CITY OF WINNIPEG

South Winnipeg Recreation Campus – Phase 2 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 its work. The information and conclusions provided in this report apply only as they existed at the time of KGS Group’s work.

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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

The firm of Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was retained by the City of Winnipeg to provide geotechnical services for the proposed South Winnipeg Recreation Campus (SWRC) to be located within the community of Waverley West. The project site is located directly west of the existing Pembina Trails Collegiate campus, and South of Bison Drive. The project site is approximately 9.2 hectares (22.8 acres) in size. This report summarizes the results of the field and laboratory investigations and final geotechnical design recommendations as part of the Phase 2 Geotechnical Investigation. The Phase 1 Geotechnical Engineering report was issued by KGS Group to the City of Winnipeg and dated July 21, 2023.

KGS Group's scope of services for Phase 2 of this project was outlined in our proposal No. 22-000-1929 "South Winnipeg Recreation Campus – Winnipeg, Manitoba, Proposal for Geotechnical Services" dated January 4, 2023.

The main components of the Phase 2 geotechnical scope of services included:

- A subsurface investigation consisting of six (6) deep test holes advanced to depths ranging from approximately 15.3 to 16.0 m (50 to 52.5 ft) below ground surface (BGS), of which five (5) test holes were completed within the footprint of the proposed recreation centre, and one (1) test hole was advanced within the footprint for the proposed future library building;
- Installation of thee (3) vibrating wire piezometers in two test holes, with one piezometer installed in each of the three (3) main soil types (clay and silt, clay, silt till) as identified during the Phase 1 investigation;
- A comprehensive review and analysis of the findings obtained from the Phase 2 site investigation; and
- An updated geotechnical report which incorporates the findings from the Phase 2 investigation and provides updated foundation and site preparation recommendations based on the additional drilling.

This report has been updated to provide further clarification to the seismic class of the project site.

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. The project site is approximately 9.2 hectares (22.8 acres) in size.

It is understood that the proposed recreational campus will include an aquatic center, multiple gymnasiums, a variety of programming spaces, multi-purpose rooms, indoor walking track, fitness space, a community library, and outdoor spray pad, adjacent park space, athletic fields, with potential future development of a twin arena. It is also understood that this site will also include a new fire hall.

Phase 1 of the project will focus on development of multiple gymnasiums with mezzanine walking/running track and fitness areas, several multi-purpose rooms, change rooms, offices, washrooms, kitchen, lobby, potential tenant leasing spaces, parking areas, outdoor spray pad, park amenities and pathways, public art components, and attached daycare facility. The phase one building will likely be two stories in height, will have limited basement/crawl spaces and is anticipated to have column load in the range of 1,800 to 2,300 kN.

Since submission of the Phase 1 Geotechnical Engineering Report dated July 21, 2023 the City of Winnipeg has finalized the location of the proposed Recreation Centre which will be located along the eastern side of the property and approximately 160 m south of the current alignment of Cadboro Road. As such, the Phase 2 geotechnical investigation was focused within the area of the proposed recreation center building. A site plan indicating the location of the proposed Recreation Center in relation to other site features and previously drilled test holes is provided in Figure 3.

As per the Request for Proposal (RFP), the geotechnical investigation for this project was split into two parts, Phase 1 general site investigation and Phase 2 detailed site investigation, as described below:

Phase 1 General Investigation – A general site investigation was completed in July 2023, at this stage of the project, the location of the proposed recreational center had yet to be determined. The purpose of the Phase 1 Geotechnical Investigation was to provide preliminary geotechnical design recommendations as requested in the RFP for Phase 1 General Investigation.

Phase 2 Detailed Investigation – A detailed geotechnical investigation was completed following development of the project site plan and is be focused within the footprint of the proposed building. The purposed detailed geotechnical investigation would be a supplemental investigation to confirm or enhance the preliminary design recommendations of the Phase 1 General Investigation.

This report summarizes the work completed as part of the Phase 2 Detailed Investigation.

3.0 INVESTIGATION PROGRAM

3.1 Review of Previously Completed Drilling

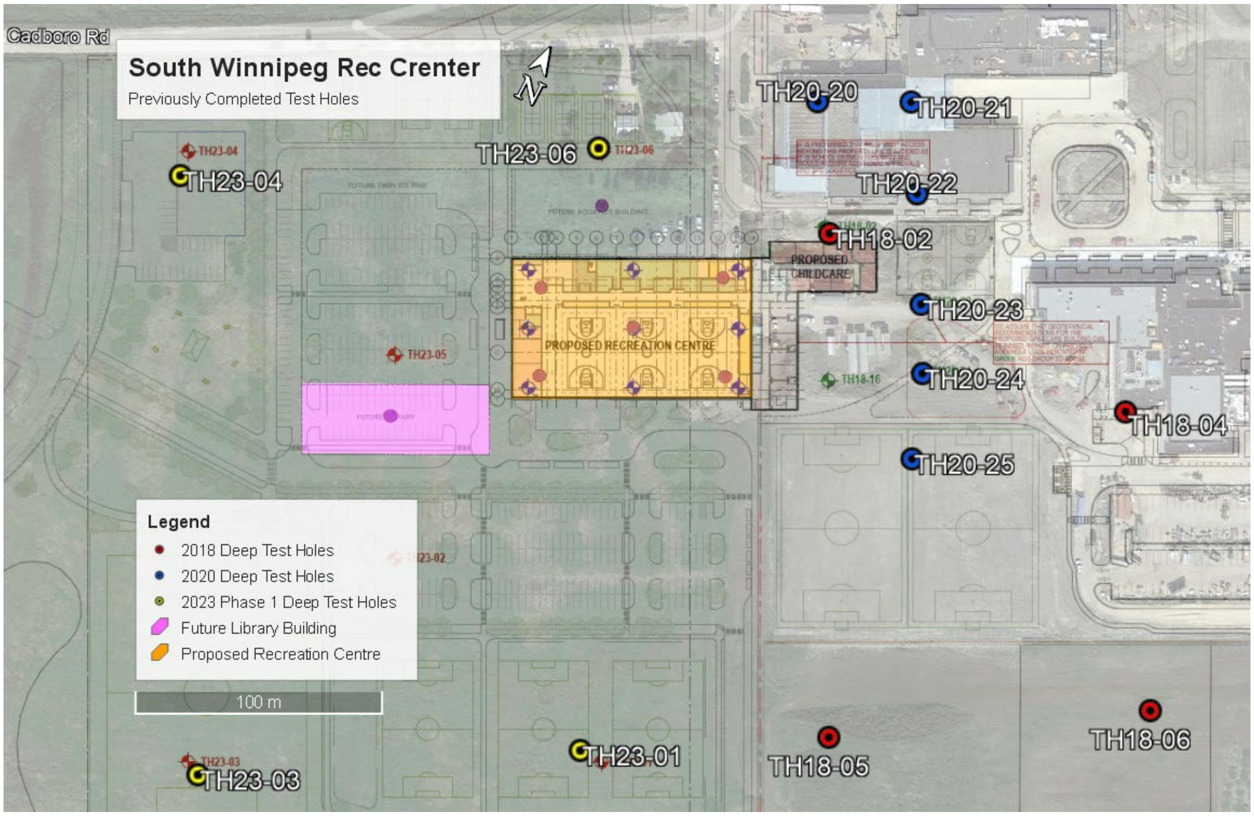
KGS Group was involved in the site investigations completed in 2018 and 2020 for the adjacent school site, located to the east of this property, and completed the Phase 1 investigation for the proposed recreation center in early 2023. As such, KGS Group has completed a review of the previously drilled deep test hole logs located near the proposed building footprint to gain a sense of anticipated refusal depth. A summary of these previously completed test hole logs which were reviewed is provided in Table 1.

TABLE 1: SUMMARY OF PREVIOUSLY COMPLETED TEST HOLES

Test Hole ID	Approximate UTM Coordinates[1]		Encountered Refusal Depth (m)	Distance from Rec Centre (m)	Recorded Soil Profile
	Northing (m)	Easting (m)			
TH18-02	5,517,718	630,631	15.3	85	Topsoil, silt, silty clay, silt till
TH18-04	5,517,713	630,770	15.4	200	Topsoil, organic clay, silt, silty clay, silt till
TH18-05	5,517,541	630,729	14.1	185	Topsoil, silty clay, silt, silty clay, silt till
TH18-06	5,517,613	630,837	15.4	260	Topsoil, silty clay, silt till
TH20-20	5,517,762	630,601	17.4	115	Topsoil, organic clay, silt, clay, clay till, silt till
TH20-21	5,517,780	630,634	18.6	145	Topsoil, organic clay, silt, clay, silt till
TH20-22	5,517,749	630,654	14.9	125	Topsoil, organic clay, silt, clay, silt till
TH20-23	5,517,711	630,677	14.9	115	Topsoil, organic clay, silt, clay, silt till
TH20-24	5,517,687	630,691	14.9	115	Topsoil, organic clay, silt, clay, clay till, silt till
TH20-25	5,517,655	630,704	15.0	125	Topsoil, organic clay, silt, clay, silt till
TH23-01	5,517,489	630,644	16.9	175	Clay, silty clay, clay, silt till
TH23-03	5,517,406	630,514	16.8	255	Silty clay, clay, silt till
TH23-04	5,517,613	630,392	17.2	195	Clay, silty clay, clay, silt till
TH23-06	5,517,703	630,533	16.6	75	Clay, silty clay, clay, silt till

Figure 1 below shows the location of the previously drilled deep test holes in the immediate area in relation to the proposed location of the recreation center. The Phase 1 detailed test hole logs with laboratory testing results, and a fence diagram of the soil profile encountered during the Phase 1 General Investigation are provided in Appendix B.

FIGURE 1: PREVIOUSLY COMPLETED DEEP TEST HOLES



Based on this information it is anticipated that auger refusal will be encountered at a depth of approximately 15.3 to 16.6 m (50 to 54.5 ft) at the proposed location of the recreation center and the soil stratigraphy will consist of clay and silt, overlying clay, overlying silt till.

3.2 Phase 2 Test Hole Drilling and Sampling

KGS Group obtained clearance from public utility companies for underground buried utilities at the site prior to conducting the Phase 2 geotechnical drilling investigation. The Phase 2 drilling and sampling program was completed between November 27 to 29, 2023 under continuous supervision of KGS Group, with drilling services provided by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba. Drilling was performed using an Acker MP5 track mounted drill rig equipped with 125 mm diameter solid stem augers and a Standard Penetration Test (SPT) safety drop hammer.

As part of the Phase 2 Detailed Site Investigation the drilling and sampling program included, a total of six (6) deep test holes advanced to power auger refusal at depths ranging 15.3 to 16.0 m (50 to 52.5 ft) below ground surface (BGS). Five (5) of the test holes were completed within the footprint of the proposed recreation centre, and one (1) test hole was completed at the approximate centre of the proposed future library building.

As part of the Phase 2 investigation a total of three vibrating wire piezometers were installed, two (2) of which were installed in the lower clay and clay till layer encountered in test hole TH23-09-PZ, and one (1) was installed in the upper clay and silt material encountered in test hole TH23-07-PZ.

Representative soil samples were obtained from each test hole 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 split spoon samplers, and visually classified in the field in general accordance with the modified Unified Soil Classification System (USCS). The SPT's were advanced at 1.5 m (5 ft) intervals in granular/till material, while clay samples were tested with a pocket Torvane to estimate the undrained shear strengths.

Test hole UTM coordinates and elevations were collected with GPS survey equipment in reference to the CGVD28 datum, coordinates are provided in Table 2 and at the top of the Phase 2 test hole logs provided in Appendix B. The location of the test holes completed as part of the Phase 2 Detailed Investigation are indicated on Figure 2. Detailed descriptions of the soil conditions encountered across the site can be found on the Phase 2 summary log reports attached in Appendix B. Also included in Appendix B is a fence diagram cross section of the soil condition encountered during the Phase 2 investigation.

FIGURE 2: PHASE 2 DETAILED INVESTIGATION TEST HOLE LOCATION PLAN

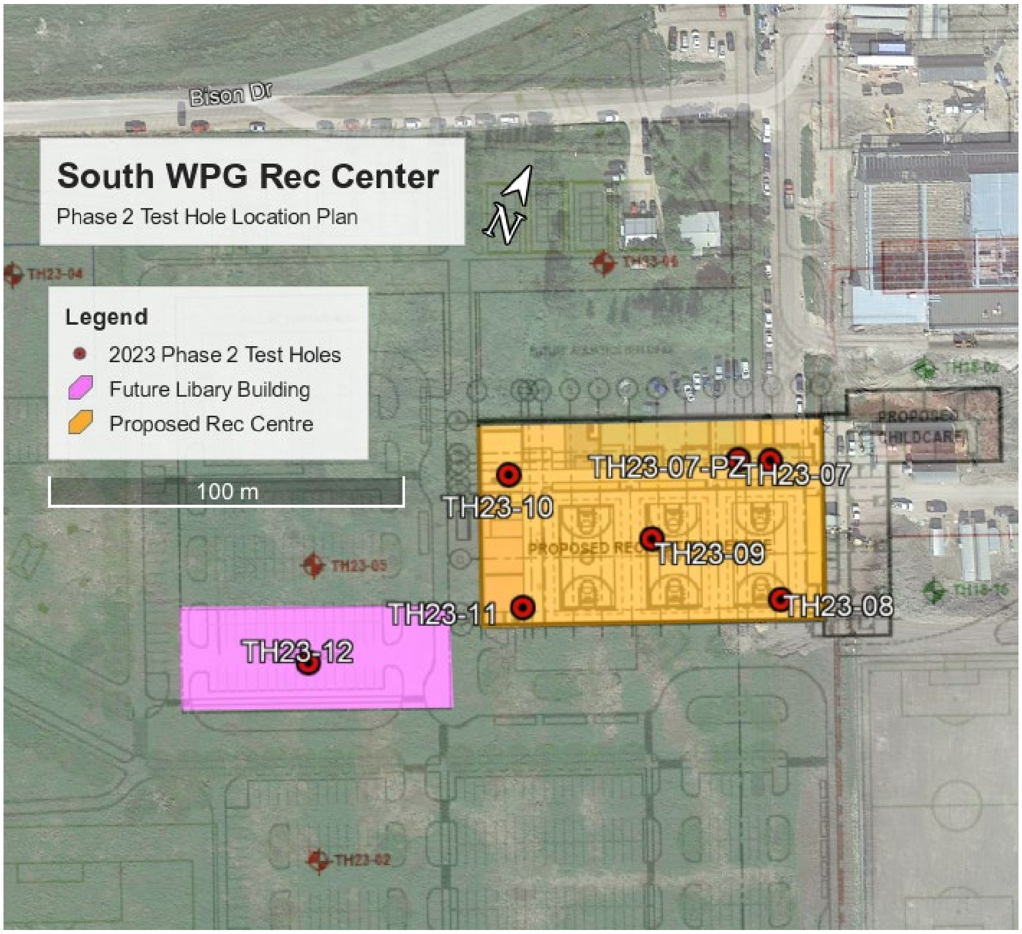


TABLE 2: SUMMARY OF PHASE 2 DETAILED INVESTIGATION TEST HOLE LOCATIONS AND DEPTHS

Test Hole ID	UTM Coordinates[1]		Surface Elevation	Test Hole Bottom Depth/ Elevation (m)	Test Hole Location
	Northing (m)	Easting (m)			
TH23-07	5,517,674.00	630,594.00	232.99	15.3/217.69	Recreation Centre
TH23-07-PZ	5,517,677.59	630,601.69	233.03	4.6/228.43	Recreation Centre
TH23-08	5,517,644.38	630,622.80	232.95	15.3/217.65	Recreation Centre
TH23-09-PZ	5,517,642.93	630,582.43	232.77	15.3/217.47	Recreation Centre
TH23-10	5,517,639.69	630,538.90	233.06	15.3/217.76	Recreation Centre
TH23-11	5,517,608.40	630,559.66	232.71	16.0/216.71	Recreation Centre
TH23-12	5,517,566.81	630,513.68	232.64	15.5/217.14	Future Library

Note: Test hole UTM coordinates and elevations were collected with GPS survey equipment in reference to the CGVD28 datum.

A plan drawing is provided in Figure 4 which provided the location of all test holes drilled during both the Phase 1 and 2 investigations.

4.0 STRATIGRAPHY AND GROUNDWATER

4.1 Stratigraphy

In general, the soil stratigraphy across the subject site consisted of surficial layers of topsoil and clay and silt, 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 B.

Topsoil – A layer of topsoil was encountered at the surface of each test hole and ranged in thickness from 152 to 610 mm.

Clay (CL)– A layer of clay was encountered directly beneath the topsoil in each test hole and extended to depths ranging from 0.5 to 4.2 m below ground surface (BGS). The clay was light brown to grey in colour, damp to moist, contained varying amount of silt, and was generally frozen to depths of 1.4 to 1.5 m BGS. A layer of high plastic clay was encountered within the lean clay layer between depths of 0.6 and 1.5 m BGS in test hole TH23-07 and TH23-07-PZ.

The undrained shear strength of the clay and silt was assessed with a pocket Torvane and ranged from 29 to 100 kPa classifying the clay and silt as firm to stiff in terms of consistency. Laboratory testing was completed on select samples of the clay and silt during the Phase 1 investigation indicating a particle size distribution of 0% gravel, 6% sand, 75% silt, and 19% clay classifying the material as lean clay as and silt. Atterberg limits testing completed within the lean clay layer indicated a liquid limit of 26, a plastic limit of 18 and a plasticity index of 8, classifying the clay as low plastic.

Clay (CH) – A layer of clay was encountered below the surficial clay and silt layer in all test holes and extended to depths ranging from 12.2 to 14.0 m BGS. The clay was brown to grey in colour, damp to wet, was of high plasticity and contained trace to some silt, trace fine gravel, and trace medium sand and fine gravel at depth.

The undrained shear strength of the clay was assessed with a pocket Torvane and ranged from 18 to 98 kPa classifying the clay as soft to stiff in terms of consistency. Laboratory testing was completed on select samples of the clay during the Phase 1 investigation indicating a particle size distribution of 0% gravel, 1% sand, 41% silt and 58% clay and a liquid limit of 76 to 102, a plastic limit of 26 to 32, and a plasticity index of 50 to 70.

Silt Till – A layer of silt till was encountered beneath the clay within all tests holes and extended to the depths explored within the test holes, 15.3 to 16.0 m BGS. The silt till was grey in colour, wet, and contained fine to coarse grained sand, trace medium gravel, and some clay. Auger refusal on boulders or bedrock was observed in test holes TH23-07 and TH23-12 at depths of 15.3 and 15.5 m respectively, while power auger refusal was encountered in very dense silt till in the remaining test holes between depths of 15.3 and 16.0 m.

Standard penetration tests were completed within the silt till indicating uncorrected N-values of 80 blows per 300 mm of penetration to 50 blows per 20 mm of penetration, classifying the silt till as very dense in terms of relative density. Laboratory testing was completed on select samples of the silt till during the Phase 1 investigation indicating a particle size distribution 7% gravel, 28% sand, 43% silt, and 22% clay and a liquid limit of 26, a plastic limit of 13, and a plasticity index of 13.

4.2 Comparison with Previous Investigations

As mentioned above KGS Group was involved with the adjacent school site investigations in 2018 and 2020 and completed the Phase 1 drilling investigation for the recreation center property in early 2023. The depth to auger refusal, and soil stratigraphy are general in agreement with the previously completed test holes. However, during the 2020 investigation, a layer of silt was found near the surface at the school site, while a layer of clay and silt was found near the surface across the recreation campus site. Only moisture content testing was completed on samples of the silt from the 2020 investigation, while moisture content, Atterberg limits, and particle size analysis were completed on a sample of the clay and silt during the 2023 Phase 1 General Investigation. Based on the completed testing the 2023 soil classification of lean clay is considered more accurate.

4.3 Seepage, Sloughing and Groundwater Conditions

Groundwater and sloughing observations were recorded during and upon completion of drilling for each test hole. The observed groundwater seepage and soil sloughing conditions for each test hole are summarized in Table 3 below.

TABLE 3: PHASE 2 DETAILED INVESTIGATION
OBSERVED GROUNDWATER SEEPAGE AND SLOUGHING CONDITIONS

Test Hole ID	Depth of Test Hole (m)	Seepage Layer	Observed Water Seepage Depth/Elev. During Drilling (m)	Depth/Elev. of Water Upon Completion of Drilling (m)	Sloughing Observations Upon Completion of Drilling
TH23-07	15.3	Clay (CL)	3.05/229.94	14.63/218.36	Test hole remained open upon completion of drilling.
TH23-07-PZ	4.6	Clay (CL)	3.05/229.98	4.20/228.83	Test hole remained open upon completion of drilling.
TH23-08	15.3	Clay (CL)	3.35/229.60	14.63/218.32	Test hole remained open upon completion of drilling.
TH23-09-PZ	15.3	NA	None Encountered	Dry	Test hole remained open upon completion of drilling.
TH23-10	15.3	NA	None Encountered	Dry	Test hole remained open upon completion of drilling.
TH23-11	16.0	NA	None Encountered	Dry	Test hole caved to a depth of 15.8 m upon completion.
TH23-12	15.7	Clay Till	13.72/218.92	13.72/218.92	Test hole caved to a depth of 15.2 m upon completion.

In general, groundwater seepage was not observed during drilling and the majority of test holes remained dry upon completion of drilling. However, groundwater seepage was observed from the upper lean clay layer in test holes TH23-07, TH23-07-PZ and TH23-08, and from the silt till layer in test hole TH23-12.

4.4 Groundwater Monitoring

During the Phase 1 investigation standpipe piezometers a total of six (6) were used to facilitate rising head hydraulic conductivity testing. The piezometers in test holes TH23-01, TH23-03, TH23-04 and TH23-06 were screened within the underling silt till, while piezometers in test holes TH23-05-PZ and TH23-06-PZ were screened within the upper lean clay materials. Since installation, the standpipe piezometers have been read twice and Table 4 summarizes the recorded groundwater depths and elevations.

TABLE 4: SUMMARY OF STANDPIPE PIEZOMETER READINGS

Test Hole ID	Screened Material Type	Screened Interval	Reading Date	Recorded Depth to Groundwater (m)	Recorded Groundwater Elevation
TH23-01	Silt Till	13.7 – 16.8	May 16, 2023	5.25	227.36
			Dec 16, 2023	7.68	224.93
TH23-03	Silt Till	13.7 – 16.8	May 15, 2023	5.49	227.34
			Dec 16, 2023	7.91	224.92
TH23-04	Silt Till	15.2 – 16.8	May 15, 2023	5.67	227.18
			Dec 16, 2023	7.84	225.01
TH23-05-PZ	Clay (CL)	0.3 – 0.9	May 16, 2023	0.64	232.00
			Dec 16, 2023	Dry	NA
TH23-06	Silt Till	13.4 – 16.5	May 12, 2023	3.44	229.69
			Dec 16, 2023	8.23	224.90
TH23-06-PZ	Clay (CL)	0.3 – 0.9	May 12, 2023	0.65	232.46
			Dec 16, 2023	Dry	NA

Based on the readings above the groundwater within the silt till is relatively constant at an elevation of 224.90 to 225.01 m in December 2023, while the lean clay layer has become dry in December 2023 since installation, likely due to groundwater levels dropping below the depth of the installed piezometers.

A total of three (3) vibrating wire piezometers were installed during the Phase 2 Detailed Investigation with the aim of installing one (1) piezometer within each of the major soil types encountered at the project site. Following installation, the water levels were allowed to stabilize for approximately two (2) weeks before an additional static groundwater level reading was collected. The details of the vibrating wire piezometers are summarized in Table 5.

TABLE 5: SUMMARY OF VIBRATING WIRE PIEZOMETER READINGS

Test Hole ID	Embedded Material Type	Installed Depth	Vibrating Wire Piezometer SN	Reading Date	Recorded Groundwater Depth (m)
TH23-07-PZ	Clay (CL)	3.35	VW176043	December 15, 2023	1.48
TH23-09-PZ	Clay (CH)	11.58	VW175851	December 15, 2023	5.25
TH23-09-PZ	Silt Till	14.91	VW176039	December 15, 2023	6.65

Based on the recorded vibrating wire piezometer readings the groundwater level within the lean clay was at a depth of approximately 1.5 m below grade. Groundwater levels within the silt till were elevated from those recoded in the standpipes which may be evidence of pore pressures still dissipating to static levels following installation. Groundwater levels within the fat clay layer were recorded at a depth of 5.25 m below ground surface as with the silt till porewater pressures may still be dissipating following installation. Based on the vibrating wire piezometers obtained above there appeared to be a downward gradient flow between the clay and silt till layers however, it is recommended that the groundwater level within the clay and silt till be further monitored until static levels are obtained.

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. It is recommended that the groundwater level within the installed standpipes (Table 4) be measured with a tape measure prior to construction to allow the contractor to quantify groundwater conditions expected at the project site during construction.

The scope of work for this project did not include a long-term piezometer monitoring program, and the Vibrating Vire Piezometers require a specialized readout box to obtain readings and a data logger to collected continuous readings. It is anticipated that the installed piezometers will be utilized to determine groundwater levels and potential seepage conditions prior to construction. As such it is recommended that a long-term piezometer monitoring program be implemented to determine the maximum groundwater level across the site which is anticipated to occur during the spring melt or summer months depending on moisture and precipitation conditions. KGS Group can provide costing for a long-term monitoring program upon request.

4.5 Hydraulic Conductivity Estimation

An estimation of the hydraulic conductivity of each of the major soil types (lean clay, fat clay, silt till) encountered across the project site is provided in the sub sections below. Hydraulic conductivity estimates for the clay and silt, and silt till materials were provided via in field rising head conductivity testing while hydraulic conductivity for clay materials was determined by laboratory testing.

4.5.1 RISING HEAD TESTING

Rising head tests to estimate the hydraulic conductivity, k, of the soils were performed by KGS Group staff between May 10 and May 18, 2023, in accordance with ASTM D4044/D4044M-15 during the Phase 1 General Investigation. KGS Group staff installed water level transducers into the bottom of each well to measure water levels within the well during each test. Manual water level measurements were recorded with a water level meter to confirm the accuracy of the data collected from the transducers.

Two of the six (2 of 6) wells were shallow wells (0.9 m below ground surface) screened through a lean clay layer. The remaining four (4) wells were deeper (16.4 to 16.8 m below ground surface) screened through a silt till layer. Each rising head test involved the following sequence of steps:

- The static water level and depth to well bottom were measured using the water level meter.
- The transducer was installed near the bottom of the well and set to record at a 30 second interval.
- The well was purged until no more water was produced, using plastic tubing and a foot valve (deep wells) or using bailers (shallow wells).
- The plastic tubing or bailer was removed from the well and manual water level readings were recorded every 30 seconds until 10 minutes had elapsed, at which point readings were taken every minute, extending to every 5 minutes and then 10 minutes as elapsed time approached 1 hour.
- The final water level was measured the following day using the water level meter and the transducer was removed from the well to download the data.

The hydraulic conductivity of the soils was calculated from the test data by using the software AQTESOLV. The software plots the transducer data as drawdown versus time beginning from the greatest drawdown (lowest water level in the well) at the end of purging. Well and aquifer geometries were input for each test based on the test-well borehole logs (provided in Appendix A). The ratio of vertical to horizontal conductivity (K_z/K_r) was assumed to be 0.1 for the soil layers. Slight sedimentation of the screened portion of the wells was assumed negligible for this analysis.

Within the software, the Bouwer-Rice (1976) solution technique for slug tests on unconfined aquifers was applied to the plotted data. For the deeper wells, the data allowed for a manual linear approximation of best-fit over the software's recommended head range (see horizontal band in AQTESOLV Reports provided in Appendix C). For the shallower wells, where data was not within the recommended head range, the manual linear approximation was applied to the initial portion of the test for a conservative estimate. Although for the deeper wells the silt till layer is confined by the overlying clay layer, the K results of analysis using the confined aquifer method were comparable to the unconfined K and therefore the more user-friendly unconfined method was used. Well and aquifer geometries, plotted data, and estimated K values are included in the AQTESOLV Reports provided in Appendix C.

4.5.1.1 Clay (CL)

The calculated hydraulic conductivity, k, for the lean clay (CL) layer as determined by rising head testing as described above are summarized on Table 6.

TABLE 6: ESTIMATION OF LEAN CLAY HYDRAULIC CONDUCTIVITY

Test Hole ID	Date of Testing	Material Type	Estimated Hydraulic Conductivity, k (cm/sec)
TH23-05-PZ	May 16, 2023	Clay (CL)	$9.5x10^{-6}$
TH23-06-PZ	May 12, 2023	Clay (CL)	$1.6x10^{-5}$

Based on the completed testing, the hydraulic conductivity, k, of the lean clay (CL) can be estimated as $1.0x10^{-5}$ cm/sec.

4.5.1.2 Silt Till

The calculated hydraulic conductivity, k, for the silt till layer as determined by rising head testing as described above are summarized on Table 7.

TABLE 7: ESTIMATION OF SILT TILL HYDRAULIC CONDUCTIVITY

Test Hole ID	Date of Testing	Material Type	Estimated Hydraulic Conductivity, k (cm/sec)
TH23-01	May 16, 2023	Silt Till	$1.2x10^{-4}$
TH23-03	May 15, 2023	Silt Till	$2.6x10^{-4}$
TH23-04	May 15, 2023	Silt Till	$1.2x10^{-4}$
TH23-06	May 12, 2023	Silt Till	$4.4x10^{-6}$

Based on the completed testing, the hydraulic conductivity, k, of the silt till can be estimated as $1x10^{-4}$ cm/sec.

4.5.2 LABORATORY TESTING

During the drilling program undisturbed samples of the clay were collected using 76 mm diameter thin wall Shelby tubes. Shelby tube samples were extruded in the laboratory then tested for hydraulic conductivity using a flexible wall permeameter and in accordance with ASTM D5084 during the Phase 1 General Investigation. The flexible wall hydraulic conductivity test lab reports are provided within Appendix D.

Results of the laboratory hydraulic conductivity, k, testing are summarized in Table 8.

TABLE 8: SUMMARY OF HYDRAULIC CONDUCTIVITY RESULTS

Test Hole ID	Sample Depth (m)	Material Type	Hydraulic Conductivity, k_{20} (cm/sec)
TH23-01	7.6	Clay (CH)	1.5×10^{-8}
TH23-05	3.0	Clay (CH)	6.3×10^{-9}

Based on the completed testing, the hydraulic conductivity, k, of the clay (CH) can be estimated at 1×10^{-8} cm/sec.

4.5.3 SEEPAGE VOLUME ESTIMATION

To calculate the potential volume of seepage within excavations, multiply exposed surface area of the excavation (area of side wall and bottom) by the hydraulic conductivity, k, for the soil type present and by the time the excavation will be open. If multiple soil layers are present within the excavation, seepage volumes for each layer should be calculated, then summated together.

$$\text{Volume (cm}^3\text{)} = \text{k (cm/sec)} \times \text{(Excavation Sidewalls (cm}^2\text{)} + \text{Excavation Bottom (cm}^2\text{))} \times \text{Time (sec)}$$

The soil profile as presented in test hole TH23-08 with a groundwater level at surface would be the worst-case scenario for estimation of groundwater seepage as it has the greatest thickens of the lean clay layer, which has the greatest hydraulic conductivity. Based on these worst-case-scenario assumptions KGS Group has estimated the maximum volume of groundwater seepage for the crawl spaces located beneath the recreation center and adjacent childcare center, as presented below.

It is recommended that the estimation provided below be refined following completion of a groundwater monitoring program to provide actual groundwater levels over the course of a year. It is anticipated that groundwater flow volumes will dissipate over time if groundwater is removed from the excavation on a continual basis and discharged outside of the groundwater recharge network (i.e. discharged into city sewer network).

4.5.3.1 Recreation Centre

It is understood that the current proposed dimensions of the recreation center are approximately 96 m by 58 m in plan area and it has been assumed that the associated excavation will be 3 m in depth. Based on the worst-case-scenario assumptions as stated above (saturated ground conditions) it is estimated that a maximum of 56.1 m^3/day of groundwater will enter the recreation center excavation.

4.5.3.2 Childcare Centre

Based on the provided site plan the footprint of the proposed childcare is an L-shape building with a perimeter length of approximately 240 m and will have a plan area of approximately 2,000 m^2, it has been assumed that the associated excavation will be 3 m in depth. Based on the worst-case-scenario assumptions as stated above (saturated ground conditions) it is estimated that a maximum of 23.6 m^3/day of groundwater will enter the childcare center excavation.

4.5.4 POTENTIAL DIFFICULT GROUND CONDITIONS

Suspected boulders or bedrock were encountered during the Phase 2 detailed investigation in test holes TH23-07 and TH23-12 at depths of 15.3 and 15.5 m respectively. Although not encountered within any of the other test holes drilled across the project site, cobbles / boulders are known to exist within till deposits. Cobbles and / or boulders can cause difficulties when advancing bored caissons into till materials. If encountered, the contractor will be required to remove cobbles and / or boulders from within foundation excavations or drilled pile shafts. Cobbles and / or boulders and may also cause driven piles to refuse early before achieving design embedment depth.

Lean clay (CL) was encountered across the project site between depths of 0 to 4.3 m. This lean clay (CL) is 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 Sections 5.1, 6.1, 7.8 respectively.

Based on the collected standpipe and vibrating wire piezometer readings, groundwater seepage should be expected from the upper lean clay and silt layer, and the lower silt till layer when advancing excavations or drilled shafts. Seepage from the clay should also be expected from the clay layer but based on the anticipated hydraulic conductivity of the clay it is anticipated that the volume of water produced from this layer will be less than that produced by the upper lean clay and silt and lower silt till layers. 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. It is recommended that excavations or drilled shafts should be limited to a maximum depth of 12.0 m BGS to avoid the seepage and soil sloughing conditions anticipated from the silt till layer.

5.0 FOUNDATION RECOMMENDATIONS

KGS Group recommends that the proposed recreation campus be founded on a deep foundation system comprised of cast-in-place concrete friction or end bearing piles, driven steel H-Piles, or driven prestressed precast concrete piles. Shallow footings are not recommended as a foundation option for the recreation campus due to potential for differential movements resulting from expansive clay soils.

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 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.

For pile foundation design, LSD prescribes Geotechnical Resistance Factors (Φ) that are based upon the method used to evaluate pile capacity to obtain the factored ULS pile capacity values.

The estimated unfactored ULS values provided below represent the nominal (ultimate) geotechnical resistance, R_n. A geotechnical resistance factor (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

Unfactored ULS values shown in the tables below should be multiplied by the appropriate resistance factor to determine the factored geotechnical resistance.

5.2 Cast-In-Place Concrete Friction Piles

Cast-in-place concrete friction piles could be considered a viable option to support the proposed recreation center. Cast-in-place concrete friction piles should be designed such that they are supported by skin friction with no contribution from end-bearing. Estimates of the ULS and SLS values for skin friction are listed in Table 9 below. The average undrained shear strength within the upper lean clay materials was approximately 45 kPa based on field Torvane measurements. Based on the α-method, and adhesion coefficient (α) of 0.8 was selected for the upper clay layers to estimate shaft skin friction.

TABLE 9: CAST-IN-PLACE CONCRETE PILE SKIN FRICTION DESIGN VALUES

	Approximate Depth Below Grade (m)	Stratigraphic Layer	Serviceability Limit State, SLS (kPa)	Unfactored Ultimate Limit State, ULS (kPa)
Unit Shaft Resistance	0 to 2.5	Clay (CL/CH)	–	-
	≥2.5 to 10.0	Clay (CL/CH)	12	35
	≥10.0 to 12.0	Clay (CH)	10	30

Notes:

1. Shaft resistance for piles exposed to freezing should neglect the upper 2.5 m of soil due to frost.
2. A Resistance Factor of 0.4 should be applied to the unfactored ULS skin friction values provided in Table 9.
3. The SLS values provided in Table 9 limit settlement to 25 mm.

It is recommended that the maximum pile length be limited to 12 m to prevent sloughing and groundwater seepage issues when advancing drilled shafts through the underlying silt till materials. Cast-in-place concrete friction piles should be at least 8.0 m long to protect against frost jacking.

Based on the observed groundwater seepage and soil sloughing conditions during the drilling investigation groundwater seepage and soil sloughing of the upper lean clay and the lower silt till layer should be expected. It is anticipated that the Contractor will need to provide pumps and temporary full shaft length steel sleeving control groundwater seepage and to maintain the integrity of the drilled shaft excavation. The Contractor may also need to place concrete beneath the groundwater level using tremie or pumping methods. Concrete should be poured immediately upon completion of drilling and inspection. Drilling and concrete placement for the piles should be inspected by experienced geotechnical personnel to verify the soil and encountered conditions are consistent with the findings of this investigation.

5.3 Cast-In-Place End Bearing Piles

Cast-in-place straight shaft concrete friction piles installed into the dense silt till at a minimum depth of 15.3 m may be considered to support the recreation center proposed for this project site. A geotechnical resistance factor (Φ) of 0.4 should be applied to the unfactored ULS values listed in Table 10 below. Cast-in-place end bearing piles should have a minimum diameter of 900 mm to facilitate removal of cobbles and/or boulders that may be encountered within the silt till.

TABLE 10: CAST-IN-PLACE CONCRETE PILE END BEARING DESIGN VALUES

Material Type	Serviceability Limit State, SLS (kPa)	Unfactored ULS Capacity (kPa)
End Bearing on Dense Silt Till at a minimum depth of 15.3 m	600	900

To obtain a sound bearing surface, the base of the cast-in-place piles must be mechanically cleaned and inspected, the excavation must be dewatered and all loose or deleterious materials removed from the base of the pile shaft prior to placement of concrete.

5.3.1 ADDITIONAL CAST-IN-PLACE PILE RECOMMENDATIONS

Additional cast-in-place 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 potential for squeezing of the clay soils, and potential shallow groundwater seepage from the upper lean clay layer, temporary full shaft length steel sleeves should be used as required during installation of CIP piles to limit groundwater seepage into drilled shafts and to maintain the integrity of the shaft excavation.
- Where seepage is encountered, which cannot be controlled by sleeves, remove water from the pile excavations prior to pouring concrete, or place concrete by tremie methods as 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 as the sleeve is withdrawn.
- 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.
- The reinforcement and concrete must be placed immediately following the drilling and inspection of each pile 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 place.
- A minimum 150 mm void form should be used below all grade beams and pile caps to protect against potential uplift from frost heave.
- All concrete piles should utilize CSA Type HS sulphate resistant cement.
- 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.
- Sono tubes should be used to maintain the top of pile at the surface and piles should not be allowed to mushroom.
- 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.

5.4 Driven Piles

5.4.1 DRIVEN STEEL H-PILES

Driven steel H-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 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 depths.

Driven steel H-piles may be used to support the proposed recreation center. The LSD capacities for driven steel piles advanced to a minimum embedment depth of 15.3 m below grade and embedded into the underling silt till are presented in the table below and consider contributions from both shaft friction and end bearing. The H-pile sections listed are typical for this application. A geotechnical resistance factor (Φ) of 0.4 should be applied to the unfactored ULS values provided in Table 11. KGS Group should be contacted to determine the final refusal criteria once required pile capacities, piles size, and hammer energy have been determined. The SLS resistance values shown in Table 11 table are anticipated to limit foundation settlement to 25 mm. Capacities for additional pile sections can be provided upon request.

The geotechnical resistance factor can be increased to 0.5 if dynamic load testing using a Pile Driving Analyzer (PDA) is completed on 2% of the piles installed at the site.

TABLE 11: DRIVEN STEEL H-PILE CAPACITIES

Pile Type / Section	Minimum Pile Embedment Length (m)	SLS (kN)	Unfactored ULS (kN)
HP250x85	15.3	295	890
HP310x79	15.3	370	1,125
HP360x108	15.3	470	1,425

Based on the completed Phase 2 Detailed Investigation power auger refusal was consistently at a depth of 15.3 m within the footprint of the proposed Recreation Centre (TH23-07 to TH23-10), with the exception of the southwest corner where refusal was encountered at a depth of 16.0 m (TH23-11).

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 conducted during pile driving. Additional pre-boring will be required if monitored vibrations are above acceptable levels, as determined by the structural engineer.

It is recommended that steel piles be driven with pile shoes to protect the pile from damage from cobbles and boulders when driving into the silt till layer. 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.

5.4.2 DRIVEN PRESTRESSED PRECAST CONCRETE PILES

Driven precast concrete piles bearing on the underlying silt till may be used to support the proposed recreation centre building. Below are the estimated factored ULS and SLS pile capacities when driven to practical refusal using a diesel hammer with a rated energy of not less than 40 KJ. End of drive refusal criteria are listed in the Table 12 below for each pile section and should be achieved for three (3) consecutive increments. A geotechnical resistance factor (Φ) of 0.4 should be applied to the unfactored ULS values provided in Table 12.

TABLE 12: DRIVEN PRESTRESSED PRECAST CONCRETE PILE CAPACITIES

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

Notes:

1) If higher energies or other types of hammers are used, they should be evaluated to ensure that piles are not overstressed and to determine an appropriate refusal criterion.

Pile penetration depths will depend on localized till conditions and the presence of cobbles and boulders. Based on the Phase 2 Detailed Investigation power auger refusal was encountered at depths of 15.3 to 16.0 m within the footprint of the proposed recreation campus building.

Piles are typically cast in lengths of up to 22 m (72 ft); however, pile lengths exceeding 18 m (60 ft) require special handling in order to prevent cracking of the piles. 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.

It should be assumed by the designers that the tensile strength of these precast piles is minimal, and they have little capacity to resist bending.

5.4.3 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 specific 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 ratings of 55 to 80 KJ (40 to 60 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 uplift capacity of driven pile can be taken as 2/3 of the vertical shaft resistance of the pile, plus the weight of the pile. The vertical shaft resistance for H-piles driven to a minimum embedment depth of 15.3 m has been determined to be 490 kN, 575 kN, 675 kN for H-pile section HP250x85, HP310x79, and HP360x108 respectively.
- The impacts of vibration from pile driving and its potential effects on existing structures should be evaluated and monitored during driving. Appropriate mitigation measures should be put in place to avoid damage to existing adjacent 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.

5.5 Subgrade Reaction for Laterally Loaded Piles

For preliminary design of laterally loaded piles, the soil response to horizontal loads can be modeled as a series of horizontal springs with uniform stiffness. The response of the soil to the horizontal loading can be estimated using an equivalent spring constant (lateral subgrade reaction modulus), K_s. The lateral subgrade reaction modulus K_s for the soil profile encountered at this project site is listed below in Table 13 below.

It is anticipated that most of the lateral resistance will typically be offered by the upper 5 to 10 m of soil, depending on the location of the applied horizontal load and relative stiffness of the pile and surrounding soil. Any void space around the piles should be filled with cement grout or lean mix concrete to ensure contact with the adjacent soil otherwise the depth with void should be excluded from the lateral capacity of the pile.

The recommended lateral subgrade reaction modulus assumes a linear response to lateral loading and is only applicable to piles subjected to static loads (no dynamic or cyclic loading) that result in small deflections (less than 1% pile diameter). The pile material itself is assumed to be within the elastic range.

A more rigorous lateral pile analysis should be completed once pile types and loading conditions are determined. The lateral pile analysis should incorporate the actual soil and section properties of the pile, applied loads, final lateral deflection criteria and a more realistic elastic-plastic model of soil response to loading should be completed to confirm lateral load capacities of the piles.

TABLE 13: LATERAL SUBGRADE REACTION MODULUS

Soil Type	Approximate Depth Range Below Grade (m)	Estimated K_s (kPa/m)
Clay (CL/CH), Firm to Stiff	0.0 to 3.0	20,000z/d
Clay (CH), Firm	3.0 to 9.0	13,000z/d
Clay (CH), Soft	9.0 to 13.0	8,000z/d

Note: z= depth (m), d = pile diameter (m)

It is important to note that the lateral subgrade reaction modulus assumes a linear response to lateral loading and therefore is only appropriate under the following conditions:

- Maximum pile deflection of less than 1% of the pile diameter;
- Static (non-cyclical) loading; and
- Pile material does not reach yield conditions.

If one or more of the above conditions are not met, a more rigorous analysis that includes non-linear behaviour of the piles and surrounding soil is required using programs such as LPILE. As part of detailed design, a lateral pile analysis that incorporates the material and section properties of the piles, final lateral deflection criteria and a more realistic elastic-plastic model of the soil response to loading should be completed.

5.1 Mat Foundations

If some movement can be tolerated lightly to moderately loaded structures may be founded on shallow mat foundation founded on granular fill, overlying the stiff high plasticity clay. Mat foundations will experience some 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 surface. The non-frost susceptible fill should extend horizontally a minimum of 600 m beyond the concrete foundation slab edges and contain less than 5% fines (silt and clay) content. Rigid insulation should be installed to further reduce the potential for frost related movements below mat foundations support on 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. It is recommended that a layer of non-woven geotextile be placed over the prepared subgrade to prevent migration of granular backfill materials.

Due to potential for movement, it is recommended that utilities or sensitive mechanical connections to structures founded on mat foundations be flexible and can accommodate potential for movement.

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 14 below.

TABLE 14: VERTICAL SUBGRADE REACTION MODULUS

Supporting Soil Type	Vertical Modulus of Subgrade Reaction, K_{v1} (MPa/m)*
Clay (CH) - Stiff	10

Where, K_{v1} is for a 0.3 x 0.3 m (1 x 1 ft) plate modulus. For actual footing of width ‘b’ by length ‘m’ (with b and m in meters) and founded on granular soils, $k_{vb} = (k_{v1}/b)*((m+0.15)/1.5m)$. If the footing is to be installed below the groundwater table k_{vb} should be multiplied by 0.6.

The following support preparations should be completed for this option:

- Sub-excavated as required to the subgrade design elevation, recommended 1.7 to 2.5 m below final ground surface. 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 replacement granular fill should extend horizontally a minimum of 0.6 m beyond the concrete mat 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 engineering granular fill. 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.
- Following examination and approval of the exposed subgrade, a non-woven geotextile should be placed over the subgrade materials then backfilled with new granular materials. Cover geotextile with new granular material ensuring that the placement or handling of the granular material does not damage the geotextile.
- Damaged portions of the geotextile 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 to prevent disturbance during subsequent construction activity.
- New granular fill materials should conform to City of Winnipeg Specification CW3110-R2 dated November 15, 2022 for Granular A Base Corse (base) or Granular A 50 mm (sub-base) and should be submitted to KGS Group for approval prior to importing to site. Granular fill should be placed in lifts and compacted to 98% Standard Proctor Maximum Dry Density (SPMDD) within 2% of optimum.
- 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 mat foundation and to reduce the potential for water to pond at the surface. Alternatively, capping materials could consist of concrete or asphalt.

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

6.0 INTERIOR SLABS

6.1 Soil Supported Slabs

Interior floor slabs may consist of either a slab-on-grade or structural slab construction. Floor slabs constructed at grade are susceptible to movement due to the swelling of underlying clay-type soils. The magnitude of swell can vary considerably and is based on the natural moisture content and plasticity of the soil. Swell is typically higher for slabs constructed over areas where trees have recently been removed. A slab-on-grade should only be selected if some movements and cracking of the floor slab can be tolerated.

The estimated magnitude of displacement due to swelling of soils below the floor slabs constructed at grade ranges between 25 and 50 mm. 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 is recommended for the support of a slab-on-grade interior floor:

- Remove surficial topsoil, fill layers, organics, silt, and soft or unsuitable materials encountered below slabs down to the high plastic clay. Proof rolling and compaction of the 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 standard Proctor Maximum Dry Density (SPMDD). If unsuitable subgrade soils such as organics, fill, silt or soft clay are encountered, they should be sub-excavated and 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 Specification CW3110-R2 dated November 15, 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 constructed over a minimum 150 mm void space to reduce the potential of movement due to swelling or frost heave from the underlying soil.

7.0 ADDITIONAL DESIGN CONSIDERATIONS

7.1 Frost Penetration

The depth of frost penetration will vary depending on air temperature, ground cover, the type of any fill material used during development and other factors. The expected depth of frost penetration has been estimated assuming a design freezing index of 2300°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 clay soils can heave upon freezing and that consideration must be considered in the foundation design. Good site drainage must also be maintained after development.

Well-graded granular materials should be utilized as structural backfill material as they are less susceptible to the effects of frost heave than the high plastic clay encountered at the site.

Soil in contact with foundation elements can freeze to the foundations and develop adfreeze bonding, which can result in uplift forces. The 4th Edition of the Canadian Foundation Engineering Manual (CFEM 2006) 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.

To calculate the frost uplift force, the adfreeze bond stress should be applied to the perimeter of the pile within the depth of frost. A resistance factor of 0.7 can be used with the unfactored ULS skin friction values on Table 9 to determine the frost uplift resistance of the pile.

The depth of burial (minimum 2.5 m) of water lines or other lines that cannot be allowed to freeze should consider local practice. Shallow lines can be protected using a heat trace or closed cell extruded polystyrene insulation. The amount and extent of insulation required will be dependent on several factors including the thermal regime around the pipe, the depth of burial, surface conditions, and fluid temperature, if present.

7.2 Backfilling

The on-site clay material is considered suitable for general backfilling. Free draining granular material should consist of less than 5% fines (passing the #200 sieve). Backfill materials should be compacted uniformly in maximum 150 mm lifts to at least 95% SPMDD. If granular soil is used as backfill behind below grade walls, the upper 1 m of fill should consist of compacted high plasticity clay, to promote surface runoff and reduce infiltration.

7.3 Lateral Earth Pressure Coefficients

For design purposes the soils may be assigned active, passive and at-rest lateral earth pressure coefficients as shown in Table 15 below.

TABLE 15: EARTH PRESSURE COEFFICIENTS

Material	Bulk Unit Weight (kN/m^3)	ϕ'	K_a	K_p	K_o
Clay (CL)	18	20	0.490	2.040	0.658
Clay (CH)	18	17	0.548	1.826	0.708
Well Graded Compacted Granular Fill (GW)	18	35	0.271	3.690	0.426

Live loads or surface surcharge loads should be included if a significant loading is applied within a distance equal to the height of the below grade wall.

7.4 Seismic Site Classification

In accordance with the 2020 National Building Code of Canada (NBCC), Table 4.1.8.4.B, the site class, S, for seismic site designation, X_S, is based on the average properties of soil and rock in the top 30 m. Based on the results of the investigation, the project site class may be considered to be E, based on an average shear strength greater than 40 kPa within the upper 30 m of the soil profiletherefore the site designation is X_E.

To obtain the seismic values for the design of buildings in Canada under Part 4 of the 2020 NBCC as prescribed in Article 1.1.3.1. of Division B, use the 2020 NBCC Seismic Hazard Tool available publicly online.

7.5 Cement Type for Foundation Concrete

It is recommended that concrete in contact with soil use a 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.

7.6 Surface and Subsurface 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. It is recommended that the sum pit be a minimum of 0.8 x 0.8 m (2.5 x 2.5 ft) in plan area and have a sealed cover suitable support the weight of an adult. Water should be pumped with the sump pit using suitable piping material with a minimum inside diameter of 30 mm, discharge piping should be equipped with a check valve to prevent backflow into the sump pit and should be graded to prevent freezing water from developing within the system. Installation of subsurface drainage should be in accordance with locally accepted practices and should conform to City of Winnipeg By-law No. 4555/87 Section 23.

However not required, installation of a weeping tile network below the floor slab maybe be considered to improve control of groundwater seepage. In this instance the entire subgrade beneath the floor slab area should be graded towards the sump pit. Weeping tile pipe wrapped in a filter shock should be placed in a grid fashion and should direct water towards the sump pit. The entire floor slab area should then be backfilled with drain rock (clean pea gravel or clean crushed rock), thickness of the drain rock should be 1.5 times the diameter of the weeping tile pipe and weeping tile should be spaced at 4.6 to 6.1 m (15 to 20 ft) intervals.

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.

7.7 Temporary Excavations

All trenching and excavations should conform to the latest version of Manitoba Occupational Health and Safety Regulations (OH&S). A side slope of 1H:1V can be used for all excavations that have a maximum depth of 1.5 m. Excavations deeper than 1.5 m should be reviewed and designed prior to construction by an experienced professional engineer with an expertise in geotechnical engineering.

It is anticipated that seepage will occur in excavations below the groundwater table, and from the shallow clay and silt layer observed at the site. To maintain safe working conditions and a stable base for construction, water should not be allowed to accumulate within the excavation. A dewatering system consisting of a series of perimeter trenches and sump pumps located at the base of the excavation can likely control the seepage by pumping the water out of the excavation and discharging away from the limits of construction. The rate of seepage is expected to decrease as pumping operations continue.

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.

7.8 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.

7.9 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 Table 16.

TABLE 16: 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 topsoil, organics, clay and silt, 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.

7.10 Construction Inspection

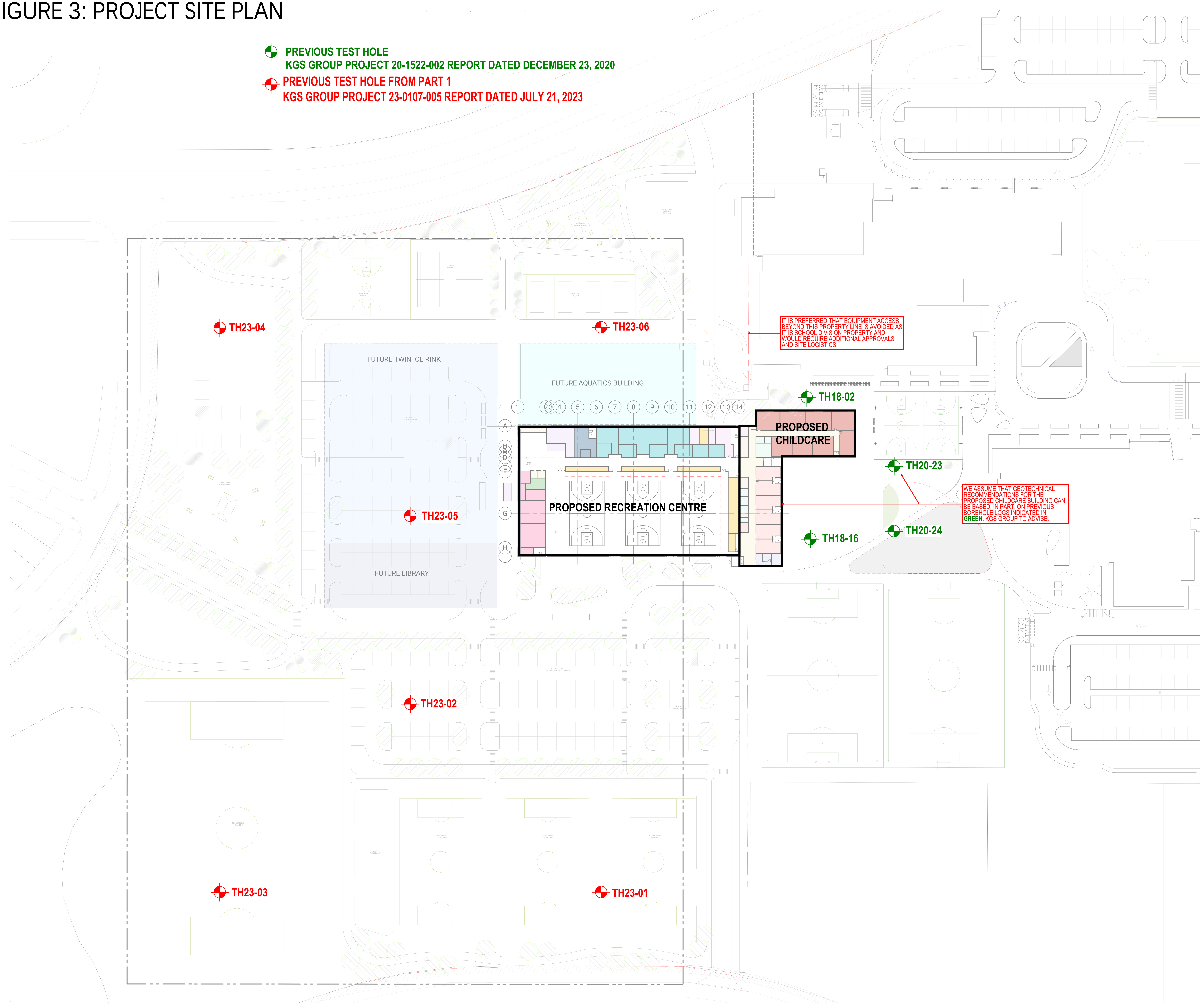
KGS Group should be retained to complete the following inspection services during construction:

- Detailed construction records and full-time inspection by experienced geotechnical personnel 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.

- Inspection of driven steel and concrete pile installation by experienced geotechnical personnel is required to ensure that the specified refusal criteria 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 sub-base materials to ensure that the supplied granular materials meet the graduation requirements specified for these materials.
- Compaction testing of sub-grade materials, and sub-base/base granular materials should be completed to ensure materials are compacted properly and meet the minimum compaction requirements specified for this project.

FIGURES

FIGURE 3: PROJECT SITE PLAN



IT IS PREFERRED THAT EQUIPMENT ACCESS BEYOND THIS PROPERTY LINE IS AVOIDED AS IT IS SCHOOL DIVISION PROPERTY AND WOULD REQUIRE ADDITIONAL APPROVALS AND SITE LOGISTICS.

WE ASSUME THAT GEOTECHNICAL RECOMMENDATIONS FOR THE PROPOSED CHILDCARE BUILDING CAN BE BASED, IN PART, ON PREVIOUS BOREHOLE LOGS INDICATED IN GREEN. KGS GROUP TO ADVISE.

diamond
schmitt

Issued

No.	Date	Description

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.

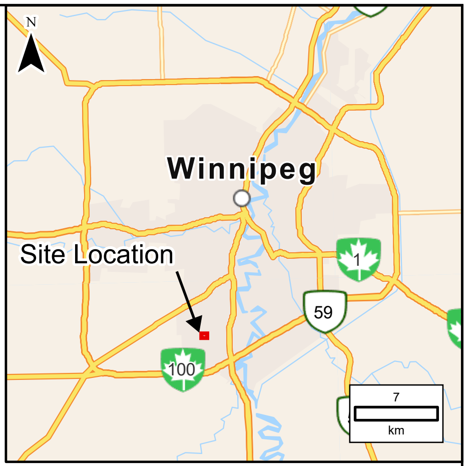
South Winnipeg Recreation
Campus

220007

Site Plan
1 : 500

P100

ID	Northing	Easting	Elevation
TH23-01	5517488.85	630644.05	232.61
TH23-02	5517512.00	630543.00	232.69
TH23-03	5517405.86	630514.06	232.83
TH23-04	5517612.58	630391.72	232.85
TH23-05	5517581.79	630513.25	232.63
TH23-05-PZ	5517578.79	630514.25	232.63
TH23-06	5517703.35	630533.45	233.13
TH23-06-PZ	5517701.00	630534.07	233.12
TH23-07	5517674.00	630594.00	232.99
TH23-07-PZ	5517677.58	630601.69	233.17
TH23-08	5517644.38	630622.80	233.09
TH23-09-PZ	5517642.92	630582.47	232.77
TH23-10	5517639.69	630538.90	233.28
TH23-11	5517608.40	630559.66	232.90
TH23-12	5517566.81	630513.68	232.90



LEGEND:

Test Hole

- 🟥 -Phase 1 Test Holes
- 🟪 -Phase 2 Test Holes

NOTES:
1. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD83 CSRS , Zone 14. Elevations are in metres above sea level (MSL). CGVD28

10 0 10 20 30 40
Metres

SCALE: 1:1,500 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
A	02/02/14	ISSUED WITH FINAL REPORT	TS	TE

REVISIONS / ISSUE

KGS GROUP

Winnipeg
Embrace the Spirit • Vivez l'esprit

SOUTH WINNIPEG RECREATION CAMPUS
GEOTECHNICAL SERVICES

TEST HOLE LOCATION PLAN

JANURAY 2024

FIGURE 4

REV: A

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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FileName: R:\Projects\2023\23-0107-005\Design\GIS\Data\ArcPro\TestHoles\TestHoles.aprx 23-0107-005_Fig01
11"x17' PLOT SCALE 1:1

APPENDIX A

Phase 1 Test Hole Logs and Fence Diagram

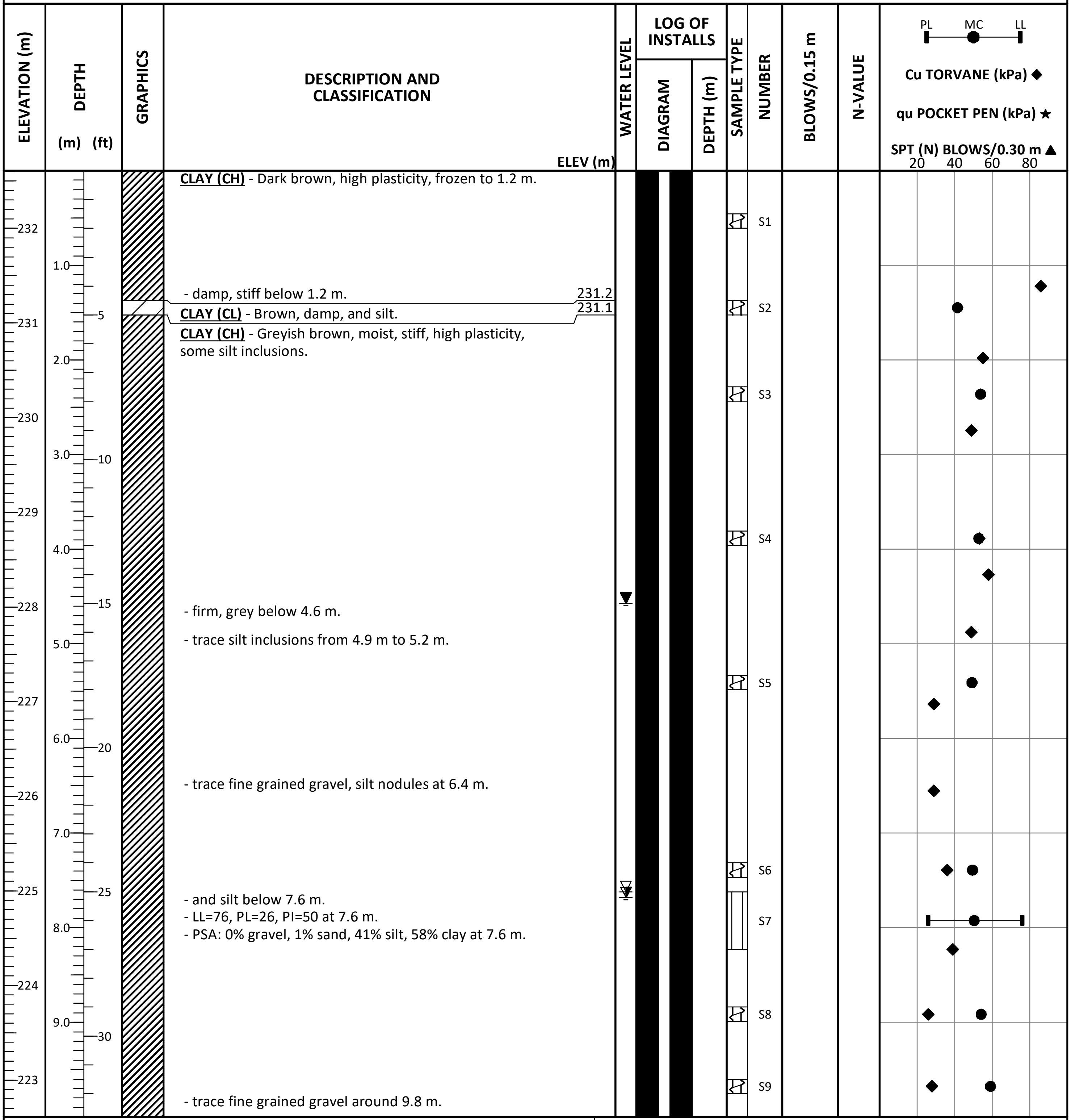
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-01

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.**	232.61 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	1.07 m / 233.68 m (Standpipe)
DESCRIPTION	SE corner of property, ~300 m South of Cadboro Road	**START DATE**	4-11-2023
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,517,488.85
METHOD(S)	0.0 m to 16.9 m: 125 mm ø SSA		E 630,644.05 Zone 14



CLAY (CH) - Dark brown, high plasticity, frozen to 1.2 m.

- damp, stiff below 1.2 m. 231.2

CLAY (CL) - Brown, damp, and silt. 231.1

CLAY (CH) - Greyish brown, moist, stiff, high plasticity, some silt inclusions.

- firm, grey below 4.6 m.
- trace silt inclusions from 4.9 m to 5.2 m.
- trace fine grained gravel, silt nodules at 6.4 m.
- and silt below 7.6 m.
- LL=76, PL=26, PI=50 at 7.6 m.
- PSA: 0% gravel, 1% sand, 41% silt, 58% clay at 7.6 m.
- trace fine grained gravel around 9.8 m.

WATER LEVELS ∇ **During Drilling/Digging**	7.62 m	
▼ **Upon Completion**	4.57 m	
▼ **Remeasured/Static**	7.68 m on 12-16-2023	

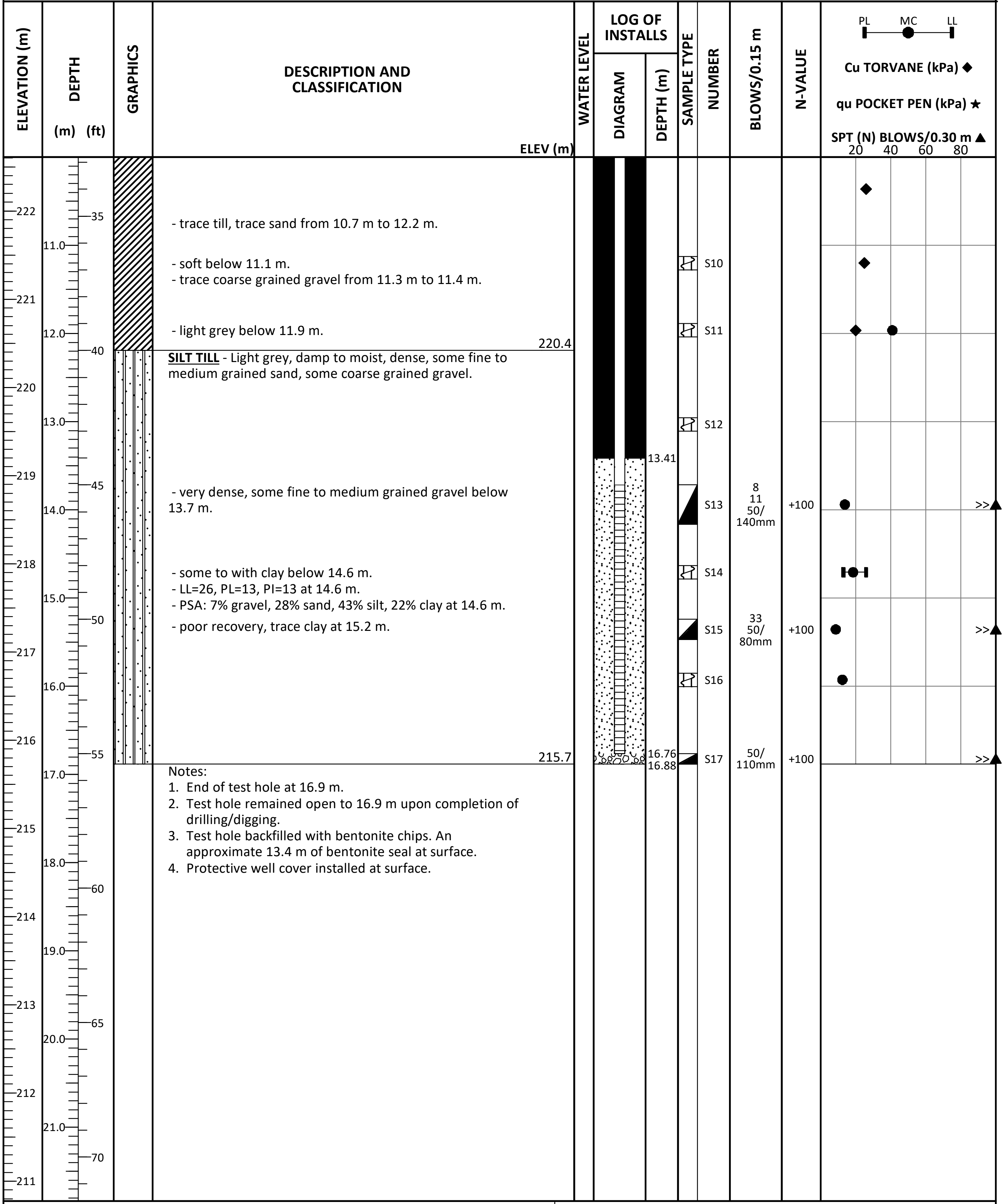
CONTRACTOR **Paddock Drilling**	INSPECTOR **H. SABHARWAL**
APPROVED T. SCHELLENBERG	DATE 4-28-2023

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-01**

SHEET 2 of 2



- trace till, trace sand from 10.7 m to 12.2 m.

- soft below 11.1 m.
- trace coarse grained gravel from 11.3 m to 11.4 m.

- light grey below 11.9 m.

220.4

SILT TILL - Light grey, damp to moist, dense, some fine to medium grained sand, some coarse grained gravel.

- very dense, some fine to medium grained gravel below 13.7 m.

- some to with clay below 14.6 m.
- LL=26, PL=13, PI=13 at 14.6 m.
- PSA: 7% gravel, 28% sand, 43% silt, 22% clay at 14.6 m.
- poor recovery, trace clay at 15.2 m.

215.7

Notes:
1. End of test hole at 16.9 m.
2. Test hole remained open to 16.9 m upon completion of drilling/digging.
3. Test hole backfilled with bentonite chips. An approximate 13.4 m of bentonite seal at surface.
4. Protective well cover installed at surface.

NUMBER	BLOWS/0.15 m	N-VALUE
S10		
S11		
S12		
S13	8 11 50/ 140mm	+100
S14		
S15	33 50/ 80mm	+100
S16		
S17	50/ 110mm	+100

WATER LEVELS		
▽	**During Drilling/Digging**	7.62 m
▼	**Upon Completion**	4.57 m
▼	**Remeasured/Static**	7.68 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.
TH23-02

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 1 General Investigation**	**SURFACE ELEV.**	232.69 m
LOCATION	Winnipeg, Manitoba	**START DATE**	4-11-2023
DESCRIPTION	Near middle of property, ~200 m South of Cadboro Road	**UTM (m)**	N 5,517,512
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer		E 630,543 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** | **RECOVERY %**

CLAY (CH) - Dark brown, trace fine to medium grained sand, trace silt nodules, frozen to 1.2 m.

- damp, stiff below 1.2 m.

231.2

CLAY (CL) - Brown, damp to moist, stiff, and silt.

230.9

CLAY (CH) - Brown, damp to moist, firm, high plasticity, oxide nodules.

- gypsum inclusions below 2.1 m.

- oxidation below 3.0 m.

- trace fine grained sand at 4.3 m.

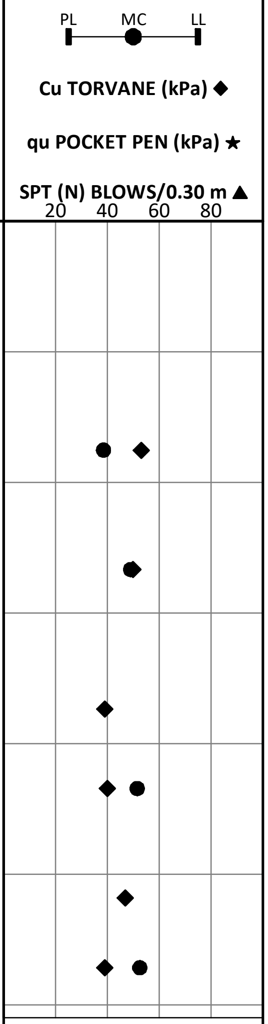
- dark grey below 4.6 m.

- trace silt inclusions, trace sand around 5.3 m.

226.6

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.

NUMBER	RECOVERY %
S1	
S2	
S3	
S4	
S5	
S6	100
S7	



WATER LEVELS	▽ **During Drilling/Digging**	Dry
	▼ **Upon Completion**	Dry

CONTRACTOR
Paddock Drilling

INSPECTOR
H. SABHARWAL

APPROVED
T. SCHELLENBERG

DATE
4-28-2023

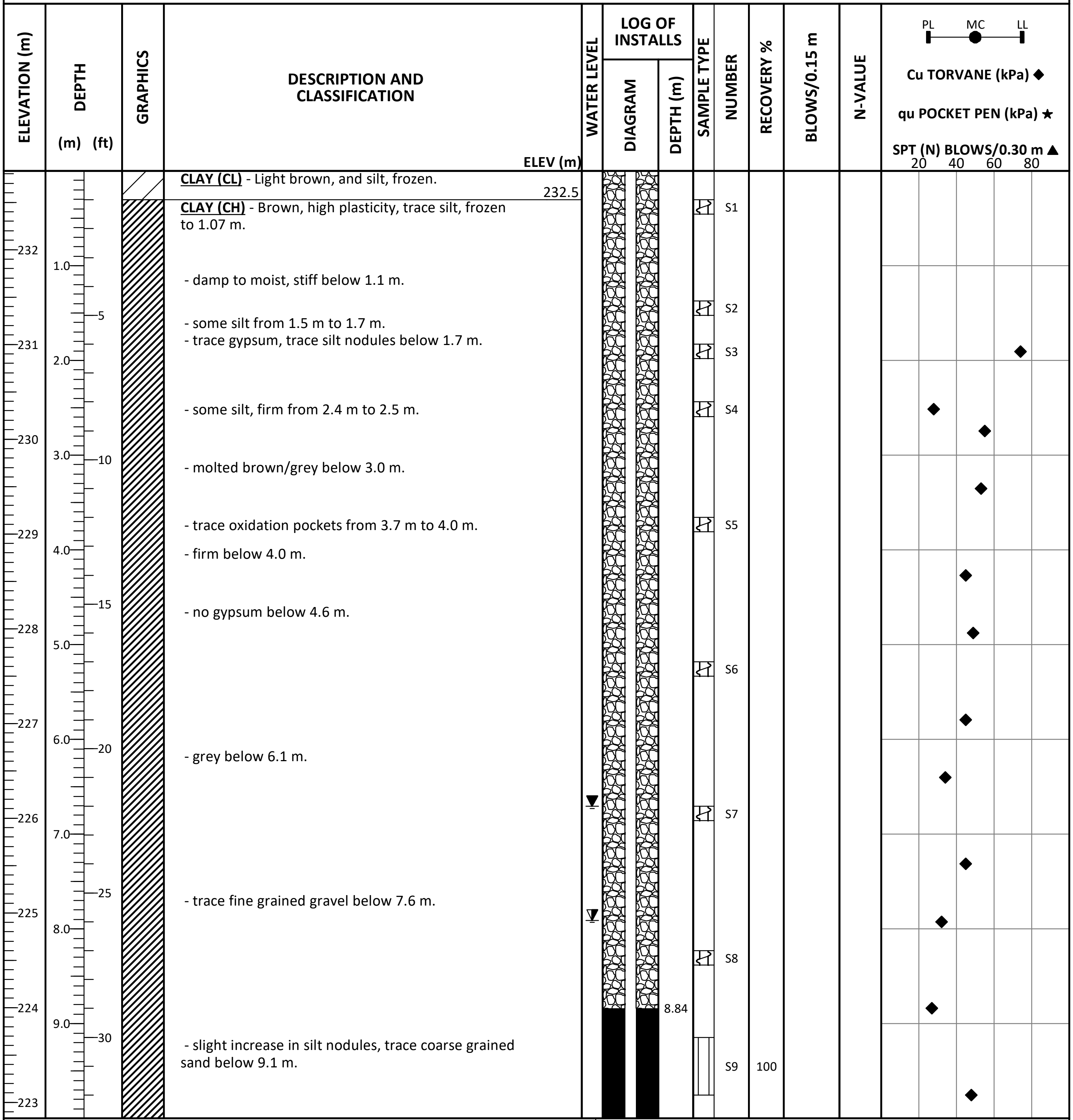
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-03

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.**	232.83 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	1.00 m / 233.83 m (Standpipe)
DESCRIPTION	SW corner of property, ~300 m South of Cadboro Road	**START DATE**	4-11-2023
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,517,405.86
METHOD(S)	0.0 m to 16.8 m: 125 mm ø SSA		E 630,514.07 Zone 14



CLAY (CL) - Light brown, and silt, frozen.

CLAY (CH) - Brown, high plasticity, trace silt, frozen to 1.07 m.

- damp to moist, stiff below 1.1 m.
- some silt from 1.5 m to 1.7 m.
- trace gypsum, trace silt nodules below 1.7 m.
- some silt, firm from 2.4 m to 2.5 m.
- molted brown/grey below 3.0 m.
- trace oxidation pockets from 3.7 m to 4.0 m.
- firm below 4.0 m.
- no gypsum below 4.6 m.
- grey below 6.1 m.
- trace fine grained gravel below 7.6 m.
- slight increase in silt nodules, trace coarse grained sand below 9.1 m.

WATER LEVELS	▽ **During Drilling/Digging**	12.80 m
	▼ **Upon Completion**	6.71 m
	▼ **Remeasured/Static**	7.91 m on 12-16-2023

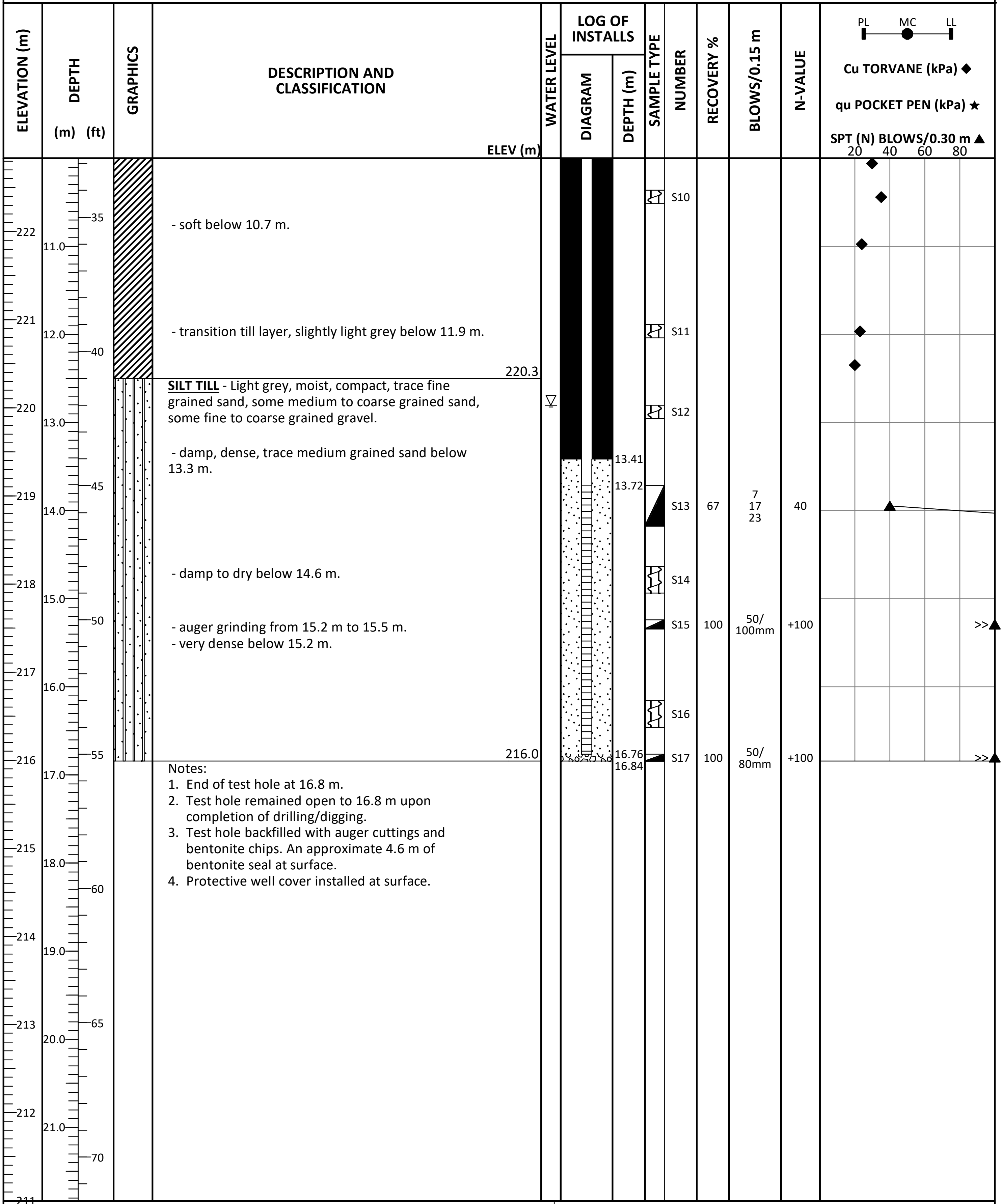
CONTRACTOR **Paddock Drilling**	INSPECTOR **C. FRIESEN**
APPROVED T. SCHELLENBERG	DATE 4-28-2023

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-03

SHEET 2 of 2



- soft below 10.7 m.

- transition till layer, slightly light grey below 11.9 m.

220.3

<u>SILT TILL</u> - Light grey, moist, compact, trace fine grained sand, some medium to coarse grained sand, some fine to coarse grained gravel.

- damp, dense, trace medium grained sand below 13.3 m.

- damp to dry below 14.6 m.

- auger grinding from 15.2 m to 15.5 m.
- very dense below 15.2 m.

216.0

Notes:
1. End of test hole at 16.8 m.
2. Test hole remained open to 16.8 m upon completion of drilling/digging.
3. Test hole backfilled with auger cuttings and bentonite chips. An approximate 4.6 m of bentonite seal at surface.
4. Protective well cover installed at surface.

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S10			
S11			
S12			
S13	67	7 17 23	40
S14			
S15	100	50/ 100mm	+100
S16			
S17	100	50/ 80mm	+100

WATER LEVELS		
∇	**During Drilling/Digging**	12.80 m
▼	**Upon Completion**	6.71 m
▼	**Remeasured/Static**	7.91 m on 12-16-2023

CONTRACTOR
Paddock Drilling

INSPECTOR
C. FRIESEN

APPROVED
T. SCHELLENBERG

DATE
4-28-2023

KGS GROUP

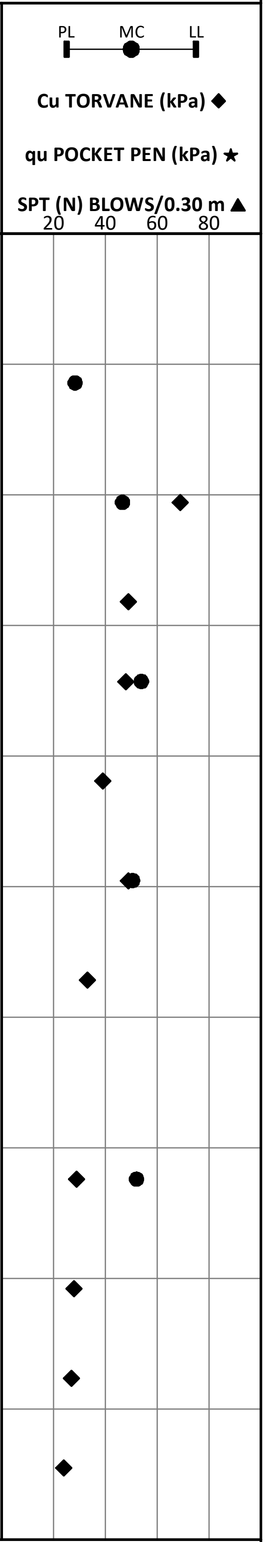
TEST HOLE LOG

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

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	RECOVERY %	BLOWS/0.15 m	N-VALUE
			CLAY (CH) - Light brown, trace sand, frozen to 0.91 m.						S1			
232	1.0		- damp, stiff below 0.9 m.	231.8					S2			
			CLAY (CL) - Light brownish grey, dry, soft, some sand, and silt.	231.5								
	5		**CLAY (CH)** - Light brown, damp to moist, stiff, high plasticity, trace silt.									
231	2.0		- moderate oxidation, trace silt nodules from 2.1 m to 2.3 m. - trace gypsum around 2.4 m.						S3			
230	3.0 (10)		- firm below 2.7 m.						S4			
									S5			
229	4.0		- oxide nodules, trace silt at 4.1 m.						S6			
228	5.0 (15)								S7			
			- grey below 5.5 m.						S8			
227	6.0 (20)		- dark grey, some silt nodules below 6.1 m.									
226	7.0								S9			
225	8.0 (25)				▼							
224	9.0 (30)						8.53		S10			
223			- 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

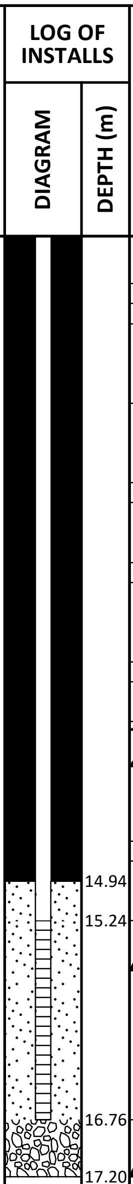
TEST HOLE LOG

HOLE NO.
TH23-04

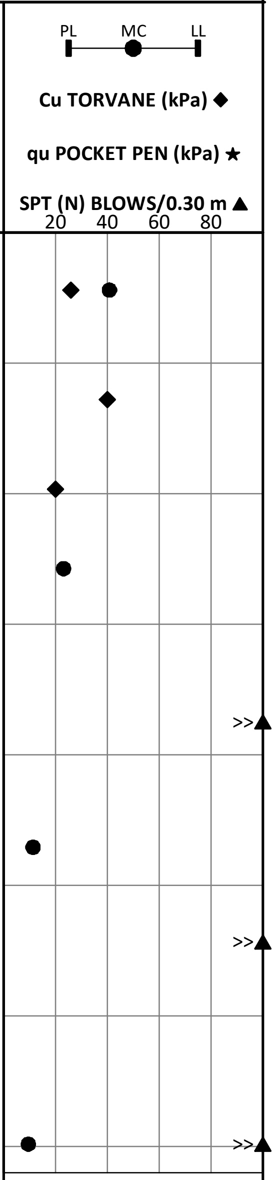
SHEET 2 of 2

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)
	- trace fine grained gravel , moist at 9.9 m. - increasing silt nodules below 10.1 m. - firm, silt till clump from 11.3 m to 11.4 m. - trace fine to medium grained gravel at 11.9 m.	
		219.9
	SILT TILL - Light grey, dry, dense, some medium to coarse grained gravel, trace fine to medium grained sand. - very dense below 13.7 m.	
		215.7

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.



NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S11			
S12	100		
S13			
S14			
S15			
S17	100	8 50/ -90mm	+100
S16			
S18			
S20	100	25 32 50/ 80mm	+100
S21	38	41 48 50/ 130mm	+100



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

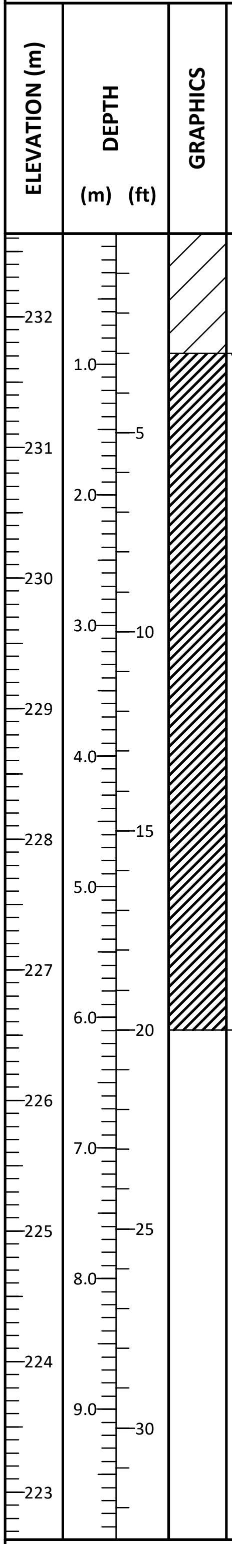
DATE
4-28-2023

TEST HOLE LOG

HOLE NO.
TH23-05

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 1 General Investigation**	**SURFACE ELEV.**	232.64 m
LOCATION	Winnipeg, Manitoba	**START DATE**	4-12-2023
DESCRIPTION	Near middle of property, ~125 m South of Cadboro Road	**UTM (m)**	N 5,517,581.79
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer		E 630,513.25 Zone 14
METHOD(S)	0.0 m to 6.1 m: 125 mm ø SSA		



DESCRIPTION AND CLASSIFICATION — ELEV (m)

CLAY (CL) - Light brown, trace to some sand, and silt, frozen to 0.76 m.

- LL=26, PL=18, PI=8 at 0.5 m.
- PSA: 0% gravel, 6% sand, 75% silt, 19% clay at 0.5 m.
- damp below 0.8 m.

231.7

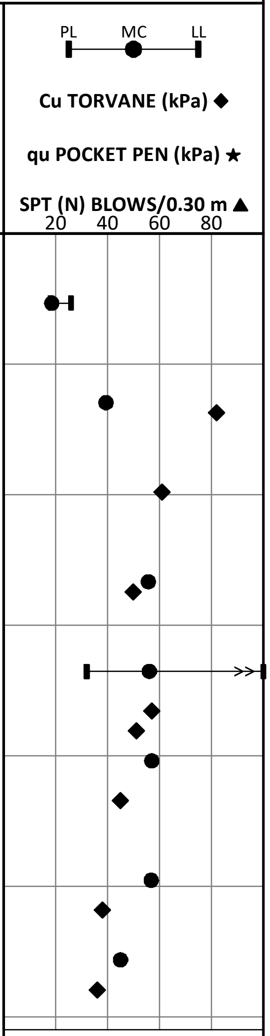
CLAY (CH) - Dark brown, damp, stiff, high plasticity, trace sand, trace silt nodules.

- minor oxidation at 2.0 m.
- light brown below 2.9 m.
- with silt at 3.0 m.
- LL=102, PL=32, PI=70 at 3.0 m.
- PSA: 0% gravel, 0% sand, 22% silt, 78% clay at 3.0 m.
- trace silt from 3.8 m to 4.3 m.
- firm below 4.3 m.
- silt pockets at 4.4 m.
- grey below 5.5 m.

226.5

Notes:
1. End of test hole at 6.1 m.
2. Test hole remained open to 6.1 m upon completion of drilling/digging.

NUMBER	RECOVERY %
S1	
S2	
S3	
S4	
S5	100
S6	
S7	
S8	
S9	



WATER LEVELS	▽ **During Drilling/Digging**	Dry
	▼ **Upon Completion**	Dry

CONTRACTOR
Paddock Drilling

INSPECTOR
H. SABHARWAL

APPROVED
T. SCHELLENBERG

DATE
4-28-2023

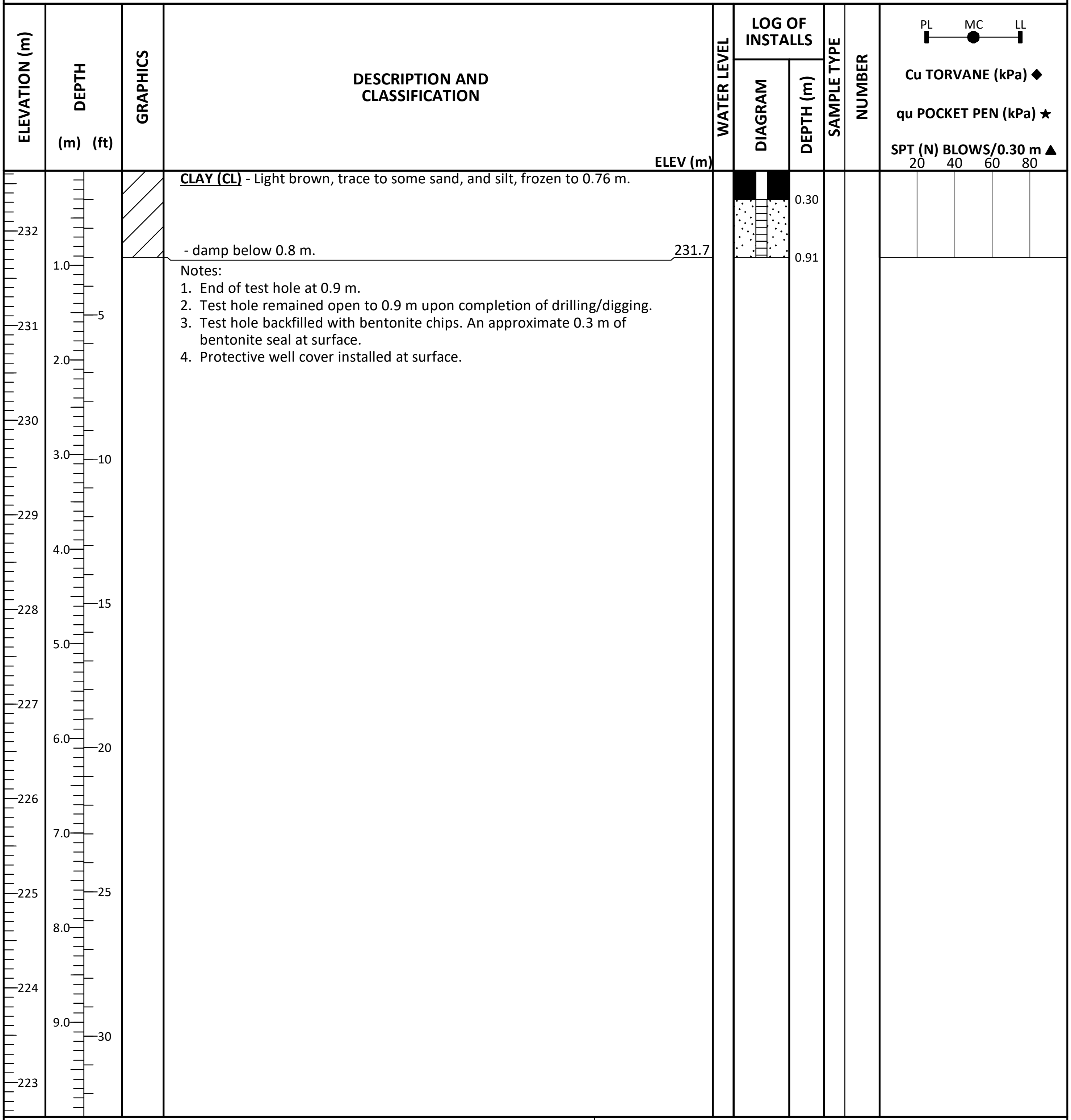
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-05-PZ

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 1 General Investigation**	**SURFACE ELEV.**	232.64 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.91 m / 233.55 m (Standpipe)
DESCRIPTION	3 m south of test hole TH23-05	**START DATE**	4-12-2023
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,517,578.79
METHOD(S)	0.0 m to 0.9 m: 125 mm ø SSA		E 630,514.25 Zone 14



CLAY (CL) - Light brown, trace to some sand, and silt, frozen to 0.76 m.

- damp below 0.8 m. 231.7

Notes:

1. End of test hole at 0.9 m.
2. Test hole remained open to 0.9 m upon completion of drilling/digging.
3. Test hole backfilled with bentonite chips. An approximate 0.3 m of bentonite seal at surface.
4. Protective well cover installed at surface.

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

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

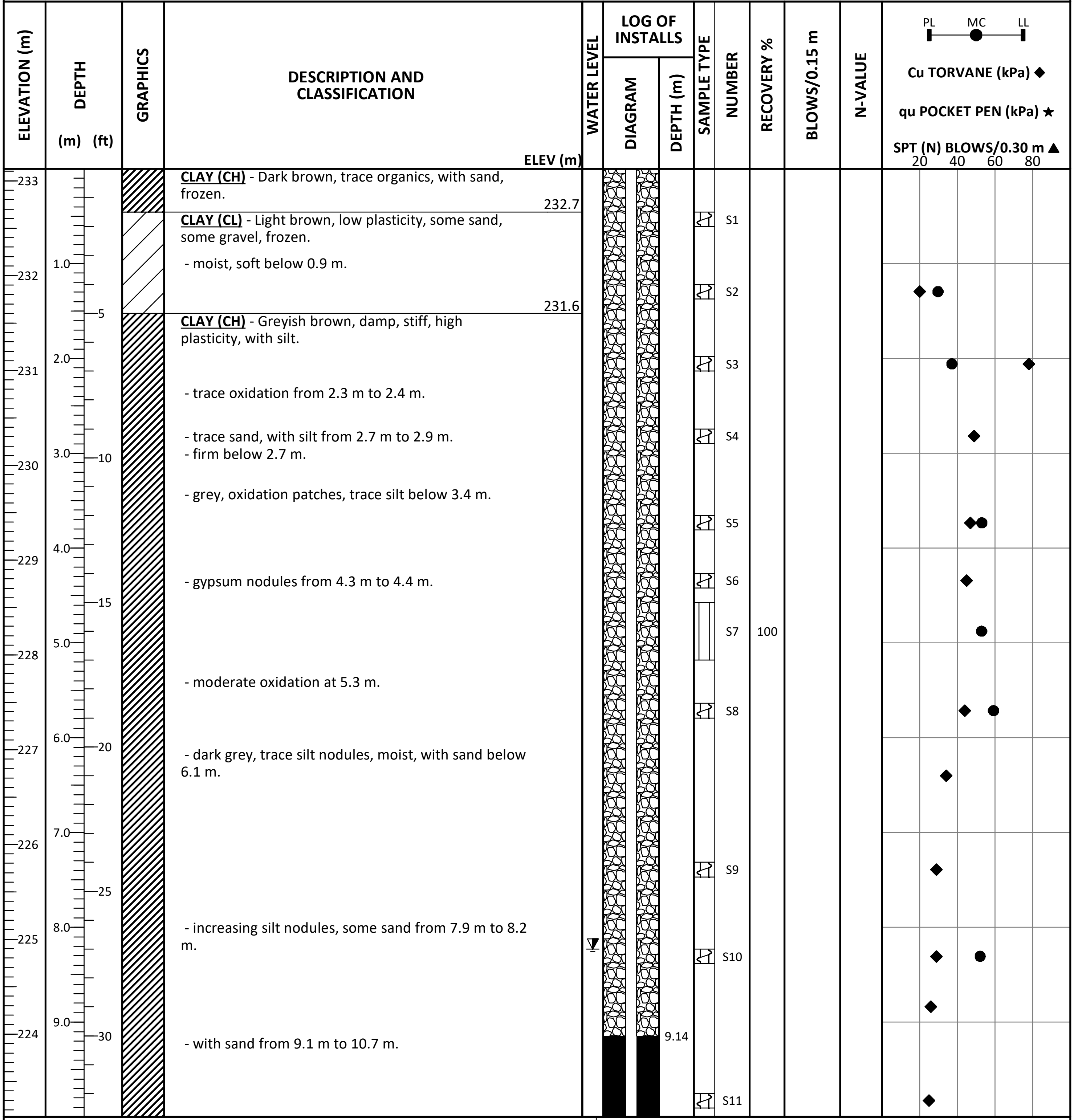
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-06

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.**	233.13 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	1.12 m / 234.24 m (Standpipe)
DESCRIPTION	NE corner of property, ~50 m South of Cadboro Road	**START DATE**	4-13-2023
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,517,703.35
METHOD(S)	0.0 m to 10.7 m: 125 mm ø SSA - switched due to wet caving sand 12.2 m to 16.5 m: 250 mm ø HSA		E 630,533.45 Zone 14



DESCRIPTION AND CLASSIFICATION	ELEV (m)
CLAY (CH) - Dark brown, trace organics, with sand, frozen.	232.7
CLAY (CL) - Light brown, low plasticity, some sand, some gravel, frozen. - moist, soft below 0.9 m.	231.6
CLAY (CH) - Greyish brown, damp, stiff, high plasticity, with silt. - trace oxidation from 2.3 m to 2.4 m. - trace sand, with silt from 2.7 m to 2.9 m. - firm below 2.7 m. - grey, oxidation patches, trace silt below 3.4 m. - gypsum nodules from 4.3 m to 4.4 m. - moderate oxidation at 5.3 m. - dark grey, trace silt nodules, moist, with sand below 6.1 m. - increasing silt nodules, some sand from 7.9 m to 8.2 m. - with sand from 9.1 m to 10.7 m.	

NUMBER	RECOVERY %
S1	
S2	
S3	
S4	
S5	
S6	
S7	100
S8	
S9	
S10	
S11	

WATER LEVELS	∇ **During Drilling/Digging**	10.67 m
	▼ **Upon Completion**	Dry
	▼ **Remeasured/Static**	8.23 m on 12-16-2023

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

KGS GROUP

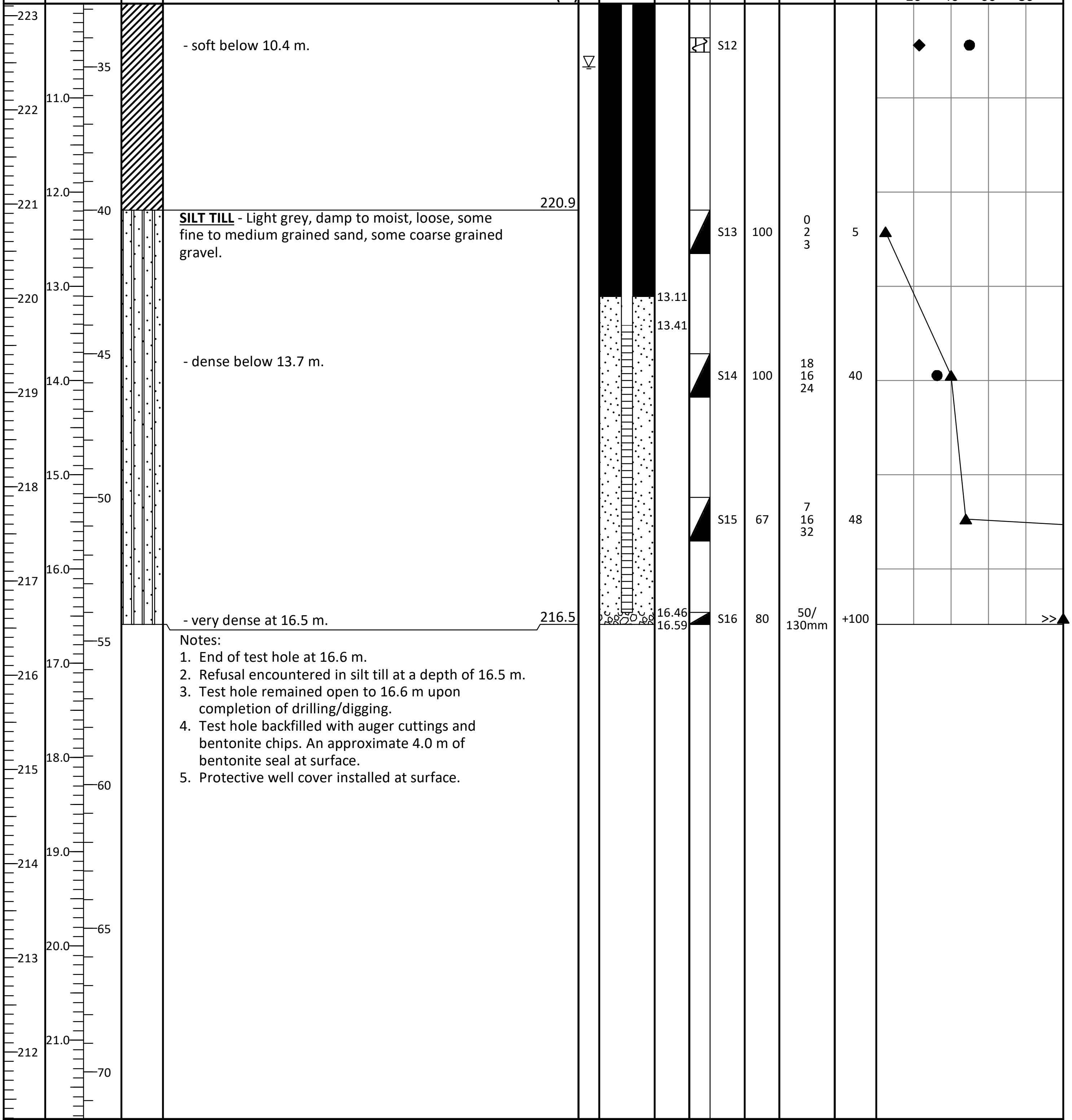
TEST HOLE LOG

HOLE NO.
TH23-06

SHEET 2 of 2

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	LOG OF INSTALLS DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
10.4	- soft below 10.4 m.					S12			
10.67			▽						
12.2	**SILT TILL** - Light grey, damp to moist, loose, some fine to medium grained sand, some coarse grained gravel.	220.9				S13	100	0 2 3	5
				13.11 13.41					
13.7	- dense below 13.7 m.					S14	100	18 16 24	40
						S15	67	7 16 32	48
16.5	- very dense at 16.5 m.	216.5		16.46 16.59		S16	80	50/ 130mm	+100

Notes:
1. End of test hole at 16.6 m.
2. Refusal encountered in silt till at a depth of 16.5 m.
3. Test hole remained open to 16.6 m upon completion of drilling/digging.
4. Test hole backfilled with auger cuttings and bentonite chips. An approximate 4.0 m of bentonite seal at surface.
5. Protective well cover installed at surface.



WATER LEVELS	▽ **During Drilling/Digging**	10.67 m
	▼ **Upon Completion**	Dry
	▼ **Remeasured/Static**	8.23 m on 12-16-2023

CONTRACTOR
Paddock Drilling

INSPECTOR
H. SABHARWAL

APPROVED
T. SCHELLENBERG

DATE
4-28-2023

KGS GROUP

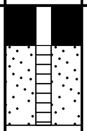
TEST HOLE LOG

HOLE NO.
TH23-06-PZ

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 1 General Investigation**	**SURFACE ELEV.**	233.11 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	1.01 m / 234.13 m (Standpipe)
DESCRIPTION	2 m north of test hole TH23-06	**START DATE**	4-14-2023
DRILL RIG / HAMMER	Mobile B57 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,517,701
METHOD(S)	0.0 m to 0.9 m: 125 mm ø SSA		E 630,534.08 Zone 14

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	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
233		▨	**CLAY (CH)** - Dark brown, trace organics, with sand, frozen.	232.7		0.30			
		▨	**CLAY (CL)** - Light brown, low plasticity, some sand, some gravel, frozen.	232.2		0.91			



Notes:
1. End of test hole at 0.9 m.
2. Test hole remained open to 0.9 m upon completion of drilling/digging.
3. Test hole backfilled with bentonite chips. An approximate 0.3 m of bentonite seal at surface.
4. Protective well cover installed at surface.

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

CONTRACTOR
Paddock Drilling

INSPECTOR
H. SABHARWAL

APPROVED
T. SCHELLENBERG

DATE
4-28-2023

KEY TO SYMBOLS

LITHOLOGIC SYMBOLS

▨ Clay (CH, high plasticity)

◿ Clay (CL, low plasticity)

▥ Silt Till

▤ Topsoil

SAMPLER SYMBOLS

▯ Auger Grab

◫ Shelby Tube

◪ SPT Split Spoon

WELL CONSTRUCTION SYMBOLS

▩ Slough

■ Standpipe (bentonite)

▦ Standpipe (cuttings)

▥ Standpipe (filter sand)

▥ Screen (filter sand)

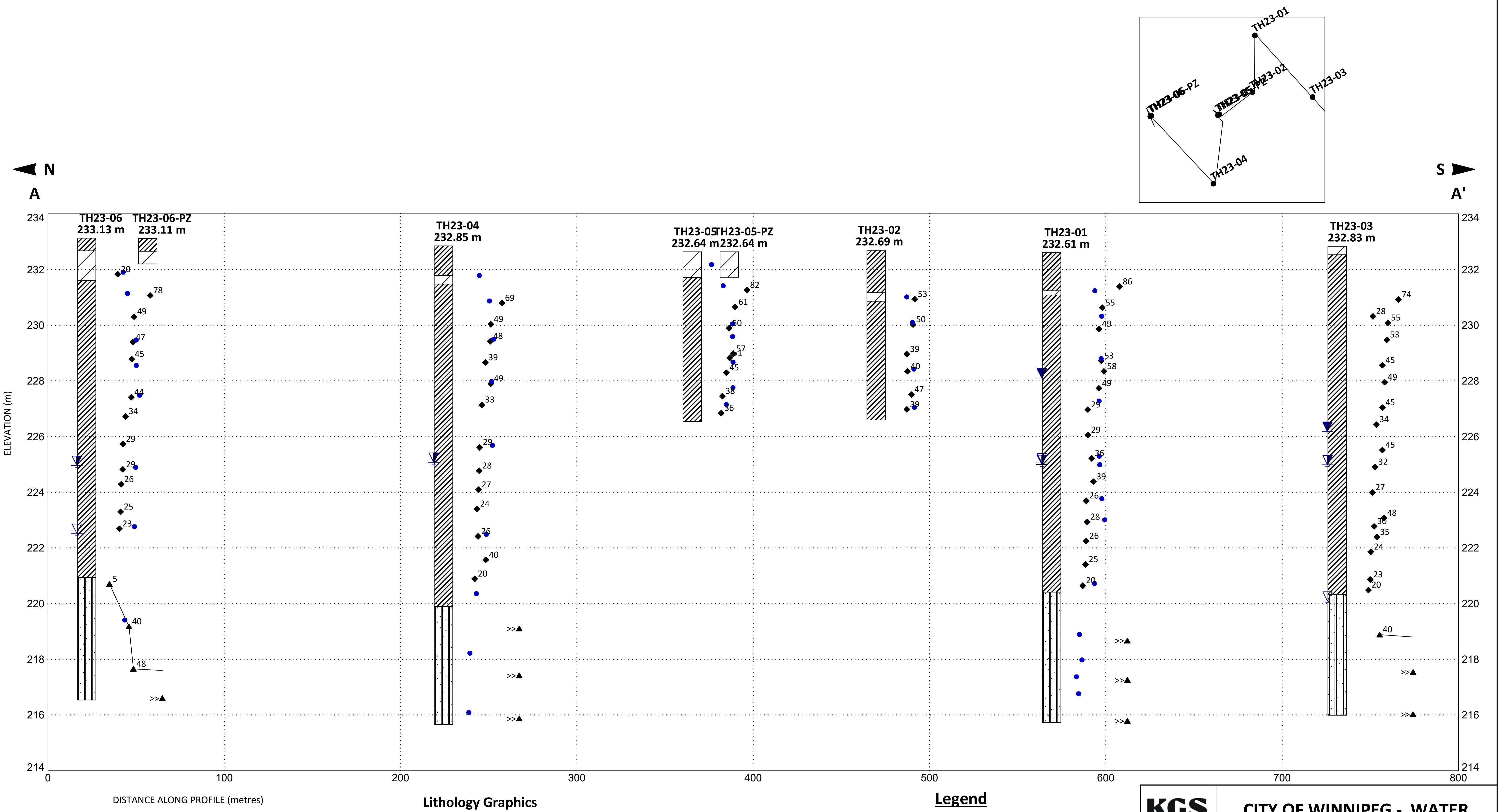
ABBREVIATIONS

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.**	23-0107-005
PROJECT NAME	South Winnipeg Rec. Campus - Phase 1 General Investigation	**LOCATION**	Winnipeg, Manitoba



Lithology Graphics

0 42

Horizontal Scale (meters)
Vertical Exaggeration: 16x

▨ Clay (CH, high plasticity)
▱ Clay (CL, low plasticity)
▥ Silt Till

Legend

TH23-01 — Test Hole ID
Test Hole Lithology

▽ Water Level During Drilling
▼ Water Level Upon Completion
▼ Water Level Static/Remeasured
▲ SPT, N-Value
◓ DCPT Value
>> ▲ ◓ values greater than 100
◆ Torvane Cu (kPa)
● Moisture Content (%)

KGS
GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Phase 1 - South Winnipeg Recreation Campus

A-A'

Dec 2023

Figure 03

FENCE W/O WELL DATA PLOT U:\FMS\23-0107-005\23-0107-005.GPJ

APPENDIX B

Phase 2 Test Hole Logs and Fence Diagram

KGS GROUP

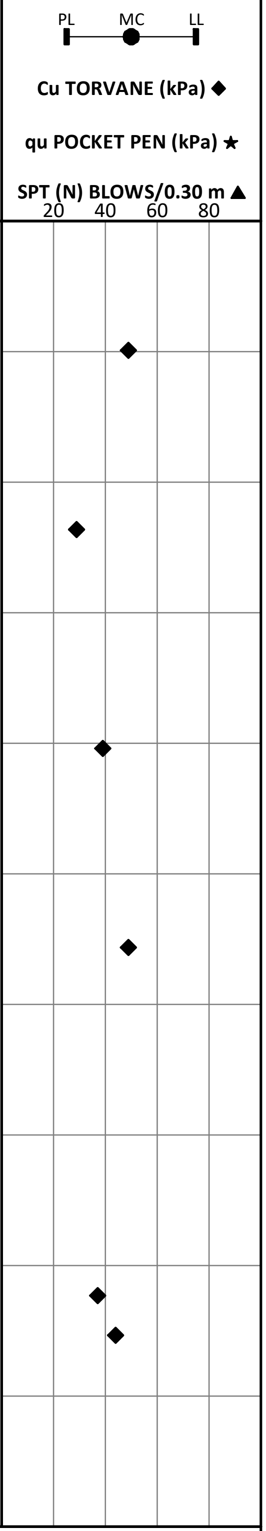
TEST HOLE LOG

HOLE NO.
TH23-07

SHEET 1 of 2

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 2 Detailed Investigation**	**SURFACE ELEV.**	232.99 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-27-2023
DESCRIPTION	NE Corner Recreation Centre Building	**UTM (m)**	N 5,517,674
DRILL RIG / HAMMER	Acker MP5 Track Mounted Drill Rig with Safety Drop Hammer		E 630,594 Zone 14
METHOD(S)	0.0 m to 15.3 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m) (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
		TOPSOIL - 152 mm, Black, damp, non-plastic, some rootlets, frozen.	232.8						
		CLAY (CL) - Light brown, damp, low plasticity, and silt, frozen.	232.4			S1			
232	1.0	**CLAY (CH)** - Brown, damp, high plasticity, silty, frozen. - firm below 1.0 m.	231.5			S2			
231	2.0 (5)	**CLAY (CL)** - Brown, damp, firm, low plasticity, and silt. - wet below 3.0 m.	228.7	▽		S3 S4 S5 S6 S7			
230	3.0 (10)								
229	4.0	**CLAY (CH)** - Grey, moist, firm, high plasticity, trace to some silt. - trace fine gravel below 9.1 m.				S8 S9 S10			
228	5.0 (15)								
227	6.0 (20)								
226	7.0								
225	8.0 (25)								
224	9.0 (30)								
223									



WATER LEVELS	▽ **During Drilling/Digging**	3.05 m
	▼ **Upon Completion**	14.63 m

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

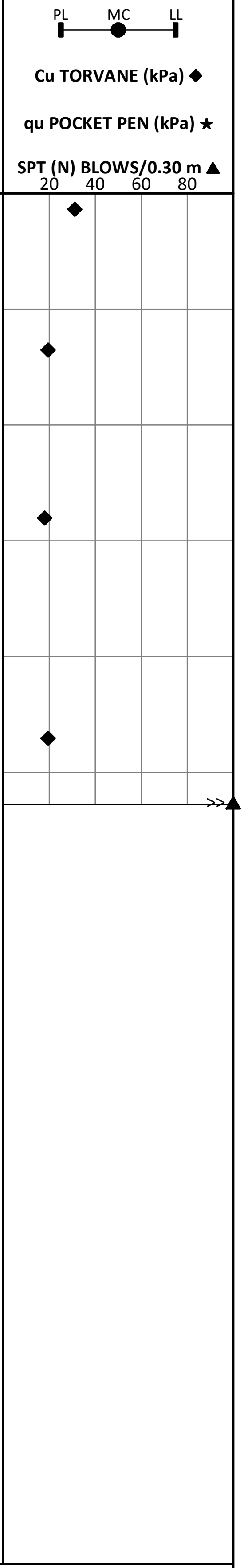
DATE
12-14-2023

TEST HOLE LOG

HOLE NO.
TH23-07

ELEV (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
					S11			
		- soft below 11.3 m.			S12			
		- till transition below 12.2 m.						
					S13			
219.0		**SILT TILL** - Grey, wet, very dense, trace medium gravel, fine-grained to coarse-grained sand, some clay.	▼		S14			
217.7					S15	75	50/ 40mm	+100

Notes:
1. End of test hole at 15.3 m.
2. Refusal encountered on boulder or bedrock at a depth of 15.3 m.
3. Test hole remained open to 15.3 m upon completion of drilling/digging.
4. Test hole backfilled with bentonite chips.



WATER LEVELS	▽ **During Drilling/Digging**	3.05 m
	▼ **Upon Completion**	14.63 m

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

DATE
12-14-2023

KGS GROUP

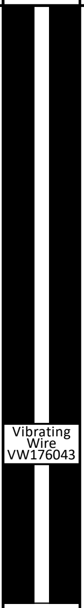
TEST HOLE LOG

HOLE NO.
TH23-07-PZ

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 2 Detailed Investigation**	**SURFACE ELEV.**	233.03 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-28-2023
DESCRIPTION	NE Corner of Recreation Centre Building	**UTM (m)**	N 5,517,677.59
DRILL RIG / HAMMER	Acker MP5 Track Mounted Drill Rig with Safety Drop Hammer		E 630,601.69 Zone 14
METHOD(S)	0.0 m to 4.6 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 - 152 mm, Black, damp, non-plastic, some rootlets, frozen.	232.9						
			CLAY (CL) - Light brown, damp, low plasticity, and silt, frozen.	232.4						
232	1.0		**CLAY (CH)** - Brown, damp, high plasticity, silty, frozen.	231.5						
231	2.0		**CLAY (CL)** - Brown, damp, firm, low plasticity, and silt.							
230	3.0 10		- wet below 3.0 m.		▽	Vibrating Wire VW176043	3.35			
229	4.0			228.8	▼					
	15		**CLAY (CH)** - Grey, moist, firm, high plasticity, trace to some silt.	228.5			4.57			



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. Grout mix consisted of 13 part cement, 10 part bentonite, 77 part water.
4. Protective well cover installed at surface.
5. VW176043 water level on Dec 15, 2025 @ 1.48 m.

ELEVATION (m)	DEPTH (m)	(ft)
232	1.0	5
231	2.0	
230	3.0	10
229	4.0	15
228	5.0	
227	6.0	20
226	7.0	
225	8.0	25
224	9.0	30

WATER LEVELS ▽ **During Drilling/Digging** 3.05 m
▼ **Upon Completion** 4.20 m

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

DATE
12-14-2023

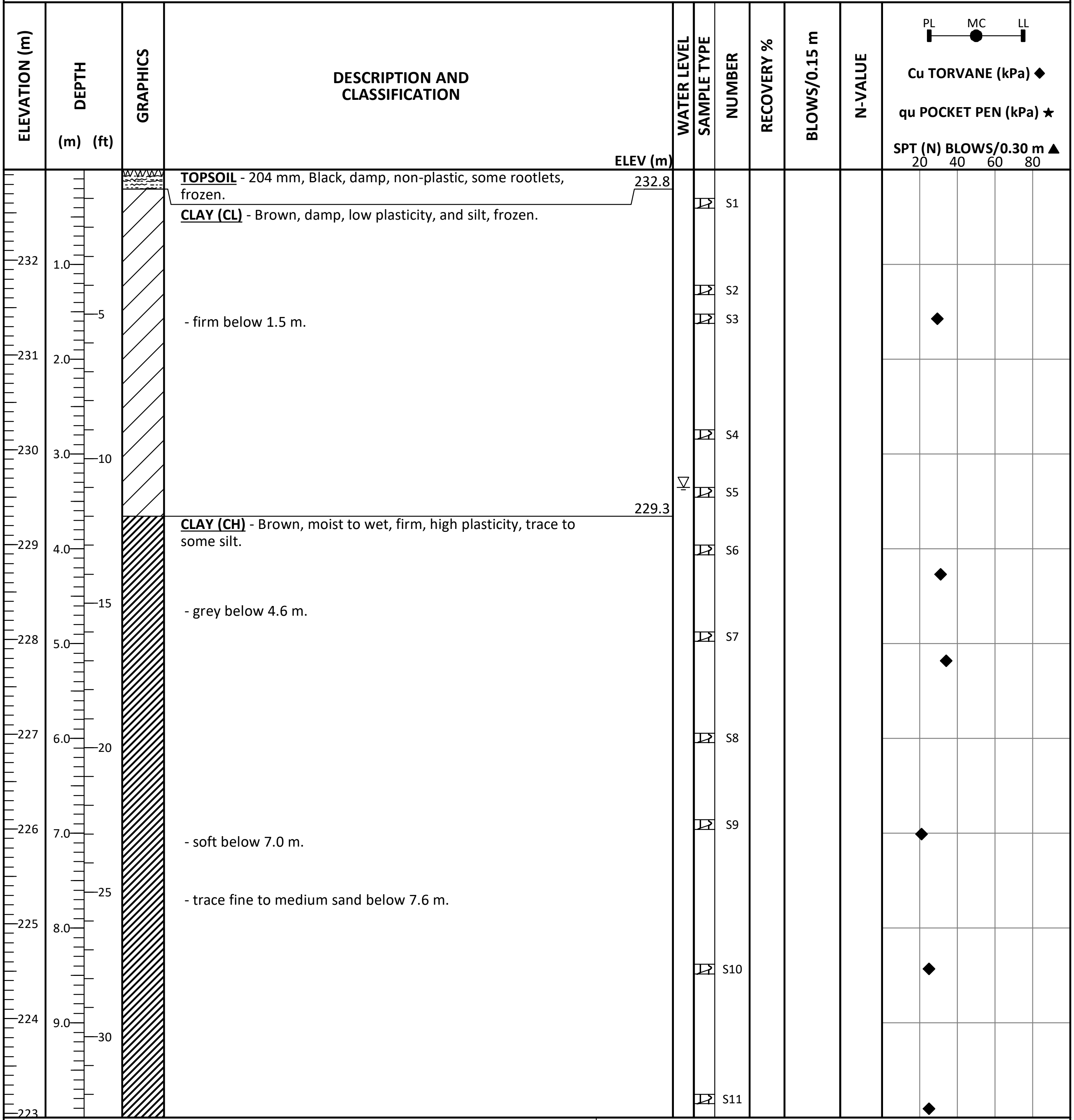
KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-08**

SHEET 1 of 2

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 2 Detailed Investigation**	**SURFACE ELEV.**	232.95 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-27-2023
DESCRIPTION	SE Corner of Recreation Centre Building	**UTM (m)**	N 5,517,644.38
DRILL RIG / HAMMER	Acker MP5 Track Mounted Drill Rig with Safety Drop Hammer		E 630,622.8 Zone 14
METHOD(S)	0.0 m to 15.3 m: 125 mm ø SSA		



TOPSOIL - 204 mm, Black, damp, non-plastic, some rootlets, frozen. (232.8)

CLAY (CL) - Brown, damp, low plasticity, and silt, frozen.

- firm below 1.5 m.

CLAY (CH) - Brown, moist to wet, firm, high plasticity, trace to some silt. (229.3)

- grey below 4.6 m.

- soft below 7.0 m.

- trace fine to medium sand below 7.6 m.

WATER LEVELS	▽ **During Drilling/Digging**	3.35 m
	▼ **Upon Completion**	14.63 m

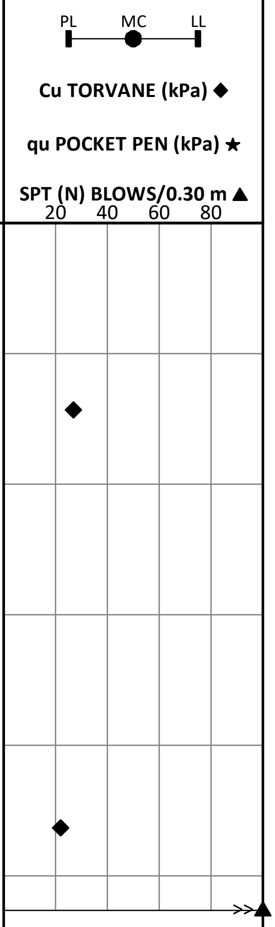
CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **J.Loewen**
APPROVED T. SCHELLENBERG	DATE 12-14-2023

TEST HOLE LOG

HOLE NO.
TH23-08

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
	11.3						S12			
220.8	12.2	40	**SILT TILL** - Grey, moist to wet, very dense, trace medium gravel, fine-grained to coarse-grained sand, some clay.	220.8						
	12.9						S13			
	14.3						S14			
	14.63				▼					
217.7	15.3	50		217.7			S15	75	50/ 20mm	+100



Notes:
1. End of test hole at 15.3 m.
2. Refusal encountered in silt till at a depth of 15.3 m.
3. Test hole remained open to 15.3 m upon completion of drilling/digging.
4. Test hole backfilled with bentonite chips.

WATER LEVELS
▽ **During Drilling/Digging** 3.35 m
▼ **Upon Completion** 14.63 m

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

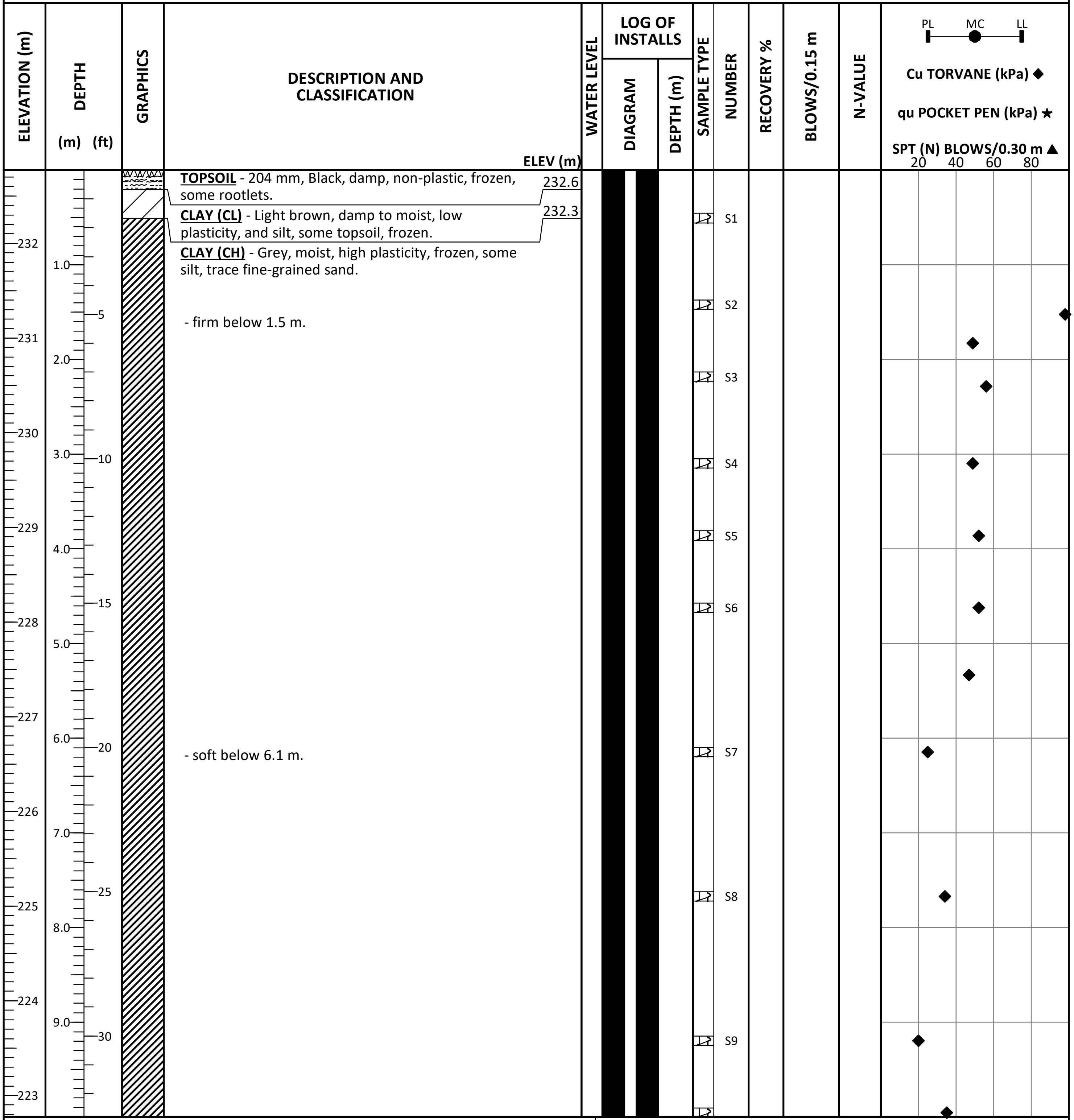
DATE
12-14-2023

TEST HOLE LOG

HOLE NO.
TH23-09-PZ

SHEET 1 of 2

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 2 Detailed Investigation**	**SURFACE ELEV.**	232.77 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-28-2023
DESCRIPTION	Approx middle of Recreation Centre Building	**UTM (m)**	N 5,517,642.93
DRILL RIG / HAMMER	Acker MP5 Track Mounted Drill Rig with Safety Drop Hammer		E 630,582.47 Zone 14
METHOD(S)	0.0 m to 15.3 m: 125 mm ø SSA		



TOPSOIL - 204 mm, Black, damp, non-plastic, frozen, some rootlets. (232.6)

CLAY (CL) - Light brown, damp to moist, low plasticity, and silt, some topsoil, frozen. (232.3)

CLAY (CH) - Grey, moist, high plasticity, frozen, some silt, trace fine-grained sand.

- firm below 1.5 m.

- soft below 6.1 m.

WATER LEVELS	▽ **During Drilling/Digging**	None Encountered
	▼ **Upon Completion**	Dry

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

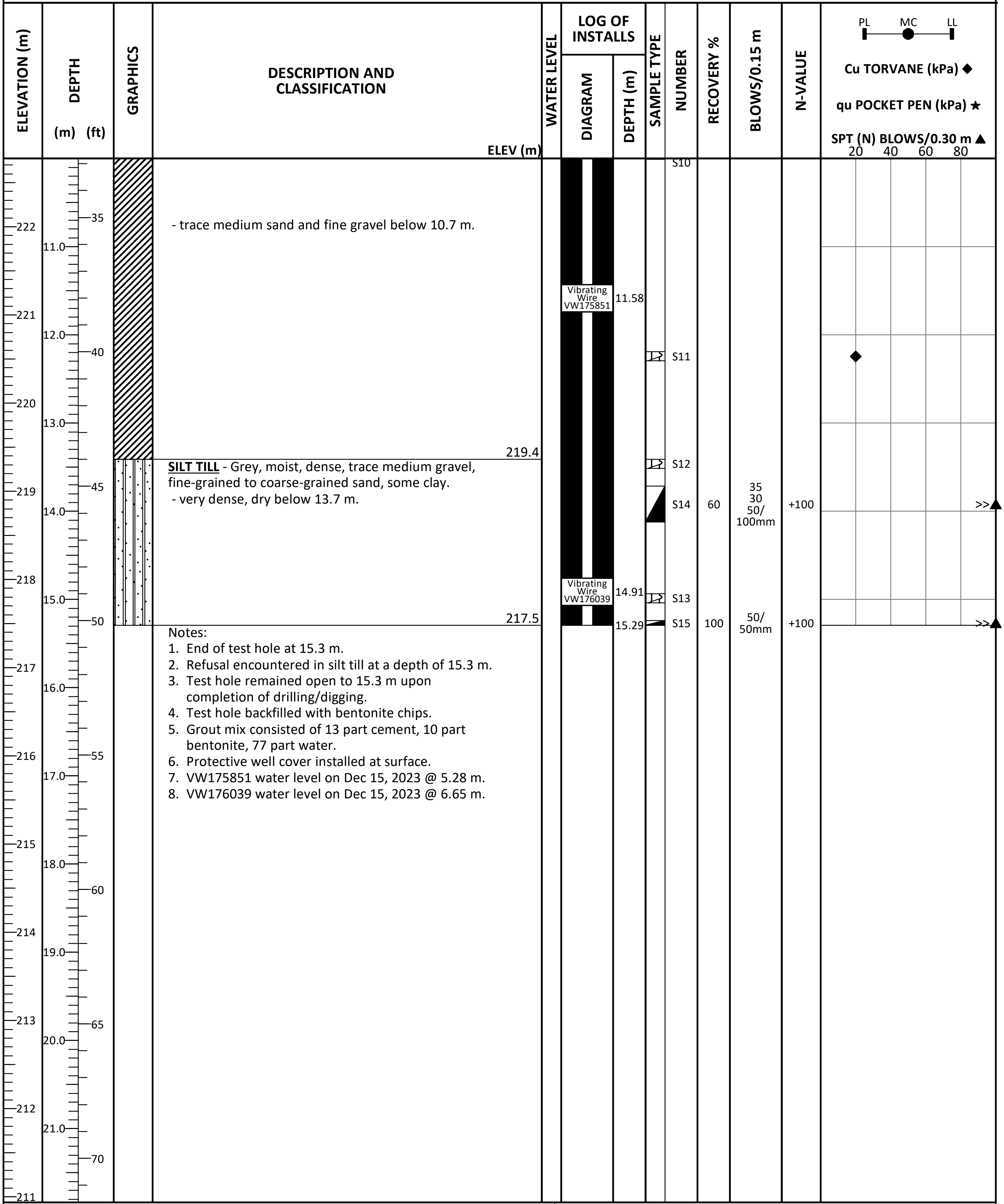
APPROVED
T. SCHELLENBERG

DATE
12-14-2023

TEST HOLE LOG

HOLE NO.
TH23-09-PZ

SHEET 2 of 2



- trace medium sand and fine gravel below 10.7 m.

219.4

SILT TILL - Grey, moist, dense, trace medium gravel, fine-grained to coarse-grained sand, some clay.
- very dense, dry below 13.7 m.

217.5

Install	Depth (m)	Number	Recovery %	Blows/0.15 m	N-Value
		S10			
Vibrating Wire VW175851	11.58				
		S11			
		S12			
		S14	60	35 30 50/ 100mm	+100
Vibrating Wire VW176039	14.91	S13			
	15.29	S15	100	50/ 50mm	+100

Notes:
1. End of test hole at 15.3 m.
2. Refusal encountered in silt till at a depth of 15.3 m.
3. Test hole remained open to 15.3 m upon completion of drilling/digging.
4. Test hole backfilled with bentonite chips.
5. Grout mix consisted of 13 part cement, 10 part bentonite, 77 part water.
6. Protective well cover installed at surface.
7. VW175851 water level on Dec 15, 2023 @ 5.28 m.
8. VW176039 water level on Dec 15, 2023 @ 6.65 m.

WATER LEVELS
∇ **During Drilling/Digging** None Encountered
▼ **Upon Completion** Dry

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

DATE
12-14-2023

TEST HOLE LOG

HOLE NO.
TH23-10

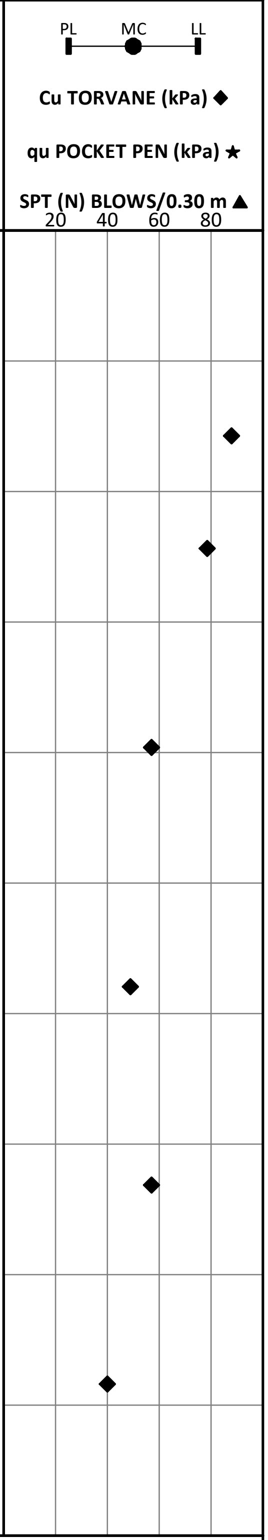
SHEET 1 of 2

CLIENT **CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**
PROJECT **South Winnipeg Rec. Campus - Phase 2 Detailed Investigation**
LOCATION Winnipeg, Manitoba
DESCRIPTION NW Corner of Recreation Centre Building
DRILL RIG / HAMMER Acker MP5 Track Mounted Drill Rig with Safety Drop Hammer
METHOD(S) 0.0 m to 15.3 m: 125 mm ø SSA

PROJECT NO. 23-0107-005
SURFACE ELEV. 233.06 m
START DATE 11-28-2023
UTM (m) N 5,517,639.69
E 630,538.9 Zone 14

ELEV (m)	DESCRIPTION AND CLASSIFICATION
	TOPSOIL - 610 mm, Black, damp, non-plastic, trace rootlets, frozen.
232.5	**CLAY (CL)** - Light brown, damp, low plasticity, and silt, frozen. - Silt below 0.9 m.
231.8	**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace to some silt trace to some silt, frozen. - stiff below 1.5 m. - grey below 3.0 m. - Firm below 5.3 m.

Samples: S1, S2, S3, S4, S5, S6, S7, S8, S9, S10



WATER LEVELS
∇ **During Drilling/Digging** None Encountered
▼ **Upon Completion** Dry

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

DATE
12-14-2023

KGS
GROUP

TEST HOLE LOG

HOLE NO.
TH23-10

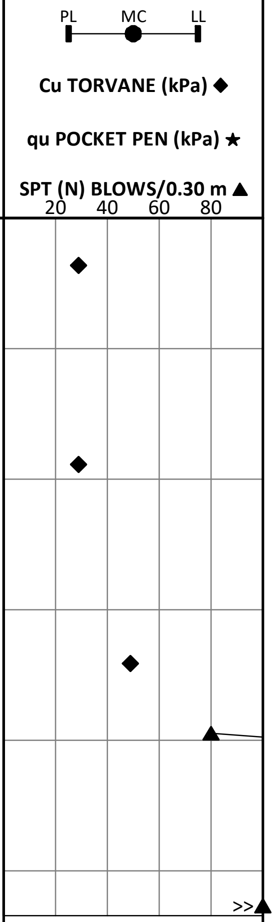
SHEET 2 of 2

ELEVATION (m): 223, 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

DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
- trace medium sand, trace fine gravel below 10.7 m.				S11			
				S12			
SILT TILL - Grey, damp, very dense, trace medium gravel, fine-grained to coarse-grained sand, some clay.	220.0			S13	75	21 34 46	80
				S14			
	217.7			S15	100	50/ 50mm	+100



Notes:
1. End of test hole at 15.3 m.
2. Refusal encountered in silt till at a depth of 15.3 m.
3. Test hole remained open to 15.3 m upon completion of drilling/digging.
4. Test hole backfilled with bentonite chips.

WATER LEVELS	▽ **During Drilling/Digging**	None Encountered
	▼ **Upon Completion**	Dry

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

DATE
12-14-2023

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-11

SHEET 1 of 2

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 2 Detailed Investigation**	**SURFACE ELEV.**	232.71 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-29-2023
DESCRIPTION	SW Corner of proposed Recreation Centre Building	**UTM (m)**	N 5,517,608.4
DRILL RIG / HAMMER	Acker MP5 Track Mounted Drill Rig with Safety Drop Hammer		E 630,559.66 Zone 14
METHOD(S)	0.0 m to 16.0 m: 125 mm ø SSA		

ELEVATION (m) | **DEPTH (m) (ft)** | **GRAPHICS** | **DESCRIPTION AND CLASSIFICATION** | **ELEV (m)** | **WATER LEVEL** | **SAMPLE TYPE** | **NUMBER** | **RECOVERY %** | **BLOWS/0.15 m** | **N-VALUE**

TOPSOIL - 610 mm, Black, damp, non-plastic, with rootlets, frozen.

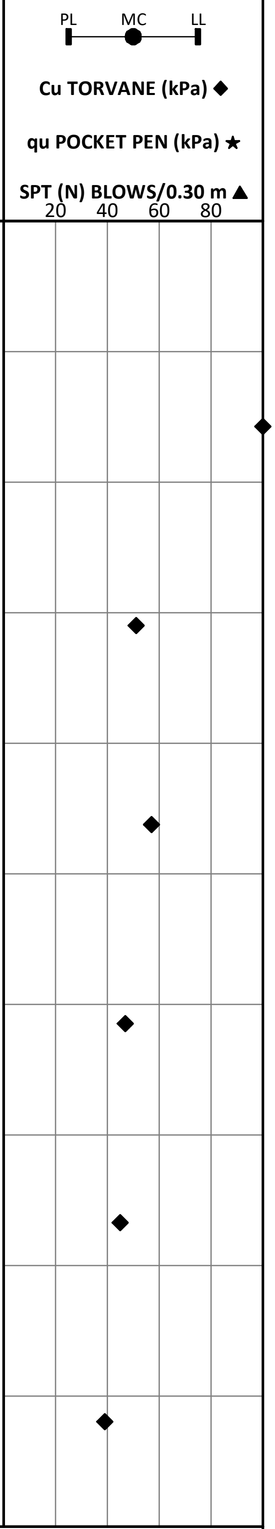
232.1

CLAY (CL) - Black, damp, low plasticity, and silt, frozen.
- brown below 0.7 m.
- stiff below 1.4 m.

230.7

CLAY (CH) - Brown, damp, stiff, high plasticity, trace to some silt.
- grey below 3.0 m.
- firm below 7.6 m.

S1
S2
S3
S4
S5
S6
S7
S8
S9
S10



WATER LEVELS	▽ **During Drilling/Digging**	None Encountered	CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **J.Loewen**
	▼ **Upon Completion**	Dry	APPROVED T. SCHELLENBERG	DATE 12-14-2023

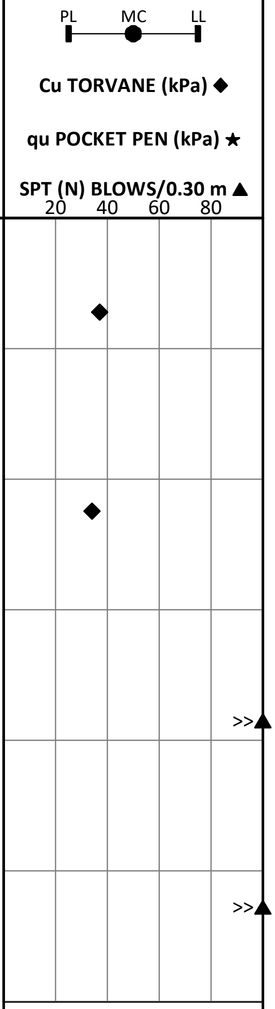
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-11

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
222		35					S11			
	11.0									
221										
	12.0	40					S12			
			SILT TILL - Grey, damp, dense, trace medium gravel, fine-grained to coarse-grained sand, some clay.	220.2						
220										
	13.0						S13			
219		45	- very dense below 13.7 m.				S14	75	42 50/ 120mm	+100
	14.0									
218										
	15.0		- dry below 14.9 m.				S15			
		50					S16	100	50/ 80mm	+100
217										
	16.0		Notes: 1. End of test hole at 16.0 m. 2. Refusal encountered in silt till at a depth of 16.0 m. 3. Test hole caved to 15.8 m upon completion of drilling/digging. 4. Test hole backfilled with bentonite chips.	216.7						
216		55								
	17.0									
215										
	18.0	60								
214										
	19.0									
213		65								
	20.0									
212										
	21.0	70								
211										



WATER LEVELS ∇ **During Drilling/Digging** None Encountered
▼ **Upon Completion** Dry

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

DATE
12-14-2023

KGS_LOG_ U:\FMS\23-0107-005\23-0107-005.GPJ

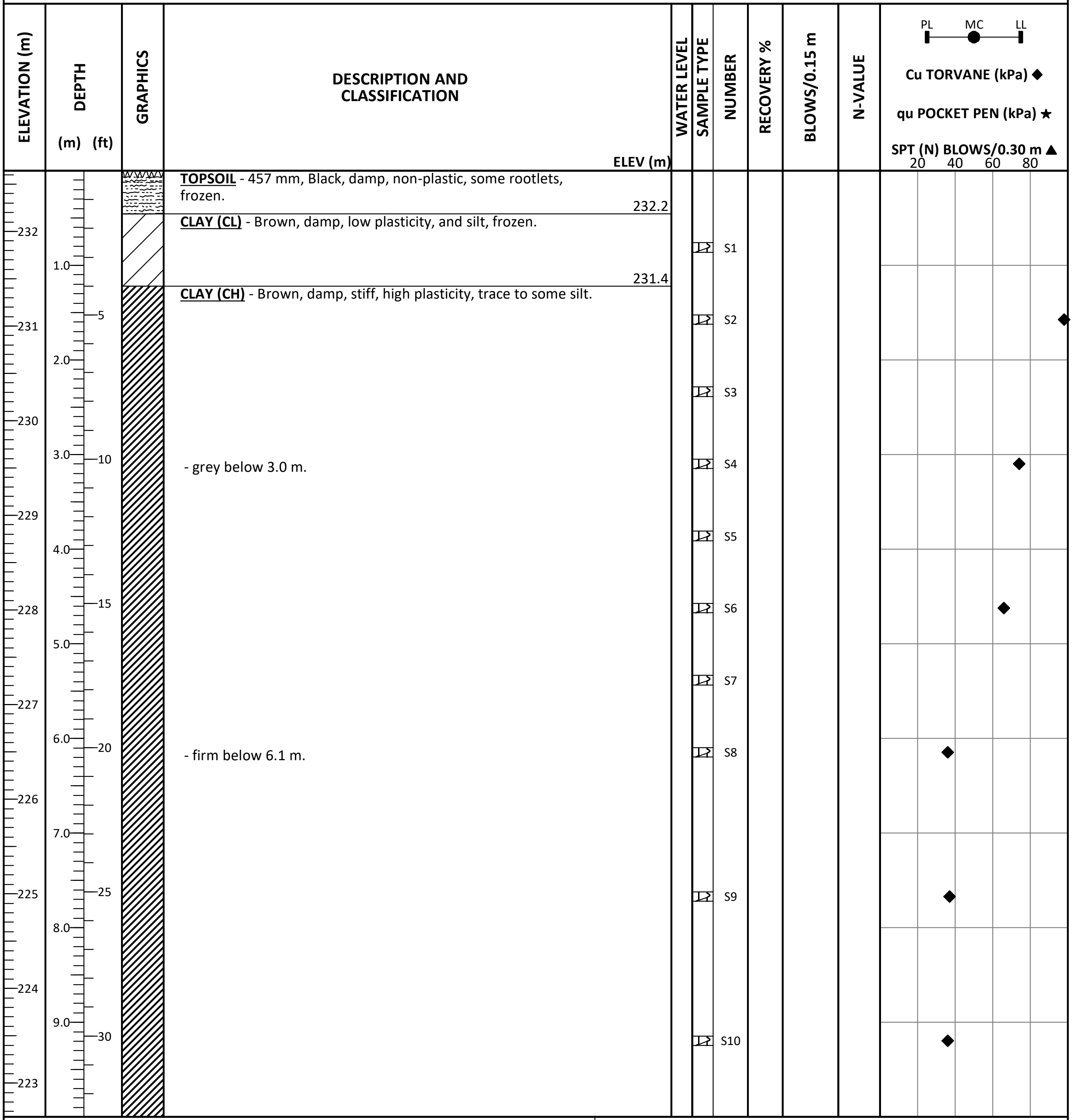
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-12

SHEET 1 of 2

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT	**South Winnipeg Rec. Campus - Phase 2 Detailed Investigation**	**SURFACE ELEV.**	232.64 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-29-2023
DESCRIPTION	Center of future Library Building	**UTM (m)**	N 5,517,566.81
DRILL RIG / HAMMER	Acker MP5 Track Mounted Drill Rig with Safety Drop Hammer		E 630,513.68 Zone 14
METHOD(S)	0.0 m to 15.3 m: 125 mm ø SSA		



DESCRIPTION AND CLASSIFICATION ELEV (m)

TOPSOIL - 457 mm, Black, damp, non-plastic, some rootlets, frozen. 232.2

CLAY (CL) - Brown, damp, low plasticity, and silt, frozen. 231.4

CLAY (CH) - Brown, damp, stiff, high plasticity, trace to some silt.

- grey below 3.0 m.

- firm below 6.1 m.

WATER LEVELS	▽ **During Drilling/Digging**	13.72 m
	▼ **Upon Completion**	13.72 m

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **J.Loewen**
APPROVED T. SCHELLENBERG	DATE 12-14-2023

KGS_LOG_U:\FMS\23-0107-005\23-0107-005.GPJ

KGS GROUP

TEST HOLE LOG

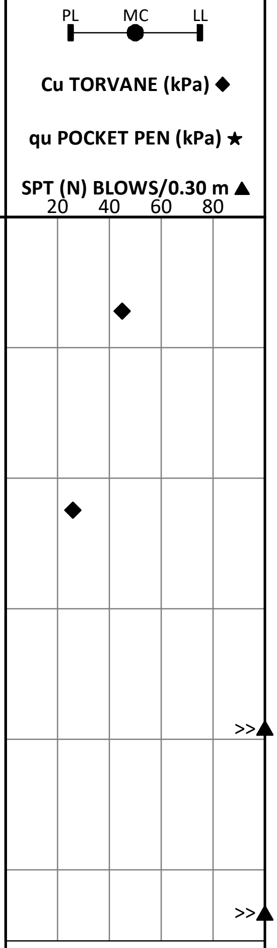
HOLE NO.
TH23-12

SHEET 2 of 2

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)
			- soft, silt till transition below 12.2 m.	
			SILT TILL - Grey, damp, dense, trace medium gravel, fine-grained to coarse-grained sand, some clay.	219.8
			- very dense below 13.7 m.	
				217.0

Notes:
1. End of test hole at 15.5 m.
2. Refusal encountered on boulder or bedrock at a depth of 15.5 m.
3. Test hole caved to 15.2 m upon completion of drilling/digging.
4. Test hole backfilled with bentonite chips.

WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
		S11			
		S12			
		S13			
▼		S14	77	26 45 50/ 90mm	+100
		S15			
				50 50/ 20mm	+100
		S16	100		



WATER LEVELS ▽ **During Drilling/Digging** 13.72 m
▼ **Upon Completion** 13.72 m

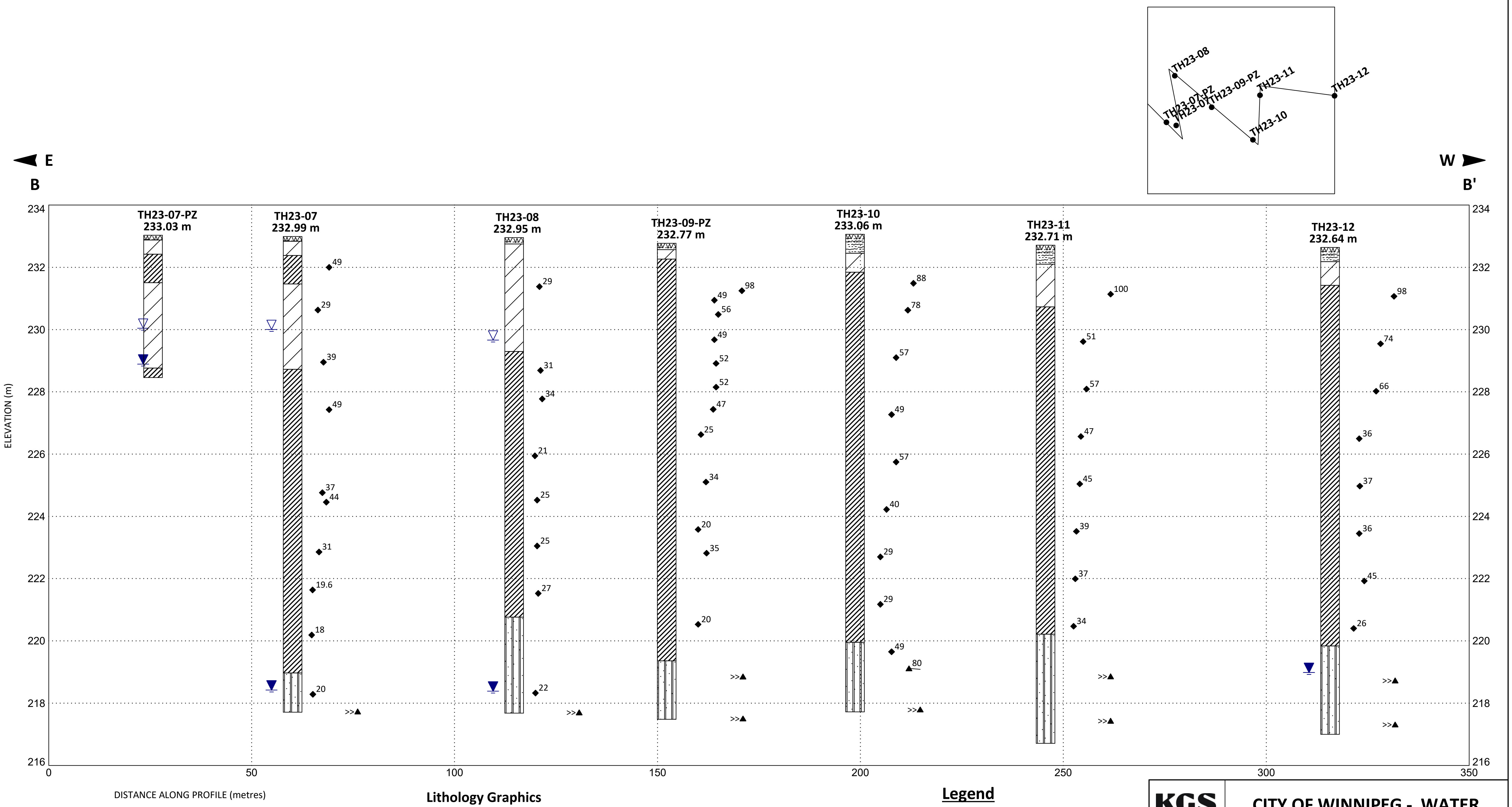
CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
J.Loewen

APPROVED
T. SCHELLENBERG

DATE
12-14-2023

KGS_LOG_ U:\FMS\23-0107-005\23-0107-005.GPJ



0 18

Horizontal Scale (meters)

Vertical Exaggeration: 7.5x

Lithology Graphics

- ▦ Topsoil
- ▨ Clay (CL, low plasticity)
- ▨ Clay (CH, high plasticity)
- ▥ Silt Till

Legend

TH23-07 — Test Hole ID

Test Hole Lithology

- ▽ Water Level During Drilling
- ▼ Water Level Upon Completion
- ▼ Water Level Static/Remeasured
- ▲ SPT, N-Value
- ▲ DCPT Value
- >> ▲ values greater than 100
- ◆ Torvane Cu (kPa)
- ● Moisture Content (%)

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

South Winnipeg Rec. Campus - Phase 2 Detailed Investigation

B-B'

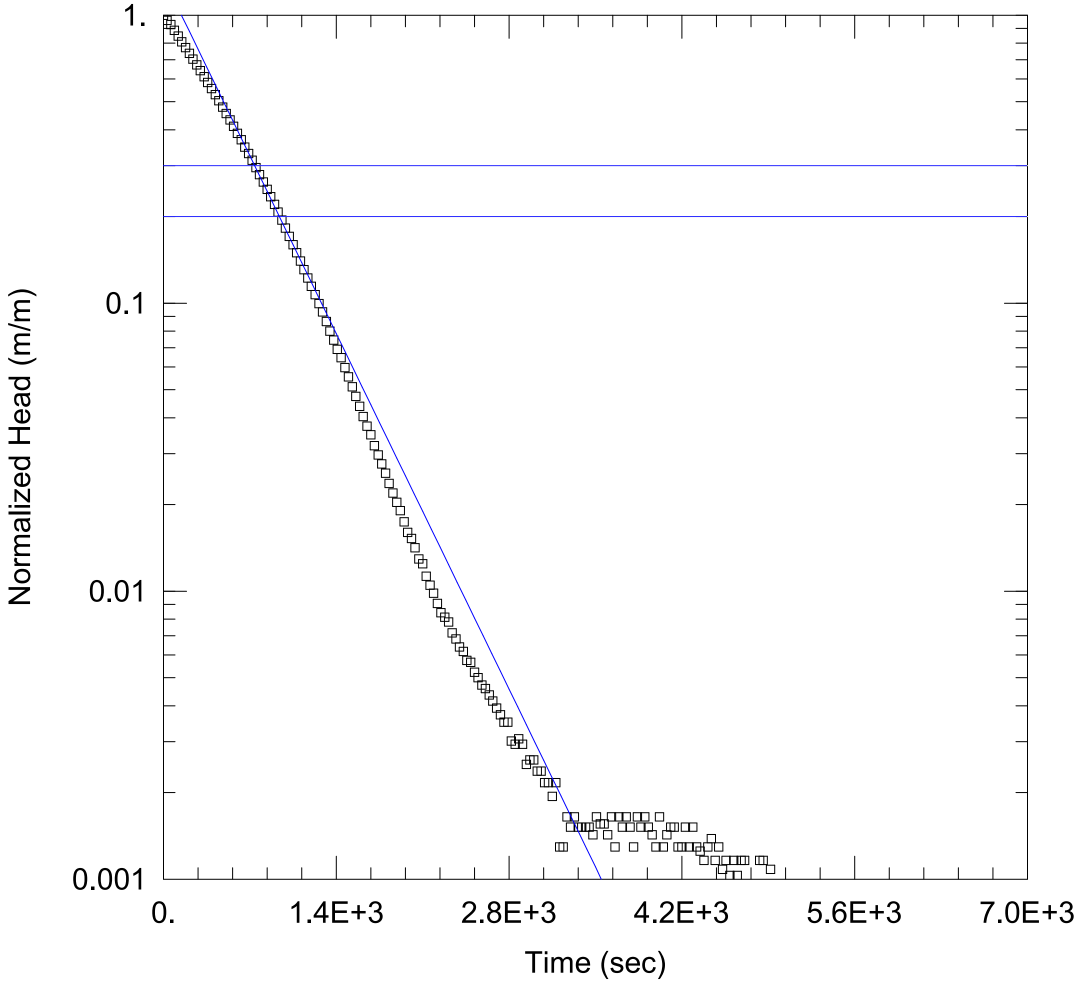
Dec 2023

Figure 04

FENCE W/O WELL DATA PLOT U:\FMS\23-0107-005\23-0107-005.GPJ

APPENDIX C

AQTESOLV Results



WELL TEST ANALYSIS

Data Set: C:\...\TH23-01 AQTESOLV results.aqt
Date: 06/02/23 Time: 09:38:16

PROJECT INFORMATION

Company: KGS
Client: City of Winnipeg
Project: 23-0107-005
Location: SWRC
Test Well: TH23-01
Test Date: May 16 2023

AQUIFER DATA

Saturated Thickness: 11.55 m
Anisotropy Ratio (Kz/Kr): 0.1

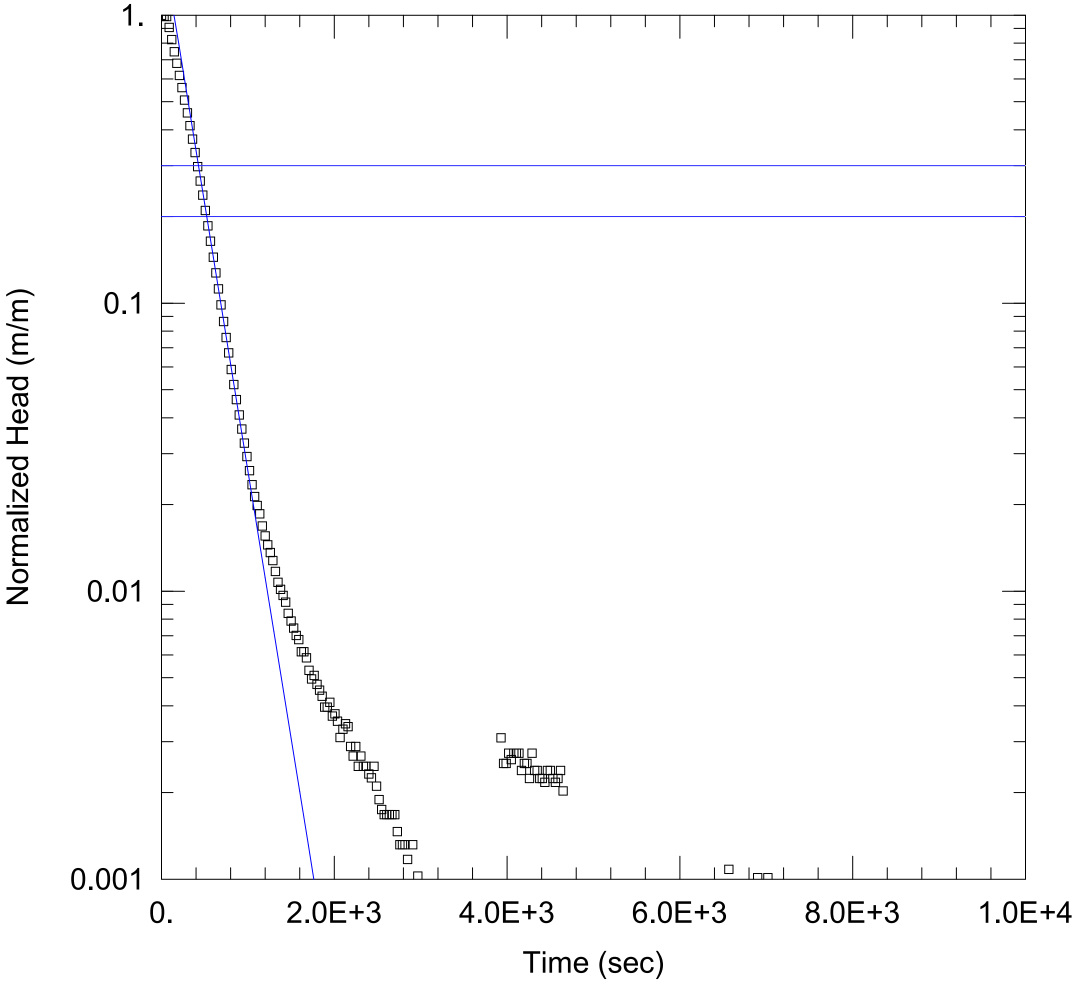
WELL DATA (TH23-01)

Initial Displacement: 9.904 m
Static Water Column Height: 11.55 m
Total Well Penetration Depth: 11.55 m
Screen Length: 3.048 m
Casing Radius: 0.0254 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.218E-6 m/sec
y0 = 13.32 m



WELL TEST ANALYSIS

Data Set: C:\...\TH23-03 AQTESOLV results.aqt

Date: 06/02/23	Time: 09:43:02

PROJECT INFORMATION

Company: KGS
Client: City of Winnipeg
Project: 23-0107-005
Location: SWRC
Test Well: TH23-03
Test Date: May 15 2023

AQUIFER DATA

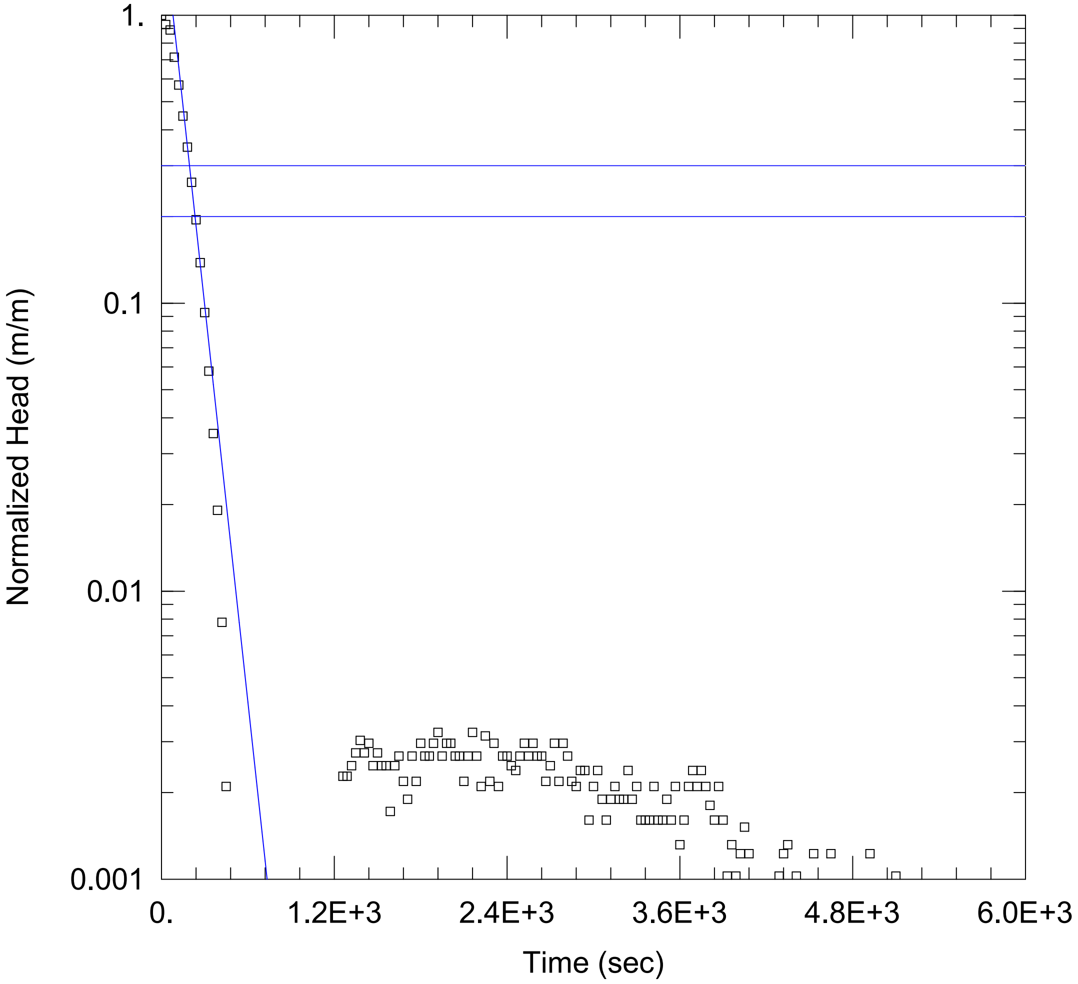
Saturated Thickness: 11.3 m	Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH23-03)

Initial Displacement: 8.89 m	Static Water Column Height: 11.3 m
Total Well Penetration Depth: 11.3 m	Screen Length: 3.048 m
Casing Radius: 0.0254 m	Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined	Solution Method: Bouwer-Rice
K = 2.555E-6 m/sec	y0 = 16.63 m



WELL TEST ANALYSIS

Data Set: C:\...\TH23-04 AQTESOLV.aqt
Date: 06/02/23 Time: 09:54:22

PROJECT INFORMATION

Company: KGS
Client: City of Winnipeg
Project: 23-0107-005
Location: SWRC
Test Well: TH23-04
Test Date: May 15 2023

AQUIFER DATA

Saturated Thickness: 11.14 m
Anisotropy Ratio (Kz/Kr): 0.1

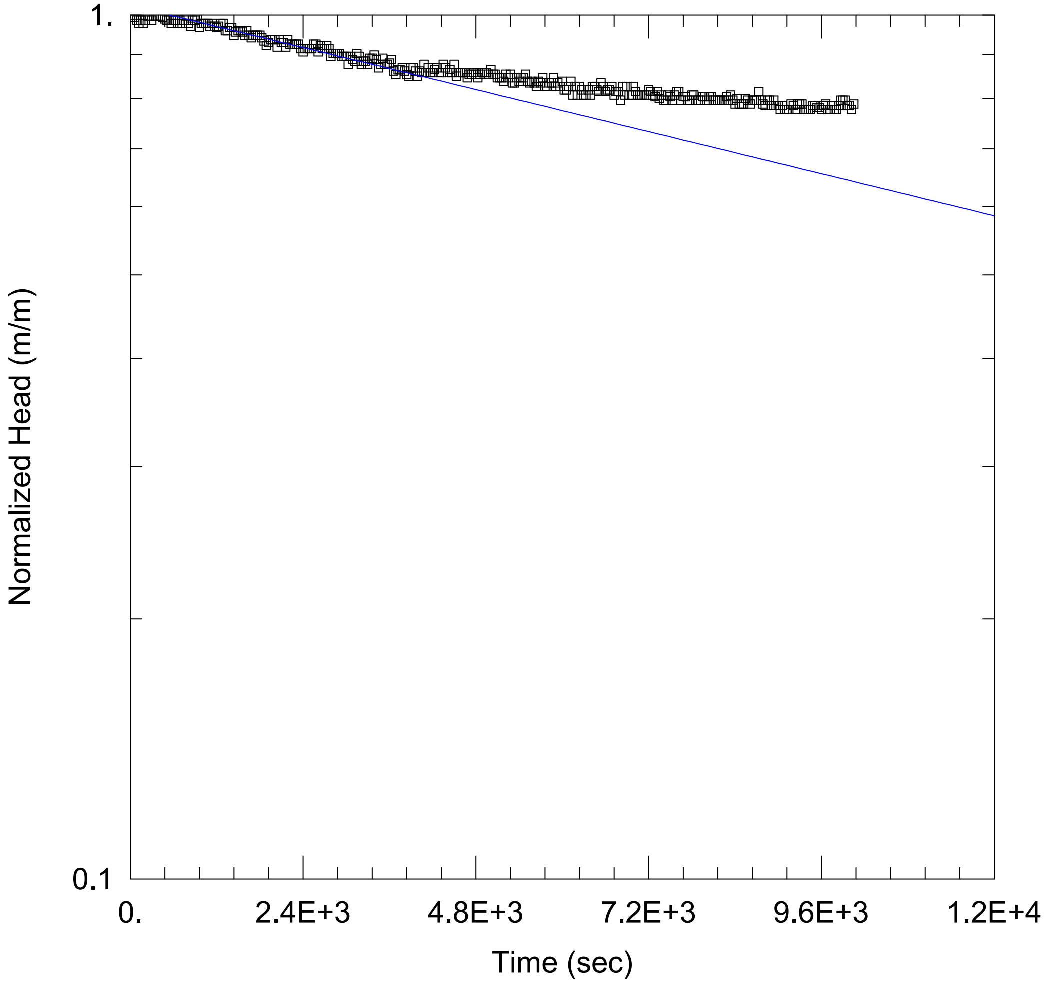
WELL DATA (TH23-04)

Initial Displacement: 4.486 m
Static Water Column Height: 11.14 m
Total Well Penetration Depth: 11.14 m
Screen Length: 1.524 m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.162E-5 m/sec
y0 = 10.55 m



WELL TEST ANALYSIS

Data Set: C:\...\TH23-05-PZ AQTESOLV.aqt
Date: 06/02/23 Time: 10:47:24

PROJECT INFORMATION

Company: KGS
Client: City of Winnipeg
Project: 23-0107-005
Location: SWRC
Test Well: TH23-05-PZ
Test Date: May 16 2023

AQUIFER DATA

Saturated Thickness: 0.257 m
Anisotropy Ratio (Kz/Kr): 0.1

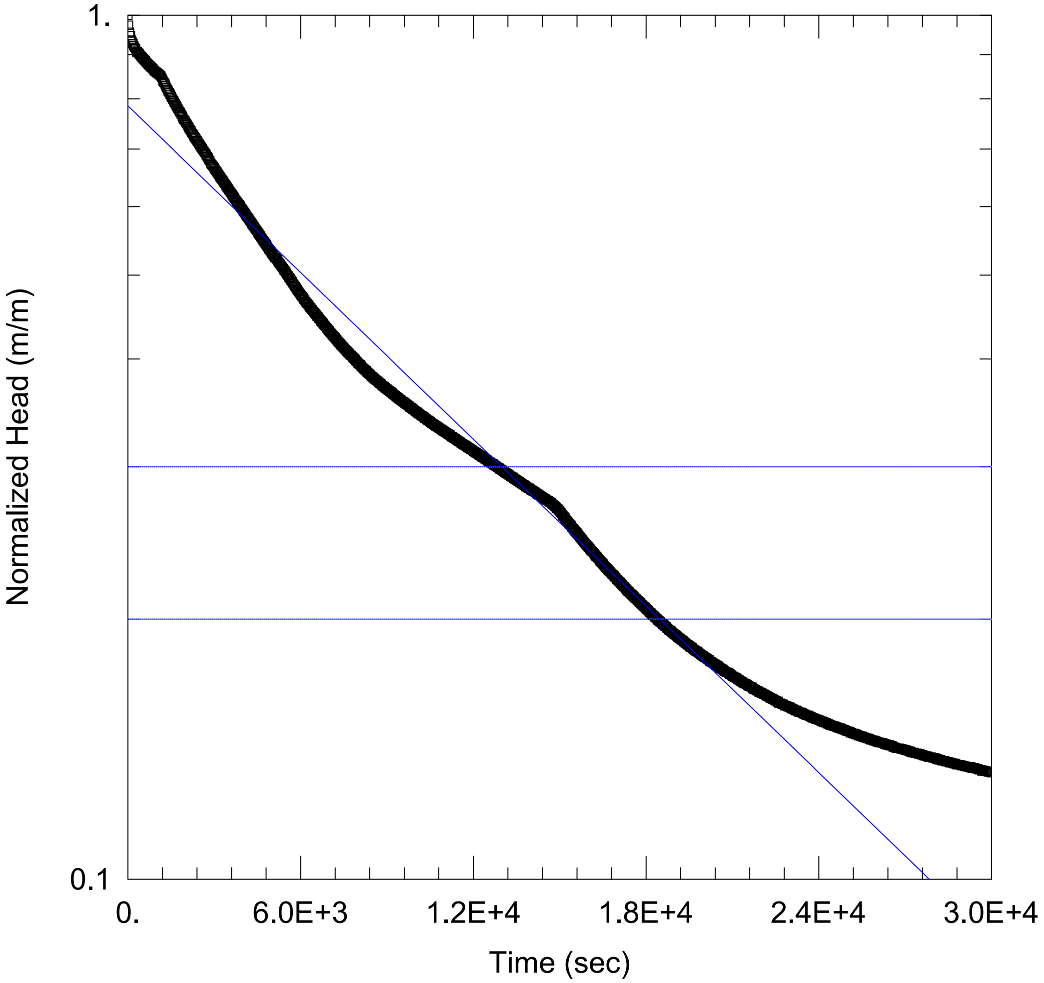
WELL DATA (TH23-05-PZ)

Initial Displacement: 0.168 m
Static Water Column Height: 0.257 m
Total Well Penetration Depth: 0.257 m
Screen Length: 0.257 m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 9.494E-8 m/sec
y0 = 0.1723 m



WELL TEST ANALYSIS

Data Set: C:\...\TH23-06 AQTESOLV.aqt
Date: 06/02/23 Time: 10:35:09

PROJECT INFORMATION

Company: KGS
Client: City of Winnipeg
Project: 23-0107-005
Location: SWRC
Test Well: TH23-06
Test Date: May 12 2023

AQUIFER DATA

Saturated Thickness: 12.97 m Anisotropy Ratio (Kz/Kr): 0.1

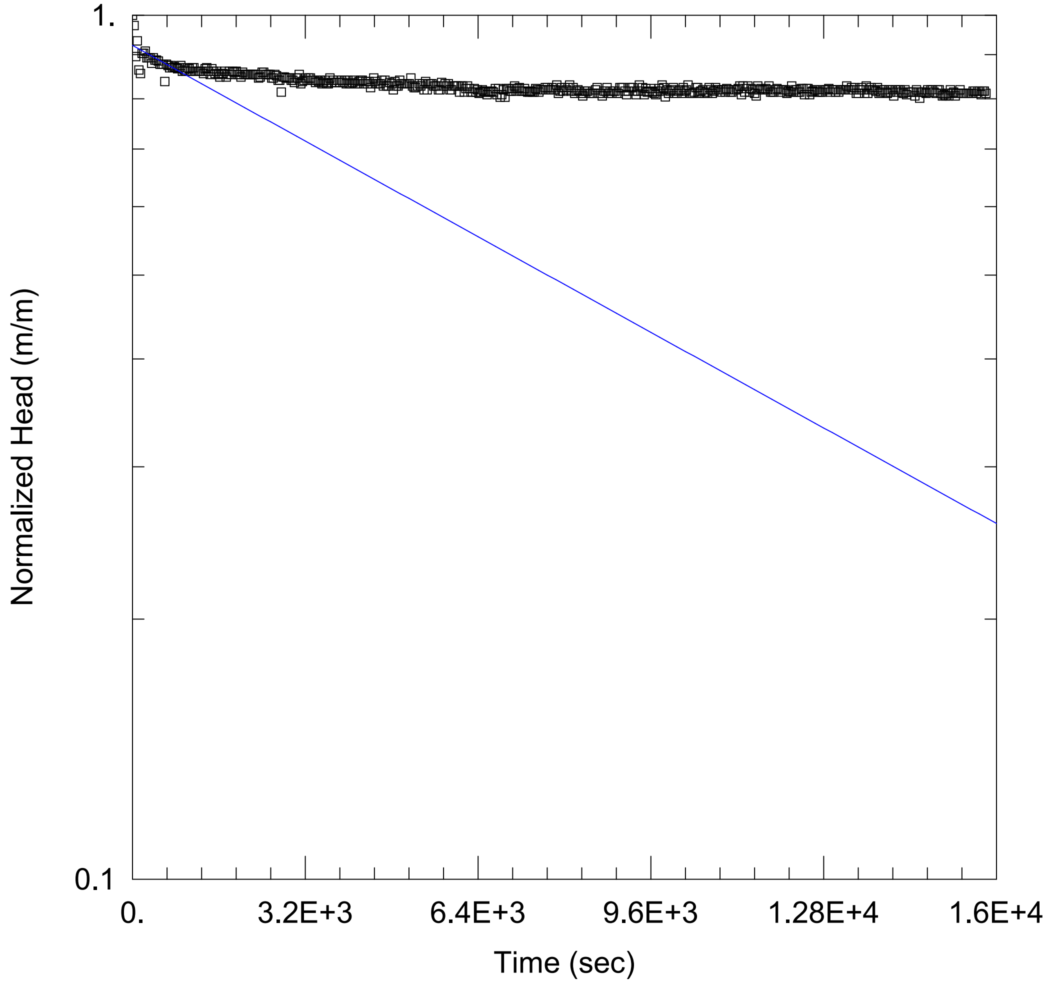
WELL DATA (TH23-06)

Initial Displacement: 12.01 m Static Water Column Height: 12.97 m
Total Well Penetration Depth: 12.97 m Screen Length: 3.048 m
Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 4.373E-8 m/sec y0 = 9.427 m



WELL TEST ANALYSIS

Data Set: C:\...\TH23-06-PZ.aqt
Date: 06/02/23
Time: 10:45:06

PROJECT INFORMATION

Company: KGS
Client: City of Winnipeg
Project: 23-0107-005
Location: SWRC
Test Well: TH23-06-PZ
Test Date: May 12 2023

AQUIFER DATA

Saturated Thickness: 0.254 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TH26-06-PZ)

Initial Displacement: 0.243 m
Static Water Column Height: 0.254 m
Total Well Penetration Depth: 0.254 m
Screen Length: 0.254 m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.629E-7 m/sec
y0 = 0.2241 m

APPENDIX D

Phase 1 Lab Test Results

SUMMARY OF INDEX TESTS

Sheet 1 of 1

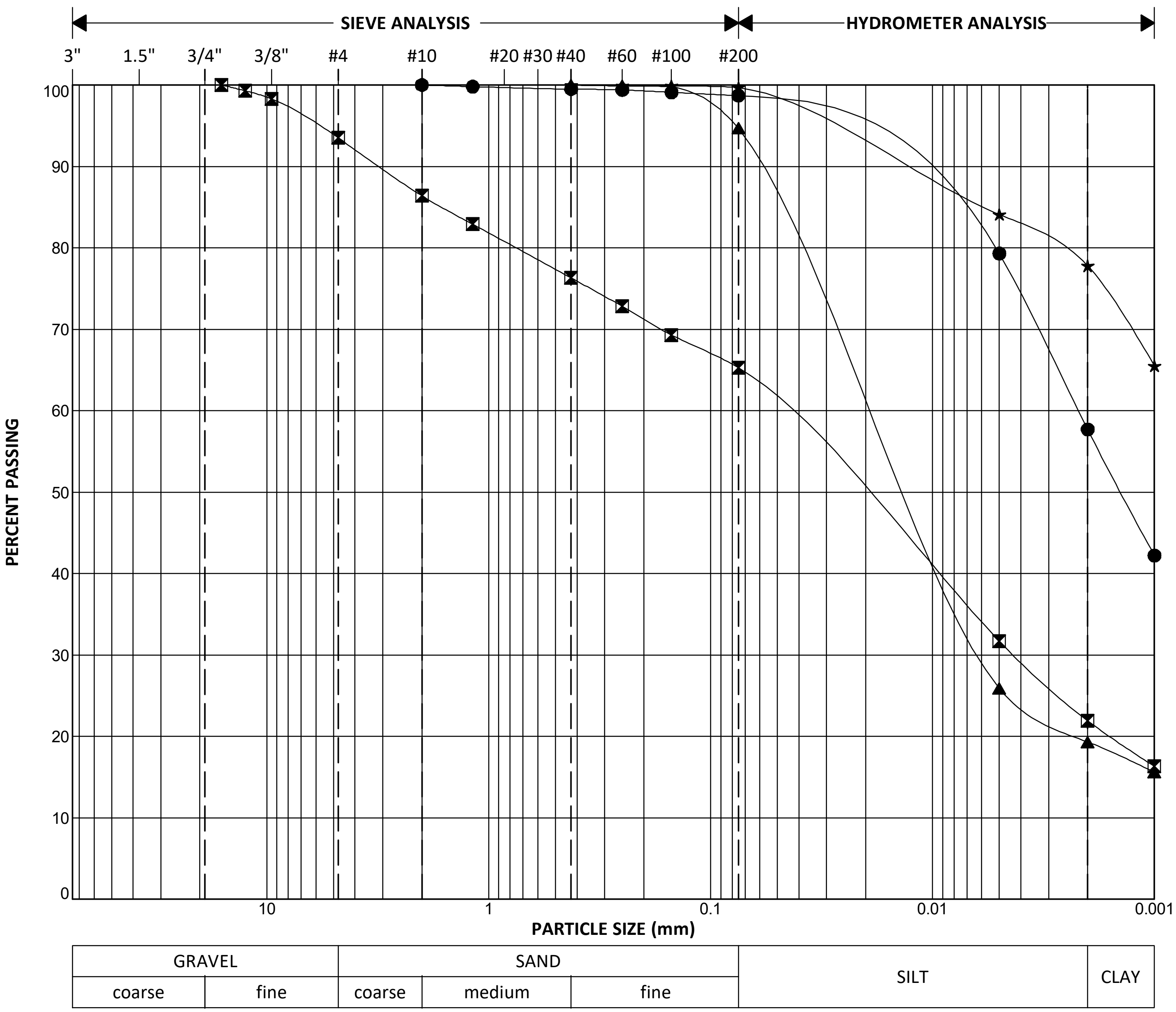
Test Hole ID	Sample No.	Depth (m)	Classification	Gravel (%)	Sand (%)	Silt/ Clay (%)	Liquid Limit	Plastic Limit	Plasticity Index	Moisture Content (%)	Dry Density (kN/m3)	Specific Gravity	Saturation (%)	Void Ratio
TH23-01	S2	1.4	CL							42				
TH23-01	S3	2.3	CH							54				
TH23-01	S4	3.8	CH							53				
TH23-01	S5	5.3	CH							49				
TH23-01	S6	7.3	CH							50				
TH23-01	S7	7.6	CH	0	1	99	76	26	50	50				
TH23-01	S8	8.8	CH							54				
TH23-01	S9	9.6	CH							59				
TH23-01	S11	11.9	CH							41				
TH23-01	S13	13.7	TILL							14				
TH23-01	S14	14.6	TILL	7	28	65	26	13	13	19				
TH23-01	S15	15.2	TILL							9				
TH23-01	S16	15.8	TILL							12				
TH23-02	S2	1.7	CL							39				
TH23-02	S3	2.6	CH							49				
TH23-02	S5	4.3	CH							52				
TH23-02	S7	5.6	CH							53				
TH23-04	S2	1.1	CL							28				
TH23-04	S3	2.0	CH							47				
TH23-04	S5	3.4	CH							54				
TH23-04	S7	4.9	CH							51				
TH23-04	S9	7.2	CH							52				
TH23-04	S11	10.4	CH							41				
TH23-04	S14	12.5	CH							23				
TH23-04	S18	14.6	TILL							11				
TH23-04	S21	16.8	TILL							10				
TH23-05	S1	0.5	CL	0	5	95	26	18	8	19				
TH23-05	S2	1.2	CH							39				
TH23-05	S4	2.6	CH							56				
TH23-05	S5	3.0	CH	0	0	100	102	32	70	56				
TH23-05	S6	4.0	CH							57				
TH23-05	S8	4.9	CH							57				
TH23-05	S9	5.5	CH							45				
TH23-06	S2	1.2	CL							30				
TH23-06	S3	2.0	CH							37				
TH23-06	S5	3.7	CH							53				
TH23-06	S7	4.6	CH							53				
TH23-06	S8	5.6	CH							59				
TH23-06	S10	8.2	CH							52				
TH23-06	S12	10.4	CH							50				
TH23-06	S14	13.7	TILL							33				

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

KGS GROUP

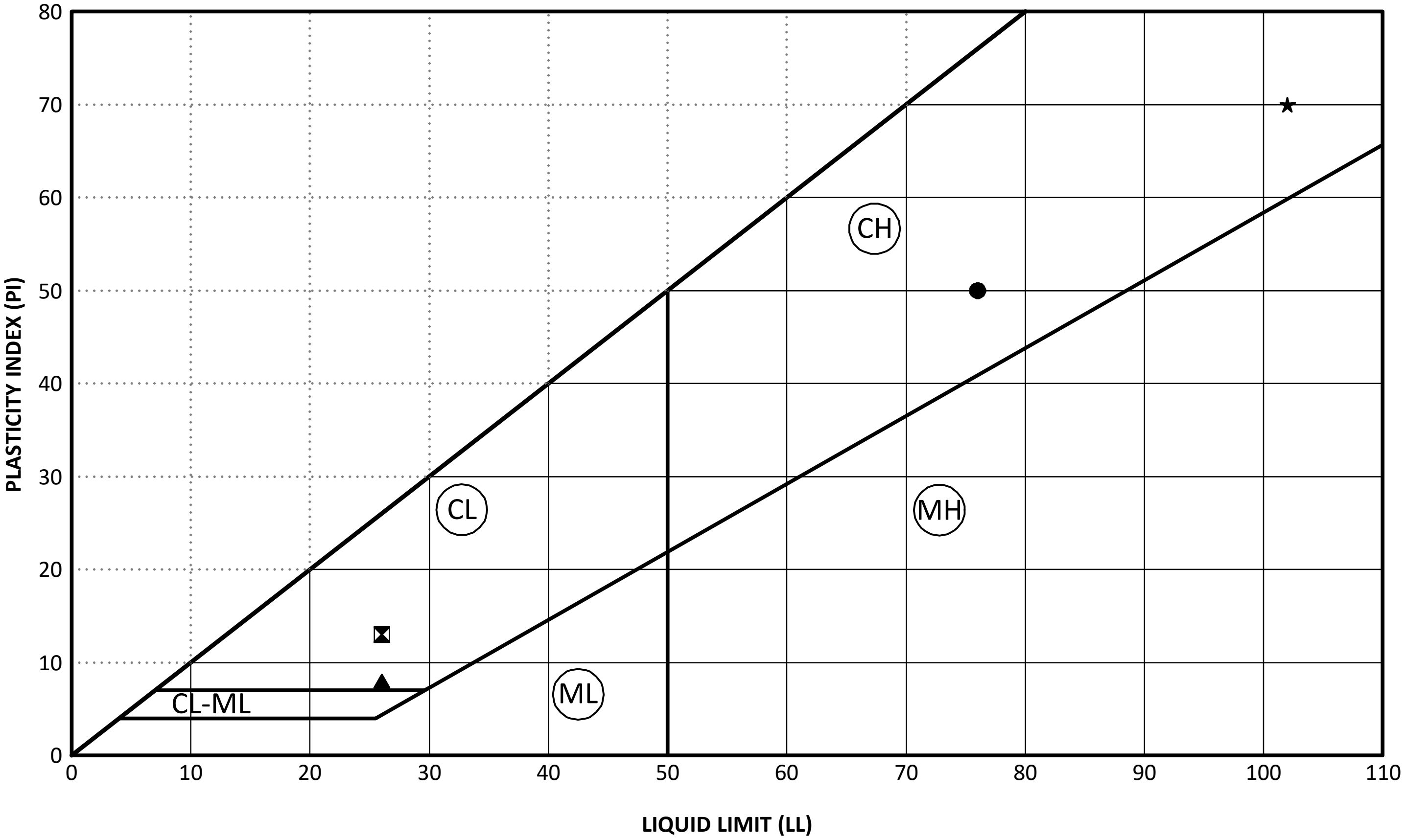
CLIENT **CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**
PROJECT NAME South Winnipeg Recreation Campus
PROJECT NO. 23-0107-005
LOCATION Winnipeg, Manitoba

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH23-01	7.6	S7	0	1	41	58	99			CH
☒	TH23-01	14.6	S14	7	28	43	22	65			TILL
▲	TH23-05	0.5	S1	0	5	75	19	95			CL
★	TH23-05	3.0	S5	0	0	22	78	100			CH

ATTERBERG LIMITS



	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	MC (%)	CLASSIFICATION
●	TH23-01	7.6	S7	76	26	50	1	41	58	99	50	CH
⧗	TH23-01	14.6	S14	26	13	13	28	43	22	65	19	TILL
▲	TH23-05	0.5	S1	26	18	8	5	75	19	95	19	CL
★	TH23-05	3.0	S5	102	32	70	0	22	78	100	56	CH

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-005
PROJECT NAME	South Winnipeg Recreation Campus	**LOCATION**	Winnipeg, Manitoba

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg, MB R3Y 1G4
Tel: (204) 488-6999

ASTM D5084 - MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

TO
KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

ATTN: Trevor Schellenberg

PROJECT South Winnipeg Recreation Centre (23-0107-005)

PROJECT NO. 123316495

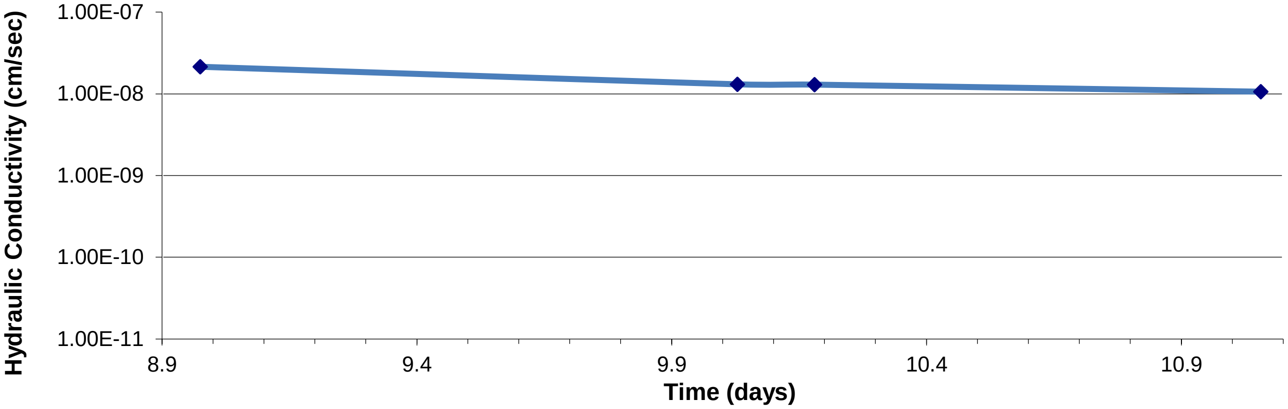
REPORT NO. 1

SAMPLE ID: TH23-01, S7, 25'-27'

SOIL DESCRIPTION: Clay, grey, firm, moist, high plasticity, trace silt, trace fine gravel

DATE TESTED: May 5 to May 19, 2023
CONFINING PRESSURE (kPa): 137.9
EFFECTIVE SATURATION STRESS (kPa): 34.5
ASSUMED SPECIFIC GRAVITY: 2.71
HYDRAULIC GRADIENT: 18.9
TYPE OF PERMEANT LIQUID: De-aired Water
HYDRAULIC CONDUCTIVITY, "k" (cm/s): 1.5E-08
HYDRAULIC CONDUCTIVITY, "k_{20}" (cm/s): 1.5E-08

	Height (mm)	Diameter (mm)	Wet Mass (g)	Dry Density (g/cm^3)	Water Content by Mass (%)	Water Content by Volume (%)	Saturation (%)
Initial Reading	77.6	71.6	548.1	1.168	50.2	58.6	103.0
Final Reading	78.4	71.8	553.5	1.174	48.5	57.0	100.5



COMMENTS:
Tube recovered 42 cm of soil. Test sample portion taken from 10 cm to 30 cm from bottom end of tube.

REPORT DATE: 2023.May.23

REVIEWED BY GBeauce
Guillaume Beauce, P.Eng.
Geotechnical Engineer - Materials Testing Services

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided only on written request. The data presented above is for the sole use of the client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.

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199 Henlow Bay, Winnipeg, MB R3Y 1G4
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ASTM D5084 - MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER

TO KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

ATTN: Trevor Schellenberg

PROJECT South Winnipeg Recreation Centre (23-0107-005)

PROJECT NO. 123316495

REPORT NO. 2

SAMPLE ID: TH23-05, S5, 10'-12'

SOIL DESCRIPTION: Clay, grey, stiff, moist, high plasticity, trace silt

DATE TESTED: May 5 to May 19, 2023

CONFINING PRESSURE (kPa): 137.9

EFFECTIVE SATURATION STRESS (kPa): 34.5

ASSUMED SPECIFIC GRAVITY: 2.71

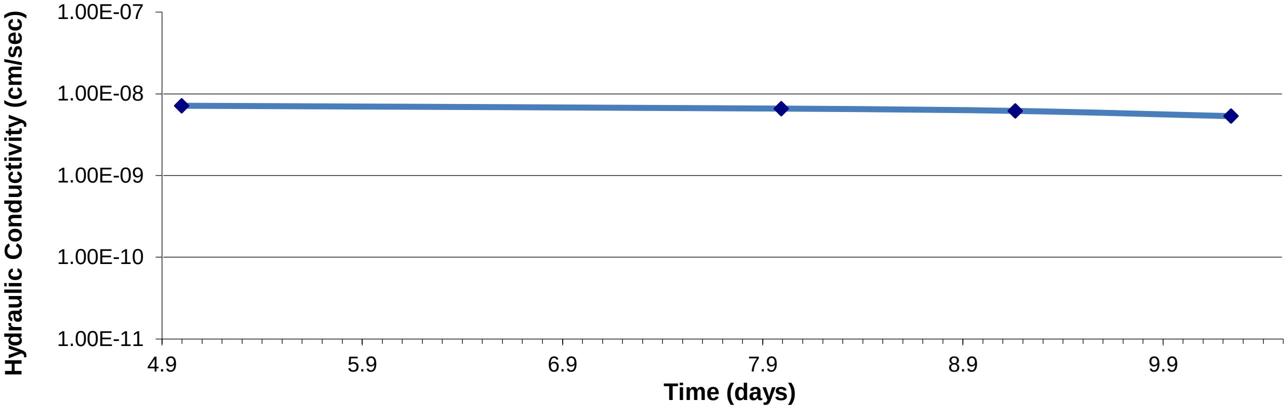
HYDRAULIC GRADIENT: 18.8

TYPE OF PERMEANT LIQUID: De-aired Water

HYDRAULIC CONDUCTIVITY, "k" (cm/s): 6.7E-09

HYDRAULIC CONDUCTIVITY, "k_{20}" (cm/s): 6.3E-09

	Height (mm)	Diameter (mm)	Wet Mass (g)	Dry Density (g/cm^3)	Water Content by Mass (%)	Water Content by Volume (%)	Saturation (%)
Initial Reading	77.2	71.5	532.2	1.104	55.6	61.4	103.7
Final Reading	78.8	72.0	540.1	1.082	55.6	60.2	100.2



COMMENTS:

Tube recovered 53 cm of soil. Test sample portion taken from 15 cm to 25 cm from bottom end of tube.

REPORT DATE: 2023.May.23

REVIEWED BY GBeauce
Guillaume Beauce, P.Eng.
Geotechnical Engineer - Materials Testing Services

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