

**FOUNDATION INVESTIGATION FOR  
UTILITY RELOCATION  
PROPOSED HIGHWAY 26 REALIGNMENT  
BETWEEN COLLINGWOOD AND  
WASAGA BEACH, ONTARIO**

Ministry of Transportation, Ontario

Project: SPT1234  
December 12, 2008

December 12, 2008

Ministry of Transportation  
Corridor Management Section, Central Region  
7<sup>th</sup> Floor, Building D  
1201 Wilson Avenue  
Downsview, Ontario  
M3M 1J3

**Attention: Mr. Eugene Marshall, O.L.S.**

Dear Sirs:

**RE: Foundation Investigation Report for Utility Relocation, Proposed Highway 26 Realignment  
Between Collingwood and Wasaga Beach, Ontario**

Please find attached the results of our foundation investigation and report relating to the above noted site.

If you have any comments or queries please contact the undersigned.

For and on behalf of Coffey Geotechnics Inc.

**Ramon Miranda, P.Eng.**  
Manager, Transportation Division

Attachment A: Attachments

# CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
<b>2</b>	<b>SITE DESCRIPTION AND PHYSIOGRAPHY</b>	<b>1</b>
<b>3</b>	<b>FIELD AND LABORATORY WORK</b>	<b>2</b>
<b>4</b>	<b>AREA 1</b>	<b>2</b>
<b>4.1</b>	<b>Summarized Subsurface Conditions</b>	<b>2</b>
4.1.1	Topsoil	3
4.1.2	Granular Fill	3
4.1.3	Surficial Silty Clay and Clayey Silt	3
4.1.4	Sand	3
4.1.5	Silty Clay to Clayey Silt Till	4
4.1.6	Sandy Silt to Silty Sand Till	4
4.1.7	Groundwater Conditions	5
<b>5</b>	<b>AREA 2</b>	<b>5</b>
<b>5.1</b>	<b>Summarized Subsurface Conditions</b>	<b>5</b>
5.1.1	Topsoil	6
5.1.2	Granular Fill	6
5.1.3	Upper Sand	6
5.1.4	Silty Sand	6
5.1.5	Sandy Silt to Silty Sand Till	7
5.1.6	Lower Sand	7
5.1.7	Sandy Silt	7
5.1.8	Groundwater Conditions	7
<b>6</b>	<b>AREA 3</b>	<b>8</b>
<b>6.1</b>	<b>Summarized Subsurface Conditions</b>	<b>8</b>
6.1.1	Granular Fill	8
6.1.2	Silty Clay to Clayey Silt	8
6.1.3	Sandy Silt Till	9
6.1.4	Groundwater Conditions	9
<b>7</b>	<b>AREA 4</b>	<b>10</b>

# CONTENTS

<b>7.1</b>	<b>Summarized Subsurface Conditions</b>	<b>10</b>
7.1.1	Asphalt Pavement and Granular Fill	10
7.1.2	Silty Clay Fill	10
7.1.3	Clayey Silt to Silty Clay	10
7.1.4	Sandy Silt to Silty Sand Till	11
7.1.5	Possible Bedrock	11
7.1.6	Groundwater Conditions	11
<b>8</b>	<b>AREA 5</b>	<b>12</b>
<b>8.1</b>	<b>Summarized Subsurface Conditions</b>	<b>12</b>
8.1.1	Fill	12
8.1.2	Pavement and Granular Fill	12
8.1.3	Silt	12
8.1.4	Sandy Silt Till	13
8.1.5	Groundwater Conditions	13

## Drawing

Key Plan

## Appendices

Appendix A: Area 1

Appendix B: Area 2

Appendix C: Area 3

Appendix D: Area 4

Appendix E: Area 5

Appendix F: Explanation of Terms Used in the Report

Appendix G: Limitations of Report

## **1 INTRODUCTION**

Coffey Geotechnics Inc. (formerly Shaheen & Peaker Limited) was retained by Ministry of Transportation, Ontario (MTO), Corridor Management Section, to carry out a foundation investigation for utility relocation at the site for proposed realignment of Highway 26 between Collingwood and Wasaga Beach, Ontario. The utility relocation site is composed of five (5) areas as shown in the key plan.

The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes, and to determine the engineering characteristics of the subsurface soils by means of field and laboratory tests.

The findings of the investigation are presented in this report.

## **2 SITE DESCRIPTION AND PHYSIOGRAPHY**

Highway 26, in the area of the project, crosses the western extremity of the Nottawasaga Basin. According to the Physiography of Southern Ontario by L.J. Chapman and D.F. Putnam, 1984, the basin is located within the Physiographic Region known as the Simcoe Lowlands. The area contains some rolling and some broad flatlands such as the Minesing Flats. The area is drained by the Nottawasaga River and its tributaries.

The Nottawasaga Basin was covered by the Georgian Bay Lobe of the Laurentide Ice Sheet which formed the Edenvale Moraine east of the project area and the Cornhill Moraine south of the project area. This ice sheet deposited sandy, silty ground moraine till over most of the basin. Sandy, silty tills with boulders and cobbles were laid down south of the project area on the slope of the Niagara Escarpment as well as within the project area. During the occupation of the area by lake waters, sandy and gravelly beaches were formed along the shorelines and on hillsides. On the Niagara Escarpment slope, shore cliffs were formed by wave action of lake waters. The Nottawasaga River deposited a large sandy delta as it entered Glacial Lake Nipissing and the current Georgian Bay. Sand with some gravel and silt were deposited along the shore forming the current Wasaga Beach.

The project area is underlain by the Collingwood member of the Middle Ordovician Lindsay Formation, consisting of interbedded, black, organic-rich limestone and highly calcareous and fossiliferous black shale. Southwest of the project area, at the lower part of the Niagara Escarpment, a blue-grey, non-calcareous, fissile shale of the late Ordovician Blue Mountain Formation is found, which is overlain by the Georgian Bay Formation blue-grey shale with light grey to cream coloured limestone and dolostone. The deposition of these formations occurred within an approximate time period between 550 and 500 million years before the present. During the wave erosion process of the Niagara Escarpment, rock from these formations contributed clay, boulders and cobbles to the till deposit of the project site.

The western and central part of the project area is underlain by a sandy, silty till with cobbles and boulders of mainly carbonate rocks, except near the present lakeshore, where sand and gravel beaches dominate.

### **3 FIELD AND LABORATORY WORK**

The fieldwork for this project was performed on September 17, 18 and 19, 2008 and consisted of drilling and sampling 21 boreholes to depths ranging from 3.7 to 6.7 m below the ground surface. The five areas (Area 1 to 5) of the site are shown on the key plan. The locations of the boreholes at each area are given on the Borehole Location Plans, Drawing Nos. A-1, B-1, C-1, D-1 and E-1 in Appendices A, B, C, D and E, respectively.

The boreholes were advanced using a truck-mounted drilling rig owned and operated by Eastern Soil Drilling of Courtice, Ontario under the full-time supervision of technical personnel from S&P. The boreholes were advanced using continuous flight solid stem augers. The boreholes were extended by augering to depths ranging from 3.7 to 6.7 m below existing ground surface. Within these depths, the sampling was effected at frequent intervals of depth by the Standard Penetration Test method (SPT), in general accordance with ASTM D1586. The test consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split barrel (SS – split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the N-value of the soil which is indicative of the compactness condition of granular (cohesionless) soils (gravels, sands and coarse silts) or the consistency of cohesive soils (clays and clayey silts).

The borehole locations were established in the field by S&P engineering staff, in relation to the existing features. The borehole geodetic elevations were determined and provided by J.D. Barnes Limited, Ontario Land Surveyors.

Water level observations in the open boreholes were made during the drilling and at completion of each borehole.

Upon their completion, the boreholes were backfilled with a mixture of auger cuttings and hole plug.

The soil samples were transported to our geotechnical laboratory in Toronto for further examination and classification. A laboratory testing programme, consisting of natural moisture content determinations, grain size analyses and Atterberg Limits tests, was performed on selected representative samples. The results of the laboratory tests are presented on the appropriate Record of Borehole Sheets in the Appendices.

### **4 AREA 1**

Area 1 is located at the future east transition area from the existing Highway 26 to the proposed Highway 26 realignment.

Boreholes U1, U2, U3, U4 and U5 were drilled at the locations shown on the Borehole Location Plan, Drawing A-1 in Appendix A.

#### **4.1 Summarized Subsurface Conditions**

Five Boreholes (Boreholes U1 to U5) were advanced in surrounding area of the existing and proposed Highway 26 near to the junction of existing Highway 26 with Ramblewood Drive in the Township of Clearview.

Boreholes U1 and U3, drilled about 7.0 to 6.5 m away from the existing Highway 26 centerline, contacted granular fill materials to depths of 0.3 to 0.5 m below the ground surface. This fill is in turn underlain by an about 0.5 m thick silty clay to clayey silt layer in both Boreholes U1 and U3. Below this cohesive soil layer, Boreholes U1 and U3 encountered silty clay and clayey silt glacial till deposit which is further underlain by sandy silt to silty sand till at depths of 1.6 m (Borehole U1) and 3.1 m (Borehole U3). Borehole U1 and U3 were terminated in sandy silt till layer at depths of 6.7 m (Borehole U1) and 3.5 m (Borehole U3)

Borehole U2 is located at about 30.0 m west of the existing Highway 26 centerline, as shown in Drawing A-1. Borehole U2 contacted 0.3 m thick of topsoil which underlain by silty clay to a depth of 0.8 m. Below the silty clay, Borehole U2 contacted a 0.4 m thick sand layer which is underlain by silty clay till at a depth of 1.2 m. This cohesive till is further underlain at a depth of 6.2 m by a granular (non-cohesive) sandy silt till to the end of borehole at a depth of 6.4 m below ground surface.

Boreholes U4 and U5 contacted an about 0.2 m thick topsoil layer at the ground surface. The topsoil in Borehole U5 is underlain by 0.3 m thick clayey silt layer with traces of organics. The topsoil in Borehole U4 and the clayey silt in Borehole U5 are in turn underlain by sandy silt till to the termination of boreholes at a depth of 6.4 m below the ground surface.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole sheets in Appendix A. The following paragraphs are only meant complement and amplify these data.

#### **4.1.1 Topsoil**

Boreholes U2, U4 and U5 which were put down some 30 m plus distance from the existing Highway 26 centerline contacted an about 0.2 m thick topsoil layer at the ground surface level.

#### **4.1.2 Granular Fill**

Boreholes U1 and U3 were drilled about 7 m left of the existing Highway 26 centerline and these contacted an approximately 0.3 m to 0.5 m thick granular fill at ground surface. Granular fill was found to consist of gravelly sand in Borehole U1 while sand with some gravel was contacted in Borehole U3.

#### **4.1.3 Surficial Silty Clay and Clayey Silt**

In all boreholes, the topsoil or the granular fill are underlain by a 0.3 to 0.6 m thick cohesive soil layer ranging in composition from silty clay to clayey silt.

These cohesive soil layers contain trace to some sand and/or trace of gravel. As well, in Boreholes U1, U3 and U5, this cohesive soil deposit exhibits traces of organics.

#### **4.1.4 Sand**

Borehole U2 contacted a sand layer at a depth of 0.8 m below the ground surface, underlying the silty clay. This sand layer contains traces of silt and organics.

#### 4.1.5 Silty Clay to Clayey Silt Till

Below the silty clay in Borehole U1, the clayey silt in Borehole U3 and the sand in Borehole U2, silty clay to clayey silt till deposit was encountered. These cohesive deposits were found to be 0.8 m, 6.0 m and 2.2 m thick and extended to depths/elevations 1.6 m/ 194.6 m, 6.2 m/188.3 m and 3.1 m/190.4 m in borehole U1, U2 and U3, respectively.

The grain-size distribution of a sample from the silty clay till in Borehole U2 was determined in the laboratory. The analysis gave the following grain-size distribution as shown in Figure A-1 in Appendix A:

Gravel:	0 %
Sand:	4 %
Silt:	47 %
Clay:	49 %

From recorded N values of 9 to 15 blows/0.3 m, the consistency of this deposit is described as stiff to a depth of about 2 m in Boreholes U2 and U3. In Borehole U2, however, low N-values of 2 blows/0.3 m were encountered below depth of about 3.0 m below ground surface indicating very soft to soft consistency.

The index properties of the deposit were determined by means of Atterberg Limits tests performed in the laboratory on two samples recovered from Boreholes U2 and U3. These tests gave the following index values (see Plasticity Chart, Figure A-2 in Appendix A):

Liquid Limit:	15-38 %
Plastic Limit:	11-22 %
Plasticity Index:	4-16

These values are characteristic of clayey soils of low to medium plasticity. The deposit is considered to be practically impervious, except for the horizontal permeability where sand seams or pockets may occur. Cobbles and boulders should be expected to occur in the till deposits, due to their mode of deposition.

#### 4.1.6 Sandy Silt to Silty Sand Till

Below the surficial cohesive soil in Boreholes U4 and U5 and silty clay to clayey silt till in Boreholes U1, U2 and U3, the boreholes contacted a sandy silt to silty sand till deposit. This deposit is basically granular soil with traces of clay. It was contacted at depths ranging from 0.5 m (Borehole U5) to 6.2 m (Borehole U2) below ground surface or below elevations 194.6 m (Borehole U1) to 188.3 m (Borehole U2). It was found to extend to the termination depths of the boreholes.

The grain-size distribution of two samples from Boreholes U1 and U4 from the deposit was determined in the laboratory which gave the following grain-size distribution as shown in Figure A-3 in Appendix A:

Gravel:	9-12 %
Sand:	34-37 %
Silt & Clay	54 %



Standard Penetration tests performed in the deposit recorded N-values which range from 22 blows/0.3 m to in excess of 50 blows/0.15 m. These N-values indicate compact to very dense condition, typically very dense. Cobbles and boulders should be expected in the till deposit.

#### **4.1.7 Groundwater Conditions**

No free standing water was noted in Boreholes U1, U3 and U5 during and at the completion of the drilling while free-standing water levels were recorded at 6.1 m below existing grade upon completion in Boreholes U2 and U4. These water levels, however, do not represent the stabilized ground water levels.

Based on the tactile examinations of the soil samples and the change in the color of the soil from brown to grey, it is our opinion that the groundwater level at the time of the investigation was at a depth of about 1.0 to 1.5 m in Boreholes U4 and U5 and about 3 m below the ground surface in the remaining boreholes.

It should be pointed out that the groundwater table would be subject to seasonal fluctuations and in response to major weather events.

## **5 AREA 2**

Area 2 is located at the junction of existing Highway 26 with Mosley Street and Airport Road about 300 m south from the shoreline of Nottawasaga Bay.

Boreholes U6, U8 and U9 were drilled on the shoulders of the road while Borehole U7 was drilled on a traffic island at the locations shown on the Borehole Location Plan, Drawing B-1 in Appendix B.

### **5.1 Summarized Subsurface Conditions**

Borehole U6 was put down on the shoulder of Mosley Street and this contacted 0.6 m thick sand fill underlain by sand to silty sand over sandy silt.

Borehole 7 was drilled in the grass traffic island area at the junction of Highway 26 with Mosley Street and Airport Road and this borehole contacted 0.2 m thick veneer of topsoil at ground surface. Underneath the topsoil, the borehole encountered a thick deposit of sand interbedded with silty sand, extending to the full depth of the borehole (6.7 m).

Borehole U8 was advanced from the shoulder of the existing Airport Road and contacted sand fill material to a depth of 0.8 m, underlain by silty sand and silty sand to sandy silt till over sand.

At the north side of the junction towards the Nottawasaga Bay, Borehole U9 was drilled from the shoulder of the existing Highway 26 and this borehole encountered sand fill underlain by 0.7 m thick native sand layer. A sandy silt to silty sand till deposit was encountered at a depth of 1.5 m underlying the sand layer. This till deposit was found to extend to a depth of 4.6 m below ground surface. Below the sandy silt till, the borehole contacted sand, which is in turn underlain by sandy silt at a depth of 6.1 m. Borehole U9 was terminated in this sandy silt deposit at a depth of 6.7 m below ground surface.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole sheets in Appendix B. The following paragraphs are only meant to complement and amplify these data.

### 5.1.1 Topsoil

Borehole U7 which was put down in the traffic island at the middle of junction of existing Highway 26 with Mosley Street and Airport Road, contacted an about 0.2 m thick topsoil at ground surface.

### 5.1.2 Granular Fill

Boreholes U6, U8 and U9 were drilled on the granular shoulder of the road and contacted an approximately 0.6 m to 0.8 m thick granular fill. This granular fill consists of sand with some gravel.

### 5.1.3 Upper Sand

Below the granular fill material in Boreholes U6 and U9, topsoil in Borehole U7, Boreholes U6, U7 and U9 encountered a 0.7 to 3.5 m thick upper sand layer with traces of silt and gravel at depths of 0.2 to 0.8 m.

The grain-size distribution of a sample from this granular material was determined in the laboratory which gave the following grain-size distribution as shown in Figure B-1 in Appendix B:

Gravel:	8 %
Sand:	82 %
Silt & Clay:	10 %

Standard Penetration tests were performed in Borehole U7 and the recorded N-values of 10 and 13 blows/0.3 m indicate a compact condition at this borehole location.

### 5.1.4 Silty Sand

The upper sand encountered in Boreholes U6 and U7 is underlain by another, somewhat finer grained, granular soil deposit (silty sand) at depths of 1.6 m / El. 181.8 m to 3.7 m / El. 181.0 m below ground surface, respectively. Borehole U8 also contacted a silty sand layer below the fill material at a depth of 0.8 m below ground surface or at El. 183.4 m. Silty sand was also contacted in Borehole U9 at a depth of 4.6 m (El. 180.1 m). This unit extends to depths/ Elevations of 4.0 m /179.4 m, 6.2 m /178.5 m, 3.0 m/181.2 m and 6.1 m/178.6 m, respectively.

This silty sand deposit in Borehole U8 exhibits trace of organics and some clay seams.

The grain-size distribution of four samples from the deposit was determined in the laboratory which gave the following grain-size distribution as shown in Figure B-2 in Appendix B:

Gravel:	0 %
Sand:	53-72 %
Silt & Clay:	27-47 %

From recorded N values of 55 blows/0.3 m to in excess of 77 blows/0.28 m, the compactness condition of this deposit at location of Boreholes U6, U7 and U9 is described as very dense.

An N-value of 3 blows/0.3 m was recorded in Borehole U8 indicating a very loose. This may however also represent the soft consistency of clayey seams within the silty sand layer.

#### 5.1.5 Sandy Silt to Silty Sand Till

In Boreholes U8 and U9, below the sand and silty sand, a silty sand to sandy silt till deposit was encountered at a depth of 3.0 m and 1.5 m, respectively.

The grain-size distribution of a sample from this basically granular (i.e. non-cohesive) deposit was determined in the laboratory which gave the following grain-size distribution as shown in Figure B-3 in Appendix B:

Gravel:	7 %
Sand:	42 %
Silt & Clay:	51 %

From recorded N values of 49 blows/0.3 m to over 75 blows/ 0.28 m, the relative density of this deposit is described as dense to very dense. The presence of cobbles and boulders should always be expected in the till deposit.

#### 5.1.6 Lower Sand

Underlying the silty sand in Borehole U7, silty sand to sandy silt till in Borehole U8, a lower sand unit was contacted at depths of 6.1 m /El. 178.1 m (Borehole U8) and 6.2 m /El. 178.5 m (Borehole U7). The boreholes were terminated in this granular deposit after penetrating it by a vertical distance of 0.3 to 0.5 m.

Standard Penetration tests performed in the deposit recorded N-values of 24 blows/0.3 m and over 67 blows/0.28 m. These N-values indicate a compact to very dense condition.

#### 5.1.7 Sandy Silt

Below the silty sand deposit, Boreholes U6 and U9 encountered a sandy silt deposit at depths/ elevations of 4.0 m/ 179.4 m and 6.1 m/ 178.6 m, respectively. This deposit extended to the termination of the boreholes at a depth of 6.7 m below ground surface.

The grain-size distribution of a sample from the deposit was determined in the laboratory which gave the following grain-size distribution as shown in Figure B-4 in Appendix B:

Gravel:	0 %
Sand:	40 %
Silt & Clay:	60 %

Standard Penetration tests performed in this fine grained granular (i.e. non-cohesive) deposit recorded N-values which range from 29 to 32 blows/0.28 m. These N-values indicate compact to dense condition.

#### 5.1.8 Groundwater Conditions

Borehole U9 was dry during and upon completion of the drilling but caved in at 5.8 m while free-standing water levels were recorded at 4.0 m, 3.8 m and 4.6 m below ground surface, upon completion in Boreholes U6, U7 and U8, respectively.

Based on these observations, visual and tactile examinations, measured moisture contents of the soil samples as well as observations made during drilling, it is our opinion that the groundwater level at the time of our investigations was at a depth of about 1.5 m (Boreholes U8 and U9) to 3.7 m (Borehole U7) below the ground surface at this site or at about elevations varying from 183.0 m (Borehole U9) to 180.7 m (Borehole U6).

It should be pointed out that the groundwater table would be subject to seasonal fluctuations and in response to major weather events.

## **6 AREA 3**

Area 3 is located at the future junction of existing Airport Road with the proposed Highway 26.

Boreholes U10, U11 and U12 were drilled on the shoulder of the existing Airport Road at the locations shown on the Borehole Location Plan, Drawing C-1 in Appendix C.

### **6.1 Summarized Subsurface Conditions**

Boreholes U12 and U10 were drilled at about 70 m west and east of proposed Highway 26 centerline while Borehole U11 was put down close to the centerline of the proposed Highway 26.

All boreholes contacted granular fill material at the ground surface, to depths of 0.3 to 0.5 m below the ground surface, underlain by a silty clay to clayey silt deposit to depths of 2.1 to 2.6 m below the ground surface. The silty clay to clayey silt deposit is in turn underlain by a sandy silt till to the full depth of the boreholes, which range from 6.4 to 6.7 m.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole sheets in Appendix C. The following paragraphs are only meant to complement and amplify these data.

#### **6.1.1 Granular Fill**

All three boreholes, put down close to the existing Airport Road, contacted a 0.3 m to 0.5 m thick granular fill material. This layer consists of sand and gravel to sand with some gravel with occasional asphalt pieces (in Borehole U10) and some clay (in Borehole U11).

#### **6.1.2 Silty Clay to Clayey Silt**

Underlying the granular fill at 0.3 to 0.5 m below the ground surface, the boreholes encountered a cohesive soil consisting of silty clay to clayey silt with some sand and gravel content, which may possibly be of glacial till origin. The deposit was found to extend to depths of 2.1 m (Boreholes U10 and U11) to 2.6 m (Borehole U12) or to elevation ranging between 187.6 to 186.8 m.

The grain-size distribution of three samples from this deposit was determined in the laboratory, which gave the following grain-size distribution as shown in Figure C-1 in Appendix C:

Gravel:	4-7 %
Sand:	24-30 %

Silt: 41-46 %  
Clay: 18-26 %

The index properties of the deposit were determined by means of Atterberg Limits tests performed in the laboratory on three samples recovered from this deposit. These tests gave the following index values (see Plasticity Chart, Figure C-2 in Appendix C):

Liquid Limit: 18-24 %  
Plastic Limit: 12-14 %  
Plasticity Index: 5-10

These values are characteristic of cohesive soils of low plasticity.

Based on the laboratory testing the deposit is considered to be of low permeability.

Standard Penetration tests were performed below a depth of 1.5 m and these tests yielded N-values of 19 to 75 blows/0.3 m, which indicate a very stiff to hard consistency.

#### **6.1.3 Sandy Silt Till**

Below the silty clay to clayey silt, the boreholes contacted at depths of 2.1 to 2.6 m (or below elevation 187.6 to 186.8 m) a predominant deposit of sandy silt till to the remaining depth of the boreholes (6.7 m, 6.4 m and 6.4 m in Boreholes U10, U11 and U12, respectively). The material consists of a heterogeneous mixture of sand and silt with traces of gravel and clay.

The grain-size distribution of a sample from this granular material (i.e. non-cohesive) was determined in the laboratory which gave the following grain-size distribution as shown in Figure C-3 in Appendix C:

Gravel: 12 %  
Sand: 46 %  
Silt & Clay: 42 %

From recorded N values of 69 blows/0.3 m to in excess of 50 blows/0.28 m, the relative density of this deposit is described as very dense. Cobbles and boulders should be expected in the till deposit.

#### **6.1.4 Groundwater Conditions**

No groundwater was observed during and upon completion of drilling of these three boreholes at the time of investigation. Based on the change of the color of the soil from brown to grey, the groundwater is probably in between 2 to 3 m below ground surface.

It should be pointed out that the groundwater table would be subject to seasonal fluctuations and in response to major weather events.

## **7 AREA 4**

Area 4 is located at the future intersection of proposed Highway 26 with the existing Poplar Sideroad at the border of Township of Clearview and Town of Collingwood.

Boreholes U16 to U21 were drilled on the existing pavement or shoulder of Poplar Sideroad at the locations shown on the Borehole Location Plan, Drawing D-1 in Appendix D.

### **7.1 Summarized Subsurface Conditions**

Boreholes U17, U18, U19, U20 and U21 contacted 0.2 m to 0.5 m thick granular fill material at the ground surface. Borehole U16, drilled on the pavement of the existing centerline of Poplar Sideroad contacted 70 mm of asphalt which is underlain by granular pavement fill to a depth of 0.5 m below ground surface.

In Borehole U16, another fill material, consisting of silty clay was encountered to a depth of 1.8 m. Underlying the fill material, Boreholes U18 through U21 contacted a surficial clayey silt or silty clay layer which extends to depths of 0.4 m to 0.6 m below the ground surface.

Below the fill and/or the surficial clayey silt to silty clay layer, all the boreholes encountered a silty sand to sandy silt till deposit. This deposit extends to the end of most of the boreholes at depths of 5.2 m to 6.1 m below ground surface. In Boreholes U20 and U21, underlying the glacial till, a hard material was encountered at depths of 3.1 m and 3.7 m, respectively. This deposit was penetrated by augering by 0.6 and 1.0 m and was identified as possible bedrock. Boreholes U17, U18 and U 19 encountered practical auger refusal at depths of 5.8, 5.2 and 5.8 m below the ground surface, respectively, also possibly on the surface of the bedrock.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole sheets in Appendix D. The following paragraphs are only meant to complement and amplify these data.

#### **7.1.1 Asphalt Pavement and Granular Fill**

Boreholes U17, U18, U19, U20 and U21 contacted 0.2 m to 0.5 m thick granular fill material at ground surface. Borehole U16 contacted 70 mm asphalt which is underlain by granular fill to a depth of 0.5 m below ground surface. The granular fill encountered in the boreholes consists of sand with some gravel and sand & gravel with traces of silt.

#### **7.1.2 Silty Clay Fill**

Underlying the granular fill at 0.5 m Borehole U16 encountered a silty clay fill (or previously disturbed) material. This deposit was found to extend to a depth of 1.8 m below the ground surface. The presence of geotextile material was noted in the fill. The geotextile may have been used to reinforce the road subbase or subgrade.

#### **7.1.3 Clayey Silt to Silty Clay**

Below the fill, all the boreholes except for Boreholes U16 and U 17 contacted a cohesive soil layer which consist of cohesive clayey silt (Boreholes U18, U19 and U20) to silty clay (Borehole U21) which extend to depths of 0.4 m (in Borehole U21) to 0.6 m (in Boreholes U18, U19 and U20) below ground surface.

Borehole U21 exhibits traces of organics in this layer. Clayey silt layer in Boreholes U18, U19 and U20 contain trace of gravel and sand.

#### **7.1.4 Sandy Silt to Silty Sand Till**

Underlying cohesive soil layer in Boreholes U16, U18, U19, U20 and U21 and granular fill in Borehole U17, all the boreholes encountered a glacial till deposit which consists of a heterogeneous mixture of sandy silt to silty sand with traces of gravel and clay size particles. This sandy silt to silty sand till deposit was found to extend in Boreholes U16 through U19 to the remaining depth of the boreholes at depths of 5.2 m to 6.1 m below ground surface. In Boreholes U17, U18 and U19, practical refusal to augering was encountered at depths ranging from 5.2 to 5.8 m (or at between elevations 185.4 and 183.9 m), probably on the surface of the bedrock.

The grain-size distribution of four samples from the deposit was determined in the laboratory which gave the following grain-size distribution as shown in Figure D-1 in Appendix D:

Gravel:	5-17 %
Sand:	38-52 %
Silt & Clay:	38-57 %

From recorded N values of 17 blows/0.3 m to in excess of 50 blows/0.15 m, the compactness condition of this glacial deposit is described as compact to very dense but typically very dense. As mentioned before, the presence of cobbles and boulders can always be expected in the glacial till deposits.

#### **7.1.5 Possible Bedrock**

In Boreholes U20 and U21, possible limestone bedrock was contacted underneath the sandy silt till deposit at depths of 3.1 m to 3.7 m below ground surface or at El. 184.9 and 182.8 m, respectively. Boreholes U20 and U21 were advanced into the possible bedrock by a augering vertical distance of 0.6 m and 1.0 m, respectively. Based on the auger refusal depths in Boreholes U20 and U21, the possible bedrock within the augered depths is considered highly weathered, immediately beneath the sandy silt till.

As mentioned before Boreholes U17, U18 and U19 encountered refusal at 5.8 m (El. 185.4 m), 5.2 m (El. 185.3 m) and 5.8 m (El. 183.9 m), respectively, possibly on the surface of the bedrock or close to it.

Based on the published information, and recent work in the area, the bedrock underlying the site is likely to consist of limestone of the Trenton and Black River Groups. This formation is approximately 480 million years old (i.e. Middle Ordovician).

#### **7.1.6 Groundwater Conditions**

Upon completion, free-standing water levels in Boreholes U16, U17, U18 and U19 were recorded at 5.2 m, 5.5 m, 3.7 m and 5.3 m, respectively.

No groundwater was observed during and upon completion of drilling of Boreholes U20 and U21.

Based on these results, observations made during drilling and the color change of the soil sample from brown to grey, it is our opinion that the groundwater level at the time of our investigation was typically between 1.5 and 3.0 m below the ground surface at the borehole locations.

It should be pointed out that the groundwater table would be subject to seasonal fluctuations and in response to major weather events.

## **8 AREA 5**

Area 5 is located at the intersection of the existing Nottawa Sideroad with proposed Highway 26, at the border of Township of Clearview and Town of Collingwood.

Boreholes U13 and U15 were drilled on the shoulder of Nottawa Sideroad while Borehole U14 was drilled at the edge of a construction access road. The locations of boreholes are shown on the Borehole Location Plan, Drawing E-1 in Appendix E.

### **8.1 Summarized Subsurface Conditions**

At this site the ground surface elevation rises from west to east from El. 191.1 m at Borehole U13 to El. 195.4 m at Borehole U15. Boreholes U13 and U15 contacted pavement and granular fill to depths of 0.9 and 0.6 m, respectively.

Borehole U14 which was off the road encountered a 0.9 m thick mixed cohesive fill material.

Below granular fill and topsoil, all three boreholes contacted a 0.6 to 0.9 m thick surficial silt layer which is underlain by sandy silt till to the termination of the boreholes (i.e. 6.2 to 6.3 m below the ground surface).

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole sheets in Appendix E. The following paragraphs are only meant to complement and amplify these data.

#### **8.1.1 Fill**

Borehole U14 contacted an about 0.9 m thick fill layer which consists of clayey silt with traces of gravel, topsoil and organics.

#### **8.1.2 Pavement and Granular Fill**

Borehole U15 was drilled from the paved portion of the road and contacted a 60 mm thick asphaltic concrete layer at the surface. Underlying asphalt layer in this borehole and from the ground surface at Borehole U13 a granular fill was contacted to depths of approximately 0.6 m to 0.9 m below the ground surface. Granular fill in the boreholes was found to consist of sand with some gravel. Some silt was also found in the granular fill in Borehole U15.

#### **8.1.3 Silt**

In all three boreholes, fill and granular fill are underlain by a 0.6 to 0.9 m thick silt layer.



This surficial silt layer contains trace to some sand, gravel and clay and extends to a depth of 1.5 m below the ground surface or to El. 193.9 to 189.6 m.

#### 8.1.4 Sandy Silt Till

Below the surficial silt layer in all the boreholes, a sandy silt till deposit was encountered. This sandy silt till consists of a heterogeneous mixture of sand and silt with traces of gravel and clay size particles and extends to the termination depths of all the boreholes to depths of 6.2 to 6.3 m or to El. 189.2 m (Borehole U15) to El. 184.9 m (Borehole U13)

The grain-size distribution of two samples from Boreholes U13 and U14 from the deposit was determined in the laboratory which gave the following grain-size distribution as shown in Figure E-1 in Appendix E:

Gravel:	5-11 %
Sand:	38-47 %
Silt & Clay	42-57 %

From recorded N values of 53 blows/0.3 m to in excess of 50/0.15 m, the compactness condition of this granular deposit is described as very dense. Cobbles and boulders should be expected in the till deposit.

#### 8.1.5 Groundwater Conditions

No groundwater was observed during and upon completion of drilling of these three boreholes. However, these are unlikely to represent the stabilized groundwater levels. Based on the change of the color of the samples from brown to grey, it is our opinion that the groundwater level at the time of the investigations was probably at  $2 \pm$  m below existing grade.

It should be pointed out that the groundwater table would be subject to seasonal fluctuations and in response to major weather events.

For and on behalf of Coffey Geotechnics Inc.

  
**Gwangha Roh, Ph.D.**  
Engineer-In-Training



  
**Ramon Miranda, P.Eng.**  
Manager, Transportation Division

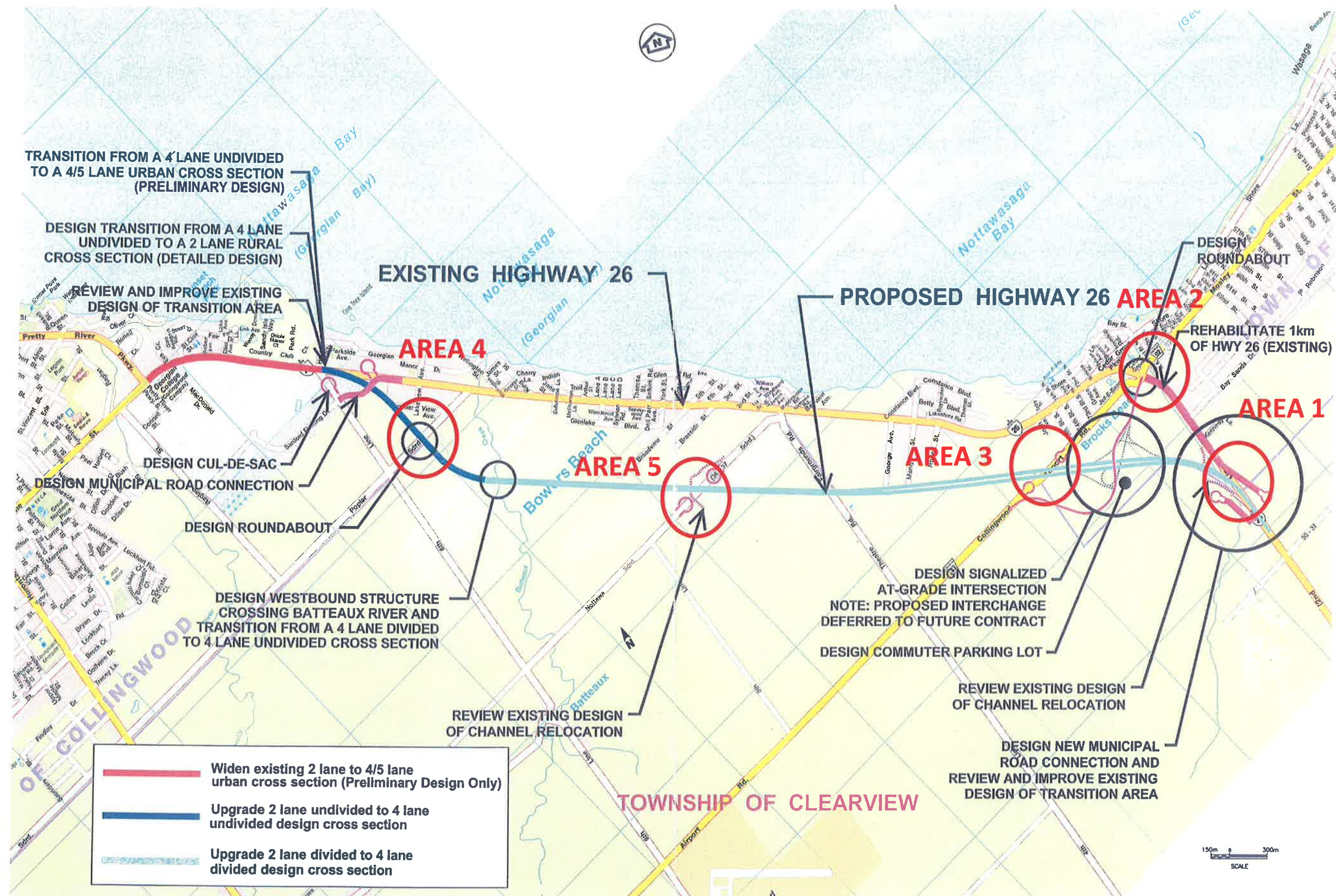
  
**Zuhtu Ozden, P.Eng.**  
Vice-President



# Drawing

**Key Plan**







# Appendix A

**Area 1**

METRIC

NOTES:  
FOR DETAILED SUBSURFACE CONDITIONS  
REFER TO RECORD OF BOREHOLE SHEETS.

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES + METRES.

CONT No.  
GWP:

Highway 26  
BOREHOLE LOCATION PLAN  
(AREA 1)

coffey geotechnics



KEY PLAN  
N.T.S.

LEGEND

- Borehole
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEV.	EASTING	NORTHING
U1	196.1	256758.992	4923961.194
U2	194.5	256705.363	4924114.052
U3	193.4	256724.790	4924203.008
U4	191.3	256664.477	4924290.078
U5	190.2	256649.723	4924408.208

NOTE

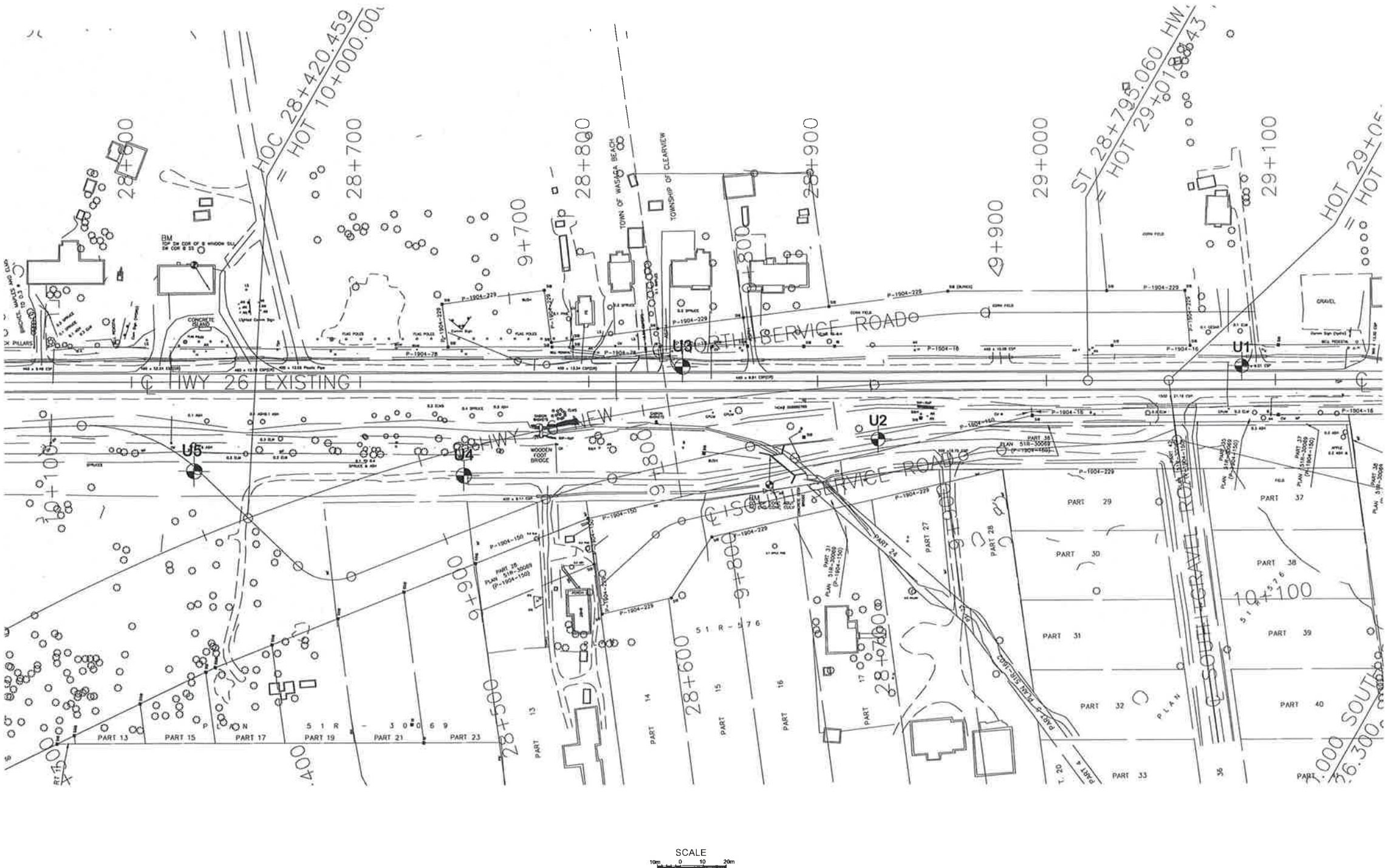
The boundaries between soil strata have been established only at Borehole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

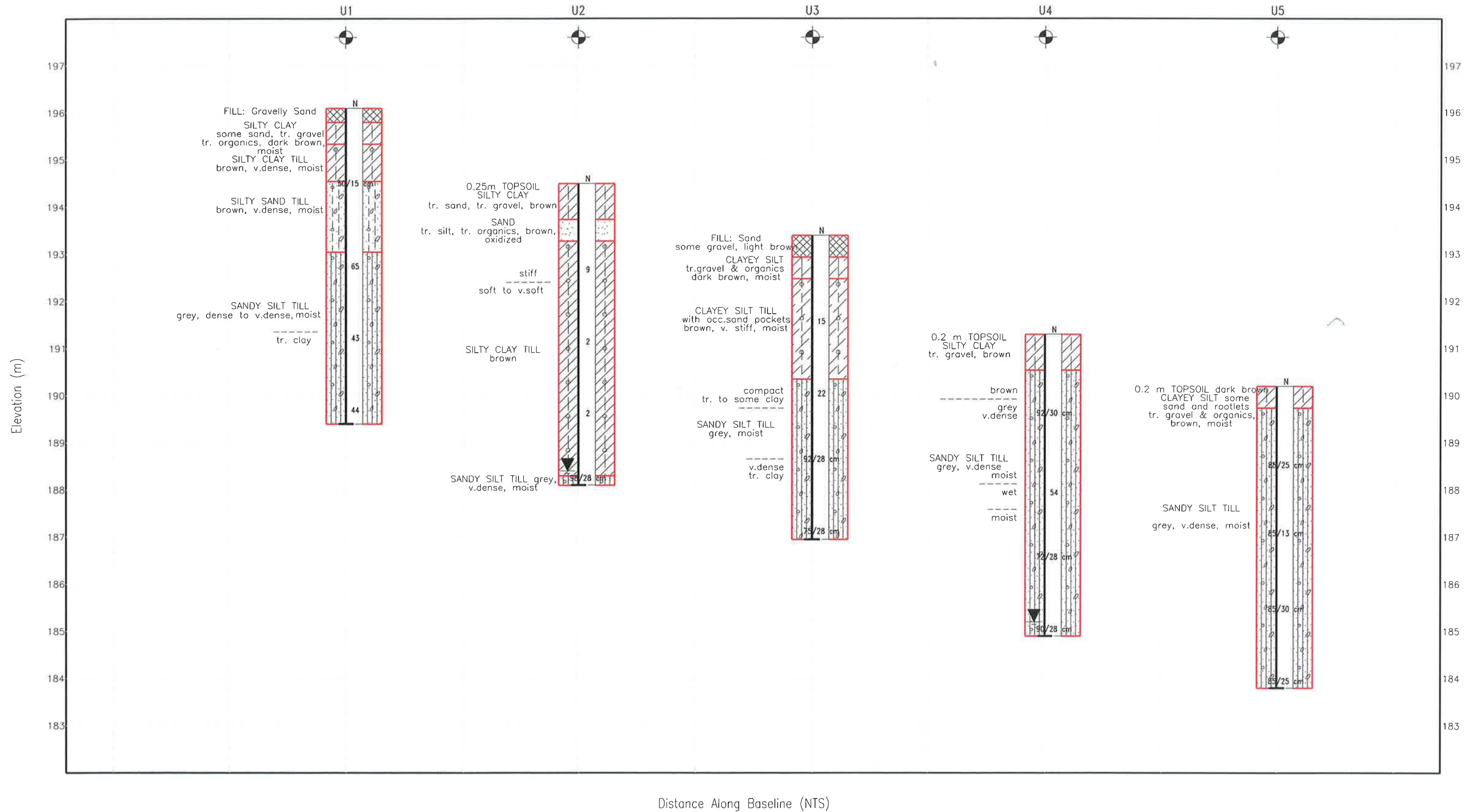
REV.	DATE	BY	DESCRIPTION

Geocres No.

SPT 1234			DIST
SUBM'D	CHECKED	DATE Dec. 2008	SITE
DRAWN PHK	CHECKED RM	APPROVED ZO	DWG A-1



BOREHOLE LOCATION PLAN



SPT1234 : Highway 26

# RECORD OF BOREHOLE No U1

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 256758.992 NORTHING 4923961.194 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/17/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI C
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)									
								○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE									
196.1	GROUND SURFACE						20	40	60	80	100						
0.0 195.8	FILL: Gravelly Sand		1	AS													
0.3 195.3	SILTY CLAY some sand, tr. gravel tr. organics, dark brown, moist		2	AS													
0.8 194.6	SILTY CLAY TILL brown, v. dense, moist		3	AS													
1.6	SILTY SAND TILL brown, v. dense, moist		4	SS	50/15 cm												
			5	AS													
193.1 3.1	SANDY SILT TILL grey, dense to v. dense, moist		6	SS	65												
			7	AS													
			8	SS	43												
			9	SS	44												
189.4 6.7	End of Borehole Borehole open and dry upon completion (not stabilized)*																

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U2

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 256705.363 NORTHING 4924114.052 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/17/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)										
								WATER CONTENT (%)										
194.5	GROUND SURFACE						20	40	60	80	100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	GR SA SI C			
0.0	0.25m TOPSOIL SILTY CLAY tr. sand, tr. gravel, brown		1	AS														
193.7																		
0.8	SAND tr. silt, tr. organics, brown, oxidized		2	AS														
193.3																		
1.2	SILTY CLAY TILL brown  stiff ----- soft to v soft		3	SS	9													
					4	AS												
					5	SS	2											spoon wet
																		0 4 47 49
			6	AS														
			7	SS	2											spoon wet		
188.3																		
6.2	SANDY SILT TILL grey, v. dense, moist		8	SS	98/28 cm											spoon wet		
188.1																		
6.4	End of Borehole Borehole open upon completion. Water level in open borehole @ 6.1 m (not stabilized)* upon completion.																	

+<sup>3</sup> ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15-10  
10  
(%) STRAIN AT FAILURE



SPT1234 : Highway 26

# RECORD OF BOREHOLE No U3

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 256724.790 NORTHING 4924203.008 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/17/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100					
								SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE					
193.4	GROUND SURFACE												
0.0	FILL: Sand some gravel, light brown		1	AS									
192.9													
0.5	CLAYEY SILT tr. gravel & organics dark brown, moist		2	AS									
192.5													
0.9	CLAYEY SILT TILL with occ. sand pockets brown, v. stiff, moist		3	SS	15								
190.4													
3.1	compact tr. to some clay		4	SS	22								
	SANDY SILT TILL grey, moist		5	AS									
	v. dense tr. clay		6	SS	92/28 cm								
187.0			7	SS	75/28 cm								
6.5	End of Borehole Hole caved in @ 5.5 m and dry upon completion (not stabilized)*												

+ 3. X 3: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U4

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 256664.477 NORTHING 4924290.078 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/16/2008 CHECKED BY RM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH (kPa)										
						20	40	60	80	100	20	40	60	80	100	10	20	30
191.3 0.0	GROUND SURFACE																	
190.5 0.8	0.2 m TOPSOIL SILTY CLAY tr. gravel, brown		1	AS														
			2	AS														
			3	SS	92/30 cm													
			4	SS														
			5	SS	54													
			6	AS														
			7	SS	72/28 cm													
184.9 6.4	End of Borehole Borehole open upon completion. Water level in open borehole @ 6.1 m (not stabilized)* upon completion.		8	SS	90/28 cm													

+<sup>3</sup> ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U5

1 OF 1

METRIC

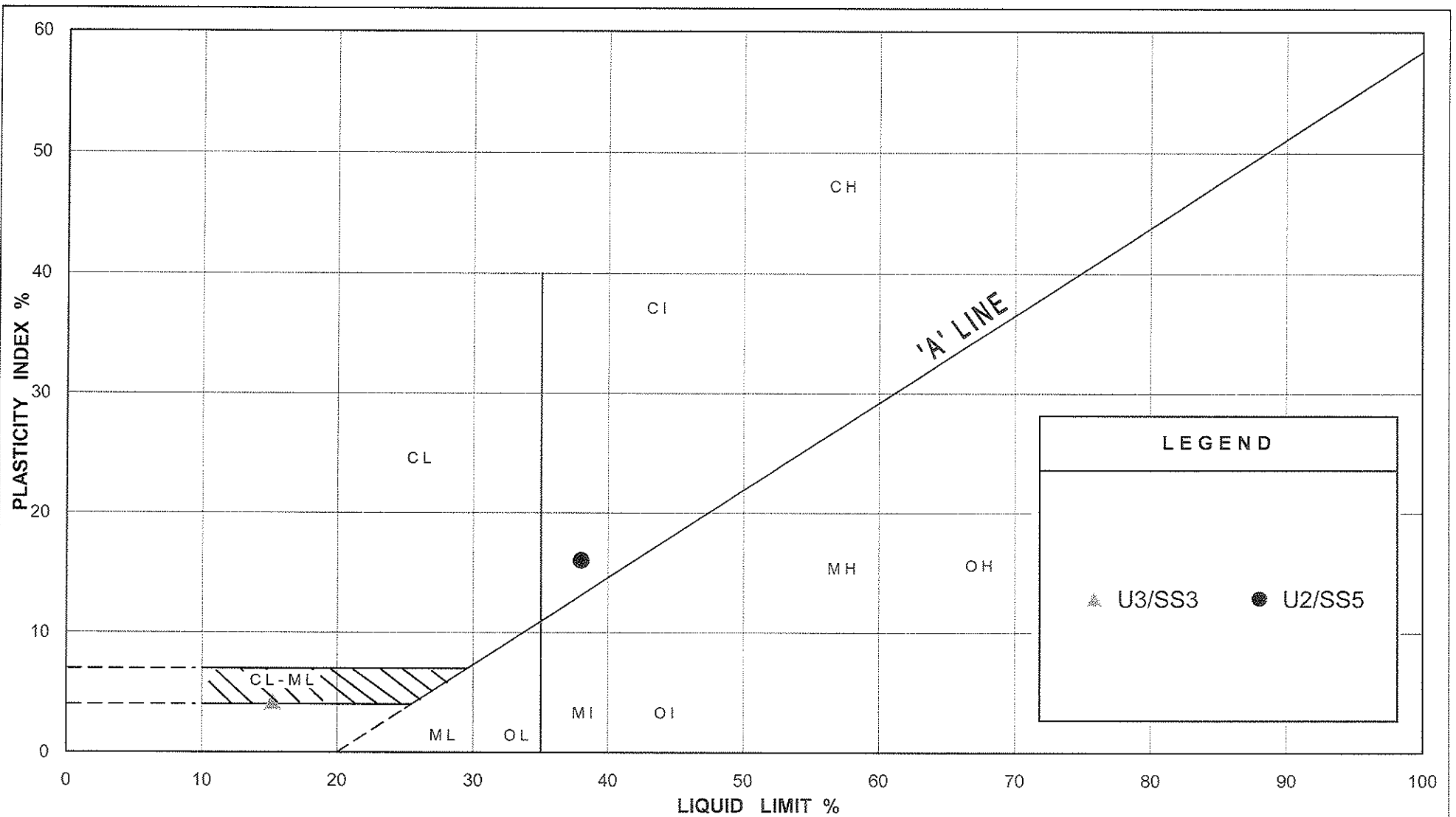
GWP \_\_\_\_\_ LOCATION EASTING 256649.723 NORTHING 4924408.208 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/18/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)						
190.2	GROUND SURFACE													
0.0	0.2 m TOPSOIL dark brown		1	AS										
189.7	CLAYEY SILT some sand and rootlets		2	AS										
0.5	Ir gravel & organics, brown, moist		3	SS	85/25 cm									
	SANDY SILT TILL grey, v. dense, moist		4	SS	85/13 cm									
			5	AS										
			6	SS	85/30 cm									
			7	SS	85/25 cm									
183.8	End of Borehole													
6.4	Borehole open and dry upon completion (not stabilized)*													

+<sup>3</sup>. X<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15-0.5  
10 (%) STRAIN AT FAILURE





Coffey Geotechnics Inc.

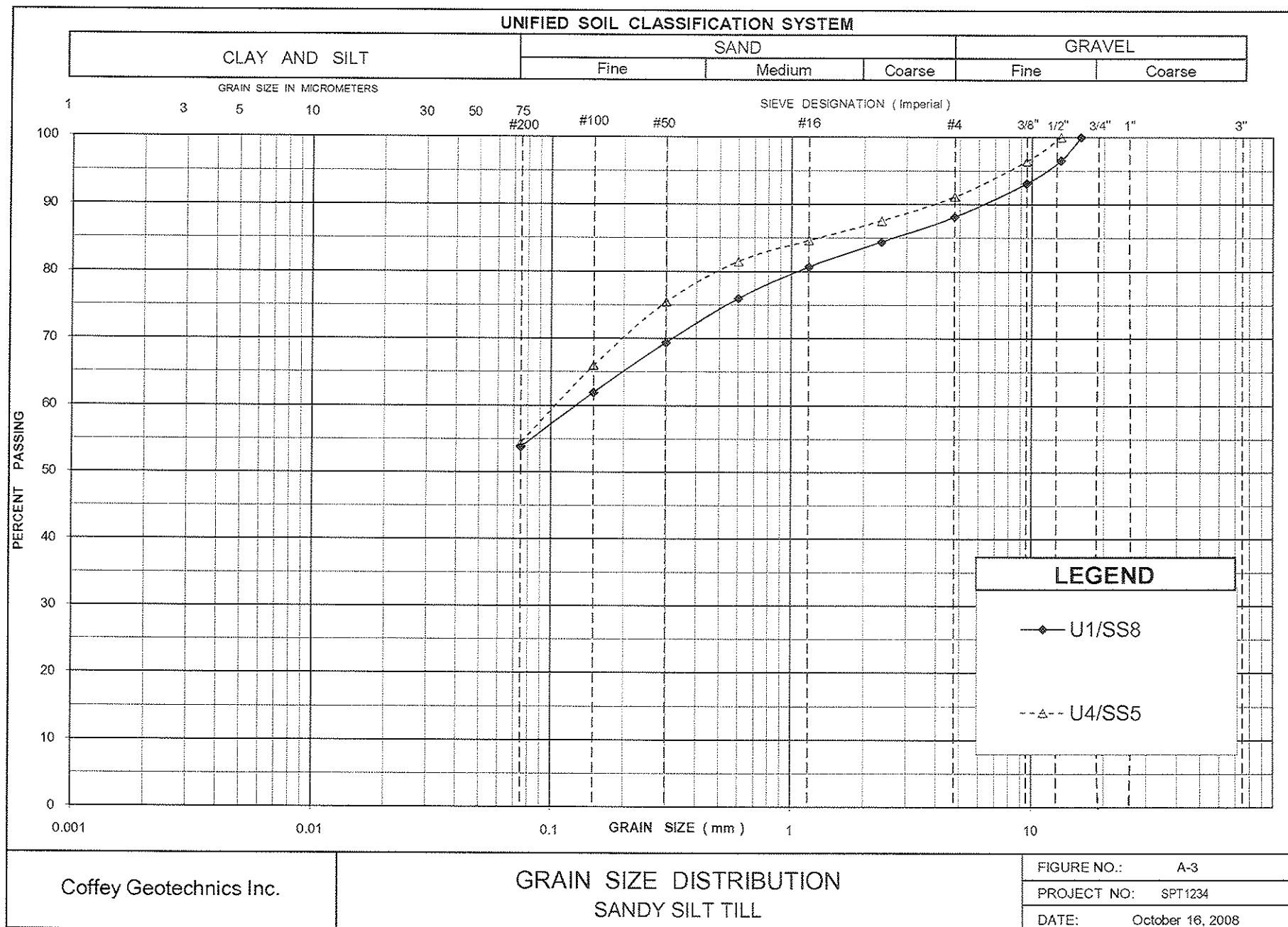
## PLASTICITY CHART

Clayey Silt to Silty Clay

FIGURE No. A-2

REF. No. SPT 1234

DATE Oct.21, 2008



# Appendix B

**Area 2**

**DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES + METRES.**

GWP:

Highway 26  
BOREHOLE LOCATION PLAN  
(AREA 2)

**coffey**  **geotechnics**



KEY PLAN  
N.T.S

### LEGEND

- 
- Borehole
- N
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation  
(W.L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEV.	EASTING	NORTHING
U6	183.4	256514.692	4925404.300
U7	184.7	256444.641	4925401.927
U8	184.2	256401.093	4925344.999
U9	184.7	256322.610	4925494.536

≡NOTE≡

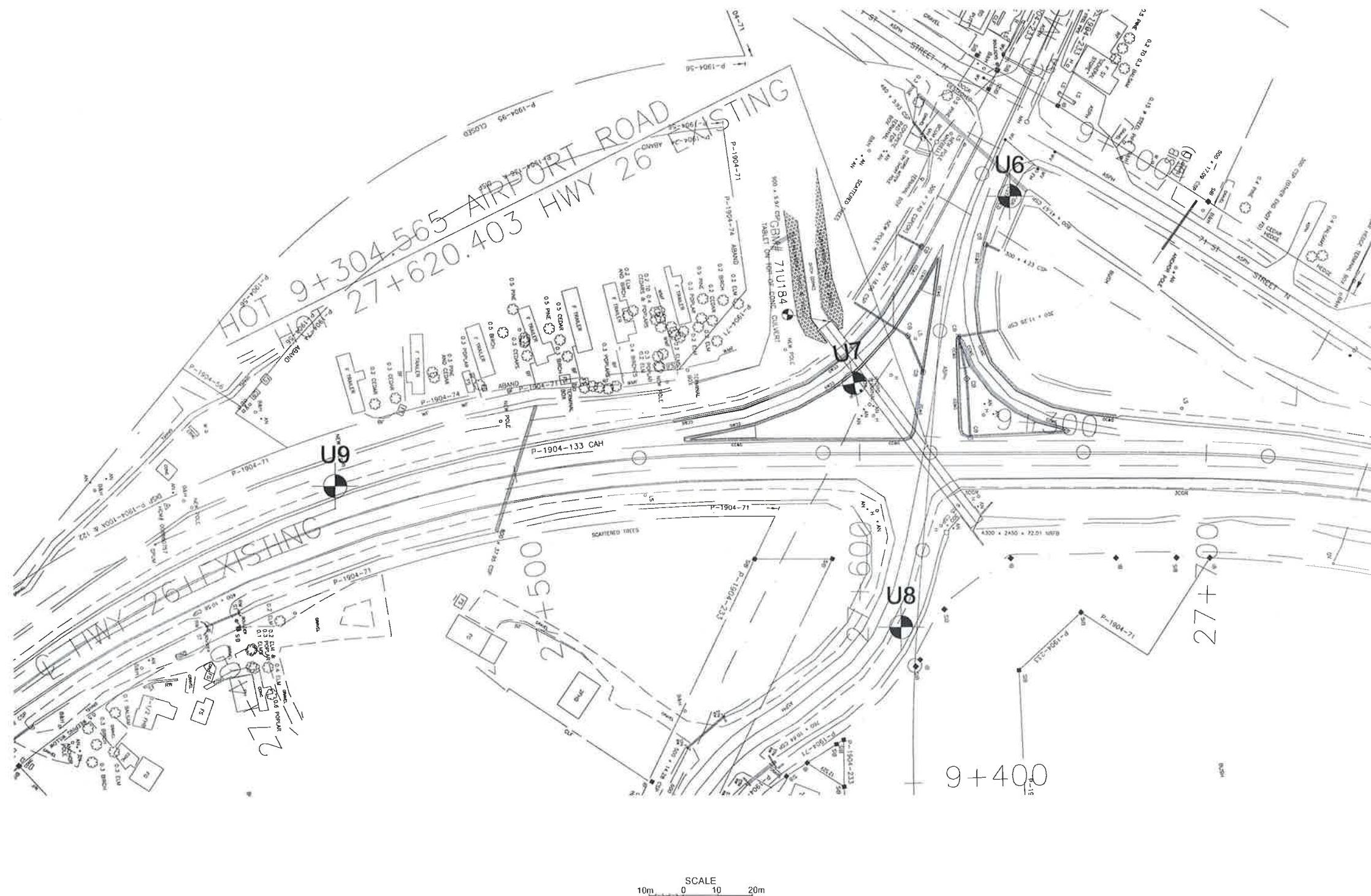
The boundaries between soil strata have been established only at Borehole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REV.			
DATE	BY	DESCRIPTION	

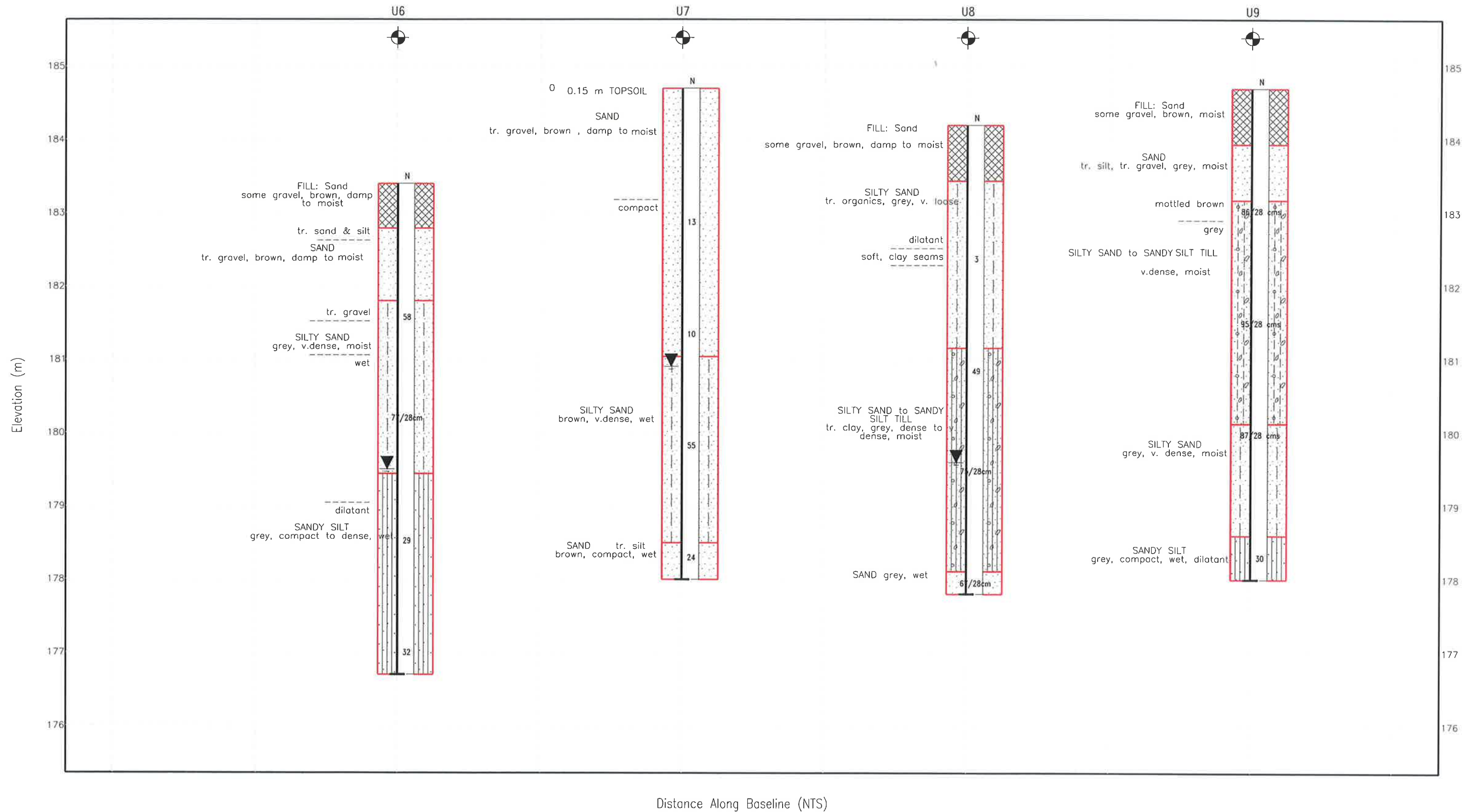
Geocres No.

SPT 1234			DIST
SUBM'D	CHECKED	DATE Dec. 2008	SITE
DRAWN PHK	CHECKED RM	APPROVED ZO	DWG B-1



## BOREHOLE LOCATION PLAN





SPT1234 : Highway 26

# RECORD OF BOREHOLE No U6

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 256514.892 NORTHING 4925404.300 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/17/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
183.4	GROUND SURFACE													
0.0	FILL: Sand some gravel, brown, damp to moist		1	AS			183							
182.8			2	AS			182							
0.6	tr. sand & silt													
181.8	SAND tr. gravel, brown, damp to moist		3	SS	58		181							
1.6	tr. gravel		4	AS			180							
	SILTY SAND grey, v. dense, moist		5	SS	77/28cm		179							
	wet		6	AS			178							
179.4			7	SS	29		177							
4.0	SANDY SILT grey, compact to dense, wet		8	AS										
	dilatant		9	SS	32									
176.7	End of Borehole Water level in open borehole @ 3.8 m (not stabilized)* and hole caved-in @ 4.0 m upon completion.													
6.7														

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U7

1 OF 1

METRIC

GWP: \_\_\_\_\_ LOCATION: EASTING 256444.841 NORTHING 4925401.927 ORIGINATED BY: RK  
 DIST: \_\_\_\_\_ HWY: 26 BOREHOLE TYPE: Solid Stem Auger COMPILED BY: SS  
 DATUM: \_\_\_\_\_ DATE: 9/17/2008 CHECKED BY: RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)										WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE										
184.7 0.0	GROUND SURFACE						20	40	60	80	100							
0.0  																		

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U8

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 256401.093 NORTHING 4925344.999 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/17/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)							WATER CONTENT (%)
								○ UNCONFINED ● POCKET PENETR.	+ FIELD VANE X LAB VANE						
184.2	GROUND SURFACE						20 40 60 80 100								
0.0	FILL: Sand some gravel, brown, damp to moist		1	AS											
183.4															
0.8	SILTY SAND tr. organics, grey, v. loose		2	AS											
	dilatant soft, clay seams		3	SS	3									0 53 (47)	
			4	AS											
181.2															
3.0			5	SS	49									spoon wet	
	SILTY SAND to SANDY SILT TILL tr. clay, grey, dense to v. dense, moist														
			6	SS	75/28cm									spoon wet	
			7	AS											
178.1															
6.1	SAND grey, wet		8	SS	67/28cm									spoon wet	
177.8															
6.4	End of Borehole Water level in open borehole @ 4.6 m (not stabilized)* and hole caved-in @ 5.2 m upon completion.														

+ 3 . X 3 Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE






SPT1234 : Highway 26

# RECORD OF BOREHOLE No U9

1 OF 1

METRIC

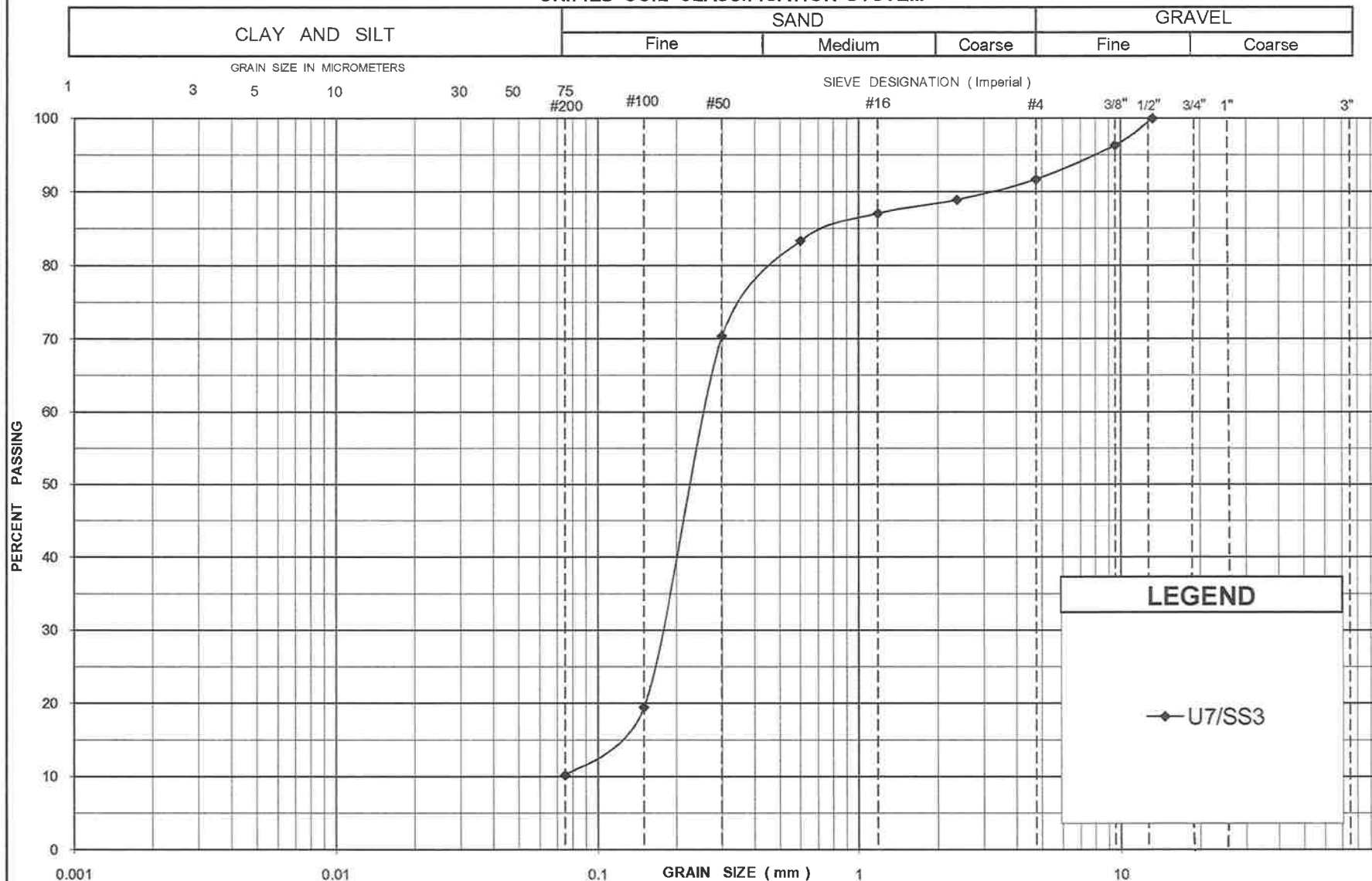
GWP \_\_\_\_\_ LOCATION \_\_\_\_\_ EASTING 256322.610 NORTHING 4925494.536 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/17/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)								WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● POCKET PENETR							× LAB VANE
184.7	GROUND SURFACE						20	40	60	80	100						
0.0	FILL: Sand some gravel, brown, moist		1	AS													
183.9																	
0.8	SAND tr. silt, tr. gravel, grey, moist		2	AS													
183.2																	
1.5	mottled brown grey SILTY SAND to SANDY SILT TILL v dense, moist		3	SS	86/28 cns												
					4	AS											
					5	SS	85/28 cns										
180.1	SILTY SAND grey, v. dense, moist		6	SS	87/28 cns												
4.6																	
178.6	SANDY SILT grey, compact, wet, dilatant																
6.1																	
178.0			7	SS	30												
6.7	End of Borehole Hole caved in @ 5.8 m upon completion Borehole dry upon completion (not stabilized)*																

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

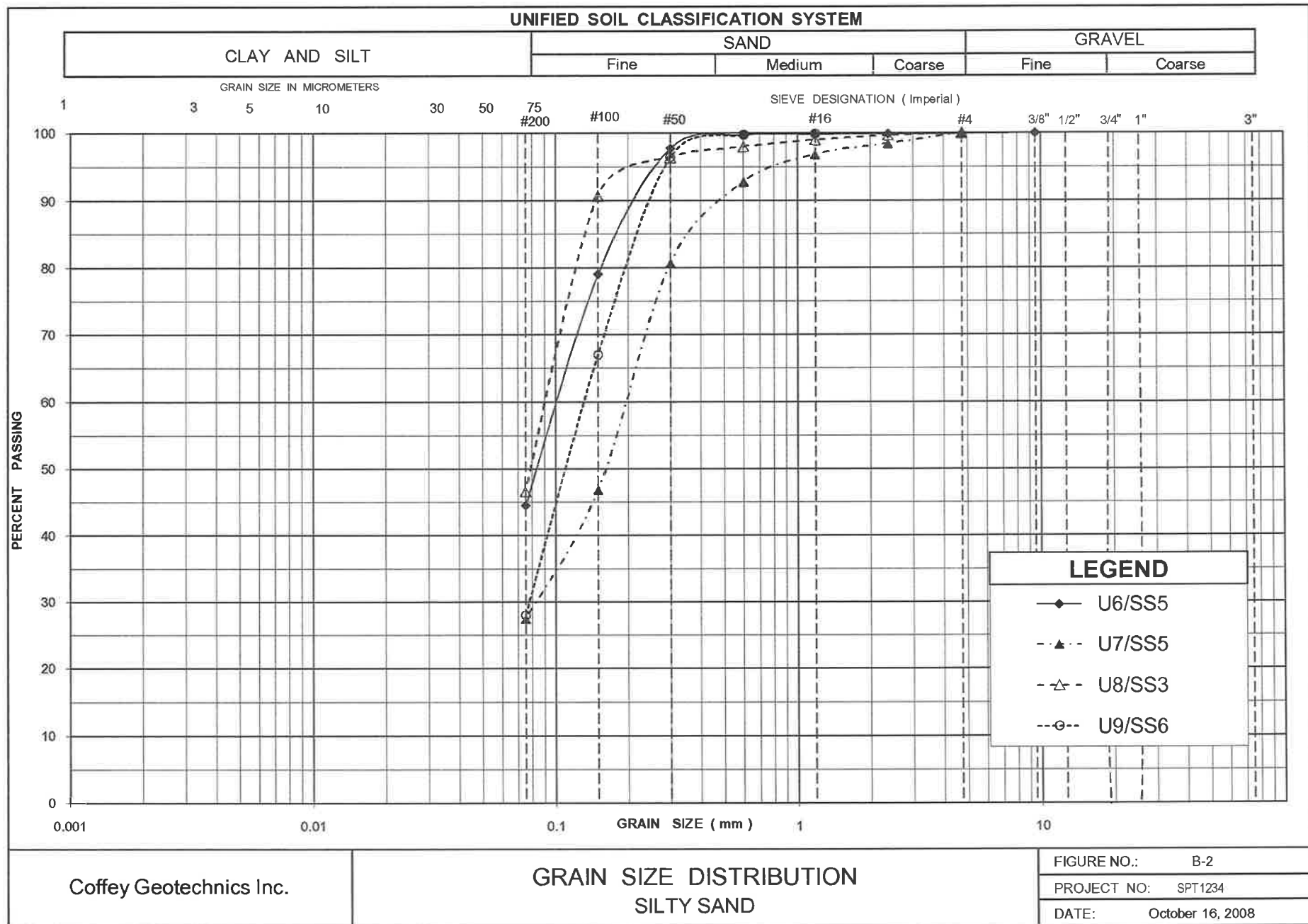
# UNIFIED SOIL CLASSIFICATION SYSTEM



Coffey Geotechnics Inc.

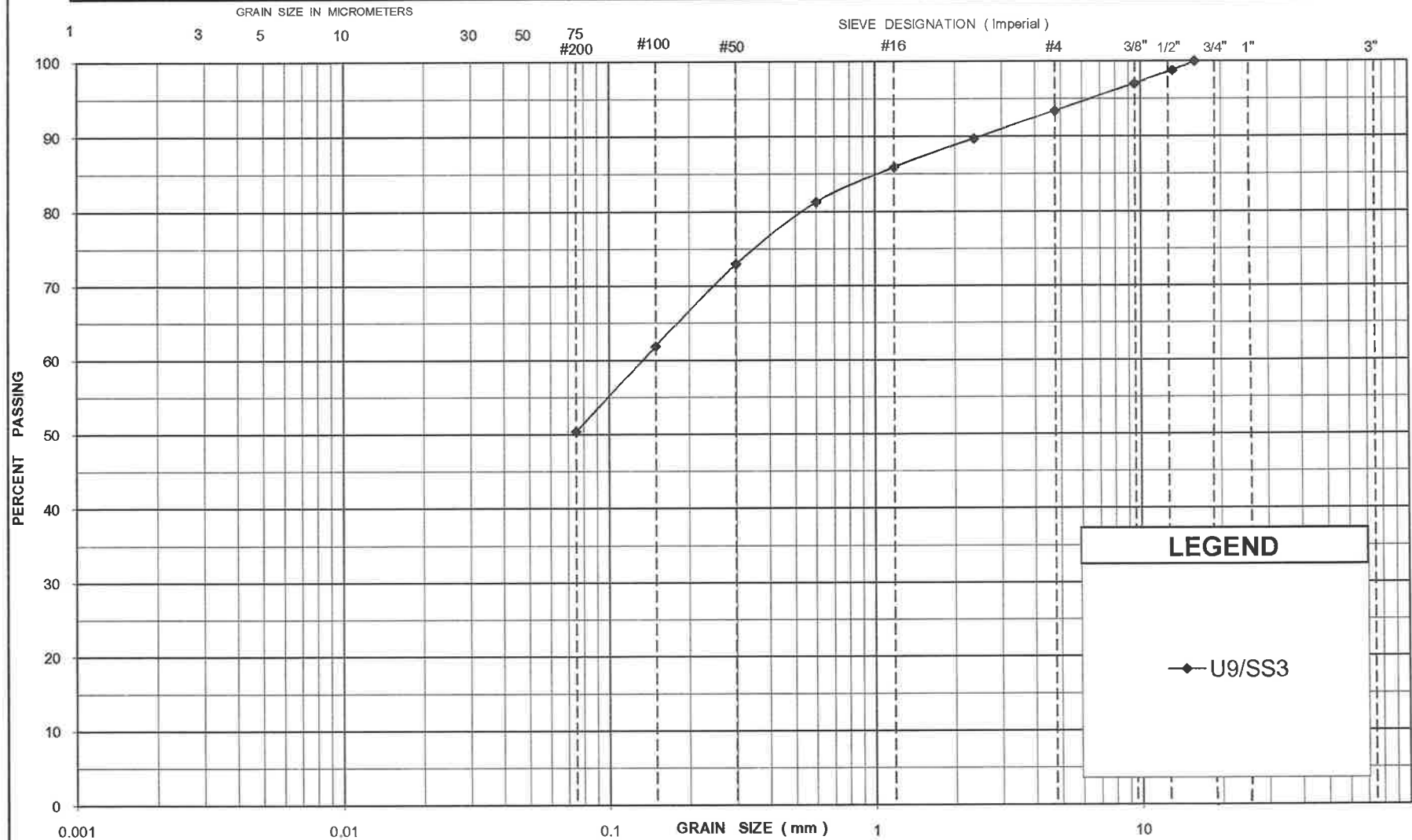
**GRAIN SIZE DISTRIBUTION**  
SAND, trace of gravel & silt

FIGURE NO.:	B-1
PROJECT NO:	SPT1234
DATE:	October 16, 2008



# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Coffey Geotechnics Inc.

GRAIN SIZE DISTRIBUTION  
SANDY SILT to SILTY SAND TILL

FIGURE NO.: B-3

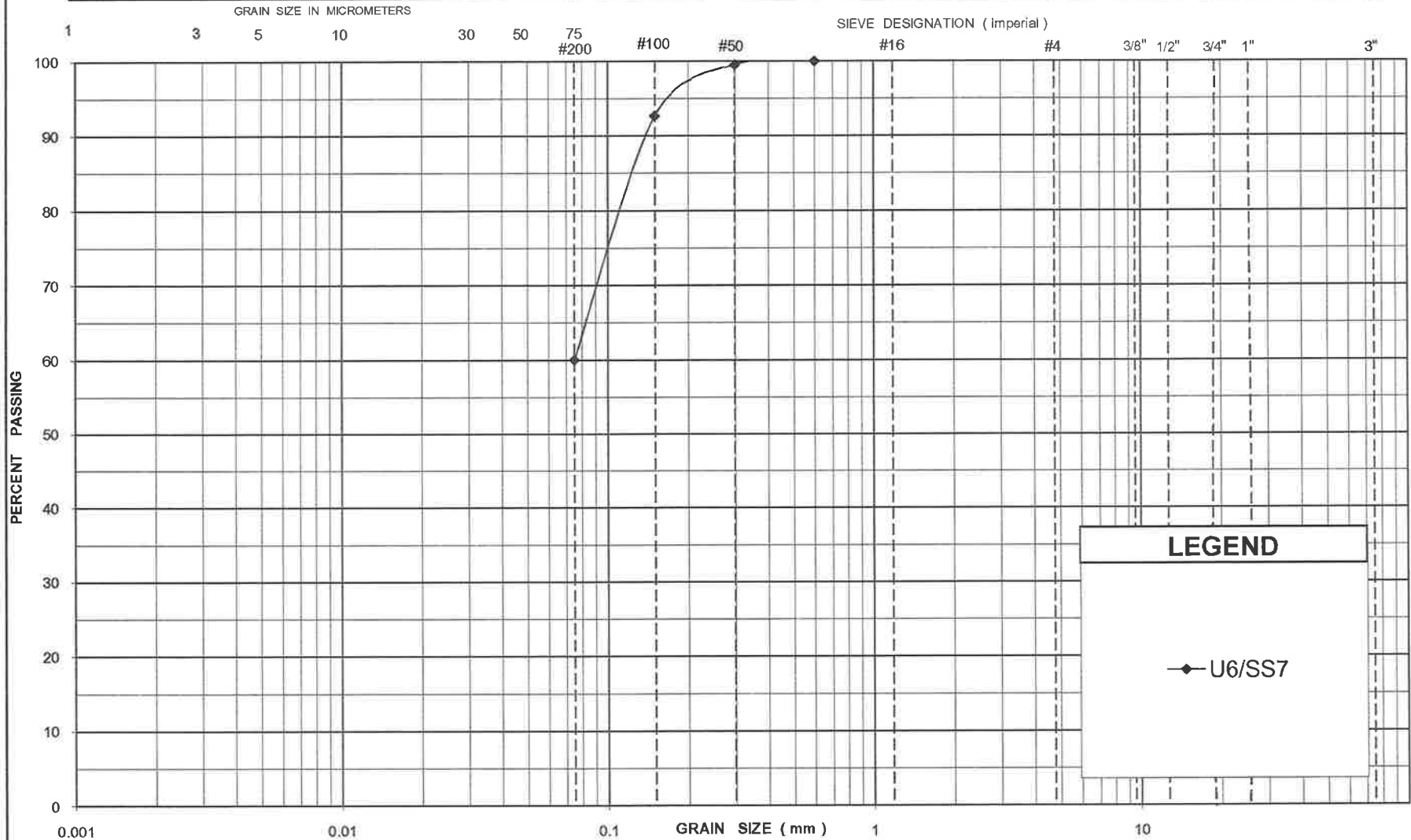
PROJECT NO: SPT1234

DATE: October 16, 2008



# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Coffey Geotechnics Inc.

GRAIN SIZE DISTRIBUTION  
SANDY SILT

FIGURE NO.: B-4

PROJECT NO: SPT1234

DATE: October 16, 2008

# Appendix C

**Area 3**

METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES + METRES.

NOTES:  
FOR DETAILED SUBSURFACE CONDITIONS  
REFER TO RECORD OF BOREHOLE SHEETS.

CONT No.  
GWP:

Highway 26  
BOREHOLE LOCATION PLAN  
(AREA 3 - Airport Road)

coffey geotechnics



KEY PLAN  
N.T.S.

LEGEND

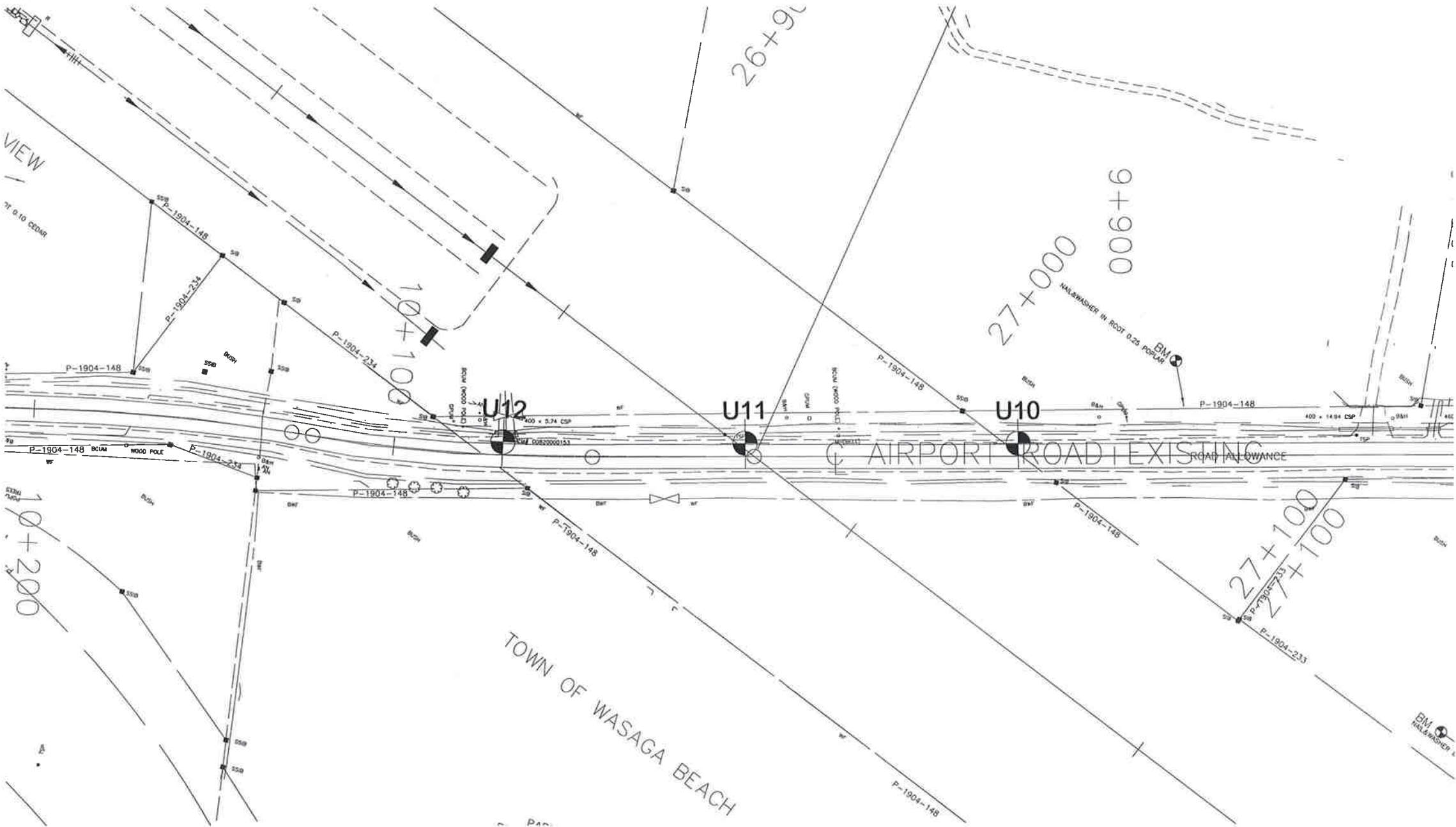
- Borehole
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEV.	EASTING	NORTHING
U10	188.9	255471.586	4925117.049
U11	189.4	255398.592	4925096.881
U12	190.2	255333.770	4925079.483

NOTE:  
The boundaries between soil strata have been established only at Borehole locations. Between Bore Holes the boundaries are assumed from geological evidence.

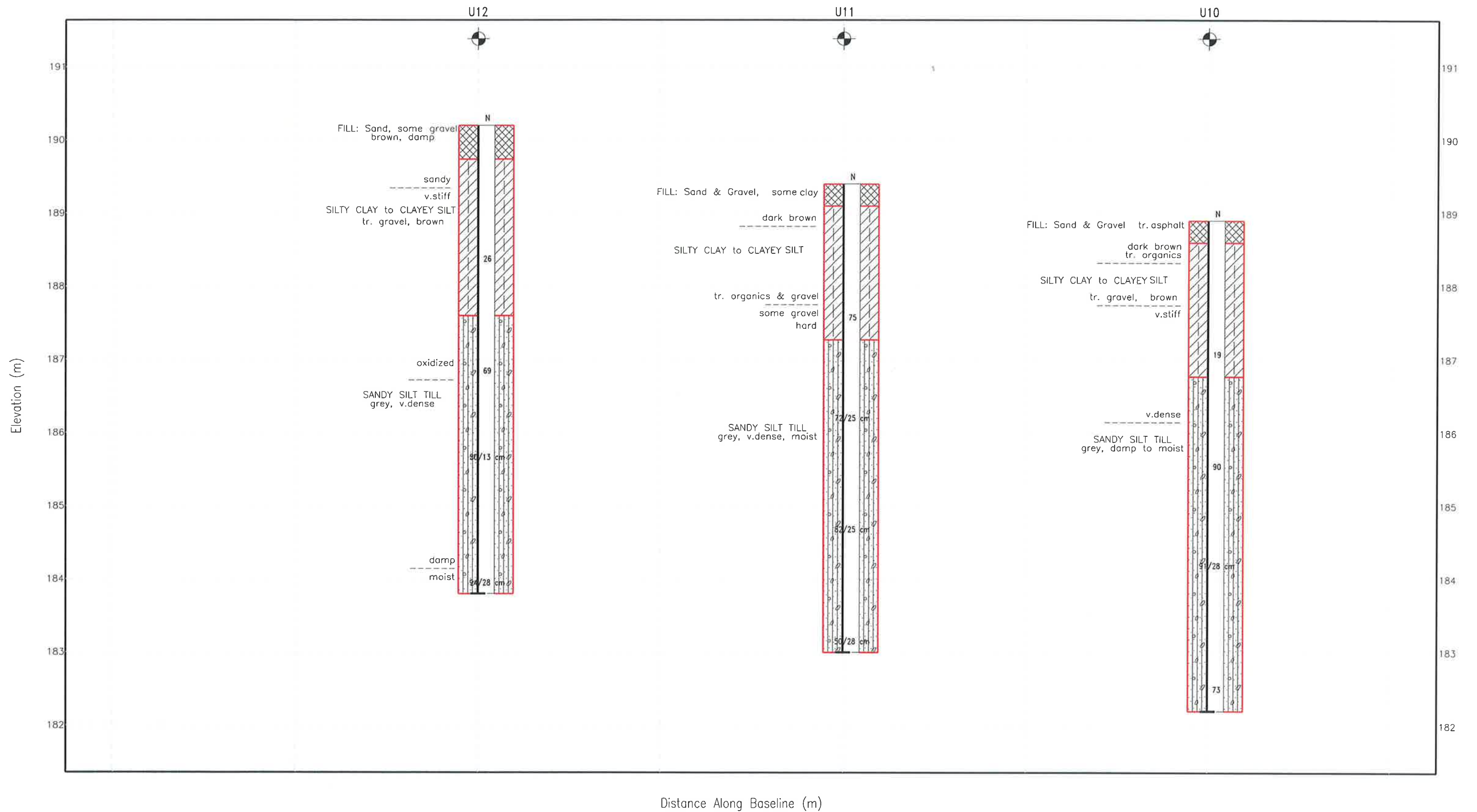
NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REV.	DATE	BY	DESCRIPTION
Geocres No.			
SPT 1234			DIST
SUBM'D	CHECKED	DATE Dec. 2008	SITE
DRAWN PHK	CHECKED RM	APPROVED ZO	DWG C-1



SCALE  
10m 0 10 20m

BOREHOLE LOCATION PLAN















SPT1234 : Highway 26

# RECORD OF BOREHOLE No U10

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION \_\_\_\_\_ EASTING 255471.586 NORTHING 4925117.049 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/18/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● POCKET PENETR.    × LAB VANE						
188.9	GROUND SURFACE						20	40	60	80	100					
0.0	FILL: Sand & Gravel tr. asphalt		1	AS												
0.3			2	AS												
	dark brown tr. organics															
	SILTY CLAY to CLAYEY SILT tr. gravel, brown		3	AS												
	v. stiff		4	SS	19											
186.8																
2.1			5	AS												
	v. dense		6	SS	90											
	SANDY SILT TILL grey, damp to moist															
																
			7	SS	91/28 cm											
																
			8	AS												
																
182.2			9	SS	73											
6.7	End of borehole Hole caved in @ 6.4 m upon completion. Borehole dry upon completion (not stabilized)*															

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT1234 : Highway 26

RECORD OF BOREHOLE No U11

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION \_\_\_\_\_ EASTING 255398.592 NORTHING 4925096.881 ORIGINATED BY RK  
DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
DATUM \_\_\_\_\_ DATE 9/18/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED    + FIELD VANE ● POCKET PENETR    × LAB VANE							
189.4	GROUND SURFACE														
0.0	FILL: Sand & Gravel, some clay														
0.3															
	dark brown		1	AS		189									
	SILTY CLAY to CLAYEY SILT		2	AS		188									
	tr. organics & gravel														
187.3	some gravel hard		3	SS	75										7 30 45 18
2.1						187									
			4	AS											
			5	SS	72/25 cm	186									
	SANDY SILT TILL					185									
	grey, v. dense, moist		6	SS	62/25 cm	184									
183.0			7	SS	50/28 cm *	183									
6.4	End of borehole Borehole open and dry upon completion (not stabilized)*														

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U12

1 OF 1

METRIC

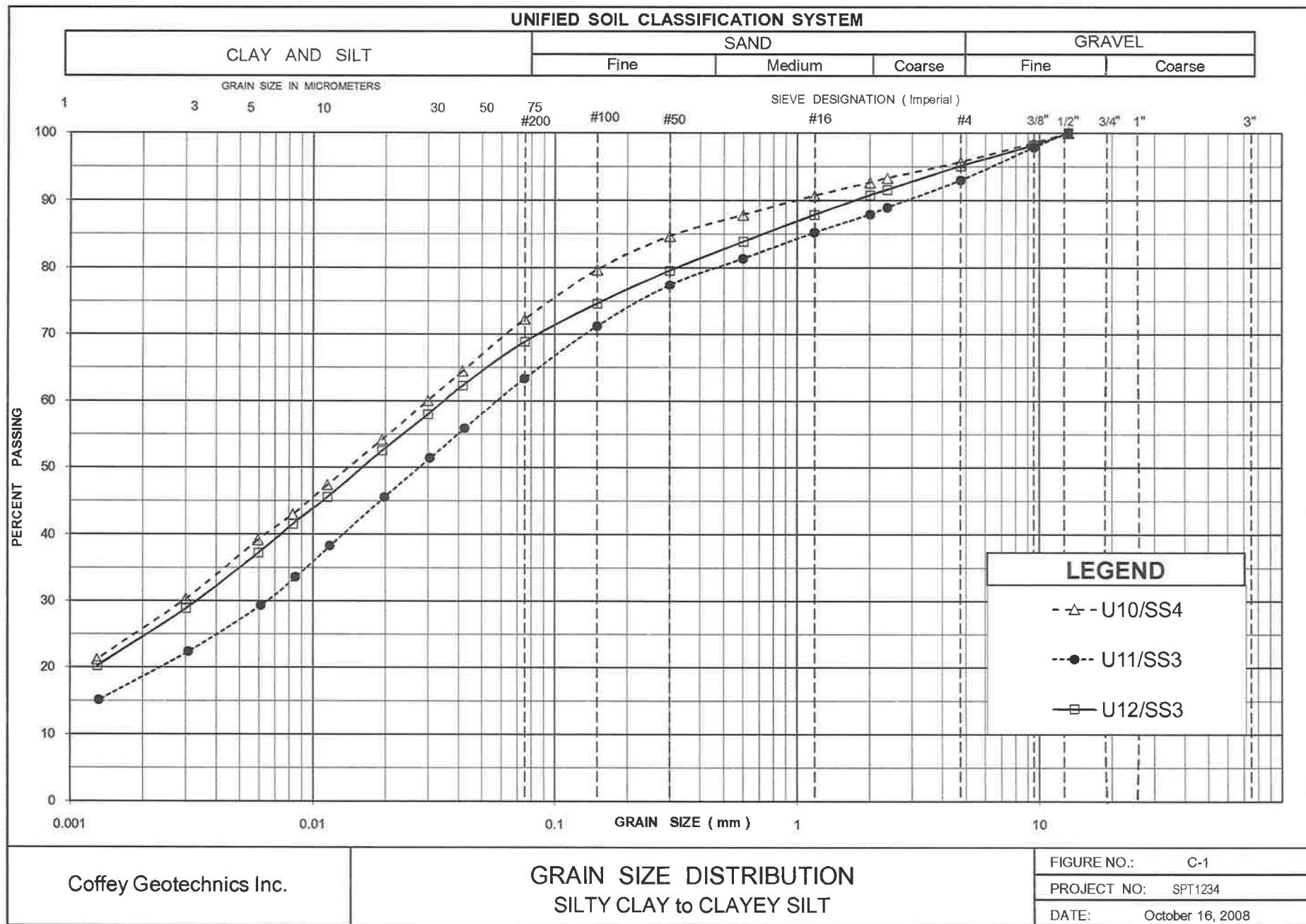
GWP \_\_\_\_\_ LOCATION EASTING 255333.770 NORTHING 4925079.483 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/18/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED    + FIELD VANE ● POCKET PENETR    x LAB VANE				
190.2	GROUND SURFACE							20 40 60 80 100	10 20 30			GR SA SI CL
0.0	FILL: Sand, some gravel brown, damp		1	AS			190					
189.7												
0.5			2	AS			189					
	SILTY CLAY to CLAYEY SILT tr. gravel, brown	sandy v. stiff										
			3	SS	26		188					5 26 44 25
187.6												
2.6			4	SS	69		187					
		oxidized										
			5	AS			186					
	SANDY SILT TILL grey, v. dense		6	SS	50/13 cm							
							185					
		damp										
183.8		moist	7	SS	94/28 cm *		184					
6.4	End of Borehole Borehole open and dry upon completion (not stabilized)*											

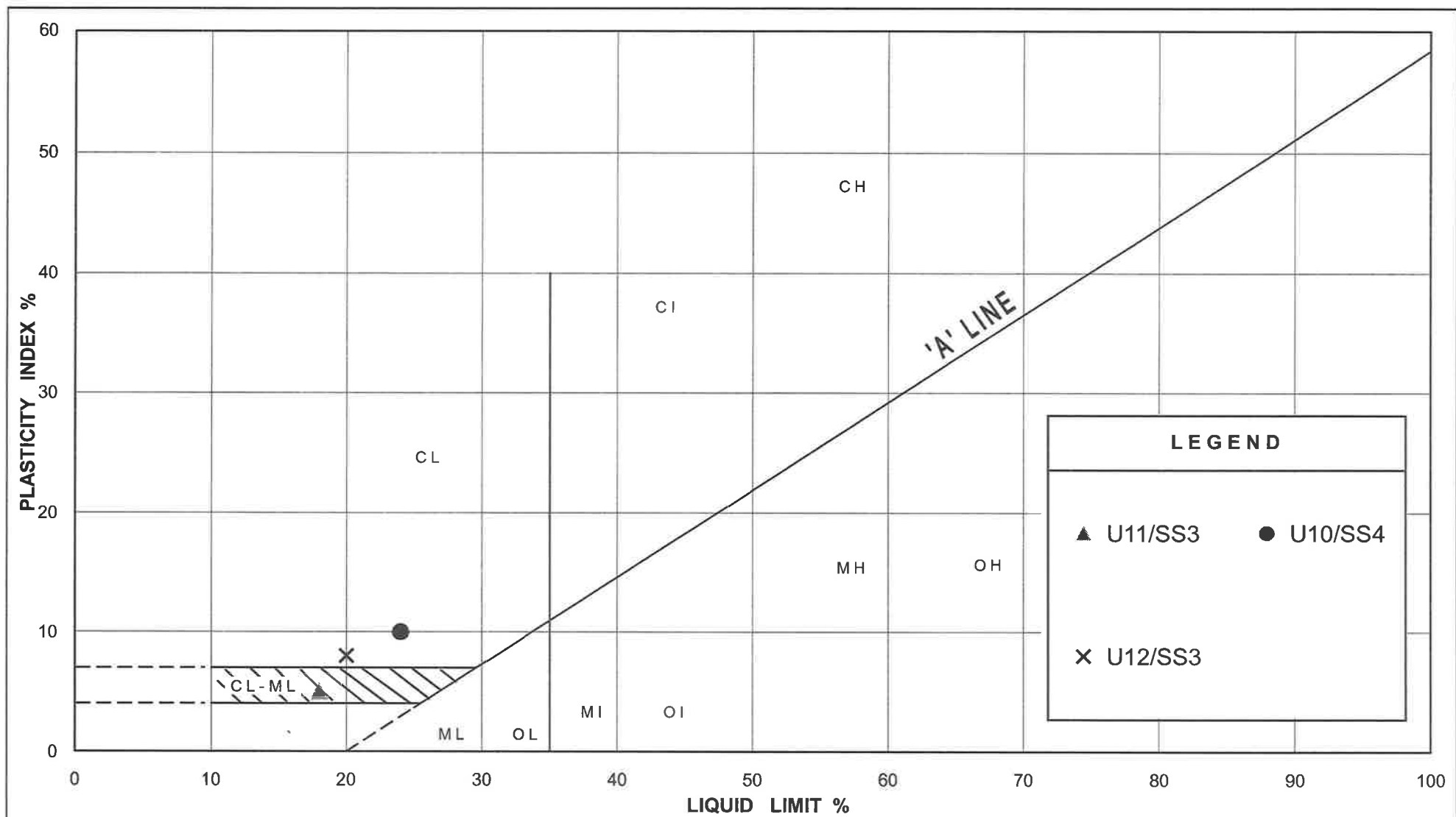
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE









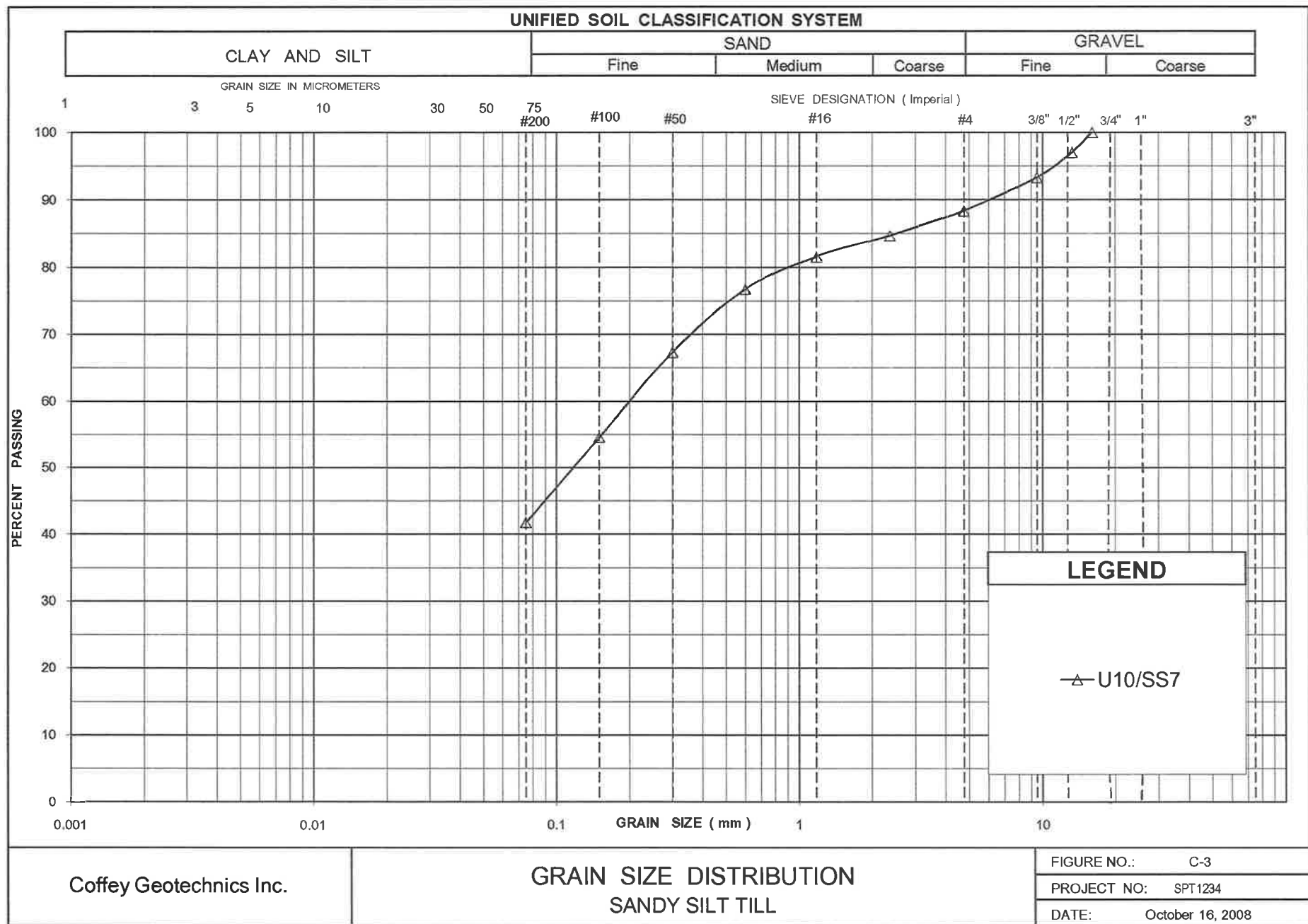
Coffey Geotechnics Inc.

**PLASTICITY CHART**  
**SILTY CLAY to CLAYEY SILT**

FIGURE No. C-2

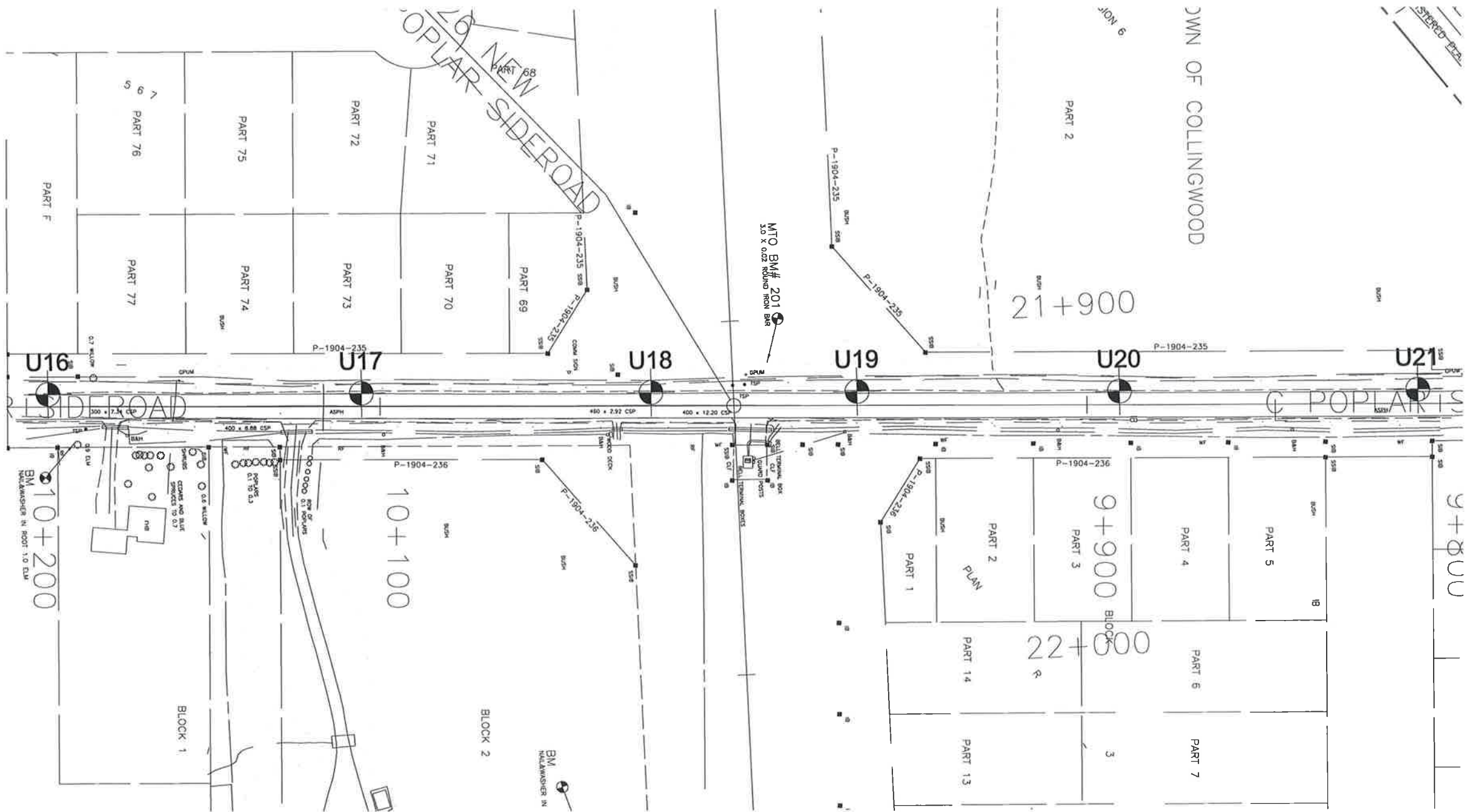
REF. No. SPT 1234

DATE Oct.21, 2008



# Appendix D

**Area 4**



SCALE  
10m 0 10 20m

BOREHOLE LOCATION PLAN

NOTES:  
FOR DETAILED SUBSURFACE CONDITIONS  
REFER TO RECORD OF BOREHOLE SHEETS.

**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES + METRES.

CONT No.  
GWP:

Highway 26  
BOREHOLE LOCATION PLAN  
(AREA 4 - Poplar Sideroad)

**coffey geotechnics**



KEY PLAN  
N.T.S

LEGEND

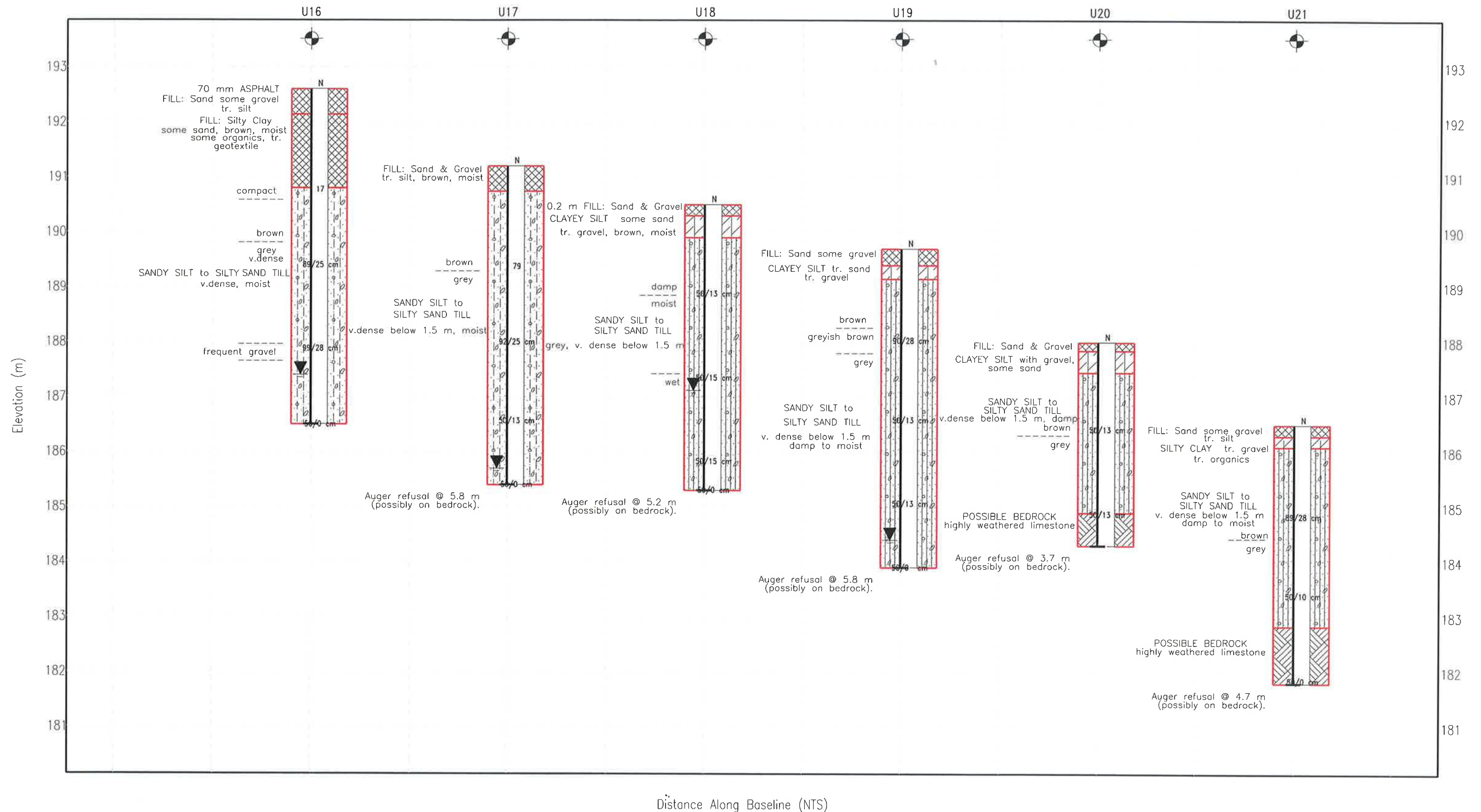
- Borehole
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation  
(W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEV.	EASTING	NORTHING
U16	192.6	251020.332	4927634.224
U17	191.2	251105.518	4927658.562
U18	190.5	251184.223	4927680.900
U19	189.7	251240.502	4927696.907
U20	188.0	251311.899	4927716.985
U21	186.5	251393.162	4927740.181

**=NOTE=**  
The boundaries between soil strata have been established only  
at Borehole locations. Between Bore Holes the boundaries  
are assumed from geological evidence.

NOTE: This drawing is for subsurface information only. Surface  
details and features are for conceptual illustration.

REV.	DATE	BY	DESCRIPTION
Geocres No.			
SPT 1234			DIST
SUBM'D	CHECKED	DATE Dec. 2008	SITE
DRAWN PHK	CHECKED RM	APPROVED ZO	DWG D-1



SPT1234 : Highway 26

# RECORD OF BOREHOLE No U16

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 251020.332 NORTHING 4927634.224 ORIGINATED BY RK  
DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
DATUM \_\_\_\_\_ DATE 9/19/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE							
192.8 0.0	GROUND SURFACE						20	40	60	80	100				
192.1 0.5	70 mm <b>ASPHALT</b> FILL: Sand some gravel tr. silt		1	AS											
	FILL: Silty Clay some sand, brown, moist some organics, tr. geotextile		2	AS											
190.8 1.8		compact	3	SS	17										
		brown	4	AS											
		grey v dense	5	SS	89/25 cm										
	<b>SANDY SILT to SILTY SAND TILL</b> v dense, moist														
		frequent gravel	6	SS	99/28 cm										
			7	AS											
186.5 6.1	End of Borehole Water level in open borehole @ 5.2 m (not stabilized)* and hole caved-in @ 5.8 m upon completion.		8	SS	50/10 cm										

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U17

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION \_\_\_\_\_ EASTING 251105.518 NORTHING 4927658.562 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/19/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)									WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● POCKET PENETR.	× LAB VANE						20	40	60
191.2	GROUND SURFACE																		
0.0	FILL: Sand & Gravel lr. silt, brown, moist		1	AS			191												
190.7			2	AS			190												
0.5	SANDY SILT to SILTY SAND TILL v. dense below 1.5 m, moist		3	SS	79		189									spoon wet 10 52 (38)			
			4	AS			188												
			5	SS	92/25 cm		187												
			6	SS	50/13 cm		186												
			7	AS															
			8	SS	50/10 cm														
185.4	End of Borehole Auger refusal @ 5.8 m (possibly on bedrock). Borehole open upon completion. Water level in open borehole @ 5.5 m (not stabilized)* upon completion.															auger grinding auger grinding auger grinding spoon bouncing no recovery			
5.8																			

+<sup>3</sup> . X<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE



SPT1234 : Highway 26

# RECORD OF BOREHOLE No U18

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 251184.223 NORTHING 4927680.900 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/19/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)								
								○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE								
190.5	GROUND SURFACE						20	40	60	80	100					
190.0	0.2 m FILL: Sand & Gravel															
0.2	CLAYEY SILT some sand tr. gravel, brown, moist		1	AS												
189.9			2	AS												
0.6			3	SS 50/13 cm												
			4	AS												
			5	SS 50/15 cm												
			6	SS 50/15 cm												
185.3	SANDY SILT to SILTY SAND TILL grey, v. dense below 1.5 m		7	GS 50/0 cm												
5.2																
	End of Borehole Auger refusal @ 5.2 m (possibly on bedrock). Water level in open borehole @ 3.4 m (not stabilized)* and hole caved in @ 3.7 m upon completion.															

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



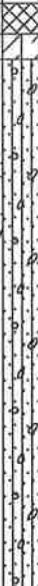
SPT1234 : Highway 26

# RECORD OF BOREHOLE No U19

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 251240.502 NORTHING 4927696.907 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/19/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE									WATER CONTENT (%)
189.7	GROUND SURFACE							20	40	60	80	100					
0.0 189.7	FILL: Sand some gravel	XXXX	1	AS													
0.3 189.2	CLAYEY SILT tr. sand, tr. gravel	XXXX	2	AS													
0.6 189.2	SANDY SILT to SILTY SAND TILL v. dense below 1.5 m, damp to moist		3	AS													
			4	SS 90/28 cm													
			5	AS													
			6	SS 50/13 cm													
			7	AS													
			8	SS 50/13 cm													
			9	AS													
			10	SS 50/8 cm													
183.9 5.8	End of Borehole Auger refusal @ 5.8 m (possibly on bedrock). Borehole open upon completion. Water level in open borehole @ 5.3 m (not stabilized)* upon completion.																

+<sup>3</sup> . X<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U20

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION EASTING 251311.899 NORTHING 4927716.985 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/19/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED    + FIELD VANE ● POCKET PENETR    × LAB VANE								
188.0	GROUND SURFACE	XXXX					20	40	60	80	100					
187.8	FILL: Sand & Gravel	XXXX														
0.2																
187.5	CLAYEY SILT with gravel, some sand	XXXX	1	AS												
0.6																
	SANDY SILT to SILTY SAND TILL v dense below 1.5 m, damp	XXXX	2	AS												
		XXXX														
		XXXX	3	SS 50/13 cm												
		XXXX														
		XXXX	4	AS												
184.9		XXXX														
3.1	POSSIBLE BEDROCK highly weathered limestone	XXXX	5	SS 50/13 cm												auger grinding
184.3		XXXX														auger grinding
3.7	End of Borehole Auger refusal @ 3.7 m (possibly on bedrock). Borehole open and dry upon completion(not stabilized)*															

+ 3, x 3<sub>2</sub> Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U21

1 OF 1

METRIC

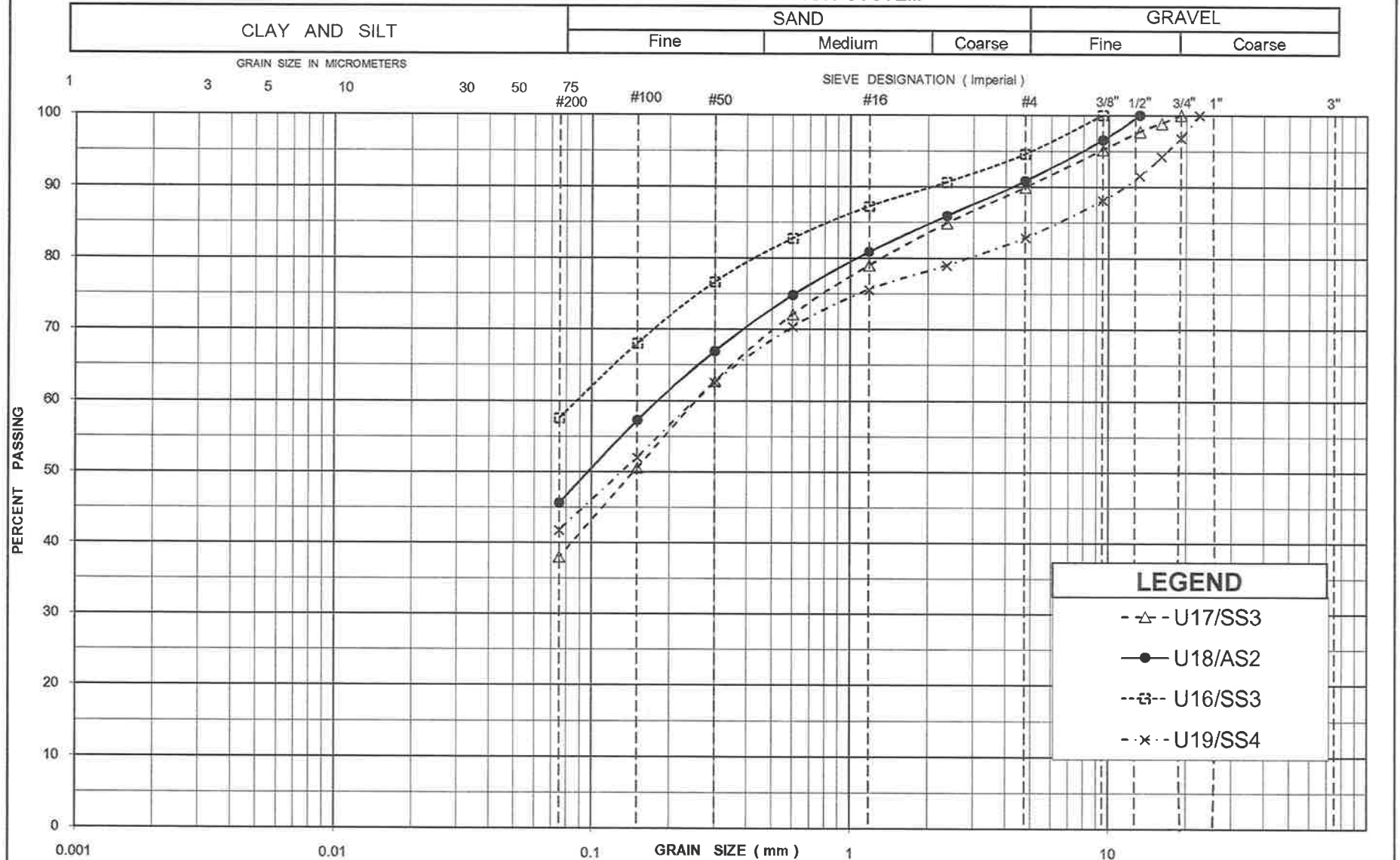
GWP \_\_\_\_\_ LOCATION EASTING 251393.162 NORTHING 4927740.181 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/19/2008 CHECKED BY RM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>P</sub>	W		
186.5	GROUND SURFACE												
186.0	FILL: Sand some gravel, tr silt		1	AS									
0.2			2	AS									
186.1	SILTY CLAY tr gravel, tr organics		3	AS									
0.4			4	SS	89/28 cm								
	SANDY SILT to SILTY SAND TILL v. dense below 1.5 m, damp to moist		5	AS									
			6	SS	50/10 cm								
182.8													
3.7	POSSIBLE BEDROCK highly weathered limestone		7	AS									auger grinding
181.8													auger grinding
4.7	End of Borehole Auger refusal @ 4.7 m (possibly on bedrock). Borehole dry upon completion (not stabilized)*												auger grinding
													spoon bouncing
													no sample
													recovery

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# UNIFIED SOIL CLASSIFICATION SYSTEM



Coffey Geotechnics Inc.

GRAIN SIZE DISTRIBUTION  
SILTY SAND to SANDY SILT TILL

FIGURE NO.: D-1

PROJECT NO: SPT1234

DATE: October 16, 2008

# Appendix E

**Area 5**

METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES + METRES.

NOTES:  
FOR DETAILED SUBSURFACE CONDITIONS  
REFER TO RECORD OF BOREHOLE SHEETS.

CONT No.  
GWP:

Highway 26  
BOREHOLE LOCATION PLAN  
(AREA 5 - Nottawa Sideroad)

coffey geotechnics



KEY PLAN  
N.T.S

LEGEND

- Borehole
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

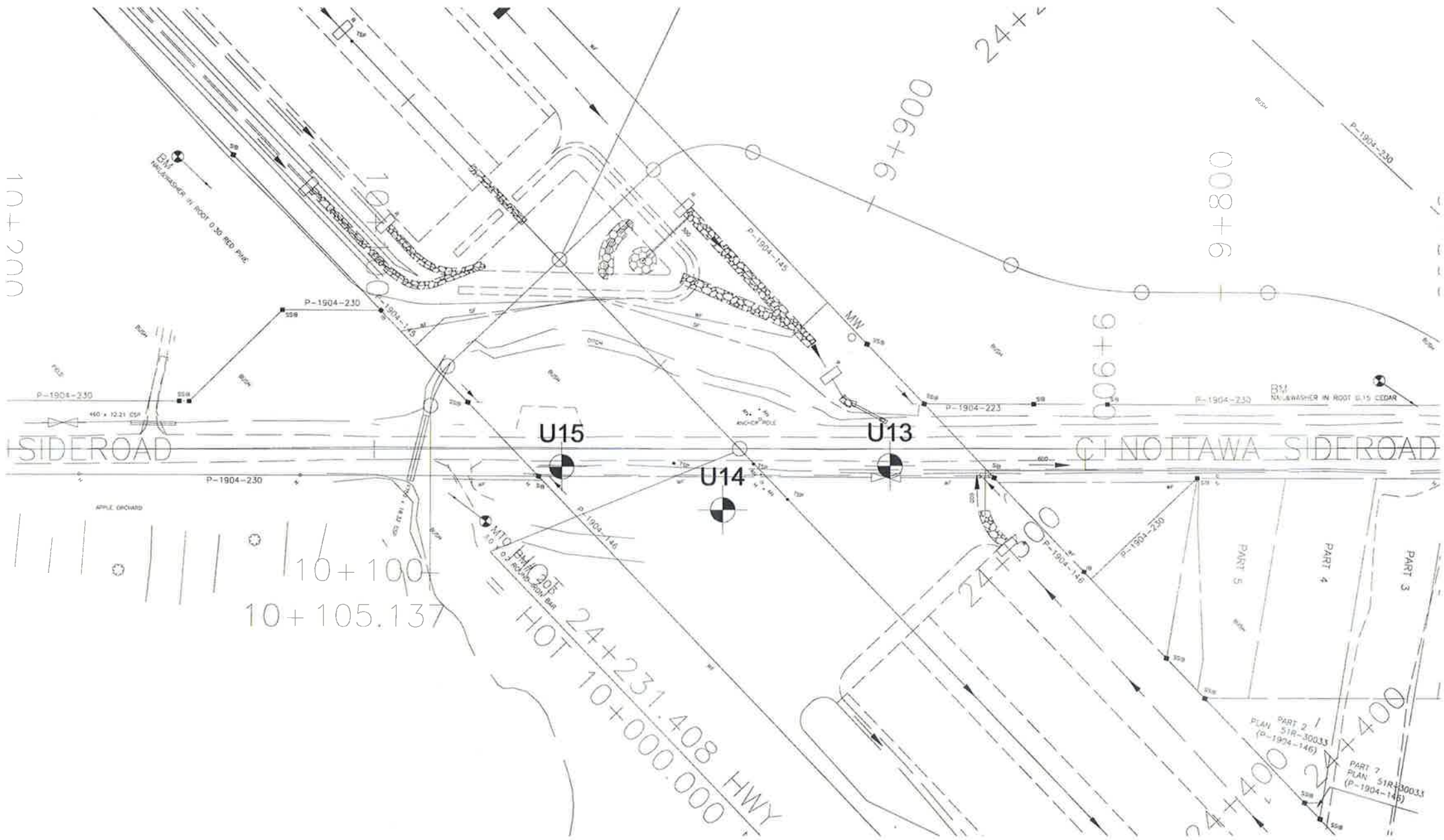
No.	ELEV.	EASTING	NORTHING
U13	191.1	252992.642	4926303.816
U14	192.5	252952.238	4926279.240
U15	195.4	252906.673	4926278.121

NOTE

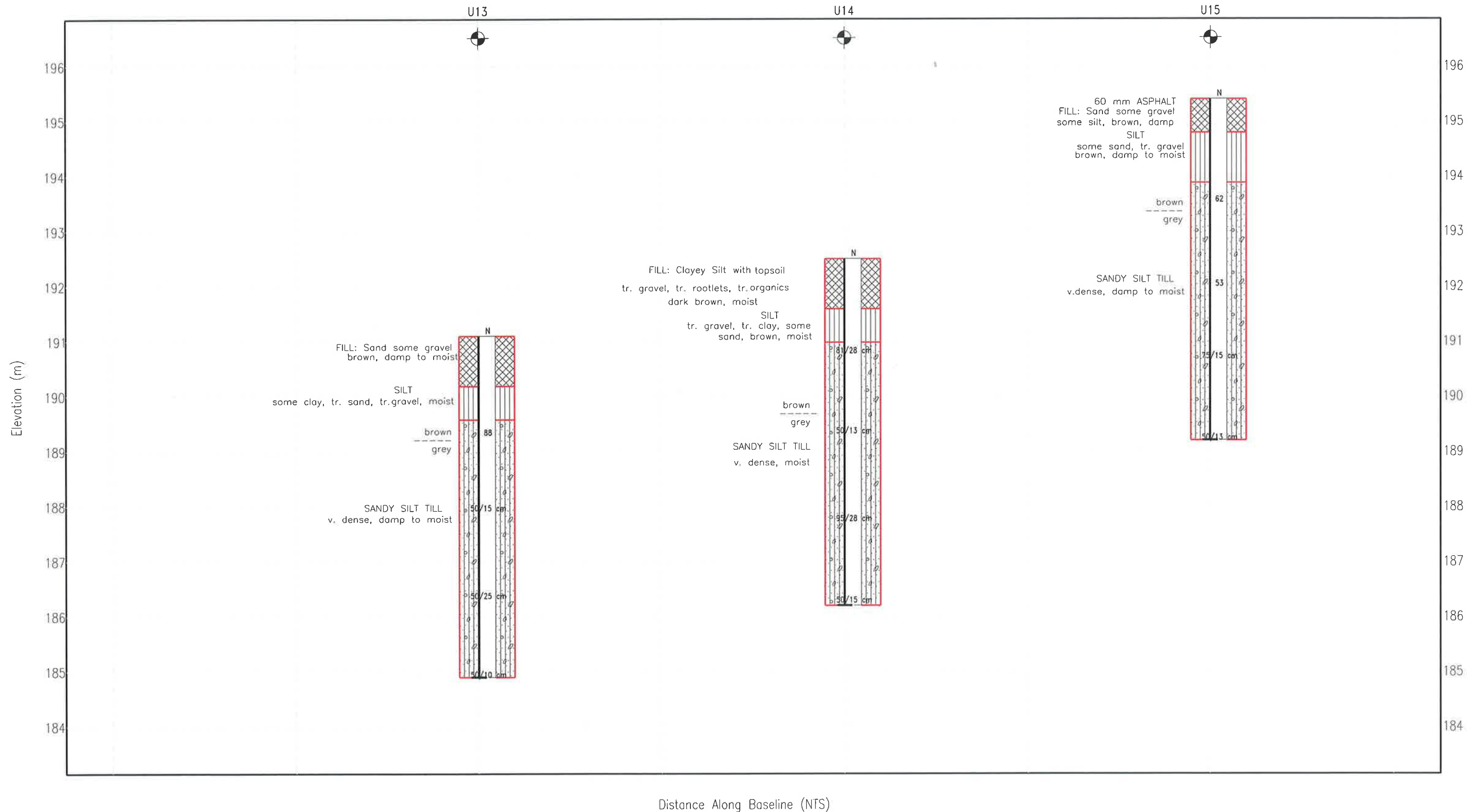
The boundaries between soil strata have been established only at Borehole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REV.	DATE	BY	DESCRIPTION
Geocres No.			
SPT 1234			DIST
SUBM'D	CHECKED	DATE Dec. 2008	SITE
DRAWN PHK	CHECKED RM	APPROVED ZO	DWG E-1



BOREHOLE LOCATION PLAN



SPT1234 : Highway 26

# RECORD OF BOREHOLE No U13

1 OF 1

METRIC

GWP \_\_\_\_\_ LOCATION \_\_\_\_\_ EASTING 252992.642 NORTHING 4926303.816 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/18/2008 CHECKED BY RM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH (kPa)					
191.1 0.0	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	10 20 30				
							○ UNCONFINED + FIELD VANE						
							● POCKET PENETR. X LAB VANE						
190.2 0.9	FILL: Sand some gravel brown, damp to moist		1	AS									
189.6 1.5	SILT some clay, tr. sand, tr. gravel, moist		2	AS									
			3	SS	88								
			4	AS									
			5	SS	50/15 cm								
			6	AS									
			7	SS	50/25 cm								
184.9 6.2	End of Borehole Borehole open and dry upon completion (not stabilized)*		X	SS	50/10 cm	*							

+ 3 . X 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



SPT1234 : Highway 26

## RECORD OF BOREHOLE No U14

1 OF 1

METRIC

GWP	LOCATION	EASTING 252952.238 NORTHING 4926279.240	ORIGINATED BY	RK
DIST	HWY	26	BOREHOLE TYPE	Solid Stem Auger
DATUM	DATE	9/18/2008	CHECKED BY	RM

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

SPT1234 : Highway 26

# RECORD OF BOREHOLE No U15

1 OF 1

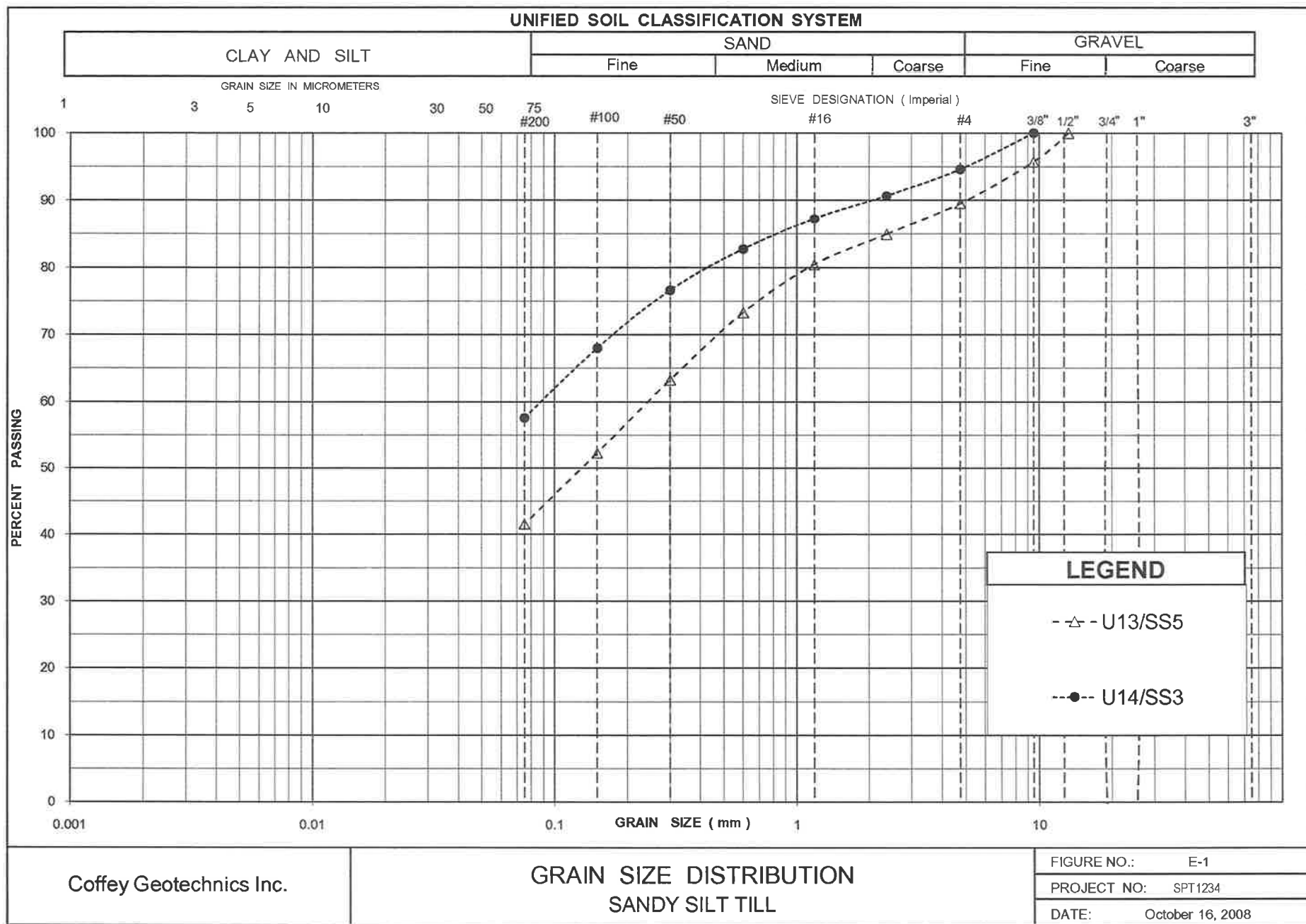
METRIC

GWP \_\_\_\_\_ LOCATION EASTING 252906.673 NORTHING 4926278.121 ORIGINATED BY RK  
 DIST \_\_\_\_\_ HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY SS  
 DATUM \_\_\_\_\_ DATE 9/18/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE							
195.4	GROUND SURFACE							20 40 60 80 100							
0.0	60 mm ASPHALT		1	AS			195								
194.8	FILL: Sand some gravel some silt, brown, damp														
0.6	SILT some sand, tr. gravel brown, damp to moist						194								
193.9			2	SS	62										
1.5			3	AS			193								
			4	SS	53		192								
	SANDY SILT TILL v dense, damp to moist						191								
			5	SS	75/15 ch										
			6	AS			190								
189.2			7	SS	50/13 ch										
6.2	End of Borehole Hole caved in @ 5.8 m and dry upon completion (not stabilized)*														

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE



# Appendix F

**Explanation of Terms Used in the Report**

## EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS  $\bar{N}$ .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$C_u$ (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCUTRAL FEATURES AND/OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINT AND BEDDING:**

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICALL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$c_c$	1	COMPRESSION INDEX
$c_s$	1	SWELLING INDEX
$c_a$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $c_u / \tau_r$

## PHYSICAL PROPERTIES OF SOIL

$P_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$j_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$P_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$j_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$s_r$	%	DEGREE OF SATURATION	$D_n$	mm	N PERCENT – DIAMETER
$P$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$j$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$P_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$j_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $(W_L - W_p) / I_p$	v	m/s	DISCHARGE VELOCITY
$P_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $(W - W_p) / I_p$	i	1	HYDAULIC GRADIENT
$j_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_c$	1	CONSISTENCY INDEX = $(W_L - W) / 1_p$	k	m/s	HYDRAULIC CONDUCTIVITY
$P'$	kg/m <sup>3</sup>	DENSITY OF SUBMERED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m <sup>3</sup>	SEEPAGE FORCE
$j'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

# Appendix G

## **Limitations of Report**

## **LIMITATIONS OF REPORT**

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Coffey Geotechnics Inc. (Coffey) at the time of preparation. Unless otherwise agreed in writing by Coffey, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Coffey accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.