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Burns Maendel Consulting Engineers Ltd.

Crystal Springs Colony Community Development Geotechnical Report

Prepared for:
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Project Number: 0105 035 00

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November 8, 2021 Our File No. 0105 035 00

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1331 Princess Avenue
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RE: Crystal Springs Colony Community Development – Geotechnical Report (Revised)

TREK Geotechnical Inc. is pleased to submit our revised final geotechnical investigation report for the above noted project.

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

Ryan Belbas M.Sc., P.Eng.
Senior Geotechnical Engineer

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	RB	October 21, 2021	Final Report
1	RB	November 8, 2021	Revised Final Report

Authorization Signatures

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1.0 Introduction

This report summarizes the results of a geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed Crystal Springs Colony community development located approximately 12 km southwest of Gimli, MB. The terms of reference for the investigation are included in our proposal to Mr. Parasdeep Kanda of Burns Maendel Consulting Engineers Ltd. (BMCE), dated July 5, 2021. The scope of work includes a sub-surface investigation, laboratory testing and provision of geotechnical recommendations for the development.

2.0 Background and Site Conditions

The property is vacant, undeveloped land measuring approximately 640 acres in area and is bounded by Road 106 N to the south, Road 15 E to the east, Road 107 N to the north and vacant, undeveloped land to the west. The property is comprised of a mixture of dense forest and open boggy areas with scattered bushes and grass. The community development will include residential, industrial, and agricultural structures, as well as a school and gymnasium, kitchen, dining room, church, orchard, cemetery, sports field, ice rink, wastewater lagoon, parking areas, and access roads. A layout of the proposed development is shown on Figure 01 (Test Hole Location Plan).

3.0 Existing Information

A conceptual layout of the community development and topographic survey information were provided by BMCE. This information was used by TREK to select the test hole/pit locations for the sub-surface investigation.

4.0 Field Program

4.1 Sub-surface Investigation

A sub-surface investigation was completed May 3 to 6, 2021 under the supervision of TREK personnel to assess soil stratigraphy and groundwater conditions at the site. A total of 23 tests holes (TH21-01 to 23) and six test pits (TP21-01 to 06) were drilled/excavated and sampled at the locations shown on Figure 01. The test holes were drilled to depths ranging from 1.5 to 15.7 m below grade and the test pits were excavated to a depth of approximately 4.0 m. The test holes were drilled by Paddock Drilling Ltd. using a CME-850 track-mounted geotechnical drill rig equipped with 125 mm diameter solid stem augers. The test pits were excavated by Graboweski Concrete using a track mounted Hitachi Zaxis 135 US excavator. The test holes were backfilled with auger cuttings and/or bentonite chips and the test pits were backfilled with excavated material and track packed.

Sub-surface soils observed during drilling were visually classified based on the Unified Soil Classification System (USCS). Samples retrieved during drilling included disturbed (auger cutting, split spoon, bulk) samples, and relatively undisturbed (Shelby tube) samples. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of moisture content determination on all samples, and undrained shear strength testing (pocket

penetrometer, torvane and unconfined compression), grain size analysis (hydrometer method), Atterberg limits, remolded permeability (flexible wall), and Standard Proctor testing on select samples. Laboratory test results are included in Appendix A.

Test hole/pit locations were recorded using a handheld GPS. Test hole/pit elevations (geodetic) were estimated based on the topographic survey information provided by BMCE. The UTM coordinates of each test hole/pit are provided on the attached test hole/pit logs. Laboratory test results are included in Appendix A. The test hole/pit logs also include a description of the soil units encountered and other pertinent information such as groundwater and sloughing conditions, and a summary of the laboratory testing results.

4.2 Soil Stratigraphy

A brief description of the units encountered at the test hole/pit locations are provided below. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole/pit logs.

The soil stratigraphy encountered at the test hole/pit locations generally consists of organic clay or silt (topsoil) or peat (approximately 0.2 m thick) overlying layers of sand, silt and clay, and/or silty clay which are underlain by silt till. The sand, silt and clay, and silty clay layers are variable in thickness. These layers were not encountered in test holes in TH21-04, 14, 18, 20, or 23 as well as TP21-06 and vary in thickness from 0.2 to 2.8 m in the remaining test holes/pits. The sand is generally poorly graded, fine to coarse grained, dry to moist, and loose. The silt and clay is typically dry to moist, stiff to hard, and of intermediate plasticity. The silty clay is moist, stiff, and of high plasticity. The silt till is generally sandy, with trace to some clay, trace gravel, and trace cobbles. It is dry to moist and compact to very dense.

4.3 Groundwater Conditions

Groundwater seepage and sloughing were observed in several of the test holes/pits as noted in Table 1. Seepage and sloughing conditions were not observed in any other test holes/pits.

Table 1. Groundwater Seepage and Sloughing Conditions

Test Hole / Test Pit	Depth Below Grade (m)	Depth Groundwater Seepage Encountered Below Grade (m)	Water Level Below Grade Upon Completion of Drilling/Excavation (m)	Depth Sloughing Encountered Below Grade (m)	Depth Below Grade Test Hole/Pit Open to Upon Completion of Drilling (m)
TH21-01	3.0	Not observed	dry	0.1 to 0.5	2.3
TH21-02	1.7	Not observed	dry	0.1 to 0.3	1.5
TH21-04	2.0	Not observed	dry	Below 1.5	1.5
TH21-05	2.0	Not observed	dry	0.3 to 0.5	1.4
TH21-08	2.0	Not observed	dry	Below 1.5	1.5
TH21-09	2.0	Not observed	dry	Below 1.5	1.5
TH21-10	2.0	Not observed	dry	Below 1.5	1.5
TH21-13	6.5	Not observed	dry	Below 6.0	6.1
TH21-14	6.6	4.6	dry	Not observed	5.8
TH21-15	6.6	2.1 to 2.4	5.6	0.1 to 1.5	5.6
TH21-16	6.5	Not observed	dry	Below 5.0	5.9
TH21-17	6.5	Not observed	dry	Below 6.0	6.1
TH21-19	6.5	Not observed	dry	Below 6.0	6.1
TH21-20	7.6	Not observed	dry	Below 7.0	7.5
TH21-21	15.7	Not observed	dry	Below 6.0	6.1
TH21-22	15.7	Not observed	dry	1.2 to 1.5	15.2
TH21-23	15.7	9.1 to 10.7	2.6	9.1 to 10.7	10.7
TP21-01	4.1	Not observed	dry	0.1 to 1.4	4.1
TP21-02	4.1	Not observed	dry	0.3 to 0.9	4.1
TP21-03	4.0	Not observed	dry	0.1 to 1.2	3.8
TP21-05	4.0	Not observed	dry	0.3 to 1.2	4.0

The groundwater observations made during drilling are short-term and should not be considered reflective of (static) groundwater levels at the site which would require monitoring over an extended period to determine. It is important to recognize that groundwater conditions may vary seasonally, annually, or as a result of construction activities.

5.0 Site Development

Site development is anticipated to require levelling of the ground surface to achieve design grades. Ground levelling is expected to consist of cut and fill methods. In areas where fill is required to raise grades, organics (topsoil, peat), silt, and any other deleterious materials should be stripped such that the sub-grade consists of sand, silt and clay, silty clay, or silt till. The fill may also consist of the local silt and clay, silty clay, sand, and silt till materials. Fill should be placed in lifts no greater than 150 mm

and compacted to at least 95% of the Standard Proctor Maximum Dry Density (SPMDD). At this level of compaction, settlement ranging from 1 to 2% of the fill thickness for soils such as the natural silt and clays and silty clays, silt tills, and sands and 0.5 to 1% of the fill thickness for imported granular fills should be expected.

6.0 Foundation Recommendations

The most suitable foundation options for the proposed development include cast-in-place concrete (CIPC) footings and thickened-edge slabs based on the observed sub-surface and loading conditions. Deep foundations such as CIPC friction piles are also suitable for heavy foundation loads but are not anticipated to be required. Recommendations according to the National Building Code of Canada (NBCC, 2010) are provided in the following sections. Driven pile options such as precast concrete piles and steel piles were not evaluated as part of our current scope of work and may not be suitable due to the potential for boulders within the till.

6.1 Limit States Design

Limit States Design recommendations for shallow and deep foundations in accordance with the NBCC (2010) are provided below. Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The **Ultimate Limit State (ULS)** is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load to provide an adequate margin of safety. Table 2 summarizes the resistance factors that can be used for the design of deep foundations as per the NBCC (2010) depending upon the method of analysis and verification testing completed during construction.

The **Service Limit State (SLS)** is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The Service Limit State should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not yet defined at the preliminary design stage. As such, SLS bearing capacities are often provided that are developed on the basis of limiting settlement to 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust the SLS capacity if a more stringent settlement tolerance is required or if large groups of piles are used.

Table 2. ULS Resistance Factors for Shallow and Deep Foundations (NBCC, 2010)

Resistance to Vertical Loads for Shallow Foundations (Analysis Methods)	Resistance Factor
Semi-empirical analysis using laboratory and *in-situ* test data	0.5
Resistance to Axial Load for Deep Foundations (Analysis Methods)	**Resistance Factor**
Semi-empirical analysis using laboratory and *in-situ* test data	0.4
Analysis using static loading test results	0.6
Uplift resistance by semi-empirical analysis.	0.3
Uplift resistance using loading test results.	0.4

6.2 Shallow Foundations

Footings and thickened-edge slabs bearing on compact to dense silt till can be designed using an SLS unit bearing resistance of 220 kPa and an ULS unit bearing resistance of 330 kPa. Footings and thickened-edge slabs bearing on compact to dense sand, stiff to hard silt and clay, or stiff to very stiff silty clay can be designed using an SLS unit bearing resistance of 100 kPa and an ULS unit bearing resistance of 150 kPa. For thickened-edge slabs the bearing resistances should only be applied to the base of the thickened-edges. The SLS values are based on a limiting settlement to 25 mm or less and the ULS values were determined using a resistance factor of 0.5.

Shallow foundations are subject to vertical movements associated with moisture and volume changes of the underlying silt and clay and silty clay soils. Although difficult to predict, these movements could be in the order of 25 mm or more. Shallow foundations in unheated areas will be subject to further movements due to freeze/thaw of the bearing soils. It may be desirable to provide control joints in the slabs to reduce random cracking and isolation joints to separate the foundations from other structural elements and accommodate these movements. If these movements are considered unacceptable, a piled foundation will be required to support the proposed buildings. It should be understood that seasonal movements are independent of displacement required to mobilize bearing capacity.

The foundation soils at the site (*i.e.* till) are frost susceptible, which refers to the propensity of the soil to grow ice lenses and heave during freezing. Methods to reduce frost-related movements include placement of the footings and thickened edges below the depth of frost penetration (2.4 m below final grade) or incorporating insulation such as Styrofoam Highload into the foundation design to provide frost protection to an equivalent depth of 2.4 m.

Additional Design Recommendations:

1. Footings and thickened edges should be placed on comact to compact to dense silt till, compact to dense sand, stiff to hard silt and clay, or stiff to very stiff silty clay to develop the recommended bearing resistances.

2. Minimum footing and thickened edge widths should be verified with the applicable building code (e.g. Manitoba Building Code, NBCC).
3. A filter-protected drainage system (weeping tile) should be installed around the perimeter of the buildings and connected to a collection (sump) pit and pumped away from the structure to reduce water infiltration into the bearing soils and minimize footing and slab movements.
4. Footings and thickened-edge slabs should be designed to resist all design loads (overturning, sliding, vertical) and forces induced from seasonal movements (swelling, shrinkage, freeze, thaw). Resistance to overturning and uplift forces due to lateral and/or eccentric loads will be provided from the weight of the backfill and structural dead loads. A unit weight of 20 kN/m^3 may be used for the backfill provided it consists of granular fill compacted to 98% of the SPMDD in lifts no greater than 150 mm.

Additional Construction Recommendations:

1. All organics, loose sands, fills and any other deleterious material should be completely removed such that the bearing surface consists of undisturbed, compact to dense silt till, compact to dense sand, stiff to hard silt and clay, or stiff to very stiff silty clay.
2. Excavations for footings and thickened-edges should be completed by an excavator equipped with a smooth-bladed bucket operating from the edge of the excavation. The till is excpected to be highly sensitive to disturbance during construction, the contractor should work carefully to prevent disturbance to the bearing surface at all times.
3. The contractor should be prepared to manage seepage through the use of temporary sumps and pumping within the excavations where encountered.
4. The bearing surfaces should be protected from freezing, drying, or inundation with water at all times. If any of these conditions occur, the disturbed soil should be reomoved in its entirety such that the bearing surface consists of undisturbed, compact to dense till. Measures to prevent freezing of the foundation soils could include construction of the footings and thickened-edge slabs during the summer and fall seasons when frost is absent at or below the footing depth, or heating and hoarding the site in late fall or early winter before frost has penetrated to the foundation level.

6.3 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete piles friction Piles bearing in till will derive a majority of their resistance in shaft friction (adhesion) with a relatively small contribution from end bearing. Table 2 provides the recommended axial (compressive and uplift) unit resistances for shaft adhesion and end bearing. Piles designed based on the SLS resistances provided in Table 3 are expected to exhibit less than 10 mm of settlement at the pile toe. Elastic shortening of the pile should be added to the tip displacement to calculate the pile head settlement.

Table 3. ULS and SLS Bearing Resistances for CIPC Piles

Approximate Pile Depth Below Existing Site Grade (m)	SLS Shaft Adhesion (kPa)	Factored ULS Unit Resistance (kPa)		
		Compression $\phi = 0.4$		Uplift $\phi = 0.3$
		Shaft Adhesion	End Bearing (Note 2)	Shaft Adhesion
0 to X (Note 1)	-	-	-	-
X (Note 1) to 3	12	14	-	10.5
3 to 9	20	24	1,000	18
9 to 15	15	18	700	13.5

1. *X=1.5 m for piles that will not be subjected to freezing conditions. For piles subject to freezing conditions X=2.5 m*
2. *For piles with a diameter of less than 0.5 m. If larger pile diameters are required TREK should be contacted to provide revised end bearing values.*

Additional Design Recommendations:

1. The weight of the embedded portion of the pile may be neglected.
2. Piles should be designed with a maximum depth of 15 m below existing site grade.
3. For piles supporting heated structures (excluding perimeter piles), shaft adhesion in compression and uplift within the upper 1.5 m below final grade should be neglected. For piles subjected to freezing conditions or perimeter piles in heated structures, shaft adhesion in compression and uplift within the upper 2.5 m below final grade should be neglected.
4. Piles should have a minimum spacing of 3 pile diameters measured centre to centre. If a closer spacing or large group of piles are required, TREK should be contacted to provide an efficiency (reduction) factor to account for potential group effects.
5. Piles require steel reinforcement designed for the anticipated axial (compression and tension), lateral and bending loads induced from the structure as well as forces induced from seasonal movements (i.e. shrinkage/swelling and frost-related movements) of the bearing soils.

Additional Construction Recommendations:

1. Temporary steel casings (sleeves) should be available and used if sloughing of the pile hole occurs and/or to control groundwater seepage which is likely to occur. Care should be taken in removing sleeves to prevent sloughing (necking) of the shaft walls and a reduction in the cross-sectional area of the pile.
2. Boulders may be encountered within the till and the contractor should be prepared to encounter boulders during piling operations.
3. Concrete should be placed in one continuous operation immediately after the completion of drilling the pile hole to avoid potential construction problems such as sloughing or caving of the pile hole and groundwater seepage. Concrete placed by free-fall methods should be poured under dry conditions. If groundwater is encountered, it should be controlled or removed. If water cannot be controlled or removed, the concrete should be placed using tremie methods.

4. Concrete placed by free-fall methods should be directed through the middle of the pile shaft and steel reinforcing cage to prevent striking of the drilled shaft walls to protect against soil contamination of the concrete.

6.4 Lateral Pile Analysis

The soil response (sub-grade reaction) to lateral loads can be modeled in a simplified manner that assumes the soil around a pile can be simulated by a series of horizontal springs for preliminary design of pile foundations. The soil behaviour can be estimated using an equivalent spring constant referred to as the lateral sub-grade reaction modulus (K_s) as provided in Table 4. The majority of lateral resistance will typically be offered by the upper 5 to 10 m of soil, depending on the relative stiffness of the pile and soil units.

Table 4. Recommended Values for Lateral Sub-grade Reaction Modulus (K_s)

Depth Below Existing Site Grade (m)	Soil type	K_s (kPa/m)
0 to 1.5	-	-
1.5 to 3.0	Clay and Silt / Silty Clay	3,500/d (Note 1)
	Sand	2,200z/d (Note 1 and 2)
3.0 to 15.0	Till	4,400z/d (Note 1 and 2)

Note 1: d = pile diameter
Note 2: z = depth below grade

It should be understood that using the lateral sub-grade reaction modulus assumes a linear response to lateral loading and therefore is only appropriate under the following conditions:

- maximum pile deflections are small (less than 1% of the pile diameter),
- loading is static (no cycling), and
- pile material behaves linear elastically (does not reach yield conditions).

If one or more of these conditions are not met, a more rigorous analysis that includes non-linear behavior of the piles and surrounding soil is required. In this regard, as part of preliminary design, a lateral pile analysis that incorporates the material and section properties of the piles, final lateral deflection criteria and a more realistic elastic-plastic model of the soil response to loading should be carried out by TREK to confirm the lateral load capacity of the piles.

6.5 Pile Caps and Grade Beams

A minimum void of 100 mm should be provided underneath all grade beams and pile caps to accommodate volumetric changes in the underlying sub-grade soils (i.e. swelling, shrinkage, and thermal expansion and contraction in unheated areas). The void can consist of a compressible layer such as low-density polystyrene void form. Void forms should be selected such that they can deform a minimum of 150 mm with minimal stress transfer to the structure. Excavations for grade beams and

pile caps should be backfilled with non-frost susceptible soils (clean, granular fill) in lifts no greater than 150 mm and compacted to 98% of the SPMDD.

6.6 Ad-freezing Effects

Concrete piles, footings, thickened edges, pile caps, grade beams, and buried walls subjected to freezing conditions should be designed to resist ad-freeze and uplift forces related to frost action acting along the vertical face of the member within the depth of frost penetration (2.4 m). In this regard, concrete piles, footings, thickened edges, pile caps, grade beams, and walls may be subject to an ad-freeze bond stress of 65 kPa within the depth of frost penetration. For piles, ad-freeze forces will be resisted by structural dead loads and uplift resistance provided by the length of the pile below the depth of frost penetration. For footings, ad-freeze forces will be resisted by structural dead loads and the weight of the backfill.

Additional Design Recommendations:

1. An ad-freeze bond stress of 65 kPa within the depth of frost penetration (2.4 m).
2. A load factor (α) of 1.2 may be used in the calculation of ad-freezing forces.
3. A reduction factor of 0.8 may be used in calculation of the geotechnical resistance for the factored ULS condition with ultimate (nominal) uplift resistances as follows:
    a. 43 kPa for piles.
    b. For footings, unit weight of 20 kN/m^3 for granular fill compacted to 98% of the SPMDD.
4. Resistance to ad-freezing within the depth of frost penetration should be neglected.
5. Structural dead loads should be added to the resistance.
6. The calculated geotechnical resistance plus the structural dead loads must be greater than the factored ad-freezing forces.
7. Piles subject to ad-freezing forces should be a minimum of 8.0 m or as calculated by the method above, whichever is greater.
8. Measures such as flat lying rigid polystyrene insulation could be considered to reduce frost penetration depths and thereby ad-freezing and uplift forces.

6.7 Foundation Concrete

All foundation concrete should be designed by a qualified structural engineer for the anticipated axial (compression and uplift), lateral, and bending loads from the structure. Two soil samples (G87 and G88 from TH21-22) were tested (by ALS Environmental) for total sulphate ion content to assess the degree of exposure for concrete subjected to sulphate attack. The samples had a total sulphate ion content less than 0.2% indicating a negligible total sulphate ion content. It should be noted that sulphate concentrations within in the soils likely vary across the site.

6.8 Foundation Inspection Requirements

In accordance with Section *4.2.2.3 Field Review* of the NBCC (2010), the designer or other suitably qualified person shall carry out a field review on:

1. a continuous basis during:
    i. the construction of all deep foundation units,
    ii. the installation and removal of retaining structures and related backfilling operations, and
    iii. during the placement of engineered fills.
2. on an as-required basis for the construction of shallow foundation units and in excavating, dewatering and other related works.

TREK, as the geotechnical engineer of record, must be retained to observe the installation of all foundation elements. TREK is familiar with the geotechnical conditions and the basis for the foundation recommendations and can provide geotechnical design modifications deemed to be necessary should altered sub-surface conditions be encountered.

7.0 Concrete Slabs

7.1 Grade Supported Floor Slabs

If some movement can be tolerated, grade supported concrete floor slabs can be used. Vertical deformation of grade supported slabs should be expected due to volumetric changes in the underlying sub-grade soils (i.e. swelling and shrinkage). Although difficult to predict these movements could be in the order of 50 mm or more. Slabs in unheated areas or near the perimeter of the structure will be subject to additional movements from freeze/thaw of the sub-grade soils. If these movements cannot be tolerated, a structural floor slab will be required.

Additional Design and Construction Recommendations:

1. Organics, loose sand, silt, and any other deleterious material should be stripped such that the sub-grade consists of compact to dense silt till, compact to dense sand, stiff to hard silt and clay, or stiff to very stiff silty clay.
2. Excavation should be completed with an excavator equipped with a smooth bucket operating from the edge of the excavation. Care should be taken to minimize the sub-grade disturbance at all times.
3. After excavation, the sub-grade should be inspected by TREK personnel. Silt and/or soft areas should be repaired as per directions provided by TREK. This will likely consist of excavating an additional 150 to 300 mm and placing a non-woven geotextile on the sub-grade and backfilling with granular fill in lifts no greater than 150 mm and compacted to a minimum of 98% of the SPMDD.
4. The exposed sub-grade surface should be protected from freezing, inundation, drying, or disturbance. If any of these conditions occur, the disturbed zone can either be over-excavated and such that the bearing surface consists of undisturbed soil consistent with the design bearing surface material, or the sub-grade could be scarified, moisture conditioned, and re-compacted to a minimum of 95% of the SPMDD.
5. In heated areas, the floor slab should be placed on a 150 mm thick layer of 37.5 mm down granular fill sub-base underlying a 150 mm thick base consisting of 20 mm down granular fill. In unheated areas (e.g. exterior slabs) the thickness of 37.5 mm down granular fill should be increased to

250 mm. The granular fill should be placed in lifts no greater than 150 mm and compacted to 98% of the SPMDD.

6. The granular fill should consist of a well graded, sand and gravel or durable crushed rock in accordance with the Manitoba Infrastructure Standard Specification No. 900.
7. A vapour barrier should be placed above the granular base and beneath the floor slab.
8. Floor slabs should be designed to resist all design loads and to minimize slab cracking associated with movements as a result of swelling, shrinkage, and thermal expansion and contraction of the sub-grade soils. To accommodate slab movements, it may be desirable to provide control joints to reduce random cracking and isolation joints to separate the slab from other structural elements. Allowances should be made to accommodate vertical movements of light weight structures (e.g. partitions) bearing on the slab.
9. A filter-protected drainage system (weeping tile) should be installed around the perimeter of all grade supported slabs and connected to a collection pit complete with a sump pump.

7.2 Structural Slabs

In areas where movement of floor slabs is not tolerable, a structural floor slab should be used. A minimum void of 150 mm beneath structural floor slabs is recommended to accommodate volumetric changes in the underlying sub-grade soils (i.e. freeze-thaw volume changes and thermal expansion and contraction in unheated areas). The void should consist of a compressible layer (e.g. void form) to permit sub-grade soil movements without causing intolerable stress on the floor slab or, alternatively, a crawl space may be used. A vapour barrier should be placed between the floor slab and the void form (if present).

8.0 Lateral Earth Pressures

The magnitude of lateral earth pressures from retained soil acting against the below grade walls will depend on the retained material type, method of placing and compacting the backfill, and the magnitude of rotation of the walls. TREK anticipates that basement and other retaining walls will be backfilled with granular fill and that the walls will be fixed and not free to rotate. Table 5 below provides K_o values for calculation of lateral earth pressures developed from backfill acting on below grade walls.

Table 5. Lateral Earth Pressure Parameters for Below Grade Wall Design

Design Parameter	Backfill
At-Rest Earth Pressure Coefficient (K_o)	0.5
Estimated Bulk Unit Weight, γ (kN/m³)	21
Estimated Effective Unit Weight, γ' (kN/m³)	11.2

Where backfill drainage is expected, such as a sub-drainage system at the base of the wall to prevent the build-up of hydrostatic pressures, the total lateral earth pressure force is the area of the triangular

pressure distribution acting on a below grade wall which can be derived based on the following equation:

$$P = K\gamma D$$

Where,
P = lateral earth pressure at depth D (kPa)
K = earth pressure coefficient (unitless)
γ = bulk unit weight of retained soil (kN/m^3)
D = depth below finished grade to where earth pressure is being calculated (m)

If drainage is not expected, the following equation should be used:

$$P = K_0\,\gamma' D + \gamma_w D$$

Where,
P = lateral earth pressure at depth D (kPa)
K = earth pressure coefficient (unitless)
γ' = effective unit weight of retained soil (kN/m^3)
D = depth below finished grade to where earth pressure is being calculated (m)
γ_w = unit weight of water (9.81 kN/m^3)

Backfill (retained fill) should not be placed and compacted until the walls can support lateral earth pressures. Over-compaction of the retained fill may result in earth pressures that are considerably higher than those predicted in design. Compaction of granular fill within about 1.5 m of the walls should be conducted with a light hand-operated vibrating plate compactor and the number of compaction passes should be limited. A maximum compacted density of 92% of the Standard Proctor Maximum Dry Density should be specified for fill placed directly adjacent to the walls.

9.0 Wastewater Lagoon

The proposed development includes a wastewater lagoon. Lagoon geometry is unknown but is anticipated to have berms in the order of 1 to 2 m above prairie level and a base at 1 to 2 m below prairie level for a total berm height of 2 to 4 m. A water depth of 1 to 2 m is anticipated under operating conditions. Lagoon berms are assumed to be designed with a 3 m wide crest and 1 m freeboard. According to provincial guidelines, the berms must have inside and outside slopes of 3H:1V and 4H:1V, respectively, or flatter. Flatter slopes are not anticipated to be required based on the soils encountered during drilling. However, TREK should be engaged during detailed design to review the proposed design and verify the factor of safety of the berm slopes based once berm design materials (i.e. site soils vs. imported soils) and geometry have been determined.

9.1 Design and Construction of Liners

The province of Manitoba requires that soil liners have a minimum hydraulic conductivity of $1x10^{-7}$cm/s. An in-situ soil liner is not anticipated to achieve the minimum hydraulic conductivity requirements due to the type, structure, and variability of the near surface soils and, therefore, the permeability of compacted site soils were assessed. Flexible wall permeability testing, Standard Proctor testing, Atterberg limits, and grain size analyses were completed on a compacted bulk sample of the silt and clay layer obtained from within the proposed wasterwater lagoon area. Atterberg limits and grain size analyses were also completed on a select auger cutting sample of the same material. Table 6 summarizes the results of the testing.

Table 6. Soil Permeability Properties

Test Hole and Sample Number	Soil Description	Sample Depth Below Grade (m)	Remoulded Hydraulic Conductivity (cm/s)	Atterberg Limits			Grain Size Distribution (%)			
				PL[1]	LL[1]	PI[1]	Clay	Silt	Sand	Gravel
TH21-17 G216	Silt and Clay	0.2 to 1.5	$1.78x10^{-8}$	14	40	26	32	46	22	0
TH21-16 G189	Silt and Clay	0.9 to 1.1	Not Measured	13	44	31	39	34	23	4

Note 1. PL- Plastic Limit, LL – Liquid Limit, PI- Plasticity Index

The silt and clay sample (G216) compacted to 96.5% of the SPMDD exceeded the provincial hydraulic conductivity requirements for use as a soil liner with a measured hydraulic conductivity of $1.78x10^{-8}$ cm/s indicating that this material will be suitable for use in a compacted liner. The permeability test results are representative of compacted silt and clay properties at a specific point and do not necessarily apply to the final properties of the silt and clay following bulk excavation, placement, and compaction. Variations in the silt and clay composition, moisture content, and compacted density can alter hydraulic conductivity properties and further testing may be required by regulatory authorities to confirm the hydraulic conductivity of the silt and clay.

The high plastic, silty clay soils present within the lagoon area, are also anticipated to meet the hydraulic conductivity requirements provided proper construction and compaction techniques are followed. Sand and silt till within the lagoon area are not suitable for lagoon construction and will have to be removed prior to placement of silt and clay and silty clay soils for a compacted soil liner.

The lagoon is anticipated to be constructed using cut and fill methods. However, sufficient volumes of silt and clay and/or silty clay are likely not present within the proposed lagoon area and additional liner material may need to be obtained from other areas of the site or imported from an off-site borrow source. TREK recommends an that an additional sub-surface investigation be undertaken to locate a suitable on-site borrow source if it is preferred to use local materials for the liner. TREK can provide a scope of work and cost estimate to perform the investigation upon request. Alternatively a synthetic liner can be used.

Placement and compaction of silt and clay, sitly clay, or imported fill for a compacted soil liner will likely be required within 1 m of the liner surface with additional sampling and Standard Proctor and

permeability testing to verify the level of compaction required to achieve a hydraulic conductivity of $1x10^{-7}$cm/s or less. Organics and sands must be removed from the subgrade prior to placement of the liner soils. This may however not be practical from a cost perspective and a synthetic liner may be preferred. In this regard, the in-situ soils at the site are sufficient for a synthetic liner sub-grade. Preparation of a synthetic liner sub-grade should consist of removal of topsoil, silt, and any other deleterious materials such that the sub-grade consists of sand, silt and clay, silty clay and/or silt till. Berms can be constructed of silt and clay, silty clay, silt till, or suitable imported fill (e.g. high plastic silty clay) in lifts of 150 mm compacted to 95% of the SPMDD. Removal of topsoil, silt, and any other deleterious materials must also be performed prior to berm construction.

10.0 Pavements

The following section on pavement structure should be used for gravel surfaced pavements. The recommended pavement structure is provided in Table 7 for parking areas and areas subject to heavier vehicular loads such as access roads. Crushed granular base course base consistent with the Manitoba Infrastructure Standard Specification No. 900 (or equivalent as approved by TREK) are recommended for the base and sub-base layers.

Table 7. Recommended Gravel Surfaced Pavement Sections for Roads and Parking Areas

Material	Layer Thickness		Compaction/Installation Requirements
	Car Parking Areas	Heavy Vehicular Loads	
20 mm down gravel / limestone (Base)	150 mm	150 mm	98% of the SPMDD
37.5 mm down gravel / limestone (Sub-base)	250 mm	350 mm	98% of the SPMDD
Non-Woven Geotextile (Geotex 801 or equivalent)	Required	Required	Install as per manufacturer's recommendations

Additional Pavement Recommendations:

1. Organics, loose sand, fills, and any other deleterious material should be stripped such that the sub-grade consists of compact to dense silt till, compact to dense sand, stiff to hard silt and clay, or stiff to very stiff silty clay.
2. Excavation should be completed with an excavator equipped with a smooth-bladed bucket and operating from the edge of the excavation in order to minimize disturbance to the exposed sub-grade.
3. After excavation, the sub-grade should be inspected by TREK personnel. The sub-grade should be proof-rolled with a fully loaded tandem axle truck to detect silt or soft areas. Silt or soft areas should be repaired as per directions provided by TREK. This will likely consist of excavating an

additional 150 to 300 mm, placing a non-woven geotextile on the sub-grade, and backfilling with a 37.5 mm down crushed granular fill. The granular fill should be placed in lifts no greater than 150 mm and compacted to a minimum of 95% of the SPMDD.

4. The sub-grade should be protected from freezing, drying, inundation with water or disturbance at all times. If any of these conditions occur the sub-grade should be scarified, moisture conditioned as appropriate, and re-compacted to a minimum of 95% of the SPMDD.
5. A non-woven geotextile should be placed in accordance with the manufacturer's recommendations on the prepared sub-grade prior to placement of granular fill.
6. The granular sub-base and base materials should be placed in lifts not exceeding 150 mm and compacted as per the recommendations in Table 7.

11.0 Temporary Excavations

Excavations must be carried out in compliance with the appropriate regulations under the Manitoba Workplace Safety and Health Act. Any open-cut excavation greater than 3 m deep must be designed and sealed by a professional engineer and reviewed by the geotechnical engineer of record (TREK). If space is limited or the stability of adjacent structures may be endangered by an excavation, a shoring system may be required to prevent damage to, or movement of, any part of adjacent structures, and the creation of a hazard to workers and the public.

Excavation stability is the responsibility of the Contractor for the duration of construction. Excavations should be monitored regularly and flattened as necessary to maintain stability recognizing that excavation stability is time and weather dependent. Excavated slopes should be covered with polyethylene sheets to prevent wetting and drying.

Stockpiles of excavated material and heavy equipment should be kept away from the edge of any excavation by a distance equal to or greater than the depth of excavation. Dewatering measures should be completed as necessary to maintain a dry excavation and permit proper completion of the work. If seepage is encountered, it should be collected and pumped out of the excavation. If saturated silts or sands are encountered, shoring or slope flattening may be required. To prevent wet silts and sands from entering the excavation, gravel buttressing could be used in conjunction with sump pits for dewatering. Surface water should be diverted away from the excavation and the excavation should be backfilled as soon as possible following construction.

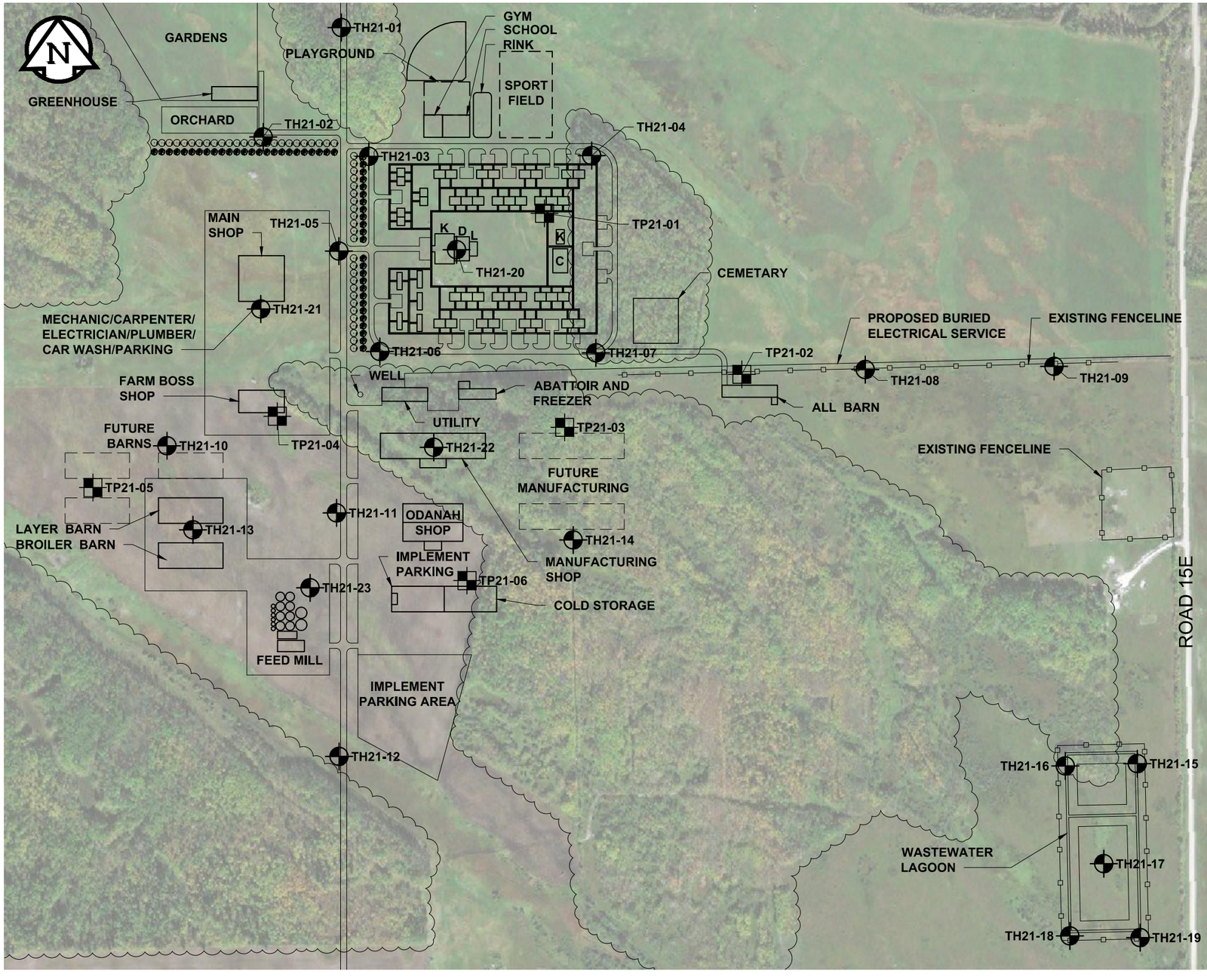
12.0 Closure

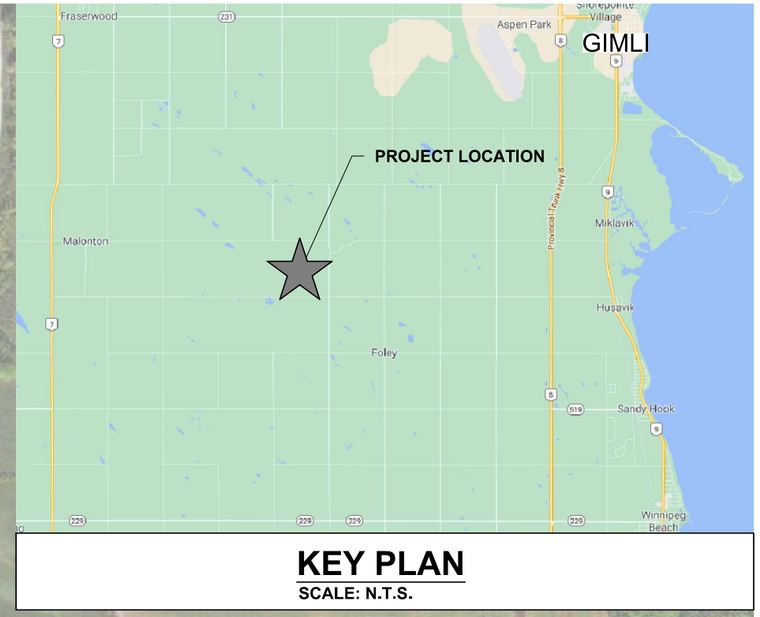
The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work or standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of Burns Maendel Consulting Engineers Ltd. (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figure





KEY PLAN
SCALE: N.T.S.

0 50 100 150 200 250 m
SCALE = 1 : 6 000 (279 mm x 432 mm)

LEGEND:
- TEST HOLE (TREK, 2021)
- TEST PIT (TREK, 2021)

NOTES:
1. AERIAL IMAGERY FROM BING MAPS, (2021).
2. TEST HOLE AND TEST PIT LOCATIONS BASED ON HANDHELD GPS.
3. TEST HOLE AND TEST PIT ELEVATIONS (GEODETIC) ESTIMATED BASED ON TOPOGRAPHIC INFORMATION PROVIDED BY BMCE.
4. SITE LAYOUT PROVIDED BY BMCE.

Figure 01
Test Hole Location Plan

Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 035 00 Crystal Spring Colony\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\0105-035-00 Crystal Springs Colony Figure 01 CT.dwg, 2021-09-23 1:25:12 PM

Test Hole Logs

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

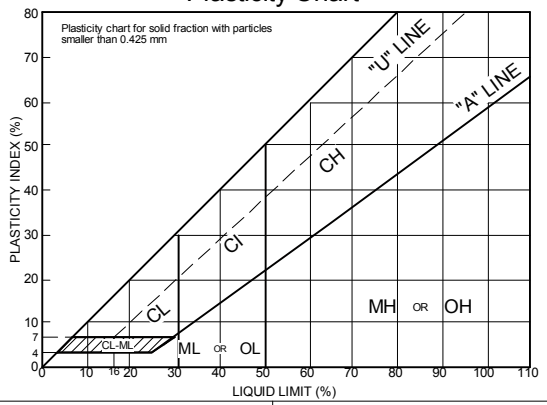
Major Divisions			USCS Classification	Symbols	Typical Names
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures
			GC		Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines
			SP		Poorly-graded sands, gravelly sands, little or no fines
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures
			SC		Clayey sands, sand-clay mixtures
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL		Organic silts and organic silty clays of low plasticity
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
	Highly Organic Soils		Pt		Peat and other highly organic soils

Laboratory Classification Criteria

Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows:
Less than 5 percent..... GW, GP, SW, SP
More than 12 percent..... GM, GC, SM, SC
6 to 12 percent..... Borderline cases requiring dual symbols*

$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
Not meeting all gradation requirements for GW	
Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
Atterberg limits above "A" line or P.I. greater than 7	
$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
Not meeting all gradation requirements for SW	
Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
Atterberg limits above "A" line or P.I. greater than 7	
Von Post Classification Limit	Strong colour or odour, and often fibrous texture

Plasticity Chart



Particle Size Material	mm	ASTM Sieve sizes
Boulders	> 300	> 12 in.
Cobbles	75 to 300	3 in. to 12 in.
Gravel		3/4 in. to 3 in.
Coarse	19 to 75	
Fine	4.75 to 19	#4 to 3/4 in.
Sand		#10 to #4
Coarse	2.00 to 4.75	
Medium	0.425 to 2.00	#40 to #10
Fine	0.075 to 0.425	#200 to #40
Silt or Clay	< 0.075	< #200

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH21-01

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604540.37, E-632375.95
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	100.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
99.8	0.0		ORGANIC CLAY (TOPSOIL) - silty, dry, hard, friable		G131			
99.5	0.3		SAND - silty, trace gravel (<230 mm diam.), light brown, dry, loose, poorly graded, fine to coarse grained		G132			
			SILT AND CLAY - laminated (<5 mm thick), some sand - light grey and dark grey - moist, very stiff - intermediate plasticity		G133			
					G134			△ ✤
97.0	3.0		END OF TEST HOLE AT 3.0 m IN SILT AND CLAY					

Notes:
1) Seepage not observed.
2) Sloughing observed between 0.1 m and 0.5 m depth.
3) Test hole dry and open to 2.3 m depth immediately after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

Sub-Surface Log

Test Hole TH21-02
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604394.56, E-632271.68
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.95 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
247.8	0.0		ORGANIC SILT (TOPSOIL) - some sand, trace rootlets, trace gravel (<10 mm diam.), black, dry, loose, low plasticity		G127	
247.5	0.3		SAND - silty, trace clay, trace gravel (<20 mm diam.), light brown, dry, loose, poorly graded, fine to coarse grained		G128	
			SILT AND CLAY - laminated (<5 mm thick), some sand, trace silt inclusions (<20 mm diam.), light grey and dark grey, dry to moist, very stiff, intermediate plasticity		G129	
246.7	1.2		SILT (TILL) - sandy, trace clay, trace gravel (<30 mm diam.), light brown, dry, compact to dense, low plasticity		SS130	37 / 24mm
246.2	1.7		END OF TEST HOLE AT 1.7 m IN SILT (TILL)			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa) — Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○: 0 50 100 150 200 250

Notes:
1) Seepage not observed.
2) Sloughing observed between 0.1 m and 0.3 m depth.
3) Test hole dry and open to 1.5 m depth immediately after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-03

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604368.65, E-632412.32
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.60 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) 0 50 100 150 200 250 / Test Type: △ Torvane △, ✤ Pocket Pen. ✤, ☒ Qu ☒, ○ Field Vane ○
247.4	0.0		ORGANIC SILT (TOPSOIL) - some sand, trace rootlets, trace gravel (<10 mm diam.), black, dry, loose, low plasticity		G135			
			SILT AND CLAY - some sand, trace silt inclusions (<20 mm diam.) - light grey and dark grey - moist, very stiff - intermediate plasticity		G136		●	
					G137		●	△ ✤
245.8	1.6		CLAY - silty, trace silt inclusions (<30 mm diam.) - dark grey - moist, stiff - high plasticity		G138		●	△ ✤
244.7	2.7							
244.6	2.8		SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.), light brown, moist, compact, low plasticity		G139		●	
	3.0		END OF TEST HOLE AT 3.0 m IN SILT (TILL)					

Notes:
1) Seepage and sloughing not observed.
2) Test hole dry and open to 3.0 m depth immediately after drilling.
3) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

Sub-Surface Log

Test Hole TH21-04

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604369.71, E-632709.58
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.36 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
247.2			ORGANIC SILT (TOPSOIL) - some sand, trace rootlets, trace gravel (<10 mm diam.), black, dry, loose, low plasticity		G173			
			SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - dry, compact to dense - low plasticity		G174		●	
245.4					SS175	51	●	

END OF TEST HOLE AT 2.0 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing observed below 1.5 m depth.
3) Test hole dry and open to 1.5 m depth immediately after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-05
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604242.49, E-632372.45
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	248.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
247.8	0.0		ORGANIC SILT (TOPSOIL) - some sand, trace rootlets, trace gravel (<10 mm diam.), black, dry, loose, low plasticity	G	G122	
247.5	0.3		SAND - trace silt, trace gravel (<20 mm diam.), light brown, dry, loose, poorly graded, fine to coarse grained	G	G123	
			SILT AND CLAY - laminated (<5 mm thick), some sand, light grey and dark grey, moist, very stiff, intermediate plasticity	G	G124	
246.8	1.2		SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - moist, compact to dense - low plasticity	G	G125	
				SS	SS126	48
246.0	2.0		END OF TEST HOLE AT 2.0 m IN SILT (TILL)			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Notes:
1) Seepage not observed.
2) Sloughing observed between 0.3 m and 0.5 m depth.
3) Test hole dry and open to 1.4 m depth immediately after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-06

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604108.5, E-632427.22
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.99 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) 0 50 100 150 200 250
247.8	0.0		ORGANIC SILT (TOPSOIL) - some sand, trace rootlets, trace gravel (<10 mm diam.), black, dry, friable, hard, intermediate plasticity		G118			
247.1	0.7		SILT AND CLAY - laminated (<5 mm thick), some sand, trace gravel (< 20 mm diam.), light brown, dry to moist, hard, intermediate plasticity		G119			
246.5	1.5		CLAY - silty, trace sand, trace silt inclusions (< 40 mm diam.), light grey and dark grey, moist, very stiff, high plasticity		G120			
246.0	2.0		SILT (TILL) - sandy, trace clay, trace gravel (< 40 mm diam.), light brown, moist, compact to dense, low plasticity		SS121	57		

END OF TEST HOLE AT 2.0 m IN SILT (TILL)

Notes:
1) Seepage and sloughing not observed.
2) Test hole dry and open to 2.0 m depth immediately after drilling.
3) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-07

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604106.79, E-632715.09
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	100.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
99.8	0.0		ORGANIC SILT (TOPSOIL) - some clay, some sand, trace gravel (< 10 mm diam.), trace rootlets, black, dry, hard, intermediate plasticity, friable	G	G176	
			SILT AND CLAY - laminated (<5 mm thick), some sand, trace gravel (< 20 mm diam.), light brown, dry to moist, hard, intermediate plasticity	G	G177	
98.9	0.9		CLAY - silty, trace sand, trace gravel (< 20 mm diam.), light grey and dark grey, moist, very stiff, high plasticity	G	G178	
98.5	1.3		SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - brown - moist, compact - low plasticity	G	G179	
				SS	SS180	20
96.5	3.5		END OF TEST HOLE AT 3.5 m IN SILT (TILL)			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Notes:
1) Seepage and sloughing not observed.
2) Test hole dry and open to 3.5 m depth immediately after drilling.
3) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-08
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604084.5, E-633074.4
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	246.65 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
246.3	0.0		ORGANIC CLAY (TOPSOIL) - silty, trace sand, black, dry, hard, friable		G181	
			SILT AND CLAY - laminated (<5 mm thick), some sand - light brown and dark grey - dry to moist, stiff - intermediate plasticity		G182	
245.3	1.0		SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - brown - moist, compact - low plasticity		SS183	18
244.7	1.6		END OF TEST HOLE AT 2.0 m IN SILT (TILL)			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

Notes:
1) Seepage not observed.
2) Sloughing observed below 1.5 m depth.
3) Test hole dry and open to 1.5 m depth immediately after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-09

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604088.62, E-633325.96
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	246.55 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
246.4	0.0		ORGANIC CLAY (TOPSOIL) - silty, trace rootlets, trace sand, black, damp, hard, friable	G	G184	
246.2	0.2		SILT AND CLAY - laminated (<5 mm thick), some sand, light brown and dark grey, dry to moist, very stiff, intermediate plasticity	G	G185	
			SILT (TILL) - sandy, trace clay, trace gravel (<30 mm diam.) - light brown - moist, compact - low plasticity	G	G186	
244.6	2.0		END OF TEST HOLE AT 2.0 m IN SILT (TILL)	SS	SS187	24

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

Notes:
1) Seepage not observed.
2) Sloughing observed below 1.5 m depth.
3) Test hole dry and open to 1.5 m depth immediately after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-10
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603982.92, E-632143.47
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	248.77 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
248.6	0.0		ORGANIC SILT (TOPSOIL) - some sand, trace gravel (<10 mm diam.), trace rootlets, black, dry, loose, low plasticity		G79			
			SILT AND CLAY - laminated (<5 mm thick), some sand, trace precipitates (< 5 mm diam.), trace gravel (< 20 mm diam.), trace silt inclusions (< 30 mm diam.), brown and light brown, moist, firm to stiff, intermediate plasticity		G80			
247.7	0.9		SILT (TILL) - some sand to sandy, trace clay, trace gravel (< 20 mm diam.) - light brown - moist, compact to dense - low plasticity		G81			
246.8	1.8		- dry, dense below 1.5 m		SS82	49		

END OF TEST HOLE AT 2.0 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing observed below 1.5 m depth.
3) Test hole dry and open to 1.8 m depth approximately 5 minutes after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-11

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603893.34, E-632369.5
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	248.76 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) 0 50 100 150 200 250 / Test Type: Torvane, Pocket Pen., Qu, Field Vane
248.6	0.0		ORGANIC CLAY (TOPSOIL) - some sand, trace gravel (< 10 mm diam.), trace rootlets, black, dry, hard, friable, intermediate plasticity		G83			
			SILT AND CLAY - laminated (<5 mm thick), some sand, trace gravel (< 20 mm diam.), brown and grey, moist, very stiff to hard, intermediate plasticity					
247.8	0.8				G84		●	
			CLAY - silty, trace sand, trace gravel (< 20 mm diam.), trace silt inclusions (< 30 mm diam.), brown and grey, moist, stiff, high plasticity					
247.2	1.5				G85		●	△ ✤

END OF TEST HOLE AT 1.5 m IN CLAY

Notes:
1) Seepage and sloughing not observed.
2) Test hole dry and open to 1.5 m depth approximately 5 minutes after drilling.
3) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-12

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603568.65, E-632372.71
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	248.04 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) 0 50 100 150 200 250 / Test Type: Torvane, Pocket Pen., Qu, Field Vane
247.9	0.0		ORGANIC CLAY (TOPSOIL) - trace sand, trace rootlets, black, damp, hard, friable		G45			
			CLAY - silty, trace sand - grey - moist, soft to firm - high plasticity		G46			
246.5	1.5		- trace silt inclusions (<20 mm diam.) below 1.2 m		G47			
			END OF TEST HOLE AT 1.5 m IN CLAY					

Notes:
1) Seepage and sloughing not observed.
2) Test hole dry and open to 1.5 m depth immediately after drilling.
3) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-13

TREK GEOTECHNICAL

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603870.85, E-632178
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	248.63 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
248.6	0.0		ORGANIC CLAY - some sand, trace rootlets, trace gravel (<10 mm diam.), black, dry, hard, friable		G69	
			SILT AND CLAY - laminated (<5 mm thick), some sand, trace gravel (<20 mm diam.) - brown and light brown - moist, firm to stiff - intermediate plasticity		G70	
247.4	1.2		SILT (TILL) - some clay, trace sand, trace gravel (<20 mm diam.) - brown and grey - moist, firm - high plasticity		G71	
					SS72	21
					G73	
			- sandy, trace clay, light brown, compact to dense, low plasticity below 3.4 m		SS74	25
					G75	
					SS76	19
					G77	
242.1	6.5				SS78	13

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

END OF TEST HOLE AT 6.5 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing observed below 6.0 m depth.
3) Test hole dry and open to 6.1 m depth approximately 5 minutes after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

Sub-Surface Log

Test Hole TH21-14
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603857.2, E-632684.88
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	100.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
99.8	0	ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, dry, hard, friable		G109	
	0.5	SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - dry, loose - low plasticity		G110	
	1.5	- compact to dense below 1.5 m		SS111	31
	2.0				
	2.5			G112	
	3.0			SS113	33
	3.5				
	4.0			G114	
	4.5	- trace gravel (<30 mm diam.) below 4.6 m		SS115	26
	5.0				
	5.5			G116	
	6.0				
93.4	6.5			SS117	27

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 6.5 m IN SILT (TILL)

Notes:
1) Seepage observed at 4.6 m depth.
2) Sloughing observed below 5.0 m depth.
3) Test hole dry and open to 5.8 m depth immediately after drilling.
4) Test hole backfilled with bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-15
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603559, E-633437
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.68 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
247.5	0		PEAT - Amorphous, trace rootlets, trace sand, damp, black, loose		G224	
	0.5		SAND - some silt, trace clay, trace gravel (<30 mm diam.) - brown - dry, loose - poorly graded, fine to coarse grained			
	1.0				G225	
	1.5		- moist below 1.5 m		SS226	
	2.0		- wet below 2.1 m		G227	
245.2	2.5		CLAY - silty, trace silt inclusions (<40 mm diam.), trace sand, trace gravel (<20 mm diam.), light brown and light grey, moist, stiff, high plasticity		G228	
244.8	3.0		SILT (TILL) - sandy, trace clay, trace gravel (<30 mm diam.) - light brown - moist, dense - low plasticity		SS229	30
	3.5					
	4.0				G230	
	4.5				SS231	40
	5.0					
	5.5				G232	
	6.0		- compact below 6.1 m		SS233	18
241.1	6.5		END OF TEST HOLE AT 6.5 m IN SILT (TILL)			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

Notes:
1) Seepage observed from 2.1 m to 2.4 m depth.
2) Sloughing observed from 0.1 m to 1.5 m depth.
3) Water level at 5.6 m depth approximately 5 minutes after drilling.
4) Test hole open to 5.6 m depth approximately 5 minutes after drilling.
5) Test hole backfilled with bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-16
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603556, E-633341
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	100.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
99.8	0	PEAT - Amorphous, trace rootlets, trace sand, damp, black, loose		G188	
	0.5	SILT AND CLAY - laminated (<5 mm thick), some sand, trace gravel (<20 mm diam.) - light grey and dark grey - moist, very stiff - intermediate plasticity		G190	
	1.0			G189	
98.5	1.5	SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - moist, compact to dense - low plasticity		SS191	23
	2.0				
	2.5			G192	
	3.0	- dense below 3.0 m		SS193	60
	3.5				
	4.0			G194	
	4.5	- trace gravel (<30 mm diam.) below 4.6 m		SS195	39
	5.0				
	5.5			G196	
	6.0				
93.4	6.5			SS197	41

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

END OF TEST HOLE AT 6.5 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing observed below 5.0 m depth.
3) Test hole dry and open to 5.9 m depth immediately after drilling.
4) Test hole backfilled with bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-17
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603425.66, E-633392.34
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	100.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
99.8	0	PEAT - Amorphous, trace rootlets, trace sand, damp, black, loose		G215	
	0.5	SILT AND CLAY - laminated (<5 mm thick), some sand, trace gravel (<20 mm diam.) - light grey and dark grey - moist, very stiff - intermediate plasticity		G216	
	1.0				
	1.5			T217	
97.9	2.0				
	2.5	SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - moist, compact - low plasticity		G218	
	3.0			T219	
	3.5				
	4.0			G220	
	4.5				
	5.0	- trace gravel (<40 mm diam.) below 4.9 m		SS221	29
	5.5			G222	
	6.0				
93.4	6.5			SS223	22

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa): 0 50 100 150 200 250
Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

END OF TEST HOLE AT 6.5 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing observed below 6.0 m depth.
3) Test hole dry and open to 6.1 m depth approximately 5 minutes after drilling.
4) Test hole backfilled with bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-18

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603329.54, E-633347.12
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.52 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
247.4	0.0		PEAT - Amorphous, trace rootlets, trace sand, damp, black, loose		G209			
			SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - dry, compact - low plasticity		G210		●	
			- dense below 1.5 m		T211			
					G212			
					SS213	50 / 101mm	●	
					G214			
243.3	4.3		END OF TEST HOLE AT 4.3 m IN SILT (TILL)					

Notes:
1) Seepage and sloughing not observed.
2) Test hole dry and open to 4.3 m depth immediately after drilling.
3) Test hole backfilled with bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-19
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603327.11, E-633440.69
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
246.8	0	PEAT - Amorphous, trace rootlets, trace sand, damp, black, loose		G198	
246.4	0.5	SAND - silty, trace gravel (<20 mm diam.) - light brown, dry, loose - poorly graded, fine to coarse grained		G199	
	1.0	SILT AND CLAY - laminated (<5 mm thick), some sand, trace gravel (<20 mm diam.) - light grey and dark grey - moist, very stiff - intermediate plasticity		T200	
245.5	1.5	CLAY - silty - dark grey - moist, stiff - high plasticity		T201	
244.6	2.0			G202	
	2.5	SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - dry, dense - low plasticity		G203	
	3.0			SS204	56
	3.5				
	4.0			G205	
	4.5			SS206	35
	5.0				
	5.5			G207	
	6.0				
240.5				SS208	56 / 229mm

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 6.5 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing observed below 6.0 m depth.
3) Test hole dry and open to 6.1 m depth approximately 5 minutes after drilling.
4) Test hole backfilled with bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-20
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604244.24, E-632529.37
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.98 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
247.8	0.0	ORGANIC SILT (TOPSOIL) - some sand, trace rootlets, trace gravel (<10 mm diam.), black, dry, loose, low plasticity		G162	
	0.5	SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - dry, compact - low plasticity		G163	
	1.0				
	1.5			SS164	21
	2.0				
	2.5			G165	
	3.0	- dense below 3.0 m		SS166	57
	3.5				
	4.0	- light grey below 4.0 m		G167	
	4.5			SS168	28
	5.0				
	5.5			G169	
	6.0			SS170	32
	6.5				
	7.0			G171	
240.3	7.5	- cobbles or boulders below 7.6 m		SS172	30 / 24mm
		END OF TEST HOLE AT 7.6 m IN SILT (TILL)			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa) — Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ : 0 50 100 150 200 250

Notes:
1) Seepage not observed.
2) Sloughing observed below 7.0 m depth.
3) Test hole dry and open to 7.5 m depth approximately 5 minutes after drilling.
4) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-21

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604165.17, E-632268.43
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	247.76 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 20, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
247.6	0.0	ORGANIC SILT (TOPSOIL) - some sand, trace gravel (<10 mm diam.), trace rootlets, black, loose, low plasticity		G140	
247.2	0.5	CLAY AND SILT - laminated (<5mm thick), some sand, trace gravel (< 20 mm diam.), light brown, dry to moist, hard, friable, intermediate plasticity		G141	
	1.0	CLAY - silty, trace sand, dark brown and grey, moist, very stiff, high plasticity		G142	
246.5	1.5	SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - moist, compact to dense - low plasticity		SS143	27
	2.0				
	2.5			G144	
	3.0				
	3.5			SS145	22
	4.0			G146	
	4.5			SS147	23
	5.0				
	5.5			G148	
	6.0	- grey, trace gravel (<30 mm diam.) below 6.1 m		SS149	31
	6.5				
	7.0			G150	
	7.5			SS151	29
	8.0				
	8.5			G152	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa) — Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-21

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	9.5		- trace gravel (<50 mm diam.) below 9.1 m		SS153	25
	10.0				G154	
	10.5					
	11.0		- wet, compact below 10.7 m		SS155	15
	11.5				G156	
	12.0					
	12.5				SS157	17
	13.0				G158	
	13.5					
	14.0				SS159	22
	14.5				G160	
	15.0					
232.1	15.5				SS161	18

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL

0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 15.7 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughin observed below 6.0 m depth.
3) Water level at 2.6 m depth approximately 5 minutes after drilling.
4) Test hole open to 15.1 m depth immediately after drilling.
5) Test hole backfilled with cuttings.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

Sub-Surface Log

Test Hole TH21-22

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603980.78, E-632499
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	100.00 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
99.8	0	PEAT - Amorphous, trace rootlets, trace sand, damp, black, loose		G86	
99.2	0.5	SILT AND CLAY - laminated (<5 mm thick), sandy, trace gravel (<15 mm diam.) - dark grey and light grey, dry to moist, very stiff, intermediate plasticity		G87	
98.8	1.0	CLAY - silty, trace silt inclusions (<20 mm diam.), trace sand, dark brown, moist, very stiff, high plasticity		G88	
98.5	1.5	SAND - silty, trace clay, trace gravel (<15 mm diam.), light brown, dry, loose, poorly graded, fine to coarse grained		G89	
		SILT (TILL) - sandy, trace clay, trace gravel (<20 mm diam.) - light brown - moist, compact to dense - low plasticity		SS90	51
	2.0				
	2.5			G91	
	3.0			SS92	35
	3.5				
	4.0			G93	
	4.5			SS94	33
	5.0				
	5.5			G95	
	6.0			SS96	43
	6.5				
	7.0			G97	
	7.5	- trace gravel (<30 mm diam.) below 7.6 m		SS98	31
	8.0				
	8.5			G99	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL — 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-22

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21	Particle Size (%) 0 20 40 60 80 100	PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
					SS100	37	●			
					G101					
					SS102	29	●			
					G103					
					SS104	32	●			
					G105					
					SS106	54	●			
			- trace gravel (<40 mm diam.) below 14.1 m		G107					
84.3					SS108	28	●			

END OF TEST HOLE AT 15.7 m IN SILT (TILL)

Notes:

1) Seepage not observed.
2) Sloughing observed between 1.2 m and 1.5 m depth.
3) Test hole dry and open to 15.2 m depth immediately after drilling.
4) Test hole backfilled with cuttings and bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Hole TH21-23

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603793.46, E-632334.09
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	248.90 m (local datum)
Method:	125 mm Solid Stem Auger / HQ Coring, CME-850 Track Mounted Rig	**Date Drilled:**	August 19, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
248.7	0.0	ORGANIC SILT (TOPSOIL) - some sand, trace rootlets, trace gravel (<10 mm diam.), black, loose, no to low plasticity		G48	
	0.5	SILT (TILL) - sandy, trace clay, trace gravel (<25 mm diam.) - light brown - moist, compact to dense - low plasticity		G49	
	1.5			SS50	45
	2.0			G51	
	3.0			SS52	42
	4.0	- moist to wet, compact below 4.0 m		G53	
	4.5			SS54	18
	5.5	- wet below 5.5 m		G55	
	6.0			SS56	15
	6.5	- trace to some gravel (<30 mm diam.) below 6.7 m		G57	
	7.5			SS58	15
	8.0			G59	
	8.5				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

Sub-Surface Log

Test Hole TH21-23

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21	Particle Size (%) 0 20 40 60 80 100	PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
	9.5				SS60	24	●			
	10.0				G61					
	10.5									
	11.0				SS62	10	●			
	11.5				G63					
	12.0									
	12.5				SS64	23	●			
	13.0				G65					
	13.5									
	14.0		- dense below 13.7 m		SS66	33	●			
	14.5				G67					
	15.0									
233.2	15.5				SS68	51	●			

END OF TEST HOLE AT 15.7 m IN SILT (TILL)

Notes:

1) Seepage and sloughing observed between 9.1 m and 10.7 m depth.
2) Water level at 2.6 m depth approximately 5 minutes after drilling.
3) Test hole open to 10.7 m depth approximately 5 minutes after drilling.
4) Test hole backfilled with cuttings and bentonite.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Pit TP21-01
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604292.79, E-632646.65
Contractor:	Graboweski Concrete	**Ground Elevation:**	100.00 m (local datum)
Method:	Hitachi Zaxis 135 US Excavator	**Date Drilled:**	August 17, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
99.8	0		SILT (TOPSOIL) - some sand, some organics, trace clay, trace rootlets, trace gravel (<30 mm diam.), dark brown, moist, loose, low plasticity		G18			
	0.5		SAND - some silt, trace gravel (<30 mm diam.) - light brown - dry, loose - poorly graded, fine to coarse grained		G19			
98.6	1.0							
	1.5		SILT (TILL) - sandy, trace clay, trace gravel (<30 mm diam.) - light brown - moist, loose - low plasticity		G20			
	2.0							
	2.5		- sandy, trace gravel (<30 mm diam.), trace cobbles, trace boulders (<500 mm diam.), compact to dense below 2.4 m		G21			
	3.0		- clay seam (<500 mm thick) at 3.0 m		G22			
	3.5		- dense below 3.6 m					
95.9	4.0				G23			

END OF TEST HOLE AT 4.1 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing and caving observed from 0.1 m to 1.4 m depth.
3) Test pit dry and open to 4.1 m depth immediately after excavation.
4) Test pit backfilled with cuttings and compacted with excavator bucket.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Pit TP21-02
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604078.11, E-632909.72
Contractor:	Graboweski Concrete	**Ground Elevation:**	100.00 m (local datum)
Method:	Hitachi Zaxis 135 US Excavator	**Date Drilled:**	August 17, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
99.7	0.0		SILT (TOPSOIL) - some sand, some organics, trace clay, trace rootlets, trace gravel (<40 mm diam.), trace cobbles (<200 mm diam.), black, moist, loose, low plasticity	G	G24	
99.1	0.6		SAND - some silt, some gravel (<40 mm diam.), trace cobbles (<300 mm diam.), trace boulders (<500 mm dam.), light brown, dry, loose, poorly graded, fine to coarse grained	G	G25	
				G	G26	
98.8	0.9		SILT and CLAY - laminated (<5 mm thick), some sand, trace gravel (<20 mm diam.), grey and brown, moist, stiff, intermediate plasticity			
			SILT (TILL) - sandy, trace clay, trace gravel (<40 mm diam.), trace cobbles, trace boulders (<500 mm diam.) - light brown - moist, compact to dense - low plasticity	G	G27	
			- dense below 2.7 m	G	G28	
				G	G29	
95.9	4.1		END OF TEST HOLE AT 4.1 m IN SILT (TILL)	G	G30	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa) — Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○: 0 50 100 150 200 250

Notes:
1) Seepage not observed.
2) Sloughing and caving observed from 0.3 m to 0.9 m depth.
3) Test pit dry and open to 4.1 m depth immediately after excavation.
4) Test pit backfilled with cuttings and compacted with excavator bucket.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Pit TP21-03
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604007.43, E-632673.56
Contractor:	Graboweski Concrete	**Ground Elevation:**	100.00 m (local datum)
Method:	Hitachi Zaxis 135 US Excavator	**Date Drilled:**	August 17, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
99.8	0		SILT (TOPSOIL) - sandy, some organics, trace clay, trace rootlets, trace gravel (<40 mm diam.), trace cobbles (<200 mm diam.), black, moist, loose, low plasticity		G37			
					G38			
	0.5		SAND - silty, some gravel (<50 mm diam.), trace clay, trace cobbles (<200 mm diam.), light brown, dry, loose, poorly graded, fine to coarse grained - silt seam (<500 mm thick) at 0.5 m		G39		●	
98.8	1.0							
	1.5		SILT (TILL) - sandy, trace clay, some gravel (<30 mm diam.), trace cobbles (<200 mm diam.) - light brown - dry to moist, compact to dense - low plasticity		G40		●	
	2.0		- sandy, trace clay, some gravel (<30 mm diam.), trace cobbles (<200 mm diam.), trace boulders (<500 mm diam.) below 1.8 m		G41			
	2.5				G42		●	
	3.0		- dense below 2.7 m					
	3.5				G43			
96.0					G44		●	

END OF TEST HOLE AT 4.0 m IN SILT (TILL)

Notes:
1) Seepage not observed.
2) Sloughing and caving observed from 0.1 m to 1.2 m depth.
3) Test pit dry and open to 3.8 m depth immediately after excavation.
4) Test pit backfilled with cuttings and compacted with excavator bucket.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Pit TP21-04
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5604022.27, E-632290.54
Contractor:	Graboweski Concrete	**Ground Elevation:**	248.33 m (local datum)
Method:	Hitachi Zaxis 135 US Excavator	**Date Drilled:**	August 17, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
248.2			SILT (TOPSOIL) - sandy, some organics, trace clay, trace rootlets, trace gravel (<20 mm diam.), black, damp, loose, no to low plasticity		G09			
248.1			SILT AND CLAY - laminated (<5 mm thick), some sand, trace rootlets, greyish brown, dry to moist, hard, friable, intermediate plasticity		G10			
			SILT (TILL) - some sand, trace clay seams (<20 mm thick), trace gravel (<50 mm diam.), trace cobbles (<200 mm diam.) - light brown - damp, compact to dense - low plasticity		G11		●	
					G12		●	
			- moist below 0.9 m		G13			
					G14		●	
			- some sand, trace gravel (<50 mm diam.), trace cobbles, trace boulders (<500 mm diam.) below 3.0 m		G15			
					G16			
244.2			- dense below 3.8 m		G17		●	

END OF TEST HOLE AT 4.1 m IN SILT (TILL)

Notes:
1) Seepage and sloughing not observed.
2) Test pit dry and open to 4.1 m depth immediately after excavation.
3) Test pit backfilled with cuttings and compacted with excavator bucket.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Pit TP21-05
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603927.09, E-632044.62
Contractor:	Graboweski Concrete	**Ground Elevation:**	249.20 m (local datum)
Method:	Hitachi Zaxis 135 US Excavator	**Date Drilled:**	August 17, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
249.0	0.0		SILT (TOPSOIL) - sandy, some organics, trace clay, trace rootlets, trace gravel (<40 mm diam.), trace cobbles (<200 mm diam.), black, moist, loose, low plasticity		G31	
248.9	0.1				G32	
			SILT AND CLAY - laminated (<5 mm thick), some sand, trace rootlets, trace gravel (<40 mm diam.), dark grey, moist, stiff to very stiff, intermediate plasticity		G33	
248.0	1.0		SAND - silty, some gravel (<40 mm diam.), light brown, dry, loose, poorly graded, fine to coarse grained			
			SILT and CLAY - laminated (<5 mm thick), some sand, trace gravel (<40 mm diam.), trace cobbles (<200 mm diam.), light brown, moist, stiff, intermediate plasticity		G34	
247.5	1.7		SILT (TILL) - sandy, trace clay, some gravel (<50 mm diam.), trace cobbles (<300 mm diam.), trace boulders (<500 mm diam.) - light brown - moist, compact to dense - low plasticity			
			- dense below 2.7 m		G35	
245.2	4.0		END OF TEST HOLE AT 4.0 m IN SILT (TILL)		G36	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa): 0 50 100 150 200 250
Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Notes:
1) Seepage not observed.
2) Sloughing and caving observed from 0.3 m to 1.2 m depth.
3) Test pit dry and open to 4.0 m depth immediately after excavation.
4) Test pit backfilled with cuttings and compacted with excavator bucket.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Sub-Surface Log

Test Pit TP21-06
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-035-00
Project Name:	Crystal Spring Colony Community Development	**Location:**	UTM N-5603803.12, E-632543.33
Contractor:	Graboweski Concrete	**Ground Elevation:**	248.82 m (local datum)
Method:	Hitachi Zaxis 135 US Excavator	**Date Drilled:**	August 17, 2021

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
248.7			SILT (TOPSOIL) - sandy, some organics, trace clay, trace rootlets, trace gravel (<40 mm diam.), black, damp, loose, no to low plasticity		G01			
			SILT (TILL) - some sand, trace clay, trace gravel (<30 mm diam.), trace cobbles (<200 mm diam.) - light brown - dry, compact to dense - low plasticity		G02		●	
			- moist below 0.9 m		G03		●	
					G04			
			- dry below 2.6 m		G05		●	
					G06			
			- trace cobbles, trace boulders (<400 mm diam.), dense below 3.5 m		G07			
244.9					G08		●	

END OF TEST HOLE AT 4.0 m IN SILT (TILL)

Notes:
1) Seepage and sloughing not observed.
2) Test pit dry and open to 4.0 m depth immediately after excavation.
3) Test pit backfilled with cuttings and compacted with excavator bucket.

Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

SUB-SURFACE LOG LOGS 2021-08-18 CRYSTAL SPRING COLONY DEV 0_A_RSA 0105-035-00.GPJ TREK.GDT 10/29/21

Appendix A

Laboratory Testing

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Moisture Content Report
ASTM D2216-10

Project No. 0105-035-00
Client Burns Maendel Consulting Engineers Ltd.
Project Crystal Spring Colony Community Development

Sample Date 20-Aug-21
Test Date 27-Aug-21
Technician DJ

Test Hole	TH21-01	TH21-01	TH21-01	TH21-02	TH21-02	TH21-02
Depth (m)	0.3 - 0.5	1.1 - 1.2	2.3 - 2.4	0.3 - 0.5	0.9 - 1.1	1.5 - 1.7
Sample #	G132	G133	G134	G128	G129	SS130
Tare ID	AB05	Z43	Z70	N113	W55	D43
Mass of tare	6.9	8.5	8.8	8.6	8.5	8.6
Mass wet + tare	247.4	237.2	237.0	222.5	258.0	238.0
Mass dry + tare	238.3	204.9	205.6	204.3	230.1	215.5
Mass water	9.1	32.3	31.4	18.2	27.9	22.5
Mass dry soil	231.4	196.4	196.8	195.7	221.6	206.9
Moisture %	3.9%	16.4%	16.0%	9.3%	12.6%	10.9%

Test Hole	TH21-03	TH21-03	TH21-03	TH21-03	TH21-04	TH21-04
Depth (m)	0.8 - 0.9	1.2 - 1.4	2.4 - 2.6	2.9 - 3.0	0.8 - 0.9	1.5 - 2.0
Sample #	G136	G137	G138	G139	G174	SS175
Tare ID	F62	AA21	Z00	AB78	Z93	E134
Mass of tare	8.6	6.8	8.4	6.7	8.6	8.3
Mass wet + tare	245.8	283.4	224.9	269.8	231.8	235.9
Mass dry + tare	207.3	212.4	157.3	242.6	219.0	218.2
Mass water	38.5	71.0	67.6	27.2	12.8	17.7
Mass dry soil	198.7	205.6	148.9	235.9	210.4	209.9
Moisture %	19.4%	34.5%	45.4%	11.5%	6.1%	8.4%

Test Hole	TH21-05	TH21-05	TH21-05	TH21-06	TH21-06	TH21-06
Depth (m)	0.3 - 0.5	0.9 - 1.1	1.5 - 2.0	0.8 - 0.9	1.2 - 1.4	1.5 - 2.0
Sample #	G123	G124	SS126	G119	G120	SS121
Tare ID	P23	Z90	W30	E211	E75	F131
Mass of tare	8.6	8.5	8.6	8.6	8.6	8.5
Mass wet + tare	289.3	238.3	243.6	227.7	291.0	229.8
Mass dry + tare	280.1	206.6	224.6	206.2	244.9	213.0
Mass water	9.2	31.7	19.0	21.5	46.1	16.8
Mass dry soil	271.5	198.1	216.0	197.6	236.3	204.5
Moisture %	3.4%	16.0%	8.8%	10.9%	19.5%	8.2%

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Test Date 27-Aug-21
Technician DJ

Test Hole	TH21-07	TH21-07	TH21-07	TH21-07	TH21-08	TH21-08
Depth (m)	0.8 - 0.9	1.2 - 1.4	2.4 - 2.6	3.0 - 3.5	0.9 - 1.1	1.5 - 2.0
Sample #	G177	G178	G179	SS180	G182	SS183
Tare ID	E94	H35	F13	E59	P34	E120
Mass of tare	8.4	8.5	8.5	8.5	8.5	8.4
Mass wet + tare	216.7	246.7	234.2	294.3	240.3	297.8
Mass dry + tare	195.8	219.9	211.1	257.6	198.7	243.0
Mass water	20.9	26.8	23.1	36.7	41.6	54.8
Mass dry soil	187.4	211.4	202.6	249.1	190.2	234.6
Moisture %	11.2%	12.7%	11.4%	14.7%	21.9%	23.4%

Test Hole	TH21-09	TH21-09	TH21-09	TH21-10	TH21-10	TH21-10
Depth (m)	0.2 - 0.3	1.1 - 1.2	1.5 - 2.0	0.8 - 0.9	1.2 - 1.4	1.5 - 2.0
Sample #	G185	G186	SS187	G80	G81	SS82
Tare ID	Z25	Z66	D50	D32	AB16	Z45
Mass of tare	8.3	8.4	8.5	8.5	6.7	8.8
Mass wet + tare	225.5	255.6	252.2	236.6	221.0	257.7
Mass dry + tare	185.1	227.3	227.2	208.0	194.1	237.8
Mass water	40.4	28.3	25.0	28.6	26.9	19.9
Mass dry soil	176.8	218.9	218.7	199.5	187.4	229.0
Moisture %	22.9%	12.9%	11.4%	14.3%	14.4%	8.7%

Test Hole	TH21-11	TH21-11	TH21-12	TH21-12	TH21-13	TH21-13
Depth (m)	0.8 - 0.9	1.2 - 1.4	0.8 - 0.9	1.4 - 1.5	0.8 - 0.9	1.5 - 2.0
Sample #	G84	G85	G46	G47	G70	SS72
Tare ID	AB40	F146	AC09	Z120	D5	AC19
Mass of tare	6.9	8.3	7.1	9.1	8.3	6.8
Mass wet + tare	231.3	240.4	214.8	252.7	224.6	288.4
Mass dry + tare	198.6	198.5	153.1	184.7	192.6	251.9
Mass water	32.7	41.9	61.7	68.0	32.0	36.5
Mass dry soil	191.7	190.2	146.0	175.6	184.3	245.1
Moisture %	17.1%	22.0%	42.3%	38.7%	17.4%	14.9%

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Project Crystal Spring Colony Community Development

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Test Date 27-Aug-21
Technician DJ

Test Hole	TH21-13	TH21-13	TH21-13	TH21-14	TH21-14	TH21-14
Depth (m)	3.0 - 3.5	4.6 - 5.1	6.1 - 6.6	0.8 - 0.9	1.5 - 2.0	3.0 - 3.5
Sample #	SS74	SS76	SS78	G110	SS111	SS113
Tare ID	H46	D48	F112	N99	Z130	A100
Mass of tare	8.4	8.6	8.2	8.4	8.4	8.6
Mass wet + tare	222.8	209.0	247.0	248.8	256.0	208.8
Mass dry + tare	203.0	191.0	225.2	226.7	234.4	192.4
Mass water	19.8	18.0	21.8	22.1	21.6	16.4
Mass dry soil	194.6	182.4	217.0	218.3	226.0	183.8
Moisture %	10.2%	9.9%	10.0%	10.1%	9.6%	8.9%

Test Hole	TH21-14	TH21-14	TH21-15	TH21-15	TH21-15	TH21-15
Depth (m)	4.6 - 5.0	6.1 - 6.6	0.9 - 1.1	1.5 - 2.0	2.4 - 2.9	3.0 - 3.5
Sample #	SS115	SS117	G225	SS226	G228	SS229
Tare ID	D17	Z23	W41	Z104	D44	F16
Mass of tare	8.6	8.6	8.7	8.5	8.5	8.5
Mass wet + tare	232.2	253.6	266.5	253.8	233.4	273.1
Mass dry + tare	213.7	233.7	257.8	215.5	183.2	251.3
Mass water	18.5	19.9	8.7	38.3	50.2	21.8
Mass dry soil	205.1	225.1	249.1	207.0	174.7	242.8
Moisture %	9.0%	8.8%	3.5%	18.5%	28.7%	9.0%

Test Hole	TH21-15	TH21-15	TH21-16	TH21-16	TH21-16	TH21-16
Depth (m)	4.6 - 5.0	6.1 - 6.6	0.9 - 1.1	1.5 - 2.0	3.0 - 3.5	4.6 - 5.0
Sample #	SS231	SS233	G189	SS191	SS193	SS195
Tare ID	AC33	D19	W97	AB84	Z114	W10
Mass of tare	7.1	8.6	8.4	6.8	8.4	8.6
Mass wet + tare	256.2	242.5	461.7	228.2	236.4	221.8
Mass dry + tare	236.0	223.4	394.9	201.0	215.9	205.6
Mass water	20.2	19.1	66.8	27.2	20.5	16.2
Mass dry soil	228.9	214.8	386.5	194.2	207.5	197.0
Moisture %	8.8%	8.9%	17.3%	14.0%	9.9%	8.2%

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Project No. 0105-035-00
Client Burns Maendel Consulting Engineers Ltd.
Project Crystal Spring Colony Community Development

Sample Date 20-Aug-21
Test Date 27-Aug-21
Technician DJ

Test Hole	TH21-16	TH21-17	TH21-17	TH21-18	TH21-18	TH21-19
Depth (m)	6.1 - 6.6	4.6 - 5.0	6.1 - 6.6	0.8 - 0.9	3.0 - 3.3	0.3 - 0.5
Sample #	SS197	SS221	SS223	G210	SS213	G199
Tare ID	K22	AC16	W26	D39	W45	F53
Mass of tare	8.6	6.9	8.4	8.3	8.5	8.6
Mass wet + tare	249.0	261.5	283.4	226.3	253.3	229.8
Mass dry + tare	229.9	239.7	260.9	210.9	236.8	201.6
Mass water	19.1	21.8	22.5	15.4	16.5	28.2
Mass dry soil	221.3	232.8	252.5	202.6	228.3	193.0
Moisture %	8.6%	9.4%	8.9%	7.6%	7.2%	14.6%

Test Hole	TH21-19	TH21-19	TH21-19	TH21-19	TH21-20	TH21-20
Depth (m)	2.1 - 2.3	3.0 - 3.5	4.6 - 5.0	6.1 - 6.5	0.8 - 0.9	1.5 - 2.0
Sample #	G202	SS204	SS206	SS208	G163	SS164
Tare ID	W101	F115	H70	Z114	E100	E35
Mass of tare	8.5	8.4	8.8	8.6	8.5	8.5
Mass wet + tare	227.2	254.1	271.3	249.9	263.2	299.8
Mass dry + tare	172.6	230.9	251.1	230.5	240.1	273.1
Mass water	54.6	23.2	20.2	19.4	23.1	26.7
Mass dry soil	164.1	222.5	242.3	221.9	231.6	264.6
Moisture %	33.3%	10.4%	8.3%	8.7%	10.0%	10.1%

Test Hole	TH21-20	TH21-20	TH21-20	TH21-20	TH21-21	TH21-21
Depth (m)	3.0 - 3.5	4.6 - 5.0	6.1 - 6.6	7.6 - 7.7	0.3 - 0.5	0.9 - 1.1
Sample #	SS166	SS168	SS170	SS172	G141	G142
Tare ID	P37	H12	N91	Z102	F58	AA14
Mass of tare	8.5	8.7	8.9	8.5	8.8	6.8
Mass wet + tare	212.3	266.0	460.4	112.6	215.3	249.7
Mass dry + tare	196.0	244.9	421.2	104.6	186.7	206.5
Mass water	16.3	21.1	39.2	8.0	28.6	43.2
Mass dry soil	187.5	236.2	412.3	96.1	177.9	199.7
Moisture %	8.7%	8.9%	9.5%	8.3%	16.1%	21.6%

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Project No. 0105-035-00
Client Burns Maendel Consulting Engineers Ltd.
Project Crystal Spring Colony Community Development

Sample Date 20-Aug-21
Test Date 27-Aug-21
Technician DJ

Test Hole	TH21-21	TH21-21	TH21-21	TH21-21	TH21-21	TH21-21
Depth (m)	1.5 - 2.0	3.0 - 3.5	4.6 - 5.0	6.1 - 6.6	7.6 - 8.1	9.1 - 9.6
Sample #	SS143	SS145	SS147	SS149	SS151	SS153
Tare ID	AB95	H11	F22	N112	D35	N111
Mass of tare	6.6	8.5	8.6	8.4	8.6	8.7
Mass wet + tare	277.2	244.3	236.7	228.5	245.0	443.3
Mass dry + tare	253.7	223.2	217.3	211.2	226.2	407.5
Mass water	23.5	21.1	19.4	17.3	18.8	35.8
Mass dry soil	247.1	214.7	208.7	202.8	217.6	398.8
Moisture %	9.5%	9.8%	9.3%	8.5%	8.6%	9.0%

Test Hole	TH21-21	TH21-21	TH21-21	TH21-21	TH21-22	TH21-22
Depth (m)	10.7 - 11.1	12.2 - 12.6	13.7 - 14.2	15.2 - 15.7	0.5 - 0.6	0.9 - 1.1
Sample #	SS155	SS157	SS159	SS161	G87	G88
Tare ID	C8	A360	F98	AB10	W04	F137
Mass of tare	8.4	6.6	8.5	6.7	8.5	8.5
Mass wet + tare	242.3	270.6	262.0	225.4	247.0	230.3
Mass dry + tare	220.1	246.2	239.7	206.5	214.2	185.7
Mass water	22.2	24.4	22.3	18.9	32.8	44.6
Mass dry soil	211.7	239.6	231.2	199.8	205.7	177.2
Moisture %	10.5%	10.2%	9.6%	9.5%	15.9%	25.2%

Test Hole	TH21-22	TH21-22	TH21-22	TH21-22	TH21-22	TH21-22
Depth (m)	1.5 - 2.0	3.0 - 3.5	4.6 - 5.0	6.1 - 6.6	7.6 - 8.1	9.1 - 9.6
Sample #	SS90	SS92	SS94	SS96	SS98	SS100
Tare ID	C7	C3	AC39	F114	C20	AB94
Mass of tare	8.4	8.7	6.8	8.4	8.8	6.8
Mass wet + tare	240.2	489.7	254.4	209.2	241.8	248.3
Mass dry + tare	222.3	447.3	233.5	192.5	225.3	227.9
Mass water	17.9	42.4	20.9	16.7	16.5	20.4
Mass dry soil	213.9	438.6	226.7	184.1	216.5	221.1
Moisture %	8.4%	9.7%	9.2%	9.1%	7.6%	9.2%

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Moisture Content Report
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Project No. 0105-035-00
Client Burns Maendel Consulting Engineers Ltd.
Project Crystal Spring Colony Community Development

Sample Date 20-Aug-21
Test Date 27-Aug-21
Technician DJ

Test Hole	TH21-22	TH21-22	TH21-22	TH21-22	TH21-23	TH21-23
Depth (m)	10.7 - 11.1	12.2 - 12.6	13.7 - 14.2	15.2 - 15.7	0.8 - 0.9	1.5 - 2.0
Sample #	SS102	SS104	SS106	SS108	G49	SS50
Tare ID	PO5	P22	AB53	F71	N61	W70
Mass of tare	8.7	8.9	6.9	8.5	8.6	8.5
Mass wet + tare	234.1	266.2	256.0	223.3	216.7	268.1
Mass dry + tare	215.3	245.8	235.2	204.7	202.2	241.1
Mass water	18.8	20.4	20.8	18.6	14.5	27.0
Mass dry soil	206.6	236.9	228.3	196.2	193.6	232.6
Moisture %	9.1%	8.6%	9.1%	9.5%	7.5%	11.6%

Test Hole	TH21-23	TH21-23	TH21-23	TH21-23	TH21-23	TH21-23
Depth (m)	3.0 - 3.5	4.6 - 5.0	6.1 - 6.6	7.6 - 8.1	9.1 - 9.6	10.7 - 11.1
Sample #	SS52	SS54	SS56	SS58	SS60	SS62
Tare ID	P01	P17	N12	A101	AB97	W73
Mass of tare	8.8	8.5	8.7	8.6	6.8	8.8
Mass wet + tare	227.0	256.8	222.0	290.1	238.6	245.3
Mass dry + tare	201.4	232.4	200.4	261.9	212.5	222.8
Mass water	25.6	24.4	21.6	28.2	26.1	22.5
Mass dry soil	192.6	223.9	191.7	253.3	205.7	214.0
Moisture %	13.3%	10.9%	11.3%	11.1%	12.7%	10.5%

Test Hole	TH21-23	TH21-23	TH21-23	TP21-01	TP21-01	TP21-01
Depth (m)	12.2 - 12.6	13.7 - 14.2	15.2 - 15.7	0.8 - 0.9	1.4 - 1.5	2.7 - 2.9
Sample #	SS64	SS66	SS68	G19	G20	G21
Tare ID	AB18	A20	AB23	Z05	K23	D04
Mass of tare	6.8	8.7	6.7	8.6	8.7	8.7
Mass wet + tare	235.7	461.6	232.5	238.2	249.3	257.3
Mass dry + tare	214.7	423.7	212.6	230.8	229.8	233.0
Mass water	21.0	37.9	19.9	7.4	19.5	24.3
Mass dry soil	207.9	415.0	205.9	222.2	221.1	224.3
Moisture %	10.1%	9.1%	9.7%	3.3%	8.8%	10.8%

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Moisture Content Report
ASTM D2216-10

Project No. 0105-035-00
Client Burns Maendel Consulting Engineers Ltd.
Project Crystal Spring Colony Community Development

Sample Date 20-Aug-21
Test Date 27-Aug-21
Technician DJ

Test Hole	TP21-01	TP21-02	TP21-02	TP21-02	TP21-02	TP21-02
Depth (m)	4.0 - 4.1	0.8 - 0.9	0.9 - 1.1	1.7 - 1.8	2.9 - 3.0	4.0 - 4.1
Sample #	G23	G25	G26	G27	G28	G30
Tare ID	D9	Z99	E83	W18	F10	H41
Mass of tare	8.6	8.6	9.0	8.4	8.7	8.7
Mass wet + tare	271.7	237.2	266.2	254.4	289.2	228.3
Mass dry + tare	248.7	216.2	237.6	232.6	266.0	210.1
Mass water	23.0	21.0	28.6	21.8	23.2	18.2
Mass dry soil	240.1	207.6	228.6	224.2	257.3	201.4
Moisture %	9.6%	10.1%	12.5%	9.7%	9.0%	9.0%

Test Hole	TP21-03	TP21-03	TP21-03	TP21-03	TP21-04	TP21-04
Depth (m)	0.5 - 0.6	1.4 - 1.5	2.6 - 2.7	3.8 - 4.0	0.8 - 0.9	1.4 - 1.5
Sample #	G39	G40	G42	G44	G11	G12
Tare ID	AB01	P36	C14	N04	F121	E27
Mass of tare	6.8	8.8	8.5	8.7	8.8	8.8
Mass wet + tare	217.5	228.9	236.0	227.9	249.3	224.8
Mass dry + tare	198.5	210.9	216.1	210.1	230.5	205.6
Mass water	19.0	18.0	19.9	17.8	18.8	19.2
Mass dry soil	191.7	202.1	207.6	201.4	221.7	196.8
Moisture %	9.9%	8.9%	9.6%	8.8%	8.5%	9.8%

Test Hole	TP21-04	TP21-04	TP21-05	TP21-05	TP21-05	TP21-05
Depth (m)	2.7 - 2.9	4.0 - 4.1	0.8 - 0.9	1.4 - 1.5	2.7 - 2.9	3.8 - 4.0
Sample #	G14	G17	G33	G34	G35	G36
Tare ID	D37	H90	C19	E34	Z97	Z140
Mass of tare	8.6	8.8	8.6	8.8	8.7	8.6
Mass wet + tare	283.6	250.9	240.9	298.6	255.6	232.8
Mass dry + tare	260.6	230	219.6	258.1	233.8	212.6
Mass water	23.0	20.9	21.3	40.5	21.8	20.2
Mass dry soil	252.0	221.2	211.0	249.3	225.1	204.0
Moisture %	9.1%	9.4%	10.1%	16.2%	9.7%	9.9%

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Moisture Content Report
ASTM D2216-10

Project No. 0105-035-00
Client Burns Maendel Consulting Engineers Ltd.
Project Crystal Spring Colony Community Development

Sample Date 20-Aug-21
Test Date 27-Aug-21
Technician DJ

Test Hole	TP21-06	TP21-06	TP21-06	TP21-06		
Depth (m)	0.6 - 0.8	1.4 - 1.5	2.6 - 2.7	3.8 - 4.0		
Sample #	G02	G03	G05	G08		
Tare ID	AC13	W76	Z118	A6		
Mass of tare	7.0	8.7	8.4	8.3		
Mass wet + tare	249.8	227.0	245.7	249.1		
Mass dry + tare	224.2	206.2	227.3	230.5		
Mass water	25.6	20.8	18.4	18.6		
Mass dry soil	217.2	197.5	218.9	222.2		
Moisture %	11.8%	10.5%	8.4%	8.4%		

Test Hole						
Depth (m)						
Sample #						
Tare ID						
Mass of tare						
Mass wet + tare						
Mass dry + tare						
Mass water						
Mass dry soil						
Moisture %						

Test Hole						
Depth (m)						
Sample #						
Tare ID						
Mass of tare						
Mass wet + tare						
Mass dry + tare						
Mass water						
Mass dry soil						
Moisture %						

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Atterberg Limits
ASTM D4318-10e1

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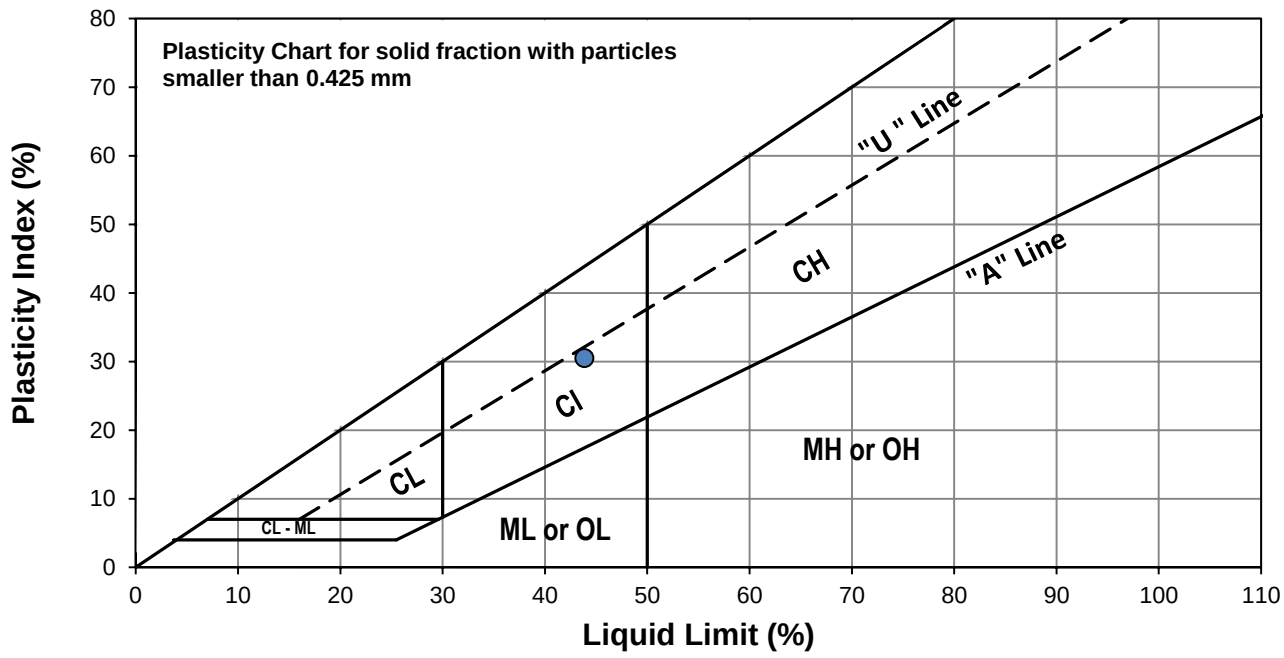
Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-16
Sample #	G189
Depth (m)	0.9 - 1.1
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	MT

Liquid Limit	44
Plastic Limit	13
Plasticity Index	30

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	15	21	27		
Mass Tare (g)	13.917	14.246	14.087		
Mass Wet Soil + Tare (g)	23.908	24.231	24.793		
Mass Dry Soil + Tare (g)	20.786	21.167	21.538		
Mass Water (g)	3.122	3.064	3.255		
Mass Dry Soil (g)	6.869	6.921	7.451		
Moisture Content (%)	45.451	44.271	43.685		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.060	13.962			
Mass Wet Soil + Tare (g)	27.051	23.815			
Mass Dry Soil + Tare (g)	25.493	22.673			
Mass Water (g)	1.558	1.142			
Mass Dry Soil (g)	11.433	8.711			
Moisture Content (%)	13.627	13.110			

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-16
Sample #	G189
Depth (m)	0.9 - 1.1
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	DJ

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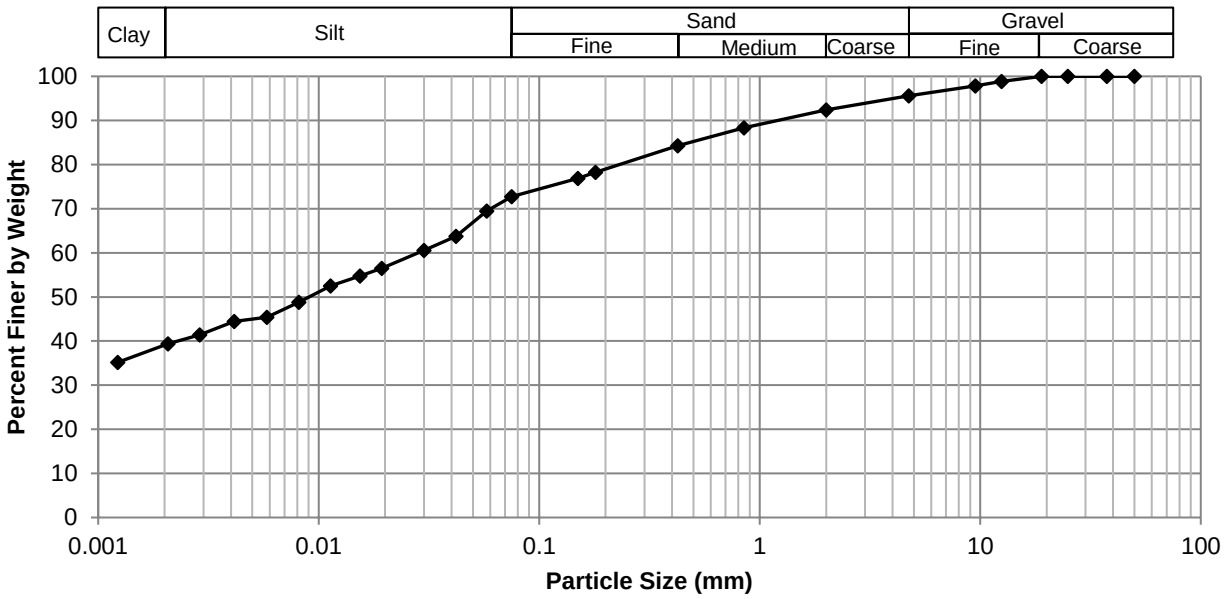
Gravel	4.4%
Sand	22.8%
Silt	33.7%
Clay	39.1%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	95.62	0.0750	72.77
37.5	100.00	2.00	92.39	0.0578	69.50
25.0	100.00	0.850	88.37	0.0420	63.73
19.0	100.00	0.425	84.25	0.0301	60.55
12.5	98.89	0.180	78.29	0.0193	56.51
9.50	97.82	0.150	76.87	0.0154	54.77
4.75	95.62	0.075	72.77	0.0113	52.53
				0.0081	48.78
				0.0058	45.38
				0.0041	44.44
				0.0029	41.40
				0.0021	39.40
				0.0012	35.18

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Atterberg Limits
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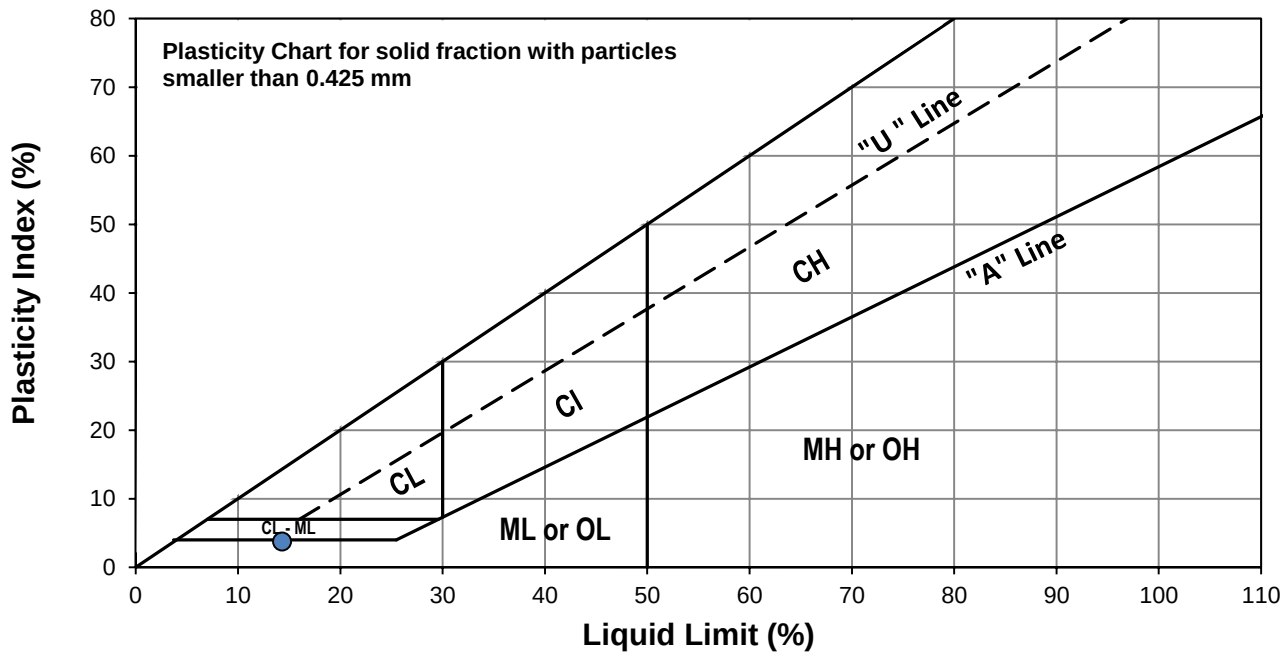
Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-20
Sample #	SS170
Depth (m)	6.1 - 6.6
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	MT

Liquid Limit	14
Plastic Limit	11
Plasticity Index	4

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	17	20	26		
Mass Tare (g)	14.420	14.467	14.104		
Mass Wet Soil + Tare (g)	26.901	28.940	23.461		
Mass Dry Soil + Tare (g)	25.220	27.019	22.306		
Mass Water (g)	1.681	1.921	1.155		
Mass Dry Soil (g)	10.800	12.552	8.202		
Moisture Content (%)	15.565	15.304	14.082		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.171	14.210			
Mass Wet Soil + Tare (g)	22.864	24.039			
Mass Dry Soil + Tare (g)	22.032	23.099			
Mass Water (g)	0.832	0.940			
Mass Dry Soil (g)	7.861	8.889			
Moisture Content (%)	10.584	10.575			

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-20
Sample #	SS170
Depth (m)	6.1 - 6.6
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	DJ

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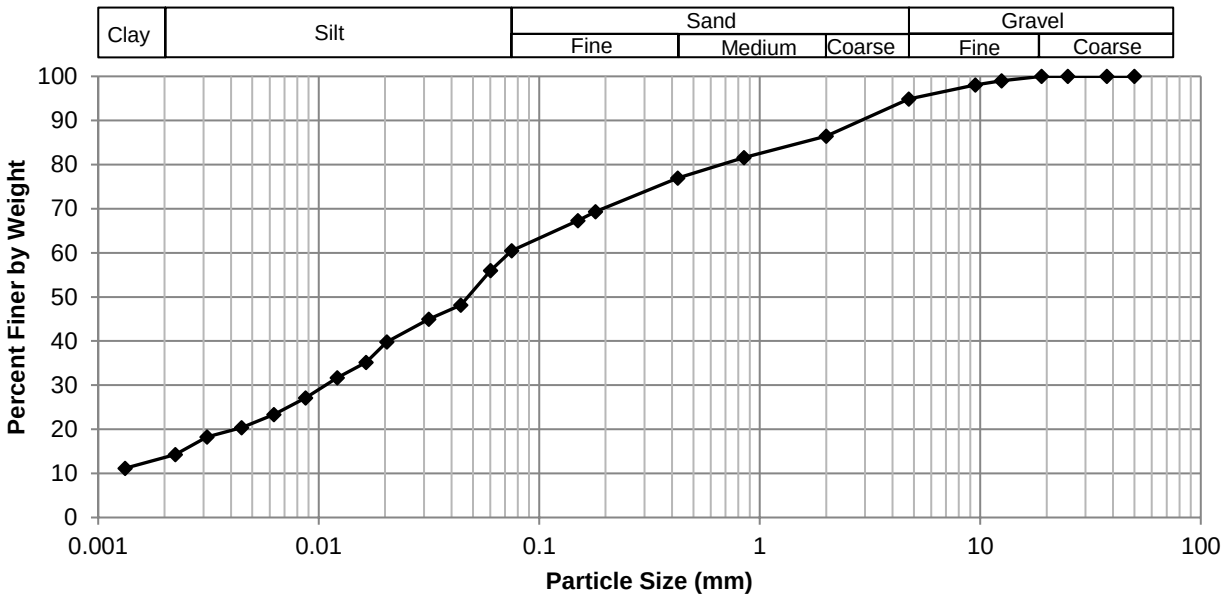
Gravel	5.1%
Sand	34.4%
Silt	47.1%
Clay	13.4%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	94.87	0.0750	60.50
37.5	100.00	2.00	86.42	0.0602	56.00
25.0	100.00	0.850	81.58	0.0441	48.17
19.0	100.00	0.425	76.97	0.0316	44.92
12.5	99.03	0.180	69.31	0.0204	39.79
9.50	98.09	0.150	67.32	0.0164	35.20
4.75	94.87	0.075	60.50	0.0122	31.69
				0.0087	27.15
				0.0063	23.31
				0.0045	20.40
				0.0031	18.29
				0.0022	14.24
				0.0013	11.16

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Atterberg Limits
ASTM D4318-10e1

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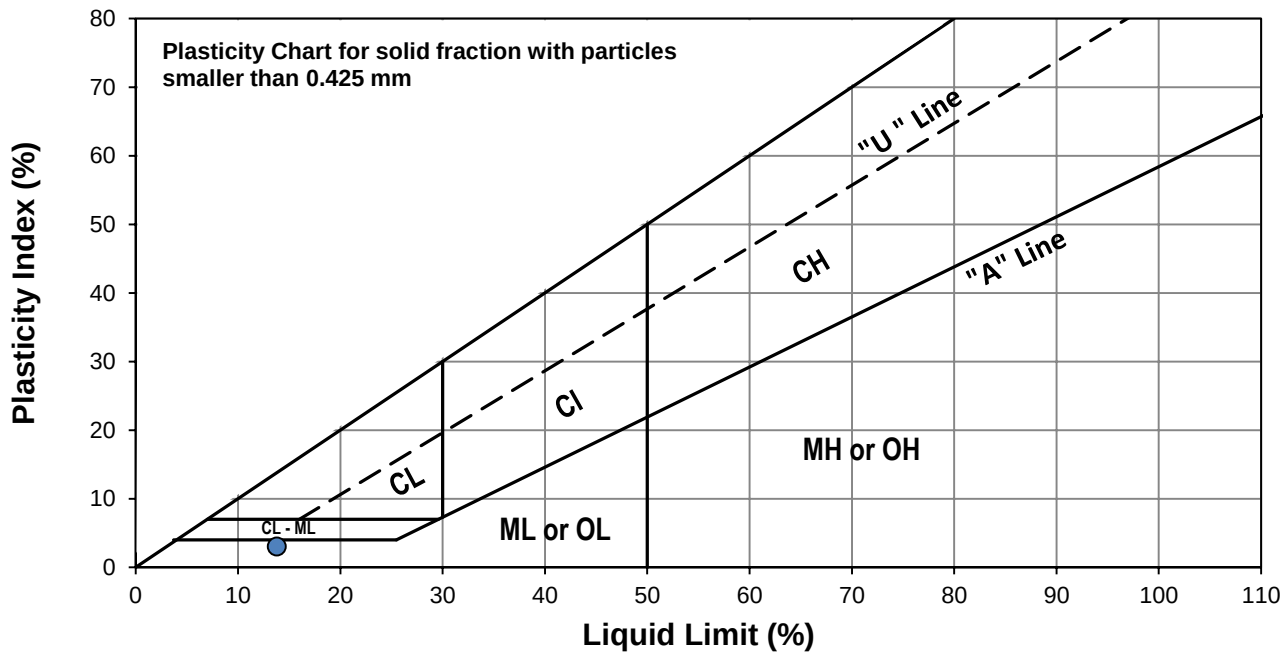
Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-23
Sample #	SS66
Depth (m)	13.7 - 14.2
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	MT

Liquid Limit	14
Plastic Limit	11
Plasticity Index	3

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	20	26	35		
Mass Tare (g)	13.834	14.055	14.124		
Mass Wet Soil + Tare (g)	28.437	26.738	27.009		
Mass Dry Soil + Tare (g)	26.644	25.202	25.482		
Mass Water (g)	1.793	1.536	1.527		
Mass Dry Soil (g)	12.810	11.147	11.358		
Moisture Content (%)	13.997	13.779	13.444		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.301	13.942			
Mass Wet Soil + Tare (g)	28.088	26.571			
Mass Dry Soil + Tare (g)	26.730	25.358			
Mass Water (g)	1.358	1.213			
Mass Dry Soil (g)	12.429	11.416			
Moisture Content (%)	10.926	10.625			

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-23
Sample #	SS66
Depth (m)	13.7 - 14.2
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	DJ

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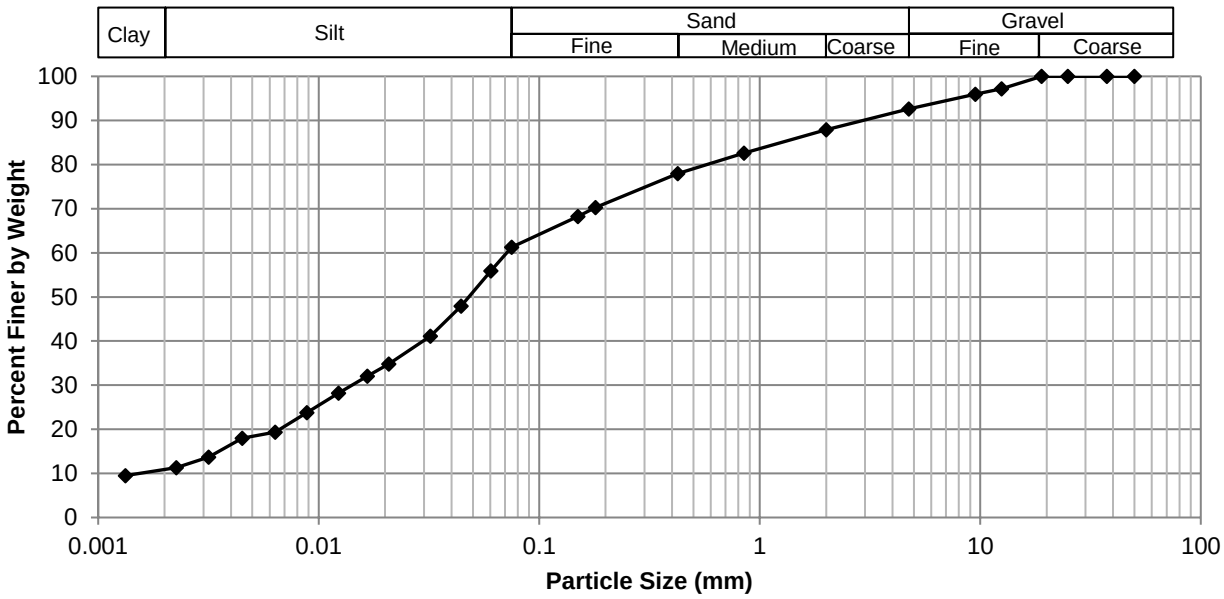
Gravel	7.4%
Sand	31.4%
Silt	50.5%
Clay	10.8%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	92.63	0.0750	61.28
37.5	100.00	2.00	87.91	0.0605	55.94
25.0	100.00	0.850	82.60	0.0442	47.97
19.0	100.00	0.425	77.95	0.0321	41.10
12.5	97.18	0.180	70.27	0.0208	34.78
9.50	95.96	0.150	68.24	0.0166	32.03
4.75	92.63	0.075	61.28	0.0123	28.18
				0.0088	23.78
				0.0064	19.33
				0.0045	18.01
				0.0032	13.67
				0.0023	11.28
				0.0013	9.50

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-21
Sample #	SS153
Depth (m)	9.1 - 9.6
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	DJ

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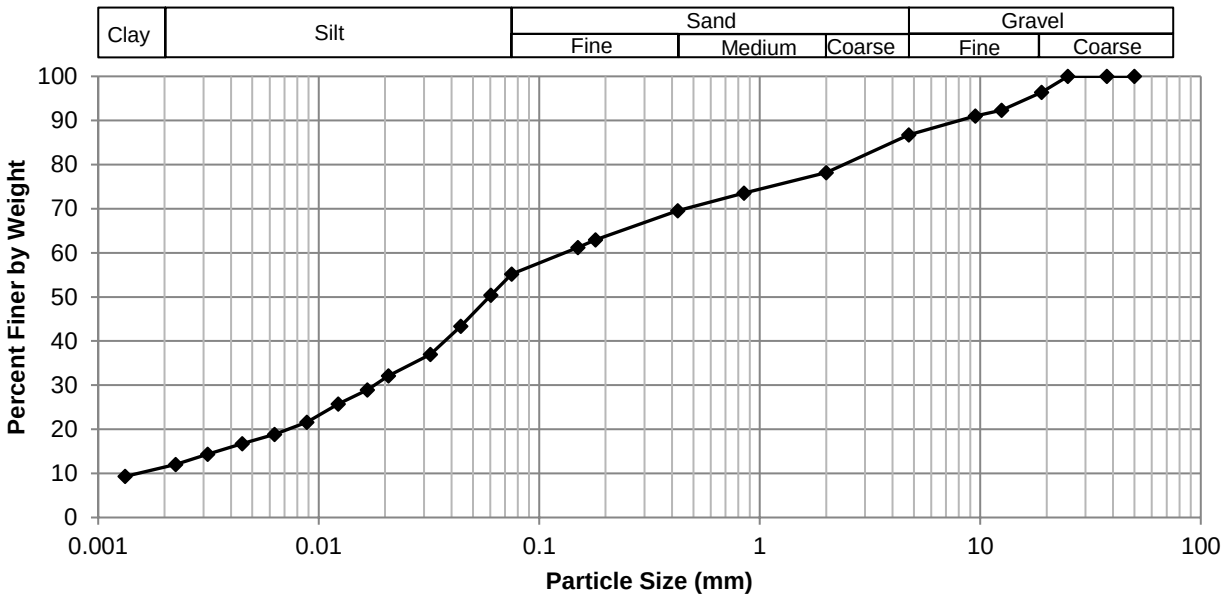
Gravel	13.3%
Sand	31.6%
Silt	43.8%
Clay	11.3%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	86.72	0.0750	55.15
37.5	100.00	2.00	78.22	0.0603	50.43
25.0	100.00	0.850	73.57	0.0441	43.34
19.0	96.40	0.425	69.59	0.0321	36.98
12.5	92.36	0.180	62.95	0.0207	32.09
9.50	91.00	0.150	61.24	0.0166	28.91
4.75	86.72	0.075	55.15	0.0123	25.77
				0.0088	21.62
				0.0063	18.88
				0.0045	16.72
				0.0031	14.32
				0.0022	12.03
				0.0013	9.32

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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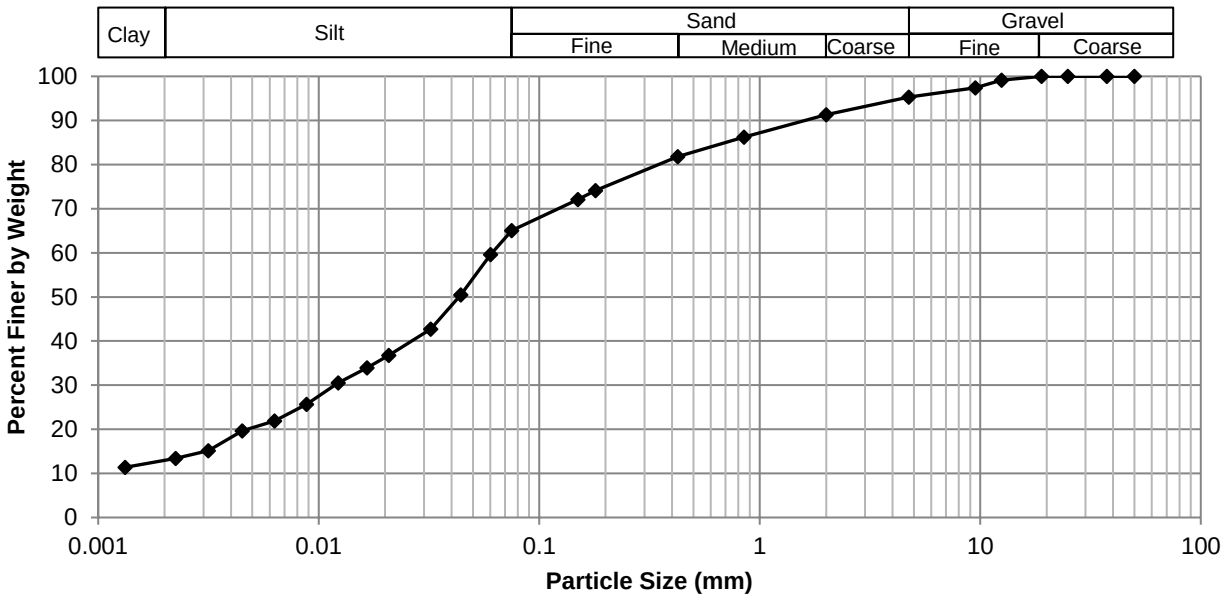
Project No.	0105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-22
Sample #	SS92
Depth (m)	3.0 - 3.5
Sample Date	20-Aug-21
Test Date	30-Aug-21
Technician	DJ

Gravel	4.7%
Sand	30.3%
Silt	52.2%
Clay	12.8%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	95.34	0.0750	65.08
37.5	100.00	2.00	91.31	0.0601	59.58
25.0	100.00	0.850	86.26	0.0442	50.45
19.0	100.00	0.425	81.84	0.0322	42.74
12.5	99.14	0.180	74.13	0.0208	36.80
9.50	97.39	0.150	72.10	0.0166	33.94
4.75	95.34	0.075	65.08	0.0123	30.51
				0.0088	25.66
				0.0063	21.90
				0.0045	19.67
				0.0032	15.15
				0.0022	13.39
				0.0013	11.37

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Atterberg Limits
ASTM D4318-10e1

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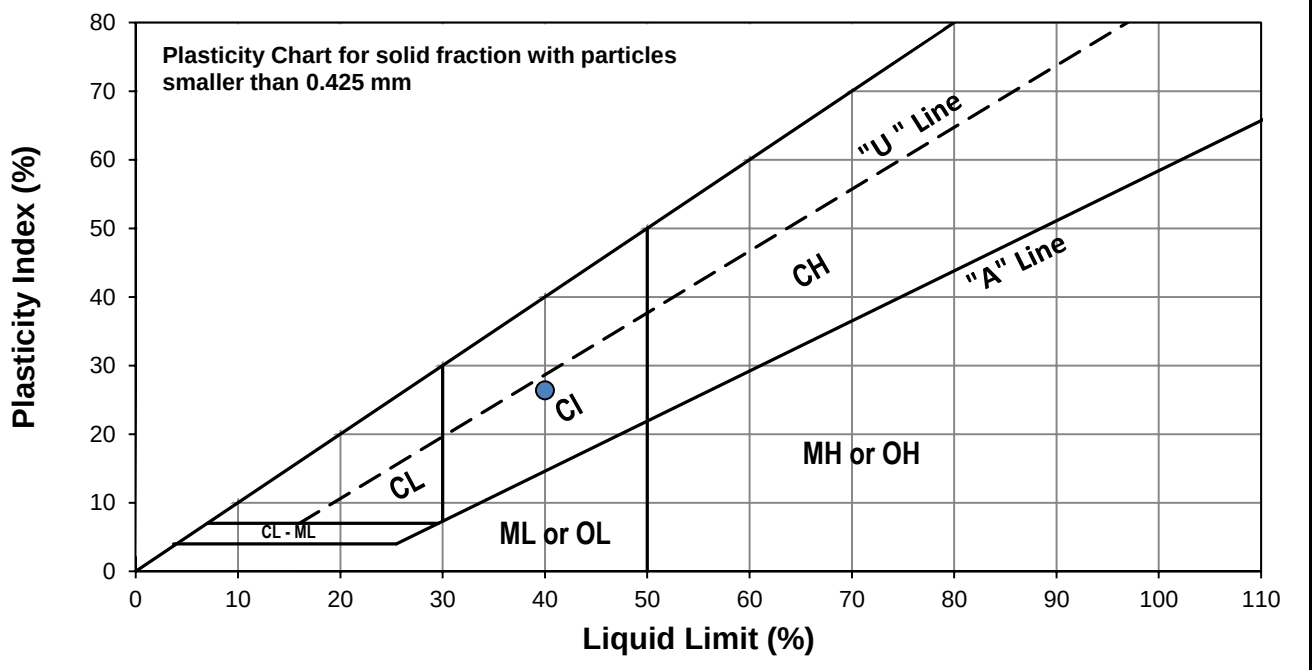
Project No.	0105-035-00
Client	Burns Maendel Consulting Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-17
Sample #	G216
Depth (m)	0.2 - 1.5
Sample Date	20-Aug-21
Test Date	27-Sep-21
Technician	MT

Liquid Limit	40
Plastic Limit	14
Plasticity Index	26

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	18	26	29		
Mass Tare (g)	13.942	14.061	14.336		
Mass Wet Soil + Tare (g)	26.063	25.507	23.489		
Mass Dry Soil + Tare (g)	22.497	22.250	20.907		
Mass Water (g)	3.566	3.257	2.582		
Mass Dry Soil (g)	8.555	8.189	6.571		
Moisture Content (%)	41.683	39.773	39.294		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.100	14.297			
Mass Wet Soil + Tare (g)	23.279	29.088			
Mass Dry Soil + Tare (g)	22.174	27.312			
Mass Water (g)	1.105	1.776			
Mass Dry Soil (g)	8.074	13.015			
Moisture Content (%)	13.686	13.646			

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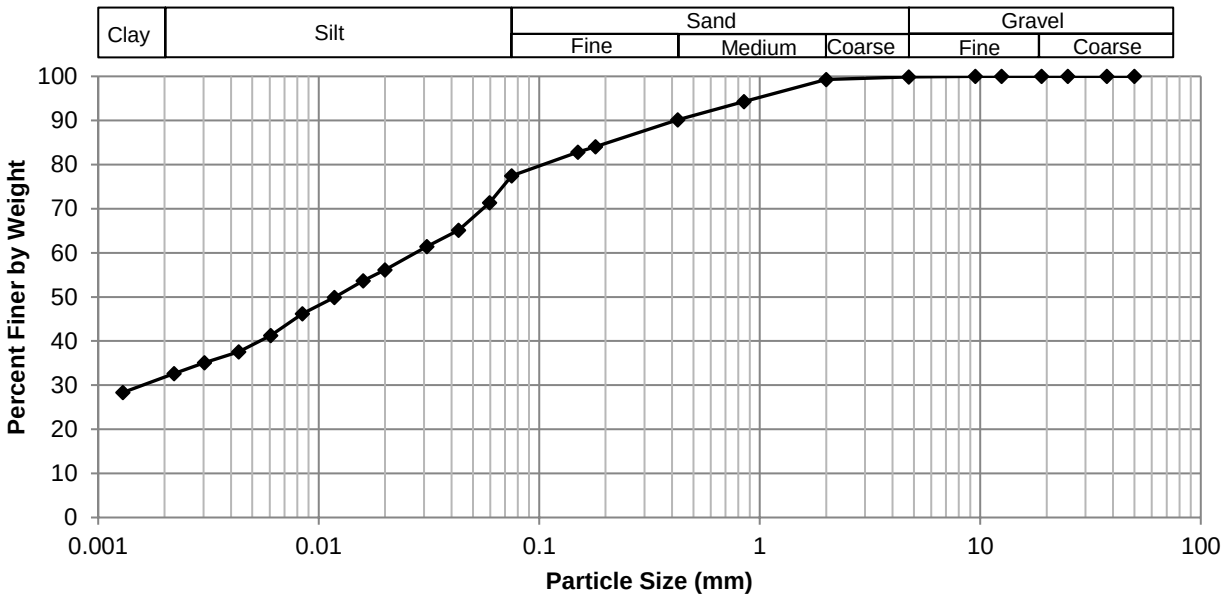
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	105-035-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Crystal Spring Colony Community Development
Test Hole	TH21-17
Sample #	G216
Depth (m)	0.2 - 1.5
Sample Date	20-Aug-21
Test Date	27-Sep-21
Technician	MT

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

Gravel	0.1%
Sand	22.4%
Silt	45.8%
Clay	31.6%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	99.87	0.0750	77.46
37.5	100.00	2.00	99.30	0.0595	71.33
25.0	100.00	0.850	94.31	0.0431	65.12
19.0	100.00	0.425	90.19	0.0310	61.40
12.5	100.00	0.180	84.03	0.0200	56.12
9.50	100.00	0.150	82.81	0.0159	53.64
4.75	99.87	0.075	77.46	0.0118	49.91
				0.0084	46.19
				0.0061	41.29
				0.0043	37.57
				0.0030	35.09
				0.0022	32.60
				0.0013	28.35

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Hydraulic Conductivity Determination (Flexible Wall)

ASTM D5084-16

Project No.	0105-035-00	**Test Hole**	TH21-16 & TH21-17
Client	Burns Maedel Consulting	**Trek Sample #**	G190 & G216 (combined)
Project	Crystal Spring Colony Development	**Depth (m)**	N/A
		Sample Date	20-Aug-21
		Test Date	September 11, 2021 to September 23, 2021
		Technician	Angela Fidler-Kliewer

Specimen Details

Visual Classification Clay, silty, trace sand, trace gravel (< 5mm diam.), brown, moist, firm, intermediate to high plasticity.

Comments The specific gravity of the soil was assumed to be 2.70. Speciman compacted to 96.5% of SPMDD.

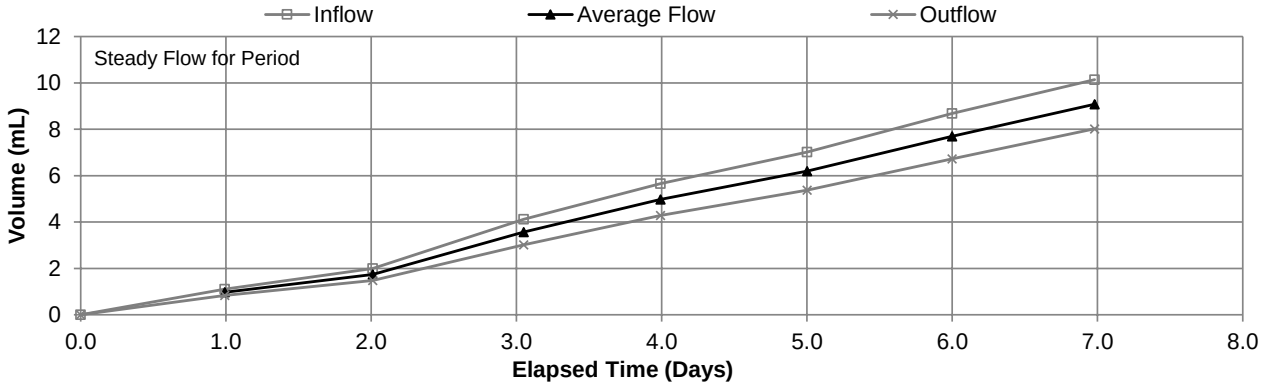
Index Testing

Liquid Limit	40
Plastic Limit	14
Plasticity Index	26
Clay Content (%)	32

Test Details

Permeant	Distilled, de-aired water
Method	Constant Head
Cell Pressure	124.2 kPa
Influent Pressure	101.6 kPa
Effluent Pressure	85.4 kPa
Gradient	18.07

Permeation Graph



Steady Flow Permeation Data

Time Increment (Days)	Elapsed Time (Days)	Flow (Q)		Inflow / Outflow Ratio	Average Flow (mL)	Temperature Correction	Corrected Hydraulic Conductivity, k_{20} (m/s)
		Influent (mL)	Effluent (mL)				
0.94	3.99	5.66	4.28	1.22	1.40	0.94	1.77E-10
1.01	5.00	7.02	5.38	1.24	1.23	0.99	1.61E-10
1.00	6.00	8.68	6.72	1.24	1.50	0.99	1.97E-10
0.98	6.98	10.14	8.02	1.12	1.38	1.00	1.77E-10

Average Temperature Corrected Hydraulic Conductivity, k_{20} (m/s) **1.78E-10** **(1.78×10^{-8} cm/s)**

Consolidation Data

	Average Height (m)	Average Diameter (m)	Moisture Content (%)	Dry Density (kN/m^3)	Degree of Saturation (%)	Cell Pressure	Back Pressure
Initial	0.0963	0.0732	18.3	17.3	93.7	119.4	85.1
Final	0.0967	0.0734	19.7	17.3	100.3	119.4	85.1

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Standard Proctor Compaction Test

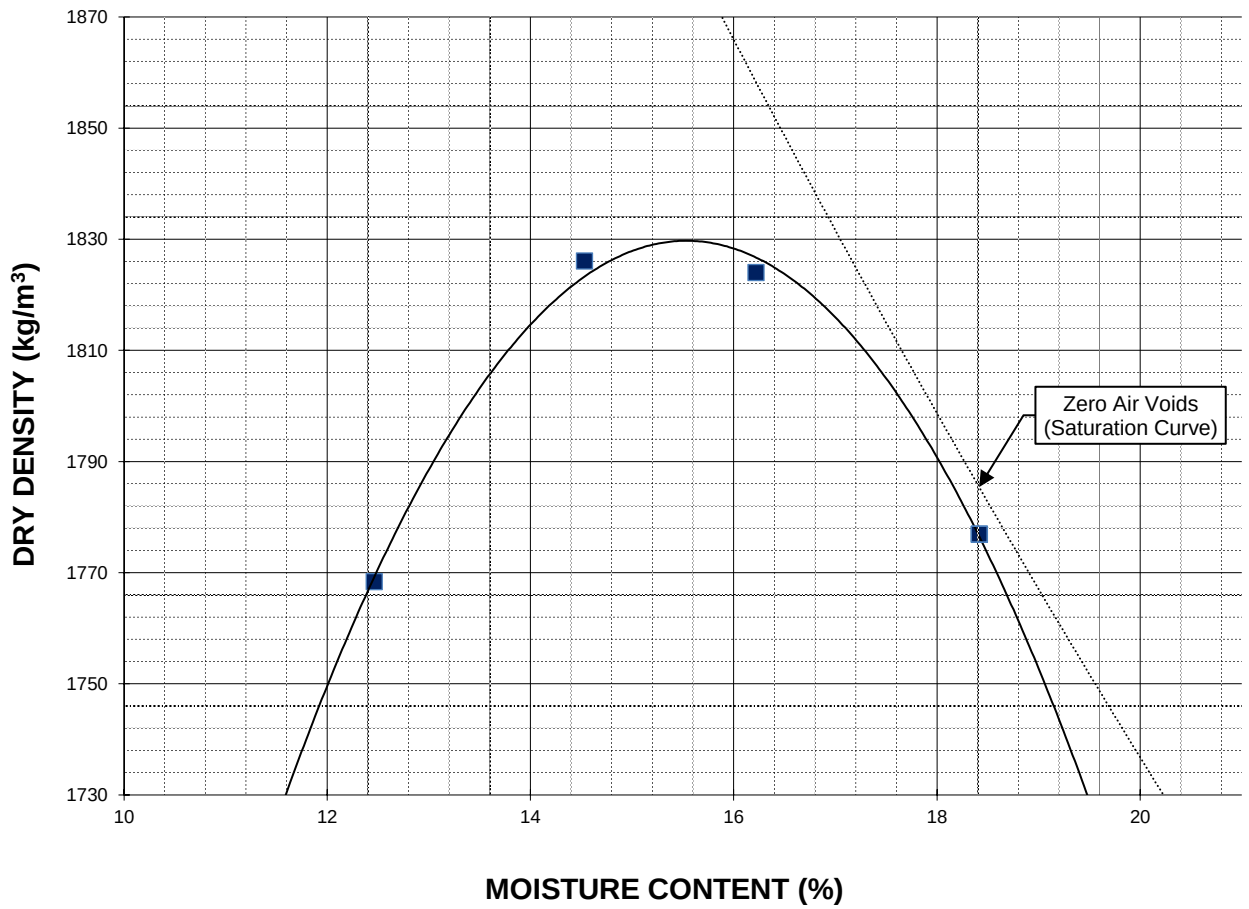
ASTM D698-12e2

Project No.	0105-035-00
Client	Burns Maendel Consulting
Project	Crystal Spring Colony Development

Sample #	G216 & G190
Source	TH21-17 & TH21-16
Material	Clay
Sample Date	20-Aug-21
Test Date	08-Sep-21
Technician	DJ

Maximum Dry Density (kg/m3)	1830
Optimum Moisture (%)	15.5

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1989	2091	2120	2104	
Dry Density (kg/m^3)	1768	1826	1824	1777	
Moisture Content (%)	12.5	14.5	16.2	18.4	



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2644411-1 TH21-22 G87 (1.5'-2.0') Sampled By: CLIENT on 19-AUG-21 Matrix: Soil - GRAB							
Miscellaneous Parameters							
Total Sulphate Ion Content	<0.050		0.050	%	01-OCT-21	01-OCT-21	R5606487
L2644411-2 TH21-22 G88 (3.0'-3.5') Sampled By: CLIENT on 19-AUG-21 Matrix: Soil - GRAB							
Miscellaneous Parameters							
Total Sulphate Ion Content	<0.050		0.050	%	01-OCT-21	01-OCT-21	R5606487

* Refer to Referenced Information for Qualifiers (if any) and Methodology.