|Kontzamanis|Graumann|Smith|MacMillan|Inc.|

KGS
GROUP
CONSULTING
ENGINEERS

3rd Floor
865 Waverley Street
Winnipeg,
Manitoba
R3T 5P4
204.896.1209
fax: 204.896.0754
www.kgsgroup.com

May 31, 2017

File No. 15-0107-014

City of Winnipeg
Water and Waste Department
Solid Waste Services Division
1120 Waverley Street
Winnipeg, Manitoba
R3T5P4

ATTENTION: Mr. Irvin Slike
Project Manager

RE: Brady Road Resource Management Facility Cell Design and Master Plan Geotechnical Investigation for Leachate Tank Foundation - Final

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Dear Mr. Slike:

This report outlines details of the geotechnical site investigations performed by KGS Group including information on test hole drilling, test pitting, soil sampling, and laboratory testing to be utilized in the foundation design for the leachate storage tank development as part of the Brady Road Resource Management Facility (BRRMF) Master Plan.

1.0 INTRODUCTION

KGS Group was authorized by the City of Winnipeg to undertake a geotechnical investigation to assess the subsurface conditions and provide geotechnical design parameters and recommendations for the foundation structure of the proposed development.

2.0 SCOPE OF SERVICES

The scope of work for the geotechnical engineering services was completed in accordance with KGS Group's proposal dated November 28, 2016, including the following:

Utility and Site Clearances: KGS Group completed all public utility clearances for site access, including identification and locating all underground and overhead utilities prior to commencement of the drilling investigation.

Test Hole Drilling, Test Pitting and Soil Sampling: An on-site drilling program was completed to investigate the subsurface and groundwater conditions at the site. The drilling program consisted of advancing one (1) deep test hole to refusal on till. The test pitting program consisted of excavating four (4) test pits to a maximum depth of 3.0 m (10 ft) below ground surface

Laboratory Soil Testing: Diagnostic laboratory testing including moisture content, Atterberg Limits, and Proctor Density was performed on select soil samples to determine the relevant engineering properties of the foundation soils.

Summary Geotechnical Report: The information provided and/or discussed in this report is detailed below:

- Description of site conditions including soil stratigraphy, sloughing, and seepage conditions.
- Description of the field investigation program including summary of soil sampling and in-situ and laboratory testing results including field Torvane, Standard Penetration Test (SPT), moisture content analyses, Atterberg Limit tests, and Proctor Density.
- Detailed test hole log records incorporating field observations, laboratory test results, and UTM coordinates of the test hole.
- Design parameters for all viable alternatives including estimation of Ultimate Limit State and Serviceability Limit State design values and resistance factors for use in the structural design in accordance with the 2010 National Building Code of Canada.
- Geotechnical design parameters and construction considerations for temporary excavations and slab-on-grade pads including native subgrade preparation, granular base material and thicknesses, as well as compaction levels.
- Considerations for cement type and concrete requirements as they relate to sulphate levels in the existing soil.
- Estimates of freeze – thaw susceptibility and evaluation of potential soil expansion and its effect on foundations and buried structures.

3.0 INVESTIGATION PROGRAM

3.1 TEST HOLE DRILLING AND SAMPLING

A drilling and sampling program consisting of one (1) deep test hole to 15.18 m (50 ft.) was completed on December 21, 2016. Drilling services were provided by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba with continuous KGS Group supervision. The test hole was completed on the approximate location of the proposed leachate storage tank using an Acker track-mounted drill rig equipped with 125 mm diameter solid stem continuous flight augers. The location of the test hole is shown on Figure 1 with the approximate UTM coordinates (Zone 14) provided in Table 1.

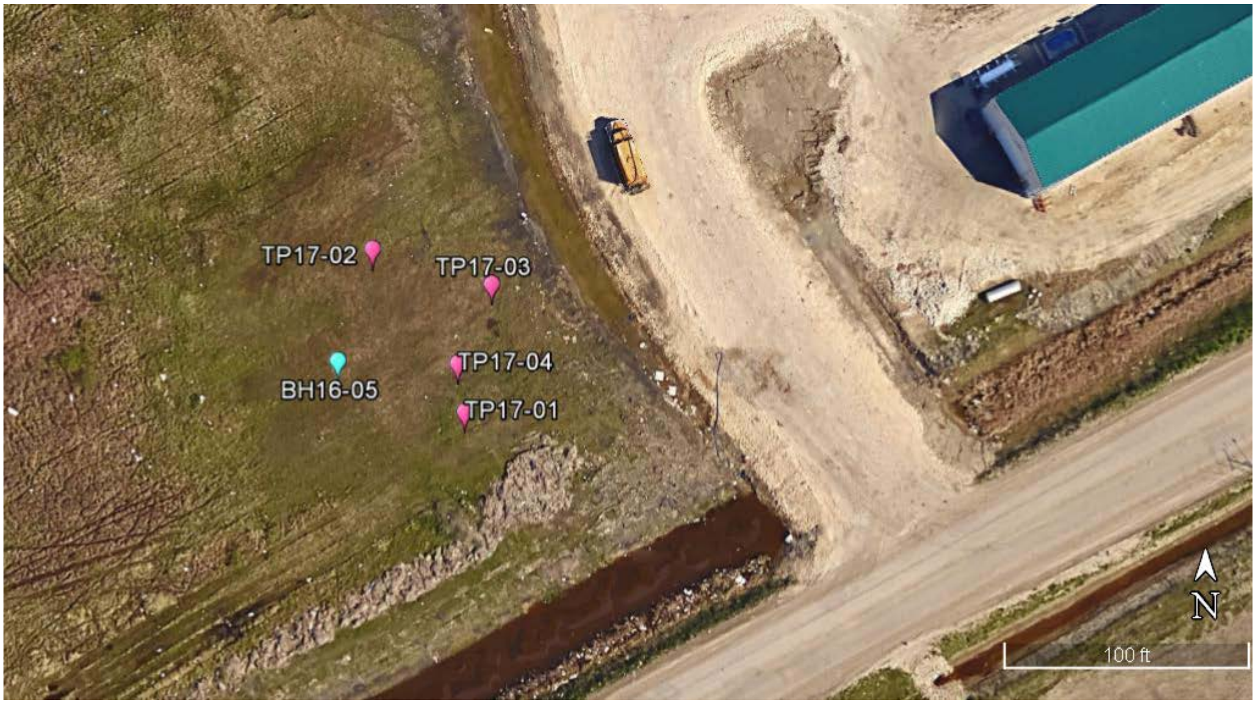
3.2 2017 TEST PITTING AND SAMPLING

A test pitting and sampling program was completed to supplement the test hole drilling and confirm the stratigraphy of the surficial soils on February 17, 2017. Four (4) test pits were excavated using a CAT 324D excavator provided by Hugh Munro Construction Ltd. (HMC) under KGS Group supervision. The test pits were excavated to between 2.6 m to 3.0 m below grade within the approximate location of the proposed leachate storage tank development. The location of the test pits are shown on Figure 1 with the approximate UTM coordinates (Zone 14) provided in Table 1.

TABLE 1
APPROXIMATE TEST HOLE COORDINATES

TEST HOLE / TEST PIT ID	APPROXIMATE UTM COORDINATES	
	NORTHING (m)	EASTING (m)
BH16-05	5,513,310	629,481
TP17-01	5,513,304	629,497
TP17-02	5,513,324	629,485
TP17-03	5,513,320	629,500
TP17-04	5,513,310	629,496

FIGURE 1
TEST HOLE AND TEST PIT LOCATIONS



Representative disturbed soil samples were obtained in test hole BH16-05 and test pits TP17-02 through TP17-04 at 1.5 m (5 ft.) intervals, or at any change in soil strata. Soil samples were collected directly off the auger flights or excavator bucket and visually classified in the field in accordance with the modified Unified Soil Classification System (USCS). Cohesive samples were tested with a field Torvane to evaluate consistency and estimate the undrained shear strength. Standard Penetration Tests (SPTs) were performed in the till to determine the relative in-situ density.

Upon completion of the soil investigation, the test hole and test pits were examined for indications of sloughing and seepage. The test hole was backfilled with bentonite chips to grade while the test pits were backfilled with cuttings to grade. Detailed summary soil logs incorporating all field observations are provided in Appendix A.

3.3 LABORATORY TESTING

A diagnostic laboratory testing program was performed on select representative soil samples to determine the relevant engineering properties of the subsurface soils relative to the foundation design. Diagnostic testing completed included four (4) moisture content tests, two (2) Atterberg Limit tests, and one (1) Proctor Density.

Laboratory testing was completed at a Standards Council of Canada accredited soil testing laboratory in Winnipeg, Manitoba in accordance with ASTM Standards. The results of the laboratory testing are included on the test hole logs in Appendix A.

4.0 INVESTIGATION RESULTS

4.1 SITE STRATIGRAPHY

In general, the stratigraphy at the site has been interpreted by KGS Group to consist of organic clay overlying high plasticity silty clay underlain by glacial silt till deposit.

Topsoil

Topsoil approximately 75 mm thick was encountered at grade in test hole. The topsoil was black in colour, damp, and contained rootlets.

Organic Clay (OH)

Organic clay was encountered below the topsoil to a depth of 1.2 m below existing ground surface. The organic clay was black in colour, damp, stiff in consistency, of high plasticity, contained organics, trace coarse grained sand, and trace rootlets. The undrained shear strength of the clay, as estimated by the Field Torvane, was 60 kPa near the bottom of the layer.

Atterberg Limit testing performed on one sample at 0.9 m measured a Liquid Limit of 82%, Plastic Limit of 25%, and Plasticity Index of 57%, resulting in a USCS classification of OH.

Silty Clay (CH)

Native silty clay of lacustrine origin was encountered below the organic clay from 1.2 m to 12.8 m below existing ground surface. The upper silty clay was brown in colour, damp, firm in consistency, of high plasticity, contained trace silt nodules, and trace fine grained sand nodules. Below a depth of 6.1 m, the silty clay was grey in colour, moist, and soft with decreased silt and sand. Some till inclusions were noted below a depth of 11.9 m and the clay was wet below 12.2 m. The undrained shear strength of the clay, as estimated by the Field Torvane, varied throughout the strata and generally decreased with depth from 45 kPa near the top of the layer to 15 kPa near the bottom.

The moisture content in the silty clay varied between 38% and 53%. Atterberg Limit testing performed on one sample at 6.1 m measured a Liquid Limit of 82%, Plastic Limit of 25%, and Plasticity Index of 57%, resulting in a USCS classification of CH.

Standard Proctor test values for soil compaction were determined using various silty clay samples from BH16-05 and are provided in Appendix A.

Till

Silt till deposit was encountered below the silty clay at a depth of 12.8 m below existing ground surface. Power auger refusal occurred in the till at 15.2 m below existing ground surface.

The silt till was light brown in colour, wet, dense, contained some fine grained sand, and trace course grained sand. Increased coarse grained sand and fine grained gravel were noted below 14.2 m. Uncorrected SPT blow counts (N) within the silt till were greater than 69 blows per 300 mm indicating refusal on suspected boulder or hardpan.

4.2 GROUNDWATER CONDITIONS

Sloughing was observed in BH16-05 below a depth of 14.6 m within the silt till deposit. At the time of investigation, the groundwater depth was measured to be approximately 12.2 m below existing ground surface. Based on previous experience, groundwater levels will fluctuate seasonally and following precipitation events, hence the actual water level at the time of construction could differ from that mentioned in this letter report.

5.0 2017 TEST PIT INVESTIGATION RESULTS

The stratigraphy of the surficial soils at the site has been interpreted to consist of topsoil overlying intermediate plasticity clay, silt, and high plasticity silty clay.

The topsoil thickness varied from 225 mm to 300 mm and was frozen. Beneath the topsoil was brown, stiff silty clay of intermediate plasticity that contained trace organics.

A layer of silt was encountered beneath the silty clay at an approximate depth of 1.5 m down to 2.0 m below grade in TP17-01 through TP17-03. The silt was brown, damp, soft to firm, and of low plasticity. This layer was not originally observed during the 2016 test hole drilling (BH16-05).

The silt was underlain by brown, firm silty clay of high plasticity that was generally consistent with the 2016 test hole drilling.

6.0 FOUNDATION ASSESSMENT

The foundation considerations described in this report follow the Limit States Design (LSD) guidelines. Limit States Design requires consideration of two (2) main loading states: Ultimate Limit States and Serviceability Limit States. The Ultimate Limit States (ULS) are primarily concerned with collapse mechanisms of the structure and safety, and the Serviceability Limits States (SLS) present conditions or mechanism that restrict or constrain the intended use, function or occupancy of the structure under expected service or working loads. For foundation design, Geotechnical Resistance Factors (Φ) are used to evaluate foundation capacity to obtain the Factored Ultimate Limit State (ULS) foundation capacity values. The SLS and ULS capacity values and recommended Geotechnical Resistance Factors (Φ) are presented in the following sections.

6.1 SHALLOW FOUNDATIONS

The proposed leachate storage tank development could be supported by a shallow or mat foundation system directly bearing on the firm silty clay below an approximate depth of 2 m below grade. The shallow foundations can be designed on the basis of the Serviceability Limit State (SLS) and unfactored Ultimate Limit State (ULS) bearing capacity values of 72 kPa and 180 kPa respectively. A recommended Geotechnical Resistance Factor (Φ) of 0.4 is to be applied to the unfactored ULS bearing capacity.

Heaving and/or settlement of a shallow footing or slab-on-grade when founded directly on the expansive clays is always a concern. If the potential slab movement is deemed to be unacceptable a structural floor slab supported by deep foundations should be utilized. Based on our experience, the potential for slab movement can be minimized by limiting the exposure of the in-situ subgrade material to moisture change (drying or wetting) and by placing crushed limestone subbase beneath the concrete slab.

Based on the investigation results, the following is recommended for the construction of a gravel pad mat foundation:

- During preparation of the foundation soils, all deleterious material, such as any organics or silt, should be removed prior to placement of the granular for the pad. The subgrade below the pad should be proof-roll compacted to expose soft spots. In areas that exhibit unsuitable deflection or if unsuitable soils such as organic matter, silts, or soft clay are encountered, they shall be sub-excavated an additional 600 mm, replaced with suitable granular in maximum 200 mm thick lifts for sub-base material, 150 mm thick lifts for base material and compacted to 98% Standard Proctor Maximum Dry Density (SPMDD).

- The contractor must make a conscious effort to protect the finished subgrade surface from excessive moisture change during construction, and promote runoff.

- A light non-woven geotextile separator should be placed between the clay subgrade and compacted granular fill.

- A minimum of 3000 mm thick layer of clean granular sub-base and base material should be placed immediately below the tank foundations. The pad should be comprised of 2000 mm of granular sub-base and 1000 mm of granular base material.

- All granular should be placed in maximum 200 mm thick lifts for sub-base material, 150 mm thick lifts for base material and compacted to 98% SPMDD. Granular base and sub-base materials should meet the City of Winnipeg Standard Material Specifications. Sieve analysis and compaction testing of the granular base and subgrade materials should be conducted by qualified geotechnical personnel to ensure that the material supplied and percent compactions are in accordance with design specification.

- All mechanical services or piping that would be buried within the engineering fill should be designed to accommodate potential slab movement.

- Construction inspection services should be provided by experienced geotechnical personnel during the construction of all foundations and preparation of the subgrade.

6.2 CAST-IN-PLACE DEEP FOUNDATIONS

Cast-in-place deep foundation such as piles may be used to support the proposed tank foundation loads. For design purposes, the upper 2.5 m of pile length potentially exposed to freeze-thaw cycle should be neglected when determining pile capacities. For piles not exposed to freezing the upper 2.0 m of pile length should be neglected. It should be noted that this applies to piles installed in the native silty clay only, and any fill or organic material should be assumed to provide no support.

Friction piles may be designed based upon the estimated Ultimate Limit State (ULS) and Serviceability Limit State (SLS) skin friction values provided on Table 2. A recommended geotechnical resistance factor (Φ) of 0.4 is to be applied to the unfactored ULS values. Piles that are designed to be friction piles should be designed to resist the load by shaft resistance only. The contribution from end bearing should be ignored in the pile capacity calculations.

TABLE 2
SKIN FRICTION VALUES FOR C.I.P. PILES
UNDER COMPRESSIVE LOADING

Depth Below Grade (m)	Serviceability Limit State (SLS) Values (kPa)	Ultimate Limit State (ULS) Values (kPa)
0 to 2.5	0	0
2.5 to 6.0	12.5	32
6.0 to 10.5	8	20

Note: Values apply for piles installed in the native silty clay only and not organic or fill materials.

Piles should have a minimum length of 8 m, with the full depth reinforced to resist frost jacking. Cast-in-place belled end bearing caissons could also be used to support heavier loads. The estimated SLS and unfactored ULS end bearing values for Limit States Design of the caissons are provided in Table 3. A recommended geotechnical resistance factor (Φ) of 0.4 is to be applied to the unfactored ULS values.

TABLE 3
END BEARING VALUES FOR C.I.P. PILES
UNDER COMPRESSIVE LOADING

Depth Below Grade (m)	Serviceability Limit State (SLS) Values (kPa)	Ultimate Limit State (ULS) Values (kPa)
End bearing on Competent Till	185	460

In general, the potential exists for squeezing of the bore hole during the installation of the cast-in-place piles at this site. Temporary steel sleeves should be used as required during pile installation in an effort to maintain the drill shaft in a clean and dry state. The concrete should be poured immediately following the drilling of each shaft. Should heavy groundwater inflow be encountered, concrete placement should be completed using tremie or pump-in methods, or alternatively driven piles should be used if seepage cannot be controlled. Drilling and concrete placement for the piles should be inspected by experienced geotechnical personnel to verify the soil conditions and proper installation of the piles.

7.0 OTHER DESIGN CRITERIA

7.1 TEMPORARY CONSTRUCTION EXCAVATIONS AND SHORING

If excavation is to be performed adjacent to existing structures, temporary shoring or bracing will be required. Suitable options include steel piling and timber lagging or driven steel sheet piling. Any excavation deeper than 1.5 m should be reviewed and designed prior to construction by an experienced professional engineer with an expertise in geotechnical engineering.

The high plasticity soils encountered at the site may be susceptible to swelling and sloughing from wetting. All open excavation side slopes should be covered to prevent saturation of the soil and all surface runoff should be directed away from excavations. All surcharge loads such as stockpiled soil, equipment, etc. should be kept a minimum of 10 m away from the edge of excavations.

There may potentially be localized groundwater infiltration into an excavation below the water table, which may require temporary pumping as well as potential shoring. Design of the above measures depends on the size, depth and extent of the excavation.

7.2 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. Surficial soils at this site consisted of silty clay and organic clay.

The expected depth of frost penetration has been estimated assuming a design freezing index of 2680^{o}C days, taken as the coldest winter over a ten (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 must be considered in the foundation design. Positive 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 fine grained silt and clay materials. Polystyrene insulation can be used as a thermal insulator to minimize any effects that frost could potentially have on foundations or slabs.

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.

7.3 TYPE OF CEMENT FOR CONCRETE MIX

All concrete should be made with high sulphate-resistant cement (HS or HSb), and all cast-in-place piles and pile caps should have a minimum specified 28 day compressive strength of 35 MPa and class of exposure of S-1 corresponding to very severe sulphate attack. 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 4, CSA A23.1-04.

7.4 SITE SURFACE DRAINAGE

Exterior grades adjacent to all buildings and retaining walls 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.

7.5 SETTLEMENT OF FOUNDATION SOILS

Given that the observed foundation soils at the site range from firm to soft silty clay and an estimated surcharge from the leachate tank of 100 kPa, the potential long term vertical movement of the foundation soils may be up to 100 mm. Heaving and settlement of the foundation soils may vary across the footprint of the foundation producing differential settlements depending on seasonal and groundwater conditions.

8.0 CONCLUSIONS

Based on the geotechnical field investigation and foundation assessment the following conclusions are made:

- In general, the stratigraphy at the site has been interpreted by KGS Group to consist of organic clay overlying high plasticity clay underlain by silt till. Power auger refusal occurred in the silt till at a depth of 15.18 m below grade.
- The clays are of high plasticity and are classified as being highly expansive in nature meaning the clays may swell (heave) or shrink (settle) in response to changes in either the effective stress state or to changes in moisture content.
- The groundwater level was observed in the test hole at 12.19 m below existing ground surface immediately upon completion of drilling. Based on previous experience the actual water level may be higher at the time of construction.
- Viable foundation alternatives for the proposed leachate storage tank development include a gravel pad mat foundation, cast-in-place friction piles, and cast-in-place straight shaft or belled end bearing piles developing their capacity in the underlying till.
- The expected depth of frost penetration has been estimated assuming a design freezing index of 2680°C days, taken as the coldest winter over a ten (10) year period. The estimated maximum depth of frost penetration is 2.5 m assuming no insulation cover.

- The potential long term movement of the leachate tank may be up to 100 mm depending on seasonal and groundwater conditions. Differential settlements are anticipated across the foundation footprint given the expansive nature of the silty clay foundation soils.

9.0 RECOMMENDATIONS

Based on the geotechnical field investigation and foundation assessment the following recommendations are made:

- The organic clay and silt observed within the top 2 m at the site are not suitable subgrade material and should be removed beneath the tank development foundations.
- A shallow or mat foundation can be designed on the basis of the unfactored Serviceability Limit State (SLS) and Ultimate Limit State (ULS) bearing capacity values of 72 kPa and 180 kPa. A recommended geotechnical resistance factor (Φ) of 0.4 is to be applied to the unfactored ULS values.
- Cast-in-place piles founded on competent till can be assigned an unfactored Ultimate Limit State (ULS) end bearing capacity of 460 kPa. The native silty clay may be assigned an unfactored ULS skin friction of 35 kPa from a depth of 2.5 m to 6.1 m and 20 kPa below a depth of 6.1 m. A recommended geotechnical resistance factor (Φ) of 0.4 is to be applied to the unfactored ULS values.
- For friction piles exposed to frost, the upper 2.5 m should be neglected throughout the depth of frost penetration.
- For end bearing piles on competent till, the elevation of the base of the pile must be selected such that it is at least 500 mm into the competent till to ensure that the desired capacities can be developed.
- It is recommended that all concrete foundations in contact with native soils utilize sulfate resistant cement CSA Type HS.
- Polystyrene insulation can be used as a thermal insulator on the foundations to minimize the effects that frost could potentially have on the foundations.
- It is recommended that water lines be buried to a depth consistent with generally accepted local practice to reduce the risk of freezing. Shallower lines can be protected using heat trace or closed cell extruded polystyrene insulation. Mechanical services or piping buried within engineered fill should be designed to accommodate movement from freeze-thaw cycles and potential foundation settlement.
- Inspection by qualified geotechnical personnel should be performed throughout the construction of foundations, and in particular for determining the quality and competency of the subgrade.

10.0 STATEMENT OF LIMITATIONS AND CONDITIONS

THIRD PARTY USE OF REPORT

This report has been prepared for the City of Winnipeg and 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 this site. 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, this office should be notified in order that the recommendations can be reviewed and modified if necessary.

Prepared By:

Andrew Chan, B.Sc., E.I.T.
Geotechnical Engineer-in-Training

Reviewed By:

David Anderson, M.Sc., P.Eng
Geotechnical Engineer

PROVINCE OF MANITOBA
May 31/17
D.E.S.
ANDERSON
Member
22316
REGISTERED PROFESSIONAL ENGINEER

Approved By:

Dami Adedapo, Ph.D., P.Eng.
Geotechnical Department Head

AKC/aa
Enclosure / Attachment
cc: Tony Kuluk, Mario Poveda

APPENDIX A

2016 KGS GROUP TEST HOLE LOGS AND DIAGNOSTIC TESTING RESULT

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **BH16-05**

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	15-0107-014
PROJECT	BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	BRRMF	WATER ELEV.	
LOCATION	APPROX. WEST EDGE OF LEACHATE TANK FOOTPRINT	DATE DRILLED	21/12/2016
DRILLING METHOD	125 mm ø Solid Stem Auger, ACKER Track Mounted Rig	UTM (m)	N 5,513,310 E 629,481

ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY %

TOPSOIL - Black, damp, rootlets.

ORGANIC CLAY (OH) - Black, damp, stiff, high plasticity, trace coarse grained sand, trace rootlets, and organics.

SILTY CLAY (CH) - Brown, damp, firm, high plasticity, trace silt nodules, trace fine grained sand nodules.

- Grey, moist, soft, no silt nodules, decreased fine grained sand nodules below 6.10 m.

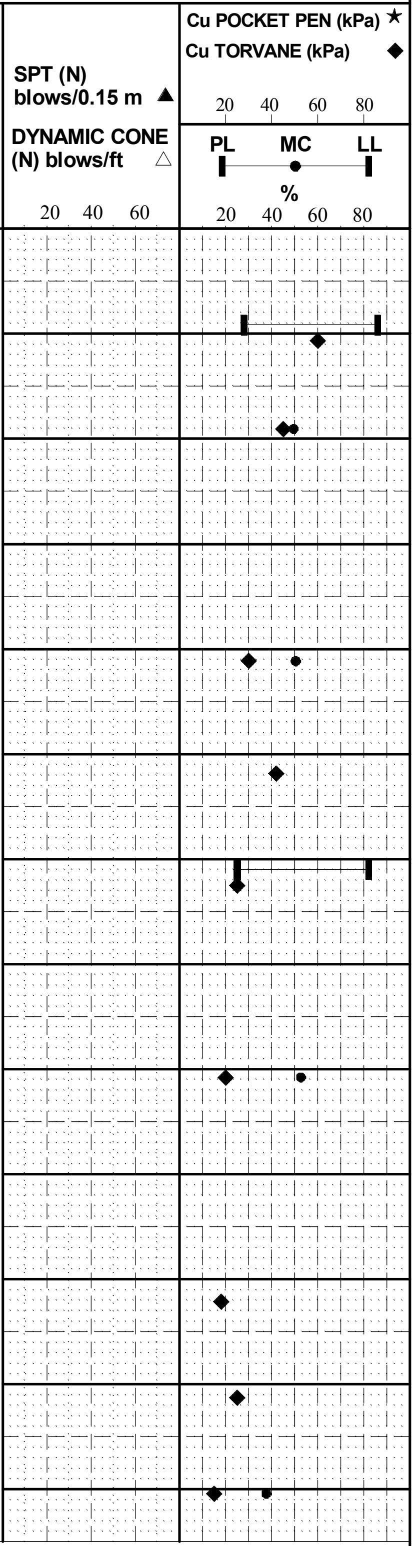
- Trace fine grained gravel below 10.97 m.

- Some till inclusions below 11.89 m.

- Wet below 12.19 m.

Depth (m)	Sample Type	Number
1	Auger Grab	S1
2	Auger Grab	S2
4	Auger Grab	S3
5	Auger Grab	S4
6	Auger Grab	S5
8	Auger Grab	S6
10	Auger Grab	S7
11	Auger Grab	S8
12	Auger Grab	S9

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 (m); 5, 10, 15, 20, 25, 30, 35, 40 (ft)



SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	L. CHALMERS	DEA	29/5/17

GEOTECHNICAL-SOIL LOG U:\FMS\15-0107-014\BRADY DUMP.GPJ

KGS GROUP

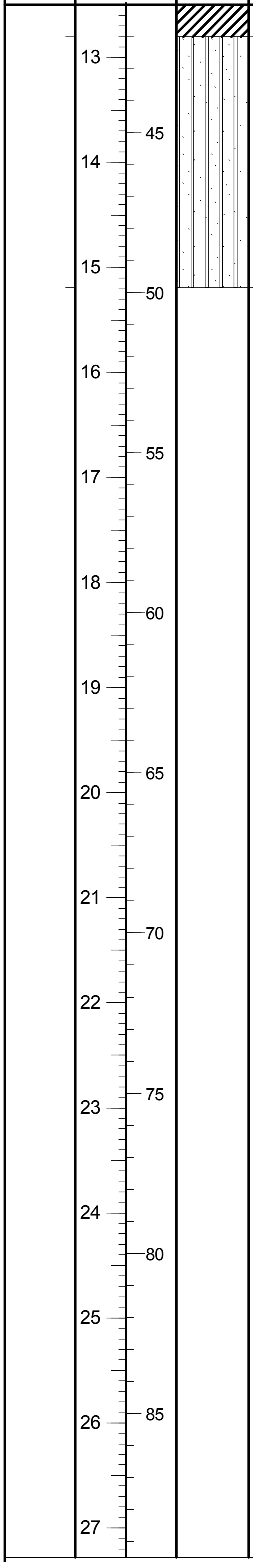
SUMMARY LOG

REFERENCE NO.

HOLE NO.
BH16-05

SHEET 2 of 2

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 %



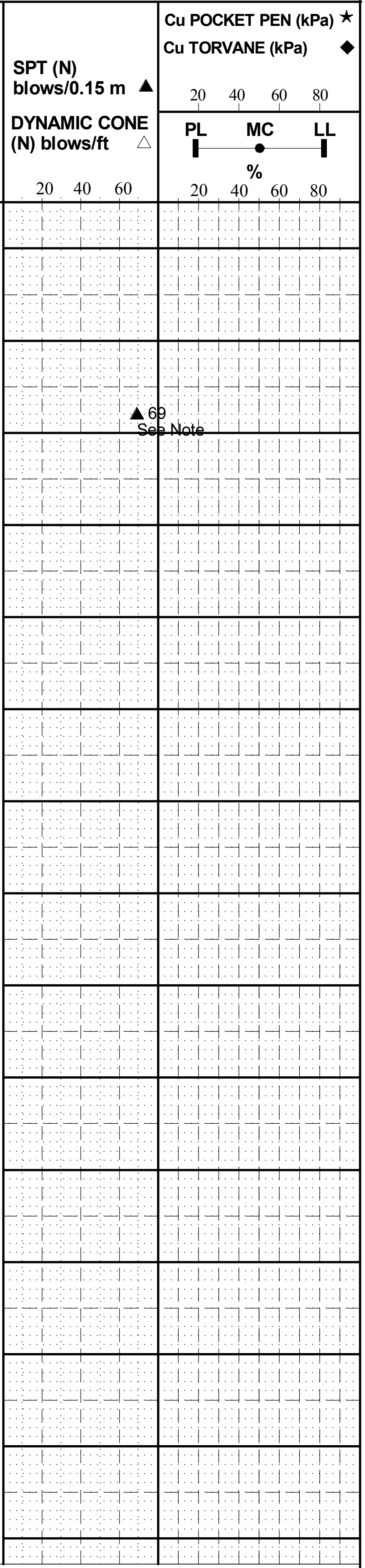
SILT TILL - Light brown, wet, stiff, intermediate plasticity, some fine grained sand, trace coarse grained sand. S10

- Increased coarse grained sand and fine grained gravel below 14.17 m. S11

S12

REFUSAL AT 15.18 m

Notes:
1. Split spoon refused within first 150 mm set of SPT.
2. Borehole open to 14.63 m upon completion of drilling.
3. Water at 12.19 upon completion of drilling.
4. Borehole backfilled with bentonite to grade.
5. Proctor density test performed on silty clay material from samples obtained between 0.91 m and 11.89 m.



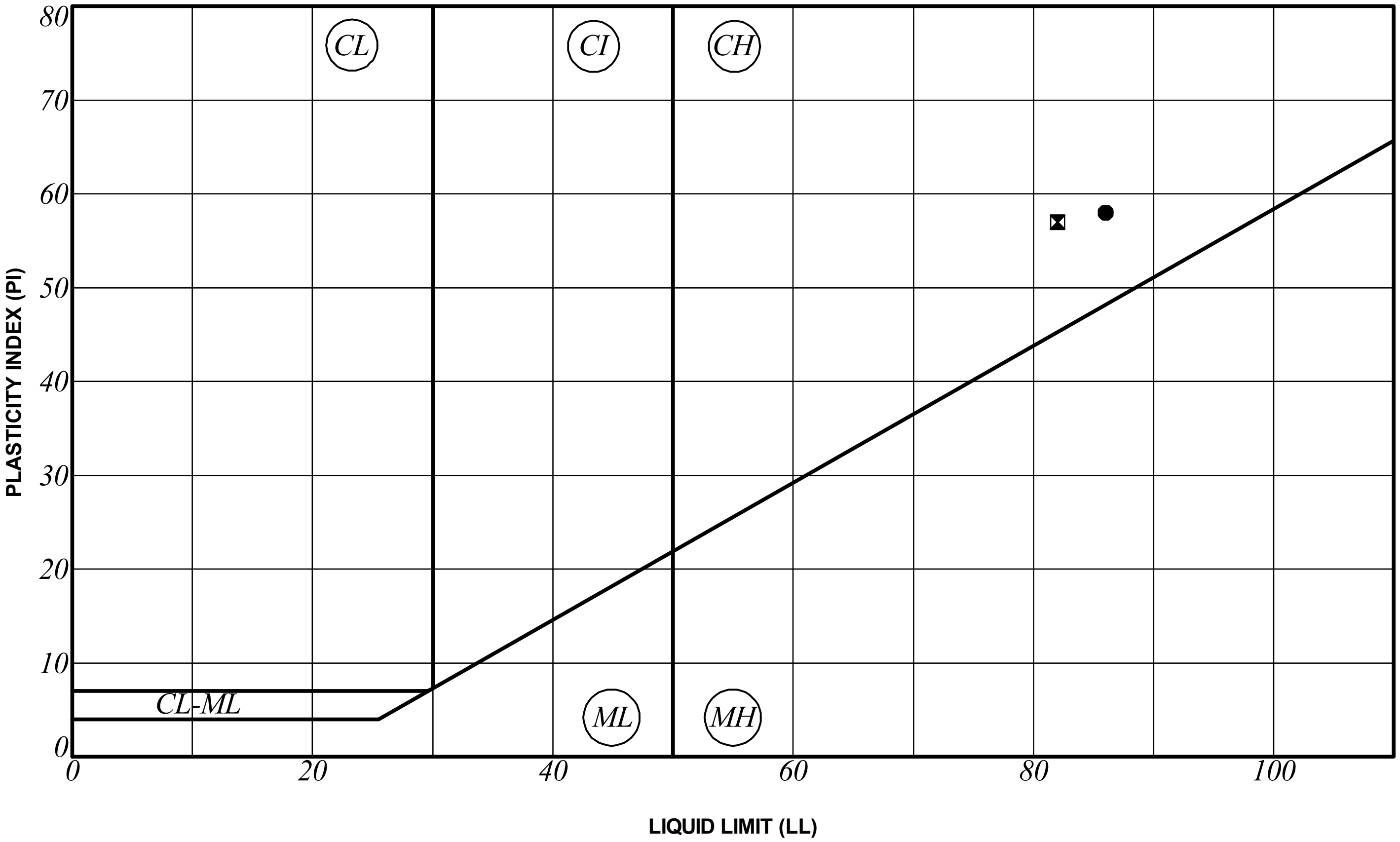
SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
L. CHALMERS

APPROVED
DEA

DATE
29/5/17



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	BH16-05	0.9	S1	86	28	58					CH
☒	BH16-05	6.1	S5	82	25	57					CH

A-LINE PLOT U:\FMS15-0107-014\BRADY DUMP.GPJ

Notes:
ML - Low Plasticity Silt
MH - High Plasticity Silt
CL-ML - Silty Clay
CL - Low Plasticity Clay
CI - Intermediate Plasticity Clay
CH - High Plasticity Clay
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
MC - Moisture Content
NP - Non-Plastic

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN

A-LINE PLOT

February 2017	**Figure A**	**Page 1 of 1**

Stantec
199 Henlow Bay
Winnipeg, Manitoba
R3Y 1G4
Tel: (204) 488-6999

CERTIFIED BY
CCIL
Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

PROCTOR TEST REPORT

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

ATTN: Mario Poveda

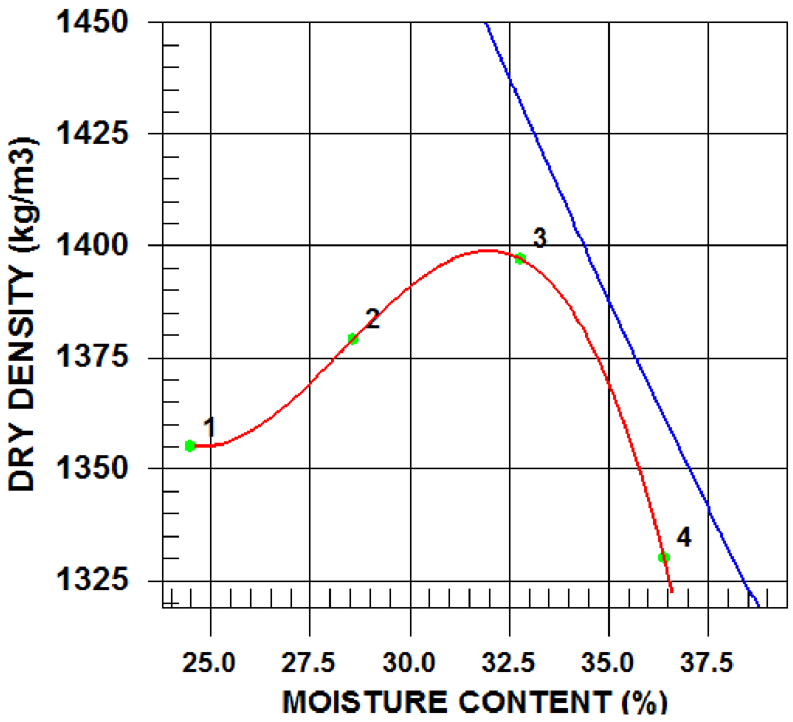
CLIENT KGS Group Inc.
C.C.

PROJECT Brady Dump (15-0107-14)

PROJECT NO. 123312923
PROCTOR NO. 1
DATE SAMPLED 2017.Jan.05
DATE RECEIVED 2017.Jan.06
DATE TESTED 2017.Jan.12

INSITU MOISTURE 49.5 %
TESTED BY Pervez Safdar
MATERIAL IDENTIFICATION
MATERIAL USE
MAX. NOMINAL SIZE
MATERIAL TYPE Silty Clay
SUPPLIER
SOURCE Test Hole BH16-05

COMPACTION STANDARD Standard Proctor, ASTM D698
COMPACTION PROCEDURE A: 101.6mm Mold, Passing 4.75mm
RAMMER TYPE Manual
PREPARATION Moist
OVERSIZE CORRECTION METHOD None
RETAINED 4.75mm SCREEN



TRIAL NUMBER	WET DENSITY (kg/m3)	DRY DENSITY (kg/m3)	MOISTURE CONTENT (%)
1	1687	1355	24.5
2	1773	1379	28.6
3	1855	1397	32.8
4	1814	1330	36.4

	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED	1400	32.0
OVERSIZE CORRECTED		

COMMENTS
Material tested was composite sample of materials obtained from test hole BH16-05, sample nos. S1 to S3, S5, S6 & S9, taken at depths of 3 to 39 feet.

REVIEWED BY Jason Thompson, C.E.T.

KGS GROUP

SUMMARY LOG

REFERENCE NO.

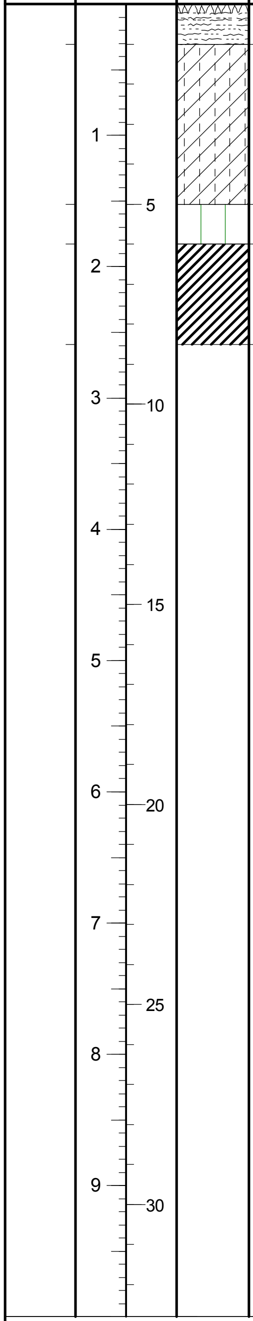
HOLE NO.
TP17-01

SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE BRRMF
LOCATION APPROX. SOUTH EDGE OF LEACHATE TANK FOOTPRINT
DRILLING METHOD CAT 324D Excavator, Toothed Bucket

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 16/02/2017
UTM (m) N 5,513,304
E 629,497

ELEVATION (m)	DEPTH (m) (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



TOPSOIL - Black, frozen, rootlets.
- Damp, not frozen below 0.1 m.

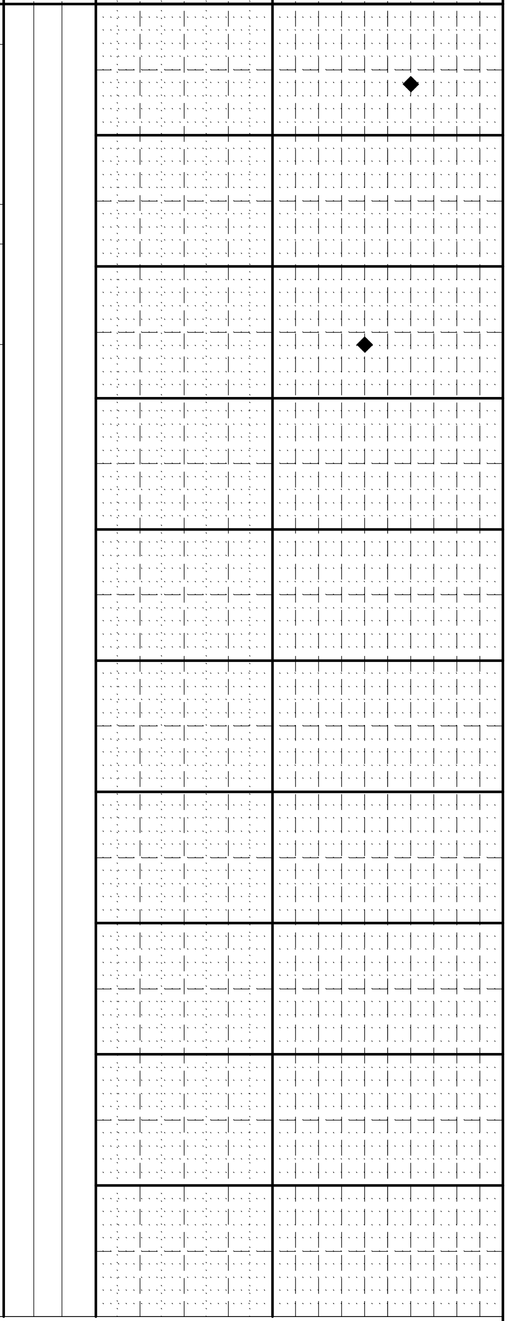
SILTY CLAY - Brown, damp, stiff, intermediate plasticity, trace organics, trace rootlets, trace oxidation.

SILT - Brown, damp, soft to firm, low plasticity, trace clay.

SILTY CLAY (CH) - Brown, damp to moist, firm, high plasticity, trace silt inclusions.

END OF TEST PIT AT 2.6 m.

Notes:
1. Test pit bottom dry upon completion.
2. Backfilled test pit with cuttings to grade.



SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
HMC	K. FORDYCE	DEA	29/5/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

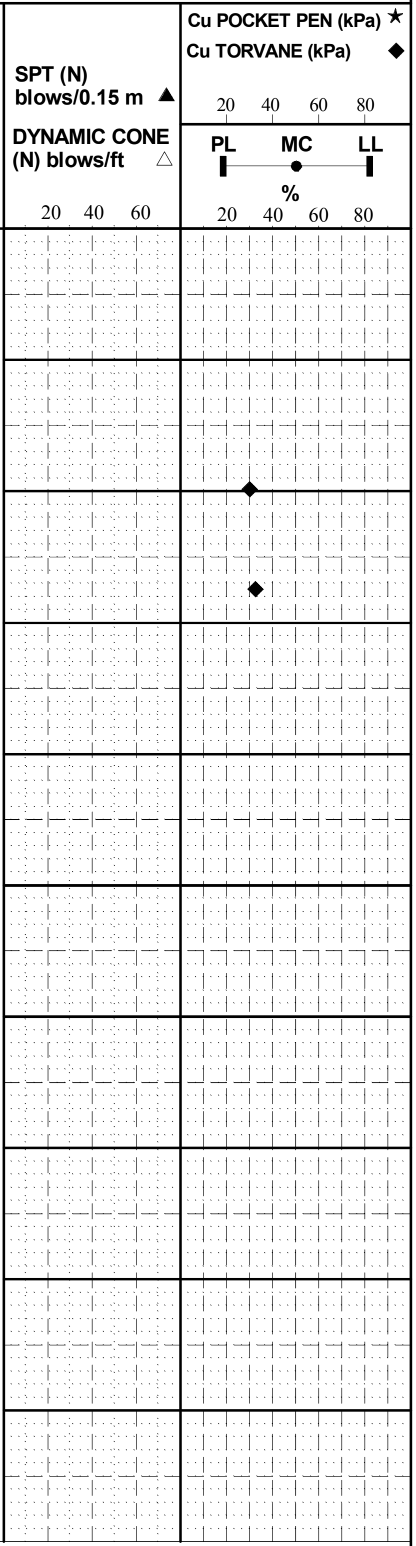
HOLE NO. **TP17-02**

SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE BRRMF
LOCATION APPROX. NORTH EDGE OF LEACHATE TANK FOOTPRINT
DRILLING METHOD CAT 324D Excavator, Toothed Bucket

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 16/02/2017
UTM (m) N 5,513,324
E 629,485

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
				TOPSOIL - Black, frozen, rootlets.	⧓	S01	
				SILTY CLAY - Brown, damp, stiff, intermediate plasticity.			
	1						
		5					
				SILT - Brown, damp, soft, low plasticity.			
	2			**SILTY CLAY (CH)** - Brown, damp to moist, firm, high plasticity, trace silt inclusions, trace gypsum inclusions.	⧓	S02	
				END OF TEST PIT AT 2.7 m.			
	3	10		Notes: 1. Test pit bottom dry upon completion. 2. Backfilled test pit with cuttings to grade.			
	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					



SAMPLE TYPE ⧓ Grab from Bucket

CONTRACTOR	INSPECTOR	APPROVED	DATE
HMC	K. FORDYCE	DEA	29/5/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TP17-03**

SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN

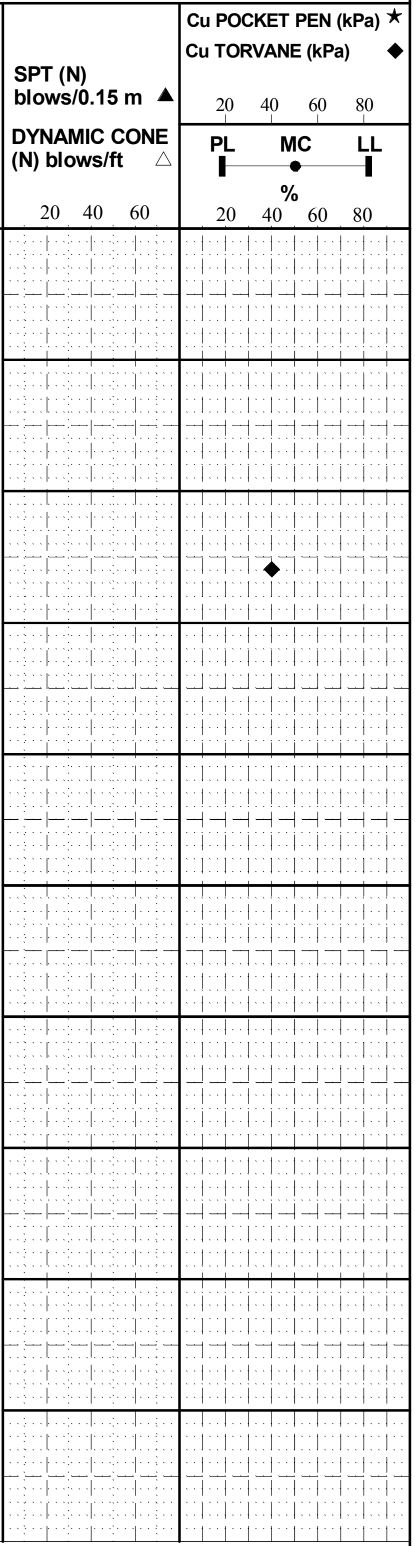
SITE BRRMF

LOCATION APPROX. EAST EDGE OF LEACHATE TANK FOOTPRINT, NEW MANHOLE LOCATION

DRILLING METHOD CAT 324D Excavator, Toothed Bucket

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 16/02/2017
UTM (m) N 5,513,320
E 629,500

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
				TOPSOIL - Black, frozen, rootlets.			
	1			**SILTY CLAY** - Brown, damp, stiff, intermediate plasticity, trace silt, trace organics, trace rootlets.	⧗	S01	
		5		**SILT** - Brown, damp, soft to firm, low plasticity.	⧗	S02	
	2			**SILTY CLAY (CH)** - Brown, damp to moist, firm, high plasticity, trace silt inclusions, trace gypsum inclusions.	⧗	S03	
				END OF TEST PIT AT 2.6 m.			
	3	10		Notes: 1. Test pit bottom dry upon completion. 2. Backfilled test pit with cuttings to grade.			
	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					



SAMPLE TYPE ⧗ Grab from Bucket

CONTRACTOR **HMC**

INSPECTOR K. FORDYCE

APPROVED DEA

DATE 29/5/17

KGS GROUP

SUMMARY LOG

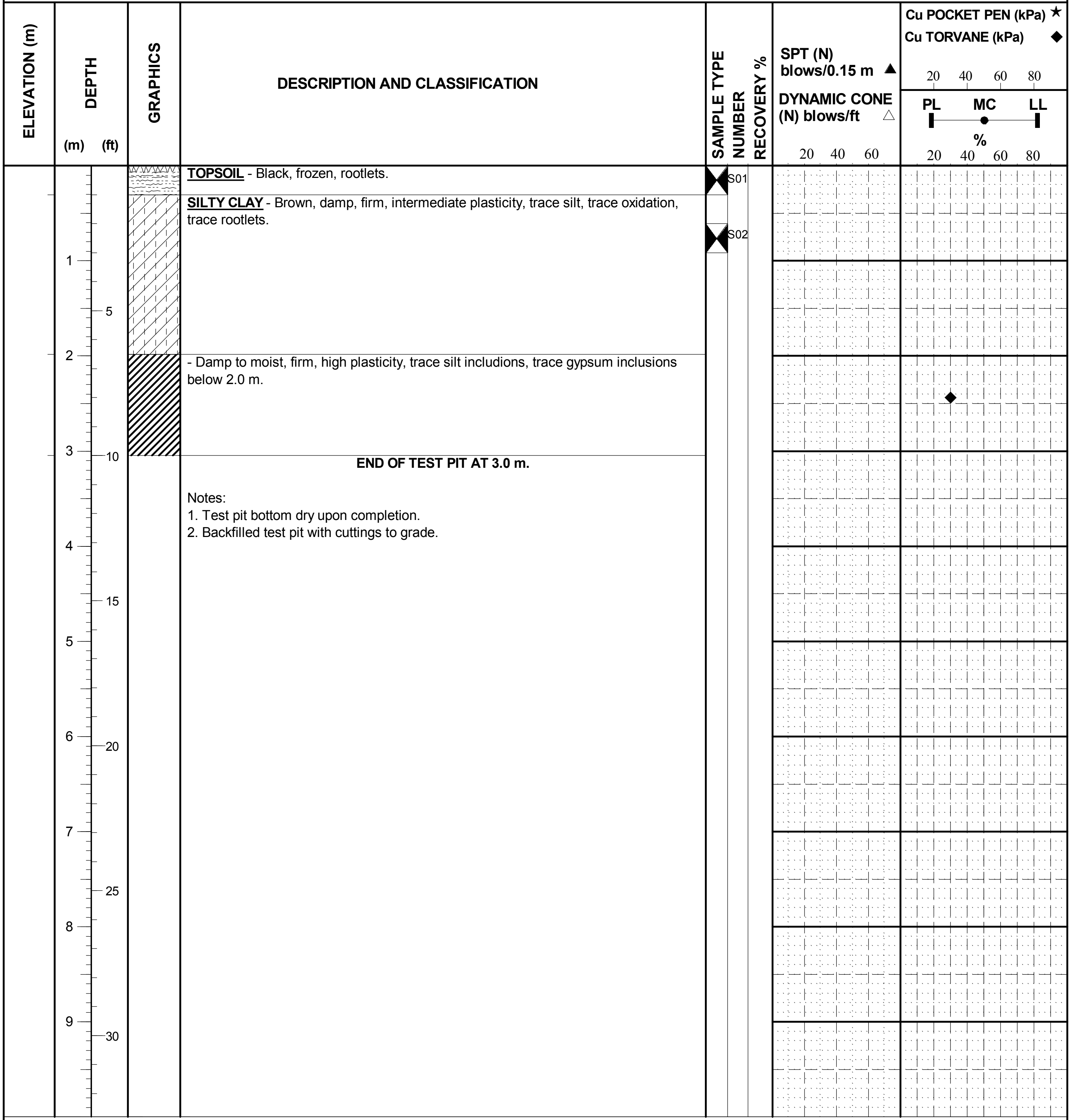
REFERENCE NO.

HOLE NO. **TP17-04**

SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE BRRMF
LOCATION TOWARDS CENTER OF LEACHATE TANK FOOTPRINT
DRILLING METHOD CAT 324D Excavator, Toothed Bucket

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 16/02/2017
UTM (m) N 5,513,310
E 629,496



TOPSOIL - Black, frozen, rootlets.

SILTY CLAY - Brown, damp, firm, intermediate plasticity, trace silt, trace oxidation, trace rootlets.

- Damp to moist, firm, high plasticity, trace silt includions, trace gypsum inclusions below 2.0 m.

END OF TEST PIT AT 3.0 m.

Notes:
1. Test pit bottom dry upon completion.
2. Backfilled test pit with cuttings to grade.

SAMPLE TYPE ⧓ Grab from Bucket

CONTRACTOR	INSPECTOR	APPROVED	DATE
HMC	K. FORDYCE	DEA	29/5/17

KGS GROUP

SUMMARY LOG

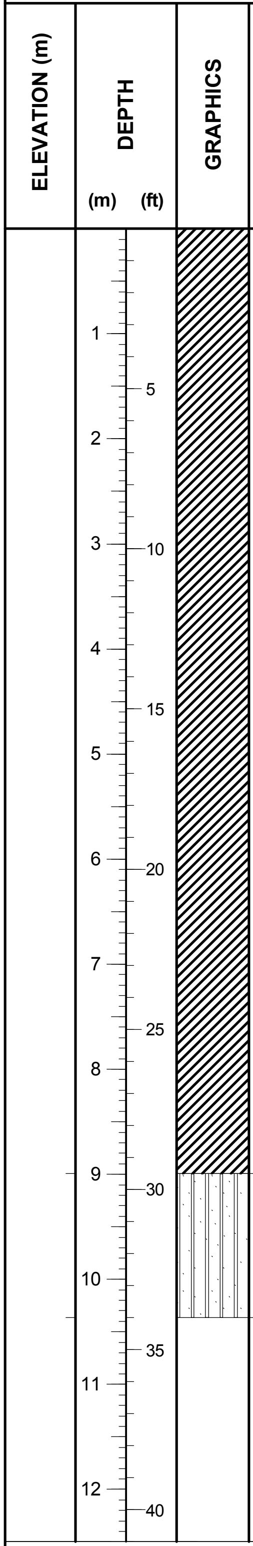
REFERENCE NO.

HOLE NO. **BH16-01**

SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE BRRMF
LOCATION SW CORNER OF CELL 31 IN EXCAVATED AREA
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER Track Mounted Rig

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 21/12/2016
UTM (m) N 5,513,810
E 629,491



DESCRIPTION AND CLASSIFICATION

SILTY CLAY (CH) - Brown, damp, firm, high plasticity, trace fine grained sand nodules.

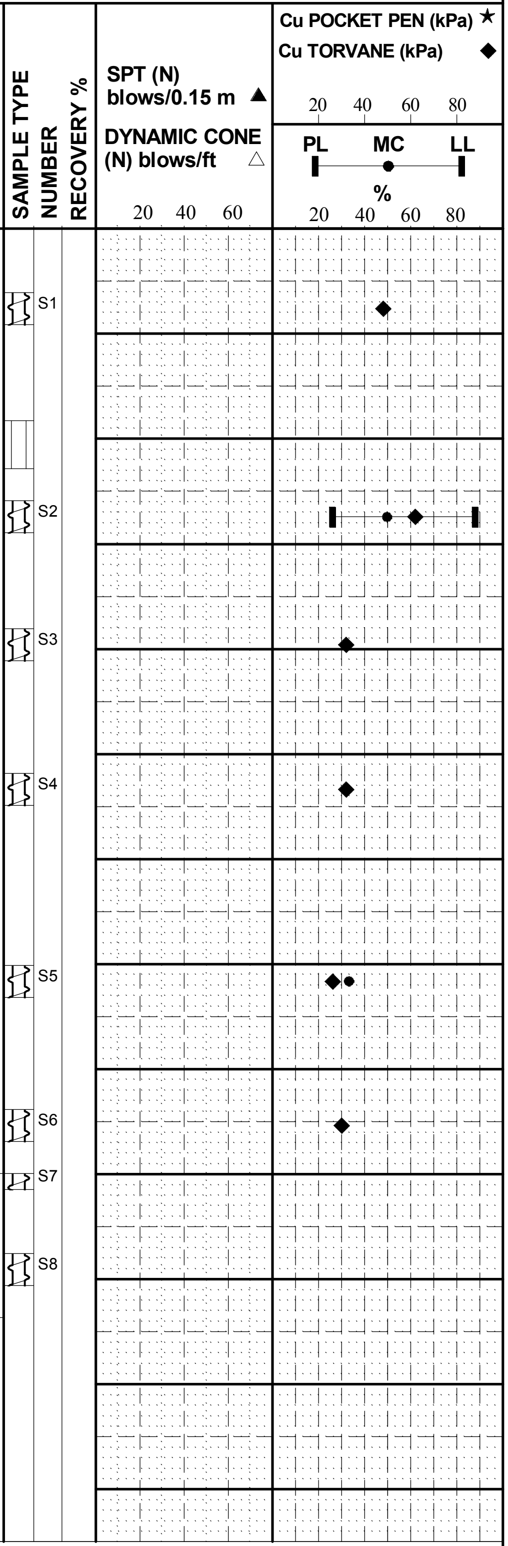
- Hydraulic Conductivity Test at approx. 2 m: 2.9E-08 cm/s
- Trace silt pockets below 2.28 m.
- Grain Size Analysis at 2.59 m: Gravel (0%), Sand (0.7%), Silt (26.5%), Clay (72.8%).
- Grey, moist, no silt nodules, decreasing fine grained sand nodules below 3.05 m.
- Increasing sand nodules below 8.23 m.

SILT TILL - Light brown, moist, stiff, intermediate plasticity, some fine grained sand, trace coarse grained sand, trace fine grained gravel.

- Increasing fine to medium grained gravel.

REFUSAL AT 10.36 m

Notes:
1. Borehole open to 10.36 m upon completion of drilling.
2. Borehole dry upon completion of drilling.
3. Borehole backfilled with grout to grade.



SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	L. CHALMERS	DEA	29/5/17

KGS GROUP

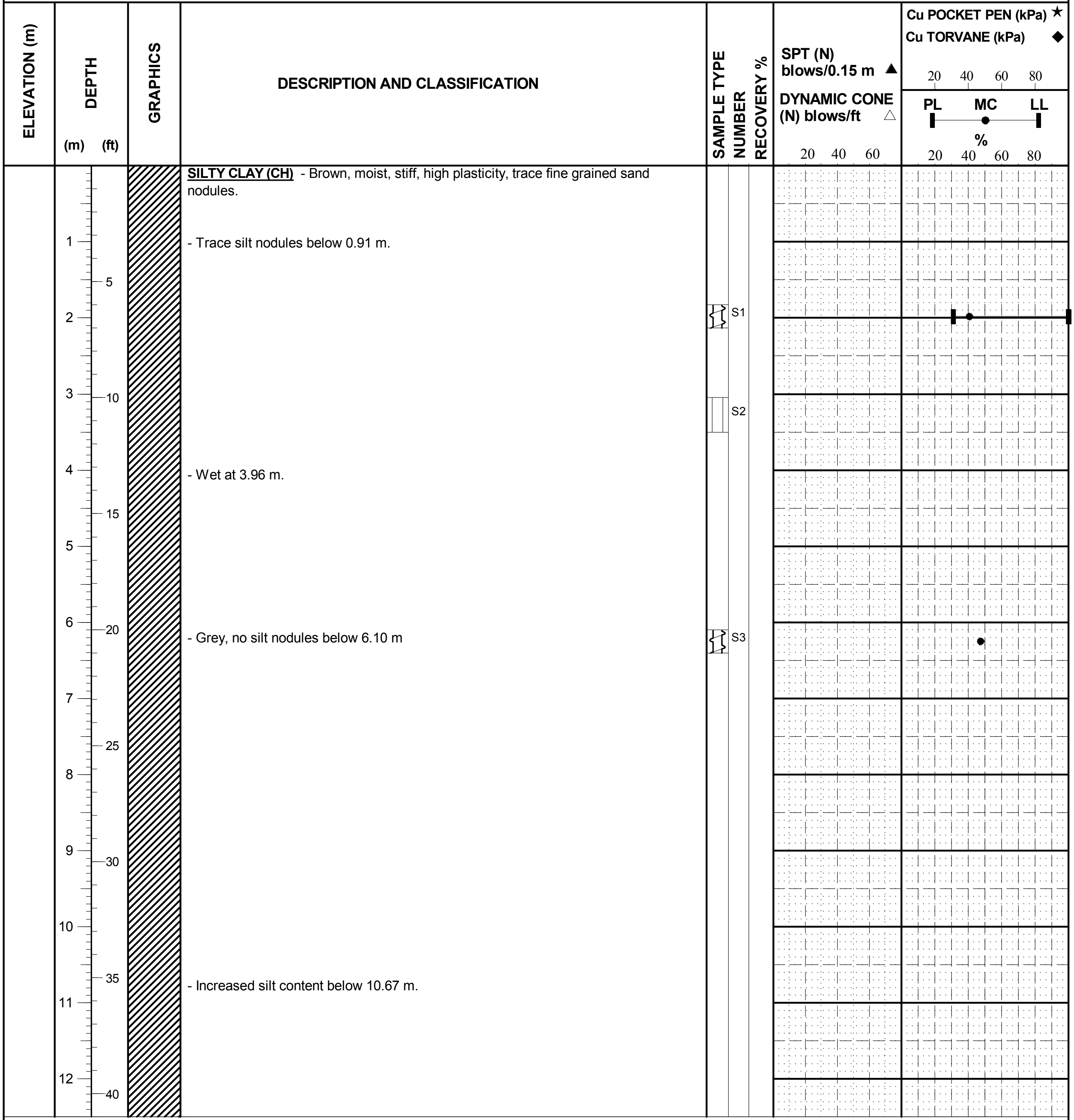
SUMMARY LOG

REFERENCE NO.

HOLE NO.
BH16-02

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	15-0107-014
PROJECT	BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	BRRMF	WATER ELEV.	
LOCATION	SE OF CELL 31	DATE DRILLED	22/12/2016
DRILLING METHOD	125 mm ø Solid Stem Auger, ACKER Track Mounted Rig	UTM (m)	N 5,513,764 E 629,611



SILTY CLAY (CH) - Brown, moist, stiff, high plasticity, trace fine grained sand nodules.

- Trace silt nodules below 0.91 m.

- Wet at 3.96 m.

- Grey, no silt nodules below 6.10 m

- Increased silt content below 10.67 m.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. THIESSEN	DEA	29/5/17

SUMMARY LOG

REFERENCE NO.

HOLE NO.
BH16-02

SHEET 2 of 2

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
	13			**SILT TILL** - Light brown, damp, stiff, intermediate plasticity, some fine grained sand, trace coarse grained sand, trace fine grained gravel.					
		45							
	14			**REFUSAL AT 14.02 m** Notes: 1. Borehole open to 14.02 m upon completion of drilling. 2. Water level not measured upon completion of drilling. 3. Borehole backfilled with grout to grade.					
	15								
		50							
	16								
		55							
	17								
	18								
		60							
	19								
		65							
	20								
	21								
		70							
	22								
		75							
	23								
	24								
		80							
	25								
		85							
	26								
	27								

SAMPLE TYPE ▨ Auger Grab ▥ Shelby Tube

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. THIESSEN	DEA	29/5/17

KGS GROUP

SUMMARY LOG

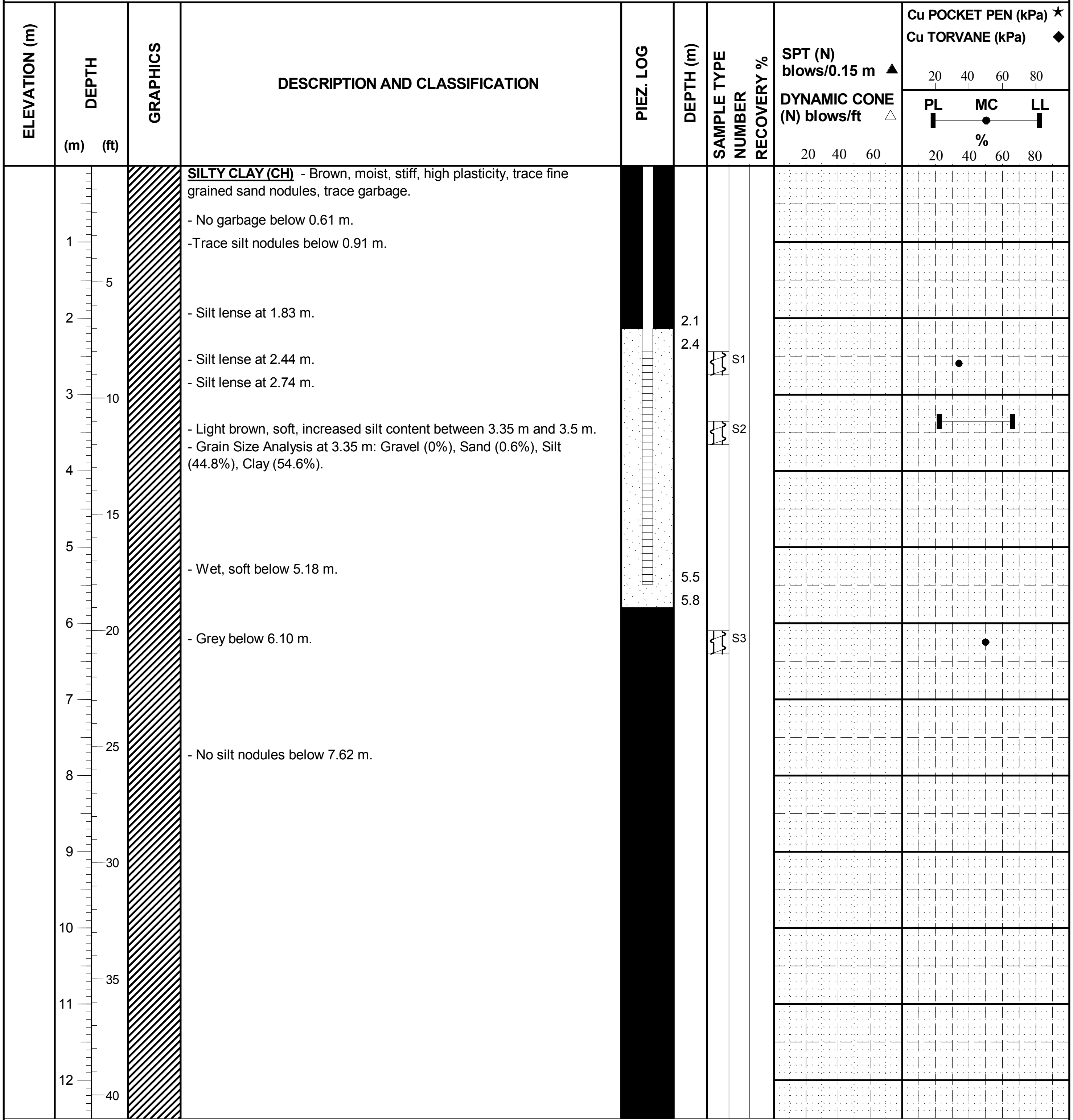
REFERENCE NO.

HOLE NO.
BH16-03

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE BRRMF
LOCATION BENCH AREA, N OF LEACHATE POND
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER Track Mounted Rig

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 22/12/2016
UTM (m) N 5,513,647
E 629,665



SILTY CLAY (CH) - Brown, moist, stiff, high plasticity, trace fine grained sand nodules, trace garbage.

- No garbage below 0.61 m.

-Trace silt nodules below 0.91 m.

- Silt lense at 1.83 m.

- Silt lense at 2.44 m.

- Silt lense at 2.74 m.

- Light brown, soft, increased silt content between 3.35 m and 3.5 m.

- Grain Size Analysis at 3.35 m: Gravel (0%), Sand (0.6%), Silt (44.8%), Clay (54.6%).

- Wet, soft below 5.18 m.

- Grey below 6.10 m.

- No silt nodules below 7.62 m.

SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. THIESSEN	DEA	29/5/17

SUMMARY LOG

REFERENCE NO.

HOLE NO.
BH16-03

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 △ 20 40 60	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆ 20 40 60 80 PL MC LL % 20 40 60 80
	13 45	▨		■						
	14		**SILT TILL** - Light brown, damp, stiff, intermediate plasticity, some fine grained sand, trace coarse grained sand, trace fine grained gravel.	■						
	15 50		**REFUSAL AT 15.24 m**	■	15.2					
	16 17 55 18 60 19 20 65 21 70 22 23 75 24 80 25 26 85 27		Notes: 1. Borehole open to 15.24 m upon completion of drilling. 2. Water level not measured upon completion of drilling. 3. Installed a monitoring well to a depth of 5.49 m below grade, slotted from 5.49 m to 2.44 m, with a 0.61 m stickup above grade. Above ground casing installed. 4. Backfilled borehole with bentonite from 15.24 m to 5.79 m, silica sand from 5.79 m to 2.13 m, and bentonite from 2.13 m to grade. 5. Installed an above ground casing.							

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. THIESSEN	DEA	29/5/17

KGS GROUP

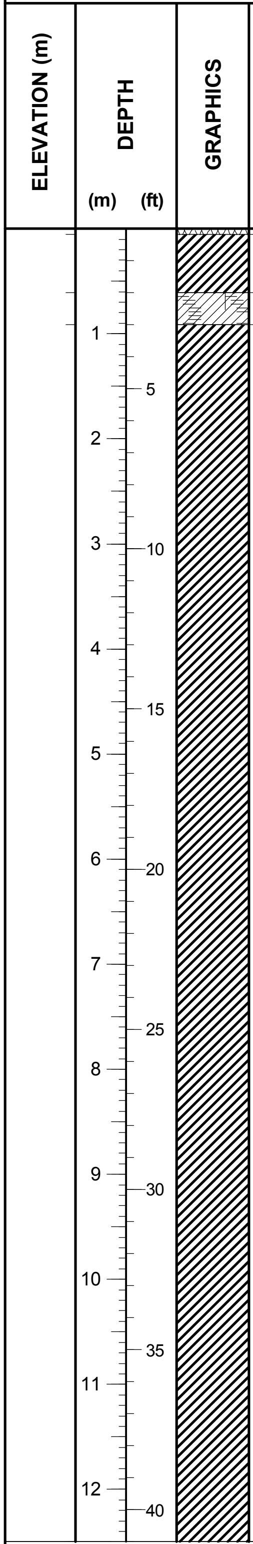
SUMMARY LOG

REFERENCE NO.

HOLE NO. **BH16-04**

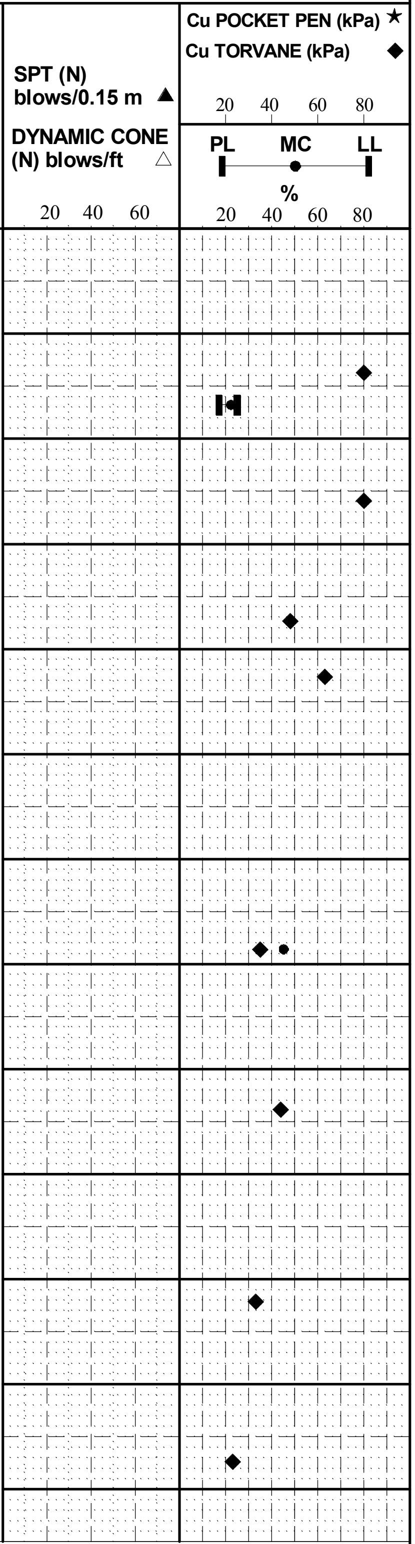
SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT	BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE	BRRMF
LOCATION	SW CORNER OF AREA A
DRILLING METHOD	125 mm ø Solid Stem Auger, ACKER Track Mounted Rig
JOB NO.	15-0107-014
GROUND ELEV.	
TOP OF CASING ELEV.	
WATER ELEV.	
DATE DRILLED	21/12/2016
UTM (m)	N 5,513,432 E 629,537



DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
TOPSOIL - Black, damp, rootlets.			
SILTY CLAY (CH) - Brown, damp, firm to stiff, high plasticity, trace fine grained sand nodules, trace organics, trace rootlets.	Auger Grab	S1	
ORGANIC CLAY (OH) - Black, damp, stiff, high plasticity, trace fine grained sand seams, trace rootlets, and organics.	Auger Grab	S2	
SILTY CLAY (CH) - Brown, damp, stiff, high plasticity, some fine grained sand, trace coarse grained sand. - (CL) Light brown, damp to moist, soft, low plasticity, some fine grained sand below 1.52 m. - (CH) Brown, damp, stiff, high plasticity, some silt seams from (30 mm to 100 mm thick), trace fine grained sand nodules below 1.82 m.	Auger Grab Auger Grab Auger Grab	S3 S4 S5	
- No silt seams after 3.05 m.			
- Fine grained sand nodules are white between 3.66 to 4.11 m.	Auger Grab Auger Grab	S6 S7	
- Grey, moist, decreased fine grained sand nodules below 6.10 m.	Auger Grab Auger Grab Auger Grab	S8 S9 S10	
- Soft below 11.58 m.	Auger Grab	S11	



SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	L. CHALMERS	DEA	29/5/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
BH16-04

SHEET 2 of 2

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
	13 14 15	45 50		**SILT TILL** - Light brown, moist, stiff, intermediate plasticity, some fine grained sand, trace coarse grained sand. - Wet from 13.11 to 13.41 m. - Clay seam (200 mm thick) at 13.41 m. - Trace fine to medium coarse gravel below 13.61 m.	{} {} {}	S12 S13 S14			
	16 17 18 19 20 21 22 23 24 25 26 27	55 60 65 70 75 80 85		**REFUSAL AT 15.08 m** Notes: 1. Borehole open to 14.47 m upon completion of drilling. 2. Water at the bottom of the hole upon completion of drilling. 3. Borehole backfilled with grout to grade.					

SAMPLE TYPE {} Auger Grab

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
L. CHALMERS

APPROVED
DEA

DATE
29/5/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

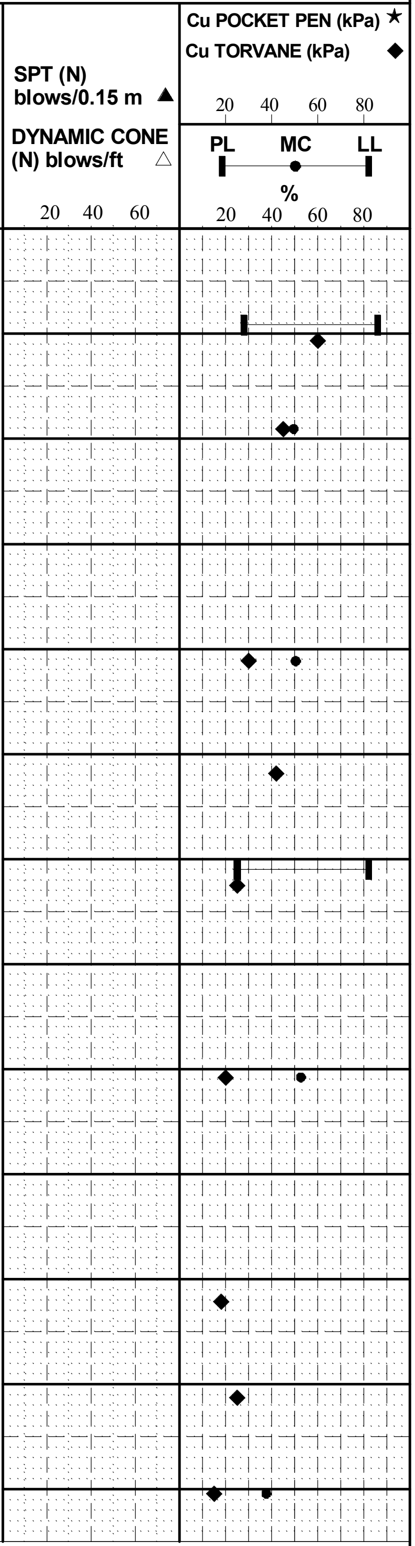
HOLE NO. **BH16-05**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE BRRMF
LOCATION APPROX. WEST EDGE OF LEACHATE TANK FOOTPRINT
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER Track Mounted Rig

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 21/12/2016
UTM (m) N 5,513,310
E 629,481

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER
			TOPSOIL - Black, damp, rootlets.		
			ORGANIC CLAY (OH) - Black, damp, stiff, high plasticity, trace coarse grained sand, trace rootlets, and organics.		
	1			Auger Grab	S1
			SILTY CLAY (CH) - Brown, damp, firm, high plasticity, trace silt nodules, trace fine grained sand nodules.		
		5			
	2			Auger Grab	S2
	3	10			
	4			Auger Grab	S3
		15			
	5			Auger Grab	S4
	6	20	- Grey, moist, soft, no silt nodules, decreased fine grained sand nodules below 6.10 m.	Auger Grab	S5
	7				
		25			
	8			Auger Grab	S6
	9	30			
	10			Auger Grab	S7
		35			
	11		- Trace fine grained gravel below 10.97 m.	Auger Grab	S8
	12		- Some till inclusions below 11.89 m.	Auger Grab	S9
		40	- Wet below 12.19 m.		



SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR Maple Leaf Enterprises
INSPECTOR L. CHALMERS
APPROVED DEA
DATE 29/5/17

GEOTECHNICAL-SOIL LOG U:\FMS\15-0107-014\BRADY DUMP.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **BH16-05**

SHEET 2 of 2

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 %
			SILT TILL - Light brown, wet, stiff, intermediate plasticity, some fine grained sand, trace coarse grained sand.	Auger Grab	S10			
			- Increased coarse grained sand and fine grained gravel below 14.17 m.	Auger Grab	S11			
				Split Spoon	S12		▲ 69 See Note	
			REFUSAL AT 15.18 m					

Notes:
1. Split spoon refused within first 150 mm set of SPT.
2. Borehole open to 14.63 m upon completion of drilling.
3. Water at 12.19 upon completion of drilling.
4. Borehole backfilled with bentonite to grade.
5. Proctor density test performed on silty clay material from samples obtained between 0.91 m and 11.89 m.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	L. CHALMERS	DEA	29/5/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TP17-01

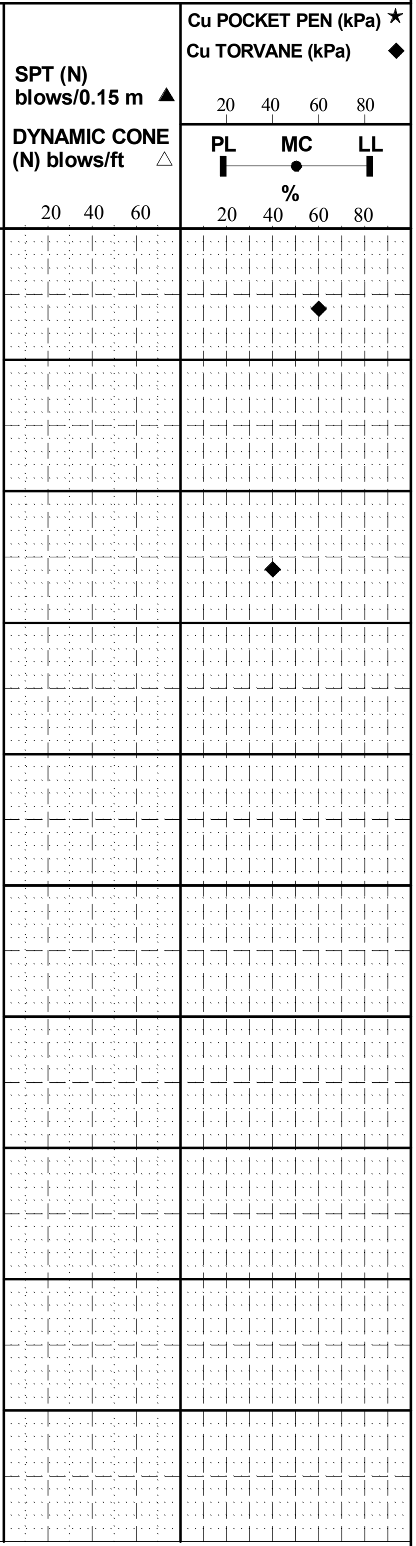
SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	15-0107-014
PROJECT	BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	BRRMF	WATER ELEV.	
LOCATION	APPROX. SOUTH EDGE OF LEACHATE TANK FOOTPRINT	DATE DRILLED	16/02/2017
		UTM (m)	N 5,513,304
DRILLING METHOD	CAT 324D Excavator, Toothed Bucket		E 629,497

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
	0.0			**TOPSOIL** - Black, frozen, rootlets. - Damp, not frozen below 0.1 m.			
				SILTY CLAY - Brown, damp, stiff, intermediate plasticity, trace organics, trace rootlets, trace oxidation.			
				SILT - Brown, damp, soft to firm, low plasticity, trace clay.			
				SILTY CLAY (CH) - Brown, damp to moist, firm, high plasticity, trace silt inclusions.			

END OF TEST PIT AT 2.6 m.

Notes:
1. Test pit bottom dry upon completion.
2. Backfilled test pit with cuttings to grade.



SAMPLE TYPE

CONTRACTOR	INSPECTOR	APPROVED	DATE
HMC	K. FORDYCE	DEA	29/5/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TP17-02**

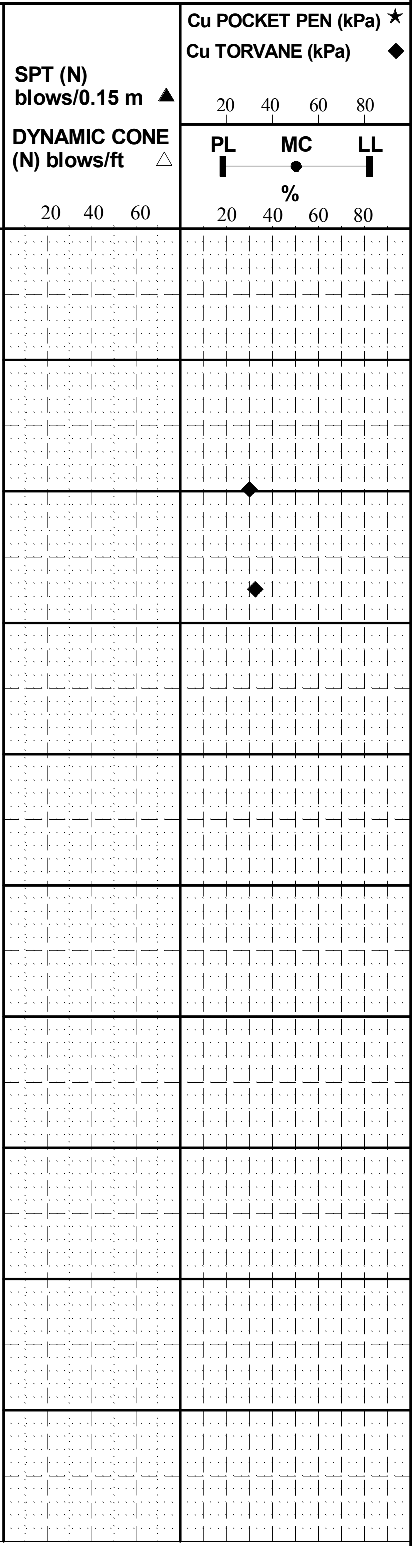
SHEET 1 of 1

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN
SITE BRRMF
LOCATION APPROX. NORTH EDGE OF LEACHATE TANK FOOTPRINT
DRILLING METHOD CAT 324D Excavator, Toothed Bucket

JOB NO. 15-0107-014
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED 16/02/2017
UTM (m) N 5,513,324
E 629,485

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
			TOPSOIL - Black, frozen, rootlets.	⧓	S01	
			SILTY CLAY - Brown, damp, stiff, intermediate plasticity.			
			SILT - Brown, damp, soft, low plasticity.			
			SILTY CLAY (CH) - Brown, damp to moist, firm, high plasticity, trace silt inclusions, trace gypsum inclusions.	⧓	S02	
			END OF TEST PIT AT 2.7 m.			

Notes:
1. Test pit bottom dry upon completion.
2. Backfilled test pit with cuttings to grade.



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

SAMPLE TYPE ⧓ Grab from Bucket

CONTRACTOR	INSPECTOR	APPROVED	DATE
HMC	K. FORDYCE	DEA	29/5/17

KGS GROUP

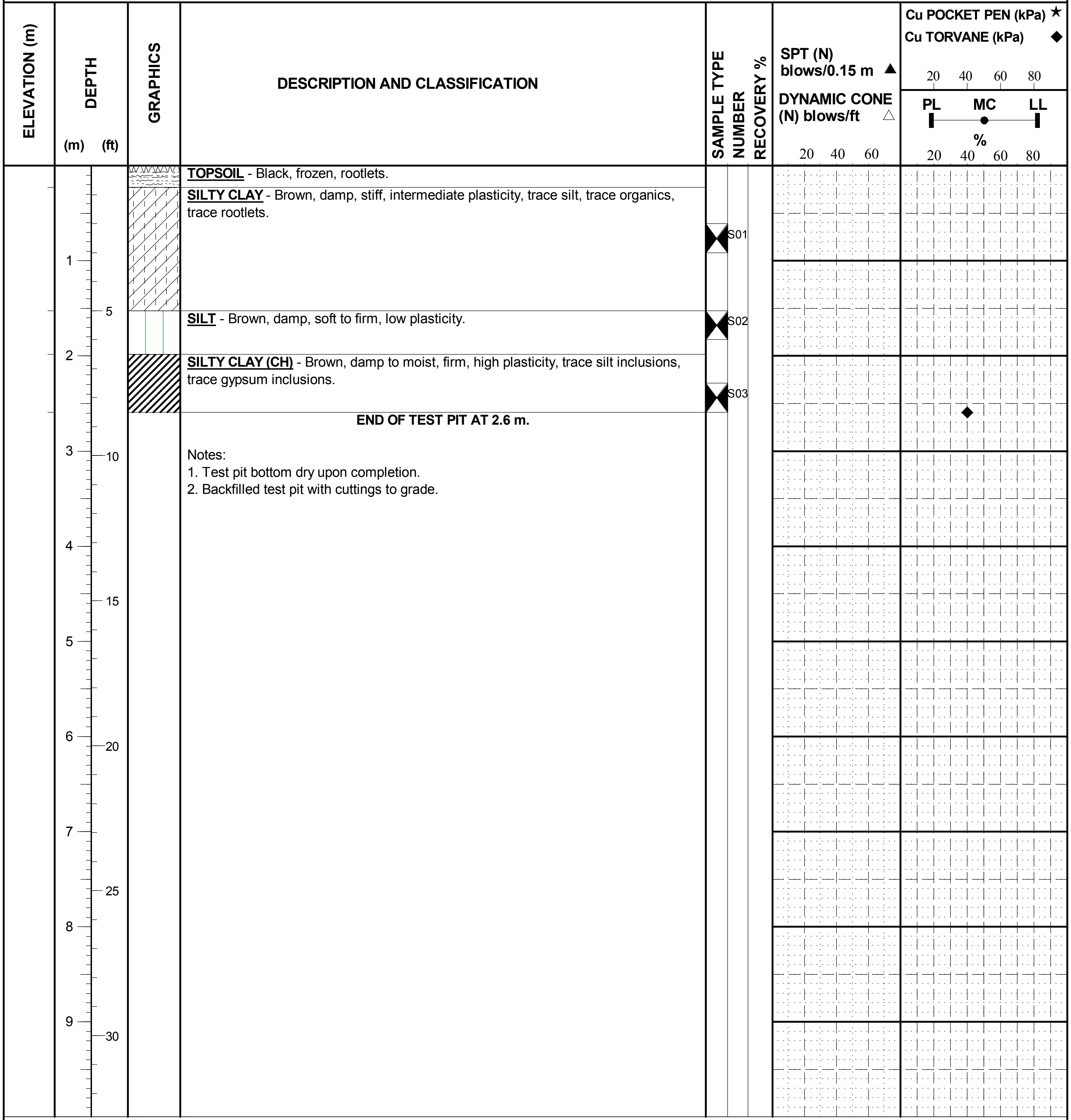
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TP17-03

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	15-0107-014
PROJECT	BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	BRRMF	WATER ELEV.	
LOCATION	APPROX. EAST EDGE OF LEACHATE TANK FOOTPRINT, NEW MANHOLE LOCATION	DATE DRILLED	16/02/2017
DRILLING METHOD	CAT 324D Excavator, Toothed Bucket	UTM (m)	N 5,513,320 E 629,500



TOPSOIL - Black, frozen, rootlets.

SILTY CLAY - Brown, damp, stiff, intermediate plasticity, trace silt, trace organics, trace rootlets.

SILT - Brown, damp, soft to firm, low plasticity.

SILTY CLAY (CH) - Brown, damp to moist, firm, high plasticity, trace silt inclusions, trace gypsum inclusions.

END OF TEST PIT AT 2.6 m.

Notes:
1. Test pit bottom dry upon completion.
2. Backfilled test pit with cuttings to grade.

SAMPLE TYPE ⧓ Grab from Bucket

CONTRACTOR	INSPECTOR	APPROVED	DATE
HMC	K. FORDYCE	DEA	29/5/17

KGS GROUP

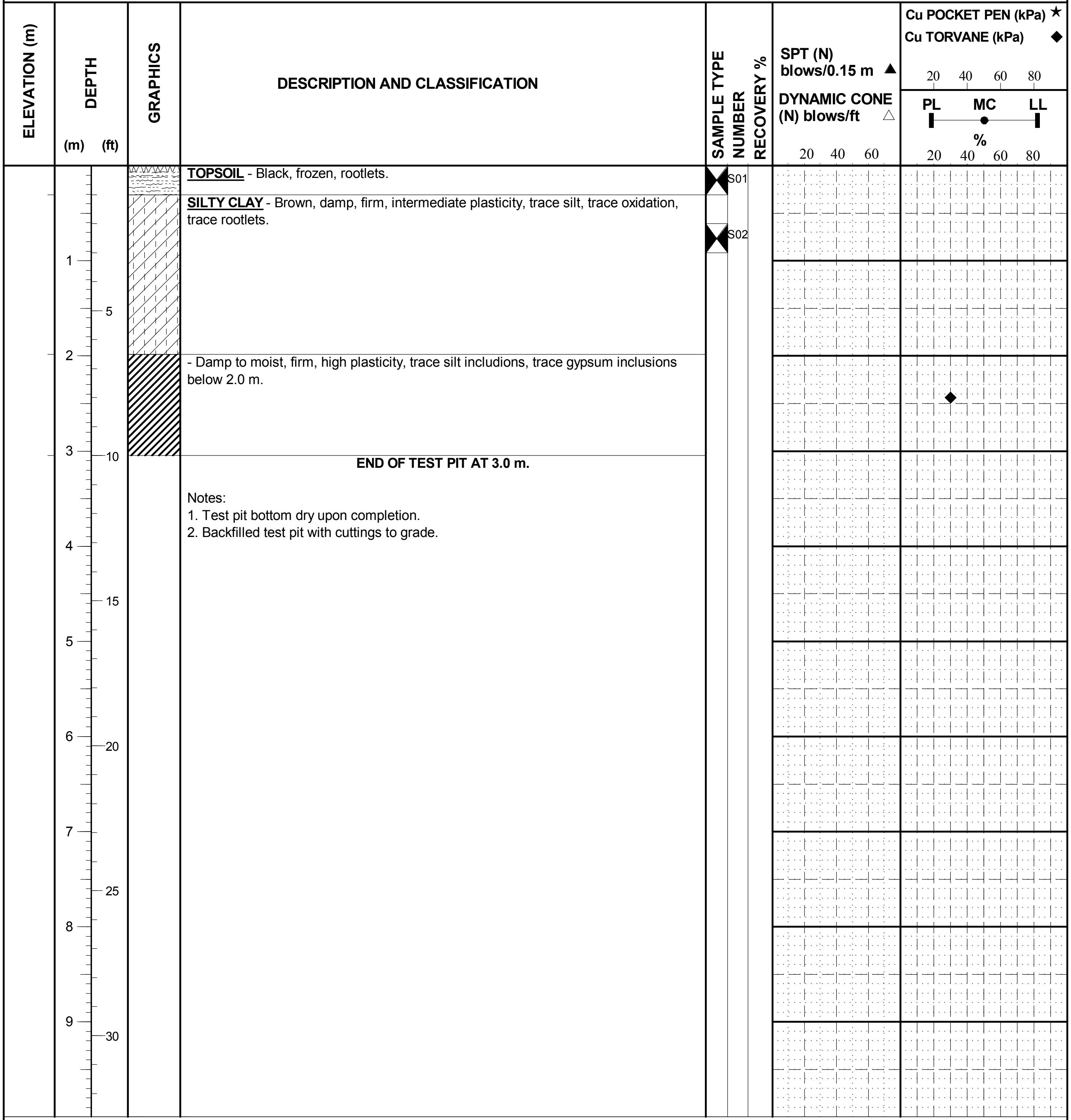
SUMMARY LOG

REFERENCE NO.

HOLE NO. **TP17-04**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	15-0107-014
PROJECT	BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN	GROUND ELEV.	
		TOP OF CASING ELEV.	
SITE	BRRMF	WATER ELEV.	
LOCATION	TOWARDS CENTER OF LEACHATE TANK FOOTPRINT	DATE DRILLED	16/02/2017
DRILLING METHOD	CAT 324D Excavator, Toothed Bucket	UTM (m)	N 5,513,310 E 629,496



TOPSOIL - Black, frozen, rootlets.

SILTY CLAY - Brown, damp, firm, intermediate plasticity, trace silt, trace oxidation, trace rootlets.

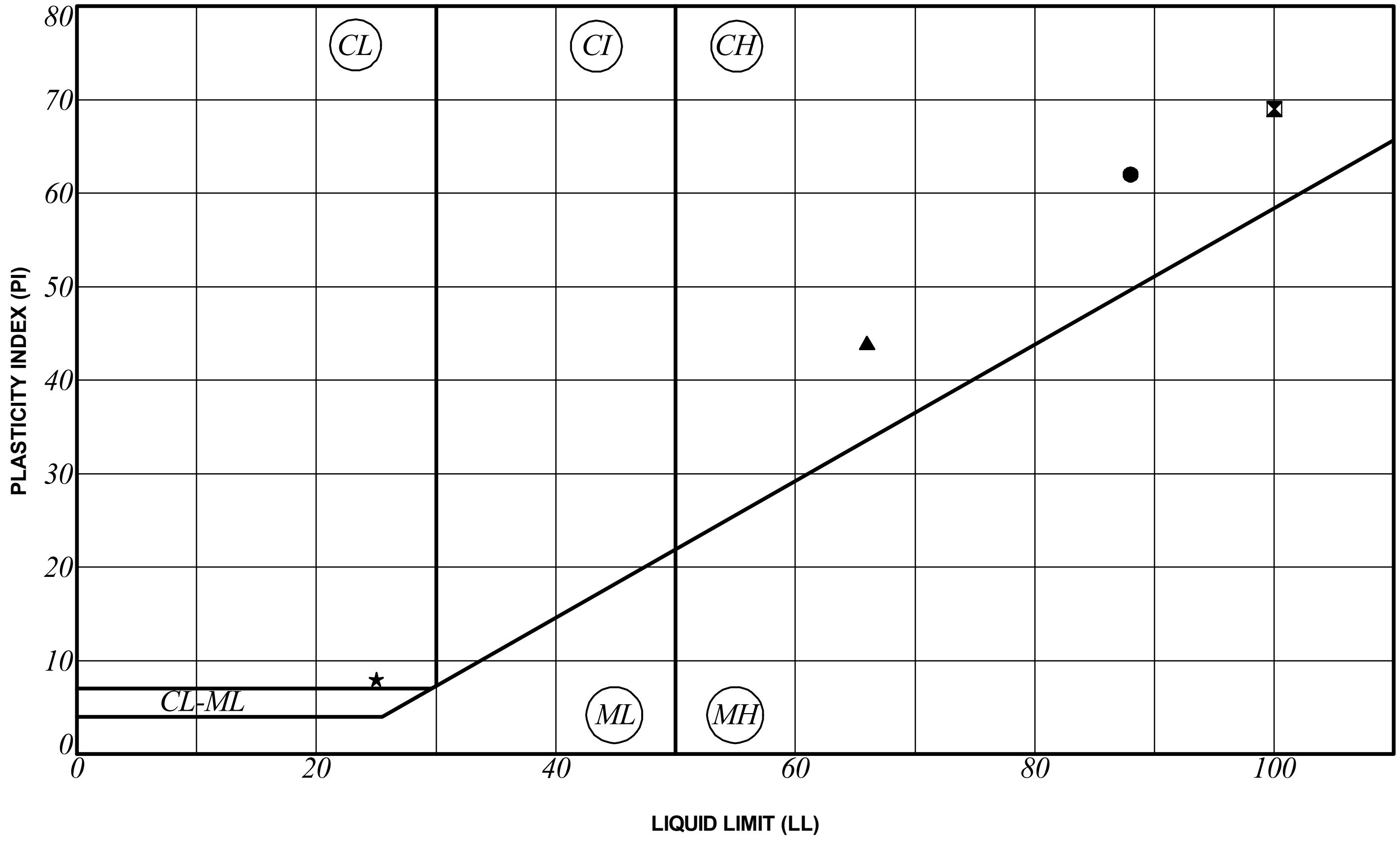
- Damp to moist, firm, high plasticity, trace silt includions, trace gypsum inclusions below 2.0 m.

END OF TEST PIT AT 3.0 m.

Notes:
1. Test pit bottom dry upon completion.
2. Backfilled test pit with cuttings to grade.

SAMPLE TYPE ⧓ Grab from Bucket

CONTRACTOR	INSPECTOR	APPROVED	DATE
HMC	K. FORDYCE	DEA	29/5/17



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	BH16-01	2.6	S2	88	26	62	0.7	26.5	72.8	49.7	CH
⧗	BH16-02	1.8	S1	100	31	69				40.7	CH
▲	BH16-03	3.4	S2	66	22	44	0.6	44.8	54.6		CH
★	BH16-04	1.5	S4	25	17	8				22.3	CL

Notes:
ML - Low Plasticity Silt
MH - High Plasticity Silt
CL-ML - Silty Clay
CL - Low Plasticity Clay
CI - Intermediate Plasticity Clay
CH - High Plasticity Clay
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
MC - Moisture Content
NP - Non-Plastic

KGS GROUP

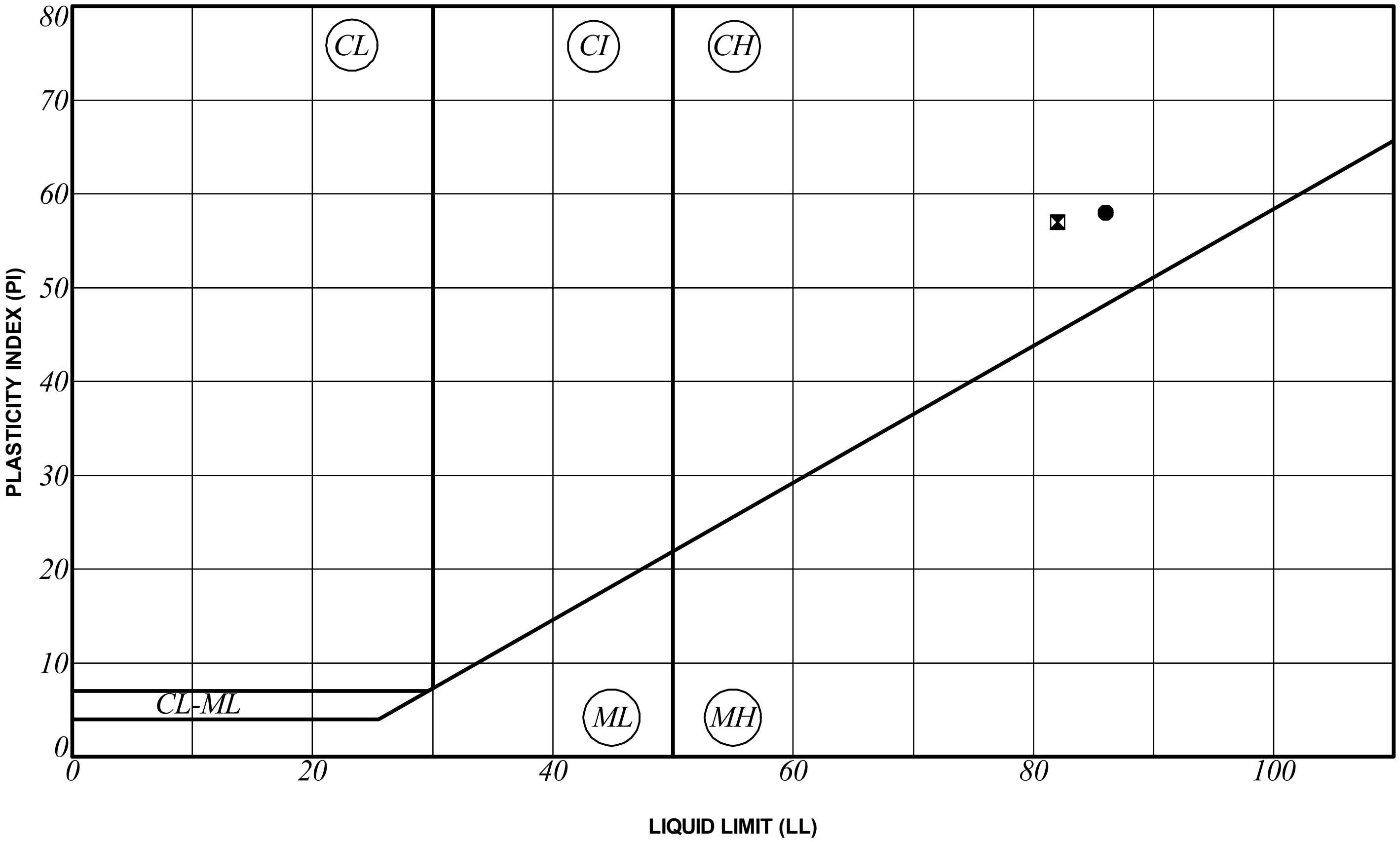
**CITY OF WINNIPEG -
WATER AND WASTE
DEPARTMENT**

BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN

A-LINE PLOT

February 2017 | **Figure B** | **Page 1 of 1**

A-LINE PLOT U:\FMS15-0107-014\BRADY DUMP.GPJ



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	BH16-05	0.9	S1	86	28	58					CH
⧗	BH16-05	6.1	S5	82	25	57					CH

Notes:
ML - Low Plasticity Silt
MH - High Plasticity Silt
CL-ML - Silty Clay
CL - Low Plasticity Clay
CI - Intermediate Plasticity Clay
CH - High Plasticity Clay
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
MC - Moisture Content
NP - Non-Plastic

A-LINE PLOT U:\FMS15-0107-014\BRADY DUMP.GPJ

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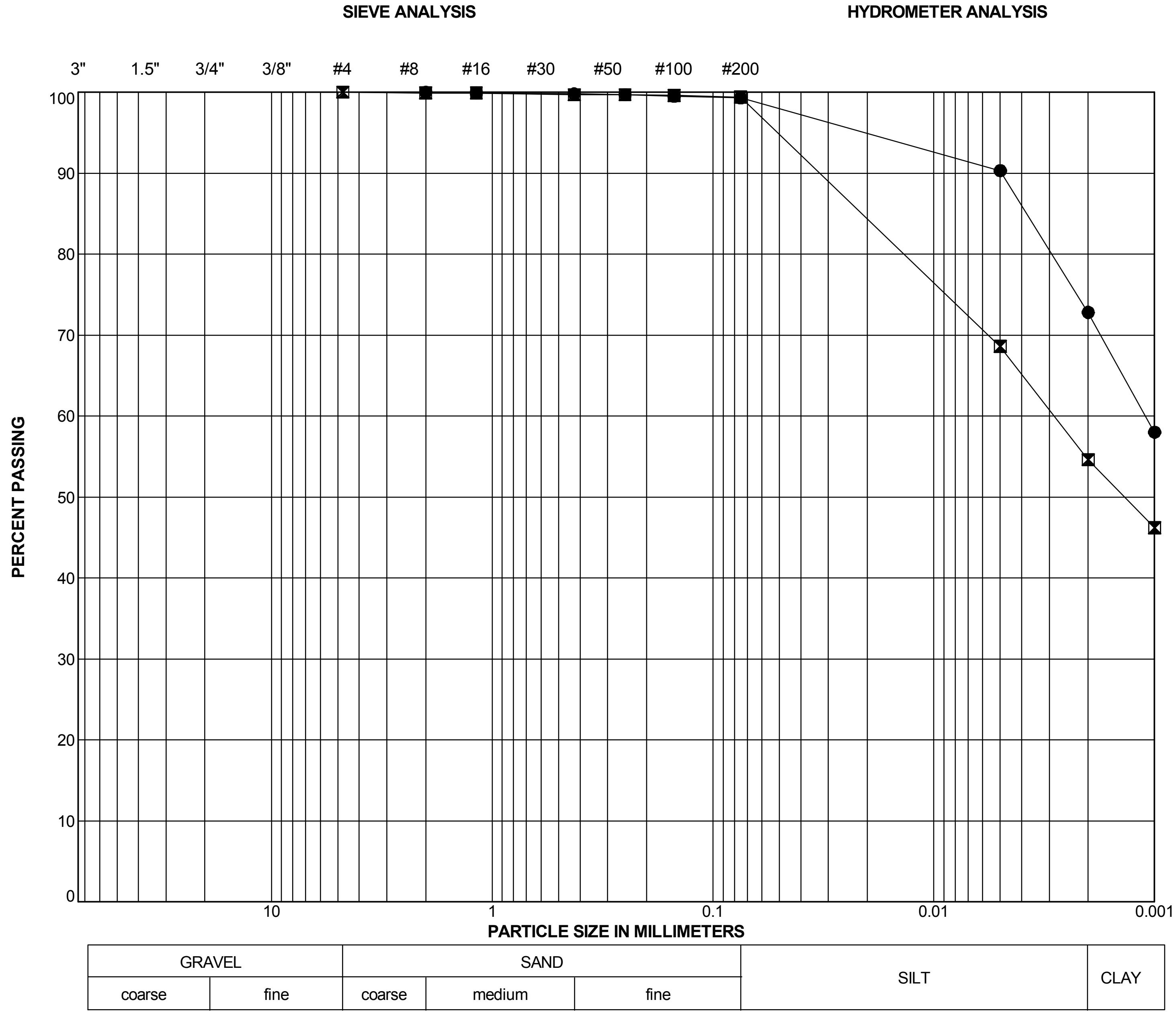
CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN

A-LINE PLOT

February 2017	**Figure A**	**Page 1 of 1**



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	% GRAVEL	% SAND	% SILT	% CLAY	% SILT & CLAY	Cu	Cc	CLASSIFICATION
●	*BH16-01*	*2.6*	*S2*	*0.0*	*0.7*	*26.5*	*72.8*	*99.3*			*CH*
☒	*BH16-03*	*3.4*	*S2*	*0.0*	*0.6*	*44.8*	*54.6*	*99.4*			*CH*

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

BRADY ROAD RESOURCE MANAGEMENT FACILITY CELL DESIGN

GRAIN SIZE ANALYSES

10/08/2004	**Figure A**	**Page 1 of 1**

SIEVE ANALYSIS U:\FMS\15-0107-014\BRADY DUMP.GPJ

Stantec
199 Henlow Bay
Winnipeg, Manitoba
R3Y 1G4
Tel: (204) 488-6999

CERTIFIED BY
CCIL
Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

PROCTOR TEST REPORT

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

ATTN: Mario Poveda

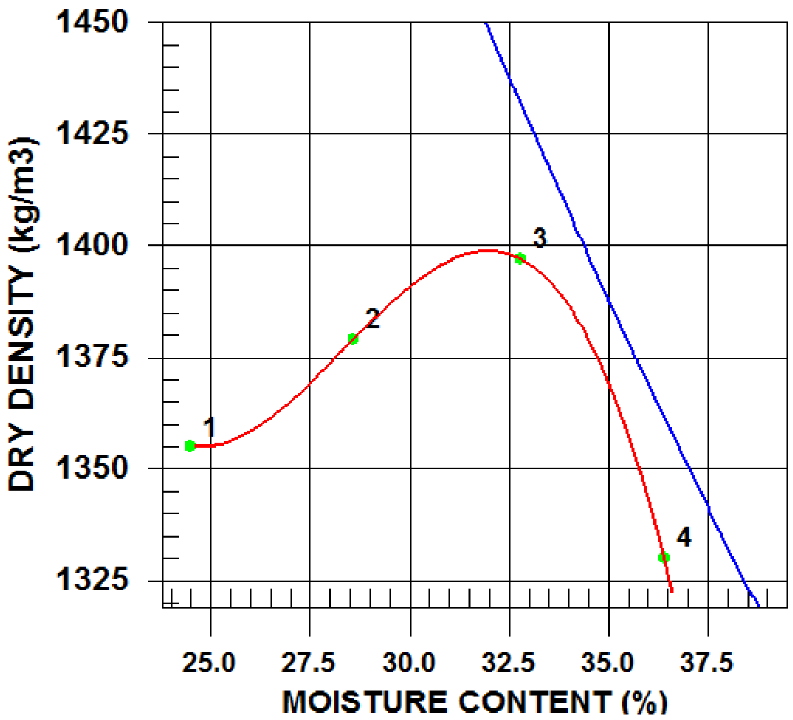
CLIENT KGS Group Inc.
C.C.

PROJECT Brady Dump (15-0107-14)

PROJECT NO. 123312923
PROCTOR NO. 1 DATE SAMPLED 2017.Jan.05 DATE RECEIVED 2017.Jan.06 DATE TESTED 2017.Jan.12

INSITU MOISTURE 49.5 %
TESTED BY Pervez Safdar
MATERIAL IDENTIFICATION
MATERIAL USE
MAX. NOMINAL SIZE
MATERIAL TYPE Silty Clay
SUPPLIER
SOURCE Test Hole BH16-05

COMPACTION STANDARD Standard Proctor, ASTM D698
COMPACTION PROCEDURE A: 101.6mm Mold, Passing 4.75mm
RAMMER TYPE Manual
PREPARATION Moist
OVERSIZE CORRECTION METHOD None
RETAINED 4.75mm SCREEN



TRIAL NUMBER	WET DENSITY (kg/m3)	DRY DENSITY (kg/m3)	MOISTURE CONTENT (%)
1	1687	1355	24.5
2	1773	1379	28.6
3	1855	1397	32.8
4	1814	1330	36.4

	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED	1400	32.0
OVERSIZE CORRECTED		

COMMENTS
Material tested was composite sample of materials obtained from test hole BH16-05, sample nos. S1 to S3, S5, S6 & S9, taken at depths of 3 to 39 feet.

REVIEWED BY Jason Thompson, C.E.T.

OFFICE
325 - 25th Street SE
Suite 200
Calgary, Alberta
Canada T2A 7H8
Tel: (403) 716-8000

LABORATORY
10830 - 46th Street SE
Calgary, Alberta
Canada T2C 1G4

Tel: (403) 253-7876

Stantec

Flexible Wall Hydraulic Conductivity Test
ASTM D5084

Tested by: C. Woods

CLIENT:	KGS Group Consulting Engineers	**PROJECT No.:**	123312923
PROJECT TITLE:	Brady Dump	**DATE:**	January 13, 2017
SAMPLE DESCRIPTION:	Brown Clay	**SAMPLE No.:**	7688

INITIAL SAMPLE DATA

Length (cm)	12.13
Diameter (cm)	7.23
Area (cm ²)	41.06
Total Mass (g)	864.0
Volume (cm³)	498.0
Water Content (%)	46.8
Degree of Saturation (%)	99
Wet Density (g/cm³)	1.735
Dry Density(g/cm³)	1.182
Assumed Specific Gravity	2.70

FINAL SAMPLE DATA

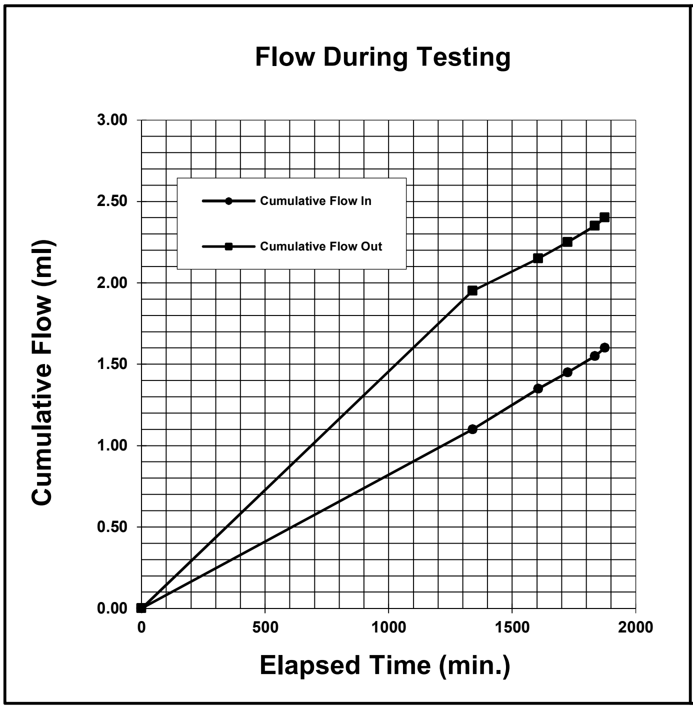
Length (cm)	12.32
Diameter (cm)	7.29
Area (cm ²)	41.74
Total Mass (g)	880.4
Volume (cm³)	514.2
Water Content (%)	49.1
Beta Saturation (%)	98
Wet Density (g/cm³)	1.712
Dry Density(g/cm³)	1.148

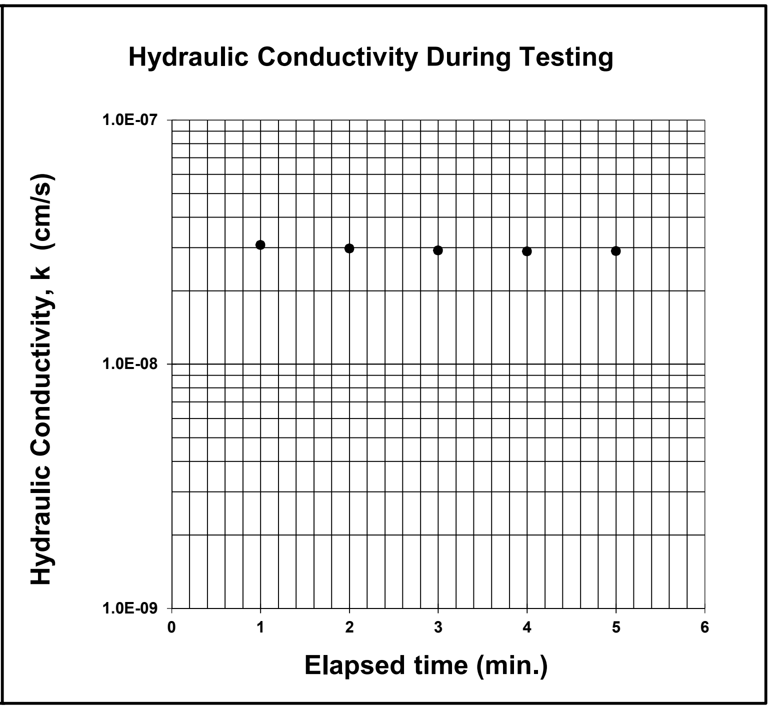
CONSOLIDATION PHASE

Cell Pressure(kPa)	220
Top Cap Pressure(kPa)	200
Bottom Cap Pressure(kPa)	200
Consolidation Pressure(kPa)	20

HYDRAULIC CONDUCTIVITY PHASE

Cell Pressure (kPa)	240
Top Cap Pressure (kPa)	220
Bottom Cap Pressure(kPa)	200
Hydraulic Gradient	16.8





Hydraulic Conductivity (cm/s) = 2.9E-08

Reviewed by: