BURNS MAENDEL
CONSULTING ENGINEERS LTD.

903 Rosser Ave.
Brandon, MB R7A 0L3
Tel: 204.728.7364
Fax: 204.728.4418
www.bmce.ca

June 22, 2023

Environmental Approvals Branch
Manitoba Environment, Climate and Parks
1007 Century Street
Winnipeg MB R3H 0W4

Reference: Environmental Act Proposal
Domestic Wastewater Lagoon
Rural Municipality of Brokenhead, MB

Dear Director,

Burns Maendel Consulting Engineers Ltd. is pleased to submit an Environment Act Proposal for the proposed domestic wastewater lagoon in the Rural Municipality of Brokenhead on behalf of Westfarm Holding Co. Ltd. (Greenwald Colony New Development). This Domestic Wastewater Lagoon will be designed to treat wastewater for the expected population of 200 people, an abattoir, and hold runoff from the residential weeping tile.

All the information relating to the Environmental Act Proposal has been compiled in the attached document. One (1) electronic PDF copy and two (2) hard copies of our proposal have been submitted as required. If you have any questions or comments, please feel free to contact the undersigned.

Regards,

[redacted]

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Burns Maendel Consulting Engineers Ltd.
No. 4559

Ashley Haigh, P.Eng.
Civil Engineer

Environmental Approvals Branch
Manitoba Environment, Climate and Parks
1007 Century Street
Winnipeg MB R3H 0W4

Environmental Act Proposal

Greenwald Colony New Development

NW 33-14-8 EPM

Submitted by:

Burns Maendel Consulting Engineers Ltd.
903 Rosser Ave.
Brandon, MB R7A 0L3
Tel: 204.728.7364
Fax: 204.728.4418

On behalf of:

Westfarm Holding Co. Ltd.
Greenwald Colony Farms Ltd.
Rural Municipality of Brokenhead

June 22, 2023

BURNS MAENDEL
CONSULTING ENGINEERS LTD.

Executive Summary

Westfarm Holding Co. Ltd., also known as Greenwald Colony Farms Ltd., has proposed a new colony development in the Rural Municipality of Brokenhead, located at NW 33-14-8 EPM. The footprint of the proposed lagoon is presently utilized as cultivated agricultural cropland. The colony intends to establish a communal farm operation with the residences, community buildings, education facilities, place of worship, utilities, and shops for the colony families at NE 32-14-08 EPM. This communal farm operation was approved for NE 32-14-08 EPM, and the adjacent site of NW 33-14-08 EPM was selected for the associated livestock facilities and the domestic lagoon.

As part of the development, a wastewater treatment facility is required. BMCE has been retained for the design of the wastewater treatment lagoon as well as the corresponding Environment Act Proposal. Due to the isolated nature of the site and its adjacency to a natural drainage path, a facultative wastewater lagoon was selected as the method of treatment.

The lagoon will consist of two cells: a primary cell with a capacity of 5,586 m^3, and a secondary cell with a capacity of 17,632 m^3 for a total of 23,218 m^3. The lagoon cells are proposed to be constructed using cut and fill methods to establish a remolded clay liner.

The treated effluent will discharge into Mile 84 Road N drain and travel west approximately 1.8 km to the Brokenhead River. The Brokenhead River is classified as a Class A drain, where indicator species of fish are present, and the channel is considered complex. During operation, wastewater effluent will be tested prior to release, in accordance with Manitoba Environment, Conservation and Parks requirements. As such, any possible or anticipated risks are minimized.

No commercial downstream users were identified along the discharge path. Additionally, well logs show the nearest domestic well user is approximately 1.5 km downstream. The distance, as well as lagoon liner requirements prohibiting infiltration, reduce the likelihood of any impact on this user or any users further downstream.

Standard Limitations

This report was prepared by Burns Maendel Consulting Engineers Ltd. (BMCE) for the account of Westfarm Holding Co. Ltd, Greenwald Colony Farms Ltd. (the Client). The disclosure of any information contained in this report is the sole responsibility of the Client. The material in this report reflects BMCE's best judgment in light of the information available to it at the time of preparation. Should this report be used by a third party, any reliance or decisions made based on this report are the responsibility of such third party. BMCE accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report. BMCE makes no representation concerning the legal significance of the findings or the information contained within this report.

Table of Contents

List of Tables

List of Appendices

1. Introduction and Background

Greenwald Colony Farms Ltd. has proposed a new colony development, unofficially referenced as Westfarm Colony (Westfarm) in the Rural Municipality of Brokenhead. The name of the new colony remains unofficial at this time; the official name of the licensee will be provided at a later date. The proposed location for the domestic lagoon is NW 33-14-8 EPM, in the northern portion of the RM of Brokenhead, proximal to the RM of St. Clements and the RM of Lac du Bonnet.

The colony intends to establish a communal farm operation with the residences, community buildings, education facilities, place of worship, utilities, and shops for the colony families at NE 32-14-08 EPM. This communal farm operation was approved for NE 32-14-08 EPM, and the adjacent site of NW 33-14-08 EPM was selected for the associated livestock facilities and the domestic lagoon.

To aid in the development process, the colony has retained Burns Maendel Consulting Engineers Ltd. (BMCE) to provide engineering design and technical support. This Environment Act Proposal has been prepared by BMCE, on behalf of the colony, to obtain a license for the proposed domestic lagoon.

1.1. Wastewater Production

Typical colony developments in Manitoba account for a population of approximately 125, however, modern trends for growth and industrialization have resulted in larger settlement sizes.

1.1.1. Population

The new colony has been designed to permanently accommodate a maximum population of 150 persons at full construction. Per traditional colony development, as the colony nears capacity it will then divide and establish another subsequent colony. As the establishment of the subsequent colony proceeds, it is reasonable to understand the colony population will continue to naturally increase in the interim. Therefore, BMCE has assumed a domestic population of 200 to accommodate a larger-than-standard population during the construction of the future subsequent colony.

1.1.2. Domestic Wastewater Production Rate

Domestic wastewater production rates were calculated using a loading rate of 0.077 $kgBOD_5$/cap/day for organic loading, and a value of 300 L/cap/day was used to determine hydraulic loading. This organic loading rate is typical for wastewater projects within Manitoba. The rate for hydraulic loading is in accordance with literature values as well as historical design wastewater loading rates from other colonies.

Table 1 – Domestic Organic and Hydraulic Loading Rates

Population	Organic Loading Rate (kg BOD_5/c/d)	Organic Loading (kg BOD5/d)	Hydraulic Loading Rate (m^3/c/d)	Hydraulic Loading (m^3/d)
200	0.077	15.40	0.3	60.0

1.1.3. Truck Wash Production Rate

Once fully constructed, the colony plans to include a truck wash. The runoff from the truck wash will be collected in the wastewater lagoon at an assumed rate of 3.89 m^3/day. This loading rate utilizes an assumed usage of 4 hours/day, 6 days/week of a 5 gpm pressure washer, based on observed loading rates from the New Rosedale Colony and discussions with Westfarm representatives.

1.1.4. Abattoir Production Rate

The proposed development includes plans for an abattoir for colony use, with no commercial processing in the facility. It is anticipated that the colony will process 25 beef cattle, 500 hogs, 1500 broiler chickens, and 800 broiler ducks/turkeys annually, at full occupancy and operations.

Typical wastewater requirements and loading rates for the slaughter of cattle, hogs, and poultry were obtained from *The Characterization of Provincial Inspected Slaughterhouse Wastewater in Ontario, 2011*. Utilizing these values, BMCE calculated the average daily organic and hydraulic loading from the proposed abattoir. As summarized in Table 2, the abattoir, at full operation, is expected to contribute 1924 L/day and 10.35 kg BOD_5/day.

Table 2 – Abattoir Organic and Hydraulic Loading Rates

Parameter		Result	
Livestock Type	Quantity (head)	Washwater Loading (L/head)	Daily Loading (L/day)
Chicken	1500	11	72
Ducks/Turkeys	800	12	42
Hogs	500	757	1646
Cattle	25	1,514	165
Chicken – Washwater BOD_5 Concentration (mg/L)		1,648	
Ducks/Turkeys - Washwater BOD_5 Concentration (mg/L)		1,999	
Hogs – Washwater BOD_5 Concentration (mg/L)		4,711	
Cattle – Washwater BOD_5 Concentration (mg/L)		14,545	
Chicken – Washwater BOD_5 Loading (kg BOD_5/d)		0.12	
Ducks/Turkeys – Washwater BOD_5 Loading (kg BOD_5/d)		0.08	
Hogs – Washwater BOD_5 Loading (kg BOD_5/d)		7.75	
Cattle – Washwater BOD_5 Loading (kg BOD_5/d)		2.39	

1.1.5. Additional Hydraulic Loading

Backwash flow rates were obtained via discussion with Westfarm based on their observed usage, records of similar colony Water Treatment Plants, and other colony domestic lagoons on the public registry. These values were then improved upon based on the anticipated treatment system and published literature regarding the frequency and volumes of reverse osmosis and filter backwash as a percentage of domestic consumption.

In the event the colony connects a weeping tile system to the domestic sewer, BMCE has allowed for a 15% weeping tile and infiltration volume. This percentage was utilized based on a study of *Infiltration/Inflow Control/Reduction for Wastewater Collection Systems*, with assumptions verified based on soil type, regional climate, and contributing area.

Organic and hydraulic loading is summarized below, demonstrating the contributions of population, abattoir, backwash, and weeping tile/infiltration.

Table 3 – Organic and Hydraulic Loading Rate Summary

Contributor	Organic Loading (kg BOD_5/d)	Hydraulic Loading (m^3/d)
Population	15.40	60.0
Abattoir	10.35	2.12
Truck Wash	N/A	3.89
Backwash	N/A	10.75
Weeping Tile	N/A	11.54
TOTAL	**25.75**	**88.3**

1.2. Topographical Survey

BMCE reviewed LiDAR data and limited GPS survey data to gain an understanding of the drainage pattern of the project site. The objective of this review was to determine existing elevations across the site. This data indicated that the cultivated field in which the domestic lagoon is proposed is relatively flat, with gradual drainage toward the municipal ditches along the north and west of the quarter section.

The existing topographic features have been further improved upon during BMCE's detailed design of the development. Drainage license No. 2023-WCW-0108 has been granted for the property.

1.3. Geotechnical Review

Accurate geotechnical investigations play a pivotal role in domestic lagoon design. Proper soil analysis determines whether a clay liner can be used, compacted or otherwise, or if a synthetic liner is required. Additionally, determining the location of the water table is necessary to determine possible interference with the present groundwater system.

BMCE retained Trek Geotechnical to conduct a geotechnical investigation of the project site.

1.3.1. Geotechnical Investigation

The geotechnical field investigation conducted May 3 to 6, 2021, included a sub-surface investigation, laboratory testing, and provisions of geotechnical recommendations. A total of 34 test holes were drilled and samples across the two properties being evaluated for the colony, NE 32-14-08 EPM and NW 33-14-08 EPM, with test holes #13 - 17 (TH21-13 to TH21-17) located under the proposed lagoon footprint. Detailed test hole summary logs are included in the Geotechnical Report in Appendix A.

Test holes were drilled by Paddock Drilling Ltd. using a track-mounted geotechnical drill rig with a 125 mm diameter solid stem auger under the supervision of Trek personnel. Test hole depth varied across the site, with those underlying the proposed lagoon location drilled to a depth of 6.1 meters.

The soil stratigraphy was visually classified at the time of drilling using the modified Unified Soil Classification System (USCS). Soil samples were collected via Shelby Tube and split spoons. Test hole logs are provided in the Geotechnical Report's appendices and detail the soil units encountered. All samples were retained for testing at Trek's Winnipeg laboratory.

1.3.1.1. Laboratory Program

Laboratory testing consisted of moisture content determination on all samples, grain size analysis via hydrometer, Atterberg limits, permeability, undrained shear strength testing via pocket penetrometer, torvane and unconfined compression, and Standard Proctor testing on select samples.

1.3.2. Soil Stratigraphy

Detailed soil stratigraphy is provided in the test hole logs. Generally, the proposed lagoon site includes a covering of organic clay topsoil, then silty clay to the depths of testing. The silty clay varied in colour with trace inclusions of silt. The clay encountered was generally of high plasticity and moist, increasing from stiff to very stiff to firm with depth.

1.3.3. Groundwater

Minimal groundwater was encountered in the geotechnical test holes. Of the five test holes in the proposed lagoon footprint, seepage and sloughing was not observed during or after drilling. The test holes remained dry and open to a depth of 6.1 m immediately after drilling. Additional information regarding the existing groundwater conditions is discussed in Section 3.5.

1.3.4. Liner Recommendations

Trek Geotechnical provided BMCE with liner recommendations based on the geotechnical investigations and lab analyses. The clay sample tested was found to meet the provincial hydraulic conductivity requirements for use as an in-sit soil liner. Based on the observed soil stratigraphy and index testing results, it is anticipated that in-situ clay soils within the proposed lagoon location will meet or be less permeable than the $1x10^{-7}$ cm/s required by MECP per the province of *Manitoba's Information Bulletin – Design Objectives for Wastewater Treatment Lagoons*.

Based on the recommendations of the Geotechnical Report, the lagoon cells are proposed to be constructed using cut and fill methods to establish a remolded clay liner. Excavation and compaction of the upper clays will be required for the side slopes, berms and liner to ensure the required hydraulic conductivity is achieved.

2. Description of Proposed Development

2.1. Certificate of Title

The legal land description where the proposed wastewater lagoon will be situated is NW 33-14-08 EPM. The legal landowner of the quarter section is Westfarm Holdings Co. Ltd. under title no. 1884491/1. Refer to Appendix B for a copy of the Certificate of Title.

2.2. Sealed Engineering Drawings

BMCE has prepared a detailed drawing set for the lagoon siting plan, site layout, lagoon plan view, section views and details. Sealed engineering drawings detailing the proposed wastewater lagoon have been included in Appendix C.

2.3. Site Selection

In selecting the location of the new Westfarm Colony, BMCE was retained to provide a technical opinion on the suitability of the proposed site. The following sections detail the reviews and research utilized to determine the location of the proposed lagoon within NW 33-14-08 EPM.

2.3.1. Land Use Planning Review

BMCE prepared a comprehensive by-law and policy review to demonstrate that developments on the project site can comply with regulations, planning documents, and regional goals.

Per the RM of Brokenhead By-law No. 1688 (Zoning By-law) and the Brokenhead River Planning District Development Plan By-law No. 166-77, the project site is classified as "A80 Rural and Agricultural" and "Agricultural", respectively. These classifications make provisions for facultative domestic wastewater lagoons, provided conformance with the Manitoba Environmental Act is met and the stated setback distances are adhered to.

As per the nutrient management regulations, part of *The Water Protection Act*, no lagoon will be located in the buffer zone adjacent to waterways. As the proposed lagoon footprint is more than one kilometer from the Brokenhead River, there is no concern regarding impact to the buffer zone resulting from the siting of the lagoon cells.

2.3.2. Flood Protection

Based on local planning documents, the proposed project site borders lands at risk of flooding by the Brokenhead River. The Brokenhead Planning District's standard for flood protection is to protect structures from a 1:200-year flood event. Per the Brokenhead Planning District Development Plan, applicants should also be able to demonstrate that any proposed flood protection measures will not increase flood velocities under such design flood conditions. BMCE contacted the Hydrologic Forecasting & Water Management division of Manitoba Transportation and Infrastructure (MTI) who had completed water modelling of this area in 2022. MTI recommended a 1:200-year flood protection level of 227.31 meters CGVD28.

BMCE also retained the services of a water resource engineer, Trek Geotechnical (Trek), to analyze the project site and adjacent flood models in order to identify the flood protection level and assess the impact of flood mitigation measures. The Brokenhead River Assessment has been included in Appendix E and details the flood protection levels and recommended mitigation for the site, as well as crest elevations for the lagoon berms. Trek recommended a minimum 1:200-year flood protection elevation of 228.28 meters CGVD28. BMCE's proposed lagoon top of berm elevation is 228.81 meters CGDV28 (228.41 meters CGVD2013).

2.3.3. Siting and Location

The province of *Manitoba's Information Bulletin – Design Objectives for Wastewater Treatment Lagoons* states that a lagoon site should be as far as practical from habitation or any area which may be built-up within a reasonable future period. Lagoons should not be located closer than 460 m from any center of population, and individual residences not being any closer than 300 m; both distances being measured from the outer toe of the nearest dyke.

Additionally, the design objectives state that the preference should be given to sites which will permit an unobstructed wind sweep across the cells of the lagoon. Consideration should be given to the lagoon location such that prevailing winds will be in the direction of uninhabited areas. Lagoons should be located such that sufficient distance is available between the lagoon and property line or the lagoon and the fence line for access of maintenance equipment. It is recommended that a minimum distance of 30 m be maintained between the outside toe of the embankment and the fence line or property.

The proposed location of the lagoon is in the northeast corner of the project site. Setbacks from property lines, centers of population, and residences are met or exceeded. Additionally, the lagoon footprint is not in, nor adjacent, to any nutrient zones nor groundwater pollution hazard areas. The proposed lagoon configuration and associated setbacks are provided on Drawing C1.2 in Appendix C.

2.4. Lagoon Design

The following sections provide information on the design considerations, assumptions, and methods used in the lagoon design.

2.4.1. Design Parameters

BMCE utilized the following rationale to establish design parameters for the proposed lagoon:

- The detention time was set at **230 days**. 227-230 days are standard detention times, based on the operational requirement that the wastewater effluent be discharged between June 15 and November 1 of a given year.
- The design organic loading rate per person is set at **0.077 kg BOD/person/day**. This is a value used commonly in wastewater treatment design in Manitoba.
- The maximum organic loading rate is set at **56 kg BOD5/ha/day**. This value is commonly used in wastewater lagoon design across Manitoba, per Manitoba's *Information Bulletin – Design Objectives for Wastewater Treatment Lagoons.*

- Per common practice and design standards for wastewater lagoon design, the available storage depth will be **1.50 m**, and active storage depth will be **1.20 m.**
- Per common practice and design standards for wastewater lagoon design, the available freeboard will be **1.00 m.**
- The area below the interconnecting pipe inverts is considered dead storage and is not part of the design storage volume or freeboard. The dead storage depth is **0.30 m**, as per common design practice and MECP standards.
- The interior slope of the primary and secondary cells will be **4:1** in accordance with the province of Manitoba's *Information Bulletin – Design Objectives for Wastewater Treatment Lagoons.*

Details of the lagoon design parameters utilized during design of the wastewater lagoon are summarized in Table 4. These parameters are in conformance with the province of Manitoba's *Information Bulletin – Design Objectives for Wastewater Treatment Lagoons.*

Table 4 – Lagoon Design Parameters

Parameter	Result
Winter Storage Period	Nov. 1 to Jun. 15
Detention Time (days)	230
Organic Loading Rate (kg BOD_5 / cap / d)	0.077
Organic Treatment Rate (kg BOD_5 / ha/ d)	56.0
Active Storage Depth (m)	1.20
Freeboard (m)	1.00
Dead Space (m)	0.30
Total Depth (m)	2.50
Cell Interior Side Slope	4:1

2.4.2. Primary Cell Design (Organic Loading)

The area outlined in Table 5 was determined at the average active storage depth in the lagoon using the 56 kg BOD_5/ha/d as outline in Section 2.4.1. This represents a depth of 0.6 m from the high-water level or 0.9 m from the bottom of cell which will represent the average water depth in the lagoon throughout the year.

Table 5 – Primary Cell Design Summary

Parameter	Result
Top of Berm Dimensions – L x W (m)	80.0 x 84.0
Floor Dimensions – L x W (m)	59.0 x 63.0
Area at Average Active Storage Depth (m^2)	5,325
Organic Treatment Capacity Provided (kg BOD_5 / d)	29.82
Organic Loading Rate (kg BOD_5 / d)	25.75
Volume Required (m^3)	5,517
Volume Provided (m^3)	5,586

2.4.3. Secondary Cell Design (Hydraulic Loading)

The total active storage volume provided for the secondary cells was calculated using the volume of the secondary cell plus half of the volume of the primary cell, per *Manitoba Sustainable Development's Design Objectives for Wastewater Treatment Lagoons*. The subsequent hydraulic capacity provided is then calculated by dividing the total active storage volume provided by the detention time to get an average inflow rate over this period of time that the lagoon can accommodate. This hydraulic capacity can then be compared to the hydraulic loading calculated in Section 1.1 (loading for population, abattoir, and extra considerations).

Table 6 – Secondary Cell Design Summary

Parameter	Result
Top of Berm Dimensions – L x W (m)	223.0 x 84.0
Floor Dimensions – L x W (m)	202.0 x 63.0
Secondary Cell Volume Provided (m^3)	17,632
Primary Cell Volume Provided (m^3)	2,793
Total Active Storage Provided (m^3)	20,425
Hydraulic Capacity Provided (m^3/d)	88.8
Hydraulic Loading (m^3/d)	88.3

2.5. Lagoon Liner

The lagoon containment will consist of a minimum of 1.0 m thick remolded clay liner at the surface of the berms surrounding and throughout the cells. BMCE anticipates that there will be adequate quantity of clay materials on site for liner construction which will meet or exceed the hydraulic conductivity requirement of 1×10^{-7} cm/s when remolded and compacted.

A geotechnical investigation was completed by TREK Geotechnical on November 8, 2021, see Section 1.3. The Geotechnical Investigation Report has been included in Appendix A. The report contains the test hole and test pit logs throughout the site and details the soil stratigraphy and laboratory testing results. In order to meet the MECP requirements for cut and fill soil liners, the report recommends the following:

- Proper construction techniques be followed,
- Provide scarification and compaction of the silty clay to address potential impact of trace sand and trace silt inclusions, and
- Berms should be constructed of silty clay in lifts of 150 mm compacted to 95% of the SPMDD and wet of optimum.

2.6. Effluent Discharge

The proposed lagoon is located in the north-east corner of NW 33-14-08 WPM, east of the intersection of Road 44E and Mile 84 Road N. The secondary cell will discharge through a release pipe sloped at 0.5% to the north ditch outfall with a 225.78 m invert. This outfall will be armoured with a 3.0 m x 3.0 m, grouted, riprap splash pad with a thickness of 0.3 m. The outlet will be operated via a gate valve in the north berm.

The treated effluent will discharge into the roadside drain where it will then flow west to the Brokenhead River, see discharge path shown in yellow in Figure 1.

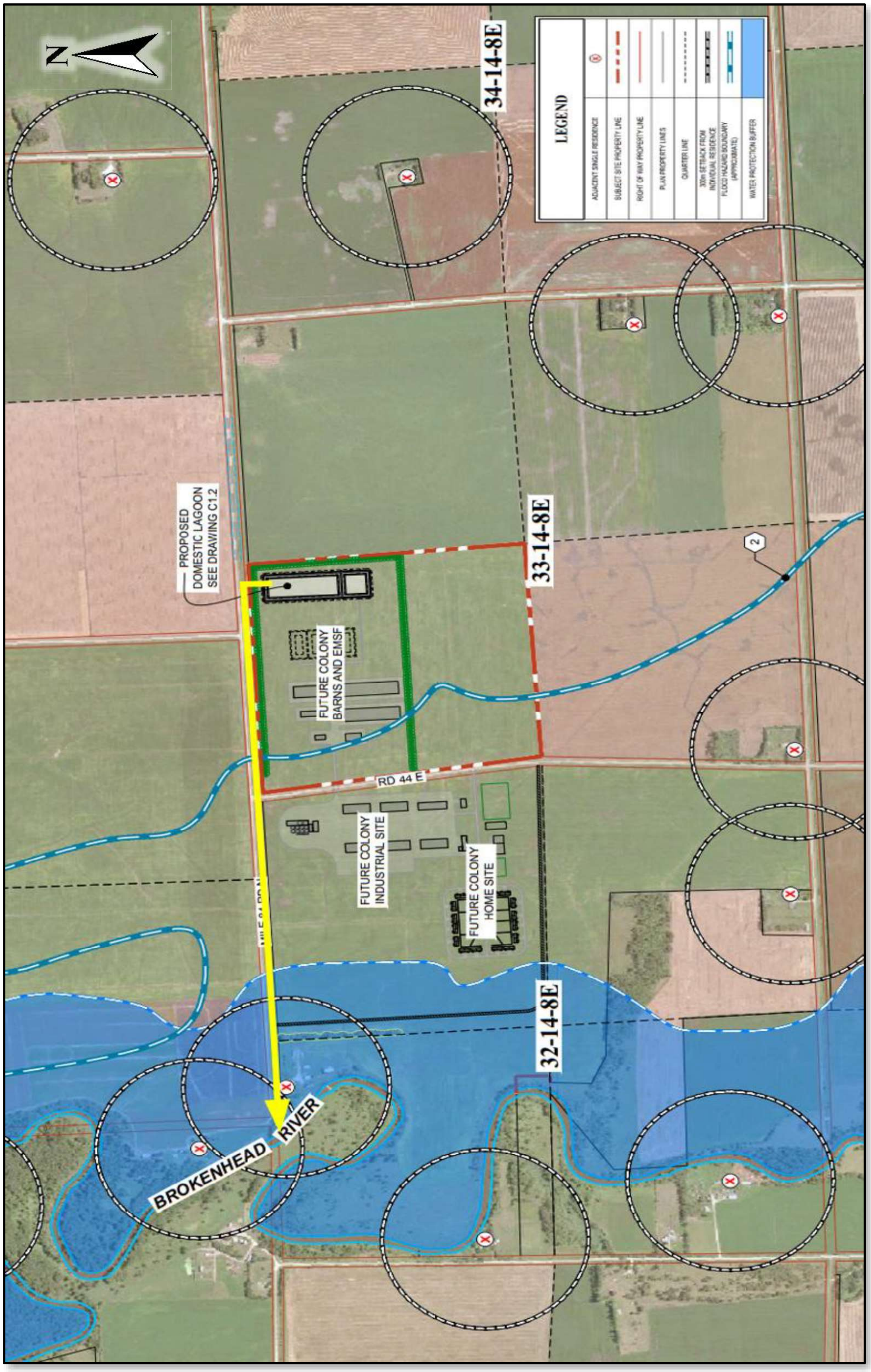


Figure 1: Discharge Path

Between the months of June and November, once the secondary cell has been tested and meets MECP effluent quality requirements, the effluent will be discharged into the roadside drain parallel to Mile 84 Road N. A trickle discharge will be used to slowly release the effluent and prevent overflow and erosion. This will allow the vegetation along the channel to further dilute and polish the effluent.

Based on the project location and effluent testing protocols that will be implemented, no effect is anticipated to downstream users.

2.7. Wastewater Collection System

The residential homes of the colony will utilize a gravity sewer network. This system will convey wastewater from residential, communal, and industrial buildings to a lift station. The lift station will then pump the water into the primary cell of the wastewater lagoon via a forcemain. Additionally, the flow from the colony's weeping tile will be conveyed into the sewer system. The wastewater collection system will be submitted separately with an Application for a Certificate of Approval for a Wastewater Collection system to MECP.

2.8. Facility Operation

Wastewater effluent collected by the sewer network will be pumped to the lagoon where the wastewater will be stored and treated until it is released in the summer/fall.

The discharge operation is summarized in the following steps:

Two weeks prior to the time of sampling, the valve permitting flow between the primary and secondary cell will be closed. This will ensure a representative water sample can be collected from the secondary cell to be discharged.

Two weeks after the valve has been closed, a water sample from the secondary cell will be obtained, using sample bottles supplied from an accredited laboratory. Water sampling and submission procedures will be performed in accordance with MECP guidelines.

If the samples do not meet MECP requirements, testing will be repeated until the samples have passed the testing criteria. Additional time will allow for natural processes, including sunlight and settling, to remove unwanted constituents from the effluent. When water samples successfully meet MECP requirements, water from the secondary cell can be discharged. Discharge will only occur within the June 15 to November 1 period each year.

Once the effluent has been drained from the secondary cell, the discharge valve will be closed. At this time, the valve regulating flow between the primary and secondary cell will be reopened.

Once the water level between the primary and secondary cell has been equalized, the secondary cell effluent can be released a second time to provide adequate capacity for winter. In the event of a subsequent release is required, the isolation sampling and release process shall be repeated. However, based on the loading calculations, we do not anticipate a second discharge will be necessary in a typical operating year.

2.9. Seasonal Maintenance

Regular observation of the lagoon will be undertaken by colony members to ensure that there is no damage to the lagoon structure.

The following tasks will be performed to ensure that the integrity of the lagoon is maintained and is functioning properly:

- Venting piping and visible sections of the liner will be inspected for damage and repaired immediately to maintain the integrity of the facility.
- The lagoon will be inspected for signs of wildlife. Any wildlife burrowing into the berm or otherwise causing damage will be removed.
- Valves and drainage areas will be checked and cleared of obstructions on a regular basis.
- Snow will be cleared on the access road so that the lagoon may be accessed at any time.
- Areas inside fencing will be mowed so berms are visible for inspection.

All inspections and maintenance will be recorded and retained for a minimum of five (5) calendar years.

3. Description of Existing Environment in the Project Area

The project site is NW 33-14-08 EPM, located in the Rural Municipality of Brokenhead. It is bounded by Mile 84 Road N to the north, Road 44 E to the west, and cultivated agricultural fields to the south and east.

3.1. Land Use

The subject site is classified as "A80" and Agricultural per the RM of Brokenhead Zoning By-law and Brokenhead River Planning District Development Plan. The footprint of the proposed lagoon is presently utilized as cultivated agricultural cropland.

3.2. Topography

The location of the lagoon will be in the northeast corner of NW 33-14-08 EPM. The area is clear of any tree cover and is adjacent to the roadside drain parallel to Mile 84 Road N. Elevations within and adjacent to the footprint of the lagoon are relatively flat, and BMCE's detailed drainage design has optimized the property to provide adequate drainage away from the lagoon and minimize the impact of stormwater on the facility during operations.

3.3. Climate

All climate information has been obtained from the *Terrestrial Ecozones, Ecoregions, and Ecodistricts of Manitoba – An Ecological Stratification of Manitoba's Natural Landscapes, 2001*. The project is located in the Stead Ecodistrict of the Lake of the Woods Ecoregion. This ecodistrict lies within the more humid and cooler subdivision of the Subhumid Low Boreal Ecoclimatic Region, which is characterized by short, warm summers and cold winters. The mean annual precipitation is about 530 mm, of which about one-fifth falls as snow.

Precipitation varies greatly from year to year and is highest from late spring through summer. The average annual moisture deficit is nearly 90 mm. The ecodistrict has a moderately cold, humid, Cryoboreal soil climate.

The climate data from the Pine Falls station (#5032164) is relevant to the ecodistrict.

3.4. Soil Conditions

See Section 1.3 and Appendix A for a summary of the soil conditions for the project.

3.5. Groundwater

BMCE retained Friesen Drillers to conduct a desktop hydrogeological study for the proposed project site. The study included a review of surficial geology, local wells, and historical reports for the area to determine aquifer conditions. Additionally, the study considered expected annual use, as well as regional hydrograph data, to provide recommendations for regulatory requirements and groundwater supply locations.

Regional hydrogeology varies due to the subject site's proximity to the boundary of the Precambrian granites and Winnipeg Sandstone formations. The hydrogeological study was reinforced by the testing program which indicated that the Precambrian bedrock, housing the primary regional aquifer, occurs approximately 35 meters below the ground surface, overlaid by approximately 20 meters of clay with low hydraulic conductivity.

3.6. Surface Waterbodies

The Brokenhead River is located over one kilometer to the west of the proposed lagoon site, and the outer toe of the berm embankments will be a minimum of 30.0 m from the property line separating the project site from the municipal ditch adjacent to Mile 84 Road N, which transmits surface water seasonally.

3.7. Wildlife in Project Area

3.7.1. Existing Aquatic Environment

The Brokenhead River is classified as a Class A fish habitat by Fisheries and Oceans Canada. This means that the creek contains indicator species including pike and walleye and is considered complex due to variations in the channel and the presence of vegetation.

3.7.2. Existing Terrestrial Environment

The project site is part of the Interlake Plain Ecoregion, no permanent habitats are expected within the cultivated areas; however, this ecoregion usually provides shelter for several species of animal. Some of the terrestrial wildlife that may be present at or near the project site are:

- **Small Mammals**: Rabbits, foxes, racoons, squirrels, chipmunks, skunks
- **Large Mammals**: Bears, Deer, Moose
- **Reptiles and Amphibians**: Frogs, turtles, snakes
- **Birds:** Woodpeckers, hummingbirds, bluebirds, cardinals

3.7.3. Rare, Threatened, Protected or Endangered Species

BMCE contacted the Manitoba Conservation Data Centre (MBCDC) to request a search of the threatened species database for the project's area of interest. The review considers the primary location, as well as a 2-kilometer radius buffer from the footprint boundary. Per the Species at Risk Act (SARA), "threatened species" means a wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.

The MBCDC completed a review of the project site and a two-kilometer radius buffer from the edge of the site boundary. It should be noted that the region within that two-kilometer buffer is significantly diverse between the cultivated land, river and banks, greater riparian areas, and intermittent deciduous forests. With an understanding of the regional diversity, it should be noted that while these species may have been observed in similar habitats as those in the greater region, it does not indicate that those species have been identified at the project site nor sites similar to the cultivated fields being considered. The identified rare species, and their location of observation, has been summarized as follows:

Correspondence with the MBCDC is included in Appendix D.

Table 7 – Conservation Data Centre Summary

Location	Informal Taxa	Scientific Name	Common Name	S Rank	SARA	COSEWIC
Within 2km of footprint boundary	Vertebrate Animal	Dolichonyx oryzivorus	Boblink	S3S4B	Threatened	Threatened
General area records, low locational accuracy	Vascular Plant	Ceanothus herbaceous	New Jersey Tea	S2S3	-	-
General area records, low locational accuracy	Vascular Plant	Claytosmunda claytoniana	Interrupted Fern	S2S3	-	-
General area records, low locational accuracy	Vascular Plant	Cyperus houghtonii	Houghton's Flatsedge	S2S3	-	-
General area records, low locational accuracy	Vascular Plant	Gentiana rubricaulis	Closed Gentian	S3	-	-
General area records, low locational accuracy	Vascular Plant	Hudsonia tomentosa	False Heather	S3	-	-

Location	Informal Taxa	Scientific Name	Common Name	S Rank	SARA	COSEWIC
General area records, low locational accuracy	Vascular Plant	Lechea intermedia var. intermedia	Large-pod pinweed	S1?	-	-
Found in broader area and similar habitat	Invertebrate Animal	Danaus plexippus	Monarch	S3S4B	Special Concern	Endangered
Found in broader area and similar habitat	Vertebrate Animal	Riparia riparia	Bank Swallow	S4B	Threatened	Threatened
Found in broader area and similar habitat	Vertebrate Animal	Lithobates pipiens	Northern Leopard Frog	S4	Special Concern	Special Concern
Found in broader area and similar habitat	Vertebrate Animal	Hirundo rustica	Barn Swallow	S4B	Threatened	Threatened

3.8. Socioeconomic Environment

The socioeconomic environment is not a large factor in the development of this wastewater lagoon. The project site is a moderately isolated location in an undeveloped area with approximately 15 non-associated residences within 3 kilometers. The proposed lagoon will be located approximately 1128 m from the nearest residence not associated with the colony.

It is important to note that the lagoon will be discharged into a municipal ditch which then releases into the Brokenhead River. Local residents have indicated that the river is utilized as a recreational site. However, due to the standards in place for effluent discharge from wastewater lagoons as well as the length of the effluent path, it is expected downstream users and the recreational area will be unaffected.

3.9. Heritage Resources

Manitoba's Historic Resources Branch was contacted to identify any potential heritage resources, historical characteristics, sites, or structures at NW 33-14-08 EPM that would be of archaeological significance and thus impact the project development. Through conversations with the senior impact assessment archaeologist, it was identified that the proposed lagoon footprint did not bear heritage resource potential, see Appendix D.

3.10. Indigenous Communities in Vicinity of Project

The proposed project is within Treaty 1 lands. The nearest indigenous community to the project is the Brokenhead Ojibway Reserve, in the Rural Municipality of St. Clements, approximately 18.8 km north-west of the project site.

No direct consultations were conducted with the regional indigenous bodies.

4. Possible Effects & Planned Mitigation of Proposed Development

Wastewater lagoons that are designed, constructed, operated, and maintained in accordance with MECP regulations pose negligible impacts to the environment nor to human health. Potential impacts that may be encountered during lagoon construction or operation, and the mitigation measures to remove or minimize these effects have been provided as follows:

4.1. Air Quality

During construction, emissions from construction equipment will be present. These emissions will be addressed and minimized by emphasizing the use of construction equipment in good operative condition and minimizing equipment idle time.

Odour nuisance is only expected to be a factor during spring and fall turnover, as this is the time when noxious gases are released. Odour will be mitigated by the fact that prevailing wind will direct the odours away from the populous regions. The period in which odours are released is short and therefore odour effects should not be a nuisance for residents in the immediate area.

Ongoing monitoring of the lagoon will be performed to ensure the proper functioning of the lagoon. Further attention will be paid to odour, and if excessive odour is noticeable the cause will be identified and dealt with accordingly. For a detailed review of the facility operation, please refer to Section 2.8.

4.2. Soils

In situ soil will be disturbed during the construction of the new lagoon. While construction equipment is on-site, there is the risk of fuel spills from the operation of heavy equipment. This risk will be reduced by prohibiting the storage of fuels and other contaminants on-site during construction. Any small spills or leaks that may occur would be addressed with standard soil contamination protocol.

Ongoing monitoring of the lagoon will be performed to ensure the proper functioning of the lagoon. Regular inspection will ensure that there is no damage to the lagoon from erosion, liner failures, or other causes. The general condition of the lagoon will be observed on an ongoing basis during all seasons.

4.3. Groundwater

There are no ground penetrations such as unsealed abandoned wells or springs that would pose a contamination risk to the groundwater as a result of the proposed lagoon.

4.4. Forestry and Vegetation

As the lagoon is proposed to be constructed on lands that consist of cultivated fields, no treed areas or significant vegetation will be cleared or disturbed during the construction of the lagoon.

During regular operation, vehicular access will be limited to the access road within the fenced enclosure. As such operational impacts to forestry and vegetation will be negligible.

4.5. Surface Water, Fish, and Fish Habitats

Minimal impacts on surface water and fish habitat are anticipated during project construction. While construction equipment is on-site, there is the risk of fuel spills from the operation of heavy equipment. This risk will be reduced by storing equipment and fuel a minimum of 100 m away from waterbodies, as per Petroleum Products & Allied Products Regulation.

Additionally, during operation, impact to surface water bodies is expected to be minimal. All effluent is tested according to the MECP license requirements and discharged between June 16th and November 1st of any year. Brokenhead River is 1.8 km downstream from the discharge location, this allows for additional natural filtering of any contamination before reaching the water body.

Because no effluent will be discharged from the lagoon until it meets MECP license requirements, no risk to fish is anticipated during operation, as potential risks of pollution can be properly monitored and mitigated.

4.6. Wildlife

The proposed project site is located on land which is currently cultivated farmland. No permanent habitats are expected within the cultivated areas and therefore, no impact on the existing terrestrial wildlife is expected.

During operation any burrowing or nesting animals will be relocated so no damage to the lagoon will occur. This monitoring practice will also mitigate any impacts on said animals due to contaminated water consumption or equipment usage within the fenced area of the lagoon.

4.7. Rare/Threatened Species

The MBCDC will be contacted again prior to any construction to ensure the most recent information is available, and to accommodate any additions to the database. Westfarm will endeavor to appropriately protect and preserve the identified species of concern during the establishment and operation of its wastewater lagoon, intending to minimize the impact of the development upon the species and its habitat. The results of any field surveys or the observation of any species of concern will immediately be reported to the MBCDC.

The MBCDC provides recommendations for construction practices in areas where sensitive species may be present in or near the project area. Following these recommendations for construction of the proposed development, the following practices will be adhered to:

- Disturbances will occur outside of breeding season,
- Minimal clearing/disturbance techniques will be utilized during and outside breeding season,
- Suitable habitat that is unavoidably disturbed will be reclaimed, and
- Where exact nesting sites cannot be identified, setback distances will be applied.

With the application of these recommendations, disturbance to these threatened species during construction will be minimized.

There is minimal expected impact on these species during the operation of the lagoon. Operation and maintenance will be carried out by minimal staff and equipment. Reeds and other vegetation adjacent to the cells will be removed making it undesirable as a nesting area. The clearing of vegetation will also deter the birds from entering the site and potentially consuming untreated effluent.

4.8. Climate Change

Impacts due to equipment usage and emissions will be mitigated by minimizing idle times and using responsible construction practices.

As this lagoon is taking advantage of natural treatment processes, no significant climate change impacts are expected during operation.

4.9. Human Health

The site location is located in the northeast corner of NW 33-14-08 EPM, separated from the proposed colony, with a max population of 200, by a setback distance of over 1030 meters from the nearest colony residence. MECP guidelines require new lagoons to be constructed with a minimum setback of 300 meters from any individual residence. The nearest residence not associated with the colony is setback 1128 meters. There are no communities within the vicinity of the proposed lagoon.

Increased dust, noise, and vehicle traffic is expected during construction. Noise pollution may be a nuisance to nearby residents, while dust and vehicles could pose a more dangerous threat with reduced visibility, and minor health issues. Dust and noise will be mitigated by using proper construction methods including specific working hours and dust reduction materials and practices. Proper signage and vehicles in good working order will minimize risks due to traffic.

As outlined in Section 4.1, odour will only be a problem for short periods of time during the spring and summer. Nuisance odours can cause several minor health effects such as headaches, eye irritation, and respiratory problems. However, due to the proposed tree line and distance of separation from the nearest residences, no adverse effects on nearby residents are anticipated.

Safety features will include a 1.8 m tall, 150 x 150 field wire fence topped with barbed wire, and descriptive signs to discourage unauthorized access to the lagoon, and to make known the potential danger. In the event that an unauthorized person accesses the lagoon facility area and falls into the cells, the 4:1 interior side slope and access ramps will provide a sufficient surface to assist the person in exiting.

The effluent discharge path was examined to determine if there were any downstream users within sufficient range to be affected. A review of MECP's *Water Rights Licensing Public Map Viewer* showed there are no registered Points of Use (> 25 000 L/d) downstream of the proposed lagoon. A review of the *Ground Water Drill Data, 2016* showed three recorded well logs within a 3.5 km radius downstream of the proposed lagoon. As the nearest user is more than 1.5 km downstream of the discharge location and a properly designed wastewater lagoon will not allow infiltration of untreated water, no impact on this user, or any additional downstream users, is expected.

4.10. Socioeconomic

The proposed lagoon site is located in a reasonably isolated area, with 20 residences in a 3 km radius, and adjacent roads are not considered main throughfares. As such, construction of the lagoon is not expected to impact the socioeconomic structure of the area.

Once the lagoon is constructed and the colony is fully built, the colony will provide major consumer and supplier goods as well as a significant source of tax revenue for the Rural Municipality of Brokenhead.

4.11. Heritage Resources

The project site was not indicated to be an area of interest with heritage resource potential. However, a Heritage Resource Protection Plan (HRPP) will be included in the construction specifications to ensure the project team and contractors are aware of the proper contacts and procedures, should heritage resources accidentally be encountered during site development.

4.12. Indigenous Communities

As the nearest indigenous community is approximately 18.8 km north-west of the project site, no impact is expected on indigenous communities during construction or operation of the wastewater lagoon.

5. Follow-Up Plans

To ensure follow-up, plans including the monitoring and reporting tasks listed herein will be performed. These are to be conducted in addition to any monitoring and reporting requirements under the Environmental Act License (EAL):

5.1. Monitoring

On-going monitoring of the lagoon will be performed to ensure the proper functioning of the lagoon. Regular inspection will ensure that there is no damage to the lagoon from erosion, failures, wildlife, or other causes. Further attention will be paid to odour, and if excessive odour is detected the cause will be identified and dealt with accordingly. The general condition of the lagoon will be observed on an ongoing basis during all seasons.

Prior to all discharges of the lagoon, all wastewater samples will be collected in accordance with Standard Methods for the Examination of Water and Wastewater, and have all analyses completed by an accredited laboratory before release.

5.2. Reporting

The following will be monitored, recorded, and retained for a minimum of five (5) calendar years, as per similar lagoon EAL’s:

- Reports of visual inspections conducted a minimum of once per month,
- Wastewater sample dates,
- Original copies of laboratory analytical results of the sampled wastewater,
- A summary and discussion of laboratory analytical results,
- Cell isolation dates (i.e., valve operation records),
- Effluent discharge dates,
- Estimated effluent discharge volumes,
- Maintenance and repairs,
- Expansions to the collection system with associated capacity assessment,
- updated organization charts identifying all certified operators, including backup operators, and
- A summary of any wastewater collection system overflows sanitary sewer overflows/combined sewer overflows.

6. Summary

The development of a domestic lagoon at NW 33-14-08 EPM in the RM of Brokenhead will meet the need of wastewater storage and treatment for the proposed colony development. All applicable regulatory requirements, guidelines, and industry standards will be adhered to for the construction, operation, and maintenance of the lagoon. Through appropriate mitigation measures, any potential negative effects associated with the lagoon can be reasonably prevented, minimized, or mitigated.

Appendix A – Geotechnical Review

Appendix B – Certificate of Title

STATUS OF TITLE

Title Number	**1884491/1**
Title Status	**Accepted**
Client File	200310

1. REGISTERED OWNERS, TENANCY AND LAND DESCRIPTION

WESTFARM HOLDING CO. LTD.

IS REGISTERED OWNER SUBJECT TO SUCH ENTRIES RECORDED HEREON IN THE FOLLOWING DESCRIBED LAND:

NW 1/4 33-14-8 EPM
EXC FIRSTLY: DRAIN PLAN 8443 WLTO AND
SECONDLY: ALL MINES AND MINERALS AS SET FORTH IN THE CROWN LANDS ACT

The land in this title is, unless the contrary is expressly declared, deemed to be subject to the reservations and restrictions set out in section 58 of *The Real Property Act.*

2. ACTIVE INSTRUMENTS

Instrument Type:	**Caveat**
Registration Number:	**2445625/1**
Instrument Status:	**Accepted**
Registration Date:	1999-12-07
From/By:	MTS COMMUNICATIONS INC.
To:	
Amount:	
Notes:	PART
Description:	EASEMENT

3. ADDRESSES FOR SERVICE

WESTFARM HOLDING CO. LTD.
P.O. BOX 3140 RR 3
BEAUSEJOUR MB
R0E 0C0

4. TITLE NOTES

No title notes

5. LAND TITLES DISTRICT

Winnipeg

6. DUPLICATE TITLE INFORMATION

Duplicate not produced

7. FROM TITLE NUMBERS

1822358/1	All

8. REAL PROPERTY APPLICATION / CROWN GRANT NUMBERS

No real property application or grant information

9. ORIGINATING INSTRUMENTS

Instrument Type:	**Transfer Of Land**
Registration Number:	**2737659/1**
Registration Date:	2002-07-02
From/By:	GREENWALD HOLDING CO. LTD.
To:	WESTFARM HOLDING CO. LTD.
Consideration:	$1.00

---

10. LAND INDEX

NW 33-14-8E
EXC DRAIN PLAN 8443 EXC RES

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA STORAGE SYSTEM OF TITLE NUMBER 1884491/1

Appendix C – Sealed Engineering Drawings

Appendix D – Correspondence

From: Murray, Colin (ARD) <Colin.Murray@gov.mb.ca>
Sent: April 12, 2021 1:55 PM
To: Kyla Dietrich <K.Dietrich@bmce.ca>
Subject: DR K Dietrich Burns 20210329 Greenwald Colony NE-32-014-08E1 and NW-33-014-08E1 SAR

Hi Kyla
Thank you for your information request. I completed a search of the Manitoba Conservation Data Centre's (CDC) rare species database for your area of interest. This includes the primary locations:
NE-32-014-08E1 and NW-33-014-08E1; and a two kilometer radius buffer from the edge of the location boundary.

The search resulted in the following occurrences:

1. Within the footprint or primary location(s):

Within NE-32-014-08E1 and NW-33-014-08E1:
No listed or tracked species occurrences found at this time.

2. Within 2km of the footprint boundary:

NE-32-014-08E1 and NW-33-014-08E1:

INFORMAL TAXA	SCIENTIFIC NAME	COMMON NAME	SRANK	ESEA	SARA	COSEWIC
Vertebrate Animal	Dolichonyx oryzivorus	Bobolink	S3S4B		Threatened	Threatened

3. General area records low locational accuracy:

NE-32-014-08E1 and NW-33-014-08E1:

INFORMAL TAXA	SCIENTIFIC NAME	COMMON NAME	SRANK	ESEA	SARA	COSEWIC
Vascular Plant	Ceanothus herbaceus	New Jersey Tea	S2S3			
Vascular Plant	Claytosmunda claytoniana	Interrupted Fern	S2S3			
Vascular Plant	Cyperus houghtonii	Houghton's Flatsedge	S2S3			
Vascular Plant	Gentiana rubricaulis	Closed Gentian	S3			
Vascular Plant	Hudsonia tomentosa	False Heather	S3			
Vascular Plant	Lechea intermedia var. intermedia	Large-pod Pinweed	S1?			

4. Found in broader area and similar habitat:

NE-32-014-08E1 and NW-33-014-08E1:

INFORMAL TAXA	SCIENTIFIC NAME	COMMON NAME	SRANK	ESEA	SARA	COSEWIC
Invertebrate Animal	Danaus plexippus	Monarch	S3S4B		Special Concern	Endangered
Vertebrate Animal	Riparia riparia	Bank Swallow	S4B		Threatened	Threatened
Vertebrate Animal	Lithobates pipiens	Northern Leopard Frog	S4		Special Concern	Special Concern
Vertebrate Animal	Hirundo rustica	Barn Swallow	S4B		Threatened	Threatened

Further information on this ranking system can be found on our website at: http://www.natureserve.org/conservation-tools/conservation-status-assessment.
These designations can be found at:
http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php,
https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife.html and
http://www.sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1.

Manitoba's recommended setback distances can be found at: https://www.gov.mb.ca/sd/pubs/conservation-data-centre/mbcdc_bird_setbacks.pdf.

The information provided in this letter is based on existing data known to the Manitoba CDC of the Wildlife and Fisheries Branch at the time of the request. These data are dependent on the research and observations of CDC staff and others who have shared their data, and reflect our current state of knowledge. **An absence of data does not confirm the absence of any rare or endangered species.** Many areas of the province have never been thoroughly surveyed, however, and the absence of data in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present. The information should, therefore, not be regarded as a final statement on the occurrence of any species of concern nor should it substitute for on-site surveys for species or environmental assessments. Also, because our Biotics database is continually updated and because information requests are evaluated by type of action, any given response is only appropriate for its respective request.

Please contact the Manitoba CDC for an update on this natural heritage information if more than six months passes before it is utilised.

Third party requests for products wholly or partially derived from the Biotics database must be approved by the Manitoba CDC before information is released. Once approved, the primary user will identify the Manitoba CDC as data contributors on any map or publication using data from our database, as the Manitoba Conservation Data Centre; Wildlife and Fisheries Branch, Manitoba Sustainable Development.

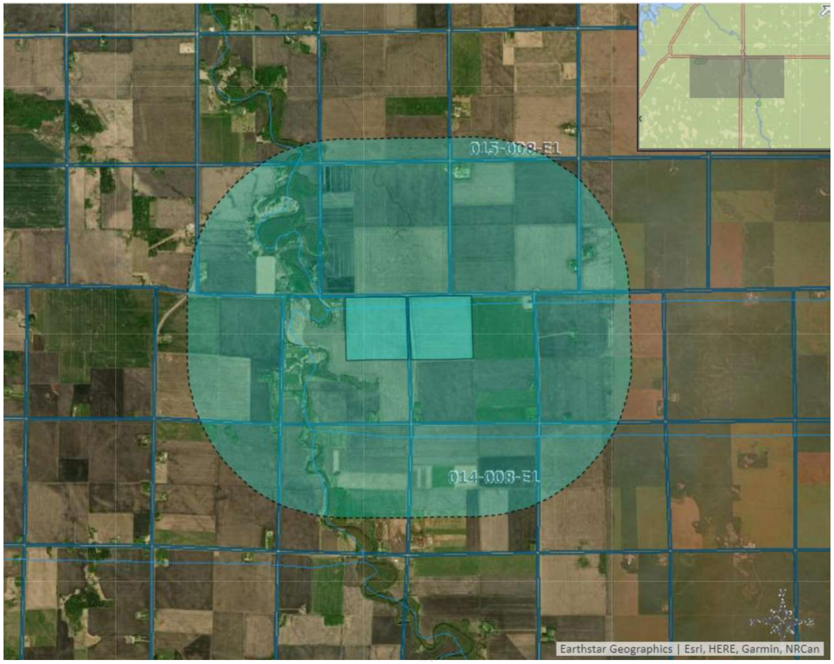
This letter is for information purposes only - it does not constitute consent or approval of the proposed project or activity, nor does it negate the need for any permits or approvals required by the Province of Manitoba.

We would be interested in receiving a copy of the results of any field surveys that you may undertake, to update our database with the most current knowledge of the area.

If you have any questions or require further information contact me directly at (204) 945-7760.

Colin

Reference screen clip:



Colin Murray
Information Manager
Manitoba Conservation Data Centre
Wildlife and Fisheries Branch
Agriculture and Resource Development

200 Saulteaux Crescent
Winnipeg, Manitoba, R3J3W3
204-945-7760
colin.Murray@gov.mb.ca
http://www.gov.mb.ca/sd/cdc/index.html

-----Original Message-----
From: +WPG969 - Form Submissions (CEN) <noreply@gov.mb.ca>
Sent: March 29, 2021 5:54 PM
To: Murray, Colin (ARD) <Colin.Murray@gov.mb.ca>
Subject: WWW Form Submission

Below is the result of your feedback form. It was submitted by CDC Information Request () on Monday, March 29, 2021 at 17:54:03

DocumentID: Manitoba_Sustainable_Development
Project Title: Greenwald Colony
Date Needed: 2021-04-12
Name: KYLA DIETRICH
Company/Organization: Burns Maendel Consulting Engineers

Address: 1331 Princess Avenue
City: Brandon
Province/State: Manitoba
Phone: 639-734-7364
Fax: 204-728-4418
Email: k.dietrich@bmce.ca

Project Description: We are representing a colony development that will include residential, industrial, and agricultural development. The residential/industrial development will be located at NE 32-14-8 E while the agricultural operation will be at NW 33-14-8 E.

Information Requested: Requesting Conservation Data Centre report as required by MR Livestock Technical Review Committee Site Assessment. Please identify any rare species that must be considered prior to development.

Format Requested: Microsoft excel, word, or emails are all fine formats
Location: Residential/Industrial: NE 32-14-8 E1
Agricultural: NW 33-14-8 E1
action: Submit

Manitoba
Sport, Culture and Heritage

Memorandum

DATE: **2023-06-22**

TO: **Burns Maendel Consulting Engineers Ltd.**
c/o Ashley Haigh
903 Rosser Avenue, Brandon, MB

FROM: Archaeological Assessment Services Unit
Historic Resources Branch
Main Floor – 213 Notre Dame Avenue
Winnipeg, MB R3B 1N3
T: (204) 945-2118 F: (204) 948-2384
e: HRB.archaeology@gov.mb.ca

SUBJECT: **New Colony Development – 2020-155:38**
AAS File: AAS-23-20564 – NE 32-14-8 E1
AAS File: AAS-23-20565 – NW 33-14-8 E1

Conditional approval

Further to your e-mail regarding the above noted application and supplemental plan drawings of the development submitted on June 21, 2023, the Manitoba Historic Resources Branch (HRB) has re-examined the locations in conjunction with Branch records for areas of potential concern.

Table 1 Screening Summary

Area/ project component	**Proposed activity**	**HRB screening and actions to be taken**
NE 32-14-8 E1	New Hutterite Colony Development	• Applicant to contact HRB if proposed activities and/or footprint changes to include further development within 200m of the western boundary of NE 32-14-8 E1 ○ Heritage Resource Impact Assessment (HRIA) *may* be required • Development may proceed as planned outside (i.e. to the east) of the 200m buffer ○ Implement an HRPP
NW 33-14-8 E1	New Hutterite Colony Development	• No concerns at this time ○ Can proceed as planned ○ Implement an HRPP

NE 32-14-8 E1 – Future Concerns – within 200m of the western boundary of the quarter section
Notably, the above-mentioned portion of the quarter section is in an area of archaeological potential located in proximity to the Brokenhead River. This watercourse was part of a transportation, trade and settlement corridor of importance during both the Pre-European Contact Period and the Historic Period. These factors, although not exclusive to the analysis, indicate a reason to believe that any future planned ground disturbance, activity, and/or development within the area has the potential to impact heritage resources, therefore, the Historic Resources Branch *may* have concerns if future development is proposed within 200m of the western boundary of NE 32-14-8 E1.

For the remaining portion of the quarter section, HRB has determined the potential to impact heritage resources to be low based on analysis of current data, therefore, the Historic Resources Branch has no concerns with the proposed activity at this time. HRB requires a HRPP be included in planning, development, and operations, in the event heritage resources (including human remains and palaeontological resources) are accidentally encountered.

NW 33-14-8 E1 – No Concerns at this time
The potential to impact heritage resources is believed to be low based on analysis of current data, therefore, the Historic Resources Branch has no concerns with the proposed activity at this time. HRB requires a HRPP be included in planning, development, and operations, in the event heritage resources (including human remains and palaeontological resources) are accidentally encountered.

Changes to current proposed activities and/or footprint
If any details of the current application undergo modification or if future work necessitates a change to the plans, the applicant is to contact HRB for re-evaluation.

Legislation
Under Section 12(2) of The Heritage Resources Act (the Act), if there is reason to believe that heritage resources or human remains upon or within or beneath lands are likely to be damaged or destroyed by any work, activity, development or project, then the Minister may require a proponent to apply for a heritage permit and conduct at his/her own expense, a heritage resource impact assessment (HRIA) and mitigation, prior to the project’s start. As per sections 46 and 51 of the Act, there is an obligation to report any heritage resources and a prohibition on destruction, damage or alteration of said resources.

A Heritage Resource Impact Assessment (HRIA) is an assessment showing the impact that proposed work is likely to have upon heritage resources or human remains. HRIAs must be conducted by a qualified archaeological consultant under a heritage permit. Please find attached a flow chart outlining the general process of an HRIA.

HRIA Expectations
The Branch will work with the proponent/land owners and its consultant to draw up terms of reference for this project. Please allow for HRIA timelines in your planning as HRIAs are conducted in snow and frost-free conditions. Any exceptions require planning and consultation with the HRB.

Please find attached an archaeological consultants’ list for reference. Due diligence should be conducted in order to assess quotes, services, and timelines.

If you have any questions, please contact as above for proper assignment and queueing.

Historic Resources Branch
Archaeological Assessment Services Unit

Enclosures: HRPP

Appendix E – Brokenhead River Assessment

Burns Maendel Consulting Engineers Ltd.

Greenwald Colony Community Development
Geotechnical Investigation Report

Prepared for:
Mr. Andrew Lepp, P. Eng.
Burns Maendel Consulting Engineers Ltd.
1331 Princess Avenue
Brandon, MB
R7A 0R4

Project Number: 0105 032 00

Date: March 9, 2022

TREK GEOTECHNICAL
Quality Engineering | Valued Relationships

March 9, 2022 Our File No. 0105 032 00

Mr. Andrew Lepp, P. Eng.
Burns Maendel Consulting Engineers Ltd.
1331 Princess Avenue
Brandon, MB
R7A 0R4

RE: Greenwald Colony Community Development
Geotechnical Investigation Report - Revised

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

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

[redacted]

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

Encl.

www.trekgeotechnical.ca
1712 St. James Street | Winnipeg, Manitoba R3H 0L3 | Tel 1.204.975.9433 | Fax 1.204.975.9435

Revision History

Revision No.	Author	Issue Date	Description
0	RSA	September 7, 2021	Final Report
1	RSA	March 9, 2022	Final Report

Authorization Signatures

Prepared By:

[redacted]

[redacted]

Ruslan Amarasinghe, EI
Geotechnical Engineering Intern

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

Reviewed By:

[redacted]

Kent Bannister, M.Sc., P.Eng.
Senior Geotechnical Engineer

ENGINEERS
GEOSCIENTISTS
MANITOBA
[redacted]
Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877 Date: March 9/22

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

This report summarizes the results of a geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed Greenwald Colony community development located approximately 20 km north of Beausejour, MB in the RM of Brokenhead. The terms of reference for the investigation are included in our proposal to Mr. Parasdeep Kanda, E.I.T., of Burns Maendel Consulting Engineers Ltd. (BMCE), dated February 11, 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 site is located near the intersection of Mile 84 Road North and Road 44 East approximately 300 m east of the Brokenhead River at its nearest point. The property is vacant farmland measuring approximately 1.3 km^2 in area. There is a ditch running along Mile 84 Road North at the north edge of the property and two ditches running Road 44 East, one on each side of the road. The community development will include residential, industrial, and agricultural structures, as well as a school and gymnasium, church, cemetery, sports field, ice rink, lagoon, manure storage cell, flood protection berms, 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 was provided by BMCE. This information was used by TREK to select the test hole 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 34 tests holes were drilled and sampled (TH21-01 to 34) at the locations shown on Figure 01 to the following depths:

- TH21-01 to 12 to 3.0 m depth
- TH21-13 to 17 to 6.1 m depth
- TH21-18 to 22 to 9.1 m depth
- TH21-23 to 34 to 12.2 m depth

Test holes TH21-01 to 12 and TH21-23 to 34 were backfilled with auger cuttings to surface. Test holes TH21-13 to 22 were backfilled with bentonite chips.

The test holes were drilled by Paddock Drilling Ltd., with a CME-850 track-mounted geotechnical drill rig equipped with 125 mm diameter solid stem augers. 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 and bulk) samples, and relatively undisturbed (Shelby tube) samples. Field vane shear testing was carried out at various depths in the silty clay layer to better characterize the undrained shear strength. A Geonor H-70 field vane was used for the in-situ testing which was completed in general accordance with ASTM 2573.

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, permeability (flexible wall), and Standard Proctor testing on select samples. Laboratory test results are included in Appendix A.

Test hole locations were recorded using a handheld GPS. Test hole elevations were surveyed, using a rod and level, relative to a temporary benchmark (PT3 established by BMCE) located at the north end of the site near the intersection of Mile 84 Road North and Road 44 East as shown on the Site Plan. The UTM coordinates of each test hole are provided on the attached test hole logs. Laboratory test results are included in Appendix A. The test hole 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 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 logs.

The soil stratigraphy encountered at the drilling locations generally consists of clay topsoil (approximately 0.2 m thick) over silty clay which extends to the maximum depth of exploration (12.2 m). The silty clay is of high plasticity, moist, and stiff to very stiff becoming firm with depth. The silty clay has a variable structure with traces of sand and trace to some silt inclusions (generally less than 25 mm in diameter). Silt was encountered below the topsoil in TH21-01, 12, 23. The silt in these test holes is 0.6 to 1.2 m thick and contains various amounts of clay (trace clay to clayey). It is generally soft and of low plasticity. A lower silt layer, approximately 0.3 m to 0.6 m thick, was also observed in TH21-18 to 20 and 22 to 34 at depths ranging from 5.5 m to 9.0 m. This silt layer also contains varying fractions of clay (trace clay to clayey) and sand (trace sand to some sand) and is wet, soft to firm, and of low plasticity.

4.3 Groundwater Conditions

A small amount of groundwater seepage was observed from both the upper and lower silt layers in all test holes where silt was observed except TH21-12. All test holes were dry at end of drilling. Minor squeezing of the test holes was also observed within the silty clay at several locations at depths varying between 2 and 11.8 m below grade. This resulted in many of the test holes staying only partially open after drilling. The squeezing can likely be attributed to disturbance of the clay during drilling.

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 Foundation Recommendations

Suitable foundation options for the proposed development include cast-in-place concrete (CIPC) footings, thickened-edge slabs, and friction piles based on the observed sub-surface and loading conditions. 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.

5.1 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 1 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 1. 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

5.2 Shallow Foundations

Footings bearing on stiff to very stiff silty clay can be designed using an SLS unit bearing resistance of 125 kPa and an ULS unit bearing resistance of 190 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 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. In this regard, it may be desirable to provide control joints in the floor 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.* silty clay) 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 have a minimum width of 0.6. Minimum widths should be verified with the applicable building code (e.g. Manitoba Building Code, NBCC).
2. A filter-protected drainage system (weeping tile) should be installed around the perimeter of the building and connected to a collection (sump) pit and pumped away from the structure to reduce water infiltration into the bearing soils and minimize footing movements associated with swelling of clay soils.

3. Footings 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, silt, debris, and any other deleterious material should be completely removed such that the bearing surface consists of stiff to very stiff silty clay.
2. Excavations for footings should be completed by an excavator equipped with a smooth-bladed bucket operating from the edge of the excavation. The contractor should work carefully to prevent disturbance to the bearing surface at all times.
3. 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 entiretysuch that the bearing surface consists of undisturbed stiff to very stiff silty clay. 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.
4. Footings should be backfilled with non-frost susceptible granular fill and compacted to 98 % of the SPMDD in lifts no greater than 150 mm.

5.3 Cast-in-Place Concrete Friction Piles

Friction piles 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 2 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 2. ULS and SLS Bearing Resistances for CIPC Friction Piles

Pile Depth Below Existing Site Grade (m approx.)	SLS Unit Resistance (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 to 9	14.5	17	85	13
9 to 12	10	12	70	9

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 12.0 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. Although not anticipated to be significant, squeezing of the pile holes may occur during drilling which could lead to a reduction in the cross-sectional area of the pile. In this regard, concrete should be placed immediately after preparation of the pile hole.
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.

5.4 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 3. 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 3. 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 9	Silty Clay	5,000/d (Note 1)
9 to 12	Silty Clay / Silt	2,000/d (Note 1)

Note 1: d = pile diameter

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.

5.5 Pile Caps and Grade Beams

A minimum void of 150 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.

5.6 Ad-freezing Effects

Concrete piles, footings, 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 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. For piles, 43 kPa above 9 m depth and 30 kPa below.
   b. For footings, a backfill unit weight of 20 kN/m^3.
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.

5.7 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. Based on local experience gathered through previous work in the area, the degree of exposure for concrete subjected to sulphate attack is classified as severe according to Table 3, CSA A23.1-14 (Concrete Materials and Methods of Concrete Construction). Accordingly, all concrete in contact with the native soil should be made with high sulphate-resistant cement (HS or HSb). Furthermore, the concrete should have a minimum specified 56-day compressive strength of 32 MPa and have a maximum water to cement ratio of 0.45 in accordance with Table 2, CSA A23.1-14 for concrete with severe sulphate exposure (S2). Concrete that may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA A23.1-14.

5.8 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.

6.0 Concrete Slabs

6.1 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. Fill soils, organics, silt and any other deleterious material should be stripped such that the sub-grade consists of 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 50 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 50 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, durable crushed rock, in accordance with the Manitoba Infrastructure Standard Specification No. 900 (or equivalent as approved by TREK).
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.

6.2 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).

7.0 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 4 below provides K_o values for calculation of lateral earth pressures developed from backfill acting on basement walls.

Table 4. 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.

8.0 Lagoon, Manure Storage Cell, and Flood Protection Berms

The proposed development includes flood protection berms to protect the community against overland flooding of the Brokenhead River as well as a lagoon and a manure storage cell.

8.1 Flood Protection Berm Details

TREK understands that the flood protection berms are designed to be approximately 1.2 m above prairie level, at the highest point, with a drainage ditch situated on the inside of the berm. The drainage ditch will be about 3 m wide at the base and about 3.6 m deep which will result in a maximum inside berm of height of approximately at 4.8 m. The berm and ditch will have 5H:1V side slopes, a 3 m wide crest, and a freeboard of at least 0.3 m.

8.2 Lagoon Berm Details

TREK understands that the lagoon berms will be 1.5 m above prairie level the lagoon base will be 1 to 1.5 m below prairie level for a total berm height of 2.5 to 3 m. The typical water depth in the lagoon will be 1.5 m under typical operating conditions. The lagoon will have a 3 m wide berm crest and a 1 m freeboard. According to provincial guidelines, the lagoon berms must have inside and outside slopes of 3H:1V and 4H:1V, respectively, or flatter.

8.3 Manure Storage Cell Berm Details

TREK understands that the manure storage cell berms will be 1.5 m above prairie level and the cell base will be 3.5 m below prairie level for a total berm height of 5 m. The typical water and sludge depth in the cell will be 4 m under typical operating conditions. The manure storage cell berm will have a 3 m wide berm crest and a 1 m freeboard. The manure storage cell berms must have inside and outside slopes of 3H:1V and 4H:1V, respectively, or flatter.

8.4 Slope Stability

Slope stability analyses were carried out to evaluate stability and determine side slope geometry for the lagoon and manure storage cell berms, and to verify that the proposed flood protection berm slope gradient (5H:1V) meets the required level of stability. The analyses of the berms were performed under assumed short-term (extreme) and long-term (typical) water/sludge levels with respective target factors of safety (FS) of 1.2 and 1.5 as described in more detail below.

8.4.1 Numerical Model

The stability analyses were conducted using a limit-equilibrium slope stability model (Slope/W) from the GeoStudio 2016 software package (Geo-Slope International Ltd.). The slope stability model used the Morgenstern-Price method of slices with the half-sine inter-slice force function to calculate factors of safety (FS) and slip surfaces were identified using a grid and radius slip surface method. A static piezometric line was used to represent water levels.

8.4.2 Soil Properties

The soil units used in the model are based on the stratigraphy encountered during drilling. The berms were modelled using a compacted, high plastic clay fill and the underlying native soils were assumed to consist of stiff to very stiff, high plastic silty clay. The strength properties selected for the materials are presented in Table 5 and are based on the soil stratigraphy, lab testing results, engineering judgement, and our experience with similar soils.

Table 5. Soil Properties used in the Stability Analysis

Soil Description	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Silty Clay (Fill)	18	2	17
Silty Clay (Native)	17.6	5	17

8.4.3 Groundwater, Lagoon, Manure Storage, and Flood Water Levels

The stability cases analyzed include long-term (typical) and short-term (extreme) conditions. The long-term case assumes typical operating conditions of the lagoon and manure storage cell such that the water and sludge are 1.5 and 4 m deep, respectively. The groundwater levels (GWLs) outside of the berms for the lagoon and manure storage cell were assumed to be situated 1 m below ground surface. For the flood protection berm, the long-term case assumes the water level in the ditch is equal to the GWL situated at 1 m below prairie level.

The short-term conditions for the lagoon and cell assume a rapid drawdown case where they are emptied for maintenance, and the GWL outside of the lagoon and cell remain at typical levels and the GWL within the lagoon and cell are situated at the ground surface (fully saturated condition). This short-term scenario is anticipated to occur occasionally for a short period. The short-term scenario for the flood protecton berm is based on an extreme post-flood condition where the GWL on the outside of the berm is situated at grade and elevated within the berm at the freeboard level (0.3 m below the berm crest), and the ditch is dry. The water/sludge levels used for the analyses are summarized in Table 6.

Table 6. Stability Cases Analyzed

Condition	GWL Below Grade Outside of Berm (m)	Lagoon Water Depth (m)	Manure Storage Cell Water/Sludge Level (m)	Flood Protection Berm Ditch Water Depth (m)
Long-term conditions	1	1.5	4	2.5
Short-term conditions[1]	0	0	0	0

Note 1. GWLs in the berms are elevated at high lagoon, manure cell, and flood water levels.

8.4.4 Stability Analysis Results

The results of the stability analyses are summarized in Table 7. Based on the analysis results and achieving the target factors of safety, the recommended berm geometries are as follows:

- 3H:1V inside slope geometry for the lagoon berm and 4H:1V for the outside slopes (to conform to the provincial standards)
- 4H:1V inside and outside slope geometry for the manure storage cell
- 5H:1V inside and outside slope geometry for the flood protection berms is adequate

Slope stability outputs for each case analyzed are provided in Appendix B.

Table 7. Slope Stability Analysis Results

Stability Case	Structure	Side Slope		Figure No. (Appendix B)
		Geometry	Calculated FS	
Long-term (typical) Conditions (FS Target ≥ 1.5)	Manure Storage Cell	4H:1V	2.26	B-1
	Lagoon	3H:1V	1.89	B-4
	Flood Protection Berm	5H:1V	2.12	B-5
Short-term (extreme) Conditions (FS Target ≥ 1.2)	Manure Storage Cell	4H:1V	1.24	B-2
	Lagoon	3H:1V	1.43	B-3
	Flood Protection Berm	5H:1V	1.36	B-6

8.5 Design and Construction of Liners

The province of Manitoba requires that soil liners have a minimum hydraulic conductivity of 1x10^{-7}cm/s. To assess the in-situ permeability of a soil liner, flexible wall permeability testing, Atterberg limits, and grain size analyses were completed in our soil's laboratory on a relatively undisturbed Shelby sample obtained from the native silty clay layer near the manure storage cell area. Atterberg limits and grain size analyses were also completed on a select auger cutting sample obtained from the silty clay layer. Table 8 summarizes the results of the testing.

Table 8. Soil Permeability Properties

Test Hole and Sample Number	Soil Description	Sample Depth Below Grade (m)	In-situ Hydraulic Conductivity (cm/s)	Atterberg Limits			Grain Size Distribution (%)		
				PL[1]	LL[1]	PI[1]	Clay	Silt	Sand
TH21-20 T-228	Silty Clay	6.4 to 6.6	8.71x10^{-9}	17	65	48	56.7	44.2	0.1
TH21-15 G266	Silty Clay	1.4 to 1.5	Not Measured	17	64	47	51.8	48.0	0.2

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

The silty clay sample tested (T-228) meets the provincial hydraulic conductivity requirements for use as an in-situ soil liner. The permeability test results are representative of the in-situ silty clay properties at a specific point and do not necessarily apply to the final properties of the silty clay following bulk excavation, placement, and compaction. Variations in the silty clay composition, moisture content, and *in-situ* density versus compacted density can alter hydraulic conductivity properties and further testing may be required by regulatory authorities to confirm the hydraulic conductivity of the silty clay. Based on the observed soil stratigraphy and index testing results, it is anticipated that in-situ silty clay soils within the lagoon and manure storage cell area will meet or be less permeable than 1x10^{-7} cm/s provided proper construction techniques are followed. It is also anticipated that compacted, silty clay would meet the hydraulic conductivity requirements for a soil liner. As described above, the silty clay has a variable structure with traces of sand and trace to some silt inclusions (< 25 mm diameter) which could affect the permeability of an in-situ liner. In this regard, scarification and compaction of the sitly clay should be completed. However, remolded permeability testing of the silty clay within this depth range was not verified with flexible wall permeability testing.

The lagoon and manure storage cell are anticipated to be constructed using cut and fill methods with a soil liner consisting of high plastic, silty clay. Compaction of the sitly clay within the 1.5 m design depth of the lagoon will likely be required and additional sampling with Standard Proctor and permeability testing of a remolded sample is recommended to verify the level of compaction required to achieve a hydraulic conductivity of 1x10^{-7}cm/s. The silty clay present at 4.5 m design depth of the manure storage cell is expected to be suitable for an in-situ soil liner. However, the upper variable structure of the sitly clay is present within the depth of the cell excavation and, therefore, additional excavation and construction of the side slopes with compacted silty clay will likely be required as discussed above. Prior to construction of the berms, topsoil, silt, and any other deleterious materials should be stripped such that the sub-grade consists of high plastic, silty clay. Berms should be constructed of silty clay in lifts of 150 mm compacted to 95% of the SPMDD and wet of optimum.

9.0 Pavements

The following section on pavement structure should be used for gravel surfaced pavements. The recommended pavement structure is provided in Table 9 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 9. Recommended 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

<u>Additional Pavement Recommendations:</u>

1. For best long-term performance, organics, fill materials, silt, debris, and any other deleterious material should be excavated such that the sub-grade consists of native 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 50 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 9.

10.0 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.

11.0 Closure

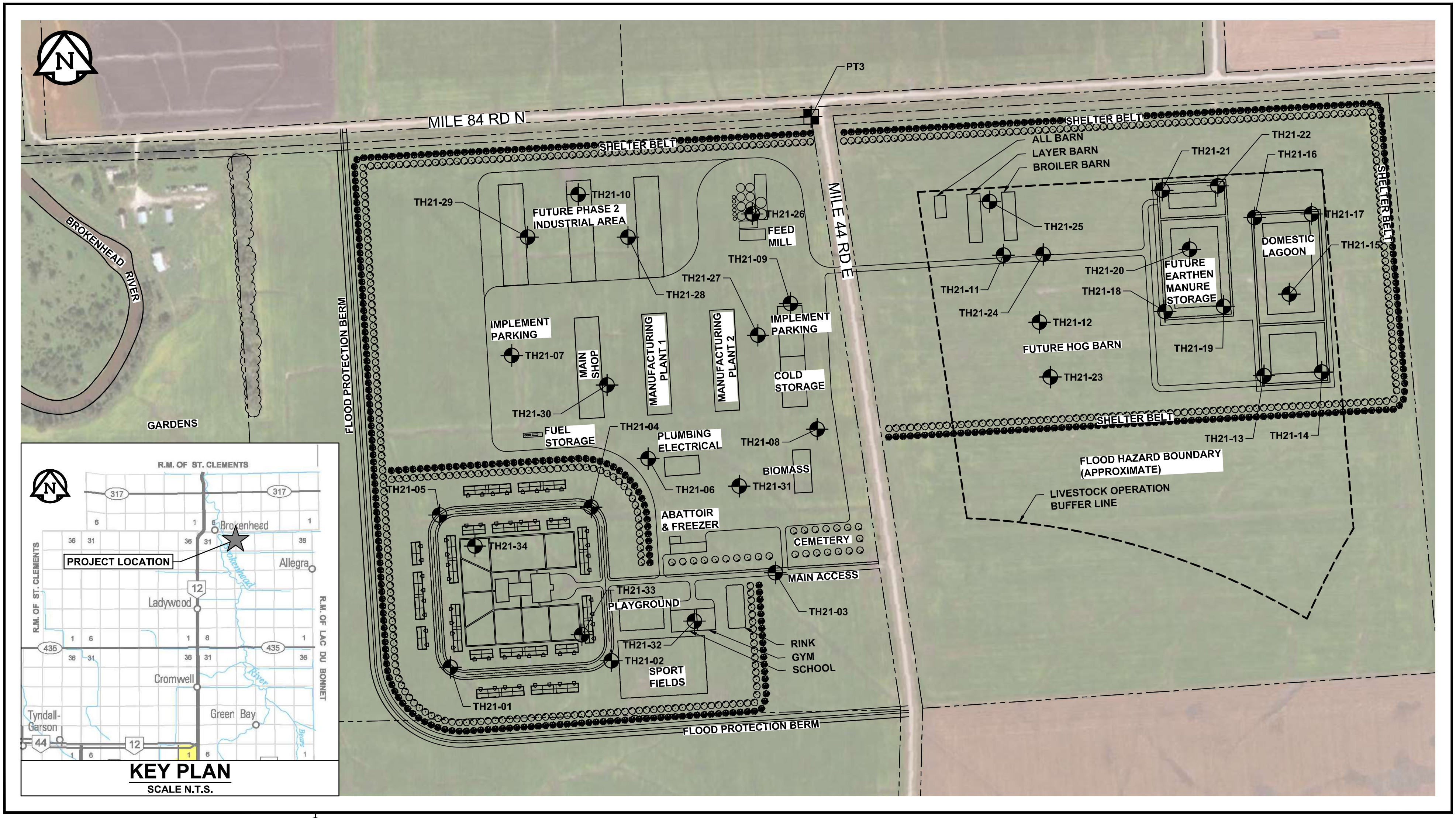
The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be 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

0105 032 00
Burns Maendel Consulting Engineers Ltd.
Greenwald Colony Community Development, RM of Brokenhead, MB.



0 50 100 150 200 250 m

SCALE = 1 : 5 000 (279 mm x 432 mm)

LEGEND:

- TEST HOLE (TREK, MAY 3 - 6, 2021)
- TEMPORARY BENCHMARK (PT3 ESTABLISHED BY BMCE, APRIL, 2021)

NOTES:

1. AERIAL IMAGE FROM BING MAPS (2021).
2. TEST HOLE LOCATIONS BASED ON HANDHELD GPS.
3. TEST HOLE ELEVATIONS (GEODETIC) SURVEYED USING A ROD AND LEVEL RELATIVE TO TEMPORARY BENCMARK (P73) PROVIDED BY BMCE.
4. SITE LAYOUT PROVIDED BY BMCE.

Figure 01
Site Plan

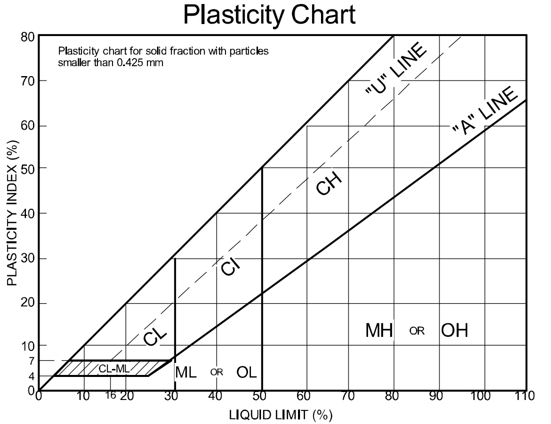
Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 032 00 Greenwald Colony\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\FIG_2021-05-29_Greenwald_0_A_BT_0105-032-00.dwg, 2021-09-07 8:39:51 AM Ansi full bleed B (11.00 x 17.00 Inches)

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	Laboratory Classification Criteria		
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	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 case4s 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	
			GP	◌	Poorly-graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	◍	Silty gravels, gravel-sand-silt mixtures		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
			GC	▨	Clayey gravels, gravel-sand-silt mixtures		Atterberg limits above "A" line or P.I. greater than 7	
	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		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	░	Poorly-graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	▥	Silty sands, sand-silt mixtures		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
			SC	▨	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
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	Plasticity Chart 		
			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	Von Post Classification Limit	Strong colour or odour, and often fibrous texture	

Material		Particle Size mm	Particle Size ASTM Sieve sizes
Sand	Coarse	2.00 to 4.75	#10 to #4
	Medium	0.425 to 2.00	#40 to #10
	Fine	0.075 to 0.425	#200 to #40
Silt or Clay		< 0.075	< #200

Material		Particle Size mm	Particle Size ASTM Sieve Sizes
Boulders		> 300	> 12 in.
Cobbles		75 to 300	3 in. to 12 in.
Gravel	Coarse	19 to 75	3/4 in. to 3 in.
	Fine	4.75 to 19	#4 to 3/4 in.

* 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

Test Hole TH21-01

1 of 1

Sub-Surface Log

Client: Burns Maendel Consulting Engineers Ltd.

Project Number: 0105-032-00

Project Name: Greenwald Colony Community Development

Location: UTM N-5567355, E-681175

Contractor: Paddock Drilling Ltd.

Ground Elevation: 226.66 m (local datum)

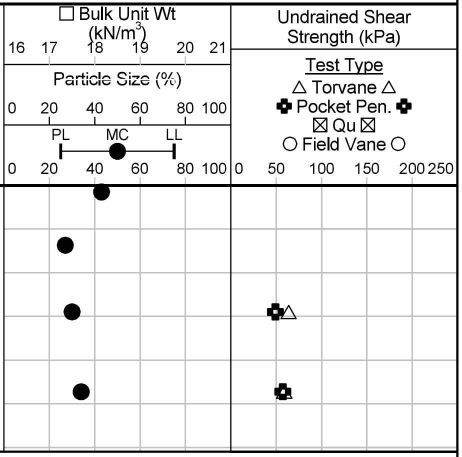
Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Date Drilled: May 4, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ 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)
226.5			ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◢	G70	
		▥	SILT - some clay, light brown, wet, loose, low plasticity	◢	G71	
225.6	1	▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff - high plasticity	◢	G72	
	2	▨		◢	G73	
223.6	3					



END OF TEST HOLE AT 3.0 m IN SILT AND CLAY

Notes:
1) Seepage observed between 0.6 m and 1.1 m depth.
2) Sloughing not observed.
3) Test hole dry and open to 3.0 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

Test Hole TH21-02

1 of 1

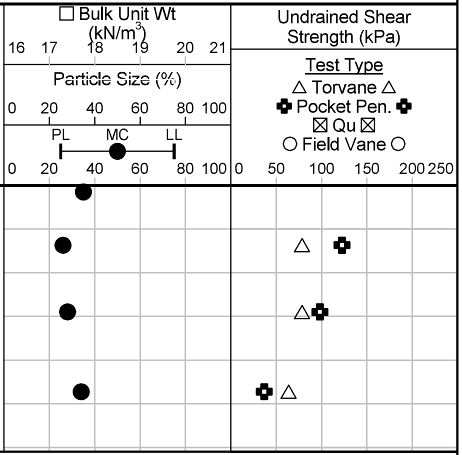
Sub-Surface Log

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5567364, E-681398
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	226.76 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 4, 2021

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ 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)
226.6			ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◩	G74	
		▨	CLAY - silty - dark brown - moist, stiff to very stiff - high plasticity	◩	G75	
	1	▨	- trace to some silt inclusions (<25 mm diam.), trace sand, stiff below 0.9 m	◩	G76	
	2	▨	- trace silt inclusions (<20 mm diam.), trace sand, brown below 2.1 m	◩	G77	
223.7	3					



END OF TEST HOLE AT 3.0 m IN CLAY

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 to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-03

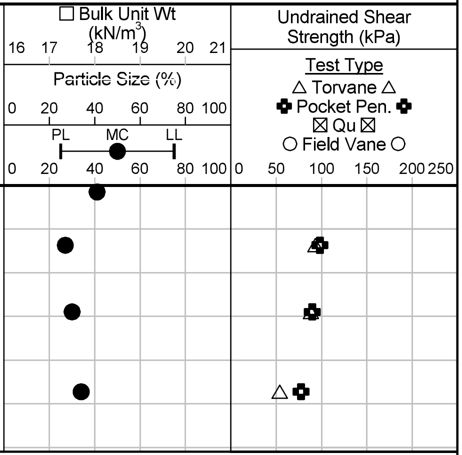
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5567486, E-681625
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	226.72 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 4, 2021

Sample Type: ◪ Grab (G) ◨ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ◫ 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)
226.6		▨	ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◪	G117	
		▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◪	G118	
	1	▨		◪	G119	
	2	▨	- some silt inclusions (<50 mm diam.), trace sand, brown, stiff below 1.8 m	◪	G120	
223.7	3					



END OF TEST HOLE AT 3.0 m IN CLAY

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 to surface with auger cuttings.

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

Sub-Surface Log

Test Hole TH21-04

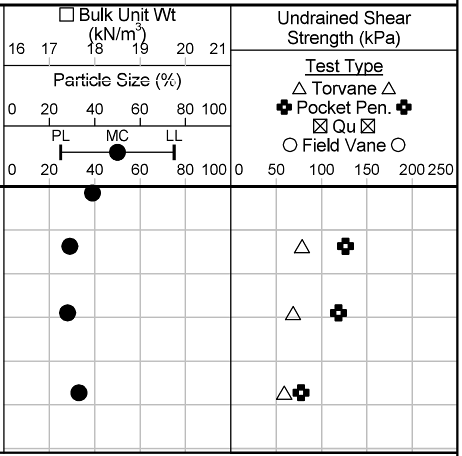
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567577, E-681370
Contractor: Paddock Drilling Ltd.
Ground Elevation: 226.77 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 3, 2021

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ 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)
226.6			ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◪	G51	
		▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◪	G52	
	1	▨		◪	G53	
	2	▨	- trace silt inclusions (<30 mm diam.), brown, stiff below 1.8 m			
		▨		◪	G54	
223.7	3					



END OF TEST HOLE AT 3.0 m IN CLAY
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 to surface with auger cuttings.

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

Sub-Surface Log

Test Hole TH21-05

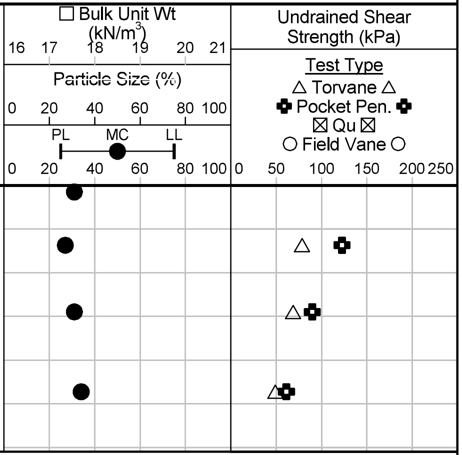
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567566, E-681160
Contractor: Paddock Drilling Ltd.
Ground Elevation: 226.89 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 3, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ▯ 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)
226.7			ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◢	G55	
	1	▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◢	G56	
	2	▨		◢	G57	
		▨	- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 2.1 m	◢	G58	
223.8	3					



END OF TEST HOLE AT 3.0 m IN CLAY
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 to surface with auger cuttings.

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

Sub-Surface Log

Test Hole TH21-06

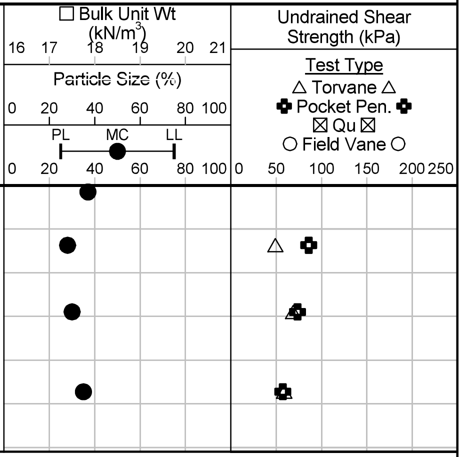
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567644, E-681449
Contractor: Paddock Drilling Ltd.
Ground Elevation: 226.82 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 3, 2021

Sample Type: ◩ Grab (G) ◨ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ◫ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
226.7		ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◩	G47	
	1	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◩ ◩	G48 G49	
	2	- trace silt inclusions (<20 mm diam.), trace sand, brown, stiff below 1.8 m	◩	G50	
223.8	3				



END OF TEST HOLE AT 3.0 m IN CLAY
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 to surface with auger cuttings.

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

Sub-Surface Log

Test Hole TH21-07

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.

Project Name: Greenwald Colony Community Development

Contractor: Paddock Drilling Ltd.

Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Project Number: 0105-032-00

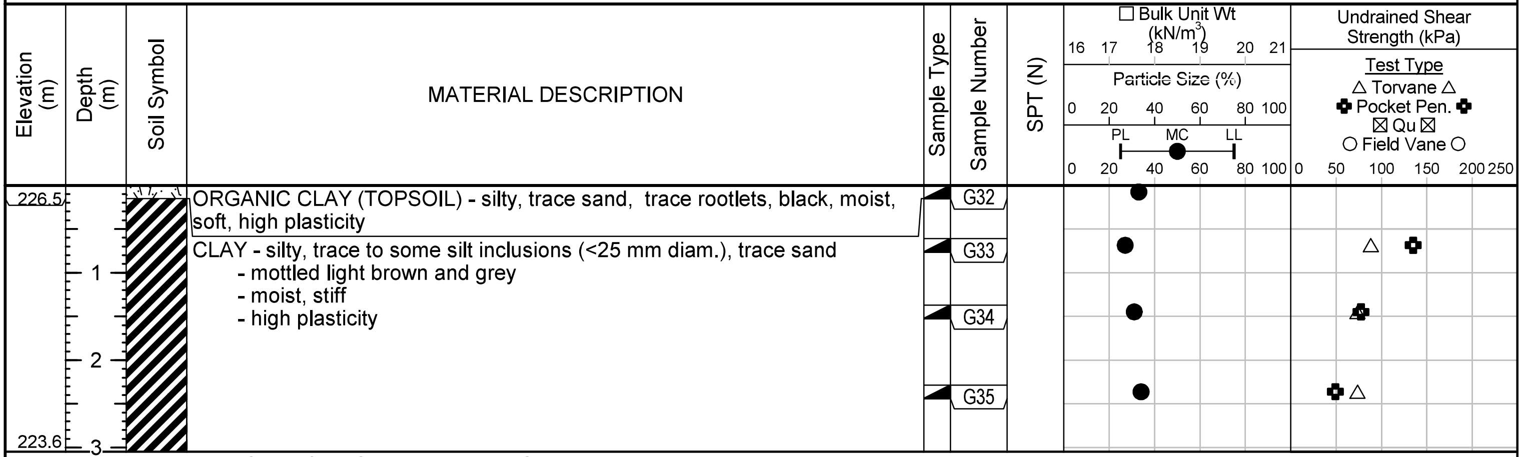
Location: UTM N-5567787, E-681260

Ground Elevation: 226.66 m (local datum)

Date Drilled: May 3, 2021

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ◌ Cobbles ■ Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand
- mottled light brown and grey
- moist, stiff
- high plasticity

END OF TEST HOLE AT 3.0 m IN CLAY
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 to surface with auger cuttings.

Logged By: Ruslan Amarasinghe

Reviewed By: Kent Bannister

Project Engineer: Ryan Belbas

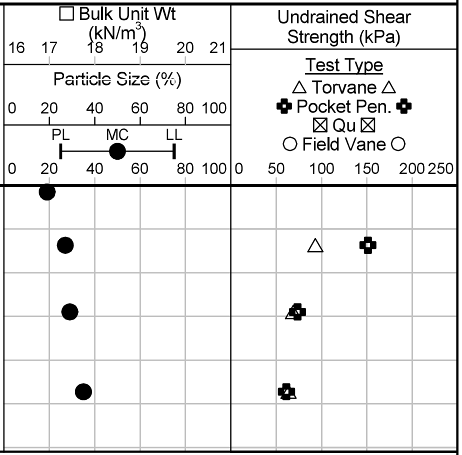
Sub-Surface Log

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567685, E-681683
Contractor: Paddock Drilling Ltd.
Ground Elevation: 226.70 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 5, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ▮ 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)
226.6			ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◢	G145	
			CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◢	G146	
	1					
				◢	G147	
	2		- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 1.8 m			
				◢	G148	
223.7	3					



END OF TEST HOLE AT 3.0 m IN CLAY
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 to surface with auger cuttings.

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

Sub-Surface Log

Test Hole TH21-09

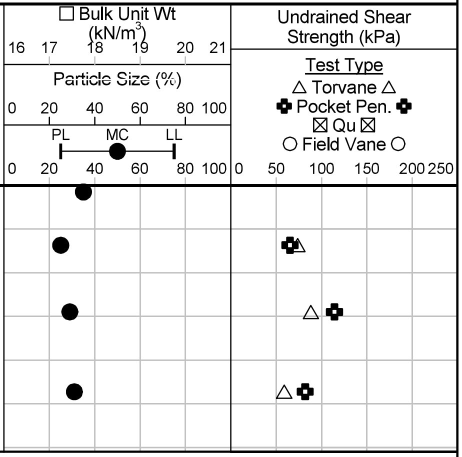
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567859, E-681646
Contractor: Paddock Drilling Ltd.
Ground Elevation: 226.70 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 5, 2021

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ 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)
226.6		▨	ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◣	G149	
		▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◣	G150	
	1	▨		◣	G151	
	2	▨	- some silt inclusions (<20 mm diam.), trace sand, brown, stiff below 1.8 m	◣	G152	
223.7	3					



END OF TEST HOLE AT 3.0 m IN CLAY

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 to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-10

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.

Project Number: 0105-032-00

Project Name: Greenwald Colony Community Development

Location: UTM N-5568010, E-681352

Contractor: Paddock Drilling Ltd.

Ground Elevation: 226.84 m (local datum)

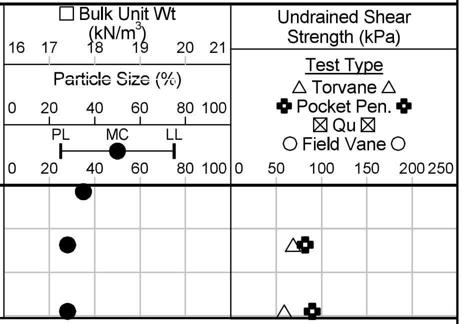
Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Date Drilled: May 3, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ▯ 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)
226.7		▨	ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◢	G01	
	1	▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand, mottled light brown and grey, moist, stiff, high plasticity - some silt inclusions (<20 mm diam.), trace sand, brown below 0.8 m	◢	G02	
225.3				◢	G03	



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 to surface with auger cuttings.

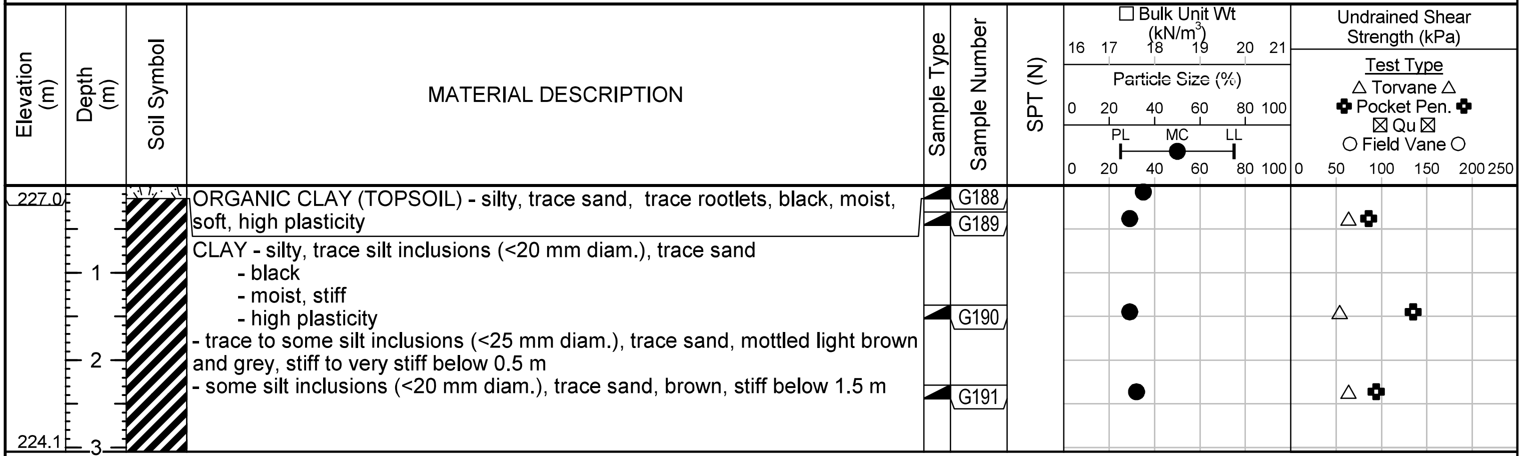
Logged By: Ruslan Amarasinghe **Reviewed By:** Kent Bannister **Project Engineer:** Ryan Belbas

Sub-Surface Log

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567926, E-681941
Ground Elevation: 227.14 m (local datum)
Date Drilled: May 5, 2021

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ▒ Sand ● Gravel ◌ Cobbles ■ Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, trace silt inclusions (<20 mm diam.), trace sand
- black
- moist, stiff
- high plasticity

- trace to some silt inclusions (<25 mm diam.), trace sand, mottled light brown and grey, stiff to very stiff below 0.5 m
- some silt inclusions (<20 mm diam.), trace sand, brown, stiff below 1.5 m

END OF TEST HOLE AT 3.0 m IN CLAY
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 to surface with auger cuttings.

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

Sub-Surface Log

Test Hole TH21-12

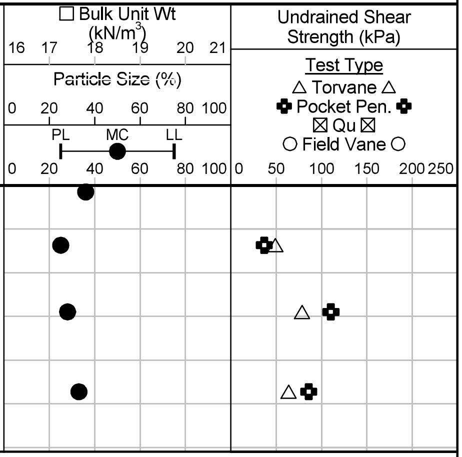
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567833, E-681991
Ground Elevation: 227.18 m (local datum)
Date Drilled: May 5, 2021

Sample Type: ◩ Grab (G) ◧ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ◫ 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)
227.0			ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◩	G192	
226.4		▥	SILT - clayey, trace sand, light brown, wet, loose, low plasticity	◩	G193	
	1	▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◩	G194	
	2	▨	- some silt inclusions (<20 mm diam.), trace sand, brown, stiff below 2.1 m	◩	G195	
224.1	3					



END OF TEST HOLE AT 3.0 m IN CLAY
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 to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

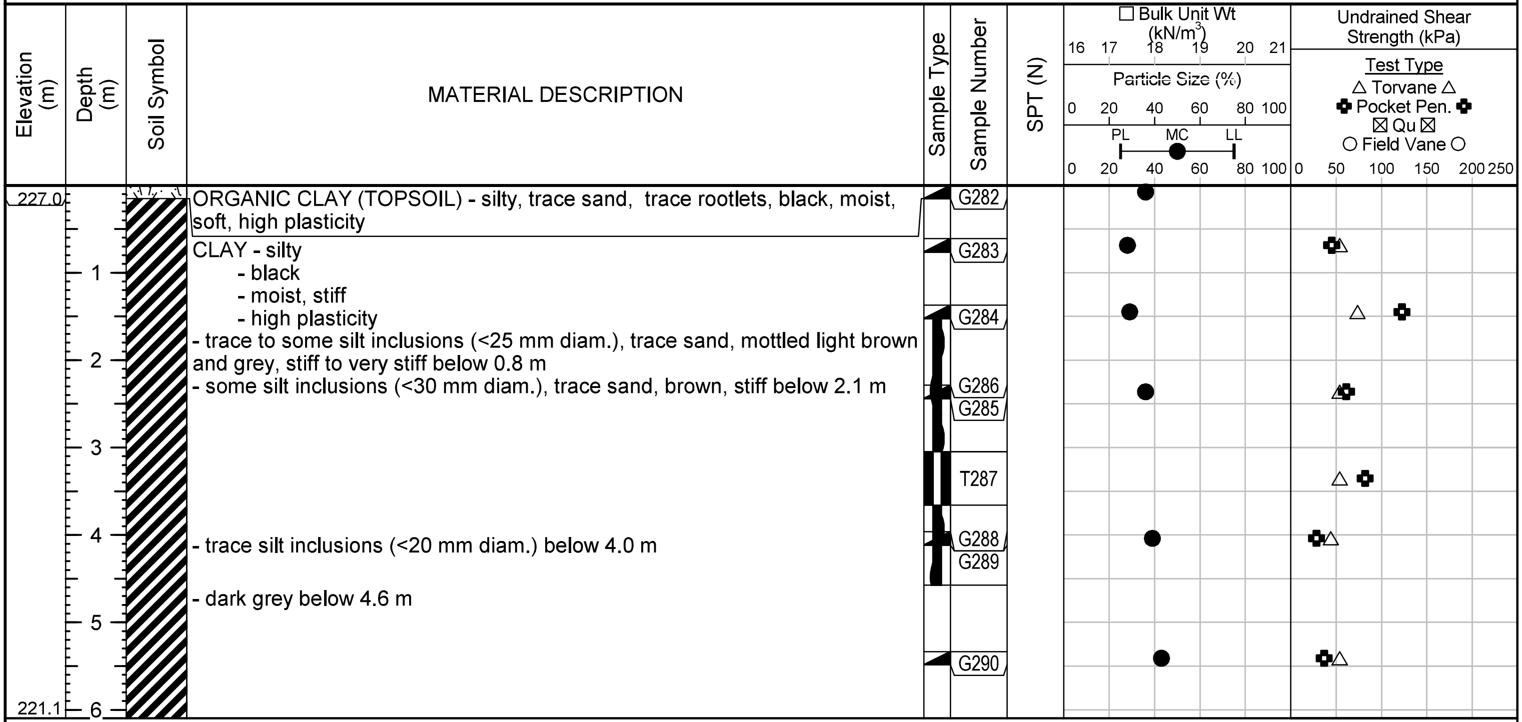
Test Hole TH21-13

1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5567759, E-682302
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	227.18 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 6, 2021

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ░ Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty
- black
- moist, stiff
- high plasticity

- trace to some silt inclusions (<25 mm diam.), trace sand, mottled light brown and grey, stiff to very stiff below 0.8 m
- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 2.1 m
- trace silt inclusions (<20 mm diam.) below 4.0 m
- dark grey below 4.6 m

END OF TEST HOLE AT 6.1 m IN CLAY

Notes:

1) Seepage and sloughing not observed.

2) Minor squeezing observing below 2.1 m depth.

3) Test hole dry and open to 2.1 m depth immediately after drilling.

4) Test hole backfilled to surface with bentonite chips.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-14

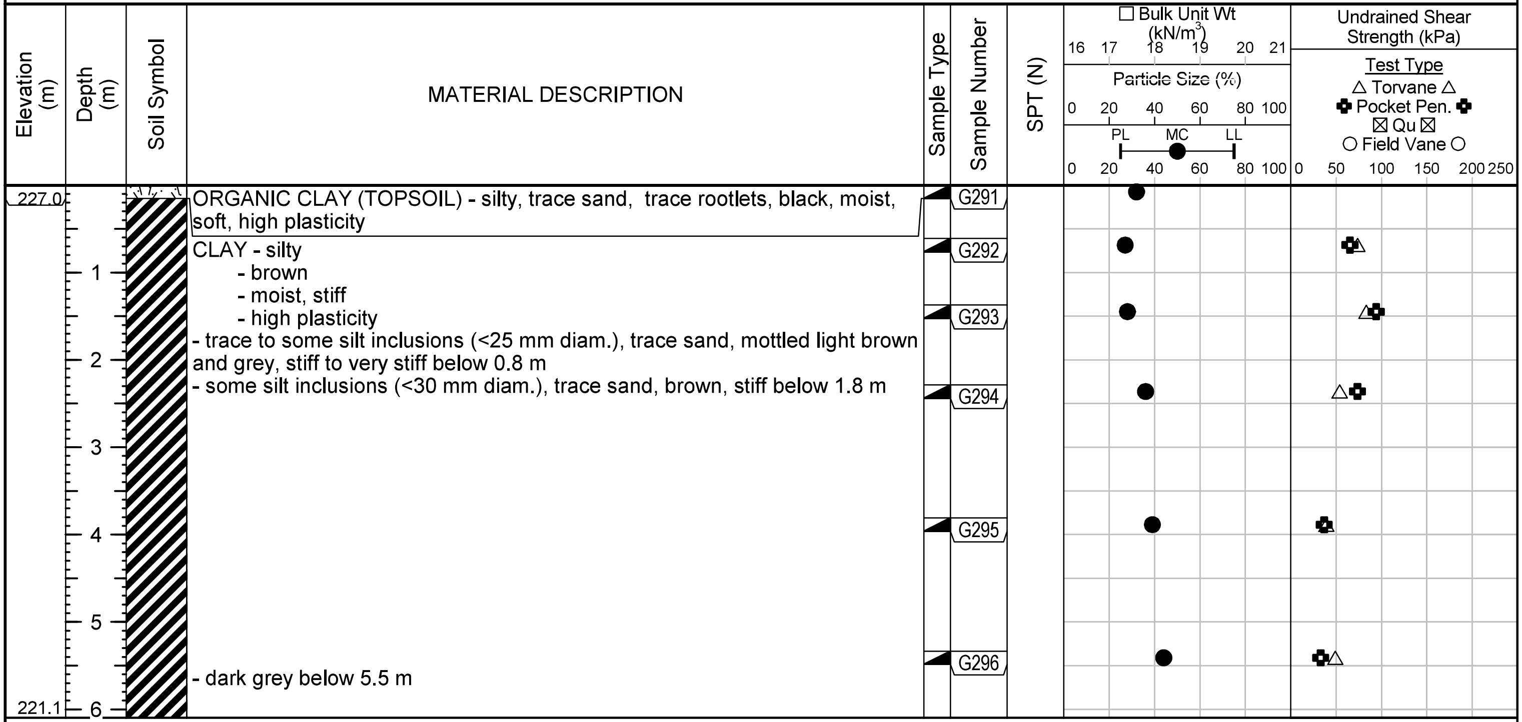
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Project Number: 0105-032-00
Location: UTM N-5567764, E-682382
Ground Elevation: 227.16 m (local datum)
Date Drilled: May 6, 2021

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

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty
- brown
- moist, stiff
- high plasticity

- trace to some silt inclusions (<25 mm diam.), trace sand, mottled light brown and grey, stiff to very stiff below 0.8 m
- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 1.8 m
- dark grey below 5.5 m

END OF TEST HOLE AT 6.1 m IN CLAY
Notes:
1) Seepage and sloughing not observed.
2) Minor squeezing observing below 2.0 m depth.
3) Test hole dry and open to 2.0 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

Sub-Surface Log

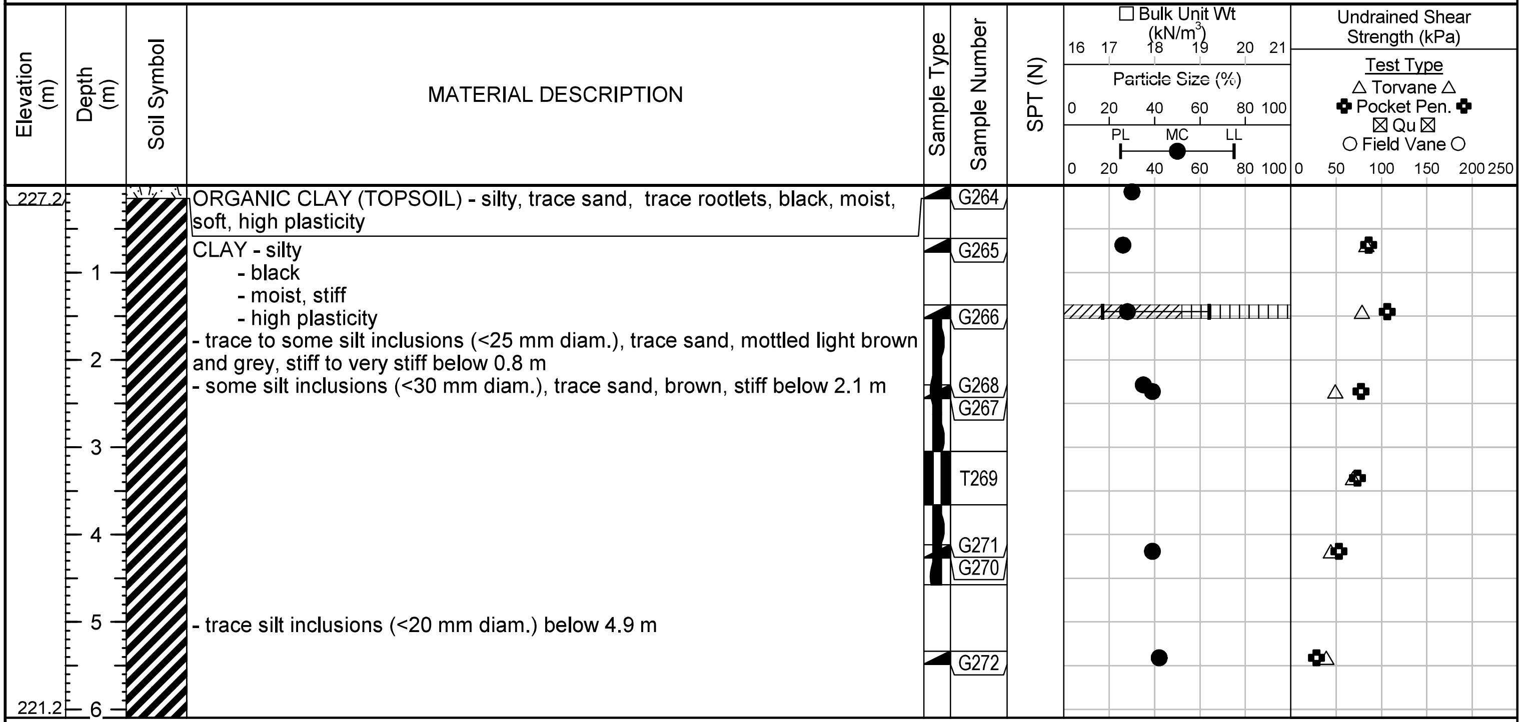
Test Hole TH21-15

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567872, E-682337
Ground Elevation: 227.31 m (local datum)
Date Drilled: May 6, 2021

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

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty
- black
- moist, stiff
- high plasticity

- trace to some silt inclusions (<25 mm diam.), trace sand, mottled light brown and grey, stiff to very stiff below 0.8 m
- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 2.1 m

- trace silt inclusions (<20 mm diam.) below 4.9 m

END OF TEST HOLE AT 6.1 m IN CLAY
Notes:
1) Seepage and sloughing not observed.
2) Minor squeezing observing below 4.6 m depth.
3) Test hole dry and open to 4.6 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-16

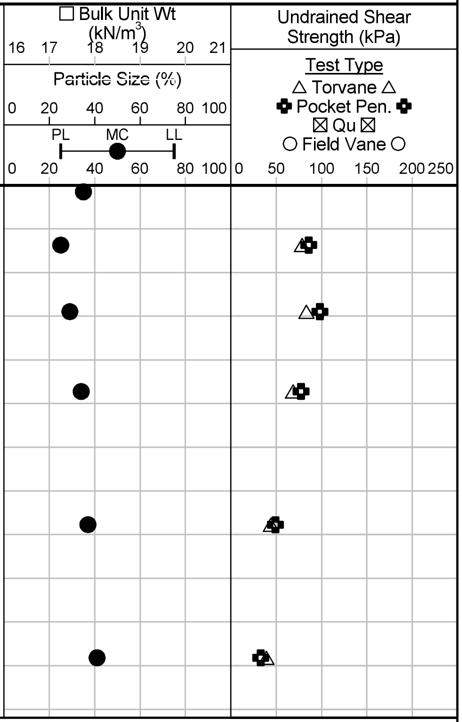
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567978, E-682289
Contractor: Paddock Drilling Ltd.
Ground Elevation: 227.08 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 6, 2021

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ 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)
226.9		▨	ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◩	G251	
	1	▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), some sand - mottled light brown and grey - moist, stiff - high plasticity	◩ ◩	G252 G253	
	2	▨	- some silt inclusions (<30 mm diam.), trace sand, brown below 1.8 m	◩	G254	
	3	▨	- trace silt inclusions (<20 mm diam.) below 3.0 m			
	4	▨		◩	G255	
	5	▨		◩	G256	
221.0	6	▨				



END OF TEST HOLE AT 6.1 m IN CLAY
Notes:
1) Seepage and sloughing not observed.
2) Minor squeezing observing below 4.8 m depth.
3) Test hole dry and open to 4.9 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-17

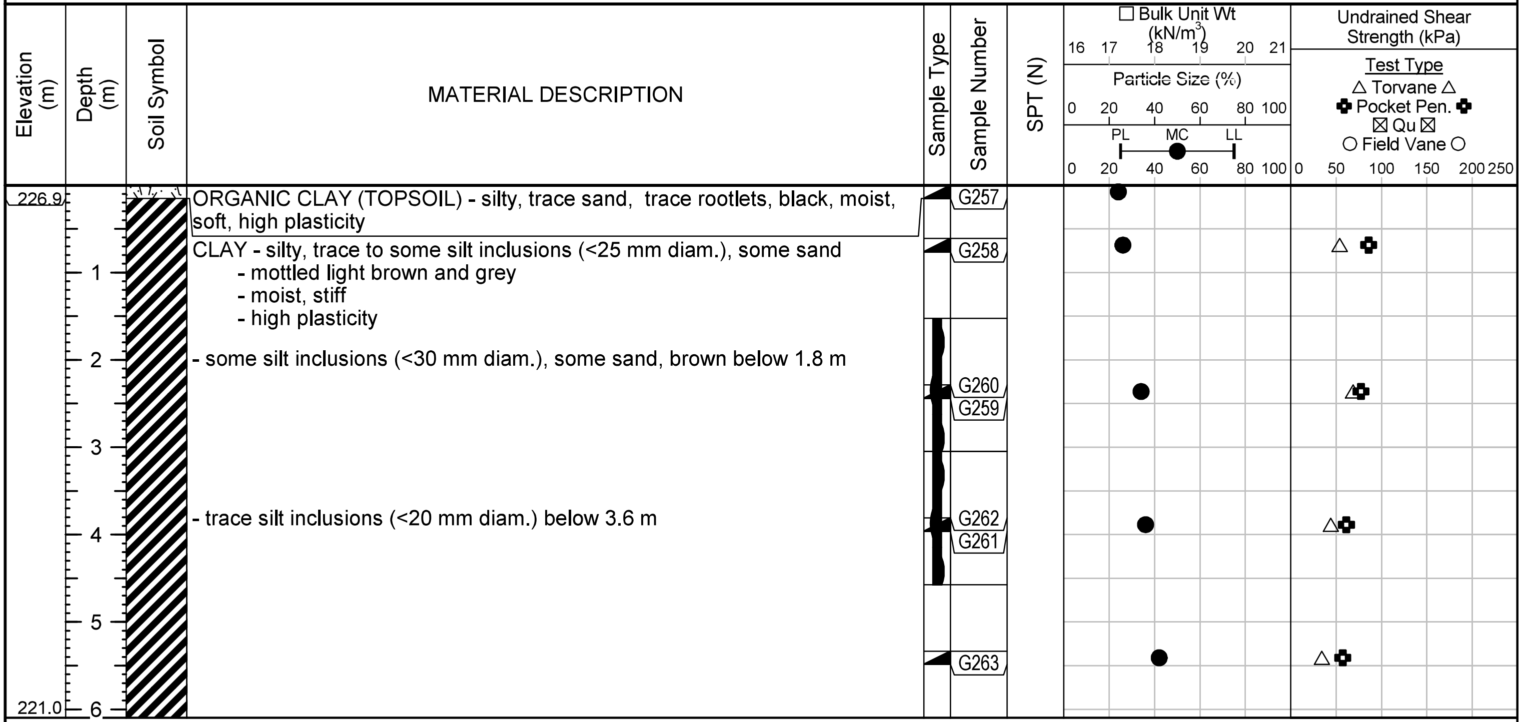
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Project Number: 0105-032-00
Location: UTM N-5567983, E-682368
Ground Elevation: 227.08 m (local datum)
Date Drilled: May 6, 2021

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, trace to some silt inclusions (<25 mm diam.), some sand
- mottled light brown and grey
- moist, stiff
- high plasticity

- some silt inclusions (<30 mm diam.), some sand, brown below 1.8 m

- trace silt inclusions (<20 mm diam.) below 3.6 m

END OF TEST HOLE AT 6.1 m IN CLAY
Notes:
1) Seepage and sloughing not observed.
2) Minor squeezing observing below 3.8 m depth.
3) Test hole dry and open to 3.8 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

Sub-Surface Log

Test Hole TH21-18

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.

Project Name: Greenwald Colony Community Development

Contractor: Paddock Drilling Ltd.

Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Project Number: 0105-032-00

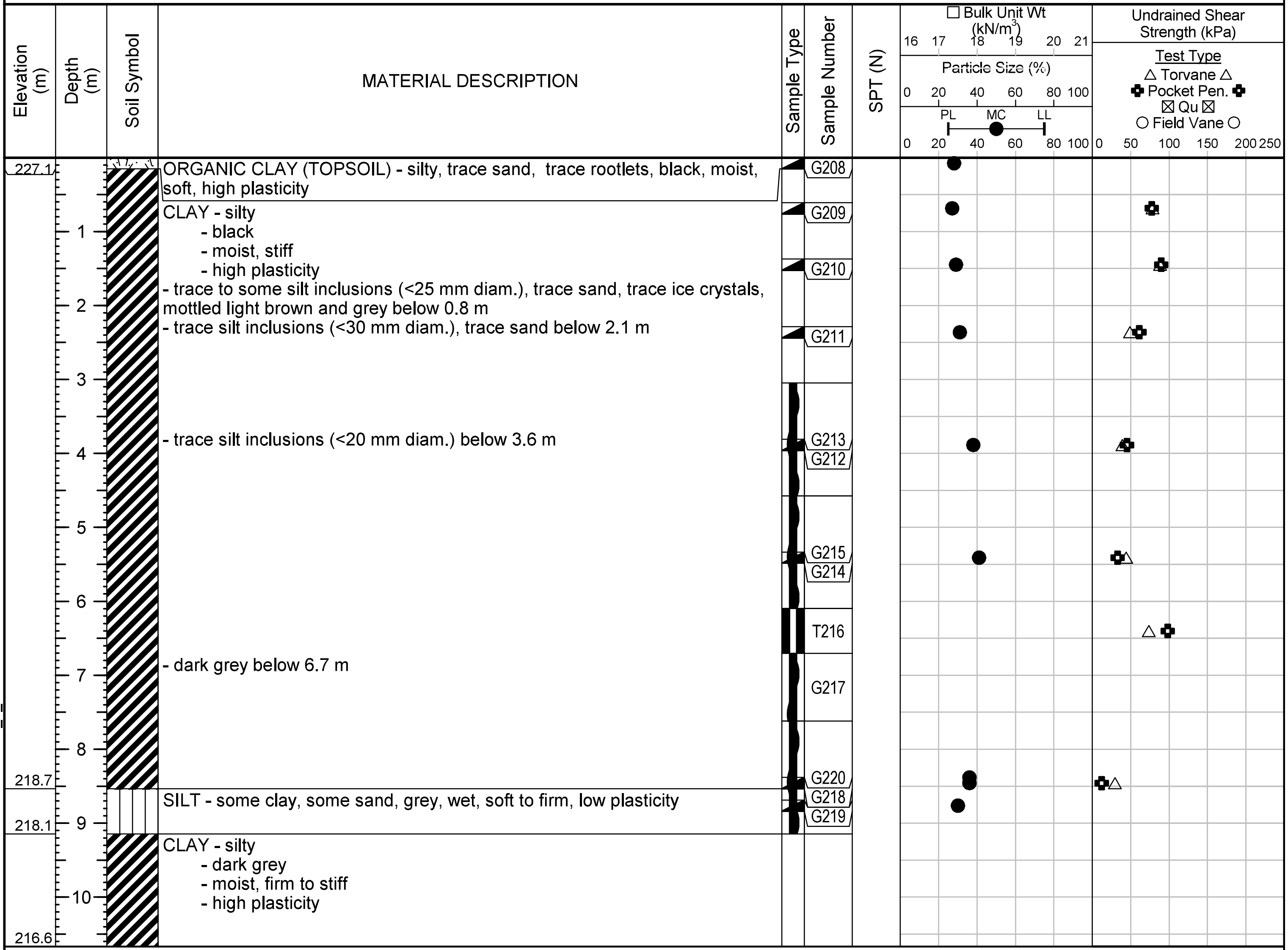
Location: UTM N-5567848, E-682165

Ground Elevation: 227.26 m (local datum)

Date Drilled: May 5, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁙ Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty
- black
- moist, stiff
- high plasticity

- trace to some silt inclusions (<25 mm diam.), trace sand, trace ice crystals, mottled light brown and grey below 0.8 m
- trace silt inclusions (<30 mm diam.), trace sand below 2.1 m
- trace silt inclusions (<20 mm diam.) below 3.6 m
- dark grey below 6.7 m

SILT - some clay, some sand, grey, wet, soft to firm, low plasticity

CLAY - silty
- dark grey
- moist, firm to stiff
- high plasticity

END OF TEST HOLE AT 10.7 m IN CLAY

Notes:

1) Seepage observed between 8.5 m and 9.2 m depth.

2) Sloughing not observed. Minor squeezing observing below 7.9 m depth.

3) Test hole dry and open to 7.9 m depth immediately after drilling.

4) Test hole backfilled to surface with bentonite chips.

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

Sub-Surface Log

Test Hole TH21-19

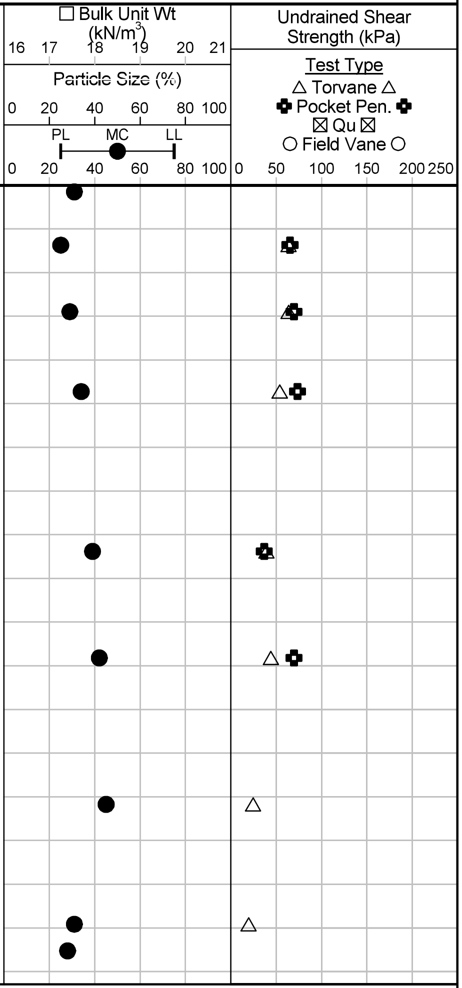
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567855, E-682246
Ground Elevation: 227.15 m (local datum)
Date Drilled: May 6, 2021

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ 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)
227.0	0		ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◣	G273	
		▨	CLAY - silty, some silt inclusions (<30 mm diam.) - brown - moist, stiff - high plasticity - trace to some silt inclusions (<25 mm diam.), some sand, mottled light brown and grey, stiff below 0.8 m - some silt inclusions (<30 mm diam.), trace sand, brown below 2.1 m - trace silt inclusions (<20 mm diam.) below 4.0 m	◣ ◣ ◣ ◣ ◣ ◣	G274 G275 G276 G277 G278 G279	
218.6		▥	SILT - some clay, some sand, grey, wet, soft to firm, low plasticity	◣	G280	
218.3		▨	CLAY - silty, trace silt inclusions (<30 mm diam.), dark grey, moist, firm, high plasticity	◣	G281	
218.0	9					



END OF TEST HOLE AT 9.1 m IN CLAY

Notes:
1) Seepage observed between 8.5 m and 8.9 m depth.
2) Sloughing not observed. Minor squeezing observing below 3.0 m depth.
3) Test hole dry and open to 3.2 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

PTH 83 TH LOGS MIT FONT LOGS 2021-09-01 GREENWALD COLONY DEVELOPMENT 0_B_RSA 0105-032-00.GPJ TREK GEOTECHNICAL.GDT 9/7/21

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-20

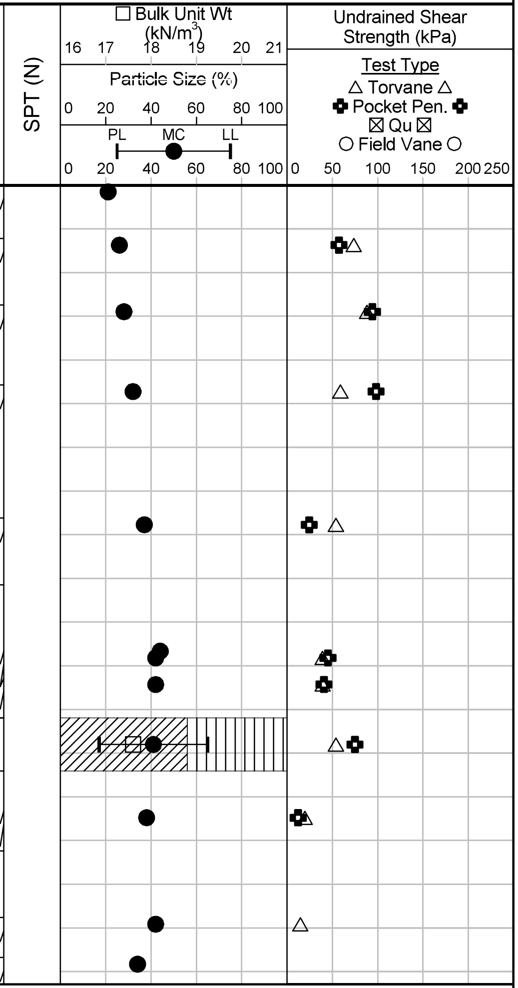
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567934, E-682199
Contractor: Paddock Drilling Ltd.
Ground Elevation: 227.25 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 6, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▩ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ◌ Cobbles ■ Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
227.1	0		ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◢	G221
		▨	CLAY - silty, trace silt inclusions (<30 mm diam.), trace sand - brown - moist, stiff - high plasticity - trace to some silt inclusions (<25 mm diam.), trace sand, trace ice crystals, mottled light brown and grey below 0.8 m - trace silt inclusions (<30 mm diam.), trace sand below 1.5 m	◢ ◢ ◢	G222 G223 G224
	3				
	4			◢	G225
	5		- trace silt inclusions (<20 mm diam.) below 4.9 m		G227 G226 G229
	6		- dark grey below 5.5 m	▮	T228
	7				G231 G230
	8			◢	G232
218.4					
218.1	9	▥	SILT - some clay, trace sand, grey, wet, soft to firm, low plasticity	◢	G233



END OF TEST HOLE AT 9.1 m IN SILT
Notes:
1) Seepage observed below 8.8 m depth.
2) Sloughing not observed. Minor squeezing observing below 4.1 m depth.
3) Test hole dry and open to 4.1 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

TREK GEOTECHNICAL

Sub-Surface Log

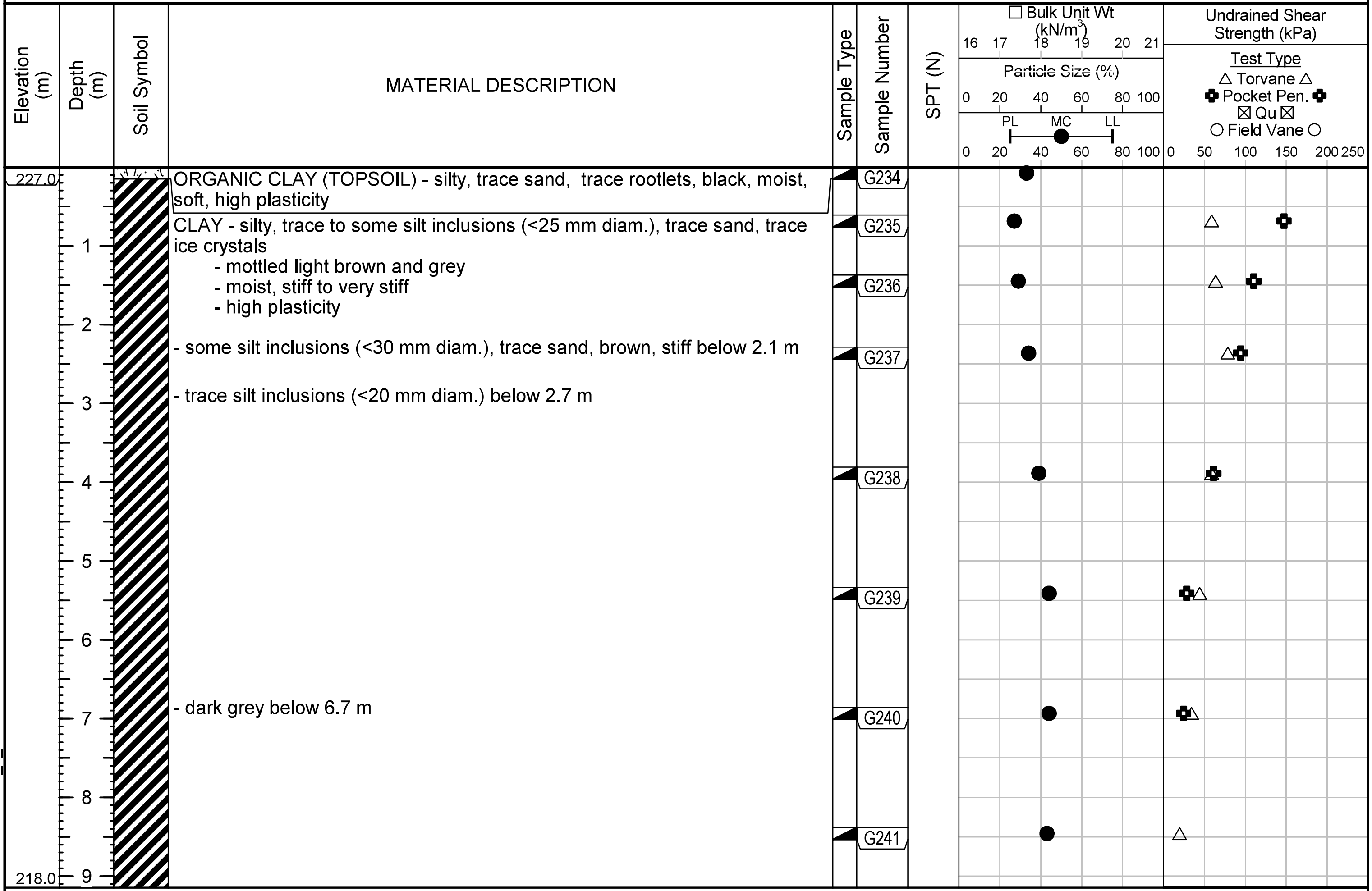
Test Hole TH21-21

1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5568016, E-682161
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	227.16 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 6, 2021

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▩ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ▢ Cobbles ■ Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand, trace ice crystals

- mottled light brown and grey
- moist, stiff to very stiff
- high plasticity

- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 2.1 m

- trace silt inclusions (<20 mm diam.) below 2.7 m

- dark grey below 6.7 m

END OF TEST HOLE AT 9.1 m IN CLAY

Notes:

1) Seepage and sloughing not observed.
2) Minor squeezing observing below 4.9 m depth.
3) Test hole dry and open to 5.0 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

Sub-Surface Log

Test Hole TH21-22

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.

Project Name: Greenwald Colony Community Development

Contractor: Paddock Drilling Ltd.

Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Project Number: 0105-032-00

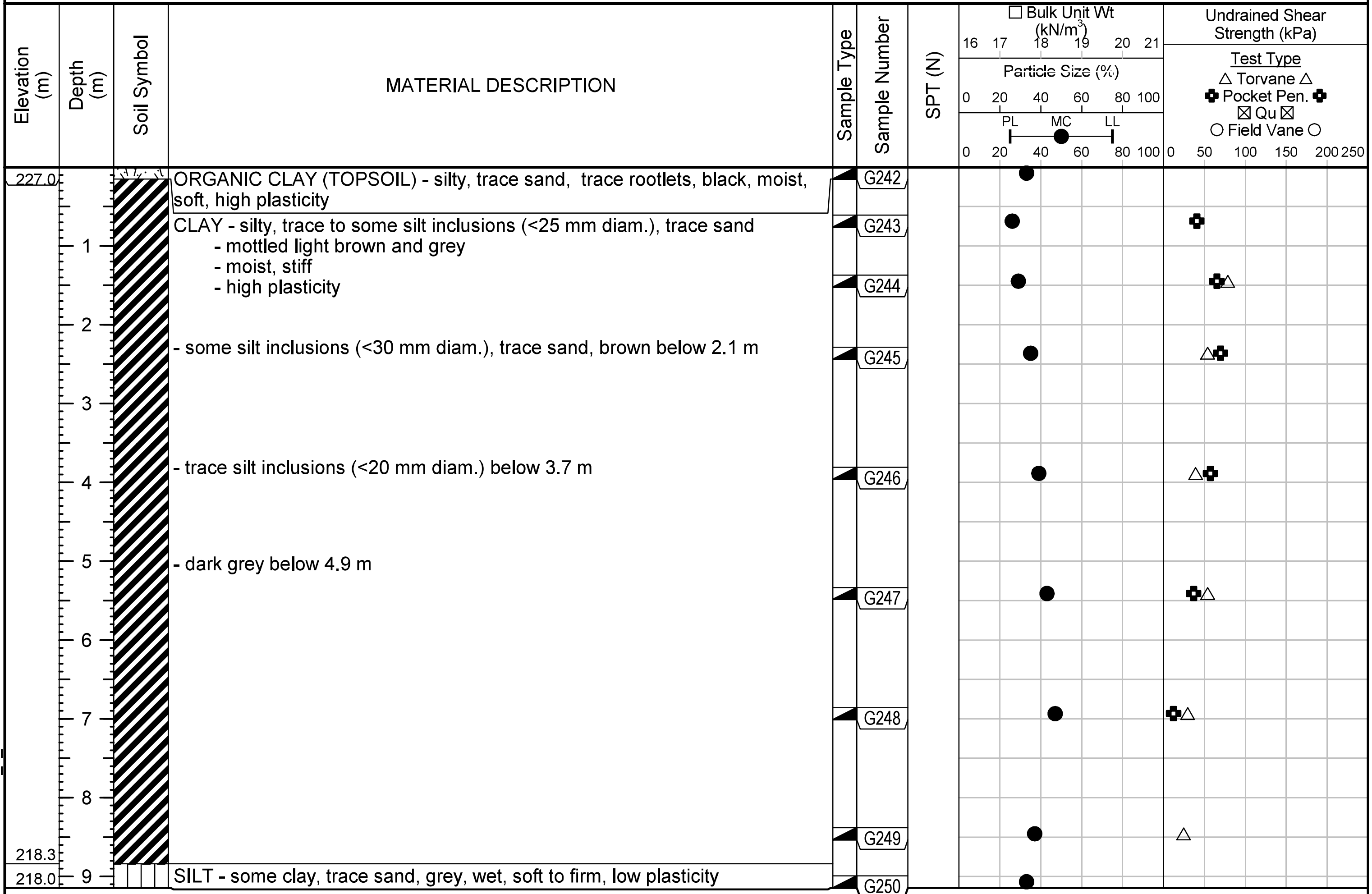
Location: UTM N-5568022, E-682238

Ground Elevation: 227.10 m (local datum)

Date Drilled: May 6, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand
- mottled light brown and grey
- moist, stiff
- high plasticity

- some silt inclusions (<30 mm diam.), trace sand, brown below 2.1 m

- trace silt inclusions (<20 mm diam.) below 3.7 m

- dark grey below 4.9 m

SILT - some clay, trace sand, grey, wet, soft to firm, low plasticity

END OF TEST HOLE AT 9.1 m IN SILT

Notes:
1) Seepage observed below 8.8 m depth.
2) Sloughing not observed. Minor squeezing observing below 3.3 m depth.
3) Test hole dry and open to 3.3 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-23
1 of 1

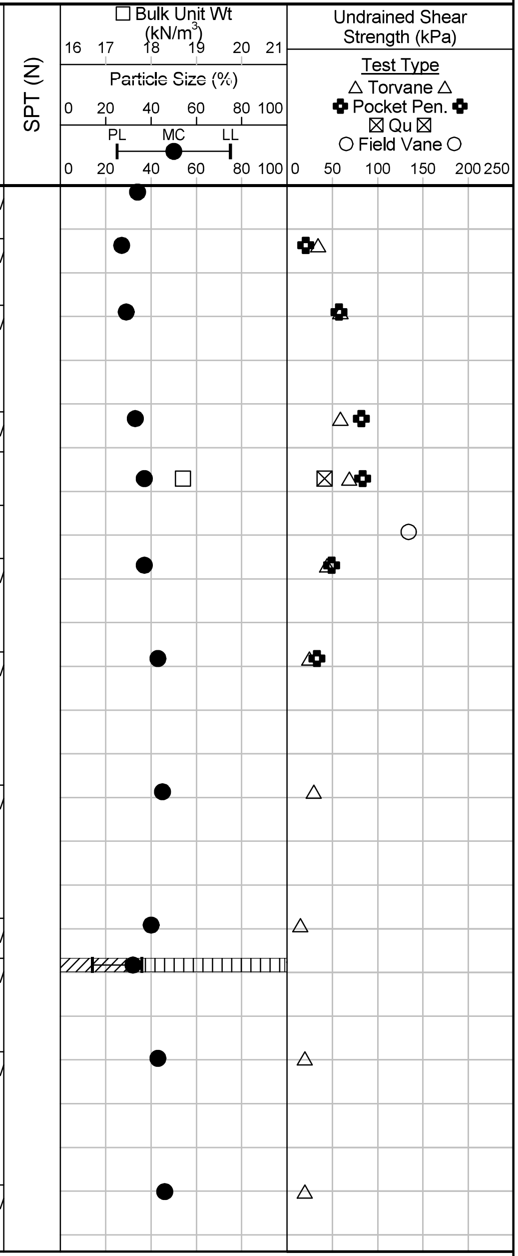
Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5567757, E-682006
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	227.25 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 5, 2021

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION
227.1		ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity
		SILT - trace clay, trace sand, light brown, wet, loose, low plasticity
225.9		CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand, trace ice crystals - mottled brown and grey - moist, stiff - high plasticity - some silt inclusions (<30 mm diam.), trace sand below 2.4 m - trace silt inclusions (<20 mm diam.) below 4.0 m - dark grey below 4.6 m
218.4		SILT - clayey, trace sand, grey, wet, soft to firm, low plasticity
218.1	9	CLAY - silty - dark grey - moist, soft to firm - high plasticity
215.1	12	

Sample Type	Sample Number
G	G196
G	G197
G	G198
G	G199
T	T200
G	G201
G	G202
G	G203
G	G204
G	G205
G	G206
G	G207



END OF TEST HOLE AT 12.2 m IN CLAY

Notes:

1) Seepage observed from 0.1 m depth to 1.4 m depth and from 8.8 m depth to 9.1 m depth.
2) Sloughing not observed. Minor squeezing observing below 3.3 m depth.
3) Test hole dry and open to 3.3 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-24

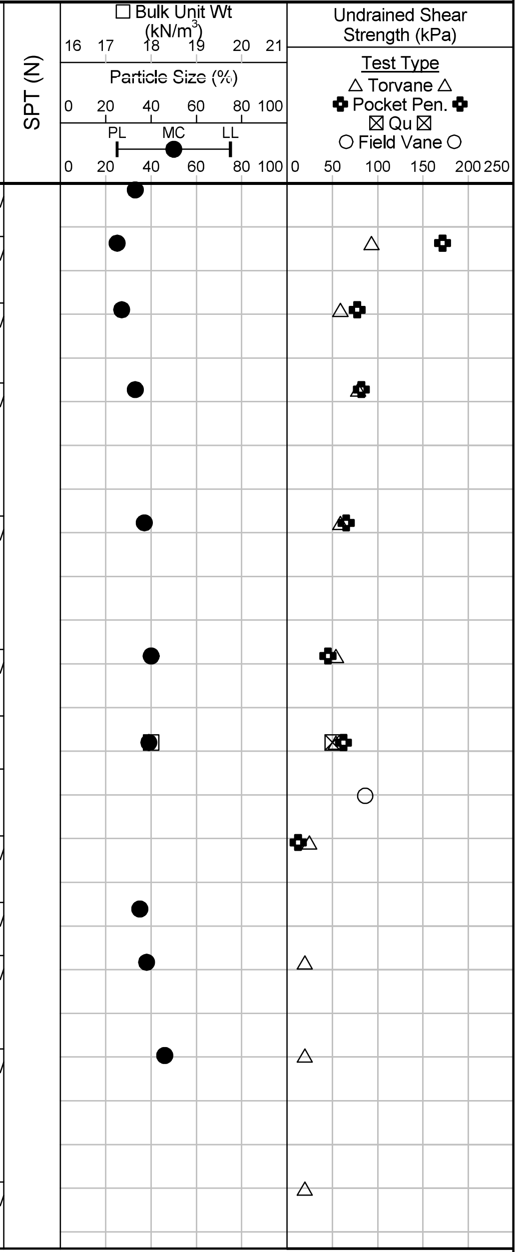
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5567927, E-681996
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	227.19 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 5, 2021

Sample Type: ◣ Grab (G) ▐ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ░ Sand ● Gravel ○ Cobbles ■ Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
227.0	0	ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	G	G176
		CLAY - silty, trace silt inclusions (<30 mm diam.), trace sand, trace ice crystals - black - moist, stiff - high plasticity - trace to some silt inclusions (<25 mm diam.), trace sand, trace ice crystals, mottled light brown and grey below 0.8 m - some silt inclusions (<20 mm diam.), trace sand below 1.8 m - trace silt inclusions (<20 mm diam.) below 3.0 m - dark grey, soft below 7.0 m	G G G G G T G	G177 G178 G179 G180 G181 T182 G183
219.3		SILT - some clay, some sand, grey, wet, soft to firm, low plasticity	G	G184
218.7		CLAY - silty - dark grey - moist, soft to firm - high plasticity	G G G	G185 G186 G187
215.0	12			



END OF TEST HOLE AT 12.2 m IN CLAY

Notes:

1) Seepage observed between 7.9 m and 8.5 m depth.
2) Sloughing not observed. Minor squeezing observing below 7.3 m depth.
3) Test hole dry and open to 7.3 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

Sub-Surface Log

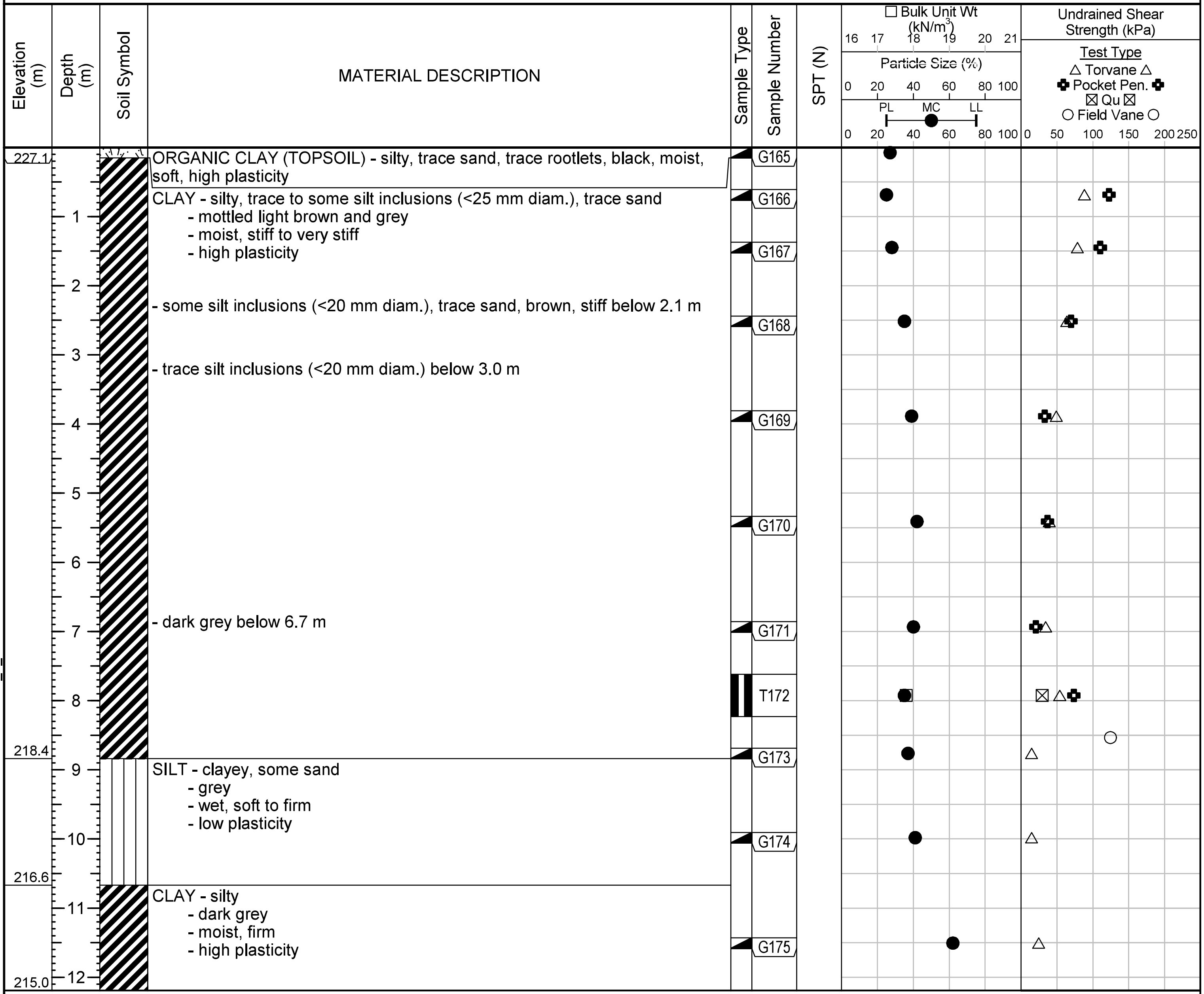
Test Hole TH21-25

1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5568000, E-681922
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	227.23 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 5, 2021

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ░ Sand ▩ Gravel ▧ Cobbles ■ Boulders



Elevation (m)	MATERIAL DESCRIPTION
227.1	ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity
	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity - some silt inclusions (<20 mm diam.), trace sand, brown, stiff below 2.1 m - trace silt inclusions (<20 mm diam.) below 3.0 m - dark grey below 6.7 m
218.4	SILT - clayey, some sand - grey - wet, soft to firm - low plasticity
216.6	CLAY - silty - dark grey - moist, firm - high plasticity
215.0	

END OF TEST HOLE AT 12.2 m IN CLAY

Notes:

1) Seepage observed between 8.8 m and 10.7 m depth.
2) Sloughing not observed. Minor squeezing observing below 8.8 m depth.
3) Test hole dry and open to 8.8 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

Sub-Surface Log

Test Hole TH21-26

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.

Project Name: Greenwald Colony Community Development

Contractor: Paddock Drilling Ltd.

Method: 125 mm Solid Stem Auger, CME-850 Track Mount

Project Number: 0105-032-00

Location: UTM N-5567983, E-681593

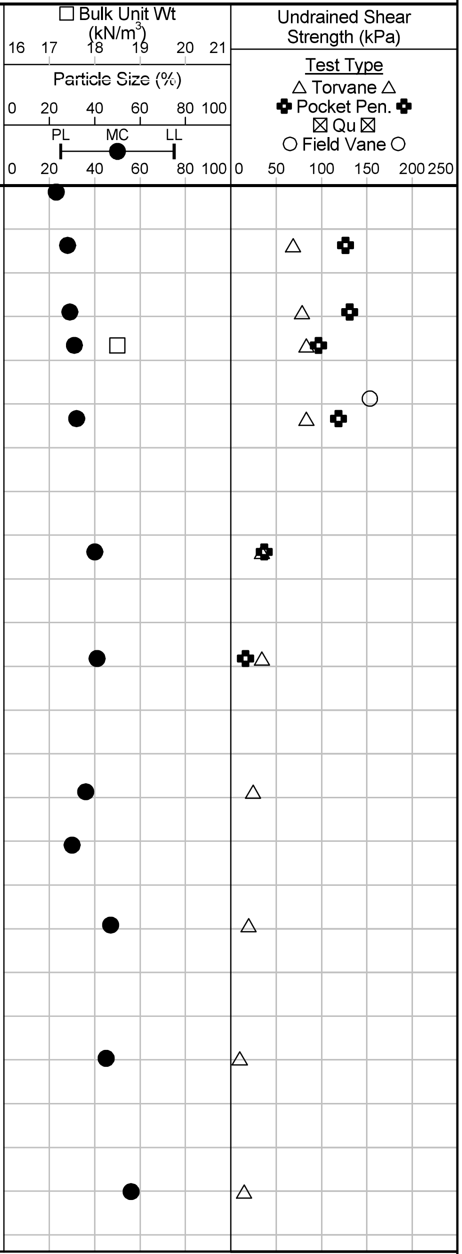
Ground Elevation: 226.65 m (local datum)

Date Drilled: May 5, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ 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)
226.5		⊠▨	CLAY (FILL) - silty, some sand, trace gravel, trace rootlets, black, moist, soft, high plasticity	◢	G153	
		▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◢	G154	
	1	▨				
		▨		◢	G155	
	2	▨	- some silt inclusions (<30 mm diam.), trace sand, brown below 1.8 m	▮	T156	
		▨		◢	G157	
	3	▨	- trace silt inclusions (<20 mm diam.) below 3.0 m			
	4	▨		◢	G158	
	5	▨		◢	G159	
	6	▨	- dark grey below 6.1 m			
		▨		◢	G160	
219.6	7	▥	SILT - some clay, some sand, grey, wet, soft to firm, low plasticity			
219.0		▨	CLAY - silty - dark grey - moist, firm - high plasticity	◢	G161	
	8	▨		◢	G162	
	9	▨				
	10	▨		◢	G163	
	11	▨		◢	G164	
214.5	12	▨				



END OF TEST HOLE AT 12.2 m IN CLAY

Notes:

1) Seepage observed below 2.4 m depth.
2) Sloughing not observed. Minor squeezing observing below 7.3 m depth.
3) Test hole dry and open to 7.3 m depth immediately after drilling.
4) Test hole backfilled to surface with bentonite chips.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-27

1 of 1

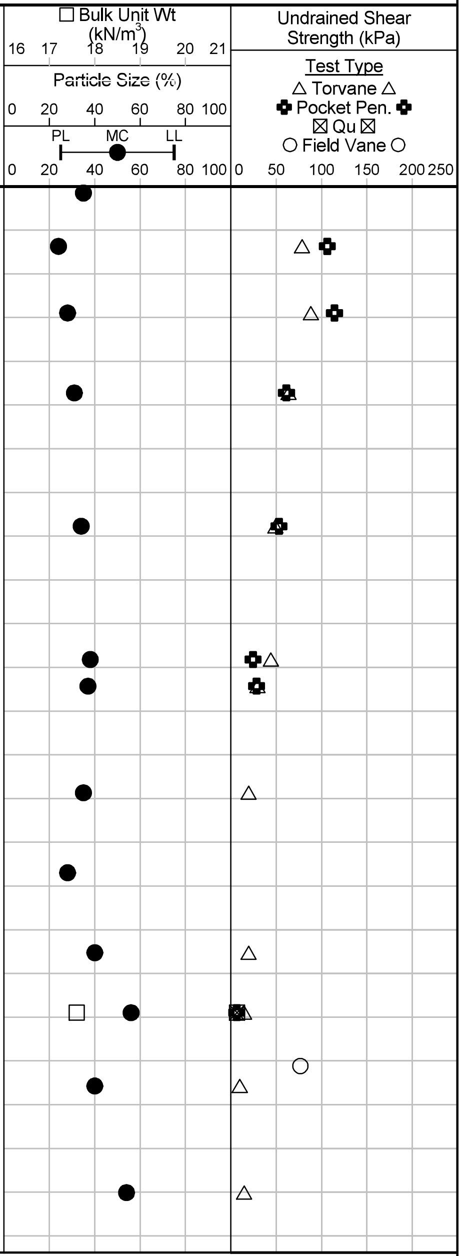
Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567815, E-681601
Ground Elevation: 226.68 m (local datum)
Date Drilled: May 4, 2021

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION
226.5		ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity
		CLAY - silty, some silt inclusions (<30 mm diam.), trace sand - brown - moist, stiff to very stiff - high plasticity - trace to some silt inclusions (<25 mm diam.), trace sand, trace ice crystals, mottled light brown and grey below 0.6 m - some silt inclusions (<30 mm diam.), trace sand, stiff below 1.8 m - trace silt inclusions (<20 mm diam.), brown below 3.8 m - dark grey below 5.5 m
219.1		SILT - some clay, some sand, grey, wet, soft to firm, low plasticity
218.1		CLAY - silty - dark grey - moist, firm - high plasticity
214.5	12	

Sample Type	Sample Number	SPT (N)
◣	G132	
◣	G133	
◣	G134	
◣	G135	
◣	G136	
◣	G137	
◣	G138	
◣	G139	
◣	G140	
◣	G141	
▮	T142	
◣	G143	
◣	G144	



END OF TEST HOLE AT 12.2 m IN CLAY
Notes:
1) Seepage observed below 7.9 m depth.
2) Sloughing not observed.
3) Test hole dry and open to 3.3 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-28

1 of 1

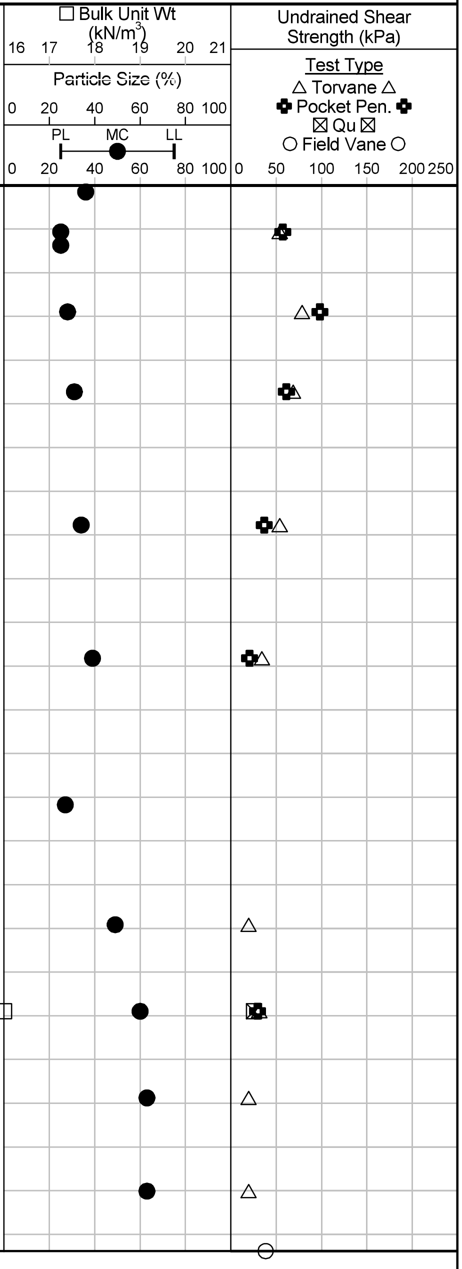
Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567951, E-681421
Ground Elevation: 226.81 m (local datum)
Date Drilled: May 3, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ◌ Cobbles ■ Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION
226.7	0	ORGANIC CLAY (TOPSOIL) - some silt, some rootlets, trace sand, black, moist, soft, high plasticity
		CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity - trace silt inclusions (<30 mm diam.), trace sand, brown, stiff below 2.1 m
220.0		SILT - trace clay, trace sand, light grey, wet, soft to firm, low plastiity
219.2		CLAY - silty, trace silt inclusions (<30 mm diam.), trace sand - dark grey - moist, firm - high plasticity
214.6	12	

Sample Type	Sample Number	SPT (N)
◢	G20	
◢	G21	
◢	G22	
◢	G23	
◢	G24	
◢	G25	
◢	G26	
◢	G27	
◢	G28	
▮	T29	15.6 □
◢	G30	
◢	G31	



END OF TEST HOLE AT 12.2 m IN CLAY
Notes:
1) Seepage observed between 6.8 m and 7.6 m depth.
2) Sloughing not observed. Minor squeezing observed below 6.9 m depth.
3) Test hole dry and open to 11.6 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-29

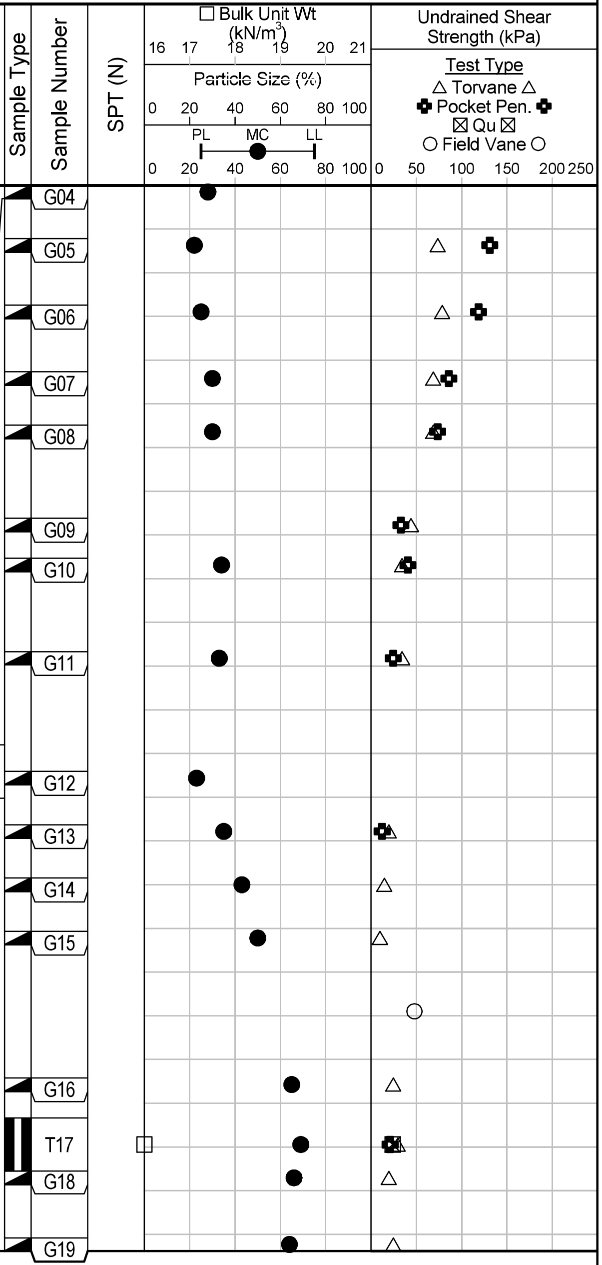
1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567951, E-681282
Contractor: Paddock Drilling Ltd.
Ground Elevation: 226.77 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 3, 2021

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION
226.6			ORGANIC CLAY (TOPSOIL) - some silt, trace sand, trace rootlets, black, moist, soft, high plasticity
	1 2 3 4 5 6		CLAY - silty, some silt inclusions (<30 mm diam.), trace sand - brown - moist, stiff to very stiff - high plasticity - stiff below 3.6 m
220.4			SILT - some clay, some sand, light brownish grey, wet, soft to firm, low plasticity
219.8	7 8 9 10 11 12		CLAY - silty, some silt inclusions (<30 mm diam.), trace sand - dark grey - moist, firm - high plasticity
214.6			



END OF TEST HOLE AT 12.2 m IN CLAY
Notes:
1) Seepage observed between 6.7 m and 7.0 m depth.
2) Sloughing not observed. Minor squeezing observing below 6.8 m depth.
3) Test hole dry and open to 9.0 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-30

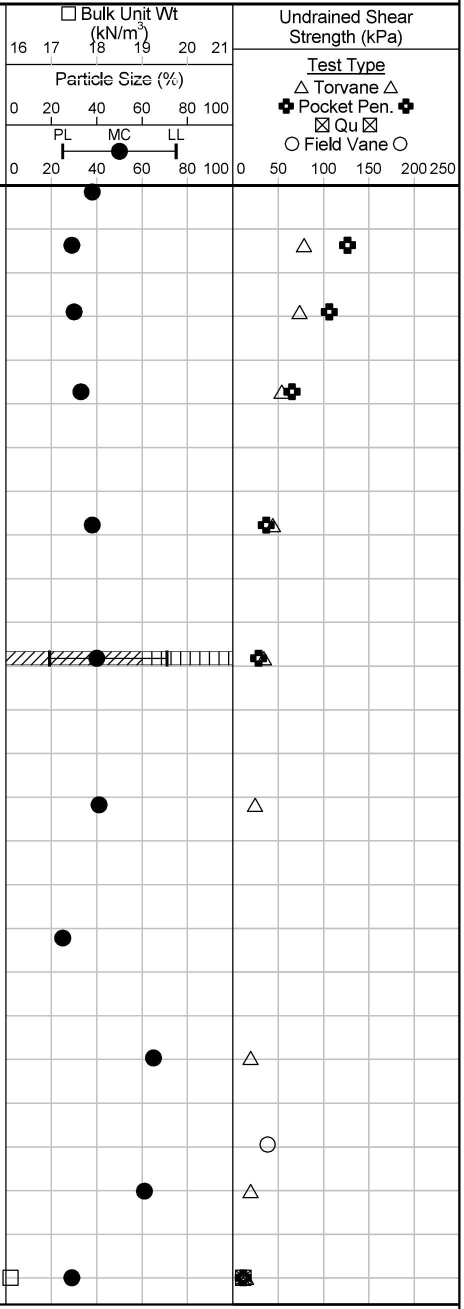
1 of 1

Client:	Burns Maendel Consulting Engineers Ltd.	**Project Number:**	0105-032-00
Project Name:	Greenwald Colony Community Development	**Location:**	UTM N-5567746, E-681392
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	226.83 m (local datum)
Method:	125 mm Solid Stem Auger, CME-850 Track Mount	**Date Drilled:**	May 3, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ 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)
226.7	0		ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity	◢	G36	
		▨	CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand - mottled light brown and grey - moist, stiff to very stiff - high plasticity	◢ ◢ ◢	G37 G38 G39	
			- trace silt inclusions (<30 mm diam.), trace sand, brown, stiff below 3.0 m	◢ ◢	G40 G41	
			- dark grey below 6.1 m depth	◢	G42	
218.6		▥	SILT - some sand, trace clay - grey - wet, soft to firm - low plasticity	◢	G43	
217.4		▨	CLAY - silty - dark grey - moist, firm - high plasticity	◢ ◢ ▮	G44 G45 T46	
214.0						



END OF TEST HOLE AT 12.8 m IN CLAY

Notes:

1) Seepage observed between 8.2 m 9.9 m depth.
2) Sloughing not observed. Minor squeezing observing below 11.3 m depth.
3) Test hole dry and open to 11.3 m depth approximately 10 minutes after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

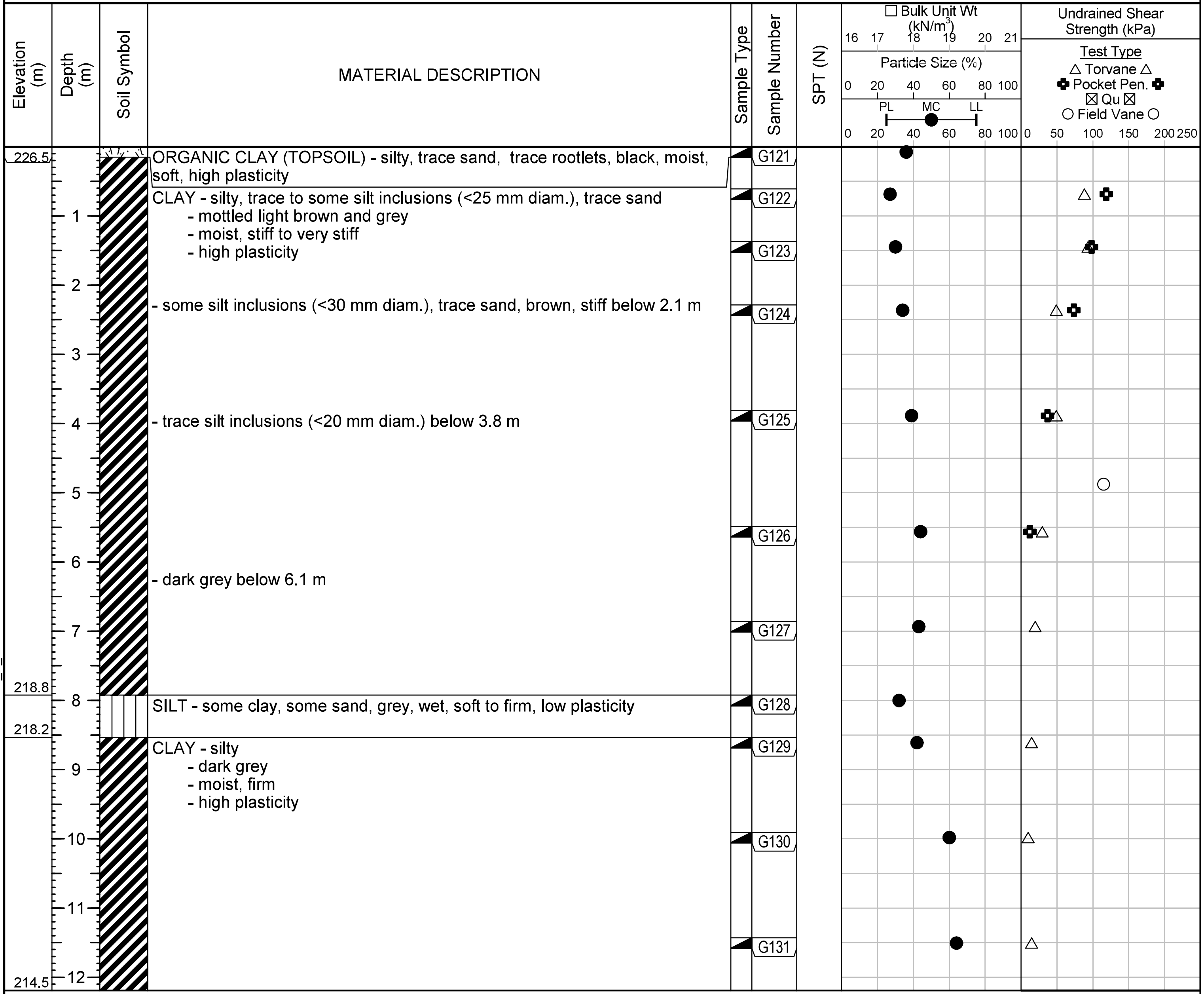
Test Hole TH21-31

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567606, E-681575
Ground Elevation: 226.69 m (local datum)
Date Drilled: May 4, 2021

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand
- mottled light brown and grey
- moist, stiff to very stiff
- high plasticity

- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 2.1 m

- trace silt inclusions (<20 mm diam.) below 3.8 m

- dark grey below 6.1 m

SILT - some clay, some sand, grey, wet, soft to firm, low plasticity

CLAY - silty
- dark grey
- moist, firm
- high plasticity

END OF TEST HOLE AT 12.2 m IN CLAY
Notes:
1) Seepage observed between 8.2 m and 8.5 m depth.
2) Sloughing not observed. Minor squeezing observing below 6.7 m depth.
3) Test hole dry and open to 7.3 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

Sub-Surface Log

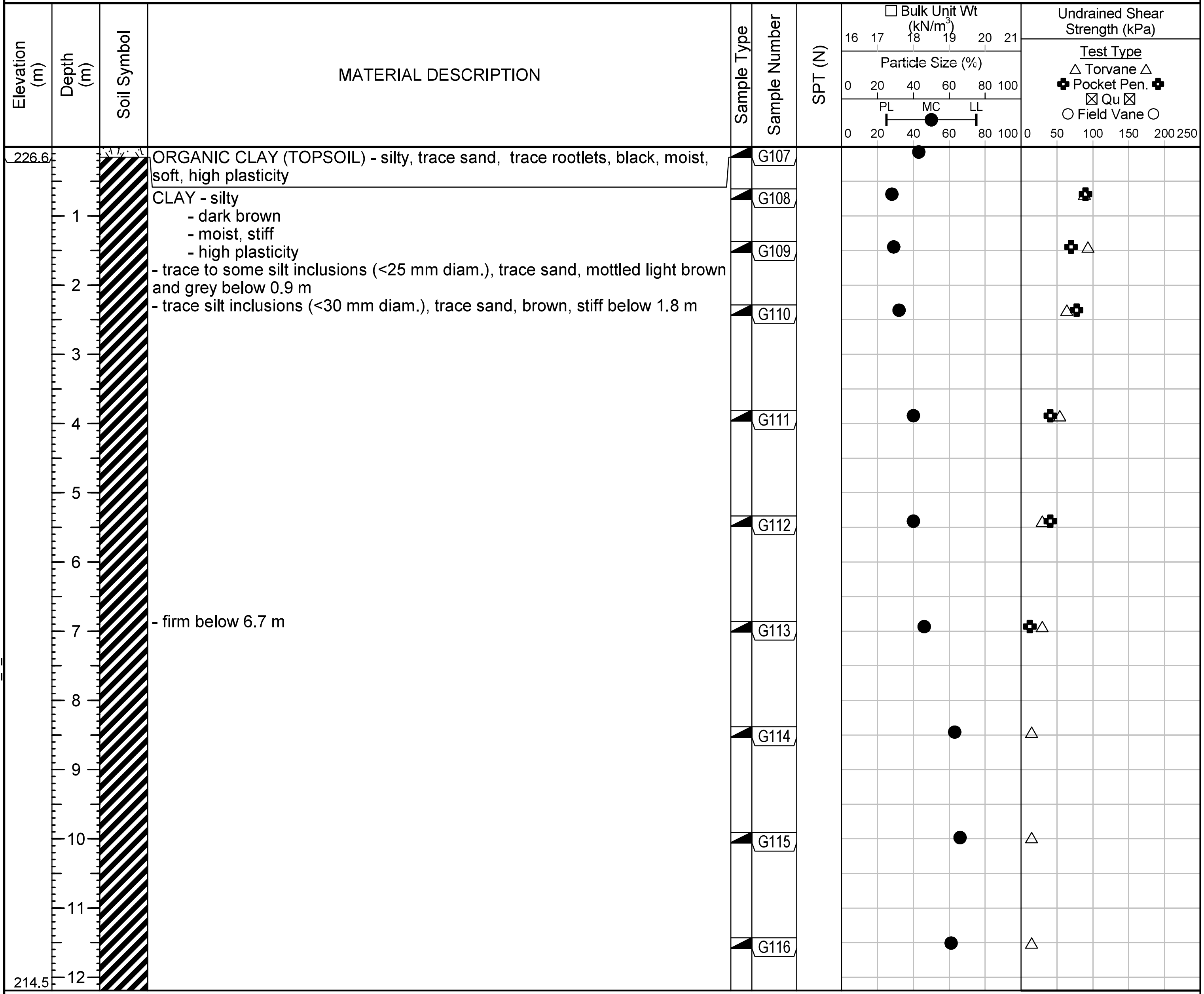
Test Hole TH21-32

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567419, E-681513
Ground Elevation: 226.70 m (local datum)
Date Drilled: May 4, 2021

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

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty
- dark brown
- moist, stiff
- high plasticity

- trace to some silt inclusions (<25 mm diam.), trace sand, mottled light brown and grey below 0.9 m
- trace silt inclusions (<30 mm diam.), trace sand, brown, stiff below 1.8 m
- firm below 6.7 m

END OF TEST HOLE AT 12.2 m IN CLAY
Notes:
1) Seepage and sloughing not observed. Minor squeezing observing below 6.4 m depth.
2) Test hole dry and open to 6.5 m depth immediately after drilling.
3) Test hole backfilled to surface with auger cuttings.

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

TREK GEOTECHNICAL

Sub-Surface Log

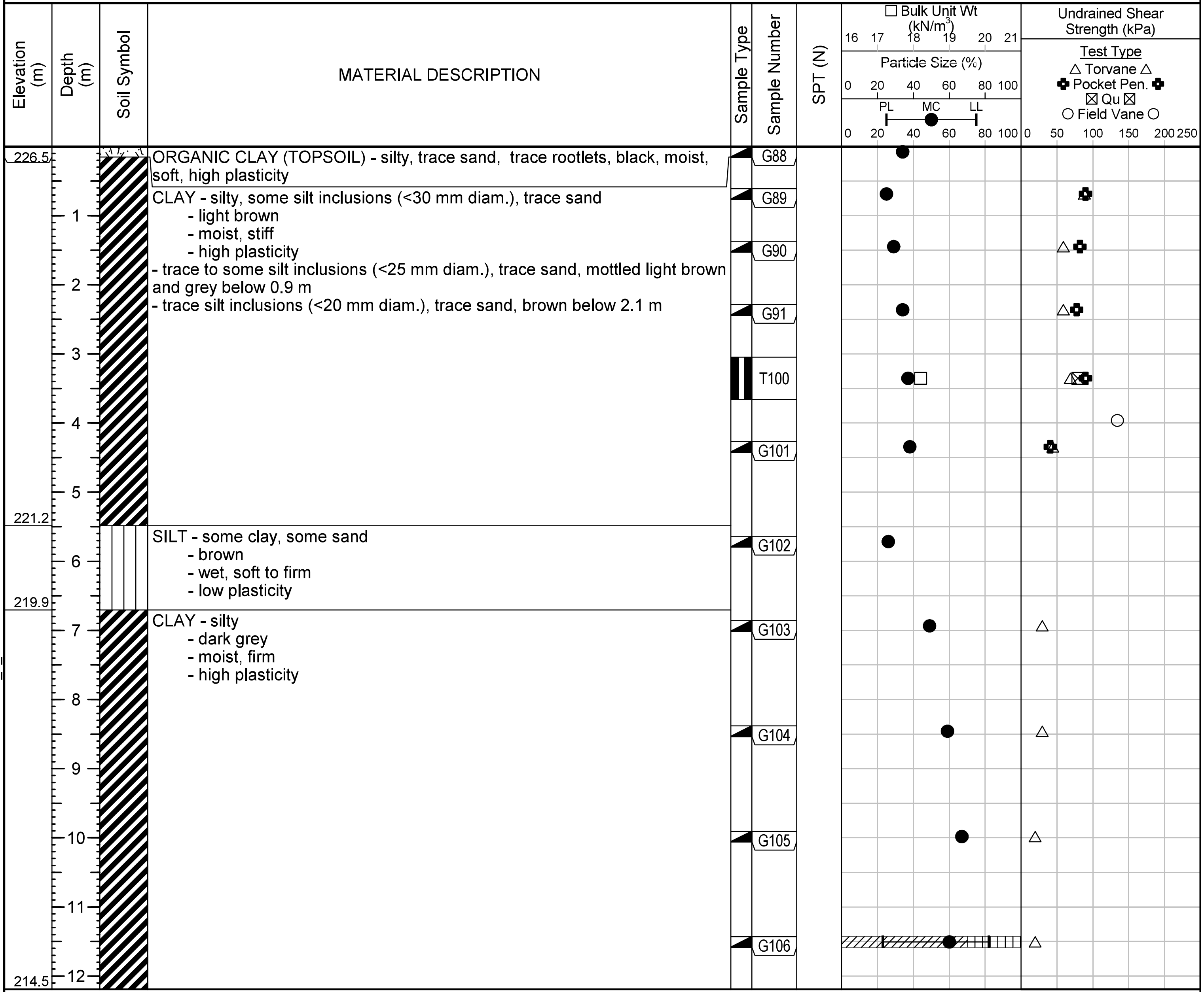
Test Hole TH21-33

1 of 1

Client: Burns Maendel Consulting Engineers Ltd.
Project Name: Greenwald Colony Community Development
Contractor: Paddock Drilling Ltd.
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Project Number: 0105-032-00
Location: UTM N-5567400, E-681357
Ground Elevation: 226.65 m (local datum)
Date Drilled: May 4, 2021

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ░ Sand Gravel Cobbles Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, some silt inclusions (<30 mm diam.), trace sand
- light brown
- moist, stiff
- high plasticity

- trace to some silt inclusions (<25 mm diam.), trace sand, mottled light brown and grey below 0.9 m
- trace silt inclusions (<20 mm diam.), trace sand, brown below 2.1 m

SILT - some clay, some sand
- brown
- wet, soft to firm
- low plasticity

CLAY - silty
- dark grey
- moist, firm
- high plasticity

END OF TEST HOLE AT 12.2 m IN CLAY
Notes:
1) Seepage observed between 5.8 m and 6.7 m depth.
2) Sloughing not observed.
3) Test hole dry and open to 3.3 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

Test Hole TH21-34

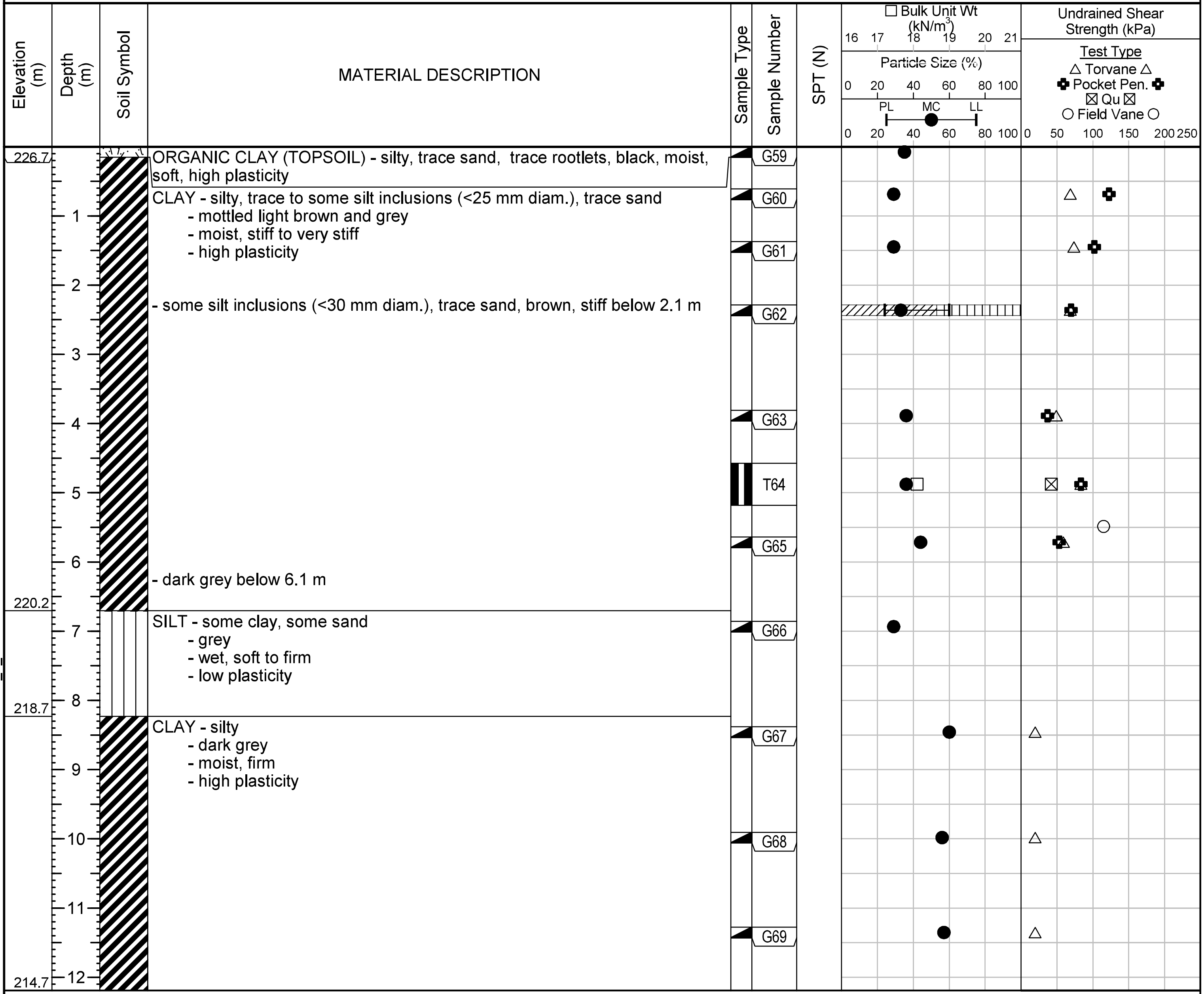
1 of 1

Sub-Surface Log

Client: Burns Maendel Consulting Engineers Ltd.
Project Number: 0105-032-00
Project Name: Greenwald Colony Community Development
Location: UTM N-5567523, E-681209
Contractor: Paddock Drilling Ltd.
Ground Elevation: 226.89 m (local datum)
Method: 125 mm Solid Stem Auger, CME-850 Track Mount
Date Drilled: May 4, 2021

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ◌ Cobbles ■ Boulders



ORGANIC CLAY (TOPSOIL) - silty, trace sand, trace rootlets, black, moist, soft, high plasticity

CLAY - silty, trace to some silt inclusions (<25 mm diam.), trace sand
- mottled light brown and grey
- moist, stiff to very stiff
- high plasticity

- some silt inclusions (<30 mm diam.), trace sand, brown, stiff below 2.1 m

- dark grey below 6.1 m

SILT - some clay, some sand
- grey
- wet, soft to firm
- low plasticity

CLAY - silty
- dark grey
- moist, firm
- high plasticity

END OF TEST HOLE AT 12.2 m IN CLAY
Notes:
1) Seepage observed between 6.8 m and 8.2 m depth.
2) Sloughing not observed. Minor squeezing observing below 5.8 m depth.
3) Test hole dry and open to 5.8 m depth immediately after drilling.
4) Test hole backfilled to surface with auger cuttings.

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

Appendix A

Laboratory Testing

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development

Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-01	TH21-01	TH21-01	TH21-01	TH21-02	TH21-02
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	0.0 - 0.2	0.6 - 0.8
Sample #	G70	G71	G72	G73	G74	G75
Tare ID	C13	AB03	P13	Z59	N32	Z68
Mass of tare	8.4	6.8	8.5	8.5	8.3	8.5
Mass wet + tare	210.0	247.3	264.7	273.9	133.5	212.2
Mass dry + tare	149.8	196.3	205.0	206.0	101.3	170.2
Mass water	60.2	51.0	59.7	67.9	32.2	42.0
Mass dry soil	141.4	189.5	196.5	197.5	93.0	161.7
Moisture %	42.6%	26.9%	30.4%	34.4%	34.6%	26.0%

Test Hole	TH21-02	TH21-02	TH21-03	TH21-03	TH21-03	TH21-03
Depth (m)	1.4 - 1.5	2.3 - 2.4	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4
Sample #	G76	G77	G117	G118	G119	G120
Tare ID	F35	F31	P14	D24	D40	E131
Mass of tare	8.5	8.6	8.8	8.4	8.3	8.7
Mass wet + tare	206.7	197.0	180.9	253.1	216.0	191.1
Mass dry + tare	163.0	148.9	131.3	201.8	168.5	144.9
Mass water	43.7	48.1	49.6	51.3	47.5	46.2
Mass dry soil	154.5	140.3	122.5	193.4	160.2	136.2
Moisture %	28.3%	34.3%	40.5%	26.5%	29.7%	33.9%

Test Hole	TH21-04	TH21-04	TH21-04	TH21-04	TH21-05	TH21-05
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	0.0 - 0.2	0.6 - 0.8
Sample #	G51	G52	G53	G54	G55	G56
Tare ID	D28	Z82	E107	AB80	AB08	F74
Mass of tare	8.6	8.3	8.7	6.8	6.8	8.5
Mass wet + tare	287.1	224.0	201.3	260.3	126.2	198.7
Mass dry + tare	209.5	175.5	158.7	198.0	97.8	158.4
Mass water	77.6	48.5	42.6	62.3	28.4	40.3
Mass dry soil	200.9	167.2	150.0	191.2	91.0	149.9
Moisture %	38.6%	29.0%	28.4%	32.6%	31.2%	26.9%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development

Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-05	TH21-05	TH21-06	TH21-06	TH21-06	TH21-06
Depth (m)	1.4 - 1.5	2.3 - 2.4	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4
Sample #	G57	G58	G47	G48	G49	G50
Tare ID	F99	W06	F75	E20	E41	AC26
Mass of tare	8.6	8.5	8.8	8.6	8.6	6.8
Mass wet + tare	268.6	206.9	161.0	217.7	193.6	226.4
Mass dry + tare	207.7	156.8	119.6	172.5	150.9	170.0
Mass water	60.9	50.1	41.4	45.2	42.7	56.4
Mass dry soil	199.1	148.3	110.8	163.9	142.3	163.2
Moisture %	30.6%	33.8%	37.4%	27.6%	30.0%	34.6%

Test Hole	TH21-07	TH21-07	TH21-07	TH21-07	TH21-08	TH21-08
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	0.0 - 0.2	0.6 - 0.8
Sample #	G32	G33	G34	G35	G145	G146
Tare ID	Z44	E62	E8	Z58	AB98	AC28
Mass of tare	8.5	8.7	8.5	8.7	6.7	6.7
Mass wet + tare	229.8	253.0	237.0	263.8	140.0	266.8
Mass dry + tare	174.6	200.9	183.3	199.4	118.9	211.6
Mass water	55.2	52.1	53.7	64.4	21.1	55.2
Mass dry soil	166.1	192.2	174.8	190.7	112.2	204.9
Moisture %	33.2%	27.1%	30.7%	33.8%	18.8%	26.9%

Test Hole	TH21-08	TH21-08	TH21-09	TH21-09	TH21-09	TH21-09
Depth (m)	1.4 - 1.5	2.3 - 2.4	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4
Sample #	G147	G148	G149	G150	G151	G152
Tare ID	H4	F76	AC01	Z57	E108	Z19
Mass of tare	9.1	8.7	6.6	8.6	8.6	8.7
Mass wet + tare	214.0	254.2	217.4	234.8	249.4	283.9
Mass dry + tare	168.4	190.8	162.3	189.3	195.8	218.2
Mass water	45.6	63.4	55.1	45.5	53.6	65.7
Mass dry soil	159.3	182.1	155.7	180.7	187.2	209.5
Moisture %	28.6%	34.8%	35.4%	25.2%	28.6%	31.4%

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development
Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-10	TH21-10	TH21-10	TH21-11	TH21-11	TH21-11
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	0.0 - 0.2	0.3 - 0.5	1.4 - 1.5
Sample #	G01	G02	G03	G188	G189	G190
Tare ID	F56	W78	K35	A20	W35	AB05
Mass of tare	8.5	8.4	8.4	8.7	8.5	6.8
Mass wet + tare	219.5	272.6	259.1	239.8	227.9	267.9
Mass dry + tare	164.6	214.8	203.6	179.8	179.2	209.6
Mass water	54.9	57.8	55.5	60.0	48.7	58.3
Mass dry soil	156.1	206.4	195.2	171.1	170.7	202.8
Moisture %	35.2%	28.0%	28.4%	35.1%	28.5%	28.7%

Test Hole	TH21-11	TH21-12	TH21-12	TH21-12	TH21-12	TH21-13
Depth (m)	2.3 - 2.4	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	0.0 - 0.2
Sample #	G191	G192	G193	G194	G195	G282
Tare ID	N110	P33	H49	AA12	F5	P36
Mass of tare	8.5	8.7	8.5	6.8	8.6	8.5
Mass wet + tare	225.3	174.0	284.5	197.1	227.8	174.6
Mass dry + tare	172.8	130.7	230.1	155.5	173.9	130.9
Mass water	52.5	43.3	54.4	41.6	53.9	43.7
Mass dry soil	164.3	122.0	221.6	148.7	165.3	122.4
Moisture %	32.0%	35.5%	24.5%	28.0%	32.6%	35.7%

Test Hole	TH21-13	TH21-13	TH21-13	TH21-13	TH21-13	TH21-14
Depth (m)	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	4.0 - 4.1	5.3 - 5.5	0.0 - 0.2
Sample #	G283	G284	G285	G288	G290	G291
Tare ID	H50	GF126	E69	AA08	N27	H43
Mass of tare	8.6	8.6	8.8	6.8	8.6	9.1
Mass wet + tare	202.5	205.2	243.0	238.5	238.3	182.4
Mass dry + tare	160.7	161.6	181.5	173.9	169.3	140.7
Mass water	41.8	43.6	61.5	64.6	69.0	41.7
Mass dry soil	152.1	153.0	172.7	167.1	160.7	131.6
Moisture %	27.5%	28.5%	35.6%	38.7%	42.9%	31.7%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No. 0105-032-00
Client Burns Maendel Consulting
Project Greenwald Colony Community Development

Sample Date 04-May-21
Test Date 17-May-21
Technician JSB

Test Hole	TH21-14	TH21-14	TH21-14	TH21-14	TH21-14	TH21-15
Depth (m)	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	0.0 - 0.2
Sample #	G292	G293	G294	G295	G296	G264
Tare ID	W65	AB33	N96	H46	E19	E88
Mass of tare	8.5	6.8	8.5	8.5	8.6	8.8
Mass wet + tare	253.1	209.4	200.5	203.5	238.5	151.4
Mass dry + tare	201.1	164.7	150.1	148.4	168.5	118.6
Mass water	52.0	44.7	50.4	55.1	70.0	32.8
Mass dry soil	192.6	157.9	141.6	139.9	159.9	109.8
Moisture %	27.0%	28.3%	35.6%	39.4%	43.8%	29.9%

Test Hole	TH21-15	TH21-15	TH21-15	TH21-15	TH21-15	TH21-16
Depth (m)	0.6 - 0.8	1.4 - 1.5	2.3 - 2.6	4.1 - 4.3	5.3 - 5.5	0.0 - 0.2
Sample #	G265	G266	G267	G270	G272	G251
Tare ID	P28	E69	E47	W49	A30	N104
Mass of tare	8.5	8.8	8.7	8.6	8.7	8.7
Mass wet + tare	242.8	436.2	261.0	203.8	256.3	174.9
Mass dry + tare	194.8	343.2	196.2	148.6	182.8	132.2
Mass water	48.0	93.0	64.8	55.2	73.5	42.7
Mass dry soil	186.3	334.4	187.5	140.0	174.1	123.5
Moisture %	25.8%	27.8%	34.6%	39.4%	42.2%	34.6%

Test Hole	TH21-16	TH21-16	TH21-16	TH21-16	TH21-16	TH21-17
Depth (m)	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	0.0 - 0.2
Sample #	G252	G253	G254	G255	G256	G257
Tare ID	Z87	AC33	F52	D2	W41	W99
Mass of tare	8.4	7	8.4	8.4	8.5	8.5
Mass wet + tare	246.6	233.9	225.1	227.7	191.1	211.2
Mass dry + tare	199.3	183.4	169.8	168.7	137.8	171.4
Mass water	47.3	50.5	55.3	59.0	53.3	39.8
Mass dry soil	190.9	176.4	161.4	160.3	129.3	162.9
Moisture %	24.8%	28.6%	34.3%	36.8%	41.2%	24.4%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development

Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-17	TH21-17	TH21-17	TH21-17	TH21-18	TH21-18
Depth (m)	0.6 - 0.8	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	0.0 - 0.2	0.6 - 0.8
Sample #	G258	G259	G261	G263	G208	G209
Tare ID	Z02	E106	W64	F16	E80	AC19
Mass of tare	8.6	8.5	8.3	8.5	8.6	6.7
Mass wet + tare	236.0	266.2	324.9	285.8	160.9	220.7
Mass dry + tare	188.7	200.6	240.7	203.6	127.7	175.6
Mass water	47.3	65.6	84.2	82.2	33.2	45.1
Mass dry soil	180.1	192.1	232.4	195.1	119.1	168.9
Moisture %	26.3%	34.1%	36.2%	42.1%	27.9%	26.7%

Test Hole	TH21-18	TH21-18	TH21-18	TH21-18	TH21-18	TH21-18
Depth (m)	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	8.4 - 8.5	8.7 - 8.8
Sample #	G210	G211	G212	G214	G218	G219
Tare ID	Z107	W13	E33	AB63	AB12	D42
Mass of tare	8.6	8.4	8.6	7.4	6.9	8.6
Mass wet + tare	198.2	193.5	245.1	194.1	258.8	191.3
Mass dry + tare	156.2	149.7	179.8	139.8	192.3	148.8
Mass water	42.0	43.8	65.3	54.3	66.5	42.5
Mass dry soil	147.6	141.3	171.2	132.4	185.4	140.2
Moisture %	28.5%	31.0%	38.1%	41.0%	35.9%	30.3%

Test Hole	TH21-19	TH21-19	TH21-19	TH21-19	TH21-19	TH21-19
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	4.1 - 4.3	5.3 - 5.5
Sample #	G273	G274	G275	G276	G277	G278
Tare ID	W87	Z127	E99	K7	E121	Z94
Mass of tare	8.5	8.5	8.6	8.6	8.5	8.5
Mass wet + tare	148.6	238.2	194.4	241.2	290.5	222.2
Mass dry + tare	115.6	192.1	153.0	182.1	211.3	158.9
Mass water	33.0	46.1	41.4	59.1	79.2	63.3
Mass dry soil	107.1	183.6	144.4	173.5	202.8	150.4
Moisture %	30.8%	25.1%	28.7%	34.1%	39.1%	42.1%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No. 0105-032-00
Client Burns Maendel Consulting
Project Greenwald Colony Community Development

Sample Date 04-May-21
Test Date 17-May-21
Technician JSB

Test Hole	TH21-19	TH21-19	TH21-19	TH21-20	TH21-20	TH21-20
Depth (m)	7.0 - 7.2	8.4 - 8.5	8.7 - 8.8	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5
Sample #	G279	G280	G281	G221	G222	G223
Tare ID	AB16	Z31	AB30	K9	GF108	AB19
Mass of tare	6.7	8.5	6.6	8.5	8.3	6.6
Mass wet + tare	213.7	259.2	150.6	157.5	224.6	247.4
Mass dry + tare	149.8	200.5	118.9	131.4	180	194.5
Mass water	63.9	58.7	31.7	26.1	44.6	52.9
Mass dry soil	143.1	192.0	112.3	122.9	171.7	187.9
Moisture %	44.7%	30.6%	28.2%	21.2%	26.0%	28.2%

Test Hole	TH21-20	TH21-20	TH21-20	TH21-20	TH21-20	TH21-20
Depth (m)	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	5.6 - 5.8	7.2 - 7.3	8.4 - 8.5
Sample #	G224	G225	G226	G229	G230	G232
Tare ID	K10	AB38	AA10	Z53	Z10	F37
Mass of tare	8.5	6.7	6.7	8.5	8.4	8.4
Mass wet + tare	230.6	258.0	242.6	153.1	217.5	180.5
Mass dry + tare	177.0	189.7	172.4	110.7	159.7	129.7
Mass water	53.6	68.3	70.2	42.4	57.8	50.8
Mass dry soil	168.5	183.0	165.7	102.2	151.3	121.3
Moisture %	31.8%	37.3%	42.4%	41.5%	38.2%	41.9%

Test Hole	TH21-20	TH21-21	TH21-21	TH21-21	TH21-21	TH21-21
Depth (m)	8.8 - 9.0	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0
Sample #	G233	G234	G235	G236	G237	G238
Tare ID	W81	E16	AC05	K18	E12	N72
Mass of tare	8.7	8.6	6.8	8.5	8.9	8.7
Mass wet + tare	206.7	124.6	267.5	251.4	323.5	253.5
Mass dry + tare	156.8	96	212.6	196.2	244.2	184.6
Mass water	49.9	28.6	54.9	55.2	79.3	68.9
Mass dry soil	148.1	87.4	205.8	187.7	235.3	175.9
Moisture %	33.7%	32.7%	26.7%	29.4%	33.7%	39.2%

Moisture Content Report
ASTM D2216-10

Project No. 0105-032-00
Client Burns Maendel Consulting
Project Greenwald Colony Community Development

Sample Date 04-May-21
Test Date 17-May-21
Technician JSB

Test Hole	TH21-21	TH21-21	TH21-21	TH21-22	TH21-22	TH21-22
Depth (m)	5.3 - 5.5	6.9 - 7.0	8.4 - 8.5	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5
Sample #	G239	G240	G241	G242	G243	G244
Tare ID	W94	E2	W85	F44	AC10	H16
Mass of tare	8.6	8.5	8.6	8.4	6.5	8.4
Mass wet + tare	296.0	281.2	242.8	182.6	253.5	223.9
Mass dry + tare	208.2	197.6	172.8	139.0	202.2	174.9
Mass water	87.8	83.6	70.0	43.6	51.3	49.0
Mass dry soil	199.6	189.1	164.2	130.6	195.7	166.5
Moisture %	44.0%	44.2%	42.6%	33.4%	26.2%	29.4%

Test Hole	TH21-22	TH21-22	TH21-22	TH21-22	TH21-22	TH21-22
Depth (m)	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	6.9 - 7.0	8.4 - 8.5	9.0 - 9.1
Sample #	G245	G246	G247	G248	G249	G250
Tare ID	AB13	D29	Z101	P03	C10	AC38
Mass of tare	6.7	8.5	8.4	8.6	8.5	6.9
Mass wet + tare	203.8	255.1	200.3	233.8	276.1	186.9
Mass dry + tare	152.4	185.5	142.7	162.1	203.7	142.8
Mass water	51.4	69.6	57.6	71.7	72.4	44.1
Mass dry soil	145.7	177.0	134.3	153.5	195.2	135.9
Moisture %	35.3%	39.3%	42.9%	46.7%	37.1%	32.5%

Test Hole	TH21-23	TH21-23	TH21-23	TH21-23	TH21-23	TH21-23
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.6 - 2.7	4.3 - 4.4	5.3 - 5.5
Sample #	G196	G197	G198	G199	G201	G202
Tare ID	K17	E60	N115	H59	P24	AB51
Mass of tare	8.3	8.4	8.5	8.5	8.6	6.6
Mass wet + tare	169.7	317.6	266.3	315.7	293.1	288.2
Mass dry + tare	128.4	252.8	208.8	240	216.2	203
Mass water	41.3	64.8	57.5	75.7	76.9	85.2
Mass dry soil	120.1	244.4	200.3	231.5	207.6	196.4
Moisture %	34.4%	26.5%	28.7%	32.7%	37.0%	43.4%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development

Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-23	TH21-23	TH21-23	TH21-23	TH21-23	TH21-24
Depth (m)	6.9 - 7.0	8.4 - 8.5	8.8 - 9.0	9.9 - 10.1	11.4 - 11.6	0.0 - 0.2
Sample #	G203	G204	G205	G206	G207	G176
Tare ID	H15	E4	AA12	Z75	F8	D13
Mass of tare	8.6	8.3	6.6	8.4	8.5	8.6
Mass wet + tare	270	279.3	356.5	259.2	207.2	168
Mass dry + tare	189	202.2	271.8	184.2	144.6	128.5
Mass water	81.0	77.1	84.7	75.0	62.6	39.5
Mass dry soil	180.4	193.9	265.2	175.8	136.1	119.9
Moisture %	44.9%	39.8%	31.9%	42.7%	46.0%	32.9%

Test Hole	TH21-24	TH21-24	TH21-24	TH21-24	TH21-24	TH21-24
Depth (m)	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	7.5 - 7.6
Sample #	G177	G178	G179	G180	G181	G183
Tare ID	W70	Z13	AC04	K4	F41	GF14
Mass of tare	8.4	8.6	6.8	8.5	8.4	8.7
Mass wet + tare	247.5	265	288.1	259.4	214.4	213.7
Mass dry + tare	199.9	210.1	217.6	192.3	155.2	158.9
Mass water	47.6	54.9	70.5	67.1	59.2	54.8
Mass dry soil	191.5	201.5	210.8	183.8	146.8	150.2
Moisture %	24.9%	27.2%	33.4%	36.5%	40.3%	36.5%

Test Hole	TH21-24	TH21-24	TH21-24	TH21-24	TH21-25	TH21-25
Depth (m)	8.2 - 8.4	8.8 - 9.0	9.9 - 10.1	11.4 - 11.6	0.0 - 0.2	0.6 - 0.8
Sample #	G184	G185	G186	G187	G165	G166
Tare ID	AC25	E79	W53	AB100	H34	H9
Mass of tare	6.7	8.6	8.4	6.8	8.5	8.5
Mass wet + tare	251.2	174.6	217.1	186.4	175.5	245.7
Mass dry + tare	188	128.5	151.1	122.1	140	198
Mass water	63.2	46.1	66.0	64.3	35.5	47.7
Mass dry soil	181.3	119.9	142.7	115.3	131.5	189.5
Moisture %	34.9%	38.4%	46.3%	55.8%	27.0%	25.2%

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development

Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-25	TH21-25	TH21-25	TH21-25	TH21-25	TH21-25
Depth (m)	1.4 - 1.5	2.4 - 2.6	3.8 - 4.0	5.3 - 5.5	6.9 - 7.0	8.7 - 8.8
Sample #	G167	G168	G169	G170	G171	G173
Tare ID	H31	N109	C6	W50	W47	GF89
Mass of tare	8.6	8.4	8.3	8.7	8.6	8.9
Mass wet + tare	258.4	345.9	301.7	287.7	298	221.2
Mass dry + tare	203.4	259.4	219.8	205.2	215.6	163.8
Mass water	55.0	86.5	81.9	82.5	82.4	57.4
Mass dry soil	194.8	251.0	211.5	196.5	207.0	154.9
Moisture %	28.2%	34.5%	38.7%	42.0%	39.8%	37.1%

Test Hole	TH21-25	TH21-25	TH21-26	TH21-26	TH21-26	TH21-26
Depth (m)	9.9 - 10.1	11.4 - 11.6	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.6 - 2.7
Sample #	G174	G175	G153	G154	G155	G157
Tare ID	Q01	F142	P114	P22	F71	W70
Mass of tare	8.7	8.8	8.4	8.9	8.7	8.8
Mass wet + tare	254.3	235.3	228.1	252.8	232.1	249.3
Mass dry + tare	183	149	186.4	199.4	182	190.8
Mass water	71.3	86.3	41.7	53.4	50.1	58.5
Mass dry soil	174.3	140.2	178.0	190.5	173.3	182.0
Moisture %	40.9%	61.6%	23.4%	28.0%	28.9%	32.1%

Test Hole	TH21-26	TH21-26	TH21-26	TH21-26	TH21-26	TH21-26
Depth (m)	4.1 - 4.3	5.3 - 5.5	6.9 - 7.0	7.5 - 7.6	8.4 - 8.5	9.9 - 10.1
Sample #	G158	G159	G160	G161	G162	G163
Tare ID	P17	A101	AB23	C20	P05	N61
Mass of tare	8.7	8.6	6.7	8.8	8.8	8.7
Mass wet + tare	223.5	264.2	234.2	266.1	248.4	243.4
Mass dry + tare	162	190	173.8	206.6	171.4	170.8
Mass water	61.5	74.2	60.4	59.5	77.0	72.6
Mass dry soil	153.3	181.4	167.1	197.8	162.6	162.1
Moisture %	40.1%	40.9%	36.1%	30.1%	47.4%	44.8%

Moisture Content Report
ASTM D2216-10

Project No. 0105-032-00
Client Burns Maendel Consulting
Project Greenwald Colony Community Development

Sample Date 04-May-21
Test Date 17-May-21
Technician JSB

Test Hole	TH21-26	TH21-27	TH21-27	TH21-27	TH21-27	TH21-27
Depth (m)	11.4 - 11.6	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0
Sample #	G164	G132	G133	G134	G135	G136
Tare ID	P01	N12	AB97	AB18	AB94	AB53
Mass of tare	8.7	8.9	6.8	6.7	6.7	7.4
Mass wet + tare	235.3	248.8	218	218	294.3	267
Mass dry + tare	154.2	187.2	176.8	172	225.8	201.4
Mass water	81.1	61.6	41.2	46.0	68.5	65.6
Mass dry soil	145.5	178.3	170.0	165.3	219.1	194.0
Moisture %	55.7%	34.5%	24.2%	27.8%	31.3%	33.8%

Test Hole	TH21-27	TH21-27	TH21-27	TH21-27	TH21-27	TH21-27
Depth (m)	5.3 - 5.5	5.6 - 5.8	6.9 - 7.0	7.8 - 7.9	8.7 - 8.8	10.2 - 10.4
Sample #	G137	G138	G139	G140	G141	G143
Tare ID	W73	Z05	P04	Z99	W18	P36
Mass of tare	8.7	8.5	8.6	8.5	8.5	8.9
Mass wet + tare	253.6	286.3	217.2	247.7	244.5	291.1
Mass dry + tare	186.2	212	162.8	195	177.4	210
Mass water	67.4	74.3	54.4	52.7	67.1	81.1
Mass dry soil	177.5	203.5	154.2	186.5	168.9	201.1
Moisture %	38.0%	36.5%	35.3%	28.3%	39.7%	40.3%

Test Hole	TH21-27	TH21-28	TH21-28	TH21-28	TH21-28	TH21-28
Depth (m)	11.4 - 11.6	0.0 - 0.2	0.5 - 0.6	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4
Sample #	G144	G20	G21	G22	G23	G24
Tare ID	N04	H90	D9	E83	F10	AB01
Mass of tare	8.9	9.1	8.8	9.2	8.8	6.7
Mass wet + tare	236.2	265.1	252.8	219.2	233.1	235.3
Mass dry + tare	156.8	197.8	204.6	177.6	184.2	181.4
Mass water	79.4	67.3	48.2	41.6	48.9	53.9
Mass dry soil	147.9	188.7	195.8	168.4	175.4	174.7
Moisture %	53.7%	35.7%	24.6%	24.7%	27.9%	30.9%

Moisture Content Report
ASTM D2216-10

Project No. 0105-032-00
Client Burns Maendel Consulting
Project Greenwald Colony Community Development

Sample Date 04-May-21
Test Date 17-May-21
Technician JSB

Test Hole	TH21-28	TH21-28	TH21-28	TH21-28	TH21-28	TH21-28
Depth (m)	3.8 - 4.0	5.3 - 5.5	7.0 - 7.2	8.4 - 8.5	10.4 - 10.5	11.4 - 11.6
Sample #	G25	G26	G27	G28	G30	G31
Tare ID	C14	F121	D37	K23	H41	E27
Mass of tare	8.5	8.8	8.6	8.6	8.7	8.8
Mass wet + tare	249.3	256.2	271.9	255.6	218.4	231.1
Mass dry + tare	188.6	187.4	215.4	174.6	137	145.2
Mass water	60.7	68.8	56.5	81.0	81.4	85.9
Mass dry soil	180.1	178.6	206.8	166.0	128.3	136.4
Moisture %	33.7%	38.5%	27.3%	48.8%	63.4%	63.0%

Test Hole	TH21-29	TH21-29	TH21-29	TH21-29	TH21-29	TH21-29
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.1 - 2.3	2.7 - 2.9	3.8 - 4.0
Sample #	G04	G05	G06	G07	G08	G09
Tare ID	Z71	A9	AB35	E94	P09	N19
Mass of tare	8.6	8.1	6.8	8.5	8.5	8.6
Mass wet + tare	163.1	213.2	248.8	233.5	200	199.6
Mass dry + tare	128.9	176.3	200.6	181.9	156.4	153.2
Mass water	34.2	36.9	48.2	51.6	43.6	46.4
Mass dry soil	120.3	168.2	193.8	173.4	147.9	144.6
Moisture %	28.4%	21.9%	24.9%	29.8%	29.5%	32.1%

Test Hole	TH21-29	TH21-29	TH21-29	TH21-29	TH21-29	TH21-29
Depth (m)	4.3 - 4.4	5.3 - 5.5	6.7 - 6.9	7.3 - 7.5	7.9 - 8.1	8.5 - 8.7
Sample #	G10	G11	G12	G13	G14	G15
Tare ID	AB69	F91	D18	AB09	F48	E24
Mass of tare	6.7	8.4	8.6	6.7	8.7	8.6
Mass wet + tare	215.1	254.6	228.6	242.3	177.8	193.3
Mass dry + tare	162.1	193.3	187.8	181.4	127.4	131.9
Mass water	53.0	61.3	40.8	60.9	50.4	61.4
Mass dry soil	155.4	184.9	179.2	174.7	118.7	123.3
Moisture %	34.1%	33.2%	22.8%	34.9%	42.5%	49.8%

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development
Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-29	TH21-29	TH21-29	TH21-30	TH21-30	TH21-30
Depth (m)	10.2 - 10.4	11.3 - 11.4	12.0 - 12.2	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5
Sample #	G16	G18	G19	G36	G37	G38
Tare ID	Z47	Z56	Z04	AB38	F148	F94
Mass of tare	8.6	8.6	8.5	6.8	8.3	8.3
Mass wet + tare	183.3	191.9	190.1	205.5	300.7	285.4
Mass dry + tare	114.4	119.3	119	151.2	235.8	221.8
Mass water	68.9	72.6	71.1	54.3	64.9	63.6
Mass dry soil	105.8	110.7	110.5	144.4	227.5	213.5
Moisture %	65.1%	65.6%	64.3%	37.6%	28.5%	29.8%

Test Hole	TH21-30	TH21-30	TH21-30	TH21-30	TH21-30	TH21-30
Depth (m)	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5	7.0 - 7.2	8.5 - 8.7	9.9 - 10.1
Sample #	G39	G40	G41	G42	G43	G44
Tare ID	K22	H73	W65	F130	E29	N83
Mass of tare	8.5	8.5	8.5	8.6	8.7	8.7
Mass wet + tare	239.1	231.4	463.7	246.7	273.1	254.2
Mass dry + tare	181.4	169.8	333.2	177	219.8	157.6
Mass water	57.7	61.6	130.5	69.7	53.3	96.6
Mass dry soil	172.9	161.3	324.7	168.4	211.1	148.9
Moisture %	33.4%	38.2%	40.2%	41.4%	25.2%	64.9%

Test Hole	TH21-30	TH21-31	TH21-31	TH21-31	TH21-31	TH21-31
Depth (m)	11.4 - 11.6	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0
Sample #	G45	G121	G122	G123	G124	G125
Tare ID	E125	N59	AB61	AC06	D45	F144
Mass of tare	8.2	8.4	6.6	6.7	8.5	8.7
Mass wet + tare	272.2	179.4	220	226.9	261	227.2
Mass dry + tare	172.4	134.2	175.3	175.8	197.5	165.6
Mass water	99.8	45.2	44.7	51.1	63.5	61.6
Mass dry soil	164.2	125.8	168.7	169.1	189.0	156.9
Moisture %	60.8%	35.9%	26.5%	30.2%	33.6%	39.3%

Moisture Content Report
ASTM D2216-10

Project No. 0105-032-00
Client Burns Maendel Consulting
Project Greenwald Colony Community Development

Sample Date 04-May-21
Test Date 17-May-21
Technician JSB

Test Hole	TH21-31	TH21-31	TH21-31	TH21-31	TH21-31	TH21-31
Depth (m)	5.5 - 5.6	6.9 - 7.0	7.9 - 8.1	8.5 - 8.7	9.9 - 10.1	11.4 - 11.6
Sample #	G126	G127	G128	G129	G130	G131
Tare ID	AA05	N98	AC40	Z96	E102	P85
Mass of tare	6.6	8.6	6.6	8.7	8.9	8.6
Mass wet + tare	225.6	242.8	263.7	232.2	186.4	157.9
Mass dry + tare	158.4	172.1	201.3	166.5	119.9	99.9
Mass water	67.2	70.7	62.4	65.7	66.5	58.0
Mass dry soil	151.8	163.5	194.7	157.8	111.0	91.3
Moisture %	44.3%	43.2%	32.0%	41.6%	59.9%	63.5%

Test Hole	TH21-32	TH21-32	TH21-32	TH21-32	TH21-32	TH21-32
Depth (m)	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4	3.8 - 4.0	5.3 - 5.5
Sample #	G107	G108	G109	G110	G111	G112
Tare ID	D11	Z73	F97	A17	Z21	N40
Mass of tare	8.8	8.6	8.6	8.6	8.5	8.4
Mass wet + tare	186.9	220.8	213.1	242.4	215.6	243.4
Mass dry + tare	133.4	174.4	167.3	185.6	156.6	176.4
Mass water	53.5	46.4	45.8	56.8	59.0	67.0
Mass dry soil	124.6	165.8	158.7	177.0	148.1	168.0
Moisture %	42.9%	28.0%	28.9%	32.1%	39.8%	39.9%

Test Hole	TH21-32	TH21-32	TH21-32	TH21-32	TH21-32	TH21-33
Depth (m)	6.9 - 7.0	8.4 - 8.5	9.9 - 10.1	11.4 - 11.6	0.0 - 0.2	0.6 - 0.8
Sample #	G113	G114	G115	G116	G88	G89
Tare ID	W42	F63	N23	W111	W28	N44
Mass of tare	8.5	8.6	8.7	8.5	8.6	8.7
Mass wet + tare	228.2	205.3	263.8	264.4	160.4	258.9
Mass dry + tare	159.5	129.4	162	167.5	122	208.4
Mass water	68.7	75.9	101.8	96.9	38.4	50.5
Mass dry soil	151.0	120.8	153.3	159.0	113.4	199.7
Moisture %	45.5%	62.8%	66.4%	60.9%	33.9%	25.3%

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No.	0105-032-00
Client	Burns Maendel Consulting
Project	Greenwald Colony Community Development
Sample Date	04-May-21
Test Date	17-May-21
Technician	JSB

Test Hole	TH21-33	TH21-33	TH21-33	TH21-33	TH21-33	TH21-33
Depth (m)	1.4 - 1.5	2.3 - 2.4	4.3 - 4.4	5.6 - 5.8	6.9 - 7.0	8.4 - 8.5
Sample #	G90	G91	G101	G102	G103	G104
Tare ID	D21	K33	F88	F23	W39	W16
Mass of tare	8.6	8.6	8.5	8.4	8.3	8.4
Mass wet + tare	252.1	202.3	243.9	246.8	194.6	197.4
Mass dry + tare	197.6	153.4	178.9	197.6	133.6	127
Mass water	54.5	48.9	65.0	49.2	61.0	70.4
Mass dry soil	189.0	144.8	170.4	189.2	125.3	118.6
Moisture %	28.8%	33.8%	38.1%	26.0%	48.7%	59.4%

Test Hole	TH21-33	TH21-33	TH21-34	TH21-34	TH21-34	TH21-34
Depth (m)	9.9 - 10.1	11.4 - 11.6	0.0 - 0.2	0.6 - 0.8	1.4 - 1.5	2.3 - 2.4
Sample #	G105	G106	G59	G60	G61	G62
Tare ID	AC07	P33	Z80	N28	D30	AA08
Mass of tare	6.8	8.5	8.5	8.3	8.4	6.7
Mass wet + tare	237.9	434.9	225	274	294.4	484.1
Mass dry + tare	145	275.9	169.4	214.4	229.4	365.8
Mass water	92.9	159.0	55.6	59.6	65.0	118.3
Mass dry soil	138.2	267.4	160.9	206.1	221.0	359.1
Moisture %	67.2%	59.5%	34.6%	28.9%	29.4%	32.9%

Test Hole	TH21-34	TH21-34	TH21-34	TH21-34	TH21-34	TH21-34
Depth (m)	3.8 - 4.0	5.6 - 5.8	6.9 - 7.0	8.4 - 8.5	9.9 - 10.1	11.3 - 11.4
Sample #	G63	G65	G66	G67	G68	G69
Tare ID	F86	H56	P33	E90	AA06	Z43
Mass of tare	8.4	8.5	8.5	8.5	6.8	8.4
Mass wet + tare	306.3	295.3	226.7	255	261.9	259.9
Mass dry + tare	228.2	207.8	177.8	162.4	170.8	168.6
Mass water	78.1	87.5	48.9	92.6	91.1	91.3
Mass dry soil	219.8	199.3	169.3	153.9	164.0	160.2
Moisture %	35.5%	43.9%	28.9%	60.2%	55.5%	57.0%

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

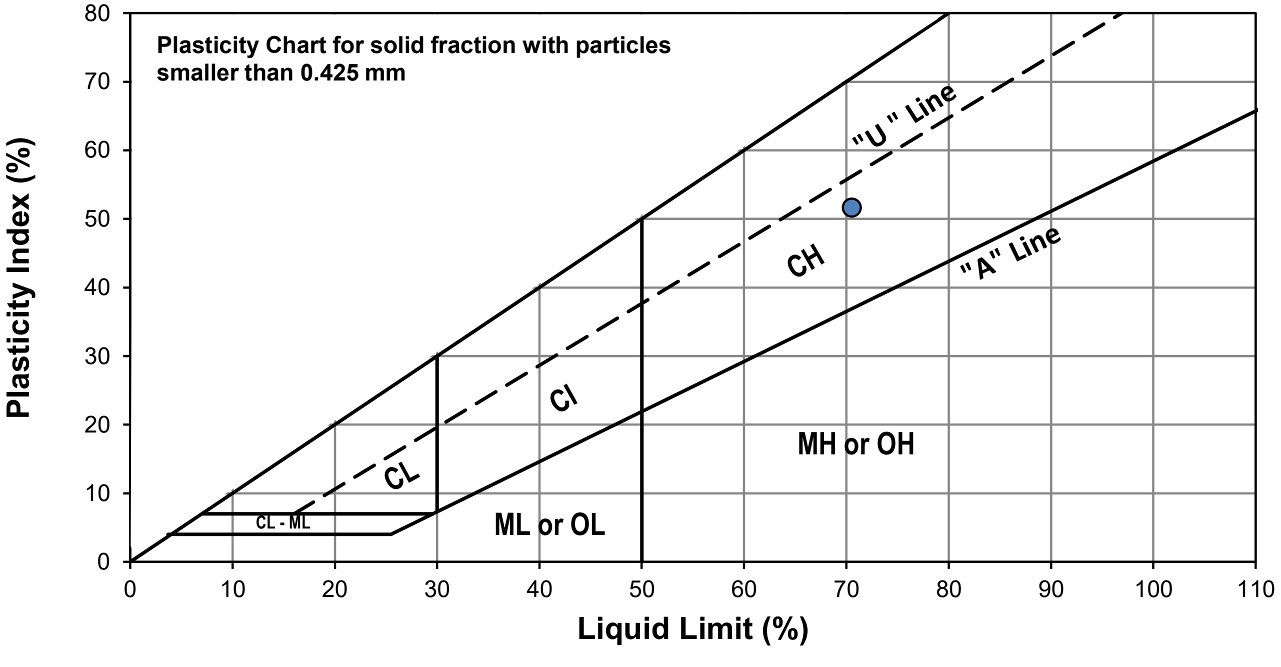
Atterberg Limits
ASTM D4318-10e1

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-30
Sample #	G41
Depth (m)	5.3 - 5.5
Sample Date	06-May-21
Test Date	23-May-21
Technician	JSB

Liquid Limit	71
Plastic Limit	19
Plasticity Index	52

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	17	24	35		
Mass Tare (g)	14.180	13.948	14.191		
Mass Wet Soil + Tare (g)	25.401	25.646	23.729		
Mass Dry Soil + Tare (g)	20.643	20.793	19.875		
Mass Water (g)	4.758	4.853	3.854		
Mass Dry Soil (g)	6.463	6.845	5.684		
Moisture Content (%)	73.619	70.898	67.804		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.128	13.965			
Mass Wet Soil + Tare (g)	22.264	21.134			
Mass Dry Soil + Tare (g)	20.976	19.987			
Mass Water (g)	1.288	1.147			
Mass Dry Soil (g)	6.848	6.022			
Moisture Content (%)	18.808	19.047			

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

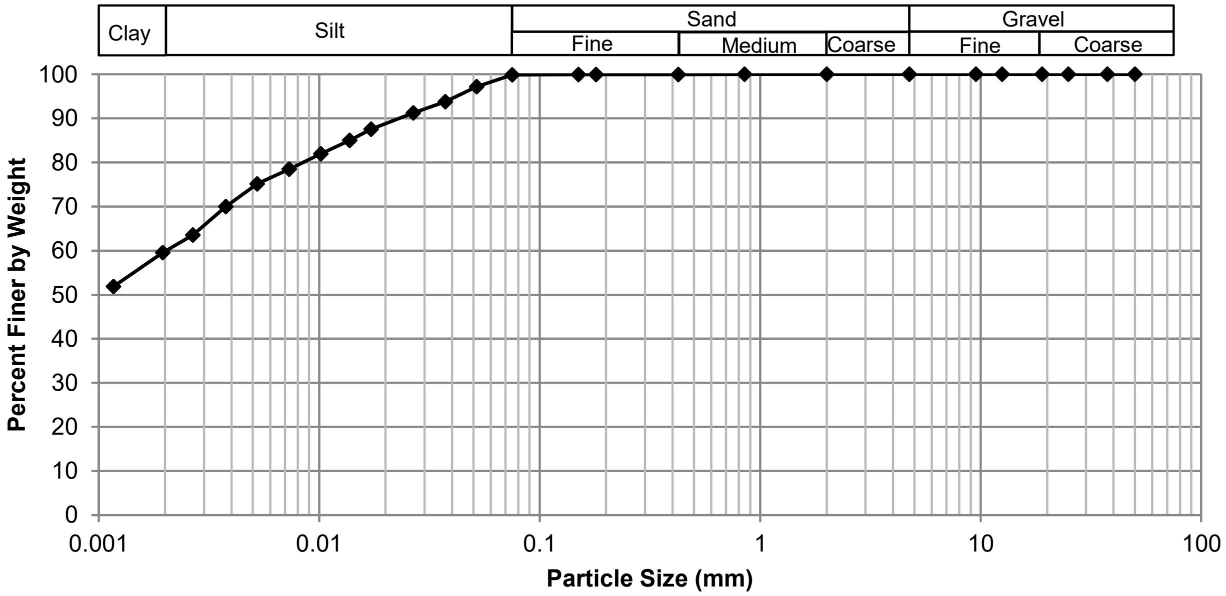
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-30
Sample #	G41
Depth (m)	5.3 - 5.5
Sample Date	6-May-21
Test Date	17-May-21
Technician	JSB

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

Gravel	0.0%
Sand	0.2%
Silt	40.0%
Clay	59.8%

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	100.00	0.0750	99.85
37.5	100.00	2.00	100.00	0.0518	97.21
25.0	100.00	0.850	99.99	0.0373	93.77
19.0	100.00	0.425	99.97	0.0267	91.27
12.5	100.00	0.180	99.93	0.0172	87.52
9.50	100.00	0.150	99.92	0.0138	85.02
4.75	100.00	0.075	99.85	0.0102	81.95
				0.0073	78.51
				0.0052	75.12
				0.0038	69.97
				0.0027	63.52
				0.0020	59.56
				0.0012	51.84

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

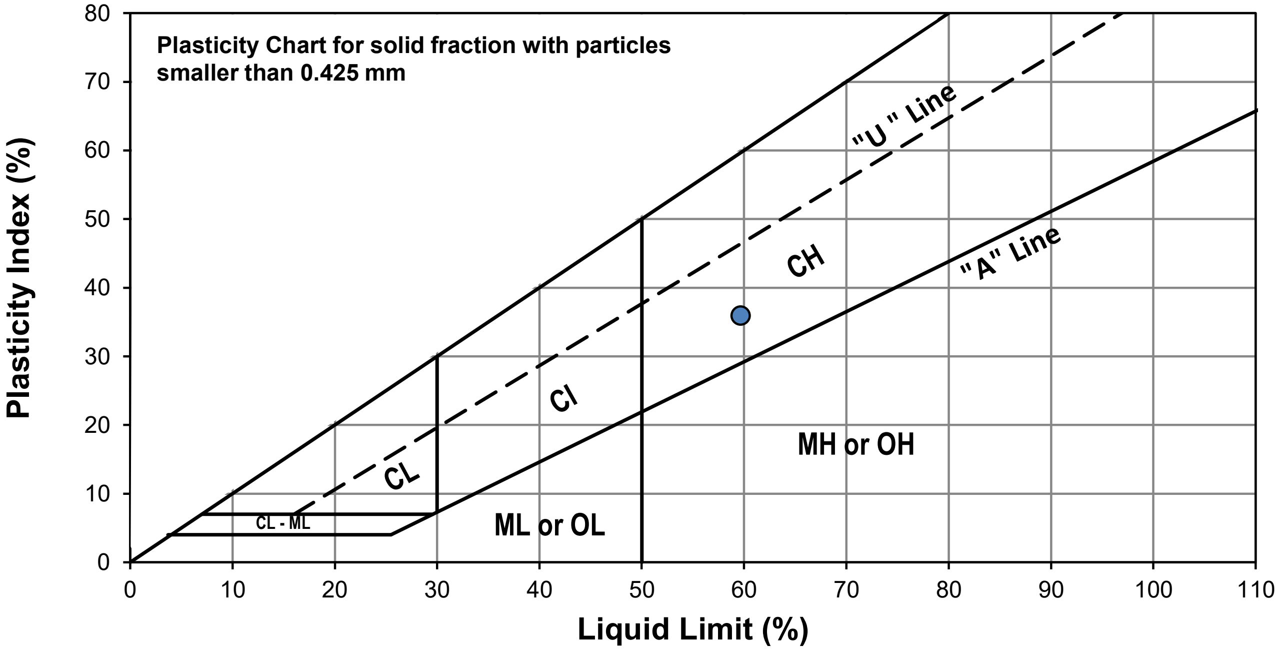
Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-34
Sample #	G62
Depth (m)	2.3 - 2.4
Sample Date	06-May-21
Test Date	20-May-21
Technician	JSB

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

Liquid Limit	60
Plastic Limit	24
Plasticity Index	36

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	16	26	32		
Mass Tare (g)	14.230	14.115	14.134		
Mass Wet Soil + Tare (g)	24.566	23.813	24.035		
Mass Dry Soil + Tare (g)	20.570	20.214	20.396		
Mass Water (g)	3.996	3.599	3.639		
Mass Dry Soil (g)	6.340	6.099	6.262		
Moisture Content (%)	63.028	59.010	58.112		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.208	13.929			
Mass Wet Soil + Tare (g)	23.152	22.390			
Mass Dry Soil + Tare (g)	21.427	20.772			
Mass Water (g)	1.725	1.618			
Mass Dry Soil (g)	7.219	6.843			
Moisture Content (%)	23.895	23.645			

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Grain Size Analysis (Hydrometer Method)
AASHTO T 88

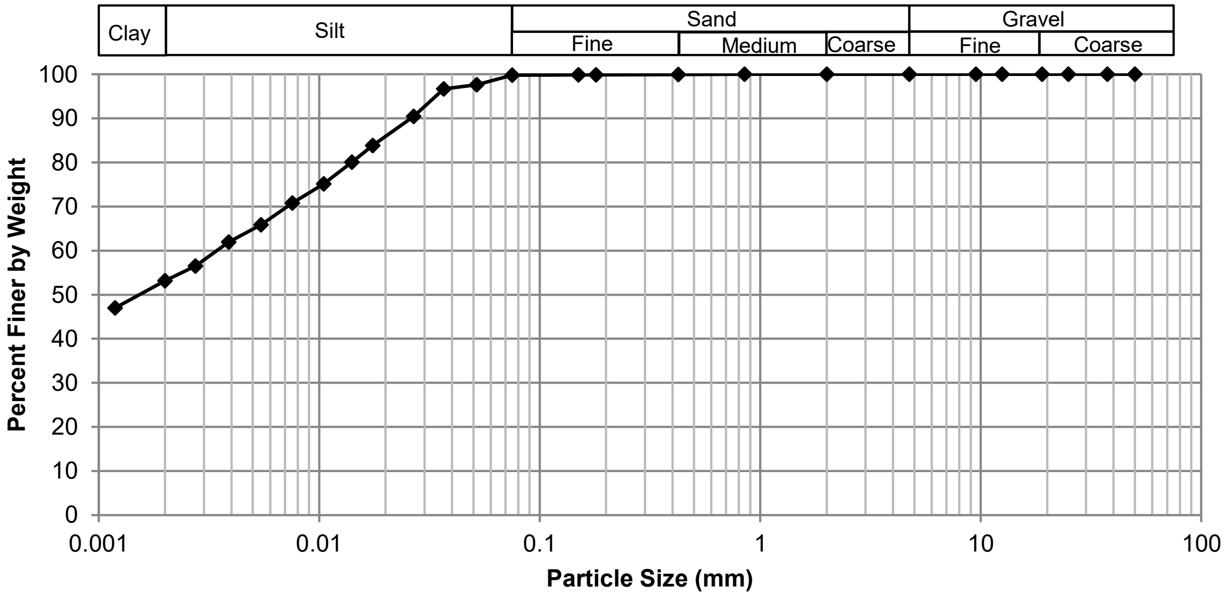
CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Test Hole TH21-34
Sample # G62
Depth (m) 2.3 - 2.4
Sample Date 6-May-21
Test Date 17-May-21
Technician JSB

Gravel	0.0%
Sand	0.2%
Silt	46.6%
Clay	53.2%

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	100.00	0.0750	99.77
37.5	100.00	2.00	100.00	0.0517	97.60
25.0	100.00	0.850	99.98	0.0367	96.66
19.0	100.00	0.425	99.95	0.0268	90.41
12.5	100.00	0.180	99.87	0.0175	83.84
9.50	100.00	0.150	99.86	0.0141	80.09
4.75	100.00	0.075	99.77	0.0105	75.15
				0.0076	70.78
				0.0054	65.84
				0.0039	61.97
				0.0027	56.47
				0.0020	53.16
				0.0012	46.96

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

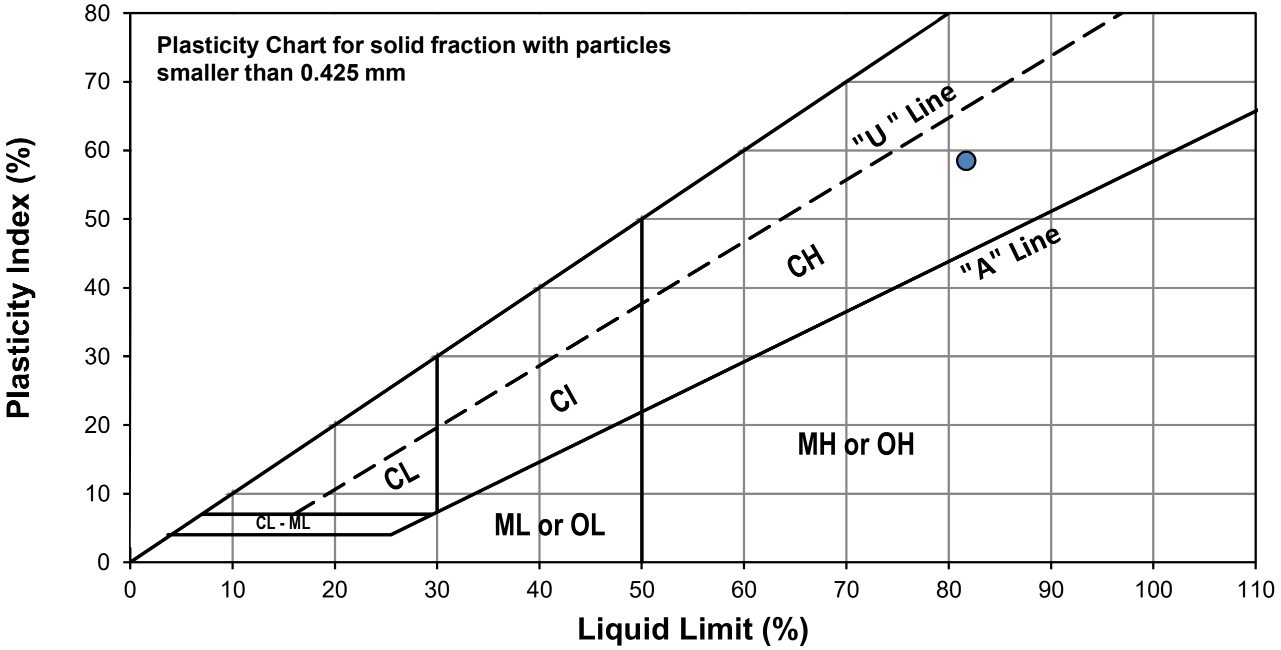
Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-33
Sample #	G106
Depth (m)	11.4 - 11.6
Sample Date	06-May-21
Test Date	23-May-21
Technician	JSB

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

Liquid Limit	82
Plastic Limit	23
Plasticity Index	58

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	18	27	35		
Mass Tare (g)	14.030	14.247	13.883		
Mass Wet Soil + Tare (g)	26.130	24.723	24.151		
Mass Dry Soil + Tare (g)	20.603	20.039	19.599		
Mass Water (g)	5.527	4.684	4.552		
Mass Dry Soil (g)	6.573	5.792	5.716		
Moisture Content (%)	84.086	80.870	79.636		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.120	13.889			
Mass Wet Soil + Tare (g)	21.829	20.160			
Mass Dry Soil + Tare (g)	20.378	18.973			
Mass Water (g)	1.451	1.187			
Mass Dry Soil (g)	6.258	5.084			
Moisture Content (%)	23.186	23.348			

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

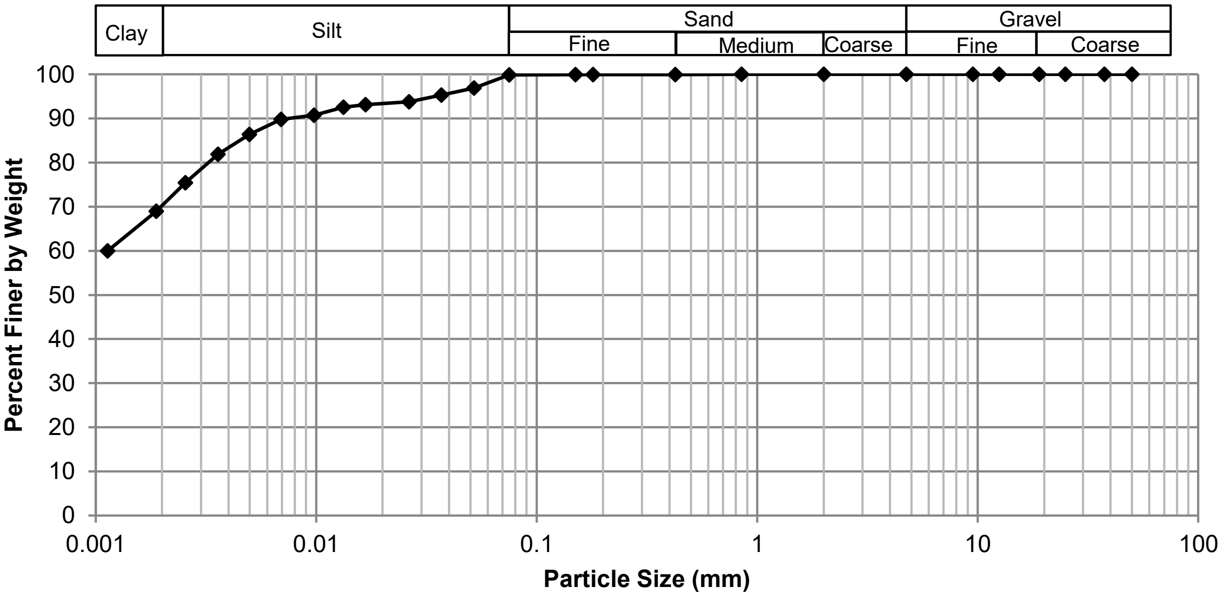
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-33
Sample #	G106
Depth (m)	11.4 - 11.6
Sample Date	6-May-21
Test Date	17-May-21
Technician	JSB

Gravel	0.0%
Sand	0.2%
Silt	29.8%
Clay	70.1%

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	100.00	0.0750	99.85
37.5	100.00	2.00	100.00	0.0519	96.90
25.0	100.00	0.850	99.98	0.0370	95.34
19.0	100.00	0.425	99.97	0.0264	93.77
12.5	100.00	0.180	99.94	0.0167	93.15
9.50	100.00	0.150	99.93	0.0133	92.52
4.75	100.00	0.075	99.85	0.0098	90.70
				0.0069	89.76
				0.0050	86.38
				0.0036	81.86
				0.0025	75.40
				0.0019	68.94
				0.0011	59.97

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

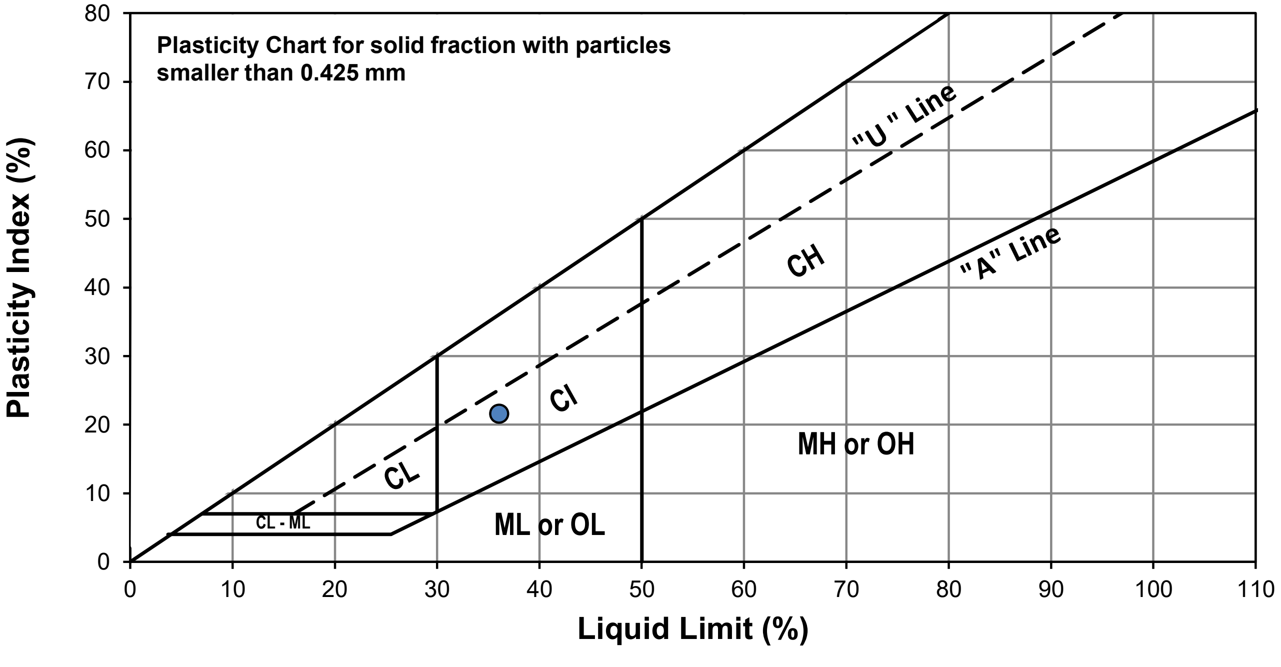
Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Test Hole TH21-23
Sample # G205
Depth (m) 8.8 - 9.0
Sample Date 06-May-21
Test Date 23-May-21
Technician JSB

Liquid Limit	36
Plastic Limit	14
Plasticity Index	22

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	19	26	33		
Mass Tare (g)	14.339	14.106	14.122		
Mass Wet Soil + Tare (g)	26.724	26.214	26.907		
Mass Dry Soil + Tare (g)	23.373	22.999	23.610		
Mass Water (g)	3.351	3.215	3.297		
Mass Dry Soil (g)	9.034	8.893	9.488		
Moisture Content (%)	37.093	36.152	34.749		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.037	14.223			
Mass Wet Soil + Tare (g)	22.814	22.416			
Mass Dry Soil + Tare (g)	21.692	21.389			
Mass Water (g)	1.122	1.027			
Mass Dry Soil (g)	7.655	7.166			
Moisture Content (%)	14.657	14.332			

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

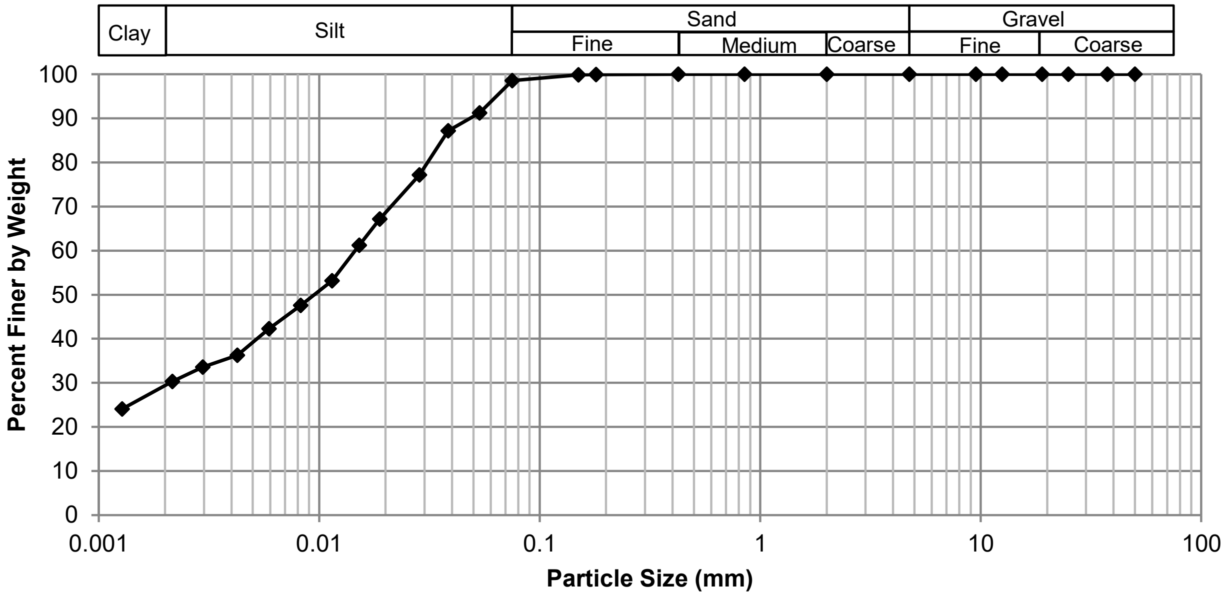
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-23
Sample #	G205
Depth (m)	8.8 - 9.0
Sample Date	6-May-21
Test Date	17-May-21
Technician	JSB

Gravel	0.0%
Sand	1.4%
Silt	69.4%
Clay	29.2%

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	100.00	0.0750	98.58
37.5	100.00	2.00	100.00	0.0534	91.24
25.0	100.00	0.850	99.99	0.0385	87.17
19.0	100.00	0.425	99.98	0.0285	77.17
12.5	100.00	0.180	99.93	0.0188	67.16
9.50	100.00	0.150	99.90	0.0152	61.22
4.75	100.00	0.075	98.58	0.0114	53.17
				0.0082	47.54
				0.0059	42.30
				0.0043	36.27
				0.0030	33.60
				0.0022	30.31
				0.0013	24.07

Atterberg Limits
ASTM D4318-10e1

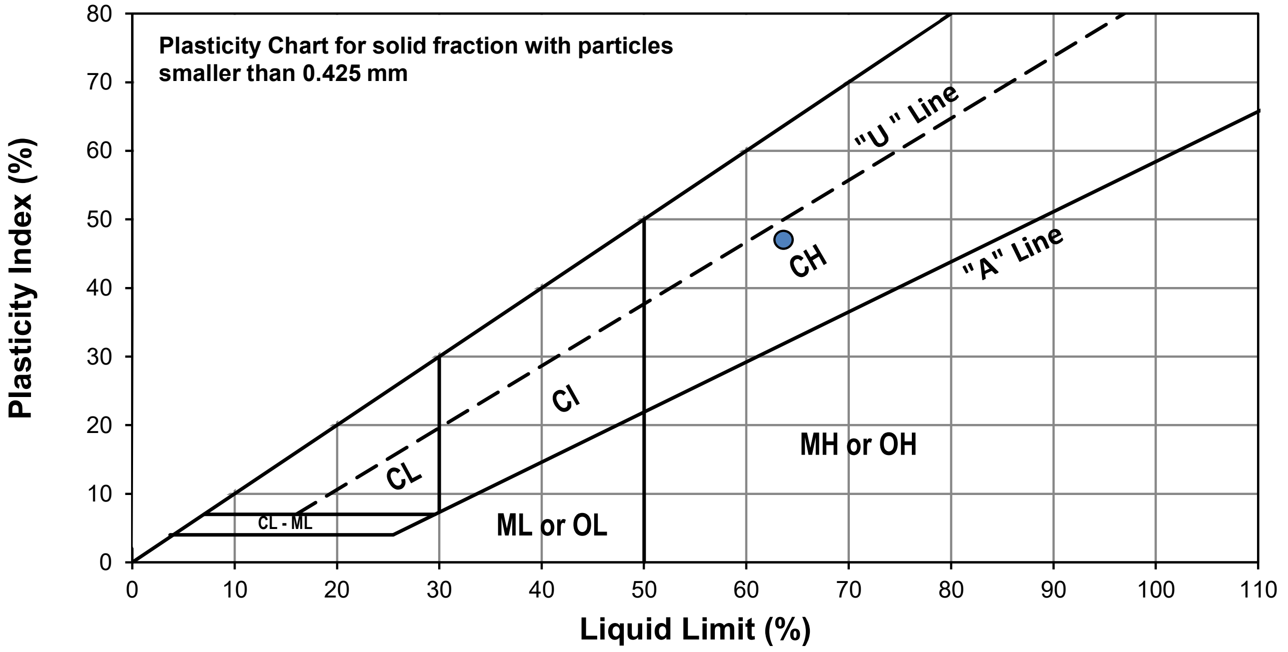
Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-15
Sample #	G266
Depth (m)	1.4 - 1.5
Sample Date	06-May-21
Test Date	23-May-21
Technician	JSB

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

Liquid Limit	64
Plastic Limit	17
Plasticity Index	47

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	16	21	29		
Mass Tare (g)	14.108	14.084	14.122		
Mass Wet Soil + Tare (g)	27.438	25.765	25.883		
Mass Dry Soil + Tare (g)	22.091	21.143	21.371		
Mass Water (g)	5.347	4.622	4.512		
Mass Dry Soil (g)	7.983	7.059	7.249		
Moisture Content (%)	66.980	65.477	62.243		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.234	13.915			
Mass Wet Soil + Tare (g)	25.250	22.278			
Mass Dry Soil + Tare (g)	23.653	21.103			
Mass Water (g)	1.597	1.175			
Mass Dry Soil (g)	9.419	7.188			
Moisture Content (%)	16.955	16.347			

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

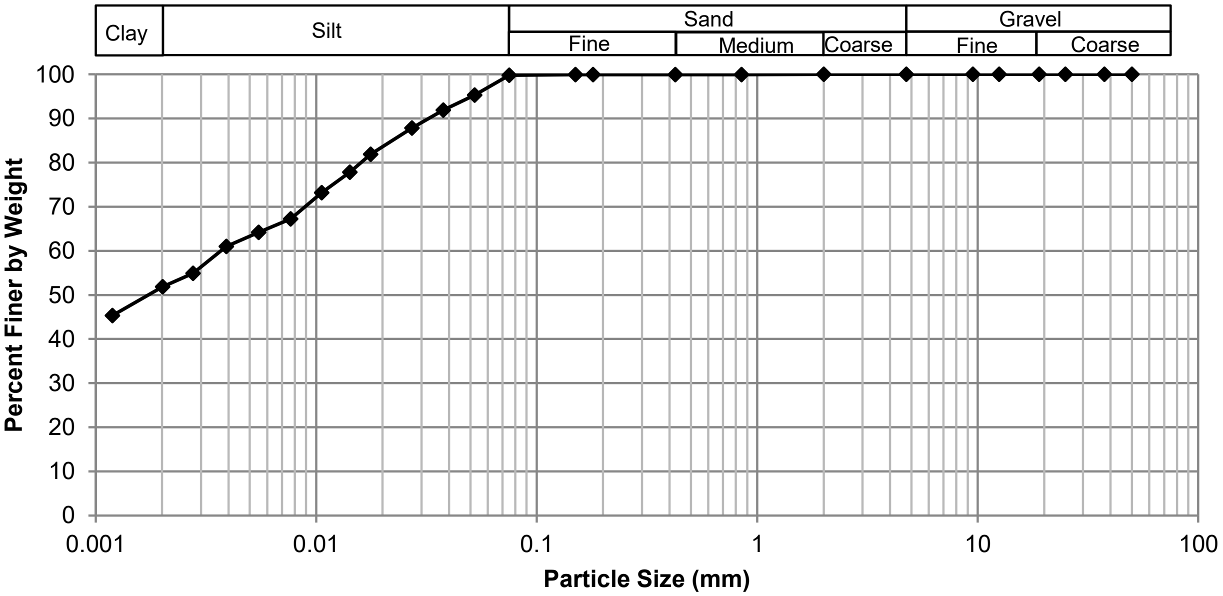
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-15
Sample #	G266
Depth (m)	1.4 - 1.5
Sample Date	6-May-21
Test Date	17-May-21
Technician	JSB

Gravel	0.0%
Sand	0.2%
Silt	48.0%
Clay	51.8%

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	100.00	0.0750	99.83
37.5	100.00	2.00	100.00	0.0523	95.30
25.0	100.00	0.850	99.98	0.0377	91.86
19.0	100.00	0.425	99.97	0.0272	87.80
12.5	100.00	0.180	99.94	0.0177	81.86
9.50	100.00	0.150	99.92	0.0142	77.79
4.75	100.00	0.075	99.83	0.0106	73.18
				0.0077	67.24
				0.0055	64.19
				0.0039	60.97
				0.0028	54.86
				0.0020	51.89
				0.0012	45.34

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-10e1

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

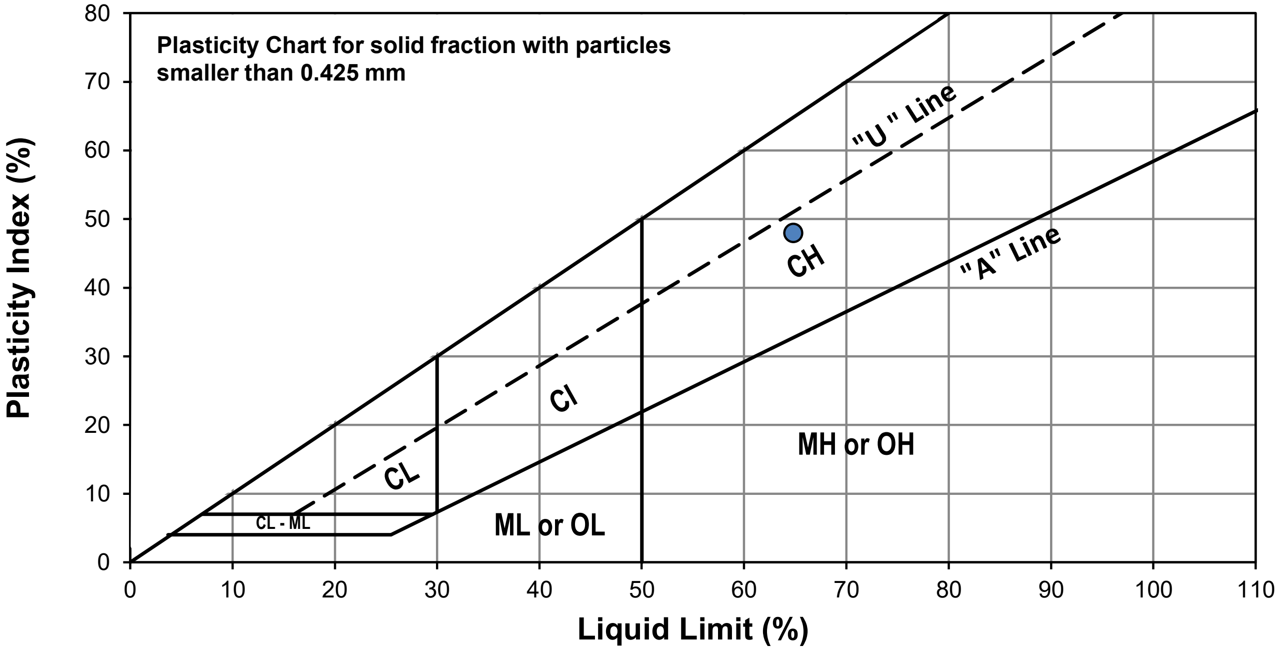
Test Hole TH21-20
Sample # T228
Depth (m) 6.1 - 6.7
Sample Date 06-May-21
Test Date 20-May-21
Technician JSB

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

Liquid Limit	65
Plastic Limit	17
Plasticity Index	48

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	17	26	35		
Mass Tare (g)	13.990	14.018	13.953		
Mass Wet Soil + Tare (g)	23.200	29.873	22.732		
Mass Dry Soil + Tare (g)	19.475	23.693	19.347		
Mass Water (g)	3.725	6.180	3.385		
Mass Dry Soil (g)	5.485	9.675	5.394		
Moisture Content (%)	67.912	63.876	62.755		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	13.890	13.680			
Mass Wet Soil + Tare (g)	21.899	20.951			
Mass Dry Soil + Tare (g)	20.753	19.893			
Mass Water (g)	1.146	1.058			
Mass Dry Soil (g)	6.863	6.213			
Moisture Content (%)	16.698	17.029			

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

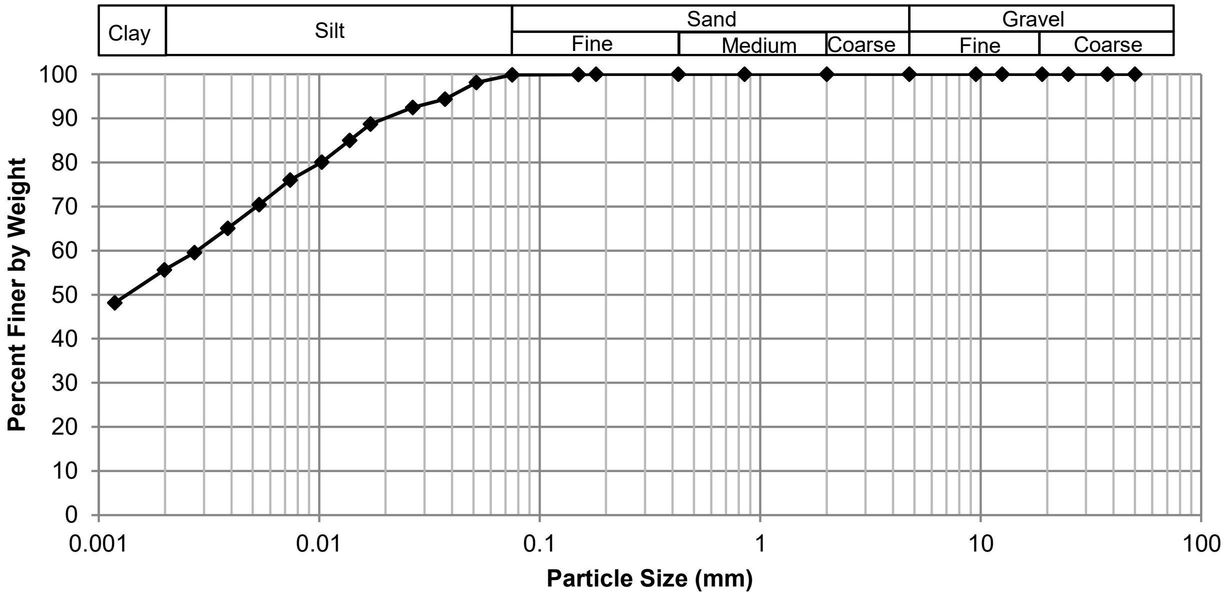
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-20
Sample #	T228
Depth (m)	6.1 - 6.7
Sample Date	6-May-21
Test Date	17-May-21
Technician	JSB

Gravel	0.0%
Sand	0.1%
Silt	44.2%
Clay	55.7%

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	100.00	0.0750	99.89
37.5	100.00	2.00	100.00	0.0516	98.12
25.0	100.00	0.850	100.00	0.0372	94.37
19.0	100.00	0.425	100.00	0.0265	92.49
12.5	100.00	0.180	99.98	0.0171	88.74
9.50	100.00	0.150	99.98	0.0138	84.99
4.75	100.00	0.075	99.89	0.0103	80.06
				0.0074	75.99
				0.0053	70.44
				0.0038	65.03
				0.0027	59.55
				0.0020	55.64
				0.0012	48.15

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

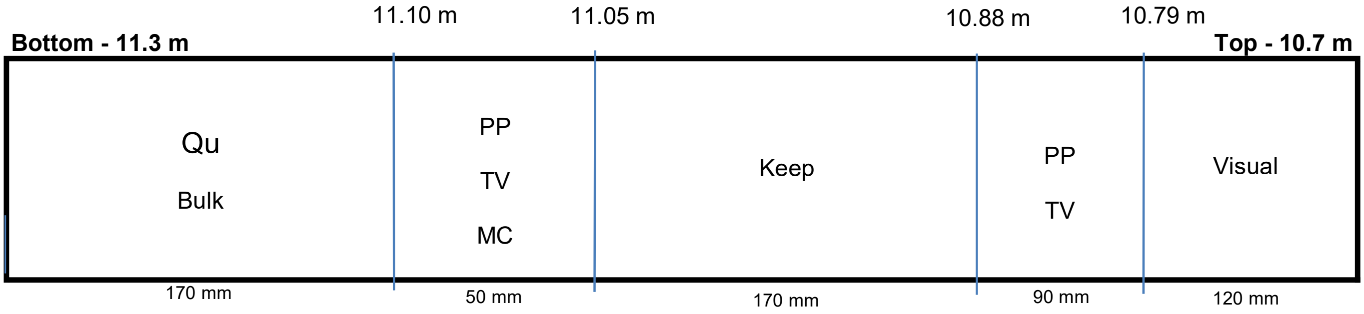
Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-29
Sample #	T17
Depth (m)	10.7 - 11.3
Sample Date	04-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 600



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<10 mm diam.)

Color	grey
Moisture	moist
Consistency	soft to firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.30
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	29.4

Pocket Penetrometer

Reading	**1**	0.40
	2	0.40
	3	0.50
	Average	0.43
Undrained Shear Strength (kPa)		21.2

Moisture Content

Tare ID	H78
Mass tare (g)	8.4
Mass wet + tare (g)	318.4
Mass dry + tare (g)	192
Moisture %	68.8%

Unit Weight

Bulk Weight (g)		957.8
Length (mm)	**1**	145.74
	2	145.80
	3	146.58
	4	146.67
Average Length (m)		0.146
Diam. (mm)	**1**	71.46
	2	71.37
	3	71.54
	4	71.95
Average Diameter (m)		0.072
Volume (m^3)		5.88E-04
Bulk Unit Weight (kN/m^3)		16.0
Bulk Unit Weight (pcf)		101.6
Dry Unit Weight (kN/m^3)		9.5
Dry Unit Weight (pcf)		60.2

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-29
Sample #	T17
Depth (m)	10.7 - 11.3
Sample Date	4-May-21
Test Date	23-May-21
Technician	JSB

Unconfined Strength

	kPa	ksf
Max q_u	47.7	1.0
Max S_u	23.9	0.5

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), grey, moist, soft to firm, high plasticity

Length	146.2	(mm)
Diameter	71.6	(mm)
L/D Ratio	2.0	
Initial Area	0.00402	(m^2)
Load Rate	1.00	(%/min)

Moisture %	69%	
Bulk Unit Wt.	16.0	(kN/m^3)
Dry Unit Wt.	9.5	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.30	29.4	0.61
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.40	19.6	0.41
	0.40	19.6	0.41
	0.50	24.5	0.51
Average	**0.43**	**21.3**	**0.44**

Failure Geometry

Sketch:

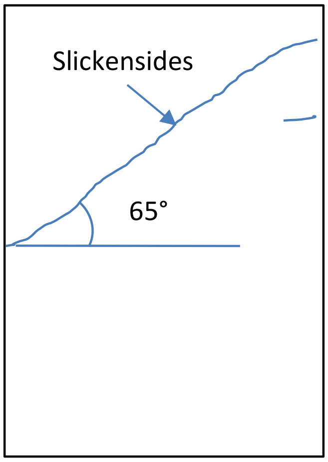
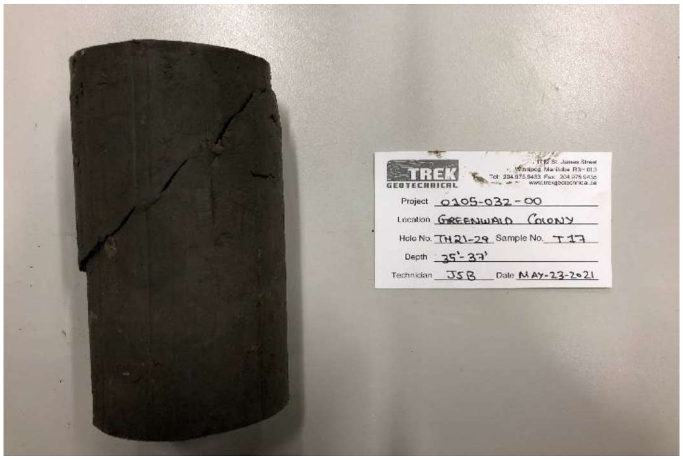


Photo:

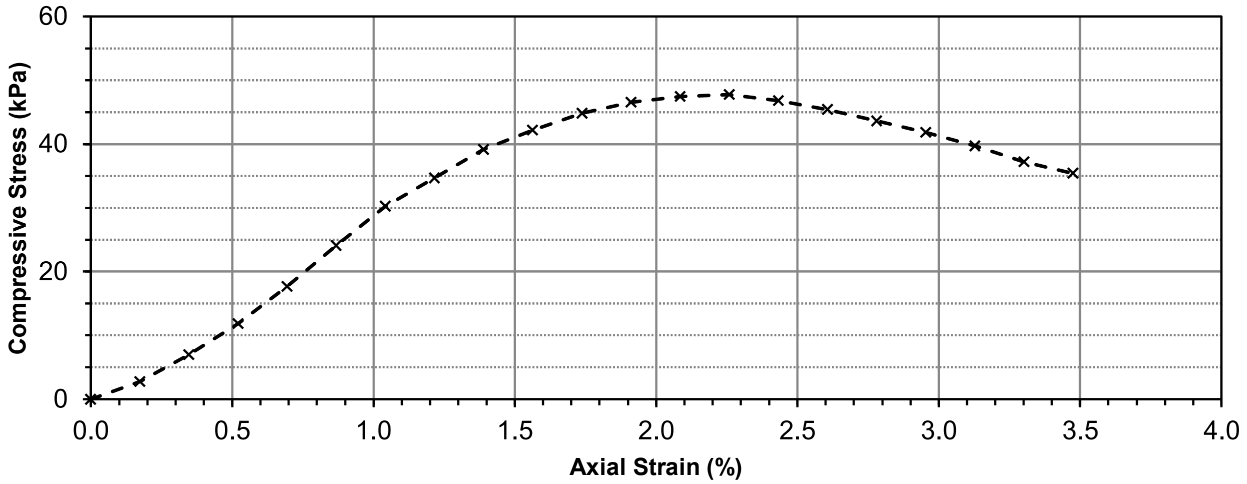


Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.10	0.0000	0.00	0.004024	0.0	0.00	0.00
10	0.12	0.2540	0.17	0.004031	11.1	2.75	1.38
20	0.46	0.5080	0.35	0.004038	28.2	6.99	3.49
30	0.85	0.7620	0.52	0.004045	47.9	11.84	5.92
40	1.32	1.0160	0.69	0.004052	71.6	17.66	8.83
50	1.84	1.2700	0.87	0.004059	97.8	24.09	12.04
60	2.34	1.5240	1.04	0.004067	123.0	30.24	15.12
70	2.70	1.7780	1.22	0.004074	141.1	34.64	17.32
80	3.07	2.0320	1.39	0.004081	159.8	39.15	19.58
90	3.32	2.2860	1.56	0.004088	172.4	42.17	21.08
100	3.54	2.5400	1.74	0.004095	183.5	44.80	22.40
110	3.69	2.7940	1.91	0.004103	191.0	46.56	23.28
120	3.77	3.0480	2.08	0.004110	195.1	47.46	23.73
130	3.80	3.3020	2.26	0.004117	196.6	47.74	23.87
140	3.73	3.5560	2.43	0.004124	193.0	46.80	23.40
150	3.62	3.8100	2.61	0.004132	187.5	45.38	22.69
160	3.48	4.0640	2.78	0.004139	180.4	43.59	21.80
170	3.34	4.3180	2.95	0.004147	173.4	41.81	20.91
180	3.17	4.5720	3.13	0.004154	164.8	39.68	19.84
190	2.97	4.8260	3.30	0.004162	154.7	37.18	18.59
200	2.83	5.0800	3.47	0.004169	147.7	35.42	17.71

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-28
Sample #	T29
Depth (m)	9.1 - 9.8
Sample Date	04-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 700 (overpush)

9.67 m 9.57 m 9.48 m 9.33 m 9.21 m

Bottom - 9.8 m **Top - 9.1 m**

Qu Bulk	Visual	PP TV	TV/PP Moisture Content Visual	Keep	Slough
170 mm	100 mm	90 mm	150 mm	120 mm	70 mm

Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<10 mm diam.)

Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.32
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	31.4

Pocket Penetrometer

Reading	**1**	0.40
	2	1.00
	3	0.40
	Average	0.60
Undrained Shear Strength (kPa)		29.4

Moisture Content

Tare ID	F42
Mass tare (g)	8.4
Mass wet + tare (g)	378.6
Mass dry + tare (g)	239.9
Moisture %	59.9%

Unit Weight

Bulk Weight (g)		904.8
Length (mm)	**1**	143.43
	2	143.51
	3	144.32
	4	142.60
Average Length (m)		0.143
Diam. (mm)	**1**	71.13
	2	70.10
	3	71.61
	4	70.93
Average Diameter (m)		0.071
Volume (m^3)		5.67E-04
Bulk Unit Weight (kN/m^3)		15.6
Bulk Unit Weight (pcf)		99.6
Dry Unit Weight (kN/m^3)		9.8
Dry Unit Weight (pcf)		62.3

Unconfined Compressive Strength

ASTM D2166

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-28
Sample #	T29
Depth (m)	9.1 - 9.8
Sample Date	4-May-21
Test Date	23-May-21
Technician	JSB

Unconfined Strength

	kPa	ksf
Max q_u	51.1	1.1
Max S_u	25.5	0.5

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), grey, moist, firm, high plasticity

Length	143.5	(mm)	**Moisture %**	60%	
Diameter	70.9	(mm)	**Bulk Unit Wt.**	15.6	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	9.8	(kN/m^3)
Initial Area	0.00395	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.32	31.4	0.66
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.40	19.6	0.41
	1.00	49.1	1.02
	0.40	19.6	0.41
Average	**0.60**	**29.4**	**0.61**

Failure Geometry

Sketch:

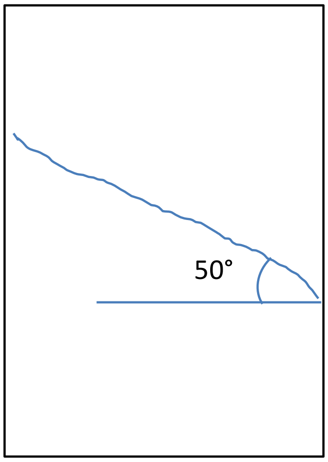
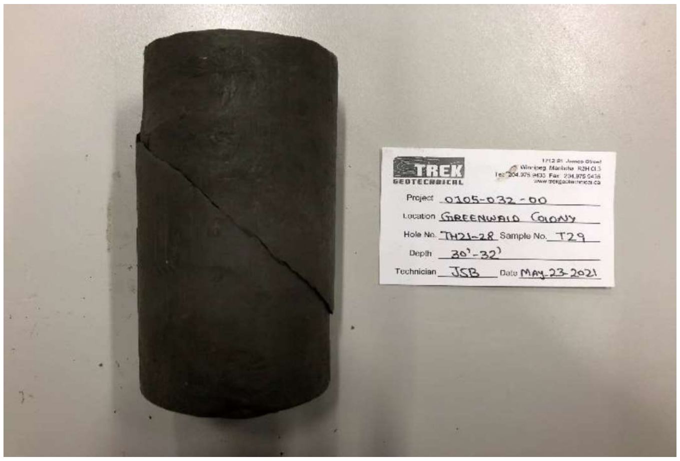


Photo:



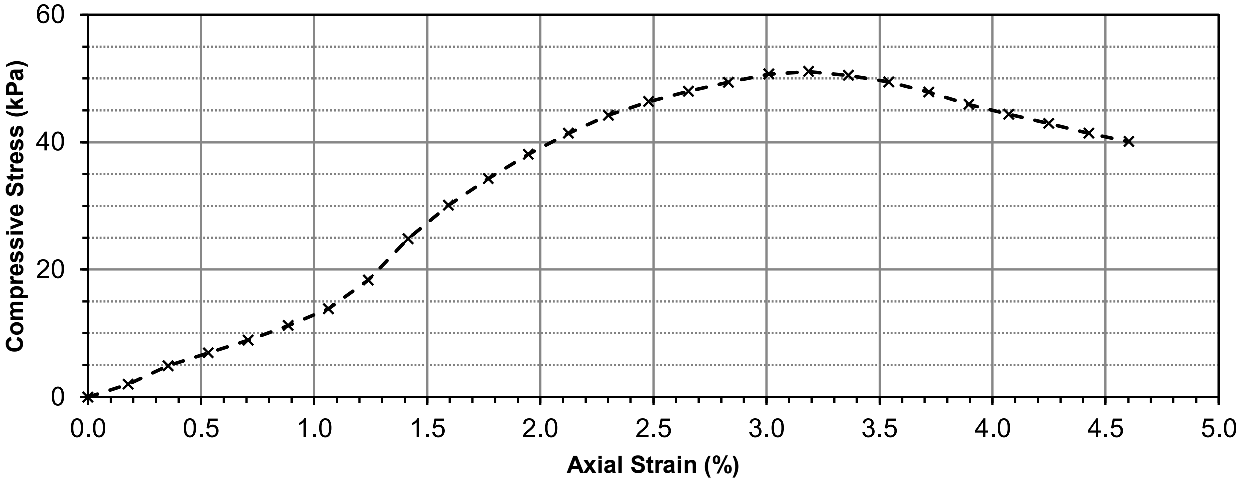
Project 0105-032-00
Location GREENWALD COLONY
Hole No. TH21-28 Sample No. T29
Depth 30'-32'
Technician JSB Date MAY-23-2021

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.01	0.0000	0.00	0.003953	0.0	0.00	0.00
10	0.15	0.2540	0.18	0.003960	7.9	2.00	1.00
20	0.38	0.5080	0.35	0.003967	19.5	4.92	2.46
30	0.54	0.7620	0.53	0.003974	27.6	6.94	3.47
40	0.70	1.0160	0.71	0.003981	35.6	8.95	4.48
50	0.88	1.2700	0.89	0.003988	44.7	11.21	5.61
60	1.09	1.5240	1.06	0.003995	55.3	13.84	6.92
70	1.45	1.7780	1.24	0.004002	73.4	18.35	9.17
80	1.97	2.0320	1.42	0.004010	99.6	24.85	12.43
90	2.39	2.2860	1.59	0.004017	120.8	30.08	15.04
100	2.73	2.5400	1.77	0.004024	138.0	34.28	17.14
110	3.04	2.7940	1.95	0.004031	153.6	38.10	19.05
120	3.31	3.0480	2.12	0.004039	167.2	41.40	20.70
130	3.54	3.3020	2.30	0.004046	178.8	44.19	22.09
140	3.72	3.5560	2.48	0.004053	187.9	46.35	23.17
150	3.86	3.8100	2.66	0.004061	194.9	48.00	24.00
160	3.98	4.0640	2.83	0.004068	201.0	49.40	24.70
170	4.09	4.3180	3.01	0.004075	206.5	50.67	25.33
180	4.13	4.5720	3.19	0.004083	208.5	51.07	25.54
190	4.09	4.8260	3.36	0.004090	206.5	50.48	25.24
200	4.01	5.0800	3.54	0.004098	202.5	49.41	24.70
210	3.89	5.3340	3.72	0.004105	196.4	47.84	23.92
220	3.74	5.5880	3.90	0.004113	188.9	45.92	22.96
230	3.62	5.8420	4.07	0.004121	182.8	44.37	22.18

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	3.51	6.0960	4.25	0.004128	177.3	42.94	21.47
250	3.39	6.3500	4.43	0.004136	171.2	41.40	20.70
260	3.29	6.6040	4.60	0.004144	166.2	40.11	20.05

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-30
Sample #	T46
Depth (m)	12.2 - 12.8
Sample Date	05-May-21
Test Date	24-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 690

Bottom - 12.8 m	12.71 m	12.54 m **Top - 12.1 m**
QU Bulk	Keep	Moisture Content PP/TV Visual
170 mm	170 mm	350 mm

Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<50 mm diam.)

Color	grey
Moisture	moist
Consistency	very soft to soft
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.15
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	14.7

Pocket Penetrometer

Reading	**1**	0.40
	2	0.20
	3	0.10
	Average	0.23
Undrained Shear Strength (kPa)		11.4

Moisture Content

Tare ID	W14
Mass tare (g)	8.4
Mass wet + tare (g)	497.6
Mass dry + tare (g)	388.6
Moisture %	28.7%

Unit Weight

Bulk Weight (g)		971.0
Length (mm)	**1**	147.50
	2	147.01
	3	147.03
	4	147.64
Average Length (m)		0.147
Diam. (mm)	**1**	70.93
	2	71.01
	3	70.53
	4	73.11
Average Diameter (m)		0.071
Volume (m^3)		5.90E-04
Bulk Unit Weight (kN/m^3)		16.1
Bulk Unit Weight (pcf)		102.8
Dry Unit Weight (kN/m^3)		12.6
Dry Unit Weight (pcf)		79.9

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Test Hole TH21-30
Sample # T46
Depth (m) 12.2 - 12.8
Sample Date 5-May-21
Test Date 24-May-21
Technician JSB

Unconfined Strength

	kPa	ksf
Max q_u	23.3	0.5
Max S_u	11.6	0.2

Specimen Data

Description CLAY - silty, trace silt inclusions (<50 mm diam.), grey, moist, very soft to soft, high plasticity

Length	147.3	(mm)	**Moisture %**	29%	
Diameter	71.4	(mm)	**Bulk Unit Wt.**	16.1	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	12.6	(kN/m^3)
Initial Area	0.00400	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.15	14.7	0.31
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.40	19.6	0.41
	0.20	9.8	0.20
	0.10	4.9	0.10
Average	**0.23**	**11.4**	**0.24**

Failure Geometry

Sketch:

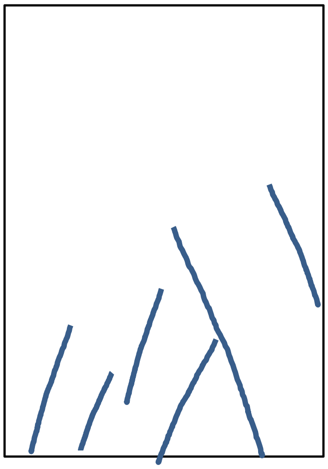
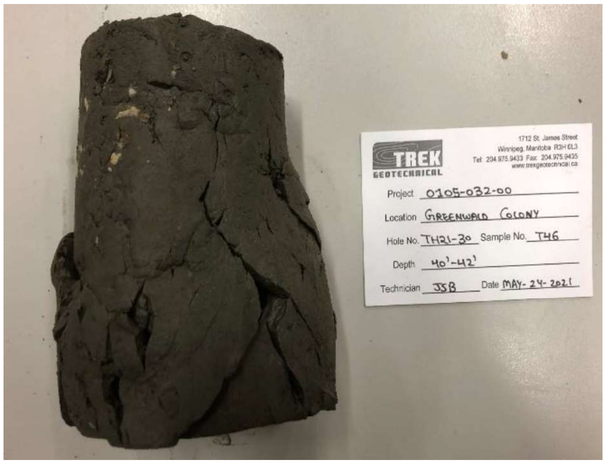


Photo:



1712 St. James Street
Winnipeg, Manitoba R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435
www.trekgeotechnical.ca

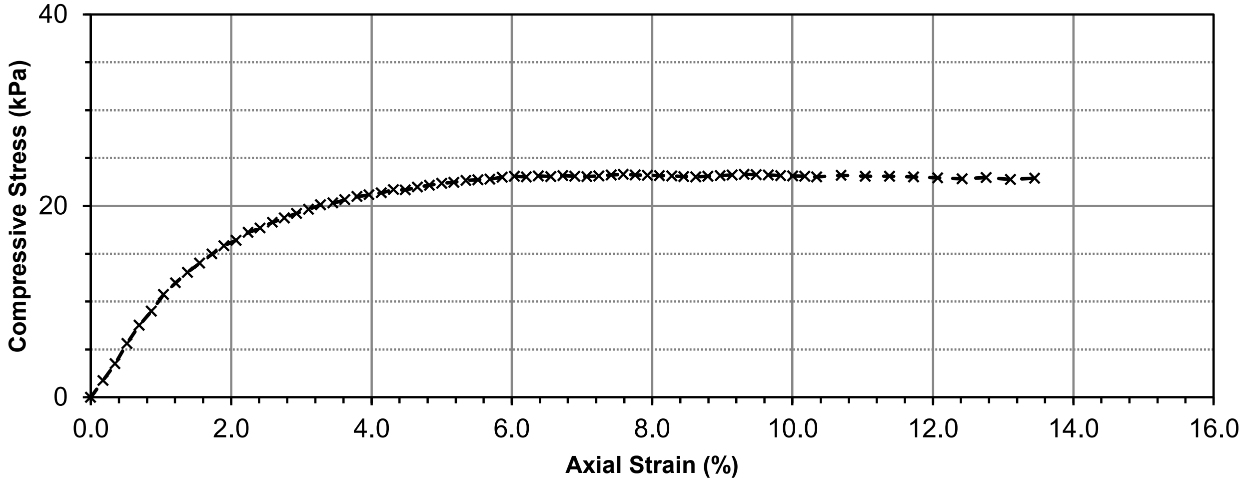
Project 0105-032-00
Location GREENWALD COLONY
Hole No. TH21-30 Sample No. T46
Depth 40'-42'
Technician JSB Date MAY-24-2021

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.09	0.0000	0.00	0.004003	0.0	0.00	0.00
10	0.05	0.2540	0.17	0.004010	7.1	1.76	0.88
20	0.19	0.5080	0.34	0.004017	14.1	3.51	1.76
30	0.36	0.7620	0.52	0.004024	22.7	5.64	2.82
40	0.51	1.0160	0.69	0.004031	30.2	7.50	3.75
50	0.63	1.2700	0.86	0.004038	36.3	8.99	4.49
60	0.77	1.5240	1.03	0.004045	43.3	10.72	5.36
70	0.87	1.7780	1.21	0.004052	48.4	11.94	5.97
80	0.96	2.0320	1.38	0.004059	52.9	13.04	6.52
90	1.04	2.2860	1.55	0.004066	57.0	14.01	7.00
100	1.12	2.5400	1.72	0.004074	61.0	14.97	7.49
110	1.19	2.7940	1.90	0.004081	64.5	15.81	7.90
120	1.24	3.0480	2.07	0.004088	67.0	16.40	8.20
130	1.31	3.3020	2.24	0.004095	70.6	17.23	8.62
140	1.35	3.5560	2.41	0.004102	72.6	17.69	8.85
150	1.40	3.8100	2.59	0.004110	75.1	18.27	9.14
160	1.44	4.0640	2.76	0.004117	77.1	18.73	9.37
170	1.48	4.3180	2.93	0.004124	79.1	19.19	9.59
180	1.52	4.5720	3.10	0.004132	81.1	19.64	9.82
190	1.56	4.8260	3.28	0.004139	83.2	20.09	10.05
200	1.58	5.0800	3.45	0.004146	84.2	20.30	10.15
210	1.61	5.3340	3.62	0.004154	85.7	20.63	10.31
220	1.64	5.5880	3.79	0.004161	87.2	20.95	10.48
230	1.66	5.8420	3.97	0.004169	88.2	21.16	10.58

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	1.68	6.0960	4.14	0.004176	89.2	21.36	10.68
250	1.71	6.3500	4.31	0.004184	90.7	21.69	10.84
260	1.71	6.6040	4.48	0.004191	90.7	21.65	10.82
270	1.74	6.8580	4.66	0.004199	92.2	21.97	10.98
280	1.76	7.1120	4.83	0.004206	93.2	22.17	11.08
290	1.78	7.3660	5.00	0.004214	94.3	22.37	11.18
300	1.79	7.6200	5.17	0.004222	94.8	22.44	11.22
310	1.81	7.8740	5.35	0.004229	95.8	22.64	11.32
320	1.82	8.1280	5.52	0.004237	96.3	22.72	11.36
330	1.83	8.3820	5.69	0.004245	96.8	22.80	11.40
340	1.85	8.6360	5.86	0.004253	97.8	22.99	11.50
350	1.86	8.8900	6.04	0.004261	98.3	23.07	11.53
360	1.86	9.1440	6.21	0.004268	98.3	23.03	11.51
370	1.87	9.3980	6.38	0.004276	98.8	23.10	11.55
380	1.87	9.6520	6.55	0.004284	98.8	23.06	11.53
390	1.88	9.9060	6.73	0.004292	99.3	23.13	11.57
400	1.88	10.1600	6.90	0.004300	99.3	23.09	11.55
410	1.88	10.4140	7.07	0.004308	99.3	23.05	11.52
420	1.89	10.6680	7.24	0.004316	99.8	23.12	11.56
430	1.90	10.9220	7.42	0.004324	100.3	23.20	11.60
440	1.91	11.1760	7.59	0.004332	100.8	23.27	11.63
450	1.91	11.4300	7.76	0.004340	100.8	23.23	11.61
460	1.91	11.6840	7.93	0.004348	100.8	23.18	11.59
470	1.91	11.9380	8.10	0.004356	100.8	23.14	11.57
480	1.91	12.1920	8.28	0.004365	100.8	23.10	11.55
490	1.91	12.4460	8.45	0.004373	100.8	23.05	11.53
500	1.91	12.7000	8.62	0.004381	100.8	23.01	11.50
510	1.92	12.9540	8.79	0.004389	101.3	23.08	11.54
520	1.93	13.2080	8.97	0.004398	101.8	23.15	11.58
530	1.94	13.4620	9.14	0.004406	102.3	23.22	11.61
540	1.95	13.7160	9.31	0.004414	102.8	23.29	11.65
550	1.95	13.9700	9.48	0.004423	102.8	23.25	11.62
560	1.95	14.2240	9.66	0.004431	102.8	23.20	11.60
570	1.95	14.4780	9.83	0.004440	102.8	23.16	11.58
580	1.95	14.7320	10.00	0.004448	102.8	23.12	11.56
590	1.95	14.9860	10.17	0.004457	102.8	23.07	11.54
600	1.95	15.2400	10.35	0.004465	102.8	23.03	11.51
620	1.97	15.7480	10.69	0.004483	103.8	23.16	11.58
640	1.97	16.2560	11.04	0.004500	103.8	23.07	11.54
660	1.98	16.7640	11.38	0.004518	104.3	23.10	11.55
680	1.98	17.2720	11.73	0.004535	104.3	23.01	11.50
700	1.98	17.7800	12.07	0.004553	104.3	22.92	11.46
720	1.98	18.2880	12.42	0.004571	104.3	22.83	11.41
740	2.00	18.7960	12.76	0.004589	105.3	22.96	11.48
760	1.99	19.3040	13.11	0.004607	104.8	22.76	11.38

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
780	2.01	19.8120	13.45	0.004626	105.8	22.88	11.44
800	2.01	20.3200	13.80	0.004644	105.8	22.79	11.40
820	2.02	20.8280	14.14	0.004663	106.4	22.81	11.40
840	2.02	21.3360	14.49	0.004681	106.4	22.72	11.36
860	2.02	21.8440	14.83	0.004700	106.4	22.63	11.31
880	2.02	22.3520	15.17	0.004720	106.4	22.53	11.27

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-34
Sample #	T64
Depth (m)	4.6 - 5.2
Sample Date	04-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 650

Bottom - 5.2 m **Top - 4.5 m**

	5.13 m	5.02 m	4.82 m
PP/TV Visual	Qu Bulk	Keep	Moisture Content Visual
100 mm	170 mm	170 mm	200 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<15 mm diam.)	
trace oxidation	
Color	brown
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)
Gradation	-

Torvane

Reading	0.85
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	83.4

Pocket Penetrometer

Reading	**1**	1.60
	2	1.70
	3	1.80
	Average	1.70
Undrained Shear Strength (kPa)		83.4

Moisture Content

Tare ID	C26
Mass tare (g)	8.4
Mass wet + tare (g)	520.8
Mass dry + tare (g)	384.5
Moisture %	36.2%

Unit Weight

Bulk Weight (g)		1120.2
Length (mm)	**1**	151.64
	2	151.48
	3	151.26
	4	151.40
Average Length (m)		0.151
Diam. (mm)	**1**	72.04
	2	71.33
	3	70.75
	4	71.70
Average Diameter (m)		0.071
Volume (m^3)		6.07E-04
Bulk Unit Weight (kN/m^3)		18.1
Bulk Unit Weight (pcf)		115.2
Dry Unit Weight (kN/m^3)		13.3
Dry Unit Weight (pcf)		84.5

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength
ASTM D2166

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-34
Sample #	T64
Depth (m)	4.6 - 5.2
Sample Date	4-May-21
Test Date	23-May-21
Technician	JSB

Unconfined Strength

	kPa	**ksf**
Max q_u	84.0	1.8
Max S_u	42.0	0.9

Specimen Data

Description CLAY - silty, trace silt inclusions (<15 mm diam.), trace oxidation, brown, moist, firm to stiff, high plasticity, stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)

Length	151.4	(mm)	**Moisture %**	36%	
Diameter	71.5	(mm)	**Bulk Unit Wt.**	18.1	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	13.3	(kN/m^3)
Initial Area	0.00401	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.85	83.4	1.74
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.60	78.5	1.64
	1.70	83.4	1.74
	1.80	88.3	1.84
Average	**1.70**	**83.4**	**1.74**

Failure Geometry

Sketch:

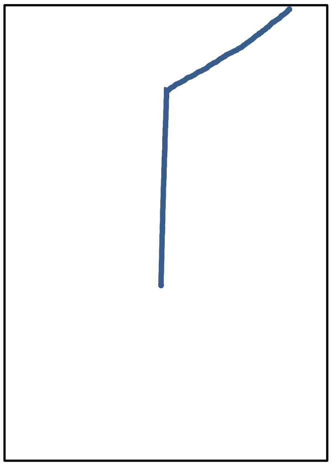
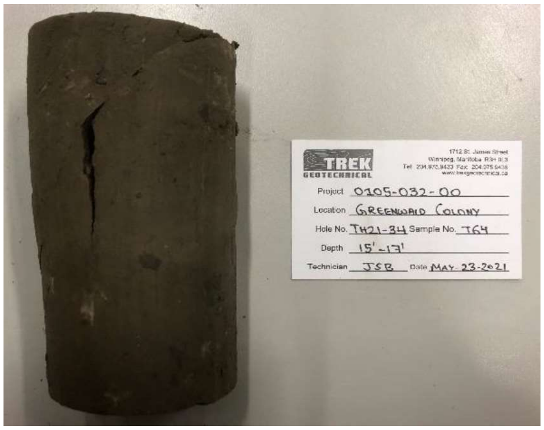


Photo:

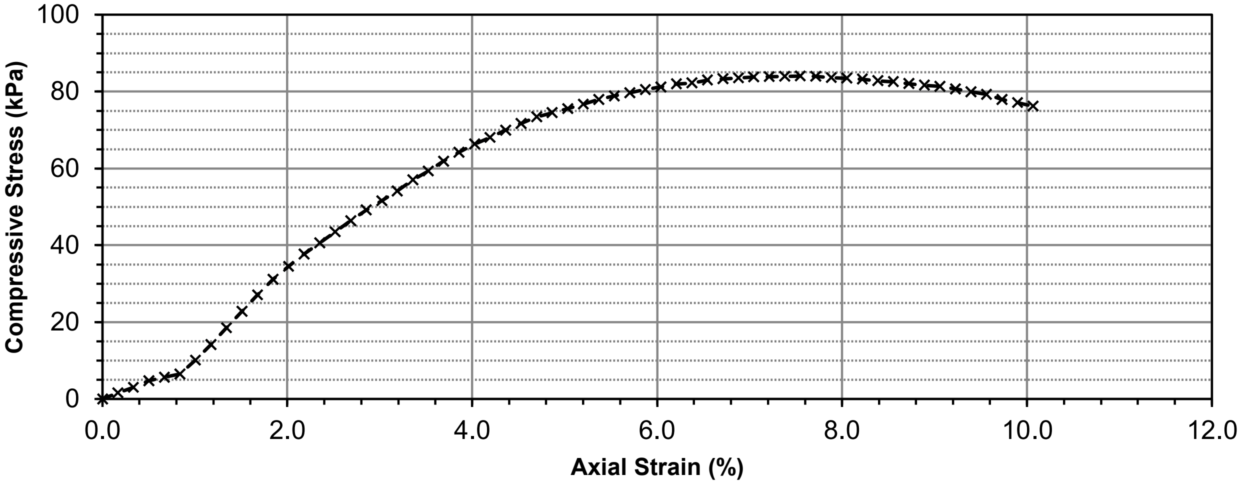


Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.13	0.0000	0.00	0.004010	0.0	0.00	0.00
10	0.00	0.2540	0.17	0.004017	6.6	1.63	0.82
20	0.11	0.5080	0.34	0.004024	12.1	3.01	1.50
30	0.25	0.7620	0.50	0.004030	19.2	4.75	2.38
40	0.32	1.0160	0.67	0.004037	22.7	5.62	2.81
50	0.39	1.2700	0.84	0.004044	26.2	6.48	3.24
60	0.68	1.5240	1.01	0.004051	40.8	10.08	5.04
70	1.01	1.7780	1.17	0.004058	57.5	14.16	7.08
80	1.36	2.0320	1.34	0.004065	75.1	18.48	9.24
90	1.71	2.2860	1.51	0.004072	92.7	22.78	11.39
100	2.06	2.5400	1.68	0.004079	110.4	27.06	13.53
110	2.39	2.7940	1.84	0.004085	127.0	31.09	15.54
120	2.67	3.0480	2.01	0.004092	141.1	34.48	17.24
130	2.94	3.3020	2.18	0.004099	154.7	37.75	18.87
140	3.18	3.5560	2.35	0.004107	166.8	40.63	20.31
150	3.42	3.8100	2.52	0.004114	178.9	43.50	21.75
160	3.66	4.0640	2.68	0.004121	191.0	46.36	23.18
170	3.90	4.3180	2.85	0.004128	203.1	49.21	24.60
180	4.10	4.5720	3.02	0.004135	213.2	51.56	25.78
190	4.32	4.8260	3.19	0.004142	224.3	54.15	27.07
200	4.56	5.0800	3.35	0.004149	236.4	56.97	28.49
210	4.76	5.3340	3.52	0.004156	246.5	59.30	29.65
220	4.98	5.5880	3.69	0.004164	257.6	61.86	30.93
230	5.18	5.8420	3.86	0.004171	267.6	64.17	32.08

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.37	6.0960	4.03	0.004178	277.2	66.35	33.17
250	5.52	6.3500	4.19	0.004186	284.8	68.04	34.02
260	5.69	6.6040	4.36	0.004193	293.3	69.96	34.98
270	5.84	6.8580	4.53	0.004200	300.9	71.64	35.82
280	6.00	7.1120	4.70	0.004208	309.0	73.43	36.71
290	6.10	7.3660	4.86	0.004215	314.0	74.50	37.25
300	6.20	7.6200	5.03	0.004223	319.1	75.56	37.78
310	6.31	7.8740	5.20	0.004230	324.6	76.74	38.37
320	6.42	8.1280	5.37	0.004238	330.1	77.91	38.95
330	6.51	8.3820	5.53	0.004245	334.7	78.84	39.42
340	6.59	8.6360	5.70	0.004253	338.7	79.65	39.82
350	6.67	8.8900	5.87	0.004260	342.7	80.45	40.23
360	6.74	9.1440	6.04	0.004268	346.3	81.14	40.57
370	6.82	9.3980	6.21	0.004275	350.3	81.93	40.97
380	6.86	9.6520	6.37	0.004283	352.3	82.26	41.13
390	6.93	9.9060	6.54	0.004291	355.8	82.93	41.47
400	6.97	10.1600	6.71	0.004298	357.9	83.25	41.63
410	7.01	10.4140	6.88	0.004306	359.9	83.57	41.79
420	7.04	10.6680	7.04	0.004314	361.4	83.77	41.89
430	7.06	10.9220	7.21	0.004322	362.4	83.85	41.93
440	7.08	11.1760	7.38	0.004330	363.4	83.94	41.97
450	7.10	11.4300	7.55	0.004337	364.4	84.02	42.01
460	7.11	11.6840	7.72	0.004345	364.9	83.98	41.99
470	7.09	11.9380	7.88	0.004353	363.9	83.59	41.80
480	7.09	12.1920	8.05	0.004361	363.9	83.44	41.72
490	7.08	12.4460	8.22	0.004369	363.4	83.18	41.59
500	7.06	12.7000	8.39	0.004377	362.4	82.79	41.40
510	7.05	12.9540	8.55	0.004385	361.9	82.53	41.26
520	7.02	13.2080	8.72	0.004393	360.4	82.03	41.02
530	7.00	13.4620	8.89	0.004401	359.4	81.65	40.83
540	6.98	13.7160	9.06	0.004409	358.4	81.27	40.64
550	6.94	13.9700	9.22	0.004418	356.3	80.67	40.33
560	6.89	14.2240	9.39	0.004426	353.8	79.95	39.97
570	6.84	14.4780	9.56	0.004434	351.3	79.23	39.62
580	6.74	14.7320	9.73	0.004442	346.3	77.95	38.97
590	6.68	14.9860	9.90	0.004450	343.2	77.13	38.56
600	6.61	15.2400	10.06	0.004459	339.7	76.19	38.10

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

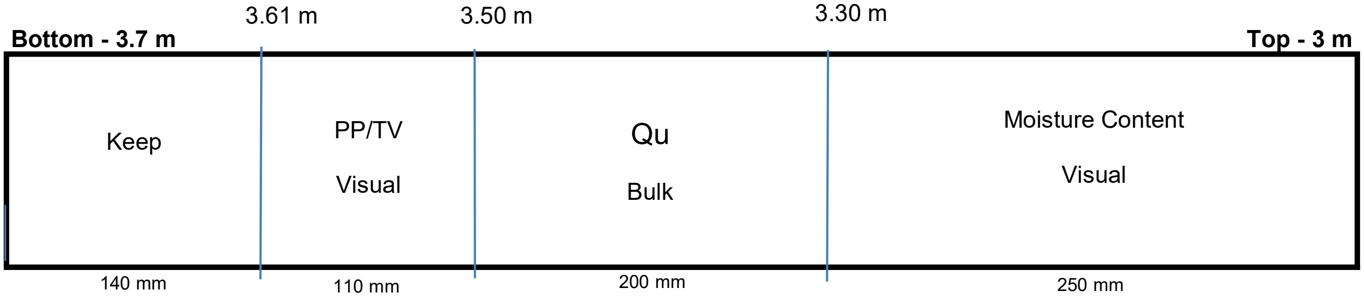
Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-33
Sample #	T100
Depth (m)	3.0 - 3.7
Sample Date	06-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 700 (overpush)



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<20 mm diam.)	
trace oxidation (15 mm diam)	
Color	olive grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)
Gradation	-

Torvane

Reading	0.70
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	68.7

Pocket Penetrometer

Reading	**1**	1.80
	2	1.90
	3	1.80
	Average	1.83
Undrained Shear Strength (kPa)		89.9

Moisture Content

Tare ID	N14
Mass tare (g)	8.6
Mass wet + tare (g)	392.6
Mass dry + tare (g)	288.8
Moisture %	37.0%

Unit Weight

Bulk Weight (g)		1151.0
Length (mm)	**1**	151.25
	2	150.96
	3	150.98
	4	151.70
Average Length (m)		0.151
Diam. (mm)	**1**	71.71
	2	72.60
	3	71.68
	4	73.27
Average Diameter (m)		0.072
Volume (m^3)		6.21E-04
Bulk Unit Weight (kN/m^3)		18.2
Bulk Unit Weight (pcf)		115.7
Dry Unit Weight (kN/m^3)		13.3
Dry Unit Weight (pcf)		84.4

Unconfined Compressive Strength

ASTM D2166

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-33
Sample #	T100
Depth (m)	3.0 - 3.7
Sample Date	6-May-21
Test Date	23-May-21
Technician	JSB

Unconfined Strength

	kPa	ksf
Max q_u	158.2	3.3
Max S_u	79.1	1.7

Specimen Data

Description CLAY - silty, trace silt inclusions (<20 mm diam.), trace oxidation (15 mm diam), olive grey, moist, stiff, high plasticity, stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)

Length	151.2	(mm)	**Moisture %**	37%	
Diameter	72.3	(mm)	**Bulk Unit Wt.**	18.2	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	13.3	(kN/m^3)
Initial Area	0.00411	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.70	68.7	1.43
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.80	88.3	1.84
	1.90	93.2	1.95
	1.80	88.3	1.84
Average	**1.83**	**89.9**	**1.88**

Failure Geometry

Sketch:

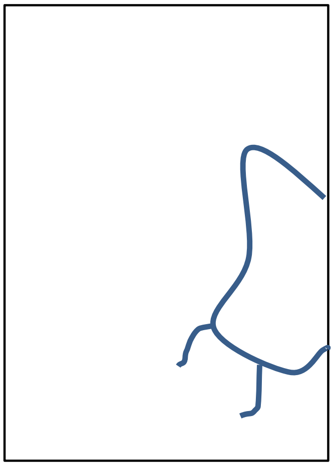
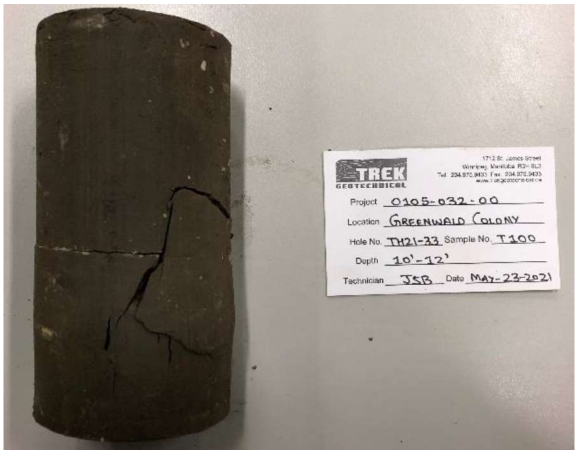


Photo:

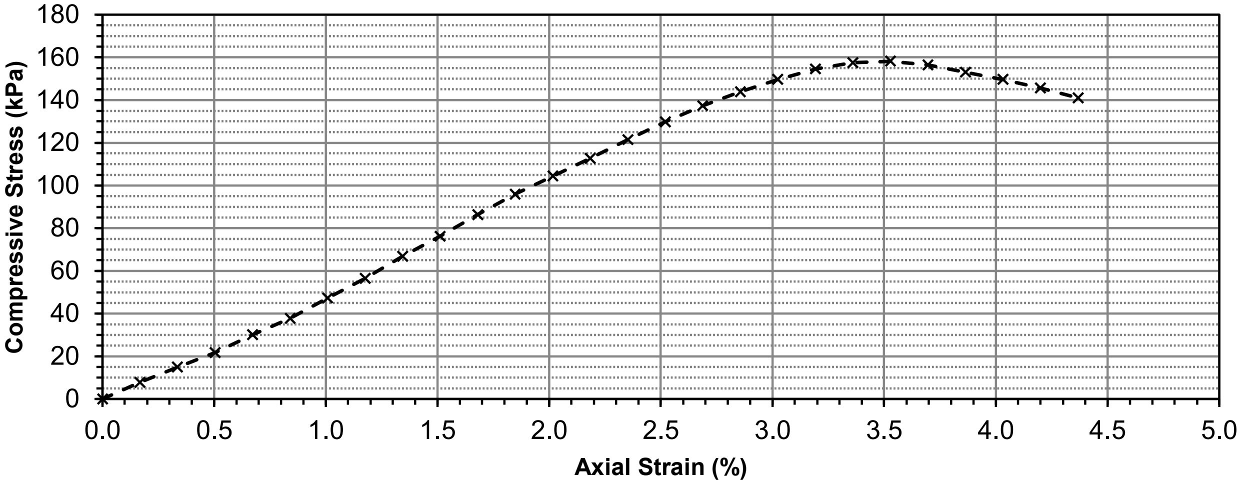


Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.06	0.0000	0.00	0.004107	0.0	0.00	0.00
10	0.58	0.2540	0.17	0.004114	32.3	7.84	3.92
20	1.16	0.5080	0.34	0.004121	61.5	14.92	7.46
30	1.72	0.7620	0.50	0.004128	89.7	21.73	10.87
40	2.40	1.0160	0.67	0.004135	124.0	29.99	14.99
50	3.04	1.2700	0.84	0.004142	156.2	37.72	18.86
60	3.83	1.5240	1.01	0.004149	196.1	47.26	23.63
70	4.59	1.7780	1.18	0.004156	234.4	56.39	28.20
80	5.46	2.0320	1.34	0.004163	278.2	66.83	33.42
90	6.24	2.2860	1.51	0.004170	317.5	76.14	38.07
100	7.09	2.5400	1.68	0.004177	360.4	86.27	43.13
110	7.90	2.7940	1.85	0.004185	401.2	95.88	47.94
120	8.62	3.0480	2.02	0.004192	437.5	104.37	52.19
130	9.33	3.3020	2.18	0.004199	473.3	112.72	56.36
140	10.08	3.5560	2.35	0.004206	511.1	121.51	60.76
150	10.79	3.8100	2.52	0.004213	546.9	129.79	64.90
160	11.44	4.0640	2.69	0.004221	579.6	137.33	68.67
170	12.01	4.3180	2.86	0.004228	608.4	143.89	71.95
180	12.51	4.5720	3.02	0.004235	633.6	149.59	74.80
190	12.95	4.8260	3.19	0.004243	655.7	154.56	77.28
200	13.22	5.0800	3.36	0.004250	669.4	157.50	78.75
210	13.30	5.3340	3.53	0.004257	673.4	158.17	79.08
220	13.18	5.5880	3.70	0.004265	667.3	156.48	78.24
230	12.91	5.8420	3.86	0.004272	653.7	153.02	76.51

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	12.64	6.0960	4.03	0.004280	640.1	149.57	74.78
250	12.33	6.3500	4.20	0.004287	624.5	145.66	72.83
260	11.95	6.6040	4.37	0.004295	605.3	140.95	70.47

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-27
Sample #	T142
Depth (m)	9.1 - 9.8
Sample Date	04-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 650

B 9.54 m 9.49 m 9.43 m A 9.27 m

Bottom - 9.8 m **Top - 9.1 m**

Bulk Qu	Moisture Content Visual PP / TV	PP TV	Bulk Qu	M.C. Visual
210 mm (B)	50 mm (B)	60 mm (A)	160 mm (A)	170 mm (A)

Visual Classification

	A	B
Material	CLAY	CLAY
Composition	silty	silty
	silt inclusions (<10 mm diam.)	silt inclusions (<10 mm diam.)
Color	grey	grey
Moisture	moist	moist
Consistency	very soft	firm
Plasticity	high plasticity	high plasticity
Structure	-	-
Gradation	-	-

Moisture Content

	A	B
Tare ID	AB87	Z63
Mass tare (g)	6.6	8.6
Mass wet + tare (g)	399.6	435
Mass dry + tare (g)	259.3	275.8
Moisture %	55.5%	59.6%

Unit Weight

		A	B
Bulk Weight (g)		1028.40	980.20
Length (mm)	1	148.54	148.41
	2	150.94	149.29
	3	151.92	150.25
	4	151.40	149.91
Average Length (m)		0.151	0.149
Diam. (mm)	1	70.14	72.13
	2	70.40	71.90
	3	69.39	71.64
	4	68.40	70.75
Average Diameter (m)		0.070	0.072
Volume (m^3)		5.73E-04	6.02E-04
Bulk Unit Weight (kN/m^3)		17.6	16.0
Bulk Unit Weight (pcf)		112.0	101.7
Dry Unit Weight (kN/m^3)		11.3	10.0
Dry Unit Weight (pcf)		72.0	63.7

Torvane

	A	B	
Reading	0.15	0.55	
Vane Size (s,m,l)	m	m	
Undrained Shear Strength	14.7	53.9	(kPa)

Pocket Penetrometer

		A	B	
Reading	**1**	0.10	1.10	
	2	0.20	1.10	
	3	0.10	1.20	
	Average	0.133	1.133	
Undrained Shear Strength		6.5	55.6	(kPa)

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-27
Sample #	T142
Depth (m)	9.1 - 9.8
Sample Date	4-May-21
Test Date	23-May-21
Technician	JSB

Unconfined Strength

	kPa	**ksf**
Max q_u	13.4	0.3
Max S_u	6.7	0.1

Specimen Data

Description A: CLAY - silty, silt inclusions (<10 mm diam.), grey, moist, very soft, high plasticity

Length	150.7	(mm)
Diameter	69.6	(mm)
L/D Ratio	2.2	
Initial Area	0.00380	(m^2)
Load Rate	1.00	(%/min)

	A	
Moisture %	56%	
Bulk Unit Wt.	17.6	(kN/m^3)
Dry Unit Wt.	11.3	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.15	14.7	0.31
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.10	4.9	0.10
	0.20	9.8	0.20
	0.10	4.9	0.10
Average	**0.13**	**6.5**	**0.14**

Failure Geometry

Sketch:

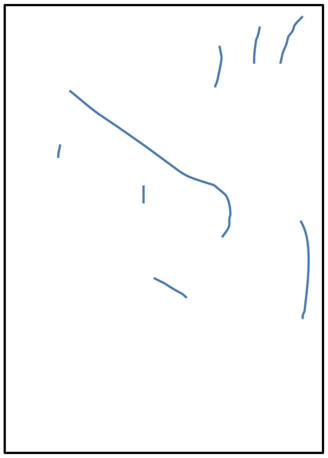
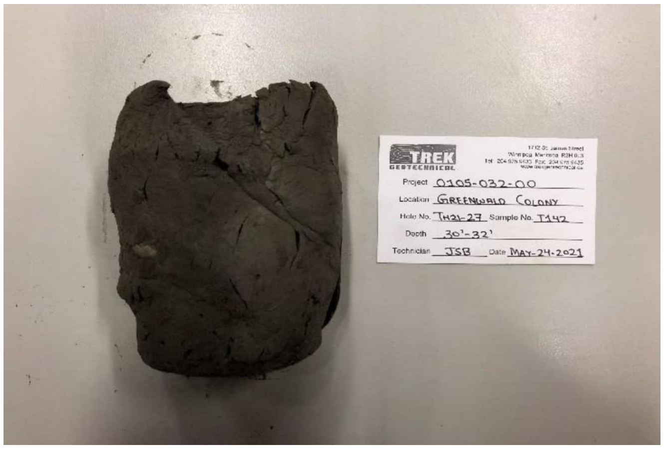


Photo:

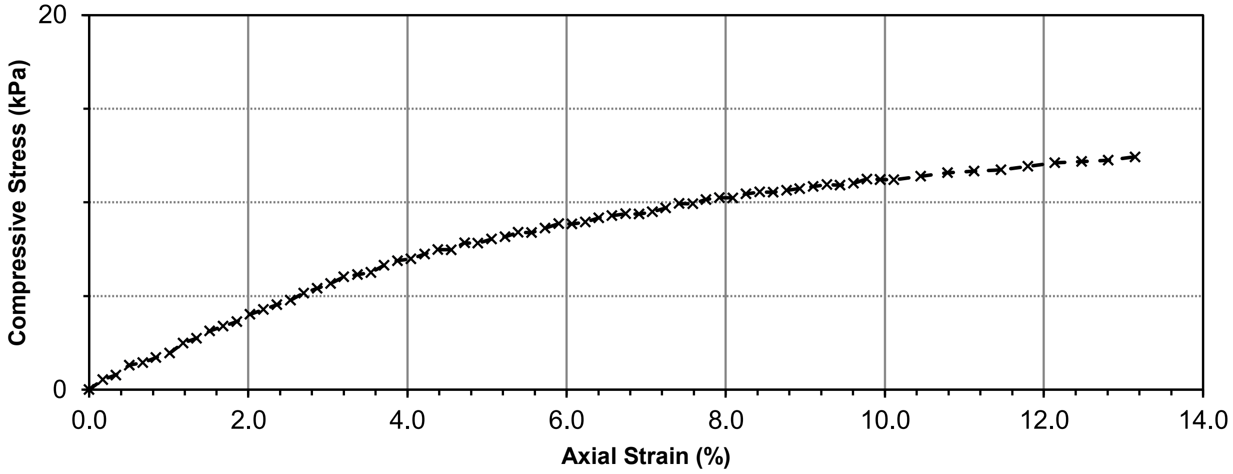


Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.13	0.0000	0.00	0.003803	0.0	0.00	0.00
10	-0.09	0.2540	0.17	0.003809	2.0	0.53	0.26
20	-0.07	0.5080	0.34	0.003816	3.0	0.79	0.40
30	-0.03	0.7620	0.51	0.003822	5.0	1.32	0.66
40	-0.02	1.0160	0.67	0.003828	5.5	1.45	0.72
50	0.00	1.2700	0.84	0.003835	6.6	1.71	0.85
60	0.02	1.5240	1.01	0.003842	7.6	1.97	0.98
70	0.06	1.7780	1.18	0.003848	9.6	2.49	1.24
80	0.08	2.0320	1.35	0.003855	10.6	2.75	1.37
90	0.11	2.2860	1.52	0.003861	12.1	3.13	1.57
100	0.13	2.5400	1.69	0.003868	13.1	3.39	1.69
110	0.15	2.7940	1.85	0.003875	14.1	3.64	1.82
120	0.18	3.0480	2.02	0.003881	15.6	4.03	2.01
130	0.20	3.3020	2.19	0.003888	16.6	4.28	2.14
140	0.22	3.5560	2.36	0.003895	17.6	4.53	2.26
150	0.24	3.8100	2.53	0.003901	18.6	4.78	2.39
160	0.27	4.0640	2.70	0.003908	20.2	5.16	2.58
170	0.29	4.3180	2.87	0.003915	21.2	5.41	2.70
180	0.31	4.5720	3.03	0.003922	22.2	5.66	2.83
190	0.34	4.8260	3.20	0.003928	23.7	6.03	3.02
200	0.35	5.0800	3.37	0.003935	24.2	6.15	3.07
210	0.36	5.3340	3.54	0.003942	24.7	6.26	3.13
220	0.39	5.5880	3.71	0.003949	26.2	6.64	3.32
230	0.41	5.8420	3.88	0.003956	27.2	6.88	3.44

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	0.42	6.0960	4.05	0.003963	27.7	7.00	3.50
250	0.44	6.3500	4.21	0.003970	28.7	7.24	3.62
260	0.46	6.6040	4.38	0.003977	29.7	7.48	3.74
270	0.46	6.8580	4.55	0.003984	29.7	7.46	3.73
280	0.49	7.1120	4.72	0.003991	31.2	7.83	3.92
290	0.49	7.3660	4.89	0.003998	31.2	7.82	3.91
300	0.51	7.6200	5.06	0.004005	32.3	8.05	4.03
310	0.52	7.8740	5.22	0.004012	32.8	8.17	4.08
320	0.54	8.1280	5.39	0.004019	33.8	8.40	4.20
330	0.54	8.3820	5.56	0.004027	33.8	8.39	4.19
340	0.56	8.6360	5.73	0.004034	34.8	8.62	4.31
350	0.58	8.8900	5.90	0.004041	35.8	8.86	4.43
360	0.58	9.1440	6.07	0.004048	35.8	8.84	4.42
370	0.59	9.3980	6.24	0.004056	36.3	8.95	4.47
380	0.61	9.6520	6.40	0.004063	37.3	9.18	4.59
390	0.62	9.9060	6.57	0.004070	37.8	9.29	4.64
400	0.63	10.1600	6.74	0.004078	38.3	9.39	4.70
410	0.63	10.4140	6.91	0.004085	38.3	9.38	4.69
420	0.64	10.6680	7.08	0.004092	38.8	9.48	4.74
430	0.66	10.9220	7.25	0.004100	39.8	9.71	4.86
440	0.68	11.1760	7.42	0.004107	40.8	9.94	4.97
450	0.68	11.4300	7.58	0.004115	40.8	9.92	4.96
460	0.70	11.6840	7.75	0.004122	41.8	10.15	5.07
470	0.71	11.9380	7.92	0.004130	42.3	10.25	5.13
480	0.71	12.1920	8.09	0.004137	42.3	10.23	5.12
490	0.73	12.4460	8.26	0.004145	43.3	10.46	5.23
500	0.74	12.7000	8.43	0.004153	43.9	10.56	5.28
510	0.74	12.9540	8.60	0.004160	43.9	10.54	5.27
520	0.75	13.2080	8.76	0.004168	44.4	10.64	5.32
530	0.76	13.4620	8.93	0.004176	44.9	10.74	5.37
540	0.77	13.7160	9.10	0.004183	45.4	10.84	5.42
550	0.78	13.9700	9.27	0.004191	45.9	10.94	5.47
560	0.78	14.2240	9.44	0.004199	45.9	10.92	5.46
570	0.79	14.4780	9.61	0.004207	46.4	11.02	5.51
580	0.81	14.7320	9.78	0.004215	47.4	11.24	5.62
590	0.81	14.9860	9.94	0.004223	47.4	11.22	5.61
600	0.81	15.2400	10.11	0.004231	47.4	11.20	5.60
620	0.83	15.7480	10.45	0.004246	48.4	11.39	5.70
640	0.85	16.2560	10.79	0.004262	49.4	11.59	5.79
660	0.86	16.7640	11.12	0.004279	49.9	11.66	5.83
680	0.87	17.2720	11.46	0.004295	50.4	11.74	5.87
700	0.89	17.7800	11.80	0.004311	51.4	11.92	5.96
720	0.91	18.2880	12.14	0.004328	52.4	12.11	6.06
740	0.92	18.7960	12.47	0.004345	52.9	12.18	6.09
760	0.93	19.3040	12.81	0.004361	53.4	12.25	6.13
780	0.95	19.8120	13.15	0.004378	54.4	12.43	6.22
800	0.96	20.3200	13.48	0.004395	54.9	12.50	6.25
820	0.98	20.8280	13.82	0.004413	55.9	12.68	6.34
840	0.98	21.3360	14.16	0.004430	55.9	12.63	6.31

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
860	0.99	21.8440	14.50	0.004447	56.5	12.69	6.35
880	1.00	22.3520	15.51	0.004465	57.0	12.76	6.38

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Greenwald Colony Community Development
Project Greenwald Colony Community Development

Test Hole TH21-27
Sample # T142
Depth (m) 9.1 - 9.8
Sample Date 4-May-21
Test Date 23-May-21
Technician JSB

Unconfined Strength

	kPa	ksf
Max q_u	62.4	1.3
Max S_u	31.2	0.7

Specimen Data

Description B: CLAY - silty, silt inclusions (<10 mm diam.), grey, moist, firm, high plasticity,

Length	149.5	(mm)	**Moisture %**	60%	
Diameter	71.6	(mm)	**Bulk Unit Wt.**	16.0	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	10.0	(kN/m^3)
Initial Area	0.00403	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.55	53.9	1.13
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.10	54.0	1.13
	1.10	54.0	1.13
	1.20	58.9	1.23
Average	**1.13**	**55.6**	**1.16**

Failure Geometry

Sketch:

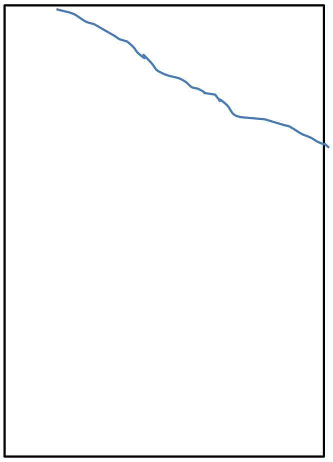
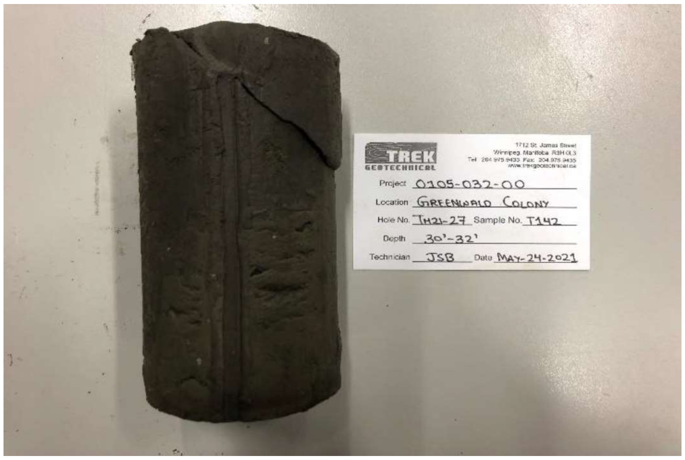


Photo:

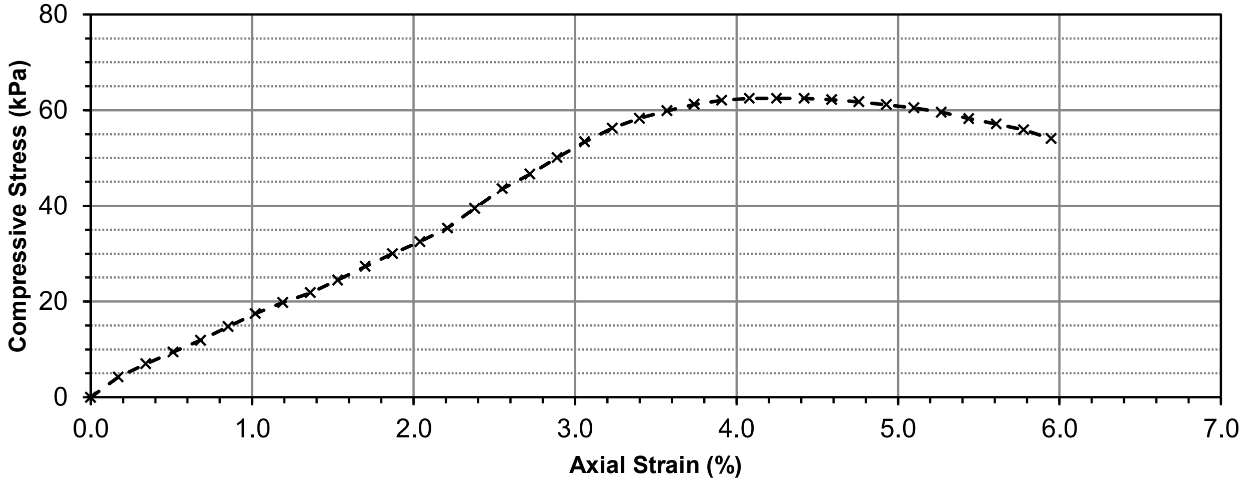


Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Greenwald Colony Community Development
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.11	0.0000	0.00	0.004027	0.0	0.00	0.00
10	0.23	0.2540	0.17	0.004034	17.1	4.25	2.12
20	0.45	0.5080	0.34	0.004041	28.2	6.99	3.49
30	0.65	0.7620	0.51	0.004048	38.3	9.46	4.73
40	0.85	1.0160	0.68	0.004055	48.4	11.93	5.97
50	1.08	1.2700	0.85	0.004061	60.0	14.77	7.38
60	1.30	1.5240	1.02	0.004068	71.1	17.47	8.73
70	1.49	1.7780	1.19	0.004075	80.6	19.79	9.89
80	1.66	2.0320	1.36	0.004082	89.2	21.85	10.93
90	1.88	2.2860	1.53	0.004090	100.3	24.53	12.26
100	2.11	2.5400	1.70	0.004097	111.9	27.31	13.66
110	2.33	2.7940	1.87	0.004104	123.0	29.97	14.98
120	2.54	3.0480	2.04	0.004111	133.6	32.49	16.25
130	2.78	3.3020	2.21	0.004118	145.7	35.37	17.69
140	3.12	3.5560	2.38	0.004125	162.8	39.47	19.73
150	3.46	3.8100	2.55	0.004132	179.9	43.54	21.77
160	3.72	4.0640	2.72	0.004140	193.0	46.63	23.32
170	4.01	4.3180	2.89	0.004147	207.7	50.08	25.04
180	4.29	4.5720	3.06	0.004154	221.8	53.39	26.69
190	4.53	4.8260	3.23	0.004161	233.9	56.20	28.10
200	4.71	5.0800	3.40	0.004169	242.9	58.28	29.14
210	4.85	5.3340	3.57	0.004176	250.0	59.87	29.93
220	4.97	5.5880	3.74	0.004183	256.0	61.21	30.60
230	5.05	5.8420	3.91	0.004191	260.1	62.06	31.03

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Greenwald Colony Community Development
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

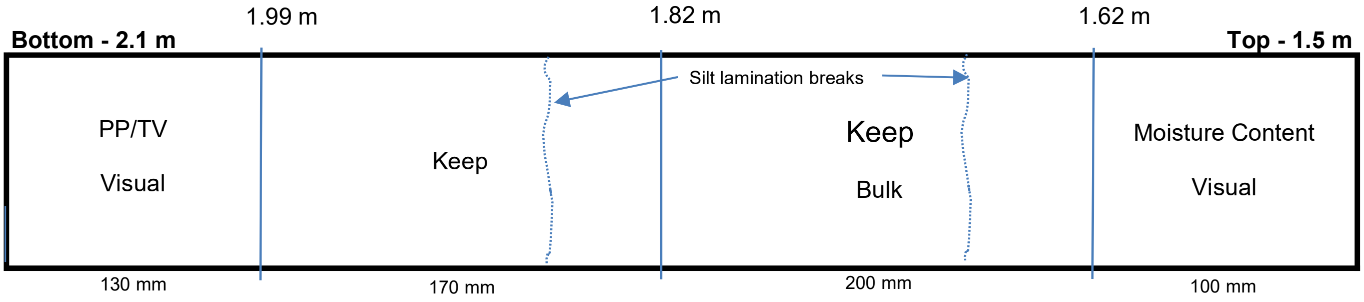
Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.09	6.0960	4.08	0.004198	262.0956	62.43	31.22
250	5.10	6.3500	4.25	0.004206	262.6	62.44	31.22
260	5.11	6.6040	4.42	0.004213	263.1	62.45	31.22
270	5.10	6.8580	4.59	0.004221	262.6	62.22	31.11
280	5.07	7.1120	4.76	0.004228	261.1	61.75	30.87
290	5.03	7.3660	4.93	0.004236	259.1	61.16	30.58
300	4.98	7.6200	5.10	0.004243	256.6	60.46	30.23
310	4.91	7.8740	5.27	0.004251	253.0	59.52	29.76
320	4.81	8.1280	5.44	0.004259	248.0	58.23	29.12
330	4.72	8.3820	5.61	0.004266	243.4	57.06	28.53
340	4.63	8.6360	5.78	0.004274	238.9	55.90	27.95
350	4.48	8.8900	5.95	0.004282	231.3	54.03	27.02

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-26
Sample #	T156
Depth (m)	1.5 - 2.1
Sample Date	06-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 600



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<20 mm diam.)	
Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)
Gradation	-

Torvane

Reading	0.85
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	83.4

Pocket Penetrometer

Reading	**1**	2.00
	2	1.90
	3	2.00
	Average	1.97
Undrained Shear Strength (kPa)		96.4

Moisture Content

Tare ID	F132
Mass tare (g)	8.6
Mass wet + tare (g)	411.2
Mass dry + tare (g)	316.5
Moisture %	30.8%

Unit Weight

Bulk Weight (g)		642.2
Length (mm)	**1**	81.83
	2	82.06
	3	82.05
	4	81.95
Average Length (m)		0.082
Diam. (mm)	**1**	72.38
	2	73.28
	3	72.62
	4	72.44
Average Diameter (m)		0.073
Volume (m^3)		3.40E-04
Bulk Unit Weight (kN/m^3)		18.5
Bulk Unit Weight (pcf)		117.9
Dry Unit Weight (kN/m^3)		14.2
Dry Unit Weight (pcf)		90.2

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-25
Sample #	T172
Depth (m)	7.6 - 8.3
Sample Date	04-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 700 (overpush)

Bottom - 8.3 m **Top - 7.6 m**

		8.14 m	8.05 m	8.01 m	7.82 m
PP TV	Visual	Moisture Content	PP TV	Keep	Qu Bulk
90 mm	90 mm	90 mm	40 mm	190 mm	200 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<20 mm diam.)	
Color	grey
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)
Gradation	-

Torvane

Reading	0.55
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	53.9

Pocket Penetrometer

Reading	**1**	1.50
	2	1.50
	3	1.50
	Average	1.50
Undrained Shear Strength (kPa)		73.6

Moisture Content

Tare ID	Z77
Mass tare (g)	8.4
Mass wet + tare (g)	447.6
Mass dry + tare (g)	334.1
Moisture %	34.8%

Unit Weight

Bulk Weight (g)		1114.2
Length (mm)	**1**	148.18
	2	148.41
	3	148.44
	4	148.49
Average Length (m)		0.148
Diam. (mm)	**1**	72.68
	2	73.34
	3	72.38
	4	72.22
Average Diameter (m)		0.073
Volume (m^3)		6.15E-04
Bulk Unit Weight (kN/m^3)		17.8
Bulk Unit Weight (pcf)		113.1
Dry Unit Weight (kN/m^3)		13.2
Dry Unit Weight (pcf)		83.9

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-25
Sample #	T172
Depth (m)	7.6 - 8.3
Sample Date	4-May-21
Test Date	23-May-21
Technician	JSB

Unconfined Strength

	kPa	**ksf**
Max q_u	58.8	1.2
Max S_u	29.4	0.6

Specimen Data

Description CLAY - silty, trace silt inclusions (<20 mm diam.), grey, moist, firm to stiff, high plasticity, stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)

Length	148.4	(mm)	**Moisture %**	35%	
Diameter	72.7	(mm)	**Bulk Unit Wt.**	17.8	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	13.2	(kN/m^3)
Initial Area	0.00415	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.55	53.9	1.13
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.50	73.6	1.54
	1.50	73.6	1.54
	1.50	73.6	1.54
Average	**1.50**	**73.6**	**1.54**

Failure Geometry

Sketch:

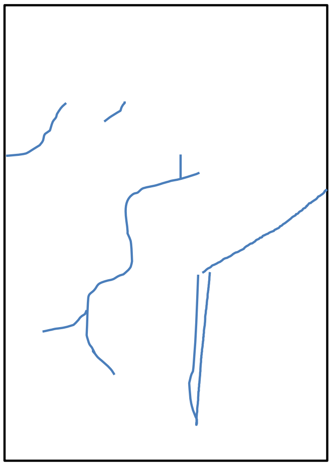
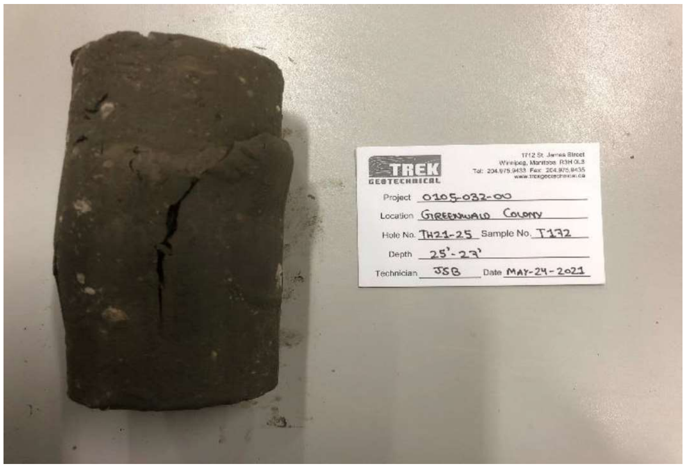


Photo:



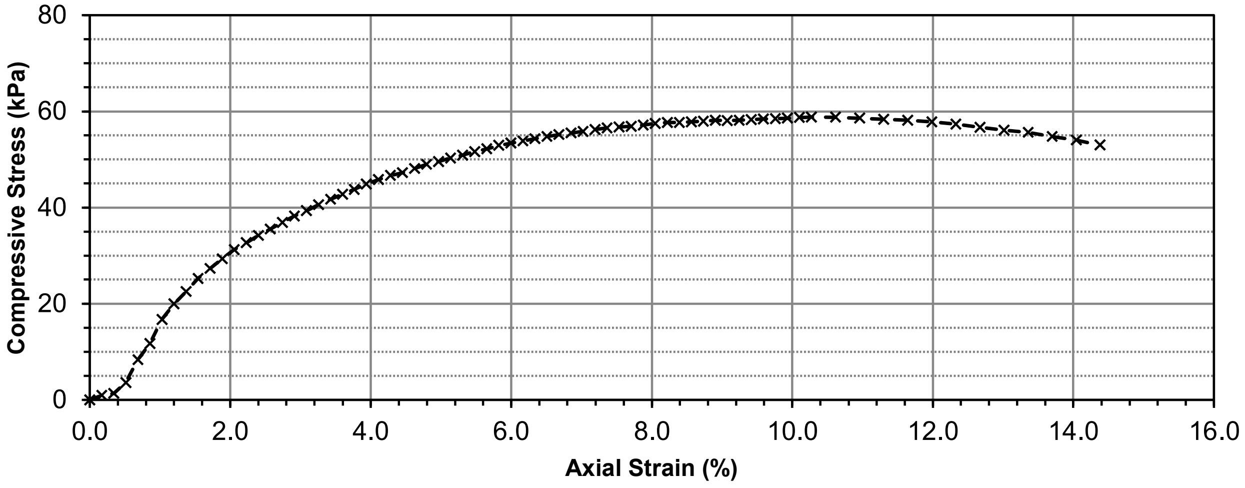
Project 0105-032-00
Location GREENWALD COLONY
Hole No. TH21-25 Sample No. T172
Depth 25'-27'
Technician JSB Date MAY-24-2021

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.11	0.0000	0.00	0.004146	0.0	0.00	0.00
10	-0.03	0.2540	0.17	0.004153	4.0	0.97	0.49
20	0.00	0.5080	0.34	0.004160	5.5	1.33	0.67
30	0.19	0.7620	0.51	0.004167	15.1	3.63	1.81
40	0.58	1.0160	0.68	0.004175	34.8	8.33	4.17
50	0.86	1.2700	0.86	0.004182	48.9	11.69	5.85
60	1.28	1.5240	1.03	0.004189	70.1	16.73	8.36
70	1.55	1.7780	1.20	0.004196	83.7	19.94	9.97
80	1.77	2.0320	1.37	0.004203	94.8	22.54	11.27
90	2.00	2.2860	1.54	0.004211	106.4	25.26	12.63
100	2.18	2.5400	1.71	0.004218	115.4	27.36	13.68
110	2.35	2.7940	1.88	0.004225	124.0	29.34	14.67
120	2.51	3.0480	2.05	0.004233	132.1	31.20	15.60
130	2.64	3.3020	2.23	0.004240	138.6	32.69	16.34
140	2.77	3.5560	2.40	0.004248	145.2	34.17	17.09
150	2.89	3.8100	2.57	0.004255	151.2	35.54	17.77
160	3.01	4.0640	2.74	0.004263	157.3	36.89	18.45
170	3.13	4.3180	2.91	0.004270	163.3	38.24	19.12
180	3.23	4.5720	3.08	0.004278	168.3	39.35	19.68
190	3.34	4.8260	3.25	0.004285	173.9	40.58	20.29
200	3.44	5.0800	3.42	0.004293	178.9	41.68	20.84
210	3.54	5.3340	3.59	0.004301	184.0	42.78	21.39
220	3.63	5.5880	3.77	0.004308	188.5	43.76	21.88
230	3.73	5.8420	3.94	0.004316	193.5	44.85	22.42

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	3.82	6.0960	4.11	0.004324	198.1	45.82	22.91
250	3.90	6.3500	4.28	0.004331	202.1	46.66	23.33
260	3.96	6.6040	4.45	0.004339	205.1	47.28	23.64
270	4.04	6.8580	4.62	0.004347	209.2	48.12	24.06
280	4.12	7.1120	4.79	0.004355	213.2	48.96	24.48
290	4.18	7.3660	4.96	0.004362	216.2	49.57	24.78
300	4.25	7.6200	5.14	0.004370	219.8	50.28	25.14
310	4.31	7.8740	5.31	0.004378	222.8	50.88	25.44
320	4.38	8.1280	5.48	0.004386	226.3	51.60	25.80
330	4.44	8.3820	5.65	0.004394	229.3	52.19	26.10
340	4.51	8.6360	5.82	0.004402	232.9	52.90	26.45
350	4.56	8.8900	5.99	0.004410	235.4	53.37	26.69
360	4.61	9.1440	6.16	0.004418	237.9	53.85	26.92
370	4.66	9.3980	6.33	0.004426	240.4	54.32	27.16
380	4.71	9.6520	6.50	0.004434	242.9	54.79	27.39
390	4.75	9.9060	6.68	0.004443	245.0	55.14	27.57
400	4.79	10.1600	6.85	0.004451	247.0	55.49	27.75
410	4.83	10.4140	7.02	0.004459	249.0	55.84	27.92
420	4.87	10.6680	7.19	0.004467	251.0	56.19	28.10
430	4.91	10.9220	7.36	0.004475	253.0	56.54	28.27
440	4.94	11.1760	7.53	0.004484	254.5	56.77	28.38
450	4.96	11.4300	7.70	0.004492	255.5	56.89	28.44
460	4.99	11.6840	7.87	0.004500	257.1	57.12	28.56
470	5.03	11.9380	8.05	0.004509	259.1	57.46	28.73
480	5.06	12.1920	8.22	0.004517	260.6	57.69	28.84
490	5.07	12.4460	8.39	0.004526	261.1	57.69	28.85
500	5.09	12.7000	8.56	0.004534	262.1	57.81	28.90
510	5.11	12.9540	8.73	0.004542	263.1	57.92	28.96
520	5.14	13.2080	8.90	0.004551	264.6	58.14	29.07
530	5.14	13.4620	9.07	0.004560	264.6	58.03	29.02
540	5.16	13.7160	9.24	0.004568	265.6	58.15	29.07
550	5.18	13.9700	9.42	0.004577	266.6	58.26	29.13
560	5.20	14.2240	9.59	0.004585	267.6	58.37	29.18
570	5.22	14.4780	9.76	0.004594	268.6	58.48	29.24
580	5.24	14.7320	9.93	0.004603	269.7	58.58	29.29
590	5.26	14.9860	10.10	0.004612	270.7	58.69	29.35
600	5.28	15.2400	10.27	0.004620	271.7	58.80	29.40
620	5.30	15.7480	10.61	0.004638	272.7	58.79	29.40
640	5.30	16.2560	10.96	0.004656	272.7	58.57	29.28
660	5.30	16.7640	11.30	0.004674	272.7	58.34	29.17
680	5.30	17.2720	11.64	0.004692	272.7	58.11	29.06
700	5.29	17.7800	11.98	0.004710	272.2	57.78	28.89
720	5.27	18.2880	12.33	0.004729	271.2	57.34	28.67
740	5.23	18.7960	12.67	0.004747	269.2	56.70	28.35
760	5.19	19.3040	13.01	0.004766	267.1	56.05	28.03

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
780	5.17	19.8120	13.35	0.004785	266.1	55.62	27.81
800	5.11	20.3200	13.69	0.004804	263.1	54.77	27.39
820	5.06	20.8280	14.04	0.004823	260.6	54.03	27.02
840	4.98	21.3360	14.38	0.004842	256.6	52.98	26.49

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-24
Sample #	T182
Depth (m)	6.1 - 6.7
Sample Date	04-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 640

Bottom - 6.7 m	6.57 m	6.37 m	6.27 m **Top - 6.1 m**
Qu	Keep Bulk	PP TV	Moisture Content Visual
170 mm	200 mm	100 mm	170 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<20 mm diam.)	
trace oxidation	
Color	olive grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)
Gradation	-

Torvane

Reading	0.55
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	53.9

Pocket Penetrometer

Reading	**1**	1.30
	2	1.30
	3	1.20
	Average	1.27
Undrained Shear Strength (kPa)		62.1

Moisture Content

Tare ID	E85
Mass tare (g)	8.6
Mass wet + tare (g)	427.6
Mass dry + tare (g)	310.3
Moisture %	38.9%

Unit Weight

Bulk Weight (g)		1154.4
Length (mm)	**1**	150.13
	2	148.33
	3	151.30
	4	149.48
Average Length (m)		0.150
Diam. (mm)	**1**	72.64
	2	72.96
	3	73.44
	4	73.55
Average Diameter (m)		0.073
Volume (m^3)		6.30E-04
Bulk Unit Weight (kN/m^3)		18.0
Bulk Unit Weight (pcf)		114.5
Dry Unit Weight (kN/m^3)		12.9
Dry Unit Weight (pcf)		82.4

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Test Hole TH21-24
Sample # T182
Depth (m) 6.1 - 6.7
Sample Date 4-May-21
Test Date 23-May-21
Technician JSB

Unconfined Strength

	kPa	ksf
Max q_u	100.1	2.1
Max S_u	50.1	1.0

Specimen Data

Description CLAY - silty, trace silt inclusions (<20 mm diam.), trace oxidation, olive grey, moist, stiff, high plasticity, stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)

Length	149.8	(mm)	**Moisture %**	39%	
Diameter	73.1	(mm)	**Bulk Unit Wt.**	18.0	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	12.9	(kN/m^3)
Initial Area	0.00420	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.55	53.9	1.13
Vane Size		
m		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	kPa	ksf
	1.30	63.8	1.33
	1.30	63.8	1.33
	1.20	58.9	1.23
Average	**1.27**	**62.1**	**1.30**

Failure Geometry

Sketch:

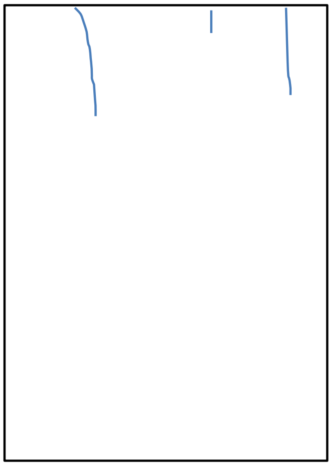
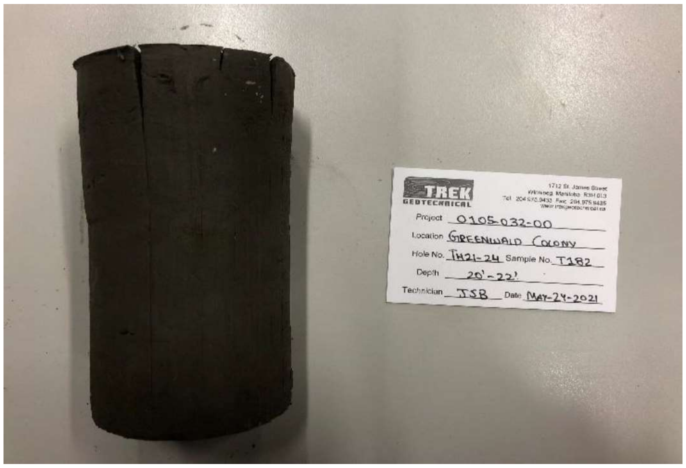


Photo:



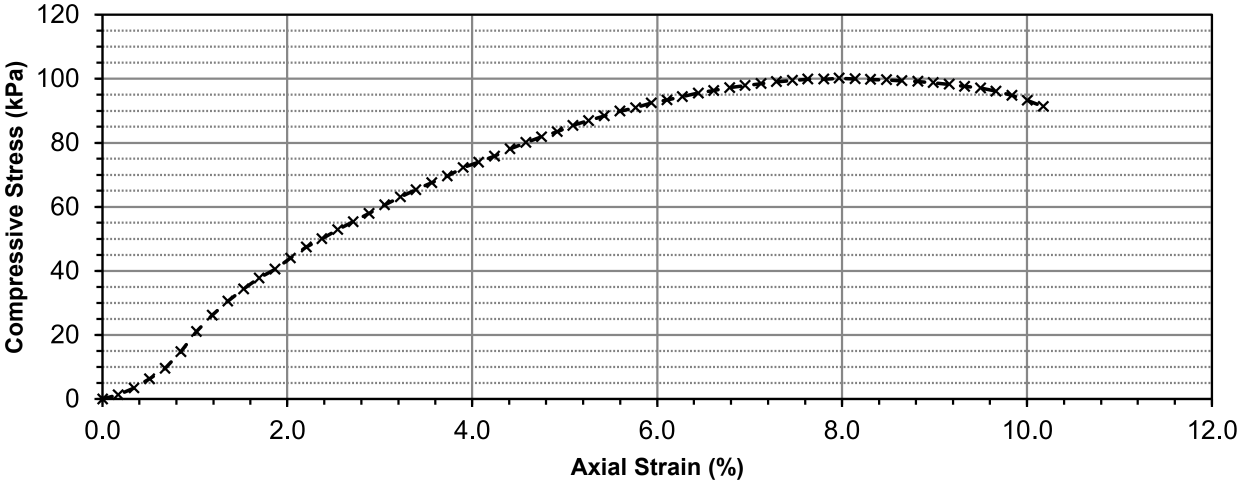
Project 0105-032-00
Location GREENWALD COLONY
Hole No. TH21-24 Sample No. T182
Depth 20'-22'
Technician JSB Date MAY-24-2021

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.14	0.0000	0.00	0.004202	0.0	0.00	0.00
10	-0.03	0.2540	0.17	0.004209	5.5	1.32	0.66
20	0.15	0.5080	0.34	0.004217	14.6	3.47	1.73
30	0.39	0.7620	0.51	0.004224	26.7	6.32	3.16
40	0.66	1.0160	0.68	0.004231	40.3	9.53	4.77
50	1.10	1.2700	0.85	0.004238	62.5	14.75	7.37
60	1.63	1.5240	1.02	0.004246	89.2	21.01	10.51
70	2.07	1.7780	1.19	0.004253	111.4	26.19	13.10
80	2.44	2.0320	1.36	0.004260	130.0	30.53	15.26
90	2.77	2.2860	1.53	0.004267	146.7	34.37	17.19
100	3.06	2.5400	1.70	0.004275	161.3	37.73	18.87
110	3.30	2.7940	1.87	0.004282	173.4	40.49	20.25
120	3.60	3.0480	2.03	0.004290	188.5	43.95	21.97
130	3.90	3.3020	2.20	0.004297	203.6	47.39	23.69
140	4.13	3.5560	2.37	0.004304	215.2	50.00	25.00
150	4.38	3.8100	2.54	0.004312	227.8	52.83	26.42
160	4.60	4.0640	2.71	0.004319	238.9	55.31	27.65
170	4.83	4.3180	2.88	0.004327	250.5	57.89	28.95
180	5.07	4.5720	3.05	0.004335	262.6	60.58	30.29
190	5.29	4.8260	3.22	0.004342	273.7	63.03	31.51
200	5.50	5.0800	3.39	0.004350	284.3	65.35	32.68
210	5.70	5.3340	3.56	0.004357	294.4	67.55	33.78
220	5.89	5.5880	3.73	0.004365	303.9	69.63	34.81
230	6.13	5.8420	3.90	0.004373	316.0	72.27	36.14

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	6.29	6.0960	4.07	0.004381	324.1	73.98	36.99
250	6.46	6.3500	4.24	0.004388	332.7	75.81	37.90
260	6.67	6.6040	4.41	0.004396	343.2	78.08	39.04
270	6.86	6.8580	4.58	0.004404	352.8	80.12	40.06
280	7.02	7.1120	4.75	0.004412	360.9	81.80	40.90
290	7.18	7.3660	4.92	0.004420	368.9	83.48	41.74
300	7.36	7.6200	5.09	0.004428	378.0	85.38	42.69
310	7.51	7.8740	5.26	0.004435	385.6	86.93	43.47
320	7.65	8.1280	5.43	0.004443	392.6	88.36	44.18
330	7.80	8.3820	5.60	0.004451	400.2	89.90	44.95
340	7.91	8.6360	5.76	0.004459	405.7	90.99	45.49
350	8.05	8.8900	5.93	0.004467	412.8	92.40	46.20
360	8.15	9.1440	6.10	0.004475	417.8	93.36	46.68
370	8.26	9.3980	6.27	0.004484	423.4	94.43	47.22
380	8.37	9.6520	6.44	0.004492	428.9	95.49	47.75
390	8.46	9.9060	6.61	0.004500	433.5	96.33	48.16
400	8.55	10.1600	6.78	0.004508	438.0	97.16	48.58
410	8.63	10.4140	6.95	0.004516	442.0	97.88	48.94
420	8.70	10.6680	7.12	0.004525	445.6	98.48	49.24
430	8.77	10.9220	7.29	0.004533	449.1	99.08	49.54
440	8.82	11.1760	7.46	0.004541	451.6	99.45	49.72
450	8.87	11.4300	7.63	0.004549	454.1	99.82	49.91
460	8.89	11.6840	7.80	0.004558	455.1	99.86	49.93
470	8.93	11.9380	7.97	0.004566	457.2	100.12	50.06
480	8.93	12.1920	8.14	0.004575	457.2	99.93	49.97
490	8.93	12.4460	8.31	0.004583	457.2	99.75	49.87
500	8.94	12.7000	8.48	0.004592	457.7	99.67	49.84
510	8.93	12.9540	8.65	0.004600	457.2	99.38	49.69
520	8.93	13.2080	8.82	0.004609	457.2	99.20	49.60
530	8.91	13.4620	8.99	0.004617	456.1	98.79	49.40
540	8.88	13.7160	9.16	0.004626	454.6	98.28	49.14
550	8.83	13.9700	9.33	0.004634	452.1	97.55	48.78
560	8.80	14.2240	9.49	0.004643	450.6	97.05	48.52
570	8.73	14.4780	9.66	0.004652	447.1	96.11	48.05
580	8.63	14.7320	9.83	0.004661	442.0	94.84	47.42
590	8.50	14.9860	10.00	0.004669	435.5	93.26	46.63
600	8.34	15.2400	10.17	0.004678	427.4	91.36	45.68

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-23
Sample #	T200
Depth (m)	3.0 - 3.7
Sample Date	04-May-21
Test Date	23-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 670

Bottom - 3.7 m 3.55 m 3.44 m 3.36 m 3.23 m **Top - 3 m**

M.C.	PP TV	Keep	Visual	Moisture Content Visual	Qu Bulk
40 mm	130 mm	110 mm	80 mm	130 mm	180 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5 mm diam.)	
trace gypsum (<5 mm diam.)	
Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 10 mm thick)
Gradation	-

Torvane

Reading	0.70
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	68.7

Pocket Penetrometer

Reading	**1**	1.70
	2	1.70
	3	1.70
	Average	1.70
Undrained Shear Strength (kPa)		83.4

Moisture Content

Tare ID	D47
Mass tare (g)	8.6
Mass wet + tare (g)	462
Mass dry + tare (g)	340.3
Moisture %	36.7%

Unit Weight

Bulk Weight (g)		1128.2
Length (mm)	**1**	147.73
	2	147.86
	3	147.98
	4	147.38
Average Length (m)		0.148
Diam. (mm)	**1**	70.85
	2	71.51
	3	71.38
	4	71.79
Average Diameter (m)		0.071
Volume (m^3)		5.91E-04
Bulk Unit Weight (kN/m^3)		18.7
Bulk Unit Weight (pcf)		119.1
Dry Unit Weight (kN/m^3)		13.7
Dry Unit Weight (pcf)		87.2

Unconfined Compressive Strength

ASTM D2166

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development

Test Hole	TH21-23
Sample #	T200
Depth (m)	3.0 - 3.7
Sample Date	4-May-21
Test Date	23-May-21
Technician	JSB

Unconfined Strength

	kPa	**ksf**
Max q_u	82.6	1.7
Max S_u	41.3	0.9

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), trace gypsum (<5 mm diam.), brown, moist, stiff, high plasticity, stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 10 mm thick)

Length	147.7	(mm)	**Moisture %**	37%	
Diameter	71.4	(mm)	**Bulk Unit Wt.**	18.7	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	13.7	(kN/m^3)
Initial Area	0.00400	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.70	68.7	1.43
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.70	83.4	1.74
	1.70	83.4	1.74
	1.70	83.4	1.74
Average	**1.70**	**83.4**	**1.74**

Failure Geometry

Sketch:

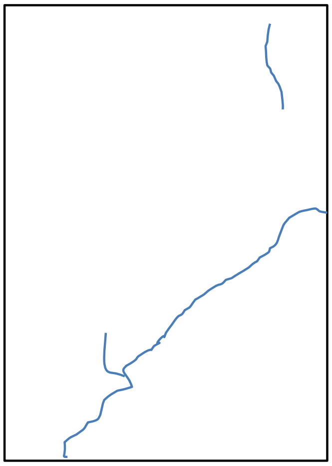
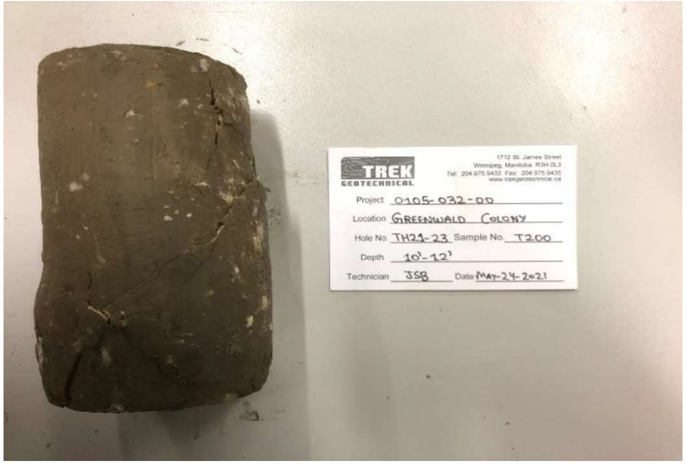


Photo:



TREK GEOTECHNICAL
1712 St. James Street
Winnipeg, Manitoba R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435
www.trekgeotechnical.ca

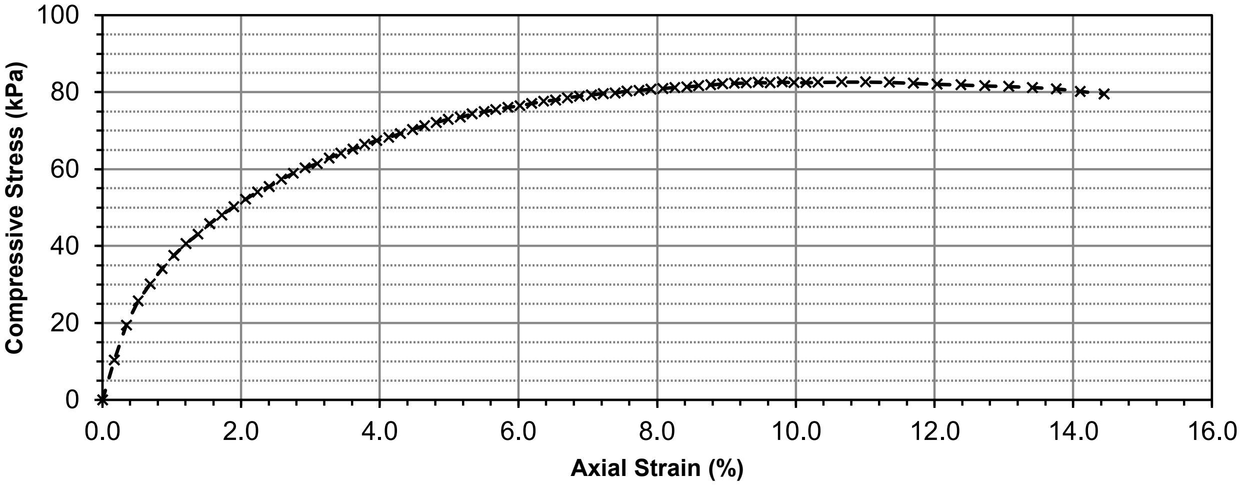
Project 0105-032-00
Location GREENWALD COLONY
Hole No. TH21-23 Sample No. T200
Depth 10'-12'
Technician JSB Date MAY-24-2021

Unconfined Compressive Strength

ASTM D2166

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	-0.11	0.0000	0.00	0.004002	0.0	0.00	0.00
10	0.71	0.2540	0.17	0.004009	41.3	10.31	5.15
20	1.44	0.5080	0.34	0.004016	78.1	19.45	9.73
30	1.94	0.7620	0.52	0.004023	103.3	25.69	12.84
40	2.30	1.0160	0.69	0.004030	121.5	30.14	15.07
50	2.62	1.2700	0.86	0.004037	137.6	34.09	17.04
60	2.90	1.5240	1.03	0.004044	151.7	37.52	18.76
70	3.15	1.7780	1.20	0.004051	164.3	40.56	20.28
80	3.36	2.0320	1.38	0.004058	174.9	43.10	21.55
90	3.58	2.2860	1.55	0.004065	186.0	45.75	22.88
100	3.77	2.5400	1.72	0.004072	195.6	48.03	24.01
110	3.95	2.7940	1.89	0.004079	204.6	50.17	25.08
120	4.12	3.0480	2.06	0.004086	213.2	52.18	26.09
130	4.28	3.3020	2.24	0.004093	221.3	54.05	27.03
140	4.40	3.5560	2.41	0.004101	227.3	55.43	27.72
150	4.56	3.8100	2.58	0.004108	235.4	57.30	28.65
160	4.70	4.0640	2.75	0.004115	242.4	58.91	29.46
170	4.82	4.3180	2.92	0.004122	248.5	60.28	30.14
180	4.92	4.5720	3.09	0.004130	253.5	61.39	30.70
190	5.05	4.8260	3.27	0.004137	260.1	62.87	31.43
200	5.16	5.0800	3.44	0.004144	265.6	64.09	32.05
210	5.26	5.3340	3.61	0.004152	270.7	65.19	32.60
220	5.37	5.5880	3.78	0.004159	276.2	66.41	33.20
230	5.46	5.8420	3.95	0.004167	280.7	67.38	33.69

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.54	6.0960	4.13	0.004174	284.8	68.22	34.11
250	5.63	6.3500	4.30	0.004182	289.3	69.19	34.59
260	5.73	6.6040	4.47	0.004189	294.4	70.26	35.13
270	5.82	6.8580	4.64	0.004197	298.9	71.22	35.61
280	5.90	7.1120	4.81	0.004204	302.9	72.05	36.02
290	5.98	7.3660	4.99	0.004212	307.0	72.88	36.44
300	6.04	7.6200	5.16	0.004220	310.0	73.46	36.73
310	6.12	7.8740	5.33	0.004227	314.0	74.28	37.14
320	6.18	8.1280	5.50	0.004235	317.0	74.86	37.43
330	6.24	8.3820	5.67	0.004243	320.1	75.44	37.72
340	6.30	8.6360	5.85	0.004250	323.1	76.01	38.01
350	6.35	8.8900	6.02	0.004258	325.6	76.47	38.23
360	6.41	9.1440	6.19	0.004266	328.6	77.03	38.52
370	6.47	9.3980	6.36	0.004274	331.7	77.60	38.80
380	6.51	9.6520	6.53	0.004282	333.7	77.93	38.96
390	6.57	9.9060	6.71	0.004290	336.7	78.49	39.25
400	6.62	10.1600	6.88	0.004298	339.2	78.93	39.47
410	6.66	10.4140	7.05	0.004305	341.2	79.25	39.63
420	6.70	10.6680	7.22	0.004313	343.2	79.58	39.79
430	6.73	10.9220	7.39	0.004321	344.8	79.78	39.89
440	6.78	11.1760	7.56	0.004329	347.3	80.21	40.11
450	6.81	11.4300	7.74	0.004338	348.8	80.41	40.21
460	6.85	11.6840	7.91	0.004346	350.8	80.73	40.36
470	6.88	11.9380	8.08	0.004354	352.3	80.92	40.46
480	6.91	12.1920	8.25	0.004362	353.8	81.12	40.56
490	6.94	12.4460	8.42	0.004370	355.3	81.31	40.66
500	6.98	12.7000	8.60	0.004378	357.4	81.62	40.81
510	7.02	12.9540	8.77	0.004387	359.4	81.93	40.96
520	7.05	13.2080	8.94	0.004395	360.9	82.12	41.06
530	7.08	13.4620	9.11	0.004403	362.4	82.30	41.15
540	7.10	13.7160	9.28	0.004412	363.4	82.38	41.19
550	7.13	13.9700	9.46	0.004420	364.9	82.56	41.28
560	7.13	14.2240	9.63	0.004428	364.9	82.41	41.20
570	7.16	14.4780	9.80	0.004437	366.4	82.59	41.29
580	7.16	14.7320	9.97	0.004445	366.4	82.43	41.22
590	7.18	14.9860	10.14	0.004454	367.4	82.50	41.25
600	7.20	15.2400	10.32	0.004462	368.4	82.57	41.28
620	7.23	15.7480	10.66	0.004479	370.0	82.59	41.30
640	7.26	16.2560	11.00	0.004497	371.5	82.61	41.30
660	7.28	16.7640	11.35	0.004514	372.5	82.51	41.26
680	7.29	17.2720	11.69	0.004532	373.0	82.30	41.15
700	7.30	17.7800	12.03	0.004549	373.5	82.09	41.05
720	7.31	18.2880	12.38	0.004567	374.0	81.88	40.94
740	7.32	18.7960	12.72	0.004585	374.5	81.67	40.84
760	7.33	19.3040	13.07	0.004603	375.0	81.46	40.73

Project No. 0105-032-00
Client Burns Maendel Consulting Engineers Ltd.
Project Greenwald Colony Community Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
780	7.33	19.8120	13.41	0.004622	375.0	81.14	40.57
800	7.33	20.3200	13.75	0.004640	375.0	80.82	40.41
820	7.30	20.8280	14.10	0.004659	373.5	80.17	40.08
840	7.27	21.3360	14.44	0.004677	372.0	79.52	39.76
860	7.22	21.8440	14.79	0.004696	369.5	78.67	39.33
880	7.13	22.3520	15.13	0.004715	364.9	77.39	38.69

TREK GEOTECHNICAL
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Test Hole	TH21-20
Sample #	T228
Depth (m)	6.1 - 6.7
Sample Date	06-May-21
Test Date	14-May-21
Technician	JSB

Tube Extraction

Recovery (mm) 650

Bottom - 6.7 m | 6.65 m | 6.59 m | 6.44 m | 6.32 m | 6.22 m | **Top - 6.1 m**

PP/TV Visual	Moisture Content	Permeability Bulk	Keep	Moisture Content Visual	Slough
100 mm	60 mm	150 mm	120 mm	100 mm	120 mm

Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<15 mm diam.)

Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	stratified layers of silty clay (~ 50 mm thick) and sandy silt (< 5 mm thick)
Gradation	-

Torvane

Reading	0.55
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	53.9

Pocket Penetrometer

Reading	**1**	1.50
	2	1.50
	3	1.60
	Average	1.53
Undrained Shear Strength (kPa)		75.2

Moisture Content

Tare ID	SPIDER PAN
Mass tare (g)	237
Mass wet + tare (g)	2106.8
Mass dry + tare (g)	1565.6
Moisture %	40.7%

Unit Weight

Bulk Weight (g)		1159.0
Length (mm)	**1**	151.17
	2	151.36
	3	151.24
	4	150.98
Average Length (m)		0.151
Diam. (mm)	**1**	74.28
	2	73.97
	3	72.97
	4	74.16
Average Diameter (m)		0.074
Volume (m^3)		6.48E-04
Bulk Unit Weight (kN/m^3)		17.6
Bulk Unit Weight (pcf)		111.7
Dry Unit Weight (kN/m^3)		12.5
Dry Unit Weight (pcf)		79.4

Standard Proctor Compaction Test

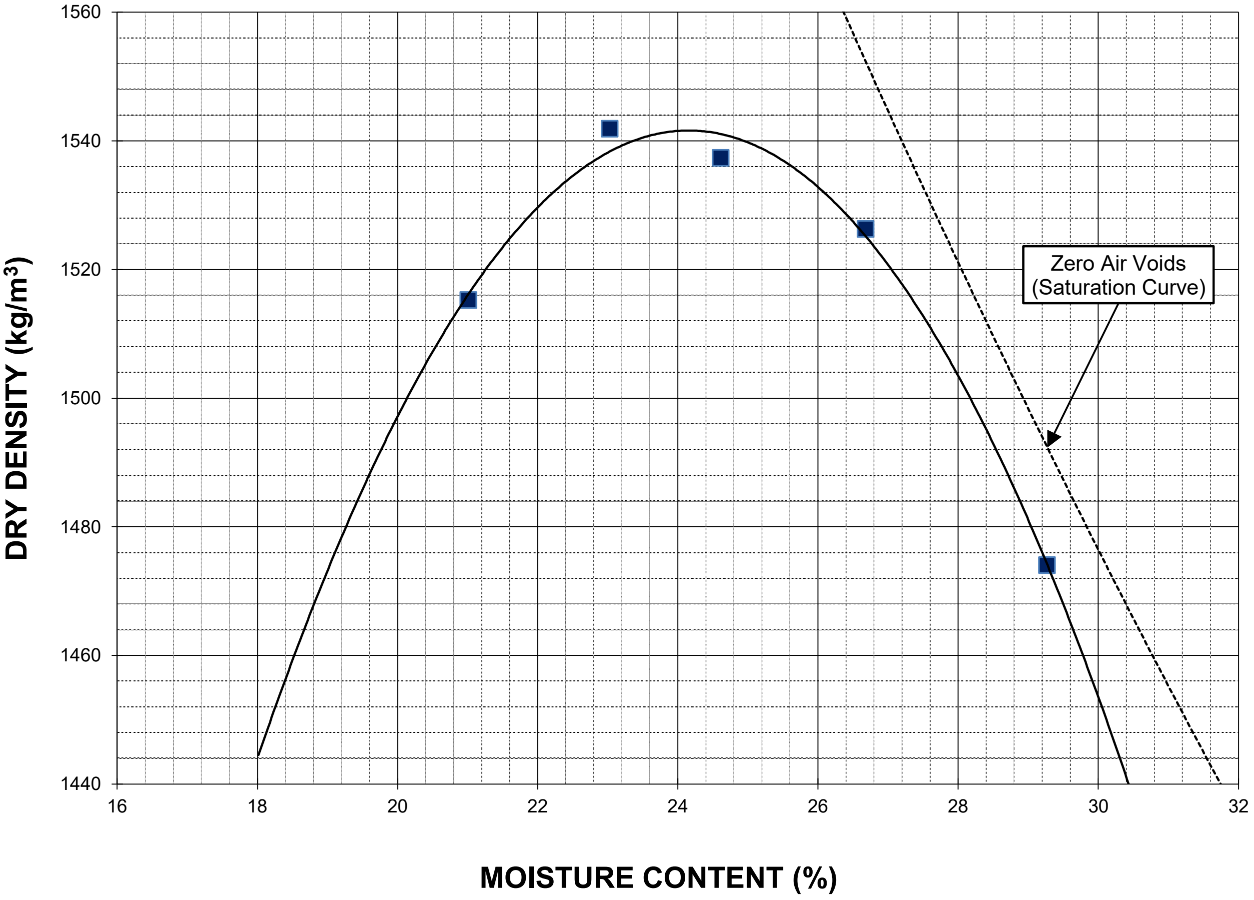
ASTM D698-12e2

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

Project No.	0105-032-00
Client	Burns Maendel Consulting Engineers Ltd.
Project	Greenwald Colony Community Development
Sample #	G231
Source	TH21-20
Material	Clay Sub-grade Material
Sample Date	20-May-21
Test Date	22-May-21
Technician	JSB

Maximum Dry Density (kg/m3)	1542
Optimum Moisture (%)	24.2

Trial Number	1	2	3	4	5
Wet Density (kg/m^3)	1834	1897	1916	1934	1906
Dry Density (kg/m^3)	1515	1542	1537	1526	1474
Moisture Content (%)	21.0	23.0	24.6	26.7	29.3



www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Hydraulic Conductivity Determination (Flexible Wall)

ASTM D5084-16

Project No.	0105-032-00	**Test Hole**	TH21-20
Client	Burns Maendel Consulting Ltd	**Trek Sample #**	T228
Project	Greenwald Colony	**Depth (m)**	6.38 to 6.55
		Sample Date	06-May-21
		Test Date	May 14, 2021 to June 1, 2021
		Technician	Angela Fidler-Kliewer

Specimen Details

Visual Classification	Clay, silty, trace silt inclusions (< 10 mm), trace oxidation, moist, grey, high plasticity.
Comments	The specific gravity of the soil was assumed to be 2.75

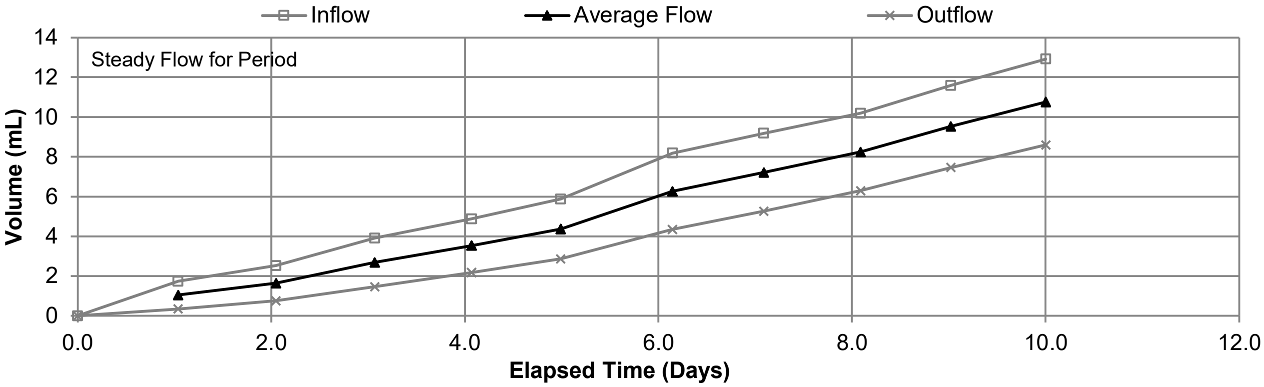
Index Testing

Liquid Limit	65
Plastic Limit	17
Plasticity Index	48
Clay Content (%)	56

Test Details

Permeant	Distilled, de-aired water
Method	Constant Rate
Cell Pressure	129.4 kPa
Influent Pressure	120.2 kPa
Effluent Pressure	84.7 kPa
Gradient	36.6

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	7.09	9.18	5.26	1.09	0.96	1.04	7.72E-11
1.00	8.09	10.18	6.30	0.96	1.02	1.02	7.70E-11
0.93	9.02	11.60	7.46	1.22	1.29	0.99	1.01E-10
0.98	10.00	12.92	8.60	1.16	1.23	1.01	9.33E-11

Average Temperature Corrected Hydraulic Conductivity, k_{20} (m/s) **8.71E-11** **(8.71×10^{-9} 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	0.0981	0.0733	43.5	12.4	102.1	120.6	85.0
Final	0.0989	0.0739	45.9	12.0	101.5	120.6	85.0

Appendix B

Slope Stability Outputs

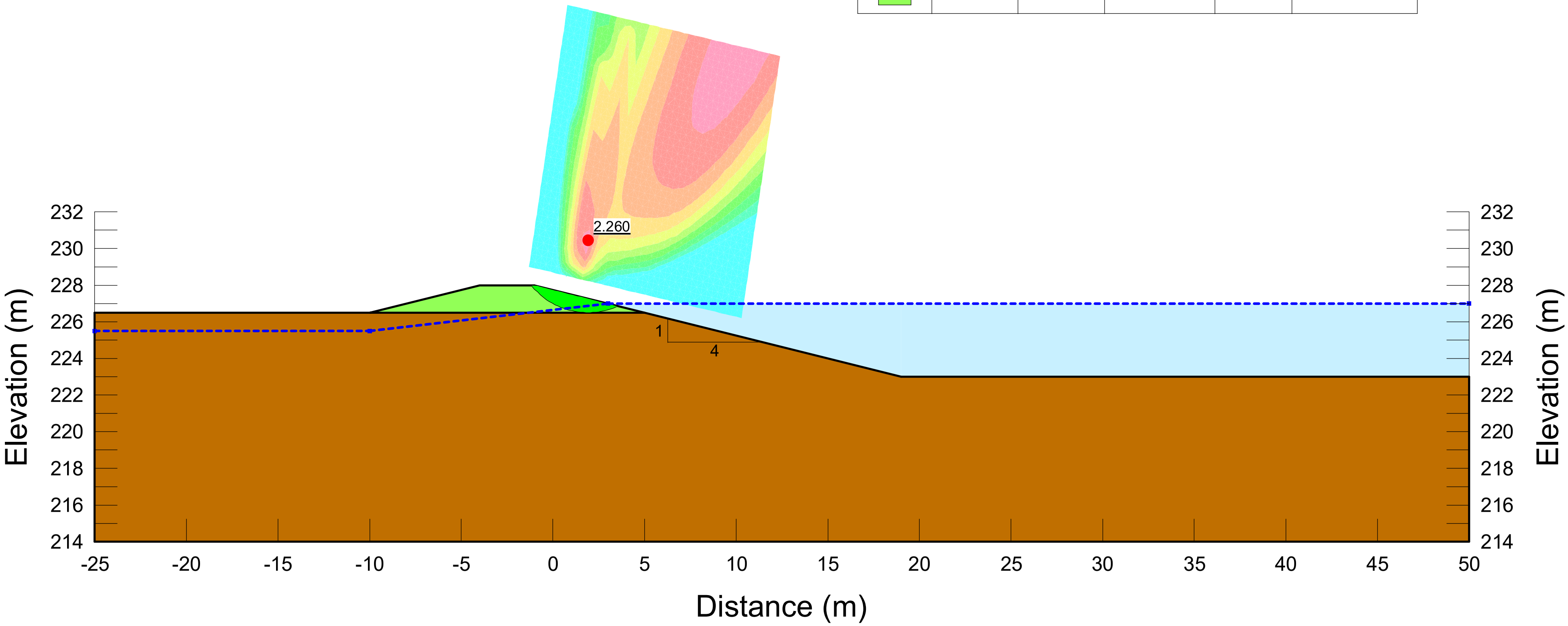
Tabloid (279mm x 432mm)

SAVED: 2021-08-30 8:54:02 AM

SCALE: 1:217 (279mm x 432mm)

Manure Storage Cell: Long-Term Conditions
Berm height: 1.5 m
Berm top width: 3.0 m
Berm side slope: 4H:1V
Cell Depth: 3.5 m
Sludge/Water Level: 4 m Deep

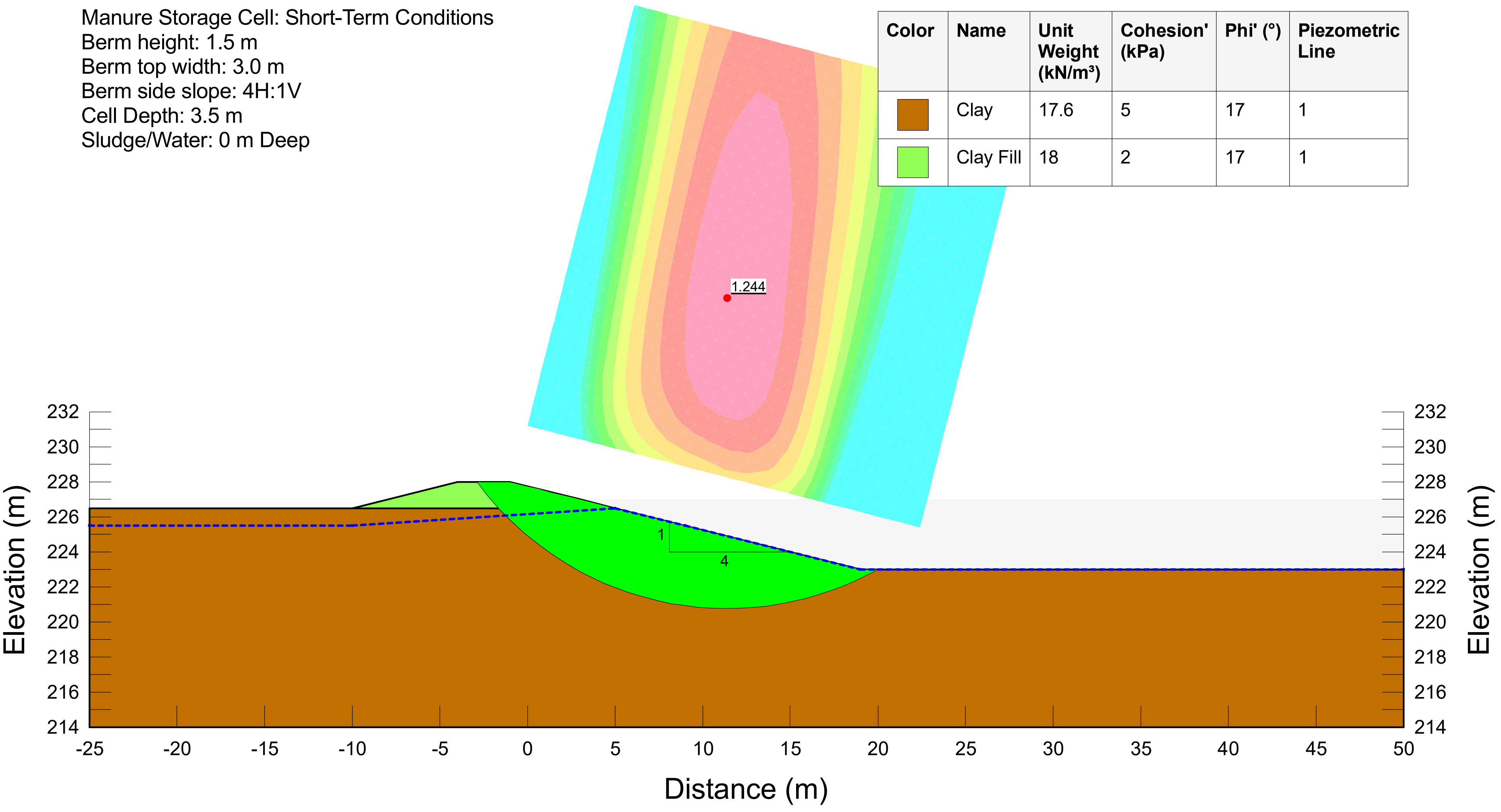
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line
🟫	Clay	17.6	5	17	1
🟩	Clay Fill	18	2	17	1



FILE PATH: Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 032 00 Greenwald Colony\2 Design\2.7 Modelling\MOD_01_Manure Storage Cell_LT Conditions.gsz

Manure Storage Cell: Short-Term Conditions
Berm height: 1.5 m
Berm top width: 3.0 m
Berm side slope: 4H:1V
Cell Depth: 3.5 m
Sludge/Water: 0 m Deep

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line
🟫	Clay	17.6	5	17	1
🟩	Clay Fill	18	2	17	1



Tabloid (279mm x 432mm)

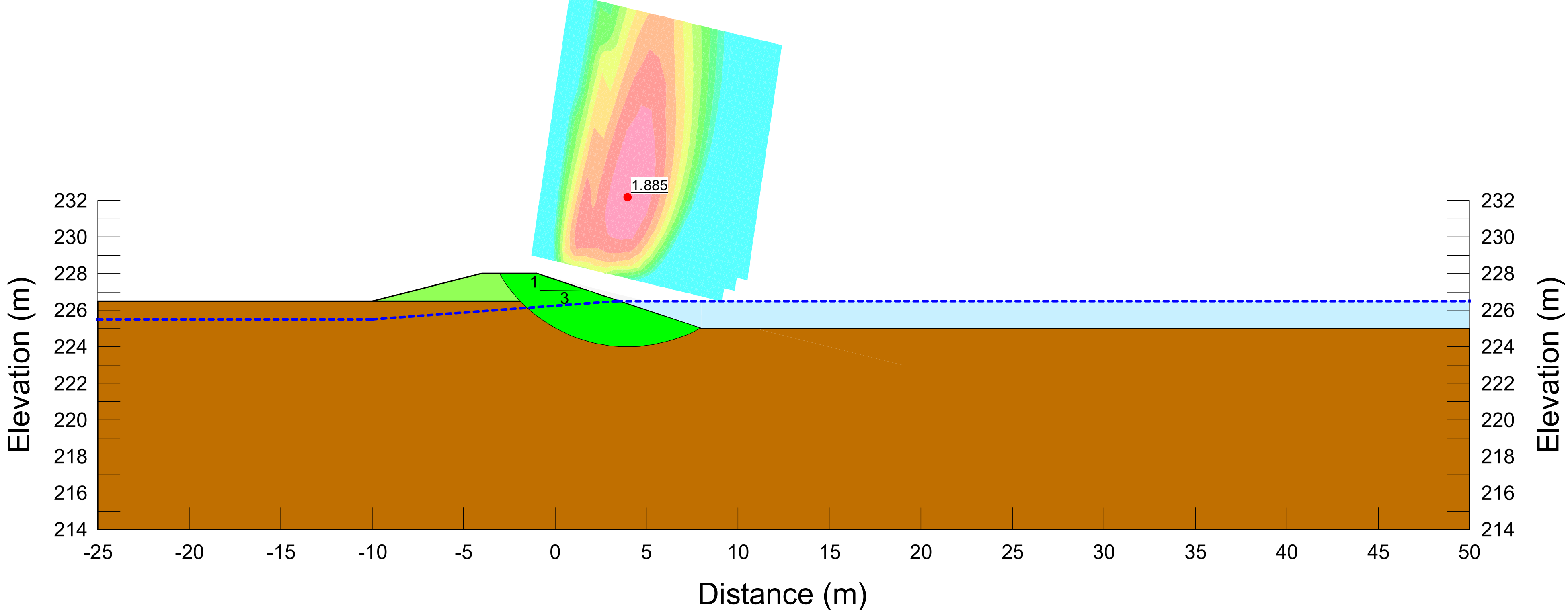
SAVED: 2021-08-30 9:00:34 AM

SCALE: 1:215 (279mm x 432mm)

FILE PATH: Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 032 00 Greenwald Colony\2 Design\2.7 Modelling\MOD_02_Manure Storage Cell_ST Conditions.gsz

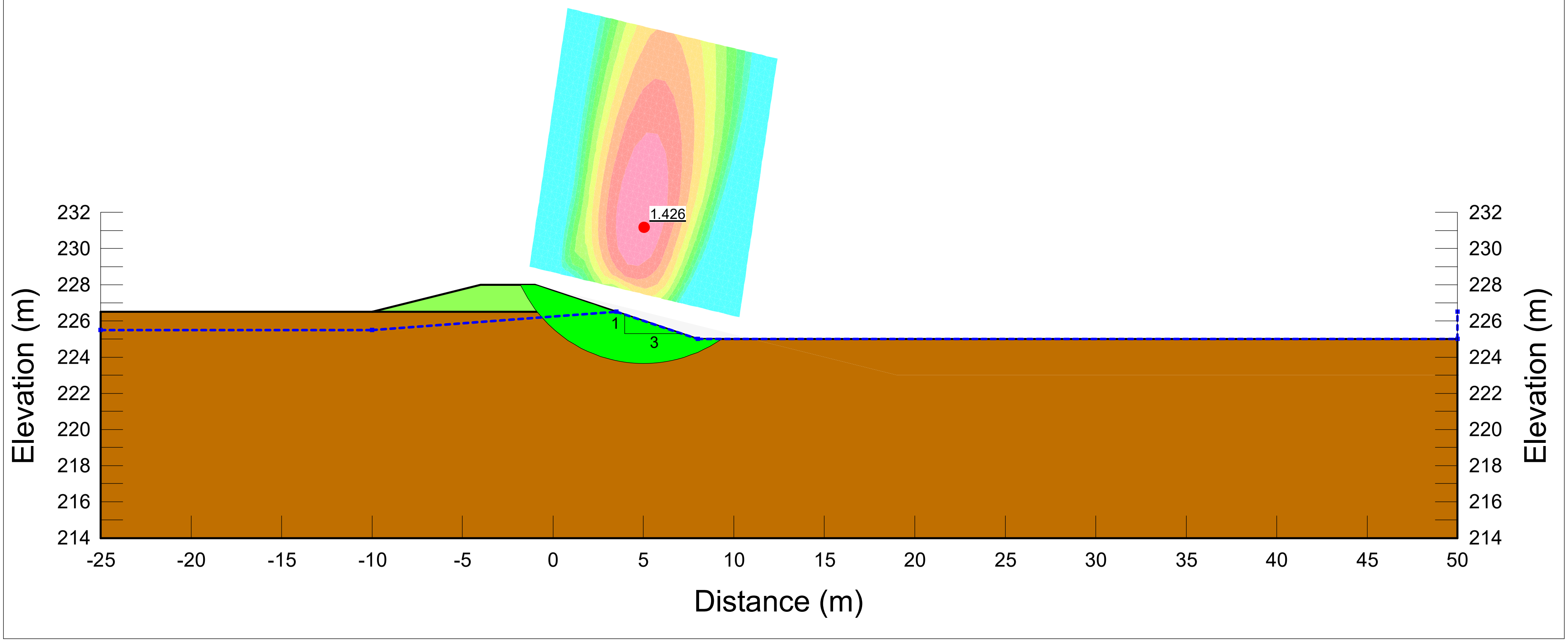
Lagoon: Long-Term Conditions
Berm height: 1.5 m
Berm top width: 3.0 m
Berm side slope: 3H:1V
Lagoon Depth Below Prairie Grade: 1.5 m
Water Level: 1.5 m Deep

Color	**Name**	**Unit Weight (kN/m³)**	**Cohesion' (kPa)**	**Phi' (°)**	**Piezometric Line**
🟫	Clay	17.6	5	17	1
🟩	Clay Fill	18	2	17	1



Lagoon: Short-Term Conditions
Berm height: 1.5 m
Berm top width: 3.0 m
Berm side slope: 3H:1V
Lagoon Depth: 1.5 m
Water Level: 0 m Deep

Color	**Name**	**Unit Weight (kN/m³)**	**Cohesion' (kPa)**	**Phi' (°)**	**Piezometric Line**
🟫	Clay	17.6	5	17	1
🟩	Clay Fill	18	2	17	1



Tabloid (279mm x 432mm)
SAVED: 2021-08-30 9:12:34 AM
SCALE: 1:215 (279mm x 432mm)

FILE PATH: Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 032 00 Greenwald Colony\2 Design\2.7 Modelling\MOD_05_Lagoon_ST Conditions_3Hto1V.gsz

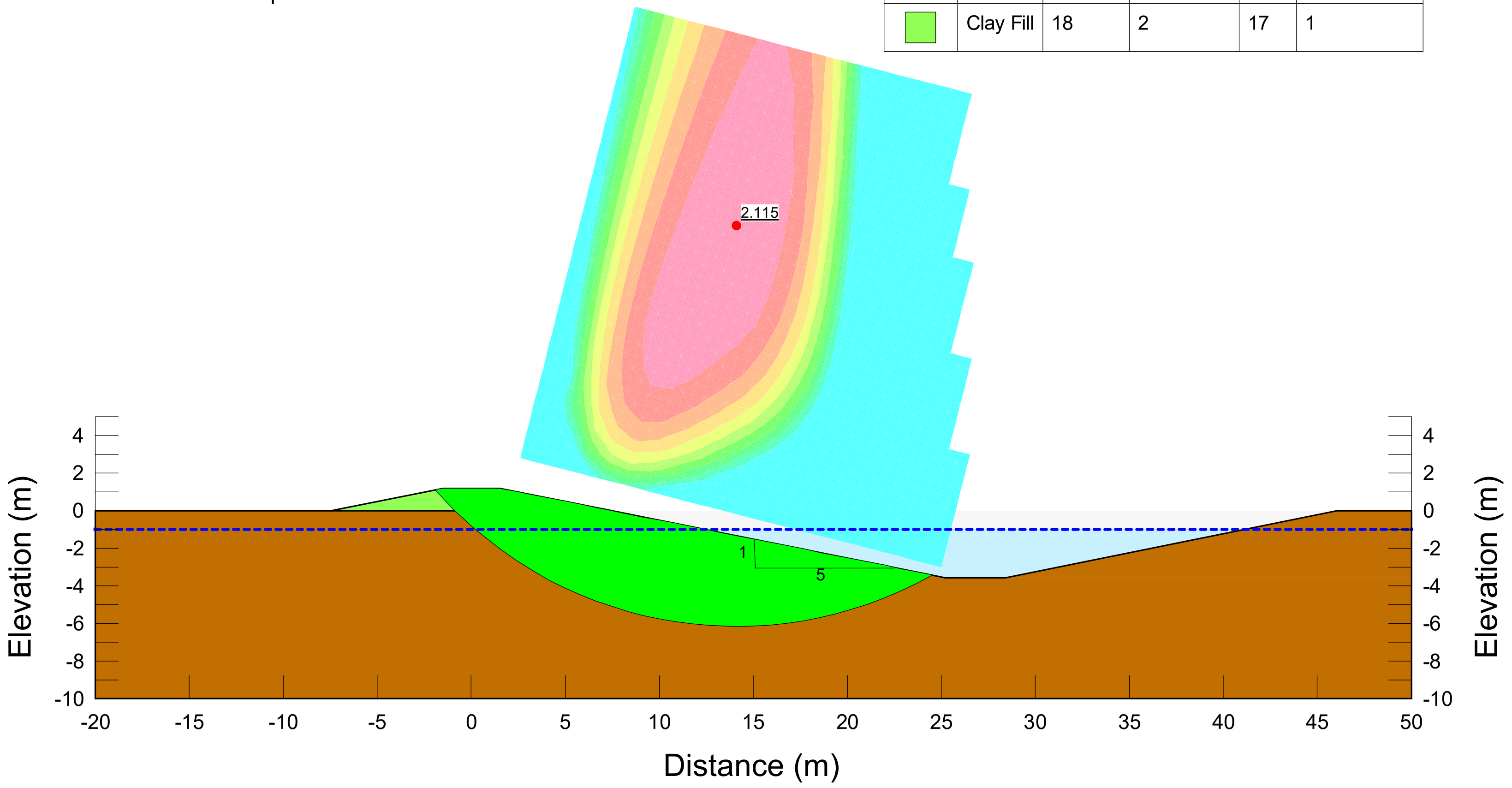
Tabloid (279mm x 432mm)

SAVED: 2022-03-07 4:36:26 PM

SCALE: 1:240 (279mm x 432mm)

Flood Protection Berm: Long-Term Conditions
Berm height: 4.75 m
Berm top width: 3.0 m
Berm side slope: 5H:1V
Ditch Water Level: 1.5 m Deep

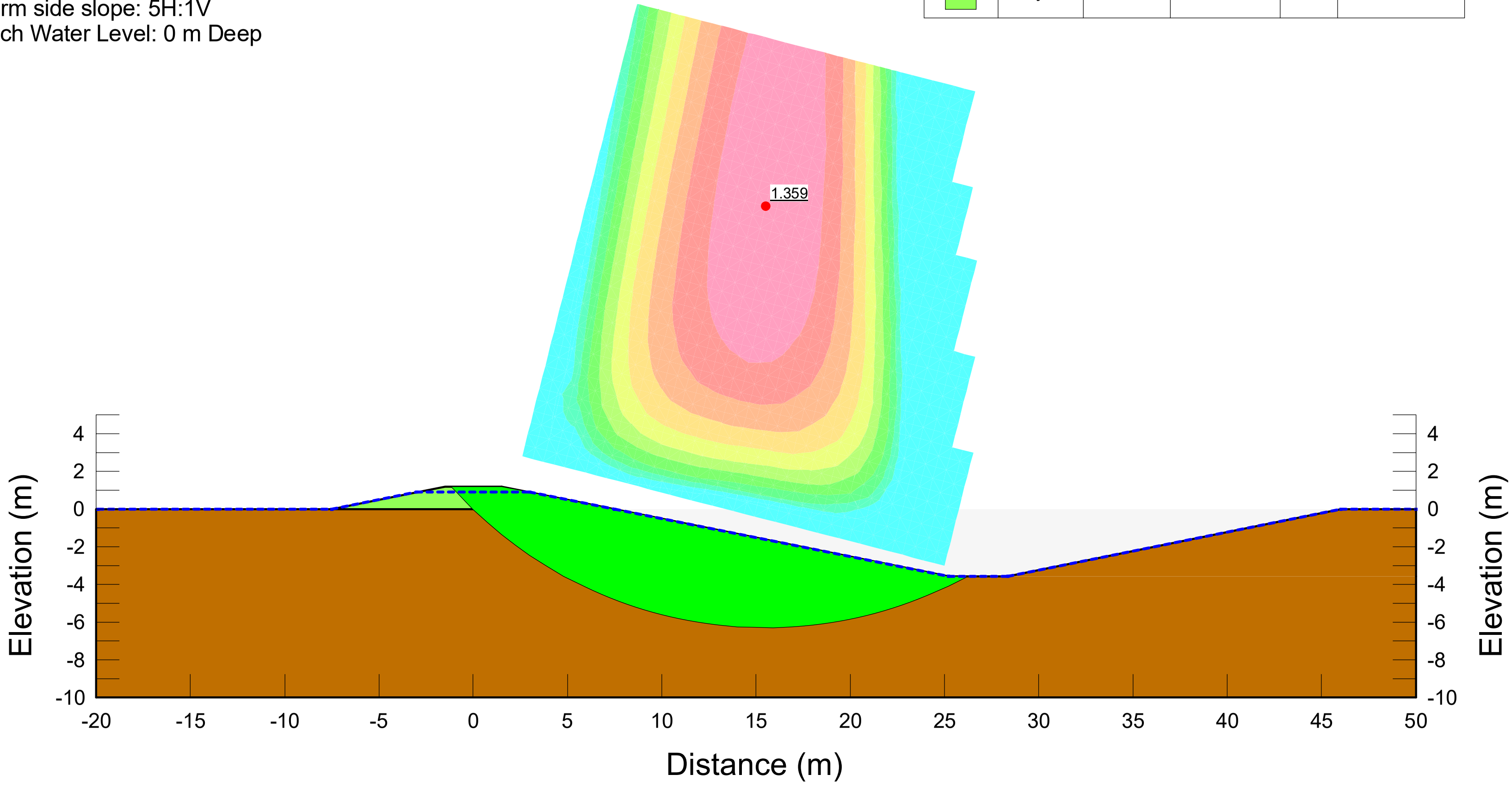
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line
🟫	Clay	17.6	5	17	1
🟩	Clay Fill	18	2	17	1



FILE PATH: Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 032 00 Greenwald Colony\4 Docs\4.4 Deliverables\Rev 1\MOD_08_Flood Protection Berm_NORMAL.gsz

Flood Protection Berm: Short-Term (Post Flood) Conditions
Berm height: 4.75 m
Berm top width: 3.0 m
Berm side slope: 5H:1V
Ditch Water Level: 0 m Deep

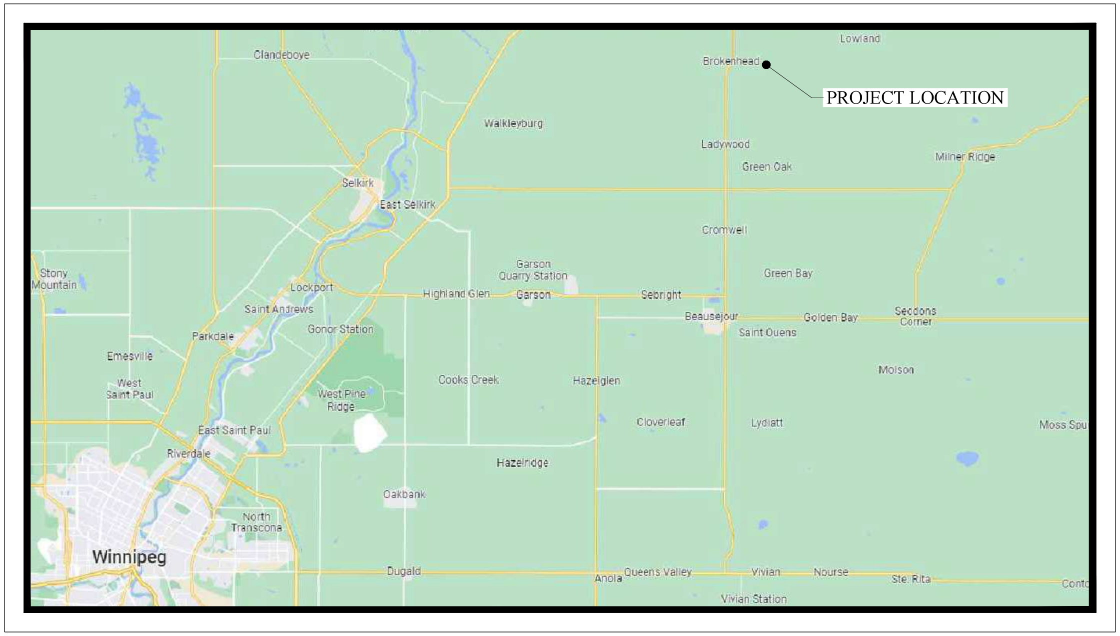
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line
🟫	Clay	17.6	5	17	1
🟩	Clay Fill	18	2	17	1



BURNS MAENDEL
CONSULTING ENGINEERS LTD.

903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

GREENWALD COLONY
DOMESTIC LAGOON DESIGN



NW 33-14-08 EPM
RM OF BROKENHEAD

CIVIL DRAWINGS

DWG NO.	DRAWING NAME	REV
C1.1	SITING PLAN	B
C1.2	LAGOON SITE PLAN	A
C1.3	LAGOON PLAN VIEW	A
C3.1	LAGOON SECTION VIEWS	A
C3.2	SECTIONS AND DETAILS	A
C3.3	FENCING AND SIGNAGE	A

DATE	PROJECT NO:
JUNE 22, 2023	BMCE 2020-155:38

GENERAL NOTES

1. ALL DISTANCES ARE IN METRES AND DECIMALS THEREOF.
2. EXISTING FEATURE LOCATIONS HAVE BEEN DERIVED FROM SURVEY INFORMATION COLLECTED BY BMCE ON DECEMBER 8, 9, & 10 2020.
3. PROPERTY LINE INFROMATION DERIVED FROM A TITLE PLOT SURVEY PROVIDED BY RICHMOND SURVEYS ON OCTOBER 14, 2020.
4. ADJACENT SITE BOUNDARIES DERIVED FROM CADASTRAL PROPERTY LINE INFORMATION THAT WAS OBTAINED FROM MANITOBA LAND INITIATIVE ON MARCH 5, 2021.
5. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.
6. ALL CONSTRUCTION TO BE IN ACCORDANCE WITH THE LATEST EDITION OF MANITOBA WATER SERVICES BOARD STANDARD CONSTRUCTION SPECIFICATIONS.

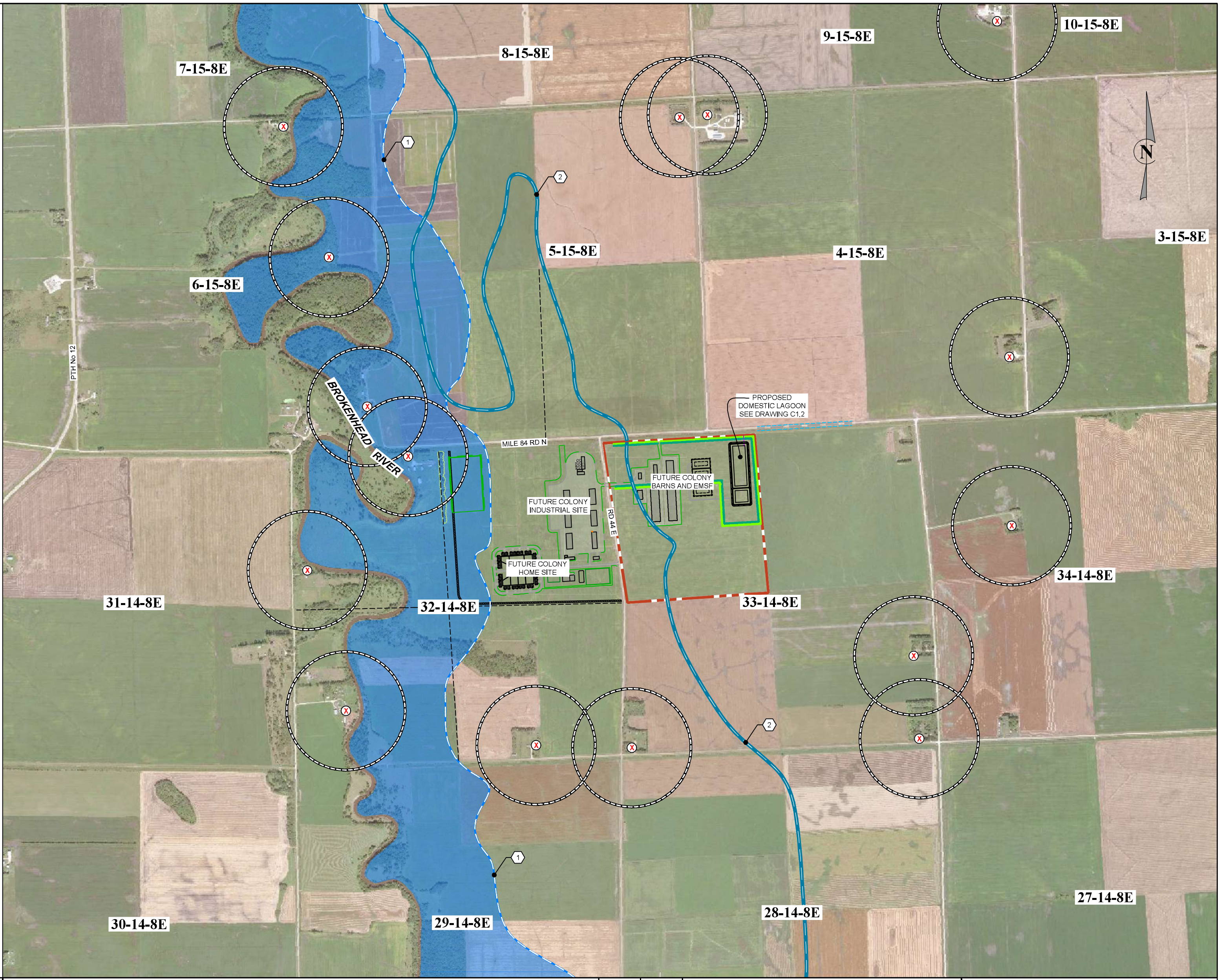
LEGEND

ADJACENT SINGLE RESIDENCE	⊗
SUBJECT SITE PROPERTY LINE	▬ ▬ ▬
RIGHT OF WAY PROPERTY LINE	───
PLAN PROPERTY LINES	───
QUARTER LINE	- - - - - -
300m SETBACK FROM INDIVIDUAL RESIDENCE	▬▬▬
FLOOD HAZARD BOUNDARY (APPROXIMATE)	▬▬▬
WATER PROTECTION BUFFER	🟦

KEYNOTES:

① WATER PROTECTION BUFFER APPROXIMATED FROM **MAP #4, LIVESTOCK OPERATIONS POLICY MAP** OF THE BROKENHEAD RIVER PLANNING DISTRICT DEVELOPMENT PLAN.

② FLOOD HAZARD BOUNDARY APPROXIMATED FROM **MAP #1, FLOOD HAZARD AREA** OF THE BROKENHEAD RIVER PLANNING DISTRICT DEVELOPMENT PLAN.



NO:	DATE	APP.	BY	DESCRIPTION
B	JUNE 22, 2023	AH	CR	ISSUED WITH EAP
A	NOV 17, 2020	CR	DAB	ISSUED FOR CLIENT REVIEW AND COMMENT

REVISIONS

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Burns Maendel Consulting Engineers Ltd.
No. 4559

[redacted]

DESIGNED BY: KD
REVIEWED BY: DB
DRAWN BY: CR
PROJECT START DATE: NOV 4, 2020
PLOT SIZE: A1 (594x841)
SCALE: 1:10,000

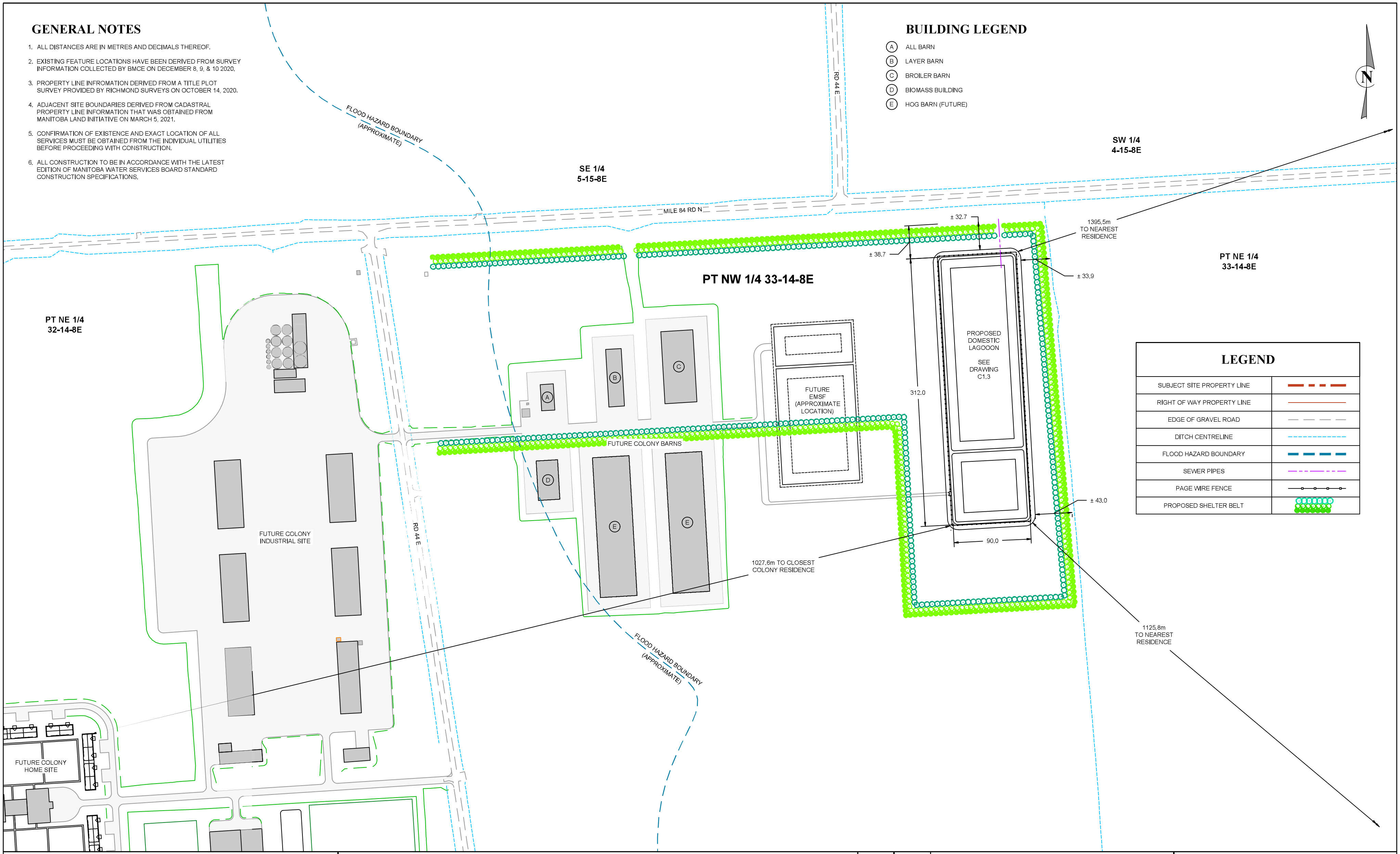
PROJECT NAME:
GREENWALD COLONY
DOMESTIC LAGOON DESIGN
NW 33-14-8 EPM, RM OF BROKENHEAD

BURNS MAENDEL
CONSULTING ENGINEERS LTD.

903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

DRAWING TITLE:
SITING PLAN

PROJECT NUMBER: BMCE-20-155:38
DRAWING NO: C1.1



GENERAL NOTES

1. ALL DISTANCES ARE IN METRES AND DECIMALS THEREOF.
2. EXISTING FEATURE LOCATIONS HAVE BEEN DERIVED FROM SURVEY INFORMATION COLLECTED BY BMCE ON DECEMBER 8, 9, & 10 2020.
3. PROPERTY LINE INFROMATION DERIVED FROM A TITLE PLOT SURVEY PROVIDED BY RICHMOND SURVEYS ON OCTOBER 14, 2020.
4. ADJACENT SITE BOUNDARIES DERIVED FROM CADASTRAL PROPERTY LINE INFORMATION THAT WAS OBTAINED FROM MANITOBA LAND INITIATIVE ON MARCH 5, 2021.
5. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.
6. ALL CONSTRUCTION TO BE IN ACCORDANCE WITH THE LATEST EDITION OF MANITOBA WATER SERVICES BOARD STANDARD CONSTRUCTION SPECIFICATIONS.

BUILDING LEGEND

Ⓐ ALL BARN
Ⓑ LAYER BARN
Ⓒ BROILER BARN
Ⓓ BIOMASS BUILDING
Ⓔ HOG BARN (FUTURE)

LEGEND

SUBJECT SITE PROPERTY LINE	▬ ▪ ▪ ▬
RIGHT OF WAY PROPERTY LINE	──
EDGE OF GRAVEL ROAD	— — —
DITCH CENTRELINE	- - - -
FLOOD HAZARD BOUNDARY	▬ ▬ ▬
SEWER PIPES	— · — · —
PAGE WIRE FENCE	—o—o—o—
PROPOSED SHELTER BELT	○○○○○

NO:	DATE	APP.	BY	DESCRIPTION
A	JUNE 22, 2023	AH	CR	ISSUED WITH EAP

REVISIONS

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Burns Maendel Consulting Engineers Ltd.
No. 4559

[redacted]

DESIGNED BY: KD
REVIEWED BY: DB
DRAWN BY: CR
PROJECT START DATE: NOV 4, 2020
PLOT SIZE: A1 (594x841)
SCALE: 1:2000

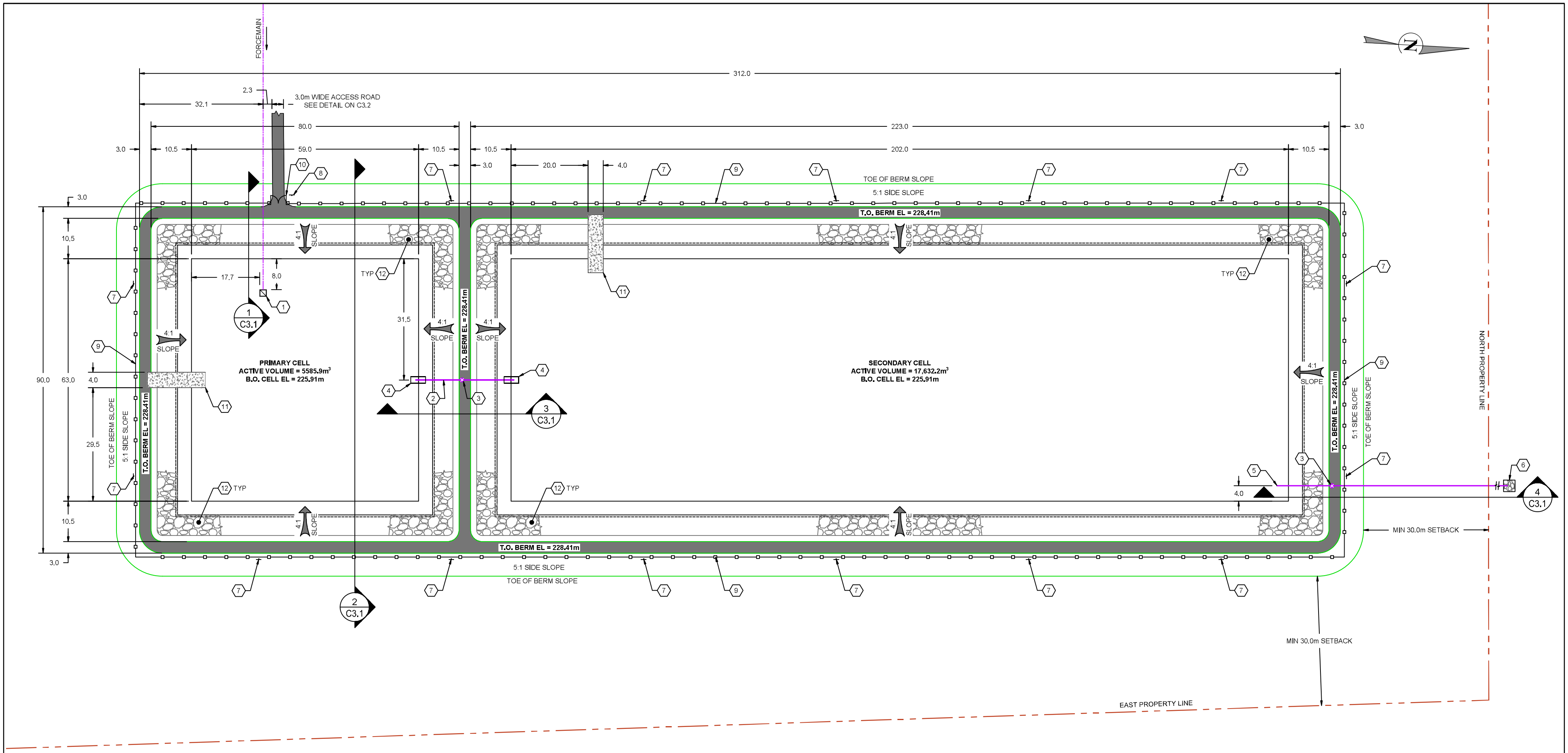
PROJECT NAME:
GREENWALD COLONY
DOMESTIC LAGOON DESIGN
NW 33-14-8 EPM, RM OF BROKENHEAD

BURNS MAENDEL
CONSULTING ENGINEERS LTD.

903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

DRAWING TITLE:
LAGOON SITE PLAN

PROJECT NUMBER: BMCE-20-155:38
DRAWING NO: C1.2



GENERAL NOTES

1. ALL DISTANCES ARE IN METRES AND DECIMALS THEREOF.
2. EXISTING FEATURE LOCATIONS HAVE BEEN DERIVED FROM SURVEY INFORMATION COLLECTED BY BMCE ON DECEMBER 8, 9, & 10, 2020.
3. PROPERTY LINE INFORMATION DERIVED FROM A TITLE PLOT SURVEY PROVIDED BY RICHMOND SURVEYS ON OCTOBER 14, 2020.
4. ADJACENT SITE BOUNDARIES DERIVED FROM CADASTRAL PROPERTY LINE INFORMATION THAT WAS OBTAINED FROM MANITOBA LAND INITIATIVE ON MARCH 5, 2021.
5. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.
6. ALL CONSTRUCTION TO BE IN ACCORDANCE WITH THE LATEST EDITION OF MANITOBA WATER SERVICES BOARD STANDARD CONSTRUCTION SPECIFICATIONS.

LAGOON DESIGN PARAMETERS:

DOMESTIC LOADING

DETENTION TIME:	230 DAYS
LOADING RATE:	300 LITRES / PERSON / DAY
POPULATION:	200 PEOPLE
ORGANIC LOADING RATE:	0.077kg BOD5 / PERSON / DAY
ORGANIC TREATMENT RATE:	56kg BOD5 / (HA*DAY)

LAGOON GEOMETRIC PARAMETERS:

CELL HEIGHT (INCLUDES DEAD SPACE):	1.5 m
FREEBOARD:	1.0 m
TOTAL CELL HEIGHT:	2.5 m
INTERIOR SIDE SLOPE:	4:1
EXTERIOR SIDE SLOPE:	5:1
BERM WIDTH:	3.0 m

KEYNOTES:

1	1800 x 1800 x 150mm THICK CONCRETE INLET PAD c/w 200mm HIGH CURB, REFER TO DETAIL ON SHEET C3.2.
2	Ø150mm EQUALIZATION PIPE.
3	GATE VALVE. REFER TO DETAIL ON SHEET C3.2.
4	1800mm x 3100mm x 150mm THICK CONCRETE SPLASH PAD w/ 200mm HIGH CURB. REFER TO DETAIL ON SHEET C3.2.
5	Ø150mm DISCHARGE PIPE @ 0.5% SLOPE.
6	DISCHARGE PIPE OUTFALL c/w GEOTEXTILE FABRIC AND 3m x 3m x 0.3m OF RIP RAP.
7	PERIMETER SIGN. REFER TO SHEET C3.3 FOR DETAILS.
8	MAIN ENTRANCE SIGN. REFER TO SHEET C3.3 FOR DETAILS.
9	PERIMETER FENCE. REFER TO SHEET C3.3 FOR DETAILS.
10	PERIMETER FENCE GATE. REFER TO SHEET C3.3 FOR DETAILS.
11	4.0m WIDE CONCRETE ACCESS RAMP. REFER TO DETAIL ON C3.2.
12	RIP RAP AROUND PERIMETER OF EACH CELL SHALL BE INSTALLED IN ACCORDANCE WITH MANITOBA INFRASTRUCTURE STANDARD CONSTRUCTION SPECIFICATION - SPECIFICATIONS FOR STONE RIP RAP - PART 1297.2.2 STONE RIP-RAP GRADATION CLASS 350.

NO:	DATE	APP.	BY	DESCRIPTION
A	JUNE 22, 2023	AH	CR	ISSUED WITH EAP

REVISIONS

ENGINEERS
GEOSCIENTISTS
MANITOBA
Certificate of Authorization
Burns Maendel Consulting
Engineers Ltd.
No. 4559

[redacted]

DESIGNED BY: KD
REVIEWED BY: DB
DRAWN BY: CR
PROJECT START DATE: JANUARY 2023
PLOT SIZE: A1 (594x841)
SCALE: AS NOTED

PROJECT NAME:
GREENWALD COLONY
DOMESTIC LAGOON DESIGN
NW 33-14-8 EPM, RM OF BROKENHEAD

BURNS MAENDEL
CONSULTING ENGINEERS LTD.

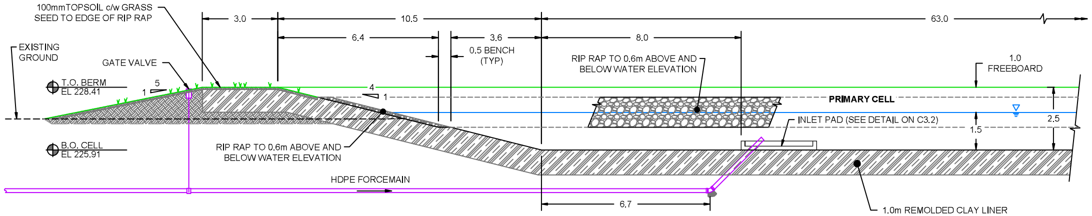
903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

DRAWING TITLE:
LAGOON PLAN VIEW

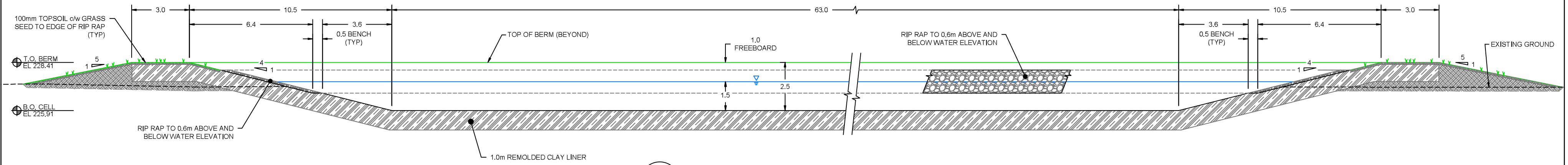
PROJECT NUMBER: BMCE-20-155:38
DRAWING NO: C1.3

GENERAL NOTES

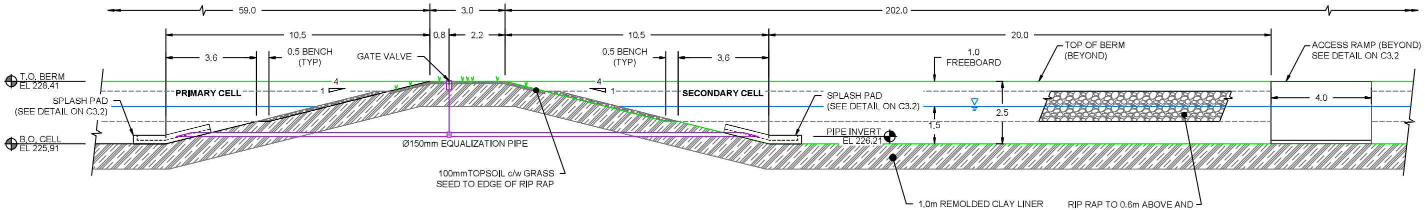
1. ALL DISTANCES ARE IN METRES AND DECIMALS THEREOF.
2. EXISTING FEATURE LOCATIONS HAVE BEEN DERIVED FROM SURVEY INFORMATION COLLECTED BY BMCE ON DECEMBER 8, 9, & 10, 2020.
3. PROPERTY LINE INFORMATION DERIVED FROM A TITLE PLOT SURVEY PROVIDED BY RICHMOND SURVEYS ON OCTOBER 14, 2020.
4. ADJACENT SITE BOUNDARIES DERIVED FROM CADASTRAL PROPERTY LINE INFORMATION THAT WAS OBTAINED FROM MANITOBA LAND INITIATIVE ON MARCH 5, 2021.
5. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.
6. ALL CONSTRUCTION TO BE IN ACCORDANCE WITH THE LATEST EDITION OF MANITOBA WATER SERVICES BOARD STANDARD CONSTRUCTION SPECIFICATIONS.



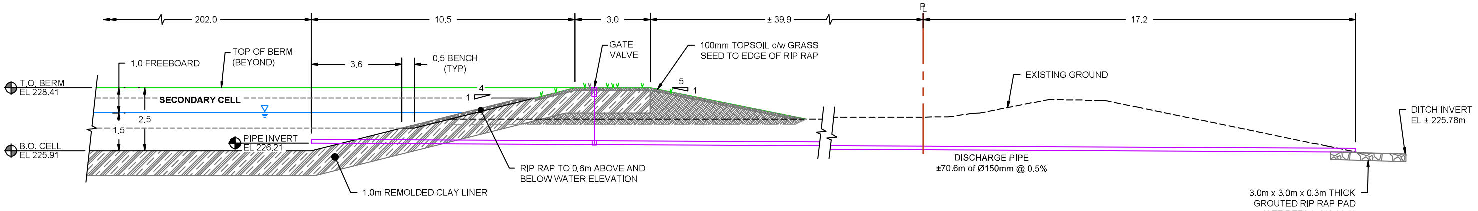
1 / C1.3 **FORCEMAIN PIPE SECTION VIEW**
SCALE: 1:100



2 / C1.3 **TYPICAL LAGOON SECTION VIEW**
SCALE: 1:100



3 / C1.3 **EQUALIZATION PIPE SECTION VIEW**
SCALE: 1:100



4 / C1.3 **DISCHARGE PIPE SECTION VIEW**
SCALE: 1:100

NO:	DATE	APP.	BY	DESCRIPTION
A	JUNE 22, 2023	AH	CR	ISSUED WITH EAP

REVISIONS

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Burns Maendel Consulting Engineers Ltd.
No. 4559

[redacted]

DESIGNED BY: KD
REVIEWED BY: DB
DRAWN BY: CR
PROJECT START DATE: JANUARY 2023
PLOT SIZE: A1 (594x841)
SCALE: AS NOTED

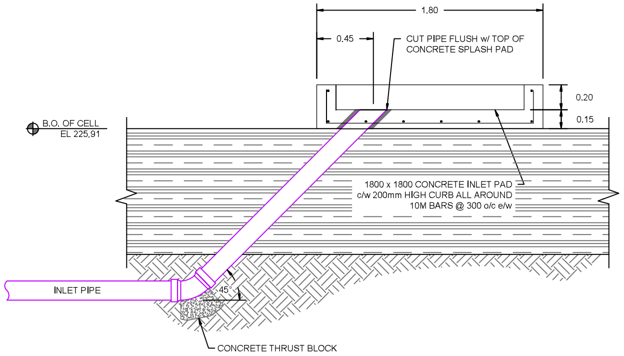
PROJECT NAME:
GREENWALD COLONY
DOMESTIC LAGOON DESIGN
NW 33-14-8 EPM, RM OF BROKENHEAD

BURNS MAENDEL
CONSULTING ENGINEERS LTD.

903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

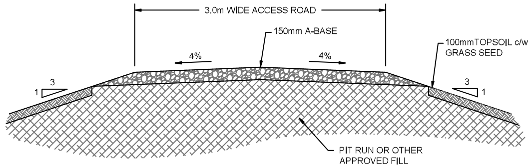
DRAWING TITLE:
LAGOON SECTION VIEWS

PROJECT NUMBER: BMCE-20-155:38
DRAWING NO: C3.1



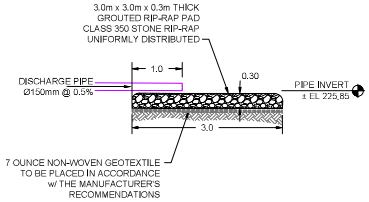
INLET PAD DETAIL

SCALE: 1:20



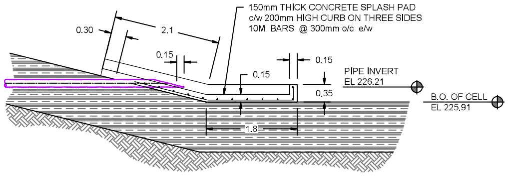
ACCESS ROAD SECTION

SCALE: 1:30



GROUTED RIP RAP PAD

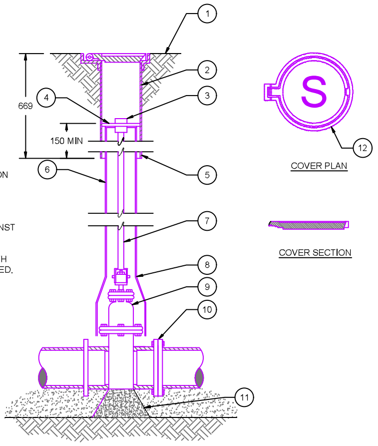
SCALE: 1:50



TYPICAL SPLASH PAD DETAIL

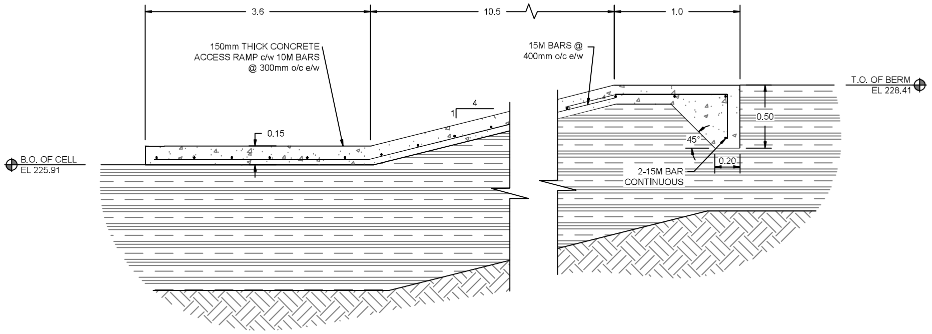
SCALE: 1:50

- (1) GRADE
- (2) DUCTILE IRON UPPER SECTION
- (3) 50mm SQUARE OPERATING NUT
- (4) STONE DISC.
- (5) ADJUSTABLE VALVE BOX
- (6) PVC or DUCTILE IRON LOWER SECTION
- (7) MINIMUM 50mm SQUARE EXTENSION SPINDLE
- (8) VALVE BOX TO BE PROTECTED AGAINST LATERAL MOVEMENT DURING BACKFILL
- (9) AWWA C500 or C509 GATE VALVE WITH JOINTS COMPATIBLE TO PIPE BEING USED. (FLANGED & PUSH ON ARE SHOWN)
- (10) GASKET
- (11) 450x450x150 CONCRETE BLOCK PLACED ON UNDISTURBED SOIL
- (12) DUCTILE IRON COVER, MARKED "S" FOR SEWER.



TYPICAL GATE VALVE DETAIL

SCALE: 1:10



CONCRETE ACCESS RAMP SECTION

SCALE: 1:20

NO:	DATE	APP.	BY	DESCRIPTION
A	JUNE 22, 2023	AH	CR	ISSUED WITH EAP

REVISIONS

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Burns Maendel Consulting Engineers Ltd.
No. 4559

[redacted]

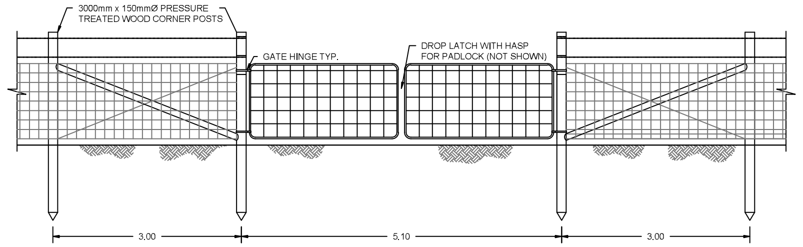
DESIGNED BY: KD
REVIEWED BY: DB
DRAWN BY: CR
PROJECT START DATE: JANUARY 2023
PLOT SIZE: A1 (594x841)
SCALE: AS NOTED

PROJECT NAME:
GREENWALD COLONY
DOMESTIC LAGOON DESIGN
NW 33-14-8 EPM, RM OF BROKENHEAD

BURNS MAENDEL
CONSULTING ENGINEERS LTD.
903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

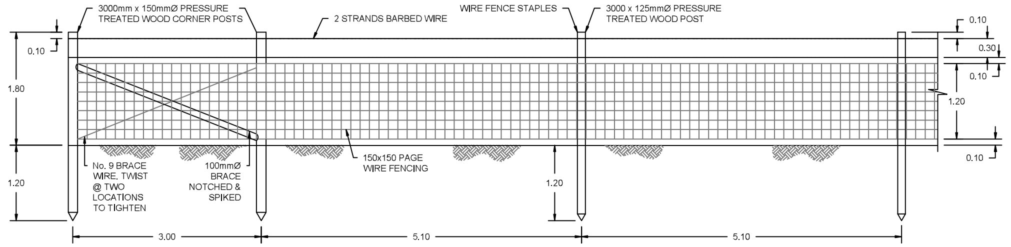
DRAWING TITLE:
SECTIONS AND DETAILS

PROJECT NUMBER: BMCE-20-155:38
DRAWING NO: C3.2



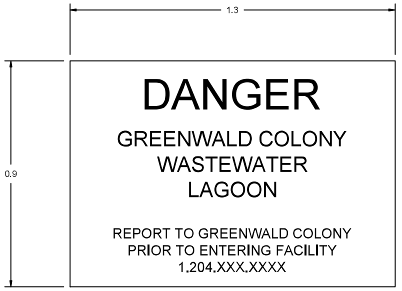
PAGE WIRE FENCE GATE DETAIL

SCALE: N.T.S.

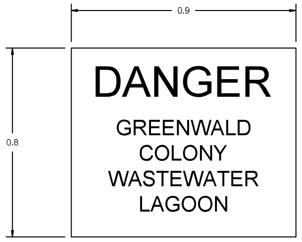


PAGE WIRE FENCE DETAIL

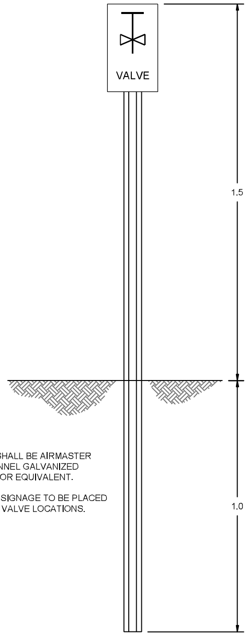
SCALE: N.T.S.



NOTES:
1) MAIN ENTRANCE SIGNAGE TO BE ATTACHED AND INSTALLED WITH TWO 4x4 PRESSURE TREATED WOOD POSTS.
2) SIGN TO BE CONSTRUCTED OF ALUMINUM AIR MASTER QUALITY OR APPROVED EQUAL.



NOTES:
1) PERIMETER SIGNAGE TO BE SECURED TO PERIMETER FENCE POSTS EVERY 50m AROUND ENTIRE FACILITY.
2) SIGNS TO BE CONSTRUCTED OF ALUMINUM AIR MASTER QUALITY OR APPROVED EQUAL.



NOTES:
1) POST SHALL BE AIRMASTER U-CHANNEL GALVANIZED STEEL OR EQUIVALENT.
2) VALVE SIGNAGE TO BE PLACED AT ALL VALVE LOCATIONS.

SIGNAGE DETAILS

SCALE: N.T.S.

NO:	DATE	APP.	BY	DESCRIPTION
A	JUNE 22, 2023	AH	CR	ISSUED WITH EAP

REVISIONS

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Burns Maendel Consulting Engineers Ltd.
No. 4559

[redacted]

DESIGNED BY: KD
REVIEWED BY: DB
DRAWN BY: CR
PROJECT START DATE: JANUARY 2023
PLOT SIZE: A1 (594x841)
SCALE: AS NOTED

PROJECT NAME:
GREENWALD COLONY
DOMESTIC LAGOON DESIGN
NW 33-14-8 EPM, RM OF BROKENHEAD

BURNS MAENDEL
CONSULTING ENGINEERS LTD.

903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

DRAWING TITLE: FENCING AND SIGNAGE

PROJECT NUMBER: BMCE-20-155:38

DRAWING NO: C3.3

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

July 11, 2022 Our File No. 0105-059-00

Kyla Dietrich E.I.T.
Burns Maendel Consulting Engineers Ltd.
903 Rosser Avenue
Brandon, MB
R7A 0L3

RE: Greenwald Colony Community Development – Brokenhead River Assessment

The following memorandum summarizes the hydrotechnical analysis of local flood impacts from the proposed Greenwald Colony community development located approximately 20 km north of Beausejour, MB and adjacent to the Brokenhead River. The community development will include residential, industrial and agricultural structures, as well as a school and gymnasium, church, cemetery, sports field, ice rink, lagoon, manure storage cell, flood protection berms, parking areas, and access roads. The proposed development is located within the Brokenhead River floodplain, and a flood protection dike/berm is to be constructed to protect the community from a 1:200 year flood event. As per the Brokenhead Development Plan policy *3.6.1 FLOODING, BANK INSTABILITY AND EROSION HAZARD AREAS*[1], the developer needs to demonstrate that the proposed flood protection will not increase flood levels and velocities under 1:200 year flood conditions, thereby further exacerbating local flooding of adjacent properties. Figure 1 and Figure 2 have been provided (appended) to show the location of the study site and pertinent details.

TREK assessed the existing hydraulic conditions within the Brokenhead River reach adjacent to the proposed Greenwald Colony Community development in Section NE 32-14-8 E as proposed by Burns Maendel Consulting Engineers Ltd. (BMCE). Furthermore, this study assessed the potential effect that the proposed flood protection berm may have on water levels and velocities within the Brokenhead River adjacent to the development.

Flood Hydrology

The hydraulic conditions of the Brokenhead River within the study reach have been assessed over a range of Brokenhead River flows up to the 0.5% (1:200 year) flood. The Brokenhead River is ungauged at the study site, requiring that hydrologic estimates be made using regional techniques. The Regional Method computations utilize the Water Survey of Canada streamflow gauge located upstream in the watershed near Beausejour (Brokenhead River near Beausejour - 05SA002) as the index gauge. Manitoba Transportation and Infrastructure (MTI) provided updated frequency flows (attached in Appendix A) for the gauge on July 4, 2022. The drainage area to the study site has been delineated as approximately 2,232 km^2. The discharge coefficients for the study site have been backcalculated using regional techniques based on the drainage area to the gauge (1,577 km^2) and the frequency flows provided by MTI for the Brokenhead River streamflow gauge using the applicable regional exponent (n=0.765 for Zone 3). TREK calculated the flood discharge estimates for the study site through proration based on the larger drainage area (2,232 km^2) and the backcalculated coefficients from the Brokenhead River near

---

[1] "Brokenhead River Planning District – Development Plan", Brokenhead River Planning District Board, Part 3 Community Wide Policies, Page 38.

Beausejour (05SA002) index gauge. The discharge estimates and coefficients are summarized in Table 1.

Table 1 – Brokenhead River Flood Hydrology at the Proposed Greenwald Colony Development

Discharge Event	Mean Daily Discharge Coefficient*	Mean Daily Discharge Brokenhead River Drainage Area = 2,232 km^2 (m^3/s)	Instanteous Peak Discharge Coefficient*	Instantaneous Peak Discharge Brokenhead River Drainage Area = 2,232 km^2 (m^3/s)
0.5%	0.591	215.2	0.607	221.4
1%	0.505	183.9	0.520	189.5
2%	0.426	155.2	0.440	160.3
3%	0.383	139.6	0.396	144.4
5%	0.329	120.0	0.342	124.5
10%	0.261	95.2	0.272	99.3
20%	0.197	71.7	0.207	75.4
50%	0.161	42.4	0.170	45.5

*Discharge coefficients backcalculated for frequency flows provided by MTI in July 2022 for the Brokenhead River near Beausejour WSC gauge (05SA002) using regional techniques utilizing the 1,577 km^2 drainage area and the reginal exponent 0.765.

Hydraulic Assessment – Existing Conditions

The Brokenhead River within the reach is a moderately sized river with a well-defined meandering main channel and heavily vegetated overbank areas. Normal flows, up to approximately a 50% discharge, are typically conveyed within the main channel, while flood flows typically extend into the overbank area. The slope of the river channel within the study reach is approximately 0.012%. Photos of the Brokenhead River within this reach are appended for reference.

A detailed steady-state backwater model of the Brokenhead River within the reach adjacent to the proposed Greenwald Colony development was developed to assess the existing hydraulic conditions within the river. The steady state hydraulic analysis was undertaken using the US Army Corps of Engineers River Analysis System HEC-RAS model. The HEC-RAS model is a one-dimensional backwater model, which is considered to be the universal standard for computing steady-state water surface profiles. It was judged that one-dimensional flow conditions predominate over the study reach. The backwater model is an extension of a previous model developed by MTI for the Brokenhead River which extends from Garven Road 66N upstream to Road 87N. MTI's provided HEC-RAS model, from June 2022, used LIDAR based cross-sections with estimated bathymetry for the lower portion of the Brokenhead River downstream of Road 66N, which included the study reach. TREK updated the HEC-RAS model within the study reach by incorporating additional cross-sections and bathymetric details for the main channel, surveyed by GDS Surveys in July 2022, which enables a more refined assessment of hydraulics within the area. The backwater model incorporates a cross-section immediately adjacent to the development, in addition to cross-sections both upstream and downstream of the development to enable accurate representation of hydraulic conditions, in addition to permitting an evaluation of the relative effects of the proposed flood protection berm on water levels and velocities for a distance upstream and downstream of the development.

The backwater model has been developed to the level of detail required to estimate the relative effect of the existing river conditions and proposed flood protection berm. The model has not been calibrated to observed water levels during periods of high flow, and hydraulic parameters such as hydraulic roughness have been selected based on judgement and experience gained from similar projects. The backwater model takes the variability of the hydraulic roughness across the cross-section width into consideration for the hydraulic calculations. The hydraulic roughness is primarily dependent on the bed material and the density of vegetation. The Manning's n hydraulic roughness values used in the detailed model are presented in Table 1.

Ineffective flow areas have been delineated and defined within the cross-sections to ensure that only the effective part of the cross-section is available for conveyance. The ineffective flow area is defined as the part of a cross section, which although wetted, does not provide area for discharge conveyance. The ineffective flow line is only defined within areas where topographical features (such as a swale, dike, embankment, etc) would influence the hydraulics characteristics of a particular cross-section.

Table 2 - Manning's n Hydraulic Roughness Values – Brokenhead River

Location	Manning's "n"
Left Overbank	Varies from 0.04 in cultivated areas to 0.1 in medium to dense brush and treed areas adjacent to the river
Main Channel	0.035
Right Overbank	Varies from 0.04 in cultivated areas to 0.1 in medium to dense brush and treed areas adjacent to the river

The estimated water surface profiles within the Brokenhead River under existing conditions are shown in Figure 3.

Hydraulic Assessment – Proposed Conditions

The approximate location of the proposed flood protection berm adjacent to the Brokenhead River is shown on Figure 2 as proposed by BMCE. The preliminary layout and details of the proposed flood protection berm have been provided by BMCE and are appended for reference.

Based on the design information provided by BMCE on July 7, 2022, the proposed berm will be constructed with a crest elevation of approximately 228.48 m CGVD 28 (228.0 m CGCD2013), with a side slope of 1V: 5H. Figure 4 shows a typical cross-section located within the study reach adjacent to the development as provided by BMCE, indicating the proposed berm placement. The developed area would be protected against a Brokenhead River flood up to a 0.5% event (200-year event). Note that BCME was provided with an initial flood protection level (FPL) for the proposed berm crest of 227.31 m (745.76 feet) CGVD28 by MTI for the development. The FPL provided by MTI includes a freeboard allowance above the 200 year water level. In order to assess the effects of the proposed berm on water surface profiles and channel velocities, the berm geometry has to be defined within the backwater model. Cross sections affected by the berm placement within the study reach have been modified to incorporate the proposed berm geometry. The estimated Brokenhead River water surface profiles with the proposed fill placement are shown in Figure 5.

As illustrated in Figure 4, it is evident that the proposed berm has no effect on upstream water surface profiles, as it is not located within the estimated 1:200-year flood fringe. As shown in Figure 4, the majority of the flow conveyance is contained within the deeper overbank section adjacent to the river and not within the flatter overbank area at the study location.

The estimated 0.5% (200-year) event water levels and velocities for cross-section 7 at STA 57+75 under the existing and proposed (i.e., post development) conditions are summarized in Table 3 below.

Table 3 – Brokenhead River 1:200 Year Flood
Estimated Hydraulic Conditions at the Proposed Development AT XS 7 (STA 57+75)

Conditions	**Design Discharge (m^3/s)**	**Estimated Water Level at Proposed Development* (m asl)**	**Estimated Average Main Channel Velocity adjacent to Proposed Development* (m/s)**
Existing Conditions: Design Flood (1:200 year) IP Modelled by TREK	221.4	227.38	0.85
Proposed Conditions: Design Flood (1:200 year) IP Modelled by TREK	221.4	227.38	0.85

-Elevations are based on the vertical datum CGVD28.

*-Suggested Flood Protection Level from MTI for the proposed dike crest (April 08, 2022).

The estimated water level in the Brokenhead River for the 200 year event is approximately 227.38 m which is higher than the FPL (227.31) provided by MTI without a freeboard applied. Assuming a minimum 0.9 m freeboard above the 200 year level for the crest elevation, would yield a minimum required crest elevation of 228.28 m. As noted, BCME has proposed a crest elevation of 228.48 m, which is slightly higher than our required minimum crest level providing 1.1 m of freeboard.

Conclusion and Recommendations

The proposed flood protection berm placement, although located within the Flood Hazard Area as per the RM Brokenhead River Planning District Development Plan Map #1 (Appendix A)[2], would have no effect on upstream water levels and velocities within the Brokenhead River study reach up to the estimated 1:200 year event on the Brokenhead River. Additionally, the berm crest elevation proposed (228.48), provides approximately 1.1 m of freeboard above the 200 year flood level on the Brokenhead River, which is judged to be acceptable.

---

[2] "Brokenhead River Planning District – Development Plan", Brokenhead River Planning District Board, Appendix A – MAP #1 – Flood Hazard Area, Page 87.

Closure

The hydrotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice).

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.

If you have any questions regarding the findings or recommendations presented, please contact the undersigned at your earliest convenience.

TREK Geotechnical Inc.
Per:

[redacted]

[redacted]

Micha Roemer, M.Sc., P.Eng.
Water Resources Engineer

Reviewed By:

[redacted]

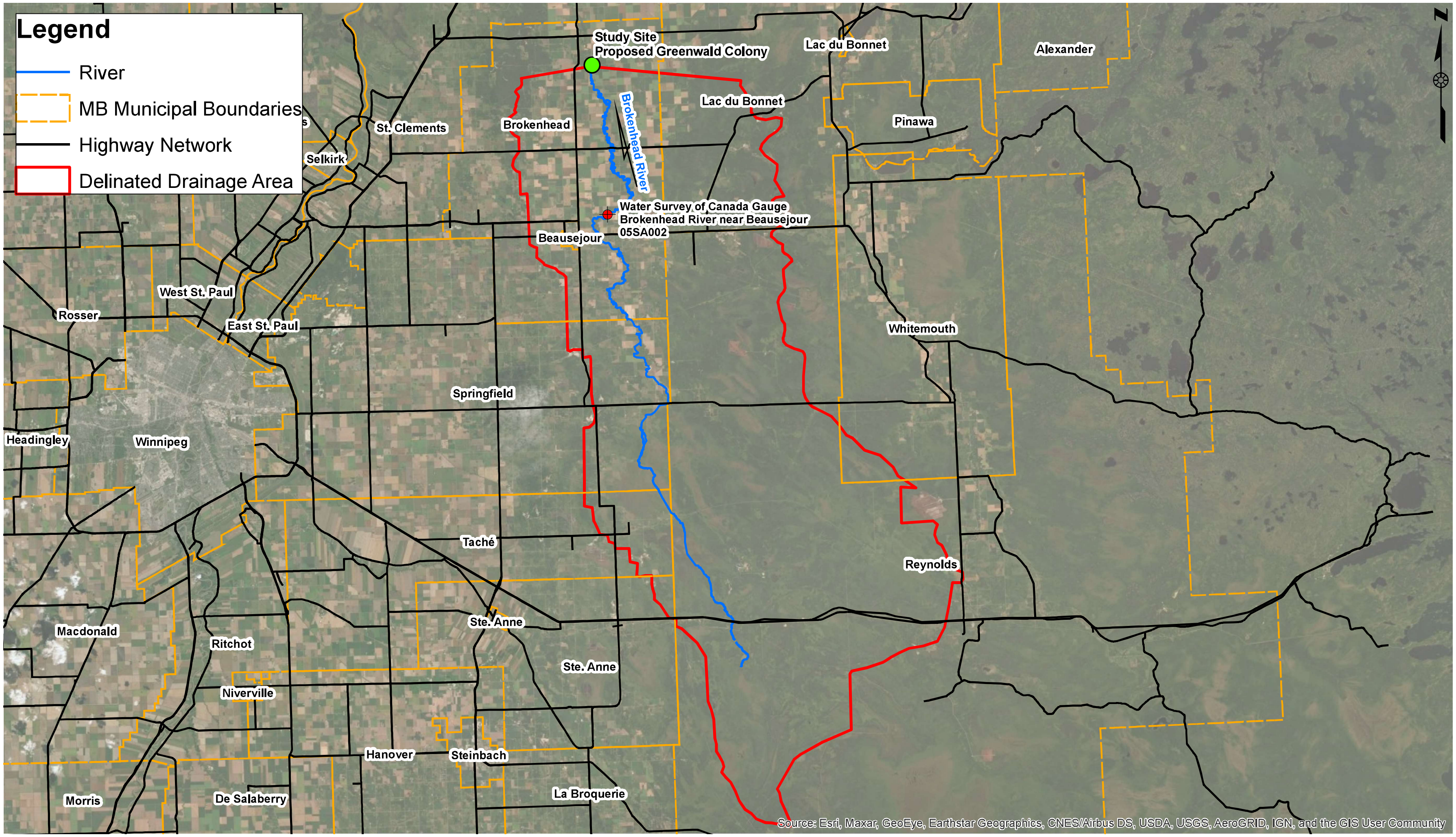
Bruce Harding, P.Eng.
Senior Water Resources Engineer

ENGINEERS
GEOSCIENTISTS
MANITOBA
[redacted]
Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877 Date: July 11/22

Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 059 00 Brokenhead River Assessment\4 Docs\4.4 Deliverables\LTR 2022-07-11 Greenwald Colony River Assessment 0_Final 0105 059 00.docx

Figures

0105 059 00
Burns Maendel Consulting Engineers Ltd.
Greenwald Colony Community Development – Brokenhead River Assessment



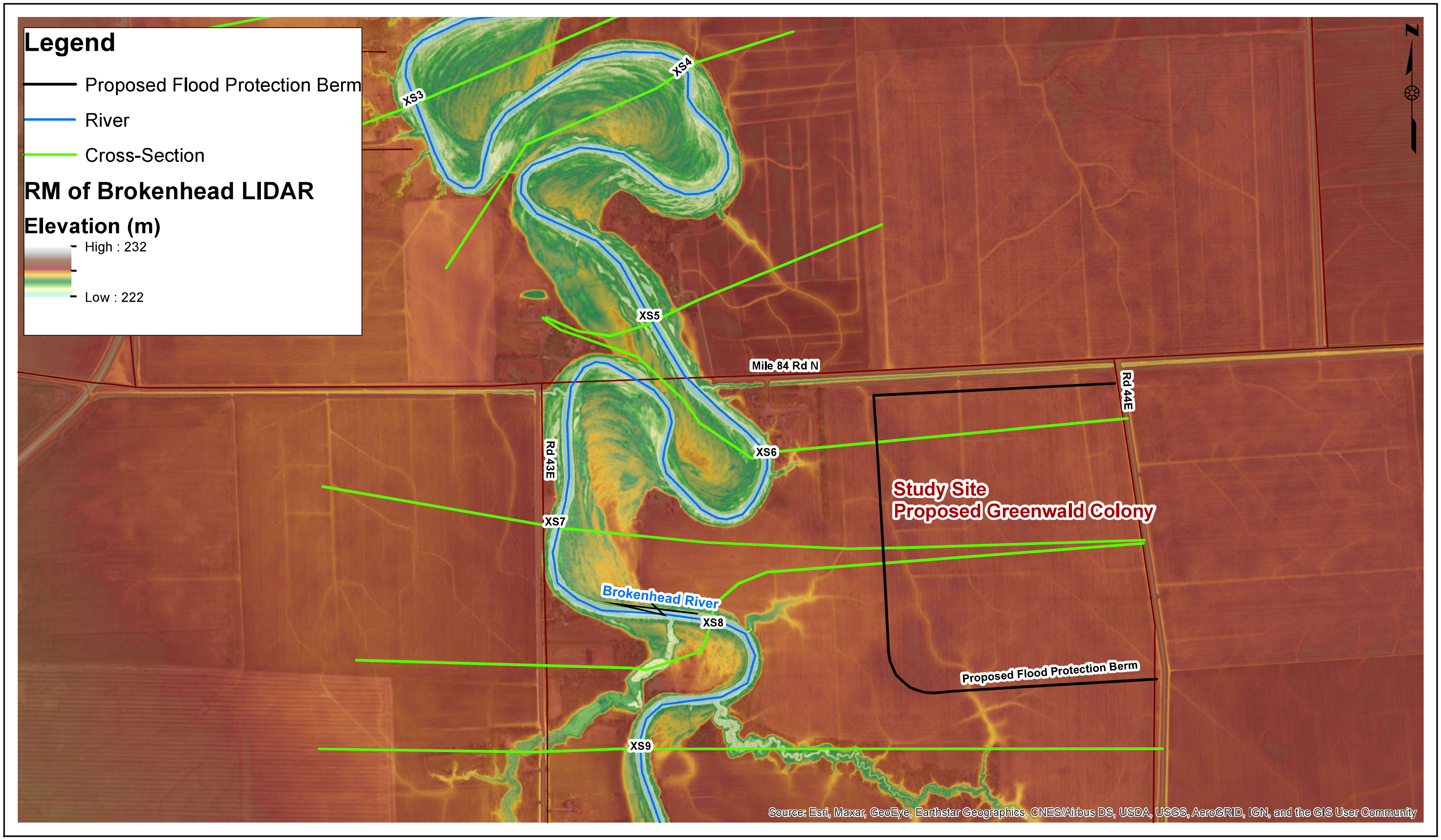
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Document Path: Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 059 00 Brokenhead River Assessment\3 Survey and Dwg\3.3 GIS\Location_Plan_TREK_TEMPLATE.mxd

NOTES:

1. REFERENCE: CANVEC © NATURAL RESOURCES CANADA, 2012
2. REFERENCE: MLI © 2001, HER MAJESTY THE QUEEN IN RIGHT OF MANITOBA, AS REPRESENTED BY THE MINISTER OF CONSERVATION

Figure 01
BROKENHEAD RIVER
LOCATION PLAN AND DRAINAGE AREA



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Document Path: Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 059 00 Brokenhead River Assessment\3 Survey and Dwg\3.3 GIS\Location_Plan_TREK_TEMPLATE_Figure 2.mxd

NOTES:

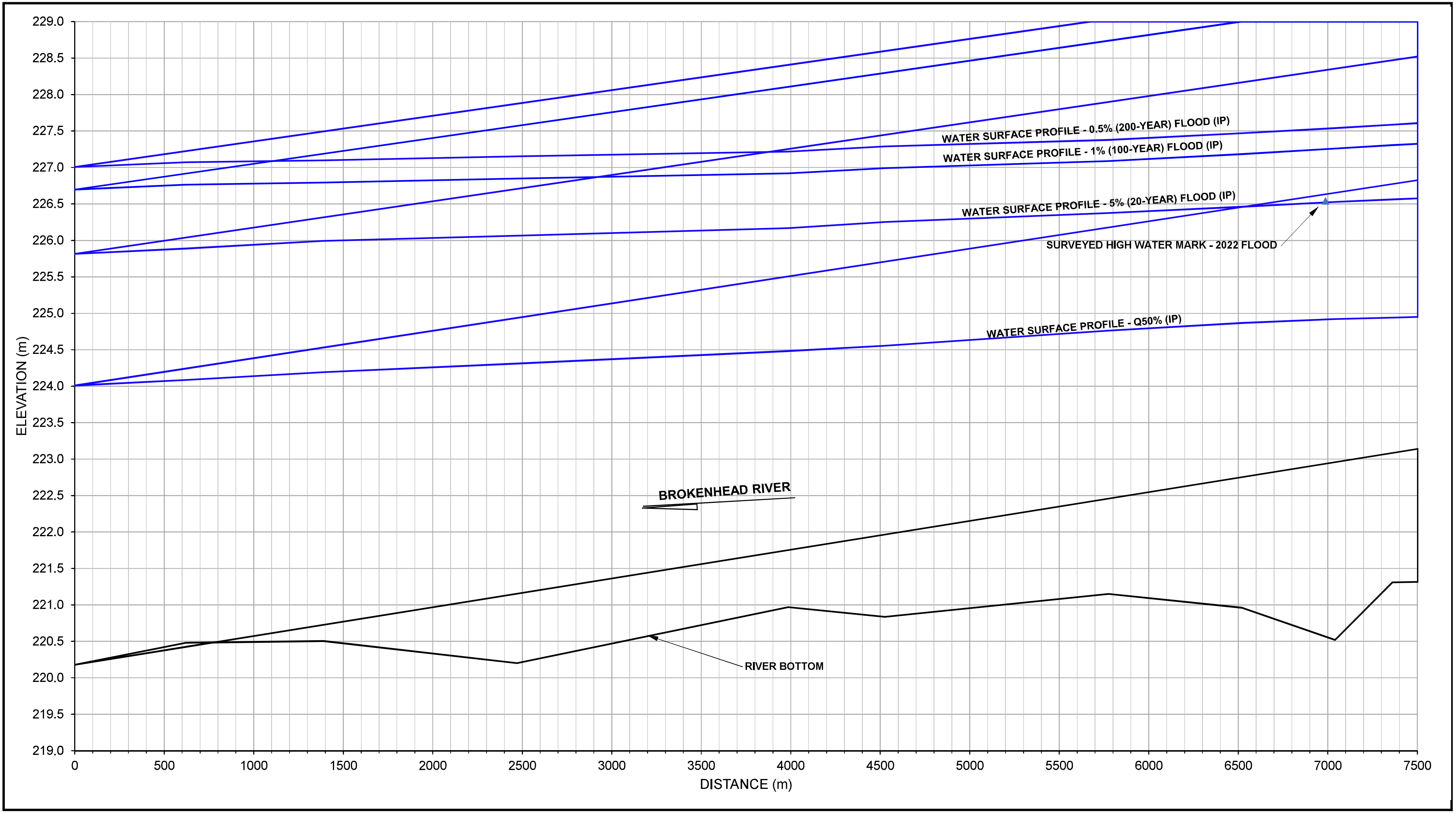
1. REFERENCE: CANVEC © NATURAL RESOURCES CANADA, 2012
2. REFERENCE: LIDAR PROVIDED BY MTI FOR THE RM OF BROKENHEAD

Figure 02
BROKENHEAD RIVER
STUDY SITE

0105 059 00

Burns Maendel Consulting Engineers Ltd.

Greenwald Colony Community Development – Brokenhead River Assessment



Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 059 00 Brokenhead River Assessment\2 Design\2.9 Analysis and Design Notes\[2022-07-08 Brokenhead- Existing PREDEV WSP 0_A_MR 0105 059 00.xlsx]WSP

Figure 03

BROKENHEAD RIVER - GREENWALD COLONY DEVELOPMENT

EXISTING CONDITIONS - WATER SURFACE PROFILES

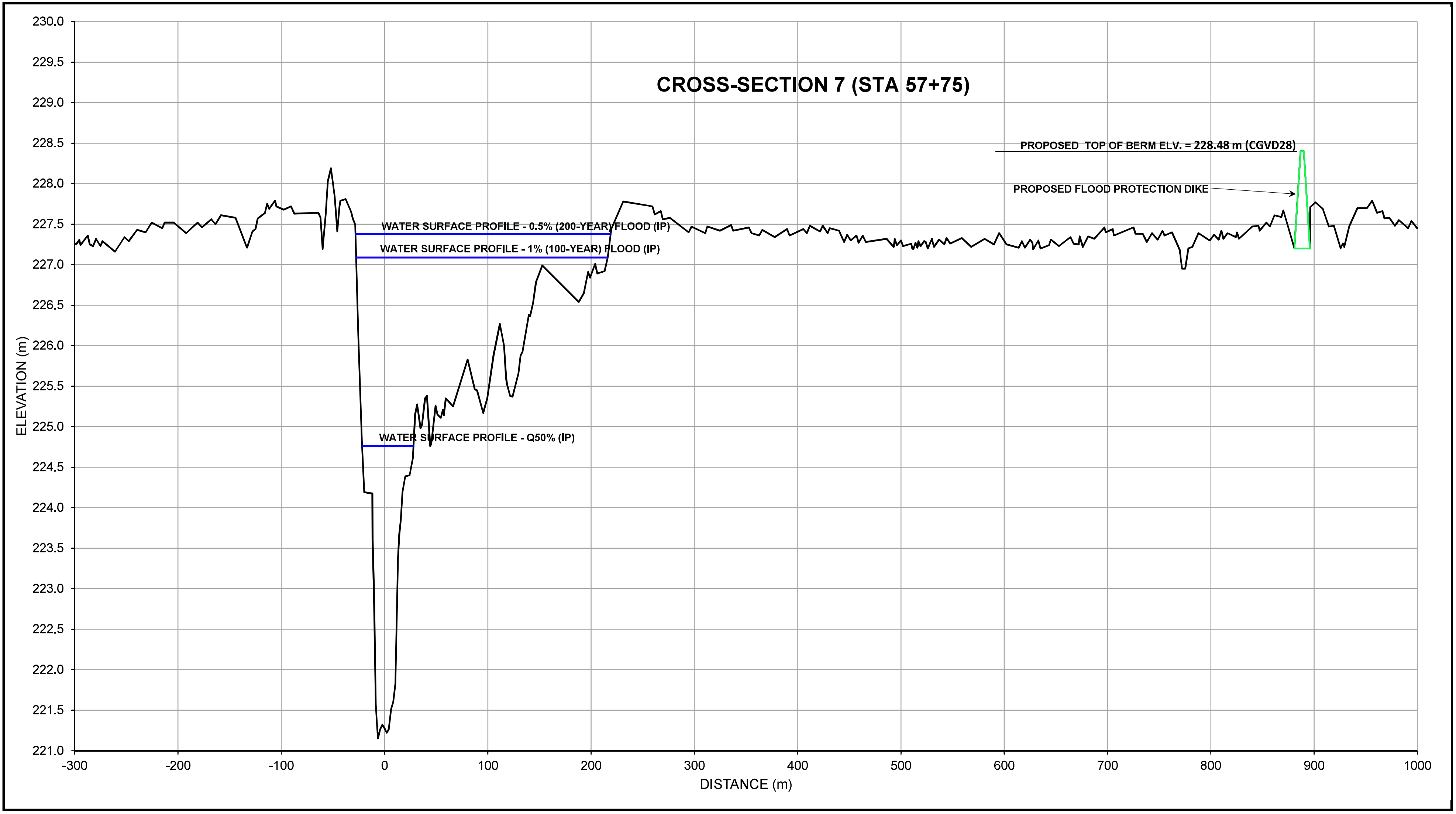
NOTES:

1. HEC-RAS MODEL DEVELOPED FROM JUNE 2022 SURVEY DATA PROVIDED BY GDS SURVEYS AND RM OF BROKENHEAD LIDAR DATA.
2. WATER SURFACE PROFILES REFLECT PRE-DEVELOPMENT CONDITIONS .

0105 059 00

Burns Maendel Consulting Engineers Ltd.

Greenwald Colony Community Development – Brokenhead River Assessment



Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 059 00 Brokenhead River Assessment\2 Design\2.9 Analysis and Design Notes\[2022-07-08 Brokenhead-XS_Plot 0_A_MR 0105 059 00.xlsx]Profile Data

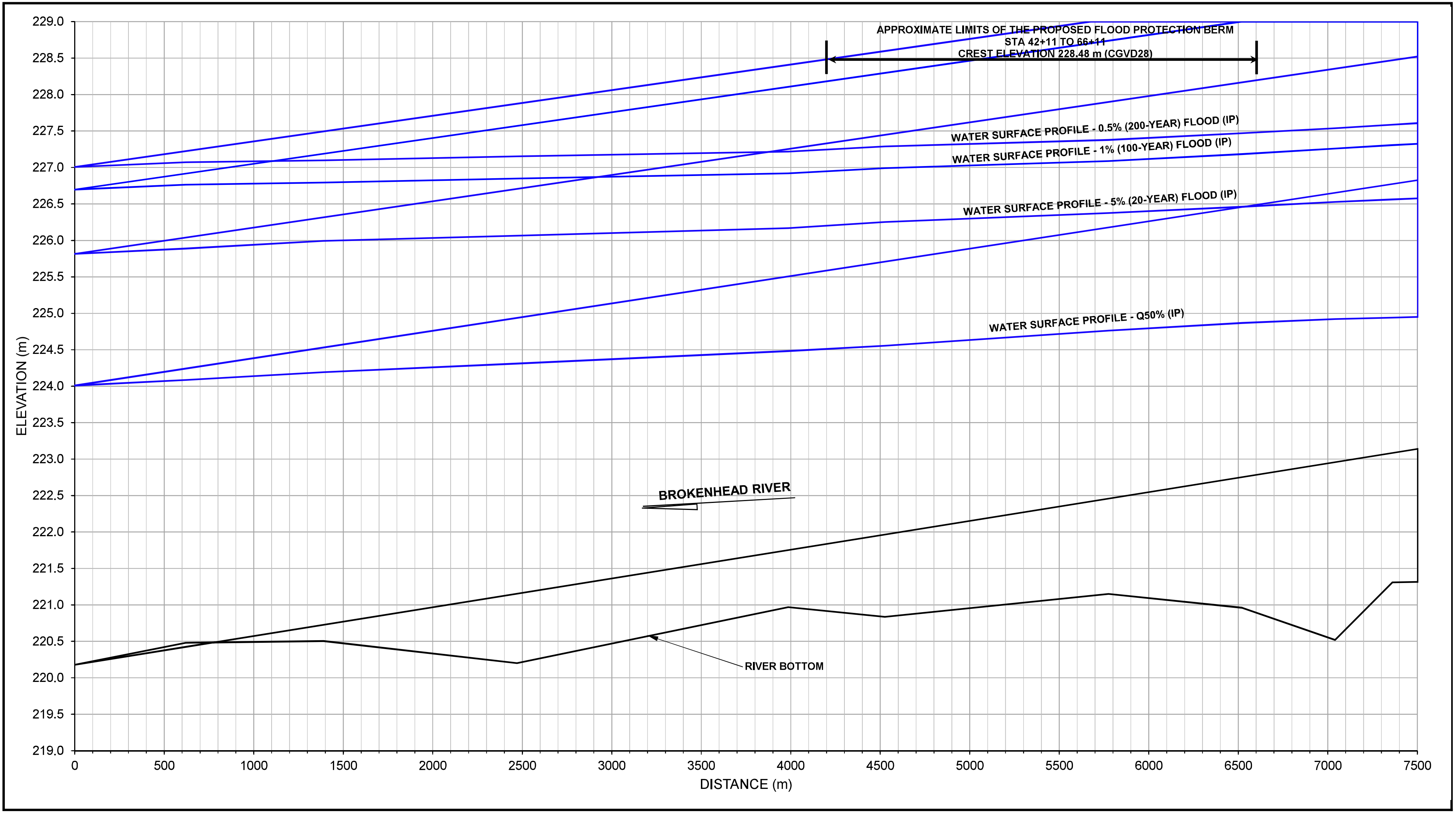
NOTES:

1. HEC-RAS MODEL DEVELOPED FROM JUNE 2022 SURVEY DATA PROVIDED BY GDS SURVEYS AND RM OF BROKENHEAD LIDAR DATA.
2. WATER LEVELS REFLECT THE EXISTING HYDRAULIC CONDITIONS PRE-DEVELOPMENT.

Figure 04

BROKENHEAD RIVER - GREENWALD COLONY DEVELOPMENT

TYPICAL CROSS-SECTION



Z:\Projects\0105 Burns Maendel Consulting Ltd\0105 059 00 Brokenhead River Assessment\2 Design\2.9 Analysis and Design Notes\[2022-07-08 Brokenhead- Post Dev WSP 0_A_MR 0105 059 00.xlsx]WSP

NOTES:

1. HEC-RAS MODEL DEVELOPED FROM JUNE 2022 SURVEY DATA PROVIDED BY GDS SURVEYS AND RM OF BROKENHEAD LIDAR DATA.
2. WATER SURFACE PROFILES REFLECT POST-DEVELOPMENT CONDITIONS WITH THE CONSTRUCTED FLOOD PROTECTION BERM.

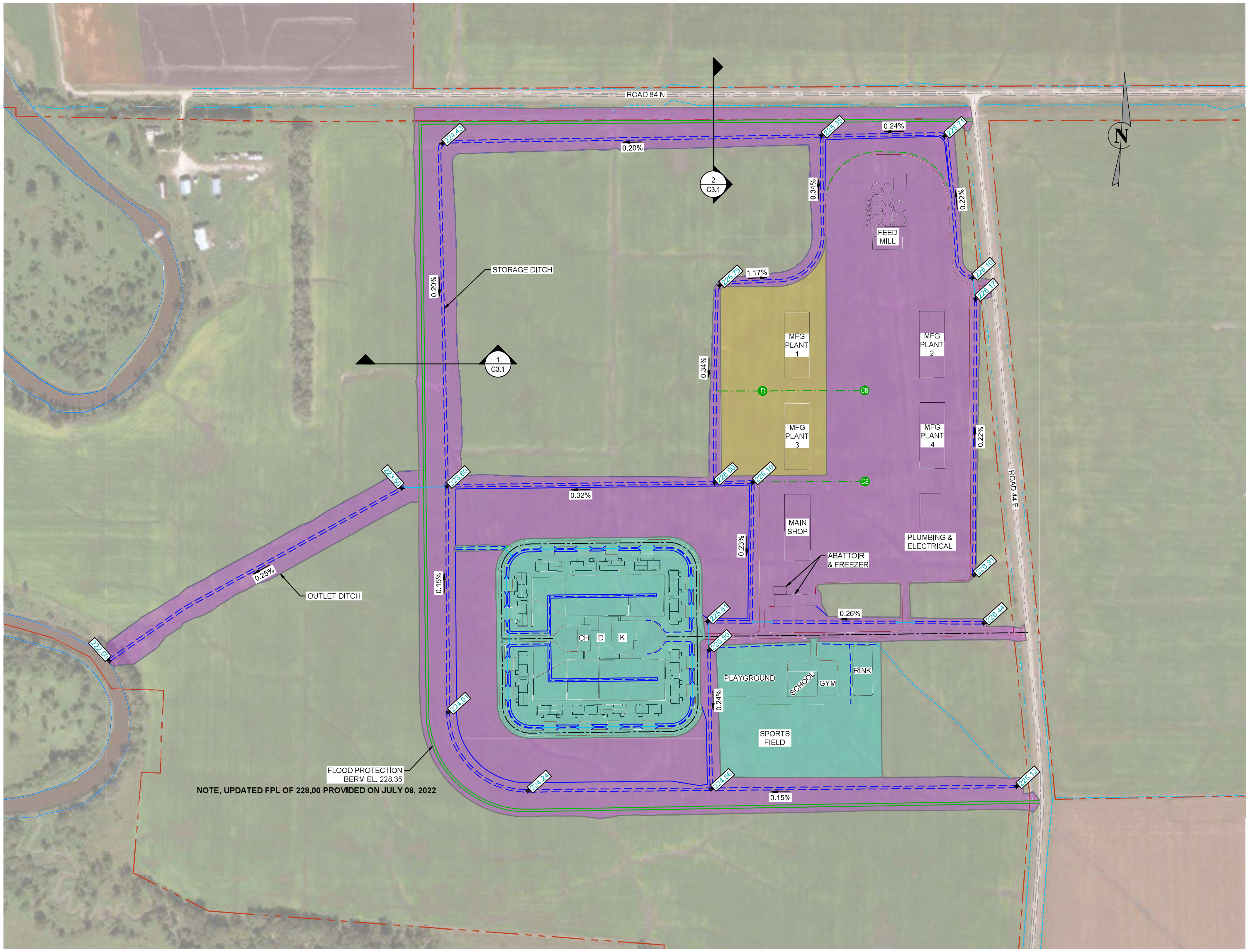
Figure 05

BROKENHEAD RIVER - GREENWALD COLONY DEVELOPMENT

POST-DEVELOPMENT CONDITIONS - WATER SURFACE PROFILES

GENERAL NOTES:

1. ALL UNITS ARE IN METRES AND DECIMALS THEREOF.
2. PROPERTY LINE INFORMATION IS DERIVED FROM SURVEY INFORMATION COLLECTED BY RICHMOND SURVEYS ON OCTOBER 7, 2020.
3. EXISTING FEATURE LOCATION AND ELEVATIONS WERE DERIVED FROM TOPOGRAPHIC SURVEY COLLECTED BY BMCE ON DATES DECEMBER 8, 9, & 10, 2020.
4. ALL ELEVATIONS ARE GEODETIC AND ARE REFERENCED TO THE NRCAN MONUMENT "69-M-126" (CGVD 2013) LOCATED IN BEAUSEJOUR, MANITOBA.



NOTE, UPDATED FPL OF 228.00 PROVIDED ON JULY 08, 2022

LEGEND

PROPERTY LINE	— — —
TOP OF DITCH	——
TOE OF DITCH	- - -
TOP OF BERM	——
TOE OF BERM	- - -
PROPOSED ROAD	——
PROPOSED ROAD CENTRE LINE	— · —
EXISTING ROAD	- - -
EXISTING ROAD CENTRE LINE	— · —
EXISTING DITCH	- - -
PROPOSED LDS MAIN	——
GRADING BREAKLINE	- - -
PROPOSED CATCH BASIN	CB
PROPOSED LDS MANHOLE	D
PROPOSED CULVERT	▷—◁
PROPOSED ELEVATION	100.00
PROPOSED GUTTER / DITCH	100.00
GRADE AT BUILDING	100.00
GRADE SLOPE	2.0% →
PHASE 1 CONSTRUCTION	🟪
PHASE 2 CONSTRUCTION	🟦
PHASE 3 CONSTRUCTION	🟨

ESTIMATED EARTHWORKS QTYS

	PHASE 1	PHASE 2 (RES)	PHASE 2 (SCHOOL)	PHASE 3
TOPSOIL STRIPPING (ASSUME 200mm)	59720 m³	11640 m³	6340 m³	5900 m³
COMMON CUT	161700 m³	3900 m³	0 m³	500 m³
COMMON FILL	151930 m³	27270 m³	13000 m³	39600 m³
GRANULAR BASE (20mm DOWN)	14875 m³	1686 m³	150 m³	4425 m³
GRANULAR SUB-BASE (37.5mm DOWN)	34705 m³	2984 m³	240 m³	10325 m³

NO.	DATE	APP.	BY	DESCRIPTION
A	MAR 22,2022	AH	JA	ISSUED FOR CLIENT REVIEW

REVISIONS

PRELIMINARY
FOR REVIEW AND COMMENT ONLY

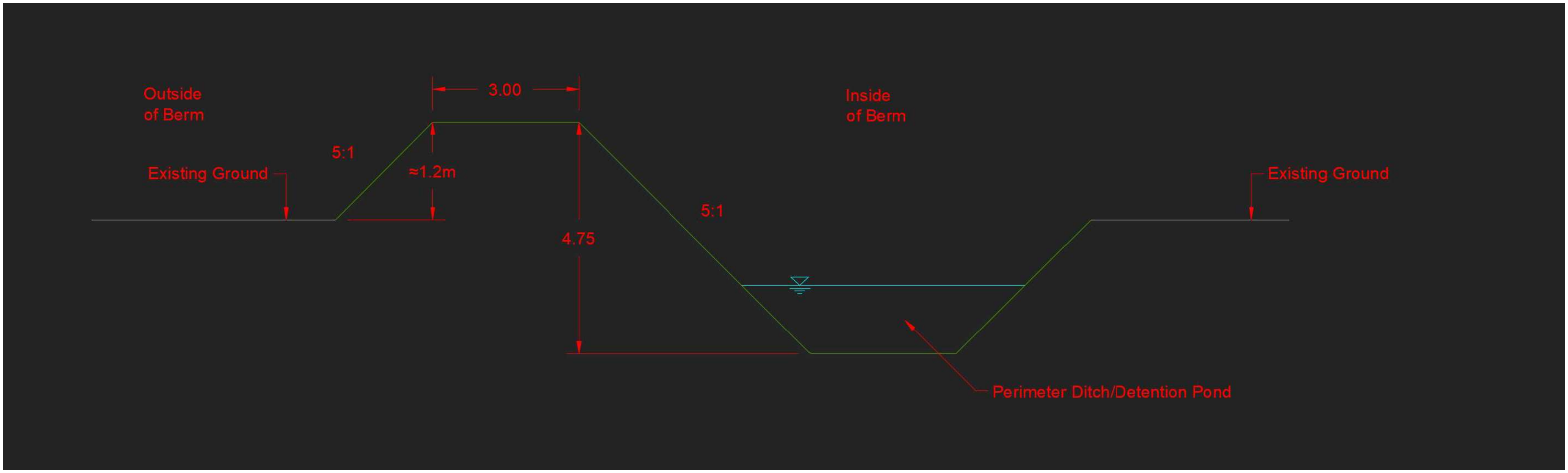
DESIGNED BY: AH
REVIEWED BY: DB
DRAWN BY: JA
PROJECT START DATE: JAN 14, 2021
PLOT SIZE: A1 (594x841)
SCALE: 1:2500(m)

PROJECT NAME:
GREENWALD COLONY
NEW SITE DEVELOPMENT
RM OF BROKENHEAD

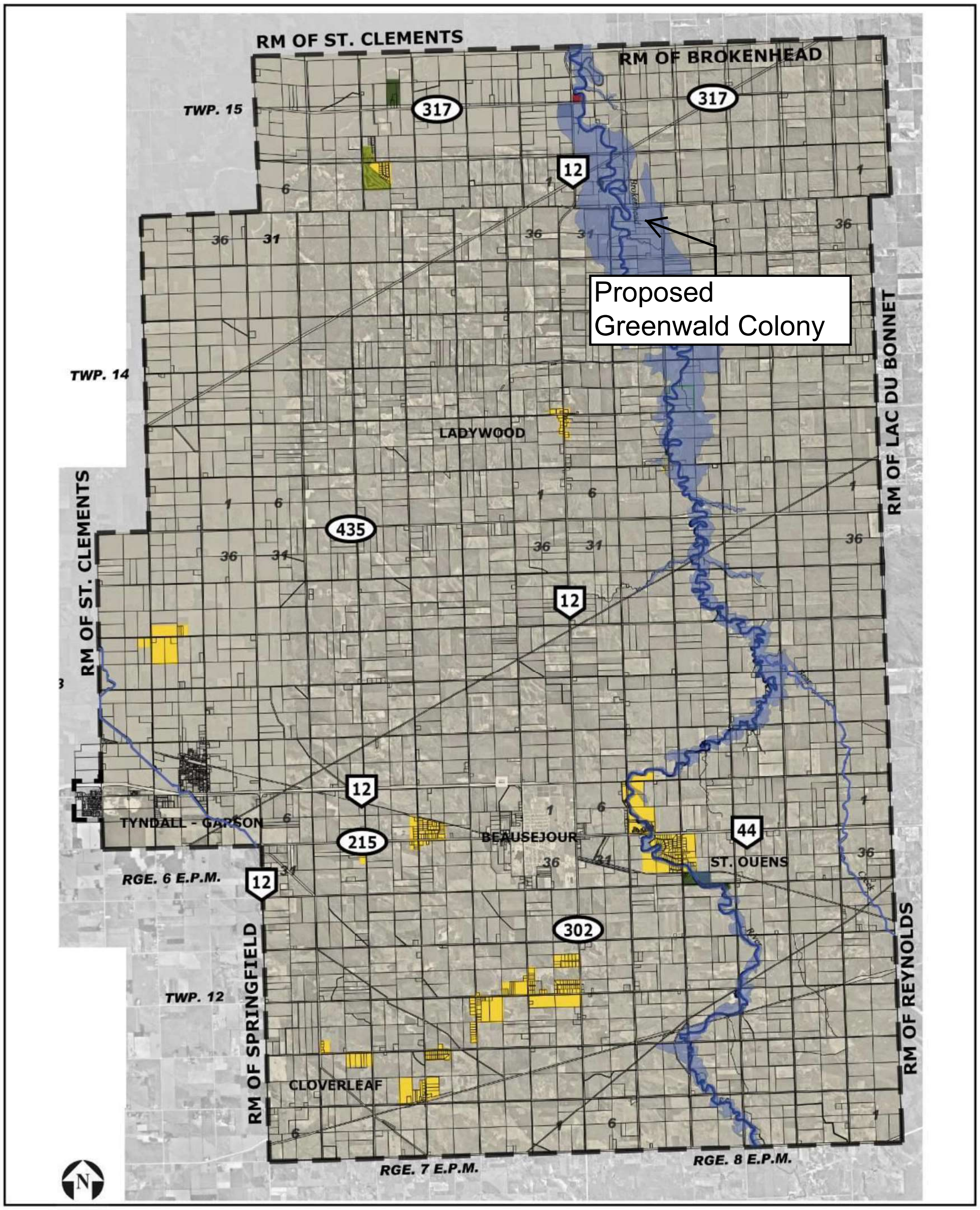
BURNS MAENDEL
CONSULTING ENGINEERS LTD.
903 Rosser Ave.
Brandon, Manitoba
R7A 0L3
Tel: (204) 728-7364
Fax: (204) 728-4418

DRAWING TITLE:
GRADING AND DRAINAGE
SITE PLAN

PROJECT NUMBER: BMCE2020-155
DRAWING NO: C1.1


Outside
of Berm
3.00
Inside
of Berm
5:1
≈1.2m
Existing Ground
5:1
4.75
Existing Ground
Perimeter Ditch/Detention Pond

APPENDIX A - MAP #1 - FLOOD HAZARD AREA



LEGEND

▨	FLOOD HAZARD AREA	—○—⬠—	HIGHWAY
▨	RURAL RESIDENTIAL	∿	WATERWAY

Information Source: Manitoba Local Government

Photos

Photo 1: Brokenhead River near XS 7 – Looking East (June 21, 2022)

Photo 2: Brokenhead River near XS 7 – Looking Downstream (June 21, 2022)