Appendix "E"

GEOTECHNICAL INFORMATION

(1) "**PROPOSED ESGENOÔPETITJ FIRST NATION PROPOSED WWTF SITE"**
(April 06, 2014)
(2) "SUPPLEMENTARY GEOTECHNICAL INVESTIGATION - NEW WWTF - ESGENOÔPETITJ FIRST NATION"
(January 23, 2015)
(3) "GEOTECHNICAL INVESTIGATION FOR A NEW TREATED WASTEWATER OUTFALL, ESGENOÔPETITJ FIRST NATION"
(to follow)

From: CONQUEST ENGINEERING LTD.

REPORT TO

Crandall Engineering Ltd.
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ON

GEOTECHNICAL INVESTIGATION NEW WASTEWATER TREATMENT FACILITY ESGENOÔPETITJ FIRST NATION BURNT CHURCH, NB

Prepared by:

CONQUEST ENGINEERING LTD.

Conquest Engineering Ltd. Project No.: 315-002
Crandall Engineering Ltd. Project No.: 12145

April 6, 2014

TABLE OF CONTENTS

Section **Page No.**

1.0 INTRODUCTION 1

2.0 SITE DESCRIPTION 1

3.0 FIELD PROCEDURES 1

4.0 SOIL PROFILE 2

4.1 TOPSOIL / PEAT 2
4.2 FILL...2
4.3 SANDY LEAN CLAY WITH TRACE OF GRAVEL..2
4.4 SILTY SAND...2
4.5 SILTY SAND WITH GRAVEL 3
4.6 INFERRED BEDROCK 3

5.0 GROUNDWATER MONITORING 3

6.0 DISCUSSION AND RECOMMENDATIONS...3

6.1 SITE PREPARATION 4
6.2 EMBANKMENT CONSTRUCTION 5
6.3 SYNTHETIC LINER CONSTRUCTION...6
6.4 LIFT STATIONS (WET WELLS) 6
6.4.1 Lift Station at BH-08...6
6.4.2 Lift Station at BH-10...7
6.4.3 General Recommendations 7
6.5 PIPE WORK 8

7.0 CLOSURE 9

List of Tables

Table 1: Pit Run Gravel – Gradation Limits 5

Table 2: Bedding Material – Gradation Limits 8

Table 3: Drainage Stone Bedding Material – Gradation Limits 8

List of Appendices

APPENDIX A SYMBOLS AND TERMS USED ON BOREHOLES AND TEST PIT RECORDS
APPENDIX B BOREHOLE RECORDS
APPENDIX C LABORATORY TESTING
APPENDIX D FIGURE 1 – BOREHOLE LOCATION PLAN

1.0 INTRODUCTION

At the request of Crandall Engineering Ltd., Conquest Engineering Ltd. (CEL) has undertaken a soils investigation for the proposed new wastewater treatment facility, consisting of aeration lagoons, new sewer systems and associated lift stations in Burnt Church, New Brunswick.

The purpose of the investigation was to determine the soil and groundwater conditions within the area of the proposed facility. This report has been prepared specifically and solely for the project described above. It contains all of our findings, and includes specific geotechnical recommendations for the design and construction of the proposed new structures (aeration lagoons, sewer systems and lift stations).

2.0 SITE DESCRIPTION

The site of the proposed facility is located off the Micmac Road in the Northumberland County, New Brunswick. Based on Crandall Engineering Ltd. 12145-1P-C106, "New Proposed WWTP", dated March 10, 2014 sent to us via email on March 12, 2014, the footprint of the proposed facility is approximately 230 m long by 170 m wide. The site parcel is bound by residential properties off Route No.11 to the north, undeveloped treed/marsh areas to the west, Burnt Church River to the south, and Micmac Road to the east.

The site of the aeration ponds is predominantly tree/vegetation covered. The site topography is sloping towards the south-east.

3.0 FIELD PROCEDURES

The field investigation was carried out on February 25 and February 26, 2014. Sixteen (16) boreholes were drilled with a track-mounted drill rig provided by Lantech Drilling Services to depths ranging between 3.9 m and 7.5 m below the existing ground surface.

CEL personnel laid out the borehole locations in the field by means of a handheld GPS unit and in general accordance with the Proposed Geotechnical Borehole Location provided by Crandall Engineering Ltd. (Drawing No.: 12145-1P-C200 dated Jan. 17, 2014). Boreholes were also laid out to avoid conflicts with existing underground/overhead services and infrastructure. The borehole locations are shown on the appended Borehole Location Plan – Figure 1 (Appendix D).

During the field work a CEL engineer supervised the drilling and sample collection activities and logged the subsurface conditions encountered at each borehole. The boreholes were advanced using 100mm diameter solid stem augers. The soils were frequently sampled using a 50mm outside diameter (OD) split spoon sampler and Standard Penetration Test (N-values) procedures. Soil samples recovered were placed in moisture tight containers and returned to our laboratory for classification and testing as required. All remaining samples will be kept in storage at our office for a period of three (3) months from the date of issue of this report. After this time the samples will be discarded unless we are instructed otherwise.

A 50mm OD PVC monitoring well was installed in boreholes BH-03 and BH-13 to permit the subsequent monitoring of groundwater conditions. Following completion of the drilling, our personnel returned to the site to monitor groundwater levels in the installed monitoring wells.

At the point of practical refusal to further penetration of the split spoon, bedrock was inferred. Proven bedrock by diamond coring techniques was not included in this scope of work.

4.0 SOIL PROFILE

The principal soil strata encountered at the site are described in detail in the following paragraphs and on the appended Borehole Records (Appendix B). Soil classification was based on the procedures described in ASTM D2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and some laboratory testing (Appendix C). For an explanation of the descriptions used on the Borehole Records, reference should be made to the appended Symbols and Terms used on Borehole and Test Pit Records (Appendix A).

4.1 TOPSOIL / PEAT

TOPSOIL/PEAT was found in BH-06, BH-08 and BH-11 to BH-16 and was generally found to be a black to reddish brown organic layer with varying sand/silt content. The thickness of this layer was found to range between 0.3 m and 0.9 m.

4.2 FILL

A layer of loose reddish brown to light brown sand with silt and gravel FILL was encountered in BH-01 through BH-10 with the exception of BH-08. The FILL material was encountered along the Micmac Road alignment and extended to depths ranging from 0.9 m and 1.2 m below the existing ground surface. Please note that Standard Penetration tests (SPT) carried out are not representative due to the presence of frost within the FILL layer.

A grain size analysis was performed on an auger sample from Borehole BH-02, which is considered to be generally representative of the FILL layer. The results indicate 29.5% gravel, 49.3% sand, and 21.2% silt/clay. The natural moisture content of the sample was 7%.

4.3 SANDY LEAN CLAY WITH TRACE OF GRAVEL

The predominant stratum encountered at the site, with the exception of boreholes BH-07, BH-08 and BH-09, was a grey to reddish brown sandy lean CLAY with trace of gravel and occasional sand seams. Standard Penetration tests (SPT) carried out gave N-values which varied from 2 to 48 indicating a consistency in the range of very soft to hard. The thickness of this layer was found to range between 2.4 m and >6.0 m.

Laboratory testing was carried out on samples taken from several boreholes. Moisture content test results indicated the natural water content of the layer to range between 12% and 26%. The results of three Atterberg limits gave liquid limits ranging from 25 and 30 and plastic limits ranging between 14 and 17 giving a plasticity of index ranging from 9 and 13. Grain size analyses were performed on several samples indicate 0 – 9.1% gravel, 17.7 – 42.6% sand, and 51.0 – 78.4% silt/clay.

4.4 SILTY SAND

A layer of silty SAND was encountered underneath the FILL layer in boreholes BH-03, BH-05, BH-06 BH-07 and BH-08. SPT carried out gave N-values from 3 to 27 indicating the relative density was in the loose to compact range. The thickness of this layer was found to range between 1.2 m and >5.1 m.

4.5 SILTY SAND WITH GRAVEL

At BH-01, BH-07 and BH-09 a granular layer of silty SAND with gravel was encountered beneath the sandy lean CLAY with trace of gravel, silty SAND and FILL layer, respectively. SPT carried out gave N-values ranging from 9 to >50 (SSR) indicating a relative density of loose to very dense. The thickness of this layer ranged between 0.4 m and >3.3 m. This layer was underlain by inferred bedrock (practical refusal to further penetration of the split spoons) in borehole BH-01.

A grain size analysis was performed on the sample collected at a depth of 3.7 m at borehole BH-01, which is considered to be generally representative of that layer. The results indicate 23.7% gravel, 39.7% sand, and 36.6% silt/clay. The natural moisture content of the sample was 9%.

4.6 INFERRED BEDROCK

Bedrock was inferred by split spoon refusal at boreholes BH-01 and BH-02. At boreholes BH-10, BH-13, BH-15 and BH-16 bedrock was not proven by diamond coring techniques but inferred by augering or refusal to split spoon.

The bedrock geology maps of the area indicate the bedrock at the site as a sedimentary rock formed during the Upper Carboniferous period and classified as Pictou Group. According to the split spoon recovery and the cutting from the augers, the inferred bedrock consists of a grey to brown SANDSTONE.

5.0 GROUNDWATER MONITORING

Groundwater conditions were observed during drilling and noted on the appended Borehole Records (Appendix B). A 50 mm OD PVC monitoring well was installed at boreholes BH-03 and BH-13 to permit the subsequent monitoring of groundwater conditions. Following completion of the drilling, our personnel returned to the site on a couple of occasions to monitor groundwater levels in the installed monitoring wells.

Groundwater levels recorded at the time of drilling, and measured at a later date, were found to range from 0 m (at surface) to 3.0 m below the existing ground surface during the period of February 25, 2014 and March 2, 2014.

Please note that groundwater levels can be expected to fluctuate due to heavy precipitation associated with seasonal weather trends, or a particular event, site use and construction activity.

6.0 DISCUSSION AND RECOMMENDATIONS

Based on the soil conditions encountered, the following recommendations are provided for the project. At the time of this report, design drawings were not available.

It is understood that the proposed wastewater treatment facility will consist of: two (2) new aerated lagoons, a Submerged Attached Growth Reactor (SAGR) system, sewer systems and three (3) lift station buildings. The facility will be developed mainly by backfilling operations to achieve the design grades. Existing surface elevations around the perimeter of the proposed lagoons vary between 2.3 m and 3.8 m. Therefore, it is anticipated that fill placements in the order of 1.2 m to 2.7 m will be necessary to achieve the design grades at the bottom of the proposed aeration lagoons (final elevation of 5 m) and approximately 5.2 m to 6.7 m at the top of the perimeter embankments (final elevation of 9.0 m).

Based on our phone conversation, March 11, 2014, we further understand that a synthetic liner will be used at the site instead of a clay liner.

We also understand the following regarding the proposed design.

- New Aerated Lagoon 1 (Cell 1 & Cell 2) is approximately 60 m x 70 m and has a design bottom and top elevation of 5.0 m and 9.0 m respectively;
- New Aerated Lagoon 2 (Cell 3 and Polishing Cell) is approximately 60 m x 53 m and has a design bottom and top elevation of 5.0 m and 9.0 m respectively;
- Proposed embankments slope 3H:1V.

The following sections provided discussion and recommendations in support of the proposed facility.

6.1 SITE PREPARATION

Initially, the area must be cleared of all TOPSOIL/PEAT, FILL and any other deleterious/unsuitable material.

The exposed subgrade should then be proof-rolled to re-compact the loosened surface soils and to identify any soft or yielding soils. This operation must be carried out under the supervision of experienced geotechnical personnel. Any soft/yielding areas revealed during the compaction operation should be excavated and replaced with compacted structural engineering fill. Any grade raising may also be carried out with compacted structural engineered fill.

The structural engineered fill should consist of a well graded pit run gravel satisfying the gradation requirements given in Table 1. Any substitute material should be reviewed by a geotechnical consultant prior to use.

Compaction of the subgrade should be verified by means of in-place density testing. Structural engineered fill must be placed in lifts not exceeding 300 mm in loose thickness and compacted to a minimum of 95% of the Standard Proctor (ASTM D698) maximum dry density.

Given the existing groundwater levels, dewatering during construction will be required. Surface water drainage controls should be provided on the up-gradient side of the site to minimize run-off onto exposed soil. Suitable erosion and sedimentation control measures should be provided. These may include silt fences, check dams in ditches, and granular working pads while respecting provincial environmental guidelines.

Note that structural engineered fill should not be placed directly below the liner material.

Table 1: Pit Run Gravel – Gradation Limits

Sieve Size	Percent Passing
125 mm	100
100 mm	95-100
75 mm	82-100
50 mm	62-100
37.5 mm	52-100
19 mm	30-90
9.5 mm	22-79
4.75 mm	16-66
2.36 mm	12-55
1.18 mm	9-44
300 μm	4-25
75 μm	0-7

6.2 EMBANKMENT CONSTRUCTION

Embankment shall be constructed with inner and outer slopes not steeper than 3H:1V. The embankment must also be constructed with a relatively impervious soil. The hydraulic conductivity of the embankment material must be in the range of $1x10^{-8}$ m/s ($1x10^{-6}$ cm/s).

Compaction of the embankment fill must be strictly controlled. The embankment fill should be compacted to a minimum of 95% of the standard Proctor maximum dry density as determined by ASTM D698. In addition to the minimum density, the moisture content of the embankment fill must be controlled within ±1% of the optimum moisture content that corresponds to the maximum dry density. For a relatively impervious material a sheep foot roller is typically required for proper compaction. Lift thickness shall be such that each successive lift is kneaded into the underlying lift. A typical loose lift thickness ranges between 150 mm and 200 mm.

Many soils (including the native sandy lean CLAY) are suitable for the construction of embankments that meet the above criteria, however very wet fine grained soils, and/or highly organic soils should not be used. Ideally, embankment materials should be of low permeability yet readily compactable to 95% of the Standard Proctor maximum dry density. Soils that are naturally wet above the optimum moisture can still be used if they can be sufficiently dried out during the construction period. Laboratory testing should be conducted on proposed materials to determine grain size, moisture-density relationship, hydraulic conductivity and natural moisture content of materials proposed for embankment construction.

Outer slopes shall have a cover layer of at least 100 mm of fertile topsoil to promote establishment of an adequate vegetation cover wherever rip-rap is not specified. Adequate erosion control shall be established from the toe of the slope to 0.5 m below the top of the berm as measured on the slope. Additional erosion control may also be necessary to protect the berm from erosion due to severe flooding.

The interior berm slopes above the effluent levels should also have adequate erosion control (vegetation, rip-rap, etc.) if required.

It is our understanding that the construction of a facility/lift station building is proposed within the top of the berm (north-east corner). The facility building footings may be proportioned for a net allowable bearing pressure of 150 kPa. Total and differential settlements under this intensity of pressure are estimated to be less than 25mm and 19mm respectively. Strict control of material placement and compaction should be conducted as detailed above.

For frost protection, the base of all exposed footings should extend to a minimum depth of 1.8 m below the final grade. To prevent ad-freezing within the frost penetration depth, non-frost susceptible fill should be used as backfill. Pit run gravel with less than 5% finer than the #200 sieve is acceptable non-frost susceptible fill material.

6.3 SYNTHETIC LINER CONSTRUCTION

It is understood that a synthetic liner will be used at the site. The seepage loss through the synthetic liner shall not exceed the quantity equivalent through an adequate soil liner. For liner durability, the minimum liner thickness for a HDPE liner shall be 1.5 mm (60 mil). The liner shall be underlain by a sand layer with a minimum thickness of 150 mm to provide a levelling course and to ensure that there are no sharp protrusion which would puncture the synthetic liner. The pond bottom should be as level as possible, finished elevations should not be more than 75mm from the average elevation of the bottom (elevation of 5.0 m)

It will also be necessary to cover the liner with a layer of sand of at least 150 mm in thickness. If it is proposed to occasionally empty the cells for maintenance purposes, and if heavy construction equipment is required for maintenance, it will be necessary to thicken the protective sand layer.

6.4 LIFT STATIONS (WET WELLS)

Two additional lift stations are proposed at the location of BH-08 and BH-10. Based on the soil conditions encountered at the borehole location, the following recommendations are provided for the new lift stations.

6.4.1 Lift Station at BH-08

We understand that the new pre-cast wet well will be placed at an approximate depth of 6.0 m below the existing ground surface and the excavations will penetrate into the saturated silty SAND layer. The groundwater table was encountered at a depth of 1.5 m at time of drilling.

Based on the soils and groundwater conditions encountered, piping from seepage into the base of the excavation is a concern that must be dealt with by effective use of shoring. We recommend that sheet piling be considered to provide cut-off of seepage and for stabilization of the excavation base. Shoring systems must be designed by geotechnical and structural engineers. Sheet piling will need to penetrate below the base of the excavation to a depth prescribed by a geotechnical engineer responsible for the shoring design. The excavations will require dewatering.

6.4.2 Lift Station at BH-10

We understand that the new pre-cast wet well will be placed at an approximate depth of 6.0 m below the existing ground surface and the wet well will be founded on inferred bedrock. The groundwater table was encountered at a depth of 3.0 at time of drilling.

Given the groundwater level and the proximity of an existing road, maintaining an open excavation may be an issue. If an open excavation is not feasible then a square, four sided slide rail system may be considered. It is recommended that the manufacture by engaged to review the specifics of the site to confirm that the proposed shoring system is feasible (excavation in overburden and bedrock).

If an open excavation does not interfere with the existing road or any other structures then an open excavation with proper sloping/benching is feasible. Excavated slopes should not be steeper that 1.5:1 given the existing soils at the site. Proper groundwater control should be used to control surface erosion on temporary slopes and potential slope surface sloughing.

Based on the soils and groundwater conditions encountered, piping and base heave will not be a concern at this site, as the bottom of the excavation will be on bedrock

We recommend that the wet well footprint be over excavated by approximately 300 mm to accommodate the placement of drainage stone bedding material (See Table 3 for gradation) as a levelling course over intact bedrock.

6.4.3 General Recommendations

It should be expected that groundwater flow into excavations will have to be controlled with the use of dewatering pumps or other means to achieve and maintain the base of excavations in a relatively dry and manageable state during construction.

We recommend that the wet well footprint be over excavated by approximately 300mm to accommodate the placement of stone bedding material (20mm clear stone) as a levelling course.

We recommend backfilling the wet well excavations using structural engineered fill. Structural engineered fill may consist of 125 mm well graded pit-run gravel complying with the NBDOT Standard Specifications Item 201. Structural engineered fill should be placed to a maximum lift of 300 mm and compacted to a minimum of 95% of the corrected maximum dry density as per ASTM D698 (standard Proctor).

For both lift stations listed above, total and differential settlements should be minimal and within tolerable limits for the wet well.

Safe excavated slopes are the responsibility of the earthwork contractor. As a minimum, temporary excavations must be sloped in accordance with the applicable Work Safe New Brunswick regulations. However, excavation slopes made below the groundwater table and in soft/loose soil will slough to slopes flatter than 1:1. Control of groundwater will be necessary to improve sloughing problems. If an excavation cannot be properly sloped or benched due to high groundwater and/or loose/soft soils, the contractor should install an engineered shoring system (with appropriate dewatering equipment) to safely support the temporary excavation. Excavation slopes should be checked regularly for signs of instability and flattened as required. Temporary slopes should be protected from surface erosion by means such as (but not limited to): swales or ditches around the perimeter of the excavation; and/or by using plastic sheeting placed over the slope.

We recommend that the shoring system be designed to safely resist lateral soil pressure, the hydrostatic pressures and the lateral pressure from construction surcharge.

When feasible, the shoring system should be extracted in small increments and backfilled to the bottom of the system as it is extracted being careful to completely fill the excavation and leave no voids.

It is recommended that the base of the wet well be designed to resist buoyant forces

6.5 PIPE WORK

Excavations for pipe work (sanitary sewer) will be made in either FILL, lean CLAY, silty SAND, silty SAND with gravel or in bedrock (between BH-01 and BH-03 and in the area of BH-10) depending on the final depth of the proposed pipes.

Bedding material shall be placed all around the new pipes with a minimum thickness of 150 mm to be placed underneath the pipes and 300 mm above the top of pipes. The bedding material should primarily consist of a well graded crushed rock satisfying the gradation requirements given in Table 2.

Table 2: Bedding Material – Gradation Limits

Sieve Size	Percent Passing
31.5 mm	100
25 mm	95-100
19 mm	71-100
12.5 mm	56-82
9.5 mm	47-74
4.75 mm	31-59
2.36 mm	21-46
1.18 mm	13-34
300 μm	5-18
75 μm	0-8

If due to groundwater migration above noted bedding material cannot be placed in a dry condition, we recommend that a minimum thickness of 150 mm crushed rock (drainage stone bedding material) be used along the new pipe works length. It shall be completely wrapped in non-woven geotextile filter fabric in order to hinder the migration of fine material into the bedding material. The bedding material should primarily consist of a 20 mm clear stone satisfying the gradation requirements given in Table 3 below.

Table 3: Drainage Stone Bedding Material – Gradation Limits

Sieve Size	Percent Passing
20.0 mm	100
14.0 mm	40-50
10.0 mm	20-62
5.0 mm	0-20

Excavated materials may be selectively reused as pipe backfill material provided they are free of organics or deleterious material and have a moisture content close to the optimum moisture content. If the reused material cannot be properly compacted then the material should be removed and replaced with approved backfill material. The reused backfill material should not be placed within the pavement structure of the existing road.

The lift thickness used during placement of bedding must be compatible with the compaction equipment and the material type to ensure the specified density is achieved throughout the backfill. The compaction equipment must be suitably sized so as not to cause damage or displacement of the pipes. The lift thickness should not exceed 150 mm for bedding material.

Pipe bedding and backfill materials should be compacted to a minimum of 95% of the maximum dry density as per the standard Proctor (ASTM D698).

Safe excavated slopes are the responsibility of the earthwork contractor. As a minimum, temporary excavations must be sloped in accordance with the applicable Work Safe New Brunswick regulations. However, excavation slopes made below the groundwater table and in soft/loose soil will slough to slopes flatter than 1:1. Control of groundwater will be necessary to improve sloughing problems. If an excavation cannot be properly sloped or benched due to high groundwater and/or loose/soft soils, the contractor should install an engineered shoring system (with appropriate dewatering equipment) to safely support the temporary excavation. Excavation slopes should be checked regularly for signs of instability and flattened as required. Temporary slopes should be protected from surface erosion by means such as (but not limited to): swales or ditches around the perimeter of the excavation; and/or by using plastic sheeting placed over the slope.

7.0 CLOSURE

This report has been prepared for the sole benefit of Crandall Engineering Ltd. Any use or reliance on this report:

a. where there have been any change in site conditions;
b. for purposes not intended or delineated in this report ; or
c. by third parties without express written agreement of Conquest Engineering

renders this report inapplicable. Any use of or reliance upon this report under such circumstances or by such parties is strictly prohibited and without risk or liability to Conquest.

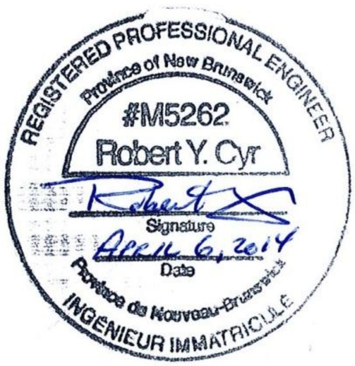
Conquest Engineering used reasonable care, skill, competence and judgment in the preparation of this report. The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. The information and conclusions contained in this report are generally consistent with professional standards for individuals providing similar services at the same time, in the same locale and under like circumstances.

A geotechnical field investigation is a limited sampling of a site. Some variation between sampling locations should be expected. The conclusions presented in this report represent the best technical judgment of Conquest Engineering based on the data obtained from the work. The conclusions are based on the site conditions observed by Conquest Engineering at the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction and other activities. Due to the nature of the investigation and the limited data available, Conquest Engineering cannot warrant against undiscovered environmental liabilities.

If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein. Further, if there are changes to the proposed work, such as adjustments in founding elevation or building loads, etc., we require that we be notified to allow for review of our recommendations.

We trust this is the information you require at this time. If you have any questions or if we can be of any further assistance please feel free to contact us.

Respectfully submitted,
CONQUEST ENGINEERING LTD.



Robert Y. Cyr, M.Sc., P. Eng.

APPENDIX A

SYMBOLS AND TERMS USED ON BOREHOLES AND TEST PIT RECORDS

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting good vegetative growth
Peat	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	>75 mm
Seam	-	2 mm to 75 mm
Parting	-	< 2 mm
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Uniformly Graded	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	Greater than 20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' – value.

Relative Density	'N' Value	Compactness %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength (Su)		'N' Value
	Kips/sq.ft.	KPa	
Very Soft	< 0.25	< 12.5	< 2
Soft	0.25 – 0.5	12.5 – 25	2 – 4
Firm	0.5 – 1.0	25 – 50	4 – 8
Stiff	1.0 – 2.0	50 – 100	8 – 15
Very Stiff	2.0 – 4.0	100 – 200	15 – 30
Hard	> 4.0	> 200	> 30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on N-size (45 mm) core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from in situ fractures.

RQD	ROCK QUALITY
90 – 100	Excellent, intact, very sound
75 – 90	Good, massive, moderately jointed or sound
50 – 75	Fair, blocky and seamy, fractured
25 – 50	Poor, shattered and very seamy or blocky, severely fractured
0 – 25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000 – 6000	*Very Thick*	*Very Wide*
600 – 2000	*Thick*	*Wide*
200 – 600	*Medium*	*Moderate*
60 – 200	*Thin*	*Close*
20 – 60	*Very Thin*	*Very Close*
< 20	*Laminated*	*Extremely Close*
< 6	*Thinly Laminated*	

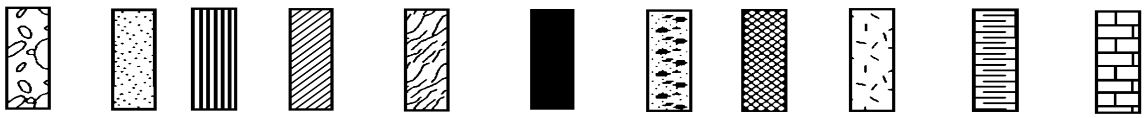
Strength Classification	Uniaxial Compressive Strength (MPa)
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing weathering:

Slight - Weathering limited to the surface of major discontinuities. Typically iron stained.
Moderate - Weathering extends throughout rock mass. Rock is not friable.
High - Weathering extends throughout rock mass. Rock is friable.

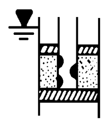
STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Metamorphic Bedrock | Sedi-mentary

WATER LEVEL MEASUREMENT



Borehole or Standpipe | Piezometer

SAMPLE TYPE AND/OR FIELD TESTS

SS	Split Spoon Sample (obtained by performing the Standard Penetration Test)	AS	Auger Sample
		BS	Bulk Sample
		WS	Wash Sample
ST	Shelby Tube or Thin Wall Tube	HQ, NQ, BQ, etc.	Rock Core Samples (obtained with the use of standard size diamond drilling bits)
PS	Piston sample		
DC	Dynamic Cone Penetration		
FSV	Field Shear Vane		

N- VALUE

Numbers in this column are the results of the SPT (Standard Penetration Test): the number of blows of a 140 pound (64kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the abbreviation SSR (Split Spoon Refusal) will appear in place of a numerical value.

OTHER TESTS

Symbols in this column indicate that the following laboratory tests have been carried out and the results are presented separately.

S	Sieve analysis	H	Hydrometer analysis
G_s	Specific gravity of soil particles	γ	Unit weight
k	Permeability	C	Consolidation
	Single packer permeability test; test interval from depth shown to bottom of borehole	CD	Consolidated drained triaxial
		CU	Consolidated undrained triaxial with pore pressure measurements
	Double packer permeability test; Test interval as indicated	UU	Unconsolidated undrained triaxial
		DS	Direct shear
	Falling head permeability test using casing	Q_u	Unconfined compression
		I_p	Point Load Index (I_p on Borehole Records equals I_p(50); the index corrected to a reference diameter of 50 mm)
	Falling head permeability test using well point or piezometer	MSV	Laboratory Miniature Shear Vane

APPENDIX B

BOREHOLE RECORDS

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
BH - 01
Client: Crandall Engineering Ltd.
Page: 1 of 1
Location: Burnt Church, NB
Date Drilled: Feb. 25, 2014
Water Level: Water level not observed
Datum: Geodetic

Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
					6.3 / 0.0
AS	1	-	-	Reddish brown to light brown sand with silt and gravel: FILL - frost to an approx. depth of 0.9 m	
SS	2	57	600		
SS	3	10	530	Stiff to hard reddish brown sandy lean CLAY with trace of gravel	5.2 / 1.1
SS	4	13	600		
SS	5	41	580		
-	-	-	-		
SS	6	12	550		
SS	7	SSR	280	Compact to very dense grey silty SAND with gravel	2.8 / 3.5
				End of Borehole Practical refusal to further penetration of the split spoon Probable bedrock	2.4 / 3.9

Columns also shown: Depth (m / ft), Water Level (m), Symbols, SPT (N) Blows/300mm (5 15 25 35 45), Moisture Content (%) Wp |---O---| WL (5 15 25 35 45)

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 0.9 m on Feb. 25, 2014

BH - 02
Page: 1 of 1
Date Drilled: Feb. 25, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Symbols	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)	SPT (N) Blows/300mm 5 15 25 35 45	Moisture Content (%) Wp |---O---| WL 5 15 25 35 45
0.0–1.2		AS	1	-	-		Reddish brown to brown sand with silt and gravel: FILL - frost to an approx. depth of 0.9 m	6.3 / 0.0		
	▼ (0.9)	SS	2	67	450					
		SS	3	6	430					
1.2–3.9		SS	4	12	600		Firm to hard reddish brown sandy lean CLAY with trace of gravel	5.1 / 1.2		
		SS	5	38	330					
		-	-	-	-					
		SS	6	36	600					
		SS	7	SSR	330		- some gravel at 3.8 m			
3.9							End of Borehole Practical refusal to further penetration of the split spoon Probable bedrock	2.4 / 3.9		

Depth scale: ft 0–26; m 0–8

Conquest Engineering Ltd.

BOREHOLE RECORD

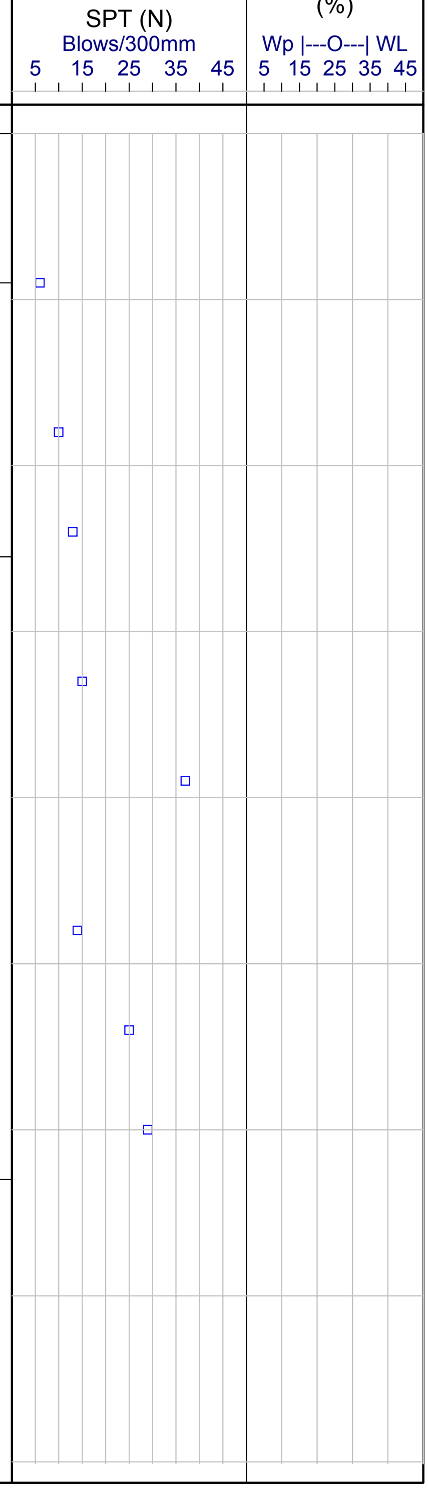
Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 1.1 m on March 2, 2014

BH - 03

Date Drilled: Feb. 25, 2014
Datum: Geodetic

Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
	-	-	-	-	Brown sand with silt and gravel: FILL - frost to an approx. depth of 0.6 m - trace of organics at a depth of 0.9 m	5.2 / 0.0
	SS	1	6	400	Loose to compact grey silty SAND	4.3 / 0.9
▼ (1.1 m)	-	-	-	-		
	SS	2	10	230	- trace of organics at a depth of 2.1 m	
	SS	3	13	400		
	-	-	-	-	Stiff to hard grey to reddish brown sandy lean CLAY with trace of gravel	2.7 / 2.5
	SS	4	15	400		
	SS	5	37	600		
	-	-	-	-		
	SS	6	14	330		
	SS	7	25	600		
	SS	8	29	300		
					End of Borehole	-1.1 / 6.3

Depth scale: 0–26 ft / 0–8 m

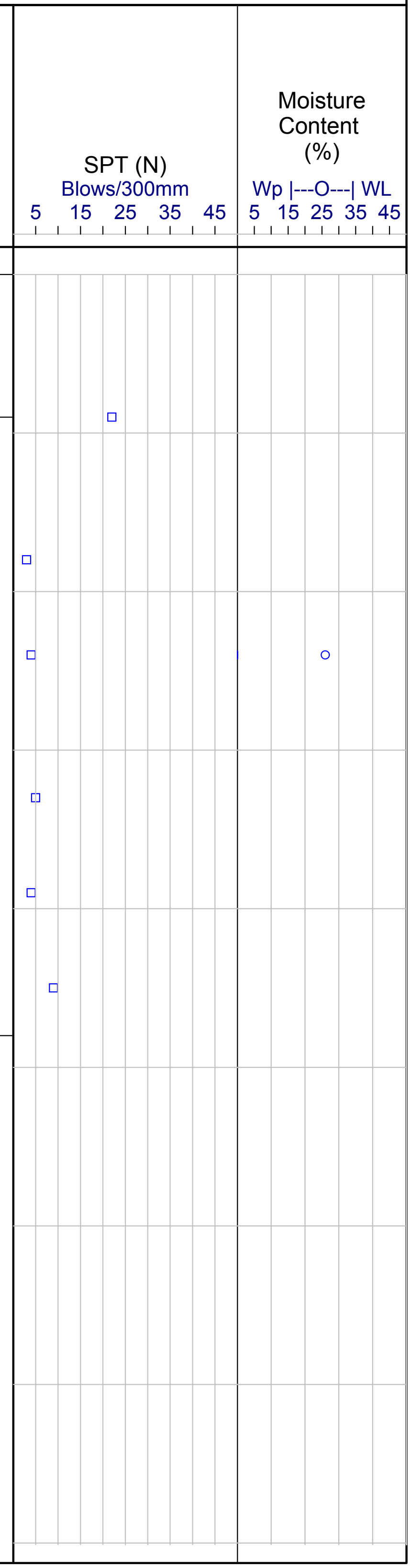


Conquest Engineering Ltd.

BOREHOLE RECORD

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 1.2 m on Feb. 25, 2014
BH - 04
Page: 1 of 1
Date Drilled: Feb. 25, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Symbols	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0 – 0.9		-	-	-	-	FILL	Brown sand with silt and gravel: FILL - frost to an approx. depth of 0.7 m - trace of organics at a depth of 0.9 m	4.7 / 0.0
		SS	1	22	400			
0.9 – 4.8	▼ 1.2	-	-	-	-	CLAY	Soft to stiff grey to reddish brown lean CLAY with sand and occasional sand seams	3.8 / 0.9
		SS	2	3	230			
		SS	3	4	400			
		-	-	-	-			
		SS	4	5	400			
		SS	5	4	500			
		SS	6	9	430			
4.8							End of Borehole	-0.1 / 4.8



BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
BH - 05
Client: Crandall Engineering Ltd.
Page: 1 of 1
Location: Burnt Church, NB
Date Drilled: Feb. 25, 2014
Water Level: 1.2 m on Feb. 25, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)	SPT (N) Blows/300mm	Moisture Content (%) Wp |---O---| WL
0		-	-	-	-	Brown sand with silt and gravel: FILL - frost to an approx. depth of 0.6 m	3.2 / 0.0		
0.9		SS	1	9	300	Loose to compact grey to reddish brown silty SAND	2.3 / 0.9		
1.2	▼	-	-	-	-				
		SS	2	16	430				
2.1		SS	3	3	400	Soft to very stiff grey to reddish brown lean CLAY with sand and occasional sand seams	1.1 / 2.1		
		-	-	-	-				
		SS	4	3	430				
		SS	5	17	450				
4.2						End of Borehole	-1.0 / 4.2		

Conquest Engineering Ltd.

BOREHOLE RECORD

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 1.5 m on Feb. 25, 2014

BH - 06
Page: 1 of 1
Date Drilled: Feb. 25, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Symbols	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)	SPT (N) Blows/300mm	Moisture Content (%) Wp |---O---| WL
0.0 – 0.3		-	-	-	-		Black to brown sand with silt and organics: TOPSOIL	3.6 / 0.0		
0.3 – 1.0		SS	1	21	450		Brown sand with silt and gravel: FILL - frost to an approx. depth of 0.6 m	3.3 / 0.3		
1.0 – 2.9	▼ 1.5	-	-	-	-		Compact grey to brown silty SAND - trace of organics at a depth of 1.5 m	2.6 / 1.0		
		SS	2	11	380					
		SS	3	11	350					
		-	-	-	-					
2.9 – 4.2		SS	4	2	480		Very soft to firm grey to reddish brown lean CLAY with sand and occasional sand seams	0.7 / 2.9		
		SS	5	6	480					
4.2							End of Borehole	-0.6 / 4.2		

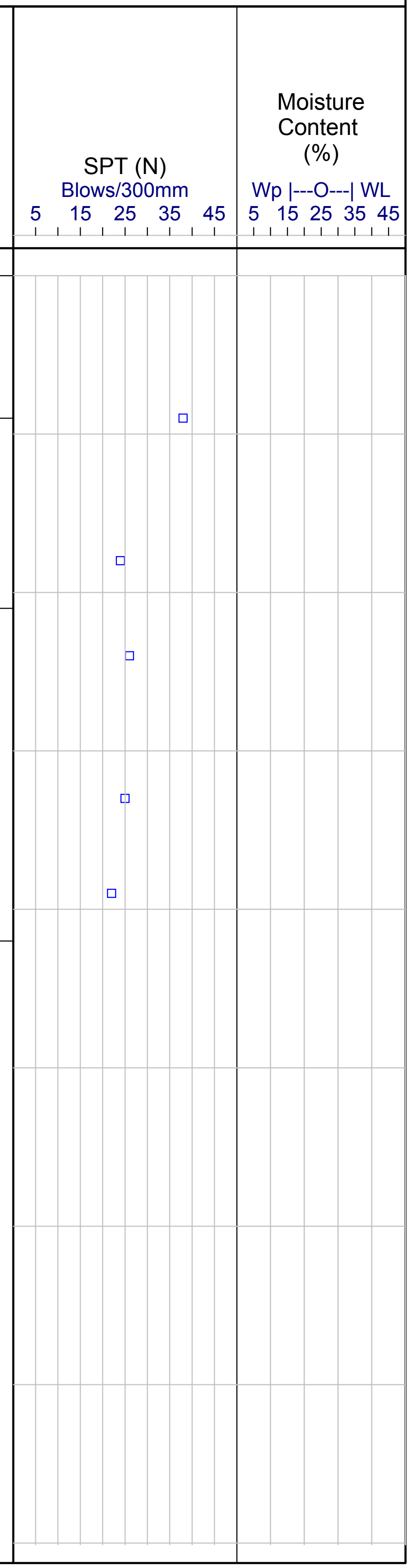
Conquest Engineering Ltd.

BOREHOLE RECORD

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 1.8 m on Feb. 25, 2014

BH - 07
Page: 1 of 1
Date Drilled: Feb. 25, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Symbols	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0 – 0.9		AS	1	-	-		Brown sand with silt and gravel: FILL - frost to an approx. depth of 0.9 m	4.6 / 0.0
		SS	2	38	450			
0.9 – 2.1							Compact light brown to brown silty SAND	3.7 / 0.9
		-	-	-	-			
	▼ 1.8	SS	3	24	380			
2.1 – 4.2		SS	4	26	600		Compact brown silty SAND with gravel	2.5 / 2.1
		-	-	-	-			
		SS	5	25	430			
		SS	6	22	600			
4.2							End of Borehole	0.4 / 4.2



BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
BH - 08
Client: Crandall Engineering Ltd.
Page: 1 of 1
Location: Burnt Church, NB
Date Drilled: Feb. 25, 2014
Water Level: 1.5 m on Feb. 25, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0 – 0.3		AS	1	-	-	Black to brown sand with silt and organics: TOPSOIL	2.8 / 0.0
0.3 – 6.0						Compact brown to reddish brown silty SAND	2.5 / 0.3
						- frost to an apporx. depth of 0.6 m	
	1.5 ▼	SS	2	18	400		
		SS	3	19	500	- some gravel from 1.6 m to 3.0 m	1.2 / 1.6
		SS	3	13	550		
		-	-	-	-		
		SS	4	13	600		
		SS	5	14	600		
		-	-	-	-		
		SS	6	11	600		
						- clay layer at 4.9 m	-2.1 / 4.9
		SS	7	27	600		
		-	-	-	-		
6.0						End of Borehole	-3.2 / 6.0

SPT (N) Blows/300mm: 5 15 25 35 45

Moisture Content (%) Wp |---O---| WL: 5 15 25 35 45

Depth scale: ft 0–26; m 0–8

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135 **BH -** 09
Client: Crandall Engineering Ltd. **Page:** 1 of 1
Location: Burnt Church, NB **Date Drilled:** Feb. 25, 2014
Water Level: 2.4 m on Feb. 25, 2014 **Datum:** Geodetic

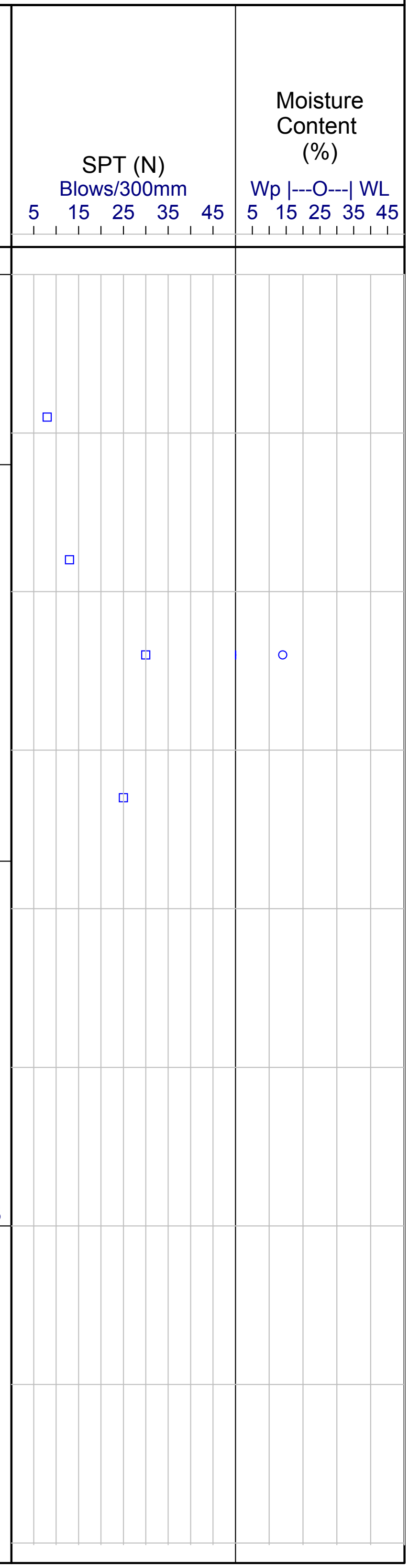
Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Soil and/or Rock Description	Elevation/Depth (m)	SPT (N) Blows/300mm	Moisture Content (%) Wp |---O---| WL
0							3.7 / 0.0		
0.0–0.9		-	-	-	-	Brown sand with silt and gravel: FILL - frost to an approx. depth of 0.6 m - cobbles at 0.8 m			
		SS	1	SSR	0				
0.9–4.2		-	-	-	-	Loose to compact brown silty SAND with gravel	2.8 / 0.9		
		SS	2	21	300			21	
	▼ (2.4)	SS	3	9	500			9	
		-	-	-	-				
		SS	4	17	250			17	
		SS	5	15	450			15	
4.2						End of Borehole	-0.5 / 4.2		

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
BH - 10
Client: Crandall Engineering Ltd.
Page: 1 of 1
Location: Burnt Church, NB
Date Drilled: Feb. 25, 2014
Water Level: 3.0 m on Feb. 25, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0–1.2		-	-	-	-	Brown sand with silt and gravel: FILL - frost to an approx. depth of 0.6 m	4.5 / 0.0
		SS	1	8	380		
1.2–3.7		-	-	-	-	Stiff to hard reddish brown sandy lean CLAY with trace of gravel	3.3 / 1.2
		SS	2	13	600		
		SS	3	30	600		
	3.0 ▼	-	-	-	-		
		SS	4	25	600		
3.7–6.0		SS	5	SSR	180	Inferred brown SANDSTONE bedrock	0.8 / 3.7
		-	-	-	-		
		SS	6	SSR	30		
		-	-	-	-		
6.0						End of Borehole	-1.5 / 6.0



BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 0.3 m on Feb. 26, 2014

BH - 11
Page: 1 of 1
Date Drilled: Feb. 26, 2014
Datum: Geodetic

Sample Type	Sample Number	N Value or RQD %	Recovery (mm)
SS	1	8	580
SS	2	6	500
-	-	-	-
SS	3	20	600
SS	4	20	400
-	-	-	-
SS	5	10	400
SS	6	16	600
-	-	-	-
SS	7	9	600
SS	8	23	600
SS	9	29	400

SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
	3.6 0.0
Reddish brown sand with silt and organics: TOPSOIL	3.3 0.3
Firm to very stiff reddish brown to dark brown sandy lean CLAY with trace of gravel	-2.7 6.3
End of Borehole	

SPT (N) Blows/300mm: 5 15 25 35 45

Moisture Content (%) Wp |---O---| WL: 5 15 25 35 45

Depth (m): 0–8; Depth (ft): 0–26

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 0.3 m on Feb. 26, 2014
BH - 12
Page: 1 of 1
Date Drilled: Feb. 26, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0						Reddish brown sand with silt and organics: TOPSOIL	5.9 / 0.0
	▼	SS	1	2	200		
0.9		SS	2	10	400	Stiff to very stiff reddish brown to dark brown sandy lean CLAY with trace of gravel	5.0 / 0.9
		-	-	-	-		
		SS	3	11	600		
		SS	4	18	600		
		-	-	-	-		
		SS	5	17	400		
		SS	6	25	130		
		-	-	-	-		
		SS	7	18	600		
		SS	8	21	400		
		SS	9	23	330		
6.3						End of Borehole	-0.4 / 6.3

SPT (N) Blows/300mm: 5 15 25 35 45

Moisture Content (%) Wp |---O---| WL: 5 15 25 35 45

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: 0.7 m on March 2, 2014

BH - 13

Date Drilled: Feb. 26, 2014
Datum: Geodetic

Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Soil and/or Rock Description	Elevation/Depth (m)
					6.7 / 0.0
SS	1	3	230	Reddish brown sand with silt and organics: TOPSOIL	
					6.3 / 0.4
SS	2	20	600	Stiff to very stiff reddish brown to brown sandy lean CLAY with trace of gravel	
-	-	-	-		
SS	3	13	250		
SS	4	48	600		
-	-	-	-		
					3.8 / 2.9
SS	5	SSR	130	Inferred grey SANDSTONE bedrock	
-	-	-	-		
SS	6	SSR	50		
-	-	-	-		
SS	7	SSR	50		
-	-	-	-		
SS	9	SSR	25		
-	-	-	-		
				End of Borehole	-0.8 / 7.5

Water level symbol at approx. 0.7 m depth.

SPT (N) Blows/300mm: 5, 15, 25, 35, 45

Moisture Content (%) Wp |---O---| WL: 5, 15, 25, 35, 45

Depth scale: 0–26 ft; 0–8 m

Conquest Engineering Ltd.

BOREHOLE RECORD

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Burnt Church, NB
Water Level: At surface on Feb. 26, 2014
BH - 14
Page: 1 of 1
Date Drilled: Feb. 26, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0	▼	SS	1	0	0	PEAT	7.6 / 0.0
		SS	2	2	330	Very soft grey to dark brown sandy lean CLAY	6.7 / 0.9
		-	-	-	-		
		SS	3	2	350	Firm to very stiff grey to reddish brown sandy lean CLAY with trace of gravel	5.7 / 1.9
		SS	4	7	250		
		-	-	-	-		
		SS	5	7	450		
		SS	6	17	330		
		-	-	-	-		
		SS	7	20	400		
		SS	8	11	600		
		SS	9	28	600	- more gravel at 6.0 m	1.6 / 6.0
						End of Borehole	1.3 / 6.3

SPT (N) Blows/300mm: 5, 15, 25, 35, 45

Moisture Content (%) Wp |---O---| WL: 5, 15, 25, 35, 45

Depth scale: ft 0–26; m 0–8

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135 **BH -** 15
Client: Crandall Engineering Ltd. **Page:** 1 of 1
Location: Burnt Church, NB **Date Drilled:** Feb. 26, 2014
Water Level: At surface on Feb. 26, 2014 **Datum:** Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Symbols	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)	SPT (N) Blows/300mm 5 15 25 35 45	Moisture Content (%) Wp |---O---| WL 5 15 25 35 45
0	▼							9.3 / 0.0		
		SS	1	0	50		PEAT			
		SS	2	3	400		Very soft grey sandy lean CLAY	8.5 / 0.8		
		-	-	-	-					
		SS	3	6	450		Firm to very stiff grey to reddish brown sandy lean CLAY with trace of gravel	7.5 / 1.8		
		SS	4	11	330					
		-	-	-	-					
		SS	5	67	450					
		-	-	-	-		Inferred grey SANDSTONE bedrock	5.9 / 3.4		
							End of Borehole	4.7 / 4.6		

Depth scale: ft 0–26; m 0–8

BOREHOLE RECORD

Conquest Engineering Ltd.

Project Name: SI - New Wastewater Treatment Facility - Burnt Church, NB
Project No.: 071-135
BH - 16
Client: Crandall Engineering Ltd.
Page: 1 of 1
Location: Burnt Church, NB
Date Drilled: Feb. 26, 2014
Water Level: At surface on Feb. 26, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Symbols	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0	▼	SS	1	0	25		PEAT	7.4 / 0.0
0.9		SS	2	3	450		Soft grey to reddish brown sandy lean CLAY	6.5 / 0.9
		-	-	-	-			
1.8		SS	3	6	400		Firm to very stiff grey to reddish brown sandy lean CLAY with trace of gravel	5.6 / 1.8
		SS	4	14	600			
		-	-	-	-			
		SS	5	18	600			
		-	-	-	-			
4.2		SS	6	SSR	80		Inferred SANDSTONE bedrock	3.2 / 4.2
		-	-	-	-			
6.0							End of Borehole	1.4 / 6.0

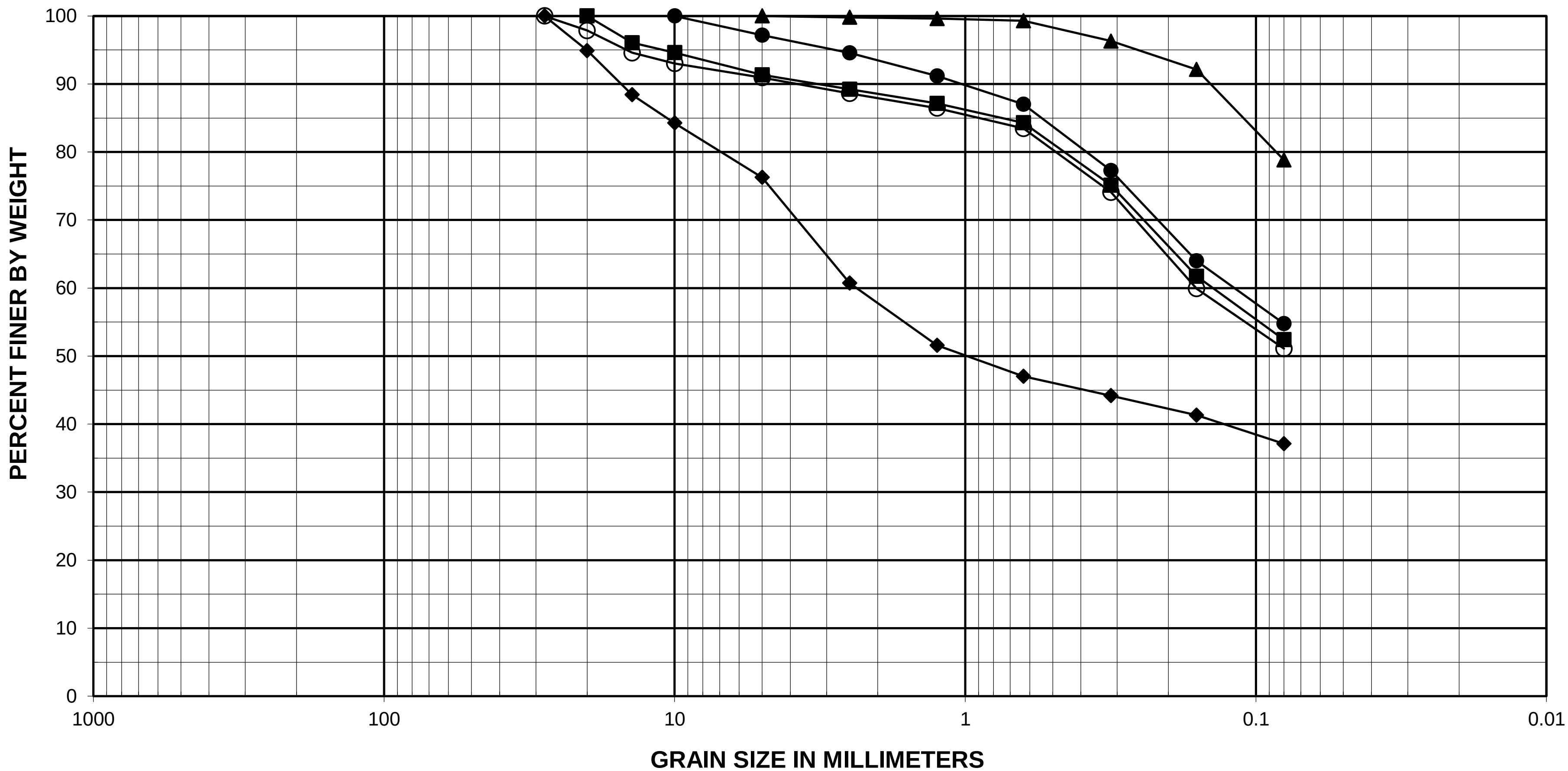
SPT (N) Blows/300mm: 5 15 25 35 45

Moisture Content (%) Wp |---O---| WL: 5 15 25 35 45

Depth scale: ft 0–26; m 0–8

APPENDIX C

LABORATORY TESTING



	Sample No.	Depth (m)	Classification	w%	Cu	Cc	% Gravel	% Sand	% Silt and Clay
◆	BH 01 - SS 7	3.66	Silty SAND with gravel	9%	NA	NA	23.7	39.7	36.6%
■	BH 01 - SS 5	2.44	Sandy lean CLAY	12%	NA	NA	8.7	39.1	52.2%
▲	BH 05 - SS 3	2.44	Lean CLAY with sand	21%	NA	NA	0.0	21.6	78.4%
●	BH 10 - SS 3	2.44	Sandy lean CLAY	14%	NA	NA	2.8	42.6	54.6%
○	BH 01 - SS 4	1.83	Sandy lean CLAY	12%	NA	NA	9.1	39.9	51.0%

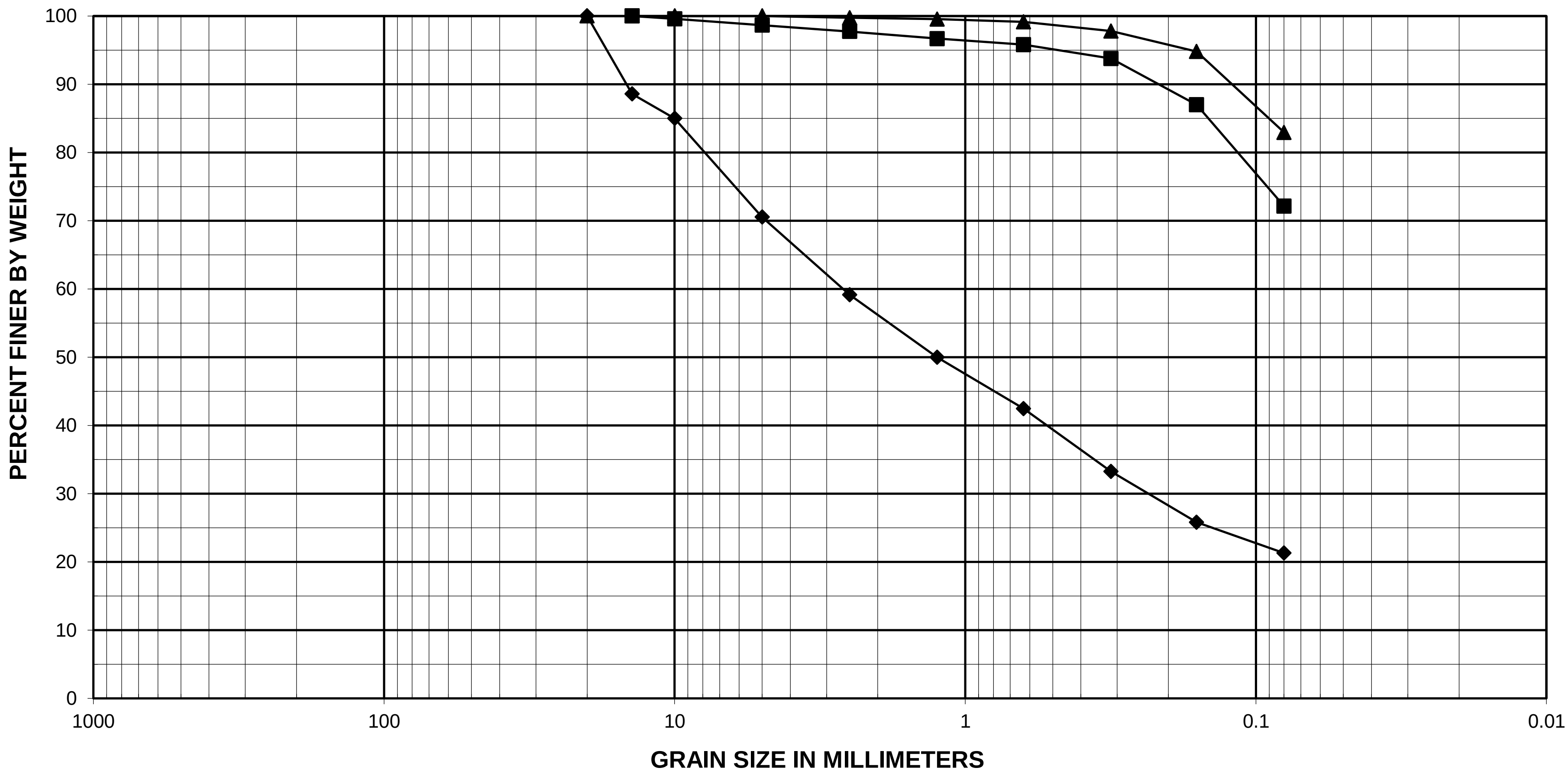
CONQUEST ENGINEERING LTD.

Project: SI - New Wastewater Treatment Facility - Burnt Church, NB

Job No.: 071-135 **Location:** Burnt Church, NB

Date: 11-Feb-14 **Notes:**

SIEVE ANALYSIS



	Sample No.	Depth (m)	Classification	w%	Cu	Cc	% Gravel	% Sand	% Silt and Clay
◆	BH 02 - AS	0.15	Silty SAND with gravel	7%	NA	NA	29.5	49.3	21.2%
■	BH 05 - SS 5	3.96	Lean CLAY with sand	20%	NA	NA	1.3	26.8	71.8%
▲	BH 04 - SS 3	2.44	Lean CLAY with sand	26%	NA	NA	0.0	17.7	82.3%
●									
○									

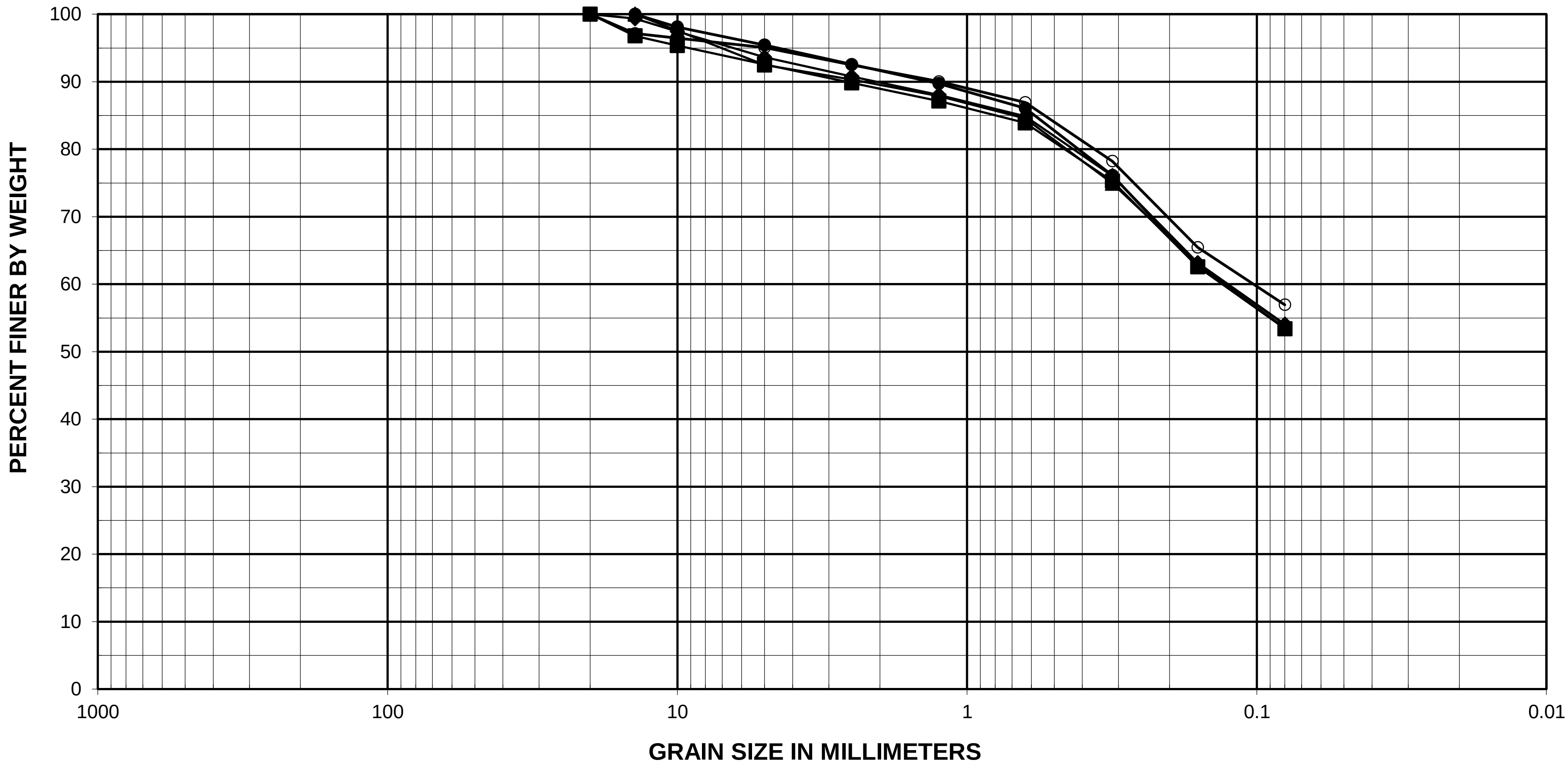
CONQUEST ENGINEERING LTD.

Project: SI - New Wastewater Treatment Facility - Burnt Church, NB

Job No.: 071-135 **Location:** Burnt Church, NB

Date: 11-Feb-14 **Notes:**

SIEVE ANALYSIS



	Sample No.	Depth (m)	Classification	w%	Cu	Cc	% Gravel	% Sand	% Silt and Clay
◆	BH 11 - SS 3	1.83	Sandy lean CLAY	14%	NA	NA	6.4	39.7	54.0%
■	BH 12 - SS 7	4.88	Sandy lean CLAY	12%	NA	NA	7.4	39.3	53.3%
▲	BH 13 - SS 4	2.44	Sandy lean CLAY	14%	NA	NA	7.5	38.5	54.0%
●	BH 14 - SS 5	3.35	Sandy lean CLAY	14%	NA	NA	4.5	42.2	53.2%
○	BH 16 - SS 4	2.44	Sandy lean CLAY	15%	NA	NA	5.0	38.3	56.8%

CONQUEST ENGINEERING LTD.

Project: SI - New Wastewater Treatment Facility - Burnt Church, NB

Job No.: 071-135 **Location:** Burnt Church, NB

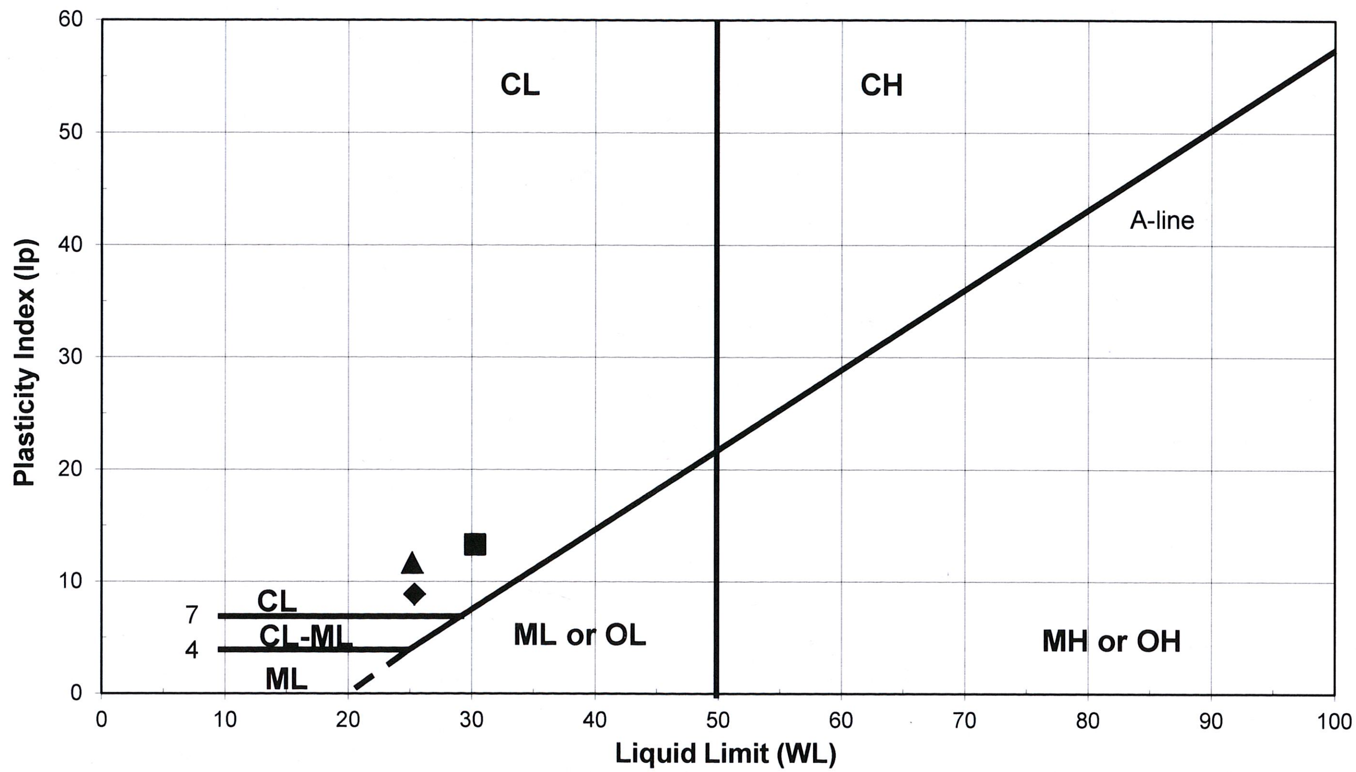
Date: 11-Feb-14 **Notes:**

SIEVE ANALYSIS

CONQUEST ENGINEERING LTD.

Client Name:	Crandall Engineering Ltd.	**Job No.:**	071-135
Project Name:	New Wastewater Treatment Facility - Burnt Church	**Date:**	04-Mar-14
Material Tested:	In-situ material - Split Spoon Samples	**Tested by:**	RRC
Site Sampled:	Burnt Church, NB		

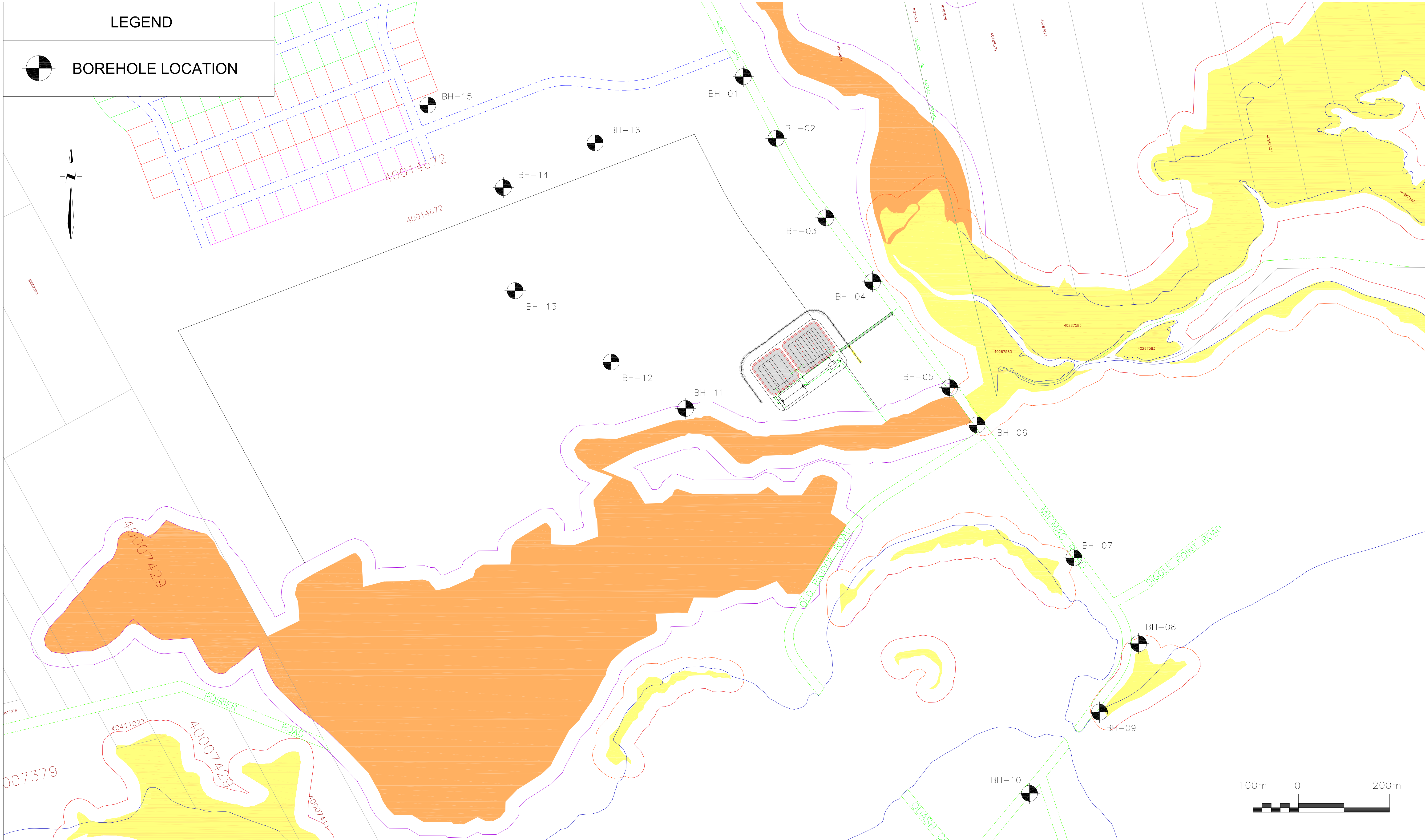
Plasticity Chart



	Borehole	Depth	Classification	USCS Symbol	Liquid Limit	Plasticity Index
◆	BH-14 - 3	1.8 m	Lean CLAY	CL	25	9
■	BH-05 - 4	3.4 m	Lean CLAY	CL	30	13
▲	BH11 - 6	4.0 m	Lean CLAY	CL	25	12

APPENDIX D

FIGURE 1 – BOREHOLE LOCATION PLAN



BOREHOLE LOCATION PLAN
PROPOSED WASTEWATER TREATMENT FACILITY
ESGENOÔPETITJ FIRST NATION
BURNT CHURCH, NB

CONQUEST ENGINEERING Ltd.
373 BAIG BOULEVARD
MONCTON, NEW BRUNSWICK, CANADA
E1E 4H8

DATE: MARCH 20, 2014	SCALE: AS SHOWN
PROJECT No.: 071–135	FIGURE: 1

REPORT TO

Crandall Engineering Ltd.
1077 St. George Blvd., Suite 400
Moncton, NB
E1E 4C9

ON

SUPPLEMENTARY GEOTECHNICAL INVESTIGATION NEW WASTEWATER TREATMENT FACILITY ESGENOÔPETITJ FIRST NATION BURNT CHURCH, NB

Prepared by:

Conquest Engineering
Experience commitment.

Geotechnical and Materials Engineers

Conquest Engineering Ltd. Project No.: 071-135-2
Crandall Engineering Ltd. Project No.: 14239

January 23, 2015

TABLE OF CONTENTS

Section **Page No.**

1.0 INTRODUCTION 1
2.0 SITE DESCRIPTION 1
3.0 FIELD PROCEDURES 1
4.0 SOIL PROFILE 2
4.1 TOPSOIL 2
4.2 FILL 2
4.3 SANDY LEAN CLAY WITH TRACE OF GRAVEL 2
4.4 LEAN CLAY WITH SAND AND TRACE OF GRAVEL 2
4.5 SILTY SAND 3
4.6 INFERRED BEDROCK 3
5.0 GROUNDWATER MONITORING 3
6.0 DISCUSSION AND RECOMMENDATIONS 3
6.1 SITE PREPARATION 4
6.2 EMBANKMENT CONSTRUCTION 5
6.3 BUILDING STRUCTURES 6
6.4 SYNTHETIC LINER CONSTRUCTION 7
6.5 LIFT STATIONS (WET WELLS) 7
6.5.1 Lift Station at BH-18 7
6.5.2 Lift Station at BH-21 7
6.5.3 General Recommendations 8
7.0 CLOSURE 9

List of Tables

Table 1: Pit Run Gravel – Gradation Limits 5

List of Appendices

APPENDIX A SYMBOLS AND TERMS USED ON BOREHOLES AND TEST PIT RECORDS
APPENDIX B BOREHOLE RECORDS
APPENDIX C LABORATORY TESTING
APPENDIX D FIGURE 1 – BOREHOLE LOCATION PLAN (BH-17 AND BH-18)
FIGURE 2 – BOREHOLE LOCATION PLAN (BH-19 TO BH-21)

1.0 INTRODUCTION

At the request of Crandall Engineering Ltd., Conquest Engineering Ltd. (CEL) has undertaken an additional soils investigation for the proposed new Aerated Lagoons and Lift Station No. 2 (LS#2) for the proposed new wastewater treatment facility to be located in Burnt Church, New Brunswick.

The purpose of the investigation was to obtain additional information on the soil and groundwater conditions within the area of the proposed new aerated lagoons and LS#2. This report has been prepared specifically and solely for the project described above. It contains all of our findings, and includes specific geotechnical recommendations for the design and construction of the proposed new structures.

2.0 SITE DESCRIPTION

The site of the proposed aerated lagoons is located off of Micmac Road in Northumberland County, New Brunswick. The site parcel is bound by undeveloped treed/marsh areas to the north and west, Burnt Church River to the south, and Micmac Road to the east.

The site of the new aerated lagoons is predominantly tree/vegetation covered. The site topography is slightly sloping towards the south-east.

The site of the proposed LS#2 (BH-18) is located east of the existing lagoon, north of Micmac Road and east of Quash Court. The site topography is relatively flat.

3.0 FIELD PROCEDURES

The field investigation was carried out on December 22, 2014. Five (5) boreholes (BH-17 to BH-21) were drilled with a track-mounted drill rig provided by Lantech Drilling Services to depths ranging between 6.1 m and 6.4 m below the existing ground surface. Please note that borehole BH-17 was drilled along the proposed outfall alignment which will be reported in a separate report upon completion of the marine drilling program, scheduled for this winter.

Borehole locations were laid out in the field by Crandall Engineering Ltd. personnel prior to the fieldwork. The borehole locations are shown on the appended Borehole Location Plans (Figure 1 and Figure 2 – Appendix D).

During the field work a CEL engineer supervised the drilling and sample collection activities and logged the subsurface conditions encountered at each borehole. The boreholes were advanced using 100mm diameter solid stem augers. The soils were frequently sampled using a 50mm outside diameter (OD) split spoon sampler and Standard Penetration Test (N-values) procedures. Soil samples recovered were placed in moisture tight containers and returned to our laboratory for classification and testing as required. All remaining samples will be kept in storage at our office for a period of three (3) months from the date of issue of this report. After this time the samples will be discarded unless we are instructed otherwise.

A 50mm OD PVC monitoring well was installed in borehole BH-18 to permit the subsequent monitoring of groundwater conditions at the proposed LS#2. Following completion of the drilling, our personnel returned to the site on several occasions to measure the groundwater level in the installed monitoring well.

At the point of practical refusal to further penetration of the split spoon, bedrock was inferred. Proving bedrock by diamond coring techniques was not included in this scope of work.

4.0 SOIL PROFILE

The principal soil strata encountered in boreholes BH-18 to BH-21 are described in detail in the following paragraphs and on the appended Borehole Records (Appendix B). Soil classification was based on the procedures described in ASTM D2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and some laboratory testing (Appendix C). For an explanation of the descriptions used on the Borehole Records, reference should be made to the appended Symbols and Terms used on Borehole and Test Pit Records (Appendix A).

4.1 TOPSOIL

TOPSOIL was found in all boreholes and was generally found to be a black to reddish brown to grey sand with silt and organics. The thickness of this layer was found to range between 0.2 m and 0.9 m.

4.2 FILL

A layer of reddish brown to brown clay with sand and trace of gravel (FILL) was encountered in borehole BH-18. The FILL material was encountered at the proposed location of LS#2 and extended to a depth of 2.1 m below the existing ground surface. Standard Penetration tests (SPT) carried out gave N-values of 3 and 11 indicating a consistency in the range of soft to firm.

4.3 SANDY LEAN CLAY WITH TRACE OF GRAVEL

A stratum of brown to reddish brown sandy lean CLAY with trace of gravel was encountered in boreholes BH-18 and BH-19. Standard Penetration tests (SPT) carried out gave N-values which varied from 2 to 27 indicating a consistency in the range of soft to very stiff. The thickness of this stratum ranged between 2.3 m and >5.2 m.

A grain size analysis was performed on the sample collected at a depth of 2.4 m at borehole BH-19, which is considered to be generally representative of that layer. The results indicate 9.9% gravel, 22.4% sand, and 67.7% silt/clay. The natural moisture content of that stratum ranged between 12% and 26%.

4.4 LEAN CLAY WITH SAND AND TRACE OF GRAVEL

A stratum of brown to reddish brown to grey lean CLAY with sand and trace of gravel was encountered in boreholes BH-20 and BH-21. Standard Penetration tests (SPT) carried out gave N-values which varied from 3 to 36 indicating a consistency in the range of soft to hard. The thickness of this stratum ranged between >3.8 m and >4.4 m.

Laboratory testing was carried out on samples taken from both boreholes. Moisture content test results indicated the natural water content of the layer to range between 13% and 25%. Grain size analyses performed on several samples indicated 0 – 7.4% gravel, 12.4 – 38.7% sand, and 53.9 – 87.6% silt/clay.

4.5 SILTY SAND

A layer of silty SAND with trace of gravel was encountered underneath the topsoil in boreholes BH-20 and BH-21. SPT carried out gave N-values from 4 to 17 indicating the relative density was in the loose to compact range. The thickness of this layer was found to range between 1.7 m and 2.0 m.

Laboratory testing was carried out on samples taken from both boreholes. Moisture content test results indicated the natural water content of the layer to range between 19% and 29%. Grain size analyses performed on two samples indicated 0 – 0.5% gravel, 75.3 – 78.3% sand, and 21.1 – 24.7% silt/clay.

4.6 INFERRED BEDROCK

Bedrock was inferred at borehole BH-18 only, bedrock was not proven by diamond coring techniques but inferred by augering or refusal to split spoon penetration.

The bedrock geology maps of the area indicate the bedrock at the site to be a sedimentary rock formed during the Upper Carboniferous period and belonging to the Pictou Group. According to the split spoon recovery and the cuttings from the augers, the inferred bedrock consists of a grey to brown SANDSTONE which is consistent with the geological mapping in this area.

5.0 GROUNDWATER MONITORING

Groundwater conditions were observed during drilling and noted on the appended Borehole Records (Appendix B). A 50 mm OD PVC monitoring well was installed at borehole BH-18 to permit the subsequent monitoring of groundwater conditions at the proposed lift station (LS#2). Following completion of the drilling, our personnel returned to the site on several occasions to measure the groundwater level in the installed monitoring well. After bailing down the monitoring well, a vibrating wire piezometer (pressure transducer) was placed in the monitoring well and left for a period of time in order to collect groundwater data.

Groundwater levels recorded at the time of drilling, and measured at a later date, were found to range from 0.6 m to 3.2 m below the existing ground surface during the period of December 22 and December 26, 2014.

Please note that groundwater levels can be expected to fluctuate due to heavy precipitation associated with seasonal weather trends, or a particular event, site use and construction activity.

6.0 DISCUSSION AND RECOMMENDATIONS

It is understood that the proposed wastewater treatment facility will consist of two (2) new aerated lagoons, a future Submerged Attached Growth Reactor (SAGR) system, a UV Blower and Lift Station building, a deep wet well and sewer systems.

The facility will be developed mainly by backfilling operations to achieve the design grades. Existing surface elevations around the perimeter of the proposed lagoons vary between 4.4 m and 4.9 m. Therefore, it is anticipated that fill placements in the order of 0.5 m will be necessary to achieve the design grades at the bottom of the proposed new aerated lagoons (final elevation of 5.0 m) and approximately 4.5 m at the top of the perimeter embankments (final elevation of 9.0 m).

We understand that a synthetic liner will be used at the site rather than a clay liner and the removal of topsoil is being considered in the design.

We further understand the following regarding the proposed design.

- New Aerated Lagoon 1 is approximately 60 m x 70 m and has a design bottom and top elevation of 5.0 m and 9.0 m respectively;
- New Aerated Lagoon 2 is approximately 60 m x 53 m and has a design bottom and top elevation of 5.0 m and 9.0 m respectively;
- Proposed embankment slopes 3H:1V.
- Maximum water/effluent level at both aerated lagoons is designed at an elevation of 8.0 m.

The following sections provide discussion and recommendations in support of the proposed facility design.

6.1 SITE PREPARATION

We recommend the area must be cleared of all TOPSOIL and any other deleterious/unsuitable material.

The exposed subgrade should then be statically proof-rolled to re-compact the loosened surface soils and to identify any yielding soils. This operation must be carried out under the supervision of experienced geotechnical personnel. Any yielding areas revealed during the compaction operation should be excavated and replaced with compacted structural engineering fill. Any grade raising may also be carried out with compacted structural engineered fill.

The structural engineered fill should consist of well graded pit run gravel satisfying the gradation requirements given in Table 1. Any substitute material should be reviewed by Conquest Engineering prior to use.

Compaction of the subgrade should be verified by means of in-place density testing. Structural engineered fill must be placed in lifts not exceeding 300 mm in loose thickness and compacted to a minimum of 95% of the Standard Proctor (ASTM D698) maximum dry density.

Contractors must be aware that the site soils have a high percentage of fines and will soften/degrade if not protected from construction traffic, freezing conditions and/or water. Contractor must take precautions to avoid disturbance of the site soils. Any softened subgrade soils should be over-excavated and replaced with structural engineered fill as discussed previously.

Note that structural engineered fill should not be placed directly below the liner material.

Given the existing groundwater levels, dewatering during construction will be required. Surface water drainage controls should be provided where required to minimize run-off onto exposed soil. Suitable erosion and sedimentation control measures should be provided. These may include silt fences, check dams in ditches, and granular working pads while respecting provincial environmental guidelines.

Table 1: Pit Run Gravel – Gradation Limits

Sieve Size	Percent Passing
125 mm	100
100 mm	95-100
75 mm	82-100
50 mm	62-100
37.5 mm	52-100
19 mm	30-90
9.5 mm	22-79
4.75 mm	16-66
2.36 mm	12-55
1.18 mm	9-44
300 μm	4-25
75 μm	0-7

6.2 EMBANKMENT CONSTRUCTION

Embankments shall be constructed with inner and outer slopes not steeper than 3H:1V. The embankment must also be constructed with a relatively impervious soil. The hydraulic conductivity of the embankment material must be in the range of $1x10^{-8}$ m/s ($1x10^{-6}$ cm/s).

Compaction of the embankment fill must be strictly controlled and observed by Conquest Engineering. The embankment fill should be compacted to a minimum of 95% of the standard Proctor maximum dry density as determined by ASTM D698. In addition to the minimum density, the moisture content of the embankment fill must be controlled within ±1% of the optimum moisture content that corresponds to the maximum dry density. For a relatively impervious material a sheep foot roller is typically required for proper compaction. Lift thickness shall be such that each successive lift is kneaded into the underlying lift. A typical loose lift thickness ranges between 150 mm and 200 mm.

Many soils (including the native sandy lean CLAY) are suitable for the construction of embankments that meet the above criteria, however very wet fine grained soils, and/or highly organic soils should not be used. Ideally, embankment materials should be of low permeability yet readily compactable to 95% of the Standard Proctor maximum dry density. Soils that are naturally wet above the optimum moisture can still be used if they can be sufficiently dried out during the construction period. Laboratory testing should be conducted on proposed materials to determine grain size, moisture-density relationship, hydraulic conductivity and natural moisture content of materials proposed for embankment construction.

Total and differential settlements in the order of 125 mm and 75 mm, respectively, should be expected following the completion of the embankment construction. We understand from our discussion that settlements of that order of magnitude are acceptable for your design.

Staged construction of the embankments will be required so as to not exceed the shear strength of the underlying lean CLAY layer. A temporary reduction in shear strength of the lean CLAY is caused by temporarily elevated pore water pressures induced by construction fills. As time proceeds, following the fill placement, elevated pore water pressures in the lean CLAY will dissipate, and allow the shear strength of the lean CLAY to improve. **Preliminary calculations indicate that the critical height of the first stage of embankment fill is on the order of 3.0 m. The next stage of embankment fill may be placed once the excess pore water pressure have dissipated.**

Prior to the start of any embankment work, we recommend the installation of a series of piezometers and settlement plates to monitor the increase of pore water pressure and settlements during the embankment construction. The construction would cease once the pore water pressure has reached the maximum pore water pressure recommended and may resume once the pore water pressure has dissipated to a safe level as recommended by the geotechnical consultant.

Further soils investigation around the embankment footprint and laboratory testing of the clay material will be required to confirm critical construction heights and maximum tolerable pore water pressures during construction.

A preliminary estimate of time rate of settlement was conducted based on limited geotechnical information. It is estimated that a post-construction settlement on the order of 50 mm may be expected 3 to 4 months following the completion of the first stage of embankment fill. Magnitude and time rate of settlement will need to be verified with the results of additional soils investigation and laboratory testing.

Outer slopes shall have a cover layer of fertile topsoil of adequate thickness to promote establishment of an adequate vegetation cover wherever rip-rap is not specified. Appropriately sized rip-rap will be required on outer slopes to provide erosion protection from hydrological events based on flood study.

The interior berm slopes should also have adequate erosion control as required (rip-rap should extent a minimal distance below the minimum operating water/effluent level).

6.3 BUILDING STRUCTURES

It is our understanding that the construction of a UV Blower and lift station building is proposed within the top of the berm (within the area of BH-21). The facility building footings may be proportioned for a net allowable bearing pressure of 150 kPa. Total and differential settlements under this intensity of pressure are estimated to be less than 25 mm and 19 mm, respectively, **in addition to settlements resulting from the construction of the embankment which should be in the order of 75 mm (if the building is built shortly after the embankment).** Strict control of material placement and compaction should be conducted as detailed above.

For frost protection, the base of all exposed footings should extend to a minimum depth of 1.8 m below the final grade or protected with proper insulation around the perimeter of a slab on grade. To prevent ad-freezing within the frost penetration depth, non-frost susceptible fill should be used as backfill. Pit run gravel with less than 5% finer than the #200 sieve is acceptable non-frost susceptible fill material.

6.4 Synthetic Liner Construction

It is understood that a synthetic liner will be used at the site. The seepage loss through the synthetic liner shall not exceed the quantity equivalent through an adequate soil liner. For liner durability, the minimum liner thickness for a HDPE liner shall be 1.5 mm (60 mil). The liner shall be underlain by a sand layer with a minimum thickness of 150 mm to provide a levelling course and to ensure that there are no sharp protrusion which would puncture the synthetic liner. The pond bottom should be as level as possible, finished elevations should not be more than 75mm from the average elevation of the bottom (elevation of 5.0 m).

It will also be necessary to cover the liner with a layer of sand of at least 150 mm in thickness. If it is proposed to occasionally empty the cells for maintenance purposes, and if heavy construction equipment is required for maintenance, it will be necessary to thicken the protective sand layer.

6.5 Lift Stations (Wet Wells)

We understand that two lift stations are proposed at the location of BH-18 and BH-21. Based on the soil conditions encountered at the borehole locations, the following recommendations are provided for the new lift stations.

6.5.1 Lift Station at BH-18

We understand that the bottom of the new pre-cast wet well will be placed at an approximate depth of 5.0 m below the existing ground surface therefore the wet well will be founded on inferred bedrock.

The groundwater table was encountered at a depth of 3.2 m on December 26, 2014. Given the groundwater level and the proximity of existing structures (underground conduits) maintaining an open excavation may be an issue. If an open excavation is not feasible then an adequate shoring system will be required.

If an open excavation does not interfere with any structures then an open excavation with proper sloping/benching is feasible. Excavated slopes should not be steeper than 1.5H:1V given the existing soils at the site. Proper groundwater control should be used to control surface erosion on temporary slopes and potential slope surface sloughing.

Based on the soils and groundwater conditions encountered, piping and base heave should not be a concern at this site, as the bottom of the excavation will be on bedrock. However, adequate shoring engineering design is the responsibility of the shoring contractor.

6.5.2 Lift Station at BH-21

We understand that the bottom of the new pre-cast wet well will be placed at an approximate depth of 6.0 m below the final grade (1 m below the existing ground surface) and the excavations will penetrate into the saturated silty SAND layer. The groundwater table was encountered at a depth of 0.6 m below the existing ground surface (5.6 m below the final grade) at time of drilling.

If an open excavation is not desirable (to minimize the excavation in the new embankment) then an adequate shoring system will be required.

Based on the soils and groundwater conditions encountered, piping from seepage into the base of the excavation is not a concern. However, adequate shoring engineering design is the responsibility of the shoring contractor.

6.5.3 General Recommendations

It should be expected that groundwater flow into excavations will have to be controlled with the use of dewatering pumps or other means to achieve and maintain the base of excavations in a relatively dry and manageable state during construction.

We recommend that the wet well footprint be over excavated by approximately 300 mm to accommodate the placement of stone bedding material (20 mm clear stone) or mud slab as a levelling course.

We recommend backfilling the wet well excavations using structural engineered fill. Structural engineered fill may consist of 125 mm well graded pit-run gravel complying with the NBDOT Standard Specifications Item 201. Structural engineered fill should be placed to a maximum lift of 300 mm and compacted to a minimum of 95% of the corrected maximum dry density as per ASTM D698 (standard Proctor).

We recommend that the shoring system be designed to safely resist lateral soil pressure, the hydrostatic pressures and the lateral pressure from construction surcharge.

It is recommended that the shoring system be extracted in small increments and backfilled to the bottom of the system as it is extracted being careful to completely fill the excavation and leave no voids.

It is recommended that the base of the wet well be designed to resist buoyant forces

For both lift stations listed above, total and differential settlements should be minimal and within tolerable limits for the wet well (assuming lift station at BH-21 is built once primary settlement from the embankment construction is completed).

Safe excavated slopes are the responsibility of the earthwork contractor. As a minimum, temporary excavations must be sloped in accordance with the applicable Work Safe New Brunswick regulations. However, excavation slopes made below the groundwater table and in soft/loose soil will slough to slopes flatter than 1H:1V. Control of groundwater will be necessary to improve sloughing problems. If an excavation cannot be properly sloped or benched due to high groundwater and/or loose/soft soils, the contractor should install an engineered shoring system (with appropriate dewatering equipment) to safely support the temporary excavation. Excavation slopes should be checked regularly for signs of instability and flattened as required. Temporary slopes should be protected from surface erosion by means such as (but not limited to): swales or ditches around the perimeter of the excavation; and/or by using plastic sheeting placed over the slope.

7.0 CLOSURE

This report has been prepared for the sole benefit of Crandall Engineering Ltd. Any use or reliance on this report:

a. where there have been any change in site conditions;
b. for purposes not intended or delineated in this report ; or
c. by third parties without express written agreement of Conquest Engineering

renders this report inapplicable. Any use of or reliance upon this report under such circumstances or by such parties is strictly prohibited and without risk or liability to Conquest.

Conquest Engineering used reasonable care, skill, competence and judgment in the preparation of this report. The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. The information and conclusions contained in this report are generally consistent with professional standards for individuals providing similar services at the same time, in the same locale and under like circumstances.

A geotechnical field investigation is a limited sampling of a site. Some variation between sampling locations should be expected. The conclusions presented in this report represent the best technical judgment of Conquest Engineering based on the data obtained from the work. The conclusions are based on the site conditions observed by Conquest Engineering at the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction and other activities. Due to the nature of the investigation and the limited data available, Conquest Engineering cannot warrant against undiscovered environmental liabilities.

If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein. Further, if there are changes to the proposed work, such as adjustments in founding elevation or building loads, etc., we require that we be notified to allow for review of our recommendations.

We trust this is the information you require at this time. If you have any questions or if we can be of any further assistance please feel free to contact us.

Respectfully submitted,
CONQUEST ENGINEERING LTD.

Robert Y. Cyr, M.A.Sc., P. Eng.
Senior Engineer / Principal

APPENDIX A

SYMBOLS AND TERMS USED ON BOREHOLES AND TEST PIT RECORDS

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting good vegetative growth
Peat	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	>75 mm
Seam	-	2 mm to 75 mm
Parting	-	< 2 mm
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Uniformly Graded	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	Greater than 20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' – value.

Relative Density	'N' Value	Compactness %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength (Su)		'N' Value
	Kips/sq.ft.	KPa	
Very Soft	< 0.25	< 12.5	< 2
Soft	0.25 – 0.5	12.5 – 25	2 – 4
Firm	0.5 – 1.0	25 – 50	4 – 8
Stiff	1.0 – 2.0	50 – 100	8 – 15
Very Stiff	2.0 – 4.0	100 – 200	15 – 30
Hard	> 4.0	> 200	> 30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on N-size (45 mm) core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from in situ fractures.

RQD	ROCK QUALITY
90 – 100	Excellent, intact, very sound
75 – 90	Good, massive, moderately jointed or sound
50 – 75	Fair, blocky and seamy, fractured
25 – 50	Poor, shattered and very seamy or blocky, severely fractured
0 – 25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000 – 6000	*Very Thick*	*Very Wide*
600 – 2000	*Thick*	*Wide*
200 – 600	*Medium*	*Moderate*
60 – 200	*Thin*	*Close*
20 – 60	*Very Thin*	*Very Close*
< 20	*Laminated*	*Extremely Close*
< 6	*Thinly Laminated*	

Strength Classification	Uniaxial Compressive Strength (MPa)
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

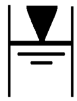
Terminology describing weathering:

Slight - Weathering limited to the surface of major discontinuities. Typically iron stained.
Moderate - Weathering extends throughout rock mass. Rock is not friable.
High - Weathering extends throughout rock mass. Rock is friable.

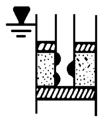
STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:

WATER LEVEL MEASUREMENT



Borehole or Standpipe



Piezometer

SAMPLE TYPE AND/OR FIELD TESTS

SS	Split Spoon Sample (obtained by performing the Standard Penetration Test)
ST	Shelby Tube or Thin Wall Tube
PS	Piston sample
DC	Dynamic Cone Penetration
FSV	Field Shear Vane
AS	Auger Sample
BS	Bulk Sample
WS	Wash Sample
HQ, NQ, BQ, etc.	Rock Core Samples (obtained with the use of standard size diamond drilling bits)

N- VALUE

Numbers in this column are the results of the SPT (Standard Penetration Test): the number of blows of a 140 pound (64kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the abbreviation SSR (Split Spoon Refusal) will appear in place of a numerical value.

OTHER TESTS

Symbols in this column indicate that the following laboratory tests have been carried out and the results are presented separately.

S	Sieve analysis
G_s	Specific gravity of soil particles
k	Permeability
	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; Test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer
H	Hydrometer analysis
γ	Unit weight
C	Consolidation
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct shear
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Records equals I_p(50); the index corrected to a reference diameter of 50 mm)
MSV	Laboratory Miniature Shear Vane

APPENDIX B

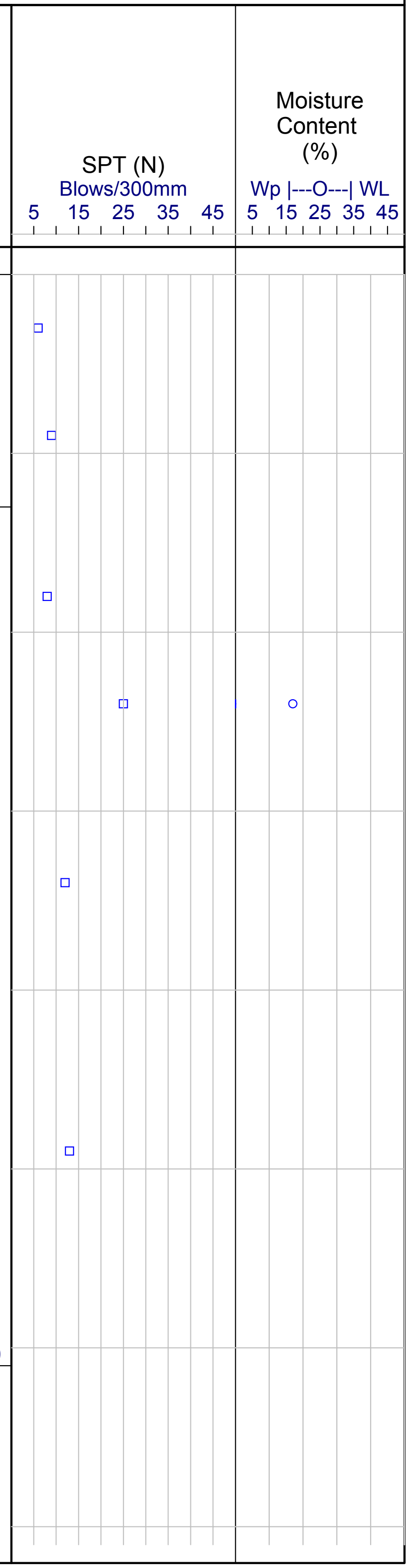
BOREHOLE RECORDS

BOREHOLE RECORD

Conquest Engineering — Experience commitment.
Geotechnical and Materials Engineers

Project Name: SI - New Wastewater Treatment Facility - 2nd Investigation
Project No.: 071-135 **BH -** 17
Client: Crandall Engineering Ltd. **Page:** 1 of 1
Location: Esgenoôpetitj First Nation - Burnt Church, NB **Date Drilled:** Dec. 22, 2014
Water Level: Tidal **Datum:** Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	Symbols	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0								2.1 / 0.0
		SS	1	6	150		Loose brown to grey silty SAND with trace of organics	
1		SS	2	9	250			
		-	-	-	-			0.8 / 1.3
							Firm to very stiff brown to reddish brown sandy lean CLAY with trace of gravel	
2		SS	3	8	300			
		SS	4	25	330			
3		-	-	-	-			
		SS	5	12	380			
4		-	-	-	-			
5		SS	6	13	430			
		-	-	-	-			
6							End of Borehole	-4.0 / 6.1
7								



BOREHOLE RECORD

Conquest Engineering — Experience commitment.
Geotechnical and Materials Engineers

Project Name: SI - New Wastewater Treatment Facility - 2nd Investigation
Project No.: 071-135
BH - 18
Client: Crandall Engineering Ltd.
Page: 1 of 1
Location: Esgenoôpetitj First Nation - Burnt Church, NB
Date Drilled: Dec. 22, 2014
Water Level: 3.2 m on December 26, 2014
Datum: Geodetic

Depth (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0					Black to reddish brown to grey sand with silt and organics: TOPSOIL	5.4 / 0.0
	SS	1	10	280	Firm to soft reddish brown to brown clay with sand and trace of gravel: FILL	
	SS	2	11	0	- organics at 2.0 m	
	-	-	-	-		
	SS	3	3	400		
2.1	SS	4	18	430	Very stiff brown to reddish brown sandy lean CLAY with trace of gravel	3.3 / 2.1
	-	-	-	-		
	SS	5	32	500		
3.5	-	-	-	-	- sand layer at 3.5 m	1.9 / 3.5
4.4	SS	6	SSR	0	Inferred grey to brown SANDSTONE bedrock - easy to medium augering	1.0 / 4.4
	-	-	-	-		
6.1					End of Borehole	-0.7 / 6.1

Water level symbol at approx. 3.2 m.

SPT (N) Blows/300mm: 5 15 25 35 45
Moisture Content (%) Wp |---O---| WL: 5 15 25 35 45

Depth scale: ft 0–23; m 0–7

BOREHOLE RECORD

Conquest Engineering — Experience commitment.
Geotechnical and Materials Engineers

Project Name: SI - New Wastewater Treatment Facility - 2nd Investigation
Project No.: 071-135 **BH -** 19
Client: Crandall Engineering Ltd. **Page:** 1 of 1
Location: Esgenoôpetitj First Nation - Burnt Church, NB **Date Drilled:** Dec. 22, 2014
Water Level: 0.6 m on December 22, 2014 **Datum:** Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0		SS	1	5	400	Black to reddish brown to grey sand with silt and organics: TOPSOIL	4.9 / 0.0
	▼ (0.6)	SS	2	6	280		
0.9						Soft to very stiff reddish brown to grey sandy lean CLAY with trace of gravel and shells	4.0 / 0.9
		-	-	-	-	- trace of organics at 1.8 m	
		SS	3	2	330	- occasional sand seams throughout	
		SS	4	9	430		
		-	-	-	-		
		SS	5	3	600		
		SS	6	22	50		
		-	-	-	-		
4.6		SS	7	21	280	- more sand and gravel from 4.6 m to 6.1 m	0.3 / 4.6
		SS	8	27	0		
		-	-	-	-		
6.1						End of Borehole	-1.2 / 6.1

SPT (N) Blows/300mm: 5 15 25 35 45

Moisture Content (%) Wp |---O---| WL: 5 15 25 35 45

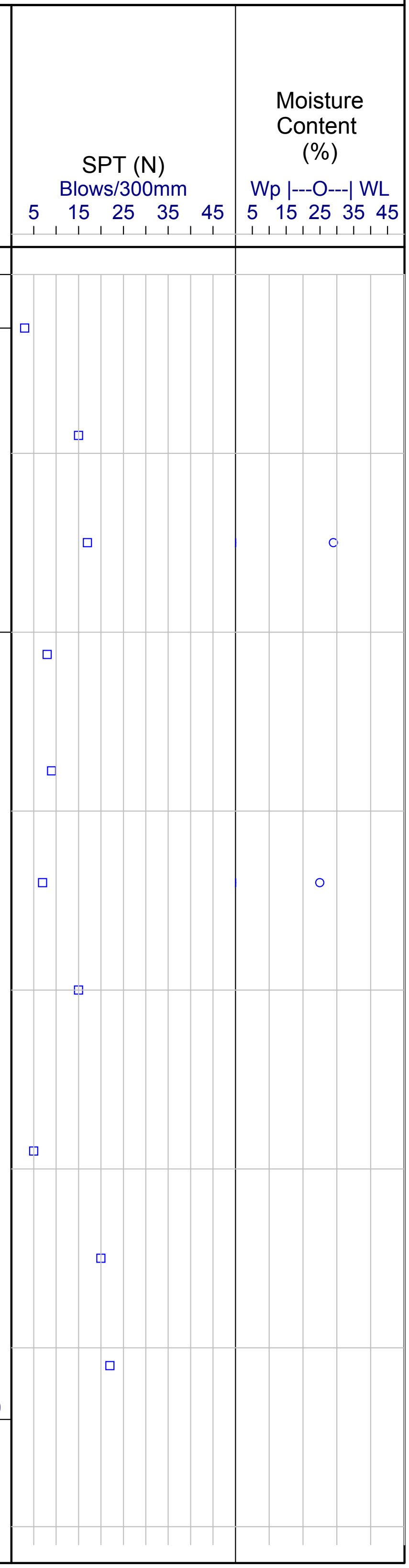
Conquest Engineering
Experience commitment.
Geotechnical and Materials Engineers

BOREHOLE RECORD

Project Name: SI - New Wastewater Treatment Facility - 2nd Investigation
Project No.: 071-135
Client: Crandall Engineering Ltd.
Location: Esgenoôpetitj First Nation - Burnt Church, NB
Water Level: 0.6 m on December 22, 2014

BH - 20
Page: 1 of 1
Date Drilled: Dec. 22, 2014
Datum: Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0		SS	1	3	250	Black to reddish brown sand with silt and organics: TOPSOIL	4.5 / 0.0
0.3	▼ (0.6)	SS	2	15	430	Loose to compact reddish brown to grey silty SAND with trace of gravel	4.2 / 0.3
		SS	3	17	450		
2.0		SS	4	8	600	Firm to very stiff reddish brown to grey lean CLAY with some sand and trace of gravel - occasional sand seams throughout	2.5 / 2.0
		SS	5	9	450		
		SS	6	7	600		
		SS	7	15	600		
		-	-	-	-		
		SS	8	5	350		
		SS	9	20	400		
		SS	10	22	200		
6.4						End of Borehole	-1.9 / 6.4



BOREHOLE RECORD

Conquest Engineering – Experience commitment.

Geotechnical and Materials Engineers

Project Name: SI - New Wastewater Treatment Facility - 2nd Investigation

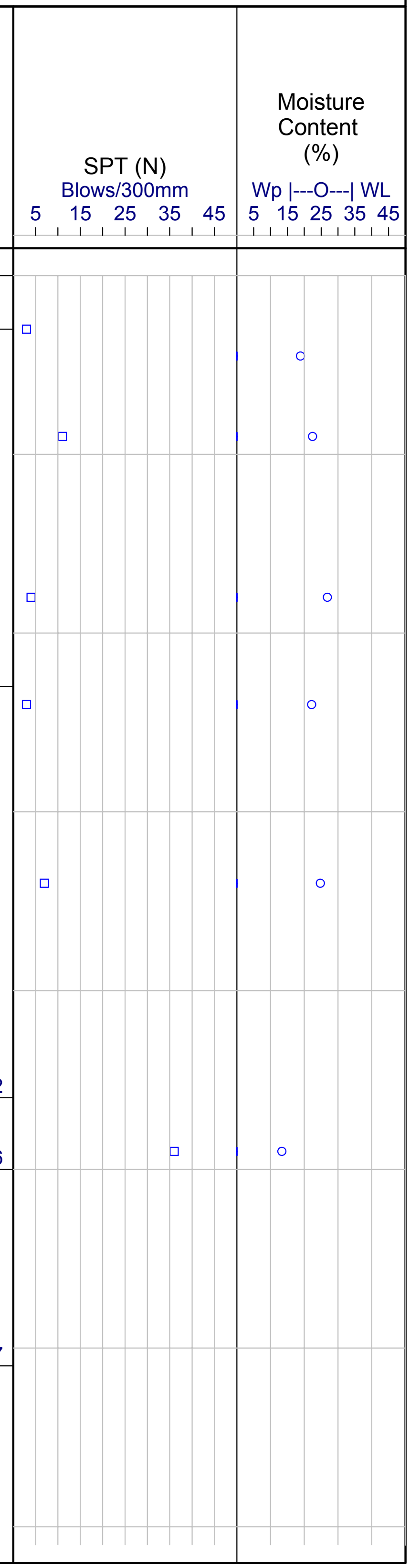
Project No.: 071-135 **BH -** 21

Client: Crandall Engineering Ltd. **Page:** 1 of 1

Location: Esgenoôpetitj First Nation - Burnt Church, NB **Date Drilled:** Dec. 22, 2014

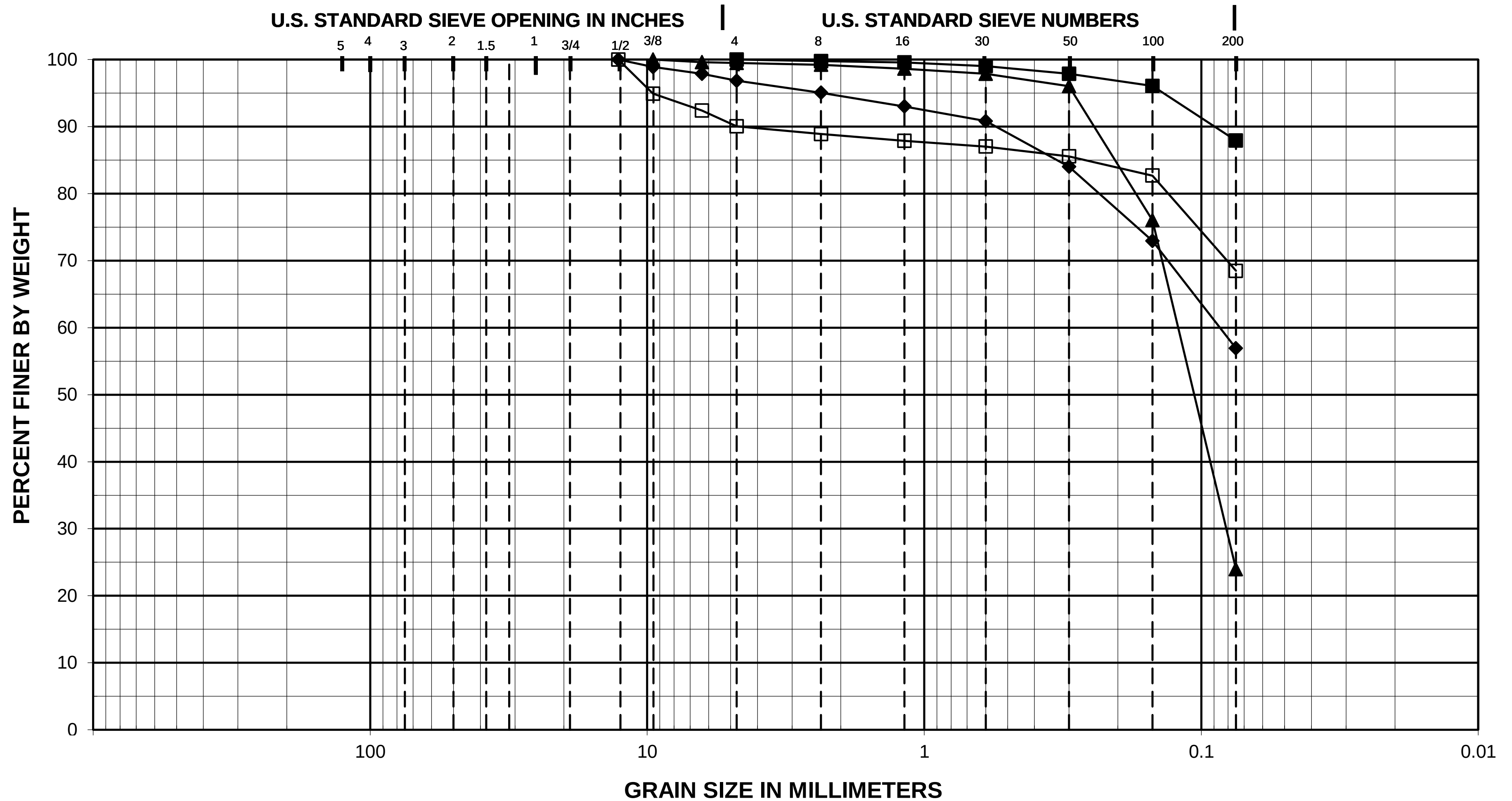
Water Level: 0.6 m on December 22, 2014 **Datum:** Geodetic

Depth (m)	Water Level (m)	Sample Type	Sample Number	N Value or RQD %	Recovery (mm)	SOIL AND/OR ROCK DESCRIPTION	Elevation/Depth (m)
0.0–0.3		SS	1	3	280	Black to reddish brown sand with silt and organics: TOPSOIL	4.4 / 0.0
0.3–2.3	▼ (0.6)	SS	2	11	400	Loose to compact grey to brown silty SAND with trace of gravel	4.1 / 0.3
		-	-	-	-		
		SS	3	4	250		
2.3–6.1		SS	4	3	430	Soft to hard brown to reddish brown lean CLAY with sand and trace of gravel	2.1 / 2.3
		-	-	-	-		
		SS	5	7	600		
		-	-	-	-		
		SS	6	36	280	- more sand and gravel from 4.6 m to 6.1 m	-0.2 / 4.6
						- cobbles at 5.0 m	-0.6 / 5.0
		-	-	-	-		
6.1						End of Borehole	-1.7 / 6.1



APPENDIX C

LABORATORY TESTING



	Sample No.	Depth (m)	Classification	w%	Cu	Cc	% Gravel	% Sand	% Silt and Clay
◆	BH 17-4	2.4	Sandy lean CLAY	17%	NA	NA	3.1	40.4	56.5%
□	BH 19-4	2.4	Sandy lean CLAY	21%	NA	NA	9.9	22.4	67.7%
▲	BH 20-3	1.5	Silty SAND	29%	NA	NA	0.5	78.3	21.1%
■	BH 20-6	3.4	Lean CLAY	25%	NA	NA	0.0	12.4	87.6%
○									

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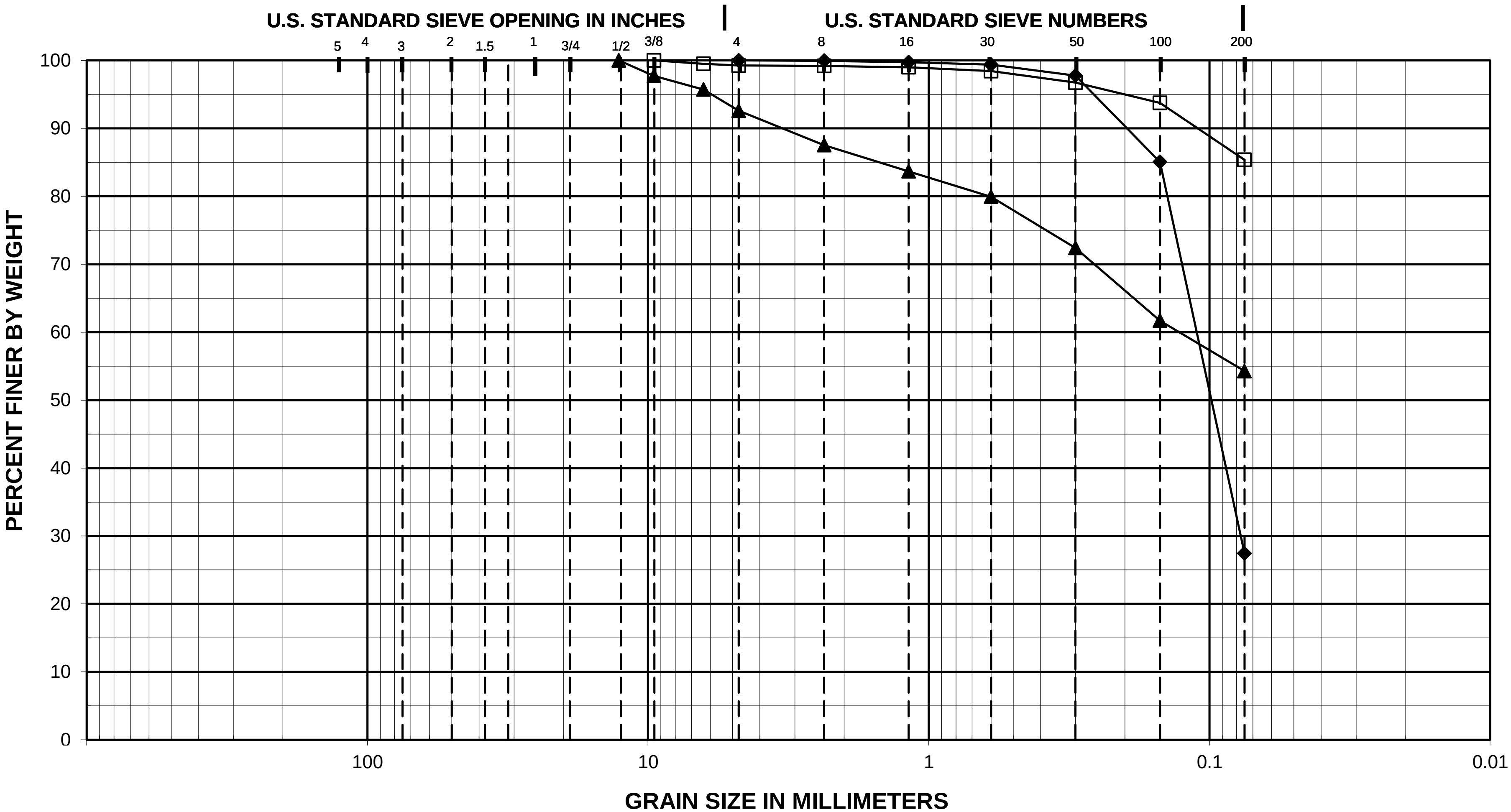
Experience commitment.
Geotechnical and Materials Engineers

Project: SI - New Wastewater Treatment Facility - Burnt Church, NB

Job No.: 071-135 **Location:** Burnt Church, NB

Date: January 5, 2015 **Notes:**

SIEVE ANALYSIS



	Sample No.	Depth (m)	Classification	w%	Cu	Cc	% Gravel	% Sand	% Silt and Clay
◆	BH 21-3	1.8	Silty SAND	27%	NA	NA	0.0	75.3	24.7%
□	BH 21-5	3.4	Lean CLAY with sand	25%	NA	NA	0.8	14.4	84.8%
▲	BH 21-6	4.9	Sandy lean CLAY	13%	NA	NA	7.4	38.7	53.9%
■									
○									

Conquest Engineering
Experience commitment.
Geotechnical and Materials Engineers

Project: SI - New Wastewater Treatment Facility - Burnt Church, NB

Job No.: 071-135 **Location:** Burnt Church, NB

Date: 5-Jan-15 **Notes:**

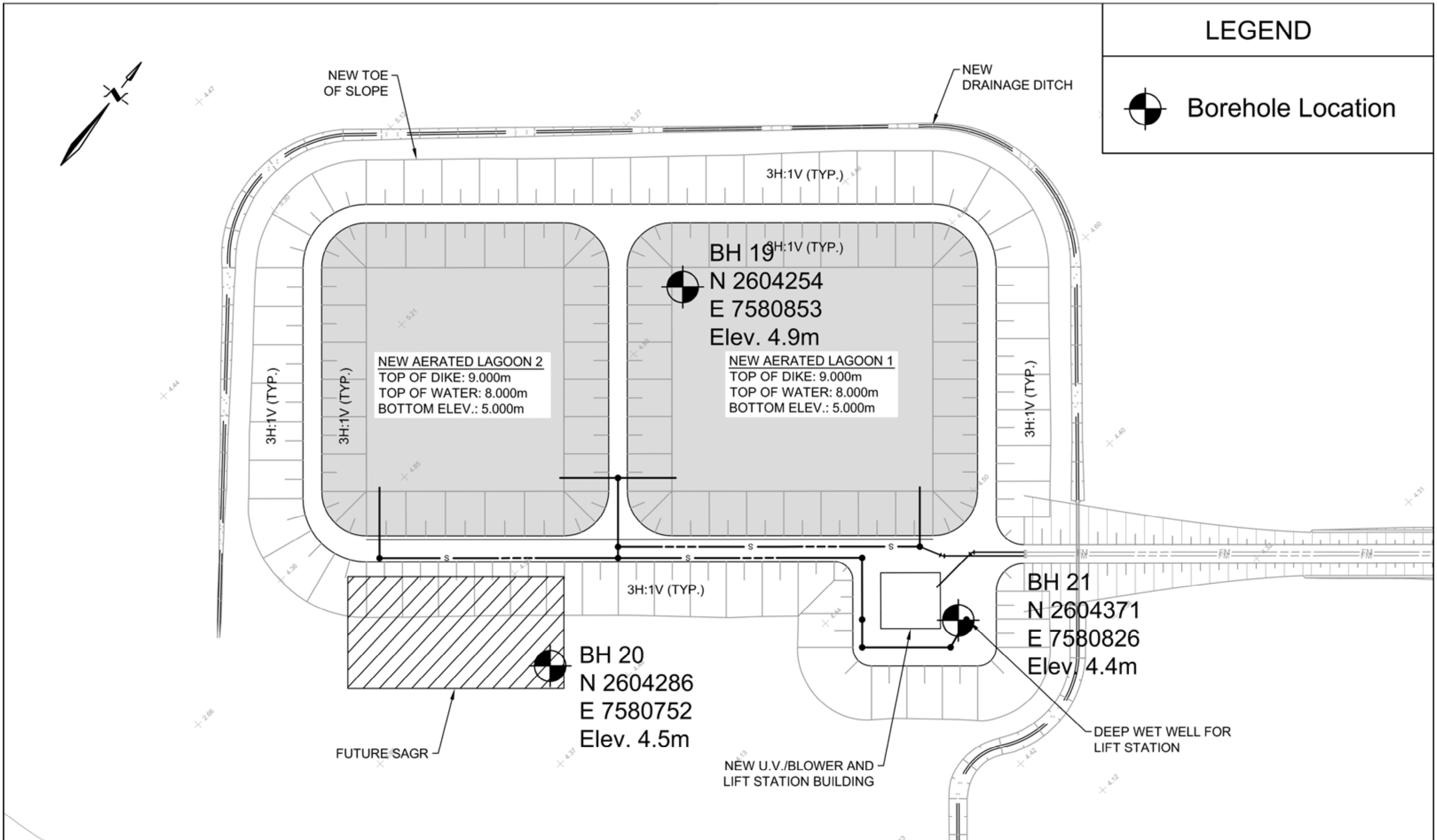
SIEVE ANALYSIS

APPENDIX D

FIGURE 1 – BOREHOLE LOCATION PLAN (BH-17 AND BH-18)

FIGURE 2 – BOREHOLE LOCATION PLAN (BH-19 TO BH-21)

BOREHOLE LOCATION PLAN PROPOSED WASTEWATER TREATMENT FACILITY ESGENOÔPETITJ FIRST NATION BURNT CHURCH, NB	Conquest Engineering Experience commitment. Geotechnical and Materials Engineers Saint John Moncton Fredericton Bedford Corner Brook	THIS DRAWING IS THE PROPERTY OF CONQUEST ENGINEERING LTD. LOANED TO THE RECIPIENT WHO AGREES THAT IT SHALL NOT BE GIVEN OUT, COPIED OR DUPLICATED FOR THE USE OF ANOTHER BUT SHALL BE USED ONLY BY THE RECIPIENT FOR THE PURPOSE TO WHICH IT REFERS.	DATE: JANUARY 16, 2015	SCALE: NTS
			PROJECT No.: 071–135	FIGURE: 1



BOREHOLE LOCATION PLAN PROPOSED WASTEWATER TREATMENT FACILITY ESGENOÔPETITJ FIRST NATION BURNT CHURCH, NB	Conquest Engineering Experience commitment. Geotechnical and Materials Engineers Saint John Moncton Fredericton Bedford Corner Brook	THIS DRAWING IS THE PROPERTY OF CONQUEST ENGINEERING LTD. LOANED TO THE RECIPIENT WHO AGREES THAT IT SHALL NOT BE GIVEN OUT, COPIED OR DUPLICATED FOR THE USE OF ANOTHER BUT SHALL BE USED ONLY BY THE RECIPIENT FOR THE PURPOSE TO WHICH IT REFERS.	DATE: JANUARY 16, 2015 PROJECT No.: 071–135	SCALE: NTS FIGURE: 2