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July 18, 2016

File No. 16-0107-012

City of Winnipeg
Planning, Property and Development
4th Floor – 185 King Street
Winnipeg, Manitoba
R3B 1J1

ATTENTION: Mr. John Atkinson

RE: Proposed Storage Facility and Rink Asphalt Surfacing
490 Keenleyside Street, Winnipeg, Manitoba
Geotechnical Foundation Assessment

Dear Mr. Atkinson:

This letter details KGS Group's geotechnical site investigation in 2013 and provides foundation recommendations for the proposed Storage Facility and Rink Asphalt Surfacing at the East Elmwood Community Centre development. Previous documents from the City of Winnipeg (City) and KGS Group indicated the address as 480 Keenleyside Street; however the address has since been updated to 490 Keenleyside Street.

1.0 BACKGROUND

The proposed East Elmwood Community Centre development is to be located at 490 Keenleyside Street in Winnipeg, Manitoba. A sketch of the proposed location of the storage facility and outdoor ice rink is shown on Figure 1.

2.0 TEST HOLE DRILLING PROGRAM

On August 23, 2013, KGS Group supervised the drilling of six test holes (TH13-01 to TH13-06) at the site. The approximate locations of the test holes are shown on Figure 1. Specific details of the drilling program can be found in the original Foundation Investigation report dated September 13, 2013 and submitted to Bridgman Collaborative Architecture Ltd. The test holes were considered to be valid for the evaluation of geotechnical conditions for additional storage facility and outdoor hockey rink asphalt pavement structure proposed on this site. For completeness, the test hole logs are included in Appendix A.

3.0 INVESTIGATION RESULTS

3.1 STRATIGRAPHY

In general, the stratigraphy consists of thin layers of topsoil, granular fill, clay fill, silty clay and silt underlain by high plasticity silty clay, which is underlain by silt till.

A topsoil layer approximately 0.3 m± thick was encountered in TH13-01 and TH13-06. Beneath the topsoil was a 0.45 m± to 1.2 m± thick layer of clay fill. The clay fill was black to light brown in colour, dry to damp, stiff in consistency, of intermediate to high plasticity, and contained trace amounts of fine to coarse grained sand. Beneath the clay fill was a layer of silty clay that extended to a depth of 0.6 m± to 2.4 m± below existing grade. The silty clay was brown in colour, damp, stiff in consistency, of high plasticity, and contained trace amounts of silt nodules and oxidation. Beneath the silty clay layer was a 0.15 m± to 0.75 m± thick layer of silt. The silt was tan in colour, moist, soft in consistency, of low to intermediate plasticity, and contained trace fine grained sand and oxidation. Beneath the silt was a massive layer of highly plastic silty clay that extended to a depth of 16.0 m± to 17.4 m± below existing grade. The silty clay was brown to grey in colour, moist, stiff to firm in consistency and decreasing in stiffness with depth to soft from 4 m± above the till interface, of high plasticity, and contained trace amounts of silt nodules and gypsum nodules.

Underlying the silty clay was a layer of silt till that extended to a depth of 18.9 m± to 21.03 m± below existing grade where power auger refusal occurred. The silt till was dark tan to grey in colour, moist to wet, compact, and contained some fine to coarse grained sand and trace amounts of fine to coarse grained gravel. The relative density of the till was estimated from an SPT with an uncorrected blow count ($N_{uncorrected}$) of 23 in TH13-02 to 25 in TH13-01.

3.2 GROUNDWATER CONDITIONS

In general, the groundwater level at the site is interpreted to be generally static through the highly plastic silty clays with a slight downward hydraulic gradient through the clays down to the till.

Groundwater levels at the site will fluctuate seasonally and following precipitation events (eg. rain, snow melt, etc). For design and construction purposes, it should also be assumed that a perched groundwater level exists within the silt layer located at a depth of 3 m±.

4.0 PROPOSED STORAGE FACILITY

The current proposed location of the storage facility overlaps with an existing swale and comes within approximately 4 to 5 m of an existing catch basin. Currently, this location poses logistical issues with a foundation design. The existing swale will have to be modified to accommodate the northeast corner of the storage facility. Modifications to the swale are not included in this report. KGS Group recommends deep foundations for the proposed storage facility to mitigate other potential issues.

Due to the expansive nature of the soils in Winnipeg, settlement, both total and differential, often becomes unacceptable for most shallow foundation supported structures, making deep foundations the preferred option to support lightly loaded structures. Suitable deep foundation types for consideration include cast-in-place concrete piles, driven pre-cast concrete piles, or timber end-bearing piles.

4.1 CAST-IN-PLACE CONCRETE PILES

Cast-in-place concrete piles founded on sound competent till may be used to support the proposed building. The recommended factored end-bearing value and factored skin friction for limit state design of the piles are as follows:

	Serviceability Limit State (SLS) values (kPa)	**Ultimate Limit State (ULS) values (kPa)**
Factored unit shaft resistance	14.5	18
Factored unit end-bearing resistance	150	187.5

Shaft friction should be neglected along the upper 3 m± portion of the pile that extends through topsoil, fill, silty clay and silt. A geotechnical resistance factor (Φ) of 0.4 has been assumed for the recommended factored compressive resistance values.

During test hole drilling, water infiltration was observed from within the silt till; however, any water inflows are expected to be able to be controlled by conventional high-capacity pumping equipment. Should heavy groundwater inflow be encountered, concrete placement should be completed using tremie or pump-in methods. Casing of the pile excavation may be required as squeezing of the hole may occur near or within the silt till stratum due to softer strengths and possible water infiltration in this layer. Casing of the pile may also be required near grade to prevent sloughing of the silt as well as possible water infiltration in this layer.

Prior to placement of concrete in the hole, the base of the hole must be mechanically cleaned to obtain a sound bearing surface.

4.2 PRE-CAST CONCRETE END-BEARING DRIVEN PILES

Pre-cast concrete piles driven to practical refusal on the underlying till are also suitable to support the proposed building. Below, are the estimated factored Limit States compressive resistance values recommended for driven, end bearing, prestressed, pre-cast concrete piles when driven to practical refusal on the underlying till or bedrock:

Pile Diameter	**Serviceability Limit State (SLS) value (kN)**	**Ultimate Limit State (ULS) value (kN)**
300 mm diameter	445	560
350 mm diameter	625	785
400 mm diameter	800	960

A geotechnical resistance factor Φ of 0.4 has been assumed in estimating the factored resistances for compressive loading conditions.

To minimize the potential for rebound during pile driving the spacing between adjacent piles should be a minimum of three (3) pile diameters from centre to centre. Pre-boring a minimum of 4 m is recommended prior to driving the piles.

4.3 DRIVEN TAPERED TIMBER PILES

Tapered timber piles driven to practical refusal on the underlying till may also be used to support the proposed structure and can be assigned the following factored end-bearing resistance values:

Pile Diameter	Serviceability Limit State (SLS) value (kN)	Ultimate Limit State (ULS) value (kN)
300 mm diameter	155	195

A geotechnical resistance factor Φ of 0.4 has been applied in estimating the factored geotechnical resistance for compressive loading conditions.

Typically, timber piles are available with 300 mm butt diameter (12 inch) tapering down to a 200 mm to 225 mm (8 to 9 inch) tip diameter. Careful attention will be required during driving, especially as the pile approaches refusal, to avoid breaking the pile.

Similar to pre-cast concrete end-bearing driven piles, to minimize the potential for rebound during pile driving the spacing between adjacent piles should be a minimum of three (3) pile diameters from centre to centre. Pre-boring a minimum of 4 m is recommended prior to driving the piles.

4.4 GENERAL PILE COMMENTS

All piles should have a minimum length of 6 m and a minimum 150 mm void form should be installed below all grade beams and pile caps to protect against potential uplift. Full-time inspection by experienced geotechnical personnel during construction of the piles is recommended.

If Pile Driving Analysis (PDA) testing is undertaken on driven piles at the site, an increased geotechnical resistance factor of 0.5 could be used on the pile resistance as determined by CAPWAP and field results. If undertaken, PDA testing should be completed under the supervision of an experienced geotechnical engineer and KGS Group should review the results of any testing and pile capacities. KGS Group can arrange for this testing to be completed on your behalf.

5.0 SHALLOW FOUNDATION CONSIDERATIONS

Shallow foundations are not typically used in Winnipeg for lightly loaded structures due to the expansive nature of the soils in the City. However, if settlement and differential settlement can be tolerated, the building can be constructed on a structural slab-on-grade.

5.1 STRUCTURAL SLAB-ON-GRADE

The proposed building foundation may consist of a structural slab-on-grade and the underlying silty clay can be assigned an unfactored ultimate bearing capacity of 200 kPa. The following is recommended for this alternative:

- Sub-excavate the surficial soils (approximately 3 m±) including the topsoil, clay fill, silty clay and silt layer to the subgrade design elevation and proof-roll compact the native soil subgrade. The silt layer is relatively thin and shallow and should be completely excavated and replaced with compacted granular sub base. A non-woven geotextile separator should also be placed over the excavated subgrade prior to sub base placement.

- A minimum 150 mm thick layer of granular base and 300 mm thick layer of sub base should be placed immediately below the slab.

- All granular should be placed in maximum 150 mm thick lifts and compacted to 98% Standard Proctor Dry Density (SPMDD). Granular base and sub base materials should be supplied in accordance with City of Winnipeg standard material specifications.

- The final ground elevation around the perimeter of the building should be sloped away at a minimum 2% grade, to protect against surface water ponding and the sub-grade should be positively graded to a sump to remove any accumulation of water beneath the floor. Alternatively, the base and sub base materials should be positively graded to the perimeter.

Some seasonal movement and/or differential settlement and potential cracking of the concrete slab may occur over time with grade-supported slabs. This alternative should be selected only if cracking and differential settlement is acceptable for the building. Some differential settlement can be mitigated through the use of a thickened edge slab that should be designed by a structural engineer. Where this is deemed unacceptable a structural floor slab supported on intermediate piles should be used as discussed in Sections 4.1 to 4.4.

5.2 ADDITIONAL CONSIDERATIONS

A slab-on-grade floor design may be suitable for a lightly loaded building at this Site. As mentioned, slab-on-grade floors supported on the in-situ clay soils will experience some differential vertical movement associated with changes in the soil moisture and possible consolidation settlement. Differential movement of grade supported floor slabs will likely result in some cracking and loss of utility. To accommodate this settlement without undue stress to the concrete slab-on-grade KGS Group recommends that a slab-on-grade:

- Be placed structurally separate from the building walls;
- Be structurally separate from all columns and footings;
- Be of sufficient thickness and well reinforced to prevent cracking under load. The thickness of the concrete slab would likely be at least 200 mm; and
- Have construction joints at 4 to 5 m spacing to permit differential movement (as a unit) to limit cracking.

Should total and/or differential settlements of the slab reach unacceptable levels, the above provisions would permit adjustment/lift of the individual slab sections by low pressure grouting (mud jacking).

As described in Section 5.1, in preparation for the floor slab placement, the exposed sub-grade should be proof-rolled with a smooth drum roller to delineate any soft and/or wet zones, or otherwise deleterious material and should not be allowed to become wet or to freeze. Frozen soils should not be placed within backfill. If soft and/or wet zones/deleterious materials are encountered, they should be sub-excavated and replaced with approved granular fill compacted to at least 98% of the material's SPMDD. Any filling operations should be monitored by qualified geotechnical personnel.

5.3 FROST PROTECTION FOR SLABS-ON-GRADE

Near surface sediments are primarily highly plastic clay deposits, which exhibit relatively low bearing capacity, moderate to high susceptibility to frost induced heave, and volume change under varied moisture and pressure conditions. Frost may be expected as deep as 2.5 m± at this site. The drilling program occurred in August and thus did not encounter frost at the time of drilling. Structure foundations bearing directly on these deposits (i.e., grade supported slabs or shallow footings) may be susceptible to vertical movements and this type of foundation should be used with due consideration. Alternatively, insulation and/or void-form materials can be used to reduce the required depth of soil cover to reduce the effects of frost heave. Otherwise, frost heave and adfreeze effects should be considered in the foundation design.

5.3.1 Frost Insulation

As an alternative to providing only soil cover for grade beams, and to reduce the effects of frost heave on slabs-on-grade, rigid insulation may be used to protect structures from frost action. Frost insulation considerations should include:

- Type of insulation (high density polystyrene, cellular concrete, etc) and properties
- Insulation thickness for heated and unheated structures
- Prepared subgrade considerations (as described above)
- Insulation bearing capacity and compressibility properties
- Insulation cover requirements
- Lateral extent of insulation
- Durability of insulation (in presence of water, hydrocarbons, and other chemicals contaminants)

If insulation is considered, as per the Canadian Foundation Engineering Manual 4th edition, Winnipeg is located in an area with a design freezing index around 2000-2400°C-days. Currently, it is anticipated that the storage facility is to be constructed as an unheated structure.

For an unheated structure with a slab-on-grade foundation, the design freezing index gives a lateral extent of the insulation extending 2.44 m (8’0”) from the outer edge of the slab. Minimum insulation thickness under the slab should be approximately 200 mm (8”). The subgrade should be prepared with a minimum of 300 mm compacted clean granular fill (Section 5.1 recommends 450 mm of base materials), and insulation extending out from the slab should have a minimum of 300 mm cover.

For heated structures with a slab-on-grade foundation, insulation under the slab does not generally provide any added benefit. However, the future use of the structure should be considered in regards to a heated or unheated building as post-construction installation of insulation under the building is not feasible and initial installation of insulation may be an unnecessary cost should the purpose of the building be altered.

For a heated structure using grade beam walls, the insulation requirements vary depending on the expected average temperature of the building. The lateral extent of the insulation from grade beam wall can vary from 1.22 m to 2.44 (4’0” to 8’0”) and the thickness of insulation along the vertical grade beam and extended laterally outward can be between 50 to 76 mm (2” to 3”). This insulation may be installed during initial construction or post-construction should the future purpose of the building change.

Required lateral extent of insulation may be difficult to achieve given the vicinity of existing walkways and the location of the existing swale and nearby catch basin.

5.3.2 Void-Forms

The use of void-forms may also be considered to reduce the potential for frost heave beneath structural slabs. If a compressible void-form is used, the uplift pressure acting on the underside of the foundation elements may be taken as the crushing strength at the design strain of the compressible medium comprising the void-form. Void-form considerations should include:

- Potential frost heave and frost heave pressures
- Potential adfreeze effects
- Type of void form
- Void-form thickness for heated and unheated structures
- Prepared subgrade considerations
- Durability of insulation (in presence of water, hydrocarbons, and other chemicals contaminants)

It is recommended that a void form of 150 mm be used for both heated and unheated structures when placed directly on sand and gravel soils at or near the final ground surface.

Where degradable void-forms are employed, frost heave pressures may be assumed to be zero where:

- The remaining void can safely accommodate the frost heave;
- The foundation or grade beam is above the groundwater table; and
- Sufficient drainage is provided such that the void cannot fill with water that may freeze.

Void-form materials can be used in conjunction with rigid insulating materials in order to reduce frost penetration depth (with the use of insulation to reduce void form thickness) and reduce potential frost heave and adfreeze effects. The thickness of rigid insulation for heated and unheated structures recommended above can be reduced to allow for some frost penetration. The corresponding frost heave and adfreeze effects could then be either accounted for in the structural design of the building or mitigated with the use of a void-form material. The final design should be reviewed by qualified geotechnical personnel to assess if adequate insulation and void-form thicknesses and materials have been specified to achieve the desired application and foundation behaviour.

6.0 OUTDOOR HOCKEY RINK

A site visit on July 8, 2016 revealed that the luminaire poles, wood paneling and fencing has already been constructed at the site. This provides a limitation on the excavation that can be completed without shoring options, as well as limiting installation of new materials and potential insulation. Based on the drawing details provided by the City, the fence posts have been installed a minimum of 6’0” (1.80 m) below grade. KGS Group understands that this hockey rink is intended to also be used as an outdoor basketball court, requiring an asphalt surface as opposed to natural ground conditions.

6.1 RINK ASPHALT SURFACING AND EXTERIOR WALKWAYS

The outdoor hockey rink surface may consist of a granular pad complete with asphaltic concrete pavement surfacing. The following is recommended for the construction the granular pad and asphalt pavement:

- Sub-excavate the surficial soils including the topsoil, clay fill, silty clay and silt layer to the subgrade design elevation and proof-roll compact the native soil subgrade. It is anticipated that the silt layer will be encountered within the initial excavation to the design elevation. This silt layer is discussed further below.
- Alternatively, a non-woven geotextile separator should can be placed over the excavated subgrade prior to sub base placement.
- A minimum 100 mm thick layer of granular base (20 mm-minus limestone or recycled concrete base material) and 350 mm thick layer of sub base (50 mm limestone or recycled concrete sub base material) should be placed immediately below the asphalt pavement structure.
- All granular should be placed in maximum 150 mm thick lifts and compacted to 98% Standard Proctor Dry Density (SPMDD). Granular base and sub base materials should be supplied in accordance with City of Winnipeg standard material specifications.
- The final ground elevation around the perimeter of the rink should be sloped away at a minimum 2% grade, to protect against surface water ponding and the sub-grade should be positively graded to a drain to remove any accumulation of water beneath the pavement structure. Subsurface drainage is discussed further in Section 7.0.
- The pavement structure to be constructed on top of the granular pad for the hockey rink base is recommended to consist of 75 mm of Type II asphalt concrete pavement.

The silt layer is sensitive to moisture content and vibration and is generally a poor construction platform and foundation for any structure. The silt layer was encountered in all test holes, but is relatively thin and somewhat shallow in TH13-06. The depth of the silt layer likely varies across the site but is anticipated to be within the upper 3 m± and is expected to be shallower in the vicinity of the hockey rink. It is recommended that this silt layer be completely excavated and replaced with suitable compacted clay backfill or granular backfill to the subgrade elevation. Total removal of the silt will minimize pavement distress resulting from frost heave and generally increase the overall life-cycle of the asphalt pavement for the hockey rink. If replacement of the silt layer is not feasible, a geogrid combined with an underlying non-woven geotextile separator should be placed over the silt layer before the sub base is placed. Table 1 provides recommended geogrid products and suppliers.

KGS Group recognizes that the presence of the existing fencing may inhibit a full excavation of the silt layer without compromising installed fence posts that may lead to damage of the existing structure. Care should be taken to protect the structure from damage during excavation by mechanical means. Excavation depth should not exceed the depth of installation of the fence posts of approximately 1.8 m±. Where excavation depth may potentially exceed the installation depth of the fence posts a geogrid combined with a non-woven geotextile separator should be considered before the sub base is placed.

All materials should be supplied and installed in accordance with the City of Winnipeg Standard Construction Specifications.

Asphalt surfacing such as this will develop surficial cracking due to weathering. Cracking may need to be addressed with tar filling or otherwise. Performance of the asphalt surface with tar filling or otherwise is not considered in this report.

TABLE 1
RECOMMENDED GEOGRID PRODUCTS AND SUPPLIERS

Product Name	Supplier
Tenax LBO 302 SAMP	Brock White Canada
Checkmate 2525PP	Brock White Canada, Titan Environmental Containment Ltd.
Tensar BX1200	Nilex Civil Environmental Group
Terrafix BX2500	Brock White Canada
Griffen GBX2000	Titan Environmental Containment Ltd.

6.2 FROST PROTECTION AND DRAINAGE CONSIDERATIONS

The installation of insulation within the asphalt pavement structure can be considered; however KGS Group considers the cost-benefit to be excessive. The use of insulation may reduce frost penetration, but would not eliminate it. Frost heave is expected on a pavement structure such as the hockey and is often best mitigated by control of moisture.

As stated in Section 6.1, the base and sub base materials should be positively graded from the centre of the hockey rink to the perimeter. A water collection system, such as perforated pipes, can be used around the perimeter of the hockey rink to collect the water and discharge to a nearby drainage collection system.

7.0 EXCAVATION CONSIDERATIONS

All trenching and excavations should be carried out according to the latest version of Manitoba Occupational Health and Safety Regulations (OH&S).

Temporary excavations and trenches within the native soils should be suitably cut back and supported, as required. Any excavation deeper than 1.5 m must be reviewed and designed by a qualified geotechnical engineer.

All excavations and foundation subgrade should be reviewed by qualified geotechnical personnel in the field to confirm that the soil and groundwater conditions are as anticipated. Stockpiling of materials should not take place within 3 m of the crest of excavations so as to not compromise stability of the excavation.

Control of surface water should be maintained at all times and surface water should be directed away from all excavations and exposed subgrade soils.

Design of temporary shoring can use the following active, passive, and at-rest earth pressure coefficients for design purposes and should be designed by a qualified geotechnical engineer with experience in designing temporary shoring. It is anticipated that the excavations at this site would encounter topsoil, clay fill, a silt layer, and native clay. The till layer is at a considerable depth below the ground surface and should not be encountered. Table 2 outlines the soil parameters for earth pressure calculations.

TABLE 2
SOIL PARAMETERS FOR EARTH PRESSURE CALCULATIONS

Soil Type	Friction Angle (°)	Active Earth Pressure Coefficient, k_a	Passive Earth Pressure Coefficient, k_p	At-Rest Earth Pressure Coefficient, k_o	Unit Weight, γ_t (kN/m^3)
Compacted Granular Fill	30	0.33	3.00	0.50	21
Native Clay	15	0.59	1.70	0.74	18

If silt layers are encountered in the upper clays, the excavation slopes may be susceptible to seepage and sloughing depending on groundwater levels at the time of construction. It is recommended that the side slopes of all open excavations be covered to prevent saturation of soil.

8.0 SUBSURFACE DRAINAGE CONSIDERATIONS

Overall subsurface drainage considerations should include grading of base and sub base materials to prevent ponding of water underneath the asphalt pavement surface and the floor slab of the proposed storage facility. A water collection system may be considered but may be costly for the type of storage facility considered in this report.

A water collection system is recommended for the asphalt pavement. Water infiltration through the pavement structure would likely be minimal, but if the silt layer is not fully excavated, it is possible to have moisture migration from that layer to the asphalt pavement structure. To minimize the potential for frost heave beneath the pavement structure, water should be directed to a water collection system (i.e. perforated weeping tile system) around the perimeter of the rink. The discharge the water collection system should be directed through a granular trench to a central sump system or discharged into a nearby catch basin. A similar system would aid in drainage during spring melt with excess runoff and the melting of ice from the hockey rink. To provide uniform support for pipes and other utility lines, it is recommended that appropriate pipe bedding be provided based on the requirements and specifications of the pipe manufacturer.

9.0 BACKFILL AND COMPACTION

Stockpiled topsoil can be used for landscaping fill, which may comprise materials without regard to engineering quality.

A provision for conventional proof-rolling using a fully loaded dump truck (or other suitable equipment) to confirm the suitability of the exposed subgrade should be carried out prior to the placement of any structural fill. Soft or loose subgrade soils should be sub-excavated to competent ground and should be free of standing water, frost, ice, organics and deleterious materials prior to placement of structural fill as determined by qualified geotechnical personnel.

General fill required to bring the site to design subgrade level should consist of clean, well-graded, granular soil, or inorganic low to medium plastic cohesive soils. The general fill should be placed in horizontal lifts, not exceeding 300 mm uncompacted thickness, and uniformly compacted to a minimum of 98 % of the SPMDD at +/- 2 % of optimum water content.

Prior to backfilling operations, the SPMDD of the native excavated soils and of potential borrow sources should be determined. An engineered backfill material should be used for subgrade replacement and site grading within the building footprint, driveways, parking areas, *etc*. Furthermore, unnecessary trafficking and disturbance of the subgrade should be avoided.

10.0 FOUNDATION CONCRETE

All concrete in contact with soils at this site should be made with HS or HSb cement (Sulphate Resistant), and in accordance with CAN/CSA A23.1-14. A maximum water/cement ratio of 0.40 and a minimum 56 day compressive strength of 35 MPa are also recommended for structurally reinforced concrete exposed to chlorides. Concrete which will be subject to freezing and thawing should have an air entrainment of 4% to 7% for improved durability. The allowable curing regime for this type of concrete is 7 days at ≥10˚C and for a time necessary to attain 70% of the specified strength. Structural criteria may dictate more stringent requirements.

11.0 SUMMARY

Based on the six test holes drilled at the site in 2013, the stratigraphy is interpreted to generally consist of a thin upper layer of topsoil, clay fill, silty clay and silt to approximately 3 m± where a thick layer of highly plastic silty clay is encountered. The highly plastic silty clay is underlain by a compact layer of silt till. Water infiltration was observed from the silt till at 9.14 m± and 9.75 m± below existing grade immediately after drilling.

It is recommended that the proposed storage facility at the East Elmwood Community Centre be supported on piles as described in Section 4.0. A slab-on-grade foundation can be used if seasonal movement, differential settlement and cracking of the slab is acceptable. Recommendations for slab-on-grade foundation and appropriate insulation thickness and cover is provided in Section 5.0.

The outdoor hockey rink and pavement structures can be founded on the in-situ clay subgrade prepared by proof-roll compaction and separated from the granular base using a non-woven geotextile as described in Section 6.0.

It is recommended that unsuitable upper soils consisting of topsoil, clay fill and silt layer encountered in TH13-01 to TH13-06 be excavated and replaced with suitable compacted material for all foundation recommendations. A geogrid underlain by a non-woven geotextile fabric should be considered if replacement of the unsuitable soils is not feasible.

12.0 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 at this site. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS or if the assumptions stated herein are not in keeping with the design, this office should be notified in order that the recommendations can be reviewed and modified if necessary.

This report has been prepared for City of Winnipeg to whom this report has been addressed and any third party use 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.

13.0 CLOSING

If you have any questions regarding the enclosed information or require additional information, please call the undersigned at (204) 896-1209.

Prepared by:

David Kurz, Ph.D., P.Eng.
Geotechnical Engineer

Reviewed by:

Bruno Arpin, P.Eng.
Senior Geotechnical Engineer

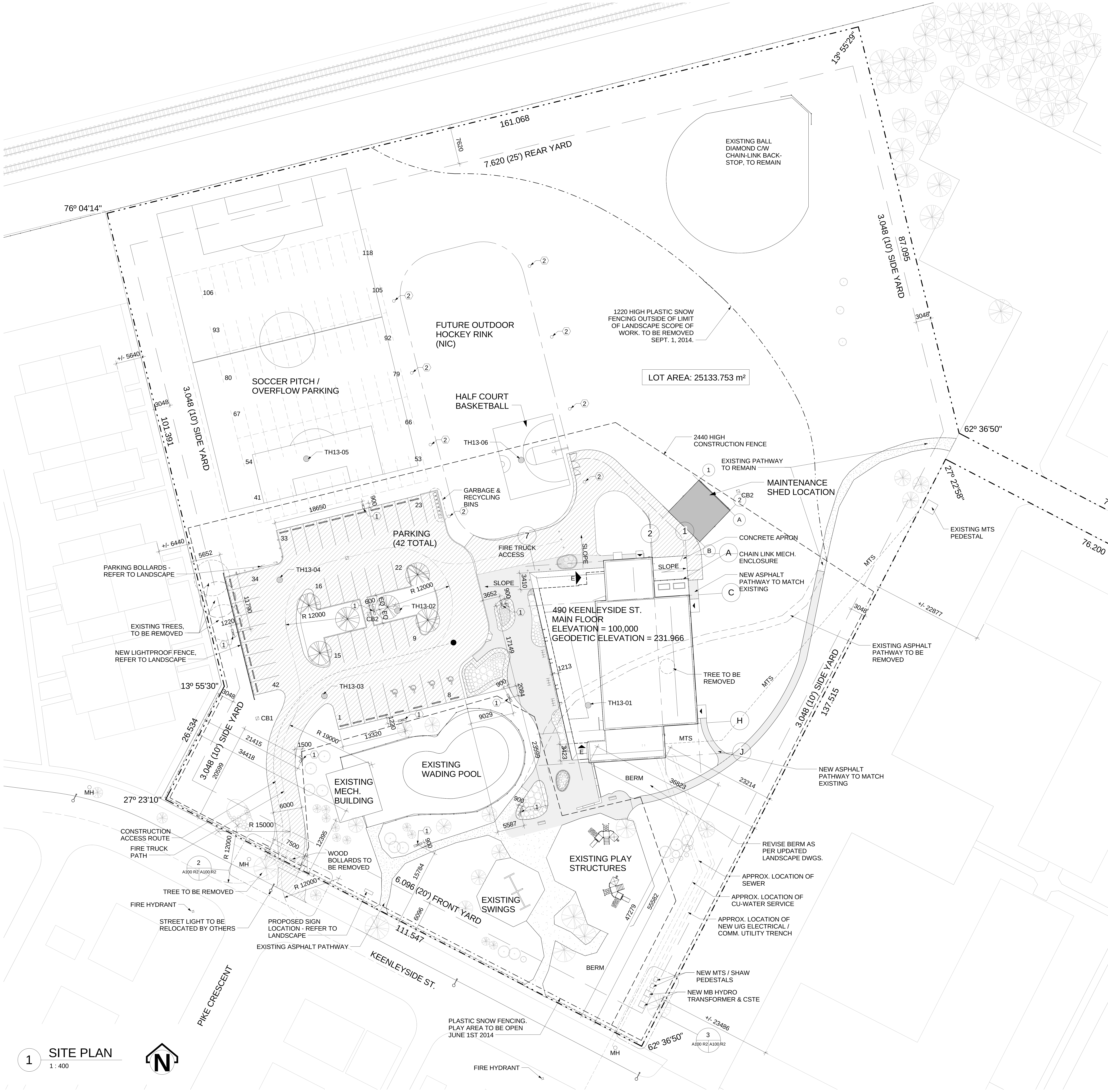
Approved by:

Rob Kenyon, Ph.D., P.Eng.
Manager, Geotechnical Engineering

PROVINCE OF MANITOBA
July 18/2016
D. R.
KURZ
Member
24615
REGISTERED PROFESSIONAL ENGINEER

DRK/BPA/aa
Enclosure

FIGURE 1



1 SITE PLAN
1 : 400

NOTES:

1. REFER TO CIVIL DRAWINGS FOR SITE TOPOGRAPHY & DRAINAGE
2. REFER TO LANDSCAPE SITE PLAN L101 FOR DIMENSIONS & SURFACE MATERIALS OF ALL HARD-PAVED GROUND SURFACES
3. REFER TO LANDSCAPE FOR LANDSCAPED AREAS AND PLANTING MATERIALS
4. REFER TO LANDSCAPE FOR PROPOSED SURFACE ALTERATIONS IN THE PUBLIC RIGHT OF WAY
5. REFER TO ELECTRICAL FOR DETAILS AND SPECIFICATIONS FOR SITE & RINK LIGHTING
6. REFER TO STRUCTURAL FOR PILE & ANCHOR DETAILS FOR SITE & RINK LIGHTING

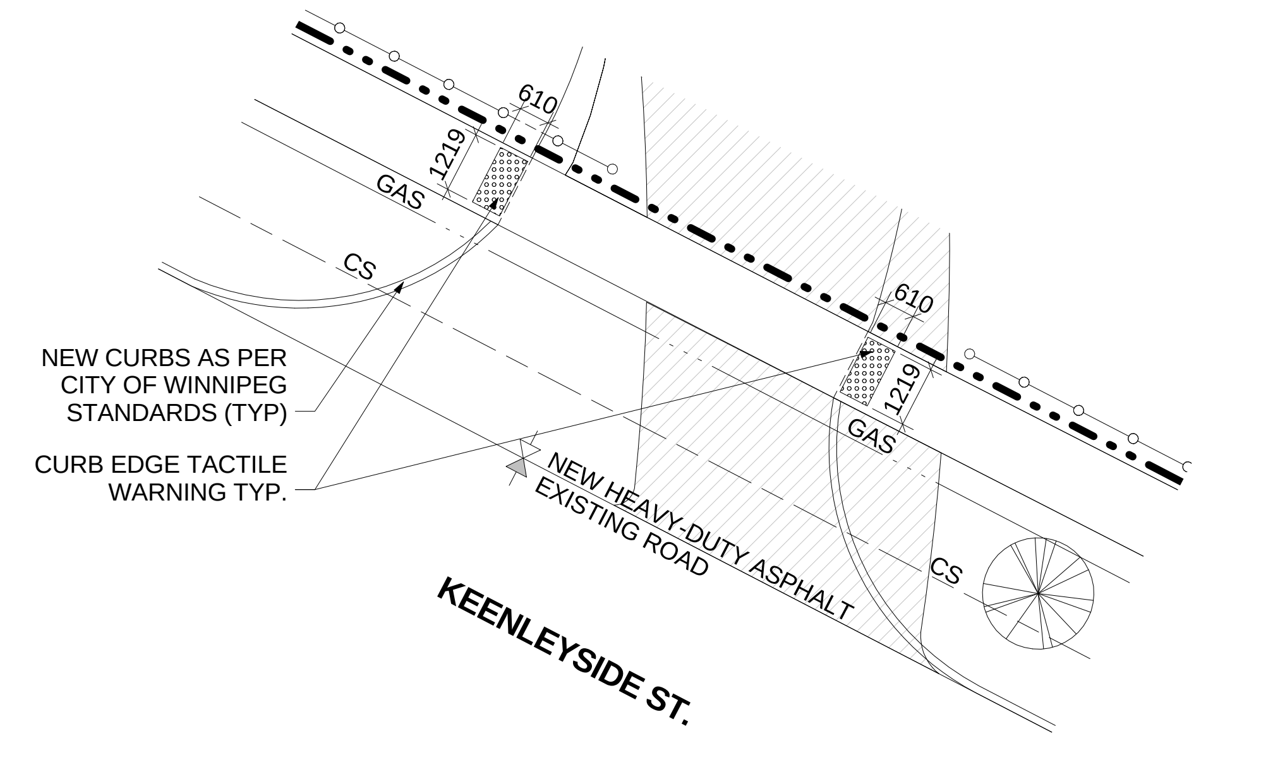
KEYNOTE LEGEND

⟨1⟩ SITE LIGHTING

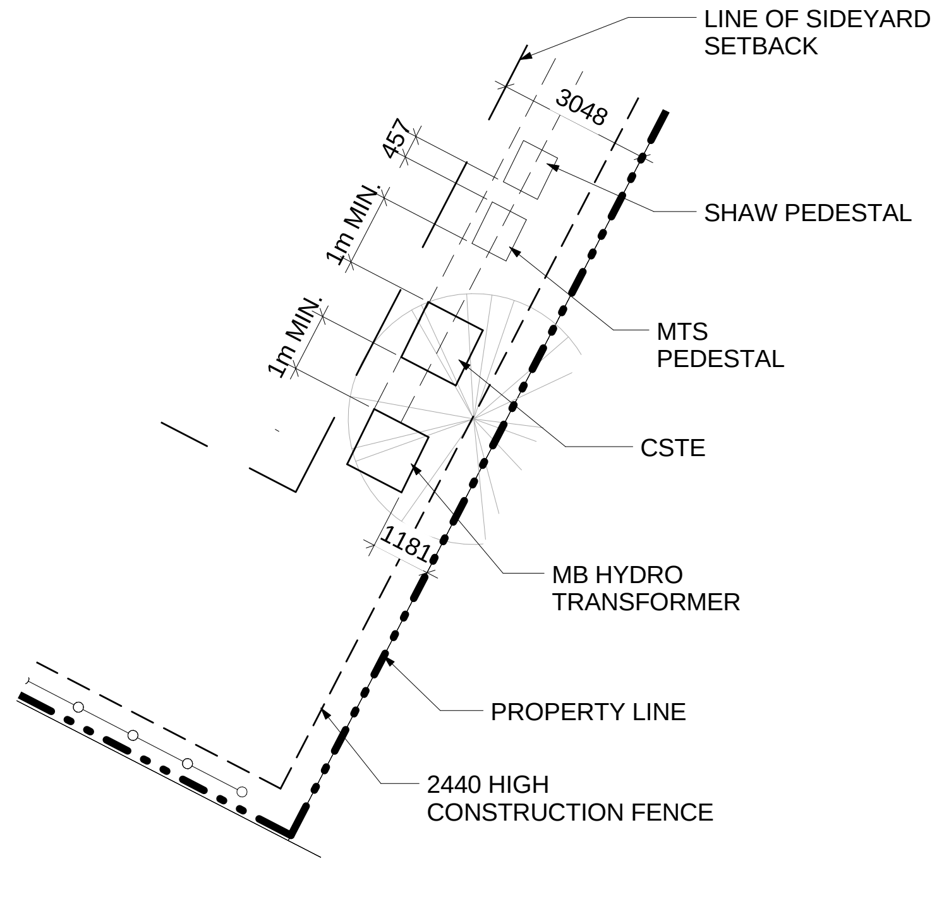
⟨2⟩ RINK LIGHTING

LEGEND

▨	NEW HEAVY-DUTY ASPHALT PAVED SURFACE
▩	NEW LIGHT-DUTY ASPHALT PAVED SURFACE
⬚	EXISTING CRUSHED LIMESTONE SURFACE
⬚	EXISTING ASPHALT PAVED SURFACE
▦	RIP-RAP GARDEN BORDER
TH13-0X ●	GEOTECHNICAL TEST HOLE APPROXIMATE LOCATION
— · · —	PROPERTY LINE
— — —	CONSTRUCTION FENCING
— · —	CONSTRUCTION FENCING TO BE REMOVED JUNE 1, 2014
———	PROPERTY SETBACKS



2 SITE PLAN - APPROACH DETAIL
1 : 150



3 SITE PLAN - ELECTRICAL
1 : 150

LEGAL DESCRIPTION:
Lot 3, Block 9, Plan 10195 WLTO in RL 92 to 97, Parish of Kildonan

SITE BOUNDARY & LOCATION INFORMATION EXTRACTED FROM 'PARTIAL SITE PLAN', SURVEY DRAWING NO. 201308199, DATED AUGUST 23, 2013, PREPARED BY PHILLIPS & STEVENS.

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www.bridgmancollaborative.ca

Winnipeg
THE CITY OF WINNIPEG PLANNING, PROPERTY AND DEVELOPMENT DEPARTMENT
MUNICIPAL ACCOMMODATIONS DIVISION

4TH FLOOR - 185 KING STREET
R3B 1J1

Project:
EAST ELMWOOD COMMUNITY CENTRE
490 KEENLEYSIDE,
WINNIPEG, MB

Project Number: 1306-006
Bid Opportunity Number 748-2013

Drawing Title:
SITE PLAN

#	Issue/Revision	Date
1	ISSUED FOR TENDER	2013-12-05
2	ISSUED FOR CLARIFICATION	2014-03-20
3	PCN 08	2014-05-07

Design By:
Date:
Design Check:
Date:
Drawn By:
Date:
DWG Check:
Date:

Sheet No: A100 R2

APPENDIX A

TEST HOLE LOGS - KGS GROUP (2013)

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH13-01

SHEET 1 of 2

CLIENT	WINS BRIDGMAN
PROJECT	East Elmwood Community Centre
SITE	480 Keenleyside Street, Winnipeg, MB
LOCATION	Rec Centre Option 2
DRILLING METHOD	125 mm ø Solid Stem Auger, Truck Mounted ACKER MP8 Drill Rig

JOB NO.	13-1409-002
GROUND ELEV.	
TOP OF CASING ELEV.	
WATER ELEV.	
DATE DRILLED	8/23/2013
UTM (m)	N 5,530,060 E 638,444

ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | PIEZ. LOG | DEPTH (m) | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △ | Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ PL MC LL %

TOPSOIL - Black, damp, crumbly, non-plastic, trace rootlets, trace fine sand.

SILTY CLAY FILL - Light brown, dry/damp, firm, intermediate plasticity, trace medium to coarse grained sand.

SILTY CLAY - Light brown, damp, stiff, high plasticity.

SILT - Tan, moist, soft, low to intermediate plasticity, trace fine sand.

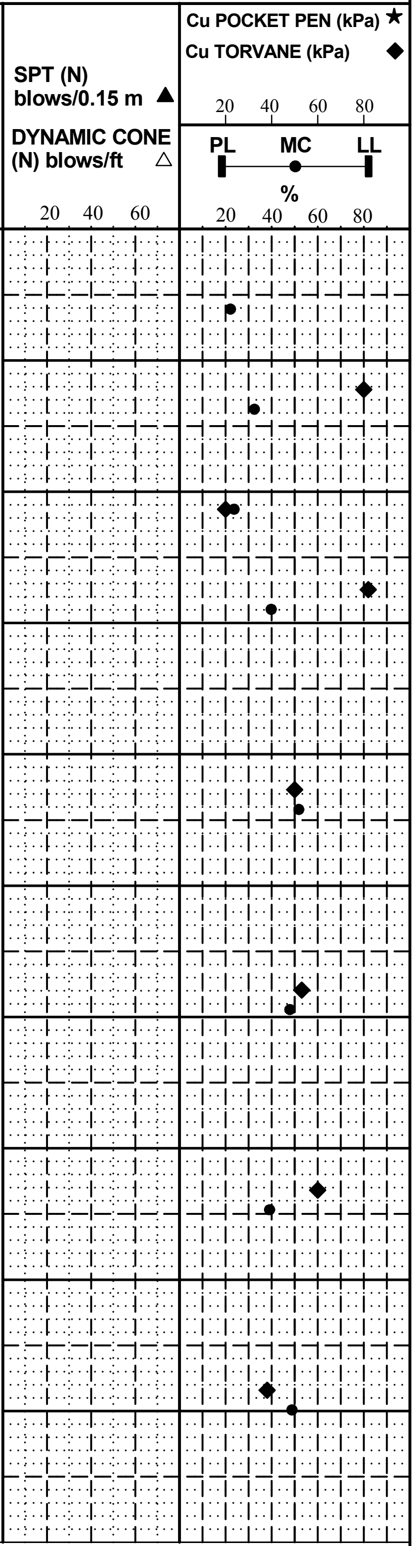
SILTY CLAY - Brown, damp/moist, stiff, high plasticity, trace silt nodules, trace gypsum.

- Mottled grey/brown, moist below 3.35 m.

- Trace oxidation below 4.11 m.

- Grey, no oxidation, firm below 7.92 m.

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



Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9; (ft): 5, 10, 15, 20, 25, 30

SAMPLE TYPE ▨ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16

GEOTECHNICAL-SOIL LOG U:\FMS\16-0107-012\KEENLEYSIDE_JRB_DRK.GPJ

KGS GROUP

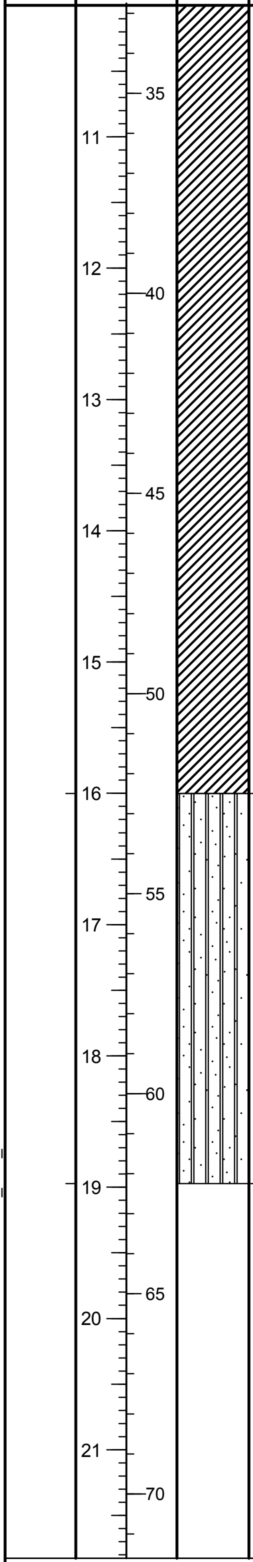
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH13-01

SHEET 2 of 2

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ PL MC LL %



- No gypsum below 12.19 m.

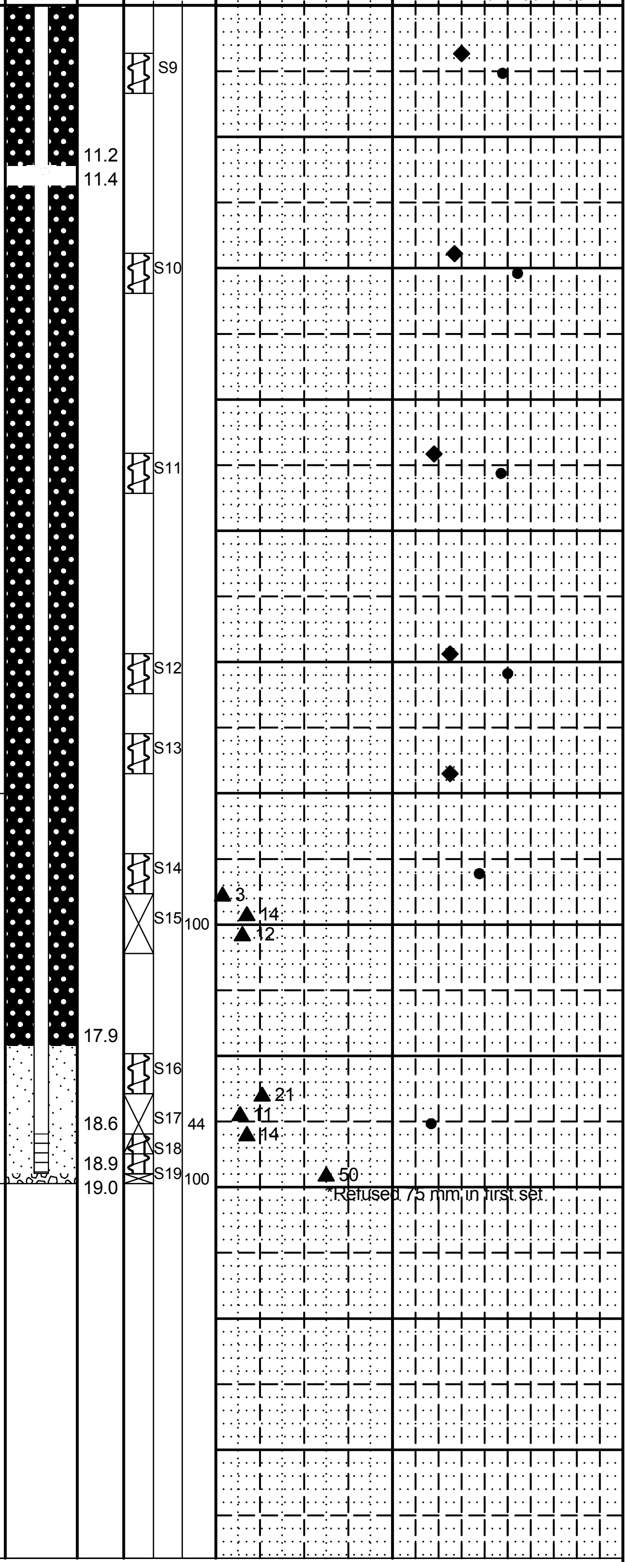
- Soft below 13.11 m.

- Trace medium grained sand below 14.63 m.

SILT TILL - Dark tan, moist, compact, some fine-coarse grained sand, trace fine-coarse gravel.

REFUSAL AT 18.97 m

Notes:
1. Installed casagrande standpipe at 18.90 m below grade in silt till with top of pipe ~0.1 m below grade.
2. Installed pneumatic piezometer (034857) at 11.23 m below grade in silty clay.
3. Backfilled test hole with silica sand from 18.97 m to 17.92 m.
4. Backfilled test hole with a bentonite grout mixture from 17.92 m to grade.
5. Water level at 9.14 m below grade after drilling.



SAMPLE TYPE Auger Grab ☒ Split Spoon

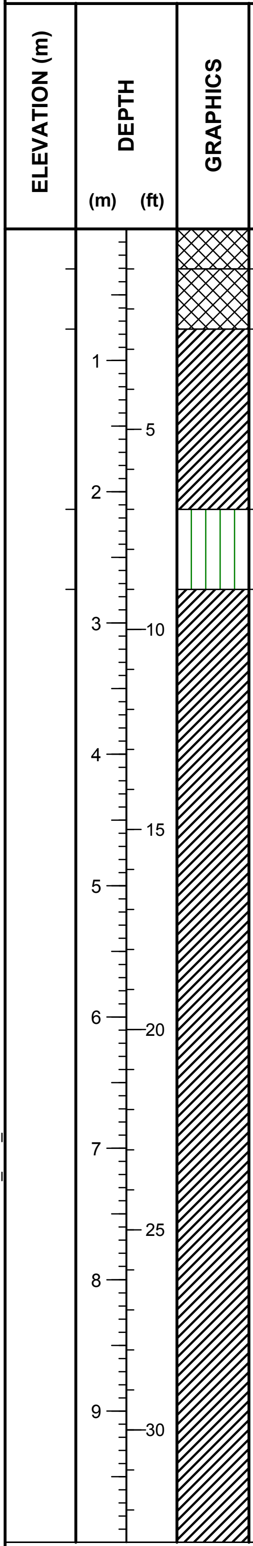
CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH13-02**

CLIENT	**WINS BRIDGMAN**	JOB NO.	**13-1409-002**
PROJECT	**East Elmwood Community Centre**	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	**480 Keenleyside Street, Winnipeg, MB**	WATER ELEV.	
LOCATION	**Rec Centre Option 1**	DATE DRILLED	**8/23/2013**
DRILLING METHOD	**125 mm ø Solid Stem Auger, Truck Mounted ACKER MP8 Drill Rig**	UTM (m)	N **5,530,072** E **638,390**



DESCRIPTION AND CLASSIFICATION

GRANULAR FILL - Reddish brown, damp, loose, with fine to med grained sand, with low plasticity clay.

SILTY CLAY FILL - Black, dry, stiff, low plasticity, trace fine to medium grained sand.

SILTY CLAY - Brown, damp/moist, very stiff, intermediate to high plasticity.

SILT - Tan, moist, soft, low to intermediate plasticity.

SILTY CLAY - Brown, moist, stiff, high plasticity, trace silt nodules.

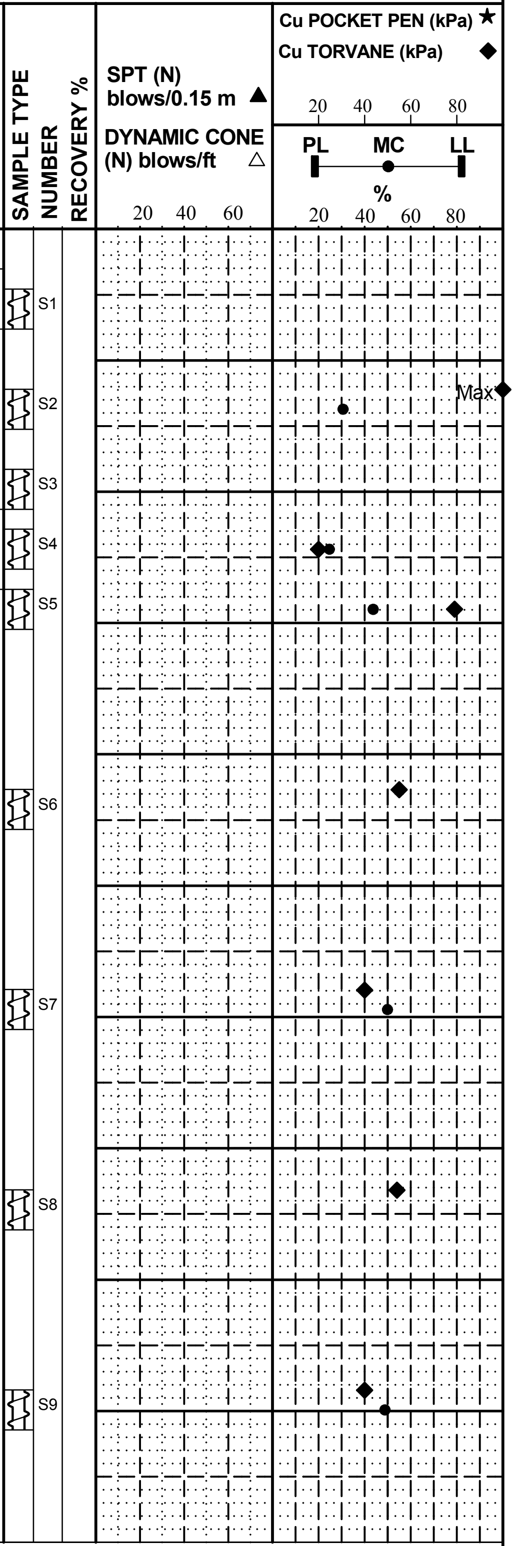
- Mottled grey/brown, trace gypsum below 3.05 m.

- Firm below 5.18 m.

- Stiff from 7.16 m to 7.62 m.

- No gypsum below 7.62 m.

- Grey below 8.23 m.



SAMPLE TYPE ▨ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16

KGS GROUP

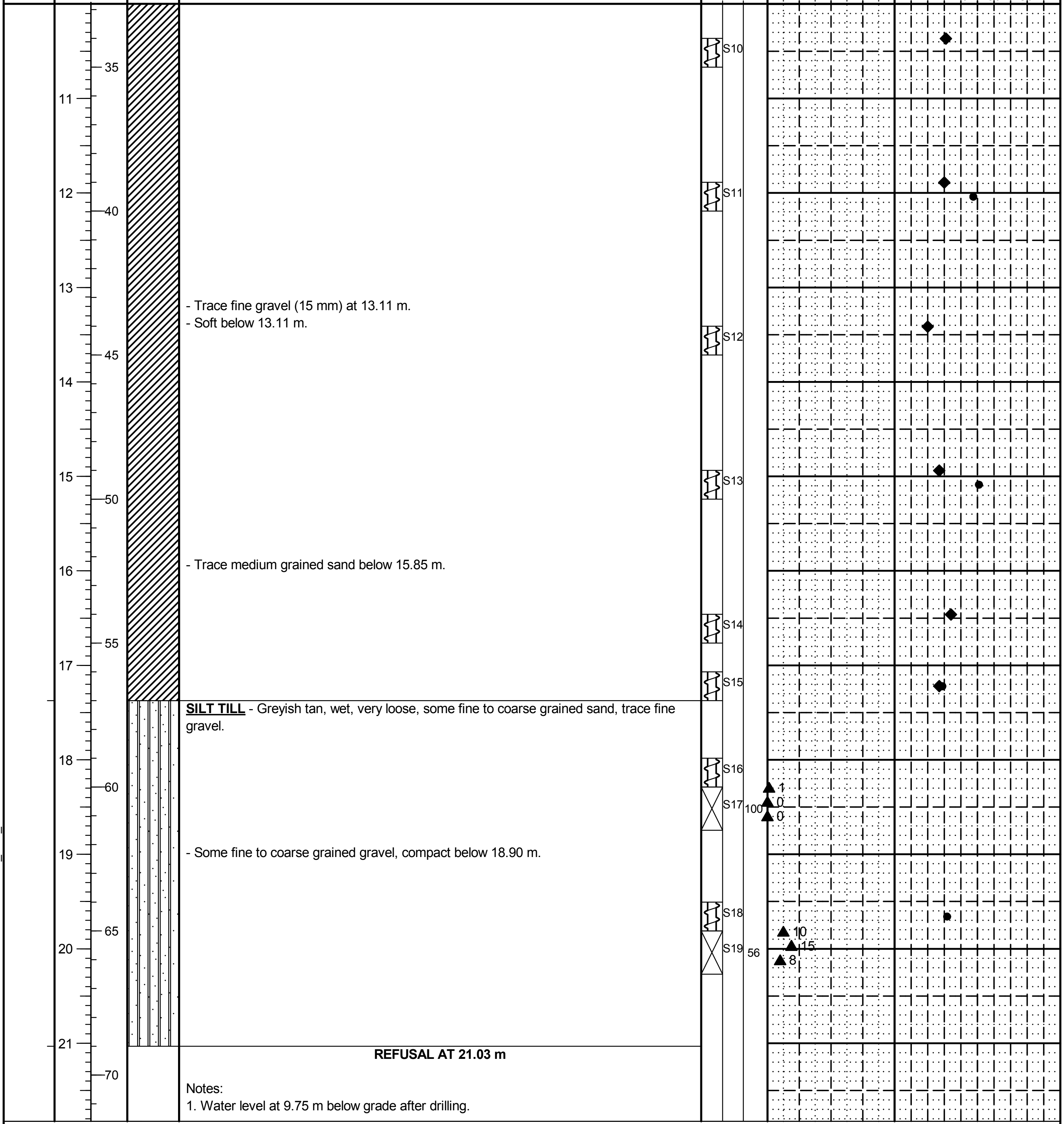
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH13-02

SHEET 2 of 3

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ PL MC LL %



- Trace fine gravel (15 mm) at 13.11 m.
- Soft below 13.11 m.

- Trace medium grained sand below 15.85 m.

SILT TILL - Greyish tan, wet, very loose, some fine to coarse grained sand, trace fine gravel.

- Some fine to coarse grained gravel, compact below 18.90 m.

REFUSAL AT 21.03 m

Notes:
1. Water level at 9.75 m below grade after drilling.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH13-02

SHEET 3 of 3

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △ 20 40 60	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ 20 40 60 80 PL MC LL % 20 40 60 80
	22			2. Test hole squeezed at 11.58 m below grade after drilling. 3. Backfilled test hole with auger cuttings from 21.03 to 0.30 m and bentonite grout mixture from 0.30 m to grade.					
		75							
	23								
	24								
		80							
	25								
		85							
	26								
	27								
		90							
	28								
	29	95							
	30								
		100							
	31								
	32	105							
	33								
		110							

SAMPLE TYPE ⊠ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16

GEOTECHNICAL-SOIL LOG U:\FMS\16-0107-012\KEENLEYSIDE_JRB_DRK.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

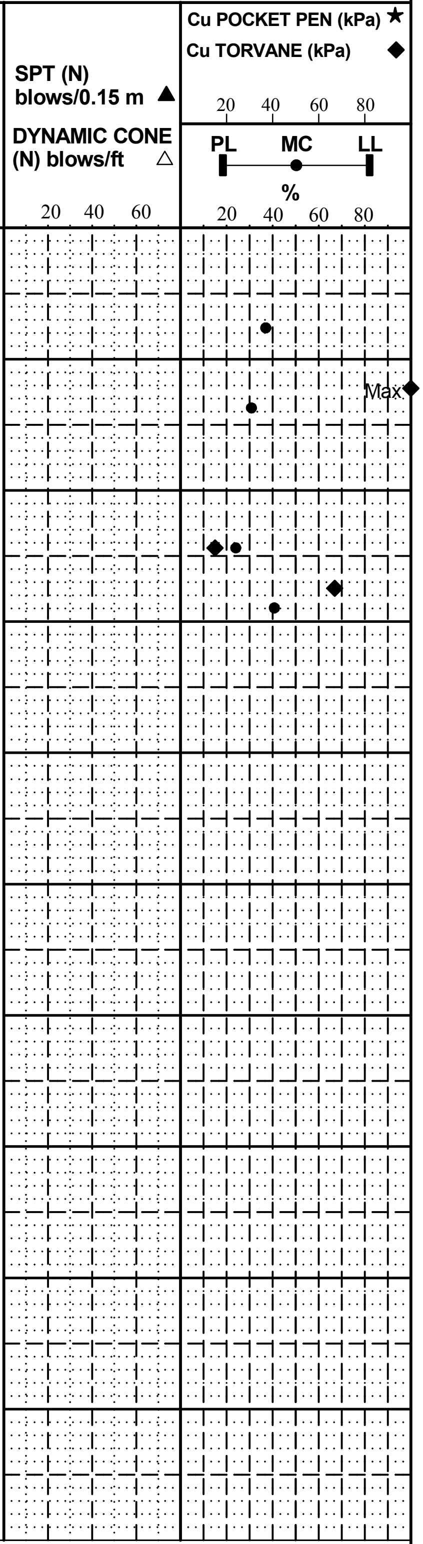
HOLE NO.
TH13-03

SHEET 1 of 1

CLIENT WINS BRIDGMAN
PROJECT East Elmwood Community Centre
SITE 480 Keenleyside Street, Winnipeg, MB
LOCATION Parking Lot / Service Road
DRILLING METHOD 125 mm ø Solid Stem Auger, Truck Mounted ACKER MP8 Drill Rig

JOB NO. 13-1409-002
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 8/23/2013
UTM (m) N 5,530,061
E 638,377

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
			GRANULAR FILL - Tan, dry, loose, fine to coarse grained sand, trace fine to coarse gravel, some silt/clay.	Auger Grab	S1	
			SILTY CLAY FILL - Blackish grey, damp, stiff, intermediate plasticity, trace fine to medium grained sand.	Auger Grab	S2	
			SILTY CLAY - Brown, damp, very stiff, high plasticity, trace silt nodules. - Trace oxidation below 1.52 m.	Auger Grab	S3	
			SILT - Tan, wet/moist, soft, low plasticity, trace oxidation.	Auger Grab	S4	
			SILTY CLAY - Mottled grey/brown, damp/moist, stiff, high plasticity, trace silt nodules.	Auger Grab	S5	
			END OF TEST HOLE AT 3.05 m			
			Note: 1. Backfilled test hole with auger cuttings.			



SAMPLE TYPE Auger Grab

CONTRACTOR
Paddock Drilling Ltd.

INSPECTOR
J. BARTZ

APPROVED
B.P. ARPIN

DATE
7/13/16

KGS GROUP

SUMMARY LOG

REFERENCE NO.

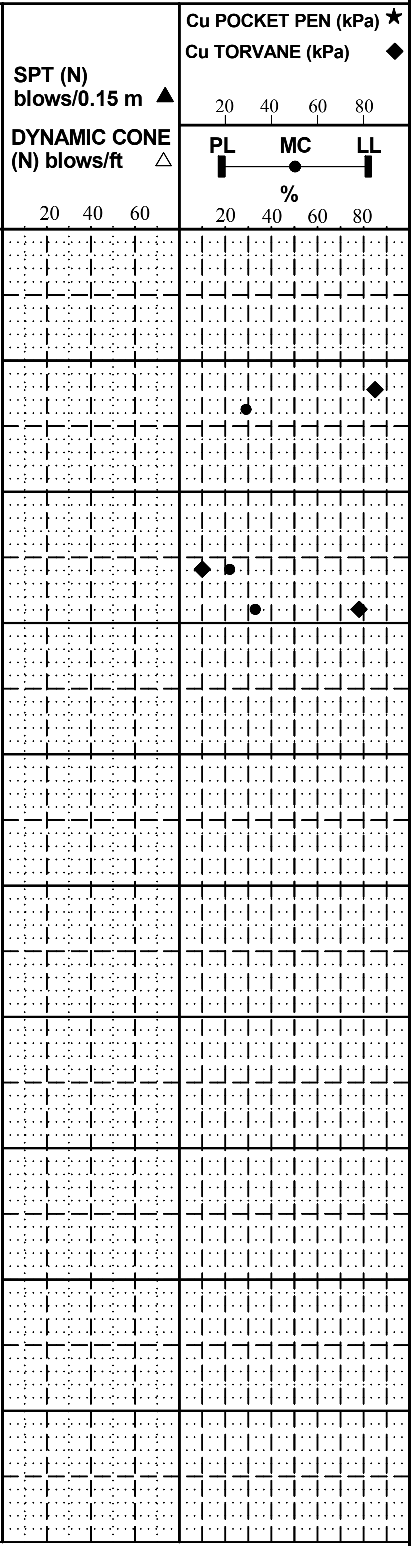
HOLE NO. **TH13-04**

SHEET 1 of 1

CLIENT	WINS BRIDGMAN	JOB NO.	13-1409-002
PROJECT	East Elmwood Community Centre	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	480 Keenleyside Street, Winnipeg, MB	WATER ELEV.	
LOCATION	Parking Lot / Service Road	DATE DRILLED	8/23/2013
		UTM (m)	N 5,530,087
DRILLING METHOD	125 mm ø Solid Stem Auger, Truck Mounted ACKER MP8 Drill Rig		E 638,370

DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER
		GRANULAR FILL - Tan, dry, loose, fine grained sand, some med to coarse grained sand, trace fine gravel, some silt/clay.	Auger Grab	S1
		SILTY CLAY FILL - Blackish grey, damp, very stiff, low plasticitity, trace fine to medium grained sand.	Auger Grab	S2
1	5	**SILTY CLAY** - Brown, damp, stiff, high plasticity.	Auger Grab	S3
2		- Trace oxidation below 2.13 m.		
		SILT - Tan, wet/moist, soft, low plasticity.	Auger Grab	S4
3	10	**SILTY CLAY** - Motlled grey/brown, damp, stiff, high plasticity, trace silt nodules.	Auger Grab	S5
		END OF TESTHOLE AT 3.05 m		

Note:
1. Backfilled test hole with auger cuttings.



SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16

KGS GROUP

SUMMARY LOG

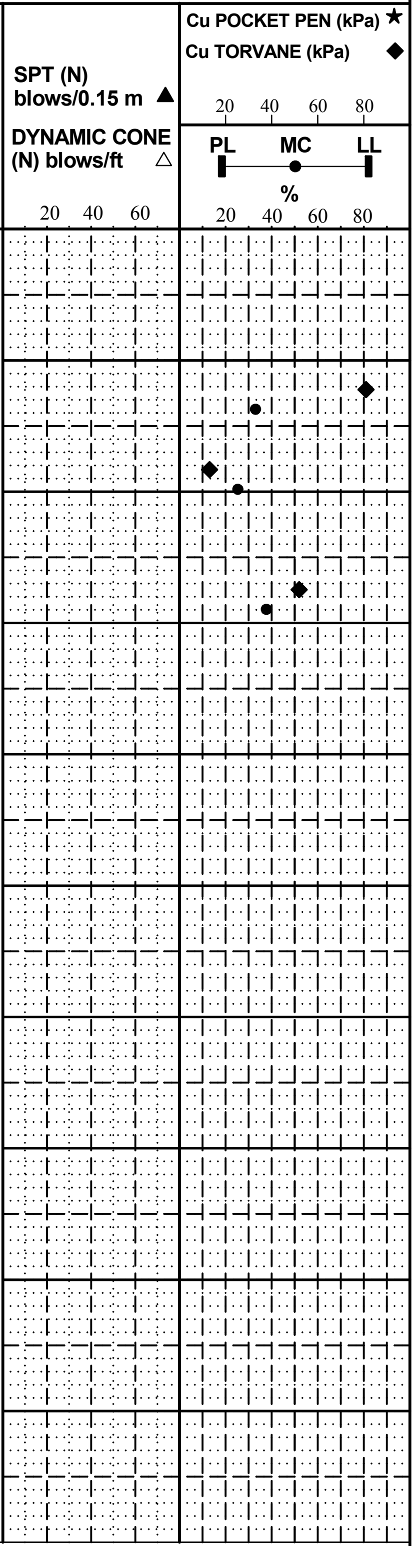
REFERENCE NO.

HOLE NO. **TH13-05**

SHEET 1 of 1

CLIENT	**WINS BRIDGMAN**	JOB NO.	**13-1409-002**
PROJECT	**East Elmwood Community Centre**	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	**480 Keenleyside Street, Winnipeg, MB**	WATER ELEV.	
LOCATION	**Parking Lot**	DATE DRILLED	**8/23/2013**
DRILLING METHOD	**125 mm ø Solid Stem Auger, Truck Mounted ACKER MP8 Drill Rig**	UTM (m)	N **5,530,109** E **638,368**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
	0 – 0.6		<u>SILTY CLAY FILL</u> - Black, dry/damp, crumbly, low plasticity, trace organics/rootlets, some fine to medium grained sand. - Trace fine to coarse grained gravel at 0.15 m.	Auger Grab	S1	
	0.6 – 1.83		<u>SILTY CLAY</u> - Blackish grey, damp, stiff, high plasticity. - Brown, trace silt nodules below 1.22 m.	Auger Grab	S2	
	1.83 – 2.13		<u>SILT</u> - Tan, moist, soft, low plasticity.	Auger Grab	S3	
	2.13 – 3.05		<u>SILTY CLAY</u> - Mottled grey/brown, damp, stiff, high plasticity, trace silt nodules, trace gypsum.	Auger Grab	S4	
	3.05	10	**END OF TESTHOLE AT 3.05 m** Note: 1. Backfilled test hole with auger cuttings.			



SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16

KGS GROUP

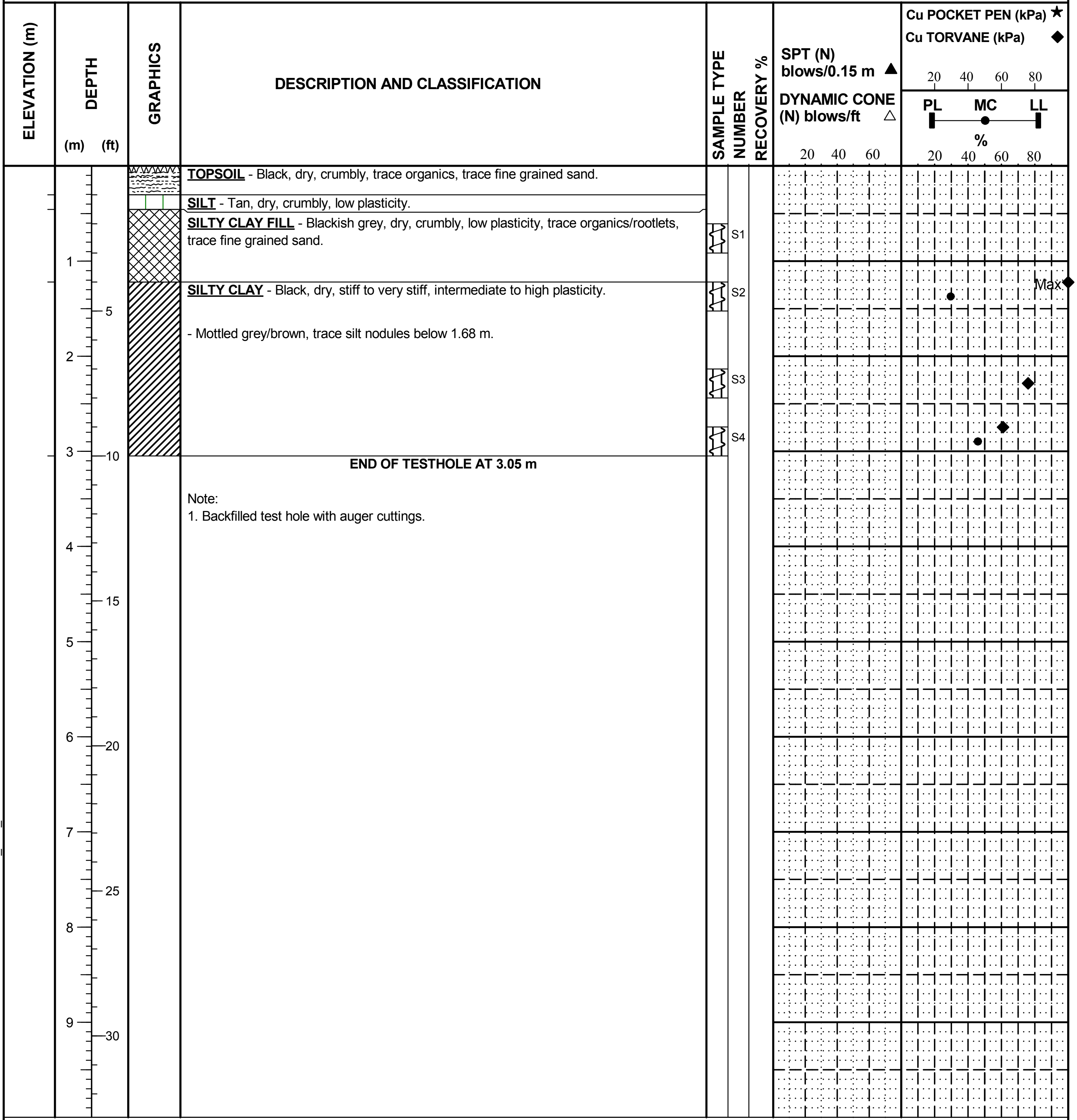
SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH13-06**

SHEET 1 of 1

CLIENT	WINS BRIDGMAN	JOB NO.	13-1409-002
PROJECT	East Elmwood Community Centre	GROUND ELEV.	
SITE	480 Keenleyside Street, Winnipeg, MB	TOP OF CASING ELEV.	
LOCATION	Parking Lot	WATER ELEV.	
DRILLING METHOD	125 mm ø Solid Stem Auger, Truck Mounted ACKER MP8 Drill Rig	DATE DRILLED	8/23/2013
		UTM (m)	N 5,530,109 E 638,419



DESCRIPTION AND CLASSIFICATION

TOPSOIL - Black, dry, crumbly, trace organics, trace fine grained sand.

SILT - Tan, dry, crumbly, low plasticity.

SILTY CLAY FILL - Blackish grey, dry, crumbly, low plasticity, trace organics/rootlets, trace fine grained sand.

SILTY CLAY - Black, dry, stiff to very stiff, intermediate to high plasticity.

- Mottled grey/brown, trace silt nodules below 1.68 m.

END OF TESTHOLE AT 3.05 m

Note:
1. Backfilled test hole with auger cuttings.

SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. BARTZ	B.P. ARPIN	7/13/16