2nd Street East Development

Geotechnical Report

2291463 Alberta Ltd.
Geotechnical Report Update | Version 01
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ENGLOBE

2291463 Alberta Ltd.
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Recommendations presented herein are based on a geotechnical evaluation of the findings in eleven (11) boreholes. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, Englobe should be notified and given the opportunity to review our current recommendations in light of new findings. This report does not include any recommendations related to contaminants in soil or groundwater. Should there be any other documentation indicating any excavation or land disturbance, such as environmental reports, Englobe would require these reports prior to site development to confirm the recommendations within this report are suitable in light of new information.

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1 Introduction

This report presents the results of a geotechnical evaluation conducted by Englobe (formerly McIntosh•Lalani Engineering Ltd. (M•L)) for a proposed residential development in Foothills County, Alberta. This evaluation was undertaken at the request of Brent Fraser of 2291463 Alberta Limited (AL). The objective of this evaluation was to assess the general subsurface soil conditions at the site for the design and construction of the proposed residential development.

This report presents the results of the drilling program and provides geotechnical recommendations for construction.

1.1 Project & Site Details

It is understood the project will include the design and construction of a residential development, consisting of single-family and multi-family homes, including two (2) storm ponds. The total site area is approximately 16.78 hectares, with 15.88 hectares of developable land. The site is located on the southeast corner of the intersection of 2nd Street East and Dunbow Road in DeWinton, Alberta. The legal land description is Lots 1 and 2, Plan 1530LK and Lot 1, Block 7, Plan 911 0757.

The site area consists of some previously developed areas along the west side of site, while the central and east side of site is undeveloped. Site grades central of site are relatively mild, while sloping at the east side of the development run from west to east at an approximate slope of 3:1 (H:V). Aerial photos show no low-lying areas throughout the site.

The location of the site is illustrated on drawing 02109833.000.G01 located in Appendix A.

2 Methodology

In order to assess the geotechnical site conditions including soil stratigraphy, groundwater conditions and soil properties, Englobe completed a program of borehole drilling and installation of standpipe wells combined with laboratory index testing.

The borehole locations were selected by representatives of Englobe. The locations of the boreholes are illustrated in Drawing 02109833.000.G002. The borehole logs are presented in Appendix C.

2.1 Soils Investigation

The subsurface investigation consisted of advancing eleven (11) boreholes within the area for the development. The boreholes were be spaced at approximately 150 metres across the site with eight (8) boreholes advanced to 6.1 metres, one (1) borehole advanced to 9.1 metres, and two (2) boreholes advanced to 12.2 metres, or until effective refusal was met. The boreholes were advanced from October 25, 2021 and October 26, 2021 using a truck mounted solid stem auger drill rig contracted from Earth Drilling of Calgary, Alberta. Classification of the soil was done from the disturbed samples obtained from the auger flights and from the Standard Penetration Test (SPT) operation. SPT blow counts were utilized to aid in determining in-situ soil strengths.

2.2 Groundwater

Upon completion of the boreholes, the depth of the borehole was measured, including any slough, and the presence or absence of free water within the borehole was noted. A 25 mm diameter slotted PVC standpipe well was installed in all deep boreholes to allow future measurement of groundwater level within the depth of the investigation. Specifics of each well installation are illustrated on the borehole logs.

2.3 Laboratory Testing

Laboratory testing including natural moisture content, soluble sulphate, and Atterberg limit testing has been completed. The results can be seen within the attached borehole logs and throughout this report.

3 Subsurface Conditions

At the time this report was prepared, information on subsurface stratigraphy was available only at discrete borehole locations. Conditions were extrapolated and interpolated from the borehole locations to develop recommendations. Adequate monitoring should be provided during construction to check that these assumptions are reasonable. The below summarizes the subgrade conditions encountered in the drilling program. More detailed soil description is contained in the borehole logs in Appendix A.

3.1 Surficial Geology

The pre-development near surface soil conditions is described by Fenton[1] as glaciolacustrine deposits consisting of a conglomerate of types of materials, ranging from silts and clays to well-sorted silty sand and gravelly deposits.

3.1.1 Topsoil & Browns

Topsoil was encountered at the surface in all the boreholes advanced. The thicknesses of topsoil ranged from 50 to 200 mm in depth.

Thicknesses of organic topsoil deposits can vary widely across the site, especially within low-lying areas or near the toe of slopes. The encountered topsoil thicknesses from the boreholes shall not be used for topsoil stripping volume calculations without being supplemented from hand-dug test pits.

3.1.2 Silty Sand

Silty sand, with traces of clay and gravel, was primarily encountered below topsoil and browns in the northwest region of the development, which includes boreholes 1 to 5, as well as borehole 6 central of site. The material was described as loose, damp to dry, and light-medium brown in colour. The silty sand primarily extended to depths of 1.8 metres below existing grade, except for borehole 2 and 3,

[1] *Fenton, M.M., Waters, E.J., Pawley, S.M., Atkinson, N., Utting, D.J. and Mckay, K. (2013): Surficial geology of Alberta; Alberta Energy Regulator, AER/AGS Map 601*

where it is encountered again, underlying a glacial till deposit, extended to a maximum depth of 5.0 metres below existing grade.

3.1.3 Sand

Sand, with traces of silt and occasional traces of gravel, was generally encountered towards the south and east sides of the development in boreholes 7, 8, 10, and 11. A shallow seam of silt, less than 600 mm in depth was found overlying the sand in borehole 8. The sand was described as fine grain, loose to compact, damp to dry, and medium to light brown in colour.

The sand in boreholes 8 and 10 extended to depths of 1.8 and 1.2 metres below existing grade, respectively. Sand encountered in boreholes 7 and 11, which are situated near top of slope of the 3:1 (H:V) running west to east of the east perimeter of the development, extend to 7.3 and 6.4 metres below existing grade, respectively. A sand seam underlying glacial till soils was encountered in borehole 7, extending to 10.4 metres below existing grade.

3.1.4 Glacial Till

Silty clay till, with traces of sand and occasional traces of gravel, were encountered in all boreholes advanced; however, the depths at which the till was encountered range significantly throughout the site. In borehole 9, glacial till soils were encountered directly underlying topsoil and browns. The till soils were generally described as stiff to very stiff, damp to moist, low plastic, and medium brown within the higher elevations of the deposit, with light to medium grey at deeper elevations in the deposit.

The glacial till deposits other than boreholes 7 and 11 along the east perimeter of the development, are encountered at depths ranging from 0.2 metres below existing grade (borehole 9), extending to end of hole in boreholes 8 and 9 at 6.1 metres below existing grade.

The glacial till deposits in boreholes 7 and 11 are encountered at lower elevations within the soil strata, ranging in depths from 7.3 to end of borehole at 12.2 metres below existing grade.

3.1.5 Sandy/Silty Gravel

Sandy gravel, with trace silt and occasional traces of clay was encountered in four (4) boreholes: boreholes 1, 3, 4 and 5. A silty gravel, with traces of sand and clay was encountered in borehole 10 and is suspected to be part of the sandy gravel deposit encountered in the other boreholes. The material was described as dense, damp to wet, and medium brown in colour.

The sandy/silt gravel deposits range in depths from 3.2 metres to at least 6.1 metres below existing grade as boreholes were terminated at this depth. Effective refusal was met within the sandy gravel soils in boreholes 2 and 3, at depths of 5.2 and 5.5 metres below existing grade.

3.1.6 Siltstone / Sandstone Bedrock

Siltstone or sandstone bedrock was encountered in three (3) boreholes: boreholes 1, 2 and 6. The bedrock was described as weak and weathered, and damp to dry in nature. The siltstone bedrock encountered in borehole 6 was described as moderately strong approximately 1.0 metre into the bedrock strata. The bedrock ranged in depths from 4.9 metres to end of hole at 6.1 and 9.1 metres below grade. All bedrock encountered was augerable to the target depth of the borehole.

A more detailed soil description is presented in the borehole logs in Appendix A.

3.2 Groundwater

During drilling, water seepage was noted in five (5) boreholes. It appears silt and sand seams throughout the soil strata, as well as some of sandy gravel layers were contributing to the water seepage. Groundwater readings were recorded throughout the development on November 9, 2021. At this time, groundwater levels were recorded in all boreholes, ranging in depths of as shallow as 1.35 metres below existing grade in borehole 6, which was advanced within one of the proposed storm pond locations, to 10.61 metres below existing grade in borehole 7. Groundwater levels fluctuate seasonally and in early November are expected to be approximately 0.5 metres below their season peak in an average year.

4 Discussion & Recommendations

4.1 General Recommendations

The site primarily consists of suitable bearing soils provided the following recommendations within this report are followed. The following is a list of a few of highlighted geotechnical aspects of the site. This summary should be read in conjunction with the entire report:

- The soils at the site, with the exception of the topsoil and other organic soils, are suitable for use as general engineered fill. Final site grades are not known at this time, but upon availability of grading and cut/fill plans, M•L should conduct a detailed deep fill grading analysis.
- The native site soils are capable of supporting residential structures, as outlined in Section 3.2 with exception to topsoil and browns. Some overexcavation may be necessary if areas of loose silty sand or sand, as described in Sections 3.2.1 and 3.2.2., are encountered. Approved engineered fill soils are also suitable to provide support, subject to a deep fills assessment.
- The above statement does not preclude the construction of multi-family residential or commercial structures. The footing design parameters of these structures should be determined by a site and project-specific geotechnical evaluation once further development plans are known.
- Some perched water pockets, typically in more permeable soil layers, were encountered within the silty clay encountered, particularly in the southern half of the development. Water was also encountered near the bedrock interface. These water pockets may be encountered within excavations for deep utilities, or basement excavations, however, it is expected that the seepage from these layers can be accommodated using a system of trenches, sumps, and pumps. These soils may also be encountered during the rough grading program, depending on proposed cut depths, and may hamper traction for rubber-tired vehicles. Deeper excavations may also encounter saturated non-cohesive soils below the water table.
- For the majority of the site, construction excavations can be completed using conventional excavators. Where silty clay tills or bedrock are present it may be possible for excavations to be made with up to 1.5 metres vertical cut and a 1 Horizontal to 1 Vertical side-slope above that. Elsewhere, in non-cohesive soils such as the encountered sand and silt soils, a minimum side-slope of 1H:1V is required. Weathered bedrock may be encountered during deep utility installation, should be excavatable.

- The site soils are suitable to support deep and shallow utilities. Compacted clay or lean mix concrete plugs should be installed at regular intervals to prevent the flow of water through the bedding gravel and reduce migration of fine-grained soils into the bedding gravel. Any utilities extending down the slope will require particular attention to clay plug design.
- Two storm ponds are proposed for the development; Boreholes 1, 2 and 6 were advanced in or within proximity of the ponds with groundwater elevations ranging from 1.35 to 1.83 metres below existing grade. There have been both wet sand gravel layers excavated in one pond location. A site-specific review of the pond design should be conducted once a pond design is complete. Depending on the pond depth relative to the wet soil layers, additional test pits may be advisable to better understand the subsurface conditions in these pond locations.

This list should not be considered all-inclusive and should be read in conjunction with the remainder of this report. Geotechnical foundation design parameters, slab-on-grade recommendations, groundwater concerns, pavement design sections, and additional construction recommendations are provided in the sections below.

4.2 Site Grading and Drainage

At the time this report was written, a cut-fill plan was not available. Some cuts and fills may be required within the proposed development. All organic topsoil, deleterious soils and vegetation should be removed from areas to be filled. The backfill should be placed in uniform lifts compacted to a minimum of 98 percent of Standard Proctor Density at a moisture content in the range of optimum to 3 percent above optimum. The maximum lift thickness is generally 300 mm but also subject to soil conditions and compaction equipment being used and should be verified by Englobe on site.

Deep fills, of thickness greater than 1.5 metres, should be reviewed in a Deep Fills Analysis Report.

Grading all slopes will require a 5H:1V backsloping in building areas prior to placing fill. Upon determination of a site grading plan, Englobe should be consulted to review the stripping requirements for the site. The development appears to have no wetland areas; however, Englobe should be notified to inspect all soil surfaces prior to placement of fill soils to verify the organic and deleterious soils have been removed. The site soils are suitable for use as engineered fill.

It is recommended that final site grading be provided to direct water to areas remote from all proposed structures. Minimum landscape gradients of 2 percent are recommended to reduce the risk of run-off ponding in localized areas. Furthermore, downspouts should be positively directed away from the buildings.

4.3 Construction Excavations

It is anticipated that excavations of up to 3 metres depth for construction of residences and up to 5 metres depth for construction of deep utilities may be required for the proposed development. The composition and consistency of the soils encountered in the boreholes is such that conventional hydraulic excavators should be able to remove these materials.

Some perched groundwater was encountered in the boreholes as noted earlier in this report. It is expected that seepage from more permeable layers and seams can be accommodated using a system of ditches and sumps equipped with submersible pumps.

Temporary excavations may be made with a vertical cut of up to 1.5 metres in height measured from the base of the excavation where the soils consist of silty clay. Above the vertical cut, and anywhere that silty clay is not present, excavations should be backsloped at a minimum gradient of 1 horizontal to 1 vertical (1H:1V) or 45°. If excessive sloughing or groundwater seepage into the excavation is

encountered, it may be necessary to flatten the sideslopes further. All temporary excavations should be carried out in accordance with the requirements of Alberta Occupational Health & Safety. Temporary excavations must be inspected by a qualified geotechnical engineering firm and monitored to ensure that safe working conditions persist. Where insufficient space is available for suitable backsloping to provide a safe working slope, shoring or trench boxes must be implemented. All shoring must be designed by a qualified engineer and Englobe can provide recommendations for shoring upon request.

4.4 Pipe Support

The composition and consistencies of the soils encountered at the site are such that conventional hydraulic excavators should be able to remove these materials. It is anticipated that open excavations of up to 3.0 metres deep will be required for the installation of deep utilities.

Fine-grained sandy silt soils are present. The soils consist mostly of fine-grained silt and silty clay, and to prevent erosion of the bedding soils by water flowing through the bedding gravel, compacted clay or lean-mix concrete plugs should be constructed at regular intervals along utility lines, as per the City of Calgary detail on the down-stream side of manholes. Drains should be installed on the upstream side of the manholes to drain groundwater into the storm system. Geotextile placed on-top of the bedding gravel will be necessary where fine-grained soil is used as fill directly on-top of the bedding gravel. The geotextile will prevent migration of fine-grained soil into the gravel which would result in future settlement. The requirements for geotextile should be assessed during construction by a qualified geotechnical engineering firm. A detail drawing of typical clay plug configurations is included in the appendices and numbered 02109833.000.D01.

4.5 Frost Protection

4.5.1 Structures

For protection against frost action, perimeter footings or grade beams in heated structures should be extended to such depths as to provide a minimum soil cover of 1.4 metres. Exterior footings or grade beams in unheated structures should have a minimum soil cover of 2.1 metres, unless provided with equivalent insulation. Grade beams that do not have adequate soil cover for frost protection should have a minimum 100 mm void space on the underside of the grade beam to reduce the risk of interaction with the underlying soil. Any portion of the foundation that extends more than 1.0 metres from the heated structure should be considered to be an unheated foundation. Any portion of the foundation that extends more than 1.0 metres from the heated structure should be considered to be an unheated foundation.

4.5.2 Surface Concrete

The on-site silty and clayey soils encountered throughout the site should be considered very frost susceptible which will result in frost heave displacement in the soil when frozen. Therefore, some precautions should be followed for the design and construction of concrete flatworks at the site.

In all unheated areas, the site soils will likely experience some degree of heave due to frost formation during the winter months. If proper consideration is given to the recommendations contained in Section 4.2, proper drainage will prevent the subgrade from becoming saturated and will help reduce the severity of frost heave. Nevertheless, concrete flatwork should be designed with anticipation of some frost heave occurring. Concrete sidewalks should be dowelled into footings or grade beams in threshold areas where heave of the concrete panels would obstruct the proper opening of the door and present a tripping hazard. As the outside edge of these panels will still heave, the panel should either

be properly jointed to control crack locations or reinforced by the placement of reinforcing steel 10 mm bars at a 300 mm spacing. The depth of the reinforcement should be controlled so that the reinforcement is properly located within the concrete panels.

Alternatively, rigid insulation can be placed below flatwork to prevent frost formation in the underlying subgrade. Englobe can provide recommendations for such insulation if required.

4.6 Groundwater Conditions

Groundwater was encountered in the boreholes at depths ranging from approximately 1.35 to 10.61 metres below the existing grade. The variability of these readings as well as observations suggest the more permeable sand and gravel layers are conveying water from potential offsite sources. The groundwater is expected to be free flowing from isolated and discrete seams and layers of higher permeability soils.

Excavations for deep utilities will require dewatering. Pond design elevations shall be reviewed and groundwater elevations will need to be considered in the pond and pond liner design.

Properly designed stormwater management will limit surface infiltration and thereby reduce the available free water within the soil. Permanent dewatering systems consisting of perimeter weeping tile at footing elevation should be installed in all buildings with below grade living space. These systems must be positively drained to the storm system.

4.7 Weeping Tile

Weeping tile subsurface drainage at footing elevation is required in areas where the groundwater table is closer than 2.1 metres below the top of footing, or for structures founded upon more than 2.0 metres of fill soils. A perforated weeping tile system at footing elevation will reduce water pooling near the footings. In addition, a weeping tile in the walkout frost footing is recommended. A sump to pump this water up to the storm sewer would be required.

Weeping tile drains should consist of a minimum of 100 mm diameter perforated pipe around the perimeter of below grade structures at the bottom of footing elevation. The pipe should be backfilled with free draining washed gravel and positively drained to a storm sewer, possibly through a sump and pump. A non-woven geotextile filter fabric should cover the top of the drainage gravel to prevent siltation of the gravel.

All backfill around the foundation walls of residential structures should be compacted. A detail drawing of typical weeping tile installation is included in the appendices and numbered 02109833.000.D02.

4.8 Shallow Foundations

Based on the results of the geotechnical investigation, conventional strip and spread footings may be used for the residential structures within this development. A conventional shallow strip and spread footing foundation system placed on approved native soils and engineered fill soils is a feasible foundation option for residential development. Some overexcavation of softened silty clay materials or saturated non-cohesive silt and/or sand deposits may be required, if encountered at footing elevation. Additionally, fill soils may be encountered in areas which previous single-family homes were present; overexcavation of the old building foundation and fill soils to development grades may be required. The capacity of all bearing surfaces must be verified by handheld Dynamic Cone Penetration Testing (DCPT) and visual bearing inspection by Englobe.

The footings should be designed for an Ultimate Limit State (ULS) unfactored bearing resistance of 260 kPa in the competent native sandy silt. silt, sand, and silty clay till on site, or engineered fill soils that meet the requirements set out in Section 4.10. A geotechnical resistance factor of 0.5 may be used in conjunction with this ULS value.

To undertake the shallow foundation design using the Working Stress Method, a net allowable bearing pressure of 100 kPa (excluding overburden soil pressure) may be used within competent native sandy silt. silt, sand, and silty clay till on site, or engineered fill soils that meet the requirements set out in Section 4.10.

All prepared bearing surfaces should be inspected by a qualified geotechnical engineering company prior to concrete or gravel placement.

The footing sizes and depths have been estimated to provide the above design values. Should unconventional footing sizes be utilized, a review of the footing sizes and bearing resistances should be undertaken. Footings should be placed on homogenous soils to avoid differential settlements that could occur if footings span non-uniform soil types (e.g. fill to native).

The allowable bearing capacities for residential structures bearing on more than 2.0 metres of fill should be assessed as part of the phase-specific Deep Fills Report.

4.9 Soluble Sulphate Attack Potential

Testing for soluble sulphate content has revealed 'Moderate' sulphate levels of up to 0.165 percent. Therefore, all concrete elements in contact with soil with which these samples represent, must meet the requirements of CSA-A23.1 4.1.1.6 which includes the use of Type HS (Sulphate Resistant) cement, a minimum 56 day compressive strength of 30 MPa, a maximum w/cm ratio of 0.5 and air entrainment of 4-7 percent by volume (based on 14-20 mm aggregate).

4.10 Soil Erodibility

Englobe has conducted laboratory testing and calculated a soil erodibility factor (K-value) for the surficial soils within the subject site for use in an Erosion and Sedimentation Control (ESC) plan. The K-value was calculated in accordance with the RUSLEFAC guidelines[2] using two (2) pairs of hydrometer and organic content test results obtained on borehole Sample 1-1 and 8-1. The sample was obtained from the surficial silty sandy clay soils at an approximate depth of 0.76 m.

The particle size distribution of the soils was obtained using the hydrometer method. The hydrometer results are attached. The USDA classification scheme was used for differentiating silts and sand when determining the soil structure and permeability classes from the Erodibility Worksheet. Sample 1-1 and 8-1 was classified as a 'Sandy Loam' (USDA). The percentage of very fine sands (0.05 - 0.10 mm) was added to percent silt for application to the nomograph in Drawing 02109833.000.B001. The samples contained 1.6 and 2.3 % organic matter, and 20.0 and 7.6 % gravel (size greater than 2 mm) by weight fraction of the total sample volume.

The soil erodibility K-value for the sample was determined graphically (refer to Drawing 02109833.000.G001) and is listed below:

[2] Wall, G.J., D.R. Coote, E.A. Pringle and I.J. Shelton (editors). 2002. RUSLEFAC – Revised Universal Soil Loss Equation for Application in Canada: A Handbook for Estimating Soil Loss from Water Erosion in Canada. Research Branch, Agriculture and Agri-Food Canada. Ottawa. Contribution No. AAFC/AAC2244E. 117 pp.

Table 1: Erodibility Factors

Sample No.	Soil Class (USDA)	Percentage Composition (normalized to passing 2 mm sieve)			Gravel	Structure Class	Permeability Class	Organics (%)	K-Value
		Clay	Silt + Very Fine Sand	Other Sand					
1-1	Sandy Loam	18.2	32.7	49.1	20	2	1	1.6	0.018
8-1	Sandy Loam	14.2	32.4	53.4	7.6	2	2	2.3	0.020

The graphically determined K-value is considered to represent the most erodible soil types on site likely to be exposed during rough grading. Furthermore, these soils are considered suitable as engineered fill soils for rough grading. Thus, a K-value of 0.019 that represents the typical result from our experience in the area can be considered suitable for application in the ESC plan for the project site.

4.11 Lateral Earth Pressure Parameters

The following Table presents coefficients lateral earth pressure and unit weights. Information on the application of these coefficients is included in the appendices.

Table 2: Coefficient of Lateral Earth Pressure

	Ka	Ko	Kp	γ (kN/m^3)
Engineered Fill	0.39	0.58	2.56	21.5
Silty and Sandy Deposits	0.35	0.52	2.88	21.0
Clay Till	0.36	0.53	2.77	20.0
Sandy Gravel	0.31	0.47	3.25	23.0

4.12 Backfill Materials and Compaction

The on-site materials may be suitable for use as general engineered or structural fill subject to material evaluation and removal of deleterious materials. Imported fill should be approved for use as structural or general engineered fill.

Recommended compaction specifications and materials are as follows:

- Structural fill - 100 percent Standard Proctor maximum dry density, maximum compacted lift thickness 250 mm, maximum grain size 200 mm. Structural fill materials should comprise clean well-graded inorganic granular soils.
- General engineered fill - 98 percent Standard Proctor maximum dry density, 0 to +3 percent of optimum moisture content, maximum compacted lift thickness 300 mm. General engineered fill materials should comprise clean well-graded granular soils, or inorganic medium to low plastic cohesive soils.

Where washing of fines is possible, fill material placed should be separated from coarser or finer material by a suitable geotextile.

Backfill comprising cohesive soils should be considered frost susceptible and should not be used in areas where it may become frozen and where frost heaving would be unacceptable.

5 Pre-Grading Slope Stability

The following sections pertain to the pre-grading slope stability analysis conducted for the development. A development setback line is provided for the north property line. Restrictive covenants are also outlined for any development immediately adjacent to the development setback.

Englobe has reviewed the most current concept plan, provided by Township Planning & Design Inc., dated October 28, 2021. Should the concept change in layout or extent, Englobe must be given the opportunity to review the final design grades. The final lot grading and building envelope needs to be reviewed for global slope stability as a post-development slope stability report. Any proposed multifamily or commercial development proposed must have a site-specific slope stability assessment completed once a design has been finalized to confirm the slope stability setback requirements given the chosen foundation type and depth of foundation systems.

5.1 East Development

The stability of the east-facing slope has been analyzed to determine the existing Factors of Safety (F.O.S.) against slope instability. The proposed eastern legal boundary line of the development is generally situated within the slope face, near the base of the slope face. A Municipal Reserve (MR) is located east of the property lines near top of slope, including a perimeter walking path around the development. An Environmental Reserve (ER) is situated downslope of the MR and encompasses the majority of the slope.

A minimum F.O.S. of 1.5 against slope instability and a F.O.S of 1.0 with the addition of seismic loading is required for any development to take place on a slope.

Two (2) cross-section locations were chosen to be representative of the eastern slopes, in their current condition. Drawing 02109833.000.S001 includes a contour survey in the slope areas as well as the location of the slope stability cross-sections.

Englobe has analyzed the cross sections presented in Drawings 02109833.000.S002 and 02109833.000.S003 using the Morgenstern Price limit equilibrium method modeled by the computer software program SLOPE/W. Englobe has used conservatively estimated shear strength soil parameters based upon our on-site observations, subsurface borehole investigation, and experience with these soils.

5.2 Analysis

5.2.1 Groundwater Conditions

An elevated groundwater levels (piezometric line) was modeled based on groundwater levels measured in the boreholes and was elevated by 1.0 metre over seasonal high levels. Groundwater in the two nearest boreholes, borehole 7 and borehole 11, were recorded on November 9, 2021 as 10.61 and 5.91 metres below existing grade, respectively.

An Ru coefficient of 0.1 was used to model the increase of moisture content of the surficial soils above the piezometric line due to heavy rainfall or snowmelt.

5.2.2 Assumed Soil Parameters

The following table presents the shear strength properties of the soil used for the slope stability analysis. The analysis was completed using these soil parameters in conjunction with the slope geometry and elevated groundwater conditions:

Table 3: Assumed Soil Parameters for Slope Stability Analysis

Soil Type	Unit Weight - γ (kN/m^3)	Cohesion - c (kPa)	Effective Friction Angle - Φ (degrees)
Sand	21.0	0.0	28.0
Silty Clay Till	20.0	0.0	29.0

Surcharge building load of 100 kPa foundation load and 5 kPa for slab-on-grade loading was applied at the top of slope within property line to simulate a future building. Additionally, a 2 kPa surcharge was applied to the pathway located within the MR zone. The foundations were placed immediately inside the property line/MR boundary to simulate worst case scenario.

5.3 Analysis Conclusions

The stability analysis of the Section A-A in this study produces a factor of safety of 1.802 against global slope instability for the worst-case scenario anticipated. The F.O.S. was encountered within the ER, approximately 12 metres downslope of the property line. Section A-A was also checked with additional seismic loading and produced a F.O.S of 1.207, at the same location, exceeding the minimum F.O.S of 1.0 required for slopes under seismic loading conditions. Drawings: 02109833.00.S002 illustrates the geometry of the slope cross-section with the calculated factor of safety.

The stability analysis of the Section B-B in this study produces a factor of safety of 1.877 against global slope instability for the worst-case scenario anticipated. The F.O.S was encountered at the East permitter of the ER. Section B-B was also checked with additional seismic loading and produced a F.O.S of 1.353, at the same location, exceeding the minimum F.O.S of 1.0 required for slopes under seismic loading conditions. Drawings: 02109833.00.S003 illustrates the geometry of the slope cross-section with the calculated factor of safety.

No development setback is required along the east property lines of the proposed residential boundaries based on the existing site grades.

6 Slope Stability Requirements

A restrictive covenant for all proposed lots that back on the development setback line should be implemented and should include the following.

— Channelized flows over the top of slope should be avoided.

- There should be no surcharge loading at the top of slope such as retaining walls, fills in excess of 0.5 metres or other permanent structures, without a full slope/global stability review by a qualified geotechnical engineer.
- Building drainage must be controlled such that there is no ponding or infiltration into the site slopes. Englobe must be given the opportunity to review the stormwater management plan to ensure there is little impact to the stability of the site slopes.
- A post-development slope stability analysis must be completed once design grades are established.

Should additional fills or cuts at the respective top or toe of the slope be proposed, or if conditions other than those assumed in the analysis are noted in subsequent phases of development, Englobe should be given the opportunity to review the slope stability assessment.

6.1 General Conditions

Englobe has prepared this report for use in subdivision planning and establishing suitable building sites from a slope stability perspective. The slope stability analysis has been prepared based upon Englobe's interpretation of the sites soils from surrounding areas and groundwater condition and design data available at the time of this report. Upon site development it is the responsibility of 2291463 Alberta Ltd. or their representative to notify Englobe to review the sites soils and groundwater conditions to verify they are consistent with Englobe's interpretation.

Englobe should be notified to review any site developments on or adjacent to the sloping lands to make our own assessment of potential impacts to the slope the development may have. The report has been prepared assuming there will be no significant cuts on adjacent lands that may impact slope stability. Any alterations to the development and resulting impacts to the slope stability will be the responsibility of the party making the alterations.

7 Review of Design and Construction

Englobe should review details of the design and specifications related to geotechnical aspects prior to construction. Adequate monitoring during construction will be required. All construction should be carried out by a qualified contractor experienced in foundation and earthworks construction. Adequate monitoring includes:

- Shallow Foundations - Inspection by a qualified geotechnical engineer prior to placement of footings.
- Earthworks - Full-time monitoring and compaction testing.

All monitoring should be carried out by a qualified person, independent of the contractor. Englobe will provide these services if requested. Failure to provide an adequate level of foundation monitoring may be contravention of building code requirements.

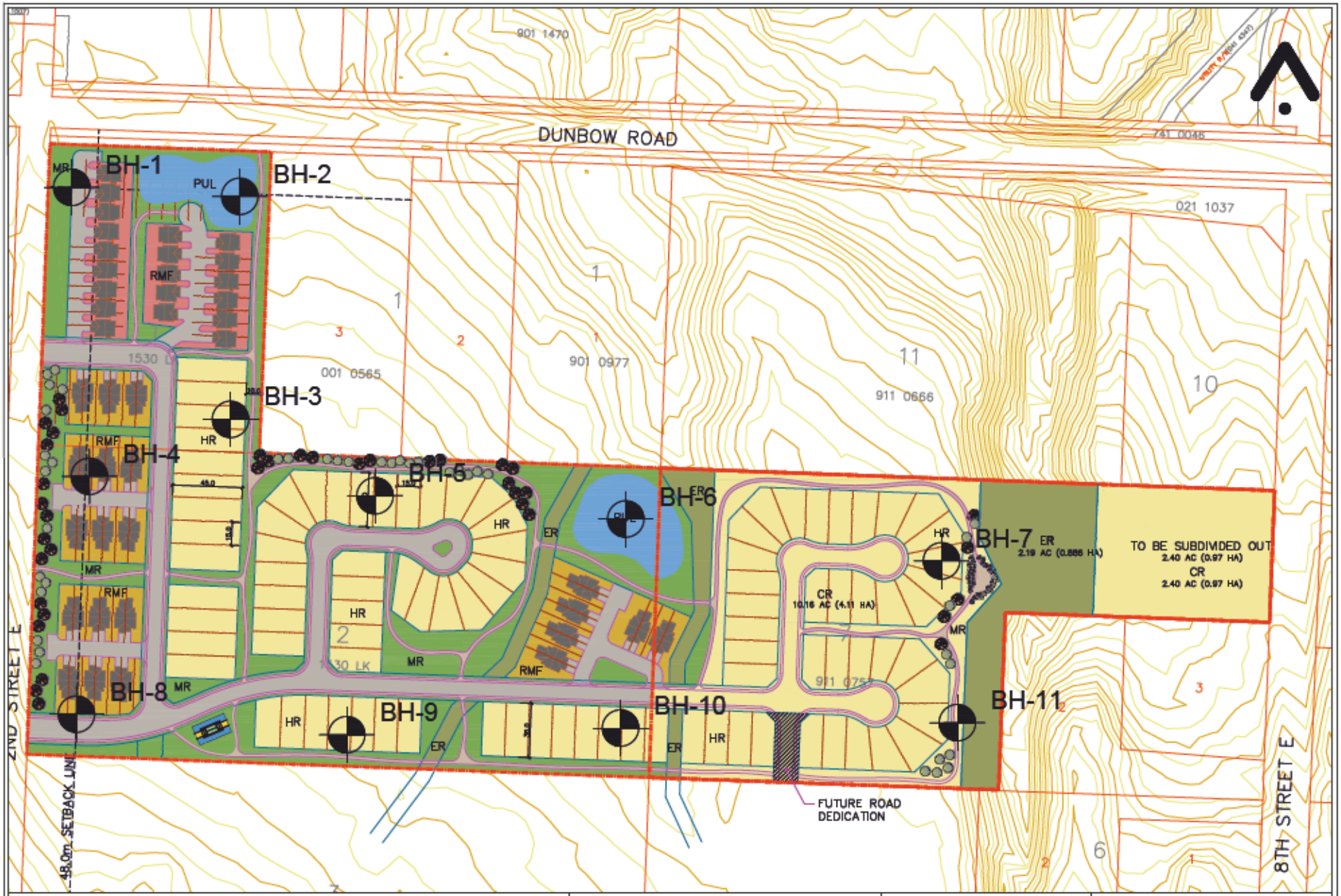
7.1 Design and Construction Guidelines

Recommended general design and construction guidelines are provided in Appendix A. These guidelines are intended to present standards of good practice. Although supplemental to the main text of this report, they should be interpreted as part of the report. Design recommendations presented herein are based on the premise that these guidelines will be followed. The design and construction guidelines are not intended to represent detailed specifications for the work, although they prove useful in the preparation of such specifications. In the event of any discrepancy between the main text of this report and Appendix A, the main text should govern.

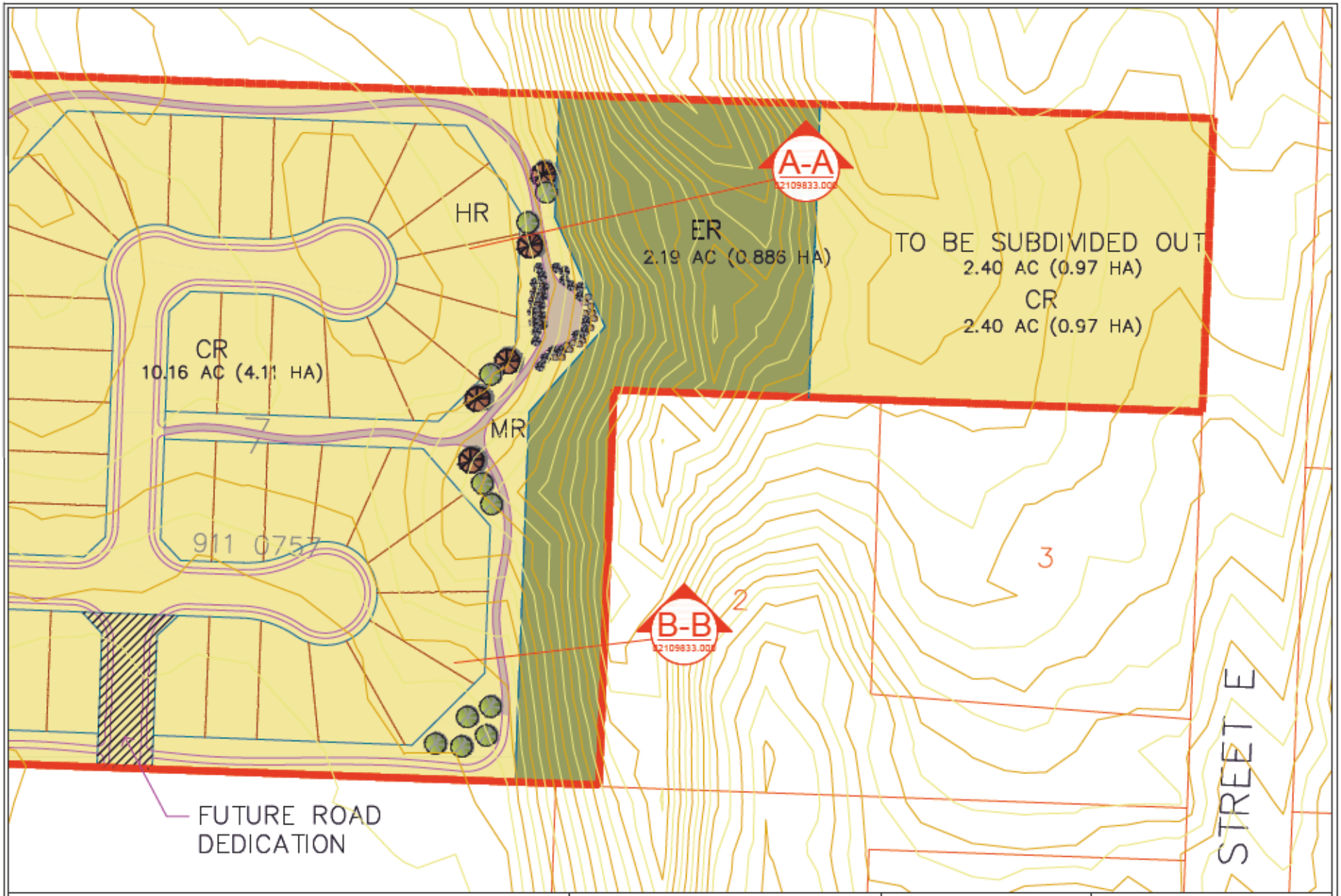
Appendix A
Drawings & Figures

ENGLOBE

Client: 2291463 Alberta Ltd.	Job Number: 02109833.000	Date: February 14, 2022	ENGLOBE
Project: 2nd Street East Development	Drawing Number: 02109833.000.G01	Scale: N.T.S.	
Title: General Site Location			

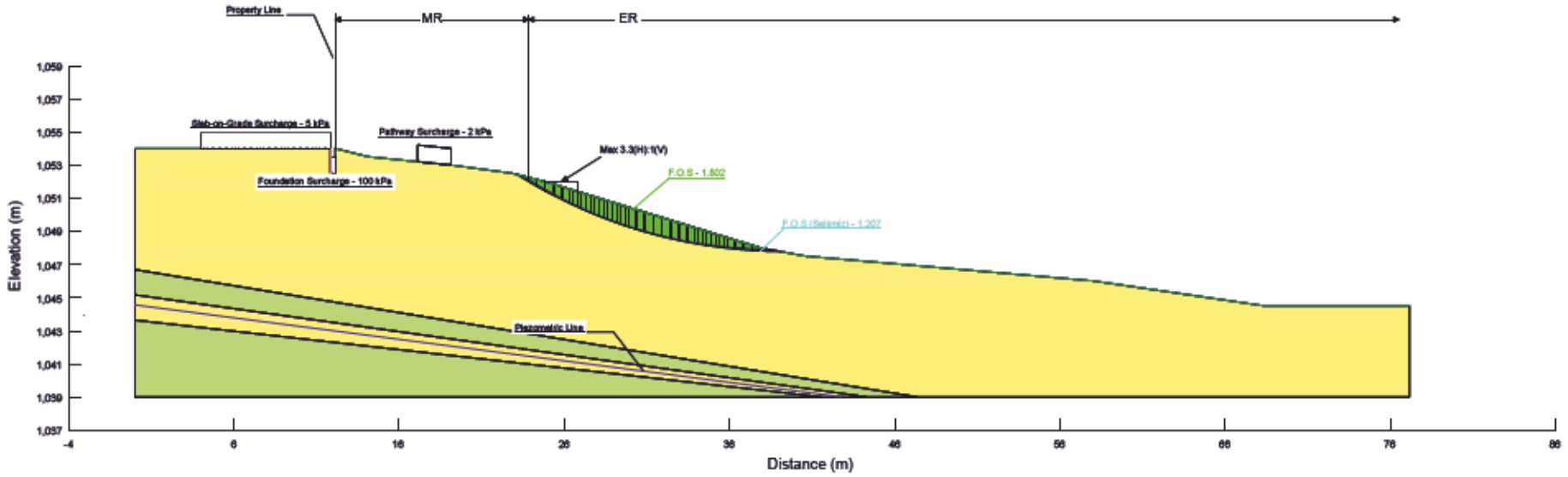


Client: 2291463 Alberta Ltd.	Job Number: 02109833.000	Date: February 14, 2022	
Project: 2nd Street East Development			
Title: Borehole Plan	Drawing Number: 02109833.000.G02	Scale: N.T.S.	



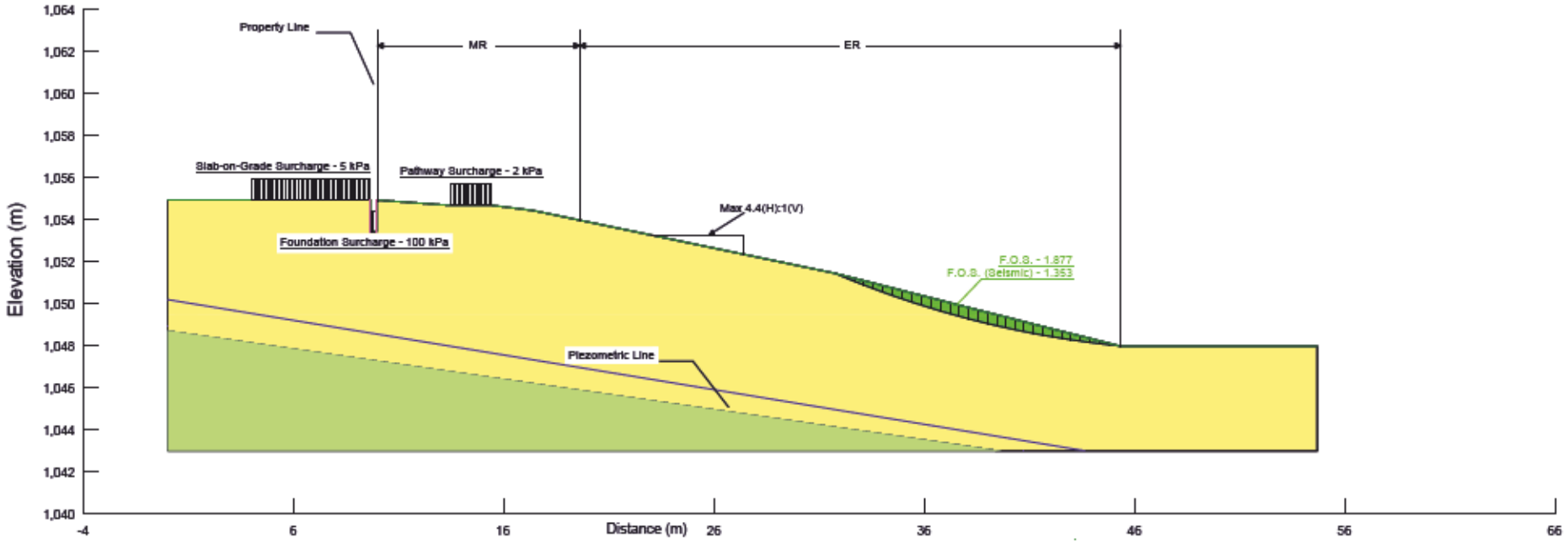
Client: 2291463 Alberta Ltd.	Job Number: 02109833.000	Date: February 14, 2022	
Project: 2nd Street East Development			
Title: Slope Sections	Drawing Number: 02109833.000.S01	Scale: N.T.S.	

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru
	Sand	21	0	28	1	0.1
	Silty Clay Till	20	0	29	1	0.1

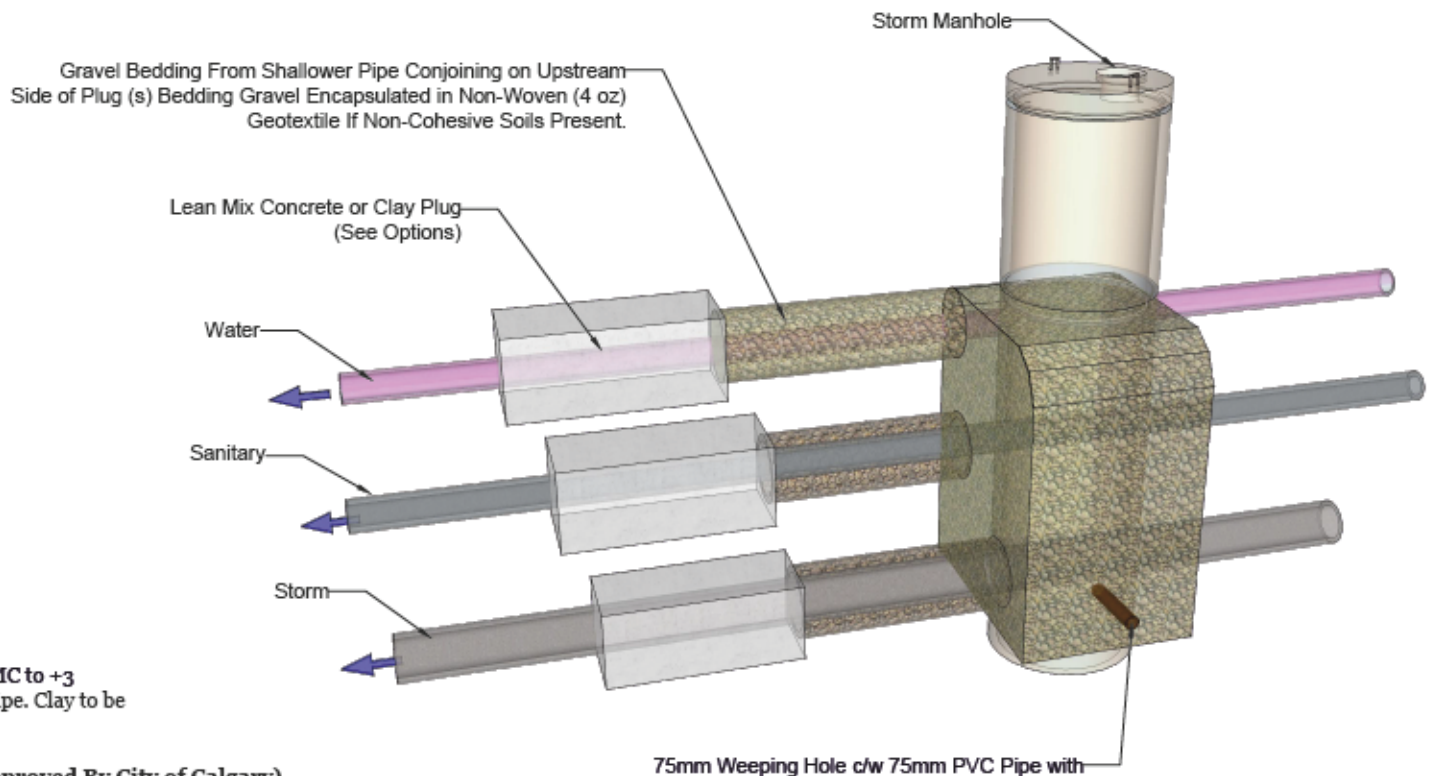


Client: 2291463 Alberta Ltd.	Job Number: 02109833.000	Date: February 14, 2022	
Project: 2nd Street East Development	Drawing Number: 02109833.000.S02	Scale: N.T.S.	
Title: Section A-A			

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru
	Sand	21	0	28	1	0.1
	Silty Clay Till	20	0	29	1	0.1



Client: 2291463 Alberta Ltd.		Job Number: 02109833.000	Date: February 14, 2022
Project: 2nd Street East Development		Drawing Number: 02109833.000.S02	Scale: N.T.S.
Title: Section B-B			



Option 1: Clay Plug

- **Compacted to minimum 98% SPD OMC to +3**
-Minimum 3.0 m long plug along the pipe. Clay to be approved by ML

Option 2: Concrete Plug (To be Approved By City of Calgary)

-Lean mix concrete, compressive strength 3-5 MPa.
-Minimum 3.0 m long along the pipe.
-Minimum 100 mm below haunch on top of pipe.
-Place 3 evenly spaced adhesive strips of water stop around entire pipe to be embedded in concrete.

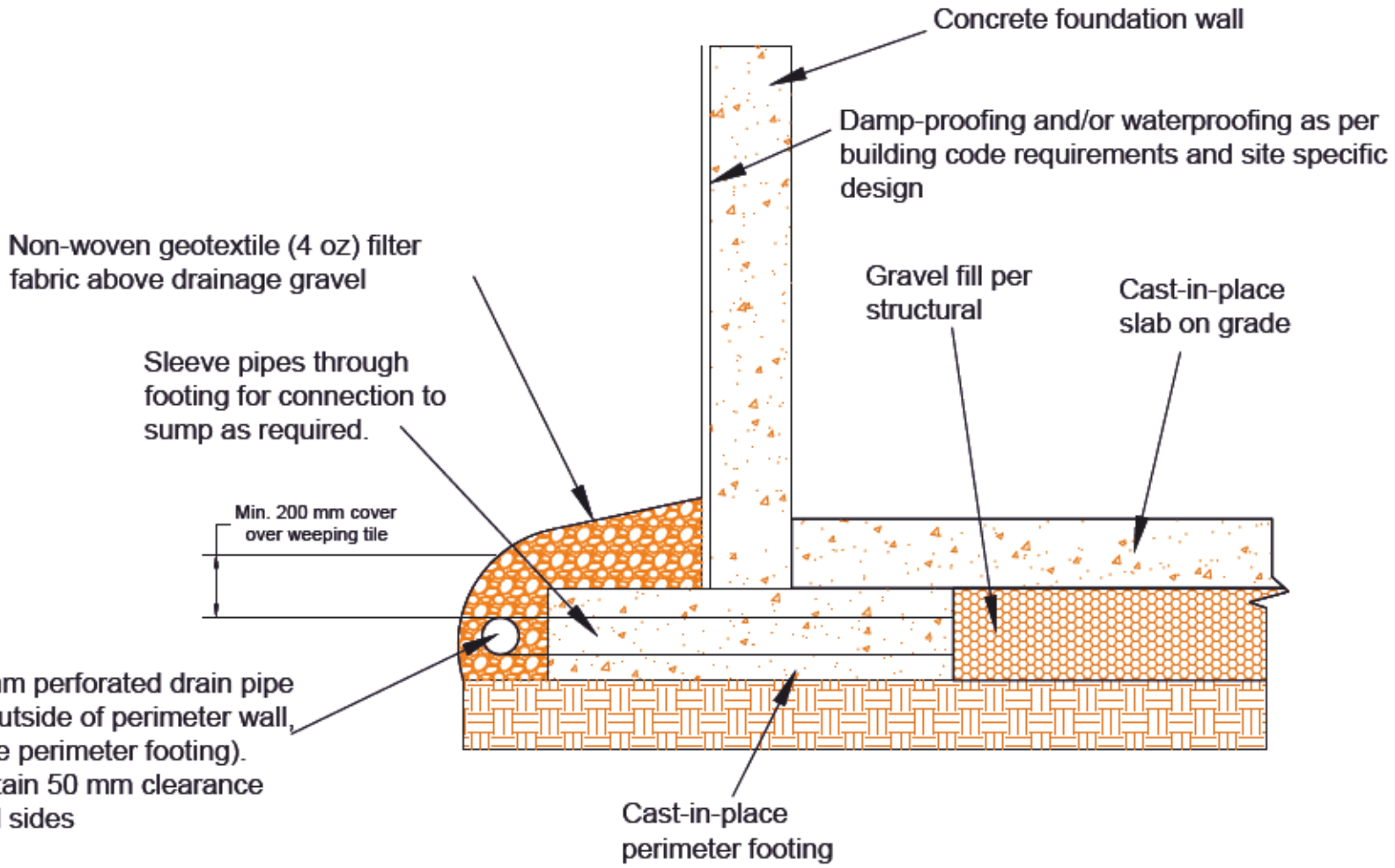
NOTE:

Review of actual pipe configuration and site soils is required and may result in altered recommendations during construction.

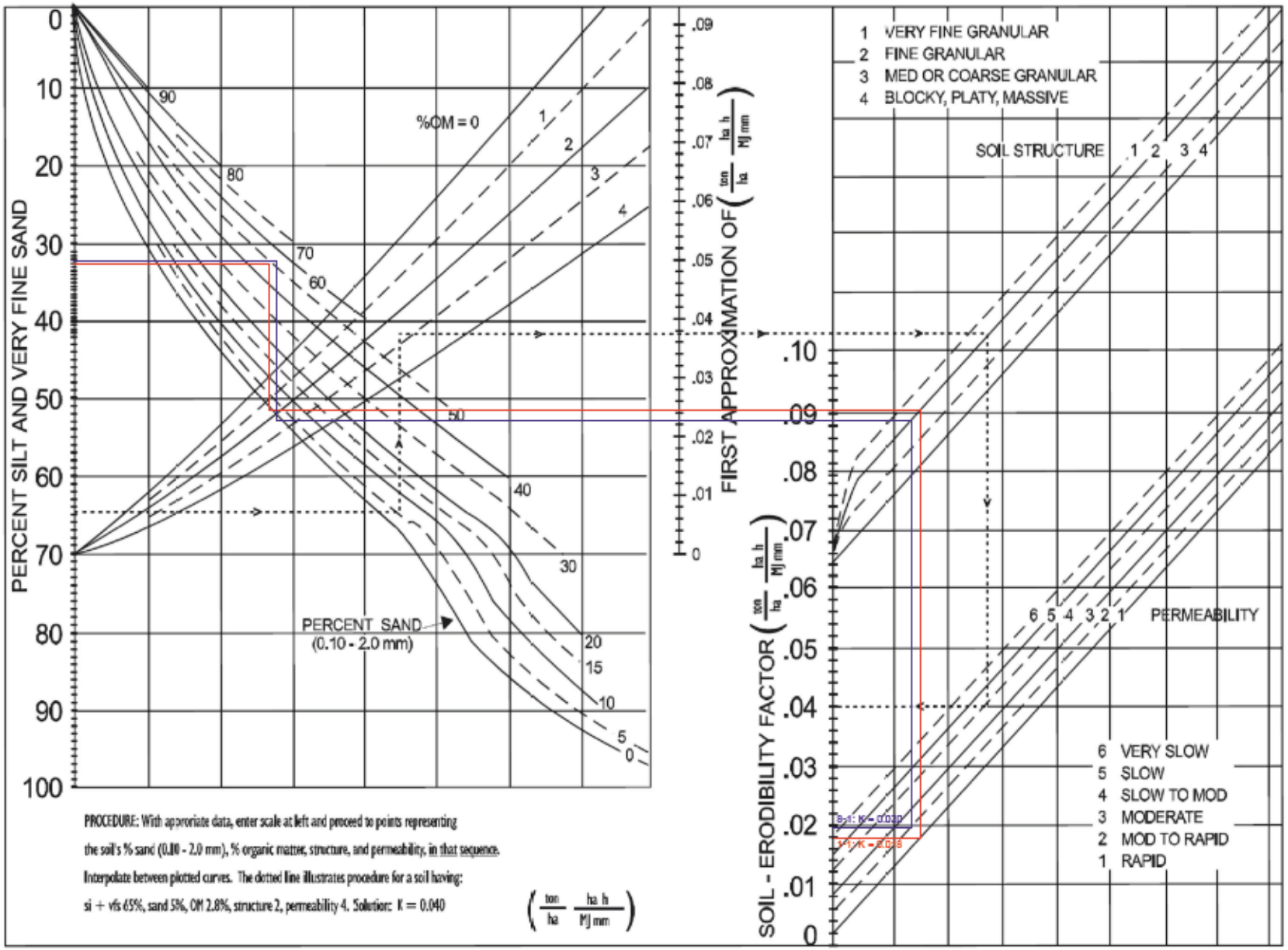
At minimum, plugs should extend through the entire bedding gravel zone. For pipes installed in separate trenches the bedding gravel should be hydraulically connected to the storm pipe bedding.

Client: 2291463 Alberta Ltd.	Job Number: 02109833.000	Date: February 14, 2022	ENGLOBE
Project: 2nd Street East Development			
Title: Pipe Support Typical Detail	Drawing Number: 02109833.000.D01	Scale: N.T.S.	

Exterior Perimeter Weeping Tile



Client: 2291463 Alberta Ltd.	Job Number: 02109833.000	Date: February 14, 2022	ENGLOBE
Project: 2nd Street East Development			
Title: Weeping Tile Typical Detail	Drawing Number: 02109833.000.D02	Scale: N.T.S.	



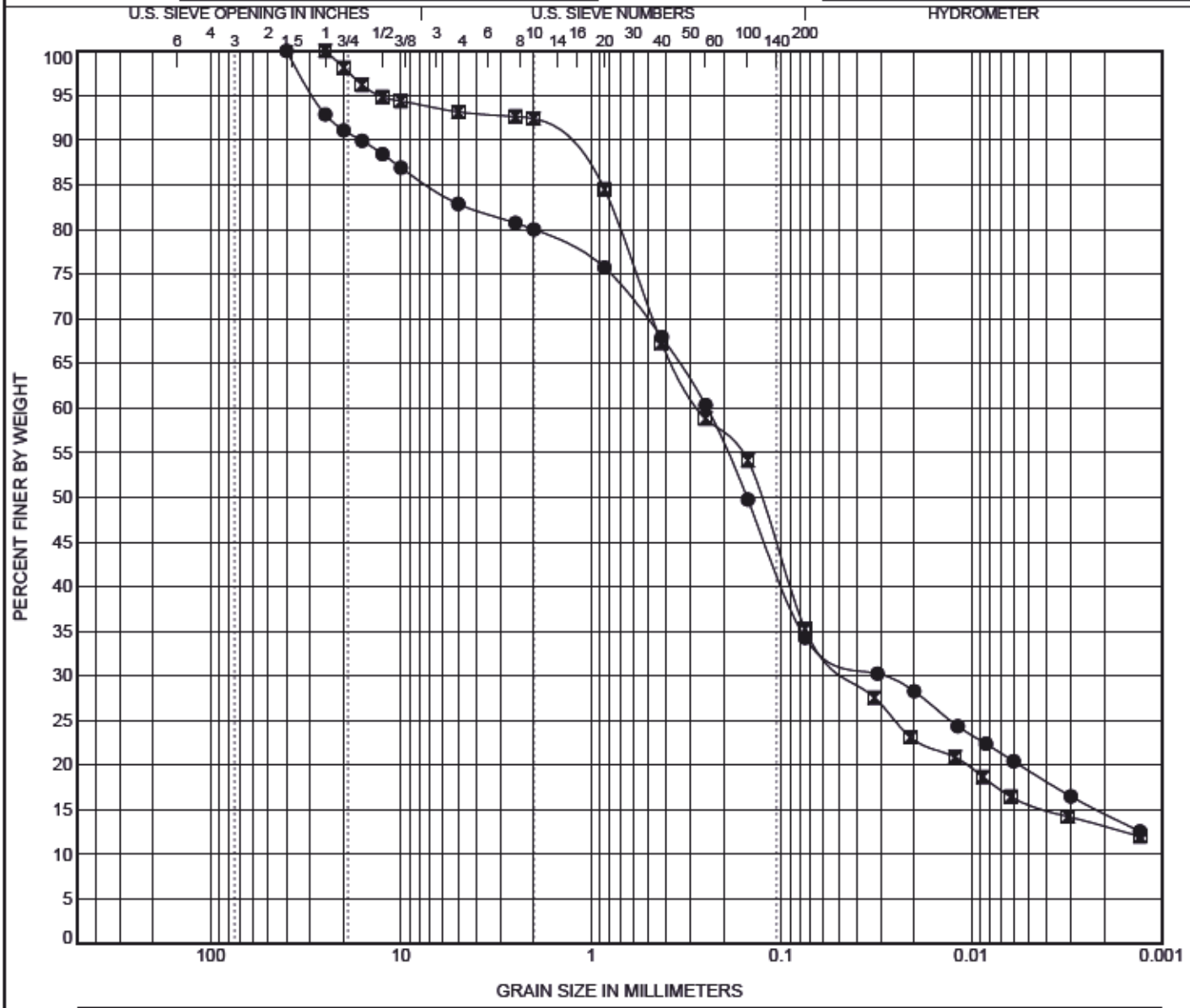
Client: 2291463 Alberta Ltd.	Job Number: 02109833.000	Date: February 14, 2022	ENGLOBE
Project: 2nd Street East Development			
Title: Soil Erodibility Nomograph	Drawing Number: 02109833.000.B01	Scale: N.T.S.	

USDA GRAIN SIZE DISTRIBUTION

Englobe

CLIENT 2291463 Alberta Ltd. **PROJECT NAME** 2nd Street East Development

PROJECT NUMBER 02109833.000 **PROJECT LOCATION** De Winton, AB, CAN



COBBLES	GRAVEL		OTHER SAND	VERY FINE SAND, SILT OR CLAY
	coarse	fine		

Specimen Identification			%Gravel	%OTHER SAND	%VFS	%Silt	%Clay
●	BH-1	0.8 (m)	20.0	39.3	8.3	17.8	14.6
⊠	BH-8	0.8 (m)	7.6	49.3	11.5	18.4	13.1

Reviewed By: _____

ERODIBILITY WORKSHEET

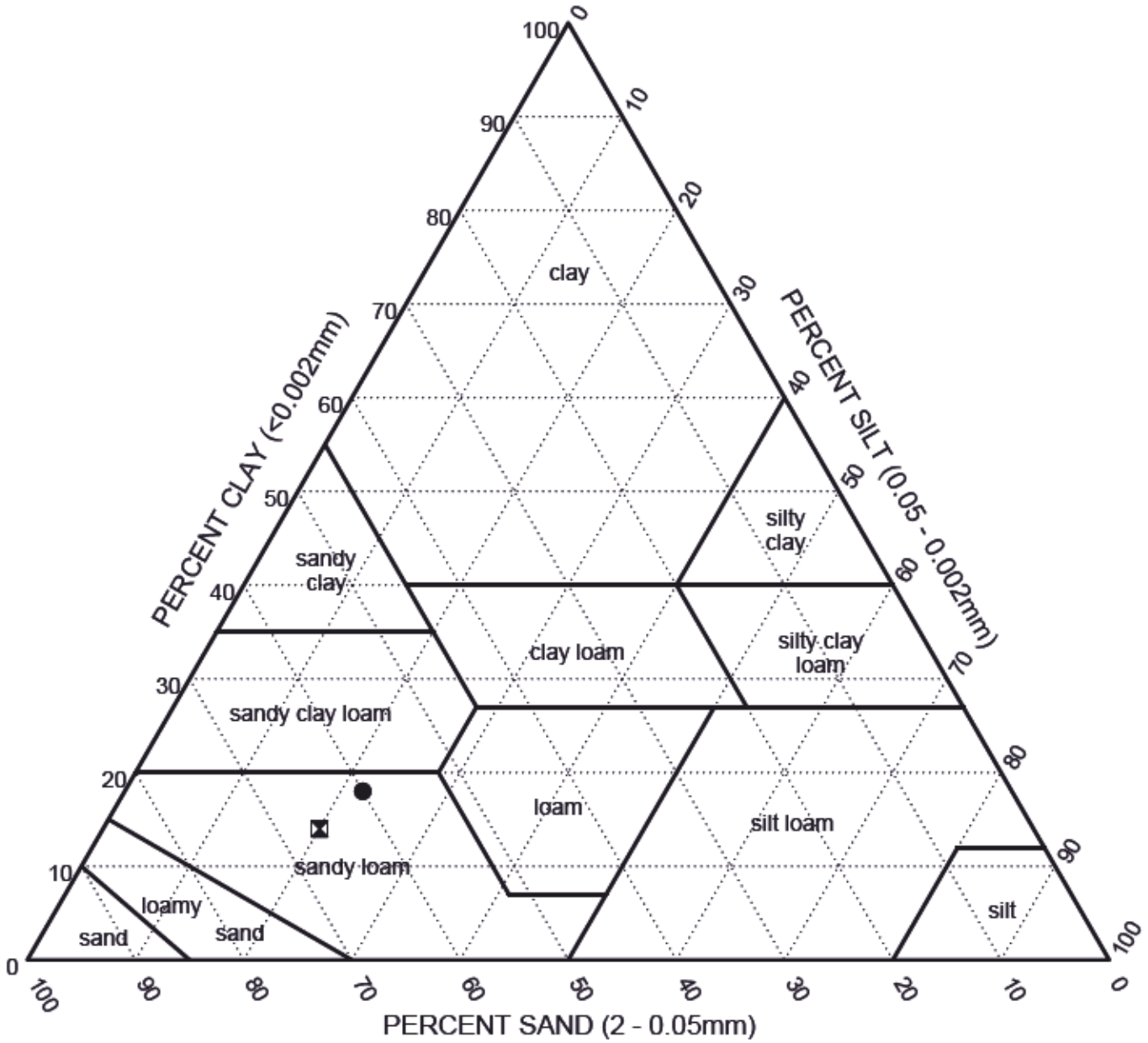
Englobe

CLIENT 2291463 Alberta Ltd.

PROJECT NAME 2nd Street East Development

PROJECT NUMBER 02109833.000

PROJECT LOCATION De Winton, AB, CAN



	Borehole	Depth (ft)		USDA Classification	Textural Class	Permeability Class	Org. Cont. (%)	Silt (%)	Clay (%)	VFS (%)	Other Sand (%)	Gravel (%)
●	1	2.5	1-1	SANDY LOAM	2	2	1.6	22.3	18.2	10.4	49.1	20.0
⊠	8	2.5	8-1	SANDY LOAM	2	2	2.3	19.9	14.2	12.5	53.4	7.6

If the percentage of the total sample retained above the 2 mm sieve is greater than 20%, subtract 1 from the permeability class shown above.

Fractions normalized to 100% passing the 2mm (#10) sieve

USDA TEXTURAL CLASSIFICATION 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ USDA TEXTURAL CLASS.GDT 2/1/22

Appendix B
Borehole Logs

ENGLOBE

Project: 2nd Street East Development	Drilling Information:	Borehole No.:1
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wet '1' SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 100 mm thick.			TPSL OR						
		BROWNS - approximately 100 mm thick.		1-1			18.6				
1		Silty SAND - trace clay and gravel, loose, damp-dry, light-medium brown.			SM						
		- damp.		1-2		10-7-4					
2		- clay lens approximately 300 mm thick.									
		Silty CLAY (Till) - trace sand, stiff, moist, low-medium plastic, trace oxides, precipitates and coal, medium brown.		1-3			18.8		$[SO_4]$ = 0.123		
3					CI						
				1-4		4-5-7					
4		Sandy GRAVEL - trace silt and clay, dense, wet, medium brown.		1-5			15.6				
					GPS						
5				1-6		17-9-18					
		Sandstone BEDROCK - weathered, weak, damp, light brown.		1-7			18.1				
		- dry.			BE						
6		END OF HOLE at a depth of 6.1 m. 25 mm PVC stand pipe installed to a depth of 6.1 m with 3.0 m slotted. Hole wet upon completion.									
7		Water Levels:									
		November 9, 2021 - 1.68 m.									
8		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
9											
10											

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/26/2021
Groundwater Depth: m	Page 1 of 1

Englobe

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Project: 2nd Street East Development	Drilling Information:	Borehole No.:2
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wat 2" SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 150 mm thick.			TPSL OR						
		BROWNS - approximately 50 mm thick.			SM						
1		Silty SAND - trace gravel, loose, dry, trace oxides, light brown.		2-1							
		Silty CLAY (Till) - trace sand and gravel, stiff, damp, low plastic, trace oxides, precipitates and coal, medium brown.		2-2	CL-ML	3-4-4	18.8				
2		- grey lenses approximately 6 mm thick throughout.		2-3							
		- moist, sand lenses approximately 6 mm thick throughout.									
3		- low-medium plastic.		2-4	CI	3-5-6	16.5 PI = 26.3				
		- light grey.									
		- gravelly lens approximately 300 mm thick.		2-5							
4		Silty SAND - trace gravel, dense, damp, trace oxides, light brown-orange.			SM						
				2-6		10-24-33	14.9				
5		Sandstone BEDROCK - weathered, weak, damp-dry, light brown.		2-7	BE						
		- moist.									
6		- trace siltsone.									
		END OF HOLE at a depth of 6.1 m. 25 mm PVC stand pipe installed to a depth of 4.9 m with 3.0 m slotted. Hole wet upon completion.		2-8		15-22-28	29.4				
7		Water Levels:									
		November 9, 2021 - 1.83 m.									
8		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
9											
10											

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Englobe

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/26/2021
Groundwater Depth: m	Page 1 of 1

Project: 2nd Street East Development	Drilling Information:	Borehole No.:3
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wat 3" SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 200 mm thick.			TPSL OR						
		BROWNS - approximately 100 mm thick.			SM						
1		Silty SAND - trace gravel, loose, damp-dry, trace oxides, light brown.		3-1			14.0				
		Silty CLAY (Till) - trace sand and gravel, very stiff, damp-dry, low plastic, trace oxides, precipitates and coal, medium brown.		3-2	CL-ML	7-11-14					
2		Silty SAND - trace gravel, compact, damp, trace oxides, light brown.		3-3	SM		12.0				
3		Silty CLAY (Till) - trace sand and gravel, hard, damp-dry, low plastic, trace oxides, precipitates and coal, trace cobbles, medium brown.		3-4		12-14-23					
				3-5	CL-ML		11.4				
4		Sandy GRAVEL - trace silt, dense, damp, trace cobbles, light-medium brown.		3-6	GPS	50@5.5"					
5		REFUSAL at a depth of 5.2 m. 25 mm PVC stand pipe installed to a depth of 4.9 m with 3.0 m slotted. Hole dry upon completion.		3-7			13.0				
6		Water Levels: November 9, 2021 - 3.46 m.									
7		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
8											
9											
10											

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Englobe

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/26/2021
Groundwater Depth: m	Page 1 of 1

Project: 2nd Street East Development	Drilling Information:	Borehole No.:4
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wet 'n' SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 100 mm thick.			TPSL OR						
		BROWNS - approximately 100 mm thick.			SM						
1		Silty SAND - trace gravel, loose, dry, trace oxides, light brown.		4-1							
		Silty CLAY (Till) - trace sand and gravel, stiff, damp-dry, low plastic, trace oxides, precipitates and coal medium brown.		4-2		5-5-7	15.6				
2		- damp, sand lenses approximately 6 mm thick throughout.		4-3							
		- very stiff.									
3					CL-ML						
		- damp-dry.		4-4		5-13-17	15.9				
		- sandstone boulder approximately 0.75 m thick.		4-5							
4											
				4-6		40-50@5"	7.1				
5		Sandy GRAVEL - trace silt, dense, damp, trace cobbles, light-medium brown.		4-7	GPS						
		REFUSAL at a depth of 6.5 m. 25 mm PVC stand pipe installed to a depth of 6.2 m with 3.0 m slotted. Hole wet upon completion.									
6		Water Levels:									
		November 9, 2021 - 3.91 m									
7		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
8											
9											
10											

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Englobe

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/26/2021
Groundwater Depth: m	Page 1 of 1

Project: 2nd Street East Development	Drilling Information:	Borehole No.:5
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wet 5' SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 100 mm thick.			TPSL OR						
		BROWNS - approximately 100 mm thick.			SM						
1		Silty SAND - trace gravel and clay, loose, damp-dry, trace oxides, light-medium brown.		5-1			15.0				
		Silty CLAY (Till) - trace sand and gravel, very stiff, damp, low plastic, trace oxides, precipitates and coal, medium brown.		5-2		4-7-21					
2		- gravelly lens approximately 300 mm thick.		5-3	CL-ML		12.8 PI = 27.5				
		- damp.dry									
3				5-4		7-11-18					
		Sandy GRAVEL - trace silt and clay, dense, damp-moist, trace cobbles, medium brown.		5-5			12.2				
4		- moist-wet.									
		- free water.		5-6	GPS	17-24-39					
5		- wet.		5-7			23.0				
6		END OF HOLE at a depth of 6.1 m. 25 mm PVC stand pipe installed to a depth of 6.1 m with 3.0 m slotted. Hole wet upon completion.									
		Water Levels:									
		November 9, 2021 - 3.37 m.									
7		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
8											
9											
10											

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Englobe

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/25/2021
Groundwater Depth: m	Page 1 of 1

Project: 2nd Street East Development	Drilling Information:	Borehole No.:6
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wet 5" SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 100 mm thick.			TPSL OR						
		BROWNS - approximately 100 mm thick.		6-1			13.6				
1		Silty SAND - loose, dry, light brown.			SM						
		- clay lens approximately 150 mm thick.									
		- damp-dry.		6-2		3-4-5					
2		Silty CLAY (Till) - trace sand and gravel, very stiff, damp, low plastic, trace oxides, precipitates and coal, medium brown.		6-3			15.9				
		- sand lenses approximately 6 mm thick throughout.									
3		- trace cobbles.									
				6-4		50@3"					
		- damp-dry.									
				6-5			13.2				
4					CL-ML						
		- hard, medium brown-medium grey.									
				6-6		16-30-44					
5											
		- medium grey.		6-7			11.9 PI = 20.5				
		- dark grey.									
6				6-8		12-15-20					
		Siltstone BEDROCK - weathered, weak, dry, light grey.		6-9			16.7				
7											
		- moderately strong.		6-10	BE	15-35-50@6"					
8		- black carbonaceous layer approximately 150 mm thick.									
		- dark brown.		9-11			12.2				
9											
		END OF HOLE at a depth of 9.1 m. 25 mm PVC stand pipe installed to a depth of 9.1 m with 3.0 m slotted. Hole dry upon completion.									
10		Water Levels:									
		November 9, 2021 - 1.35 m.									
		END OF BOREHOLE at a depth of 30.0 metres (). Wet upon completion.									

Englobe

Logged By: SW	Completion Depth: 30 ft
Reviewed By: Tyler Windsor	Drilled on: 10/25/2021
Groundwater Depth: m	Page 1 of 1

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Project: 2nd Street East Development	Drilling Information:	Borehole No.:7
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Well "7" SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 100 mm thick.			TPSL OR						
		BROWNS - approximately 150 mm thick.		7-1			4.8				
1		SAND - trace silt, loose, dry, fine grain, light-medium brown.									
		- damp.		7-2		4-4-8					
2		- compact, silty lens approximately 75 mm thick.		7-3			8.3				
				7-4		3-4-4			$[SO_4]$ = 0.123		
3				7-5	SP		8.1				
4											
		- compact.		7-6		4-6-6					
5				7-7			8.0				
				7-8		5-6-6					
6											
		- trace clay.		7-9			17.3				
7		Silty CLAY (Till) - trace sand, firm, damp, low-medium plastic, trace oxides, medium brown.		7-10	CI	4-4-5					
8				7-11			15.8				
		SAND - trace silt, compact, damp, trace oxides, medium-coarse grain, light-medium brown.		7-12	SP	4-5-8					
9				7-13			14.3				
10											
		Silty CLAY - trace gravel, firm, moist, low-medium plastic, low-medium plastic, trace oxides, medium grey.		7-14	CI	4-4-4					
11		- silty lens approximately 0.6 m thick.		7-15			29.3				
		- stiff, damp.									
12		- medium plastic.									
		END OF HOLE at a depth of 12.2 m. 25 mm PVC stand pipe installed to a depth of 12.2 m with 3.0 m slotted. Hole dry upon completion.									
13		Water Levels:									
		November 9, 2021 - 10.61 m.									
14		END OF BOREHOLE at a depth of 40.0 metres (). Wet upon completion.									

Englobe

Logged By: SW	Completion Depth: 40 ft
Reviewed By: Tyler Windsor	Drilled on: 10/25/2021
Groundwater Depth: m	Page 1 of 1

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Project: 2nd Street East Development	Drilling Information:	Borehole No.:8
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wet 5' SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 150 mm thick.			TPSL OR						
		BROWNS - approximately 150 mm thick.		8-1	ML		16.0				
1		SILT - trace sand and clay, loose, moist, light brown.									
		SAND - trace silt and gravel, compact, damp, fine grain, light brown.		8-2	SP	4-4-6					
2		Silty CLAY (Till) - trace sand and gravel, very stiff, damp, low plastic, trace oxides, precipitates and coal, medium brown.		8-3			15.1		$[SO_4]$ = 0.035		
		- sand lenses approximately 6 mm thick throughout.									
3				8-4		8-12-18					
		- hard, damp-dry, trace cobbles.									
4				8-5	CL-ML		14.4				
				8-6		17-15@2"					
5		- high oxide concentration, light grey.		8-7			21.1				
6		END OF HOLE at a depth of 6.1 m. 25 mm PVC stand pipe installed to a depth of 6.1 m with 3.0 m slotted. Hole dry upon completion.		8-8		17-29-43					
		Water Levels:									
		November 9, 2021 - 5.09 m.									
		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
7											
8											
9											
10											

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Englobe

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/25/2021
Groundwater Depth: m	Page 1 of 1

Project: 2nd Street East Development	Drilling Information:	Borehole No.:9
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Wet 9" SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 50mm thick.			TPSL OR						
		BROWNS - approximately 100 mm thick.									
		Silty CLAY (Till) - trace sand and gravel, very stiff, damp, low plastic, trace oxides, precipitates and coal, medium brown.		9-1			16.0				
1		- sand lenses approximately 6 mm thick throughout.		9-2		4-5-8					
2				9-3			15.1				
3		- damp-dry.		9-4	CL-ML	6-10-21					
		- sandy lens approximately 75 mm thick.		9-5			14.4 PI = 29.8				
4		- hard.									
		- gravelly lens approximately 300 mm thick.		9-6		24-31-27					
5		- very stiff, damp.									
		- high oxide concentration for approximately 0.6 m thick, medium brown-orange.		9-7			21.2				
6		- moist.									
		- some sand, medium grey.									
		END OF HOLE at a depth of 6.1 m. 25 mm PVC stand pipe installed to a depth of 6.1 m with 3.0 m slotted. Hole dry upon completion.									
7		Water Levels:									
		November 9, 2021 - 5.46 m.									
8		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
9											
10											

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Englobe

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/25/2021
Groundwater Depth: m	Page 1 of 1

Project: 2nd Street East Development	Drilling Information:	Borehole No.:10
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC M.C. LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Well '10' SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 150 mm thick.			TPSL OR						
		BROWNS - approximately 150 mm thick.									
1		SAND - trace silt, loose, dry, light brown.		10-1	SP		15.5				
		Silty CLAY (Till) - trace sand and gravel, stiff, damp, low plastic, trace oxides, precipitates and coal, medium brown.		10-2	CL-ML	4-5-5					
2				10-3			18.7		$[SO_4]$ = 0.165		
		- very stiff, low-medium plastic.									
3				10-4		9-35-22					
		- boulder approximately 150 mm thick.									
		- hard, dry.		10-5	CI		12.0				
4											
				10-6		18-31-29					
5		Silty GRAVEL - trace sand and clay, dense, moist-wet, trace cobbles, medium brown.		10-7	SPG		17.5				
		- free water.									
6		END OF HOLE at a depth of 6.1 m. 25 mm PVC stand pipe installed to a depth of 6.1 m with 3.0 m slotted. Hole wet upon completion.		10-8		16-38-47					
		Water Levels:									
		November 9, 2021 - 3.08 m.									
		END OF BOREHOLE at a depth of 20.0 metres (). Wet upon completion.									
7											
8											
9											
10											

Engtobe

Logged By: SW	Completion Depth: 20 ft
Reviewed By: Tyler Windsor	Drilled on: 10/25/2021
Groundwater Depth: m	Page 1 of 1

AUGER 02109833.000 2ND STREET EAST DEVELOPMENT.GPJ M-L STANDARD.GDT 2/14/22

Project: 2nd Street East Development	Drilling Information:	Borehole No.:11
Client: 2291463 Alberta Ltd.	Earth Drilling	Project No.:02109833.000
	D-120 SS-Auger	Elevation:

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

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

Depth (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	USCS	BLOWS /150 mm	PLASTIC / M.C. / LIQUID (10 20 30 40)	BLOW COUNT (10 20 30 40) / POCKETPEN (kPa) (80 160 240 320)	OTHER DATA	Well '11' SLOTTED PIEZOMETER	Elevation (m)
0		TOPSOIL - black, approximately 100 mm thick.			TPSL OR						
		BROWNS - approximately 100 mm thick.		11-1			6.2				
1		SAND - trace silt, oose, dry, fine grain, light-medium brown.									
				11-2		3-4-4					
2		- compact.									
				11-3			3.1				
		- damp-dry.									
3				11-4	SP	5-5-6					
		- damp.		11-5			6.0				
4											
		- trace oxides, medium-coarse grain.		11-6		3-5-7					
5		- loose.									
				11-7			18.8				
6		- moist-wet.									
				11-8		4-3-3					
		Silty CLAY (Till) -trace sand, stiff, moist, low-medium plastic, trace oxides and precipitates, medium grey.		11-9			24.0				
7											
		- trace gravel, very stiff, damp.		11-10		50@3"					
8											
		- hard, damp-dry.		11-11			12.1				
9				11-12	CI	14-18-23					
				11-13			11.8				
10											
				11-14		5-15-23					
11				11-15			11.9				
12		END OF HOLE at a depth of 12.2 m. 25 mm PVC stand pipe installed to a depth of 12.2 m with 4.6 m slotted. Hole dry upon completion.									
		Water Levels:									
13		November 9, 2021 - 5.91 m.									
		END OF BOREHOLE at a depth of 40.0 metres (). Wet upon completion.									
14											

Englobe

Logged By: SW	Completion Depth: 40 ft
Reviewed By: Tyler Windsor	Drilled on: 10/25/2021
Groundwater Depth: m	Page 1 of 1

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Appendix C
Design and Construction Guidelines

ENGLOBE

Backfill Materials And Compaction

Maximum density, as used in this section, means Standard Proctor Maximum Dry Density (ASTM Test D698) unless otherwise noted. Optimum moisture content is as defined in this text.

Backfill adjacent to exterior footings, foundation walls, grade beams and pile caps and within 300 mm of final grade should comprise low-plastic cohesive general engineered fill as defined above. Such backfill should provide a relatively impervious surface layer to reduce seepage in the sub-soil.

Backfill should not be placed against a foundation structure until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction. During compaction, careful observation of the foundation wall for deflection should be carried out continuously. Where deflection is apparent, the compactive effort should be reduced accordingly. In order to reduce potential compaction induced stresses, only hand held compaction equipment should be used in the compaction of fill within 500 mm of retaining walls or basement walls.

Backfill materials should not be placed in a frozen state or placed on a frozen subgrade. All lumps of materials should be broken down during placement.

Where the maximum-sized particles in any backfill material exceed 50 percent of the lift thickness or minimum dimension of the cross-section to be backfilled, such particles should be removed and placed at other more suitable locations on site or screened-off prior to delivery to site.

Bonding should be provided between backfill lifts, if the previous lift has become desiccated. For fine-grained materials, the previous lift should be scarified to 75 mm in depth followed by proper moisture conditioning and recompaction.

General Engineered Fill

Backfill adjacent to and above footings, abutment walls, basement walls, grade beams and pile caps or below highway, street or parking lot pavement sections should comprise general engineered fill. “General engineered fill” materials should comprise clean, well-graded granular soils or inorganic, low-plastic cohesive soils. Such material should be placed in lifts not exceeding an uncompacted thickness of 300 mm, and compacted to not less than 98 percent of maximum density, at a moisture content at or slightly above optimum. The uncompacted lift thickness may be adjusted based on the method of fill placement and the size and type of compaction equipment in use.

Structural Fill

Backfill supporting structural loads should comprise structural fill materials. “Structural fill” materials should comprise clean, well-graded inorganic granular soils. Such fill should be placed in compacted lifts not exceeding 150 mm and compacted to not less than 98 percent of maximum density, at a moisture content at or slightly (0 to 3 percent) above optimum. The following table provides gradation limits for structural fill of various nominal sizes. The gradation limits have been adapted from the City of Calgary Roads Construction 2015 Standard Specifications, Section 303.00.00 Materials. Other gradations may be approved on a project specific basis by a qualified geotechnical engineer.

Sieve Size (mm)	Percent Passing By Weight Nominal Gravel Size		
	80 mm	50 mm	25 mm
80	100		
75	---		

50	---	100	
40	60 - 90	95 - 100	
25	---	---	100
20	40 - 70	50 - 75	95 - 100
10	25 - 60	25 - 52	55 - 80
5	15 - 45	15 - 40	35 - 65
2.5	10 - 35	10 - 33	28 - 52
0.63	5 - 23	5 - 23	13 - 35
0.315	---	---	9 - 26
0.16	3 - 12	2 - 14	6 - 18
0.08	2 - 10	1 - 10	4 - 10
%Fractures (2 faces)	20	30	60

Lean Mix Concrete

"Lean-mix concrete" should be low strength concrete having a minimum 28 days compressive strength of 3.5 MPa.

Landscape Fill

"Landscape fill" material may comprise soils without regard to engineering quality. Such soils should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90 percent of maximum density.

Pipe Bedding and Drainage

Bedding for pipes and utilities should generally conform to the manufacturer's specification. The type and depth of bedding material relative to the size of pipe are a function of the rigidity of the utility and the embedment depth. For drainage blankets and weeping tile, an open-graded, clean aggregate is required. The following table represents the gradation limits for bedding gravel. The gradation limits have been adapted from the City of Calgary Standard Specifications: Sewer Construction 2012 Section 402.10.00. Class IA material as defined in the table is also suitable for use in drainage applications. Local municipal specifications or manufacturer's specifications may be substituted at the discretion of a qualified engineer.

Sieve Size (mm)	For Pipe 375 mm and Smaller (20 mm Nominal Size) % passing by mass		Sieve Size (mm)	For Pipe Larger than 375 mm (40 mm Nominal Size) % passing by mass
Class IA*				
20	100		40	100
4.75	0 - 10		4.75	0 - 10
2.5	0 - 5		2.5	0 - 5
0.075	0 - 5		0.075	0 - 5
Class IB				
20	100		40	100

4.75	10 - 50		4.75	10 - 50
2.5	0 - 5		2.5	0 - 5
0.075	0 - 5		0.075	0 - 5
Class II				
20	100		40	100
4.75	0 - 100		4.75	0 - 100
0.075	0 - 12		0.075	0 - 12
Class III				
20	100		40	100
4.75	0 - 100		4.75	0 - 100
0.075	12 - 50		0.075	12 - 50

[1] * Class IA material is suitable for granular material below slabs-on-grade for which a subfloor depressurization system is required for soil gas control, as specified in section 9.16.2.1 of the 2014 Alberta Building Code Volume 2.

CONSTRUCTION EXCAVATIONS

Construction should be in accordance with good practice and comply with the requirements of the responsible agencies.

All excavations greater than 1.5 m deep should be sloped or shored for worker protection.

Shallow excavations up to 3 m depth may use temporary side slopes of 1H:1V. A flatter slope of 2H:1V should be used if groundwater is encountered. Localized sloughing can be expected from these slopes.

Deep excavations or trenches may require temporary support if space limitations or economic considerations preclude the use of sloped excavations.

For excavations greater than 3 m depth, temporary support should be designed by a qualified geotechnical engineer. The design and proposed installation and construction procedures should be submitted to McIntosh•Lalani Engineering Ltd. for review.

The construction of a temporary support system should be monitored. Detailed records should be taken of installation methods, materials, in situ conditions and the movement of the system. If anchors are used, they should be load tested. McIntosh•Lalani Engineering Ltd. can provide further information on monitoring and testing procedures, if required.

Attention should be paid to structures or buried service lines close to the excavation. For structures, a general guideline is that if a line projected down at 45° from a horizontal, from the base of foundations of adjacent structures, intersects the extent of the proposed excavation, then these structures may require underpinning or special shoring techniques to avoid damaging earth movements. The need for any underpinning or special shoring techniques and the scope of monitoring required can be determined when details of the service ducts and vaults, foundation configuration of existing buildings and final design excavation levels are known.

No surface surcharges should be placed closer to the edge of the excavation than a distance equal to the depth of the excavation, unless the excavation support system has been designed to accommodate such surcharge.

FLOOR SLABS-ON-GRADE

All soft, loose or organic material should be removed from beneath slab areas. If any local hard spots such as old basement walls are revealed beneath the slab area, these should be over-excavated and removed

to not less than 0.9 m below underside of slab level. The exposed soil should be proof-rolled and the final grade restored by general engineered fill placement. If proof-rolling reveals any soft or loose spots, these should be excavated and the desired grade restored by general engineered fill placement. Proof-rolling should be carried out in accordance with the recommendations given elsewhere in this Appendix. The subgrade should be compacted to a depth of not less than 0.3 m to density of not less than 95 percent Standard Proctor Maximum Dry Density (ASTM Test Method D698).

If for economic reasons, it is considered desirable to leave low quality material in place beneath a slab-on-grade, special ground treatment procedures may be considered. McIntosh•Lalani Engineering Ltd. could provide additional advice on this aspect, if required.

A leveling course of at least 150 mm in compacted thickness is recommended directly beneath all slabs-on-grade. For slabs in buildings requiring a subfloor depressurization system for soil gas control, the underslab gravels should consist of an open graded clean gravel with limited fine grained inclusions to allow free flow of gasses. The Class IA material (drainage gravel) is a suitable material for this application. Where these gravels are placed on top of fine grained soils, a geotextile filter fabric should be placed between the gravel and subgrade soils. Geotextile filter fabric is also recommended between the gravels and the polymer vapour barrier to protect the polymer from punctures. Where no subfloor depressurization system is required, the levelling course may consist of structural fill. Alternatively, a minimum thickness of 150 mm of pit-run gravel overlain by a minimum thickness of 50 mm of crushed gravel may be used. Very coarse material (larger than 25 mm diameter) should be avoided directly beneath the slabs-on-grade to limit potential stress concentrations within the slab.

General engineered fill, structural fill, pit-run gravel and crushed gravel are defined under the heading “Backfill Materials and Compaction” elsewhere in this Appendix.

The slab should be structurally independent from walls and columns supported on foundations. This is to reduce any structural distress that may occur as a result of differential soil movements. If it is intended to place any internal non-load bearing partition walls directly on a slab-on-grade, such walls should be structurally independent from other elements of the building founded on a conventional foundation system so that some relative vertical movement of the walls can occur freely.

The excavated subgrade beneath slabs-on-grade should be protected at all times from rain, snow, freezing temperatures, excessive drying and the ingress of free water. This applies during and after the construction period.

A minimum slab concrete thickness of 100 mm is recommended. Control joints should be provided in all slabs. Typically for a 125 mm slab thickness, control joints should be placed on a 3 m square grid, should be sawn to a depth of one-quarter the slab thickness and have a width of approximately 3 mm.

Wire mesh reinforcement, 150 mm square grid, should be provided to reduce the possibility of uncontrolled slab cracking. The mesh should be adequately supported and should be located at or above mid-height of the slab with adequate cover.

Lateral Wall Pressures

Permanent and temporary walls should be designed to resist all lateral pressures including those due to soil or backfill, surcharges, water and adjacent footings using the following expressions defined in terms of total and effective stresses:

$$P_{lateral\ pressure} = P'_{earth+surcharge} + P_{net\ water} + P'_{adj\ ft}$$

where $P_{lateral\ pressure}$ = total lateral pressure at a given depth (kN/m^2)

$P'_{earth+surcharge}$	=	lateral earth pressure due to soil or fill and surcharges at a given depth (kN/m²)
	=	K (γ h + q) above water table or phreatic surface
	=	K (γ' h + q) below water table or phreatic surface
$P_{net\ water}$	=	net water pressure on wall at a given depth (kN/m²), calculated by hand drawn flow net or computer solution based on drainage conditions
$P'_{adj\ ft}$	=	lateral earth pressure due to adjacent footings at given depth (kN/m²)
K	=	coefficient of lateral earth pressure, K_a, K_o, K_p or combination of as noted below
K_a	=	coefficient of active earth pressure
K_o	=	coefficient of at-rest earth pressure
K_p	=	coefficient of passive earth pressure
γ'	=	submerged unit weight of backfill or natural soil (kN/m³)
γ'	=	$\gamma - \gamma_w$
γ	=	bulk unit weight of backfill or natural soil (kN/m³)
γ_w	=	unit weight of water 9.81 kN/m³
h	=	excavation depth (m)
q	=	surcharge load (kN/m²)

Permanent Lateral Wall Pressures

The distribution of soil pressure against a permanent wall may be assumed using the general equation given above with a coefficient of lateral earth pressure equal to the at rest coefficient of earth pressure, k = k_o. Values of k_o are given above for fill and native silt and clay as permanent walls can be constructed with backfill or poured neat to temporary shoring and native soils.

Permanent walls should be designed to resist the maximum possible water pressure subject to drainage conditions determined by design.

Temporary Lateral Wall Pressures

The distribution of soil pressure against a temporary wall may be assumed using the general equation given above and values of K according to deformation restrictions as follows:

- If moderate wall movements can be permitted: $K = K_a$
- If foundations of buildings or services exist at a shallow depth, at a distance less than H (height of the wall) behind the top of the wall and not closer than 0.5H: $K = 0.5 (K_a + K_o)$
- If foundations or services exist at a shallow depth, at a distance less than 0.5H: $K = K_o$

Temporary Passive Wall Resistance

Passive resistance at the base of a temporary wall may be calculated as follows:

$$P_p = K_p (\gamma' d/1.5)$$

Where P'_p = passive resistance at depth below excavation (kN/m^2)

K_p = coefficient of passive earth pressure

γ' = submerged unit weight (kN/m^3)

d = depth below excavation level (m)

The passive resistance should be taken to act on an area twice the pile diameter below grade.

Shallow Foundations

Design and construction of shallow foundations should comply with relevant Building Code requirements.

The term “shallow foundations” includes strip and spread footings, mat slab and raft foundations.

Minimum footing dimensions in plan should be 0.45 m for strip footings and 0.9 m for square footings.

No loose, disturbed or sloughed material should be allowed to remain in open foundation excavations. Hand cleaning should be undertaken to prepare an acceptable bearing surface. Recompaction of disturbed or loosened bearing surface may be required.

Foundation excavation and bearing surfaces should be protected from rain, snow, freezing temperatures, drying and the ingress of free water, during and after footing construction.

Footing excavations should be carried down into the designated bearing stratum.

After the bearing surface is approved, a mud slab should be poured to protect the soil and provide a working surface for construction, should immediate foundation construction not be intended.

All constructed foundations should be placed on unfrozen soils, which should be at all times protected from frost penetration.

All foundation excavations and bearing surface should be observed by a qualified geotechnical engineer to confirm that the recommendations contained in this report have been followed and that soil conditions are consistent with those assumed in the design.

Where over-excavation has been carried out through a weak or unsuitable stratum in order to reach a suitable bearing stratum; or where a foundation pad is to be placed above stripped natural ground surface, lean-mix concrete or structural fill may be used to reinstate the grade. These materials are defined under the separate heading “Backfill Materials and Compaction.”