APPENDIX 6:

WAVERLEY WEST FIRE PARAMEDIC STATION

GEOTECHNICAL REPORT

JUL-18-2025

CITY OF WINNIPEG

Waverley West Fire/Paramedic Station – Geotechnical Engineering Report

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STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This report has been prepared for the City of Winnipeg in accordance with the agreement between KGS Group and the City of Winnipeg (the “Agreement”). This report represents KGS Group’s professional judgment and exercising due care consistent with the preparation of similar reports. The information, data, recommendations and conclusions in this report are subject to the constraints and limitations in the Agreement and the qualifications in this report. This report must be read as a whole, and sections or parts should not be read out of context.

This report is based on information made available to KGS Group by the City of Winnipeg. Unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of these services. The information and conclusions provided in this report apply only as they existed at the time KGS Group’s services were completed.

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Any use a third party makes of this report or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

Geotechnical Investigation Statement of Limitations

The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at the site at the time of drilling. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.

1.0 INTRODUCTION

Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was retained by the City of Winnipeg to provide geotechnical services for the proposed new fire/paramedic station to be constructed within the community of Waverley West. The project site is located immediately southeast of the intersection of Bison Drive and Ruth Crossing in Winnipeg, Manitoba.

This geotechnical report summarizes the findings of the geotechnical investigation as described in the scope of services outlined in KGS Group's proposal titled "Waverley West Fire and Paramedic Station – Winnipeg, Manitoba Proposal for Geotechnical Engineering Services dated March 14, 2025.

The main components of the geotechnical site investigation included:

- A subsurface investigation consisting of two (2) deep test holes advanced to depths ranging from approximately 15.0 to 15.3 m (49.4 to 50.2 ft) below ground surface (BGS) within the footprint of the proposed new fire-paramedic building and four (4) shallow test holes advanced to depths ranging from 3.05 to 6.1 m (10 to 20 ft) within proposed access and parking areas.
- In-situ testing including field Torvane and Standard Penetration Tests completed as appropriate during sampling;
- Two (2) standpipe piezometers installations to monitor stabilized groundwater conditions;
- A laboratory testing including moisture content, particle size analyses and Atterberg limits;
- A comprehensive review and analysis of the findings obtained from the site investigation and laboratory testing program; and
- A geotechnical report (this report) outlining the field and laboratory test results, and geotechnical design recommendations and other construction considerations; and
- A desktop hydrogeological assessment report as attached in Appendix 1.

2.0 PROJECT UNDERSTANDING

The project site is located within a currently undeveloped portion of the community of Waverley West in Winnipeg, Manitoba, and directly west of the existing Pembina Trails Collegiate campus, and south of Bison Drive. KGS Group is familiar with this area having completed previous geotechnical investigations on the adjacent sites of Pembina Trails Collegiate in 2020, and Bison Run School in 2018. KGS Group also completed a phased geotechnical investigation and a long-term groundwater monitoring plan for City of Winnipeg for the proposed South Winnipeg Recreation Centre (SWRC) project which is located directly west of the project site. As a part of the SWRC project, one test hole was drilled within the vicinity of the proposed new fire/ paramedic station. This test hole has been completed 2023 with standpipe piezometer installed and screened within the silt till layer.

Based on the site plan drawings provided by the client as attached in Appendix 2, the proposed new fire/paramedic station will have a footprint area of approximately 948 m^2 (10,200 ft^2). There will be three (3) vehicle bays, a partial basement, and a mezzanine level. It is anticipated that the new building will have a prefabricated steel or timber frame structure with a slab-on-grade floor system. The proposed fire/ paramedic station will also include parking areas and access driveways.

3.0 INVESTIGATION PROGRAM

3.1 Utility Clearance

KGS Group obtained clearances from the public utility companies for underground facilities at the project site before commencing the geotechnical drilling program to determine the approximate position of underground utility lines before any drilling operations commenced.

3.2 Test Hole Drilling and Sampling

A drilling and sampling program was completed on May 20 to 21, 2025, under continuous supervision by KGS Group, while drilling services were provided by Paddock Drilling of Brandon, Manitoba. Drilling was performed using an Acker SS3 track mounted geotechnical drill rig equipped with 125 mm diameter solid stem augers and a Standard Penetration Test (SPT, N-value) safety drop hammer. A total of two (2) deep test holes (TH25-01 and TH25-02) were advanced to power auger refusal at depths ranging from 15.0 to 15.3 m (49.2 to 50.2 ft), and four (4) shallow test holes (TH25-03, TH25-03a, TH25-04, and TH25-05) with depths ranging from 3.05 to 6.1 m (10 to 20 ft) were also completed. The completed test hole locations are shown in Table 1 for reference.

Representative soil samples were obtained from the test holes at 0.75 to 1.5 m (2.5 to 5 ft) intervals or at any change in soil strata. Soil samples were collected directly off the auger, or from a split spoon sampler, and visually classified in the field in general accordance with the modified Unified Soil Classification System (USCS). The SPTs were completed in non-cohesive materials strata to assess relative density, while handheld Torvane tests were conducted on cohesive soils to assess the undrained shear strength. Test holes were backfilled with auger cuttings and bentonite chips to the surface.

Two (2) 50 mm diameter standpipe piezometer was installed within test hole TH25-03a and TH25-05, with a tip embedment depth of 3.05 m (10 ft) and 4.57 m (15 ft) BGS, respectively, such that the piezometers are screened within the lean clay seepage layer.

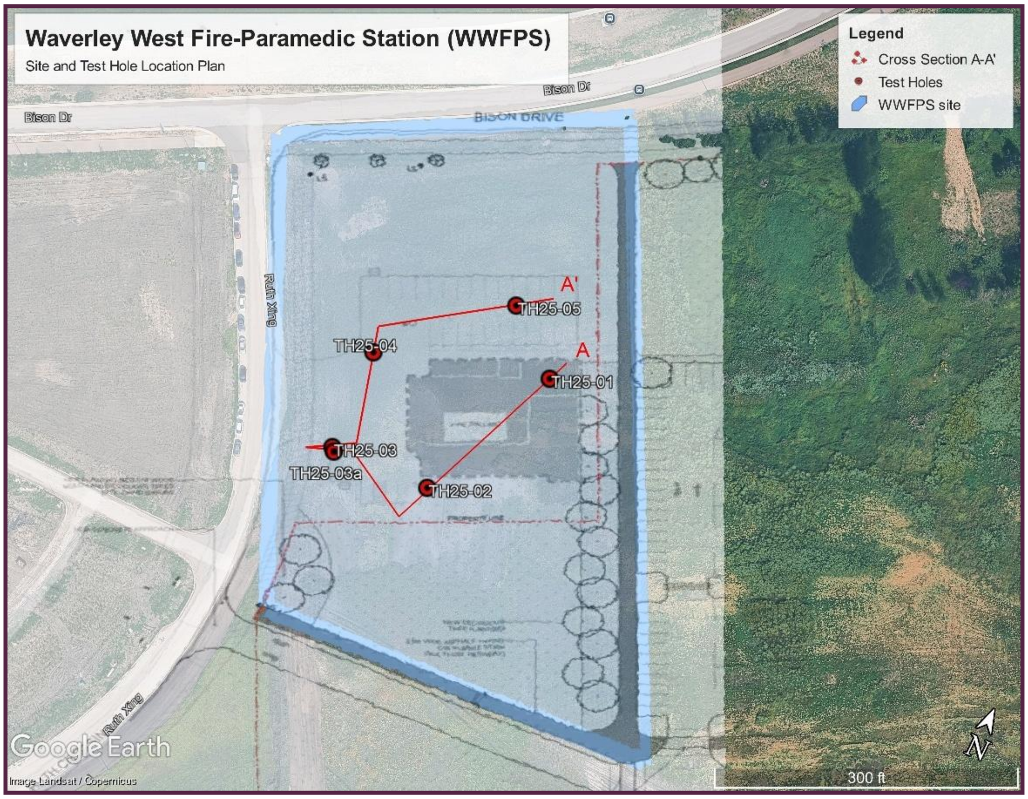
The UTM coordinates and ground surface elevations were collected using a Trimble Catalyst GPS unit with an accuracy of ±10 cm and are listed below in Table 1. The test hole location is shown in Figure 1 below.

TABLE 1: SUMMARY OF TEST HOLE LOCATIONS

Test Hole ID	Location	UTM Coordinates[1]		Surface Elevation (m)	Depth BGS (m)
		Northing (m)	Easting (m)		
TH25-01	Southwest corner of the proposed building	5,517,616.0	630,454.6	232.03	15.30
TH25-02	Northeast corner of the proposed building	5,517,570.8	630,436.7	232.25	15.10
TH25-03	Site access off Ruth Crossing	5,517,568.5	630,405.7	232.27	6.10
TH25-03a	Site access off Ruth Crossing	5,517,567.5	630,406.1	232.37	3.05
TH25-04	West end side of the proposed parking lot	5,517,599.3	630,403.4	232.20	3.05
TH25-05	East end side of the proposed parking lot	5,517,631.2	630,435.9	232.17	4.57

Note: Test hole coordinates and elevations were collected with a Trimble Catalyst GPS unit with an accuracy of ±10 cm.

FIGURE 1: TEST HOLE LOCATION PLAN



3.3 Laboratory Testing

Laboratory tests were completed on representative soil samples to assess index properties for correlation to relevant engineering properties. Testing was completed in Winnipeg, Manitoba at a certified laboratory by the Canadian Council of Independent Laboratories (CCiL). The testing included 32 moisture contents, three (3) Atterberg limits, and two (2) particle size analyses. Laboratory test results are included on the summary test hole logs and laboratory test reports provided in Appendix 3 and Appendix 4, respectively.

4.0 STRATIGRAPHY AND GROUNDWATER

4.1 Stratigraphy

In general, the soil stratigraphy across the subject site consisted of surficial layers of topsoil and lean clay, overlying a deep deposit of high plastic clay, overlying silt till. A detailed description of the soil stratigraphy encountered at the project site is provided below. Summary test hole logs and a fence diagram of the soil conditions profiles are provided in Appendix 3.

Topsoil – A layer of topsoil was encountered at the surface of each test hole and ranged in thickness from 152 to 229 mm (6 to 9 in). Topsoil was generally observed to be black, dry to damp and contained some rootlets.

Clay (CL) – A layer of low plasticity clay was encountered beneath the topsoil in test holes TH25-04 and TH25-05 at approximate depth of 0.2 m (0.7 ft) and extended to depths 1.5 and 2.1 m (5 and 7 ft) BGS, respectively. Based on the observation, the clay was grey to light brown in colour, damp to wet, and contained varying amounts of silt and sand. The undrained shear strength of the clay ranged from 15 to 90 kPa classifying the clay as soft to stiff in consistency.

One (1) Atterberg limit test was completed on the clay layer indicating a Liquid Limit (LL) of 26, a Plasticity Limit (PL) of 17, and a Plasticity Index (PI) of 9, classifying the clay as low plasticity. One (1) particle size analysis was completed on clay layer indicating 0% gravel, 10% sand, 77% silt, and 13% clay. The moisture content of the clay ranged from 22 to 35 % based on five (5) tests.

Clay (CH) – High plasticity clay was encountered below the topsoil layer in test holes TH25-01 to TH25-03a and extended to approximate depths ranging from 3.0 to 12.8 m (10 to 42 ft) m BGS. In test holes TH25-04 to TH25-05, high plasticity clay layer was encountered underneath the low plasticity clay layer. The high plastic clay was grey to mottled grey/brown in colour, damp to wet, and contained trace to some silt and sand at depth. The undrained shear strength of the clay was assessed with a handheld Torvane and ranged from 30 to 90 kPa classifying the clay as firm to stiff in consistency.

Two (2) Atterberg limits were completed on select samples of the clay with the results for LL of 92 on both, PL ranging from 37 to 38, and PI of 58 to 59, classifying the clay as high plasticity fat clay. One (1) particle size analysis was completed on clay layer indicating 0% gravel, 0% sand, 25% silt, and 75% clay. The moisture content of the clay ranged from 21 to 65 % based on twenty-three tests.

Silt Till – Silt till was encountered beneath the high plasticity clay in test holes TH25-01 and TH25-02 and extended to the depths explored within the test holes of 15.3 m (50.3 ft) and 15.0 m (49.4 ft) BGS, respectively. The silt till was light grey in colour, moist to wet, and contained fine to coarse grained sand, gravel, and some clay.

Four (4) SPTs were completed within the silt till indicating uncorrected N-values ranging 80 to 100+ blows, classifying the silt till as hard in consistency. The moisture content of the silt till ranged from 8 to 10% based on four (4) tests.

4.2 Groundwater and Sloughing Conditions

Groundwater seepage and soil sloughing conditions were recorded during and upon completion of drilling for each test hole. The groundwater seepage and soil sloughing conditions observed within the completed test holes, and the standpipe piezometer reading (May 21, 2025) are summarized in Table 2 below.

TABLE 2: OBSERVED GROUNDWATER AND SLOUGHING CONDITIONS

Test Hole ID	Test Hole Depth (m)	Observed Water Depth During Drilling (m)	Depth of Water Upon Completion of Drilling (m)	Observed Sloughing Conditions Upon Completion
TH25-01	15.30	11.89	Unknown due to squeezing	Squeezing encountered at approximately 9.15 m upon completion of drilling.
TH25-02	15.00	13.72	11.28	Squeezing encountered at approximately 6.71 m upon completion of drilling.
TH25-03	6.10	Dry	Dry	Test hole remained open to 6.1 m upon completion of drilling.
TH25-03a	3.05	Dry	Dry (Piezometer Reading on May 21, 2025)	Test hole remained open to 3.0 m upon completion of drilling.
TH25-04	3.05	1.37	Unknown due to caving	Test hole caved to 1.4 m upon completion of drilling.
TH25-05	4.57	1.52	3.08 (Piezometer Reading on May 21, 2025)	Test hole remained open to 4.6 m upon completion of drilling.

Groundwater levels will fluctuate seasonally and following precipitation events; as such, the actual groundwater level at the time of construction could differ from the conditions observed on-site during the drilling investigation. The foundation contractor should consider reading the water level within the installed standpipes to assess groundwater levels prior to construction.

4.3 Groundwater Monitoring

During the geotechnical investigation, standpipes were installed in TH25-03a and TH25-05 to facilitate groundwater monitoring. The first piezometer was installed in test hole TH25-03a as it was located furthest way from the existing standpipe which was installed during the investigation for the South Winnipeg Recreation Campus. This piezometer was screened within the underlying clay (CH) material such that the screen portion was embedded from 1.52 to 3.05 m (5 to 10 ft) BGS. Test hole TH25-03a was backfilled with filter sand to 1.22 m (4 ft) BGS and the remaining depth was backfilled with bentonite. Above-ground protective cover was installed upon completion of the test hole TH25-03a.

An additional piezometer was installed in TH25-05 as the seepage volume was observed to be greater than that overved in TH25-03a. The piezometer in TH25-05 was screened between 3.05 to 4.57 m (5 to 10 ft) BGS. Test hole TH25-05 was backfilled with filter sand to 0.91 m (3 ft) BGS to allow the lean clay seepage layer to be hydraulically connected to the standpipe, and the remaining depth was backfilled with bentonite seal. A protective well cover was not provided at the surface in TH25-05 as only one (1) standpipe piezometer installation was anticipated prior mobilization. Since installation, the standpipe piezometers have been read twice and the groundwater conditions observed within the completed test hole are summarized in Table 3.

TABLE 3:SUMMARY OF STANDPIPE PIEZOMETER READINGS

Test Hole ID	Screened Material Type	Screened Interval (m)	Reading Date	Recorded Depth to Groundwater (m)	Recorded Groundwater Elevation
TH25-03a	Clay (CH)	1.52 – 3.05	May 21, 2025	Dry	NA
			June 13, 2025	2.98	229.39
TH25-05	Clay (CH)	3.05 – 4.57	May 21, 2025	3.08	229.09
			June 13, 2025	1.65	230.52

Based on the readings above, the groundwater in TH25-05 has raised by an approximate 1.4 m (4.6 ft) from 3.08 m BGS on May 21 to 1.65 m BGS on June 13. In TH25-03a, groundwater level was dry on May 21 and recorded at a depth of 2.98 m on June 13, 2025.

Groundwater levels will fluctuate seasonally and following precipitation events; as such, the actual groundwater level at the time of construction could differ from the conditions observed on-site during the drilling investigation. The scope of services for this project did not include a long-term piezometer monitoring program. It is recommended that the groundwater level within the installed standpipes in TH25-03a and TH25-05 be measured prior to construction to allow the contractor to quantify groundwater conditions expected at the project site during construction.

4.4 Potential Difficult Ground Conditions

Groundwater seepage and soil sloughing should be anticipated when advancing excavations or drilled shafts into the upper lean clay and underlying silt till materials. Shallow excavations will need to be appropriately shored to prevent soil sloughing, and drilled shafts will require full length steel sleeves to retain the sloughing soils and control groundwater seepage. Where if groundwater seepage can not be adequately controlled using pumps for concrete placement, placement of concrete using tremie methods may be required.

Cobbles and boulders, although not encountered during our drilling investigation, are known to be present within the silt till layer and may prevent driven piles from achieving the necessary embedment depth. Cobbles and boulders must be removed if encountered during advancement of drilled shafts for cast-in-place piles. Additionally, cobbles and boulders can cause damage to the piles during driving. Boulders within the silt till may also prevent the advancement of helical piles and have the potential to damage helical piles.

Lean clay (CL) was encountered in TH25-04 and TH25-05 between depths approximately 0.152 to 1.4 m BGS. This lean clay (CL) was silty and not considered suitable for the support of foundations, parking lots, roadways or sidewalks. If soft materials such as organics, silt, silty clay, or saturated clays are encountered at the prepared subgrade elevation these materials should be removed and replaced with compacted granular fill. Recommendation on how to remove and replace soft material beneath mat slabs, soil supported floor slabs, and pavement sections are provided in this report.

Based on the collected standpipe readings, groundwater seepage should be expected from the upper lean clay and upper fat clay layer when advancing excavations or drilled shafts. Contractors should anticipate groundwater seepage and soil sloughing while advancing excavations or drilled shafts and should be prepared to control seepage and sloughing with the use of pumps or steel sleeves.

5.0 FOUNDATION RECOMMENDATIONS

5.1 Limit States Design

The foundation considerations described in this report follow Limit State Design (LSD) guidelines. Limit State Design requires consideration of two (2) main loading states: Ultimate Limit State (ULS) and Serviceability Limit State (SLS). The ULS are primarily concerned with the collapse mechanisms of the structure and safety, and the SLS present conditions or mechanisms that restrict or constrain the intended use, function, or occupancy of the structure under expected service or working loads.

Design parameters listed in the following tables present the unfactored ULS design values and represent nominal (ultimate) geotechnical resistance, R_n. The appropriate geotechnical resistance factors (Φ) should be applied to determine the factored geotechnical resistance as presented in the following equation:

$$\Phi R_n \geq \Sigma \alpha_i S_{ni}$$

where:

Φ – geotechnical resistance factor

R_n – nominal (ultimate) geotechnical resistance

$\Sigma \alpha_i S_{ni}$ – summation of the factored overall load effects for a given load combination

The soil design parameters have been estimated based on the site investigation and correlations to engineering properties. The interpreted stratigraphy should be verified during the installation of the building foundations. KGS Group should be notified if conditions vary from what is described in this report so, if necessary, the foundation design can be modified based on the observed change of conditions.

5.2 Cast-In-Place Concrete Piles

The estimated LSD parameters to design end-bearing cast-in-place (CIP) or continuous flight auger (CFA) piles on very dense silt till are provided in Table 4. End-bearing piles should be designed to support loads by end-bearing resistance only with no contribution from shaft friction. End-bearing piles should be inspected by qualified geotechnical personnel during installation to confirm the piles are founded on suitable very dense silt till. The SLS capacity of an end bearing pile on very dense silt till is not provided as settlement of end bearing piles on very dense silt till is expected to be less than 25 mm therefore ULS capacity governs. A geotechnical resistance factor of 0.4 should be applied to the ULS values shown in Table 4 to determine the factored geotechnical resistance in axial compression.

TABLE 4: END-BEARING PILE DESIGN PARAMETERS

Material Type	Unfactored ULS Capacity (kPa)
End-bearing in very dense silt till, with estimated minimum pile embedment depth of 15.0 m	750

5.2.1 ADDITIONAL CIP AND CFA PILE RECOMMENDATIONS

Additional CIP and CFA pile recommendations are provided below:

- The spacing between adjacent piles should be a minimum of three-pile diameters center to center. If closer pile spacings are required, KGS Group can review the specific configuration and whether a reduction in capacity is required due to group effects.
- Due to potential groundwater seepage and soil sloughing from the upper lean clay and underling silt till, full-length temporary steel sleeves and pumps should be used as required during installation of piles to maintain the integrity of the shaft excavation and remove groundwater. Where groundwater seepage cannot be adequately controlled using pumps, placement of concrete using tremie methods may be required.
- To resist tensile forces from frost action acting on piles (frost jacking), all concrete piles shall be reinforced their entire length and be designed by an experienced structural engineer and have a minimum embedment length of 8 m.
- If pile foundations are used for unheated structures, a poly wrapped and greased Sonotube should be placed around the upper 2.5 m of the pile shaft to protect against frost jacking.
- All concrete piles should utilize CSA Type HS sulphate resistant cement.
- The reinforcement and concrete must be placed immediately following the drilling and inspection of each pile shaft to prevent disturbance to the foundation soil during subsequent construction activity. Where this is not possible on the day of drilling, the pile hole should be refilled and later redrilled once concrete is ready to be placed. Groundwater should be removed from the pile hole prior to pouring the concrete. Where this is not possible tremie methods may be required. At all times during removal of the steel sleeve, a head of concrete shall be maintained sufficiently above the sleeve bottom to limit sloughing and seepage into the pile excavation.
- Detailed construction records and full-time inspection by experienced geotechnical personnel is recommended throughout construction of foundations to verify the soil and encountered conditions are consistent with the findings of this investigation, and that piles are installed according to the project specifications and meet the intent of the geotechnical design.

5.3 Driven Piles

Driven pile capacities were developed based on the soil profile strength parameters and static analysis of the pile section in the GRL Wave Equation Analysis of Piles (GRLWEAP) program. Design capacities are listed for prestressed precast concrete or steel H-piles driven to refusal in silt till. Pile lengths may vary as pockets of cobbles and boulders are known to exist in till which could result in variable pile refusal depth.

5.3.1 DRIVEN STEEL H-PILES

Driven steel H-piles may be used to support the proposed new fire/paramedic station building. The LSD capacities for driven steel piles advanced to refusal in very dense silt till are presented in the table below. The H-pile sections listed are common for this application. A geotechnical resistance factor (Φ) of 0.4 should be applied to the unfactored ULS values provided in Table 5. SLS capacities for steel H-piles driven to refusal are not provided as settlement of piles end-bearing on very dense till is expected to be less than 25 mm, therefore, ULS will govern the design. Capacities for additional pile sections can be provided upon request.

TABLE 5: DRIVEN STEEL H-PILE CAPACITIES

Estimated Minimum Pile Embedment Depth (m)	Pile Type / Section	Unfactored ULS Values (kN)
15.0	HP250x85	900
	HP310x79	1,150

Based on the results of the geotechnical investigation, power auger refusal was encountered in silt till between depths ranging from 15.0 to 15.3 m (49.2 to 50.2 ft). It should be anticipated that actual pile tip elevations can vary depending on localized till conditions. KGS Group should be contacted to determine the final refusal criteria once required pile capacities, piles size, and hammer energy have been determined and prior to mobilizing equipment to site.

Pre-boring approximately 3 m below grade is recommended to allow for standing of the piles, ease of setting, pile plumbness / alignment and to reduce potential ground heave in large pile groups. If significant squeezing or sloughing of the bore hole occurs during pre-boring, then the pre-boring depth may be reduced accordingly. Vibration monitoring of the adjacent buildings should be completed during pile driving. Additional pre-boring will be required if monitored vibrations are above acceptable levels, as determined by the structural engineer.

Steel piles equipped with pile shoes can protect the pile from damage if cobbles and boulders in the till layer are encounter during pile driving. Driving stresses should not exceed 90% of the nominal yield stress of the steel (F_y). As a minimum, steel piles should meet the requirements of CAN/CSA-G40.20/G40.21, Grade 350 W. The piles should be free from protrusions which could create voids in the soil around the pile during driving. Piles driven within five-pile diameters of each other should be monitored for heave. If heave occurs, these piles should be re-driven to refusal.

5.3.2 DRIVEN PRESTRESSED PRECAST CONCRETE PILES

Prestressed precast concrete piles driven to practical refusal and bearing in the silt till may be used to support the new fire/paramedic station building, designed using the estimated unfactored ULS and SLS pile capacities when driven to practical refusal as listed below. A geotechnical resistance factor (Φ) of 0.4 should be applied to the unfactored ULS values provided in Table 6. It is anticipated that practical pile refusal will be achieved at a depth of approximately 15.0 to 15.5 m below existing grade.

TABLE 6: DRIVEN PRECAST CONCRETE PILE CAPACITIES

Pile Diameter (mm)	SLS Values (kN)	Unfactored ULS Values (kN)	Refusal Criteria[1] (blows/25 mm)
300	445	1,400	5
350	625	1,960	8
400	800	2,400	12

Notes:

1) Piles should be driven to the criteria listed above for the (3) consecutive sets of 25 mm or less. If higher energies or other hammers types are used from that indicated below, they should be evaluated to ensure that piles are not overstressed and to determine an appropriate refusal criterion.

Pile penetration depths will vary depending on localized till conditions and the presence of cobbles and boulders. Two (2) test holes were advanced to power auger refusal in silt till at depths ranging from 15.0 to 15.3 m (49.2 to 50.2 ft). The final selection of driven prestressed precast concrete pile lengths will be the responsibility of the piling contractor using the available test hole information provided in this report.

Pre-boring approximately 3 m below grade should allow for standing of the piles, enhance pile plumbness/alignment, reduce potential ground heave in large pile groups and reduce vibrations induced on the adjacent buildings. Vibration monitoring of the adjacent buildings should be completed during pile driving. Additional pre-boring will be required if monitored vibrations are above acceptable levels, as determined by the structural engineer.

If significant squeezing or sloughing of the bore hole occurs during pre-boring, the pre-boring depth may be reduced accordingly. Piles driven within five-pile diameters of each other should be monitored for heave. If heave occurs, these piles should be re-driven to refusal. Careful attention will be required during driving, especially as the pile tip approaches the dense silt till, to ensure practical refusal has been achieved with the proper hammer energy, while avoiding overdriving that would damage the pile.

Designers should consider that the tensile strength of these precast piles is limited, and their ability to withstand bending is minimal.

5.3.3 ADDITIONAL DRIVEN PILE RECOMMENDATIONS

Additional driven pile recommendations are provided below:

- The spacing between adjacent piles should be a minimum of three-pile diameters center to center. If closer pile spacings are required, KGS Group can review the pile group configuration and whether a reduction in capacity is required.
- All piles driven within five (5) pile diameters of one another should be monitored for heave and where heave is observed the piles should be re-driven to confirm the specified refusal criteria.
- The noted unfactored ULS capacities pertain to geotechnical resistance only. The pile cross-sections must be designed to withstand the design loads, handling stresses and the driving forces during installation.

- Diesel hammers with a maximum energy rating of 45 to 70 kN-m (33 to 52 kip-ft) may be required to install the above pile sections to planned depth. Final drive criteria (set) can be provided once the driving hammer and the maximum energy requirement of a hydraulic hammer will be less.
- During the final set, piles should be driven continuously once driving is initiated to the required refusal criteria.
- A steel follower should not be used for driving of steel piles.
- The impacts of vibration from pile driving and its potential effects on the neighboring structures should be evaluated and monitored during driving. Appropriate mitigation measures, such as home inspections both before and after pile driving activities, should be put in place to avoid damage to the neighboring structures.
- Piles that will be exposed to frost should have a minimum embedment length of 8 m to resist frost jacking.
- A minimum 150 mm void form should be used below all grade beams and pile caps to protect against potential uplift from frost heave.
- Detailed construction records and full-time inspection by experienced geotechnical personnel is recommended throughout construction of foundations to confirm that piles are installed according to the project specifications and meet the intent of the geotechnical design.
- The uplift capacity of driven piles can be determined by applying a geotechnical resistance factor (Φ) of 0.3 to the skin friction design values provided in Table 7, plus the self-weight of the pile.

TABLE 7: SKIN FRICTION DESIGN VALUES

Pile Type / Section	Unfactored ULS Values (kN)
300 hex,	540
350 hex,	630
400 hex,	720
HP250x85,	590
HP310x79,	690

5.4 Helical Screw Piles

A helical pile foundation is a proprietary system and the final design including the helix configuration, required installation torque and the associated loads that can be achieved, are generally established by each installer. Helical piles can be configured with multiple helices to achieve capacity at shallower depths if desired, or advanced to a target bearing stratum. Helical piles can typically be installed using available hydraulic equipment when equipped with an appropriate drive head attachment. A helical pile manufacturer with support engineering services should be contacted to provide recommendations for pile configuration and design capacities. There are numerous helical pile installers in the region and pile configurations and specifications will vary.

Helical piles typically have a smaller shaft diameter and a large diameter helix bearing plate(s) and need to be installed a fair distance away from existing structures such that helix bearing plate does not damage structures or existing foundations as it is advanced. Additionally, there should be sufficient spacing between existing foundations at the final depth of the helix bearing plates(s) generally assumed to be three-times the diameter of the largest foundation element.

Cobbles and boulders were not encountered during the drilling investigation however, if encountered, cobbles and boulders have potential to obstruct helical pile installations preventing the pile from achieving the minimum required embedment depth, required torque, or may damage the piles helices during installation.

In all cases, helical pile design and installation should consider the following:

- The ULS capacity of the pile will be governed by the manufacturer’s specified maximum capacity for piles in compression and consider the pile shaft, helix bearing plate and the plate’s connection to the shaft, pile extension joints, and any structural connections or brackets.
- The required installation torque to achieve the required pile capacity is to be provided by the helical pile manufacturer/designer. Generally, piles are installed to a “refusal” torque which should not exceed the manufacture’s maximum torque rating.
- If abrupt refusal on cobbles/boulders is encountered the helical pile installer should avoid “flat spinning” of the pile. Continuing to rotate the pile without downward advancement will result in excessive disturbance of the soil near the pile tip and significantly reduce the capacity of the pile
- The helical plate shall be normal to the central shaft (within 3º) over its entire length.
- During installation, the torque applied to the helical pile should be continuously monitored by experienced geotechnical personnel to avoid pile damage, monitor subsurface soil consistency and to verify final installation torque. The final installation torque should be recorded for each pile installed.
- Spacing of the helical piles should be determined by the helical pile designer, and the specific arrangement of helical piles should consider potential reduction in capacity related to group effects.
- Piles should be designed in accordance with appropriate geotechnical engineering principles pertaining to a helical pile foundation.
- A minimum 150 mm void form should be used below all grade beams and pile caps to protect against potential uplift from frost heave.
- The design of helical piles for protection from frost related movements is the responsibility of the helical pile designer who is ultimately responsible for the final helical pile foundation system design.

5.5 Mat Foundation

If some movement can be tolerated lightly to moderately loaded structures may be supported on a shallow mat foundation founded on compacted granular fill overlying firm to stiff high plasticity clay. Mat foundations will experience differential movements associated with variations in moisture content and frost related movements. While some movements will likely occur over time, a uniformly prepared subgrade will reduce post-construction differential movement.

To limit frost related movements, mat foundations should be constructed on non-frost susceptible granular materials extending to the depth of frost penetration (2.5 m) below the final exterior graded surface. The non-frost susceptible fill should extend horizontally a minimum of 600 mm (2 ft) beyond the edges of the concrete pad and contain less than 5% fines (silt and clay) content. Rigid insulation should be installed to further reduce the potential for frost penetration below mat foundations supported on non-frost susceptible granular fill. If some movement can be tolerated, partial removal and replacement of 2/3 the depth of the frost zone (1.7 m) with non-frost susceptible granular fill can be considered.

Due to the expected presence of the high plasticity clay (frost susceptible soil) layer at the subgrade elevation, as encountered during the geotechnical drilling investigation, it is recommended that a layer of geotextile (Titan TE-6 or equivalent) and bi-axial geogrid (Titan Earth Grid 15 or equivalent) be placed over the subgrade materials as separator and reinforcement.

Typically, the coefficient of subgrade reaction is required for a mat foundation design. The estimated vertical modulus of subgrade reaction, based on the findings of the geotechnical investigation and recommendations from the Canadian Foundation Engineering Manual, is presented in Table 8 below.

TABLE 8: MODULUS OF SUBGRADE REACTION

Supporting Soil Type	Vertical Modulus of Subgrade Reaction, k_{v1} (MPa/m)1
Clay (CH)	10

Note 1: k_{v1} is for 1 ft (0.3 m) x 1 ft (0.3 m) plate, Modulus for actual footing with width of b and length of m, k_{vb} = (kv1/b)*((m + 0.15)/(1.5m)), where b and m are provided in meters.

The following support preparations should be completed for this option:

- Sub-excavate the frost susceptible clay as required to the subgrade design elevation, recommended 1.7 to 2.5 m below existing ground surface for some movements and no movement tolerance conditions respectively. The exposed native subgrade should be proof rolled with heavy wheeled equipment to detect soft areas. Soft areas should be over-excavated, a minimum of 600 mm and replaced with base or subbase materials compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD) near optimum moisture.
- Excavation and placement of granular fill should extend horizontally, a minimum of 600 mm (2 ft) beyond the concrete slab edges.
- Once the bottom of excavation is exposed, the native subgrade surface should be examined and approved by qualified geotechnical personnel, prior to placing geotextile, geogrid, and granular fill materials. Bearing soils that become frozen, dried, or softened should be removed and replaced with granular base course material compacted to 98% SPMDD.
- The contractor must make a conscious effort to protect the finished subgrade surface from getting wet and direct runoff away from the excavation.
- KGS Group should be contacted if a significant amount of water seepage is observed at the time of installation to determine if a foundation drainage system is required.
- Following examination and approval of the exposed subgrade, a woven geotextile and a bi-axial geogrid should be placed over the subgrade materials with proper overlapping of the joints in accordance with the manufacturer’s specifications, then backfilled with new granular materials. To ensure proper performance of the geogrid layer, the geogrid must be placed flat without kinks or folds. Cover

geotextile and geogrid layers with new granular material ensuring that the placement or handling of the granular material does not damage the geotextile or geogrid layers.

- Damaged portions of the geotextile and geogrid layers must be removed and replaced. Repair patches must provide a minimum of 450 mm overlap to the damaged area in all directions.
- Granular fill should be placed as soon as possible after the placement of the geotextile and geogrid to prevent disturbance during subsequent construction activity.
- New granular fill materials should be well-graded and be free of organics and frozen material supplied in accordance with appliable standard specifications, such as City of Winnipeg CW 3110-R22 dated November 2022. Sieve analysis and compaction testing of the granular base and sub-base materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied, and percent compactions are in accordance with design specifications.
- To allow for proper compaction, new granular fill materials must be placed and compacted in a thawed and unfrozen state. Heating and hoarding of granular material stockpiles will be required if construction is to proceed under freezing conditions.
- The entire extent of the controlled granular fill should be capped at the surface with a minimum of 150 mm (6 in) of compacted clay and be sloped away at a minimum 2% grade to provide positive drainage away from the concrete pad and to reduce the potential for surface water to pond at the surface. Alternatively, capping materials could consist of concrete or asphalt.

KGS Group should be consulted if the pad is to be constructed above existing grade on fill material, so appropriate recommendations and procedures can be provided for the placement of fill below mat foundations.

6.0 INTERIOR SLABS AND SURFACING

6.1 Slab-On-Grade

Interior floor slabs may consist of either a slab-on-grade or structural slab construction. A slab-on-grade should only be selected if some movement and cracking of the floor slab can be tolerated. Differential movements ranging from 50 to 60 mm are commonly observed for floor slabs supported at grade. If the potential for movement and cracking of the interior slab is unacceptable, the floor should be constructed as a structural slab. Under no circumstance should slab-on-grade construction take place during freezing conditions or on frozen ground or while frozen ground is thawing. The following recommendations should be considered for the support of an interior floor constructed as a slab-on-grade:

- Remove surficial topsoil, fill layers, organics, silt, and soft or unsuitable materials encountered below slabs down to the native high plasticity clay. Proof rolling and compaction of the high plasticity clay subgrade soil should be completed using a heavy roller under the supervision of an experienced geotechnical engineer to identify unsuitable or soft areas to achieve a minimum of 95% of the SPMDD. If unsuitable subgrade soils such as organics, fill, silt or soft clay are encountered, they should be sub-excavated by additional 600 mm and backfilled with compacted granular sub-base to 98% SPMDD.
- The contractor must protect the finished subgrade surface from excessive moisture during construction and promote runoff away from the subgrade.
- Site grading fill placed to raise the site to finished grade (i.e., fill placed above the existing ground surface) can consist of a sub-base granular fill if properly moisture conditioned to within 2% of optimum moisture content and compacted to 98% SPMDD.
- A minimum 150 mm of granular base over 300 mm of sub-base should be placed immediately below the floor slab. All granular fills should be placed in maximum 150 mm thick lifts and compacted to 98% SPMDD. A non-woven geotextile fabric should be placed as a separator between the native subgrade materials and compacted granular fill.
- The granular base course and sub-base course should be well-graded and be free of organics and frozen material supplied in accordance with appliable standard specifications, such as City of Winnipeg CW 3110-R22 dated November 2022. Sieve analysis and compaction testing of the granular base and sub-base materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied, and percent compactions are in accordance with design specifications.
- All mechanical services or piping that would be buried within the engineered fill should be designed to accommodate potential slab movement.

6.2 Structural Slabs

Where slab movements cannot be tolerated, structural floor slabs are recommended. Structural floor slabs are constructed over a minimum 150 mm void space to reduce the potential movement due to swelling or frost heave from the underlying soil.

7.0 ADDITIONAL DESIGN RECOMMENDATIONS

7.1 Frost Penetration

The depth of frost penetration will vary depending on air temperature, ground cover, the type of fill material used during development and other factors. The expected depth of frost penetration has been estimated assuming a design freezing index of 2360^{o}C days, taken as the coldest winter over a 10-year period. The estimated maximum depth of frost penetration is 2.5 m assuming bare ground and no insulation cover. The soil can heave upon freezing and must be considered in the foundation design. Good site drainage must also be maintained after development.

Well-graded granular materials should be used as structural backfill material as they are less susceptible to the effects of frost heave than fine-grained silt and clay materials. Polystyrene insulation can be used as a thermal insulator to minimize any effects that frost could potentially have on foundations or slabs.

Soil in contact with foundation elements can freeze to the foundations and develop adfreeze bonding, which can result in uplift forces. The 5th Edition of the Canadian Foundation Engineering Manual (CFEM 2023) recommends the following adfreeze bond stresses for soil and foundation materials:

- 65 kPa for fine-grained soils frozen to wood or concrete;
- 100 kPa for fine-grained soils frozen to steel; and
- 150 kPa for saturated gravel frozen to steel.

The adfreeze bond stresses listed above should be considered for foundation elements exposed to frost beneath non-heated structures.

7.2 Pavement Surfacing

Based on the soil conditions encountered during drilling and subject to inspection by qualified geotechnical personnel, the asphalt surfaced parking areas and new access road may be design based on the recommendations in the Table 9 below.

TABLE 9: PAVEMENT SURFACING SECTIONS

Material	Light Traffic Loading (mm)	Heavy Traffic Loading (mm)	Compaction (%)
Asphalt Pavement	50	100	N/A
Granular Base Course (Gradation A)	150	150	100% standard Proctor
Granular Subbase (50 or 100 mm, Gradation A or B)	350	450	100% standard Proctor
Subgrade	• Proof-rolled with heavy sheepsfoot roller • Place non-woven geotextile		

The existing native materials should be sub-excavated to the subgrade design elevation and proof-rolled using a heavy sheepsfoot roller to a minimum compaction of 98% SPMDD. The subgrade should be inspected by qualified geotechnical personnel prior to the placement of the overlying granular base. Areas that exhibit unsuitable deflection or unsuitable soils such as organic matter, silts or soft clays should be sub-excavated an additional 600 mm or as directed by the geotechnical personnel and replaced with compacted granular subbase. Non-woven geotextile fabric should be placed as a separator between the clayey subgrade and compacted granular fill.

The granular base course (Gradation A) and sub-base (50 or 100 mm, Gradation A or B) should be well-graded and be free of organics and frozen material supplied in accordance with appliable standard specifications, such as City of Winnipeg Specification CW 3110-R22 dated November 2022. Sieve analysis and compaction testing of the granular base and sub-base materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied, and percent compactions are in accordance with design specifications.

7.3 Curbs and Sidewalks

It is recommended that curbs and sidewalks be constructed in accordance with the City of Winnipeg standard construction details and SD-200 and SD-228A/SD-228B. Based on these details a minimum sidewalk slab thickness of 100 mm is specified, however thickness of granular base course beneath the sidewalk slab is not provided. KGS Group recommends a minimum thickness of 150 mm of granular base course materials be provided beneath the concrete sidewalk slab.

Exterior grade supported concrete slabs such as sidewalks will be subjected to seasonal vertical movements related to frost action and varying subgrade moisture conditions. Connection and tie-in details between the exterior concrete slabs and rigid structure elements such as footings or interior slabs should account for this potential vertical movement. To minimize the frost heave movements, consideration should be given to the use of rigid synthetic insulation, extending outward laterally 1.8 m (min) in length beyond the sidewalk slab with a 100 mm (min) thickness. The insulation should be covered with a minimum of 300 mm of soil to protect from damage and sloped away to promote drainage.

7.4 Cement Type for Foundation Concrete

It is known that the clay soils in Winnipeg contain sulphates which will damage concrete with prolonged exposure. Therefor it is recommended that all foundation concrete in contact with soil be made with high sulphate-resistant cement (HS or HSb). A maximum water to cement ratio of 0.40 should be specified in accordance with Table 2, CSA A23.1-04 for concrete with very severe sulphate exposure (S1). Concrete which may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 5, CSA A23.1-04.

7.5 Subsurface and Surface Drainage

A permanent subdrain system should be installed around the exterior of below grade walls. Subdrains should be constructed with a perforated weeping tile wrapped with a filter sock and backfilled with drain rock (clean pea gravel or clean crushed rock), placed in a trench directing flows to a central sump pit. Installation of subsurface drainage should be in accordance with locally accepted practices.

The final ground elevation around the perimeter of the structures should be sloped a minimum 2% to promote positive drainage away from the perimeter of all structures and to protect against surface water ponding. Roadways, parking lots, unloading areas and landscaping within a zone of approximately 2 m of the exterior perimeter of any structure should be sloped at a minimum gradient of 5% to compensate for future loss of grade that may result from potential settlement. Downspouts should be positively directed away from structures and beyond the backfill zone.

7.6 Temporary Excavations

All excavations should be carried out in accordance with Safe Work Manitoba rules and regulations. Excavations deeper than 1.5 m should be reviewed and designed prior to construction by an experienced professional engineer with expertise in geotechnical engineering. For preliminary planning purposes, it should be assumed that temporary excavation slopes be no steeper than 2:1 (H:V) in the clay soil. Flatter slopes may be required if the upper fill soils are loose or soft and do not appear to be properly compacted.

Open excavation side slopes should be covered to prevent from drying or saturation and surface runoff should be directed away from excavations. Surcharge loads such as soil stockpiles, equipment, etc. should be kept a minimum of 1 m or a distance equal to the depth of excavation away from the edge of excavation, whichever is greater.

If a deep excavation with a shoring system is considered, KGS Group recommends that an excavation and shoring plan should be prepared and submitted by a registered Professional Engineer who is skilled in these designs.

7.7 Seismic Site Classification

In accordance with the 2020 National Building Code of Canada (NBCC), the site designation, X, is determined using the average shear wave velocity, V_{s30}, calculated from in-situ measurements. Where in-situ measurements are not available, the site designation shall be X_S, where S is the Site Class determined based on the average properties of soil and rock in the top 30 m. In reference to Table 4.1.8.4.-B and based on the results of the 2025 geotechnical investigation, the building's area Class may be D; therefore, the site designation is X_D.

Additional site testing, consisting of geophysical techniques (e.g., shear wave velocity sounding(s) by seismic methods), will allow for more accurate determination of seismic Site Class and Site Designation.

7.8 Construction Inspection

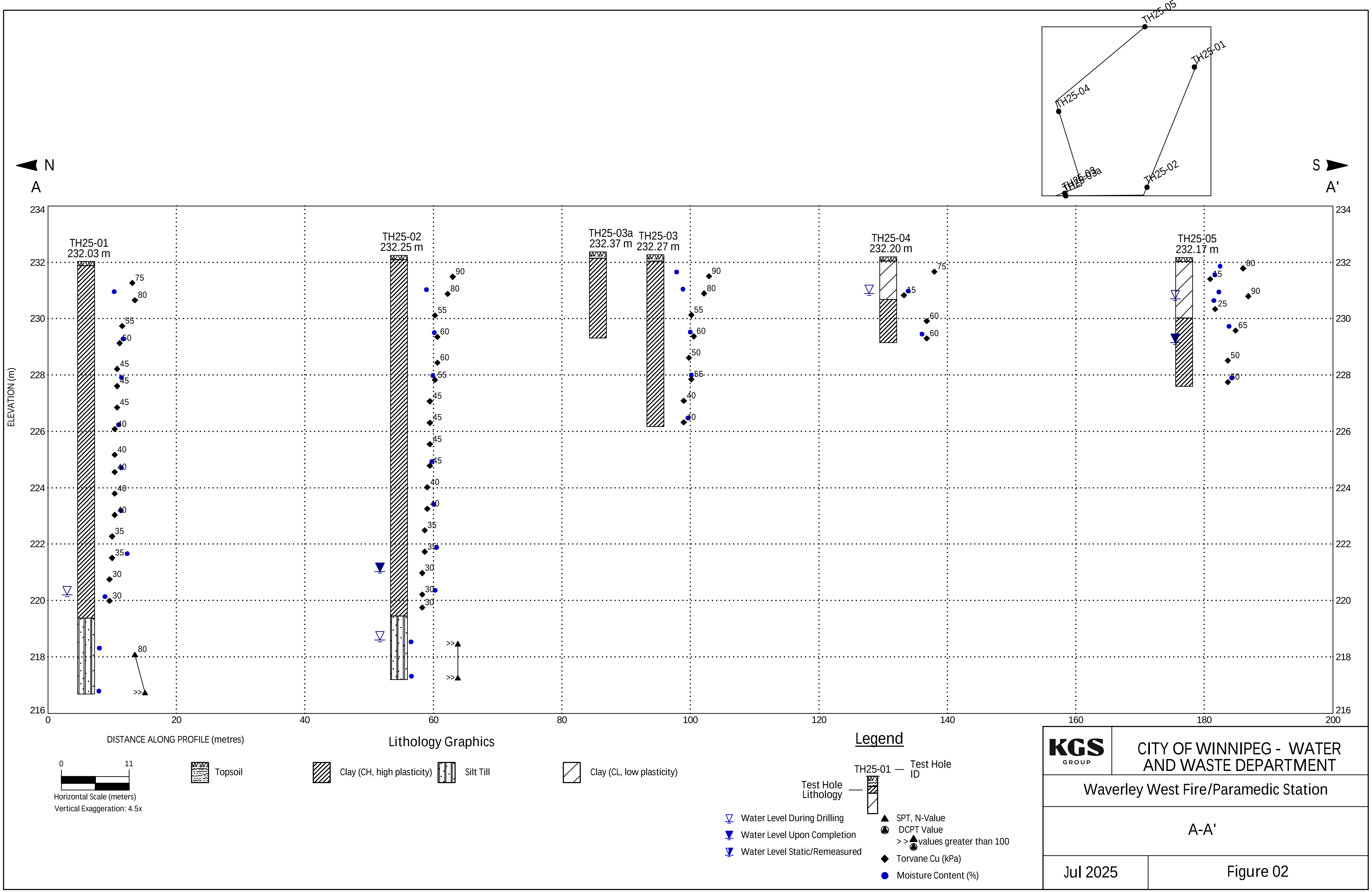
KGS Group should be retained to complete the following inspection services during construction:

- Detailed construction records and full-time inspection by experienced geotechnical personnel are recommended throughout the construction of foundations to ensure that the design capacities indicated in this report are achieved. Inspection of pile installation by experienced geotechnical personnel is required to ensure that the specified embedment depths are achieved and will allow for KGS Group to make changes if the soil types encountered at the time of installation are not consistent with those presented within this report.
- Observe proof rolling of sub-grade materials beneath slabs-on-grade, exterior slabs, and pavement sections. Proof rolling inspection by an experienced geotechnical engineer is required to identify unsuitable or soft areas which will need to be sub-excavated and replaced with compacted granular materials.
- Sieve testing of granular base and subbase materials to ensure that the supplied granular materials meet the graduation requirements specified for these materials.
- Compaction testing of sub-grade materials, and subbase / base granular materials should be completed to ensure materials are compacted properly and meet the minimum compaction requirements specified for this project.

FIGURE

Figure 2: Cross-Section A-A’

FENCE W/O WELL DATA PLOT U:\FMS\25-0107-008\25-0107-008 WAVERLEY WEST FIRE PARAMEDIC STATION - GEOTECHNICAL INVESTIGATION - MAY 2025.GPJ



KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Waverley West Fire/Paramedic Station

A-A'

Jul 2025	Figure 02

APPENDIX 1

Desktop Hydrogeological Assessment Report

Memorandum

To:	**Kathy Roberts** Project Coordinator Municipal Accommodations Assets & Project Management City of Winnipeg	**Date:**	June 23, 2025
		Project No.:	25-0107-008
From:	**Simratpal Singh, M.Sc., EIT** Environmental Hydrogeologist, KGS Group **Leif Nelson, M.Sc., P.Geo.** Senior Hydrogeologist, KGS Group **Jason Mann, M.Sc., P.Geo., FGC** Principal, Environmental, KGS Group	**Cc:**	**Eric Levay, C.E.T., PMP** Geosciences/Geothermal Lead, KGS Group **Trevor Schellenberg, B.Sc., P.Eng.** Geotechnical Engineer, KGS Group
Re:	Hydrogeological Desktop Review for the proposed Waverley West Fire/Paramedic Station (Final - Rev 0)		

1.0 BACKGROUND

KGS Group conducted a hydrogeological desktop review of the project area to understand the geology of the area and to interpret the existing groundwater conditions in order to estimate the groundwater conditions that might be encountered during construction of proposed fire and paramedic station within the community of Waverley West in Winnipeg, MB.

The project site is located immediately southeast of the intersection of Bison Drive and Ruth Crossing on a currently vacant piece of land. Based on information provided by the client, it is understood that the proposed fire and paramedic station will have a planned area of approximately 948 m^2 (10,200 ft^2), and will include three (3) vehicle bays, a partial basement, and a mezzanine level. Based on the site plan provided, parking areas and access driveways will be constructed on the north and west sides of the proposed building.

The depth to which ground will be excavated during the construction phase of the building's foundation is currently being confirmed by City of Winnipeg's project team, however, groundwater may seep into the excavation if it is deeper the shallow groundwater table in the overburden.

In this hydrogeological desktop review, KGS Group reviewed the outcomes of previous geotechnical investigations conducted in the project area to estimate the groundwater conditions at the site during and after the construction of new underground infrastructure, and to determine the potential need for groundwater depressurization during the excavation and construction phases.

2.0 METHODOLOGY

To prepare for any potential challenges related to groundwater seepage during excavation and construction, KGS Group reviewed the following historical and recent investigation reports:

1) University of Manitoba's Department of Geological Engineering Maps and Report for Urban Development of Winnipeg (Baracos, A., et al., 1983) were reviewed to gather information on regional clay and till surfaces, transmissivity, potentiometric surface, etc., for the project and surrounding areas (Appendix A).
2) Bedrock Topography and Surface Deposit Maps (Appendix B) developed by Department of Natural Resources at Province of Manitoba (J. Little, 1974).
3) Borehole logs and groundwater monitoring results from the historical investigations conducted at the project site or in the area around it. This includes the geotechnical investigations conducted on the Pembina Trails Collegiate and Bison Run School properties in 2020 and 2018, respectively, as well as the geotechnical investigation and groundwater monitoring study at the proposed South Winnipeg Recreation Campus to be located approximately 425 m southwest of the intersection of Bison Drive and Frontier Trail in 2024 (Appendix C).
4) An inventory of well logs extracted from the Province of Manitoba's drilling database (GWDrill) within and around the project area (Appendix D)

The following subsections include the details of findings from this desktop review.

3.0 DESKTOP REVIEW

3.1.1 GEOLOGICAL ENGINEERING MAPS AND GROUNDWATER AVAILABILITY MAP SERIES

The Geological Engineering Report outlines that a layer of glacial till exists above the confined limestone-bedrock (upper carbonate bedrock) in the Winnipeg area. The till is overlain by a surficial layer of glaciolacustrine silts and clays, resulting in the flat topography that exists today. The Geological Engineering Report further describes this uppermost lithological unit, which extends from the surface to approximately 4.5 m below the surface, as a *complex zone* that consists of silty clays, silt, organic soils, sands, along with varying amounts of man-made fill.

The findings outlined in the Geological Engineering Report were compared with the drilling investigations conducted by KGS Group in previous years. A total of sixteen (16) boreholes (Table 1) drilled under KGS Group's supervision at or around the site between the years 2018 and 2025 (Figure 1 and Appendix C) were reviewed as a part of this desktop study in addition to three borehole logs extracted from the provincial well (GWDrill) database (Table 2, section 3.1.2 and Appendix D).

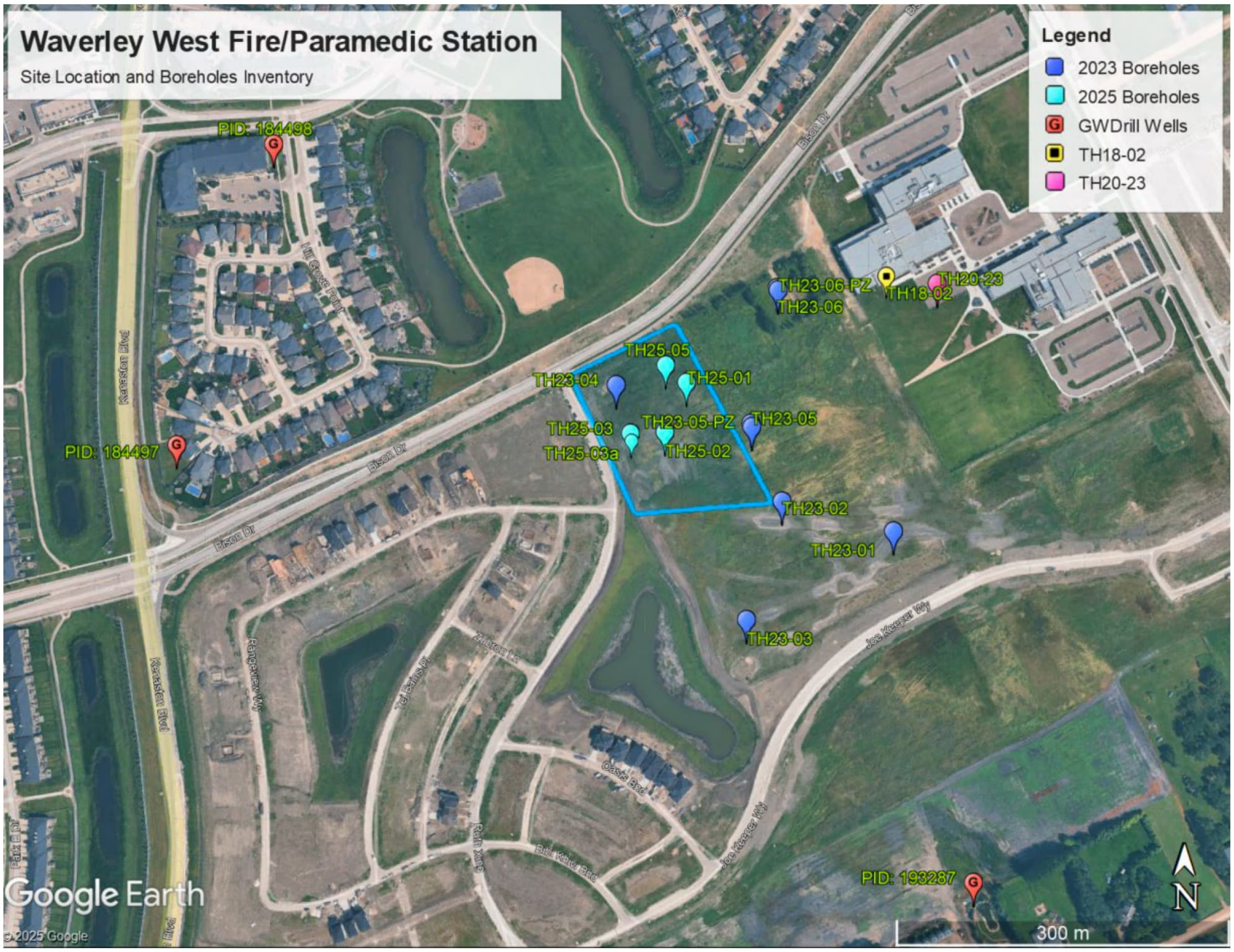


FIGURE 1: PROJECT AREA AND LOCATION OF BOREHOLES REVIEWED

TABLE 1: BOREHOLE LOGS FROM DRILLING INVESTIGATIONS CONDUCTED BY OTHERS AND KGS GROUP

S.No.	Well ID	UTM N (m)	UTM E (m)	Ground Elevation (m)	Well Installed (Y/N)	Well Diameter	Well Use
1	TH25-01	5517616	630455	232	N	-	N/A
2	TH25-02	5517571	630437	232	N	-	N/A
3	TH25-03	5517569	630406	232	N	-	N/A
4	TH25-03a	5517568	630406	232	Y	2-inch PVC	Observation Well
5	TH25-04	5517600	630403	232	N	-	N/A
6	TH25-05	5517631	630436	232	Y	2-inch PVC	Observation Well
7	TH23-01	5517489	630644	233	Y	2-inch PVC	Observation Well
8	TH23-02	5517512	630543	233	N	-	N/A
9	TH23-03	5517406	630514	233	Y	2-inch PVC	Observation Well
10	TH23-04	5517613	630392	233	Y	2-inch PVC	Observation Well
11	TH23-05	5517582	630513	233	N	-	N/A
12	TH23-05-PZ	5517579	630514	233	Y	2-inch PVC	Observation Well
13	TH23-06	5517703	630533	233	Y	2-inch PVC	Observation Well
14	TH23-06-PZ	5517701	630534	233	Y	2-inch PVC	Observation Well
15	TH20-23	5517711	630677		N	-	N/A
16	TH18-02	5517718	630631	233	N	-	N/A

The logs for the sixteen boreholes drilled by KGS Group in the project area (Appendix C) indicate the presence of topsoil, along with a layer of silt and clay within the first 2 m below the ground surface. A layer of native clay lies underneath the upper silt and clay layer and this native clay extends to the top of till layer. The average thickness of the native clay unit encountered in the boreholes is approximately 12.7 m. On average, the geodetic bottom of the clay layer is approximately 216.4 m. These findings also corelate well with the Surface Deposits Map (Appendix B) developed by the Natural Resources Branch of the Province of Manitoba that indicates the presence of a surficial clay layer across much of the Winnipeg area (J. Little, 1974).

The Geological Engineering Report (Baracos, A., et al., 1983) mentions that in the Winnipeg area, the top of the till layer lies at approximately 15.2 m (50 ft) depth below ground surface, while the top of confined bedrock is approximately 3 m (10 ft) deeper than the top of till, i.e. at about 18.2 m (60 ft) depth. In general, the top of bedrock in majority of the Winnipeg area ranges between 15.2 to 18.2 m (50 to 70 ft) depth below ground surface. This indicates that the till layer above the bedrock extends up to about 18.2 m (70 ft) depth below ground surface where the top of bedrock is deeper (Baracos, A., et al., 1983). The Bedrock Topography map (Appendix B) developed by the Natural Resources Branch of the Province of Manitoba (J. Little, 1974) also indicates the top of bedrock in the project area is at around 213.0 m (700 ft) elevation which is approximately 20 m below the ground surface.

The Plate 2 Map (Depth to Till) developed by the Geological Engineering Department of University of Manitoba in 1983 shows that the top of till layer in the project area is between 12.4 to 18.2 m (41 to 60 ft) below ground surface which correlates with the findings from the Geological Engineering Report (Baracos, A., et al., 1983).

The Plate 11 Map (1974) shows the potentiometric surface elevation in the upper carbonate aquifer within the Winnipeg area. Based on this map, the groundwater elevations in the upper limestone bedrock within the project area were in the range of 228.6 and 225.5 m (750 and 740 ft) with geodetic elevation during early 1970s. The groundwater elevations within the clay and till layer were observed between 224.7 m and 233 m during the groundwater monitoring program conducted by KGS Group at the South Winnipeg Recreation Campus between March 2024 and December 2024 (Appendix E). The groundwater elevations were higher during the summer of 2022 (between June and August 2024) while they were lower during the fall and winter months. It is also generally observed that groundwater pressure within the overburden clay and till aquifer is in equilibrium with the bedrock groundwater pressure. Hence, KGS Group anticipates similar groundwater levels in both overburden and bedrock aquifers within the project area.

If the design depth of proposed new building infrastructure and depth of excavation are below the potentiometric groundwater table in the overburden material, groundwater depressurization will be required at the project site; however, the depressurization rates will depend on the overburden (clay and till zones) and upper bedrock transmissivities, as well as the confining pressures between these zones.

To assess the groundwater quality that might be encountered during depressurization, Plate 15 (Total Dissolved Solids), Plate 16 (chloride ion), and Plate 17 (sulphate ion) maps were reviewed for the upper carbonate aquifer in the Winnipeg area. The groundwater in the upper carbonate zone in the Site area is estimated to have TDS values around 5,000 – 6,000 mg/L, the chloride ion concentrations in the range of 2,000 mg/L, and sulphate ion concentrations near 1,000 mg/L, however, it is anticipated that base of excavation will be in the overburden clay zone and the concentrations of TDS and other ions will likely be lower than the anticipated concentrations in the bedrock aquifer. Overall, the interpreted groundwater quality in the area is brackish.

3.1.2 PROVINCIAL WELL INVENTORY (GWDRILL)

KGS Group reviewed the Province of Manitoba’s wells record database (GWDrill) for the area around the project site. The inventory near the Site area consists of two production and one recharge well (Table 2). Through this wells’ record database (Appendix D), the stratigraphy at these well locations was reviewed which reveals the presence of overburden material comprising of the clay and till layer above the upper carbonate bedrock (limestone).

TABLE 2: NEARBY GROUNDWATER WELL DATABASE

S.No.	Well PID	UTM N (m)	UTM E	Ground Elevation (m)	Well Diameter	Well Use	Groundwater Elevation (m)	Date Monitored
1	184498	5517820	630077	233	5-inch PVC	Geothermal Recharge Well	223.3	August 11, 2013
2	184497	5517548	629998	233	5-inch PVC	Geothermal Production Well	223.8	August 11, 2013
3	193287	5517177	630724	229	5-inch PVC	Domestic Production Well	222.9	September 1, 2016

Long-term groundwater elevation data for these three GWDrill wells was not available. The groundwater elevations at these wells from a single monitoring event is provided above in Table 2. It can be noted that groundwater elevation in the bedrock was between 222.9 and 223.8 m during the 2013 and 2016 period. Recent data from these three wells is not available, however, groundwater depressurization will be required at the project site if the design depth of proposed new building infrastructure and depth of excavation are below the potentiometric groundwater pressures in the overburden or bedrock aquifers. Dewatering rates will be dependent on several factors including excavation size, excavation depth below the potentiometric surface and hydraulic conductivity of the soil/bedrock.

CONCLUSIONS

KGS Group conducted this desktop review to understand the existing hydrogeological data at, and around, the proposed Waverley West Firehall/Paramedic station to understand the potential need for groundwater dewatering during excavation.

Based on the review of available resources, groundwater is interpreted to occur in both the fine-grained overburden and the underlying bedrock. In general, it has been observed that groundwater pressures in the overburden clay and till layers are in equilibrium with the underlying bedrock aquifer. Monitoring at a nearby site reported groundwater elevations between 224.7 m and 233 m. Hence, depending on the location and depth of the excavation, groundwater dewatering may be required during construction and there is potential for basal heave. Additionally, seasonal fluctuations in groundwater elevation (of up to three metres) are estimated at the project site, and any groundwater depressurization program should be planned accordingly.

Based on the TDS, chloride ion, and sulphate ion concentration maps developed by the Geological Engineering Department at the University of Manitoba, the groundwater quality during dewatering is interpreted to have a TDS in the range of 5000 - 6000 mg/L, the chloride ion concentrations in the range of 2000 mg/L, and sulphate ion concentrations near 1000 mg/L. Overall, the interpreted groundwater quality in the area is brackish.

REFERENCES

Baracos, A., et al. Geological Engineering Report for Urban Development of Winnipeg. Cantext Publications, 1983.

J. Little, 1974. Groundwater Availability Study. Winnipeg Area. Water Resources Branch. Department of Natural Resources. Province of Manitoba. Revised 1980.

STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This memorandum has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the “Agreement”). This memorandum represents KGS Group’s professional judgment and exercising due care consistent with the preparation of similar documents. The information, data, recommendations, and conclusions in this memorandum are subject to the constraints and limitations in the Agreement and the qualifications in this memorandum. This memorandum must be read as a whole, and sections or parts should not be read out of context.

This memorandum is based on information made available to KGS Group by City of Winnipeg. Unless stated otherwise, KGS Group has not verified the accuracy, completeness, or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this memorandum apply only as they existed at the time of KGS Group’s work.

Third Party Use of Memorandum

Any use a third party makes of this memorandum or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this memorandum.

Geo-Environmental Statement of Limitations

KGS Group prepared the geo-environmental conclusions and recommendations for this memorandum in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this memorandum is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of City of Winnipeg. As this memorandum is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate, or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

Geotechnical Investigation Statement of Limitations

The geotechnical investigation findings and recommendations of this memorandum were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at the site at the time of drilling. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.

Prepared By:

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Principal

SPS/LN/jdm/jr
Attachments

APPENDIX A

Geological Engineering Maps (University of Manitoba)

LEGEND

Depth to glacial till in feet

- ▨ Subcrop
- ▥ 1-10
- ▨ 11-20
- ▧ 21-30
- ▨ 31-40
- ▨ 41-50
- ▨ 51-60
- ▨ 61-70
- ▨ 71-80
- 🟩 Complex areas
- ☐ No data
- ∼ Defined boundary
- ∼ Approximate boundary

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ENGINEERING

GEOLOGICAL ENGINEERING REPORT
FOR
URBAN DEVELOPMENT
WINNIPEG

PLATE 2

DEPTH TO TILL

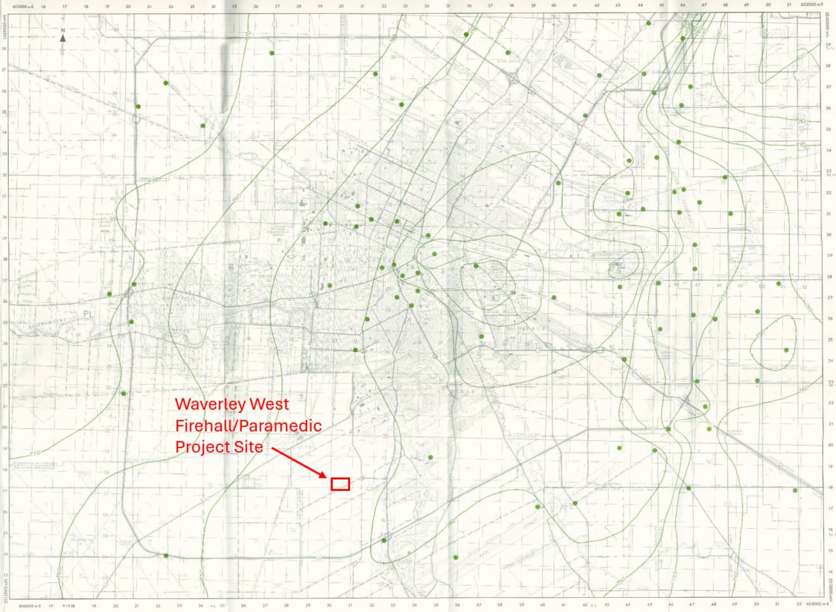
MANITOBA ENERGY & MINES LIBRARY

LEGEND

● Control Well

750 Potentiometric Contour Line with Geodetic Elevation in Feet

ACKNOWLEDGEMENT:
Map provided by the Manitoba Water Resources Branch



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DEPARTMENT OF GEOLOGICAL
ENGINEERING

GEOLOGICAL ENGINEERING REPORT
FOR
URBAN DEVELOPMENT
WINNIPEG

PLATE 11

POTENTIOMETRIC SURFACE
UPPER CARBONATE AQUIFER
APRIL 1974

To accompany report edited by
A. Baracos, D.H. Shields, B.H. Kjartanson

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MAY 27 1986

LEGEND

● Control Well

5000 Contour of Total Dissolved Solids Content in Milligrams Per Litre

ACKNOWLEDGEMENT:
Map provided by the Manitoba Water Resources Branch

Scale 1:50,000

Base Maps provided by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES

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GEOLOGICAL ENGINEERING REPORT FOR URBAN DEVELOPMENT WINNIPEG

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PLATE 15

TOTAL DISSOLVED SOLIDS
UPPER CARBONATE AQUIFER
SEPTEMBER 1980

To accompany report dated by
A. Baracos, D.H. Shields, B.H. Kjartanson

LEGEND

● Control Well

~300 Chloride Ion Contour Line with Concentration in Milligrams Per Litre

ACKNOWLEDGEMENT
Map provided by the Manitoba Water Resources Branch

Scale 1:50,000

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PLATE 16

UPPER CARBONATE AQUIFER
CHLORIDE ION
1980

LEGEND

● Control Well

300 Sulphate Ion Contour Line with Concentration in Milligrams Per Litre

ACKNOWLEDGEMENT:
Map provided by the Manitoba Water Resources Branch

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WINNIPEG

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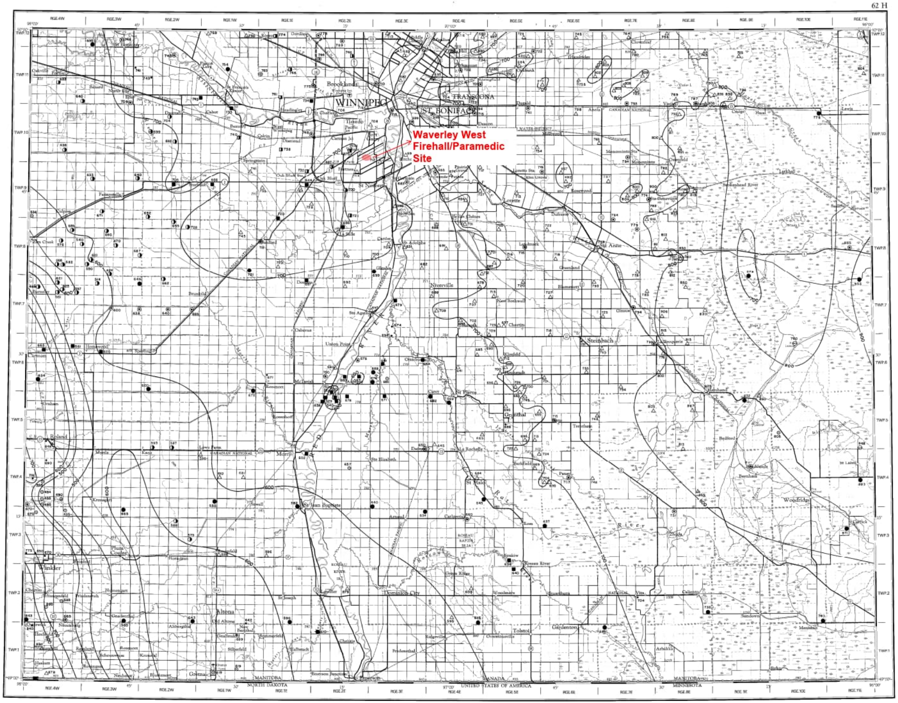
PLATE 17

UPPER CARBONATE AQUIFER
SULPHATE ION CONCENTRATION
1980

To accompany report edited by:
R. Baracos, D.H. Shields, B.H. Kjartanson

APPENDIX B

Groundwater Availability Maps (Natural Resources Department, Province of Manitoba)




Index to adjoining sheets of National Topographic System.

MAP LEGEND

Road	▬
Railway	—
Town	□
Village or Settlement	○
Intermittent Lake and Stream	
Marsh or Swamp	

Scale 1:250,000

Miles 5 0 5 10

Kilometres 5 0 5 10 15

Magnetic declination 1976 varies from 7°27' easterly at centre of west edge to 9°38' easterly at centre of east edge. Mean annual change decreasing 4.0'.

Base Map by Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa.

PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH

GROUNDWATER AVAILABILITY STUDY WINNIPEG AREA

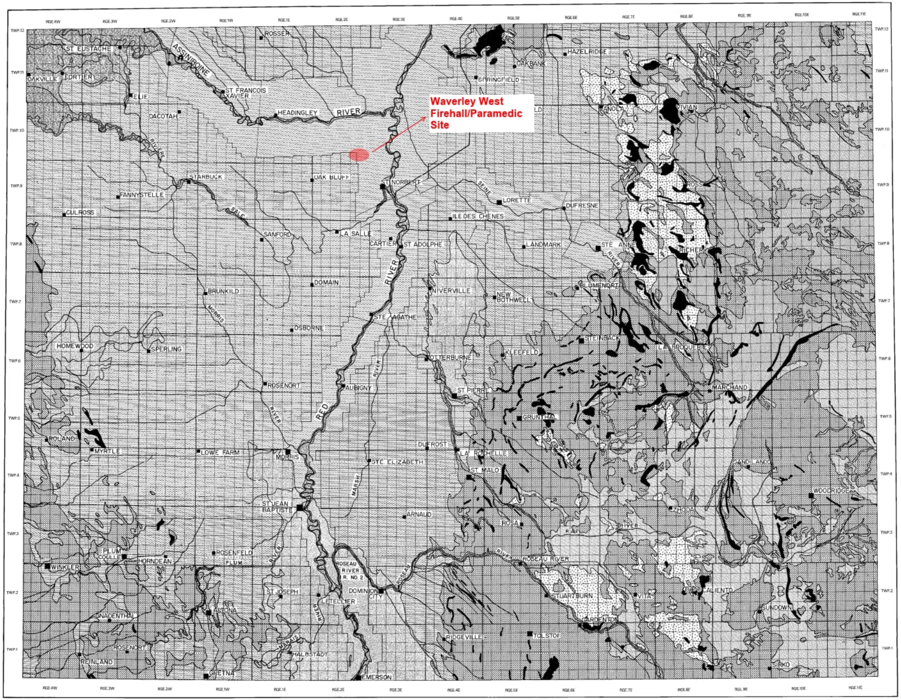
BEDROCK TOPOGRAPHY

FIGURE 3

LEGEND

W.R.B. GROUND-WATER AVAILABILITY BOREHOLE-WINNIPEG AREA	●
W.R.B. MUNICIPAL WATER SUPPLY BOREHOLE	•
W.R.B. BOREHOLE, OTHER	⊙
GEOLOGICAL SURVEY OF CANADA BOREHOLE	⊝
UNIVERSITY OF MANITOBA BOREHOLE	⊖
MINERAL EXPLORATION BOREHOLE—GYPSUM	■
MINERAL EXPLORATION BOREHOLE—LIMESTONE	◨
GREATER WINNIPEG GAS STRUCTURE TEST HOLE	◑
OIL EXPLORATION BOREHOLE	⊗
WATER WELL	△
BEDROCK ELEVATION (DATUM:M.S.L.)	● 830
CONTOUR OF EQUAL ELEVATION	—800—

Prepared by: J. LITTLE, 1974
Revised by: J. LITTLE, 1980



Index to adjoining sheets of National Topographic System.

Magnetic declination 1975 varies from 7°37'
easterly at centre of west edge to 9°30'
easterly at centre of east edge.
Mean annual change decreasing 4.3'.

Scale:1:250,000

Miles 5 0 5 10

Kilometres 5 0 5 10 15

PROVINCE OF MANITOBA
DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES BRANCH

GROUNDWATER AVAILABILITY STUDY
WINNIPEG AREA

SURFACE DEPOSITS MAP

FIGURE 5

LEGEND

▨	SWAMP DEPOSITS
▨	ALLUVIUM
■	BEACH DEPOSITS AS RIDGES (SAND AND GRAVEL)
▨	LACUSTRINE DEPOSITS (CLAY)
▨	LACUSTRINE DEPOSITS (SILT)
▨	LACUSTRINE DEPOSITS (SAND)
⁘	TILL

MODIFIED FROM SOILS MAPS

Prepared by: J. LITTLE, 1974
Revised by: J. LITTLE, 1980

FILE 10-1-7-897

APPENDIX C

Borehole Logs from KGS Group’s historical investigations

KGS
GROUP

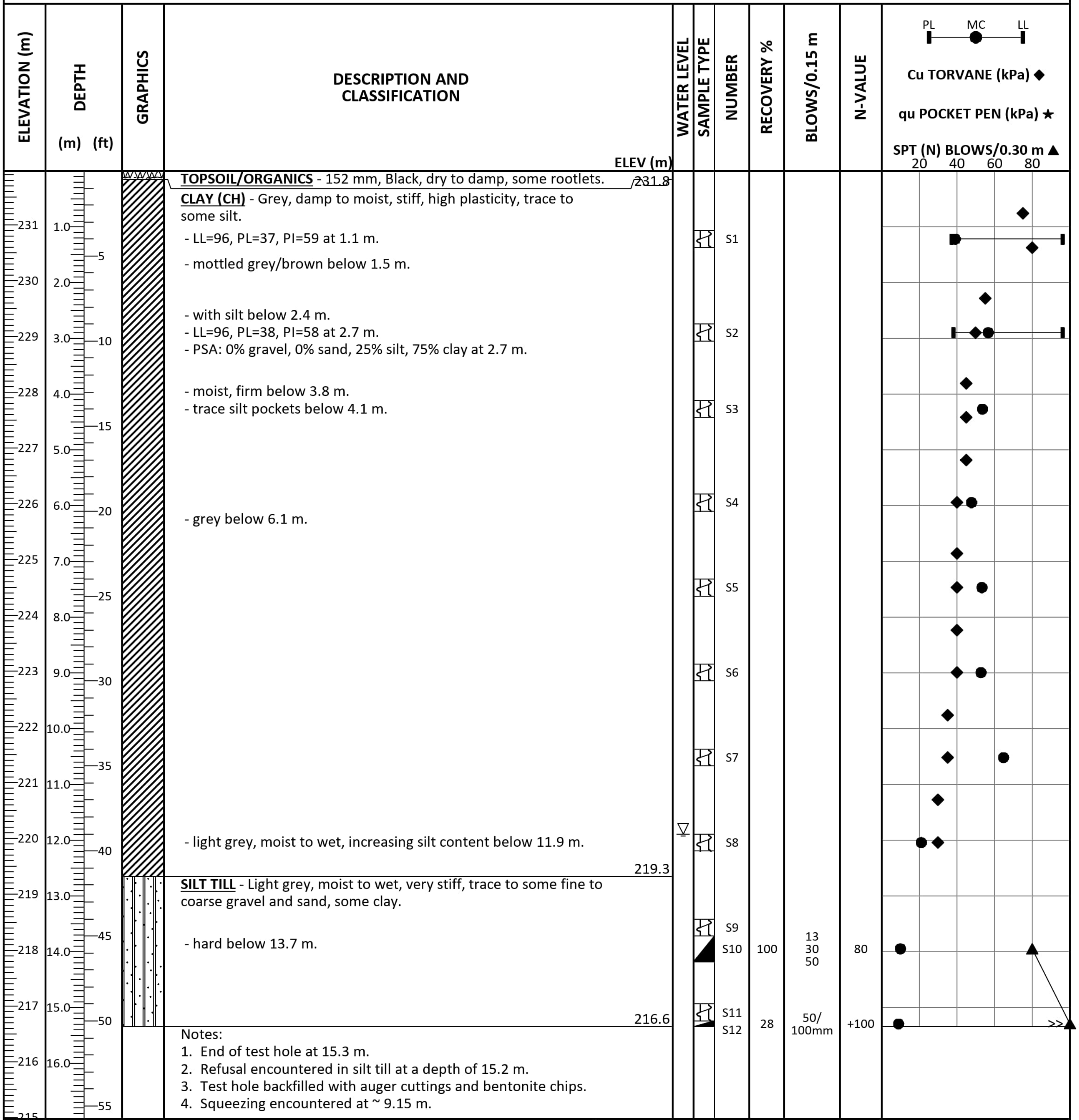
TEST HOLE LOG

HOLE NO.
TH25-01

SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Waverley West Fire/Paramedic Station
LOCATION Winnipeg, Manitoba
DESCRIPTION Southwest corner of the proposed building
DRILL RIG / HAMMER Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer
METHOD(S) 0.0 m to 15.3 m: 125 mm ø SSA

PROJECT NO. 25-0107-008
SURFACE ELEV. 231.97 m
START DATE 5/20/2025
UTM (m) N 5,517,616
E 630,454.6 Zone 14



DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND CLASSIFICATION	ELEV (m)
TOPSOIL/ORGANICS - 152 mm, Black, dry to damp, some rootlets.	231.8
CLAY (CH) - Grey, damp to moist, stiff, high plasticity, trace to some silt. - LL=96, PL=37, PI=59 at 1.1 m. - mottled grey/brown below 1.5 m. - with silt below 2.4 m. - LL=96, PL=38, PI=58 at 2.7 m. - PSA: 0% gravel, 0% sand, 25% silt, 75% clay at 2.7 m. - moist, firm below 3.8 m. - trace silt pockets below 4.1 m. - grey below 6.1 m. - light grey, moist to wet, increasing silt content below 11.9 m.	219.3
SILT TILL - Light grey, moist to wet, very stiff, trace to some fine to coarse gravel and sand, some clay. - hard below 13.7 m.	216.6

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6			
S7			
S8			
S9			
S10	100	13 30 50	80
S11			
S12	28	50/ 100mm	+100

Notes:
1. End of test hole at 15.3 m.
2. Refusal encountered in silt till at a depth of 15.2 m.
3. Test hole backfilled with auger cuttings and bentonite chips.
4. Squeezing encountered at ~ 9.15 m.

WATER LEVELS ∇ **During Drilling/Digging** 11.89 m on 5/20/2025
▼ **Upon Completion** on 5/20/2025 Unknown due squeezing

CONTRACTOR
Paddock Drilling

INSPECTOR
M. RODRIGUEZ

APPROVED
DRAFT

DATE

KGS GROUP

TEST HOLE LOG

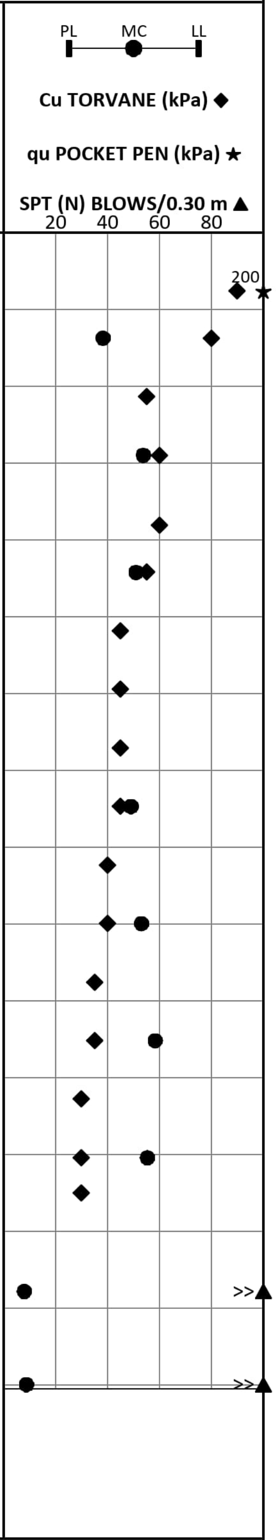
HOLE NO. **TH25-02**

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.19 m
LOCATION	Winnipeg, Manitoba	**START DATE**	5/20/2025
DESCRIPTION	Northeast corner of the proposed building	**UTM (m)**	N 5,517,571
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer		E 630,436.7 Zone 14
METHOD(S)	0.0 m to 15.0 m: 125 mm ø SSA		

ELEV (m)	DESCRIPTION AND CLASSIFICATION
232.0	**TOPSOIL/ORGANICS** - 152 mm, Black, dry to damp, some rootlets.
	CLAY (CH) - Grey, damp to moist, stiff, high plasticity, trace to some silt, trace to some sand to a depth of 0.75 m. - mottled grey/brown below 1.5 m. - trace silt pockets below 3.7 m. - firm below 5.2 m. - moist below 6.1 m. - grey below 9.1 m.
219.4	**SILT TILL** - Light grey, moist to wet, very stiff, trace to some fine to coarse gravel and sand, some clay. - wet, hard below 13.7 m. - hard drilling/ grinding below 14.0 m.
217.1	Notes: 1. End of test hole at 15.0 m. 2. Refusal encountered in silt till at a depth of 14.9 m. 3. Test hole backfilled with auger cuttings and bentonite chips. 4. Squeezing encountered at ~ 6.71 m.

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6			
S7			
S8			
S9			
S10	28	50/ 130mm	+100
S11	25	50/ 110mm	+100



WATER LEVELS	▽ **During Drilling/Digging**	13.72 m on 5/20/2025
	▼ **Upon Completion**	11.28 m on 5/20/2025

CONTRACTOR **Paddock Drilling**

INSPECTOR **M. RODRIGUEZ**

APPROVED DRAFT

DATE

KGS GROUP

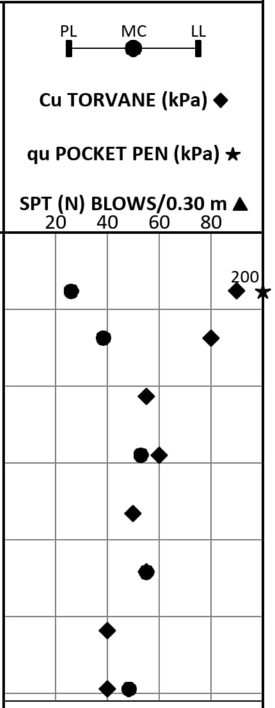
TEST HOLE LOG

HOLE NO.
TH25-03

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.21 m
LOCATION	Winnipeg, Manitoba	**START DATE**	5/21/2025
DESCRIPTION	Site access off of Ruth Crossing	**UTM (m)**	N 5,517,569
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer		E 630,405.7 Zone 14
METHOD(S)	0.0 m to 6.1 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m) (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
232		**TOPSOIL/ORGANICS** - 229 mm, Black, dry to damp, some rootlets.	232.0			
		CLAY (CH) - Grey, damp to moist, stiff, high plasticity, trace to some silt, trace to some sand to a depth of 0.75 m.				S1
231	1.0	- mottled grey/brown below 1.1 m.				S2
229	3.0	- moist below 3.0 m.				S3
228	4.0	- grey, firm below 4.6 m.				S4
226	6.0		226.1			S5



Notes:
1. End of test hole at 6.1 m.
2. Test hole remained open to 6.1 m upon completion of drilling/digging.
3. Test hole backfilled with auger cuttings and bentonite chips.

WATER LEVELS
▽ **During Drilling/Digging** on 5/21/2025 Dry
▼ **Upon Completion** on 5/21/2025 Dry

CONTRACTOR
Paddock Drilling

INSPECTOR
M. RODRIGUEZ

APPROVED
DRAFT

DATE

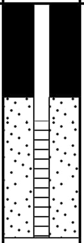
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH25-03a

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.31 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.91 m / 233.23 m (Standpipe)
DESCRIPTION	Site access off of Ruth Crossing	**START DATE**	5/21/2025
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer	**UTM (m)**	N 5,517,568
METHOD(S)	0.0 m to 3.0 m: 125 mm ø SSA		E 630,406.1 Zone 14

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	LOG OF INSTALLS DIAGRAM	LOG OF INSTALLS DEPTH (m)	SAMPLE TYPE	NUMBER	PL MC LL / Cu TORVANE (kPa) ◆ / qu POCKET PEN (kPa) ★ / SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
232			**TOPSOIL/ORGANICS** - 229 mm, Black, dry to damp, some rootlets.	232.1						
231 – 230	1.0 – 3.0 (5 – 10)	▨	**CLAY (CH)** - Grey, damp to moist, stiff, high plasticity, trace to some silt, trace to some sand to a depth of 0.75 m. - mottled grey/brown.	229.3			1.22 1.52 3.05			

Notes:
1. End of test hole at 3.0 m.
2. TH25-03a is located ~1.0 m south of TH25-03.
3. No soil sampling and field testing performed in TH25-03a.
4. A 50 mm (2") Ø standpipe piezometer with 1.52 m slotted screen installed in TH25-03a.
5. Backfilled with filter sand to 1.22 m BGS, remaining depth backfilled with bentonite seal to surface.
6. Above-ground protective well cover installed at surface.

WATER LEVELS	▽ **During Drilling/Digging**	on 5/21/2025 Dry
	▼ **Upon Completion**	on 5/21/2025 Dry

CONTRACTOR **Paddock Drilling**	INSPECTOR **M. RODRIGUEZ**
APPROVED DRAFT	DATE

KGS GROUP

TEST HOLE LOG

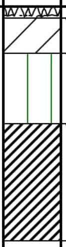
HOLE NO.
TH25-04

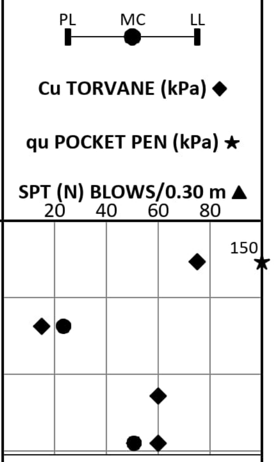
SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Waverley West Fire/Paramedic Station
LOCATION Winnipeg, Manitoba
DESCRIPTION West end side of the proposed parking lot
DRILL RIG / HAMMER Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer
METHOD(S) 0.0 m to 3.0 m: 125 mm ø SSA

PROJECT NO. 25-0107-008
SURFACE ELEV. 232.14 m
START DATE 5/21/2025
UTM (m) N 5,517,600
E 630,403.4 Zone 14

DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
TOPSOIL/ORGANICS - 152 mm, Black, dry to damp, some rootlets.	232.0			
CLAY (CL) - Grey, damp, stiff, low plasticity, trace to some silt and sand.	231.5		⊓	S1
SILT (ML) - Light brown, moist, soft, low plasticity, trace to some clay, trace fine sand. - moist to wet around 1.4 m.	230.6	∇	⊓	S2
CLAY (CH) - Mottled grey/brown, moist, stiff, high plasticity.	229.1		⊓	S3





Notes:
1. End of test hole at 3.0 m.
2. Test hole backfilled with auger cuttings and bentonite chips.
3. Caving encountered at ~ 1.37 m.

WATER LEVELS
∇ **During Drilling/Digging** 1.37 m on 5/21/2025
▼ **Upon Completion** on 5/21/2025 Unknown due to caving

CONTRACTOR
Paddock Drilling

INSPECTOR
M. RODRIGUEZ

APPROVED
DRAFT

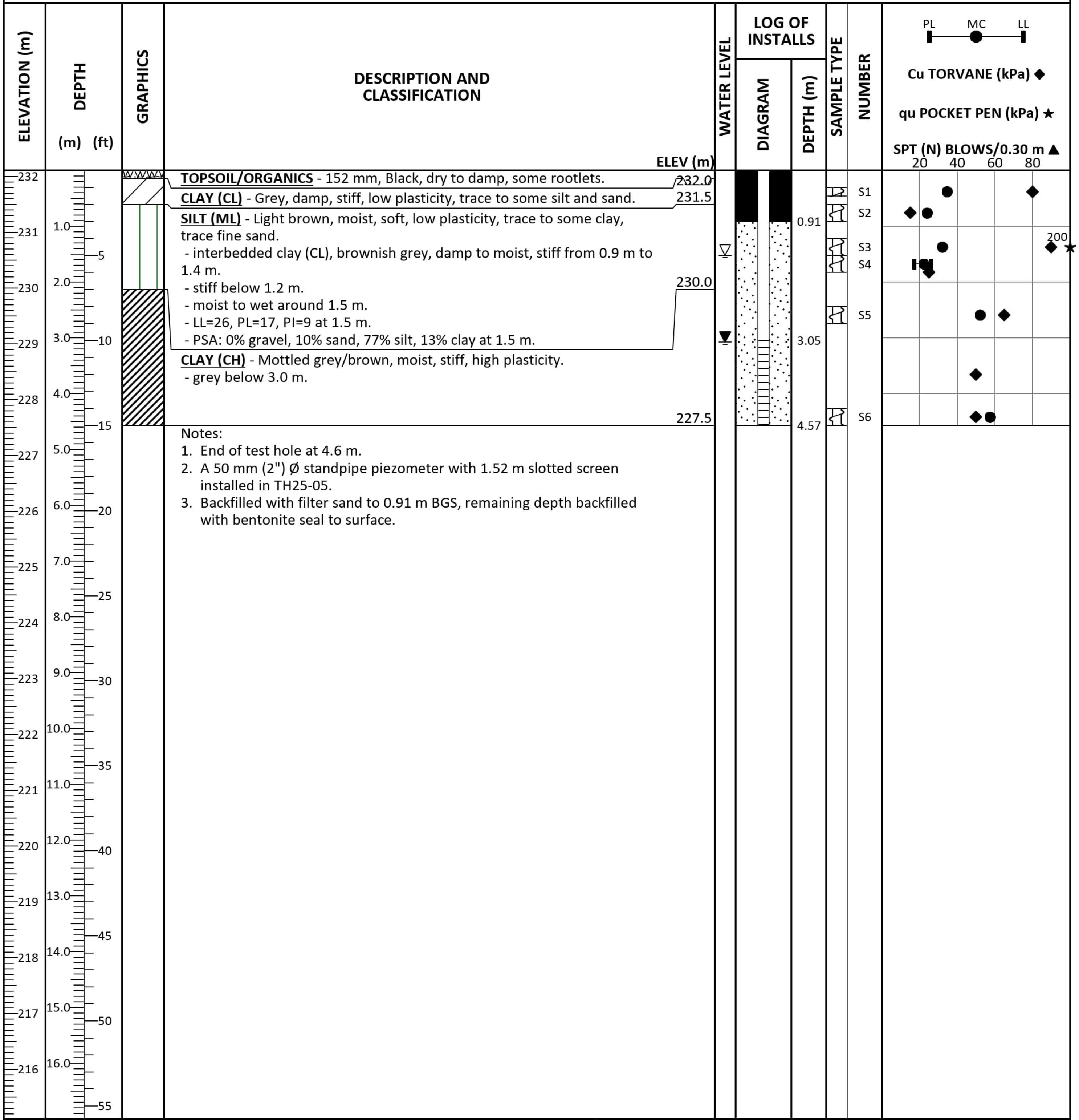
DATE

TEST HOLE LOG

HOLE NO.
TH25-05

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.11 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.91 m / 233.02 m (Standpipe)
DESCRIPTION	East end side of the proposed parking lot	**START DATE**	5/21/2025
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer	**UTM (m)**	N 5,517,631
METHOD(S)	0.0 m to 4.6 m: 125 mm ø SSA		E 630,435.9 Zone 14



TOPSOIL/ORGANICS - 152 mm, Black, dry to damp, some rootlets.

CLAY (CL) - Grey, damp, stiff, low plasticity, trace to some silt and sand.

SILT (ML) - Light brown, moist, soft, low plasticity, trace to some clay, trace fine sand.
- interbedded clay (CL), brownish grey, damp to moist, stiff from 0.9 m to 1.4 m.
- stiff below 1.2 m.
- moist to wet around 1.5 m.
- LL=26, PL=17, PI=9 at 1.5 m.
- PSA: 0% gravel, 10% sand, 77% silt, 13% clay at 1.5 m.

CLAY (CH) - Mottled grey/brown, moist, stiff, high plasticity.
- grey below 3.0 m.

Notes:
1. End of test hole at 4.6 m.
2. A 50 mm (2") Ø standpipe piezometer with 1.52 m slotted screen installed in TH25-05.
3. Backfilled with filter sand to 0.91 m BGS, remaining depth backfilled with bentonite seal to surface.

WATER LEVELS	▽ **During Drilling/Digging**	1.52 m on 5/21/2025
	▼ **Upon Completion**	3.08 m on 5/21/2025 Monitoring Well

CONTRACTOR **Paddock Drilling**	INSPECTOR **M. RODRIGUEZ**
APPROVED DRAFT	DATE

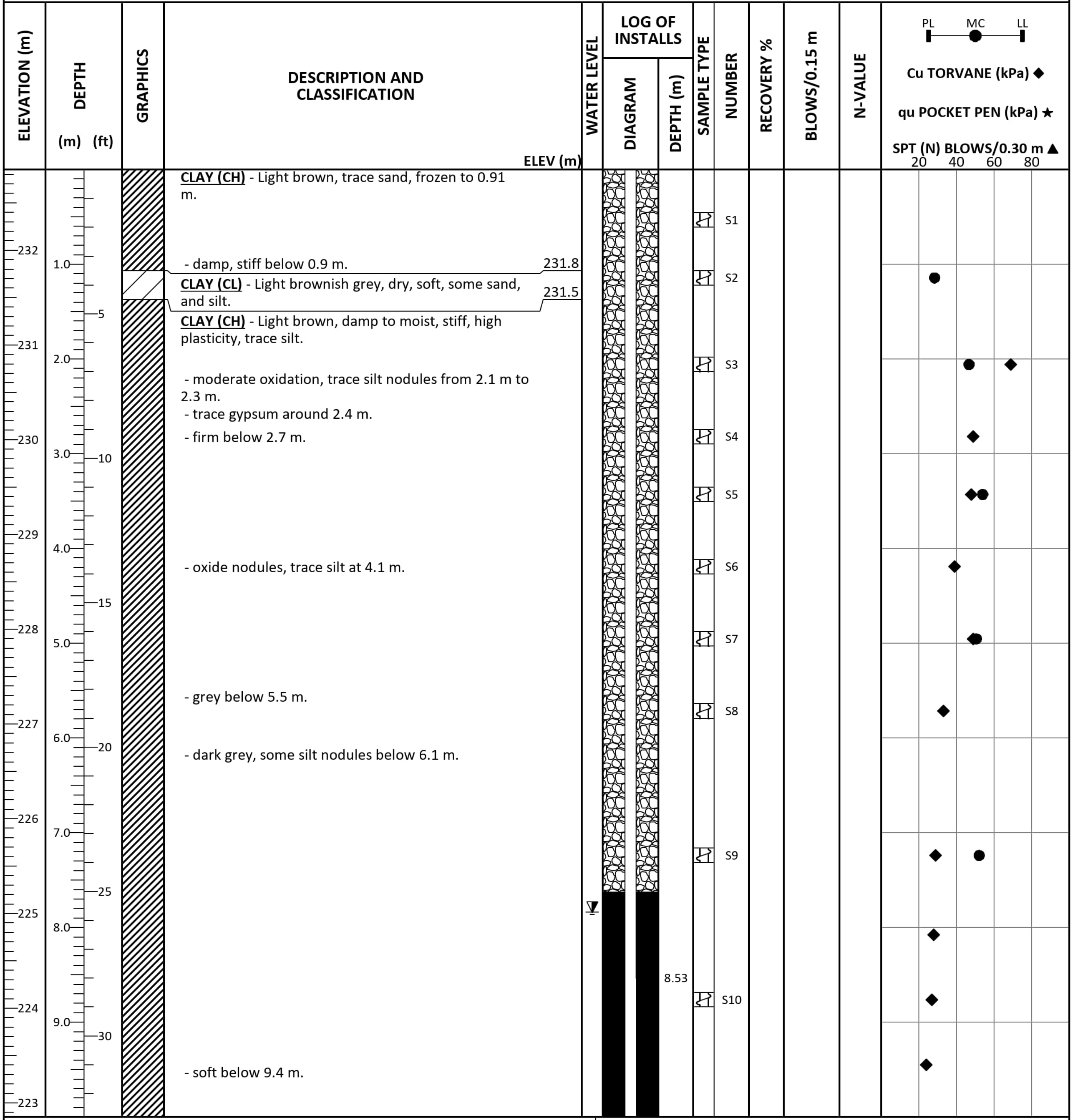
KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-04**

SHEET 1 of 2

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 1 General Investigation**	**SURFACE ELEV.**	232.85 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.98 m / 233.83 m (Standpipe)
DESCRIPTION	NE corner of property, ~50 m South of Cadboro Road	**START DATE**	4-12-2023
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,517,612.58
METHOD(S)	0.0 m to 13.7 m: 125 mm ø SSA - switched due to Sand Blowout 13.7 m to 16.8 m: 150 mm ø HSA		E 630,391.72 Zone 14



<u>CLAY (CH)</u> - Light brown, trace sand, frozen to 0.91 m.

- damp, stiff below 0.9 m. 231.8

<u>CLAY (CL)</u> - Light brownish grey, dry, soft, some sand, and silt. 231.5

<u>CLAY (CH)</u> - Light brown, damp to moist, stiff, high plasticity, trace silt.

- moderate oxidation, trace silt nodules from 2.1 m to 2.3 m.
- trace gypsum around 2.4 m.
- firm below 2.7 m.
- oxide nodules, trace silt at 4.1 m.
- grey below 5.5 m.
- dark grey, some silt nodules below 6.1 m.
- soft below 9.4 m.

WATER LEVELS	▽ **During Drilling/Digging**	Dry
	▼ **Upon Completion**	Dry
	▼ **Remeasured/Static**	7.84 m on 12-16-2023

CONTRACTOR **Paddock Drilling**	INSPECTOR **H. SABHARWAL**
APPROVED T. SCHELLENBERG	DATE 4-28-2023

KGS
GROUP

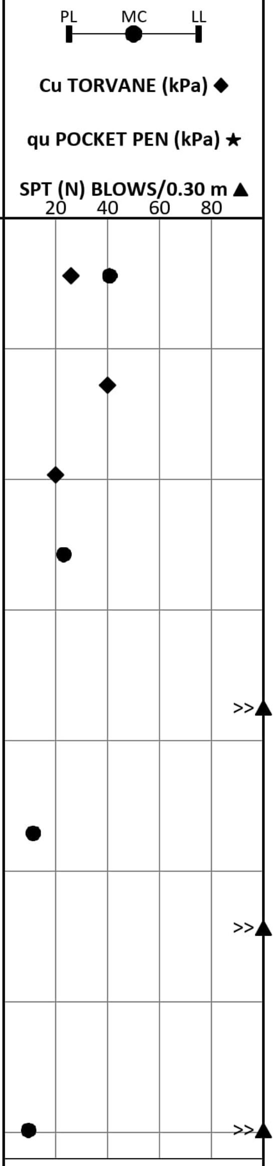
TEST HOLE LOG

HOLE NO.
TH23-04

SHEET 2 of 2

ELEV (m)	DESCRIPTION AND CLASSIFICATION	LOG OF INSTALLS DEPTH (m)	SAMPLE NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
	- trace fine grained gravel , moist at 9.9 m. - increasing silt nodules below 10.1 m.		S11			
			S12	100		
	- firm, silt till clump from 11.3 m to 11.4 m.					
	- trace fine to medium grained gravel at 11.9 m.		S13			
			S14			
219.9	**SILT TILL** - Light grey, dry, dense, some medium to coarse grained gravel, trace fine to medium grained sand.		S15			
	- very dense below 13.7 m.		S17 S16	100	8 50/ -90mm	+100
			S18			
		14.94				
		15.24	S20	100	25 32 50/ 80mm	+100
		16.76	S21	38	41 48 50/ 130mm	+100
215.7		17.20				

ELEVATION (m): 222, 221, 220, 219, 218, 217, 216, 215, 214, 213, 212
DEPTH (m): 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0
DEPTH (ft): 35, 40, 45, 50, 55, 60, 65, 70



Notes:
1. End of test hole at 17.2 m.
2. Test hole remained open to 17.2 m upon completion of drilling/digging.
3. Test hole backfilled with auger cuttings and bentonite chips. An approximate 7.3 m of bentonite seal at surface.
4. Protective well cover installed at surface.

WATER LEVELS		
▽	**During Drilling/Digging**	Dry
▼	**Upon Completion**	Dry
▼	**Remeasured/Static**	7.84 m on 12-16-2023

CONTRACTOR
Paddock Drilling

INSPECTOR
H. SABHARWAL

APPROVED
T. SCHELLENBERG

DATE
4-28-2023

KGS GROUP

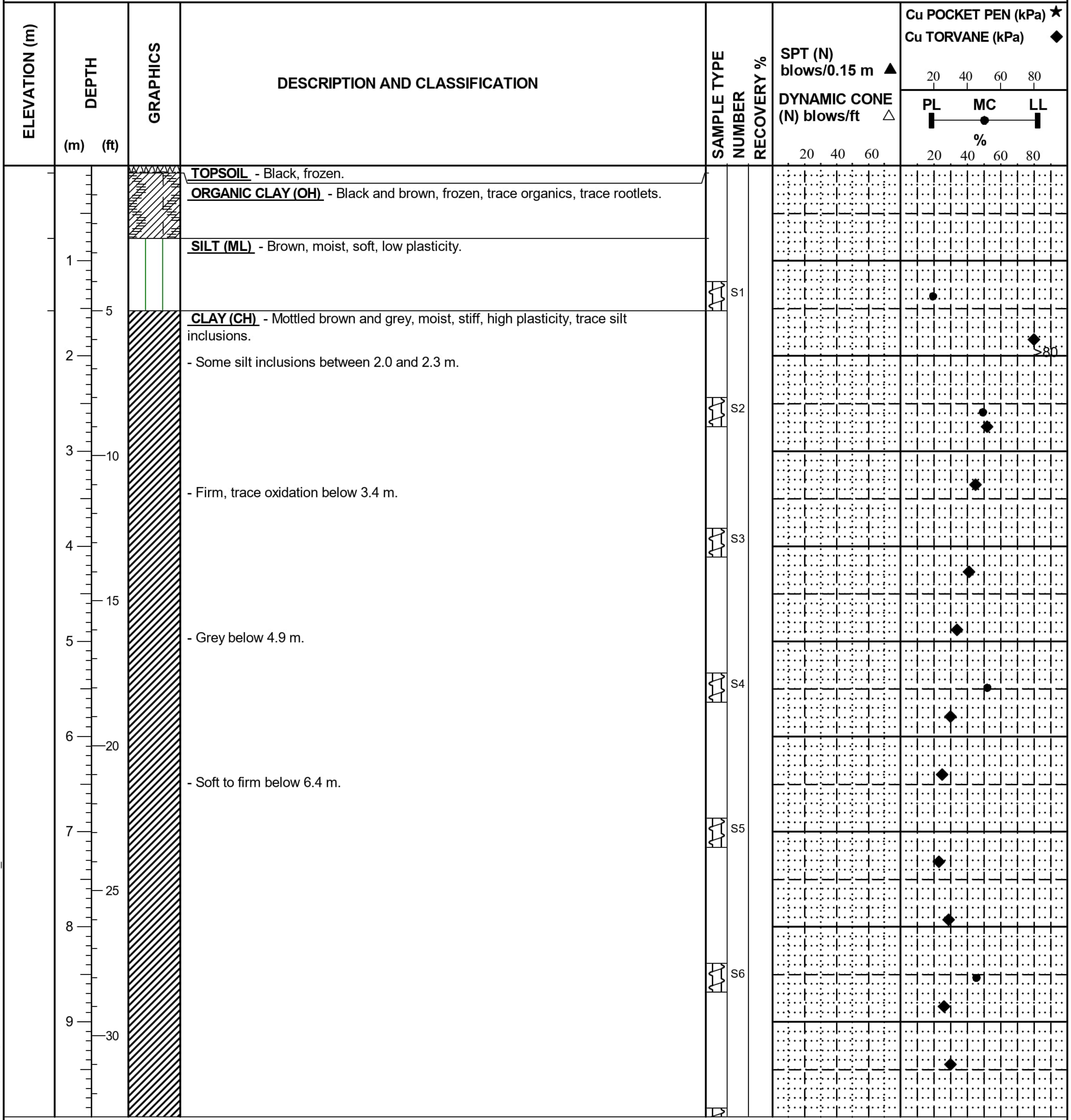
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH20-23

SHEET 1 of 2

CLIENT	**PEMBINA TRAILS SCHOOL DIVISION**	JOB NO.	**20-1522-001**
PROJECT	**Waverley West School Geo. Investigation - Extra Services**	GROUND ELEV.	
		TOP OF PVC ELEV.	
SITE	**Waverley West, Cadboro Rd.**	WATER ELEV.	
LOCATION	**South End Lot, Southeast/Central Daycare**	DATE DRILLED	**1/21/2020**
DRILLING METHOD	**125 mm ø Solid Stem Auger, ACKER MP5 Track Mounted Drill Rig**	UTM (m)	N **5,517,711** E **630,677**



TOPSOIL - Black, frozen.

ORGANIC CLAY (OH) - Black and brown, frozen, trace organics, trace rootlets.

SILT (ML) - Brown, moist, soft, low plasticity.

CLAY (CH) - Mottled brown and grey, moist, stiff, high plasticity, trace silt inclusions.

- Some silt inclusions between 2.0 and 2.3 m.

- Firm, trace oxidation below 3.4 m.

- Grey below 4.9 m.

- Soft to firm below 6.4 m.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

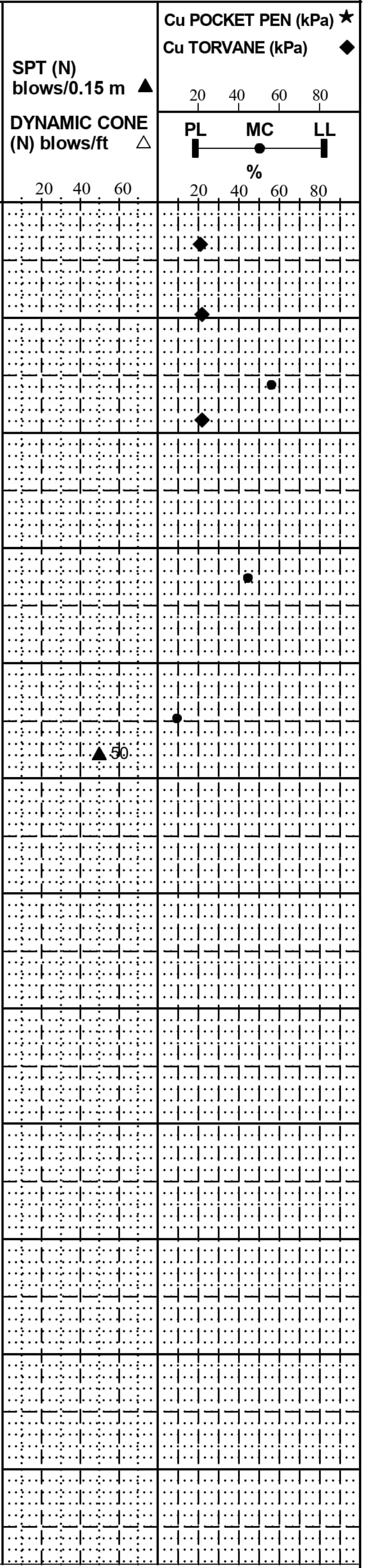
CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	N.BRAY	TE	2/19/20

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
			- Soft below 10.4 m.	⌇	S7	
				⌇	S8	
			- Increased silt inclusions, trace coarse sand below 12.8 m.	⌇	S9	
			SILT TILL - Light brown, dry to moist, some to with fine to coarse grained sand, some fine gravel.	⌇	S10	
				☒	S11	36
			POWER AUGER REFUSAL AT 14.9 m			

Depth (m): 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Depth (ft): 35, 40, 45, 50, 55, 60, 65, 70

Notes:
1. Test hole remained open to 14.0 m upon completion of drilling.
2. No water infiltration observed after completion of drilling.
3. Test hole backfilled with cutting and bentonite chips.



SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR
Paddock Drilling Ltd.

INSPECTOR
N.BRAY

APPROVED
TE

DATE
2/19/20

KGS GROUP

SUMMARY LOG

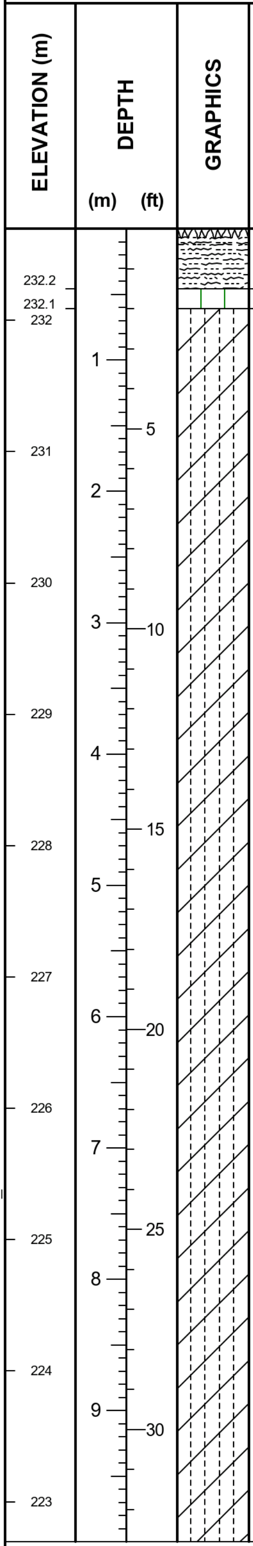
REFERENCE NO.

HOLE NO.
TH18-02

SHEET 1 of 2

CLIENT
PROJECT Waverley West School Geo. Investigation
SITE 2 Design-Build Schools in Waverley West
LOCATION Cadboro Road - South Lot
DRILLING METHOD 125 mm ø Solid Stem Auger, Acker MP5-T

JOB NO. 18-1517-001
GROUND ELEV. 232.70
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 10/26/2018
UTM (m) N 5,517,718
E 630,631



DESCRIPTION AND CLASSIFICATION

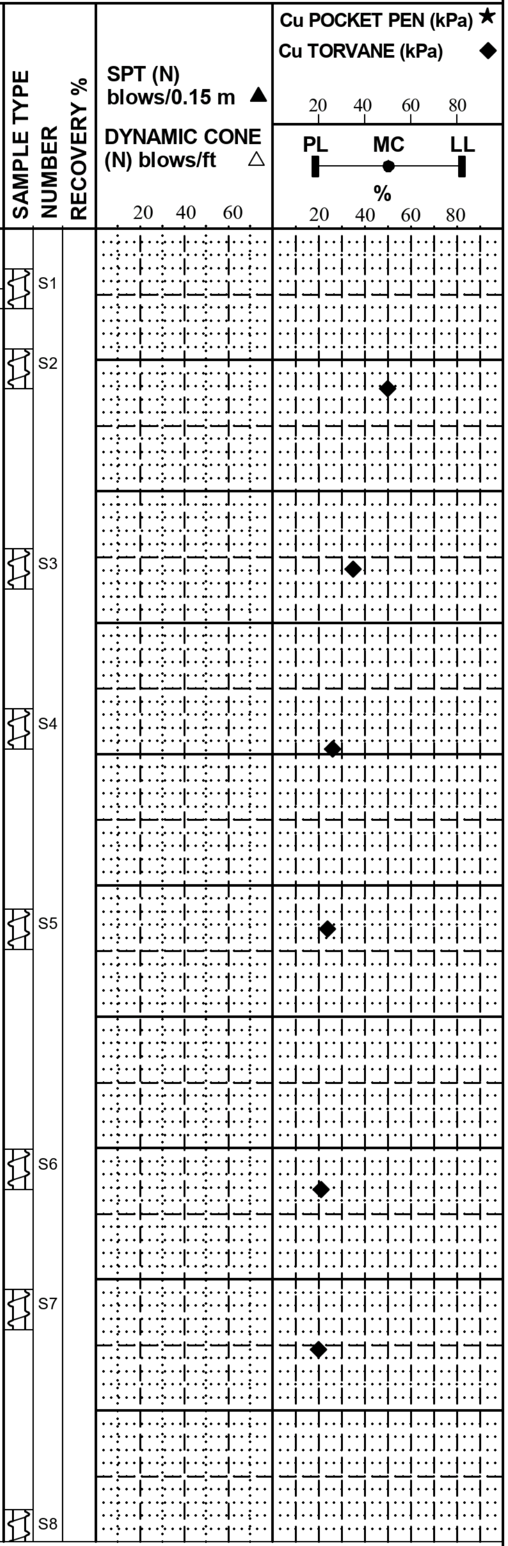
TOPSOIL - Black, dry, loose, with organics.

SILT - Light brown, dry, compact.

SILTY CLAY - Brown, damp-moist, firm, high plasticity.

- Mottled brown below 2.90 m.

- Grey, moist below 8.38 m.



SAMPLE TYPE ⍓ Auger Grab ☒ Split Spoon

CONTRACTOR
Paddock Drilling Ltd.

INSPECTOR
J. WONG

APPROVED
D. ANDERSON

DATE
2/12/19

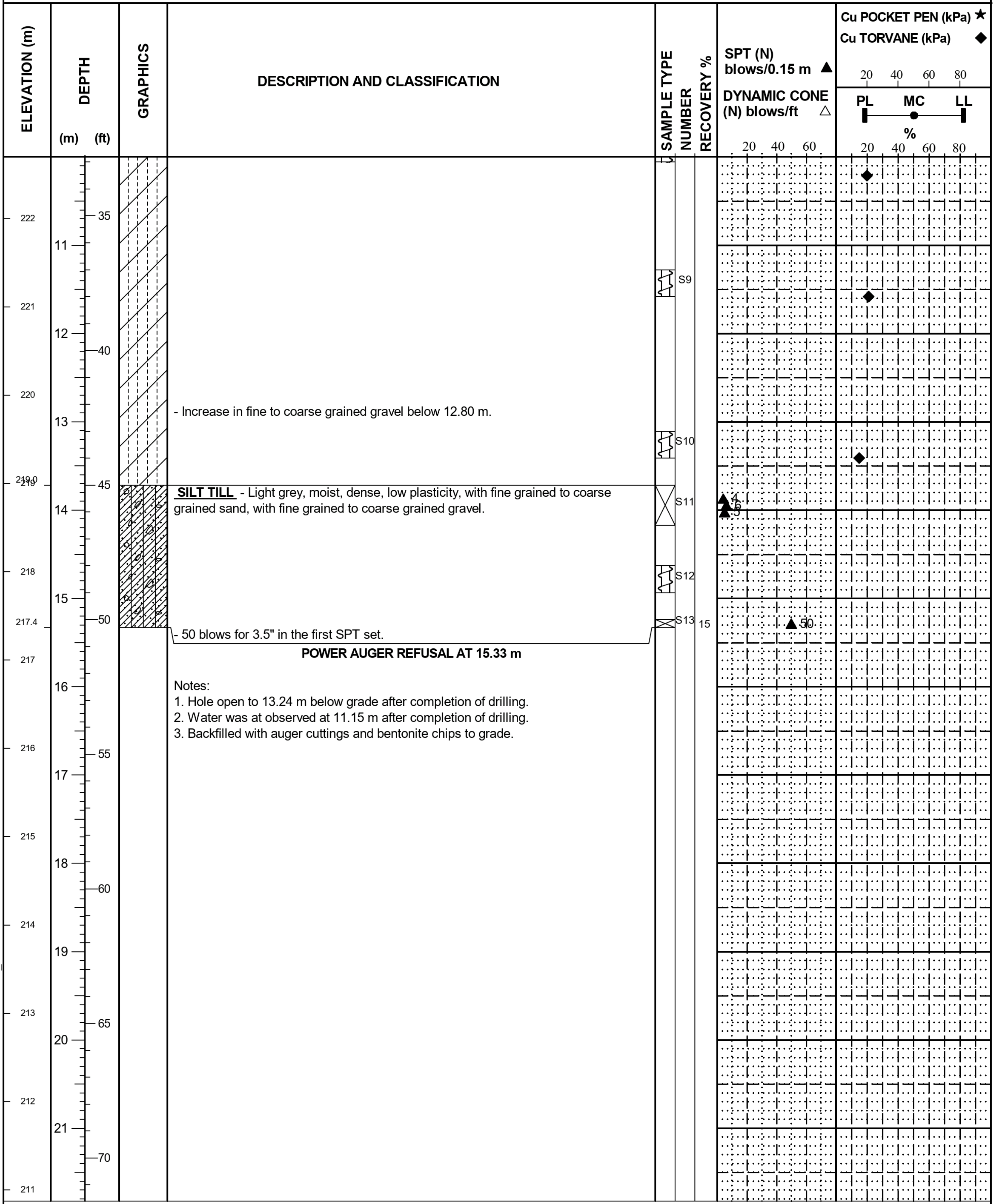
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH18-02**

SHEET 2 of 2



- Increase in fine to coarse grained gravel below 12.80 m.

SILT TILL - Light grey, moist, dense, low plasticity, with fine grained to coarse grained sand, with fine grained to coarse grained gravel.

- 50 blows for 3.5" in the first SPT set.

POWER AUGER REFUSAL AT 15.33 m

Notes:
1. Hole open to 13.24 m below grade after completion of drilling.
2. Water was at observed at 11.15 m after completion of drilling.
3. Backfilled with auger cuttings and bentonite chips to grade.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. WONG	D. ANDERSON	2/12/19

APPENDIX D

Borehole Logs (GWDrill Database)

GW Drill Well Logs
Near the proposed Waverley West Firehall/Paramedic Station

Location: RIVER LOT 0009 IN PARISH OF St. Vital

Well_PID: 184498
Owner: STREETSIDE DEVELOPMENTS INC (QUALICO)
Driller: Friesen Drillers Ltd.
Well Name: RETURN WELL
Well Use: RECHARGE
Water Use:
UTMX: 630077.3390
UTMY: 5517819.7210
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 233
Accuracy Z: 5 General - Shuttle at Centroid
Date Completed: 2015 Jan 19

WELL LOG

From (ft.)	To (ft.)	Log
0	45.0	GREY CLAY
45.0	62.0	GREY CLAY TILL
62.0	67.0	BROWN TILL
67.0	72.0	BROKEN BEDROCK
72.0	260.0	LIMESTONE BEDROCK

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	74.0	CASING	5.00	5.50		INSERT	PVC
74.0	260.0	OPEN HOLE					
15.0	70.0	CASING GROUT				CEMENT	

Top of Casing: 2.000 ft. above ground

PUMPING TEST

Date: 2013 Aug 11
Pumping Rate: 75.000 Imp. gallons/minute
Water level before pumping: 31.7 ft. below ground

Pumping level at end of test: 33.1 ft. below ground
Test duration: 4 hours, minutes
Water temperature: ?? degrees F

REMARKS

RETURN WELL. WELL IS LOCATED 10 HILL GROVE POINT WAVERLY WEST, THE MIX CONDO BUILDING. WEST OF THE MIX CONDO. 1 DR. DAVID FRIESEN DR, WINNIPEG, MANITOBA, R3X 0G8

Location: RIVER LOT 0009 IN PARISH OF St. Vital

Well_PID: 184497
Owner: STREETSIDE DEVELOPMENTS INC (QUALICO)
Driller: Friesen Drillers Ltd.
Well Name: SUPPLY WELL
Well Use: PRODUCTION
Water Use: GEOTHERMAL
UTMX: 629998.2140
UTMY: 5517547.5110
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 233
Accuracy Z: 5 General - Shuttle at Centroid
Date Completed: 2015 Jan 19

WELL LOG

From (ft.)	To (ft.)	Log
0	44.0	GREY CLAY
44.0	70.0	GREY CLAY TILL
70.0	78.0	BROKEN BEDROCK
78.0	200.0	LIMESTONE BEDROCK

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	81.0	CASING	5.00	5.50		INSERT	PVC
81.0	200.0	OPEN HOLE		4.80			
15.0	80.0	CASING GROUT					CEMENT

Top of Casing: 2.000 ft. above ground

PUMPING TEST

Date: 2013 Aug 11
Pumping Rate: 90.000 Imp. gallons/minute
Water level before pumping: 30.2 ft. below ground
Pumping level at end of test: 33.7 ft. below ground
Test duration: 4 hours, minutes
Water temperature: ?? degrees F

REMARKS

WELL LOCATED AT 10 HILL GROVE POINT ROAD, WAVERLY WEST THE MIS CONDO BUILDING SOUTHWEST OF THE RETURN WELL. 1 DR. DAVID FRIESEN DR, WINNIPEG, MANITOBA, R3X 0G8.Q:50IGPM PI:80FT

Location: OUTER TWO MILE LOT 0001 IN PARISH OF St. Vital

Well_PID: 193287
Owner: DR GHULAM MEMON
Driller: Perimeter Drilling Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 630724.3670
UTMY: 5517176.8350
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 229
Accuracy Z: 5 General - Shuttle at Centroid
Date Completed: 2016 Sep 23

WELL LOG

From (ft.)	To (ft.)	Log
0	4.0	BACKFILL
4.0	53.0	CLAY
53.0	70.0	TILL
70.0	72.0	BROKEN LIMESTONE
72.0	100.0	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	75.0	CASING	5.00	5.50		INSERT	PVC
75.0	100.0	OPEN HOLE	4.75				

Top of Casing: 2.000 ft. above ground

PUMPING TEST

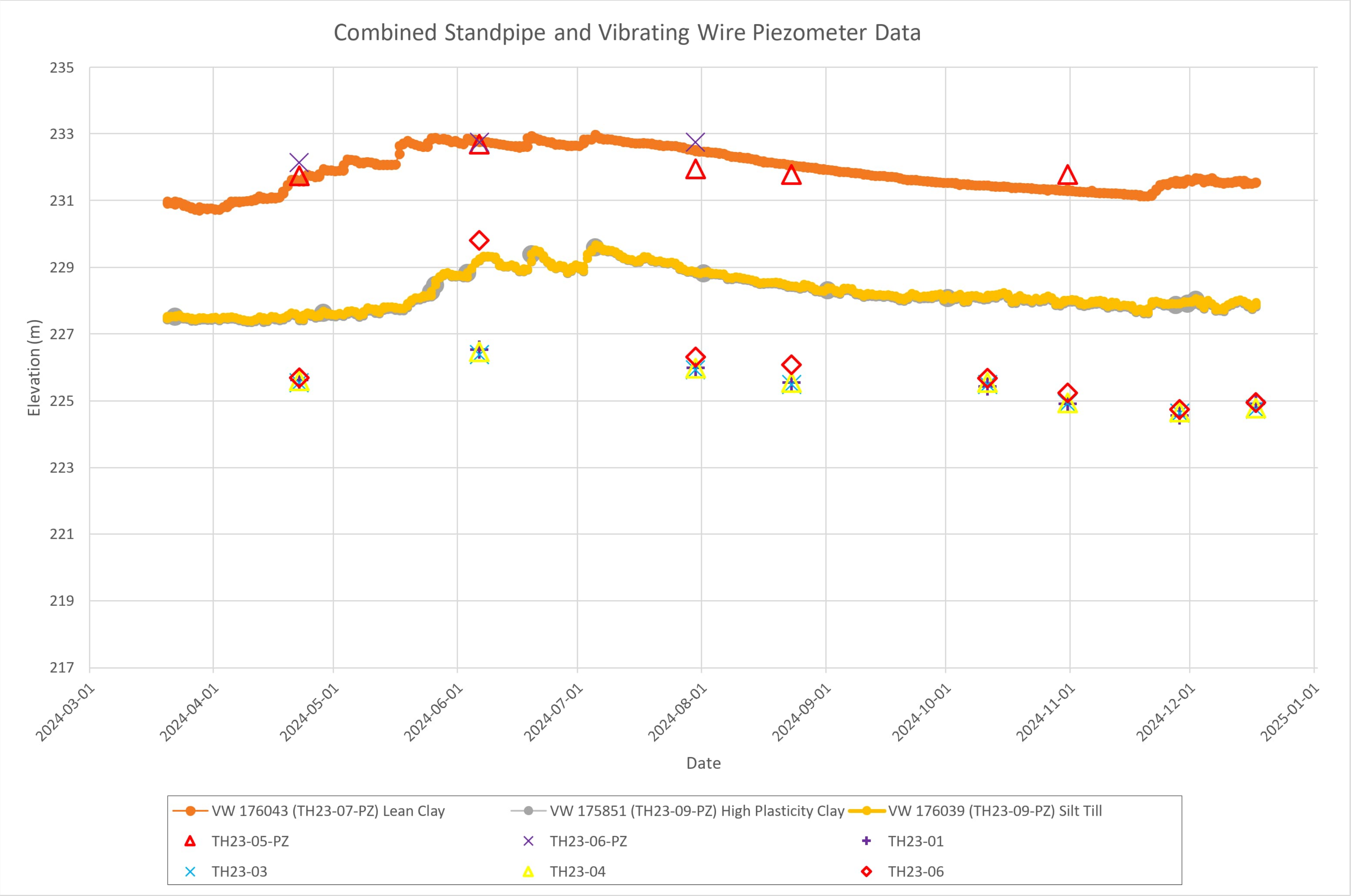
Date: 2016 Sep 01
Pumping Rate: 30.000 Imp. gallons/minute
Water level before pumping: 20.0 ft. below ground
Pumping level at end of test: 20.0 ft. below ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

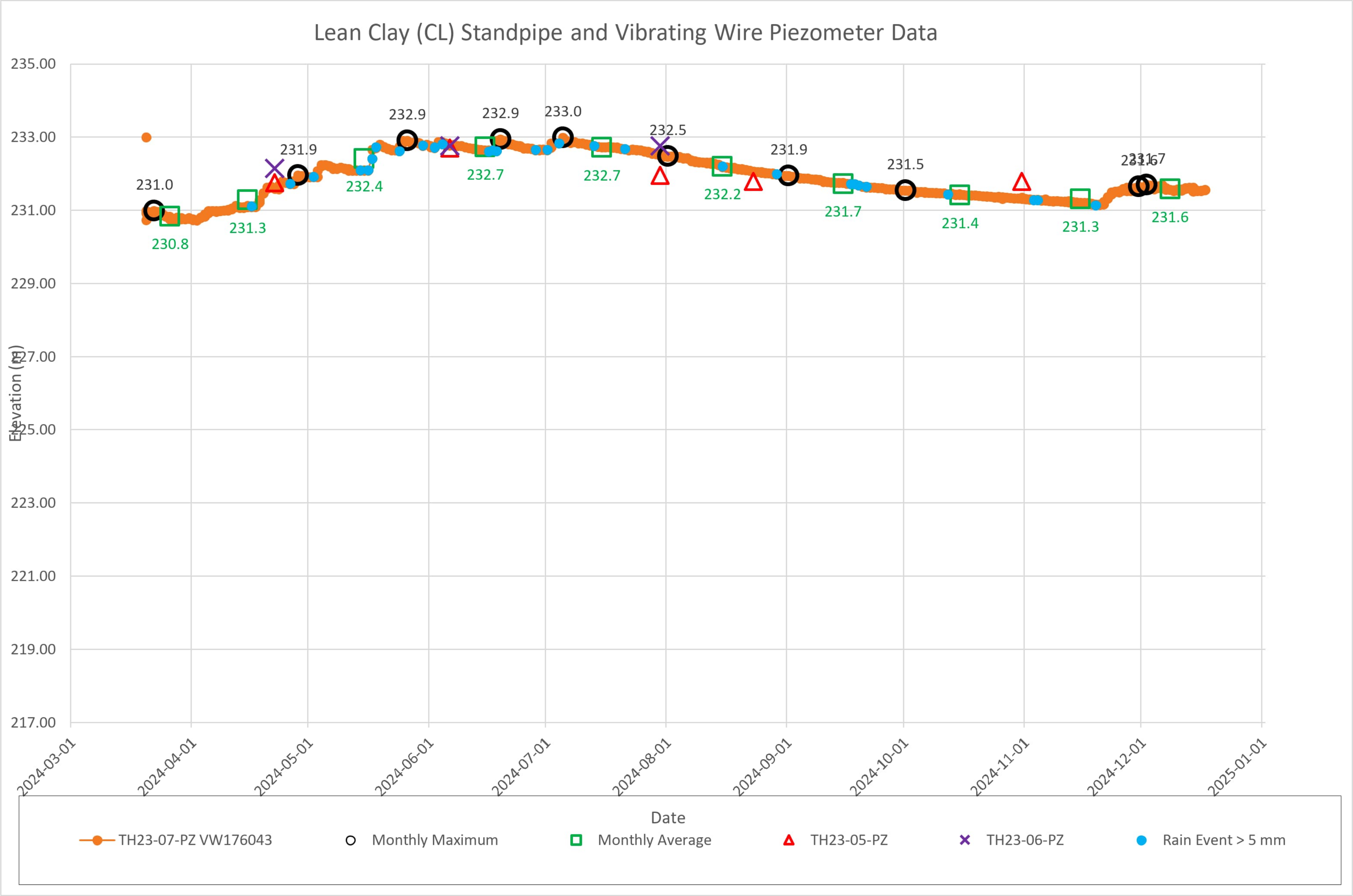
REMARKS

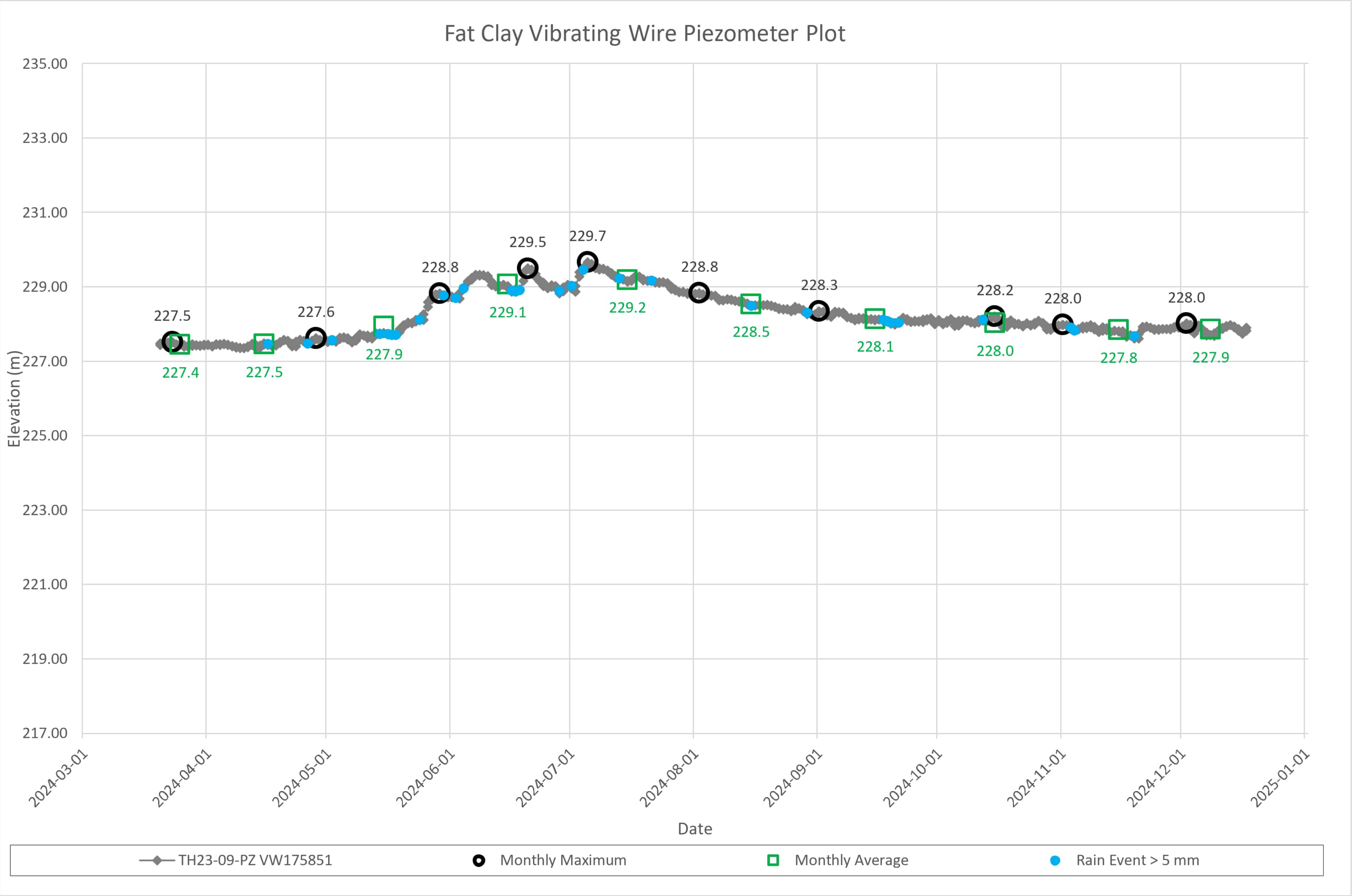
185 LEE BLVD , WPG MB . WELL GROUTED . AIR LIFT . Q: 20 IGPM PI: 50 FT .

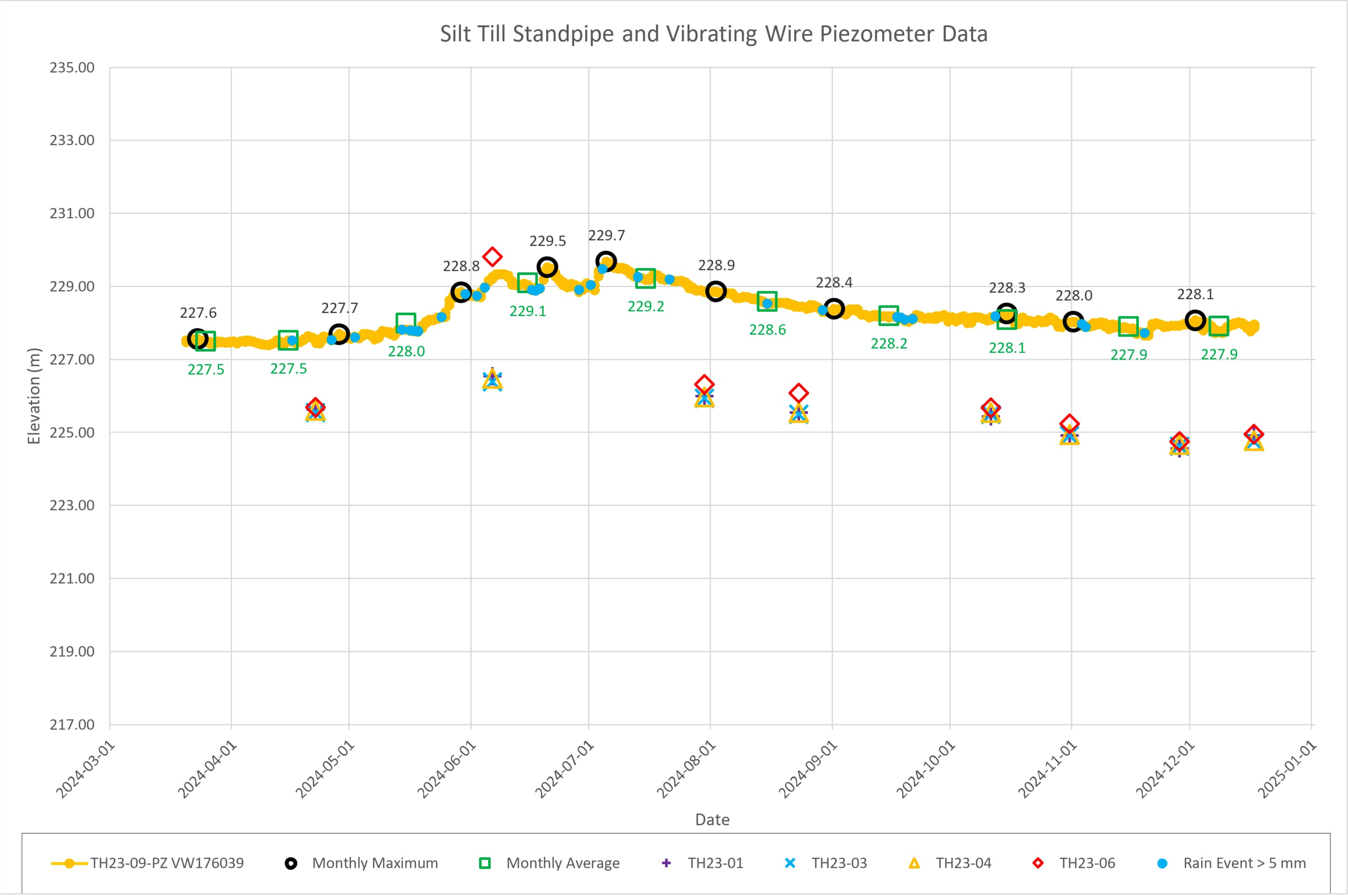
APPENDIX E

Groundwater Monitoring Data (2024) from South Winnipeg Recreation Campus by KGS Group


Combined Standpipe and Vibrating Wire Piezometer Data
235
233
231
229
227
225
223
221
219
217
Elevation (m)
2024-03-01
2024-04-01
2024-05-01
2024-06-01
2024-07-01
2024-08-01
2024-09-01
2024-10-01
2024-11-01
2024-12-01
2025-01-01
Date
VW 176043 (TH23-07-PZ) Lean Clay
VW 175851 (TH23-09-PZ) High Plasticity Clay
VW 176039 (TH23-09-PZ) Silt Till
TH23-05-PZ
TH23-06-PZ
TH23-01
TH23-03
TH23-04
TH23-06


Lean Clay (CL) Standpipe and Vibrating Wire Piezometer Data
Elevation (m)
235.00
233.00
231.00
229.00
227.00
225.00
223.00
221.00
219.00
217.00
2024-03-01
2024-04-01
2024-05-01
2024-06-01
2024-07-01
2024-08-01
2024-09-01
2024-10-01
2024-11-01
2024-12-01
2025-01-01
Date
231.0
231.9
232.9
232.9
233.0
232.5
231.9
231.5
231.6
231.7
230.8
231.3
232.4
232.7
232.7
232.2
231.7
231.4
231.3
231.6
TH23-07-PZ VW176043
Monthly Maximum
Monthly Average
TH23-05-PZ
TH23-06-PZ
Rain Event > 5 mm


Fat Clay Vibrating Wire Piezometer Plot
Elevation (m)
235.00
233.00
231.00
229.00
227.00
225.00
223.00
221.00
219.00
217.00
2024-03-01
2024-04-01
2024-05-01
2024-06-01
2024-07-01
2024-08-01
2024-09-01
2024-10-01
2024-11-01
2024-12-01
2025-01-01
Date
227.5
227.4
227.5
227.6
227.9
228.8
229.5
229.1
229.7
229.2
228.8
228.5
228.3
228.1
228.2
228.0
228.0
227.8
228.0
227.9
TH23-09-PZ VW175851
Monthly Maximum
Monthly Average
Rain Event > 5 mm


Silt Till Standpipe and Vibrating Wire Piezometer Data
235.00
233.00
231.00
229.00
227.00
225.00
223.00
221.00
219.00
217.00
Elevation (m)
2024-03-01
2024-04-01
2024-05-01
2024-06-01
2024-07-01
2024-08-01
2024-09-01
2024-10-01
2024-11-01
2024-12-01
2025-01-01
Date
227.6
227.7
228.8
229.5
229.7
228.9
228.4
228.3
228.0
228.1
227.5
227.5
228.0
229.1
229.2
228.6
228.2
228.1
227.9
227.9
TH23-09-PZ VW176039
Monthly Maximum
Monthly Average
TH23-01
TH23-03
TH23-04
TH23-06
Rain Event > 5 mm

APPENDIX 2

Landscape Site Plan L1.00

LEGEND

- PROPERTY LINE
- 3.5m WIDE ASPHALT MULTI-USE PATHWAY PAVING C/W RUMBLE STRIP
- CONCRETE PAVING
- CONCRETE SPRAY PAD BASIN & 1.5m OVERSPRAY AREA, SANDBLASTING PATTERN THROUGHOUT TBC
- SOD
- PLANTING BED
- TACTILE WARNING PLATES
- CONCRETE CURB
- PLUGS ON PEDESTAL, REFER TO ELECTRICAL
- NEW SPEED TABLE CROSSING C/W UNIT PAVERS
- NEW TREE
- BUILDING ENTRANCE
- ELECTRIC VEHICLE PARKING SPOT, REFER TO ELECTRICAL
- PARKING STALL
- ACCESSIBLE PARKING SPOT
- BIKE PARKING
- PEDESTRIAN CROSSING (PAINTED LINES)

CITY OF WINNIPEG LANDSCAPING REQUIREMENTS AS PER BY-LAW NO. 200/2006 - PART 5: DEVELOPMENT AND DESIGN STANDARDS

STREET EDGE LANDSCAPING:
1 TREE PER 9.144 LIN. METERS OF STREET FRONTAGE
3 SHRUBS PER 6.096 LIN. M. OF STREET FRONTAGE.

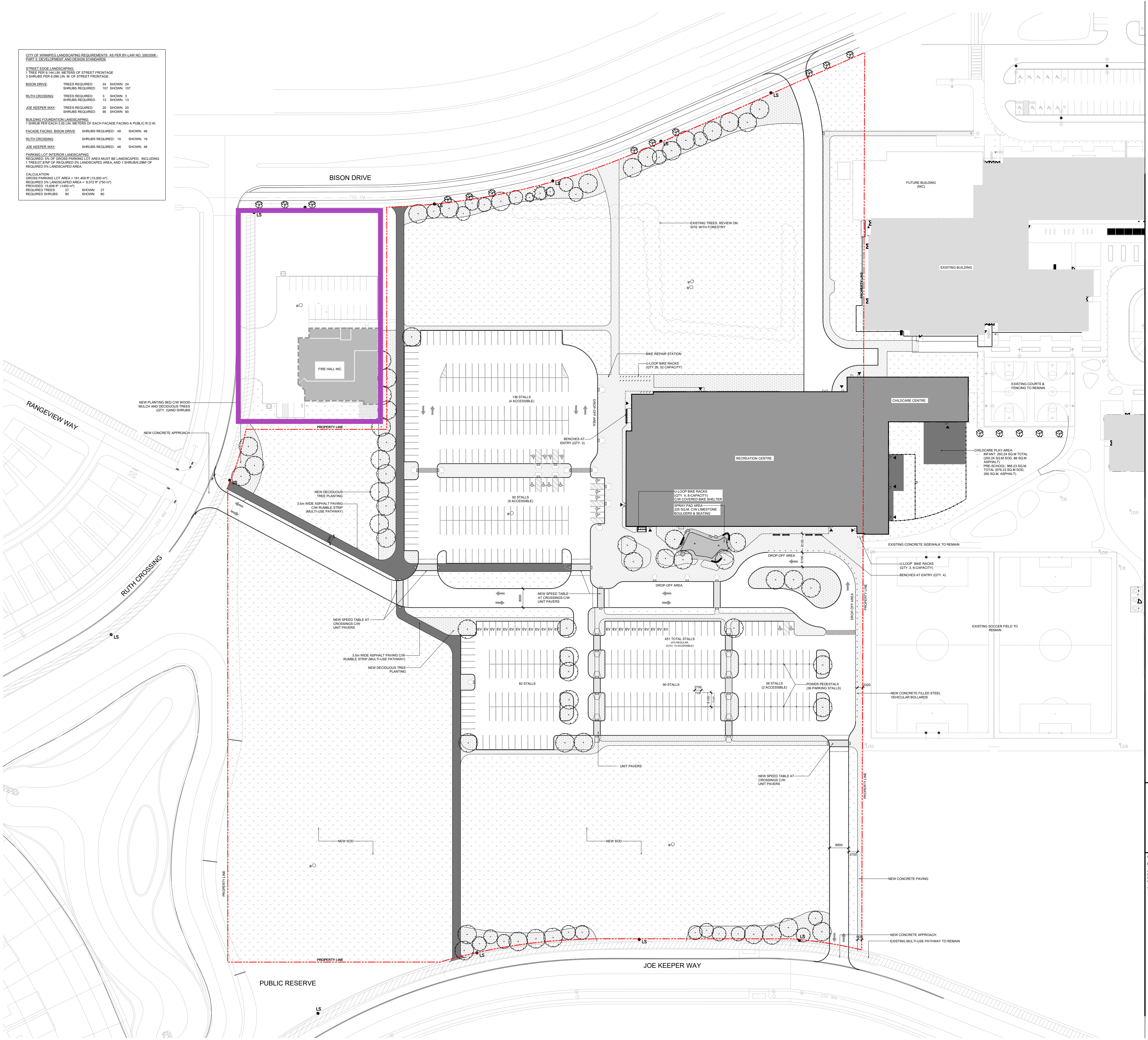
BISON DRIVE:	TREES REQUIRED:	24	SHOWN: 24
	SHRUBS REQUIRED:	107	SHOWN: 107
RUTH CROSSING:	TREES REQUIRED:	3	SHOWN: 3
	SHRUBS REQUIRED:	13	SHOWN: 13
JOE KEEPER WAY:	TREES REQUIRED:	20	SHOWN: 20
	SHRUBS REQUIRED:	90	SHOWN: 90

BUILDING FOUNDATION LANDSCAPING:
1 SHRUB PER EACH 3.05 LIN. METERS OF EACH FACADE FACING A PUBLIC R.O.W.

FACADE FACING BISON DRIVE:	SHRUBS REQUIRED: 48	SHOWN: 48
RUTH CROSSING:	SHRUBS REQUIRED: 19	SHOWN: 19
JOE KEEPER WAY:	SHRUBS REQUIRED: 48	SHOWN: 48

PARKING LOT INTERIOR LANDSCAPING:
REQUIRED: 5% OF GROSS PARKING LOT AREA MUST BE LANDSCAPED. INCLUDING 1 TREE/27.87M² OF REQUIRED 5% LANDSCAPED AREA, AND 1 SHRUB/9.29M² OF REQUIRED 5% LANDSCAPED AREA.

CALCULATION:
GROSS PARKING LOT AREA = 161,459 ft² (15,000 m²)
REQUIRED 5% LANDSCAPED AREA = 8,072 ft² (750 m²)
PROVIDED: 15,608 ft² (1450 m²)
REQUIRED TREES: 27 SHOWN: 27
REQUIRED SHRUBS: 80 SHOWN: 80



diamond schmitt

Stamp

BrookMcIlroy/

Winnipeg
THE CITY OF WINNIPEG
ASSETS & PROJECT MANAGEMENT DEPARTMENT
MUNICIPAL ACCOMMODATIONS DIVISION
3-65 GARRY STREET, R3C 4K4

Manitoba
Consumer Protection and Government Services
200 - 400 Ellice Avenue,
Winnipeg, Manitoba R3B 3M3

Issued

No.	Date	Description
1.	2042/12/02	DD SUBMISSION

NOT FOR CONSTRUCTION

Contractor Must Check & Verify all Dimensions on the Job.

Do Not Scale Drawings.

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This Drawing is Not to be Used for Construction Until Signed by the Architect.

South Winnipeg Recreation Campus
Address: 145 Cadboro Rd
Winnipeg, MB R3Y 1R7
Consultant Project No: 220007
City of Winnipeg Project No: 2020-127
City of Winnipeg Tender No: -

LANDSCAPE SITE PLAN
Scale: As Indicated

L1.00

APPENDIX 3

Test Hole Logs

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH25-01

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.03 m
LOCATION	Winnipeg, Manitoba	**START DATE**	5/20/2025
DESCRIPTION	Southwest corner of the proposed building	**UTM (m)**	N 5,517,616.04
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer		E 630,454.56 Zone 14
METHOD(S)	0.0 m to 15.3 m: 125 mm ø SSA		

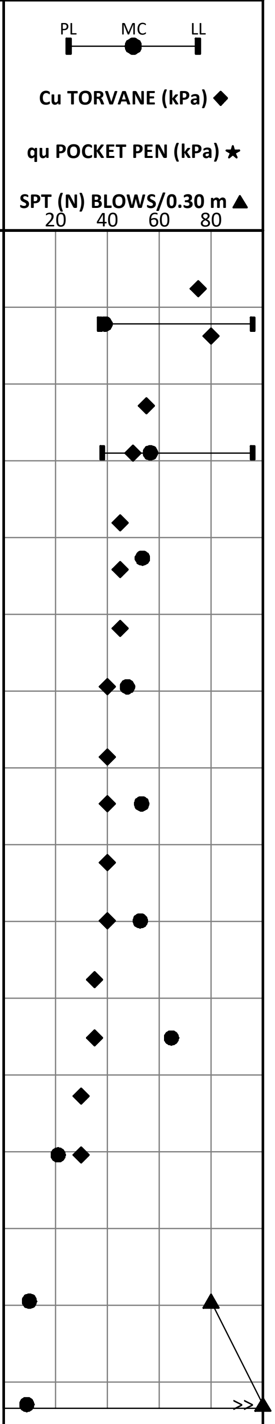
DESCRIPTION AND CLASSIFICATION

ELEV (m)	Description
231.9	**TOPSOIL/ORGANICS** - 152 mm, Black, dry to damp, some rootlets.
	CLAY (CH) - Grey, damp to moist, stiff, high plasticity, trace to some silt. - LL=96, PL=37, PI=59 at 1.1 m. - mottled grey/brown below 1.5 m. - with silt below 2.4 m. - LL=96, PL=38, PI=58 at 2.7 m. - PSA: 0% gravel, 0% sand, 25% silt, 75% clay at 2.7 m. - moist, firm below 3.8 m. - trace silt pockets below 4.1 m. - grey below 6.1 m. - light grey, moist to wet, increasing silt content below 11.9 m.
219.4	**SILT TILL** - Light grey, moist to wet, very stiff, trace to some fine to coarse gravel and sand, some clay. - hard below 13.7 m.
216.7	

Notes:
1. End of test hole at 15.3 m.
2. Refusal encountered in silt till at a depth of 15.2 m.
3. Test hole backfilled with auger cuttings and bentonite chips.
4. Squeezing encountered at approximately 9.15 m.

Water level during drilling: ⊽ at approx. 11.9 m.

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6			
S7			
S8			
S9			
S10	100	13 30 50	80
S11			
S12	28	50/ 100mm	+100



WATER LEVELS	⊽ **During Drilling/Digging**	11.89 m on 5/20/2025
	▼ **Upon Completion**	on 5/20/2025 Unknown due squeezing

CONTRACTOR **Paddock Drilling**	INSPECTOR **M. RODRIGUEZ**
APPROVED T. SCHELLENBERG	DATE 6/20/2025

TEST HOLE LOG

HOLE NO.
TH25-02

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.25 m
LOCATION	Winnipeg, Manitoba	**START DATE**	5/20/2025
DESCRIPTION	Northeast corner of the proposed building	**UTM (m)**	N 5,517,570.76
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer		E 630,436.68 Zone 14
METHOD(S)	0.0 m to 15.0 m: 125 mm ø SSA		

ELEVATION (m) | **DEPTH (m) (ft)** | **GRAPHICS** | **DESCRIPTION AND CLASSIFICATION** | **ELEV (m)**

TOPSOIL/ORGANICS - 152 mm, Black, dry to damp, some rootlets. — 232.1

CLAY (CH) - Grey, damp to moist, stiff, high plasticity, trace to some silt, trace to some sand to a depth of 0.75 m.

- mottled grey/brown below 1.5 m.
- trace silt pockets below 3.7 m.
- firm below 5.2 m.
- moist below 6.1 m.
- grey below 9.1 m.

219.4

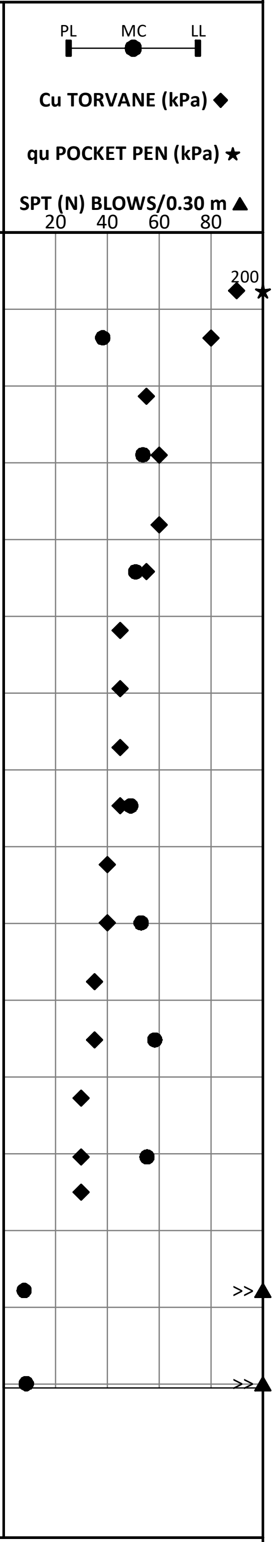
SILT TILL - Light grey, moist to wet, very stiff, trace to some fine to coarse gravel and sand, some clay.

- wet, hard below 13.7 m.
- hard drilling/ grinding below 14.0 m.

217.2

Notes:
1. End of test hole at 15.0 m.
2. Refusal encountered in silt till at a depth of 14.9 m.
3. Test hole backfilled with auger cuttings and bentonite chips.
4. Squeezing encountered at approximately 6.71 m.

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6			
S7			
S8			
S9			
S10	28	50/ 130mm	+100
S11	25	50/ 110mm	+100



WATER LEVELS	▽ **During Drilling/Digging**	13.72 m on 5/20/2025	
	▼ **Upon Completion**	11.28 m on 5/20/2025	

CONTRACTOR
Paddock Drilling

INSPECTOR
M. RODRIGUEZ

APPROVED
T. SCHELLENBERG

DATE
6/20/2025

TEST HOLE LOG

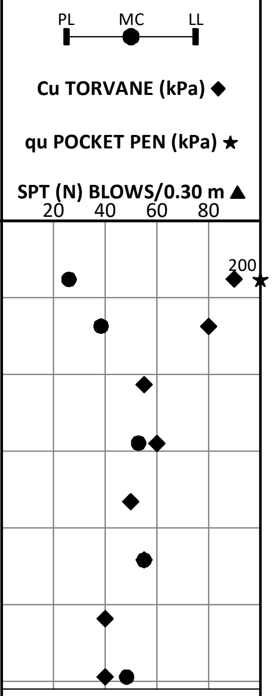
HOLE NO.
TH25-03

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.27 m
LOCATION	Winnipeg, Manitoba	**START DATE**	5/21/2025
DESCRIPTION	Site access off of Ruth Crossing	**UTM (m)**	N 5,517,568.48
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer		E 630,405.7 Zone 14
METHOD(S)	0.0 m to 6.1 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
232			**TOPSOIL/ORGANICS** - 229 mm, Black, dry to damp, some rootlets.	232.0			
			CLAY (CH) - Grey, damp to moist, stiff, high plasticity, trace to some silt, trace to some sand to a depth of 0.75 m.				S1
231	1.0		- mottled grey/brown below 1.1 m.				S2
229	3.0		- moist below 3.0 m.				S3
228			- grey, firm below 4.6 m.				S4
226	6.0			226.2			S5

Notes:
1. End of test hole at 6.1 m.
2. Test hole remained open to 6.1 m upon completion of drilling/digging.
3. Test hole backfilled with auger cuttings and bentonite chips.



WATER LEVELS ▽ **During Drilling/Digging**	on 5/21/2025 Dry	
▼ **Upon Completion**	on 5/21/2025 Dry	

CONTRACTOR
Paddock Drilling

INSPECTOR
M. RODRIGUEZ

APPROVED
T. SCHELLENBERG

DATE
6/20/2025

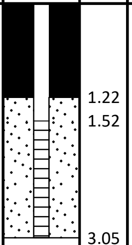
TEST HOLE LOG

HOLE NO.
TH25-03a

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.37 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.85 m / 233.22 m (Standpipe)
DESCRIPTION	Site access off of Ruth Crossing	**START DATE**	5/21/2025
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer	**UTM (m)**	N 5,517,567.51 E 630,406.06 Zone 14
METHOD(S)	0.0 m to 3.0 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	LOG OF INSTALLS: DIAGRAM	LOG OF INSTALLS: DEPTH (m)	SAMPLE TYPE	NUMBER	PL MC LL Cu TORVANE (kPa) ◆ qu POCKET PEN (kPa) ★ SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
			TOPSOIL/ORGANICS - 229 mm, Black, dry to damp, some rootlets.	232.1						
		▨	**CLAY (CH)** - Grey, damp to moist, stiff, high plasticity, trace to some silt, trace to some sand to a depth of 0.75 m. - mottled grey/brown below 1.1 m.	229.3			1.22 1.52 3.05			



Notes:
1. End of test hole at 3.0 m.
2. Test hole remained open to 3.0 m upon completion of drilling/digging.
3. Protective well cover installed at surface.
4. TH25-03a is located approximately 1.0 m south of TH25-03.
5. No soil sampling and field testing performed in TH25-03a.
6. A 50 mm (2") Ø standpipe piezometer with 1.52 m slotted screen installed in TH25-03a.
7. Backfilled with filter sand to 1.22 m BGS, remaining depth backfilled with bentonite seal to surface.

WATER LEVELS ▽ **During Drilling/Digging**	on 5/21/2025 Dry	
▼ **Upon Completion**	on 5/21/2025 Dry	

CONTRACTOR
Paddock Drilling

INSPECTOR
M. RODRIGUEZ

APPROVED
T. SCHELLENBERG

DATE
6/20/2025

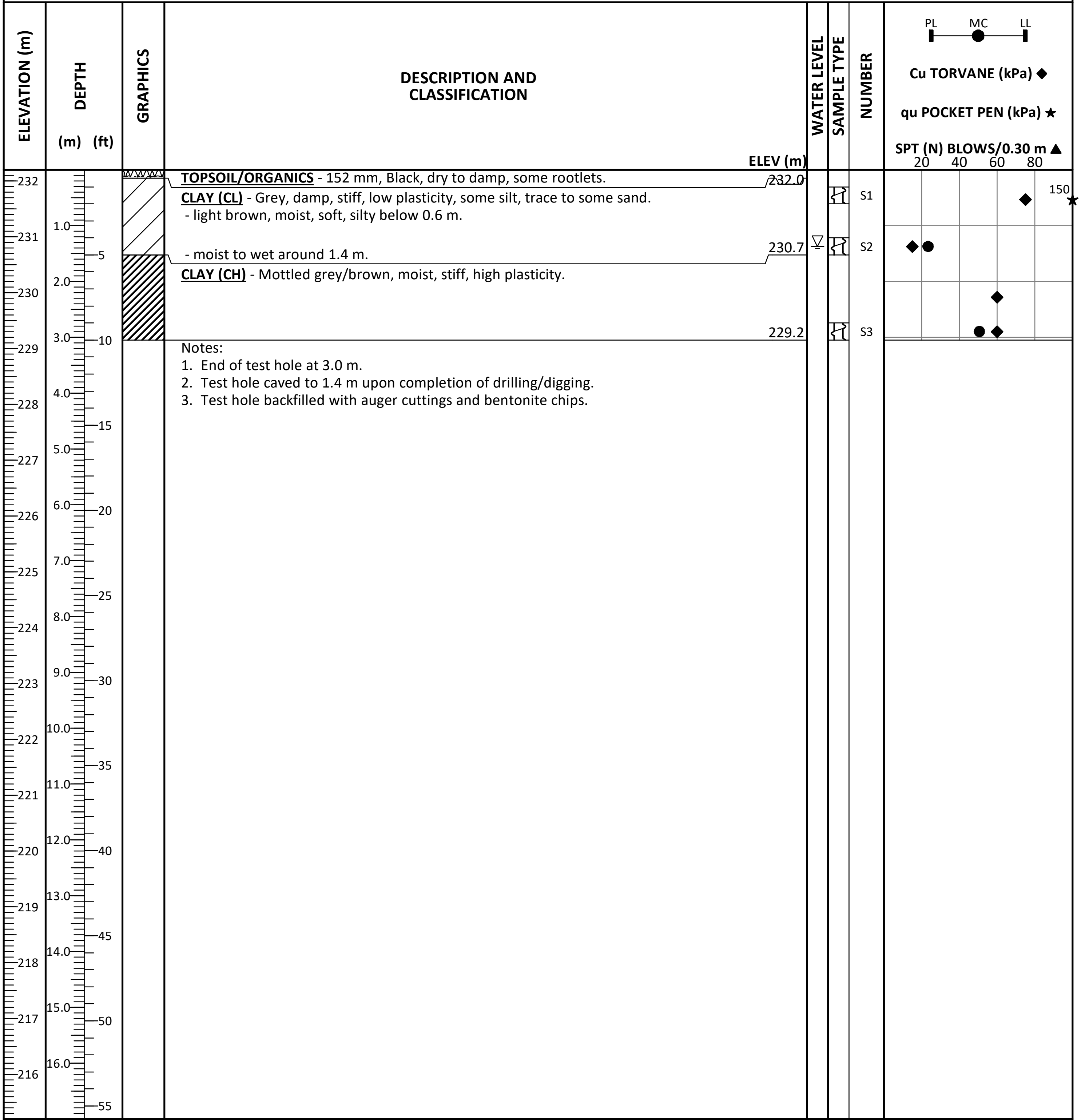
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH25-04

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.20 m
LOCATION	Winnipeg, Manitoba	**START DATE**	5/21/2025
DESCRIPTION	West end side of the proposed parking lot	**UTM (m)**	N 5,517,599.34
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer		E 630,403.41 Zone 14
METHOD(S)	0.0 m to 3.0 m: 125 mm ø SSA		



TOPSOIL/ORGANICS - 152 mm, Black, dry to damp, some rootlets.

CLAY (CL) - Grey, damp, stiff, low plasticity, some silt, trace to some sand.
- light brown, moist, soft, silty below 0.6 m.

- moist to wet around 1.4 m.

CLAY (CH) - Mottled grey/brown, moist, stiff, high plasticity.

Notes:
1. End of test hole at 3.0 m.
2. Test hole caved to 1.4 m upon completion of drilling/digging.
3. Test hole backfilled with auger cuttings and bentonite chips.

WATER LEVELS	∇ **During Drilling/Digging**	1.37 m on 5/21/2025
	▼ **Upon Completion**	on 5/21/2025 Unknown due to caving

CONTRACTOR
Paddock Drilling

INSPECTOR
M. RODRIGUEZ

APPROVED
T. SCHELLENBERG

DATE
6/20/2025

TEST HOLE LOG

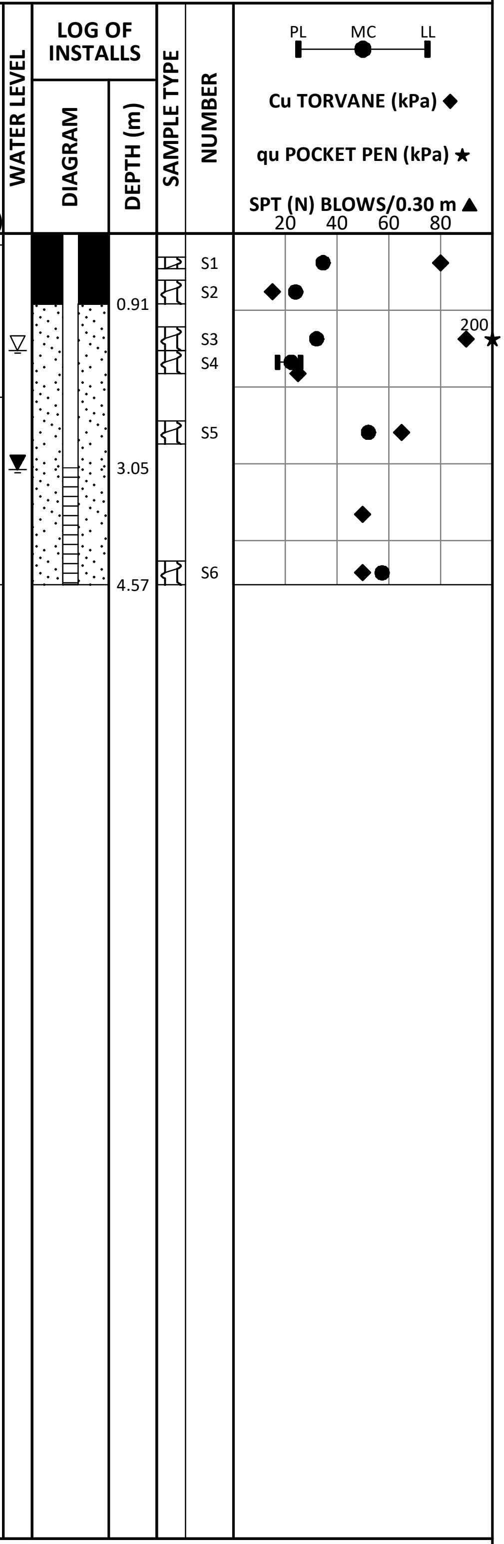
HOLE NO.
TH25-05

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT	**Waverley West Fire/Paramedic Station**	**SURFACE ELEV.**	232.17 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.85 m / 233.02 m (Standpipe)
DESCRIPTION	East end side of the proposed parking lot	**START DATE**	5/21/2025
DRILL RIG / HAMMER	Acker SSIII Track Mounted Drill Rig with Safety Drop Hammer	**UTM (m)**	N 5,517,631.21
METHOD(S)	0.0 m to 4.6 m: 125 mm ø SSA		E 630,435.87 Zone 14

DESCRIPTION AND CLASSIFICATION	ELEV (m)
TOPSOIL/ORGANICS - 152 mm, Black, dry to damp, some rootlets.	232.0
CLAY (CL) - Grey, damp, stiff, low plasticity, some silt, trace to some sand. - light brown, moist, soft, silty below 0.6 m. - brownish grey, stiff below 0.9 m. - moist to wet around 1.5 m. - LL=26, PL=17, PI=9 at 1.5 m. - PSA: 0% gravel, 10% sand, 77% silt, 13% clay at 1.5 m.	230.0
CLAY (CH) - Mottled grey/brown, moist, stiff, high plasticity. - grey below 3.0 m.	227.6

Notes:
1. End of test hole at 4.6 m.
2. Test hole remained open to 4.6 m upon completion of drilling/digging.
3. A 50 mm (2") Ø standpipe piezometer with 1.52 m slotted screen installed in TH25-05.
4. Backfilled with filter sand to 0.91 m BGS, remaining depth backfilled with bentonite seal to surface.
5. Protective well cover not provided at surface as only one (1) piezometer installation was anticipated prior to mobilization.



ELEVATION (m): 232, 231, 230, 229, 228, 227, 226, 225, 224, 223, 222, 221, 220, 219, 218, 217, 216
DEPTH (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0
DEPTH (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55

WATER LEVELS ▽ **During Drilling/Digging**	1.52 m on 5/21/2025	
▼ **Upon Completion**	3.08 m on 5/21/2025 Monitoring Well	

CONTRACTOR **Paddock Drilling**	INSPECTOR **M. RODRIGUEZ**
APPROVED T. SCHELLENBERG	DATE 6/20/2025

KEY TO SYMBOLS

LITHOLOGIC SYMBOLS

▨ Clay (CH, high plasticity)

⧄ Clay (CL, low plasticity)

▥ Silt Till

▤ Topsoil

SAMPLER SYMBOLS

§ Auger Grab

◪ SPT Split Spoon

WELL CONSTRUCTION SYMBOLS

■ Standpipe (bentonite)

░ Standpipe (filter sand)

▦ Screen (filter sand)

ABBREVIATIONS

LL	- Liquid Limit
PL	- Plastic Limit
PI	- Plastic Index
MC	- Moisture Content
DD	- Dry Density
NP	- Non-Plastic
-200	- Percent Passing No. 200 Sieve
TV	- Torvane (kPa)
PP	- Pocket Penetrometer (kPa)
PSA	- Particle Size Analysis
TOC	- Top Of Casing

PN	- Pneumatic Piezometer
VW	- Vibrating Wire Piezometer
PID	- Photoionization Detector
ppm	- Parts Per Million
▽	Water Level During Drilling
▼	Water Level Upon Completion of Drilling
▼	Water Level Remeasured/Static

KGS
GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT NAME	Waverley West Fire/Paramedic Station	**LOCATION**	Winnipeg, Manitoba

APPENDIX 4

Laboratory Test Results

SUMMARY OF INDEX TESTS

Sheet 1 of 1

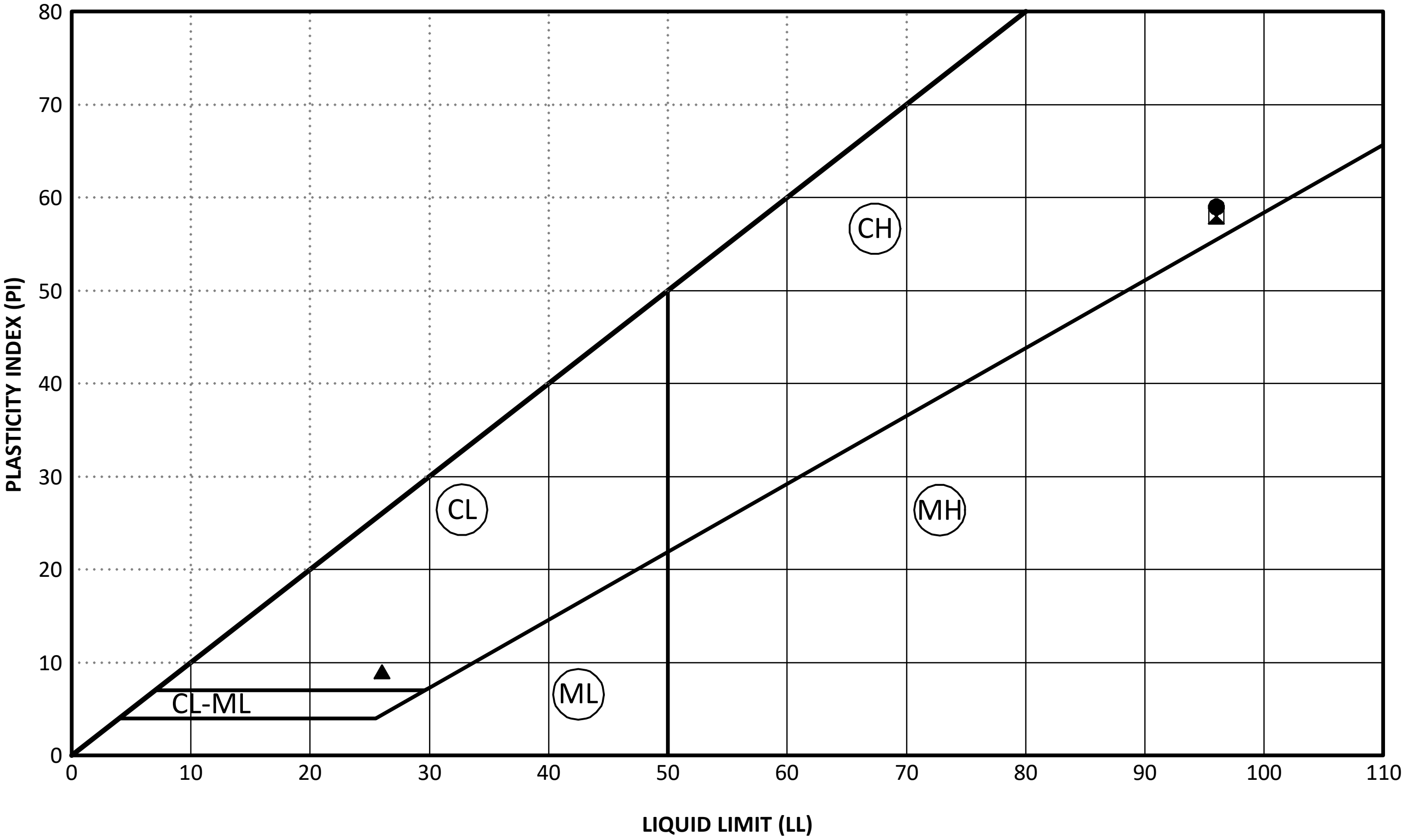
Test Hole ID	Sample No.	Depth (m)	Class- ification	Gravel (%)	Sand (%)	Silt/ Clay (%)	Liquid Limit	Plastic Limit	Plas- ticity Index	Moisture Content (%)	Dry Density (kN/m3)	Specific Gravity	Satur- ation (%)	Void Ratio
TH25-01	S1	1.1	CH				96	37	59	39				
TH25-01	S2	2.7	CH	0	0	100	96	38	58	57				
TH25-01	S3	4.1	CH							54				
TH25-01	S4	5.8	CH							48				
TH25-01	S5	7.3	CH							53				
TH25-01	S6	8.8	CH							53				
TH25-01	S7	10.4	CH							65				
TH25-01	S8	11.9	CH							21				
TH25-01	S10	13.7	Silt Till							10				
TH25-01	S12	15.2	Silt Till							9				
TH25-02	S1	1.2	CH							38				
TH25-02	S2	2.7	CH							54				
TH25-02	S3	4.3	CH							51				
TH25-02	S5	7.3	CH							49				
TH25-02	S6	8.8	CH							53				
TH25-02	S7	10.4	CH							58				
TH25-02	S8	11.9	CH							55				
TH25-02	S10	13.7	Silt Till							8				
TH25-02	S11	14.9	Silt Till							9				
TH25-03	S1	0.6	CH							26				
TH25-03	S2	1.2	CH							38				
TH25-03	S3	2.7	CH							53				
TH25-03	S4	4.3	CH							55				
TH25-03	S5	5.8	CH							48				
TH25-04	S2	1.2	CL							23				
TH25-04	S3	2.7	CH							51				
TH25-05	S1	0.3	CL							35				
TH25-05	S2	0.6	CL							24				
TH25-05	S3	1.2	CL							32				
TH25-05	S4	1.5	CL	0	10	90	26	17	9	22				
TH25-05	S5	2.4	CH							52				
TH25-05	S6	4.3	CH							57				

* Moisture conditioned and remolded sample.
** Assumed specific gravity.

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT NAME	Waverley West Fire/Paramedic Station	**LOCATION**	Winnipeg, Manitoba
TESTED BY	Stantec	**DATE TESTED**	May 27, 2025

ATTERBERG LIMITS

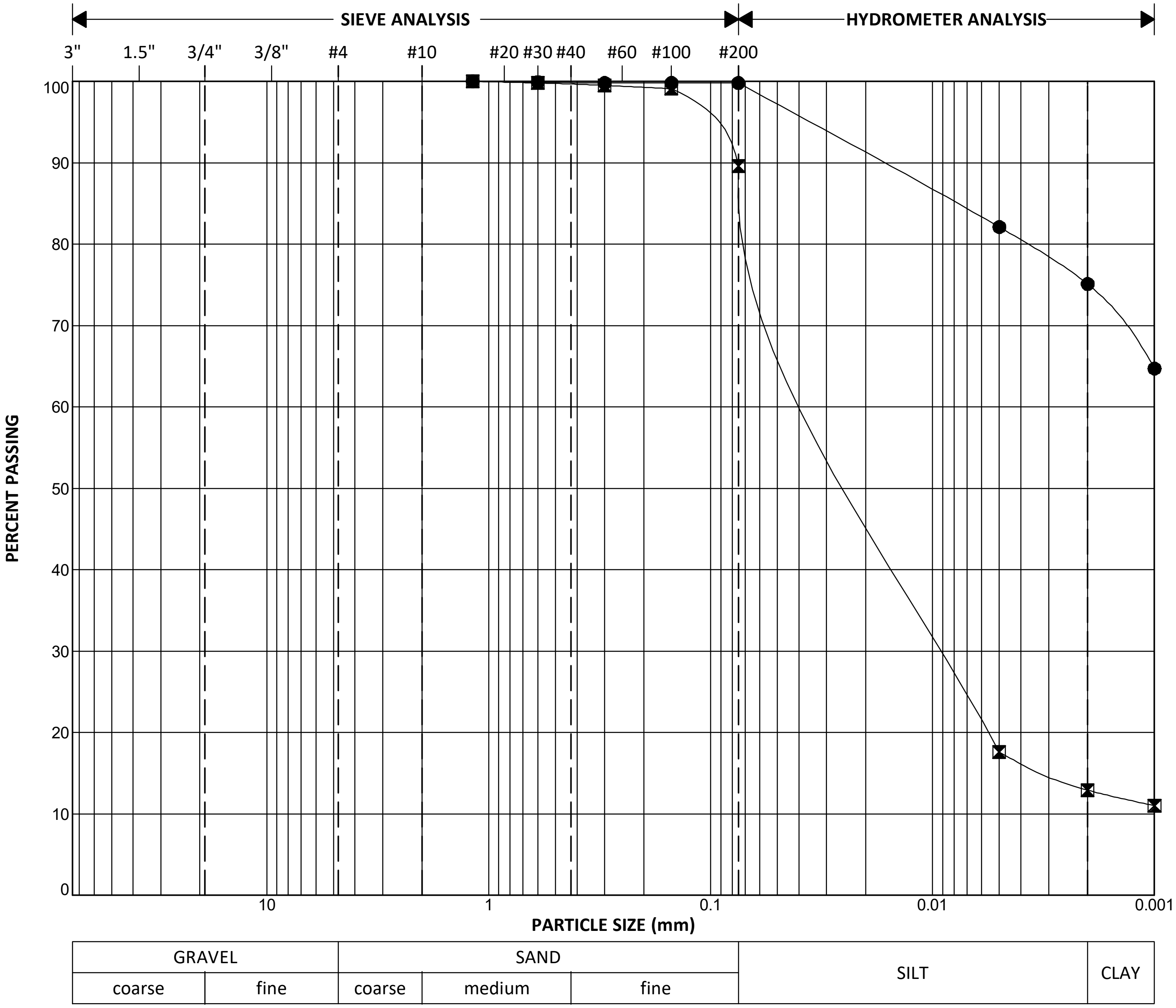


	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	MC (%)	CLASSIFICATION
●	TH25-01	1.1	S1	96	37	59					39	CH
☒	TH25-01	2.7	S2	96	38	58	0	25	75	100	57	CH
▲	TH25-05	1.5	S4	26	17	9	10	77	13	90	22	CL

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT NAME	Waverley West Fire/Paramedic Station	**LOCATION**	Winnipeg, Manitoba
TESTED BY	Stantec	**DATE TESTED**	May 29, 2025

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH25-01	2.7	S2	0	0	25	75	100			CH
⧗	TH25-05	1.5	S4	0	10	77	13	90			CL

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	25-0107-008
PROJECT NAME	Waverley West Fire/Paramedic Station	**LOCATION**	Winnipeg, Manitoba
TESTED BY	Stantec	**DATE TESTED**	May 27, 2025

KGS

GROUP

Experience in Action