HOGGAN ENGINEERING & TESTING (1980) LTD.
An Affiliate of J.R. Paine & Associates Ltd.
17505 - 106 Avenue, Edmonton, Alberta T5S 1E7

February 8, 2013
File No. 6004 – 28

STANTEC CONSULTING LTD.
10160 – 112 Street
Edmonton, Alberta
T5K 2L6

Attention: Randall Sonnenberg, P. Eng.

Dear Sir:

Re: Geotechnical Investigation
Proposed East Schonsee Subdivision
Block C, Plan 2887AQ
16704 – 66 Street NW
Edmonton, Alberta

Please find enclosed our report with respect to the above noted investigation. In brief, this report presents the general soil conditions and geotechnical recommendations for the construction of this project.

Thank you for the privilege of providing this service to your organization. We will be pleased to meet with you and review the contents of this report at your convenience.

Yours truly,
HOGGAN ENGINEERING & TESTING (1980) LTD.

John Tsoi, P. Eng.

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REPORT NO: 6004 – 28

**GEOTECHNICAL INVESTIGATION
PROPOSED EAST SCHONSEE SUBDIVISION
BLOCK C, PLAN 2887AQ
16704 – 66 STREET NW
EDMONTON, ALBERTA**

February 2013

**HOGGAN ENGINEERING & TESTING (1980) LTD.
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REPORT NO: 6004 – 28

GEOTECHNICAL INVESTIGATION
PROPOSED EAST SCHONSEE SUBDIVISION
BLOCK C, PLAN 2887AQ
16704 – 66 STREET NW
EDMONTON, ALBERTA

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GEOTECHNICAL INVESTIGATION

PROJECT: Proposed East Schonsee Subdivision

LOCATION: Block C, Plan 2887AQ
16704 – 66 Street NW
Edmonton, Alberta

CLIENT: STANTEC CONSULTING LTD.
10160 – 112 Street
Edmonton, Alberta
T5K 2L6

ATTENTION: Randall Sonnenberg, P.Eng.

1.0 INTRODUCTION

This report presents the results of a subsurface investigation made on the site of the proposed East Schonsee Subdivision in Edmonton, Alberta. The project is understood to consist of a fully serviced residential subdivision. It is understood the maximum trench depth is 10 metres. Construction of the pond is near completion and is beyond the scope of this investigation. The objective of the investigation is to determine the general subsurface soil conditions in order to provide geotechnical recommendations for planning and construction aspects of the residential subdivision. Previous land use and environmental issues are beyond the scope of this report.

Authorization to proceed was granted by Mr. Randall Sonnenberg, P. Eng. of Stantec Consulting Ltd. (Stantec) in November 2012. Permission to access the site was granted by the City of Edmonton. Field work was completed in December 2012.

2.0 SITE DESCRIPTION AND DESKTOP STUDY

The subject site is situated directly north of 167 Avenue and west of 66 Street in the Edmonton, Alberta. The site consists of almost the entire east half of SW 3 – 54 – 24 – W4M, except for two parcels along 66 Street and 167 Avenue. The site is bordered by farmland to the north, 66 Street to the east, 167 Avenue to the south, and existing stages of the Schonsee neighbourhood under construction to the west.

Aerial Photography Review

Several sets of aerial photography taken between 1962 and 2012, covering the subject site and surrounding areas, were obtained from the City of Edmonton Mapping Department and the Alberta Sustainable Resource Development Library. The photos were carefully compared and reviewed for any signs of disturbances within the site.

In 1962, the pond occupied the north central portion of the site where open water was visible. A channel connecting to the pond was noted, cutting across the southwest portion of the site. The pond and channel appeared wet and vegetated. Residential or industrial developments were noted at the northeast and southeast corners of the site. The remainder of the site was grass covered or farmed.

In 1974, the size of open water in the pond was greatly reduced and the channel appeared dry. A tree line was noted along 66 Street. A small patch of trees appeared northwest of the pond and a bigger patch of trees was also noted near the south boundary. Bare ground was noted east of the pond near 66 Street. Development in the northeast corner of the site had expanded.

In 1984, the southeast part of the channel appeared filled in.

In 1992, no significant changes were noted.

In 2005, development in the southeast corner of the site had expanded and filled in portion of the channel. The channel appeared wet and vegetated.

In 2012, construction was underway and major ground disturbance was noted throughout the site. The pond was drained. The pond and the channel were stripped and graded. The patch of trees near the south boundary was cleared and replaced by a storage yard. Soil stockpiles were noted west of the pond near 66 Street.

The one concern seen in the air photos was the infilling of the pond and channel. Uncontrolled fill may be present near the pond and channel, thus require treatment.

Current Site Conditions

At the time of the investigation, the site was snow covered. No visible markers were noted along the west and north boundaries. A storage yard at 167 Avenue was fenced off. A farm yard located in the northeast corner of the site was also fenced off. A soil mount at least 5 metres high was noted near in the east central portion of the site.

Vegetation was noted within the pond, but little to no vegetation was noted under the snow cover away from the pond. The shape and extent of the pond is similar to that observed in the 1962 air photo, expect for the northeast portion where the soil mount and the farm yard is located. An observation deck was noted in the north end of the pond.

The site appeared to be rough graded. The terrain is considered rolling in nature, with the pond in the middle being the lowest and the soil mount east of the pond being the highest. The site grading appeared to be graded to drain toward the pond.

Access to the site was gained off 66 Street and 167 Avenue. Snow clearing and all-wheel-drive vehicles were required to travel across the site.

Coal Mine Atlas Review

No coal mining information of the area was found in the Alberta Coal Mine Atlas ST45 made available by Energy Resources Conservation Board. Coal mining related issues should not be a concern for this site and were not investigated further.

Geotechnical Report Review

No geotechnical report of the site from previous investigations was provided by City of Edmonton. Our library was searched and no geotechnical report for the subject area was found.

3.0 FIELD INVESTIGATION

Soil sampling was performed over two days utilizing a truck mounted drill rig owned and operated by Mobile Augers And Research Ltd. in December 2012. Eight testholes were drilled to depths of approximately 11.9 and 7.3 metres below ground surface (BGS). The testhole layout was selected by our fim and all the testholes were located away from the pond. JRP personnel later surveyed the testhole locations and elevations using a Trimble GeoExplorer 6000 GPS unit. The approximate testhole locations are shown on the attached site plan in the Appendix.

All testholes were advanced with solid stem augers at 1.5 metre increments. Continuous visual descriptions in accordance with the modified Unified Soil Classification System including the soil types, depths, moisture contents, transitions, and other pertinent observations were recorded on site. Soil samples were collected from the auger at approximately 750 millimetre intervals for

laboratory testing. Standard Penetration Tests (SPT) complete with split spoon samplings were also taken at regular 1.5 metre intervals in the testholes. Where suitable soils were encountered, undisturbed Shelby Tube samples were taken instead of SPT.

Following the drilling operation, a slotted piezometric standpipe was inserted in each testhole for watertable level measurement. The testholes were backfilled with drill cuttings and sealed with bentonite at the surface to help prevent surface water infiltration.

4.0 LABORATORY TESTING

Soil samples retrieved from augers were bagged and returned to the laboratory for further testing. All samples were tested for moisture content. Representative samples were also tested for Atterberg Limits and soluble soil sulphate concentrations. All Shelby Tube samples were tested for unconfined compressive strength and dry density. The results of all laboratory testing and field observations are summarized in the attached testhole logs.

5.0 GEOLOGICAL AND SOIL CONDITIONS

According to GIS maps made available by Alberta Geological Survey, the local surficial geology of the area is classified as lacustrine deposit of Pleistocene and Holocene age. The lacustrine deposits were described in the legend as to consist of sand, silt, and clay with local ice-drafted stones deposited in proglacial or recent lake environment. It was also noted that fine sediment is expected west of the pond while coarse sediment is expected east of the pond. The general bedrock geology in the region was identified as the Horseshoe Canyon Formation of late Cretaceous age. The Horseshoe Canyon Formation generally comprised of grey feldspathic clayey sandstone and bentonitic mudstone, with scattered coal and bentonite beds of various thickness.

Detailed soil description of each testhole within this site can be found in the attached testhole logs in the Appendix. In general, soils encountered consisted of fill at the surface, followed by layers of lacustrine clay and clay till, and transitioned into bedrock to testhole termination depths.

Topsoil & Fill

Approximately 100 millimetres of topsoil and organic clay was encountered in Testhole 2012-1 at the surface. In general, the organic soil was considered silty, moist, black, and frozen.

Clay fill approximately 0.3 to 2.1 metres deep was encountered at the surface in all testholes. The quality of fill encountered was varible. In general, the clay fill material was considered silty to very silty, sandy, medium to high plastic, moist to very moist, brown and black, and contained a trace to considerable organic content. SPT "N" values between 4 and 13 blows per 300 millimetres of penetration were recorded, indicating firm to stiff consistency.

It is emphasized that the depths of organic soil and fill are known only at each testhole location and may vary significantly away from the testhole location. The noted soil mount on site was not investigated.

Clay & Clay Till

Native deposit of lacustrine clay was encountered below the fill in all testholes. In general, the lacustrine clay was considered silty, medium to high plastic, moist, brown, and contained a trace of oxide. SPT "N" values between 4 and 25 blows per 300 millimetres of penetration were recorded, indicating firm to very stiff consistency. Unconfined compressive strengths between approximately 63 and 186 kilopascals were obtained from the undisturbed Shelby tube samples at various depths. The moisture contents of the lacustrine clay were typically slightly above to more than 15 percent above the plastic limits.

A layer of clay till was encountered below approximately 2.7 to 4.3 metres in Testholes 2012-1, 2012-5, and 2012-6 directly above the bedrock. A mixture of clay till and bedrock was encountered in Testhole 2012-4 and a layer of clay till was also encountered in between the bedrocks in Testhole 2012-2. In general, the clay till material was considered silty, sandy, medium to high plastic, moist, brown, and contained bedrock fragments and traces of coal. SPT "N" values between 17 and 38 blows per 300 millimeters of penetration were recorded, indicating very stiff to hard consistency.

Sand

A layer of sand was encountered below approximately 1.2 metres in Testhole 2012-6. In general, the sand material was considered silty, medium to fine grained, moist, and brown.

Bedrock

Clay shale bedrock of the Horseshoe Canyon Formation was encountered in all testholes at approximately 3.4 to 6.4 metres BGS. In general, the bedrock material was considered high plastic, damp to moist, grey and brown, and weathered. SPT "N" values between 12 and 79 blows per 300 millimetres of penetration were recorded, indicating stiff to hard consistency.

A bentonite seam, approximately 0.6 metres thick, was noted within the bedrock in Testholes 2012-1 and 2012-2. The bentonite was very high plastic with liquid limits well above 300 percent, indicating an extremely high swelling potential.

Testhole Condition At Completion

Upon completion of drilling, no significant immediate groundwater seepage was observed in any testhole. However, minor amount of sough was noted in four testholes.

6.0 GROUNDWATER CONDITIONS

Watertable measurements were taken within seven weeks after the completion of drilling. For all practical purposes, only the highest recorded watertable level of each testhole was considered. The watertable readings and corresponding elevations are summarized below.

Table 1: Watertable Measurements

Testholes	Watertable Depth Below Ground Surface (m) 28-Dec-12	Watertable Depth Below Ground Surface (m) 21-Jan-13	Ground Elevation (m)	Watertable Elevation (m)
2012 - 1	6.91 (24 days)	6.45 (48 days)	685.36	678.91
2012 - 2	5.32 (24 days)	3.76 (48 days)	683.71	679.95
2012 - 3	5.50 (24 days)	3.36 (48 days)	683.87	680.51
2012 - 4	3.49 (24 days)	2.98 (48 days)	683.42	680.44
2012 - 5	2.54 (24 days)	1.96 (48 days)	683.25	681.29
2012 - 6	dry at 6.23 (24 days)	5.06 (48 days)	683.00	677.94
2012 - 7	dry at 7.12 (23 days)	dry at 7.12 (47 days)	683.54	below 676.42
2012 - 8	dry at 6.41 (23 days)	6.36 (47 days)	683.43	677.07

It should be noted that watertable levels might fluctuate on a seasonal or yearly basis with the highest readings obtained in the spring or after periods of heavy rainfall. The above recorded watertable depths should reflect the below average seasonal level.

It appears that the watertable levels were highest at Testholes 2012-4 and 2012-5 located in the east central portion of the site adjacent to the soil mount.

7.0 RECOMMENDATIONS

7.1 Site Grading

1. Topsoil and all other organic soil are considered unsuitable for footing and basement slab-on-grade support and should be completely stripped away, stockpiled, and reused for landscaping purposes only. The existing fill encountered contained considerable organic content and would not be considered engineered fill. All existing fill on site should be removed and stockpiled. Field judgment and careful inspection will be required to identify any clean fill with minimum organic content to be reworked as engineered or grading fill.
2. The measured watertable levels were well below the bottom of the fill in most testholes. Conventional clearing and stripping should be suitable for most part of this site. However, the watertable levels measured in Testholes 2012-4 and 2012-5 were within 1.0 metres below the bottom of the fill. Removal of the fill might expose the very moist and firm native soil near the watertable. A hoe and loaders may be required to move the fill in the high watertable areas.
3. Engineered fill may be considered in areas where low elevations necessitate deep fill zones. This option should be reviewed by our firm to evaluate site conditions and borrow material sources prior to implementation. Fill deeper than 4.0 metres should be reviewed by our firm prior to construction to address potential settlement.

   Engineered fill is soil that is placed in a controlled manner under the full-time inspection of a qualified soil technician. The fill is placed and compacted to a minimum 98 percent of its Standard Proctor Density (SPD) near its optimum moisture content, in maximum 150 millimetre lifts. All topsoil and non-engineered fill must first be stripped from the engineered fill area. Engineered fill placement requires full-time monitoring and extensive testing by the geotechnical consultant during construction. However, proper placement of engineered fill will negate the need for pile foundations in deep lot fill areas, and possibly reduce the foundation costs to the builders and developer.

   Engineered fill requires the support of strong underlying soil. The near surface clay encountered throughout the site is considered suitable to support engineered fill.

Although soil conditions encountered throughout the site appeared adequate, it should be noted that engineered fill construction is not possible in soft, very moist, underlying soils. Compacting the first lift of fill material over these soft underlying soils to the engineered fill standard may be impossible. Where a minimum fill depth condition is met, construction of a clay pad approximately of 300 to 500 millimetres in thickness will be required to obtain an adequate working platform. This pad should be compacted to a minimum of 98 percent of SPD where possible. The normal engineered fill lift thickness and compaction criteria mentioned above should be applied to successive lifts. To employ this method, a minimum of 1.0 metre of engineered fill must be placed on top of the clay pad. If this condition is not met, the fill would not be considered to have met engineered fill standards.

In addition, engineered fill requires fill depth differentials across the building footprint of less than 1.5 metres. This may be a limiting factor in some area, due to the sloping nature of the existing ground. In some cases, removal of native material may allow for the minimum fill depth or the maximum fill differential conditions to be met. However, this may not always be the most economical solution.

4. The near surface inorganic clay and clay till encountered throughout the site would be considered suitable to be used as engineered fill. The high plastic clay should be placed at slightly above optimum moisture content, to minimize possible swelling and softening concerns. The moisture contents of the clay and clay till on site were slightly to over 15 percent above the plastic limit. Singificant drying will be required to reach the above mentioned compaction standard in some instances. It is important that changes in moisture content be avoided both during and after construction. Proper site grading is also imperative.

5. Clay shale bedrocks encountered were not considered suitable to be used as engineered lot fill due to a high swelling potential. Bedrocks may be used as lot grading fill above the footing elevations away from the driveway area or in parks where soil bearing is not required. Bedrock may also be used as road or trench fill placed at least 1.5 metres or more below the road subgrade. Excavated bedrock should be separated and adequately pulverized.

7.2 Residential Housing

1. The very high plastic bentonite and clay shale bedrock encountered has a considerable swelling and shrinkage potential. After the removal of existing fill, bedrock will be closest to the surface at Testhole 2012-3 at 3.4 metres BGS or elevation of 680.5 metres. Assuming the final grade will be restored to near the current grade with engineered fill, a 2.0 metre cut for a typical house basement should not be an issue. The remaining testholes encountered the bedrock at 3.8 metres or more BGS. However, bedrock elevations can vary substantially so there is no certainty. The following recommendations should be considered to minimize the bedrock swelling concerns.
   a. A 1.0 metre separation between the house footing and the bedrock should be maintained. The 1.0 metre buffer is chosen based on our knowledge and research in similar areas of North Edmonton. The value is not conservative and is not meant to be an exact limit to prevent swelling. The design lot grading should be raised if possible in high bedrock areas to help maintain the 1.0 metre buffer from the bedrock. If bedrock is found at the foundation level during basement excavation, the bedrock should be excavated to 1.0 metre below footing grade and replaced with engineered fill consisting of low to medium plastic clay.
   b. In order for swelling or shrinkage to occur, the moisture content must change. If water transfer does not occur, swelling or shrinkage of the clay would not occur. Therefore, the control of free water and excessive drying are important factors for minimizing the risk of swelling/shrinkage. Upgraded foundation drainage may help regulate surface water infiltration into the bedrock.
   c. As with many geotechnical considerations, the swelling and shrinkage risk cannot be completely eliminated, only minimized. All parties should be made aware of and must accept the risk of foundation and slab movement in order to utilize footing foundation or slab on grade. Otherwise, pile foundation and structure slab with void forms would be required.
2. The native inorganic clay, clay till, and sand encountered throughout this site are considered satisfactory for supporting wood framed single-family dwellings utilizing standard concrete footing foundations. Soft and very moist soils were encountered below the fill in Testholes 2012-4 and 2012-5. It should be noted that the bearing capacity of

soft materials in isolated areas may fall below the minimum 75 kilopascals required for applying the Alberta Building Code Section 9. In such cases, wider footings will be required.

3. The watertable is high in the northeast portion of the site near Testholes 2012-4 and 2012-5. More recommendations on groundwater and drainage issues are provided in Section 7.5.

4. No loose, disturbed, remoulded or slough material should be allowed to remain in the open footing excavations. Hand cleaning is advised if an acceptable surface cannot be prepared by mechanical equipment. In order to reduce the disturbance to the bearing surface, a backhoe operating remotely from the bearing surface should advance all basement excavations.

5. To ensure the structural integrity of a foundation, continuous footings should be designed as a structural beam with proper reinforcement and should be treated together with the foundation walls if applicable. Such design should permit foundation components to allow a small amount of differential moment induced by any soil volume changes.

6. Lot grading plans are not known at this time. If general lot grading will produce areas of fill extending in depth below that of the footing elevation, it is strongly recommended that qualified geotechnical personnel inspect the house excavations. Generally, it is not recommended that footings be constructed on non-engineered fill. In such cases, the following alternatives are commonly recommended:

   - Removal of the fill down to native soil and backfill with a compacted granular material. A normal footing foundation may then be utilized.
   - Utilize a pile foundation.

7. The soils encountered at this site are generally considered suitable for cast-in-place pile installation. No significant groundwater seepage was encountered in during testhole drilling. If pile drilling encounter groundwater seepage, casing will be required. At the very least, pile concrete should be on-site during the pile drilling to allow for immediate concrete placement.

8. All piles should be adequately reinforced. Concrete for all piles should be adequately vibrated.

9. To compensate the possible swelling of the subsoil beneath the pile caps and the effects of frost action, void form or other means to allow soil expansion beneath the grade beams pile caps, and structural slabs are recommended.
10. Foundation drain services are recommended in all residential lots due to the presence of near surface bedrock and high watertable. All basements should be provided with a suitable peripheral drainage system with an adequate filter placed at footing elevation and connected positively with an approved drainage system. More recommendations on groundwater and drainage issues are provided in Section 7.5.
11. All houses will require at least 1.5 metres of earthen cover to prevent potential frost heave problems, and to minimize movements associated with seasonal variations in moisture content. The amount of cover should be increased to 2.0 metres for exterior isolated footings or for footings of non-continuously heated structures.
12. All backfill against foundation walls should be inorganic material and should be moderately compacted with care taken not to over compact the fill and generate excessive lateral pressure. The backfill should be placed in lifts not great than 150 millimetres after compaction. It is recommended that floor joists be placed prior to backfilling in order to minimize any detrimental effects on the foundation walls caused by soil compaction.
13. Proper lot grading away from the houses must be provided to minimize the ingress of surface water into the subsoil. Special care should be taken during construction and for the rest of the structure's design life to prevent excessive changes in moisture content of the soil. Footing excavations should be protected from rain, snow and influx of groundwater. Trees should not be planted near the foundation. Additional lot grading recommendations are provided in Section 7.5.
14. During cold weather construction, it is essential that all interior fill and load bearing materials remain frost free. Recommended cold weather construction practices, with respect to hoarding and heating of the forms and the fresh concrete, should be followed. In order to minimize the potential frost heave problems, the interior of the building must be heated as soon as the walls have been poured. The period in which the excavation is left open due to freezing conditions should be as short as possible. If doubts remain as to the suitability of the foundation during construction, the builder should consult a qualified geotechnical engineer.

15. The native inorganic clay, clay till, and sand on this site are considered suitable for slab-on-grade support. However, the near surface high plastic clay has a moderate to high swelling and shrinkage potential. Change in soil moisture content is not desirable and should be avoided during construction and throughout the structure design life. A 150 millimetre layer of clean granular material and a non-deteriorating vapour barrier should be placed immediately below the floor slab to prevent desiccation of the subgrade material. Grade-supported floor slabs should be structurally separated from the main structure to minimize the damage cause by heaving and swelling. If minor slab movement cannot be tolerated, structural slab would be required.

7.3 Underground Utilities

1. The near surface native inorganic clay encountered throughout the site is generally considered fair for the installation of underground utilities. Minor sloughing conditions should be expected for excavations within the sand due to the lack of cohesion. Excavation within the bedrock may experience some difficulty. Topsoil and all other organic materials should be separated from the inorganic soils, and should not be re-used as trench backfill.
2. The watertable readings were high in Testholes 2012-4 and 2012-5. However, no significant immediate groundwater seepage was encountered in any testhole. Trenching in high watertable areas will likely encounter minor water seepage. More recommendations on groundwater issues are provided in Section 7.5.
3. Open cut trenching techniques should be suitable for the testholes soils. Standard trenching cutback angles of approximately 45 degrees from the vertical are expected to be adequate for the near surface clay and clay till. Trenching in sand materials will require increased cutback angles of 45 degrees or more in order to remain stable.

   Since existing fractures and bentonite may be present, bedrock can be a weak material and prone to sliding. Trenches in bedrock material must be done cautiously and with careful and continuous monitoring for movement. More recommendations are provided in item 5.

   The optimum cutback angles for utility trenches should be determined in the field during construction. Exact stable slope values cannot be pinpointed without detailed and

extensive analysis. For this reason, this information should be used as a guideline only. Part 32 of the Occupational Health and Safety Regulation should be strictly followed, except were superseded by this report.

4. Temporary surcharge loads, such as spill piles, should not be allowed within 3.0 metres of an unsupported excavation face, while vehicles and machineries should be kept back at least 1.0 metre.

5. Bentonite is typically associated with bedrock soils and can be recognized by its peculiar color with typical colors being yellow, green, or brown. Although, it can be grey and match the bedrock. Bentonite can also be identified by its soapy texture. If bentonite is suspected present during underground construction, our firm should be contacted quickly to evaluate the situation and determine the need for any of the following extra trench slope measures. In the area of Testhole 2013-1 where bentonite was found, our firm should be contacted to inspect the site prior to letting workers entering the trench. Measures such as keeping spill piles at a minimum 10 metres away and a minimum cutback angle of 2H:1V may be required. Temporary retaining cages may also be required.

6. Our firm was involved with a base heaving issue in the deep sewer construction that occurred last year along 66 Street, adjacent to the subject subdivision. The installed sewer heaved 100 millimetres in one day during construction and this appeared to be associated with a thick bentonite layer below the pipe. The heaving was mitigated by rapid backfilling of a minimum 3 metres height with no testing and limited compaction. Our firm has not witnessed this heave phenomenon before in Northeast Edmonton sewer installation. All parties on the subject subdivision should be aware of it and be ready to take action where observed. Our firm should be contacted immediately to inspect the site if any thick bentonite or pipe heave is observed.

7. All excavation side slopes should be checked regularly for signs of sloughing, cracking, movements, or failures, especially after periods of rainfall. Remediation should be performed immediately wherever such signs are observed. Opening relatively long portions of utility trench over an extended period of time is not recommended.

8. Pipe bedding procedures should adhere to the City of Edmonton Design And Construction Specifications. The backfill material immediately beneath and above the pipe should be an approved bedding sand material where conditions allow. This material should be hand

placed and hand tamped, with care taken to fill the underside of the pipe. If groundwater seepage or saturated conditions are encountered in trenches, washed rock and geotextile separator are recommended for pipe bedding. The washed rock and geotextile configuration should be determined in the field during construction. The need for this configuration at the maximum trench depth of 10 metres is moderate for this site.

9. Trench backfill procedures should adhere to the City of Edmonton Design And Construction Specifications. All trench backfill to be placed above bedding material should be compacted in maximum 300 millimetre lifts. The minimum compaction requirements are 100 percent of the corresponding One Point Proctor Density for all fill within the top 1.5 metres beneath the top of subgrade, and 97 percent of the corresponding One Point Proctor Density for all fill more than 1.5 metres below the top of road subgrade. Uniform backfill is required by City of Edmonton Specifications for this project and is also recommended by JRP.

10. The following table compares the native moisture content of the materials encountered at the time of investigations, with different moisture content criteria for trench backfill at this site. It should be noted that moisture contents varied significantly within the site. More Atterberg Limit testing will be required at the time of construction to confirm these results.

Table 2: Trench Backfill Maximum Moisture Content Criteria

Testhole Number	Sample Depth m	Liquid Limit %	Plastic Limit %	Field Moisture Content %	Plasticity Index (PI) %	Maximum Moisture Content Criteria: Uniform Backfill		Conventional Backfill		PL+10 Criteria	
						PL+PI/2	+/- Criteria	PL+PI/3	+/- Criteria	PL+10	+/- Criteria
2012 - 1*	9.75	313.0	33.5	45.8	279.5	173.3	-127.5	126.7	-80.9	43.5	2.3
2012 - 2	1.52	63.7	20.6	34.2	43.1	42.2	-8.0	35.0	-0.8	30.6	3.6
2012 - 3	3.05	29.8	12.3	29.5	17.5	21.1	8.5	18.1	11.4	22.3	7.2
2012 - 4	4.57	57.7	23.9	27.7	33.8	40.8	-13.1	35.2	-7.5	33.9	-6.2
2012 - 5	0.61	48.7	15.9	24.3	32.8	32.3	-8.0	26.8	-2.5	25.9	-1.6
2012 - 6	0.61	45.1	14.5	22.7	30.6	29.8	-7.1	24.7	-2.0	24.5	-1.8
2012 - 7	2.13	37.5	13.9	16.5	23.6	25.7	-9.2	21.8	-5.3	23.9	-7.4
2012 - 8	3.05	26.2	14.0	14.5	12.2	20.1	-5.6	18.1	-3.6	24.0	-9.5

Notes:
- City specifications state that when the plasticity index criteria for maximum moisture content exceeds 10 percent over the plastic limit, the plastic limit plus 10 percent shall govern.
- All values of under the criteria are percentages.
* Bentonite should not be used as trench backfill regardless of moisture content
- Chart shows only the moisture content of samples tested for Atterberg Limits. See testhole logs for all moisture content data

The moisture contents of the near surface clay and clay till in the testholes were generally slightly above to over 15 percent above the plastic limit. Significant drying will be required in areas to meet the compaction requirements.

It is suggested that a maximum moisture content of 5.0 percent above the plastic limit be set for the top 1.5 metres of the trench, in order to improve conditions for the construction of surface utilities. Weather conditions should be considered during trench backfill operations.

11. Bentonite should also be completely removed if encountered. Bedrock materials should be separated from clay soils. Bedrock should only be placed at least 1.5 metres below the final grade in areas below existing or future surface utilities. Due to the variability of the soils at this site, trench backfill material should be carefully chosen in the field for placement at various trench depths.

12. It should be noted that the ultimate performance of the trench backfill is directly related to the consistency and uniformity of the backfill compaction, as well as the contractor's underground construction procedures. In order to achieve this uniformity, the lift thickness and compaction criteria should be strictly enforced. The quality of the trench backfill compaction affects the subgrade and pavement design.

7.4 Surface Utilities

1. The subsurface inorganic soil conditions encountered throughout this site are considered generally fair to satisfactory for the construction of roads, curbs, and sidewalks. The near surface upper clay encountered was medium to high plastic and exhibited moderate to high swelling and shrinkage potential. Topsoil and all other deleterious materials, should be removed prior to construction of roads, sidewalks and other surface utilities.

2. Where fill is to be placed, the fill material below the upper 150 millimetres should be compacted to 98 percent of Standard Proctor Density. All fill should be placed in maximum lift thickness of 150 millimetres. Any high plastic clay should be compacted at 1 to 3 percent over optimum moisture content, to help control future swelling. Poorly compacted fill will produce a soft subgrade, and a larger pavement structure will be required as a result.

3. Cement stabilization is the recommended subgrade preparation which is also effective in reducing the swelling potential to high plastic clays and bedrocks encountered on site. The minimum subgrade preparation of 10 kilogram of cement per square metre of road subgrade mixed to 150 millimetres depth and recompacted to a minimum 100 percent of SPD at optimum moisture content should be expected. In any road areas where bedrock was encountered in the underground utility trenches, a minimum 20 kilogram of cement per square metre of road subgrade mixed to 300 millimetres depth is recommended for swelling control purposes.

   The subgrade should be proof rolled prior to stabilization to determine the exact cement content needed. If very soft native soil or improperly compacted utility backfill is present, increased cement stabilization (25 to 30 kilograms per square metre of subgrade to 300 millimetres in depth) may be applicable. Replacement of the very soft soil with drier clay material to obtain a more stable and stronger subgrade would also be an option.

   The subgrade should be proof rolled after final compaction and any areas showing visible deflections should be inspected and repaired. If cement stabilization fails to produce an adequate subgrade, upgraded pavement structures with an additional gravel base may be required.

4. It is recommended that all areas beyond the back of curb/sidewalk be landscaped as soon as possible to avoid water permeating into the subgrade from free standing puddles. The near surface soils encountered throughout this area exhibit a high swelling potential. It is important that subgrade soils not be allowed to dry excessively when exposed, and moisture contents are kept slightly over optimum. Weather conditions should be considered during construction.

5. The following staged pavement designs are recommended for this site. An estimated California Bearing Ratio (CBR) of 3.0 percent is used in the design, as well as a design life of 20 years.

Table 3: Recommended Staged Roadway Structures				
	Traffic Loading	Local ($3.6x10^4$ ESALs)	Minor Collector ($1.8x10^5$ ESALs)	Major Collector ($3.6x10^5$ ESALs)
Stage 1	Asphaltic Concrete	65 mm ACR	75 mm ACR	75 mm ACO
	Crushed Gravel (3-20)	200 mm	250 mm	325 mm
Stage 2	Asphaltic Concrete	35 mm ACR	35 mm ACR	35 mm ACO
Note:	ACR = City of Edmonton Asphaltic Concrete Residential or equivalent ACO = City of Edmonton Asphaltic Concrete Overlay or equivalent All granular base material should be compacted to 100 percent of the Standard Proctor Density in maximum 150 mm lifts.			

The stated Equivalent Single Axle Load (ESAL) values for different roadway designations were obtained from City of Edmonton guidelines. Our firm should be advised if traffic loading information becomes available and the pavement design should be modified accordingly.

6. Surface water will often collect within the granular base, causing subgrade softening and pavement damage. Therefore, it is recommended that wic drains be installed in the gravel road base at the curb bottom locations. The wic drains must be properly attached to the catch basins. All subgrade, granular base and pavement surface should be constructed with proper crossfalls at minimum of 2.0 percent grade towards the gutter.

7.5 Groundwater and Drainage Issues

1. Upon removal of the existing fill, the groundwater levels at Testholes 2012-3 and 2012-4 will be within 1.2 metres from the surface and may be a concern for house, underground utility, and road construction. Design lot grading should be kept high to avoid basements from intercepting the watertable.

   The maximum trench depth of 10 metres is also below the pond bottom level. Although no immediate groundwater seepage was noted any testhole, excavation below the watertable may experience minor groundwater seepage. Sumps and in trench pumping should be able to handle the water seepage.

2. Foundation drain services are recommended for all lots in this subdivision. At a minimum, peripheral exterior weeping tile lines will be required for all houses. All lines should be placed at or slightly below footing elevation and connected to ensure positive drainage to an

approved system. The weeping tile lines will require a filter sock with a suitable clean tile rock drainage filter, with a minimum of 150 millimetres of rock around the line, all encompassed with a non-woven geotextile for separation.

Where house basements and footing foundations are near the watertable, upgraded foundation drain services to include a washed rock slab base, as well as interior and exterior weeping tile would be required. A schematic drawing depicting the recommended drainage measures is attached. Frequent pump operations should also be expected. The need for upgraded foundation drain services should be determined on a lot by lot basis.

3. Water dispersed on the property from the roof leaders should not be allowed to accumulate against the foundation walls. To ensure positive drainage, the soil surface of all lots should be made sloping away from all buildings. This will require a positive lot grading of at least five percent away from the foundation walls for a minimum of 1.5 metres. In cases where the lot drainage runs from the back of the lot to the front, runoff should be kept 1.2 metres away from the house.
4. In order to ensure no flow paths for water from the roof leaders occur adjacent to the foundation walls, the following two alternatives are proposed:
   a. A concrete splash pad, placed beneath the downspouts, a minimum of 1.2 metres long and firmly anchored to the house foundation can be used.
   b. A permanent downspout extension could be used to carry water away from the foundation wall.
5. Clay is the preferred backfill material around the basement walls. This serves to reduce water penetration into the backfill, and subsequently into the weeping tile system. The near surface clay and clay till encountered throughout the site are suitable for this purpose.

7.6 Strom Water Management Facility (SWMF)

1. It is understood the recently drained and regraded pond occupying most of the site will be a SWMF. The pond is designed and constructed by others and is beyond the scope of this report.

7.7 Cement

Tests on selected soil samples indicated negligible to severe concentrations of water soluble soil sulphates in the near surface clay deposits. The following comments are provided on soluble soil sulphate levels on site.

1. Underground Concrete Pipe

   Concrete used for all underground pipes must be constructed of C.S.A. Type HS, sulphate resistant hydraulic cement.

2. Curbs and Sidewalks

   All concrete for surface improvements such as sidewalks and curbs may be constructed using CSA Type GU, General Use Portland cement.

3. Foundation Construction

   All concrete used for project construction and coming into direct contact with the soil should be constructed with CSA Type HS Sulphate Resistant Hydraulic Cement. Based on CSA Standards A23.1-09, class exposure S-2 should be applied to the design requirements, with a minimum 56 day concrete strength of 30 MPa, as well as other requirements as given in the noted CSA guideline. However, individual locations may show higher or lower concentrations of soluble soil sulphate, and thus additional soil testing on particular lots may prove valuable.

   All concrete subject to freeze thaw must be air entrained with 5 to 7 percent air. Other exposure conditions and structural requirements should be considered when choosing a minimum strength for the concrete. Concrete should conform to CSA Standards A23.1-09 and A23.2-09.

8.0 CLOSURE

This report has been prepared for the exclusive and confidential use of City of Edmonton, Stantec Consulting Ltd., and their authorized agents. Use of this report is limited to the subject proposed residential subdivision only. The recommendations given are based on the subsurface soil conditions encountered during testhole drilling, current construction techniques and generally accepted engineering practices. No other warranty, expressed or implied, is made. Due to geological randomness of many soils formations, no interpolation of soil conditions between or

away from the testholes has been made or implied. Soil conditions are known only at the testhole location. Should other soils be encountered during construction or other information pertinent becomes available, the undersigned should be contacted as the recommendations may be altered or modified.

We trust this information is satisfactory. If you should have any questions, please contact our office.

Respectfully Submitted,

HOGGAN ENGINEERING & TESTING (1980) LTD.

PROFESSIONAL ENGINEER
JOHN TSOI
ALBERTA

February 8, 2013.

John Tsoi, P. Eng.

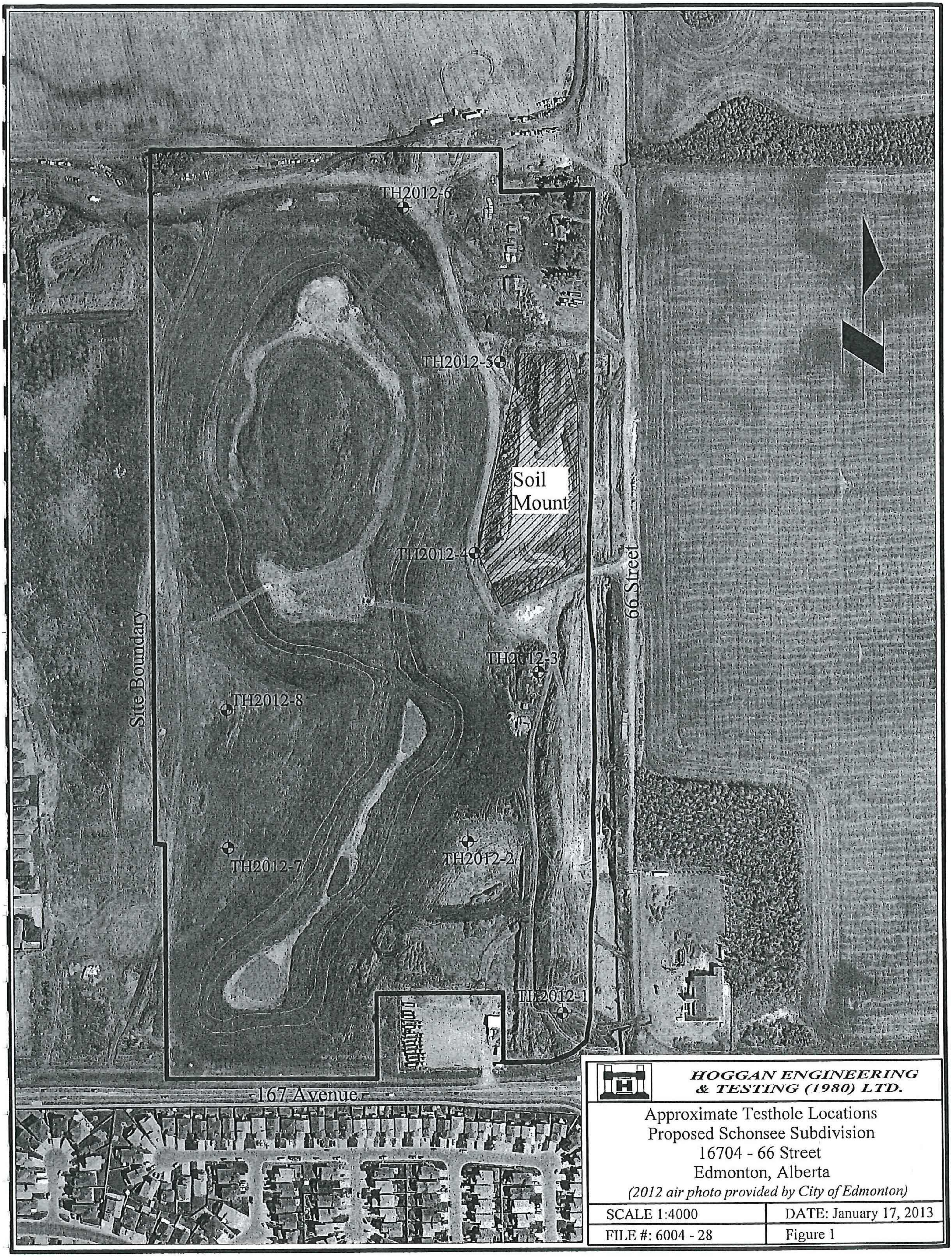
PERMIT TO PRACTICE
HOGGAN ENGINEERING & TESTING (1980) LTD.
Signature
Date Feb. 8, 2013
PERMIT NUMBER: P 3691
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Reviewed by: Rick Evans, P. Eng.

Manager, Geotechnical Engineering

H:\DATA 2013\6004 Stantec\6004-28(Curr) 16704-66 Street\hr1003sta.docx

APPENDIX



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Approximate Testhole Locations
Proposed Schonsee Subdivision
16704 - 66 Street
Edmonton, Alberta

(2012 air photo provided by City of Edmonton)

SCALE 1:4000	DATE: January 17, 2013
FILE #: 6004 - 28	Figure 1

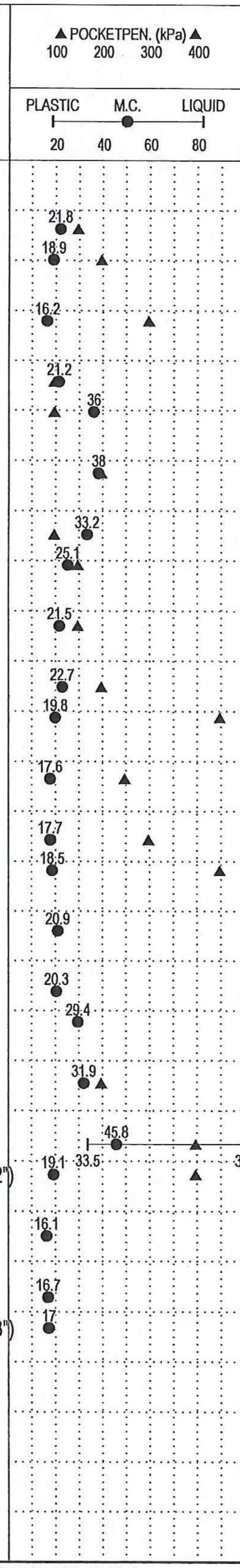
PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision		PROJECT NO: 6004-28	BOREHOLE NO: **2012-1**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger		ELEVATION: 685.36 m
OWNER:	LOCATION: As per site plan		

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

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

Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	OTHER DATA
0 – 100 mm	OR	**TOPSOIL/ORGANIC CLAY**: silty, moist, black, trace roots, frozen		
100 mm – 800 mm	FILL	**CLAY FILL**: silty, sandy, moist, high plastic, grey, traces of organics at transition, frozen to 0.6 metres	5	
800 mm – 2.7 m	CH	**CLAY**: silty, moist, stiff to very stiff, high plastic, traces of oxides, light brown		**Shelby Tube:** QU: 94.4 kPa; DD: 1414 Kg/m^3; MC: 36.0 %
2.7 m – 4.6 m	CI-CH	**CLAY**: silty, very moist, firm, medium to high plastic, traces of oxides, bedrock like	6	at 3.8m: trace free water
4.6 m – 6.4 m	CI	**CLAY TILL**: silty, sandy, moist, stiff to very stiff, medium plastic, brown/grey, trace coal, oxides, gravel	19	
6.4 m – 11.9 m	BR / BE / BR	**BEDROCK**: clay shale, damp, hard, high plastic, friable on augers, weathered At 7.4 metres: trace of free water on augers. At 7.9 metres: dark brown. Between 9.3 and 9.9 metres: bentonite seam, very high plastic	29 29 42-50 (2") 14-50 (3")	P.L. = 33.5 L.L. = 313.0 M.C. = 45.8 **Soluble Sulphates:** Moderate

END OF TESTHOLE @ 11.9 m. No water and no slough on completion of testhole. Slotted standpipe installed to 11.48 m.
24 day waterlevel reading: 6.91 m bgs.
48 day waterlevel reading: 6.45 m bgs.



Water levels: 6.45 (depth), 678.91 (elevation)

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Phone: (780) 489-0700
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LOGGED BY: O Sleiman	COMPLETION DEPTH: 11.89 m
REVIEWED BY: R Evans	COMPLETION DATE: 12/4/12

PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision	PROJECT NO: 6004-28	BOREHOLE NO: **2012-2**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger	ELEVATION: 683.71 m
OWNER:	LOCATION: As per site plan	

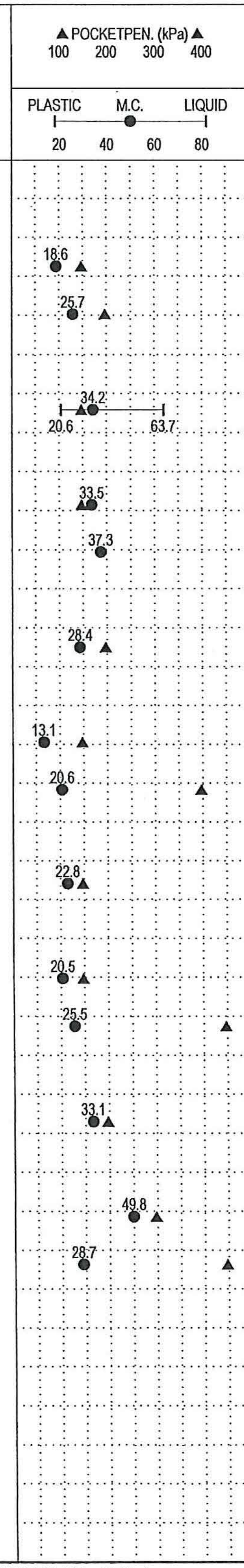
SAMPLE TYPE: SHELBY TUBE | CORE SAMPLE | SPT SAMPLE | GRAB SAMPLE | NO RECOVERY

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

Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	OTHER DATA
0	FILL	**CLAY FILL :** silty to very silty, sandy, moist to very moist, stiff, grey, trace to moderate organic content — 1.1 m	4	
1.1	CH	**CLAY :** silty, very moist,stiff, high plastic, brown/grey, trace oxides		P.L. = 20.6 L.L. = 63.7 M.C. = 34.2 **Soluble Sulphates:** Severe
				Shelby Tube Sample too small for Qu.
3		Below 3.0 metres: some bedrock features in seams — 3.8 m		
3.8	BR	**BEDROCK :** sandstone, grey, silty, clayey, medium plastic, very stiff, friable on augers, trace free water on augers — 4.6 m	27	
4.6	CI	**CLAY TILL :** silty sandy, moist to very moist, stiff to very stiff, medium plastic, trace coal, oxides, gravel At 5.2 metres: sand seam, moist, trace of water, bedrock features — 6.4 m	38	
6.4	BR	**BEDROCK :** clay shale, stiff, high plastic, dark brown, highly weathered, friable in seams Below 6.7 metres: bentonitic in seams, moist, stiff, very high plastic, grey, traces of water — 6.9 m		
6.9		**BENTONITE :** moist, hard, grey, very high plastic, brown in seams	14	
7.3		**END OF TESTHOLE @ 7.3 m.** No water and no slough on completion of testhole. Slotted standpipe installed to 7.19 m. 24 day waterlevel reading: 5.32 m bgs. 48 day waterlevel reading: 3.76 m bgs.		

Water level: 3.76 (depth) / 679.95 (elevation)

Elevation (m): 683, 682, 681, 680, 679, 678, 677, 676, 675



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Phone: (780) 489-0700
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LOGGED BY: O Sleiman	COMPLETION DEPTH: 7.32 m
REVIEWED BY: R Evans	COMPLETION DATE: 12/4/12

PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision		PROJECT NO: 6004-28	BOREHOLE NO: **2012-3**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger		ELEVATION: 683.87 m
OWNER:	LOCATION: As per site plan		

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

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

Depth (m)	SOIL SYMBOL	USC	SOIL DESCRIPTION	SAMPLE TYPE	SPT (N)	▲POCKETPEN. (kPa)▲ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		FILL	**CLAY FILL :** silty to silty, sandy, some organics, very stiff, medium plastic, brown						
			At 0.6 metres: very stiff, considerable organics			20.9			683
1					10	28			
						25			682
2		CH	2.1 m **CLAY :** silty, moist, very stiff, high plastic, brown			27.6	Insufficient Shelby tube sample		
3		CL-CI	Below 3.0 metres; very moist, soft, medium plastic			29.5 (12.3 29.8)	P.L. = 12.3 L.L. = 29.8 M.C. = 29.5 **Soluble Sulphates:** Negligible	680.51	681
3.36		BR	3.4 m **BEDROCK :** clay shale, silty, damp, high plastic, grey and brown, bentonitic, weathered			44			680
4					14	26.8			
						24.8			679
5			At 5.2 metres: trace water on augers			24.6			
					20	25.3			678
6						21.6			
						22.7			677
7					26	22.8			
8			**END OF TESTHOLE @ 7.3 m.** No water and 0.7 m of slough on completion of testhole. Slotted standpipe installed to 6.58 m. 24 day waterlevel reading: 5.5 m bgs. 48 day waterlevel reading: 3.36 m bgs.						676
9									675

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LOGGED BY: O Sleiman	COMPLETION DEPTH: 7.32 m
REVIEWED BY: R Evans	COMPLETION DATE: 12/4/12

PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision	PROJECT NO: 6004-28	BOREHOLE NO: **2012-4**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger	ELEVATION: 683.42 m
OWNER:	LOCATION: As per site plan	

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

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

Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	OTHER DATA
0 – 2.1 m	FILL	**CLAY FILL :** silty, considerable organics, moist, friable, medium plastic, brown/black	13	
2.1 – 2.7 m	CI-CH	**CLAY :** silty, sandy, moist, stiff, brown/grey, medium to high plastic, traces of oxides		Shelby Tube: QU: 101.1 kPa; DD: 1655 Kg/m^3; MC: 28.5 %
2.7 – 3.4 m	CI	**CLAY :** silty, sandy, very moist, firm, medium plastic, trace coal, oxides, till like		
3.4 – 6.1 m	CI-CH	**MIXTURE CLAY TILL & BEDROCK :** clay shale, silty;clay till, sandy, silty; Both moist, medium to high plastic, brown At 5.2 m: trace water	17 28	P.L. = 23.9 L.L. = 57.7 M.C. = 27.7 **Soluble Sulphates:** Negligible
6.1 – 6.9 m	BR	**SANDSTONE :** friable, limited recovery		
6.9 – 7.3 m	BR	**SHALE :** grey, moist, medium to high plastic, hard, trace of water on SPT	33	

END OF TESTHOLE @ 7.3 m. No water and no slough on completion of testhole. Slotted standpipe installed to 6.78 m.
24 day waterlevel reading: 3.49 m bgs.
48 day waterlevel reading: 2.96 m bgs.

Water level: 2.96 m depth (Elev. 680.46 m)

POCKETPEN. (kPa): 100 200 300 400 — PLASTIC / M.C. / LIQUID: 20 40 60 80

Moisture contents (top to bottom): 19.2, 19.9, 23, 25.1, 28.5, 20.4, 30.8, 28.4, 27.7 (23.9 – 57.7), 27.8, 23.6, 16.7, 16.1, 20.4

Elevation (m): 683, 682, 681, 680, 679, 678, 677, 676, 675

SLOTTED PIEZOMETER

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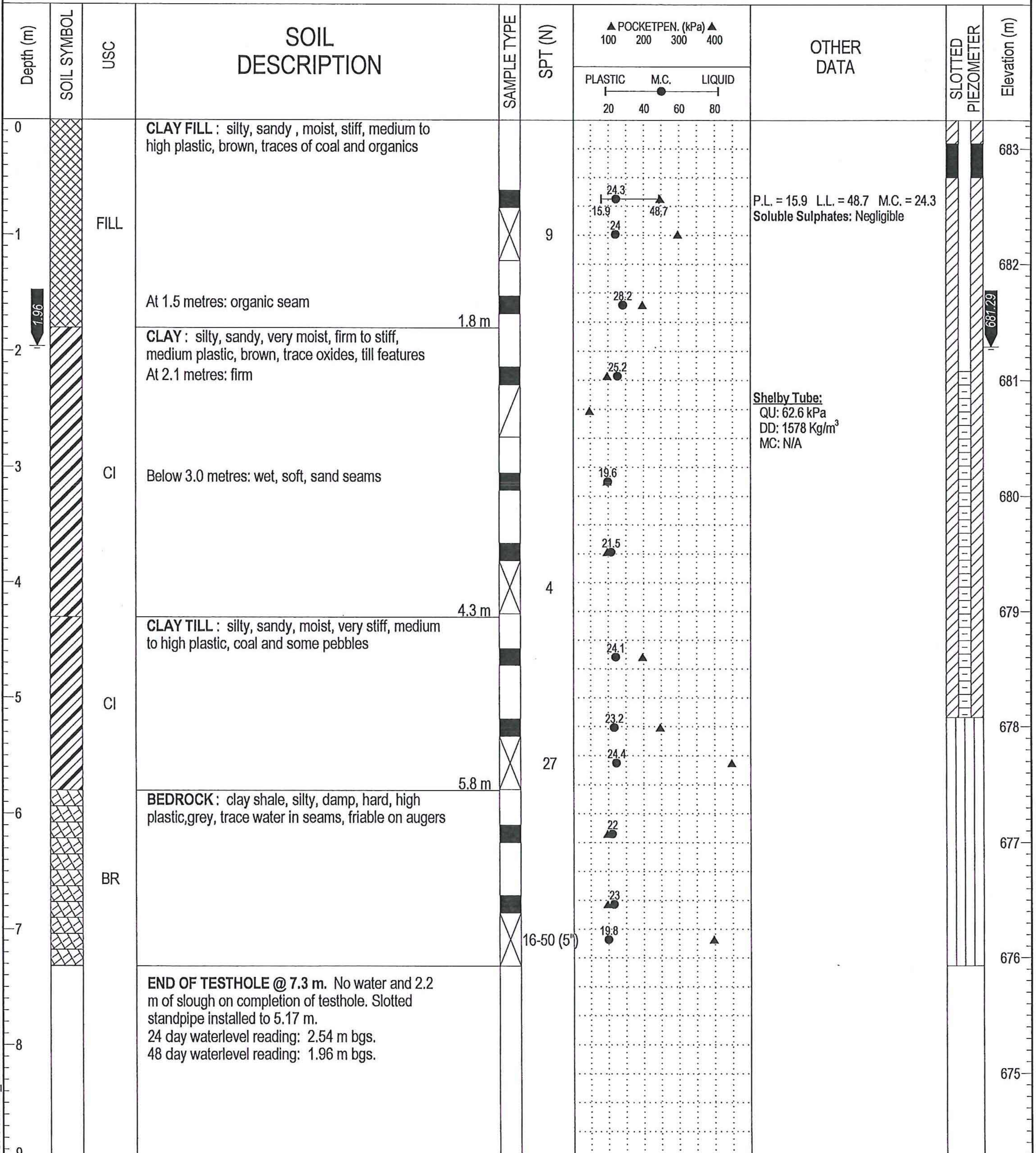
	REVIEWED BY: R Evans	COMPLETION DATE: 12/4/12

PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision	PROJECT NO: 6004-28	BOREHOLE NO: **2012-5**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger	ELEVATION: 683.25 m
OWNER:	LOCATION: As per site plan	

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

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



Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	OTHER DATA
0 – 1.8 m	FILL	**CLAY FILL :** silty, sandy , moist, stiff, medium to high plastic, brown, traces of coal and organics At 1.5 metres: organic seam	9	P.L. = 15.9 L.L. = 48.7 M.C. = 24.3 Soluble Sulphates: Negligible
1.8 – 4.3 m	CI	**CLAY :** silty, sandy, very moist, firm to stiff, medium plastic, brown, trace oxides, till features At 2.1 metres: firm Below 3.0 metres: wet, soft, sand seams	4	Shelby Tube: QU: 62.6 kPa DD: 1578 Kg/m^3 MC: N/A
4.3 – 5.8 m	CI	**CLAY TILL :** silty, sandy, moist, very stiff, medium to high plastic, coal and some pebbles	27	
5.8 – 7.3 m	BR	**BEDROCK :** clay shale, silty, damp, hard, high plastic,grey, trace water in seams, friable on augers	16-50 (5")	

Moisture contents (M.C., %) plotted: 24.3 (P.L. 15.9, L.L. 48.7), 24, 28.2, 25.2, 19.6, 21.5, 24.1, 23.2, 24.4, 22, 23, 19.8

END OF TESTHOLE @ 7.3 m. No water and 2.2 m of slough on completion of testhole. Slotted standpipe installed to 5.17 m.
24 day waterlevel reading: 2.54 m bgs.
48 day waterlevel reading: 1.96 m bgs.

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Phone: (780) 489-0700
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LOGGED BY: O Sleiman	COMPLETION DEPTH: 7.32 m
REVIEWED BY: R Evans	COMPLETION DATE: 12/4/12

PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision	PROJECT NO: 6004-28	BOREHOLE NO: **2012-6**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger	ELEVATION: 683 m
OWNER:	LOCATION: As per site plan	

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

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

Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	OTHER DATA
0 – 600 mm	FILL	**CLAY FILL** : Moderate organic, moist, silty, sandy, medium plastic, brown		
600 mm – 1.2 m	CI	**CLAY** : silty, high plastic, very moist, stiff, brown	13	P.L. = 14.5 L.L. = 45.1 M.C. = 22.7 **Soluble Sulphates:** Moderate
1.2 m – 1.8 m	SM	**SAND** : Silty, moist, medium to fine grained, brown		
1.8 m – 3.4 m	CI-CH	**CLAY** : silty, very moist, medium plastic, firm to stiff, mixture, traces of oxides and coal, till-like		Shelby Tube Sample too small for Qu.
3.4 m – 5.3 m	CH	**CLAY TILL** : mixed with clay shale, very moist, stiff, high plastic, brown and grey	19	
5.3 m – 7.3 m	BR	**BEDROCK** : clay shale, moist, very stiff to hard, high plastic, grey	12 19-50 (5")	

END OF TESTHOLE @ 7.3 m. No water and 1.1 m of slough on completion of testhole. Slotted standpipe installed to 6.23 m.
24 day waterlevel reading: Dry to 6.23 m bgs.
48 day waterlevel reading: 5.06 m bgs.

POCKETPEN. (kPa) ▲ 100 200 300 400; PLASTIC – M.C. – LIQUID 20 40 60 80

M.C. values (top to bottom): 22.7 (14.5 – 45.1), 24.9, 12.9, 23.8, 21.1, 21.1, 27.1, 23, 21.4, 27.5, 25.8, 22.5, 19.8, 18.8

Water level: 5.06 m depth / 677.94 m elevation

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		REVIEWED BY: R Evans	COMPLETION DATE: 12/4/12

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PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision		PROJECT NO: 6004-28	BOREHOLE NO: **2012-7**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger		ELEVATION: 683.54 m
OWNER:	LOCATION: As per site plan		

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

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

Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	M.C. (%)	OTHER DATA
0 – 300 mm	FILL	**CLAY FILL** : high organics, silty, moist, very stiff, medium plastic, brown and black			
300 mm – 900 mm	CH	**CLAY** : silty, moist, very stiff, high plastic		19	
900 mm – 2.7 m	CI	**CLAY** : silty, medium plastic, stiff to hard, moist, till-like, coal pieces, oxides, brown	15	25.4, 24.3, 16.5, 17.7	P.L. = 13.9 L.L. = 37.5 M.C. = 16.5; Soluble Sulphates: Moderate; Insufficient Shelby tube sample
2.7 m – 4.6 m	CI	**CLAY TILL** : silty, sandy, medium plastic, stiff to very stiff, brown, sand seams, bedrock mixed in	24	12.4, 14.3, 17	
4.6 m – 6.1 m	BR	**BEDROCK** : Clay shale, moist, hard, high plastic, friable, grey and brown	52	20.7, 20.3, 19	
6.1 m – 7.3 m	BR	**BEDROCK** : Sandstone, clayey, hard, slightly moist	79	18.1, 13.8, 15.6	

Pocket pen. (kPa): 100 200 300 400; Plastic – M.C. – Liquid: 20 40 60 80

END OF TESTHOLE @ 7.3 m. No water and no slough on completion of testhole. Slotted standpipe installed to 7.12 m.
23 day waterlevel reading: Dry to 7.12 m bgs.
47 day waterlevel reading: Dry to 7.12 m bgs.

Elevation (m): 683, 682, 681, 680, 679, 678, 677, 676, 675

SLOTTED PIEZOMETER

JRP 6004-28.GPJ JRPV2_6.GDT 7/2/13

HOGGAN ENGINEERING & TESTING (1980) LTD. 17505 - 106 Avenue Edmonton, AB T5S 1E7 Phone: (780) 489-0700 Fax: (780) 489-0800	LOGGED BY: O Sleiman	COMPLETION DEPTH: 7.32 m
	REVIEWED BY: R Evans	COMPLETION DATE: 12/5/12

PROJECT: Geotechnical Investigation - Proposed East Schonsee Subdivision		PROJECT NO: 6004-28	BOREHOLE NO: **2012-8**
CLIENT: Stantec Consulting Ltd	DRILL METHOD: Solid Stem Auger		ELEVATION: 683.43 m
OWNER:	LOCATION: As per site plan		

SAMPLE TYPE	SHELBY TUBE	CORE SAMPLE	SPT SAMPLE	GRAB SAMPLE	NO RECOVERY	
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	GROUT	DRILL CUTTINGS	SAND

Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	OTHER DATA
0 – 500 mm	FILL	**CLAY FILL :** silty, moist, frozen		
500 mm – 2.0 m	CH	**CLAY :** silty, stiff to very stiff, high plastic, moist, brown	12	
2.0 m – 4.3 m	CI	**CLAY :** silty, stiff, moist, low to medium plastic, brown, till-like, sand seams	25	**Shelby Tube:** QU: 185.9 kPa DD: 1850 Kg/m^3 MC: 16.7 % P.L. = 14.0 L.L. = 26.2 M.C. = 14.5 **Soluble Sulphates:** Negligible
4.3 m – 7.3 m	BR	**BEDROCK :** Clay shale, very stiff to hard, moist, high plastic, grey, weathered, some sandstone layers	29, 41	

END OF TESTHOLE @ 7.3 m. No water and 0.9 m of slough on completion of testhole. Slotted standpipe installed to 6.41 m.
23 day waterlevel reading: Dry to 6.41 m bgs.
47 day waterlevel reading: 6.36 m bgs.

▲ POCKETPEN. (kPa) ▲ 100 200 300 400
PLASTIC M.C. LIQUID 20 40 60 80

Moisture contents (top to bottom): 16.3, 30, 28.9, 17.5, 16.7, 14.5 (14 : 26.2), 11.6, 22.5, 20, 18.2, 20.3, 21.6, 18.6, 20.8

SLOTTED PIEZOMETER — Elevation (m): 683, 682, 681, 680, 679, 678, 677, 676, 675
Water level: 6.36 (677.07)

HOGGAN ENGINEERING & TESTING (1980) LTD.
17505 - 106 Avenue
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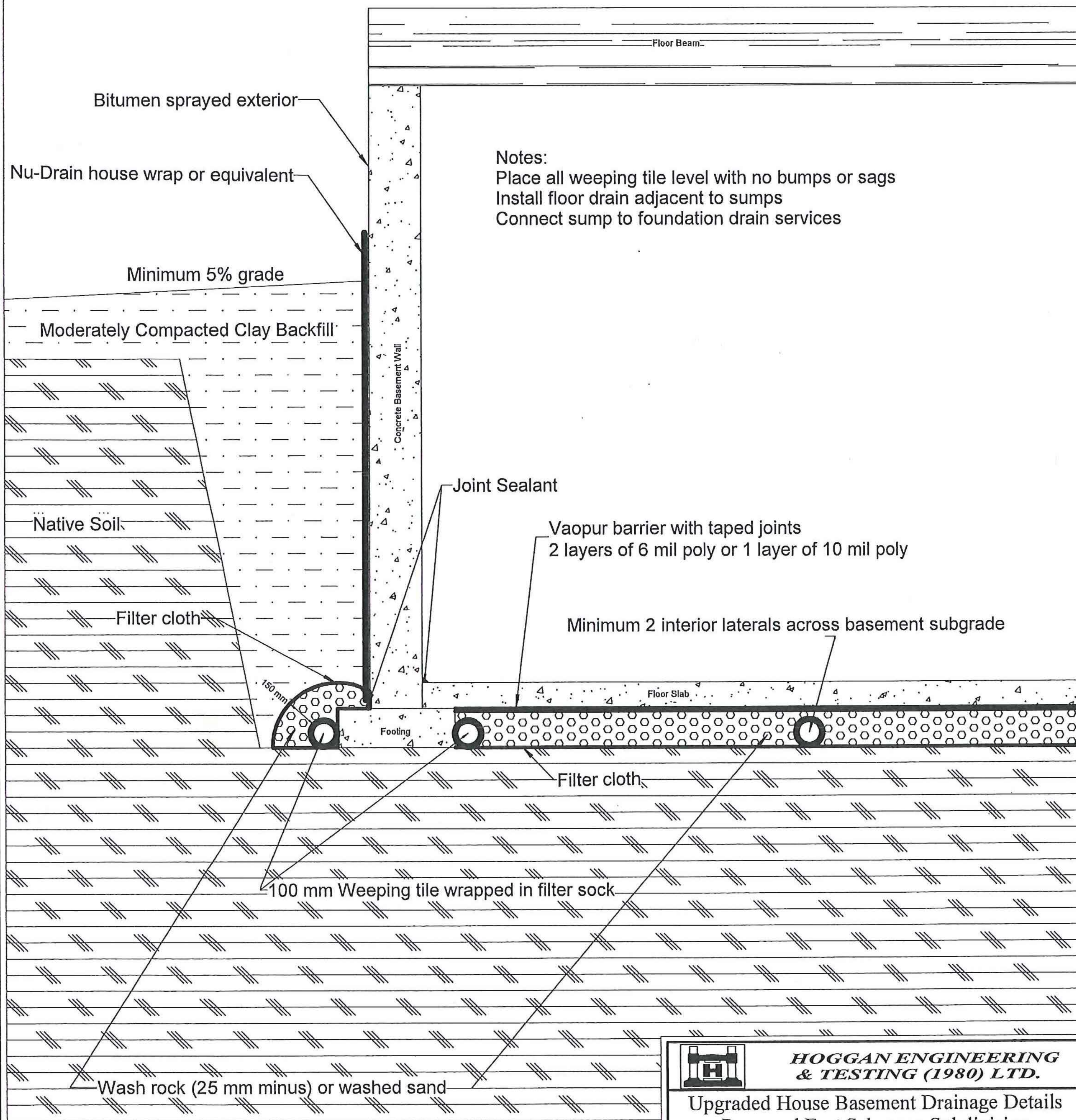
Fax: (780) 489-0800

LOGGED BY: O Sleiman	COMPLETION DEPTH: 7.32 m
REVIEWED BY: R Evans	COMPLETION DATE: 12/5/12



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Upgraded House Basement Drainage Details
Proposed East Schonsee Subdivision
Block C, Plan 2887AQ
16704 - 66 Street NW
Edmonton, Alberta

NOT TO SCALE	DATE:
FILE #: 6004 - 28	Figure 2