.3 m (58 to 60 feet), suggesting that the lower portion of the tills are highly permeable. Limestone bedrock was encountered from a depth of 18.3 m (60 feet) to the maximum depth of drilling of 24.4 m (80 feet). Significant fractures were encountered at depths of 19.8 and 22.3 m (65 and 73 feet). Additional minor fractures were present above the 22.3 m (73 foot) depth, and relatively competent bedrock was present below.

An initial 125 mm (5 inch) test well casing was installed to a depth of 19.4 m (63.5 feet) and an initial pumping test conducted at a rate of 6.5 Lps (86 Igpm). The static water level at the start of the test was 11.3 m (37.05 feet below the top of the casing) and the pumping level after 35 minutes of pumping was 11.5 m (37.65 feet), for a total drawdown of 0.2 m (0.6 feet). The indicated specific capacity was 32.5 Lps/m (143 Igpm/ft). As the initial test results indicated that a high transmissivity location had been encountered, the decision was made to proceed with the removal of the 125 mm (5 inch) casing and installation of a 200 mm (8 inch) test well to allow a pumping test to be completed at a higher rate.

The final test well construction at the TW 13-01 site consists of 200 mm (8 inch) diameter Schedule 40 PVC casing installed to a depth of 18.9 meters (62 feet) followed by open bedrock hole to a depth of 24.4 m (80 feet). Bentonite grout was installed in the annulus around the casing using the tremie method. The well was then developed using air lift pumping methods to a level appropriate for the subsequent test pumping. As noted previously, full development of the well was not possible due to the proximity to the adjoining sewer and water line trench and potential flooding issues. Further development will be required if this well is to be used as part of the groundwater depressurization program.

Test Well TW 13-02 - Test well TW 13-02 was drilled on the north side of the lift station shoring (Figure C.8) on August 12, 2013. A copy of the Driller's Report outlining the stratigraphy encountered and the final well construction details are included in Appendix D. The stratigraphy consists of 18.0 m (59 feet) of clay followed by 0.8 m (2.5 feet) of limestone rubble. All drill returns were lost from a depth of 18.0 to 18.8 m (59 to 61.5 feet), suggesting that the limestone rubble is highly permeable. Solid limestone bedrock was encountered from a depth of 18.8 m (61.5 feet) to the maximum depth of drilling of 24.7 m (81 feet). Significant fractures were encountered at depths of 19.5 and 22.3 m (64 and 72 feet). Additional minor fractures were present above the 22.3 m (72 foot) depth, and relatively competent bedrock was present below.

An initial 125 mm (5 inch) test well casing was installed to a depth of 19.7 m (64.5 feet) and the well developed using air lift pumping. The well development was capable of producing a high volume of water indicating that high transmissivity conditions had been encountered at this site, similar to the TW 13-01 test site. Therefore, the decision was made to proceed with the removal



of the 125 mm (5 inch) casing and installation of a 200 mm (8 inch) test well to allow a pumping test to be completed at a higher rate.

The final test well construction at the TW 13-02 site consists of 200 mm (8 inch) diameter Schedule 40 PVC casing installed to a depth of 19.1 meters (62.5 feet) followed by open bedrock hole to a depth of 24.7 m (81 feet). Bentonite grout was installed in the annulus around the casing using the tremie method. The well was then developed using air lift pumping methods to a level appropriate for the subsequent test pumping. As noted previously, full development of the well was not possible due to the proximity to the adjoining sewer and water line trench and potential flooding issues. Further development will be required if this well is to be used as part of the groundwater depressurization program.

2.2 Site Specific Water Level Monitoring Data

In preparation for the pumping tests, transducers were installed in monitoring well MW D01 on August 8, 2013, and in test well TW 13-01 on August 12, 2013. The transducers continuously recorded water levels until August 30, 2013 and the accumulated data is included in Appendix E. The continuous monitoring of water levels continues in well TW 13-01. Note: monitoring well MW D01 is located within the CN right-of-way, and due to constraints by CN, the transducer could not be accessed until August 30, 2013. Therefore information from that well was not available until well after the pumping tests were completed. As is noted below, third party pumping at the time of the pumping tests were having an effect on water levels in the area, and therefore an effect on the results of the pumping tests. The interpretation of the pumping test results has been made in consideration of the third party effects noted below.

Over the approximately 22 day period of record, groundwater levels have varied by up to one meter and are currently on a declining trend. This is consistent with recent observations made from the regional provincial monitoring data (Appendix A) which shows that groundwater levels decline during the summer, particularly in the last two years. Detailed review of the accumulated data from the site transducers has found that the effects of two separate groundwater users can be discerned. This effect is illustrated most clearly in the monitoring data from the evening of August 13 through August 14, 2013 (Appendix A) when no pumping at the Plessis site was occurring. Groundwater pumping began at approximately 10:00 PM on August 13 and continued through the night at variable rates until approximately 5:30 AM of August 14, 2013. This pumping results in a drawdown in water levels of up to 0.15 to 0.2 meters at the Plessis site. A second groundwater user initiated pumping at approximately 6:19 AM on August 14 and continued pumping until 1:18 PM of that day. This pumping resulted in a drawdown of approximately 0.35 meters at the Plessis site. Based on the review of the available information concerning existing groundwater users in the area (see Section 3), it is considered most likely that the pumping during the night is associated with the irrigation system operating at the Transcona Golf Course to the southeast of the Plessis underpass site. The second groundwater user is most likely the Freshwater Fish Marketing Corporation wells located approximately 250 meters northeast of the Plessis Underpass site. Of these existing users, it is the Freshwater Fish Marketing Corporation that is having the largest effect on the groundwater levels beneath the Plessis Underpass site. In particular, it is noted that pumping was occurring at the Freshwater

site at the same time that the test was conducted on test well TW13-02. It is also noted from the accumulated data that due to the multiple groundwater users in the area, static groundwater conditions are never achieved. As a result, it is difficult to conduct pumping tests capable of achieving highly accurate estimates of transmissivity without a high level of coordination between the various users in the area. Nevertheless, the estimates of transmissivity obtained from the pumping tests are considered accurate enough to determine if depressurization by pumping alone is possible, or if artificial modification of the transmissivity is necessary.

2.3 Pumping Tests/Transmissivity Estimates

A series of pumping tests were conducted on the two test wells installed at this site in order to obtain the required information to verify the transmissivity of the aquifer at this location. As noted in Section 1.0, preliminary analysis of drawdown effects versus pumping had established that if the transmissivity of the aquifer exceeded $7 \times 10^{-3} \text{ m}^2/\text{s}$ (50,000 USgpd/ft), it would not be possible to depressurize the site at the 11.4 Lps (150 Igpm) pumping rate limitation imposed by drainage constraints. If this transmissivity was exceeded, it would be necessary to artificially lower the transmissivity so that groundwater pressures could be controlled in the immediate area of the lift station excavation at or below the 11.4 Lps (150 Igpm) pumping limit.

The analysis of the data obtained from these pumping tests is summarized in Table 1. The transmissivity was found to vary from a low of 3.9×10^{-2} to $1.1 \times 10^{-1} \text{ m}^2/\text{s}$ (274,000 to 828,000 USgpd/ft). The transmissivity of the aquifer at this site is therefore well in excess of the $7 \times 10^{-3} \text{ m}^2/\text{s}$ (50,000 USgpd/ft) limit and it will therefore be necessary to artificially lower the transmissivity in the immediate area of the lift station excavation. It is noted that an estimated pumping rate of 115 to 150 Lps (1,500 to 2,000 Igpm) would be required to depressurize the aquifer by 3 meters, without any artificial modification of the transmissivity in the area. High pumping rates such as this would not only overwhelm the drainage system in the area, but would also have a high probability of impacting existing groundwater users in the area. As such, groundwater depressurization solely by pumping is not a viable option in this case.

3.0 Existing Groundwater Users

As part of this hydrogeologic assessment, the existing groundwater users in the area were identified by searching the provincial GWDRILL database containing the Driller's Reports for wells drilled within the province, and by requesting information on existing licensed groundwater users within the area from the Water Use Licensing Section of MB Conservation and Water Stewardship. The search of the GWDRILL database identified 4 domestic wells in the area, all more than 800 meters from the site. The status of these wells is unknown but it is noted that all are located within the area of the city supplied with treated water.

The Water Use Licensing Section of MB Conservation and Water Stewardship identified the following licensed groundwater users in the area:

- Freshwater Fish Marketing Corporation (License No. 2006-038) – The supply wells for this system are located approximately 250 meters northeast of the Plessis Underpass site. The system uses water for food processing and geothermal cooling.
- Transcona Golf Club (License No. 2002-064) – This site uses water for irrigation purposes and is located southeast of the Plessis Underpass site.
- Vantage Foods (MB) Inc. (Granny's Poultry, License No. 2011-102) – This site is located approximately 1.4 kms southwest of the Plessis Underpass site. This system is a non-consumptive geothermal system.
- Malteurope Canada Ltd (License No. unknown) – This system is located approximately 2 kms east of the Plessis Underpass site. Groundwater use is both for non-consumptive geothermal cooling and consumptive process water.

Hydrogeologic investigations at the Plessis Underpass site, and at other nearby sites have identified that the transmissivities of the aquifer are high throughout this area. Given that pumping at the Plessis Underpass site will be limited to 11.4 Lps (150 Igpm) due to the drainage constraints, the potential for the pumping to adversely affect groundwater users is very limited. The exception is the Freshwater Fish Marketing Corporation (FFMC) pumping system located in relatively close proximity to the site. Assuming a transmissivity for the aquifer on the order of 2.9×10^{-2} to $5.8 \times 10^{-2} \text{ m}^2/\text{s}$ (200,000 to 400,000 USGPD/ft), it is estimated that the drawdown effects at the Freshwater Fish supply wells would be approximately 0.2 to 0.3 meters.

The available information associated with the FFMC groundwater supply system (KGS Group Report, July 2009) documents that groundwater is withdrawn from one of two wells on the site. The original well was installed in 1990 and consists of a 250 mm (10 inch) casing installed to a depth of 18.0 meters (59.0 feet) followed by open bedrock hole. The second well was installed in 2009 and consists of a 300 mm (12 inch) casing installed to a depth of 17.8 m (58.5 feet). Both wells withdraw water from fractures located near the top of the bedrock profile, similar to the upper fractures at the Plessis Underpass site. The available information (KGS, 2009) indicates that the pump intake in the 300 mm (12 inch) well is set at a depth of 16.9 m (55.5 feet), and the pump intake in the 250 mm (10 inch) well is set at a depth of 18.0 m (59.0 feet). Assuming that the current static depth to water is 10.5 meters (34.4 feet, as measured at the Plessis Underpass site), the available drawdown in the two wells are 6.4 m (300 mm well) and 7.5 m (250 mm well).

The results of pumping tests on the two wells (KGS, 2009), indicate that at the licensed peak pumping rate for this facility of 34 Lps, the drawdown in either well is approximately 2.0 meters. Therefore at the current water levels, the residual available drawdown in each well is 4.4 meters (300 mm well) and 5.5 meters (250 mm well). Therefore, sufficient residual available drawdown is present at either well to accommodate the estimated 0.2 to 0.3 meters of drawdown that pumping at the Plessis Underpass site would induce, plus any additional lowering of water levels that could reasonably be expected to occur during the Plessis Underpass construction schedule due to natural variations in water levels. The KGS Group report also documents that during periods of low water levels, the option exists to pump both wells in tandem at a combined total pumping rate of 34 Lps to reduce the drawdown effects in an individual well. As such, even though the Plessis Underpass pumping is not expected to adversely affect FFMC ability to pump groundwater, a contingency plan is available should any unexpected excess drawdowns occur.

While it is not expected that the pumping at the Plessis Underpass will affect the ability of FFMC to pump groundwater, it is nevertheless prudent to install groundwater level monitoring equipment to verify the lack of an effect. Ideally, the monitoring equipment would be installed in the FFMC supply wells. However, monitoring of water levels at a monitoring well located outside the FFMC property could also be done.

4.0 Assessment of Options to Depressurize the Aquifer During Construction

The hydrogeologic investigation at the Plessis Underpass site has demonstrated that the transmissivity of the aquifer at this site is too high to allow the aquifer to be depressurized during construction by pumping at rates below the 11.4 Lps (150 Igpm) limit imposed due to drainage constraints. Consideration was given to the possibility of pumping groundwater and reinjecting it into the aquifer at a distance to achieve the required depressurization. However, the close proximity of the Freshwater Fish supply wells, and the limited available public, undeveloped land in the area precludes this as a viable option. It will therefore be necessary to artificially lower the transmissivity in the immediate area of the lift station excavation to the point that groundwater pressures can be lowered to the desired level at pumping rates below the 11.4 Lps (150 Igpm) limit.

The transmissivity of the aquifer can be lowered by restricting the ability of water to flow through the fractures in the bedrock towards the lift station excavation. This can be achieved by a variety of means, including but not limited to:

Grout curtain – As has been done at numerous sites such as the Red River Floodway Inlet Structure and the City of Winnipeg South End Wastewater Treatment Plant, the transmissivity of the aquifer can be reduced by injecting grout into the fractures in a ring around the proposed excavation. The grout would consist of a mixture of cement, bentonite and sand which is injected into the fractures via a series of holes drilled in a ring around the excavation limits. Grout injection would occur in a series of stages, and would continue until pumping tests from wells within the grout curtain confirm that the groundwater pressures can be lowered and maintained at the desired level at pumping rates below the 11.4 Lps (150 Igpm) limit.

Freeze Curtain – Similar to the grout curtain option, the transmissivity of the aquifer is reduced by freezing the aquifer in a ring around the excavation limits. A series of geothermal holes equipped with supply and return tubing loops are drilled around the excavation. A refrigeration plant is connected to the tubing and coolants are circulated to remove heat from the subsurface until the groundwater freezes. The frozen ground conditions are maintained for the duration of construction. Any residual groundwater seepage is pumped to the drainage system (at rates below the 11.4 Lps (150 Igpm) limit).

5.0 Conclusion and Recommendations

The hydrogeologic investigation at the Plessis Underpass site has demonstrated that it will not be possible to depressurize the aquifer during construction at the 11.4 Lps (150 Igpm) pumping

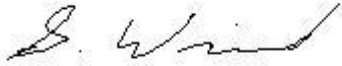
rate limit imposed by the drainage constraints. It will therefore be necessary to artificially lower the transmissivity of the aquifer to the point that depressurization can be achieved at or below that pumping rate limit. The contractors for the construction of this lift station should be required to prepare and submit a plan to control the groundwater pressures during construction in consideration of the following information and design constraints:

- The stratigraphy at this site consists of 18.3 meters (60 feet, +/-) of clay followed by limestone bedrock. Pervious till and/or limestone rubble is present in the lower 1.5 meters (5 feet) of the overburden profile. The upper portion of the limestone bedrock is fractured and highly pervious to a depth of approximately 22.3 meters (73 feet). The available information indicates that the limestone bedrock below a depth of 22.3 meters (73 feet) is competent and fractures were not noted in the investigations conducted to date. Nevertheless, some seepage of groundwater through this relatively competent bedrock upwards towards the excavation should be expected.
- Due to constraints in the drainage system in the area, the maximum allowable pumping rate to control groundwater pressures will be 11.4 Lps (150 Igpm).
- Two 200 mm (8 inch) wells have been installed in close proximity to the proposed lift station and are available for use as either monitoring wells or pumping wells. If the wells are to be used as pumping wells, further development will be required to remove any residual sediment and drill cuttings.
- The site is located in relatively close proximity to an operating groundwater supply system that affects groundwater levels at the Plessis Underpass site. It will be necessary to closely monitor groundwater levels during the operation of any groundwater pumping system to ensure that groundwater is not overpumped to the point that the existing groundwater systems ability to pump groundwater is affected.
- The nearby operating groundwater supply system could be adversely affected by changes in water quality, in particular any turbidity generated by the construction activities. The generation of turbid water should be minimized and controlled to the degree practical. The existing 200 mm (8 inch) wells at this site should be used to pump any turbid groundwater generated and discharge it to waste.
- Provincial Water Rights law specifies that any pumping in excess of 25,000 Lpd can only be done under the authorization of a Water Rights License issued by the Water Use Licensing Section of MB Conservation and Water Stewardship. The contractor will be required to comply with the terms and conditions associated with that Water Rights License.

Mr. A. Nagy
November 12, 2013
Page 11

We trust that the preceding meets your requirements. If you have any questions or require further information, please contact the undersigned.

Sincerely,



Steve Wiecek, P.Geo., P.Eng.
Senior Geologic Engineer
swiecek@mts.net

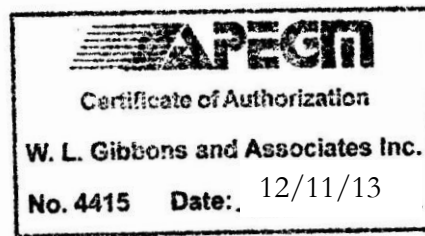
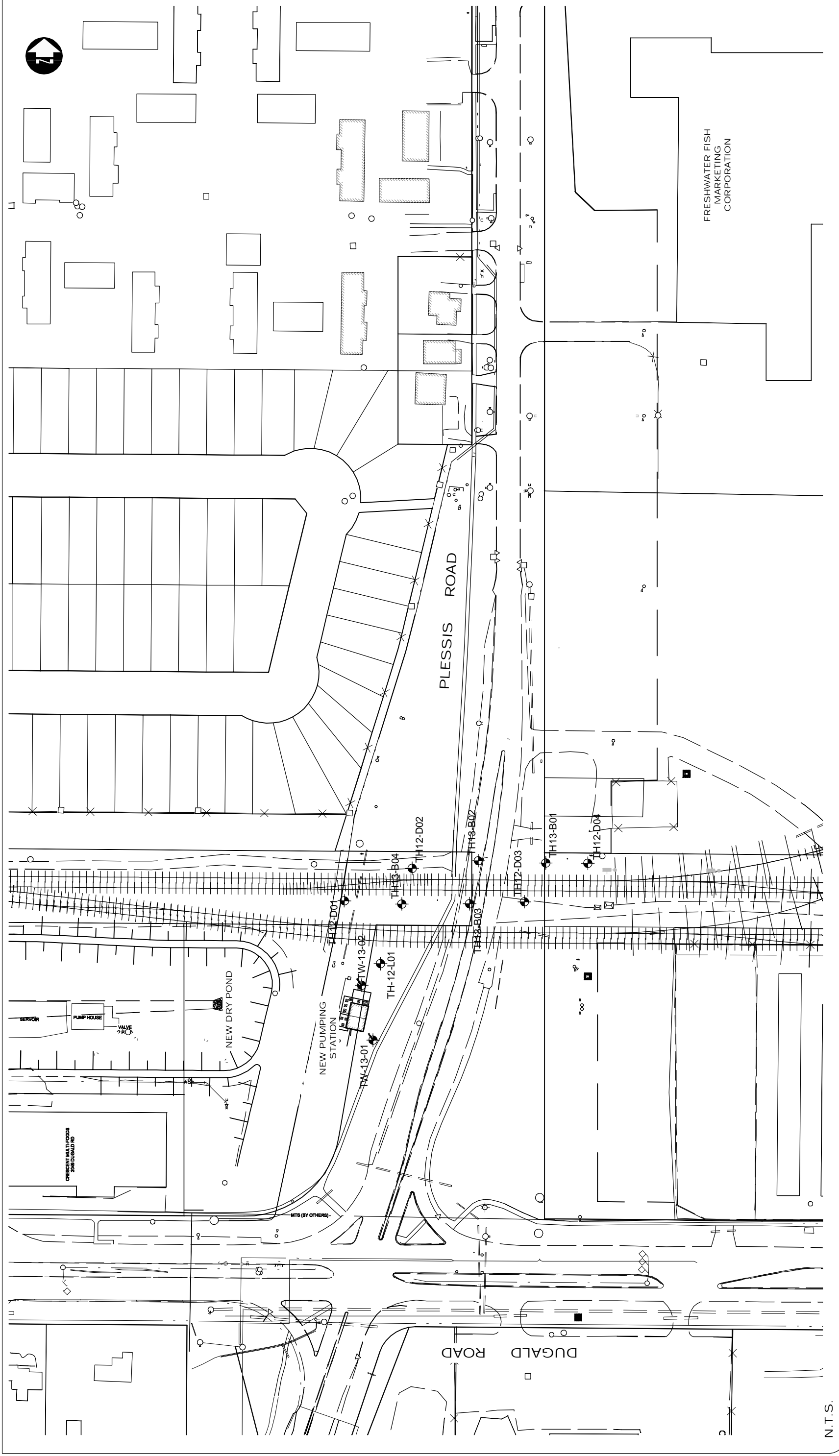


Table 1
Transmissivity Estimates

Pumping Well	Monitoring Well	Pumping Rate (Lps)	Pumping Duration (hrs)	Transmissivity m²/s / USgpd/ft	Analytic Method
TW 13-01 ⁽¹⁾	TW 13-01	6.5	0.5	3.9 x 10 ⁻² / 274,000	MNJE ⁽²⁾
TW 13-01 ⁽³⁾	TW 13-01	37.1	2.75	6.1 x 10 ⁻² / 425,000	MNJE ⁽²⁾
TW 13-01 ⁽³⁾	MW D01	37.1	2.75	1.1 x 10 ⁻¹ / 828,000	Theis ⁽⁴⁾
TW 13-02 ⁽³⁾	TW 13-02	37.9	2.5	5.7 x 10 ⁻² / 400,000	MNJE ⁽²⁾
TW 13-02 ⁽³⁾	TW 13-01	37.9	2.5	1.1 x 10 ⁻¹ / 828,000	Theis ⁽⁴⁾
TW 13-02 ⁽³⁾	MW D01	37.9	2.5	1.1 x 10 ⁻¹ / 828,000	Theis ⁽⁴⁾

- (1) - With well in 125 mm (5 inch) casing configuration
- (2) - Modified Nonequilibrium Jacob Equation (Driscoll, 1986)
- (3) - With well in 200 mm (8 inch) casing configuration
- (4) - Theis (1935) method using AQTESOLV Pro (Appendix F)

Figures

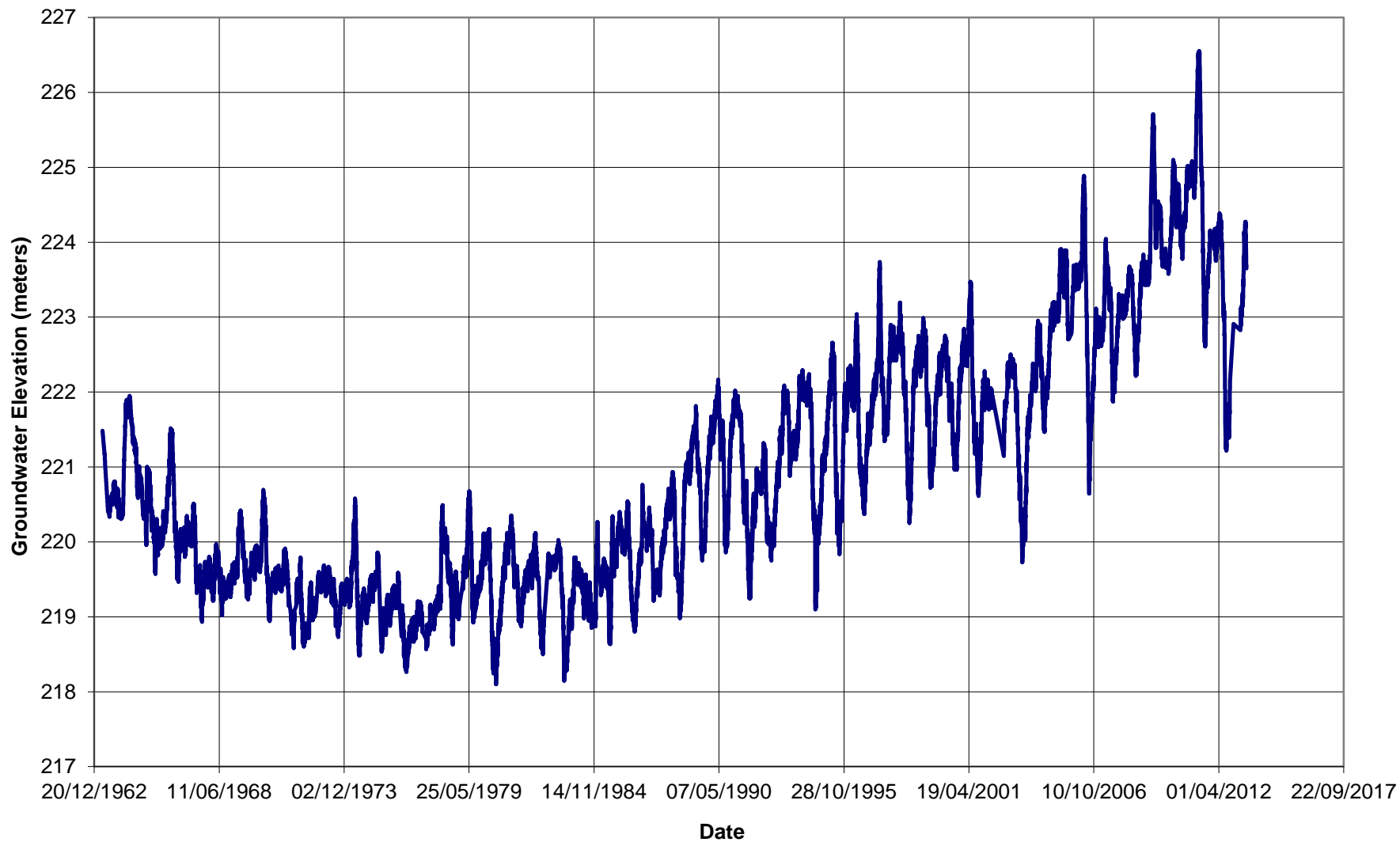


N.T.S.

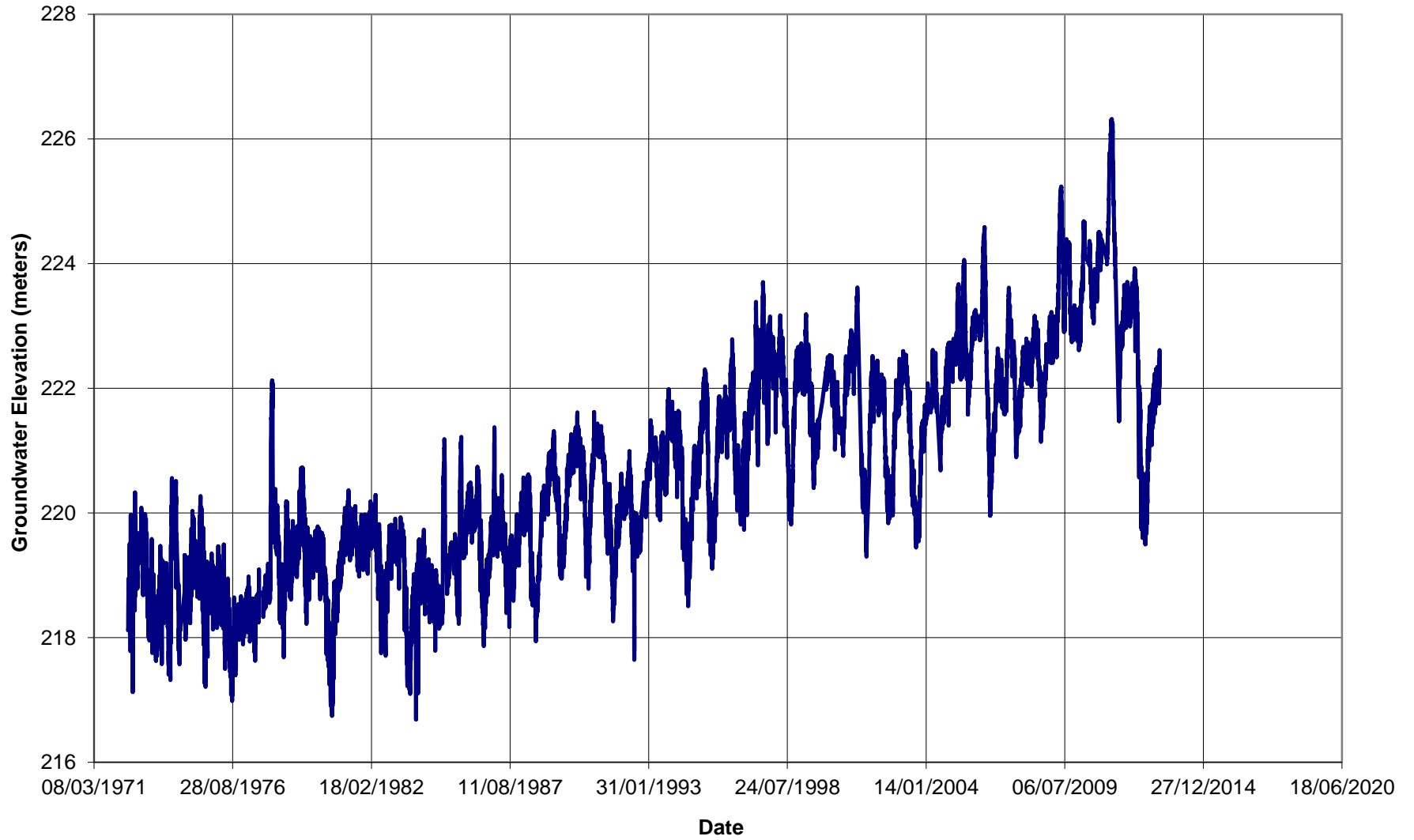


Appendix A
Regional Groundwater Levels

**Groundwater Monitoring Station OH-004
Mazenod Road and Camiel Sys Street**

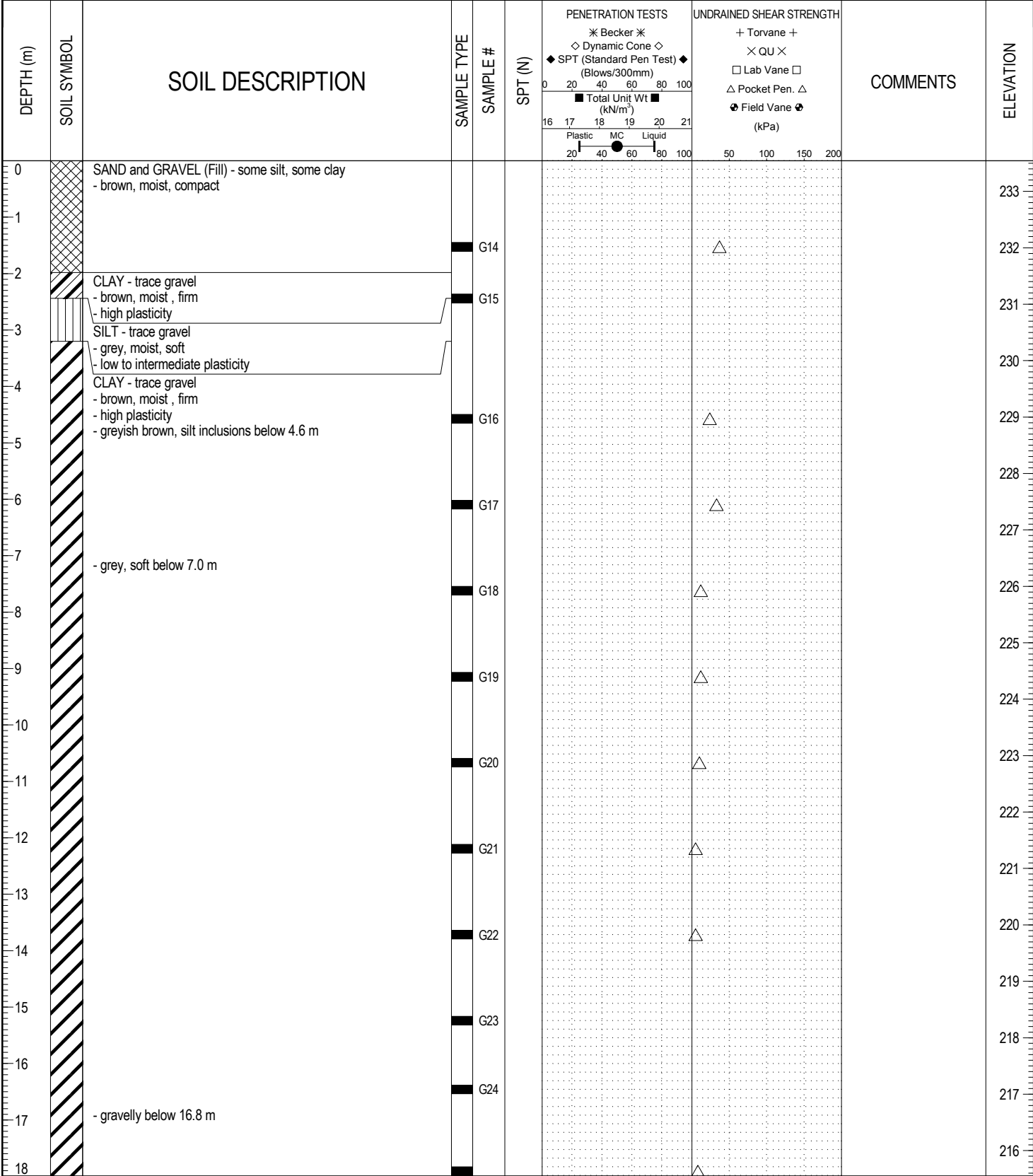


**Groundwater Monitoring Station OJ-030
Dugald Road and McFadden Avenue**



Appendix B
Geotechnical Test Hole Logs

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: TH13-B01	
LOCATION: Plessis East Abutment, N: 5528000.9 E: 641834.1				PROJECT NO.: 60273041	
CONTRACTOR: Paddock Drilling Ltd.			METHOD: Track Mounted Acker SS 3, 125 mm SSA		ELEVATION (m): 233.54
SAMPLE TYPE		GRAB	SHELBY TUBE	SPLIT SPOON	BULK
		NO RECOVERY	CORE		



LOG OF TEST HOLE SUPPLEMENTAL INVESTIGATION-BRIDGE TEST HOLE LOGS-PRU-60273041.GPJ UMA WINN.GDT 8/7/13



LOGGED BY: Sam Oshati	COMPLETION DEPTH: 24.69 m
REVIEWED BY: Zeyad Shukri	COMPLETION DATE: 7/30/13
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: TH13-B01	
LOCATION: Plessis East Abutment, N: 5528000.9 E: 641834.1				PROJECT NO.: 60273041	
CONTRACTOR: Paddock Drilling Ltd.			METHOD: Track Mounted Acker SS 3, 125 mm SSA		ELEVATION (m): 233.54
SAMPLE TYPE		GRAB	SHELBY TUBE	SPLIT SPOON	BULK
		NO RECOVERY	CORE		

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	ELEVATION		
						Becker	Dynamic Cone	Torvane	QU				
18	[Cross-hatched symbol]	LIMESTONE (Bedrock) - light grey to white, core angle: 90 degrees - fine to medium grained, no foliation - close to moderately close spacing, rough undulating joints, unaltered joints - R2 to R3 (weak to medium strong) - fossiliferous - fractured to 20.1 m (Elev. 213.4) below ground surface - competent rock (RQD > 70%) below 20.1 m	[Vertical bar symbol]	G25						C1 RQD: 22% Core Recovery: 64%	215		
19				C2							C2 RQD: 51% Core Recovery: 88%	214	
20				C3								C3 RQD: 79% Core Recovery: 92%	213
21				C4								C4 RQD: 79% Core Recovery: 94%	211
24				C5								C5 RQD: 93% Core Recovery: 98%	209
25		END OF TEST HOLE AT 24.69 m IN BEDROCK Notes: 1. Power auger refusal at 18.05 m below ground surface on BEDROCK. 2. HQ coring below 18.05 m. 3. Test hole sealed with bentonite up to 3.05 m and grouted from 3.05 to ground surface.									208		
26											207		
27											206		
28											205		
29											204		
30											203		
31											202		
32											201		
33											200		
34											199		
35											198		
36											198		

LOG OF TEST HOLE SUPPLEMENTAL INVESTIGATION-BRIDGE TEST HOLE LOGS-PRU-60273041.GPJ UMA WINN.GDT 8/7/13



LOGGED BY: Sam Oshati	COMPLETION DEPTH: 24.69 m
REVIEWED BY: Zeyad Shukri	COMPLETION DATE: 7/30/13
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass CLIENT: City of Winnipeg TESTHOLE NO: TH13-B02
 LOCATION: Plessis North Pier, N: 5527999.0 E: 641663.6 PROJECT NO.: 60273041
 CONTRACTOR: Paddock Drilling Ltd. METHOD: Track Mounted Acker SS 3, 125 mm SSA ELEVATION (m): 232.96

SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
						* Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) ■ Total Unit Wt ■ (kN/m ³)	+ Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ⊕ Field Vane ⊕ (kPa)			
0	■	ASPHALT (300 mm)								
0-1	▨	SAND and GRAVEL (Base) - light brown, dry, compact - medium to coarse grained								232
1-2	▩	CLAY (Fill) - some gravel, some sand, trace organics - brown, moist, firm - Intermediate plasticity	■	G1				+		231
2-3	▩		■	G2						230
3-4	▨	ORGANICS - wood chips - brown to black, moist to wet - hydrocarbon (diesel fuel)	■	G3						229
4-5	▩		■	G4						228
5-6	▩	CLAY - greyish brown, moist, firm - high plasticity	■	G5						227
6-7	▩		■	G6						226
7-8	▩	- grey, trace silt inclusions, soft below 7.62 m	■	G7						225
8-9	▩		■	G8						224
9-10	▩		■	G9						223
10-11	▩	- trace gravel below 11 m	■	G10						222
11-12	▩		■	G11						221
12-13	▩		■	G12						220
13-14	▩		■	G13						219
14-15	▩		■							218
15-16	▩		■							217
16-17	▩		■							216
17-18	▩	- silty, wet, some gravel	■							

LOG OF TEST HOLE SUPPLEMENTAL INVESTIGATION-BRIDGE TEST HOLE LOGS-PRU-60273041.GPJ UJA WINN.GDT 8/7/13



LOGGED BY: Sam Oshati COMPLETION DEPTH: 26.21 m
 REVIEWED BY: Zeyad Shukri COMPLETION DATE: 7/31/13
 PROJECT ENGINEER: Zeyad Shukri Page 1 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH13-B02
LOCATION: Plessis North Pier, N: 5527999.0 E: 641663.6		PROJECT NO.: 60273041
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Track Mounted Acker SS 3, 125 mm SSA	ELEVATION (m): 232.96
SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE	

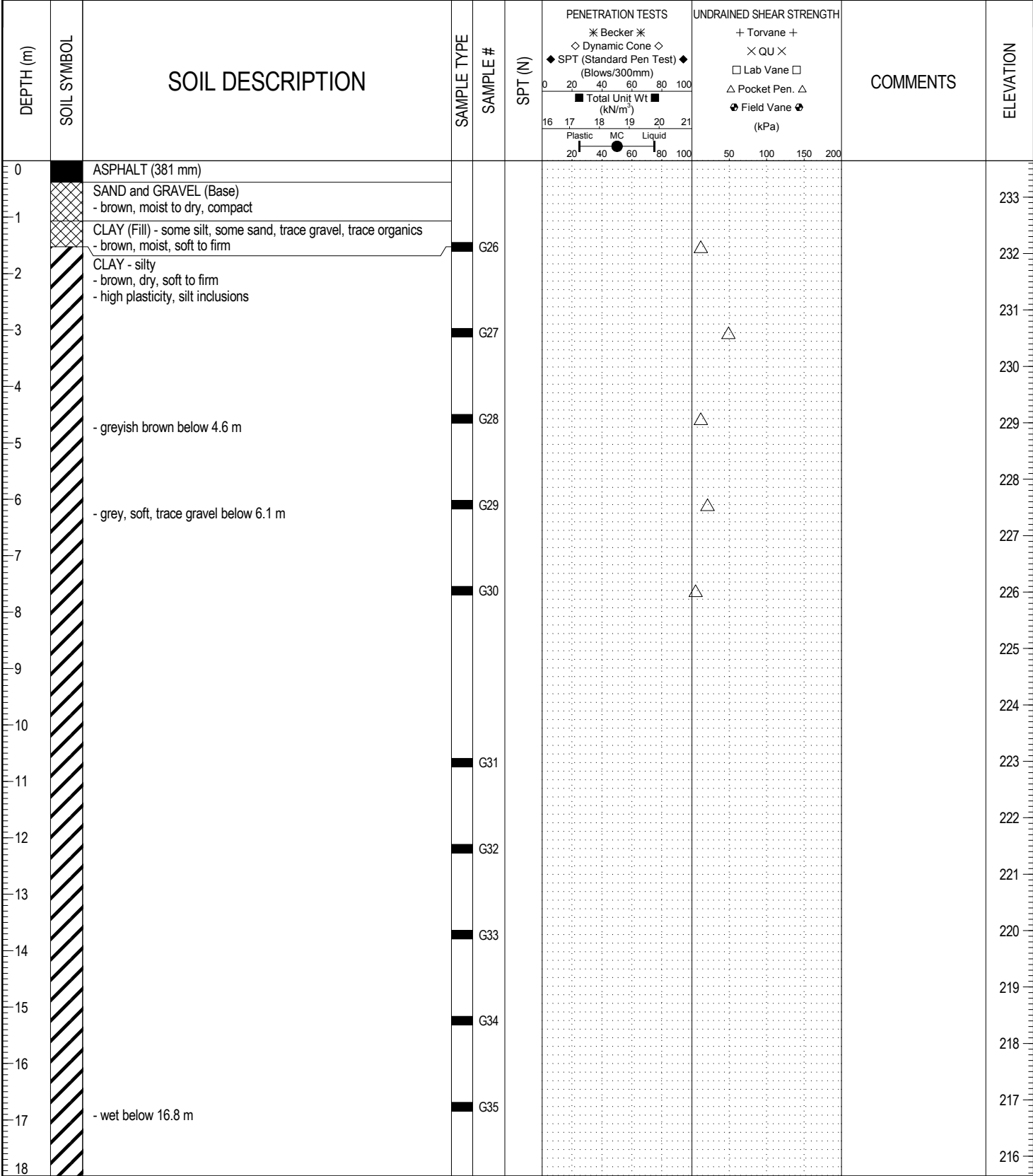
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS	UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
18		- cobbly, some boulders below 17.7 m							
19		LIMESTONE (Bedrock) - light grey, core angle: 90 degrees - fine to medium grained, no foliation - close to moderately close spacing, rough undulating joints, unaltered joints		C1				C1 RQD: 40% Core Recovery: 70%	214
20		- R2 to R3 (weak to medium strong) - fossiliferous, vuggy to 21.6 m - fractured to 21.6 m (Elev. 211.4) below ground surface		C2				C2 RQD: 48% Core Recovery: 93%	213
21				C3				C3 RQD: 75% Core Recovery: 92%	212
22		- competent rock (RQD > 70%) below 21.6 m - mottled yellow to 21.95 m		C4				C4 RQD: 81% Core Recovery: 90%	211
23				C5				C5 RQD: 85% Core Recovery: 96%	210
24									209
25									208
26									207
27		END OF TEST HOLE AT 26.21 m IN BEDROCK Notes: 1. Power auger refusal at 18.5 m below ground surface on BEDROCK. 2. HQ coring below 18.5 m. 3. Seepage observed at 17.5 m below ground surface. 4. Test hole grouted up to 18.3 m and sealed with bentonite to ground surface.							206
28									205
29									204
30									203
31									202
32									201
33									200
34									199
35									198
36									

LOG OF TEST HOLE SUPPLEMENTAL INVESTIGATION-BRIDGE TEST HOLE LOGS-PRU-60273041.GPJ UJMA WINN.GDT 8/7/13



LOGGED BY: Sam Oshati	COMPLETION DEPTH: 26.21 m
REVIEWED BY: Zeyad Shukri	COMPLETION DATE: 7/31/13
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: TH13-B03	
LOCATION: Plessis South Pier, N: 5527960.9 E: 641831.2				PROJECT NO.: 60273041	
CONTRACTOR: Paddock Drilling Ltd.			METHOD: Track Mounted Acker SS 3, 125 mm SSA		ELEVATION (m): 233.64
SAMPLE TYPE		GRAB	SHELBY TUBE	SPLIT SPOON	BULK
		NO RECOVERY	CORE		



LOGGED BY: Sam Oshati	COMPLETION DEPTH: 24.69 m
REVIEWED BY: Zeyad Shukri	COMPLETION DATE: 8/1/13
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass CLIENT: City of Winnipeg TESTHOLE NO: TH13-B03
 LOCATION: Plessis South Pier, N: 5527960.9 E: 641831.2 PROJECT NO.: 60273041
 CONTRACTOR: Paddock Drilling Ltd. METHOD: Track Mounted Acker SS 3, 125 mm SSA ELEVATION (m): 233.64
 SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	ELEVATION
						Becker	Dynamic Cone	+	×		
18				G36							215
19				G37							214
20		LIMESTONE (Bedrock) - light grey to white, core angle: 90 degrees - fine to medium grained, no foliation - close to moderately close spacing, rough undulating joints, unaltered joints		C1						C1 RQD: 15% Core Recovery: 45%	213
21		- R2 to R3 (weak to medium strong) - fossiliferous, vuggy - fractured to 21.6 m (Elev. 212.0) below ground surface		C2						C2 RQD: 62% Core Recovery: 97%	212
22		- competent rock (RQD > 70%) below 21.6 m		C3						C3 RQD: 78% Core Recovery: 99%	211
23				C4						C4 RQD: 83% Core Recovery: 97%	210
24											209
25		END OF TEST HOLE AT 24.69 m IN BEDROCK Notes: 1. Power auger refusal at 19.2 m below ground surface on BEDROCK. 2. HQ coring below 19.2 m. 3. Seepage observed at 16.8 m below ground surface. 4. Test hole sealed with bentonite up to 19.8 m and grouted from 19.8 m to ground surface.									208
26											207
27											206
28											205
29											204
30											203
31											202
32											201
33											200
34											199
35											198
36											198

LOG OF TEST HOLE SUPPLEMENTAL INVESTIGATION-BRIDGE TEST HOLE LOGS-PRU-60273041.GPJ UJMA WINN.GDT 8/7/13



LOGGED BY: Sam Oshati COMPLETION DEPTH: 24.69 m
 REVIEWED BY: Zeyad Shukri COMPLETION DATE: 8/1/13
 PROJECT ENGINEER: Zeyad Shukri Page 2 of 2

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: TH13-B04	
LOCATION: Plessis West Abutment, N: 5527982.0 E: 641811.9				PROJECT NO.: 60273041	
CONTRACTOR: Paddock Drilling Ltd.			METHOD: Track Mounted Acker SS 3, 125 mm SSA		ELEVATION (m): 233.00
SAMPLE TYPE		GRAB	SHELBY TUBE	SPLIT SPOON	BULK
		NO RECOVERY	CORE		

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	ELEVATION
						Becker	Dynamic Cone	Torvane	QU		
0		SAND and GRAVEL (Fill) - trace organics - brown, dry to moist, compact									
1		CLAY (Fill) - some sand, some gravel, trace organics - dark brown to brown, moist, firm - intermediate plasticity		G38							232
2		SILT - light brown, moist, soft - low to intermediate plasticity CLAY - brown, moist, firm - high plasticity - silty to 3.4 m		G39							231
3				G40							230
4		- greyish brown below 4.6 m		G41							229
5		- grey below 5.2 m		G42							228
6				G43							227
7				G44							226
8				G45							225
9		- silt inclusions, moist to wet below 9.1 m		G46							224
10				G47							223
11		- moist below 10.7 m		G48							222
12				G49							221
13				G50							220
14		- moist to wet below 13.7 m									219
15											218
16											217
17											216
18											

LOG OF TEST HOLE SUPPLEMENTAL INVESTIGATION-BRIDGE TEST HOLE LOGS-PRU-60273041.GPJ UJMA WINN.GDT 8/7/13



LOGGED BY: Sam Oshati	COMPLETION DEPTH: 30.78 m
REVIEWED BY: Zeyad Shukri	COMPLETION DATE: 8/2/13
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH13-B04
LOCATION: Plessis West Abutment, N: 5527982.0 E: 641811.9		PROJECT NO.: 60273041
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Track Mounted Acker SS 3, 125 mm SSA	ELEVATION (m): 233.00
SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB <input type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> BULK <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE	

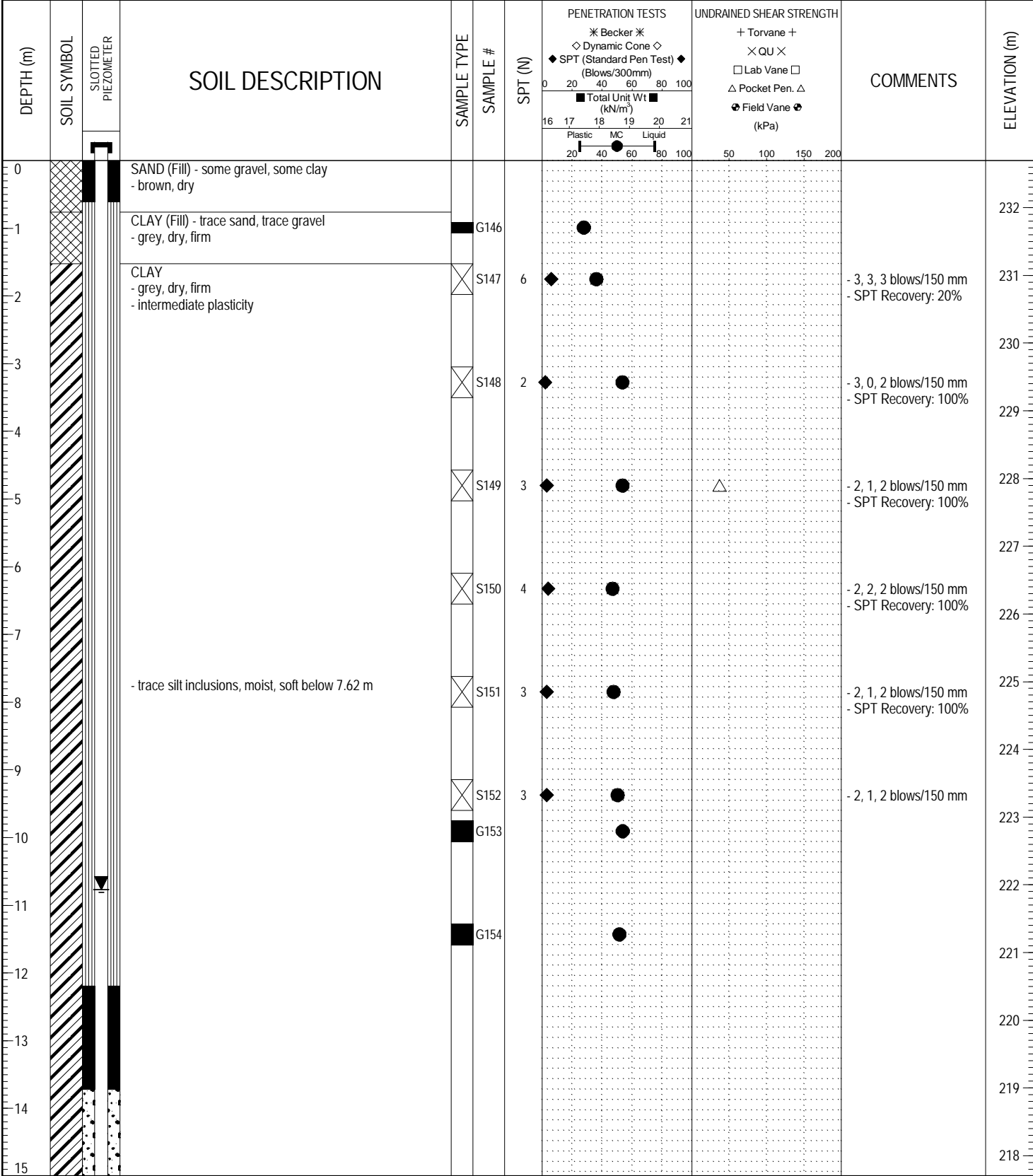
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	ELEVATION
						* Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m ³) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100	+ Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ● Field Vane ● (kPa) 50 100 150 200				
18											
19		LIMESTONE (Bedrock)		G51							214
20		- light grey to white, core angle: 90 degrees - fine to medium grained, no foliation - close to moderately close spacing, rough undulating joints, unaltered joints		C1						C1 RQD: 56% Core Recovery: 75%	213
21		- R2 to R3 (weak to medium strong) - fossiliferous - fractured to 20.1 m (Elev. 212.9) below ground surface - competent rock below 20.1 m - mottled yellow to 21.8 m		C2						C2 RQD: 82% Core Recovery: 96%	212
22				C3						C3 RQD: 92% Core Recovery: 98%	211
23				C4						C4 RQD: 78% Core Recovery: 95%	210
24				C5						C5 RQD: 64% Core Recovery: 75%	209
25				C6						C6 RQD: 80% Core Recovery: 98%	208
26		- ripple marks to 26.4 m		C7						C7 RQD: 81% Core Recovery: 99%	207
27				C8						C8 RQD: 94% Core Recovery: 99%	206
28											205
29											204
30											203
31		END OF TEST HOLE AT 30.78 m IN BEDROCK									202
32		Notes:									201
33		1. Power auger refusal at 18.9 m below ground surface on BEDROCK.									200
34		2. HQ coring below 18.9 m.									199
35		3. Seepage observed at 15.24 m below ground surface.									198
36		4. sloughing observed at 19.8 m below ground surface in rock.									
		5. Test hole grouted up to 19.8 m and sealed with bentonite from 19.8 m to ground surface.									

LOG OF TEST HOLE SUPPLEMENTAL INVESTIGATION-BRIDGE TEST HOLE LOGS-PRU-60273041.GPJ UJMA WINN.GDT 8/7/13



LOGGED BY: Sam Oshati	COMPLETION DEPTH: 30.78 m
REVIEWED BY: Zeyad Shukri	COMPLETION DATE: 8/2/13
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: TH12-D01			
LOCATION: Plessis South Bound/CN Rail Intersection, West Shoulder Lawn				PROJECT NO.: 60273041			
CONTRACTOR: Maple Leaf Drilling Ltd.		METHOD: Mobile B-40, 125 mm SSA		ELEVATION (m): 232.70			
SAMPLE TYPE		GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
BACKFILL TYPE		BENTONITE	GRAVEL	SLOUGH	GROUT	CUTTINGS	SAND

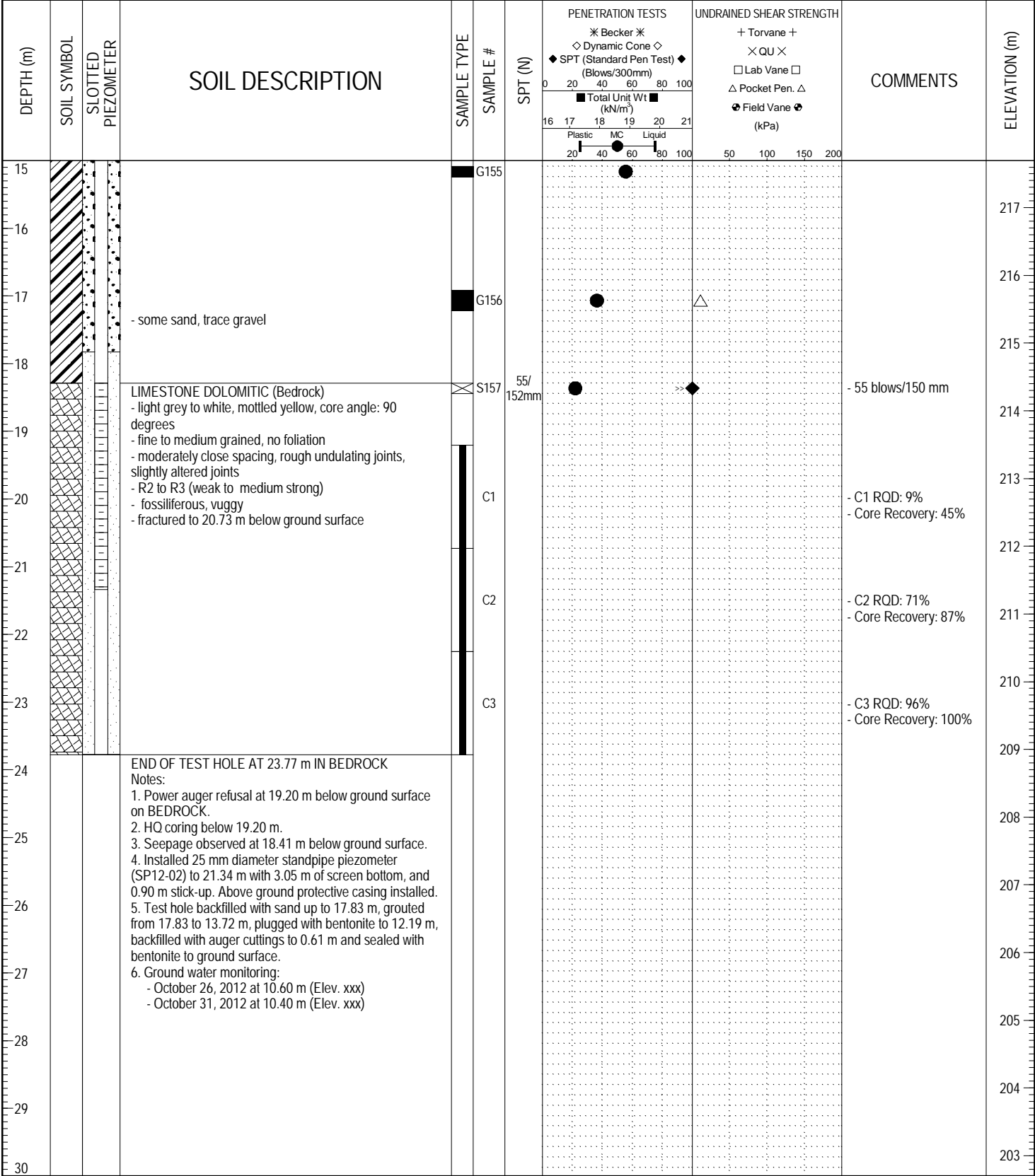


LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 23.77 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/26
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: TH12-D01		
LOCATION: Plessis South Bound/CN Rail Intersection, West Shoulder Lawn				PROJECT NO.: 60273041		
CONTRACTOR: Maple Leaf Drilling Ltd.		METHOD: Mobile B-40, 125 mm SSA		ELEVATION (m): 232.70		
SAMPLE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
BACKFILL TYPE	BENTONITE	GRAVEL	SLOUGH	GROUT	CUTTINGS	SAND



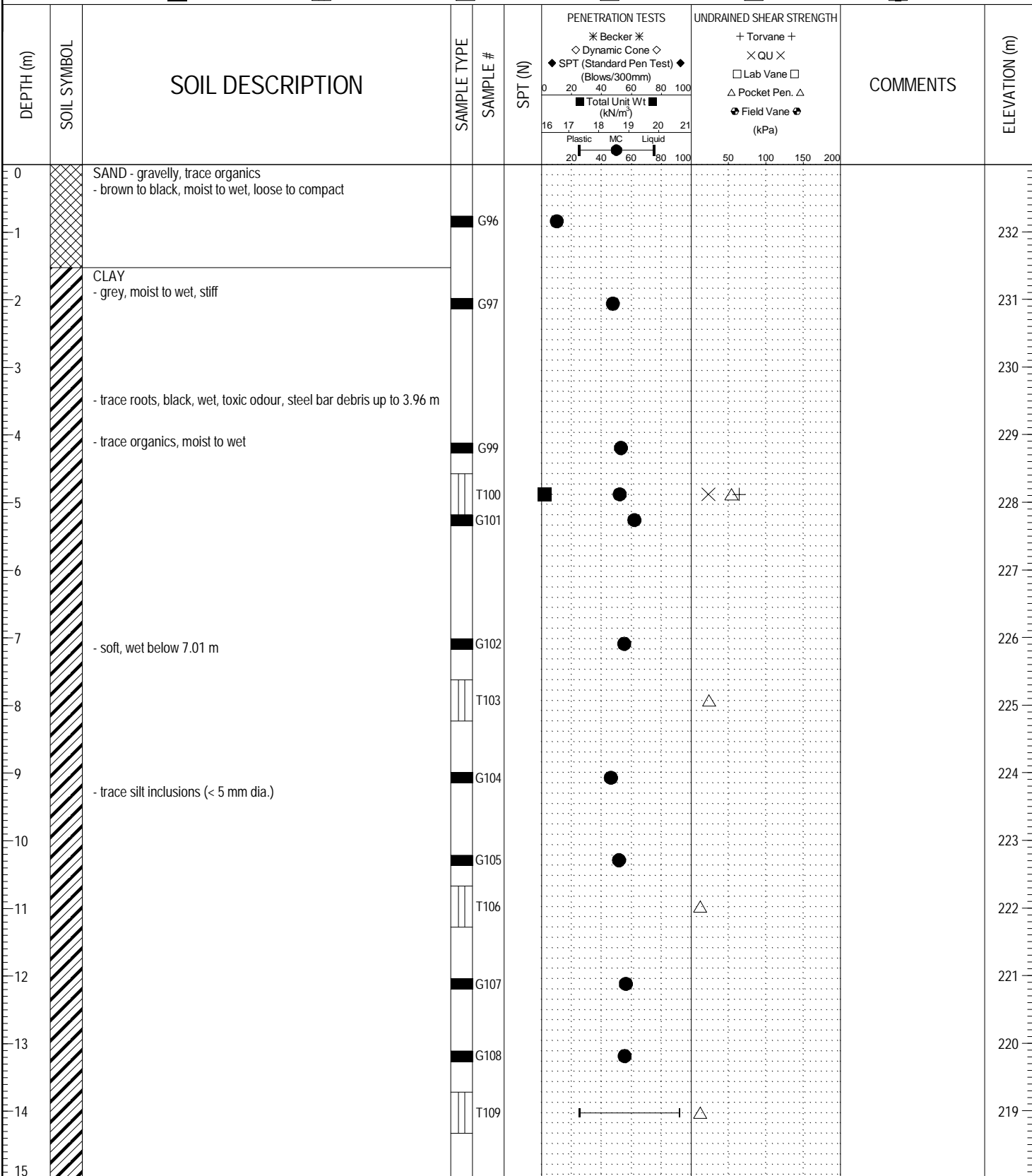
LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 23.77 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/26
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-D02
LOCATION: Plessis South Bound/CN Rail Intersection, West Shoulder		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Mobile B-40, 125 mm SSA	ELEVATION (m): 232.99

SAMPLE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
-------------	------	-------------	-------------	------	-------------	------



LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 21.95 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/22
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-D02
LOCATION: Plessis South Bound/CN Rail Intersection, West Shoulder		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Mobile B-40, 125 mm SSA	ELEVATION (m): 232.99

SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> SHELBY TUBE	<input checked="" type="checkbox"/> SPLIT SPOON	<input type="checkbox"/> BULK	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE
-------------	--	--------------------------------------	---	-------------------------------	--------------------------------------	-------------------------------

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	ELEVATION (m)
						Blows/300mm	Total Unit Wt (kN/m ³)	(kPa)	(kPa)		
15				G110	55	20	50				217
16				G111	55	20	50				216
17				G112	55	20	50				215
18											214
19		LIMESTONE (Bedrock)		C1						- C1 ROD: 26%	213
20		- light grey to white, core angle: 90 degrees - fine to medium grained, no foliation - close spacing, rough undulating joints, slightly altered joints - R2 to R3 (weak to medium strong) - fossiliferous, filled vugs - high calcium limestone		C2						- Core Recovery: 66%	212
21											211
22		END OF TEST HOLE AT 21.95 m IN BEDROCK									210
23		Notes: 1. Power auger refusal at 18.90 m below ground surface on BEDROCK. 2. HQ coring below 18.90 m. 3. Test hole grouted up to 13.72 m, plugged with bentonite from 13.72 to 12.80 m and backfilled with auger cuttings to ground surface.									209
24											208
25											207
26											206
27											205
28											204
29											203
30											202

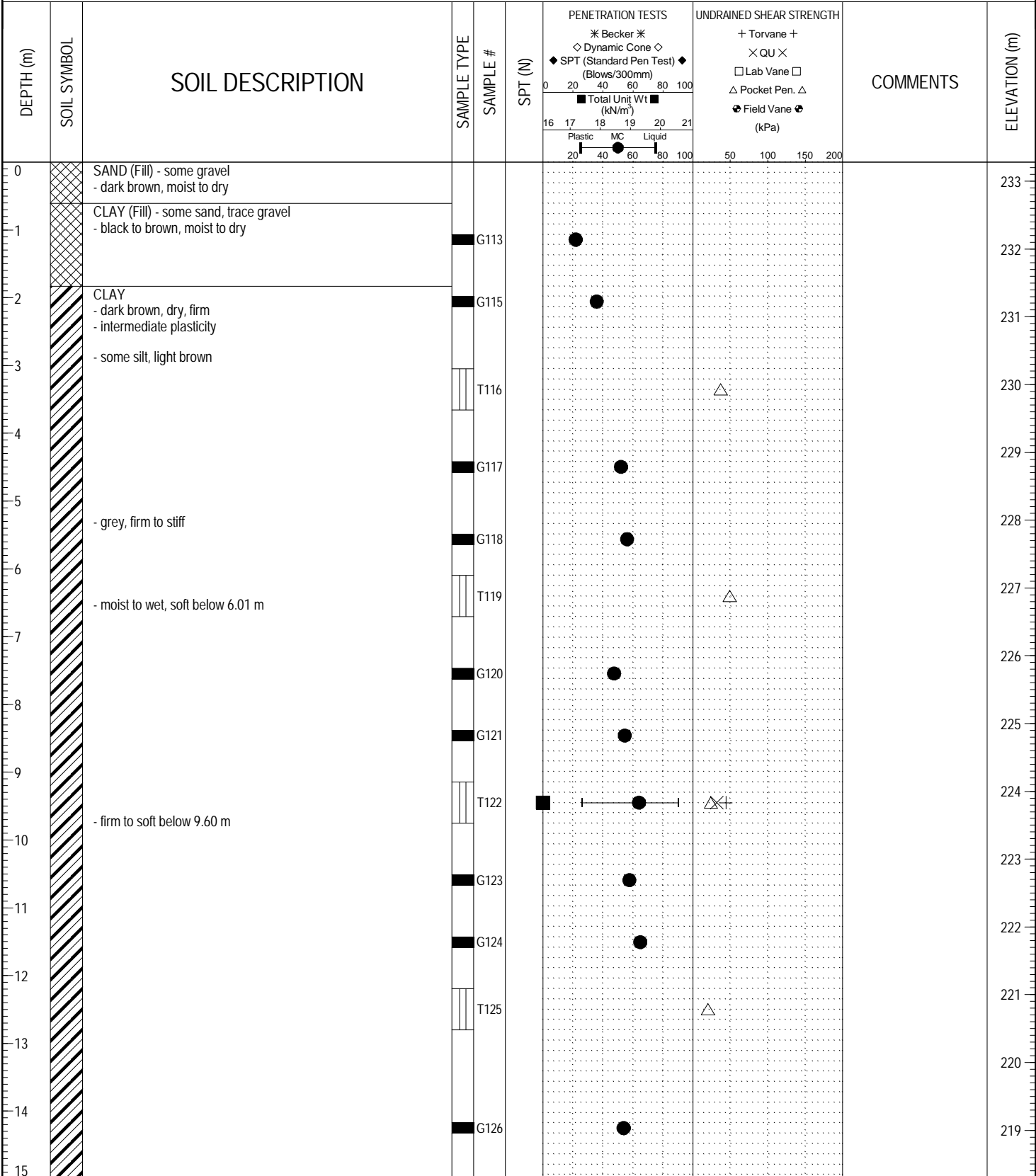
LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 21.95 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/22
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-D03
LOCATION: Plessis North Bound/CN Rail Intersection, East Shoulder		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Mobile B-40, 125 mm SSA	ELEVATION (m): 233.28

SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> SHELBY TUBE	<input checked="" type="checkbox"/> SPLIT SPOON	<input type="checkbox"/> BULK	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE
-------------	--	--------------------------------------	---	-------------------------------	--------------------------------------	-------------------------------



LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 22.25 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/23
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-D03
LOCATION: Plessis North Bound/CN Rail Intersection, East Shoulder		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Mobile B-40, 125 mm SSA	ELEVATION (m): 233.28

SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> SHELBY TUBE	<input checked="" type="checkbox"/> SPLIT SPOON	<input type="checkbox"/> BULK	<input checked="" type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE
-------------	--	--------------------------------------	---	-------------------------------	---	-------------------------------

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	ELEVATION (m)
						Becker	Dynamic Cone	Torvane	QU		
15											218
16											217
17											216
18		- some gravel, trace cobbles below 17.98 m		G127							215
19											214
20		LIMESTONE DOLOMITIC (Bedrock) - light grey to white, mottled yellow, core angle: 90 degrees - fine to medium grained, no foliation - close spacing, rough undulating joints, unaltered joints - R2 to R3 (weak to medium strong) - fossiliferous, vuggy - healed joint - slightly altered joint below 20.12 m		C1						- C1 ROD: 73% - Core Recovery: 92%	213
21											212
22		- rough planar joint		C2						- C2 ROD: 60% - Core Recovery: 94%	211
23		END OF TEST HOLE AT 21.95 m IN BEDROCK Notes: 1. Power auger refusal at 18.90 m below ground surface on BEDROCK. 2. HQ coring below 18.90 m. 3. Test hole backfilled with bentonite and auger cuttings.									210
24											209
25											208
26											207
27											206
28											205
29											204
30											204

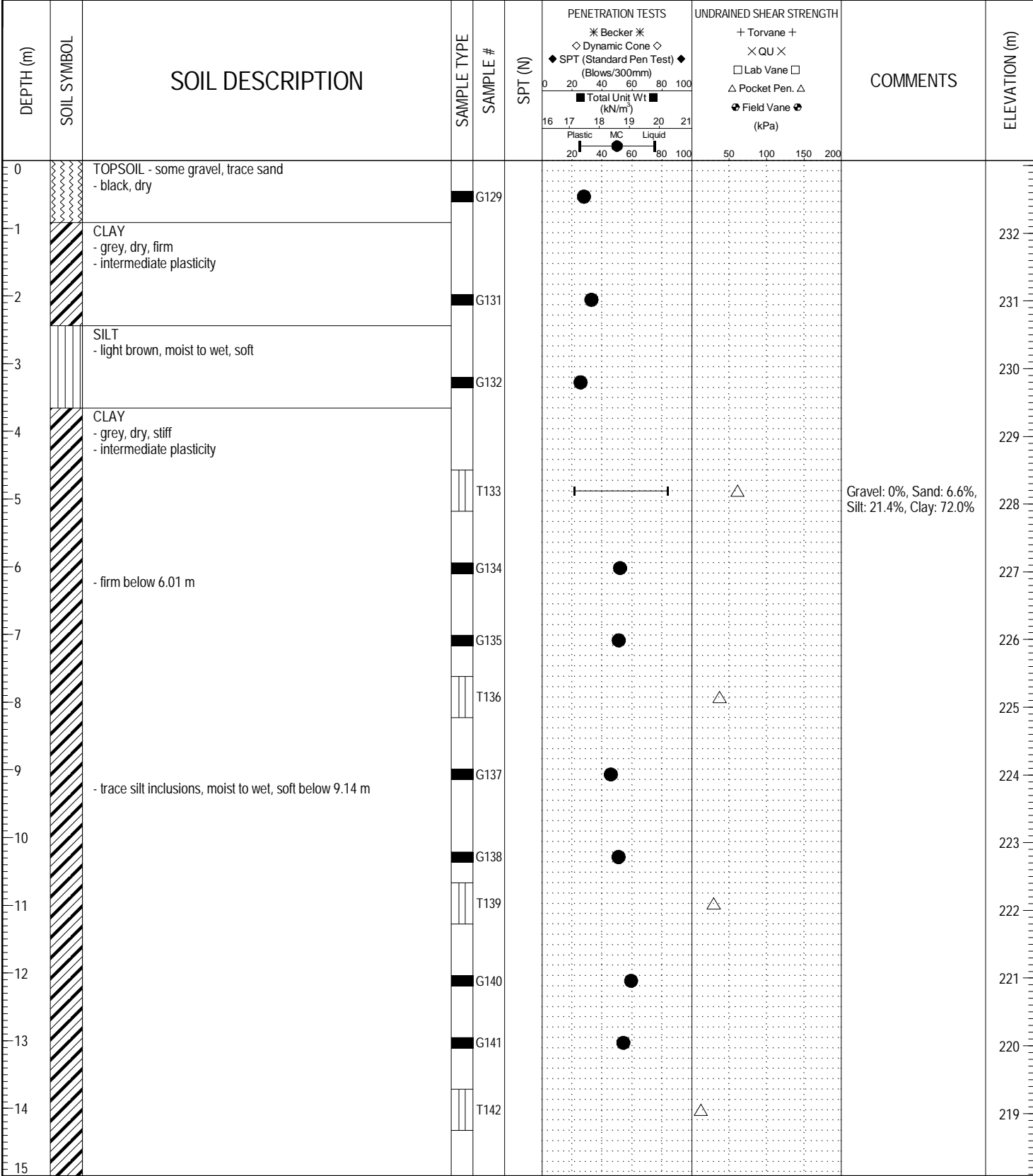
LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 22.25 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/23
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-D04
LOCATION: Plessis North Bound/CN Rail Intersection, East Shoulder Lawn		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Mobile B-40, 175 mm HSA	ELEVATION (m): 233.08

SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> SHELBY TUBE	<input checked="" type="checkbox"/> SPLIT SPOON	<input type="checkbox"/> BULK	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE
-------------	--	--------------------------------------	---	-------------------------------	--------------------------------------	-------------------------------



LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 23.77 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/24
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-D04
LOCATION: Plessis North Bound/CN Rail Intersection, East Shoulder Lawn		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Mobile B-40, 175 mm HSA	ELEVATION (m): 233.08

SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> SHELBY TUBE	<input checked="" type="checkbox"/> SPLIT SPOON	<input type="checkbox"/> BULK	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE
-------------	--	--------------------------------------	---	-------------------------------	--------------------------------------	-------------------------------

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	ELEVATION (m)
						Becker	Dynamic Cone	Torvane	QU		
15											
16				G143							217
17		- trace gravel, wet below 16.76 m		G144							216
18		LIMESTONE (Bedrock) - light grey to white, core angle: 90 degrees - fine to medium grained, no foliation - moderately close spacing, rough undulating joints, unaltered joints		C1						- C1 RQD: 33% - Core Recovery: 82%	215
19		- R2 to R3 (weak to medium strong) - fossiliferous, filled vugs - high calcium limestone - rough planar joint		C2						- C2 RQD: 35% - Core Recovery: 100%	214
20				C3						- C3 RQD: 45% - Core Recovery: 100%	213
21				C4						- C4 RQD: 99% - Core Recovery: 100%	212
22											211
23											210
24		END OF TEST HOLE AT 23.77 m IN BEDROCK									209
25		Notes: 1. Power auger refusal at 17.68 m below ground surface on BEDROCK. 2. HQ coring below 17.68 m. 3. Seepage observed at 16.76 m below ground surface. 4. Test hole backfilled with bentonite and auger cuttings.									208
26											207
27											206
28											205
29											204
30											

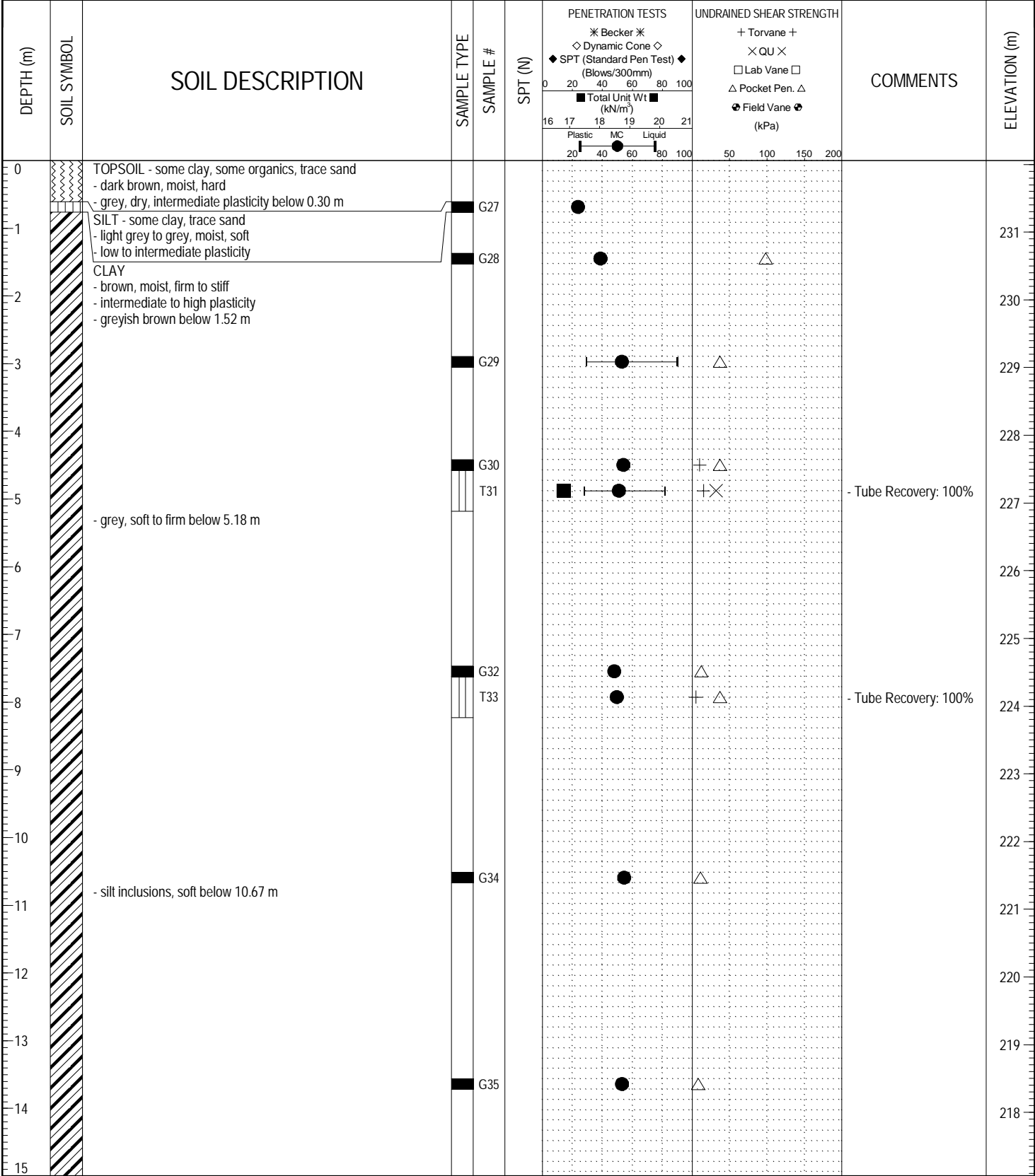
LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 23.77 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/24
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-L01
LOCATION: East of Plessis Road		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Track Mounted MP5, 125 mm SSA	ELEVATION (m): 232.06

SAMPLE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
-------------	------	-------------	-------------	------	-------------	------



LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 17.98 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/10
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: Plessis Road Underpass	CLIENT: City of Winnipeg	TESTHOLE NO: TH12-L01
LOCATION: East of Plessis Road		PROJECT NO.: 60273041
CONTRACTOR: Maple Leaf Drilling Ltd.	METHOD: Track Mounted MP5, 125 mm SSA	ELEVATION (m): 232.06

SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> SHELBY TUBE	<input checked="" type="checkbox"/> SPLIT SPOON	<input type="checkbox"/> BULK	<input checked="" type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE
-------------	--	--------------------------------------	---	-------------------------------	---	-------------------------------

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS	UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION (m)
15									216
16									215
17				G36					214
18		- limestone cobble up to 0.08 m thick		G37					213
18		END OF TEST HOLE AT 17.98 m ON BEDROCK							212
19		Notes: 1. Power auger refusal at 17.98 m below ground surface on BEDROCK. 2. Seepage observed at 10.97 m below ground surface. 3. Test hole remained open to 12.80 m below ground surface after completion of drilling. 4. Test hole backfilled with auger cuttings upon completion.							211
20									210
21									209
22									208
23									207
24									206
25									205
26									204
27									203
28									203
29									203
30									203

LOG OF TEST HOLE TEST PIT LOGS-PRU-60273041.GPJ UMA WINN.GDT 13/3/19



LOGGED BY: Sam O.	COMPLETION DEPTH: 17.98 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 12/10/10
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: Test Caisson	
LOCATION: Plessis South Bound/CN Rail Intersection, West of Sidewalk				PROJECT NO.: 60273041	
CONTRACTOR: Subterranean (Manitoba) LTD.		METHOD: Track Mounted Soilmec SR-65		ELEVATION (m): +/- 232.5	
SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> SPLIT SPOON	<input type="checkbox"/> BULK	<input type="checkbox"/> NO RECOVERY
BACKFILL TYPE	<input checked="" type="checkbox"/> BENTONITE	<input type="checkbox"/> GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> CUTTINGS
					<input type="checkbox"/> CORE
					<input type="checkbox"/> SAND

DEPTH (m)	SOIL SYMBOL	BACKFILL DETAILS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	DEPTH
							* Becker * ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) ■ Total Unit Wt (kN/m³)	+ Torvane + × QU × □ Lab Vane □ △ Pocket Pen. △ ⊕ Field Vane ⊕ (kPa)				
0			CLAY - brown, moist, stiff - high plasticity, silt lenses									0
1												1
2												2
3												3
4			- greyish brown below 3.66 m									4
5												5
6			- grey, soft to firm below 5.49 m									6
7												7
8												8
9												9
10												10
11												11
12												12
13												13
14												14
15												15

LOG OF TEST HOLE TEST CAISSON LOGS-PRU-60273041.GPJ UMA WINN.GDT 7/19/13



LOGGED BY: Sam O.	COMPLETION DEPTH: 23.93 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 7/9/13
PROJECT ENGINEER: Omer Eissa	Page 1 of 2

PROJECT: Plessis Road Underpass		CLIENT: City of Winnipeg		TESTHOLE NO: Test Caisson		
LOCATION: Plessis South Bound/CN Rail Intersection, West of Sidewalk				PROJECT NO.: 60273041		
CONTRACTOR: Subterranean (Manitoba) LTD.		METHOD: Track Mounted Soilmec SR-65		ELEVATION (m): +/- 232.5		
SAMPLE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
BACKFILL TYPE	BENTONITE	GRAVEL	SLOUGH	GROUT	CUTTINGS	SAND

DEPTH (m)	SOIL SYMBOL	BACKFILL DETAILS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS		UNDRAINED SHEAR STRENGTH		COMMENTS	DEPTH
							Becker	Dynamic Cone	Torvane	QU		
15												
16												16
17			- wet below 16.76 m									17
18			- fractured rock, cobbles and boulders below 17.53 m									18
19			LIMESTONE (Bedrock) - weathered - light grey to white - fine to medium grained, no foliations - R2, weak strength rock - suspected cavity (< 0.5 m) - fractured to 20.9 m below ground surface									19
20												20
21												21
22			- competent rock at 21.6 m below ground surface, R3 (medium strong) - light grey to white - fine to medium grained, no foliations - Rough planar joints									22
23												23
24			END OF TEST CAISSON AT 23.9 m IN BEDROCK									24
25			Notes: 1. bedrock encountered at 17.8 m below ground surface. 2. Seepage observed at 16.7 m below ground surface, static water level at 10.7 m below ground surface. 3. 0.76 m diameter coring below 17.8 m. 4. Test caisson backfilled with concrete up to 11.4 m, plugged with stabilized fill from 11.4 to ground surface.									25
26												26
27												27
28												28
29												29
30												30

LOG OF TEST HOLE TEST CAISSON LOGS-PRU-60273041.GPJ UMA WINN.GDT 7/19/13



LOGGED BY: Sam O.	COMPLETION DEPTH: 23.93 m
REVIEWED BY: Omer Eissa	COMPLETION DATE: 7/9/13
PROJECT ENGINEER: Omer Eissa	Page 2 of 2

Appendix C
Groundwater Exploration Permit



July 15, 2013

File: Plessis Underpass

Manitoba Conservation & Water Stewardship
Water Use Licensing Section
Box 16, 200 Saulteaux Crescent
Winnipeg, MB R3J 3W3

Attention: Mr. R. Matthews, P.Geo.
Manager

Dear Mr. Matthews:

**RE: City of Winnipeg
Plessis Road Underpass
Application For License To Construct A Well And Divert Groundwater**

On behalf of the City of Winnipeg, W.L. Gibbons & Associates Inc. (WLG) is writing you to obtain approvals to conduct a groundwater exploration program for the purposes of establishing a groundwater depressurization system at the proposed Plessis Road Underpass site. The design of the lift station to be constructed as part of the underpass project will require excavation to depths at which base heave due to high groundwater pressures in the underlying bedrock aquifer become a concern. In order to mitigate this concern, it may be necessary to temporarily lower the groundwater pressures within the aquifer during construction. The final disposition of the discharge from this system has not been determined but will likely be to the municipal drainage system. A completed Application For License To Construct A Well And Divert Groundwater is attached. The following letter provides further details on the proposed groundwater withdrawal.

The potential pumping rates required to achieve the necessary temporary depressurization will be established during the exploration program. For planning purposes, it is being assumed that the pumping of up to 40 Lps will be required. The expected duration of pumping could be 4 to 5 months.

The proposed location for the lift station is approximately 100 meters north of the corner of Plessis Road and Dugald Road, and on the west side of the existing Plessis Road. The work will be conducted on municipal lands.

All information collected during this work program would be compiled into a report complete with copies of the Drillers Reports documenting the test hole results, well construction details, a site plan showing the locations of the wells, UTM coordinates for the wells, results of the pumping tests, and details of the pumping rates, discharge location and pumping duration. The report will also identify existing groundwater users in the area who might be impacted by the pumping and a plan to mitigate any potential impacts will be prepared. A copy of the report would be forwarded to MB Conservation & Water Stewardship, Water Use Licensing Section in

Mr. R. Matthews
July 15, 2013
Page 2

support of the application for a Water Rights License, if it is determined that a groundwater depressurization system will be required and therefore a Water Rights License will be required.

We trust that the preceding meets your requirements to issue the approvals. If you have any questions or require further information, please contact the undersigned at (204) 771-4389 or swiecek@mymts.net.

Sincerely,



Steve Wiecek, P.Geo., P.Eng.
Senior Geologic Engineer
swiecek@mts.net

SJW/sw

Cc: Mr. Blake Kibbins – City of Winnipeg
Mr. Andy Nagy - AECOM



Application for Licence to Construct a Well and Divert Groundwater

Demande de licence de construction d'un puits et de détournement d'eaux souterraines



Manitoba Water Stewardship
Water Licensing Branch
200 Saulteaux Crescent
Winnipeg MB R3J 3W3

Gestion des ressources hydriques Manitoba
Direction des licences d'utilisation de l'eau
200, croissant Saulteaux
Winnipeg (Manitoba) R3J 3W3

Pursuant to The Water Rights Act / En vertu de la Loi sur les droits d'utilisation de l'eau

APPLICANT'S NAME: City of Winnipeg NOM DU DEMANDEUR : Attn: Mr. Blake Kibbins, P. Eng.	TELEPHONE: (204) 451-3757 TÉLÉPHONE :
POST OFFICE ADDRESS: 106-1155 Pacific Avenue ADRESSE POSTALE : Winnipeg, MB R3E 3P1	

hereby applies for authority to construct a water well(s) on the following described land(s) :
demande par la présente l'autorisation de construire un ou plusieurs puits sur le ou les biens-fonds suivants :

	SE	6	11	4	E
LSD / SUBDIVISION LÉGALE	OR QUARTER / OU QUART DE SECTION	SECTION	TOWNSHIP	RANGE / RANG	E OR W / EST OU OUEST

or otherwise described as / ou autrement décrit comme approx. 100 meters north of Plessis Road and Dugald Road intersection and on west side of Plessis Road

and divert groundwater for / et de détourner des eaux souterraines pour des fins

_Construction Dewatering
(domestic, municipal, agricultural, industrial, irrigation, other) / (domestiques, municipales, agricoles, industrielles, d'irrigation, autres)

purposes on the following described land: / sur le bien-fonds suivant :

	SE	6	11	4	E
LSD / SUBDIVISION LÉGALE	OR QUARTER / OU QUART DE SECTION	SECTION	TOWNSHIP	RANGE / RANG	E OR W / EST OU OUEST

or otherwise described as / ou autrement décrit comme _____

at the following rates: _____ 0.04 _____ cubic metres per second / mètres cubes par seconde
aux taux suivants : _____ cubic decametres per day / décamètres cubes par jour
_____ cubic decametres per year / décamètres cubes par année

Number of hectares to be irrigated / Nombre d'hectares à irriguer : _____ (if applicable / le cas échéant)

The above described lands are held as follows: (check applicable box) /
Type de possession des biens-fonds décrits ci-dessus (cocher la case appropriée) :

X as registered owner / propriétaire inscrit ρ purchased under agreement for sale / acheté selon une convention de vente
ρ lessee / preneur à bail ρ to be negotiated / à négocier

Copy(s) of the Certificate(s) of Title or Title Number(s) must be included /
Des copies des certificats de titre ou des numéros de titre doivent être inclus :

Date: July 15 _____ 2013 _____
(signature of applicant / signature du demandeur)

FOR OFFICE USE ONLY / RÉSERVÉ À L'ADMINISTRATION

Application filed with the Executive Director, Infrastructure and Operations, at Winnipeg, Manitoba on /
Demande déposée auprès du directeur général, Infrastructures et opérations, à Winnipeg (Manitoba), le

_____, 20 ____.

(Signature of Executive Director / Signature du directeur général)

** IMPORTANT **

FEE OF \$50.00 MUST ACCOMPANY THIS APPLICATION, CHEQUE AND APPLICATION TO BE MAILED TO:
LE PAIEMENT DES DROITS DE 50 \$ DOIT ACCOMPAGNER CETTE DEMANDE. FAIRE PARVENIR LE CHÈQUE ET LA DEMANDE
À L'ADRESSE SUIVANTE :

MANITOBA CONSERVATION
CASHIER'S OFFICE
BOX 42, 200 SAULTEAUX CRESCENT
WINNIPEG MB R3J 3W3

CONSERVATION MANITOBA
BUREAU DU CAISSIER
C. P. 42, 200, CROISSANT SAULTEAUX
WINNIPEG (MANITOBA) R3J 3W3



Conservation and Water Stewardship

Water Use Licensing Section
Box 16, 200 Saulteaux Crescent
Winnipeg, Manitoba, Canada R3J 3W3
T 204-945-6118 F 204-945-7419
Rob.Matthews@gov.mb.ca

July 17, 2013

File: Winnipeg, City of -30

Blake Kibbins, P. Eng.
106-1155 Pacific Avenue
Winnipeg, MB R3E 3P1

Dear Mr. Kibbins:

Attached herewith is a **Groundwater Exploration Permit** issued in response to an application dated July 15, 2013 which was submitted by W.L. Gibbons & Associates Inc. on behalf of the City of Winnipeg for a licence to construct wells and conduct pumping tests for construction dewatering purposes on SE 6-11-4 EPM, Manitoba.

The Groundwater Exploration Permit authorizes the City of Winnipeg to carry out exploration test drilling, construct well(s), and conduct aquifer pump testing. The purpose of the pump testing is to determine if sufficient water is available from the well(s) and from the aquifer to support the project and to determine water level impacts on existing local wells and/or registered projects with earlier precedence dates than the proposed project. Please note that during testing, pumping must cease if any local water supplies are negatively impacted as a result of testing. The City of Winnipeg would further be responsible to correct any water supply problems or provide temporary water supply to anyone whose water supplies are negatively impacted as a result of testing. Please familiarize yourself with the terms and conditions of the Groundwater Exploration Permit.

A licensing decision on this project will be held pending submission of the required information. Please note that diversion of water without a Water Rights Licence or written authorization would constitute a violation of *The Water Rights Act* and may be subject to enforcement.

Please contact Kylene Wiseman, directly at 204-945-7424 should you have any questions regarding the requirements outlined in this letter and the attached permit or the water rights licensing aspects of this project.

Yours truly,

Rob Matthews
Manager
Water Use Licensing Section

cc: S. Wiecek, W.L. Gibbons & Associates Inc.
A. Nagy, AECOM
K. Wiseman, Water Use Licensing Section

Groundwater Exploration Permit

Pursuant to The Water Rights Act

City of Winnipeg

is hereby permitted to construct a water well or wells on the following described lands to explore for groundwater in **SE 6-11-4EPM** for **site assessment** purposes, subject, however, to the following conditions:

1. The permittee must have legal access to the site where the exploration work and project wells are to be located.
2. This Authorization is not transferable or assignable to any other party.
3. Prior to undertaking any work or construction of any works authorized by this permit the permittee is required to retain the services of a hydrogeologist registered with Association of Professional Engineers and Geoscientists of Manitoba, who would be required to:
 - Plan and supervise the drilling of boreholes, test wells, production wells, observation wells and well pump testing as authorized by this permit.
 - Conduct pumping tests on proposed dewatering well(s) in accordance with Form H (attached), for a period of time as deemed necessary by the consulting hydrogeologist.
 - Conduct a recovery test for a period equal to pump test or 90% recovery.
 - Carry out an inventory of private and commercial wells within a 1.0 mile radius of the project well site. The inventory may need to be expanded based on the assessment of the expected area of water level drawdown impact resulting from future pumping.
 - Prepare and submit to the Water Use Licensing Section a technical report on drilling of boreholes and wells, pump testing of well, well inventory and water quality sampling. The report would contain, but not limited to, such things as: well driller's reports for test wells, production wells and observation wells; a plan showing the location of these wells on the property and/or GPS locations of the wells; an analysis of aquifer pumping tests; calculations of storativity and transmissivity; and a description of the amount of water level interference that would be expected to occur at existing local wells that are located within a 1.0 mile radius of the project well site. The report would also indicate if any local wells are expected to be adversely affected by the proposed use of water and where these wells are located. Two copies of the report shall be submitted, one hardcopy and one digital copy.
4. During any pumping tests that may be conducted, pumping must cease immediately if any local water supplies are negatively impacted as a result of the tests. The permittee is also responsible to correct any water supply problems or provide temporary water supply to anyone whose water supplies are negatively impacted as a result of the tests.
5. This permit expires within twelve (12) months of the date of issuance.
6. Please note that diversion of water without a Water Rights Licence or written authorization would constitute a violation of The Water Rights Act and may be subject to enforcement.

Issued at the City of Winnipeg in the Province of Manitoba, this 17th day of July, A.D. 20 13


for The Honourable Minister of Water Stewardship

Requirements for High Capacity Aquifer Pumping Tests to Support Applications for a Water Rights Licence

Manitoba
Conservation
Water Branch

200 Saulteaux Crescent
Winnipeg, Manitoba
R3J 3W3



FLOW RATE

The flow rate should be kept as constant as possible and should be monitored at least every hour during the test. The flow should be monitored by a device such as a standard orifice meter or a weir box capable of reading the rate to within five percent accuracy. Also, it is desirable that the pumping rate be as close to the desired licence pumping rate as conditions permit.

DISPOSAL OF WATER

Water from the pumped well should be disposed of in such a manner as to prevent recirculation to the water bearing zone being tested.

OBSERVATION WELLS

Where the water bearing zone being tested is buried under a substantial thickness of low permeability material, one observation well should be established at a distance from the pumped well equal to twice the thickness of the water bearing zone being tested, but not further than 91 metres.

Where the water bearing zone being tested is not buried under a substantial thickness of low permeability material, two observation wells should be established in the lower part of the water bearing zone being tested, one being 9 to 12 metres from the pumped well and the other being 24 to 30 metres from the pumped well. Preferably both wells should be established in the same direction from the pumped well.

WATER LEVEL READINGS

Timing:

Very careful observation of time is essential to obtaining accurate test data. The water level readings in the pumped and observation well(s) should be measured at the same instant for the first hour of the test and should be measured as close to the same time as possible for the remainder of the pumping time.

During the first ten minutes of the test the water levels should be read every minute. During the next ten minutes water levels should be read every two minutes. Thence, the water levels should be read once every five minutes until the first hour of testing has elapsed. For the next hour, readings should be taken every 15 minutes. Then for the following two hours, the water levels should be recorded once every half hour. Thence, water levels should be recorded once an hour until the test is completed.

Measurement:

The water level measurements within the observation wells should be recorded with engineering or construction type measuring tapes or preferably with electric measuring tapes commonly used in ground-water observation work. The readings in the observation wells should be measured to within 0.3 centimetres accuracy. In the pumping well, water levels should be recorded either with an electric water level measuring taped or with an airline water level measuring device. The readings in the pumping well should be measured to 3.0 centimetres.

DURATION OF THE TESTING

The pumping test should be run at the same continuous pumping rate until equilibrium conditions are reached or for a minimum of 24 hours. Equilibrium conditions exist when the water levels in all observation wells have remained stable for at least six hours. If, at the end of the 24 hours equilibrium conditions have not been reached, the test should continue at the established pumping rate until these conditions are reached; or a total time of 48 hours has elapsed.

OR

The duration of the pumping test may be as otherwise directed by the Director, Water Branch or his Agents.

RECOVERY TEST

Once the pumping interval of the test has been completed, the recovery water levels in the pumping and the observation wells should be recorded in exactly the same manner, particularly with respect to timing of the readings, as the drawdown readings, for a period equal at least to the duration of the pumping test or until the water levels have returned to normal.

GENERAL

The above test work is required in order to assess the functioning of the pumping well and more importantly the capability of the aquifer to sustain the withdrawal rate that has been requested. The data collected will help make sure that a viable water supply system is established prior to proceeding with full scale development. The information will also be available should there be problems with the pumping well in the future. The original data can also be used to assess future aquifer problems.

Appendix D
Test Well Logs

Driller's Report



WELL LOCATION	QTR. <u>SE</u> SEC. <u>6</u> TWP. <u>11</u> RGE. <u>4</u> E1. <u> </u> R. LOT _____ PARISH _____ REMARKS: 0641787 5527946	Location Sketch of Well
WELL OWNER	NAME: City of Winnipeg ADDRESS: PHONE:	
WELL ID.	TW 13-02	
WELL USE	Test Well	
WATER USE	Construction Dewatering	
DATE	12/08/2013	

WELL LOG	Depth Below Ground In Feet		DESCRIPTION	Water Record (Kind of Water)
	From	To		
	0	59	Clay – soft, brown to 25 feet then gray	
	59	61.5	Limestone Rubble – Lost drill returns	
	61.5	81	Limestone – Significant fractures at 64 and 72 feet. Fractured to 72 feet then Competent bedrock	
		81	End of hole	

WELL CONSTRUCTION	Depth Below Ground Level In Feet		CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO. OR INCH	TYPE	MATERIAL	MAKE
	From	To												
	0	62.5	X						8			Sched 40 (Tremied)	PVC	
	0	60				X							Bentonite	
	62.5	81		X					7.5					

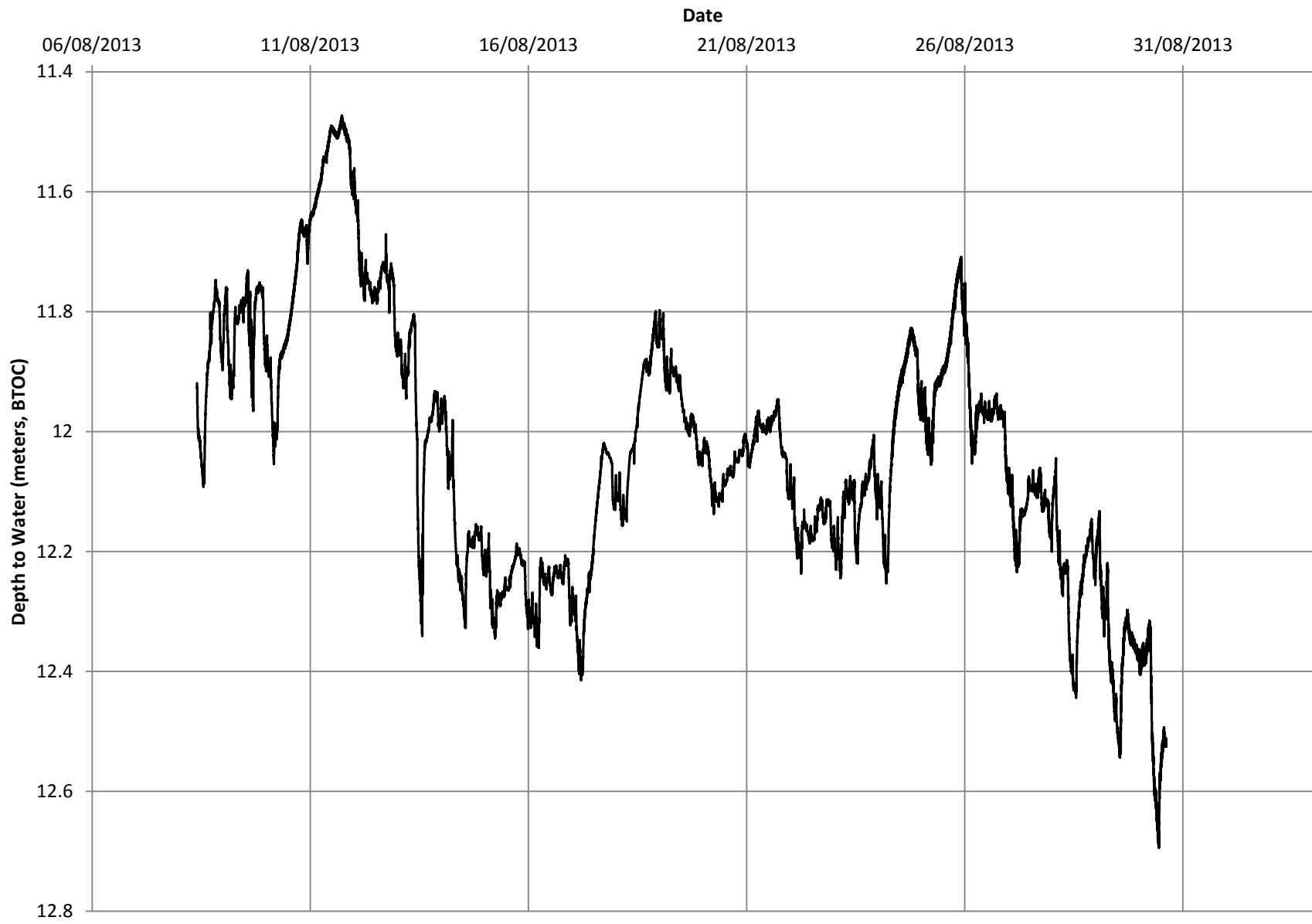
Top Of Casing Or Pitless Adapter: _____ 2 _____ Feet Above X Below _____ Ground Level

Remarks: Test well for Plessis Underpass Lift Station. Drilled on north side of lift station outside potential Shoring limits. Initially completed as a 5 inch test well then reamed to an 8 inch test well.

PUMPING TEST	Date Of Test: (y/mm/d) 2013/08/13	CONTRACTOR	Licence No.:
	Pumping / Flowing Rate: 500 I.G.P.M.		
	Water Level Before Pumping: 37.96 ft. Above _____ Ground		Name: Maple Leaf Drilling
	Below <u>X</u> Level		Address:
	Pumping Level At End Of Test: 40.15 ft. Above _____ Ground		Phone
	Below <u>X</u> Level		Drill Operator: Albert
	Duration Of Test: (Hrs:Min) 3:08		
	Water Temperature: _____ Conductivity: _____		(Signature of Contractor)
Recommended Pumping Rate: With Pump Intake At: _____ ft. Below Ground Level			

Appendix E
Site Monitoring Data

MW D01



TW 13-01

Date/Time

09/08/2013 0:00

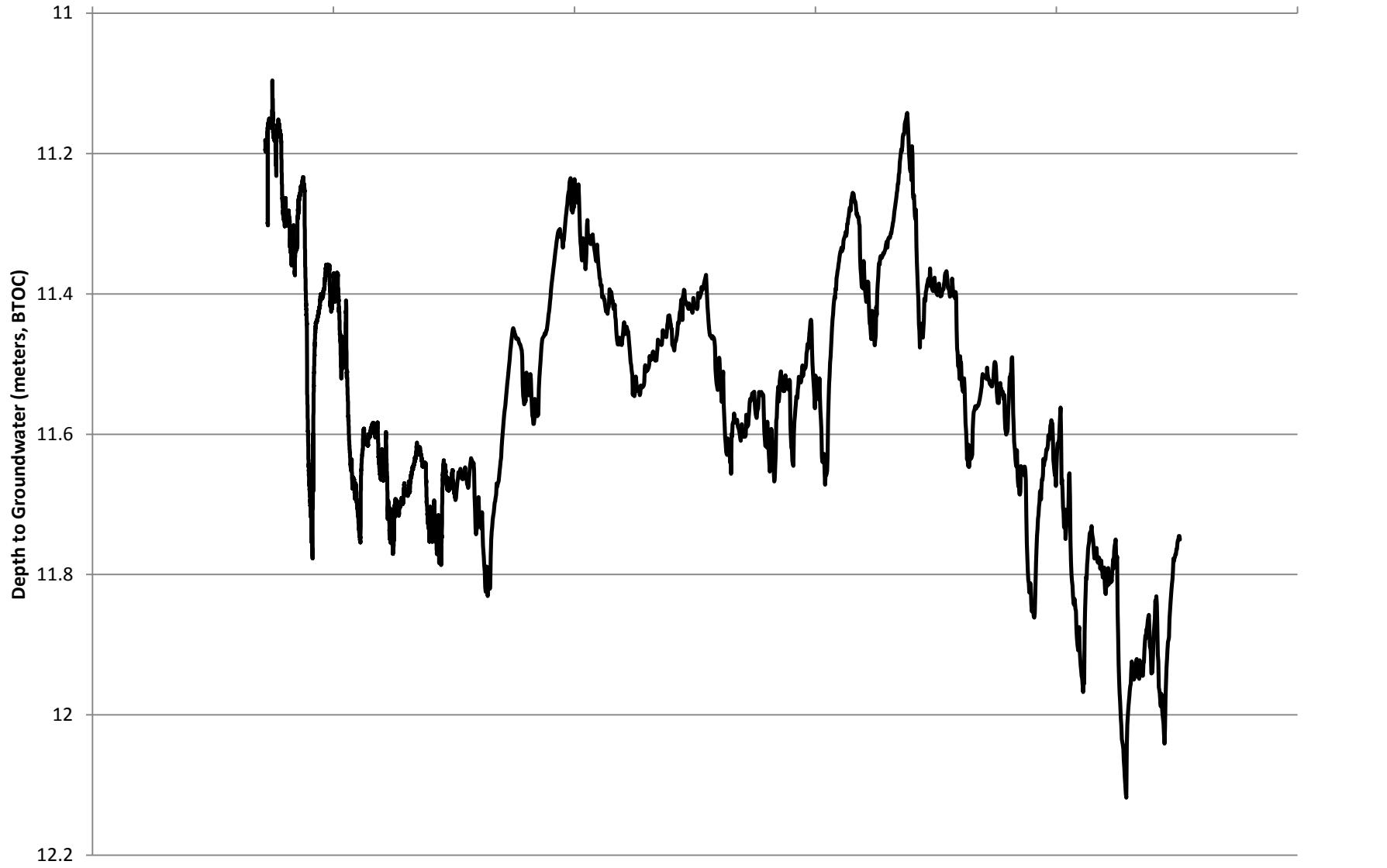
14/08/2013 0:00

19/08/2013 0:00

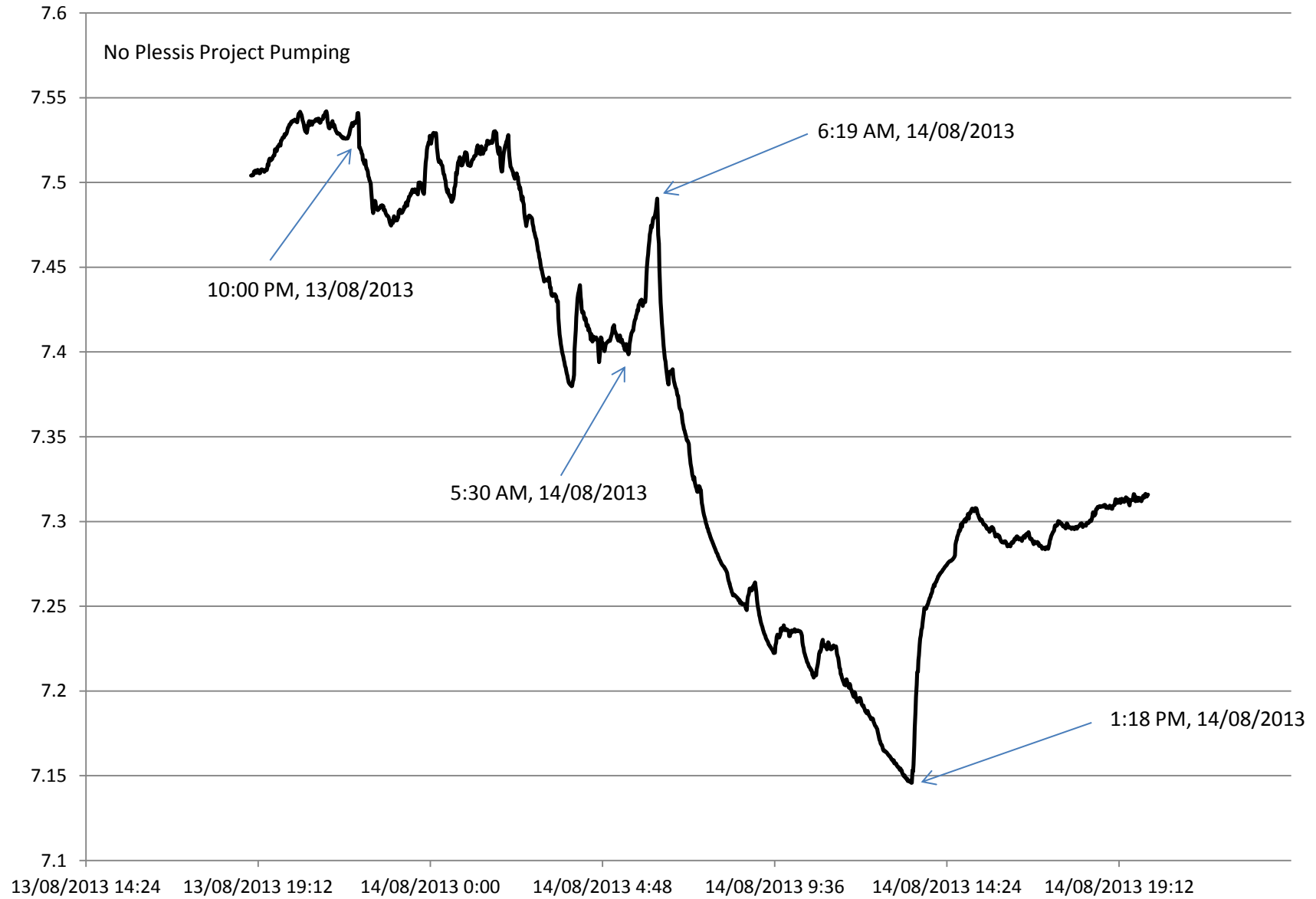
24/08/2013 0:00

29/08/2013 0:00

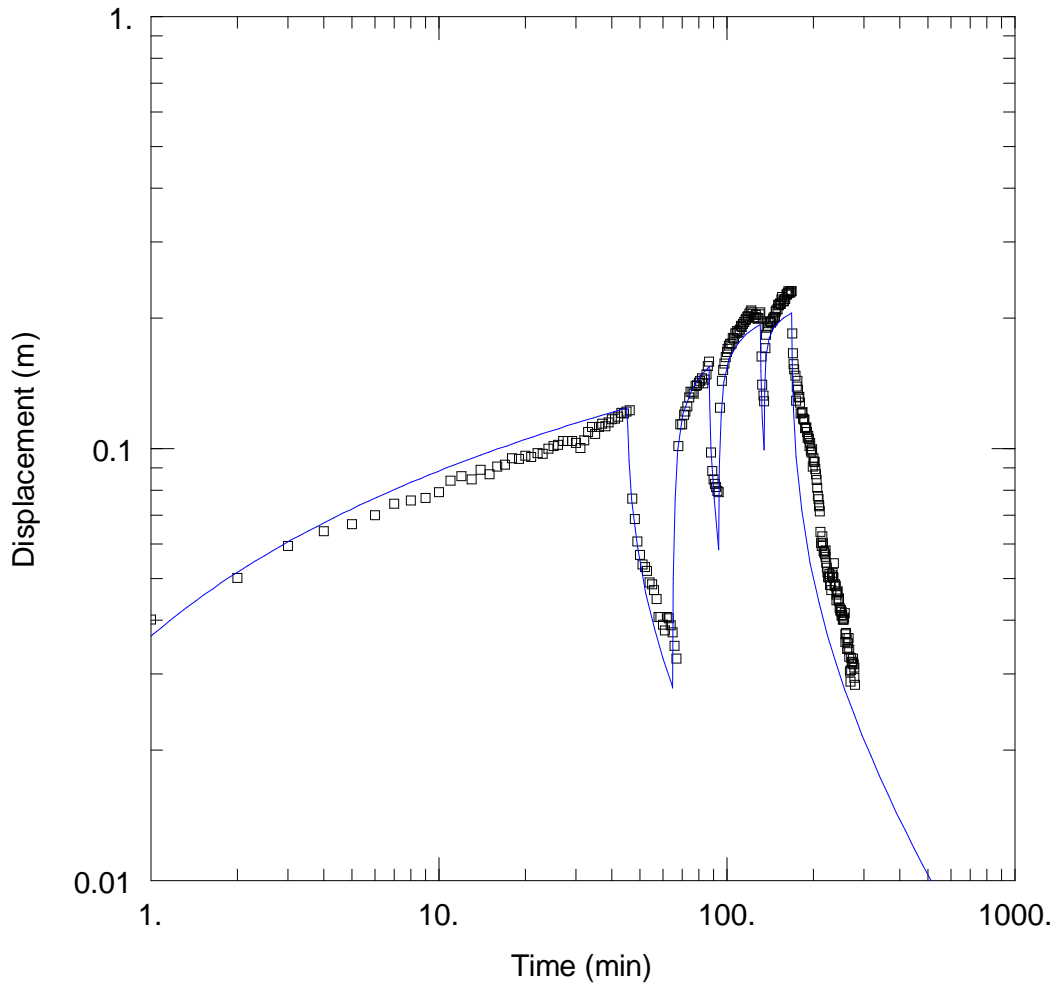
03/09/2013 0:00



Water Levels August 13/14, 2013



Appendix F
Transmissivity Estimates



WELL TEST ANALYSIS

Data Set: C:\Documents and Settings\Steve\Desktop\TW 13-01 MW-D01.aqt
 Date: 09/08/13 Time: 12:40:22

PROJECT INFORMATION

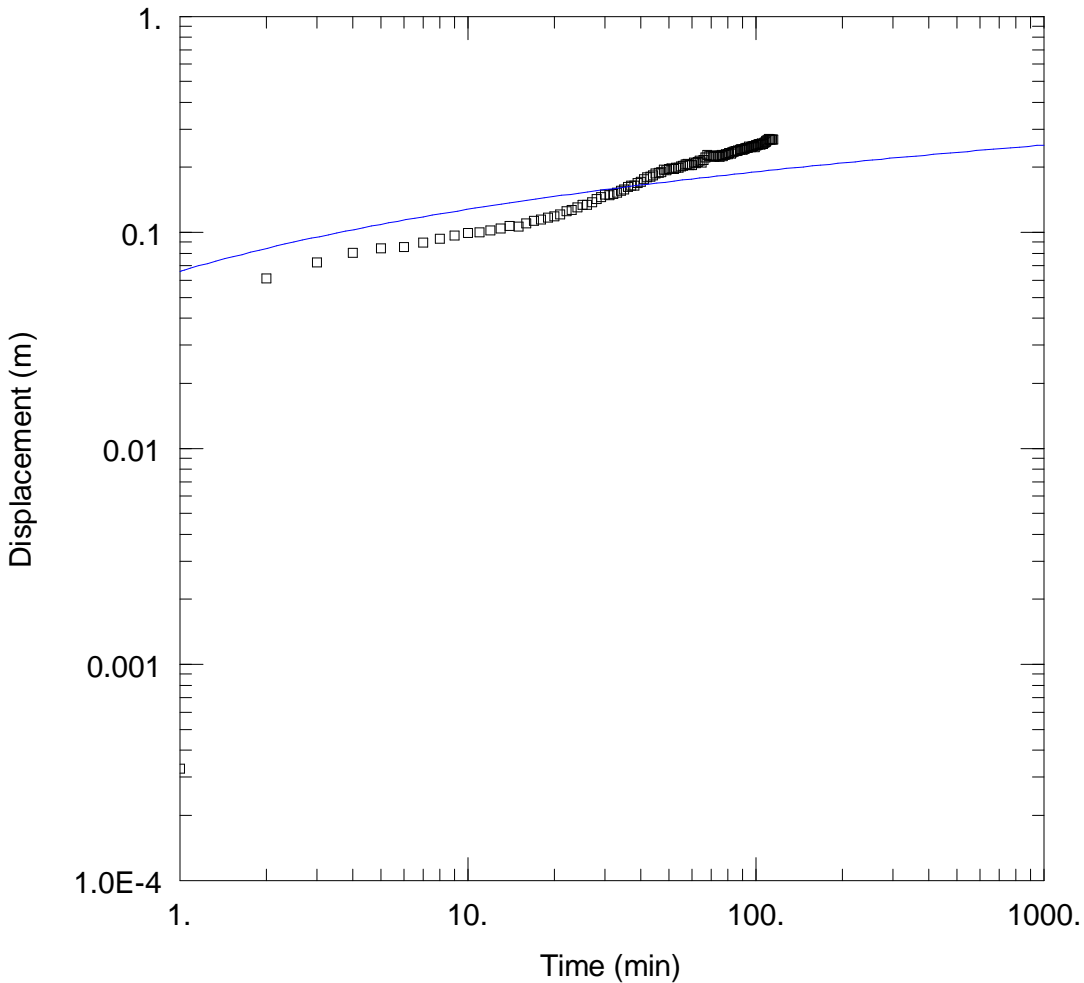
Company: W.L. Gibbons & Associates
 Client: City of Winnipeg
 Project: Plessis Underpass
 Location: Plessis & Dugald
 Test Well: TW 13-01
 Test Date: 09/08/2013

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
TW 13-01	0	0	□ MW D01	56	0

SOLUTION

Aquifer Model: <u>Confined</u>	Solution Method: <u>Theis</u>
T = <u>6.897E+5 gal/day/ft</u>	S = <u>0.001032</u>
Kz/Kr = <u>1.</u>	b = <u>10. m</u>



WELL TEST ANALYSIS

Data Set: C:\Documents and Settings\Steve\Desktop\TW 13-02 MW-D01.aqt
 Date: 09/08/13 Time: 12:40:49

PROJECT INFORMATION

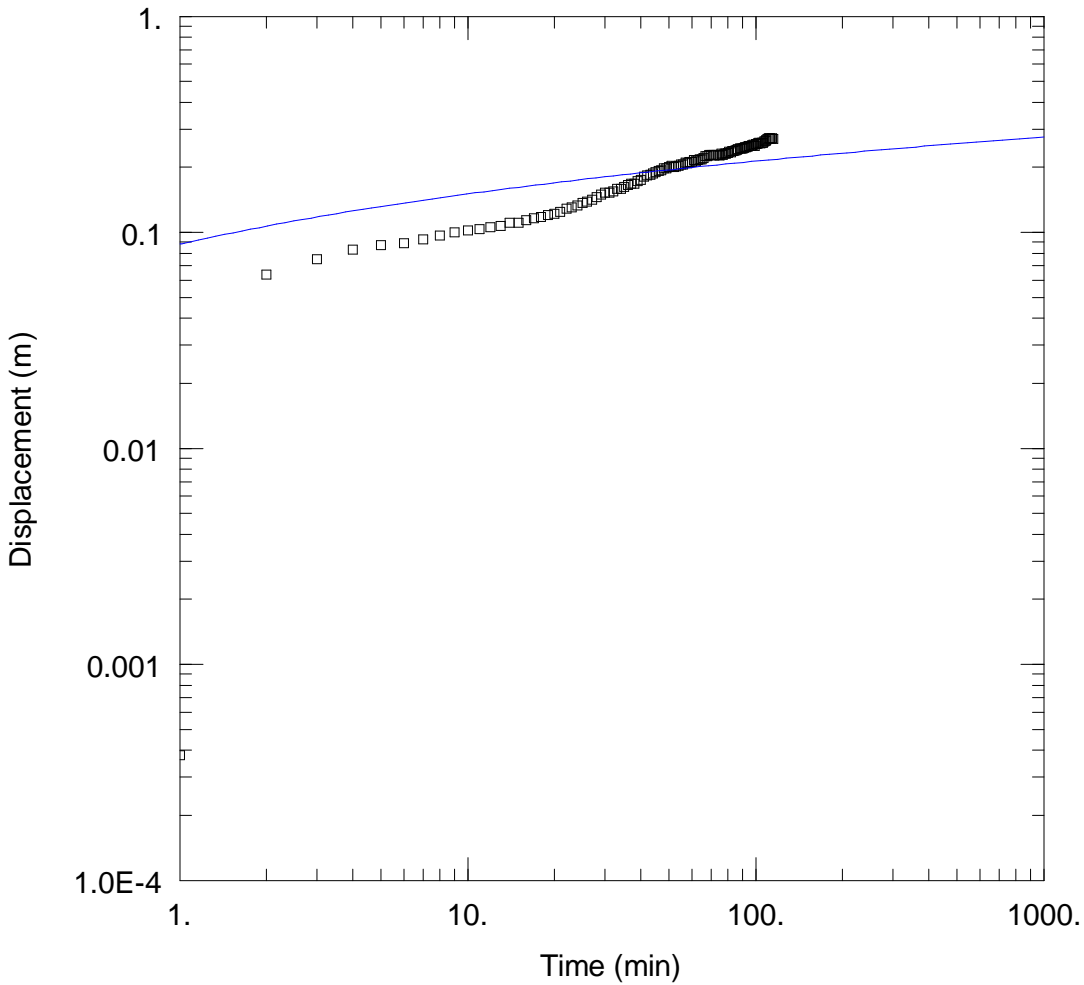
Company: W.L. Gibbons & Associates
 Client: City of Winnipeg
 Project: Plessis Underpass
 Location: Plessis & Dugald
 Test Well: TW 13-02
 Test Date: 13/08/2013

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
TW 13-02	0	0	□ MW D01	35	0

SOLUTION

Aquifer Model: <u>Confined</u>	Solution Method: <u>Theis</u>
T = <u>6.897E+5 gal/day/ft</u>	S = <u>0.001032</u>
Kz/Kr = <u>1.</u>	b = <u>10. m</u>



WELL TEST ANALYSIS

Data Set: C:\Documents and Settings\Steve\Desktop\TW 13-02 TW 13-01.aqt
 Date: 09/08/13 Time: 12:41:12

PROJECT INFORMATION

Company: W.L. Gibbons & Associates
 Client: City of Winnipeg
 Project: Plessis Underpass
 Location: Plessis & Dugald
 Test Well: TW 13-02
 Test Date: 13/08/2013

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
TW 13-02	0	0	□ TW 13-01	23	0

SOLUTION

Aquifer Model: <u>Confined</u>	Solution Method: <u>Theis</u>
T = <u>6.897E+5 gal/day/ft</u>	S = <u>0.001032</u>
Kz/Kr = <u>1.</u>	b = <u>10. m</u>