KGS GROUP

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January 31, 2022

City of Winnipeg
110-1199 Pacific Avenue
Winnipeg, Manitoba R3E 3S8

Attention: Ms. Erica Campbell

Re: NEWPCC Interim Phosphorous Removal
Geotechnical Foundation and Environmental Assessment

Dear Ms. Campbell:

KGS Group was retained by the City of Winnipeg to complete the design and to provide contract administration services for the proposed North End Water Pollution Control Centre (NEWPCC) Interim Phosphorous Removal works. As part of this project, KGS Group provided geotechnical services to support design of the new day tank chemical storage building, chemical storage buildings 2 and 3, rail car shelter 2, and associated rail line.

1.0 INTRODUCTION

The project site is located 2230 Main Street. The project components include a new rail line on the south edge of the property south of the existing siding line, new rail car shelter 2, new chemical storage building 2 and 3 and potentially a new day tank storage building. The new railcar shelter 2 will tie into the south wall of the existing building and have an overall footprint of roughly 21.2 by 8.1 m. The chemical storage building 2 will be constructed to the east of the existing railcar shelter and will tie into the east wall of the existing and new railcar shelter buildings. The new building will have an overall footprint of approximately 16.1 by 8.2 m. Chemical storage building 3 will be located either west of the existing chemical storage building, or southeast of the new chemical storage building 2. The new building will have an overall footprint of approximately 11.0 by 7.0 m. The work may include a new day tank storage building to the west of the existing grit building. It is understood, at the time of this report, the new day storage building may not be required for the project.

The geotechnical scope of work is outlined in the following section.

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1.1 Scope of work

The requested consulting services for project included the following scope of work:

Geotechnical Investigation Program – A geotechnical drilling program was completed to investigate the subsurface and groundwater conditions. The investigation program consisted of advancing a total of three (3) shallow boreholes to approximately 4.6 m along the proposed new rail line and three (3) depth boreholes to power auger refusal in the dense glacial till at depths ranging from 20.7 to 24.4 m at the proposed building structure locations.

Geotechnical Assessment Report – As provided herein, our report detailing the findings of our investigations, geotechnical assessment, and foundation recommendations.

2.0 FIELD AND LABORATORY INVESTIGATIONS

2.1 Test Hole Drilling and Soil Sampling Program

A drilling and sampling program consisting of three (3) deep test holes to power auger refusal, and three (3) shallow test holes to approximately 4.6 m was completed on November 25 and 26, 2021. Drilling services were provided by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba. All test holes were completed using an Acker Renegade track mounted drill rig equipped with 125 mm diameter solid stem augers and an automatic hammer. The approximate locations of the test holes are shown on Figure 1.

Representative disturbed soil samples were obtained from select test holes at 1.5 m (5 ft) intervals, or at any change in soil strata. Soil samples were collected directly off the auger flights and visually classified in the field in general accordance with the modified Unified Soil Classification System (USCS). Strength index testing was performed on the clay soil samples using field Torvane to estimate the undrained shear strength. Standard Penetration Tests (SPTs) were completed in select boreholes to estimate the density of the silt till. Upon completion of drilling, the test holes were examined for indications of sloughing and seepage, and then backfilled to grade.

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FIGURE 1: TEST HOLE LOCATIONS

2.2 Laboratory Testing

Laboratory tests were completed on representative soil samples to determine index properties for correlation to relevant geotechnical engineering properties. Laboratory testing was completed at a laboratory in Winnipeg, Manitoba certified by the Canadian Council of Independent Laboratories (CCiL). Testing included moisture contents, grain size analysis, Atterberg limits tests, Proctor density testing and California Bearing Ratio Tests. The results of the laboratory testing are included on the test hole logs in Appendix A and in Appendix B.

3.0 INVESTIGATION RESULTS

3.1 Stratigraphy

In general, the stratigraphy at the site was interpreted by KGS Group to consist of topsoil, and fill underlain by high plasticity clay, silt and silt till.

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Topsoil – An approximate 100 to 200 mm layer of topsoil was encountered at ground surface in test holes BH21-03 to BH21-06. The topsoil was black in colour, and moist.

Sand Fill – Sand fill was encountered at the ground surface in test holes BH21-01 and BH21-02 and a depth of 0.9 m in test hole BH21-06. The sand fill ranged in thickness from 0.6 to 2.7 m and extended to elevations of 229.3 to 231.9 m. The sand fill was brown in colour, dry, compact, contained fine to coarse grained sand, and some gravel.

The particle size distribution consists of 18% gravel, 74% sand, 8% silt and 0% clay based on one test completed in test hole BH21-01.

Clay Fill – Clay fill was encountered underlying the topsoil in test hole BH21-03, and BH21-06 from elevation 231.3 to 230.5 m, and 230.6 to 229.9 m respectively. The clay fill was brown in colour, damp to moist, stiff in consistency, of intermediate plasticity, and contained with sand.

One (1) Atterberg limits was completed on a sample from a depth of 0.6 m in test hole BH21-03. The Atterberg limit test measured a liquid limit of 47, plastic limit of 20 and plasticity index of 27, classifying the soil as intermediate plasticity clay (CI). The particle size distribution consists of 2% gravel, 43% sand, 28% silt and 27% clay fill based on one (1) test completed in test hole BH21-03.

A proctor test was completed on the clay fill in test hole BH21-03. The maximum dry density was measured to be 1547 kg/m^3 and the optimum moisture content is 24%.

Clay (CH) – Clay was encountered at elevations ranging from 231.9 to 229.3 m and extended to elevations ranging from 212.4 to 210.2 m. The clay was brown in colour and became grey with depth, moist, stiff to soft in consistency, of high plasticity, contained trace silt

The undrained shear strength of the clay, estimated from the field Torvane tests, generally ranged from 40 to 60 kPa at elevations ranging from 231.9 to 221 m, decreasing to 15 to 40 kPa below 221 m.

The moisture content of the clay ranged from 23 to 56%, as measured from seven (7) tests. One (1) Atterberg limits was completed on a sample from a depth of 0.6 m in test hole BH21-02. The Atterberg limit test measured a liquid limit of 68, plastic limit of 25 and plasticity index of 43, classifying the soil as high plasticity clay (CH). The particle size distribution consists of 1% gravel, 10% sand, 40% silt and 49% clay based on one (1) test completed in test hole BH21-02.

A proctor test was completed on the native clay in test hole BH21-02. The maximum dry density was measured to be 1531 kg/m^3 and the optimum moisture content is 25%.

Silt (ML) – A silt layer was encountered within the high plasticity clay in test holes BH21-02, BH21-04, and BH21-05. The silt was observed from elevations 229.4to 227.1 m, and ranged in thickness from 1.7 to 2.3 m. The silt was light brown, moist, soft, and of low plasticity. The undrained shear strength of the silt, estimated from field Torvanes was 20 kPa.

The moisture content of the silt was measured to be 25% from one (1) test.

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Glacial Silt Till – Glacial silt till was encountered underlying the high plasticity clay in the test holes drilled to auger refusal, BH21-04, BH21-05, and BH21-06, at elevations ranging from 212.4 to 210.2 m. The silt till was light brown in colour, moist to wet, compact, increase to dense with depth, and contained fine to coarse grained sand and gravel. Power auger refusal was encountered at elevations ranging from 210.0 to 207.1 m.

Standard Penetration Tests (SPT) were completed in the silt till to estimate in-situ density. The SPT blow counts ranged between 27 to greater than 50 blows / 300 mm, classifying the material as compact to dense.

The moisture content of the silt ranged from 10 to 12%, as measured from two (2) tests.

3.2 Groundwater

Groundwater levels were observed at elevations ranging from 210 to 221.0 m during drilling and after the completion of drilling. Upon the completion of drilling, the deep test holes caved-in to depths ranging from 218.5 to 227 m.

Groundwater levels may differ from those provided in this report in response to seasonal conditions and following heavy precipitation or spring snow melt events.

4.0 FOUNDATION CONSIDERATIONS

The proposed structures can be founded on deep foundations. Shallow foundations bearing on the native clay are not considered an acceptable option. Foundation constructed on the native clay can be expected to swell or shrink with varying seasonal subsurface moisture conditions. Clay soil is also susceptible to significant movement due to frost heave.

4.1 Limit State Design

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

The estimated unfactored ULS values provided below represent the nominal (ultimate) geotechnical resistance, R_n. A geotechnical resistance factor (Φ) should be applied to determine the factored geotechnical resistance as presented in the following equation:

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

where:

- Φ – geotechnical resistance factor
- R_n – nominal (ultimate) geotechnical resistance
- $\Sigma \alpha_i S_{ni}$ – summation of the factored overall load effects for a given load combination

A geotechnical resistance factor of 0.4 should be used in the design of piles and be applied to the ULS values shown in Tables 1, 2 and 3 below to determine the factored geotechnical resistance.

4.2 Cast-In-Place Concrete and Continuous Flight Augers Piles

Friction Piles – straight shaft cast-in-place (CIP) or continuous flight auger (CFA) concrete friction piles may be used to support the loads. Friction CIPP or CFA piles may be designed based upon the estimated unfactored ULS and SLS skin friction values provided in Table 1 below. The recommended SLS values limit settlements to 25 mm. Piles designed as friction piles should be designed to support the loads by shaft resistance only with no contribution from end-bearing. Straight shaft cast-in-place concrete piles should be at least 8.0 m long to protect against frost jacking. For design purposes, where pile will be exposed to frost, the upper 2.5 m below final ground should be neglected when determining pile capacities.

TABLE 1: ESTIMATED AVERAGE SKIN FRICTION RESISTANCE FOR LIMIT STATE DESIGN

	Approximate Depth Below Grade	Serviceability Limit State, SLS (kPa)	Unfactored Ultimate Limit State, ULS (kPa)
Unit Shaft Resistance	0 to 2.5 m	–	-
	2.5 m to 10 m	14	35
	Below 10 m	8	20

The potential exists for squeezing/sloughing of the shaft excavations during the installation of the cast-in-place concrete piles at the site. Temporary steel sleeves should be used as required during installation to maintain the integrity of the shaft excavation. Concrete should be poured immediately upon completion of drilling. Should heavy groundwater inflow be encountered, concrete placement should be completed using tremie or pump-in methods. Drilling and concrete placement for the piles should be inspected by experienced geotechnical personnel to verify the soil and encountered conditions are consistent with the findings of this investigation.

End Bearing Piles – Cast-in-place straight shaft concrete caissons end bearing on the dense silt till can be used to support the loading. The estimated average unfactored end bearing values for Limit States Design of the piles are provided in Table 2. The recommended SLS value would limit settlement to 25 mm. The end-bearing piles need to be drilled to dense till as estimated during geotechnical investigation program. It is recommended that

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geotechnical personnel are on site to confirm end bearing piles are founded on dense silt till during pile installation.

TABLE 2: ESTIMATED AVERAGE END BEARING RESISTANCE FOR LIMIT STATES DESIGN FOR CAST-IN-PLACE PILES

Material Type	Serviceability Limit State, SLS (kPa)	Unfactored Ultimate Limit State, ULS (kPa)
End Bearing on Dense Silt Till	650	1800

A geotechnical resistance factor of 0.4 should be applied to the ULS values shown in Tables 1 and 2 to determine the factored geotechnical resistance. The base of the cast-in-place piles must be mechanically cleaned prior to placement of concrete to obtain a sound bearing surface and ensure that all deleterious material has been removed from the bearing surface. The potential exists for squeezing of the test holes during the installation of the cast-in-place concrete piles at the site. Temporary steel sleeves should be used as required during pile installation to maintain the drill shaft in a clean and dry state. 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. 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.

4.3 Prestressed Precast Concrete End Bearing Piles

Hexagonal, prestressed precast concrete end bearing piles are used extensively in Winnipeg area and may be assigned the allowable (static) service load capacities shown on Table 3 when driven to practical refusal on the underlying till using a hammer with a maximum energy rating of 40 kJ. The final refusal criteria indicated on Table 3 below should be achieved at least three (3) consecutive increments. A geotechnical resistance factor of 0.4 should be applied to the ULS values shown in Table 3 to determine the factored geotechnical resistance.

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TABLE 3: PRECAST CONCRETE PILE CAPACITIES

Pile Diameter (mm)	Serviceability Limit State, SLS (kN)	Unfactored Ultimate Limit State, ULS (kN)	Final Refusal Criteria[1] (Blows per 25 mm)
300	450	1,250	5
350	625	1,750	8
400	800	2,200	12

Note 1: If higher energies or other types of hammers are used, they should be evaluated to ensure that piles are not overstressed and suitable refusal criteria needs to be determined.

Pile embedment lengths may vary considerably across the site due to localized till conditions and thickness. Power auger refusal was encountered in dense silt till at depths ranging from 20.7 to 24.4 m below the existing ground surface.

Pre-boring is recommended to allow for standing of the piles, better pile plumbness/alignment and to reduce potential ground heave in large pile groups. If significant squeezing or sloughing of the borehole occurs during pre-boring then the pre-boring depth may be reduced accordingly. All piles driven within five-pile diameters should be monitored for heave. If heave occurs, these piles should be re-driven to refusal. Careful attention will be required during driving, especially as the pile approaches refusal, to avoid breaking the pile.

Reduction in pile load carrying capacity due to group action is not necessary for the precast concrete piles when driven to practical refusal, since the pile design relies mainly on the base-resistance developed at the tip. The design capacity of a pile group is the sum of the allowable capacity of the individual pile.

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

Pile driving operations will result ground vibration that could affect existing adjacent properties. The potential adverse impact of pile driving on the adjoining properties should be carefully evaluated by the structural engineer and mitigated, if the driven pile option is select.

4.4 Additional Pile Foundation Considerations

Additional considerations for design and construction of the pile foundations are provided below:

- The spacing between adjacent piles should be a minimum of three-pile diameters center to center. If closer pile spacings are required, KGS Group should be contacted to evaluate if a capacity reduction is required due to group action.
- To resist tensile forces from frost action acting on piles (frost jacking), all concrete piles shall be reinforced their entire length and be designed by an experienced structural engineer.

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- Piles exposed to frost should be a minimum of 8.0 m long to resist frost jacking.
- Full-length steel sleeves should be maintained on site and utilized as required when seepage or soil sloughing is encountered, which cannot be controlled by pumping during piling.
- The reinforcement and concrete must be placed immediately following the drilling of each pile to prevent disturbance to the foundation soil during subsequent construction activity. Where this is not possible on the day of drilling, the pile hole should be refilled, and later redrilled once concrete is ready to place.
- Concrete should be poured immediately upon completion of drilling. Removal of the water from pile excavations prior to pouring concrete or placing concrete by tremie methods may be required. At all times during removal of the steel sleeve, a head of concrete shall be maintained sufficiently above the sleeve bottom to limit sloughing and seepage into the pile excavation.
- All concrete piles should utilize Canadian Standards Association (CSA) Type HS sulphate resistant cement.
- A minimum 150 mm void form should be used below all grade beams and pile caps to protect against potential uplift from frost heave.
- Detailed construction records and full-time inspection by experienced geotechnical personnel is recommended throughout construction of foundations to confirm that piles are installed according to the project specifications and meet the intent of the geotechnical design.

5.0 DESIGN CONSIDERATIONS FOR OTHER STRUCTURES

5.1 Slab-on-Grade

If a slab-on-grade foundation is selected for any structure, the native clay may be assigned an estimated unfactored Ultimate Limit States (ULS) bearing capacity of 200 kPa. The following should be considered for this alternative:

- Sub-excavate the surficial topsoil and fill to the intact native clay. Proof rolling and compaction of the subgrade should be completed under the supervision of an experienced geotechnical engineer to identify unstable or unsuitable areas. The subgrade should be sub-excavated to the design elevation and proof-rolled using a heavy sheepsfoot roller to achieve a minimum compaction of 98% SPMDD. If any soft spots are encountered, they should be sub excavated 600 mm and backfilled with compacted granular fill to 98% SPMDD.
- A non-woven geotextile fabric should be placed as a separator between the subgrade and compacted granular fill.

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- 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 100% SPMDD.
- The granular fill should be well-graded free-draining and include organic-free and non-frozen aggregate supplied in accordance with applicable standard specification (such as City of Winnipeg Specification CW3110-R21 dated February, 2020). Sieve analysis and compaction testing of the granular base and subgrade materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied, and percent compactions are in accordance with design specifications.
- The final ground elevation around the perimeter of the building structures should be sloped away at a minimum 5% grade for a distance of 2 m away from the building. Beyond 2 m, the final ground elevation should be sloped at 2% away from the building. The final ground elevations should be sloped away from the building structures to protect against surface water ponding and compensate for future loss of grade that may result from potential settlement.
- Both seasonal movement and differential settlement and associated potential cracking of the concrete slab may occur over time with grade supported slabs. This alternative should be selected only if some movement and differential settlement is acceptable. Differential settlements of 50 to 100 mm do routinely occur for floor slabs poured directly on grade. Higher differential settlements are possible. Where these potential movements are deemed unacceptable a structural slab supported on intermediate piles should be utilized. Under no condition should slab-on-grade construction proceed in freezing conditions or on frozen ground or while frozen ground is thawing out.

5.2 Lateral Earth Pressure

For design purposes the soils may be assigned active, passive and at-rest lateral earth pressure coefficients as shown in Table 4.

TABLE 4: LATERAL EARTH PRESSURE COEFFICIENTS

Material	Unit Weight (kN/m^3)	ϕ'	K_a	K_o	K_p
Fill	16	14°	0.610	1.638	0.758
Clay	17	18°	0.52	0.69	1.89
Silt Till	18	30°	0.33	0.50	3.00
Well Graded Compacted Granular Fill	18	35°	0.27	0.43	3.69

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6.0 OTHER DESIGN CRITERIA

6.1 Rail Line

6.1.1 RAIL LINE GRADING

The proposed rail alignment and profile are included in Appendix B of the Preliminary Design NEWPCC Interim Phosphorous Removal Report. Based on the geotechnical field investigation the existing subgrade will consist of sand fill from approximately Sta. 0+032 to 0+080, and native clay and clay fill materials from Sta. 0+080 to the proposed railcar shelter 2.

Based on the preliminary profile, the proposed track would require up to 0.2m of fill placement above existing ground between Sta. 0+032 and approximately Sta. 0+060. Whereas existing subgrade would require excavation (cut) of up to 0.5 m from approximately Sta. 0+060 to Sta. 0+115. The proposed track would require up to 0.5 m of fill placement above existing ground between Sta. 0+115 and the proposed railcar shelter 2.

6.1.2 SUITABILITY OF IN-SITU MATERIAL

The California Bearing Ratio (CBR) of the native clay deposit and the clay fill materials at 2.54 mm plunger penetration was 5.2 and 5.8, and at 5.08 mm 4.1 and 4.8, as measured by two (2) tests. Based on the results of the CRB testing the clay fill and clay observed on the site have poor bearing capacity and are not suitable for re-use as structural subgrade fill materials.

The existing sand and gravel fill can be used re-use as backfill material with the following recommendations:

- The subgrade should be cleaned of all organics prior to the placement of fill.
- All deleterious material should be removed from the sand and gravel fill including organic materials, silts clays and large cobbles and boulders.
- Sand and gravel should be placed in 300 mm thick lifts and compacted to 95% SPMDD.
- The sand and gravel fill material should in inspected by qualified geotechnical personnel prior to placement.

6.1.3 FROST SUSCEPTIBILITY

The Canadian Foundation Engineering Manual (CFEM) references the guideline developed by Casagrande (1932) and extended by the U.S. Corps of Engineers which relates frost susceptibility of soils to the percentage of fines fraction less than 0.02 mm. Soils are listed in four categories, F1 to F4, in approximate increasing order of frost susceptibility and loss of strength during thaw.

The existing sand and gravel fill subgrade material are classified as frost group F1 and are not susceptible to frost. The native clay deposit and the clay fill materials are highly susceptible to frost and are classified as frost group F4.

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6.1.4 RAIL LINE SECTIONS

On the basis of the soil conditions encountered during the drilling and subject to inspection by qualified geotechnical personnel during construction, the rail line for the proposed development can be designed on the basis of the values provided in Table 5, and the gradations shown on Table 6. The gradation of the ballast material should comply with AREMA Specification Grade 4.

TABLE 5: RAIL LINE SECTION

Material	Minimum Thickness
Ballast	300 mm (Below bottom of ties)
Sub-Ballast	400 mm
Subgrade	• 300 mm minimum thickness • Sub-excavated existing clay materials as required and proof-roll the clay surface with heavy sheepsfoot roller. • Proof-roll existing granular subgrade with a heavy smooth drum roller • Place non-woven geotextile • Place geogrid, as required

TABLE 6: SUB-BALLAST GRADATION

Sieve Size (mm)	Sub-Ballast Percent Passing (by weight)
50	100
25	90-100
15	50-80
2	25-50
0.425	12-30
0.075	0-5

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The following should be considered for the rail line:

- Removal the surficial topsoil, and organics along the length of the proposed new rail line, with an average thickness of 0.3 m.
- Sub-excavate the clay fill and clay sub grade, observed from Sta. 0+080 to the proposed railcar shelter 2, a minimum of 300 mm.
- Proof rolling and compaction of the subgrade should be completed under the supervision of an experienced geotechnical engineer to identify unstable or unsuitable areas. The subgrade should be sub-excavated to the design elevation and proof-rolled to achieve a minimum compaction of 98% SPMDD. The subgrade should be proof-rolled using a heavy sheepsfoot roller for the clay subgrade and smooth drum roller for the granular subgrade.
- The subgrade should be inspected by qualified geotechnical personnel prior to the placement of geotextile. If any soft spots are encountered, they should be sub excavated 600 mm and backfilled with compacted granular fill to 98% SPMDD.
- A non-woven geotextile fabric should be placed as a separator between the clay and compacted granular material.
- All granular backfill material should be placed in maximum 150 mm thick lifts and compacted to 100% SPMDD.
- The sub-ballast material should be crushed gravel or crushed stone and meet the quality requirements of ASTM Standard D1241.
- The ballast should consist of crushed stone composed of hard and durable particles free from deleterious substances.
- Borrow material for grading the subgrade should be accordance with the Granular A Base Course on Table CW 3110.1 of the City of Winnipeg Standard Construction Specification CW 3110 – Sub-grade, Sub-base, and Base Course Construction.
- The side slopes of the embankment should be a graded to a slope no steeper than 2H:1V, and no benching is required for slopes less than 2 m.
- Culvert bedding material should be in accordance with Type 2 sand material on Table CW 2030.1 of the City of Winnipeg Standard Construction Specification CW2030 – Excavation Bedding and Backfill.

6.2 Pavement Structure

On the basis of the soil conditions encountered during drilling and subject to inspection by qualified geotechnical personnel, the asphalt concrete pavement structure can be designed on the basis of the section recommended on Table 7.

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TABLE 7: RECOMMENDED ASPHALT CONCRETE PAVEMENT SECTIONS

Material	Medium Traffic Loading	Heavy Traffic Loading
Asphaltic Concrete	80 mm	125 mm
Base Course (Class A)	150 mm	150 mm
Sub-base (Class C)	350 mm	500 mm
Subgrade	• Proof-rolled with a heavy smooth drum roller (granular) or sheep foot (clay) • Place non-woven geotextile	

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

The granular base should be well-graded and be free of organics and frozen material and meet the City of Winnipeg Standard Specification. Granular base and sub-base material should be compacted to 100% SPMDD. Sieve analysis and compaction testing of the granular base and subgrade materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied, and percent compactions are in accordance with design specifications.

For the hot mix asphaltic concrete, gradation analysis of the aggregates compaction testing and Marshall testing should be undertaken. This will provide data to confirm that the asphaltic concrete pavement complies with the project specification. The asphaltic concrete should meet 98% Marshall testing.

Slab-on-grade concrete pads are recommended for isolated area where larger static wheel loads may exist, including the delivery / loading dock and garbage pick up areas. Exterior grade supported concrete slabs (including sidewalks) will be subjected to seasonal vertical movements related to frost. Connection and tie-in details between the exterior concrete slabs and rigid structures element such as grade beams, pile caps or interior slabs should account for this potential frost jacking. To minimize the frost heave movements, consideration should be given to the use of rigid synthetic insulation, extending outward laterally (minimum 1.8 m length and about 100 mm thick) and beneath the structure.

6.3 Temporary Construction Excavations and Shoring

Construction excavation details were not available at the time of preparation of this report. All trenching and excavations should conform to the latest version of Manitoba Occupational Health and Safety Regulations

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(OH&S). A side slope of 1H:1V can be used for all excavations that have a maximum depth of 1.5 m. Preliminary guidance for temporary excavations is provided on Table 8.

TABLE 8: PRELIMINARY GUIDANCE FOR TEMPORARY EXCAVATIONS

Height of Excavation (m)	Side Slope
0 – 1.5	1H:1V
1.5 – 3.0	2H:1V

Notwithstanding Table 7, 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. If any excavation is to be performed adjacent to the existing streets or infrastructure, temporary shoring or bracing will be required. Suitable options include steel piling and timber lagging or driven steel sheet piling.

The soil may be susceptible to sloughing from wetting and mechanical disturbance. 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 is the potential for localized groundwater inflows into an excavation that may require temporary pumping as well as potential shoring. Design of the above measures will depend on the size, depth and extent of the excavation.

6.4 Depth of Frost Penetration

The depth of frost penetration will vary depending on air temperature, ground cover, the type of any fill material used during development and other factors.

The expected depth of frost penetration has been estimated assuming a design freezing index of 2680°C days, taken as the coldest winter over a 10 year period. The estimated maximum depth of frost penetration is 2.5 m assuming bare ground and no insulation cover. The clay soils can heave upon freezing and that consideration must be considered in the foundation design. Good site drainage must also be maintained after development.

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

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

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

The depth of burial (minimum 3 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.

6.5 Type of Cement for Concrete Mix

It is recommended that all concrete be made with high sulphate-resistant cement (HS or HSb), and all concrete piles and pile caps should have a minimum specified 28-day compressive strength of 35 MPa and S-1 class of exposure, 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 5, CSA A23.1-04.

6.6 Site Surface Drainage

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

7.0 CONCLUSIONS

Based on our assessment the following conclusions are made:

- A total six (6) test holes were drilled for the additional structures at the NEWPCC. In general, the stratigraphy at the site was interpreted by KGS Group to consist of thin layer of topsoil, various fill materials underlain by clay and silt till.
- Based on the geotechnical field investigation the existing subgrade will consist of sand fill from approximately Sta. 0+032 to 0+080, and native clay and clay fill materials from Sta. 0+080 to the proposed railcar shelter 2.

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- Groundwater inflows and potential sloughing may have to be dealt with during construction depending on the type of foundation being installed and whether groundwater conditions differ from those encountered during the investigation at the individual test hole locations. If water inflows are encountered, water inflows will have to be controlled. Shoring or temporary cut slopes greater than 1.5 m deep or below the water table must be designed by a qualified geotechnical engineer.
- In KGS Group's experience, sporadic and irregular zones of cobbles and/or boulders have been encountered within till deposits. These zones can cause difficulties when advancing bored piles or caissons through the till. The cobbles and boulders would need to be removed when encountered within foundation excavations. Contractors should anticipate that sleeving may be required for all bored piles to keep the holes open.
- Straight shaft cast-in-place concrete friction piles, continuous flight auger concrete friction piles, straight shaft cast-in-place end-bearing concrete piles and driven concrete piles may be used to support the foundation loads for the proposed development.
- The estimated maximum depth of frost penetration is 2.5 m assuming no insulation cover.

8.0 RECOMMENDATION

Based on our assessment the following recommendations are made:

- A geotechnical resistance factor Φ, of 0.4 should be applied for the design of the piles and 0.5 should be used for slab-on-grade floors if no further confirmation of ULS capacity is undertaken.
- Potential settlements of the deep foundations considered in this report should be reviewed during detailed design to ensure estimated settlement is within the acceptable limits of the proposed development.
- A slab-on-grade foundation can be used if seasonal movement, differential settlement and cracking of the slab up to 100 mm are acceptable. If not, then a structural slab supported on intermediate piles should be utilized. If slab-on-grade floor construction founded on the native clay is selected for any structure, the clay may be assigned an estimated unfactored Ultimate Limit States (ULS) bearing capacity of 200 kPa.
- A minimum of 150 mm void space should be constructed under all structural elements including pile caps, grade beams and structural floor slabs to accommodate for frost action of the underlying soil.
- The reinforcement and concrete should be placed as soon as possible after bearing surface is approved to prevent disturbance to the foundation soil during subsequent construction activity.
- Cast-in-place concrete piles should have steel reinforcement designed by a structural engineer.
- It is recommended that all concrete foundations in contact with native soils utilize sulphate resistant cement CSA Type HS.

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- Since seepage and sloughing may occur, full-length steel sleeves should be maintained on site and utilized as required during construction to maintain the pile shaft and base in a clean dry state.
- Full-time inspection by experienced geotechnical personnel should be completed throughout construction of foundations to ensure that the design capacities indicated in this report are achieved. Detailed construction records should also be kept by qualified personnel throughout construction.
- Based on the results of the CRB testing the clay fill and clay observed on the site have poor bearing capacity and are not suitable for re-use as structural subgrade fill materials.
- The existing sand and gravel fill subgrade material are classified as frost group F1 and are not susceptible to frost. The native clay deposit and the clay fill materials are highly susceptible to frost and are classified as frost group F4.
- The clay fill and clay subgrade, observed from Sta. 0+080 to the proposed railcar shelter 2, should be sub-excavated a minimum of 300 mm.

9.0 CLOSURE

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

Prepared By:

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Approved By:

Dami Adedapo, Ph.D., P.Eng.
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STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

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

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

Third Party Use of Report

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

Geotechnical Investigation Statement of Limitations

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

APPENDIX A

Test Hole Log Records

KGS GROUP

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TEST HOLE LOG

HOLE NO.
BH21-01

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	21-0107-015
PROJECT	**NEWPCC Interim Phosphorous Removal**	**SURFACE ELEV.**	232.88 m
LOCATION	NEWPCC Winnipeg, MB	**DATE DRILLED**	11-25-2021
DESCRIPTION	South of rail track	**UTM (m)**	N 5,534,872.62
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer		E 635,588.17
METHOD(S)	0.0 m to 4.6 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
232	1	5		**SAND FILL** - Brown, dry, compact, fine to coarse grained, some gravel.				S1
				- PSA: 18% gravel, 74% sand, 8% silt, 0% clay at 0.8 m.				S2
								B1
								B2
231	2							S3
				- Some light brown silt below 2.3 m.				S4
					230.1			B3
230	3	10		**CLAY (CH)** - Brown, moist, firm, high plasticity, trace silt.				B4
								S5
229	4							
		15			228.3			S6
228	5			Notes: 1. End of test hole at 4.6 m. 2. Test hole remained open to 4.6 m upon completion of drilling.				
227	6	20						
226	7							
		25						
225	8							
224	9	30						
223								

PL MC LL

Cu TORVANE (kPa) ◆

qu POCKET PEN (kPa) ★

SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS ▼ **Upon Completion of Drilling** on 11-25-2021 Dry

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **I. MONTANI**
APPROVED J. MACLENNAN	DATE 1-31-2022

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TEST HOLE LOG

HOLE NO.
BH21-02

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	21-0107-015
PROJECT	**NEWPCC Interim Phosphorous Removal**	**SURFACE ELEV.**	232.50 m
LOCATION	NEWPCC Winnipeg, MB	**DATE DRILLED**	11-25-2021
DESCRIPTION	South of rail track	**UTM (m)**	N 5,534,859.26
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer		E 635,636.02
METHOD(S)	0.0 m to 4.6 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
232				**GRAVEL FILL** - Light brown, dry, compact, fine to coarse grained, some gravel.				S1
					231.9			
	1			**CLAY (CH)** - Brown, moist, stiff, high plasticity, trace silt. - LL=68, PL=25, PI=43 at 0.6 m. - PSA: 1% gravel, 10% sand, 40% silt, 49% clay at 0.6 m.				S2
								B1
								B2
231		5						S3
	2			- Black to dark brown below 1.8 m.				
								S4
230								B3
	3	10						B4
								S5
229								
	4							
228		15			227.9			S6
	5			Notes: 1. End of test hole at 4.6 m. 2. Test hole remained open to 4.6 m upon completion of drilling.				
227								
	6	20						
226								
	7							
225		25						
	8							
224								
	9	30						
223								

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS ▼ **Upon Completion of Drilling** on 11-25-2021 Dry

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **I. MONTANI**
APPROVED J. MACLENNAN	DATE 1-31-2022

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KGS GROUP

TEST HOLE LOG

HOLE NO.
BH21-03

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	21-0107-015
PROJECT	**NEWPCC Interim Phosphorous Removal**	**SURFACE ELEV.**	231.68 m
LOCATION	NEWPCC Winnipeg, MB	**DATE DRILLED**	11-26-2021
DESCRIPTION	South of rail track	**UTM (m)**	N 5,534,848.75
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer		E 635,659.23
METHOD(S)	0.0 m to 4.6 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
231	0	0		**TOPSOIL** - Black, frozen to 0.2 m.	231.3			S1
	1			**CLAY FILL** - Dark brown, damp, stiff, intermediate plasticity, with sand. - LL=47, PL=20, PI=27 at 0.6 m. - PSA: 2% gravel, 43% sand, 28% silt, 27% clay at 0.6 m.				S2
					230.5			B1
				CLAY (CH) - Dark brown, moist, stiff, high plasticity, trace silt.				B2
230	2	5						S3
					229.4			S4
229	3	10		**SILT (ML)** - Light brown, moist, soft, low plasticity.				B3
								B4
228	4							S5
		15			227.1			S6
227	5			Notes: 1. End of test hole at 4.6 m. 2. Test hole remained open to 4.6 m upon completion of drilling.				
226	6	20						
225	7							
224		25						
	8							
223								
	9	30						
222								

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS ▼ **Upon Completion of Drilling** on 11-26-2021 Dry

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **I. MONTANI**
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TEST HOLE LOG

HOLE NO.
BH21-04

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	21-0107-015
PROJECT	**NEWPCC Interim Phosphorous Removal**	**SURFACE ELEV.**	231.46 m
LOCATION	NEWPCC Winnipeg, MB	**DATE DRILLED**	11-24-2021
DESCRIPTION	South of existing building adjacent to the rail track	**UTM (m)**	N 5,534,833.07
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer		E 635,689.16
METHOD(S)	0.0 m to 24.4 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER	PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ (20 40 60 80)
231				**TOPSOIL** - Black, No logging or sampling.	231.4			
				CLAY (CH) - Dark brown, moist, stiff, high plasticity, trace silt, No logging or sampling.				
	1							
230		5		- Firm below 1.8 m.				
	2				229.1			
229				**SILT (ML)** - Light brown, moist, soft, low plasticity, trace to some clay.				
	3	10						
228					227.8			
				CLAY (CH) - Brown, moist, stiff, high plasticity, some silt, trace silt inclusions.				
	4							
227		15						
	5							
226								
	6	20						
225				- Grey below 6.4 m.				
	7							
224		25						
	8							
223								
	9	30						
222								

WATER LEVELS

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **I. MONTANI**
APPROVED J. MACLENNAN	DATE 1-31-2022

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TEST HOLE LOG

HOLE NO.
BH21-04

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER	PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
221	11 35						
220	12 40						
219	13						
218	45						
217	14						
216	15 50						
215	16						
214	55						
213	17						
212	18 60						
211	19						
210	20 65			211.3			
	21 70		**SILT TILL** - Light brown, moist, compact, some fine to coarse grained gravel, trace to some fine grained sand. - dense below 20.7 m.				

WATER LEVELS

CONTRACTOR
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TEST HOLE LOG

HOLE NO.
BH21-04

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ (20 40 60 80)
209	22					
	75					
208	23					
	24					
207	80		ELEV (m) 207.1			
	25		Notes: 1. End of test hole at 24.4 m. 2. Auger refusal encountered in till at a depth of 24.4 m.			
206	85					
	26					
205	27					
204	90					
	28					
203	29					
	95					
202	30					
201	100					
	31					
200	32					
	105					
199	33					
198	110					

WATER LEVELS

CONTRACTOR
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TEST HOLE LOG

HOLE NO.
BH21-05

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	21-0107-015
PROJECT	**NEWPCC Interim Phosphorous Removal**	**SURFACE ELEV.**	231.33 m
LOCATION	NEWPCC Winnipeg, MB	**DATE DRILLED**	11-26-2021
DESCRIPTION	West of existing Building	**UTM (m)**	N 5,534,866.42
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer		E 635,684.31
METHOD(S)	0.0 m to 22.9 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
231	0	0		**TOPSOIL** - Black.	231.2						
				CLAY (CH) - Dark brown, moist, stiff, high plasticity, trace silt.				S1			
								S2			
230	1	5						S3			
				- Firm below 1.8 m.							
229	2				229.0			S4			
				SILT (ML) - Light brown, moist, soft, low plasticity, trace to some clay.							
228	3	10						S5			
					227.7						
227	4			**CLAY (CH)** - Brown, moist, stiff, high plasticity, some silt, trace silt inclusions.				S6			
		15		- Mottled grey/brown below 4.6 m.				S7			
	5			- Firm at 4.6 m.							
226								S8			
	6	20						S9			
225				- Grey below 6.4 m.							
	7			- Firm below 6.9 m.							
224		25						S10			
	8										
223											
	9	30		- Increased silt content from 9.1 m to 10.1 m.				S11			
222											

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS
During Drilling 21.34 m on 11-26-2021
Upon Completion of Drilling 10.36 m on 11-26-2021

CONTRACTOR
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TEST HOLE LOG

HOLE NO.
BH21-05

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
221	0		- Soft below 9.9 m.		▼					
	35		- Some silt inclusions below 10.7 m.			S	S12			
	11									
220			- Trace fine to coarse grained gravel below 11.3 m.							
	12									
	40					S	S13			
219										
	13									
218										
	45					S	S14			
	14									
217										
	15									
	50					S	S15			
216										
	16									
215										
	55					S	S16			
	17									
214										
	18									
	60					S	S17			
213				212.4						
	19		**SILT TILL** - Light brown, moist, compact, some fine to coarse grained gravel, trace to some fine grained sand.							
212										
	65					S	S18			
	20									
211										
	21									
210	70		- Wet, infrequent cobbles below 21.3 m.		▽	S	S19			
						S	S20	72	10 18 9	27

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

120 ★
215 ★

WATER LEVELS
▽ **During Drilling** 21.34 m on 11-26-2021
▼ **Upon Completion of Drilling** 10.36 m on 11-26-2021

CONTRACTOR
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INSPECTOR
I. MONTANI

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TEST HOLE LOG

HOLE NO.
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ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE	PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ (20 40 60 80)
209	22	75			208.4		S21	100	50/ 90mm	+100		
208	23			Notes: 1. End of test hole at 22.9 m. 2. Auger refusal encountered in till at a depth of 22.9 m. 3. Test hole caved to 12.8 m upon completion of drilling.								
207	24	80										
206	25											
205	26	85										
204	27											
203	28	90										
202	29	95										
201	30											
200	31	100										
199	32	105										
198	33	110										

WATER LEVELS
- **During Drilling** 21.34 m on 11-26-2021
- **Upon Completion of Drilling** 10.36 m on 11-26-2021

CONTRACTOR: **Maple Leaf Drilling Ltd.**
INSPECTOR: **I. MONTANI**
APPROVED: J. MACLENNAN
DATE: 1-31-2022

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KGS GROUP

TEST HOLE LOG

HOLE NO.
BH21-06

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	21-0107-015
PROJECT	**NEWPCC Interim Phosphorous Removal**	**SURFACE ELEV.**	230.75 m
LOCATION	NEWPCC Winnipeg, MB	**DATE DRILLED**	11-25-2021
DESCRIPTION	North compound	**UTM (m)**	N 5,535,100.8
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer		E 635,667.27
METHOD(S)	0.0 m to 20.7 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	PL MC LL / Cu TORVANE (kPa) ◆ / qu POCKET PEN (kPa) ★ / SPT (N) BLOWS/0.30 m ▲ (20 40 60 80)
				TOPSOIL - Black, moist, with organics.	230.6				
				CLAY FILL - Brown, moist, stiff, high plasticity, some medium to coarse grained sand, trace fine to medium grained gravel.				S1	
230	1				229.9			S2	
				SAND AND GRAVEL FILL - Brown, moist, compact, fine to coarse grained.					
		5			229.3			S3	
229	2			**CLAY (CH)** - Brown, moist, stiff, high plasticity. - Brown mottled light brown, some silt to 1.5 m.					
				- Firm at 2.3 m.				S4	◆
228	3	10						S5	◆
				- Sand seam, medium to coarse grained from 3.3 m to 3.5 m.					
				- black smears to 3.6 m.		▼		S6	◆
227	4								
		15		- Trace silt inclusions below 4.6 m.				S7	◆
226	5							S8	◆
225	6	20		- Grey below 6.1 m.				S9	◆
224	7								◆
		25						S10	◆
223	8								◆
222	9	30						S11	◆
221									◆

WATER LEVELS
▽ **During Drilling** 20.57 m on 11-25-2021
▼ **Upon Completion of Drilling** 3.66 m on 11-25-2021

CONTRACTOR **Maple Leaf Drilling Ltd.**
INSPECTOR **I. MONTANI**
APPROVED J. MACLENNAN
DATE 1-31-2022

KGS_LOG C:\USERS\JMACLENNAN\ONEDRIVE - KGS GROUP\FMS\FMS\21-0107-015\NEWPCC LOGS.GPJ

KGS GROUP

TEST HOLE LOG

HOLE NO.
BH21-06

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
220	11	35						S12
219	12	40						S13
218	13							
217	14	45						S14
216	15	50		- Trace gravel below 15.2 m.				S15
215	16							
214	17	55						S16
213	18							
212	19	60						S17
211	20	65						S18
210	21	70			210.2	▽		S19
				SILT TILL - Light grey, wet, compact, some fine to coarse grained gravel.	210.0			S20
209				- White rock at end of split spoon at 20.7 m.				

Notes:
1. End of test hole at 20.7 m.
2. Auger refusal encountered in till at a depth of 20.7 m.
3. Test hole caved to 3.7 m upon completion of drilling.

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS
▽ **During Drilling** 20.57 m on 11-25-2021
▼ **Upon Completion of Drilling** 3.66 m on 11-25-2021

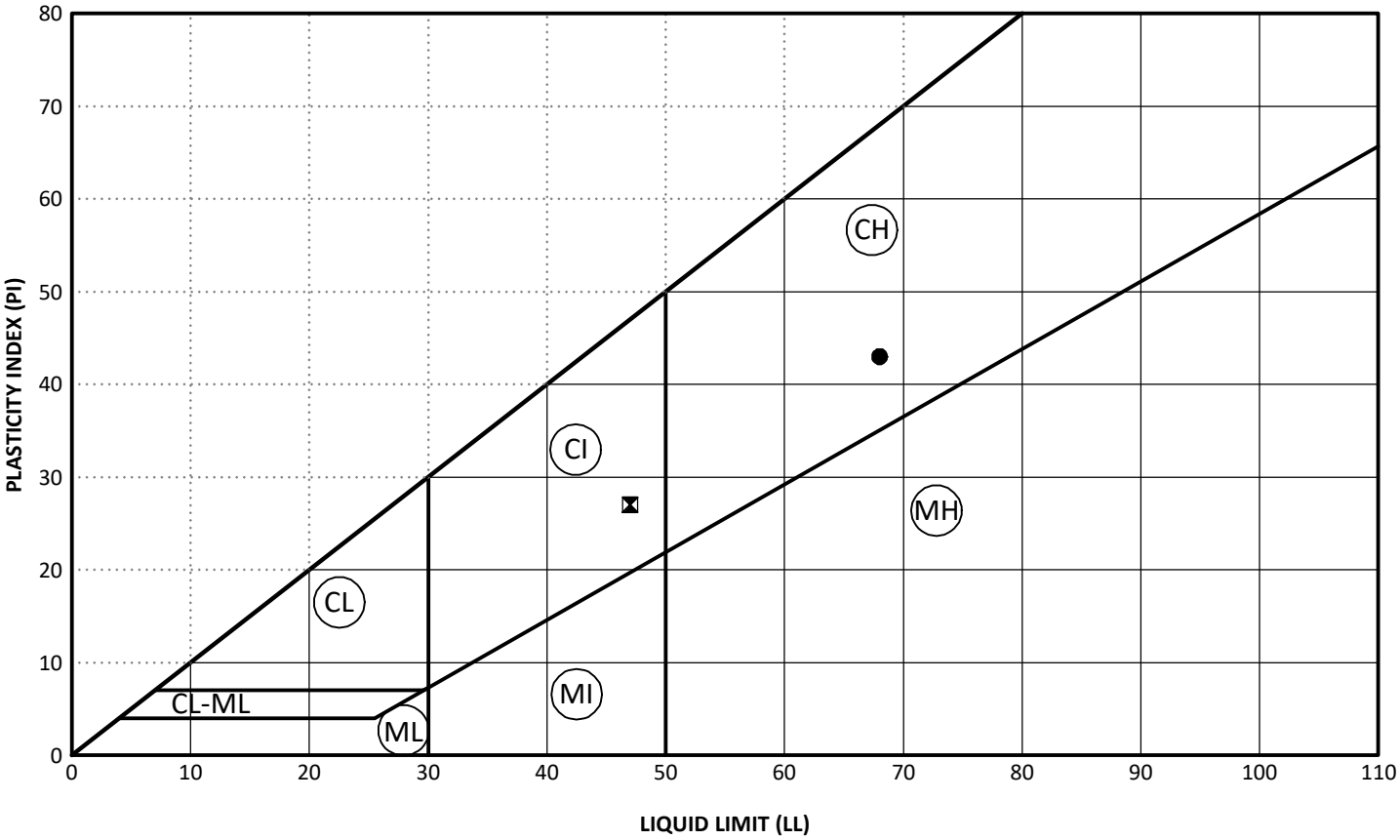
CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
I. MONTANI

APPROVED
J. MACLENNAN

DATE
1-31-2022

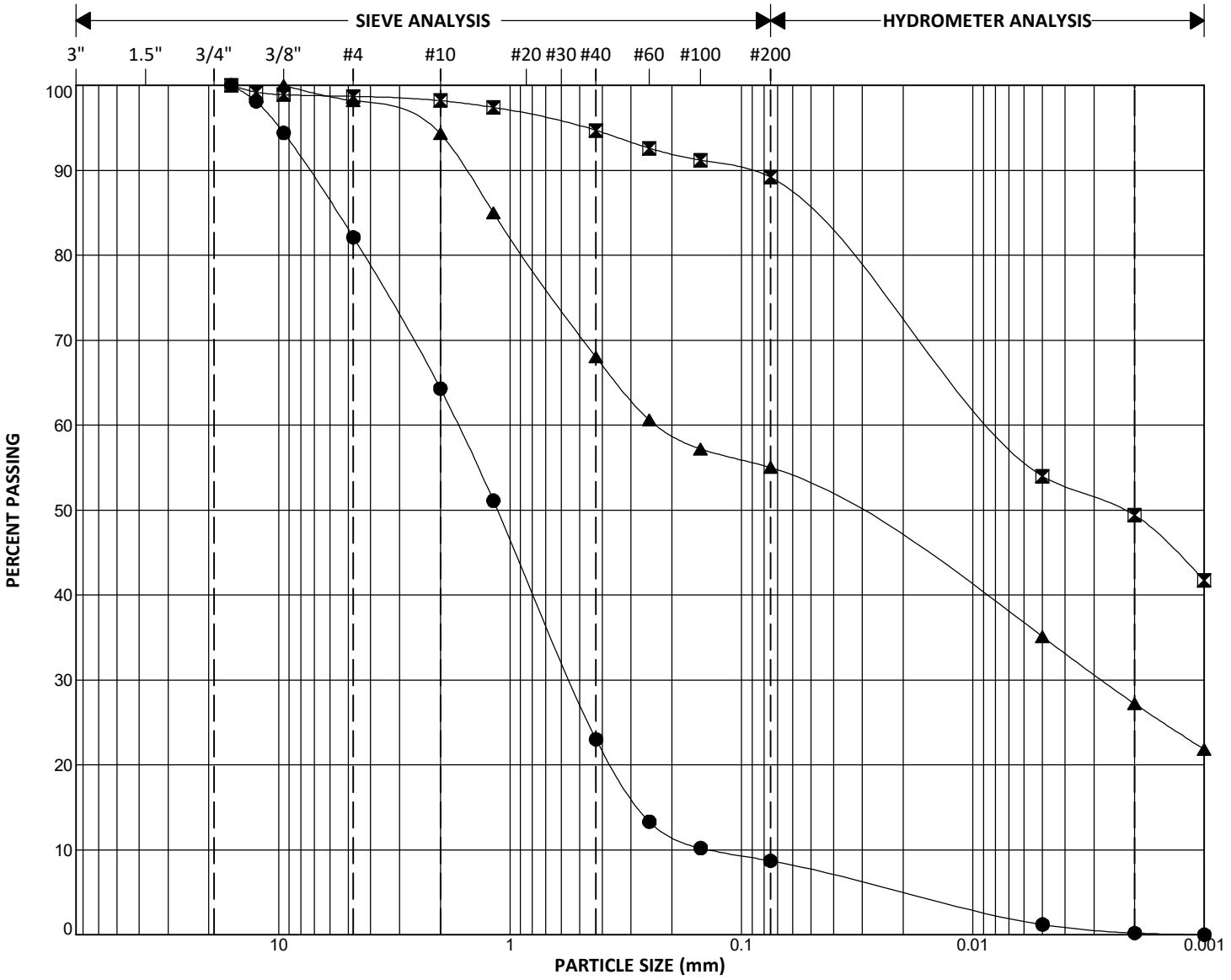
ATTERBERG LIMITS



	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	MC (%)	CLASSIFICATION
●	BH21-02	0.6	B1	68	25	43	10	40	49	89	29	CH
⊠	BH21-03	0.6	B1	47	20	27	43	28	27	55	25	CL

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**		**PROJECT NO.**	21-0107-015
PROJECT NAME	NEWPCC Interim Phosphorous Removal		**LOCATION**	NEWPCC Winnipeg, MB
TESTED BY	Stantec		**DATE TESTED**	December 7, 2021

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	BH21-01	0.8	S2	18	73	8	0	9	12.3	1.3	SP
⊠	BH21-02	0.6	B1	1	10	40	49	89			CH
▲	BH21-03	0.6	B1	2	43	28	27	55			CL

SIEVE ANALYSIS C:\USERS\JMACLENNAN\ONEDRIVE - KGS GROUP\FMS\FMS\21-0107-015\NEWPCC LOGS.GPJ

KGS GROUP

CLIENT	**CITY OF WINNIPEG - PUBLIC WORKS**	**PROJECT NO.**	21-0107-015
PROJECT NAME	NEWPCC Interim Phosphorous Removal	**LOCATION**	NEWPCC Winnipeg, MB
TESTED BY	Stantec	**DATE TESTED**	Decemeber 6. 2021

KEY TO SYMBOLS

LITHOLOGIC SYMBOLS


Clay (CH, high plasticity)


Fill (made ground)


Silt (ML)


Silt Till


Topsoil

SAMPLER SYMBOLS


Auger Grab


Continuous/Bulk


SPT Split Spoon

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

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

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

KGS GROUP

CLIENT CITY OF WINNIPEG - PUBLIC WORKS
PROJECT NAME NEWPCC Interim Phosphorous Removal
PROJECT NO. 21-0107-015
LOCATION NEWPCC Winnipeg, MB

APPENDIX B

Laboratory Testing Results

KGS GROUP

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

ASTM D2216 - LABORATORY DETERMINATION OF WATER (MOISTURE) CONTENT OF SOIL AND ROCK BY MASS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal (21-0107-015)

PROJECT NO. 123315814

REPORT NO. 1

DATE SAMPLED: Nov. 25-26, 2021
SAMPLED BY: Client

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: Hongwei Liu

DATE TESTED: 2021.Dec.02
TESTED BY: Larry Presado

TESTHOLE	SAMPLE	MC %
BH21-02	BS, 2'-5'	28.8
	S4	38.4
BH21-03	BS, 2'-5'	25.0
	S3	34.5
	S4	25.7
BH21-05	S2	23.0
	S5	25.2
	S8	54.9
	S11	48.5
	S13	54.2
	S15	56.9
	S18	10.3
	S21	11.6

TESTHOLE	SAMPLE	MC %

REPORT DATE 2021.Dec.08

REVIEWED BY Guillaume Beauce, P.Eng.
Associate - Materials Testing Services

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

ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal (21-0107-015)

PROJECT NO. 123315814

REPORT NO. 1

DATE SAMPLED: 2021.Nov.25
SAMPLED BY: Ivanna Montani

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: Hongwei Liu

DATE TESTED: 2021.Dec.07
TESTED BY: Carson Cockwell

SAMPLE ID: BH21-02, BS, 2'-5'

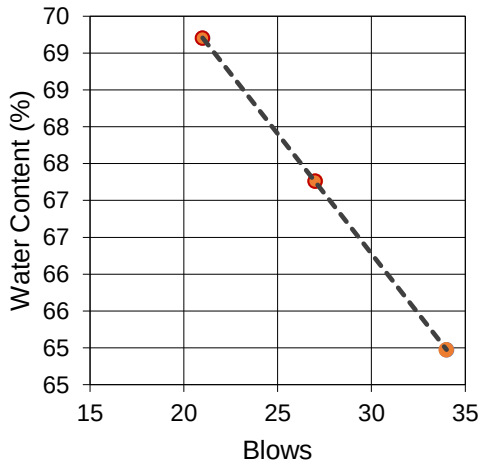
LIQUID LIMIT

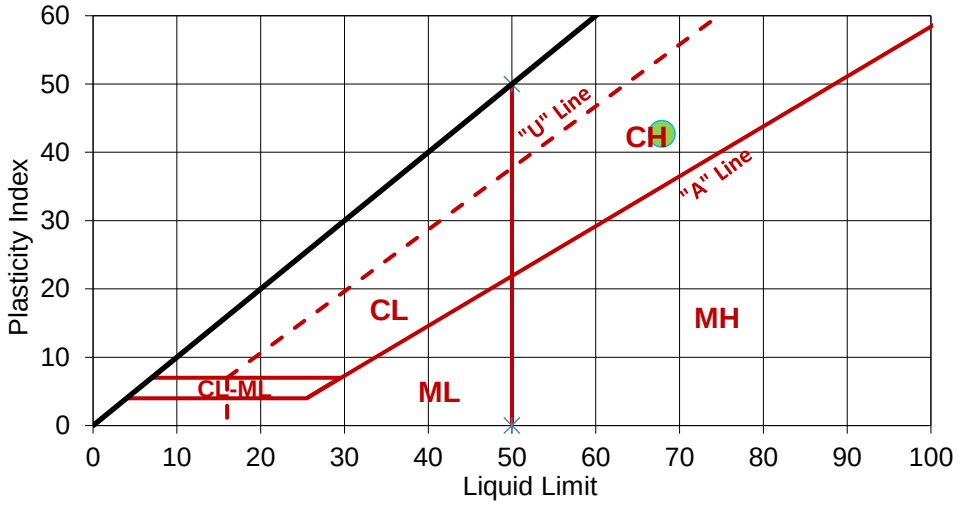
TRIAL	1	2	3
BLOWS	34	27	21
MC (%)	65	67	69

PLASTIC LIMIT

TRIAL	1	2
MC (%)	25	25

LIQUID LIMIT, LL	68
PLASTIC LIMIT, PL	25
PLASTICITY INDEX, PI	43
AS REC'D MC (%)	28.8





COMMENTS:

REPORT DATE 2021.Dec.08

REVIEWED BY Guillaume Beauce, P.Eng.
Associate - Materials Testing Services

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

ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal (21-0107-015)

PROJECT NO. 123315814

REPORT NO. 2

DATE SAMPLED: 2021.Nov.26
SAMPLED BY: Ivanna Montani

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: Hongwei Liu

DATE TESTED: 2021.Dec.07
TESTED BY: Carson Cockwell

SAMPLE ID: BH21-03, BS, 2'-5'

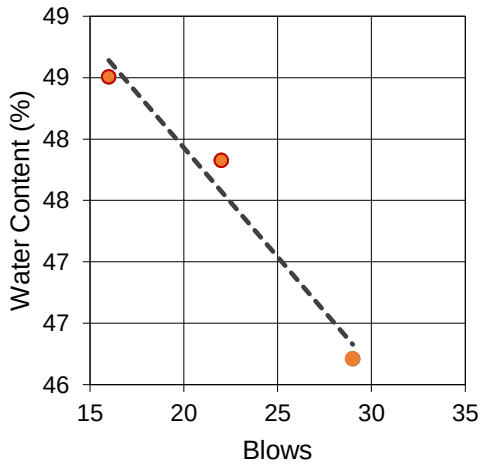
LIQUID LIMIT

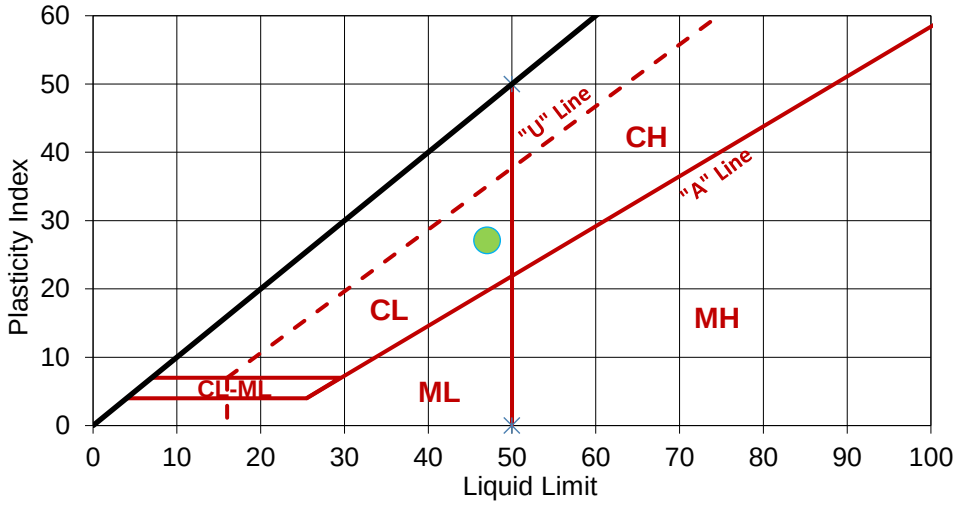
TRIAL	1	2	3
BLOWS	29	22	16
MC (%)	46	48	49

PLASTIC LIMIT

TRIAL	1	2
MC (%)	20	20

LIQUID LIMIT, LL	47
PLASTIC LIMIT, PL	20
PLASTICITY INDEX, PI	27
AS REC'D MC (%)	25.0





COMMENTS:

REPORT DATE 2021.Dec.08

REVIEWED BY Guillaume Beauce, P.Eng.
Associate - Materials Testing Services

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

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal (21-0107-015)

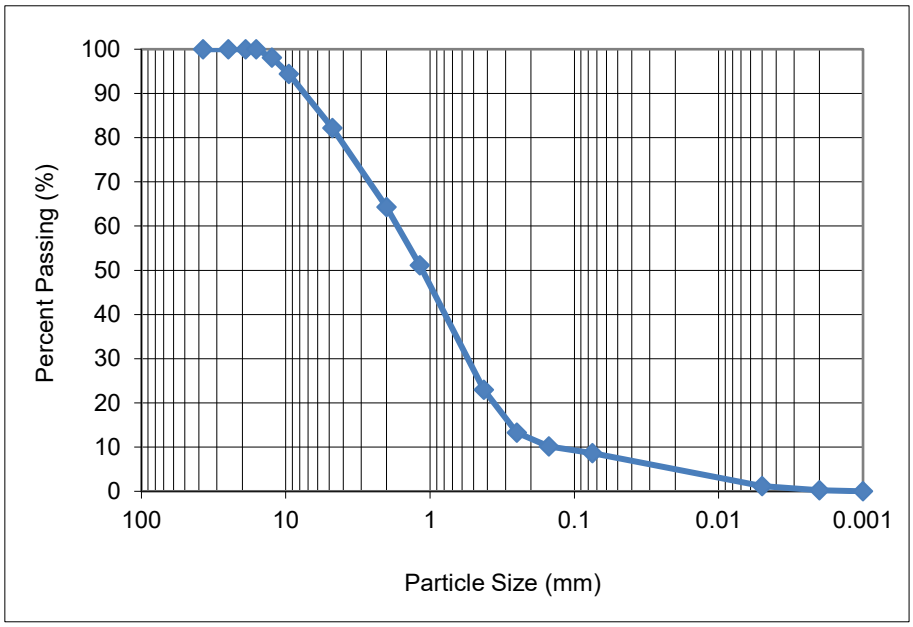
PROJECT NO. 123315814

REPORT NO. 1

DATE SAMPLED: 2021.Nov.25
SAMPLED BY: Ivanna Montani

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: Hongwei Liu

DATE TESTED: 2021.Dec.06
TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	98.1
9.5	94.4
4.75	82.1
2.00	64.3
1.18	51.1
0.425	23.0
0.250	13.3
0.150	10.2
0.075	8.7
0.005	1.2
0.002	0.2
0.001	0.0

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
17.9	17.8	41.3	14.3	8.5	0.2	0.0

COMMENTS:
Material tested was identified as being sampled from BH21-01, S2.

REPORT DATE 2021.Dec.08

REVIEWED BY Guillaume Beauce, P. Eng.
Associate - Materials Testing Services

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

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal (21-0107-015)

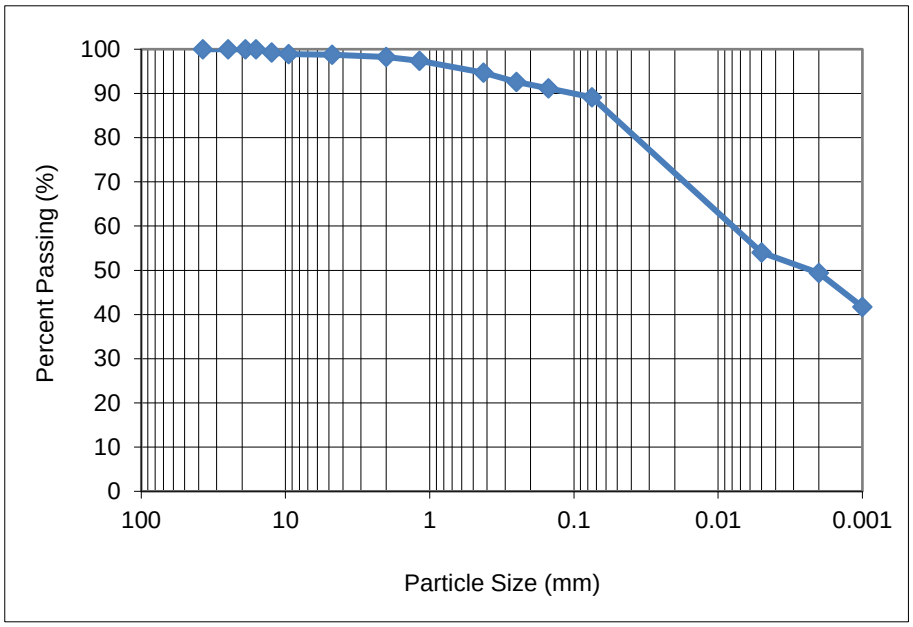
PROJECT NO. 123315814

REPORT NO. 2

DATE SAMPLED: 2021.Nov.25
SAMPLED BY: Ivanna Montani

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: Hongwei Liu

DATE TESTED: 2021.Dec.06
TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	99.2
9.5	98.9
4.75	98.7
2.00	98.2
1.18	97.4
0.425	94.7
0.250	92.6
0.150	91.2
0.075	89.2
0.005	54.0
0.002	49.4
0.001	41.7

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
1.3	0.5	3.5	5.5	39.8	49.4	41.7

COMMENTS:
Material tested was identified as being sampled from BH21-02, BS, 2'-5'.

REPORT DATE 2021.Dec.08

REVIEWED BY Guillaume Beauce, P. Eng.
Associate - Materials Testing Services

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

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal (21-0107-015)

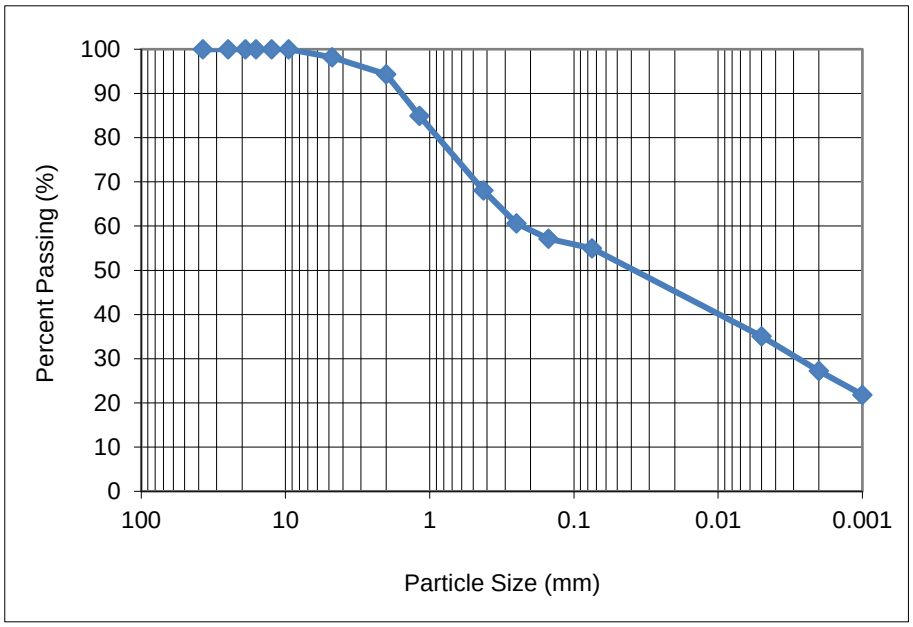
PROJECT NO. 123315814

REPORT NO. 3

DATE SAMPLED: 2021.Nov.26
SAMPLED BY: Ivanna Montani

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: Hongwei Liu

DATE TESTED: 2021.Dec.06
TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	100.0
9.5	100.0
4.75	98.2
2.00	94.3
1.18	85.0
0.425	68.0
0.250	60.6
0.150	57.2
0.075	55.0
0.005	35.1
0.002	27.2
0.001	21.8

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
1.8	3.9	26.3	13.0	27.8	27.2	21.8

COMMENTS:
Material tested was identified as being sampled from BH21-03, BS, 2'-5'.

REPORT DATE 2021.Dec.08

REVIEWED BY Guillaume Beauce, P. Eng.
Associate - Materials Testing Services

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: Jacqueline MacLennan

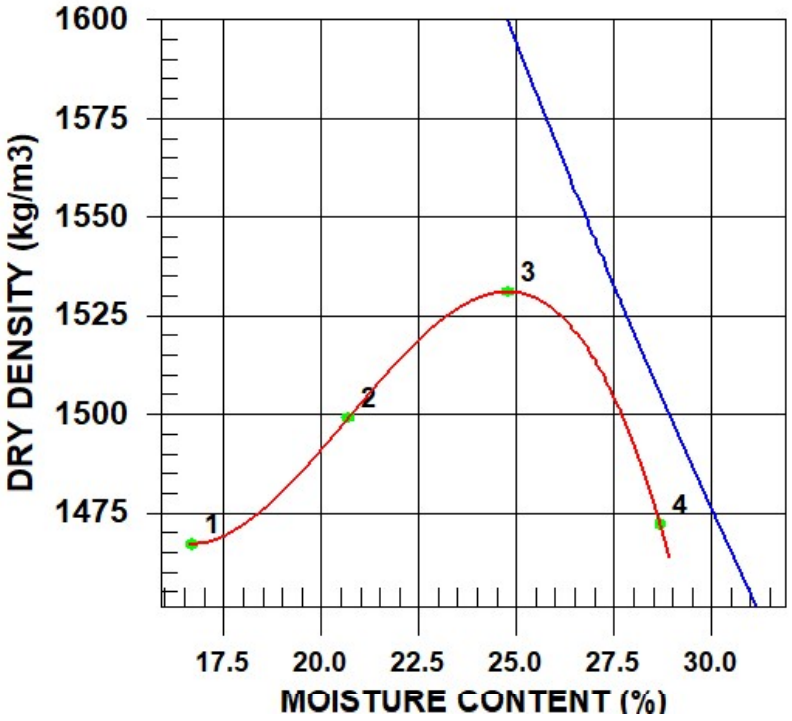
CLIENT KGS Group Inc.
C.C.

PROJECT NEWPCC Interim Phosphorous Removal

PROJECT NO. 123315814
PROCTOR NO. 1 DATE SAMPLED 2021.Nov.25 DATE RECEIVED 2021.Dec.02 DATE TESTED 2021.Dec.07

INSITU MOISTURE 28.8 %
TESTED BY Donald Eliazar
MATERIAL IDENTIFICATION
MATERIAL USE Subgrade
MAX. NOMINAL SIZE
MATERIAL TYPE Silty Clay
SUPPLIER Existing
SOURCE BH21-02, 2' - 5'

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	1712	1467	16.7
2	1809	1499	20.7
3	1911	1531	24.8
4	1894	1472	28.7

	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED	1531	25.0
OVERSIZE CORRECTED		

COMMENTS

REVIEWED BY Jason Thompson, C.E.T.

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: Jacqueline MacLennan

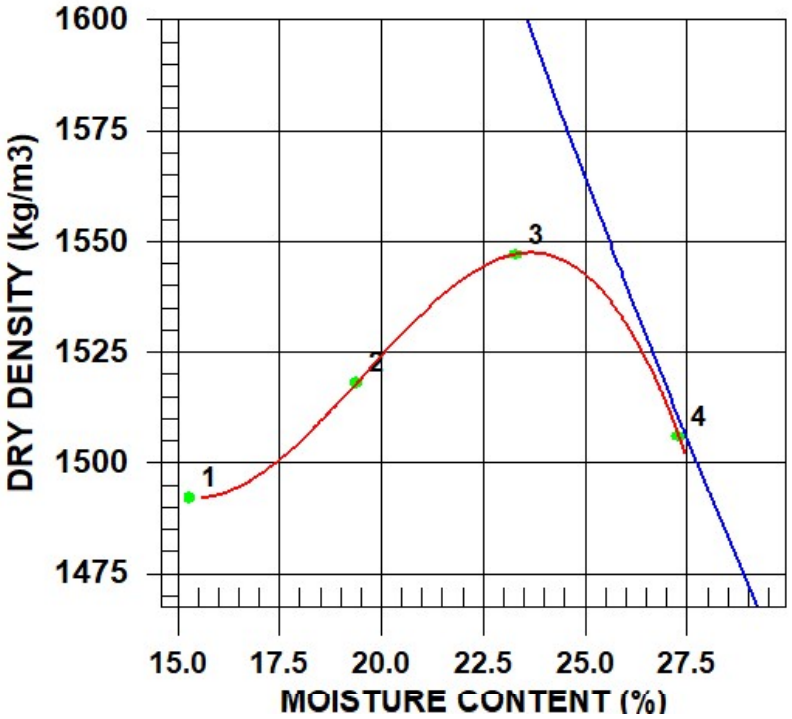
CLIENT KGS Group Inc.
C.C.

PROJECT NEWPCC Interim Phosphorous Removal

PROJECT NO. 123315814
PROCTOR NO. 2 DATE SAMPLED 2021.Nov.26 DATE RECEIVED 2021.Dec.02 DATE TESTED 2021.Dec.07

INSITU MOISTURE 25.0 %
TESTED BY Donald Eliazar
MATERIAL IDENTIFICATION
MATERIAL USE Subgrade
MAX. NOMINAL SIZE
MATERIAL TYPE Silty Clay
SUPPLIER Existing
SOURCE BH21-03, 2' - 5'

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	1720	1492	15.3
2	1813	1518	19.4
3	1908	1547	23.3
4	1917	1506	27.3

	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED OVERSIZE CORRECTED	1547	23.5

COMMENTS

Page 1 of 1 2021.Dec.08

REVIEWED BY Jason Thompson, C.E.T.

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

ASTM D1883 - CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOILS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal

PROJECT NO. 123315814

REPORT NO. 1 (Data page - see Page 2 for Chart)

DATE SAMPLED: 2021.Nov.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2021.Dec.15
TESTED BY: Donald Eliazar

MATERIAL IDENTIFICATION

MATERIAL USE	Not Provided	SUPPLIER	Existing Material
MAX. NOMINAL SIZE	< 4.75 mm	SOURCE	BH21-02, Bulk sample 1 & 2
MATERIAL TYPE	Silty Clay	SAMPLE LOCATION	2' - 5'
SPECIFICATION	Not Applicable	STANTEC SAMPLE NO.	1876

IMMERSION PERIOD	96 ± 2 hr	TARGET MAX. DRY DENSITY	1531 kg/m^3
		TARGET OPTIMUM MOISTURE	25.0 %
CONDITION OF SAMPLE	Soaked		
		AS-COMPACTED MAX. DRY DENSITY	1459 kg/m^3
SURCHARGE MASS	4.54 kg	AS-COMPACTED MOISTURE CONTENT	24.8 %
SWELL OF SAMPLE	2.2%	POST-TEST MOISTURE CONTENT (TOP 25 mm)	31.2 %

CBR VALUE AT **2.54 mm** PENETRATION	**5.2**
CBR VALUE AT **5.08 mm** PENETRATION	**4.1**

COMMENTS:
We appreciate the opportunity to assist you on this project. Please contact the undersigned if you have any questions regarding this report.

REPORT DATE 2021.Dec.16

REVIEWED BY Jason Thompson, C.E.T.
Principal - Manager of Materials Testing Services

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

ASTM D1883 - CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOILS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal

PROJECT NO. 123315814

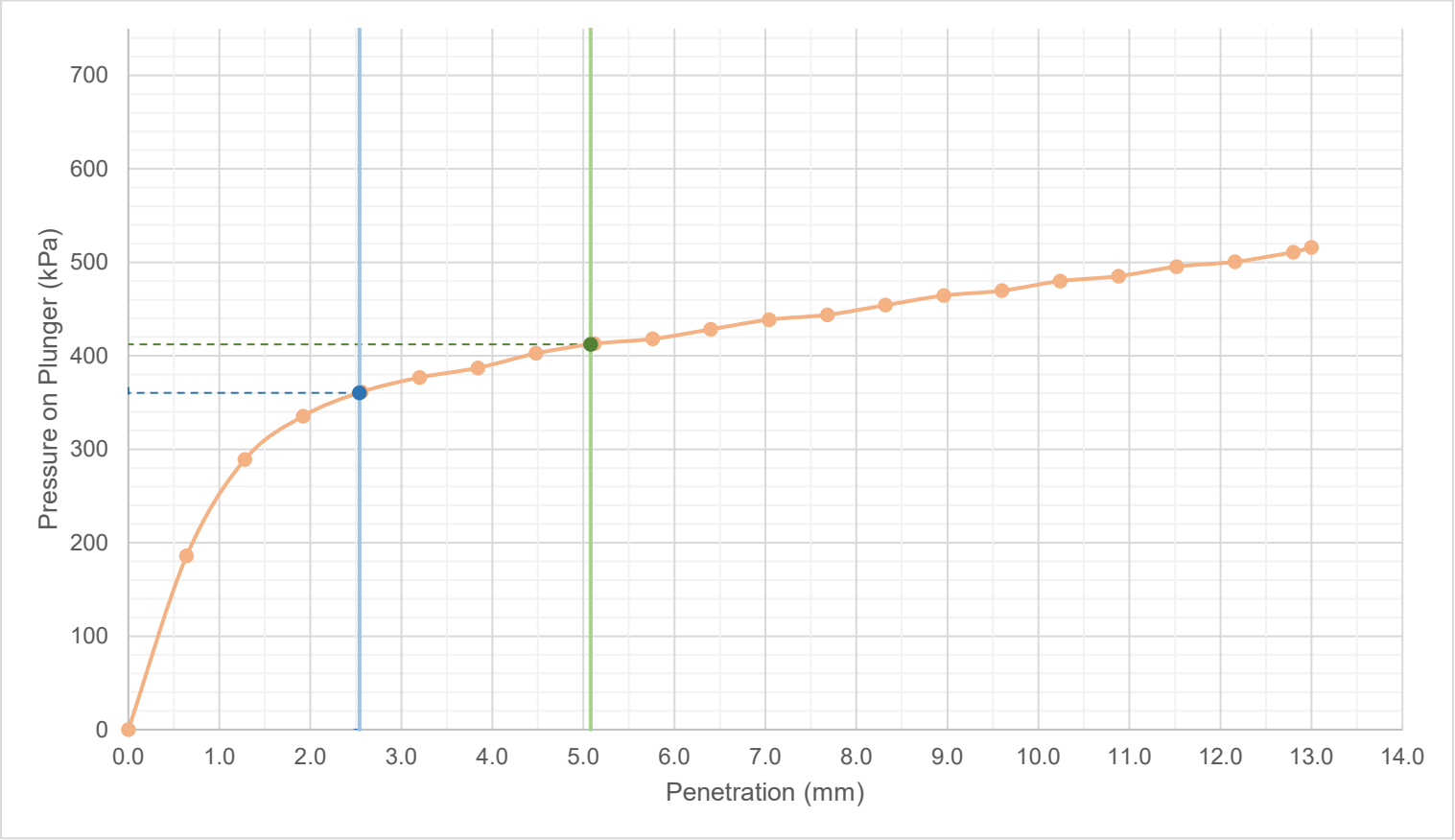
REPORT NO. 1 (Chart page - See Page 1 for Data)

DATE SAMPLED: 2021.Nov.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2021.Dec.15
TESTED BY: Donald Eliazar

LOAD PENETRATION CURVE



REPORT DATE 2021.Dec.16

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

ASTM D1883 - CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOILS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal

PROJECT NO. 123315814

REPORT NO. 2 (Data page - see Page 2 for Chart)

DATE SAMPLED: 2021.Nov.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2021.Dec.15
TESTED BY: Donald Eliazar

MATERIAL IDENTIFICATION

MATERIAL USE	Not Provided	SUPPLIER	Existing Material
MAX. NOMINAL SIZE	< 4.75 mm	SOURCE	BH21-03, Bulk Sample 1
MATERIAL TYPE	Silty Clay	SAMPLE LOCATION	2' - 5'
SPECIFICATION	Not Applicable	STANTEC SAMPLE NO.	1877

IMMERSION PERIOD	96 ± 2 hr	TARGET MAX. DRY DENSITY	1547 kg/m^3
		TARGET OPTIMUM MOISTURE	23.5 %
CONDITION OF SAMPLE	Soaked		
		AS-COMPACTED MAX. DRY DENSITY	1474 kg/m^3
SURCHARGE MASS	4.54 kg	AS-COMPACTED MOISTURE CONTENT	23.4 %
SWELL OF SAMPLE	1.4%	POST-TEST MOISTURE CONTENT (TOP 25 mm)	30.1 %

CBR VALUE AT **2.54 mm** PENETRATION	**5.8**
CBR VALUE AT **5.08 mm** PENETRATION	**4.8**

COMMENTS:
We appreciate the opportunity to assist you on this project. Please contact the undersigned if you have any questions regarding this report.

REPORT DATE 2021.Dec.16

REVIEWED BY Jason Thompson, C.E.T.
Principal - Manager of Materials Testing Services

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

ASTM D1883 - CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOILS

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

ATTN: Jacqueline MacLennan

PROJECT NEWPCC Interim Phosphorous Removal

PROJECT NO. 123315814

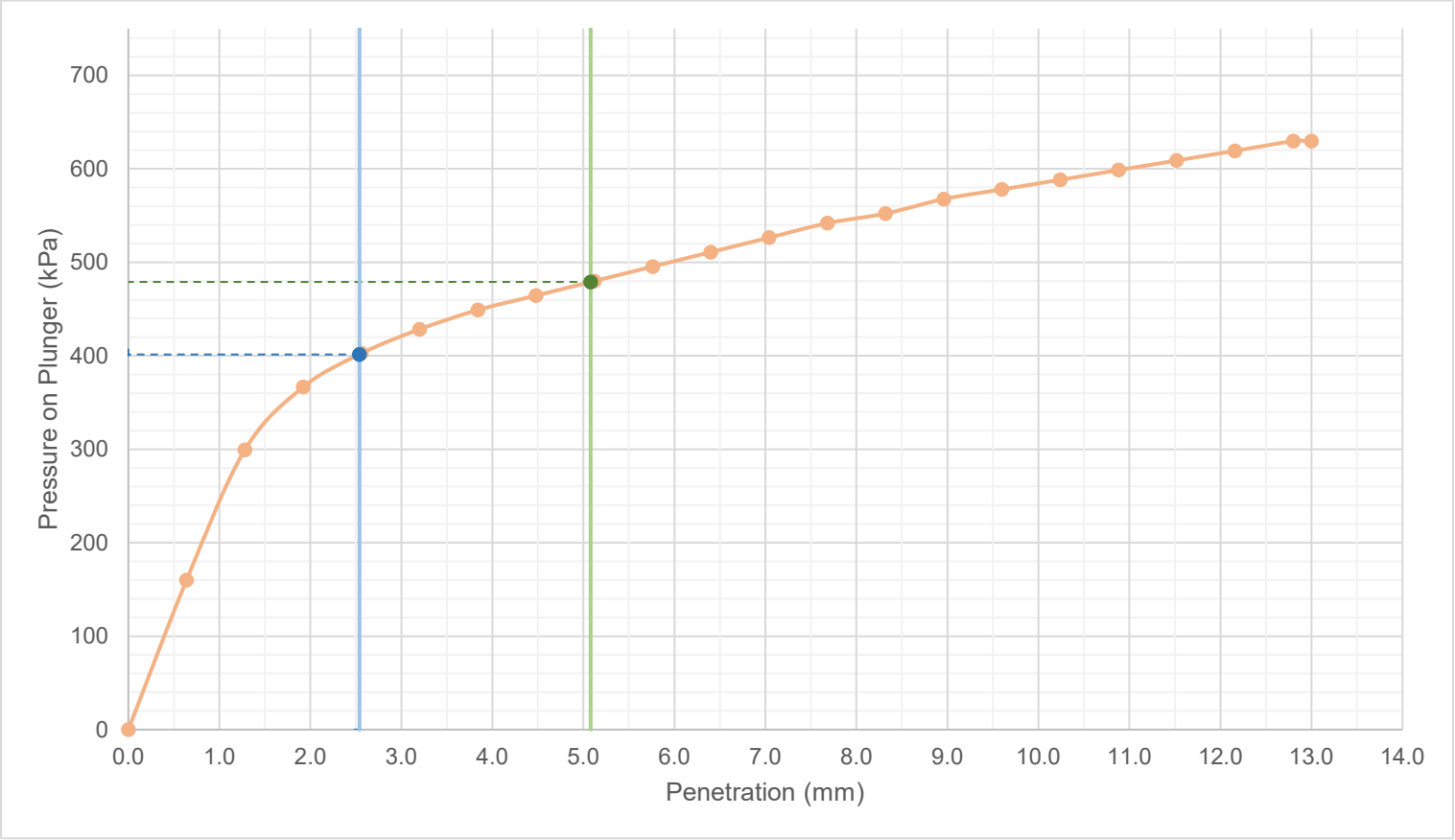
REPORT NO. 2 (Chart page - See Page 1 for Data)

DATE SAMPLED: 2021.Nov.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2021.Dec.02
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2021.Dec.15
TESTED BY: Donald Eliazar

LOAD PENETRATION CURVE



REPORT DATE 2021.Dec.16