THURBER ENGINEERING LTD.

RCMP DETACHMENT BUILDING
LOT 8, BLOCK 15, PLAN 972-3974
WABASCA-DESMARAIS, ALBERTA
GEOTECHNICAL INVESTIGATION

Report

to

ACI ARCHITECTS

Jhuma Saha, M.Tech., MSc., P.Eng., PMP
Project Engineer

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
Signature ____________
Date November 29, 2016
PERMIT NUMBER: P 5186
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Date: November 29, 2016
File: 15726

Harjeet Panesar, MSc, P.Eng.
Review Principal

MEMORANDUM

To: Trish Bolen, Associate
ACI Architects

Date: February 21, 2017

From: Harjeet Panesar, M.Sc., P.Eng.
(Reviewed by Renato Clementino, Ph.D., P.Eng.)

File: 15726

RCMP DETACHMENT BUILDING
WABASCA-DESMARAIS, ALBERTA
SLAB RECOMMENDATIONS – ADDENDUM 1

We understand the finished main floor for the RCMP Detachment Building is at an elevation of 555.25, and a concrete slab of 130 mm thickness may be considered. Thurber's geotechnical report dated November 29, 2016 (Thurber File #15726) recommended a minimum 150 mm thickness of gravel below the concrete. Based on the cross-sections provided by Al-Terra Engineering Ltd., a fill of about 0.3 m to 0.5 m is required above existing grade to achieve the subgrade (below the gravel layer) elevation. The following options for compacted fill maybe considered:

1. If low to medium plastic clay is used as fill to the subgrade elevation, slab movements of up to 30 mm should be expected due to potential swelling and shrinkage of the clay fill and underlying high plastic clay.

2. The anticipated slab movements can be reduced to up to about 20 mm, if a uniform 0.5 m layer of pit run gravel is used as the subgrade fill layer. This will require cutting some areas of the site to 0.5 m below subgrade elevation, to accommodate a uniform 0.5 m layer of pit run gravel.

3. If the movements stated in Options 1 and 2 are not acceptable, structural slab supported on piles should be considered.

All other recommendations stated in our November 29, 2016 report remain applicable.

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1. INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed single story masonry type building development at Wabasca-Desmarais, Alberta.

The scope of the geotechnical investigation was outlined in our proposal dated October 11, 2016 to Mr. Tony Brammar of ACI Architects (ACI). Authorization to proceed with the investigation was received from Mr. Brammar on October 23, 2016.

The scope of work did not include an environmental assessment for potential soil and/or groundwater contamination.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. PROPOSED DEVELOPMENT

The proposed development site is located at 2140 Airport Road, Wabasca-Desmarais, Alberta. The legal land description of the property is Lot 8, Block 15 and Plan 972-3974.

The development consists of a new one storey masonry RCMP Detachment building with no basement, and associated paved surface parking. The proposed building has a footprint of about 1143 m^2. The proposed development area and layout plan is shown on Drawing No. 15726-1 in Appendix A.

3. METHOD OF INVESTIGATION

3.1 Field Drilling Program

Seven test holes were drilled on November 8, 2016 using a truck mounted auger drill rig owned and operated by All Service Drilling Inc. of Nisku, Alberta, under the supervision of our drilling inspector. Four test holes TH16-1 through -4 were drilled to a depth of about 10 m within the building footprint, and three test holes TH16-5, -7 and -8 to a depth of about 3 m below ground surface within the associated paved parking area. The test holes were laid out by Thurber in accordance to the site plan provided by ACI.

Due to soft ground conditions and the risk of the drill rig getting stuck, it is was not possible to drill test hole TH16-6, and test hole TH16-2 was relocated about 5 m towards west from the original location. The approximate test hole locations are shown on the site plan, Drawing No. 15726-1, in Appendix A.

Prior to the field drilling program, Thurber arranged for Alberta One-Call underground utility locates.

Disturbed samples were obtained from the auger flights during drilling and Standard Penetration Tests (SPTs) were carried out at selected depths in the test holes. The undrained shear strength (Cpen value) of cohesive samples was estimated using a pocket penetrometer.

On completion of the drilling, 25 mm diameter standpipe piezometers were installed in two test holes TH16-1 and -4. Water and slough levels were noted in the open test holes during and immediately after the completion of drilling, before backfilling the test holes. The groundwater levels in the standpipe piezometers were measured prior to demobilizing from site.

3.2 Laboratory Testing

Laboratory testing included visual classification and natural moisture content determination of all the soil samples. In addition, Atterberg limits and water soluble sulphate tests were carried out on selected representative soil samples.

The results of the drilling program and laboratory testing are summarized on the test hole logs in Appendix B. An explanation of the symbols and terms used to describe the test hole logs and the Modified Unified Soil Classification are also provided in Appendix B.

4. SITE DESCRIPTION

4.1 Surface Conditions

At the time of the field investigation, the proposed development area was generally flat with some uneven ground. The site is bounded by Airport Road on South and Waskway Drive on west, and undeveloped land at the east and north. The site area was covered with tall grass and some ponded water in some areas. Surficial soft ground conditions were observed at the southeast portion of the site.

4.2 Subsurface Conditions

In general, the subsurface conditions at the drilled locations consisted of the following in descending order:

- Topsoil or Surficial Fill (Gravel)
- Clay
- Clay Till.

Further descriptions of the main soil layers are provided in the following sections. A detailed description of subsurface conditions observed at each test hole location is presented on the test hole logs in Appendix B. The detailed description in Appendix B should be used in preference to the generalized descriptions given below.

4.2.1 Topsoil

Topsoil was encountered at the surface in test holes TH16-3, -4, -7 and -8. The topsoil thickness at the test hole locations ranged between 125 mm to 200 mm, and may be thicker or thinner at other areas of the site. The topsoil was generally black, with organics and rootlets. The natural moisture content of the topsoil ranged from about 51 to 86 percent.

If the thickness of topsoil presented on the test hole logs is used to estimate stripping volume, there is a high risk that the estimated volume may substantially differ from the actual volume removed. If a more accurate determination of topsoil thickness is required for volume calculations, additional hand excavated test holes or test pitting should be carried out.

4.2.2 Surficial Fill

A gravel fill layer of about 100 mm to 125 mm thickness was encountered at ground surface in test holes TH16-1, -2 and -5. Gravel was typically grey, graded from rounded to angular, with occasional pebbles.

4.2.3 Clay

Clay was encountered underlying topsoil/gravel fill in all the test holes and extended to depths ranging between 1.5 m and 2.3 m.

The clay was generally light brown, with occasional silt partings. SPT N values in the clay layer ranged from 7 to 12 blows per 300 mm penetration, indicating a firm to stiff consistency. The natural moisture content of the clay ranged from about 26 to 38 percent.

Atterberg Limits test conducted on two clay samples from test holes TH16-1 and -4 yielded liquid limits ranging between 61 and 88 percent, and the corresponding plastic limits between 24 and 27 percent, indicating the clay samples are high plastic.

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4.2.4 Clay Till

Clay till was encountered underlying the clay in all test holes and extended to test hole termination depths. The clay till was light grey to light brown, silty, and contained traces of sand, gravel and oxides.

Although not encountered in the test holes, cobbles and boulders are often present within the clay till.

The natural moisture contents of the clay till ranged between 11 and 20 percent. SPT "N" values of the clay till layer ranged between 7 and 53 blows per 300 mm penetration, indicating a stiff to very stiff consistency.

4.3 Groundwater and Slough Conditions

Slough and water levels were recorded at the completion of drilling and are noted in the test hole logs in Appendix B. Standpipe piezometers were installed in test holes TH16-1 and -4. Groundwater levels were recorded at the end of the drilling. The groundwater and slough levels are summarized in Table 4.1.

TABLE 4.1
SUMMARY OF SLOUGH AND GROUNDWATER LEVELS

TEST HOLE	TEST HOLE DEPTH B.G.S. (m)	SEEPAGE DEPTH B.G.S. (m)	SLOUGH ON COMPLETION B.G.S. (m)	FREE WATER ON COMPLETION (ABOVE SLOUGH) B.G.S. (m)	STANDPIPE WATER LEVELS B.G.S. (m)
					Nov. 8, 2016
TH16-1	10.4	7.3	No Slough	9.4	6.8
TH16-2	10.4	3.1	No slough	9.8	N/A
TH16-3	10.4	2.3	No Slough	9.4	N/A
TH16-4	10.4	1.7	No Slough	8.5	6.6
TH16-5	2.7	2.3	No Slough	2.4	N/A
TH16-7	2.7	-	No Slough	No Water	N/A
TH16-8	4.2	-	No Slough	No Water	N/A

Note: B.G.S = Below Ground Surface

It should be noted that groundwater levels can vary in response to seasonal factors and precipitation; hence, the actual groundwater conditions at the time of construction could vary from those recorded during this investigation.

4.4 Frost Effects

The native clay at this site is considered to have high frost susceptibility, and hence is susceptible to heaving during winter and softening and strength loss as a result of thaw. Where the silty clay is continuous from ground surface the average annual depth of frost penetration is estimated to be about 1.6 m, based on an average air freezing index of 1400 degree-days Celsius. Based on an air freezing index of 2200 degree-days Celsius for a 50 year return period, the maximum depth of frost penetration is estimated to be about 2.4 m.

The estimated depths of frost penetration are based on a uniform soil type with no snow/insulation cover. If the area is covered with turf or significant snow cover, the depth of frost penetration will be less. The mean annual freezing index could be used for construction problems with some risk; the 50-year return index is usually chosen for long term design of foundations.

5. GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

5.1 General

The proposed site is underlain by topsoil/gravel fill at ground surface overlying high plastic clay and medium plastic clay till in descending order. Spread footings, cast-in-place concrete friction and end bearing piles are considered feasible for the building foundations. Recommendations for these foundations are provided in the following sections.

The results of the Atterberg limits tests show that the near surface clay (native) soils are high plastic. This type of soil is prone to volume variation with change in moisture content. This means that shrinkage or heave of the soil can occur with moisture variation (drying or wetting specifically). The change in moisture can happen when the surface of soil is left to dry, freezes or gets soaked with water. Tree roots mainly from broad leafed (deciduous) trees can also suck moisture out of the soils and as a consequence drying it and thus contributing to shrinkage. Upon regaining its natural moisture content, the soil can return to a stable condition but not necessarily to the same elevation. To avoid such movement, a stable environment would be required to be maintained as best as possible.

Slab-on-grade construction is considered feasible for the buildings at this site. The underlying clay is high plastic; hence, some movement is anticipated with any moisture content variations within the clay. If some movement cannot be tolerated, a structural slab supported on piles should be considered.

5.2 Site Preparation and Surface Drainage

All topsoil, organics and deleterious material should be removed from below the building areas prior to construction.

Engineered fill (if required) for site grading should consist of low to medium plastic clay placed and compacted in lifts not exceeding 150 mm in compacted thickness. The uniformity and compactive effort of the engineered fill are important in minimizing the potential for differential settlement. The following recommendations are provided for fill placement and compaction:

- All site grading fill to be placed under the building floor slab should be placed in maximum 150 mm thick lifts and compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD) within +/-2 percent of Optimum Moisture Content (OMC).

- Site grading fills below asphalt pavement, sidewalks etc. outside the building footprint should also be placed in 150 mm thick lifts and compacted to at least 98 percent of SPMDD within +/- 2 percent of OMC; except for the upper 150 mm, which should be compacted to 100 percent of SPMDD.

- All fill used for landscaping purposes needs only moderate compaction (i.e., 92 percent of SPMDD) such that future settlements do not affect site drainage.

Frozen soil should not be used for backfill. Clean (<5 percent Fines) well-graded, pit-run gravel should be used as backfill in cold weather conditions.

The lift thickness and in-situ density of compacted fills should be confirmed by field density test measurements during construction.

It is recommended that the finished subgrade below pavements and sidewalks be sloped at a minimum gradient of 1 percent toward catch basins or ditches to drain subsurface water away from the roadways and structures. This will reduce the likelihood of ponding of water which could result in frost heaving of the clay subgrade.

5.3 Open Excavation

5.3.1 Temporary Excavation Slopes

Temporary trench excavations up to 4 m deep in the clay and clay till are expected to remain stable at slope angles of about 1H:1V or flatter over the short term. Flatter slopes of about

1.5H:1V or flatter may be required where the trench excavations encounter loose sand or zones of significant seepage.

Alternatively, portable trench shields or other shoring methods may be used where steeper slopes are required. If movement of excavation slopes occur during construction flatter slopes may be required.

Dewatering should be undertaken for excavations near or below the water table.

The above slope excavations are provided for design purposes and are not to be considered as clearance for Occupational Health and Safety requirements; therefore, at all times the Alberta Occupational Health and Safety Regulation and Code must be followed by the prime contractor.

The excavated soil and construction materials should be stockpiled at least 1.5 m back from the top of the trench slopes or the depth of excavation (whichever is greater). Site grading away from all excavations should be maintained during construction to minimize potential runoff into the excavation.

5.3.2 Backfilling

The excavated inorganic soils free of debris or organics may be utilized for backfilling.

The municipal specifications of the relevant county should be followed for backfill. In the absence of such specification, backfill in areas where no future development is proposed should be compacted to at least 95 percent of SPMDD to limit future ground settlements.

Visual monitoring of the excavation slopes should be continuous during excavation and backfilling. Depending on the time of construction, moisture conditioning may be required to achieve moisture content and compaction requirements.

The onsite native inorganic material should not be placed frozen, nor placed at temperatures below freezing. If frozen material is used for backfilling, long term settlement will occur; hence it is preferable that unfrozen material be used for backfilling.

5.4 Building Foundations

5.4.1 General

The following foundation types are considered feasible for buildings on this site:

- Spread Footings

- Raft Foundations
- Cast-in-place Concrete Friction Piles
- Cast-in-place Concrete End Bearing Piles.

It should be noted that the upper horizon consists of firm to stiff clay and pile foundations are generally less prone to settlement and season movements than spread footings; hence, it is recommended that pile foundations be considered.

Recommendations for these foundation types are provided in the following sections. Additional recommended construction procedures are provided in Appendix C.

5.4.2 Spread Footings

Spread footings should be founded on the undisturbed native clay or clay till in accordance with the following recommendations.

a) Perimeter of exterior footings supporting heated structures should have a minimum soil cover of 1.6 m below finished grade to provide adequate protection against frost.

   Interior footings may be founded in the native firm to stiff clay at a minimum depth of 1.0 m below finished grade.

   For unheated structures, exterior and interior footings should be founded at a minimum depth of 2.4 m below the floor slab level.

b) All footings should be founded on the undisturbed, inorganic, native clay or clay till. Footings should not be supported on fill. Where local soft zones or organic pockets are encountered in the footing trenches, it may be necessary to increase the size of the footings or to remove the soft/organic material and replace with lean concrete. Disturbed soil should not be allowed to remain in the footing trenches.

c) Strip and square footings founded on the native clay or clay till may be designed using a factored ULS bearing resistance of 125 kPa and 150 kPa, respectively based on an ultimate bearing capacity of 250 kPa and 300 kPa, respectively, and a geotechnical Resistance Factor (Φ) of 0.5.

d) Care should be taken to prevent excessive drying or wetting or freezing during construction and soils in the footing trenches that become dried or wetted should be sub-excavated and replaced with lean concrete.

   The excavated base of the foundation level should be protected from weathering and frost action to prevent the deterioration of the soil at footing level. Footings should not be allowed to freeze after construction. Settlements could be greater if the soils are disturbed by construction activities or not properly protected.

e) The footing excavations should be inspected by qualified geotechnical personnel to ensure that the footings are located in suitable clay soils. Where spread footings are constructed at different levels, the maximum slope angle between adjacent footings should be limited to 1.5H:1V or flatter. Where necessary, temporary shoring of cut slopes or protection with plastic tarps may be used to protect the slopes from weathering and degradation.

f) The immediate (elastic) settlement for the new isolated footings can be calculated as follows:

   S = 5B for square footings

   S = 10B for strip footings

   Where:

   S is settlement in mm, and B is footing width in metres. Additional long-term consolidation settlement of approximately 30 percent of that calculated for immediate settlement should also be expected for footings founded on cohesive soils.

5.4.3 Raft Foundations

A raft foundation may also be considered for the support of a lightly loaded structure. It is expected that the raft will be founded on top of the firm to stiff clay layer.

The raft slab founded on native firm to stiff clay may be designed based on a factored ULS bearing resistance of 150 kPa, based on an ultimate bearing capacity of 300 kPa and a geotechnical resistance Factor (Φ) of 0.5.

A modulus of subgrade reaction (ks) of 13 MPa/m may be used for structural design of a raft slab founded on at least 300 mm of compacted gravel underlain by the native stiff clay stratum.

The values of k_s apply for a 1 m square rigid plate placed on clay. The design values should be corrected for the actual attributed area based on the following formula:

$k_b = k_s / B$ (MN/m^3)

Where:

k_b = modulus of subgrade reaction for footing width (MN/m^3)

k_s = modulus of subgrade reaction for 1 m square plate (MN/m^3)

B = effective footing width (MN/m^3)

It should be recognized that the structural analyses using the recommended modulus of subgrade reaction will not predict the correct amount of settlement for the structure. If required, settlement analyses could be carried out to determine the expected total and differential settlements based on the foundation layout, depth of embedment and loading once these are known.

5.4.4 Cast-in-Place Concrete Friction Piles

Foundation loads may be carried on cast-in-place concrete friction piles. An advantage in using friction piles is that the bases need not be thoroughly cleaned or inspected as they do not rely on end bearing resistance. The recommendations for the construction of cast-in-place concrete friction piles are as follows:

a) The piles should be designed and installed in accordance to the parameters provided in Table 5.1 below:

TABLE 5.1
CAST-IN-PLACE CONCRETE FRICTION PILES
ULS SHAFT FRICTION PARAMETERS

DEPTH BELOW EXISTING GROUND SURFACE (m)	SOIL TYPE	ULTIMATE SHAFT RESISTANCE (kPa)	FACTORED ULS SHAFT RESISTANCE	
			Compression (GRF**=0.4)	Tension (GRF**=0.3)
			(kPa)	(Φ)
0 – 1.5*	Clay	0	0	0
Below 1.5	Clay Till	35	14	10.5

* Or depth of fill, whichever is greater
** Geotechnical resistance factor

Shaft adhesion should not be included in the upper 1.5 m of the pile to allow for the possibility of the soil drying and shrinking away from the pile shaft or for future shaft or for future fill settlement. Cast-in-place concrete friction piles should be at least 7.0 m long below finished grade to resist potential frost heave forces. The pile length will need to be evaluated by the structural engineer to provide resistance to other forces such as uplift loads.

b) End bearing resistance should not be included in calculating the ultimate design load of a friction pile.

c) A minimum pile shaft diameter of 400 mm is recommended to prevent voids from forming during pouring of the concrete. A minimum pile spacing of 3 shaft diameters center to center is recommended. Skin friction should be reduced for pile spacing less than 3 diameters.

d) A minimum, and not including structural requirements, a nominal percentage of longitudinal reinforcement is required throughout the length of the pile shaft to resist potential uplift forces on the pile due to frost action and seasonal moisture variations. If piles are designed as tension elements, the pile reinforcing should be designed to resist the anticipated uplift stresses.

e) Concrete should be poured immediately after drilling of the pile hole to reduce the risk of groundwater seepage and sloughing soil. It should be noted that the seepage was noted at depths ranging from 1.7 m to 3.1 m below the existing ground surface. Casing should be available during pile construction and used if seepage and/or soil sloughing becomes excessive.

f) Cobbles and boulders were not encountered in the test holes; nevertheless, there is a potential for random cobbles and boulders in the clay till which could hamper augering if encountered in the pile hole.

g) The concrete materials and methods of concrete construction should be as per CSA A23.1-09/A23.2-09.

5.4.5 Cast-in-Place Concrete End-Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed in accordance with the following recommendations.

a) Pile bases should be founded at a minimum 7 m depth below ground surface to be supported on the very stiff clay till.

b) Cast-in-place concrete end bearing piles founded in the very stiff clay till at or below 7 m below ground surface may be designed using a factored ULS bearing resistance of 400 kPa, based on an ultimate bearing capacity of 1000 kPa and a Geotechnical Resistance Factor (Φ) of 0.4.

c) A minimum pile depth of 2.5 times the bell diameter has been assumed in calculation of the above bearing capacity. If less cover is provided, the specified bearing capacity must be reduced.

d) The bell diameter to shaft diameter ratio should not exceed 3:1 and the bell should not be sloped at more than 30° to the vertical.

e) A minimum pile shaft diameter of 400 mm is recommended to prevent voids from forming during pouring of the concrete.

f) A nominal percentage of longitudinal reinforcement should be provided throughout the pile shaft length to resist potential uplift forces on the pile due to frost action and seasonal moisture variations. If piles are designed as tension elements or are left exposed to subzero temperatures, the pile reinforcing should be designed to resist the anticipated uplift stresses.

g) All pile excavations should be thoroughly cleaned and visually inspected prior to pouring of the concrete to ensure a satisfactory base has been achieved. No slough or disturbed material should be allowed to remain in the pile excavations.

h) Cobbles and boulders were not encountered in the test holes; nevertheless, there is a potential for random cobbles and boulders in the clay till which could hamper augering if encountered in the pile hole.

i) Concrete should be poured immediately after drilling and inspection of the pile hole is complete in order to reduce the risk of groundwater seepage and sloughing soil.

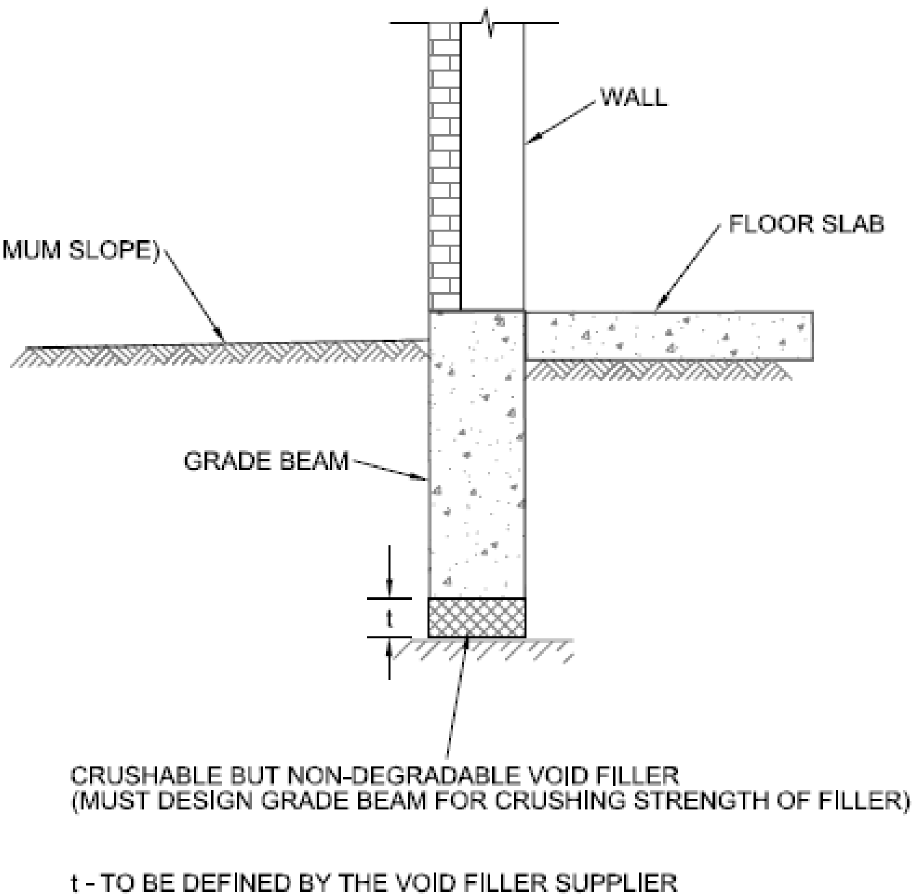
j) It should be noted that the seepage was noted at depths ranging from 1.7 m to 3.1 m below the existing ground surface. Suitable length casing should be available on site during pile installation and used as necessary to allow proper base cleaning. Geotechnical inspection is recommended to confirm suitable bearing conditions have been achieved.

k) The concrete materials and methods of concrete construction should be as per CSA A23.1-09/A23.2-09.

5.5 Concrete Grade Beams

Piles used to support the building may require concrete grade beams and pile caps along the tops of the piles. Precautions should be taken to prevent heaving of the grade beams due to seasonal moisture variation.

The recommended construction procedures for preventing heave under the grade beam are through use of a crushable non-degradable void form material (such as Beaver Plastics Frost Cushion) as shown in Figure 5.1. The grade beam must be designed in accordance with the crushing strength of the void filler used and the piles must be able to resist the resulting uplift load.



TYPICAL UNINSULATED GRADE BEAM

BASE OF GRADE BEAM ABOVE ZONE OF SEASONAL VOLUME CHANGE

FIGURE 5.1

5.6 Concrete Floor Slabs

The results of the investigation indicate the presence of high plastic clay near the surface. Site preparation includes removal of all topsoil and deleterious material from below the building areas prior to construction. All site raising fill should be placed and compacted as per the recommendations provided in Section 5.2.

A concrete slab-on-grade is considered feasible and may be supported on native material or engineered fill, subject to the following recommendations:

a) All topsoil, organic soil, deleterious material, any loose/soft or wet soils should be removed from below the building floor slab. The excavation should be inspected by geotechnical personnel that all unsuitable soil has been removed from beneath the floor slab.

b) The replacement soil should preferably consist of pit run sand or gravel fill or alternatively imported low to medium plastic clay fill.

c) All fill should be compacted in lifts not exceeding 150 mm and compacted to at least 98 percent of SPMDD within plus or minus 2 percent of OMC.

d) The near surface clay is high plastic and is prone to swelling and shrinkage in response to variations in moisture conditions. It is important to prevent drying, desiccation or freezing of the exposed clay subgrade during construction as this can lead to future swelling and heave of floor slabs. Any clay that becomes over dried or wetted should be removed and replaced as noted above.

e) Section 9.16.2 of the NBCC 2014 requires not less than 100 mm of coarse clean granular material containing not more than 10 percent passing a 4 mm sieve be placed beneath floor slabs on grade for occupied buildings. It is recommended that a minimum thickness of 150 mm of gravel meeting this requirement and having a maximum particle size of 25 mm be provided for this purpose as a radon mitigation. Furthermore, it is recommended to place a non-woven geotextile layer below the gravel for separation. The gravel layer should be compacted with at least four complete coverages of a vibratory roller to ensure that the gravel is well compacted.

f) The floor slab should be separate from the building structure and should be designed to tolerate movements due to potential future swelling and shrinkage of the clay, possibly up to about 30 mm. If slab movement cannot be tolerated, consideration should be given to use a structural floor slab supported on piles with a void form underneath to accommodate potential soil movements.

g) Non-load bearing partition walls supported on the slab-on-grade should have a gap of at least 30 mm between the top plate and ceiling to accommodate potential heave movements, and should therefore be separated from the building structure.

h) All heated utilities located beneath the slab should be insulated to reduce the potential for drying and shrinkage of the clay subgrade.

i) Surface grading and landscaping should be designed to shed water away from the building and slab-on-grade area to reduce ingress of water and swelling.

j) It is important that water and sewer lines be designed and installed to accommodate differential movements so as not to develop leaks and introduce moisture to near surface soils.

k) It is important that deciduous trees not be planted close to the building at a distance shorter than two times the mature height of the trees.

5.7 Cement

Two (2) tests were conducted to determine the water-soluble sulphate ion content in soil samples recovered from the test holes as presented in Table 5.2.

TABLE 5.2
SOLUBLE SULPHATE CONTENT TESTING

SAMPLE LOCATION	SOLUBLE SULPHATE CONTENT (PFRA Method)
TH16-2 @ 0.3 m	0 – 0.04%
TH15-3 @ 1.5 m	0 – 0.42%

These tests show the presence of 0.0 percent to 0.4 percent water-soluble sulphate (SO_4) content in the soil samples.

As per the guidelines of Table 3 of CSA Standard A23.1-09, the subsurface concrete at this site may be exposed to a “Severe” degree of exposure (Exposure Class S-2) to sulphate attack and would require the use of CSA Type HS or HSb Portland cement (regular or blended high sulphate-resistant hydraulic cement). Following the guidelines of Table 2 of CSA A23.1-09, we recommend that such concrete should have a maximum water to cementing materials ratio of 0.45 with the specified minimum 56-day compressive strength of 32 MPa, and should incorporate appropriate air entrainment. Further, such concrete should be cured as per the applicable “Curing Type” stated in Tables 2 and 20.

The recommendations stated above for the subsurface concrete at this site may require further additives and / or modifications due to structural, durability, service life or other considerations which are beyond the geotechnical scope.

In addition, if imported material is required to be used at the site and will be in contact with concrete, it is recommended the fill soil be tested for sulphate content so that the above stated recommendations remain valid.

5.8 Seismicity

Based on the available geotechnical information and 2015 National Building Code Seismic Hazard Calculation, the site is classified as Site Class C.

5.9 Parking Areas and Roadways

5.9.1 Subgrade Preparation

It is recommended that all topsoil, soil with excessive amounts of organics, and any poor quality soils be removed from the parking and apron areas. If required, additional excavations should be carried out to accommodate the pavement structure. As the gravel layer is relatively thin, it is unlikely that the gravel can be salvaged for use as GBC base material; however, the gravel can be used as general fill for site grading. The exposed surfaces should then be proof rolled and inspected by qualified geotechnical personnel to confirm that all deleterious material have been removed, and to identify wet or weak areas.

The roadway subgrade is expected to consist of high plastic, firm to stiff clay. Moisture conditioning will be required to achieve compaction requirements. Depending on the construction timing, drying of the clays may be difficult and it may be preferable to use one of the alternative methods provided in the next page for preparing the subgrades.

The following recommendations apply to design and construction of the paved areas:

a) The prepared subgrade should be proof-rolled to detect soft/wet zones as outlined in the recommended construction procedures in Appendix C.

b) Subgrade areas that become softened as a result of construction traffic or weather conditions should be sub-excavated and replaced with inorganic low to medium plastic clay or clean granular fill.

c) The exposed subgrade should be scarified to a depth of 150 mm, properly moisture conditioned, and re-compacted to a minimum of 95 percent of SPMDD at a moisture content of ± 2 percent of optimum moisture content except for the upper 150 mm, which should be compacted to 100 percent of SPMDD.

d) Fill required to raise the road to subgrade level should consist of inorganic low to medium plastic clay or clean granular fill. The backfill should be placed and compacted in lifts not exceeding 150 mm compacted thickness to at least 98 percent of SPMDD at a moisture content of ± 2 percent of optimum moisture content, except for the upper 150 mm, which should be compacted to 100 percent of SPMDD.

At areas of soft, wet, or weak subgrades, conventional subgrade preparation consisting of dicing and drying may not produce adequate subgrade depending on the nature of the subgrades and the time of the year. Alternative methods of preparing subgrades at these locations are provided below. The decision for the preferred method should be made at the time of construction after the areas have been excavated and the subgrade conditions assessed. The objective of the subgrade preparation would be to produce a stable non-yielding construction platform for the support of construction traffic and the pavement structure.

- Modify the upper portion of the subgrades with 5 percent cement (dry mass basis). It is expected that the depth of modification would vary from 150 mm to 300 mm which would require a cement application of between 12 to 25 kg/m^3.

- Remove and replace the upper portions of the subgrade with well compacted and well graded gravel. A geotextile separator should be placed between the clay and the underside of the gravel. It is expected that the depth of removal and replacement would vary from 300 mm to 500 mm.

- Remove and replace the upper portions of the subgrade with a well compacted, well graded gravel in combination with the provision of a geogrid such as Tensar BX1100 or equivalent and a non-woven geotextile. It is expected that the depth of removal and replacement would vary from 200 mm to 400 mm.

- Remove, air-dry and replace the upper portions of the existing subgrade with a well compacted engineered fill. It is expected that the depth of removal and replacement would vary from 400 mm to 750 mm.

It would be prudent to include unit prices for each alternative in the tender documents.

It is recommended that the finished subgrade surface be sloped at a minimum of 1 percent toward catch basins, gutters or perimeter ditches. The purpose of this is to drain any subsurface water from the subgrade and thereby prevent ponding of water on the pavement subgrade which could result in swelling, softening and/or possible frost heaving of the clay subgrade. The final compacted subgrade surface should be proof-rolled to confirm that surface deflections are minimal under the influence of construction traffic.

5.9.2 Pavement Design

A soaked California Bearing Ratio (CBR) value of 3 is considered applicable for design of the pavement structure on the types of subgrade materials encountered at this site. The design of pavement thickness will depend on the magnitude, frequency and distribution of traffic loading anticipated in the site. In lieu of this information, the guidelines presented in Table 5.3 below can be used for design of the pavement structures at the proposed roadway and parking lot areas.

TABLE 5.3
TYPICAL PAVEMENT STRUCTURES

PAVEMENT TYPE	PAVEMENT STRUCTURE
Light Duty (such as parking areas for light cars and pickup trucks)	75 mm Asphaltic Concrete over 250 mm Crushed Granular Base Course over 300 mm prepared subgrade
Heavy Duty (access route)	100 mm Asphaltic Concrete over 300 mm Crushed Granular Base Course over 300 mm prepared subgrade

The asphaltic concrete pavement should be compacted to at least 98 percent of the Marshall density of the mix design being utilized.

The pavement materials should be supplied and constructed in accordance with the latest edition of the Alberta Transportation Standard Specifications for Highway Construction. Granular base materials should be compacted to a minimum of 100 percent of SPMDD. Asphalt pavements should be compacted to a minimum of 98 percent of the Marshall density.

6. CONSTRUCTION INSPECTION

The performance of the buildings and parking areas will depend upon the quality of workmanship during construction. This is particularly important in regard to foundation installations and other earthwork where variations in soil conditions could occur. Therefore, it is recommended that inspection be provided by qualified geotechnical personnel during foundation and earthwork construction to confirm soil material encountered and/or used for construction is similar to that considered for the design. Compaction testing for backfill will also be required.

7. LIMITATION AND USE OF REPORT

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before any final design or construction details have been prepared or issued. Therefore, differences may exist between the report recommendations and the final design, in the contract documents, or during construction. In such instances, Thurber Engineering Ltd. should be contacted immediately to address these differences.

Designers and contractors undertaking or bidding the work should examine the factual results of the investigation, satisfy themselves on to the adequacy of the information for design and construction, and make their own interpretation of the data as it may affect their proposed scope of work, cost, schedules, and safety and equipment capabilities.

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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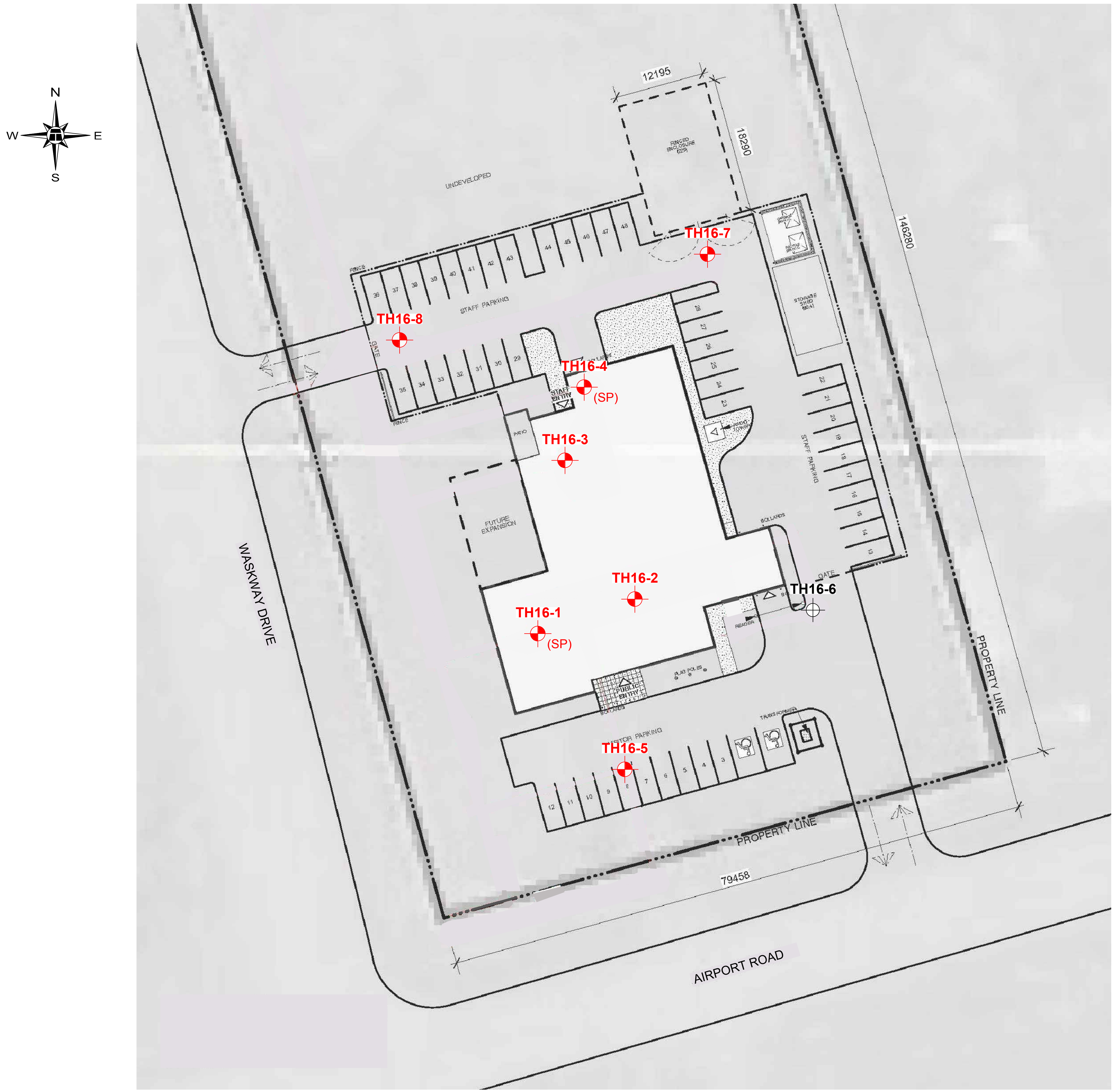
APPENDIX A

Site Plan Showing Approximate Test Hole Locations and Development Layout
Drawing No. 15726 - 1

H:\15000\15726 Geotechnical Survey - Wabasca-Demarais\Drafting\15726-1.dwg - Layout1 - Nov. 28, 2016



LEGEND

- APPROXIMATE TEST HOLE LOCATION
- TEST HOLE NOT DRILLED
- (SP) STANDPIPE PIEZOMETER

0 5 10 15 20 30m
SCALE APPROX. 1:600

BASE PLAN PROVIDED BY

ACI ARCHITECTS INC.

WABASCA-DESMARAIS, ALBERTA
GEOTECHNICAL INVESTIGATION

SITE PLAN SHOWING APPROXIMATE TEST HOLE LOCATIONS

DWG No. 15726-1

DRAWN BY	KLW
DESIGNED BY	JS
APPROVED BY	DWS
SCALE	APPROX. 1:600
DATE	NOVEMBER 2016
FILE No.	15726

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APPENDIX B

Symbols and Terms Used on Test Hole Logs
Modified Unified Soils Classification
Test Hole Logs

Z:_Edmonton office\Soil_Rock classification\Symbols & Terms-2012.dwg

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

1. VISUAL TEXTURAL CLASSIFICATION OF MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200 mm	Greater than 200 mm
Cobbles	75 mm to 200 mm	75 mm to 200 mm
Gravel	4.75 mm to 75 mm	5 mm to 75 mm
Sand	0.075 mm to 4.75 mm	Visible particles to 5 mm
Silt	0.002 mm to 0.075 mm	Non-Plastic particles, not visible to the naked eye
Clay	Less than 0.002 mm	Plastic particles, not visible to the naked eye

2. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	APPROXIMATE UNDRAINED SHEAR STRENGTH		APPROXIMATE SPT * 'N' VALUE
Very Soft	Less than 10 kPa		Less than 2
Soft	10 - 25 kPa		2 to 4
Firm	25 - 50 kPa		4 to 8
Stiff	50 - 100 kPa		8 to 15
Very Stiff	100 - 200 kPa	Modified from	15 to 30
Hard	200 - 300 kPa	National Building	Greater than 30
Very Hard	Greater than 300 kPa	Code	

* SPT 'N' Value   Standard Penetration Test 'N' Value - refers to the number of blows from a 63.5 kg hammer free falling a height of 0.76m to advance a standard 50mm outside diameter split spoon sampler for 0.3m depth into the undrilled portion of the test hole.

3. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	STANDARD PENETRATION TEST (SPT) (Number of Blows per 300 mm)	
Very Loose	0 - 4	
Loose	4 - 10	
Compact	10 - 30	Modified from
Dense	30 - 50	National Building
Very Dense	Over 50	Code

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

Shelby Tube	A-Casing
SPT	Grab
No Recovery	Core

SYMBOLS USED FOR TEST HOLE LOGS

●		MC - Moisture Content (% by weight) of soil sample
▼		Water Level
■	SPT	Standard Penetration Test 'N' Value (Blows/300mm)
▲	CPen	Shear Strength determined by pocket penetrometer
	CVane	Shear Strength determined by pocket vane
	Cu	Undrained Shear Strength determined by unconfined compression test
	SO_4%	Percent (%) of water soluble sulphate ions

THURBER ENGINEERING LTD.

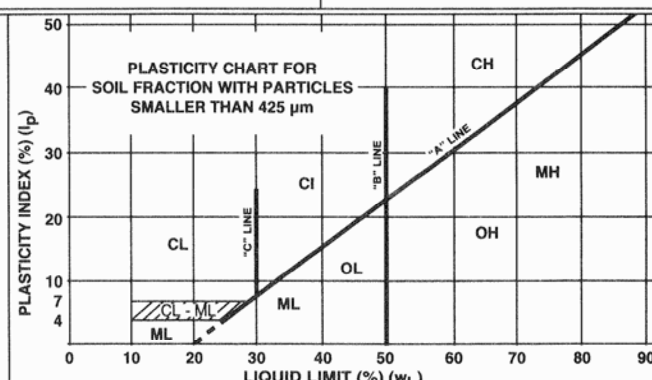
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(MODIFIED BY PFRA, 1985)

MAJOR DIVISION			GROUP SYMBOL	THURBER LOG SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75μm)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75μm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP; More than 12% GM, GC, SM, SC; 5% to 12% Borderline cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR GW	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
	SANDS MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR SW	
		SAND WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75μm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 50\%$	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)		
		$w_L > 50\%$	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, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS			
		$w_L > 50\%$	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS			
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$w_L < 50\%$	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW AND MEDIUM PLASTICITY			
		$w_L > 50\%$	OH		ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS			
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE		

SPECIAL SYMBOLS

- BEDROCK (UNDIFFERENTIATED)
- SANDSTONE
- CLAYSTONE (CLAYSHALE OR MUDSTONE)
- LIMESTONE
- CONGLOMERATE
- COAL
- OVERBURDEN (UNDIFFERENTIATED)
- SILTSTONE



THURBER ENGINEERING LTD.

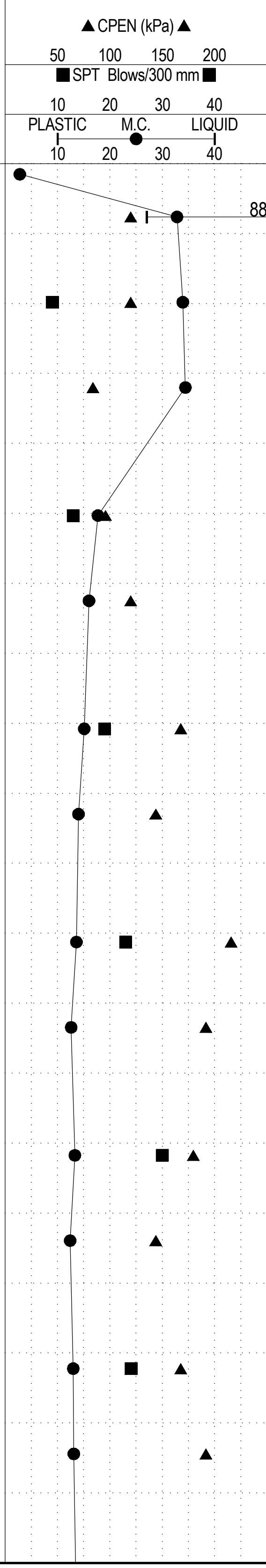
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(MODIFIED BY PFRA, 1985)

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-1**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE, SPT

BACKFILL TYPE: BENTONITE, DRILL CUTTINGS



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0	Grab			GP	GRAVEL (FILL), grey, rounded to angular, occasional pebbles
	Grab			CH	CLAY stiff, light brown, occasional silt
1	SPT	9		CH	
	Grab			CH	
2					CLAY (TILL) stiff, light grey to brown, occasional silt, sand, gravel, and oxide stains
	SPT	13		CI	
3	Grab			CI	
4	SPT	19		CI	-very stiff, occasional oxide pockets
	Grab			CI	-occasional pebbles
5	SPT	23		CI	-increasing in sand content, occasional oxide stains
6	Grab			CI	
7	SPT	30	-Trace seepage	CI	-hard, oxide stains, 25mm thick sand lens
	Grab			CI	-dark grey
8	SPT	24		CI	-very stiff
9	Grab			CI	
10					

BOREHOLE LOG 15726.GPJ THRBR_AB.GDT 11/29/16- LIBRARY-NEW LOGO - COPY.GLB

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
PREPARED BY: JS	COMPLETION DATE: 11/8/16
REVIEWED BY:	

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-1**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
10	SPT	31	● ■ ▲		DRILL CUTTINGS	CI		CLAY (TILL) - CONTINUED -hard	10
								END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -No slough -Water at 9.4m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -November 8, 2016 = 6.8m	
11									11
12									12
13									13
14									14
15									15
16									16
17									17
18									18
19									19
20									20

THURBER ENGINEERING LTD.

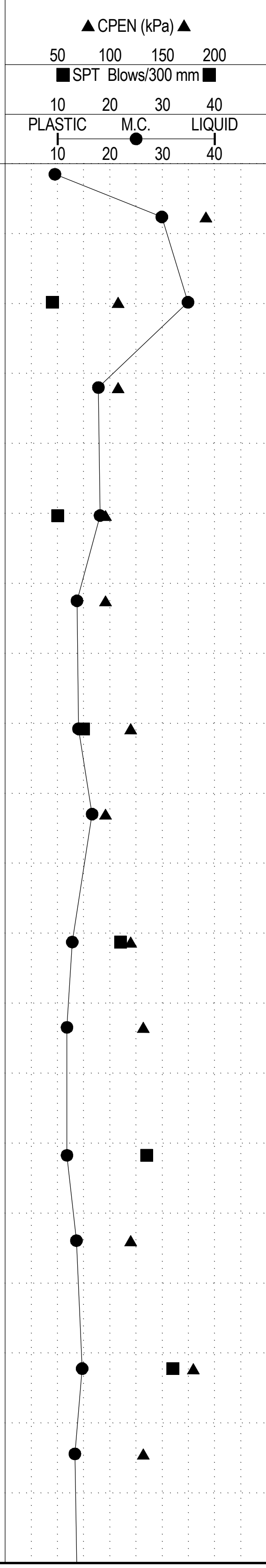
FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
PREPARED BY: JS	COMPLETION DATE: 11/8/16
REVIEWED BY:	Page 2 of 2

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE, SPT

SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
GRAB SAMPLE			GC	GRAVEL (FILL), grey, rounded to angular
GRAB SAMPLE		-SO_4 = 0.04%	CH	CLAY stiff, light brown
SPT	9		CH	
GRAB SAMPLE			CI	CLAY (TILL) stiff, light brown, occasional silt, sand, and fine gravel
SPT	10		CI	
GRAB SAMPLE		-Trace seepage	CI	
SPT	15		CI	-very stiff
GRAB SAMPLE			CI	
SPT	22		CI	
GRAB SAMPLE			CI	-light grey to brown
SPT	27		CI	-occasional oxide stains
GRAB SAMPLE			CI	
SPT	32		CI	-hard
GRAB SAMPLE			CI	
SPT				

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10



THURBER ENGINEERING LTD.	FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
	PREPARED BY: JS	COMPLETION DATE: 11/8/16
	REVIEWED BY:	Page 1 of 2

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE | SPT

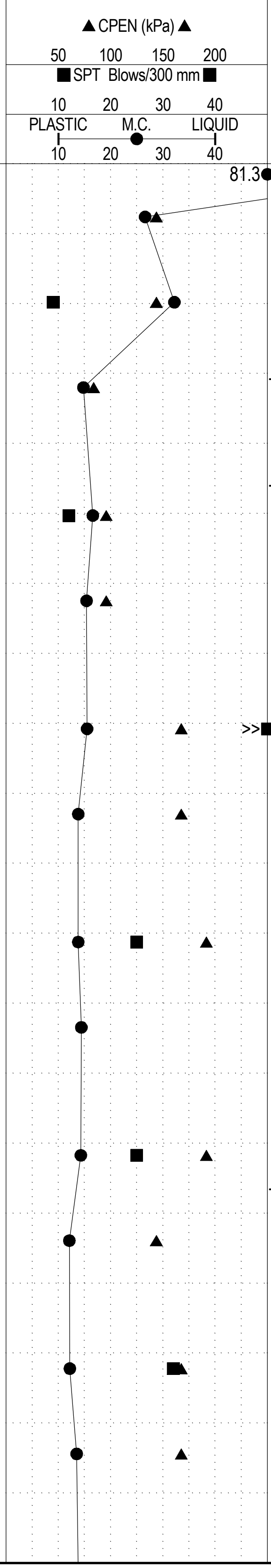
DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
10	SPT	44	● ▲ ■		CI		CLAY (TILL) - CONTINUED	10
							END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -No slough -Water at 9.8m Backfilled with drill cuttings and bentonite chips at surface	
11								11
12								12
13								13
14								14
15								15
16								16
17								17
18								18
19								19
20								20

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
PREPARED BY: JS	COMPLETION DATE: 11/8/16
REVIEWED BY:	Page 2 of 2

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-3**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE, SPT



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0	GRAB SAMPLE			PEAT	TOPSOIL, black, organics and rootlets
	GRAB SAMPLE			CH	CLAY stiff, light brown, occasional oxides
1	SPT	9		CH	
	GRAB SAMPLE		-SO_4 = 0.42%	CL	CLAY (TILL) stiff, brown, silty, sand, occasional fine gravel and oxide stains
2			-Trace seepage		
	SPT	12		CI	
3	GRAB SAMPLE			CI	-occasional pebbles
4	SPT	53	SPT pounded on pebble	CI	
	GRAB SAMPLE			CI	-light brown to grey
5	SPT	25		CI	-very stiff, 50mm thick sand parting
6	GRAB SAMPLE			CI	-sandy
7	SPT	25	-Seepage	CI	
	GRAB SAMPLE			CI	-dark grey
8	SPT	32		CI	-hard
9	GRAB SAMPLE			CI	
10	SPT				

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FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
PREPARED BY: JS	COMPLETION DATE: 11/8/16
REVIEWED BY:	

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-3**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE; SPT

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
10	SPT	27			CI		CLAY (TILL) - CONTINUED -very stiff	10
							END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -No slough -Water at 9.4m Backfilled with drill cuttings and bentonite chips at surface	
11								11
12								12
13								13
14								14
15								15
16								16
17								17
18								18
19								19
20								20

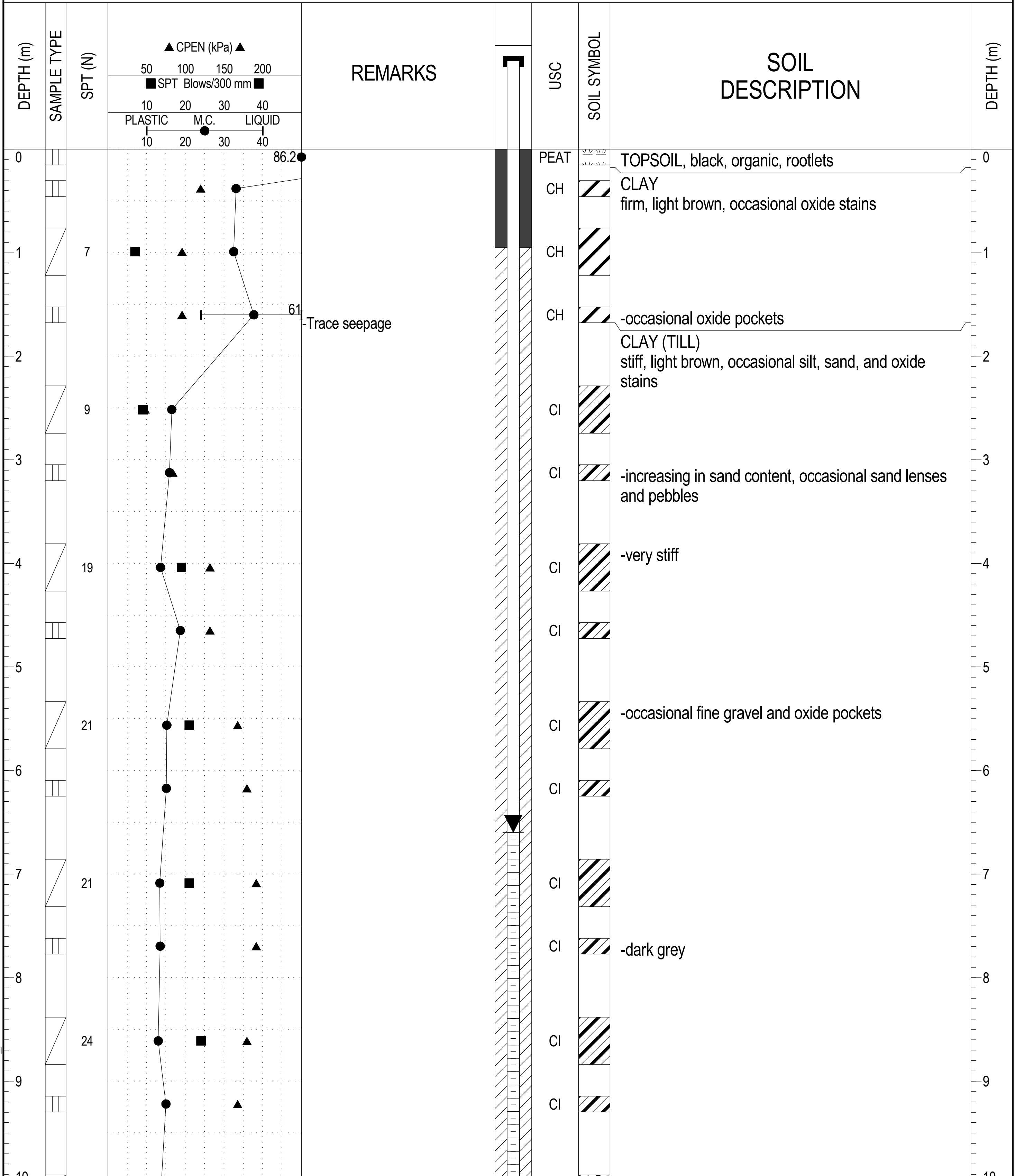
THURBER ENGINEERING LTD.

FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
PREPARED BY: JS	COMPLETION DATE: 11/8/16
REVIEWED BY:	Page 2 of 2

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-4**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE, SPT

BACKFILL TYPE: BENTONITE, DRILL CUTTINGS



BOREHOLE LOG 15726.GPJ THRBR_AB.GDT 11/29/16- LIBRARY-NEW LOGO - COPY.GLB

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
PREPARED BY: JS	COMPLETION DATE: 11/8/16
REVIEWED BY:	

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-4**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS

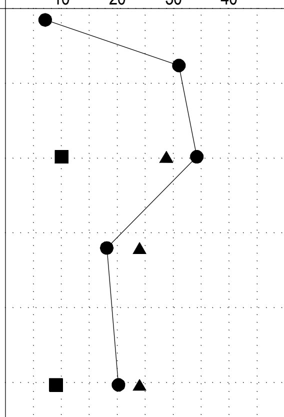
DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
10	SPT	25		-Seepage		CI		CLAY (TILL) - CONTINUED -50mm thick sand lens	10
								END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -No slough -Water at 8.5m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -November 8, 2016 = 6.6m	
11									11
12									12
13									13
14									14
15									15
16									16
17									17
18									18
19									19
20									20

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NKR	COMPLETION DEPTH: 10.4 m
	PREPARED BY: JS	COMPLETION DATE: 11/8/16
	REVIEWED BY:	

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-5**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE; SPT

▲CPEN (kPa)▲ 50 100 150 200
■SPT Blows/300 mm■ 10 20 30 40
PLASTIC M.C. LIQUID 10 20 30 40



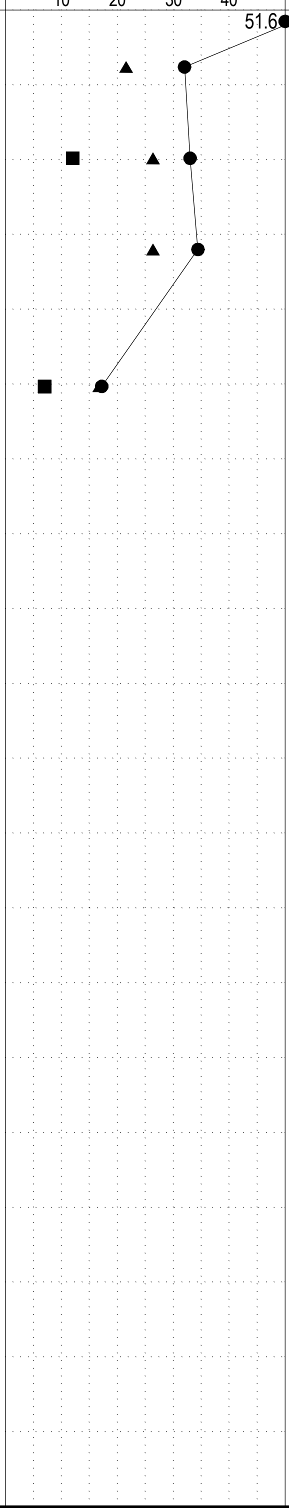
DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0	GRAB SAMPLE			GM	GRAVEL (FILL), grey, rounded to angular
	GRAB SAMPLE			CH	CLAY stiff, light brown
1	SPT	10		CH	
	GRAB SAMPLE			CI	CLAY (TILL) stiff, light brown, occasional silt, sand, fine gravel, and oxides
2	SPT	9	-Trace seepage	CI	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -No slough -Water at 2.4m Backfilled with drill cuttings and bentonite chips at surface

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NKR	COMPLETION DEPTH: 2.7 m
	PREPARED BY: JS	COMPLETION DATE: 11/8/16
	REVIEWED BY:	Page 1 of 1

CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-7**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE; SPT

▲CPEN (kPa)▲ 50 100 150 200
■SPT Blows/300 mm■ 10 20 30 40
PLASTIC M.C. LIQUID 10 20 30 40



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0	GRAB			OL	TOPSOIL, black, organic, rootlets
	GRAB			CH	CLAY stiff, light brown, occasional oxide stains
1	SPT	12		CH	
	GRAB			CH	
2.5	SPT	7		CI	CLAY (TILL), firm, light brown, occasional silt, sand, fine gravel, and oxides
					END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NKR	COMPLETION DEPTH: 2.7 m
	PREPARED BY: JS	COMPLETION DATE: 11/8/16
	REVIEWED BY:	Page 1 of 1

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CLIENT: ACI Architects Inc.	PROJECT: RCMP Building - Wabasca-Desmarais	BOREHOLE NO: **TH16-8**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: November 8, 2016	PROJECT NO: 15726
DRILL/METHOD: Truck / Solid Stem Augers	LOCATION: See Drawing #15726-1	ELEVATION: (Estimated)

SAMPLE TYPE: GRAB SAMPLE; SPT

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
0	GRAB		167.8●		PEAT		TOPSOIL, black, organics and rootlets	0
	GRAB				CH		CLAY stiff, light brown, occasional oxide stains	
1	SPT	8			CH		-occasional silt partings	1
	GRAB				CL		CLAY (TILL) stiff, light brown, occasional silt, sand, fine gravel, and oxide stains	
2								2
	SPT	9			CI		-increasing in sand content, occasional oxide pockets	
3	GRAB			-Trace seepage	CI		-silty, sandy	3
4	SPT	19			CI		-very stiff	4
							END OF TEST HOLE AT 4.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	
5								5
6								6
7								7
8								8
9								9
10								10

BOREHOLE LOG 15726.GPJ THRBR_AB.GDT 11/29/16- LIBRARY-NEW LOGO - COPY.GLB

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NKR	COMPLETION DEPTH: 4.3 m
PREPARED BY: JS	COMPLETION DATE: 11/8/16
REVIEWED BY:	

APPENDIX C

Recommended Construction Procedures

THURBER

RECOMMENDED CONSTRUCTION PROCEDURES

The following construction procedures are considered to represent good practice and are to be read in conjunction with the text of this report.

1. EXCAVATED FOUNDATIONS

1.1 Excavation close to foundation level should be done carefully to avoid disturbance of the soil. It is essential to prevent the soil at foundation level from deterioration due to excessive drying or becoming wet from surface or seepage water. Good drainage both during and after construction is essential.

1.2 Sumps, if required, should be located well away from the foundation area. Softened or overdried soil must be removed and replaced by lean mix concrete or by extending the foundations.

1.3 The foundation must be kept from freezing both during and after construction. Foundation concrete should not be placed on or against frozen soil.

2. PROOF ROLLING

2.1 Proof rolling is a method of detecting soft areas in a subgrade for fill, pavement, floors or foundations. The intent is to detect softened areas not revealed by the test holes or visual examination of the site surface, and is used where normal scarification and compacting procedures would not be successful in detecting and eliminating soft areas. It is usually accomplished with the use of heavy 130 to 220 kN (15-25 ton) compaction equipment with high contact wheel pressures on independent axles, although heavily loaded single axle trucks will provide the equivalent result.

2.2 The procedure requires 2 complete passes with the heavy equipment in one direction and then a second series of 2 passes made at right angles to the first series.

2.3 While the passes are being made, any softened, rutted or displaced areas detected should be examined and either recompacted with additional fill or the existing material removed and replaced with better quality material.

THURBER

3. BACKFILLING

3.1 Backfill around foundations should be placed in such a manner so as to prevent settlement and to be relatively impervious near the surface so that water does not pond against foundations nor be allowed to seep into the soil.

3.2 Backfill should not be placed until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction.

3.3 All backfill around grade beams, foundation walls, etc. must be carefully and uniformly compacted. The backfill should be placed in even layers and no frozen nor organic material should be incorporated into the fill. All lumps of material must be broken down or squeezed together during placing and compaction.

3.4 The final grade (allowing for some settlement of the backfill) should shed water away from the structure.

3.5 During construction, precautions should be taken to prevent water ponding in grade beam excavations thereby acting as a source of water to soften the soil under the floor slab area or providing a source of water for frost action if the building is not heated during freezing weather.

4. BORED CAST-IN-PLACE CONCRETE PILES

4.1 If there is evidence of water bearing and/or sloughing soil, casing should be used to seal off the water or prevent the sloughing of the sides of the hole. The concrete and reinforcing steel should be on hand and placed as soon as the pile hole has been completed and approved.

4.2 Pile bells, if used, should be formed entirely in self-supporting soil and it may be necessary in some cases to extend the pile bell if caving occurs at the location of the bell.

4.3 Water should not be left ponded on the pile base and should be removed, or dried by the use of dry cement when permitted by the engineer.

4.4 Concrete should be placed without segregation and carefully vibrated throughout the full length of the pile to ensure that voids do not exist in the pile shaft. The concrete slump should be between 75 and 125 mm with a minimum compressive strength at 28 days of

21 MPa (3000 psi). Higher compressive strengths may be required for structural or durability reasons, and higher slumps may be necessary for closely spaced reinforcing bars or where concrete is to be tremied under water.

4.5 Steel reinforcing should be tied into the grade beam reinforcing steel. This recommendation is important where the soil below grade beam can swell from a change in moisture content or by frost action before the building is heated.

4.6 Piles closer than 2½ diameters should not be drilled and poured consecutively unless permitted by the engineer and depending upon soil conditions. Where the drilling operation might affect the concrete in the adjacent pile, the drilling should not be carried out until the concrete has at least 24 hours to set, or before the concrete has reached its initial set.