March 21, 2019 File: 2018-4227

PO Box 272
Okotoks, AB T1S 1A5

Attention: Mr. Jorie McKenzie, PL (Eng), PMP

**Re: Slope Stability Assessment**
**Urban Star Horse Creek Development**
**Rocky View County, Alberta**

This report presents the results of a slope stability assessment completed by E2K Engineering Ltd. (E2K) at the above noted site known as Urban Star Horse Creek Development. It is understood that preparation of a conceptual scheme of this site is underway. According to the information provided to E2K at the time of this report, the proposed development will consist of a 280 acres fully serviced residential development.

The objective of the assessment was to evaluate soil and groundwater conditions in order to assess the stability of slopes with the proposed site configuration and provide geotechnical recommendations for the proposed development.

## 1.0 SITE DESCRIPTION

The site is located at NE-29-26-4-W5M and SE-32-26-04-W5M, northwest of Cochrane, adjacent to Range Road 44, and south of Weedon Trail in Rocky View County.

The investigated area is approximately 1500 m x 650 m and is bound by Range Road 44 to the east, private properties to the north, and an escarpment along the west and south sides. The escarpment overlooks Horse Creek Road to the west and south.

According to the available drawings, the maximum elevation difference across the site is approximately 60 m with critical slopes of 13% to 26%. The site slopes down towards the west and south. The drainage pattern at this site is towards the west and south, where the escarpment is located.

A driveway provides access from Range Road 44 to a residence located in the middle of the site, and the rest of the site is undeveloped. Two high pressure and low pressure gas lines owned by Plains Midstream and Cochrane Gas Co-Op run along the east side of the site.

The site was comprised of several fenced fields at the time of the investigation, and was covered with snow.

A review of aerial imagery and on-site visual slope assessment indicates the slope is mostly vegetated with grass with no evidence of past slope instability.

Based on our survey of the boreholes, the elevation variation across the portion of the site investigated was approximately 14 m. The east portion of the site is relatively flat with an approximate slope of 2% down towards the east.

## 2.0 SCOPE OF WORK

The scope of work as executed included the following:

- conduct a geotechnical borehole investigation
  - procurement of a drilling subcontractor;
  - review of ground disturbance documents (line locates);
  - supervision of the drilling of thirty six (36) boreholes to depths described in Section 3.0. The boreholes were labeled as BH-01 to BH-36;
  - detailed logging of soil stratigraphy and groundwater conditions encountered during the geotechnical investigation using the Modified Unified Soil Classification System (USCS) logging procedures per the Canadian Foundation Engineering Manual (CFEM 2006);
  - collection of disturbed samples for geotechnical laboratory testing and visual inspection, and conducting in-situ penetration testing (SPT);
  - installation of thirty six (36) 25 mm standpipe piezometers for groundwater monitoring;
  - recording groundwater level measurements and surveying the borehole locations using a Global Navigation Satellite System (GNSS) as input to slope stability model;

## 3.0 DETAILS OF THE INVESTIGATION

This section provides detailed information pertaining to E2K's drilling and laboratory testing program, which were determined after reviewing available information such as surficial geology maps provided site plans, and conducting the field investigation.

### 3.1 Field Program

On January 23 to 28, 2019, the drilling was performed utilizing a track-mounted drill rig operated by All Service Drilling from Airdrie, Alberta employing a solid stem auger method for Boreholes BH-01 to BH-36. The drilling was conducted using 1.5 m auger sections and the boreholes were drilled to depths ranging from approximately 2.4 and 8.8 meters below ground surface (mbgs). Most boreholes didn't achieve target depths due to practical auger refusal within the bedrock.

The subsurface soil conditions encountered were continuously logged as drilling processed, using the Modified Unified Soil Classification System as described above. Disturbed soil samples were obtained at regular intervals from the auger and Standard Penetration Tests (SPTs) tests were conducted approximately every 1.5 m for applicable

soils encountered. Pocket penetrometer readings were taken on disturbed samples of cohesive soils encountered during drilling.

Upon completion of drilling, 25 mm standpipe piezometers were installed in all boreholes for subsequent groundwater table monitoring to depths ranging from 1.9 m to 7.4 m, and backfilled with drill cuttings and then sealed with bentonite chips at the top.

Borehole locations were surveyed on February 1, 2019 by an E2K site representative using a Global Navigational Satellite System (GNSS) receiver. Coordinates, elevations and drill depths of all boreholes are provided in Table 1 below.

**Table 1 Borehole Location and Elevation Data**

| Borehole No. | Northing | Easting | Elevation (masl[1]) | Drilling Depth (mbgs[2]) |
|---|---|---|---|---|
| **BH-01** | 5681993.88 | 672827.07 | 1,314.54 | 7.3 |
| **BH-02** | 5681982.11 | 672967.28 | 1,311.51 | 4.3 |
| **BH-03** | 5681957.18 | 673150.16 | 1,308.84 | 4.0 |
| **BH-04** | 5681989.98 | 673369.02 | 1,304.15 | 5.5 |
| **BH-05** | 5681805.09 | 672874.22 | 1,312.11 | 4.6 |
| **BH-06** | 5681799.14 | 673005.57 | 1,310.54 | 4.3 |
| **BH-07** | 5681807.79 | 673171.82 | 1,306.90 | 3.8 |
| **BH-08** | 5681809.25 | 673405.99 | 1,301.65 | 4.0 |
| **BH-09** | 5681642.21 | 677847.17 | 1,315.34 | 8.8 |
| **BH-10** | 5681632.33 | 673029.74 | 1,309.74 | 3.8 |
| **BH-11** | 5681670.04 | 673172.57 | 1,309.98 | 3.0 |
| **BH-12** | 5681629.28 | 673312.45 | 1,304.84 | 4.3 |
| **BH-13** | 5681485.33 | 672894.27 | 1,311.23 | 7.5 |
| **BH-14** | 5681519.33 | 673066.59 | 1,306.97 | 2.4 |
| **BH-15** | 5681456.06 | 673148.19 | 1,302.90 | 3.7 |
| **BH-16** | 5681470.13 | 673338.90 | 1,304.44 | 4.3 |
| **BH-17** | 5681374.21 | 672954.50 | 1,308.23 | 5.3 |
| **BH-18** | 5681315.06 | 673094.07 | 1,305.85 | 4.0 |
| **BH-19** | 5681334.72 | 673390.10 | 1,303.59 | 5.2 |
| **BH-20** | 5681251.05 | 673325.31 | 1,304.00 | 6.1 |
| **BH-21** | 5681191.25 | 673147.69 | 1,301.18 | 4.6 |
| **BH-22** | 5681203.63 | 673208.91 | 1,303.67 | 6.1 |
| **BH-23** | 5681206.77 | 673278.01 | 1,304.40 | 4.6 |
| **BH-24** | 5681054.40 | 673418.03 | 1,307.06 | 4.6 |
| **BH-25** | 5680925.27 | 673123.62 | 1,308.61 | 4.0 |
| **BH-26** | 5681043.16 | 673209.83 | 1,307.11 | 2.4 |
| **BH-27** | 5680998.68 | 673293.56 | 1,305.32 | 3.4 |
| **BH-28** | 5680914.03 | 673420.67 | 1,309.89 | 6.0 |
| **BH-29** | 5680770.66 | 673173.28 | 1,309.46 | 7.0 |
| **BH-30** | 5680805.72 | 673275.50 | 1,308.21 | 5.8 |

| | | | | |
|---|---|---|---|---|
| **BH-31** | 5680752.80 | 673430.81 | 1,311.44 | 5.3 |
| **BH-32** | 5680666.74 | 673223.44 | 1,309.31 | 7.3 |
| **BH-33** | 5680663.11 | 673323.87 | 1,309.20 | 5.5 |
| **BH-34** | 5680643.70 | 673431.95 | 1,310.04 | 6.1 |
| **BH-35** | 5680544.23 | 673314.94 | 1,307.85 | 7.0 |
| **BH-36** | 5680567.49 | 673428.98 | 1,307.89 | 5.5 |

[1]masl – metres above sea level
[2]mbgs – metres below ground surface
Horizontal precision of surveying – 2.1 m

The soil stratigraphy, field testing and sampling sequences, groundwater level measurements, and field and laboratory test results are shown on the borehole logs attached in the Appendix.

Site walkovers were also performed by E2K on January 29, February 4, February 11, and February 28 to review current slope conditions. At that time, no obvious signs of slope movement tension cracks, above-ground boulder movement, surface bulging or slope toe erosion were observed.

### 3.2 Laboratory Testing

Collected samples were taken from the site and transported to E2K's Calgary Laboratory and reviewed by a geotechnical engineer. After review, select soil samples were chosen for identification, classification and testing in accordance with ASTM standards. The laboratory index testing included: one hundred seventy eight (178) moisture content tests, five (5) Atterberg limits tests, five (5) hydrometer tests, and ten (10) sulphate content tests. The results are discussed in the following sections of this report and included in the borehole logs.

## 4.0 SUBSURFACE CONDITIONS

Below is a summary of the subsurface conditions encountered at the borehole locations which were drilled on site.

### 4.1 Soil Stratigraphy

In general, the soil profile at the boreholes consisted of topsoil overlying clay till overlying weathered bedrock which extended to the final depths explored in all of the boreholes. Bedrock consisting of siltstone was encountered at all borehole locations. Detailed description of soils encountered is provided on the borehole logs and is discussed in the following sections. Variations in the thickness and conditions of soil materials identified could be encountered between the boreholes and in areas of the site not investigated.

### 4.1.1 Topsoil

A layer of topsoil was encountered at the ground surface in all boreholes and extended to depths of 0.1 to 0.2 mbgs. The topsoil comprised silty clay with some organics and rootlets, and was described as dark brown and damp.

### 4.1.2 Clay (Till)

Clay Till material was encountered beneath the topsoil. The clay till layer was described as silty, containing some gravel to gravelly, trace sand to sandy, low to medium plastic, containing trace amount of oxides, light brown to brown in color, and dry to moist.

The clay deposits are typically "till-like". These glacial deposits have been heavily pre-consolidated in their geological history. The excellent bearing and deformation properties of the glacial deposits have been verified by numerous structures founded on or within these deposits.

The clay is generally in a damp to moist condition. Rafted bedrock pieces are also common within this deposit, although they were not encountered in our investigation.

It should be noted, that the clay till is of heterogeneous character of all particle sizes ranging from gravel to clay and the composition of the soil matrix substantially varies. It is possible to encounter cobbles and boulders within the till deposits.

Moisture content tests performed on the samples taken within clay till material ranged from 4.4% to 24.6%, indicative of damp to very moist in-situ moisture content.

The SPTs performed in the clay till layer resulted in blow counts ranging from 19 to over 50, indicative of stiff to hard consistency.

Pocket penetrometer readings taken within the clay layer also had a wide range between 50 kPa and 225 kPa, indicative of a stiff to hard cohesive material.

Five (5) Atterberg Limits tests were performed on selected samples within this layer, which are shown in Table 2 below:

**Table 2 Summary of Atterberg Limit Test of Clay Layer**

| Borehole No. | Depth (mbgs) | Liquid Limit (%) | Plastic Limit (%) | Plasticity |
|---|---|---|---|---|
| **BH-01** | 1.5 | 36 | 15 | Medium |
| **BH-15** | 3.1 | 35 | 17 | Medium |
| **BH-21** | 1.5 | 46 | 25 | Medium |
| **BH-28** | 3.1 | 37 | 15 | Medium |
| **BH-35** | 1.5 | 40 | 16 | Medium |

The results indicate a cohesive soil of medium plasticity.

Five (5) hydrometer tests were conducted on disturbed samples in order to assess the grain size distribution of the clay. The results of the tests are summarized in Table 3 below:

**Table 3 Summary of Hydrometer Test of Clay Layer**

| Borehole No. | Depth (mbgs) | Clay Content (%) | Silt Content (%) | Sand Content (%) | Gravel Content (%) |
|---|---|---|---|---|---|
| **BH-01** | 1.5 | 23 | 60 | 17 | 0 |
| **BH-15** | 3.1 | 32 | 50 | 18 | 0 |
| **BH-21** | 1.5 | 27 | 58 | 15 | 0 |
| **BH-28** | 3.1 | 22 | 50 | 23 | 5 |
| **BH-35** | 1.5 | 24 | 51 | 18 | 7 |

The result indicates that the material primarily consists of silty clay. It should be noted that even though the material consists primarily of silt, the material behaves as a cohesive material. The details are shown on the borehole logs.

### 4.1.3 Bedrock

Weathered bedrock was encountered at the locations of all boreholes underneath the clay till deposits at depth ranging from 0.6 to 4.0 below existing grade and extended to the final depth of the investigation, where practical auger refusal was met. The bedrock was described as weathered and weak siltstone that was light brown to grey in color and dry. It should be noted that the bedrock elevation decreased as we moved towards the west portion of the investigated area of the site, where the escarpment is located.

Moisture content tests performed on the samples taken within the bedrock material ranged from 4.0% to 20.2%, indicative of dry to damp in-situ moisture content.

It is noted that the identification of the weathered siltstone bedrock is based of disturbed samples, and rock coring should be completed to further determine bedrock characteristic, if deemed necessary.

## 4.2 Groundwater Conditions

During drilling, seepage or saturated conditions was not encountered. A standpipe was installed in all boreholes and groundwater monitoring was also performed by E2K personnel 1 day, 7 days, 14 days and 30 days after drilling. All boreholes were dry.

It should be noted that the groundwater may significantly vary with seasonal conditions including precipitation, temperature, site drainage characteristics, etc. Further groundwater measurements will be made once per month for the next six months and the summary of the groundwater monitoring program which are not provided above will be provided.

Seasonal variations in groundwater levels are likely to be experienced, with higher levels occurring following periods of prolonged rainfall or spring thaw. With normal seasonal variations, fluctuations in groundwater levels are typically estimated to be in a range of ±0.5 to 1 m.

## 5.0 SLOPE STABILITY ANALYSIS

It is understood that a slope stability analysis is required for this as the existing slopes within the site are greater than 15%. This section of the report provides engineering information regarding E2K's slope stability analysis of the project, based on our interpretation of the borehole information from the geotechnical investigation, review of available information, and on our understanding of the project requirements.

### 5.1 General

A slope stability assessment of the existing pre-development slopes was completed based on the onsite observations, and the subsurface soil and groundwater information obtained from the field investigation completed by E2K. The global stability of the downward slope from east to west was analysed utilizing the geotechnical software GeoStudio 2012 (Slope/W), a commercially available software provided by Geo-Slope International Ltd. The slope was analysed for existing soil conditions at the time of E2K's investigation. It should be noted that future development grading was not included in the scope of the slope stability assessment.

### 5.2 Input Parameters

Soil parameters for stability modelling were selected based on the in-situ soils encountered and laboratory testing conducted as part of the site investigation, local experience and empirical correlations. The proposed development was assumed to exert a bearing pressure of 50 kPa for design purposes.

As described in the Section 4.0, the materials used for the slope was clay till and weathered siltstone bedrock. The soil parameters used in the analysis are summarized in Table 4 below.

**Table 4 Soil Parameters**

| Soil Type | Total Unit Weight ($kN/m^3$) | Cohesion (kPa) | Friction Angle |
|---|---|---|---|
| **Clay Till** | 18 | 0 | 26º |
| **Bedrock** | Built-in Parameter | Built-in Parameter | Built-in Parameter |

For the worst case cross section, groundwater level was set at 1.0 m higher than maximum groundwater elevation recorded to account for seasonal changes. It should be noted that the extent that seasonal changes can affect groundwater elevations in this area is unknown.

## 5.3 Slope Geometry and Inspection

Based on the information provided, existing slope gradients in the vicinity of the proposed development range from approximately 13 % to 26%. As slopes are present which exceed 15%, a geotechnical slope stability analysis is required. Existing slopes in excess of 15% were located throughout the escarpment excluding the western central part of the site which is indicated at Section C-C' in Figure 1.

In order to assess the Factor of Safety (FOS) of the pre-development slopes, four critical cross sections were selected for pre-development conditions (A-A', B-B', D-D' and E-E'). A less critical slope section (C-C') was also chosen for comparative purposes between the critical slopes identified. Cross sections were determined based on the steepness of slope gradients, our understanding of the subsurface ground conditions, and our understanding of the proposed developments. Figure 1 indicates the approximate locations of the cross sections relative to borehole locations.

Detailed information regarding the critical cross sections A-A' to E-E' are provided below in Table 5.

**Table 5 Cross Section Information**

| Cross Section | Approximate Cross Section Length (m) | Approximate Top of Slope (m) | Approximate Toe of Slope (m) |
|---|---|---|---|
| **Section A-A'** | 160 | 1314 | 1274 |
| **Section B-B'** | 218 | 1314 | 1258 |
| **Section C-C'** | 418 | 1302 | 1248 |
| **Section D-D'** | 252 | 1308 | 1248 |
| **Section E-E'** | 199 | 1310 | 1258 |

## 5.4 Slope Stability Analysis Results

Based on the results, the minimum Factor of Safety (FOS) of Sections A-A' to E-E' against slope instability ranges from 1.962 to 3.885 without house surcharge on the crest of

the slope. The results of the slope stability analysis for pre-development slopes at the project site are presented in Table 7 below, and are attached in the Appendix, Figures 2 to 6.

**Table 6 Slope Stability Analysis Results**

| Cross-Section | Pre-Development Slope Stability Factor of Safety |
|---|---|
| Section A-A' | 2.103 |
| Section B-B' | 2.055 |
| Section C-C' | 3.885 |
| Section D-D' | 2.133 |
| Section E-E' | 1.962 |

The obtained Factors of Safety assumes that the soil profile is as shown on the borehole log in the Appendix of this report and the soil parameters given in Section 5.2 are applicable.

**Based on the slope stability analysis, the slope is considered stable. As described above, house surcharge loads were not applied to the pre-development conditions which means minimum setback distances were not assessed. In addition, the slope stability factors of safety will differ from the pre-development assessment once external loads or excavations are considered on the crest of the slope.**

If conditions at the subject site change in a way that negatively impacts slope stability, such as excessive rainfall, removal of vegetation intentionally or via natural process, localized slumping may occur and the Factor of Safety will be lower than that calculated by E2K for this report.

## 5.5 Slope Stability Recommendations

Based on E2K's investigation, laboratory testing and slope stability analyses, the following recommendations are provided:

- Where vegetation has been removed, re-vegetation of the slope with shrubs or trees is recommended;
- No additional fill or surcharge not included in the design should be added to the top of the slope;
- Drainage from the site should be directed away from the slope;
- The owner should monitor the slope for signs of movements during construction and after construction of the structure, and where movement occurs, contact a qualified professional to provide recommendations.

## 6.0 LIMITATIONS

Recommendations made within this report are based on the interpreted findings encountered within the thirty six (36) geotechnical boreholes. It should be noted that natural conditions are innately variable particularly in glacial deposits and glacially modified areas. Should conditions other than those reported herein, be identified at any stage of development, E2K should be notified and given the opportunity to re-evaluate current information, if required.

This report has been prepared with accepted soil and foundation engineering practices for the project as described above. No other warranty is expressed or implied.

## 7.0 CLOSURE

We trust the information contained herein meets your present requirements. Should you require further information regarding the geotechnical aspects of this project, please do not hesitate to contact our office.

Yours truly,
**E2K Engineering Ltd.**
**APEGA Permit to Practice: P9582**


Prepared By:
Hank Lee, M.Eng, E.I.T.
Junior Geotechnical Engineer

Reviewed By:
Peyman Tabatabaei, P. Eng.
Project Geotechnical Engineer

Attachments:
Figure 1: Site Plan – Cross Section and Borehole Locations
Figure 2: Slope Stability Analysis – Cross Section A-A'
Figure 3: Slope Stability Analysis – Cross Section B-B'
Figure 4: Slope Stability Analysis – Cross Section C-C'
Figure 5: Slope Stability Analysis – Cross Section D-D'
Figure 6: Slope Stability Analysis – Cross Section E-E'
Borehole Logs
Explanation of Terms and Symbols

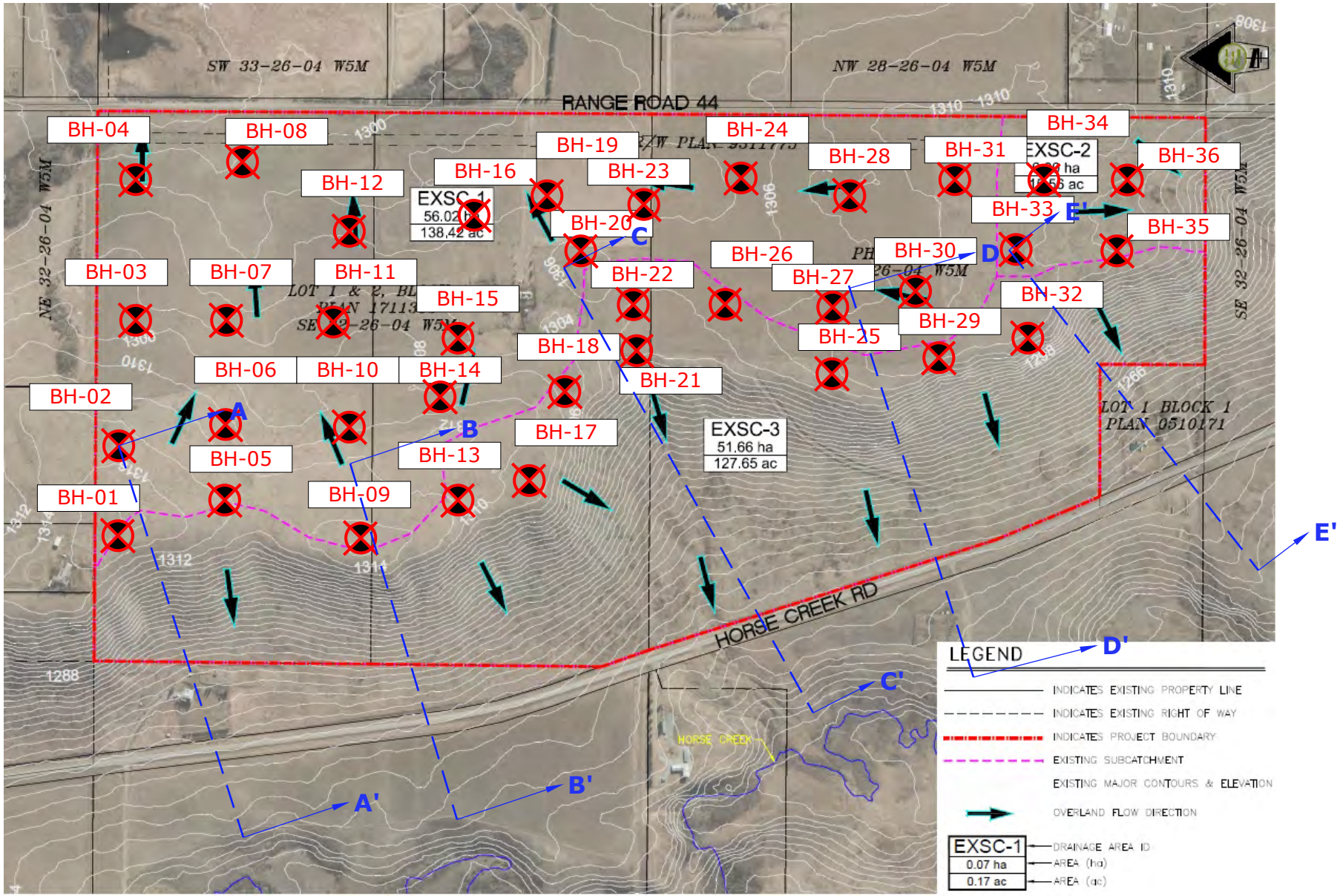


Figure #1 - Slope Stability Section Locations
NE 29-26-4-W5M SE 32-26-04-W5M

| Color | Name | Model | Unit Weight (kN/m³) | Cohesion' (kPa) | Phi' (°) |
|---|---|---|---|---|---|
| | Bedrock | Bedrock (Impenetrable) | | | |
| | Silty Clay | Mohr-Coulomb | 18 | 0 | 26 |

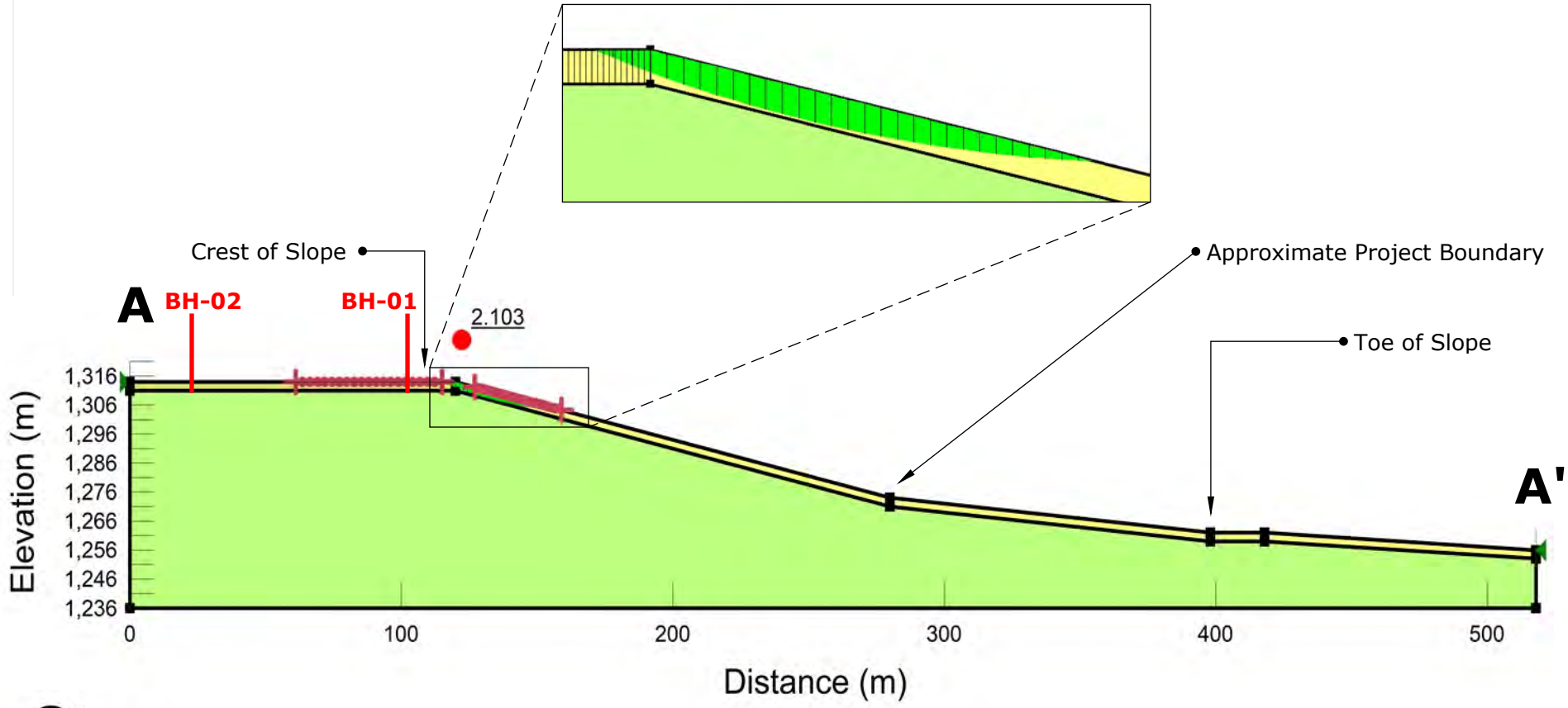


Figure #2 - Slope Stability Section A - A'
NE 29-26-4-W5M SE 32-26-04-W5M

| Color | Name | Model | Unit Weight (kN/m³) | Cohesion' (kPa) | Phi' (°) |
|---|---|---|---|---|---|
| | Bedrock | Bedrock (Impenetrable) | | | |
| | Silty Clay | Mohr-Coulomb | 18 | 0 | 26 |

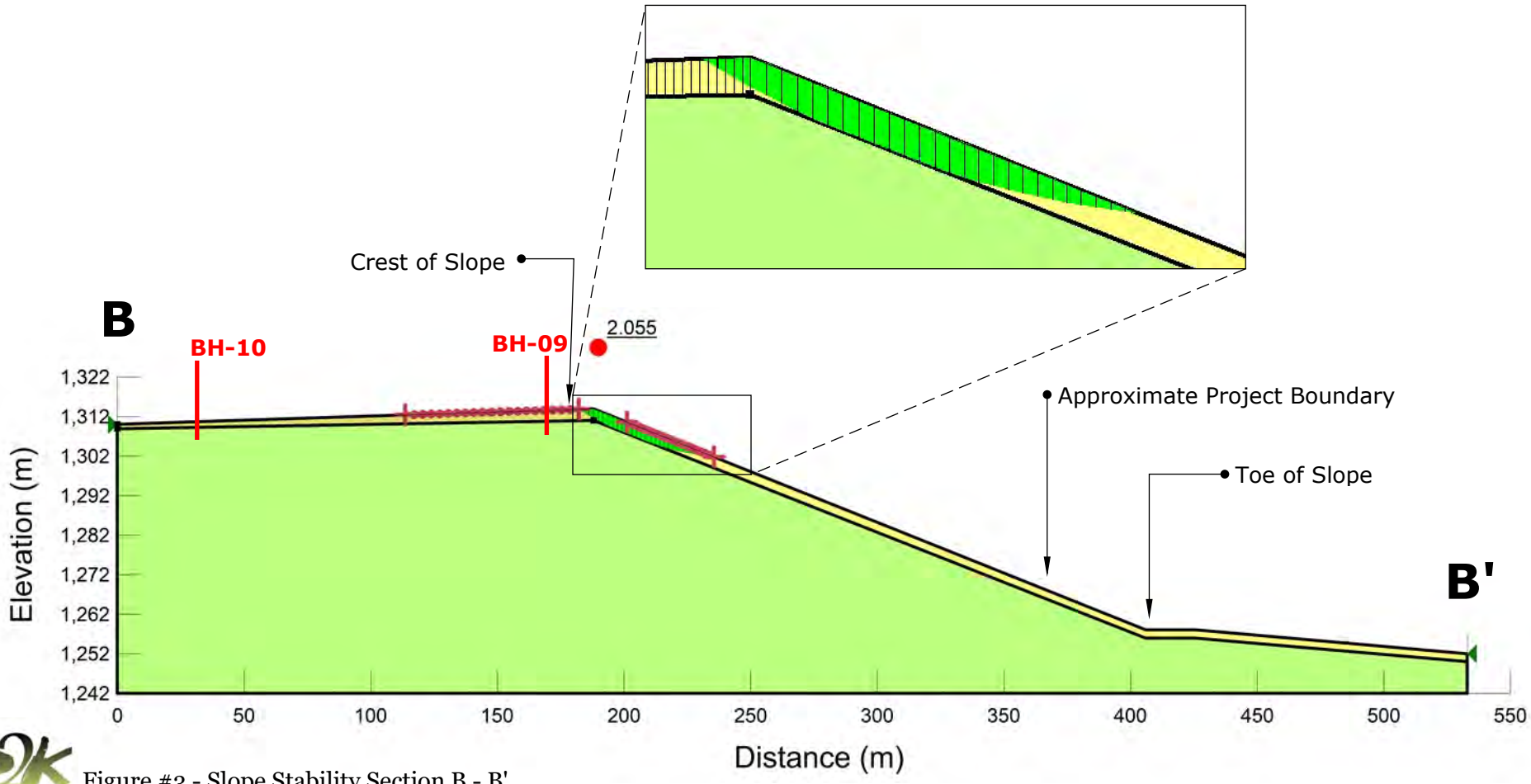


Figure #3 - Slope Stability Section B - B'
NE 29-26-4-W5M SE 32-26-04-W5M

| Color | Name | Model | Unit Weight (kN/m³) | Cohesion' (kPa) | Phi' (°) |
|---|---|---|---|---|---|
| | Bedrock | Bedrock (Impenetrable) | | | |
| | Silty Clay | Mohr-Coulomb | 18 | 0 | 26 |

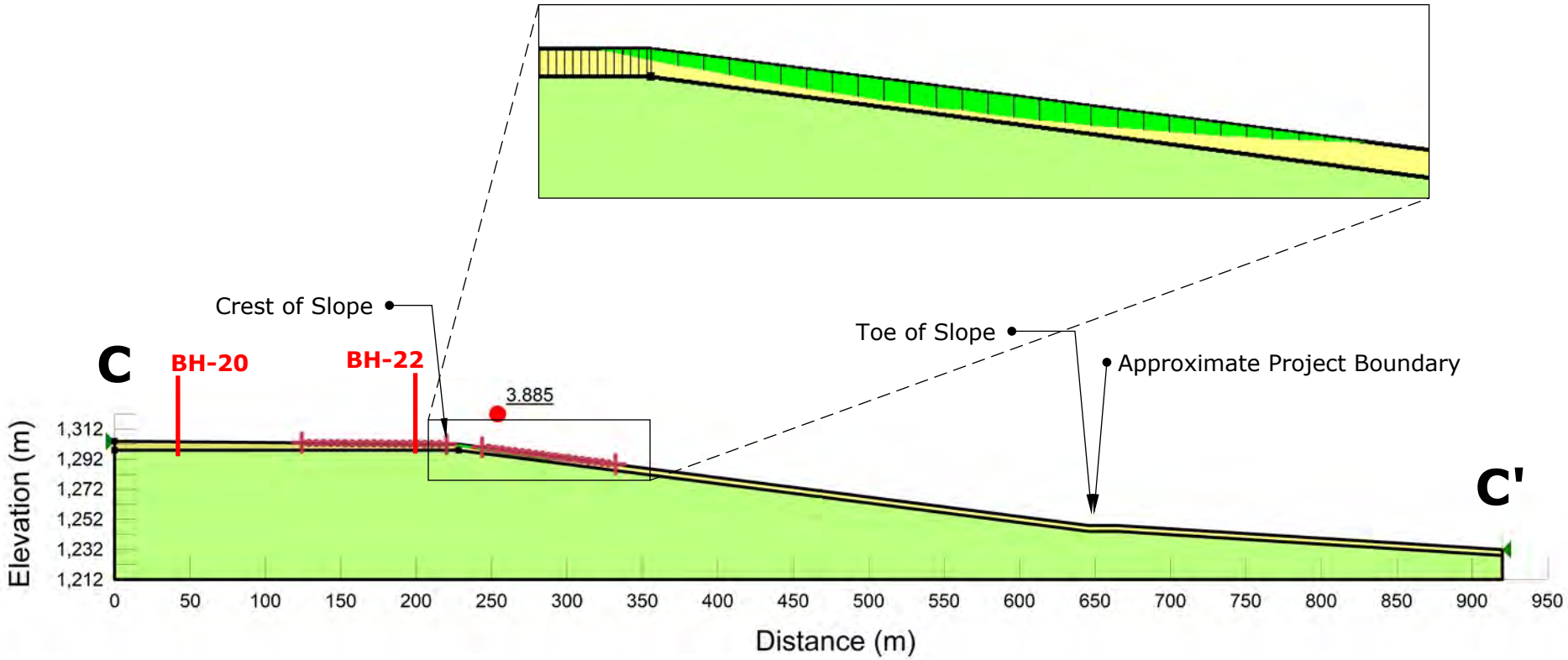


Figure #4 - Slope Stability Section C - C'
NE 29-26-4-W5M SE 32-26-04-W5M

| Color | Name | Model | Unit Weight (kN/m³) | Cohesion' (kPa) | Phi' (°) |
|---|---|---|---|---|---|
| | Bedrock | Bedrock (Impenetrable) | | | |
| | Silty Clay | Mohr-Coulomb | 18 | 0 | 26 |

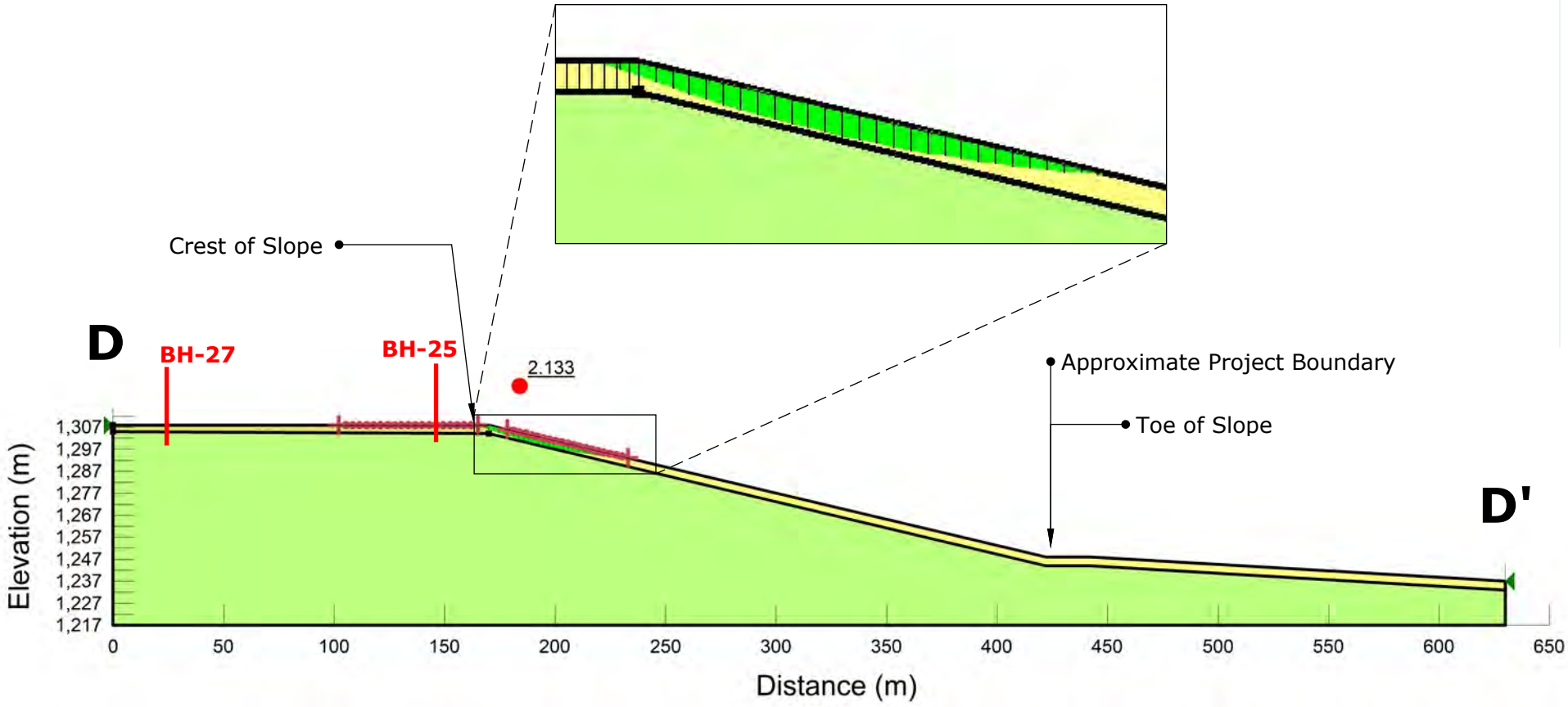


Figure #5 - Slope Stability Section D - D'
NE 29-26-4-W5M SE 32-26-04-W5M

| Color | Name | Model | Unit Weight (kN/m³) | Cohesion' (kPa) | Phi' (°) |
|---|---|---|---|---|---|
| | Bedrock | Bedrock (Impenetrable) | | | |
| | Silty Clay | Mohr-Coulomb | 18 | 0 | 26 |

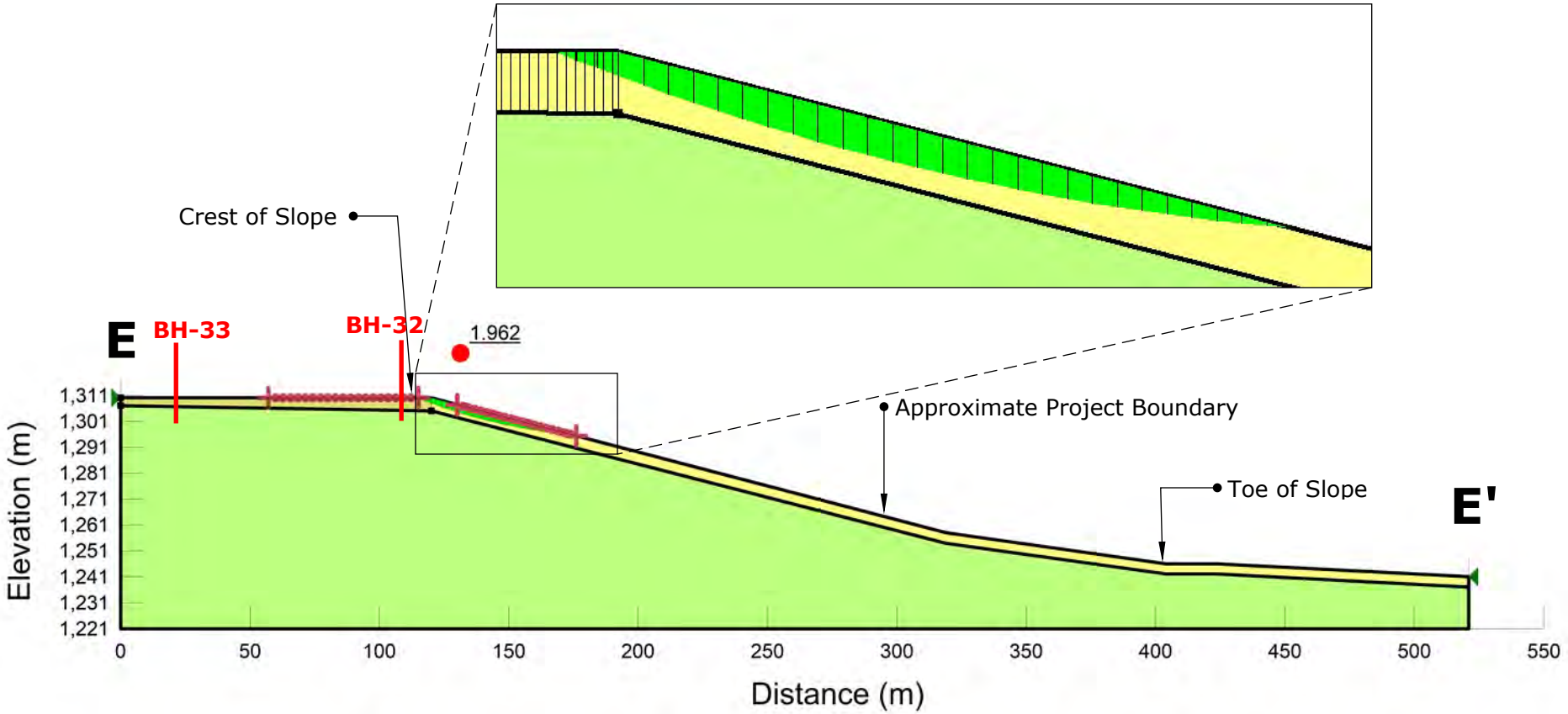


Figure #6 - Slope Stability Section E - E'
NE 29-26-4-W5M SE 32-26-04-W5M

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-01** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681993.88 EASTING: 672827.07 | ELEVATION: 1314.54m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID) | VANE SHEAR (kPa) / BLOW COUNT / UNCONF. SHEAR STR. (kPa) / 0.5 x POCKETPEN. (kPa) | OTHER DATA |
|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | |
| | | CLAY(Till), silty, some gravel, trace sand, low to medium plastic, damp, brown, trace oxides | | S1 | | 9.3 | | |
| 1 | | | | | | | | |
| | | | | SPT1 | 8-12-19 | 11.9 | | Clay: 23%<br>Silt: 60%<br>Sand: 17%<br>SO4=0.047%<br>(Neg.)<br>REC = 95% |
| 2 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 7.1 | | |
| 3 | | | | | | | | |
| | | | | S3 | | 13.5 | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| | | | | S4 | | 8.7 | | |
| 6 | | | | | | | | |
| 7 | | | | S5 | | 6.5 | | |
| | | End of Hole at 7.3 m due to practical auger refusal.<br>Dry upon completion.<br>Standpipe installed to 6.33 m.<br>Hole backfilled with drill cuttings and a bentonite cap.<br>Dry on February 4, 2019. | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 9.3 | | | | | | | | |

SLOTTED PIEZOMETER

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 7.30 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-02** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681982.11 EASTING: 672967.68 | ELEVATION: 1311.51m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400<br>■ BLOW COUNT ■ 20 40 60 80<br>◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400<br>● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some grave, trace sand, low to medium plastic, brown, damp, hard, trace oxides | | S1 | | 5.9 | 50 | | | |
| 1 | | | | | | | | | | 1 |
| | | | SPT | SPT1 | 10-11-20 | 11.6 | | REC = 95% | | |
| 2 | | | | | | | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 9.6 | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 6.3 | | | | |
| 4 | | | | | | | | | | 4 |
| | | End of Hole at 4.3 m due to practical auger refusal.<br>Dry upon completion.<br>Standpipe installed to 3.47 m.<br>Hole backfilled with drill cuttings and a bentonite cap.<br>Dry on February 4, 2019. | | | | | | | | |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 6.3 | | | | | | | | | | 6.3 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 4.30 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-03** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID) | VANE SHEAR (kPa) / BLOW COUNT / UNCONF. SHEAR STR. (kPa) / 0.5 x POCKETPEN. (kPa) | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), some sand to sandy, some gravel, low to medium plastic, light brown, damp, very stiff | | S1 | | 7.1 | | | | |
| 1 | | | | | | | | | | 1 |
| | | CLAY (Till), silty, some gravel, trace sand, low to medium plastic, brown, damp, very stiff, trace oxides | | SPT1 | 2-11-16 | 11.3 | | REC = 90% | | |
| 2 | | | | S2 | | 7.4 | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 5.4 | | | | |
| 4 | | End of Hole at 4 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.21 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |

| LOGGED BY: HL | COMPLETION DEPTH: 4.00 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/28/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-04** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | VANE SHEAR (kPa) (100 200 300 400) / BLOW COUNT (20 40 60 80) / UNCONF. SHEAR STR. (kPa) (100 200 300 400) / 0.5 x POCKETPEN. (kPa) (100 200 300 400) | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some gravel to gravelly, trace sand, low to medium plastic, brown, damp, very stiff, trace oxides | | S1 | | 10.4 | 125 | | | |
| 1 | | | | | | | | | | 1 |
| | | CLAY and SILT (Till), some sand to sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | SPT1 | 4-13-13 | 8.6 | | REC = 80% | | |
| 2 | | | | S2 | | 5.2 | | | | 2 |
| | | | | SPT2 | 13-28-50(3) | 6.4 | >> | SO4=0.044% (Neg.) REC = 80% | | |
| 3 | | | | | | | | | | 3 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S3 | | 5.7 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | S4 | | 8.2 | | | | 5 |
| | | End of Hole at 5.5 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.79 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | |
| 6 | | | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.5 | | | | | | | | | | 7.5 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| LOGGED BY: HL | COMPLETION DEPTH: 5.50 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/28/19 |
| | Page 1 of 1 |

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-05** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681805.09 EASTING: 672874.22 | ELEVATION: 1312.11m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some gravel, some sand, low to medium plastic, brown, damp, very stiff, trace oxides | | S1 | | 8.6 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 4-12-13 | 8.8 | ■ | REC = 80% | | |
| 2 | | | | | | | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 9.9 | 100 | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 11.3 | 75 | | | |
| 4 | | | | | | | | | | 4 |
| | | End of Hole at 4.6 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.94 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 6.7 | | | | | | | | | | 6.7 |

| LOGGED BY: HL | COMPLETION DEPTH: 4.70 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-06** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681799.14 EASTING: 673005.57 | ELEVATION: 1310.54m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID) | VANE SHEAR (kPa) / BLOW COUNT / UNCONF. SHEAR STR. (kPa) / 0.5 x POCKETPEN. (kPa) | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some gravel, trace sand, low to medium plastic, brown, damp, hard, trace oxides | | S1 | | 10.8 | 75 | | | |
| 1 | | | | | | | | | | 1 |
| | | | SPT | SPT1 | 14-15-18 | 10.1 | | REC = 20% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 13.6 | 200 | | | |
| 3 | | BEDROCK, siltstone, weathered, weak, light brown, dry | SPT | SPT2 | 15-50(6) | 20.2 | >> | REC = 50% | | 3 |
| | | | | S3 | | 6.5 | | | | |
| 4 | | | | | | | | | | 4 |
| | | End of Hole at 4.3 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.54 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 6.3 | | | | | | | | | | 6.3 |

| LOGGED BY: HL | COMPLETION DEPTH: 4.30 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/20/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-07** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), some sand to sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, very stiff | | S1 | | 8.3 | | | | |
| 1 | | | | | | | | | | 1 |
| | | CLAY (Till), silty, some gravel, trace sand, low to medium plastic, brown, damp, hard, trace oxides | | SPT1 | 2-7-12 | 12.7 | ■ | REC = 85% | | |
| 2 | | | | | | | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 7.8 | | | | |
| 3 | | | | | | | 125 | | | 3 |
| | | | | S3 | | 4.6 | | | | |
| 4 | | End of Hole at 3.8 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.2 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 5.7 | | | | | | | | | | 5.7 |

| LOGGED BY: HL | COMPLETION DEPTH: 3.70 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/28/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-08** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC, M.C., LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ / ■ BLOW COUNT ■ / ◆ UNCONF. SHEAR STR. (kPa) ◆ / ● 0.5 x POCKETPEN. (kPa) ● (100 200 300 400; 20 40 60 80) | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some gravel, some sand, low to medium plastic, brown, damp, hard, trace oxides | | | | | | | | |
| | | | | S1 | | 9.6 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | SPT | SPT1 | 6-15-50(3) | 12.2 | | >>■REC = 20% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 6.3 | | | | |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 6.3 | | | | |
| 4 | | End of Hole at 4 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.45 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |

| LOGGED BY: HL | COMPLETION DEPTH: 4.00 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/28/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/21/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-09** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681642.21 EASTING: 677847.17 | ELEVATION: 1315.34m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID) | VANE SHEAR (kPa) / BLOW COUNT / UNCONF. SHEAR STR. (kPa) / 0.5 x POCKETPEN. (kPa) | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, very stiff | | S1 | | 4.4 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 15-15-9 | 5 | | REC = 40% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 5.7 | 150 | | | |
| 3 | | CLAY (Till), silty, some gravel, some sand, low to medium plastic, brown, damp, very stiff, trace oxides | | SPT2 | 7-7-14 | 7.5 | | SO4=0.061% (Neg.) REC = 50% | | 3 |
| | | | | S3 | | 13.8 | | | | |
| 4 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | 4 |
| 5 | | | | S4 | | 8.4 | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 7 | | | | S5 | | 9 | | | | 7 |
| 8 | | | | | | | | | | 8 |
| | | | | S6 | | 6.6 | | | | |
| 9 | | End of Hole at 8.8 m due to practical auger refusal. Dry upon completion. Standpipe installed to 7.41 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | 9 |
| 10 | | | | | | | | | | 10 |
| 10.8 | | | | | | | | | | 10.8 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| | LOGGED BY: HL | COMPLETION DEPTH: 8.80 m |
| | REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-10** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681632.33 EASTING: 673029.74 | ELEVATION: 1309.74m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC — M.C. — LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), some gravel, trace sand, low to medium plastic, light brown, damp, hard | | | | | | | | |
| 1 | | | | S1 | | 8.2 | | | | 1 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| 2 | | | | S2 | | 5.8 | 125 | | | 2 |
| 3 | | | | S3 | | 5.9 | | | | 3 |
| | | End of Hole at 3.8 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 5.7 | | | | | | | | | | 5.7 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 3.70 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-11** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC M.C. LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), some sand, some gravel, low to medium plastic, light brown, damp, hard | | S1 | | 9.4 | | | | |
| 1 | | | SPT | SPT1 | 11-13-19 | 10.4 | ■ | REC = 50% | | 1 |
| | | CLAY (Till), silty, some gravel to gravelly, trace sand, low to medium plastic, brown, damp, hard, trace oxides | | | | | | | | |
| 2 | | | | S2 | | 10.9 | | | | 2 |
| | | BEDROCK, siltstone, competent, light brown, dry | | | | | | | | |
| 3 | | End of Hole at 3 m due to practical auger refusal. Dry upon completion. Standpipe installed to 2.5 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | 3 |
| 4 | | | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |

| LOGGED BY: HL | COMPLETION DEPTH: 3.00 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/28/19 |
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GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-12** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and SILT (Till), sandy, some gravel, low to medium plastic, light brown, damp, hard | | | | | | | | |
| 1 | | | | S1 | | 10.4 | | | | 1 |
| | | | | | | | | | | |
| | | | SPT | SPT1 | 8-15-16 | 10.6 | ■ | REC = 50% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 5.2 | | | | |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | | | | | | | |
| | | | | S3 | | 12.7 | | | | |
| 4 | | | | | | | | | | 4 |
| | | End of Hole at 4.3 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.46 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 6.3 | | | | | | | | | | 6.3 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| LOGGED BY: HL | | COMPLETION DEPTH: 4.30 m |
| REVIEWED BY: PT | | COMPLETION DATE: 1/28/19 |
| | | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-13** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681485.33 EASTING: 672894.27 | ELEVATION: 1311.23m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), some sand to sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | S1 | | 6.8 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | SPT | SPT1 | 9-10-21 | 14 | ■ | REC = 95% | | |
| 2 | | | | | | | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 9.9 | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 9.6 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| | | | | S4 | | 6.2 | | | | |
| 6 | | | | | | | | | | 6 |
| | | | | S5 | | 9.2 | | | | |
| 7 | | | | | | | | | | 7 |
| | | End of Hole at 7.3 m due to practical auger refusal. Dry upon completion. Standpipe installed to 6.34 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | |
| 8 | | | | | | | | | | 8 |
| 9 | | | | | | | | | | 9 |
| 9.3 | | | | | | | | | | 9.3 |

| | | |
|---|---|---|
| | LOGGED BY: HL | COMPLETION DEPTH: 7.30 m |
| | REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-14** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), some sand to sandy, trace gravel, low to medium plastic, light brown, damp, hard | | S1 | | 8.1 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 10-13-19 | 10.1 | ■ | REC = 90% | | |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry<br><br>- becomes competent | | S2 | | 5.4 | | | | |
| 2 | | | | | | | | | | 2 |
| | | End of Hole at 2.4 m due to practical auger refusal.<br>Dry upon completion.<br>Standpipe installed to 1.98 m.<br>Hole backfilled with drill cuttings and a bentonite cap.<br>Dry on February 4, 2019. | | | | | | | | |
| 3 | | | | | | | | | | 3 |
| 4 | | | | | | | | | | 4 |
| 4.4 | | | | | | | | | | 4.4 |

| LOGGED BY: HL | COMPLETION DEPTH: 2.40 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-15** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681456.06 EASTING: 673148.19 | ELEVATION: 1302.90m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC M.C. LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, trace sand, low to medium plastic, brown, damp, hard, trace oxides | | | | | | | | |
| | | | | S1 | | 24.6 | 225 | | | |
| 1 | | | | | | | | | | 1 |
| | | | SPT | SPT1 | 3-9-11 | 14.3 | | REC = 60% | | |
| 2 | | | | | | | | | | 2 |
| | | - trace gravel | | S2 | | 12.3 | | | | |
| | | | SPT | SPT2 | 1-3-14 | 13.2 | | Clay: 32%<br>Silt: 50%<br>Sand: 18%<br>SO4=0.020%<br>(Neg.)<br>REC = 70% | | |
| 3 | | | | | | | | | | 3 |
| | | BEDROCK, siltstone, competent, light brown, dry | | | | | | | | |
| | | End of Hole at 3.7 m due to practical auger refusal.<br>Dry upon completion.<br>Standpipe installed to 3.2 m.<br>Hole backfilled with drill cuttings and a bentonite cap.<br>Dry on February 4, 2019. | | S3 | | 9.1 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 5.7 | | | | | | | | | | 5.7 |

| LOGGED BY: HL | COMPLETION DEPTH: 3.70 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-16** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC — M.C. — LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400<br>■ BLOW COUNT ■ 20 40 60 80<br>◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400<br>● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | 0 |
| | | CLAY and SILT (Till), some sand to sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | | | | | | |
| 1 | | | | S1 | | 8.8 | | | 1 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | |
| 2 | | | | S2 | | 11.7 | | | 2 |
| 3 | | | | | | | | | 3 |
| 4 | | | | S3 | | 5.8 | | | 4 |
| | | End of Hole at 4.3 m due to practical auger refusal.<br>Dry upon completion.<br>Standpipe installed to 3.62 m.<br>Hole backfilled with drill cuttings and a bentonite cap.<br>Dry on February 4, 2019. | | | | | | | |
| 5 | | | | | | | | | 5 |
| 6 | | | | | | | | | 6 |
| 6.3 | | | | | | | | | 6.3 |

| LOGGED BY: HL | COMPLETION DEPTH: 4.30 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/28/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-17** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681374.21 EASTING: 672954.5 | ELEVATION: 1308.23m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC — M.C. — LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, low to medium plastic, light brown, damp, hard | | | | | | | | |
| 1 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S1 | | 6 | | | | 1 |
| 2 | | | | S2 | | 7.3 | | | | 2 |
| 3 | | | | | | | | | | 3 |
| 4 | | | | S3 | | 9.9 | | | | 4 |
| 5 | | | | S4 | | 6.4 | | | | 5 |
| | | End of Hole at 5.3 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.34 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | |
| 6 | | | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.2 | | | | | | | | | | 7.2 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| e2k engineering ltd. | LOGGED BY: HL | COMPLETION DEPTH: 5.20 m |
| | REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
| | | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-18** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681315.06 EASTING: 673094.07 | ELEVATION: 1305.85m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC – M.C. – LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), some sand, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | S1 | | 9 9 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | SPT | SPT1 | 1-11-24 | 42 4 | ■ | REC = 95% | | |
| 2 | | | | | | | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 4 | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 7 | | | | |
| 4 | | End of Hole at 4 m due to practical auger refusal. Dry upon completion. Standpipe installed to 2.85 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 4.00 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/25/19 |
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GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-19** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC – M.C. – LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | | | | | | | |
| 1 | | | | S1 | | 5.8 | | | | 1 |
| | | | | SPT1 | 50(3) | 13.6 | | REC = 5% | | |
| 2 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 11.5 | | | | 2 |
| 3 | | | | | | | | | | 3 |
| 4 | | | | S3 | | 5.3 | | | | 4 |
| | | | | S4 | | | | | | |
| 5 | | End of Hole at 5.2 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.55 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 4, 2019. | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 6.9 | | | | | | | | | | 6.9 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/21/19

| LOGGED BY: HL | COMPLETION DEPTH: 4.90 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-20** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC M.C. LIQUID) | VANE SHEAR (kPa) / BLOW COUNT / UNCONF. SHEAR STR. (kPa) / 0.5 x POCKETPEN. (kPa) | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, trace to some sand, some gravel, low to medium plastic, very stiff, light brown, damp | | S1 | | 19 | | | | |
| 1 | | | | | | | | | | 1 |
| | | - becomes gravelly | | SPT1 | 6-11-14 | 12.2 | | REC = 90% | | |
| 2 | | | | S2 | | 11.5 | 225 | | | 2 |
| 3 | | | | | | | | SO4=0.033% (Neg.) REC = 95% | | 3 |
| | | BEDROCK, Siltstone, weathered, weak, light brown, dry | | SPT2 | 6-26-40 | 11.8 | | | | |
| | | | | S3 | | 7.8 | 175 | | | |
| 4 | | | | | | | | | | 4 |
| | | | | SPT3 | 50(4) | 10.9 | | REC = 10% | | |
| 5 | | | | S4 | | 7.7 | | | | 5 |
| 6 | | End of Hole at 6.1 m due to practical auger refusal. Dry upon completion. Standpipe installed to 5.61 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.8 | | | | | | | | | | 7.8 |

| LOGGED BY: HL | COMPLETION DEPTH: 5.80 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/23/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-21** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681191.25 EASTING: 673147.69 | ELEVATION: 1301.18m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm |
|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | S1 | |
| 1 | | | | | |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | SPT1 | 8-13-25 |
| 2 | | | | S2 | |
| 3 | | | | | |
| | | | | S3 | |
| 4 | | | | | |
| 5 | | End of Hole at 4.6 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.82 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | |
| 6 | | | | | |
| 6.6 | | | | | |

ATTERBERG LIMITS & MOISTURE CONTENT: PLASTIC — M.C. — LIQUID (20 40 60 80)

▲ VANE SHEAR (kPa) ▲ (100 200 300 400)

■ BLOW COUNT ■ (20 40 60 80)

◆ UNCONF. SHEAR STR. (kPa) ◆ (100 200 300 400)

● 0.5 x POCKETPEN. (kPa) ● (100 200 300 400)

9.5

13.7

9.8

4.5

OTHER DATA

Clay: 27%
Silt: 58%
Sand: 15%
SO4=0.044%
(Neg.)
REC = 75%

SLOTTED PIEZOMETER

DEPTH (m)

| | | |
|---|---|---|
| LOGGED BY: HL | | COMPLETION DEPTH: 4.60 m |
| REVIEWED BY: PT | | COMPLETION DATE: 1/24/19 |
| | | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-22** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681203.63 EASTING: 673208.91 | ELEVATION: 1303.67m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC – M.C. – LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | | | | | | | |
| 1 | | | | S1 | | 8.3 | | | | 1 |
| | | | | SPT1 | 6-18-20 | 9.8 | ■ | REC = 65% | | |
| 2 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 5.7 | | | | 2 |
| 3 | | | | | | | | | | 3 |
| 4 | | | | S3 | | 9 | | | | 4 |
| 5 | | | | S4 | | 7 | | | | 5 |
| 6 | | | | | | | | | | 6 |
| | | End of Hole at 6.1 m due to practical auger refusal. Dry upon completion. Standpipe installed to 5.02 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 7 | | | | | | | | | | 7 |
| 8 | | | | | | | | | | 8 |
| 8.1 | | | | | | | | | | 8.1 |

| | | |
|---|---|---|
| | LOGGED BY: HL | COMPLETION DEPTH: 6.10 m |
| | REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-23** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681206.77 EASTING: 673278.01 | ELEVATION: 1304.40m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | S1 | | 8.6 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 16-20-26 | 9.2 | ■ | REC = 80% | | |
| 2 | | | | | | | | | | 2 |
| | | CLAY (Till), silty, some gravel, some sand, low to medium plastic, brown, damp, hard, trace oxides | | S2 | | 12.9 | 1.75 | | | |
| 3 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | 3 |
| | | | | S3 | | 5.8 | | | | |
| 4 | | | | | | | | | | 4 |
| | | End of Hole at 4.6 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.4 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 6.6 | | | | | | | | | | 6.6 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| LOGGED BY: HL | COMPLETION DEPTH: 4.60 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-24** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681054.4 EASTING: 673418.03 | ELEVATION: 1307.06m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC M.C. LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some gravel to gravelly, trace sand, low to medium plastic, light brown, damp, hard | | | | | | | | |
| | | | | S1 | | 9.2 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | | | | | REC = 90% | | |
| | | | | SPT1 | 6-15-15 | 9.1 | ■ | | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 11.3 | 200 | | | |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| 3 | | | | | | | | REC = 70% | | 3 |
| | | | | SPT2 | 15-50(6) | 10.9 | >>■ | | | |
| | | | | S3 | | 5.3 | | | | |
| 4 | | | | | | | | | | 4 |
| | | End of Hole at 4.6 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.68 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |
| 6.3 | | | | | | | | | | 6.3 |

| LOGGED BY: HL | COMPLETION DEPTH: 4.30 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/23/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/20/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-25** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680925.27 EASTING: 673123.62 | ELEVATION: 1308.61m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | | | | | | | |
| | | | | S1 | | 9.8 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | SPT | 1 | 20-22-20 | 9.4 | ■ | REC = 35% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 9.9 | | | | |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 8.4 | | | | |
| 4 | | End of Hole at 4 m due to practical auger refusal. Dry upon completion. Standpipe installed to 3.08 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 6 | | | | | | | | | | 6 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 4.00 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/20/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-26** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5681043.16 EASTING: 673209.83 | ELEVATION: 1307.11m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low to medium plastic, light brown, damp, hard | | | | | | | | |
| | | | | S1 | | 7.8 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | | | | | SO4=0.016% (Neg.) | | |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | REC = 50% | | |
| | | | SPT1 | | 17-50(5) | 9.1 | | >>■ | | |
| 2 | | | | | | | | | | 2 |
| | | becomes competent | | S2 | | 3.8 | | | | |
| | | End of Hole at 2.4 m due to practical auger refusal. Dry upon completion. Standpipe installed to 2.03 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 3 | | | | | | | | | | 3 |
| 4 | | | | | | | | | | 4 |
| 4.4 | | | | | | | | | | 4.4 |

| LOGGED BY: HL | COMPLETION DEPTH: 2.40 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-27** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: EASTING: | ELEVATION: 1305.32m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC M.C. LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | S1 | | 5.8 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 10-25-25 | 9.1 | ■ | REC = 60% | | |
| 2 | | | | S2 | | 5 | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| 3 | | | | S3 | | 4.1 | | | | 3 |
| | | End of Hole at 3.4 m due to practical auger refusal. Dry upon completion. Standpipe installed to 2.84 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 5.4 | | | | | | | | | | 5.4 |

| LOGGED BY: HL | COMPLETION DEPTH: 3.40 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-28** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680914.03 EASTING: 673420.67 | ELEVATION: 1309.89m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, gravelly, some sand, low to medium plastic, brown, damp, hard | | | | | | | | |
| | | | | S1 | | 7.3 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 6-23-25 | 8.8 | ■ | REC = 60% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 8 | | | | |
| 3 | | | | | | | | Clay: 22%<br>Silt: 50%<br>Sand: 23%<br>SO4=0.016%<br>(Neg.)<br>REC = 80% | | 3 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | SPT2 | 5-25-29 | 9.1 | ■ | | | |
| | | | | S3 | | 6.2 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | S4 | | 7 | | | | 5 |
| 6 | | End of Hole at 6 m due to practical auger refusal.<br>Dry upon completion.<br>Standpipe installed to 5.72 m.<br>Hole backfilled with drill cuttings and a bentonite cap.<br>Dry on February 1, 2019. | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.9 | | | | | | | | | | 7.9 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 5.90 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/23/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-29** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680770.66 EASTING: 673173.28 | ELEVATION: 1309.46m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOPE INDICATOR | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | | | | | | | |
| 1 | | | | S1 | | 8.8 | | | | 1 |
| | | | SPT | SPT1 | 50(5) | 11.7 | | REC = 10% | | |
| 2 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 7.1 | | | | 2 |
| 3 | | | | | | | | | | 3 |
| 4 | | | | S3 | | 7 | | | | 4 |
| 5 | | | | | | | | | | 5 |
| 6 | | | | S4 | | 7.5 | | | | 6 |
| 7 | | End of Hole at 7 m due to practical auger refusal. Dry upon completion. Standpipe installed to 6.38 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | S5 | | 5.5 | | | | 7 |
| 8 | | | | | | | | | | 8 |
| 9 | | | | | | | | | | 9 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 7.00 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-30** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680805.72 EASTING: 673275.5 | ELEVATION: 1308.21m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | S1 | | 11.2 | | | | |
| 1 | | | | | | | | | | 1 |
| | | CLAY (Till), silty, some gravel to gravelly, trace sand, low to medium plastic, brown, damp, hard | | SPT1 | 8-22-29 | 10.7 | ■ | REC = 60% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 10.1 | 225 | | | |
| 3 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | 3 |
| | | | | S3 | | 6.9 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | S4 | | 10.9 | | | | 5 |
| 6 | | End of Hole at 5.8 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.63 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.8 | | | | | | | | | | 7.8 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 5.80 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
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GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-31** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680752.8 EASTING: 673430.81 | ELEVATION: 1311.44m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC M.C. LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOTTED PIEZOMETER | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some gravel to gravelly, trace sand, low to medium plastic, brown, damp, very stiff | | | | | | | | |
| 1 | | | | S1 | | 8.1 | 175 | | | 1 |
| | | | | | | | | REC = 70% | | |
| | | | | SPT1 | 6-12-12 | 11.7 | ■ | | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 11.2 | 125 | | | |
| 3 | | | | SPT2 | 50(6) | 9.6 | | REC = 20% | | 3 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | | | | | | | |
| | | | | S3 | | 6.7 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | S4 | | 5.6 | | | | 5 |
| | | End of Hole at 5.3 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.43 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 6 | | | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.2 | | | | | | | | | | 7.2 |

| LOGGED BY: HL | COMPLETION DEPTH: 5.20 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/23/19 |
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GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/20/19

| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-32** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680666.74 EASTING: 673223.44 | ELEVATION: 1309.31m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOPE INDICATOR | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | S1 | | 8.8 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 7-16-19 | 10 | ■ | REC = 85% | | |
| 2 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 10.1 | | | | 2 |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 8.4 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| | | | | S4 | | 7.9 | | | | |
| 6 | | | | | | | | | | 6 |
| 7 | | | | S5 | | 6.9 | | | | 7 |
| | | End of Hole at 7.3 m due to practical auger refusal. Dry upon completion. Standpipe installed to 6.58 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 8 | | | | | | | | | | 8 |
| 9 | | | | | | | | | | 9 |
| 9.3 | | | | | | | | | | 9.3 |

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e2k engineering ltd.

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 7.30 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
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| | | |
|---|---|---|
| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-33** |
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680663.11 EASTING: 673323.87 | ELEVATION: 1309.20m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOPE INDICATOR | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY (Till), silty, some gravel, some sand, medium plastic, brown, damp, hard, trace oxides | | S1 | | 22.6 | 175 | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 10-16-20 | 11.9 | ■ | REC = 98% | | |
| 2 | | | | | | | | | | 2 |
| | | | | S2 | | 12.5 | 200 | | | |
| 3 | | | | SPT2 | 12-10-9 | 13.4 | | REC = 98% | | 3 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S3 | | 15.4 | 200 | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | S4 | | 11.4 | | | | 5 |
| | | End of Hole at 5.5 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.68 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 6 | | | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.5 | | | | | | | | | | 7.5 |

| | |
|---|---|
| LOGGED BY: HL | COMPLETION DEPTH: 5.50 m |
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-34** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680643.7 EASTING: 673431.95 | ELEVATION: 1310.04m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC – M.C. – LIQUID; 20 40 60 80) | VANE SHEAR (kPa) (100 200 300 400) / BLOW COUNT (20 40 60 80) / UNCONF. SHEAR STR. (kPa) (100 200 300 400) / 0.5 x POCKETPEN. (kPa) (100 200 300 400) | OTHER DATA | SLOPE INDICATOR | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | S1 | | 8.3 | | | | |
| 1 | | | | | | | | | | 1 |
| | | CLAY (Till), silty, some gravel, some sand, low to medium plastic, brown, damp, hard | | SPT1 | 12-22-30 | 10.2 | | REC = 70% | | |
| 2 | | | | S2 | | 10.4 | 225 | | | 2 |
| 3 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | SPT2 | 21-31-42 | 13.4 | | SO4=0.016% (Neg.) REC = 95% | | 3 |
| | | | | S3 | | 5.3 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | S4 | | 5.4 | | | | 5 |
| 6 | | End of Hole at 6.1 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.7 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.3 | | | | | | | | | | 7.3 |

| LOGGED BY: HL | COMPLETION DEPTH: 5.30 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/23/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-35** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680544.23 EASTING: 673314.94 | ELEVATION: 1307.85m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOPE INDICATOR | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard, trace oxides | | S1 | | 13.1 | | | | |
| 1 | | | | | | | | | | 1 |
| | | | | SPT1 | 10-18-22 | 7.4 | | Clay: 24%<br>Silt: 51%<br>Sand: 18%<br>Gravel: 7%<br>SO4=0.024%<br>(Neg.)<br>REC = 90% | | |
| 2 | | | | | | | | | | 2 |
| | | BEDROCK, siltstone, weathered, weak, light brown, dry | | S2 | | 5.1 | | | | |
| 3 | | | | | | | | | | 3 |
| | | | | S3 | | 5.6 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | | | | | | | 5 |
| | | | | S4 | | 10.8 | | | | |
| 6 | | | | | | | | | | 6 |
| | | | | S5 | | 6.9 | | | | |
| 7 | | End of Hole at 7 m due to practical auger refusal.<br>Dry upon completion.<br>Standpipe installed to 6.12 m.<br>Hole backfilled with drill cuttings and a bentonite cap.<br>Dry on February 1, 2019. | | | | | | | | 7 |
| 8 | | | | | | | | | | 8 |
| 9 | | | | | | | | | | 9 |
| 9.2 | | | | | | | | | | 9.2 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

| LOGGED BY: HL | COMPLETION DEPTH: 7.20 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/24/19 |
| | Page 1 of 1 |

| PROJECT NAME: Horse Creek Road | LOCATION: See Figure 1 | BOREHOLE NO: **BH-36** |
|---|---|---|
| CLIENT: Urban Star Ltd. | DRILL TYPE: Solid Stem Auger | E2K PROJECT NO: 2018-4227 |
| | NORTHING: 5680567.49 EASTING: 673428.98 | ELEVATION: 1307.89m |

SAMPLE TYPE: CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY | SHELBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

| DEPTH (m) | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT BLOWS /300 mm | ATTERBERG LIMITS & MOISTURE CONTENT (PLASTIC / M.C. / LIQUID; 20 40 60 80) | ▲ VANE SHEAR (kPa) ▲ 100 200 300 400; ■ BLOW COUNT ■ 20 40 60 80; ◆ UNCONF. SHEAR STR. (kPa) ◆ 100 200 300 400; ● 0.5 x POCKETPEN. (kPa) ● 100 200 300 400 | OTHER DATA | SLOPE INDICATOR | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | TOPSOIL | | | | | | | | 0 |
| | | CLAY and Silt (Till), sandy, some gravel, trace cobbles, low plastic, light brown, damp, hard | | | | | | | | |
| 1 | | | | S1 | | 7.9 | | | | 1 |
| | | | | SPT1 | 12-28-31 | 9.6 | ■ | REC = 80% | | |
| 2 | | | | S2 | | 10 | 225 | | | 2 |
| 3 | | BEDROCK, siltstone, weathered, weak, light brown, dry | | SPT2 | 50(5) | 7.6 | | REC = 20% | | 3 |
| | | | | S3 | | 11.4 | | | | |
| 4 | | | | | | | | | | 4 |
| 5 | | | | S4 | | 5.8 | | | | 5 |
| | | End of Hole at 5.5 m due to practical auger refusal. Dry upon completion. Standpipe installed to 4.97 m. Hole backfilled with drill cuttings and a bentonite cap. Dry on February 1, 2019. | | | | | | | | |
| 6 | | | | | | | | | | 6 |
| 7 | | | | | | | | | | 7 |
| 7.3 | | | | | | | | | | 7.3 |

| LOGGED BY: HL | COMPLETION DEPTH: 5.20 m |
|---|---|
| REVIEWED BY: PT | COMPLETION DATE: 1/23/19 |
| | Page 1 of 1 |

GEOTECHNICAL LOG JAN 23, 2019.GPJ AB_TRANS.GPJ 2/19/19

## EXPLANATION OF TERMS AND SYMBOLS

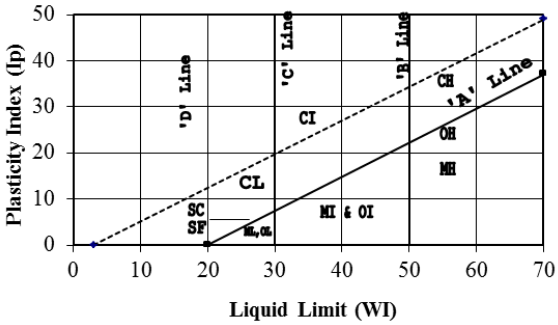
The terms and symbols used on the borehole logs to summarize the results of the field investigation and subsequent laboratory testing are described below. It should be noted that materials, boundaries, and conditions have been established only at the borehole locations at the time of investigation and are not necessarily representative of subsurface conditions elsewhere across the site.

### SOIL DESCRIPTIONS

The soils in the borehole logs have been described using the Modified Unified Soil Classification System in conjunction with description guidelines from the Canadian Foundation Engineering Manual 4th Edition.

| Secondary Constituents | |
|---|---|
| Descriptor | Percentage by Weight |
| And | > 35% |
| y/ey | 20 – 35% |
| Some | 10 – 20% |
| Trace | < 10% |

**Plasticity Chart**




| Consistency of Cohesive Soils | | |
|---|---|---|
| Classification | Undrained Shear Strength (kPa) | "N" Blow Count |
| Very Soft | < 12 | < 2 |
| Soft | 12 – 25 | 2 – 4 |
| Firm | 25 – 50 | 4 – 8 |
| Stiff | 50 – 100 | 8 – 15 |
| Very Stiff | 100 – 200 | 15 – 30 |
| Hard | > 200 | > 30 |

| Relative Density of Non-Cohesive Soils | |
|---|---|
| Classification | SPT – N |
| Very Loose | 0 – 4 |
| Loose | 4 – 10 |
| Compact | 10 – 30 |
| Dense | 30 – 50 |
| Very Dense | > 50 |

### SYMBOLS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Asphalt | High Plasticity Clay | Intermediate Plasticity Clay | Low Plasticity Clay | Fill | Poorly Graded Gravel | Well Graded Gravel | High Plasticity Silt | Intermediate Plasticity Silt |
| Low Plasticity Silt | Low Plasticity Organics | Clayey Sand | Silty Sand | Poorly Graded Sand | Well Graded Sand | Shale | Sandstone | Measured water level |

## MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

| Major Division | | | Symbol | Description | Criteria | |
|---|---|---|---|---|---|---|
| Coarse Grained Soils | Gravel (More than half coarse grains larger than 4.75 mm) | Clean Gravel (little or no fines) | GW | Well graded gravels, little or no fines | $C_u = \frac{D_{60}}{D_{10}} > 4 \;\; C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \; to \; 3$ | |
| | | | GP | Poorly graded gravels and gravel-sand mixtures, little or no fines | Not meeting above criteria | |
| | | Gravel with fines | GM | Silty gravels, gravel-sand-silt mixtures | Fines content > 12% | Atterberg Limit below "A" Line, $w_p < 4$ |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | | Atterberg Limit above "A" Line, $w_p > 7$ |
| | Sand (More than half of coarse grains smaller than 4.75 mm) | Clean Sand (little or no fines) | SW | Well graded sands, gravelly sands, little or no fines | $C_u = \frac{D_{60}}{D_{10}} > 6 \; C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \; to \; 3$ | |
| | | | SP | Poorly graded sands, little or no fines | Not meeting above criteria | |
| | | Sand with fines | SM | Silty sand, sand-silt mixtures | Fines content > 12% | Atterberg Limit below "A" Line, $w_p < 4$ |
| | | | SC | Clayey sand, sand-clay mixtures | | Atterberg Limit above "A" Line, $w_p > 7$ |
| Fine Grained Soils | Silts (Below "A" line, negligible organic content) | $W_L < 50$ | ML | Inorganic silts and very fine sands, rock flour, silty sands with low plasticity | See plasticity chart | |
| | | $W_L > 50$ | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils | | |
| | Clays (Above "A" line, negligible organic content) | $W_L < 30$ | CL | Inorganic clays of low plasticity, gravelly, sandy, or silty clays, lean clays | | |
| | | $30 < W_L < 50$ | CI | Inorganic clays of medium plasticity, silty clays | | |
| | | $W_L > 50$ | CH | Inorganic clays of high plasticity, fat clays | | |
| | Organic silts and clays (Below "A" line | $W_L < 50$ | OL | Organic silts and organic silty clays of low plasticity | | |
| | | $W_L > 50$ | OH | Organic clays of high plasticity | | |
| Highly Organic Soils | | | Pt | Peat and other highly organic soils | Strong colour or odour, often fibrous texture | |

- The soil of each stratum is described using the Unified Soil Classification System modified slightly so that an inorganic clay of "medium plasticity" is recognized
- "REC" denotes percentage sample recovery
- SPT "N" values represent the number of blows by a 63.6 kg hammer dropped 760 mm to drive a 50 mm diameter open sampler a distance of 300 mm after an initial penetration of 150 mm