

**FOUNDATION INVESTIGATION AND  
DESIGN REPORTS  
PROPOSED WIDENING OF HIGHWAY 17 FROM  
STATION 26+100 TO 26+240  
FROM 9.5 KM EAST OF HIGHWAY 533  
EASTERLY 14.9 KM  
MATTAWA, ONTARIO  
G.W.P. 173-98-00; AGREEMENT NO. 5006-E-0040  
GEOCRES NO. 31L-126**

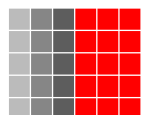
**Prepared For:**

**D. M. WILLS ASSOCIATES**

**Prepared by:**

**SHAHEEN & PEAKER  
A Division of Coffey Geotechnics Inc.**

**Project: SPT1211A  
November 24, 2008**



**shaheen & peaker**

**20 Meteor Drive  
Toronto, Ontario  
M9W 1A4**

**Tel: (416) 213-1255**

**Fax: (416) 213-1260**

**EMAIL: [info@shaheenpeaker.ca](mailto:info@shaheenpeaker.ca)**

**FOUNDATION INVESTIGATION REPORT  
PROPOSED WIDENING OF HIGHWAY 17 FROM  
STATION 26+100 TO 26+240  
FROM 9.5 KM EAST OF HIGHWAY 533  
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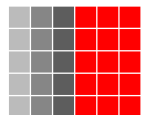
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**20 Meteor Drive  
Toronto, Ontario  
M9W 1A4  
Tel: (416) 213-1255  
Fax: (416) 213-1260**

**EMAIL: [info@shaheenpeaker.ca](mailto:info@shaheenpeaker.ca)**

## Table of Contents

<b>1. INTRODUCTION</b>	<b>1</b>
<b>2. PHYSIOGRaPHY AND GEOLOGY</b>	<b>1</b>
<b>3. INVESTIGATION PROCEDURES</b>	<b>2</b>
<b>4. SUBSURFACE CONDITIONS</b>	<b>3</b>
4.1 Embankment Fill.....	4
4.2 Peat and Organic Soils.....	5
4.3 Upper Sand .....	5
4.4 Layered Silty Fine Sand/Silt/Clayey Silt .....	6
4.5 Lower Sand .....	7
4.6 Refusal Depths .....	7
4.7 Groundwater Conditions.....	7

### **DRAWING**

### **DRAWING No.**

**BOREHOLE LOCATIONS & SOIL STRATA**

**1**

**APPENDIX A: RECORD OF BOREHOLE SHEETS**

**APPENDIX B: LABORATORY TEST RESULTS**

**APPENDIX C: SITE PHOTOGRAPHS**

**APPENDIX D: EXPLANATION OF TERMS USED IN REPORT**

**FOUNDATION INVESTIGATION REPORT  
PROPOSED WIDENING OF HIGHWAY 17  
FROM STATION 26+100 TO 26+240 FROM 9.5 KM  
EAST OF HIGHWAY 533, EASTERLY 14.9 KM  
MATTAWA, ONTARIO  
G.W.P. 173-98-00; AGREEMENT NO. 5006-E-0040**

## **1. INTRODUCTION**

As part of rehabilitation of Highway 17, from 9.5 km east of Highway 533 (Mattawa) easterly for 14.9 km, it is proposed to widen a section of Highway 17 to accommodate an eastbound truck passing lane.

Shaheen & Peaker (S&P) was retained by D. M. Wills Associates Limited to carry out a foundation investigation at the site of the proposed widening.

The purpose of this investigation was to obtain subsurface conditions at the site of the proposed widening by means of boreholes and to determine the relevant engineering characteristics of the subsurface soils by means of field and laboratory tests.

The findings of the investigation are presented in this report.

## **2. PHYSIOGRAPHY AND GEOLOGY**

The project site is located on Highway 17, between Mattawa and Deux-Rivieres, some 70 km east of North Bay, Ontario.

According to the Physiography of Southern Ontario by L.J. Chapman and D.F. Putnam, 1984, the site is located within the Physiographic Region known as the Algonquin Highlands. Much of this region is underlain by Precambrian granitic bedrock. Locally, relief is rough, rounded knobs and ridges standing up, usually 15 to 60 m but occasionally up to 150 m high. The overburden is generally shallow but its thickness over the bedrock varies greatly over short distances. Many of the valleys are floored with outwashes of sand and gravel, with frequent swamp and bogs in the hollows. The northern part of Algonquin lake plain, that extends east to near Mattawa, shows the presence of silty clay, silt and sand deposits. In general, the highway in the project area appears to be built along spillways and shallow rock ridges, along with shallow till deposits.

According to Bedrock Geology of Ontario Map 2544 (Ministry of Northern Development and Mines, Ontario), the bedrock underlying the site consists of Mesoproterozoic Precambrian rocks (i.e. approximately 900 million years old), primarily felsic igneous tonalite, granodiorite, monzonite, granite, syenite and derived gneisses.

The site is located in between two rock knobs, with a grade sharply falling towards a creek valley (Resmer Creek) located in between knobs. Starting from the west side the grade falls sharply towards the east (i.e. towards the project site), to about El. 208 m at about Station 26+050. The grade continues to fall to about El. 200 m at Station 26+250. From thereon, the grade falls more gradually towards the Resmer Creek at about Station 26+500 to about El. 194 m. Beyond the creek, the grade rises easterly to about 204 m at about Station 26+800, and finally, to a rock outcrop (i.e. top of the second knob) at about Station 27+100.

### 3. INVESTIGATION PROCEDURES

The fieldwork for this project was performed during the period from April 21 to April 26, 2008 and consisted of drilling and sampling a total of eight boreholes to depths ranging from 2.4 to 11.0 m below the ground surface, as follows:

Borehole 26+050,	17.4 m Rt of CL	-	2.4 m deep
Borehole 26+100,	20.0 m Rt of CL	-	5.4 m deep
Borehole 26+125,	4.8 m Rt of CL	-	11.0 m deep
Borehole 26+150,	20.0 m Rt of CL	-	3.2 m deep
Borehole 26+190,	21.0 m Rt of CL	-	4.7 m deep
Borehole 26+200,	8.2 m Rt of CL	-	6.2 m deep
Borehole 26+228,	6.8 m Rt of CL	-	6.0 m deep
Borehole 26+245,	17.0 m Rt of CL	-	4.6 m deep

In addition, Dynamic Cone Penetration tests were performed at Station 26+125, 20 m Rt of CL and at Station 26+200, 19 m Rt of CL.

Landcore Drilling Inc of Chelmsford, Ontario, drilling contractor, carried out the drilling, testing and sampling under the supervision and direction of a Professional Engineer from S&P.

The positions of the boreholes in the field are given on the Borehole Location Plan, Drawing No. 1.

Samples in the boreholes were taken 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 diameter 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 (or cohesionless) soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey soils).

As mentioned before, Dynamic Cone Penetration Tests were performed at two locations. In Dynamic Cone Penetration Test (DCPT), a 51 mm diameter, 60 deg. apex cone point, screw-attached to the tip of A-size rods, is driven into the ground using the same driving energy as in the SPT method. By recording the number of blows to drive the cone/rod assembly into the soil every 0.3 m, a qualitative record of relative density/consistency is obtained. Although the interpretation of the test results is difficult because no samples are obtained by the DCPT method and the penetration resistances are not necessarily equal to the N-values, useful information is gained by the continuity of the results and by the elimination of unbalanced hydrostatic effects which in many cases affect the SPT values, especially in the fine-grained granular soils. In the present case, the DCPT was generally terminated when the number of blows to drive the cone/rod assembly by 0.2 m exceeded 200.

Groundwater conditions in the boreholes were observed during the drilling in the open boreholes. Upon their completion, the boreholes were grouted using a cement/bentonite mixture as per MTO procedures. In Borehole 26+100, a piezometer was installed to enable us to monitor the groundwater level over a prolonged period of time without interference from surface water.

The details of the drilling, sampling, field testing and soil conditions encountered are presented on the Record of Borehole Sheets in Appendix A. An inferred subsurface profile is given in Drawing No. 1.

A laboratory testing programme, consisting of natural moisture content measurements and grain-size analyses was performed on selected soil samples. The results of laboratory tests are presented on the appropriate Record of Borehole Sheets and also in Appendix B.

The ground surface elevations at the borehole locations were provided to us by our client (D. M. Wills Associates Limited). We understand that the elevations are related to the Geodetic Datum.

#### **4. SUBSURFACE CONDITIONS**

For this investigation, eight boreholes were drilled and two DCPT were put down between Stations 20+050 and 26+250, on the right side of the highway. Three of the boreholes were put down from the top of the embankment, four boreholes from the bottom (i.e. from the o.g. level) while one borehole (Borehole 26+190 Rt) was drilled from about halfway up the embankment (from a local driveway area).

The top of the road elevation (i.e. center line elevation) in this stretch ranges from about 210.6 m at Station 26+050 gradually decreasing to about El. 202.0 m at Station 26+250 (i.e. on elevation drop of 8.6 m over a horizontal distance of 200 m), representing an approximate 4.3% average gradient.

The o.g. level elevations in this area range from about 208 m at Station 26+050 to about 200 m at Station 26+250 m. The embankment is typically 3 to 5 m high.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix A, while a stratigraphic profile is given in Drawing No. 1. The various soil strata encountered in the boreholes and their geotechnical properties are briefly described in the following paragraphs. It should be noted that the soil and groundwater conditions may vary in between and beyond the borehole locations.

#### 4.1 EMBANKMENT FILL

Boreholes 26+125, 26+190, 26+200 and 26+228 were drilled from the highway embankment and consequently encountered embankment fill.

Borehole 26+125 was drilled from the paved shoulder of the road and encountered 0.1 m of asphaltic concrete followed by a 0.15 m thick granular base fill. Underlying the granular base material, a granular fill was contacted to 0.7 m below the ground surface.

Granular fill was also encountered in Borehole 26+190 to a depth of 1.4 m below the ground surface.

Based on Standard Penetration test results, which yielded N-values of 15 to 18 blows/0.3 m, these granular fills appear to have received some systematic compaction (i.e. in a compact condition).

Granular fill was also contacted in Borehole 26+228 between 1.4 and 3.0 m below the ground surface and consisted of sand with traces of gravel to gravelly sand. From recorded N-values of 3 and 12 blows/0.3 m, the granular fill in this borehole does not appear to have received a systematic compaction (i.e. very loose to compact).

The remaining portions of the embankment fill in these four boreholes was found to generally consist of fine-grained granular fill ranging from sand with some gravel and silt to sandy silt. The presence of cobbles, gravel along with occasional asphalt pieces and topsoil pockets/organics was also noted.

The grain-size distribution of three samples from the embankment fill is given in Figures B-1 and B-2 in Appendix B. These show the following grain-size distribution.

Gravel:	0 – 22%
Sand:	59-92%
Silt & Clay:	8-19%

N-values recorded in the relatively finer graded granular embankment fill range from 5 to 31 blows/0.3 m, indicating a loose to dense condition.

It should also be pointed out that in Borehole 26+125, a 1.5 m thick rock fill zone with sand and gravel infill was found from 1.5 to 3.0 m below the ground surface. Some pavement boreholes in this area also indicate probable rockfill (based on auger refusal) below depths of about 1 to 1.5 m.

#### 4.2 PEAT AND ORGANIC SOILS

In the boreholes drilled from the bottom of the embankment (i.e. from the o.g. level), peat and other organic rich soils (e.g. organic silt) were found to extend to depths ranging from 0.25 m to 1.4 m, as detailed below:

Borehole 26+050	0.25 m Peat
Borehole 26+100	0.4 m Peat
	0.4-0.7 m Sandy Silt with organics
	0.7-1.4 m Organic Silt
Borehole 26+150	0.7 m Peat
Borehole 26+245	0.3 m Peaty topsoil

It should be noted that, based on our experience at many sites, the thickness of peat and organic soils may vary considerably between and beyond the borehole locations, especially in the low lying areas; therefore, allowances should be made for possible variations in quantities when making estimates.

In the boreholes drilled from the embankment, organic soils were not found underlying the embankment fill (i.e. organic soils appear to have been properly stripped prior to placing the embankment fill, as per MTO procedures), except for Borehole 26+190 where a 0.6 m thick organic silt deposit was found underlying the embankment fill, from 2.3 to 2.9 m below the ground surface. This borehole was however located on a driveway adjacent to the shoulder of the highway and the fill for the driveway may therefore have been placed without prior stripping.

N-values recorded in the organic deposits range from 0 to 7 blows/0.3 m, indicating a very loose to loose relative density or a very soft to soft consistency.

#### 4.3 UPPER SAND

Borehole 26+050 (which is the most westerly borehole) was drilled from the o.g. level with the highest elevation and encountered, immediately below a 0.25 m thick peat layer, a sand deposit with some silt and gravel and occasional inferred cobbles. This deposit which has a glacial till-like texture was found to extend to 2.1 m below the ground surface or to El. 205.9 m. Standard Penetration tests performed in the upper 1.3 ±m of the deposit yielded N-values of 3 and 4 blows/0.3 m indicating a very loose condition. Below this, an



N-value of 24 blows/0.3 m was recorded. From this, the relative density of the soil below about 1.3 m is described as compact.

Underlying the sand deposit at 2.1 m below the ground surface, a 0.3 m thick sandy gravel layer was found with some cobbles. Auger refusal was encountered in the borehole at 2.4 m where it was terminated.

An upper silty fine sand layer was contacted in Borehole 26+200, immediately below the embankment fill at (3.0 m depth). This deposit was found to be 1.5 m thick and extended to 4.5 m depth or to El. 198.7 m.

The grain-size distribution of a sample from the deposit is given in Figure B-3 in Appendix B. The curve indicates the following grain-size distribution.

Gravel:	0%
Sand:	74%
Silt:	19%
Clay:	7%

N-values recorded in this fine-grained granular material were 8 and 17 blows/0.3 m which indicate a loose to compact denseness condition.

#### 4.4 LAYERED SILTY FINE SAND/SILT/CLAYEY SILT

In all boreholes, except for Borehole 26+050, underlying the embankment fill, organic soils or the upper fine sand, a thinly interbedded deposit was contacted. The composition of the interbeds in this deposit ranges from fine-grained granular silty very fine sand, sandy silt and silt to basically cohesive silt to clayey silt with very thin clay seams as detailed on the Record of Borehole Sheets. This deposit was contacted at depths ranging from 0.3 m (Borehole 26+245) to 5.3 m (Borehole 26+125) below the ground surface and was found to extend to depths ranging from 1.8 m (Borehole 26+150) to 7.2 m (Borehole 26+125) below the ground surface. Its thickness was found to range from 0.8 m (Boreholes 26+100 and 26+200) to 1.9-2.3 m in Boreholes 26+125, 26+228 and 26+245.

In general, the deposit is considered to be a fine-grained granular (i.e. non-cohesive) material with cohesive layers (e.g. Boreholes 26+100 and 26+125). The grain-size distribution of two samples from the relatively coarser and less distinctly interbedded zones of the deposit was determined in our laboratory. The results are presented in Figures B-4 and B-5 in Appendix B.

Standard Penetration tests performed in the deposit yielded N-values which range from 2 to 14 blows/0.3 m but typically 3 to 8 blows/0.3 m which indicate a very loose to compact but typically very loose to loose relative density or soft to firm consistency.

#### 4.5 LOWER SAND

The layered silt deposit described in the preceding section is underlain by a basal sand deposit ranging in composition from silty fine sand to gravelly sand. The grain-size distribution of four samples from the deposit is shown in Figures B-6 and B-7 in Appendix B. These indicate the following range of grain-size distribution:

Gravel:	4-22%
Sand:	59-90%
Silt & Clay	6-19%

The presence of cobbles and boulders was also inferred in the deposit. In many cases, the structure of the deposit resembled that of a glacial till.

The recorded N-values in the deposit range widely from 3 to in excess of 50 blows/0.3 m. These results indicate a very loose to very dense relative density.

#### 4.6 REFUSAL DEPTHS

All the boreholes were terminated in the lower sand deposit after encountering refusal on the split-spoon penetration and on the augers at depths of between 2.4 and 11.0 m below the ground surface or 2.4 m (Boreholes 26+050 and 26+190) and 5.7 m (Borehole 26+125) below the o.g. levels.

#### 4.7 GROUNDWATER CONDITIONS

The groundwater conditions in the open boreholes were observed during the drilling and upon completion of each borehole, as shown on the individual Record of Borehole Sheets. In addition, a piezometer was installed in Borehole 26+100. The observations made indicate that at the time of our investigation the groundwater level was at most borehole locations close to the original ground (o.g.) levels.

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



ZO:tr/drive

**SHAHEEN & PEAKER**

  
Ramon Miranda, P.Eng.



Z.S. Ozden, P.Eng.



# Drawing



# METRIC

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

CONT No. 5006-E-0040

WP: 173-98-00



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

Highway 17 Mattawa  
BOREHOLE LOCATION PLAN &  
STRATIGRAPHY (Station 26+100 to 26+240)

SHAHEEN & PEAKER  
A Division of Coffey Geotechnics Inc.



KEY PLAN  
N.T.S.

## LEGEND

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

STATION NO.	ELEVATION (m)	
26+050 Rt	208.0	
26+100 Rt	203.0	
26+125 Rt	206.8	
26+125	201.9	DCPT
26+150 Rt	201.1	
26+190 Rt	202.4	
26+200 Rt	200.5	
26+200	200.2	DCPT
26+228 Rt	202.2	
26+245 Rt	200.0	

## NOTE

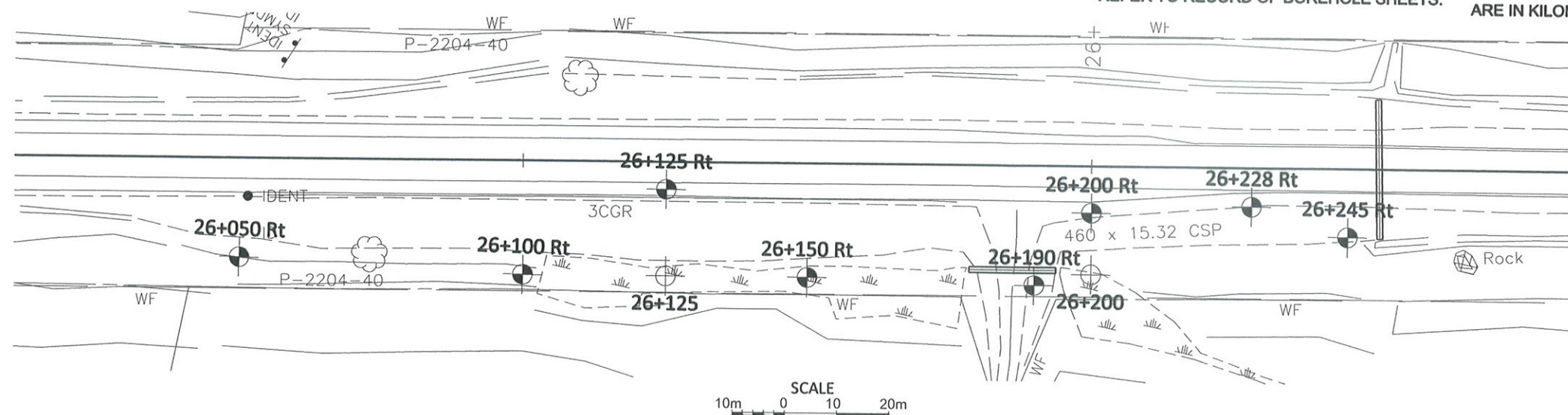
The boundaries between soil strata have been established only at Borehole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

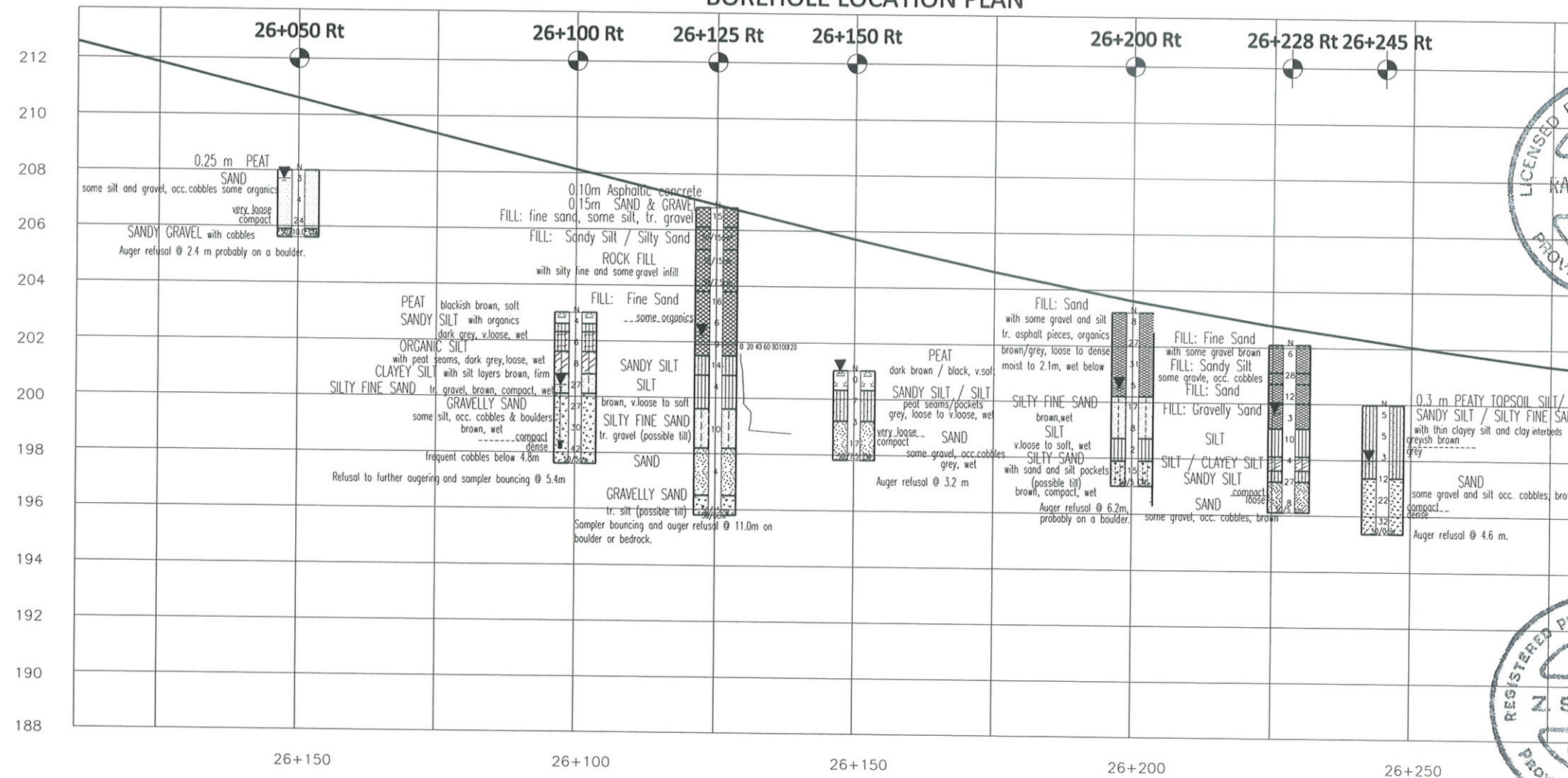
REV.	DATE	BY	DESCRIPTION

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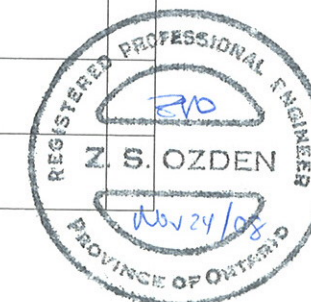
SPT 1211A			DIST
SUBM'D	CHECKED	DATE Oct. 2008	SITE
DRAWN PHK	CHECKED RM	APPROVED ZO	DWG 1



BOREHOLE LOCATION PLAN



Profile (along Highway 17 centerline)



# Appendix A

## Record of Borehole Sheets

SPT1211 : Highway 17 (Mattawa)

# RECORD OF BOREHOLE No 26+050Rt

1 OF 1

METRIC

GWP G.W.P. 173-98-00 LOCATION Sta. 26+050 : 17.4m Rt of C/L of Hwy 17 ORIGINATED BY GI  
DIST HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SS  
DATUM Geodetic DATE 4/26/2008 CHECKED BY ZO

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 (%)					
208.0	GROUND SURFACE													
0.0	0.25 m PEAT		1	SS	3									
	SAND some silt and gravel, occ. cobbles some organics		2	SS	4									
	very loose													
	compact		3	SS	24									
205.9														
2.1	SANDY GRAVEL with cobbles		4	SS	10									
205.6														
2.4	End of Borehole Auger refusal @ 2.4 m probably on a boulder. Water level @ 0.3 m (not stabilized)* and hole caved @ 0.6 m upon completion													

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

20  
15  
10  
(%) STRAIN AT FAILURE

SPT1211 : Highway 17 (Mattawa)

# RECORD OF BOREHOLE No 26+100Rt

1 OF 1

METRIC

GWP G.W.P. 173-98-00 LOCATION Sta. 26+100 : 20m Rt C/L of Hwy 17 (Ditch) (D-4.5m) ORIGINATED BY GI  
 DIST            HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SS  
 DATUM Geodetic DATE 4/22/2008 CHECKED BY ZO

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				
203.0	GROUND SURFACE							20 40 60 80 100				
0.0	PEAT		1	SS	4							
202.6	blackish brown, soft											
0.4	SANDY SILT with organics											
202.3	dark grey, v loose, wet		2	SS	6							
0.7	ORGANIC SILT											
201.6	with peat seams, dark grey, loose, wet											
1.4	CLAYEY SILT		3	SS	8							
200.8	with silt layers brown, firm											
2.2	SILTY FINE SAND		4	SS	27							
200.1	tr gravel, brown, compact, wet											
2.9	GRAVELLY SAND		5	SS	27							
	some silt, occ. cobbles & boulders brown, wet											
	compact		6	SS	30							
	dense											
	frequent cobbles below 4.8 m		7	SS	42							
197.6			8	SS	40							
5.4	End of borehole. Refusal to further augering and sampler bouncing @ 5.4 m.  Water level @ 2.6 m (El 200.4 m- not stabilized)* and caved in @ 2.9 m upon completion. Piezometer installed to 4.9 m Water level in piezometer on April 23, 2008 - 0.3 m (El. 202.7 m)											

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

20  
15  
10  
(%) STRAIN AT FAILURE



SPT1211 : Highway 17 (Mattawa)

# RECORD OF BOREHOLE No 26+125Rt

1 OF 1

METRIC

GWP G.W.P. 173-98-00 LOCATION Sta. 26+125 : 4.8m Rt C/L of Hwy 17 (Paved Shoulder) (D-0.1m) ORIGINATED BY GI  
 DIST            HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SS  
 DATUM Geodetic DATE 4/25/2008 CHECKED BY ZO

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					
							20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		
							○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE			WATER CONTENT (%)			
206.8 0.0	GROUND SURFACE											GR SA SI CL	
206.1 0.7	0.10 m Asphaltic concrete 0.15 m SAND & GRAVEL FILL: fine sand, some silt, tr. gravel brown, compact, damp		1	SS	15							*sampler pushing cobble N-value unreliable	
205.3 1.5	FILL: Sandy Silt / Silty Sand brown, compact, moist		2	SS	50/15cm*								
203.8 3.0	ROCK FILL with silty fine and some gravel infill		3	SS	50/15cm							4 82 (14)	
203.8 3.0			4	SS	50/7.5cm								
201.5 5.3	FILL: Fine Sand some silt, tr. gravel		5	SS	16							peat seam/pocket @ 4.1 m 0 92 (8)	
200.8 6.0	greyish brown compact and damp to 3.8 m loose and wet below	some organics	6	SS	6								
199.6 7.2	SANDY SILT with silt seams greyish brown, compact, wet		7	SS	9							0 27 63 10	
198.2 8.6	SILT with sandy silt and occ. clayey silt and silty clay seams brown, v. loose to soft, wet		8	SS	14								
196.5 10.3	SILTY FINE SAND tr. gravel (possible till) grey, compact, wet		9	SS	4							4 90 (6)	
195.8 11.0	SAND tr. gravel, brown, v. loose, wet		10	SS	10								
			11	SS	4								
			12	SS	50/15cm								
			13	SS	50/0cm							Auger Refusal *No Recovery	
	End of borehole: Sampler bouncing and auger refusal @ 11.0 m on boulder or bedrock.  Water level @ 4.5 m (not stabilized)* and hole caved in @ 5.6 m upon completion.												

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

20  
15  
10  
(%) STRAIN AT FAILURE



SPT1211 : Highway 17 (Mattawa)

RECORD OF BOREHOLE No 26+125 (DCPT)

1 OF 1

METRIC

GWP G.W.P. 173-98-00 LOCATION Sta. 26+125 :20.0m Rt of C/L of Hwy 17 ORIGINATED BY GI  
DIST            HWY 17 BOREHOLE TYPE DCPT COMPILED BY SS  
DATUM Geodetic DATE 4/25/2008 CHECKED BY ZO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ 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 (%)	W <sub>p</sub>	W		
201.9 0.0	GROUND SURFACE						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE	20 40 60 80 100	10 20 30				
198.6 3.3	Dynamic Cone Penetration Test (DCPT) performed from o.g. level to 3.3 m												

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

20  
15- $\phi$ -5  
10 (%) STRAIN AT FAILURE

SPT1211 : Highway 17 (Mattawa)

# RECORD OF BOREHOLE No 26+150Rt

1 OF 1

METRIC

GWP G.W.P. 173-98-00 LOCATION Sta. 26+150 :20.0m Rt of C/L of Hwy 17 (D-4.5m) ORIGINATED BY GI  
 DIST HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SS  
 DATUM Geodetic DATE 4/23/2008 CHECKED BY ZO

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 (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
201.1 0.0	GROUND SURFACE		1	SS	0		201						
200.4 0.7	PEAT dark brown / black, v. soft		2	SS	7		200						
199.3 1.8	SANDY SILT / SILT with thin clayey silt & clay interbeds, peat seams/pockets grey, loose to v. loose, wet		3	SS	3		199						
197.9 3.2	SAND some gravel, occ. cobbles grey, wet		4	SS	17		198						
3.2	End of Borehole Auger refusal @ 3.2 m Water level @ ground surface upon completion		5	SS	50/7.5 CM		198						

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

20  
15  
10  
(%) STRAIN AT FAILURE

SPT1211 : Highway 17 (Mattawa)

## RECORD OF BOREHOLE No 26+190Rt

1 OF 1

METRIC

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		
202.4 0.0	GROUND SURFACE										
201.0 1.4	GRANULAR FILL sand, some gravel, occ. cobbles brown, compact, damp		1	SS	18		202				
			2	SS	15		201				
200.1 2.3	FILL: Sandy Silt tr. gravel, brown / grey, damp		3	SS	8		200				
199.5 2.9	ORGANIC SILT some rootlets, dark grey / blackish loose, moist		4	SS	7		199				
	SILT / SANDY SILT layers with some thin clay interbeds grey, loose to v. loose, wet		5	SS	7		198				
197.9 4.4			6	SS	3						
197.7 4.7	SAND, some gravel		7	SS	50/5cm						
End of borehole.											
Water level @ 2.4 m (not stabilized)* and borehole caved @ 2.4 m upon completion.											

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

RECORD OF BOREHOLE No 26+200Rt

1 OF 1

METRIC

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

SPT1211 : Highway 17 (Mattawa)

# RECORD OF BOREHOLE No 26+200 (DCPT)

1 OF 1

METRIC

GWP G.W.P. 173-98-00 LOCATION Sta. 26+200 :19.0m Rt of C/L of Hwy 17 ORIGINATED BY GI  
 DIST            HWY 17 BOREHOLE TYPE DCPT COMPILED BY SS  
 DATUM Geodetic DATE 4/25/2008 CHECKED BY ZO

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 Y 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					
200.2 0.0	GROUND SURFACE						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE	20 40 60 80 100	10 20 30				
196.1 4.1	Dynamic Cone Penetration Test (DCPT) performed from o.g. level to 4.1 m						200/15cm						



SPT1211 : Highway 17 (Mattawa)

# RECORD OF BOREHOLE No 26+245Rt

1 OF 1

METRIC

GWP G.W.P. 173-98-00 LOCATION Sta. 26+245 : 17m Rt C/L of Hwy 17 (Off Road) (D-2.8m) ORIGINATED BY GI  
 DIST            HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SS  
 DATUM Geodetic DATE 4/22/2008 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ 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	WATER CONTENT (%) W <sub>p</sub> W W <sub>L</sub>				
200.0 0.0	GROUND SURFACE 0.3 m PEATY TOPSOIL												
	SILT / SANDY SILT / SILTY FINE SAND with thin clayey silt and clay interbeds very loose, wet		1	SS	5								
	greyish brown		2	SS	5								
	grey		3	SS	3								
197.4 2.6	SAND some gravels and silt occ. cobbles brown, wet		4	SS	12								
	compact		5	SS	22								
	dense		6	SS	32								
195.4 4.6	End of borehole. Auger refusal @ 4.6 m. Water level in open hole @ 2.0 m (not stabilized)* and hole covered @ 2.4 m upon completion.		7	SS	500 cm								12 70 (18) Auger Refusal No Recovery

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

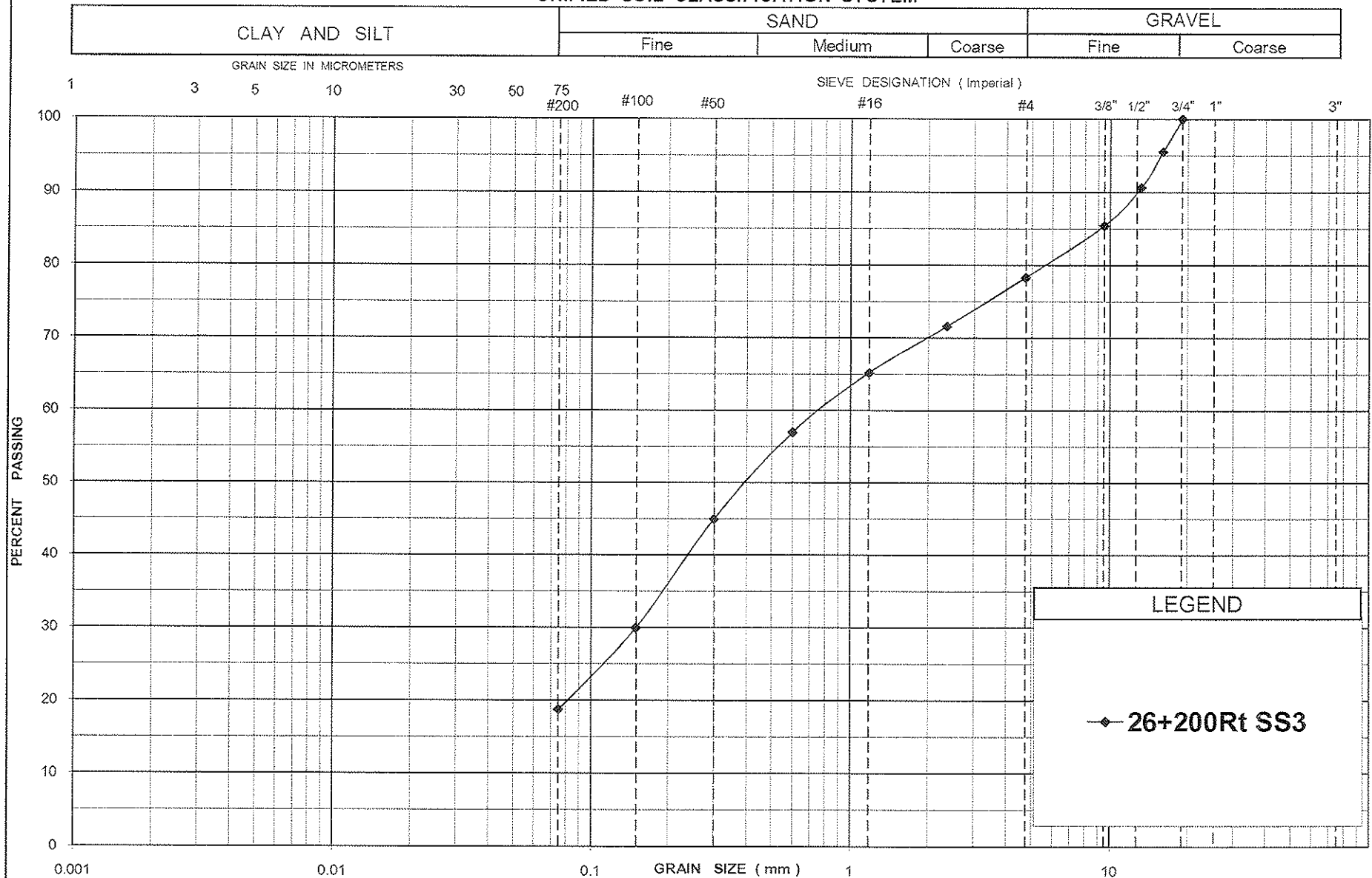
20  
15 10 5  
10 (%) STRAIN AT FAILURE

# Appendix B

## Laboratory Test Results



# UNIFIED SOIL CLASSIFICATION SYSTEM



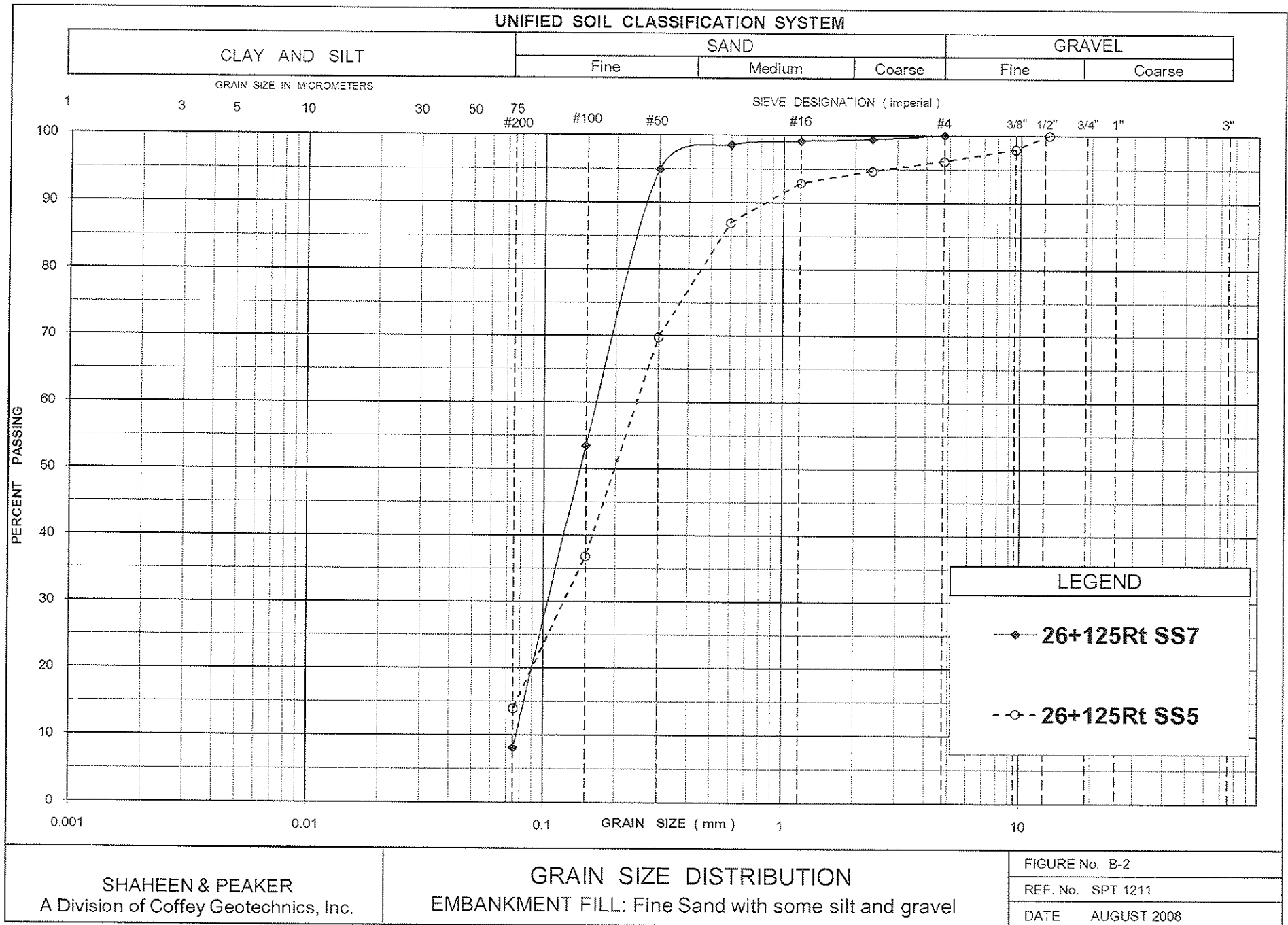
SHAHEEN & PEAKER  
A Division of Coffey Geotechnics, Inc.

**GRAIN SIZE DISTRIBUTION**  
EMBANKMENT FILL: Sand with some gravel and silt

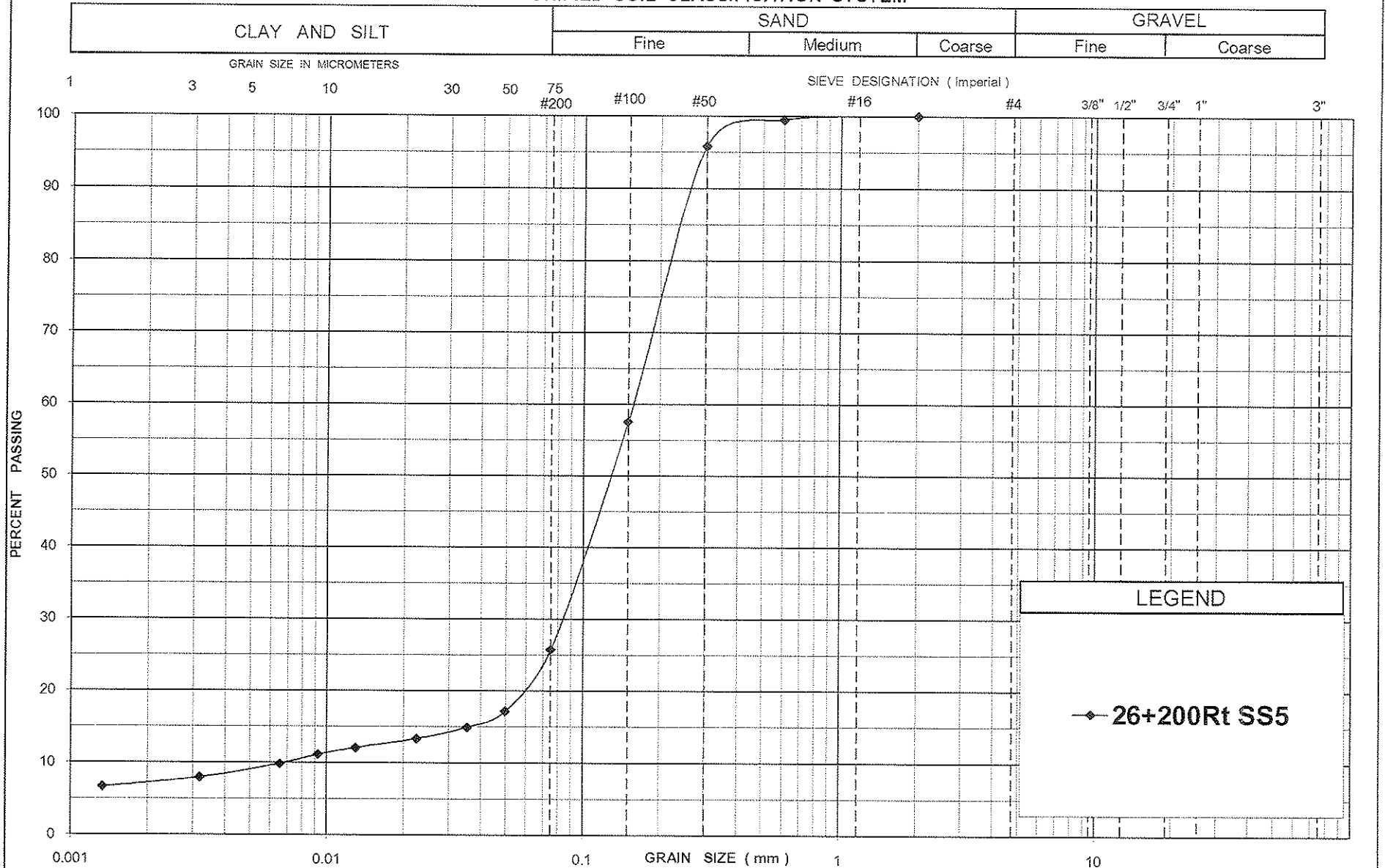
FIGURE No. B-1

REF. No. SPT 1211

DATE AUGUST 2008



# UNIFIED SOIL CLASSIFICATION SYSTEM



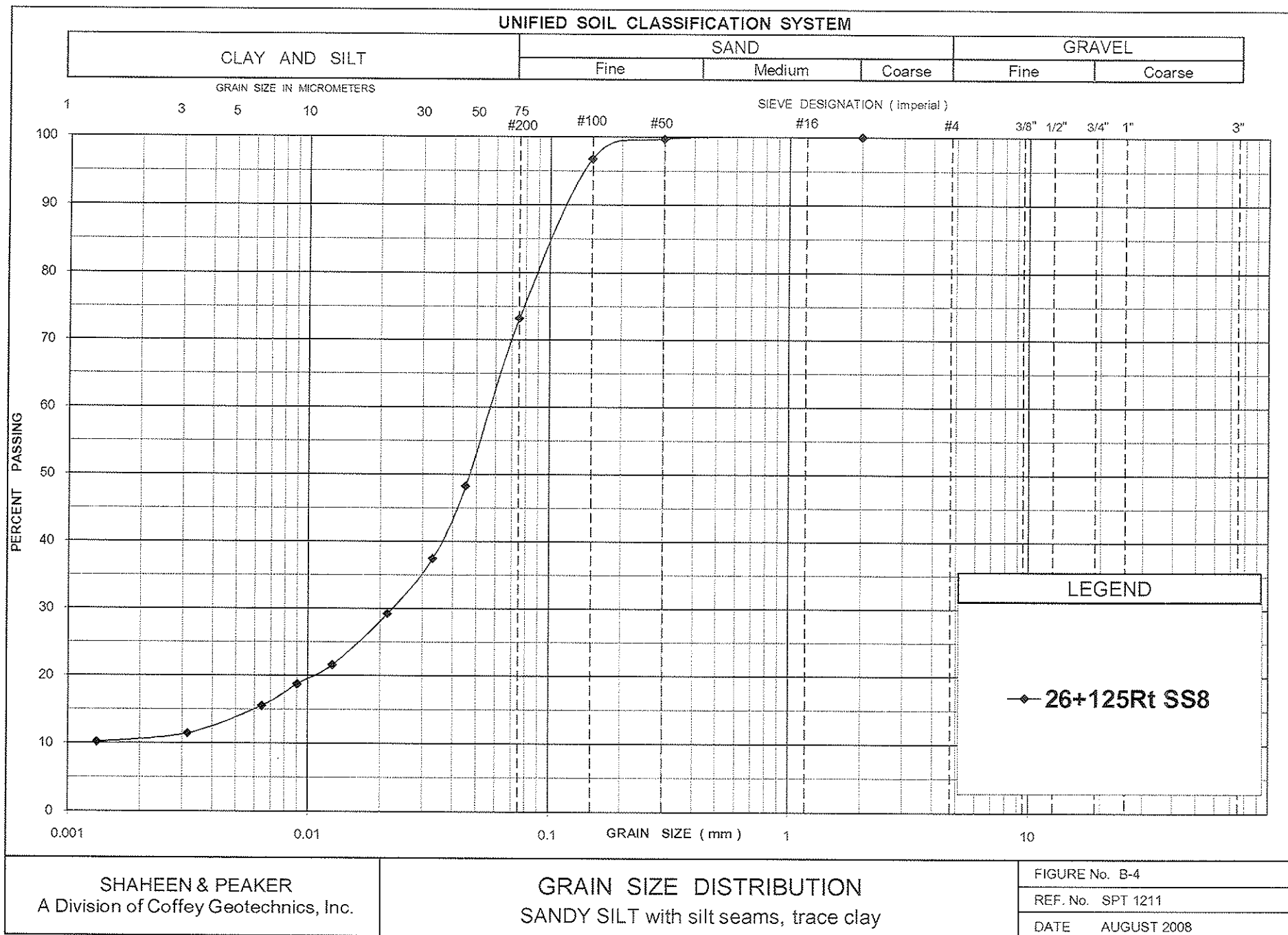
SHAHEEN & PEAKER  
A Division of Coffey Geotechnics, Inc.

GRAIN SIZE DISTRIBUTION  
SILTY FINE SAND

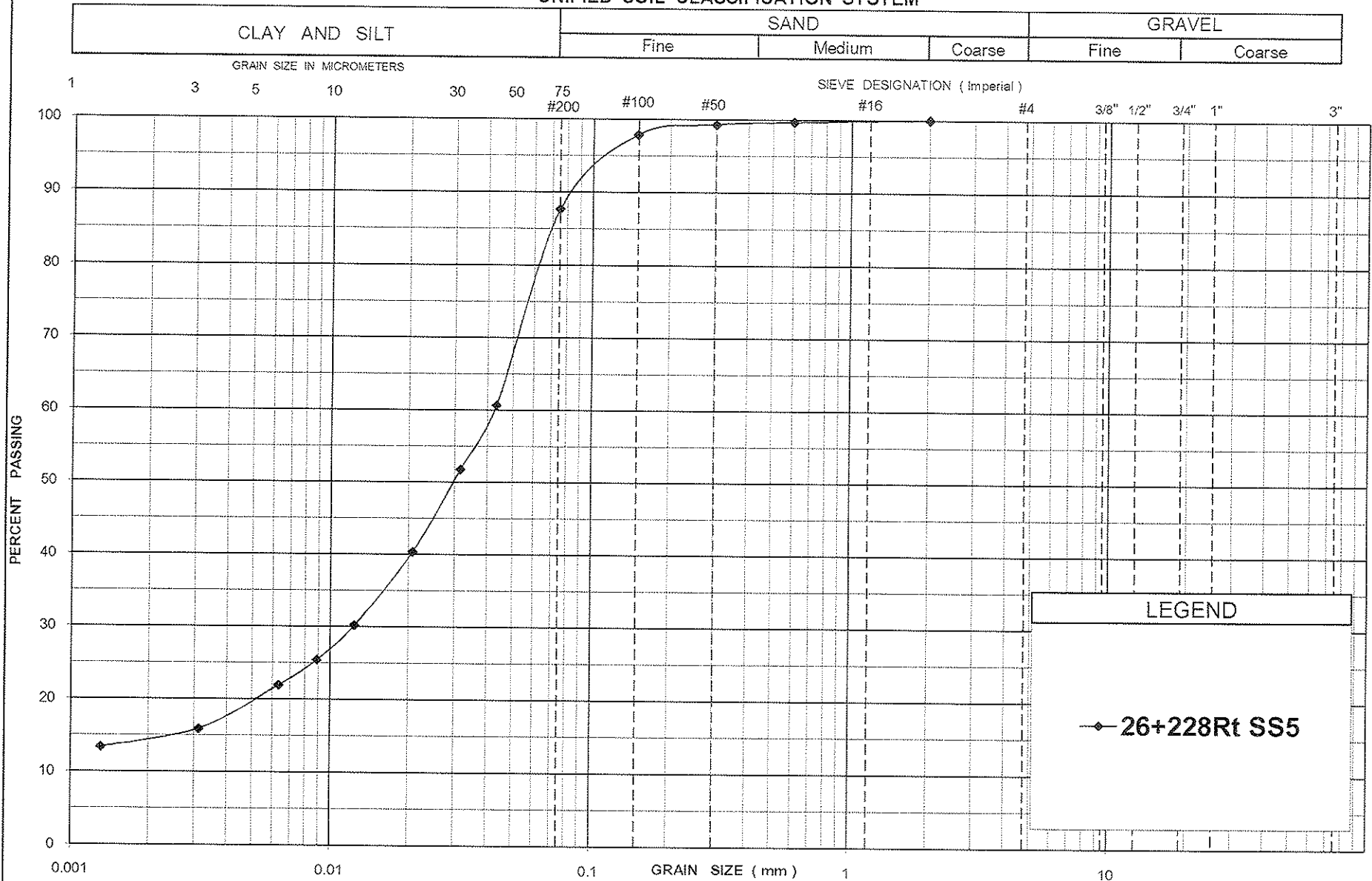
FIGURE No. B-3

REF. No. SPT 1211

DATE AUGUST 2008



# UNIFIED SOIL CLASSIFICATION SYSTEM

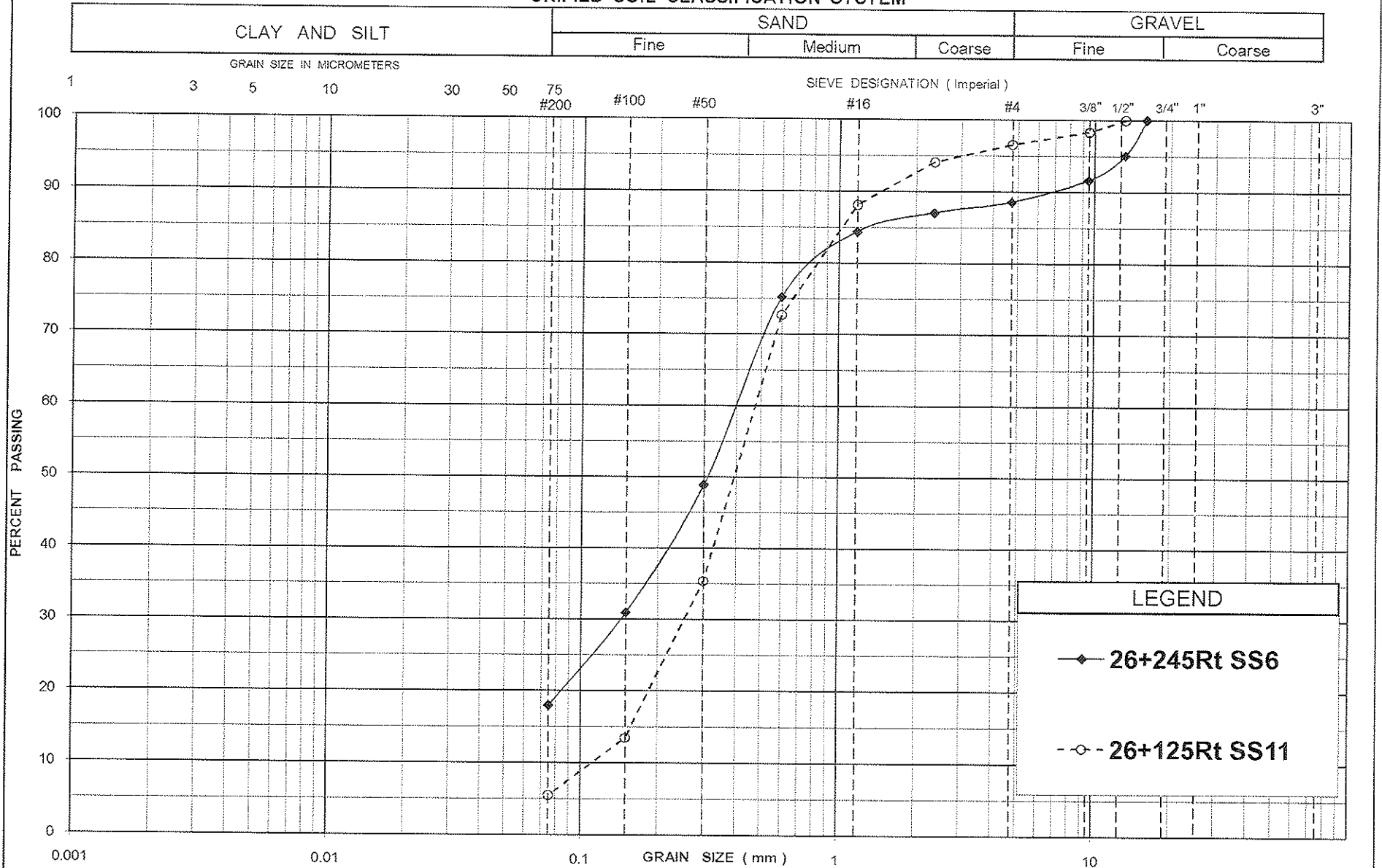


SHAHEEN & PEAKER  
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**GRAIN SIZE DISTRIBUTION**  
SILT with occasional thin clayey silt & clay seams

FIGURE No. B-5  
REF. No. SPT 1211  
DATE AUGUST 2008

# UNIFIED SOIL CLASSIFICATION SYSTEM



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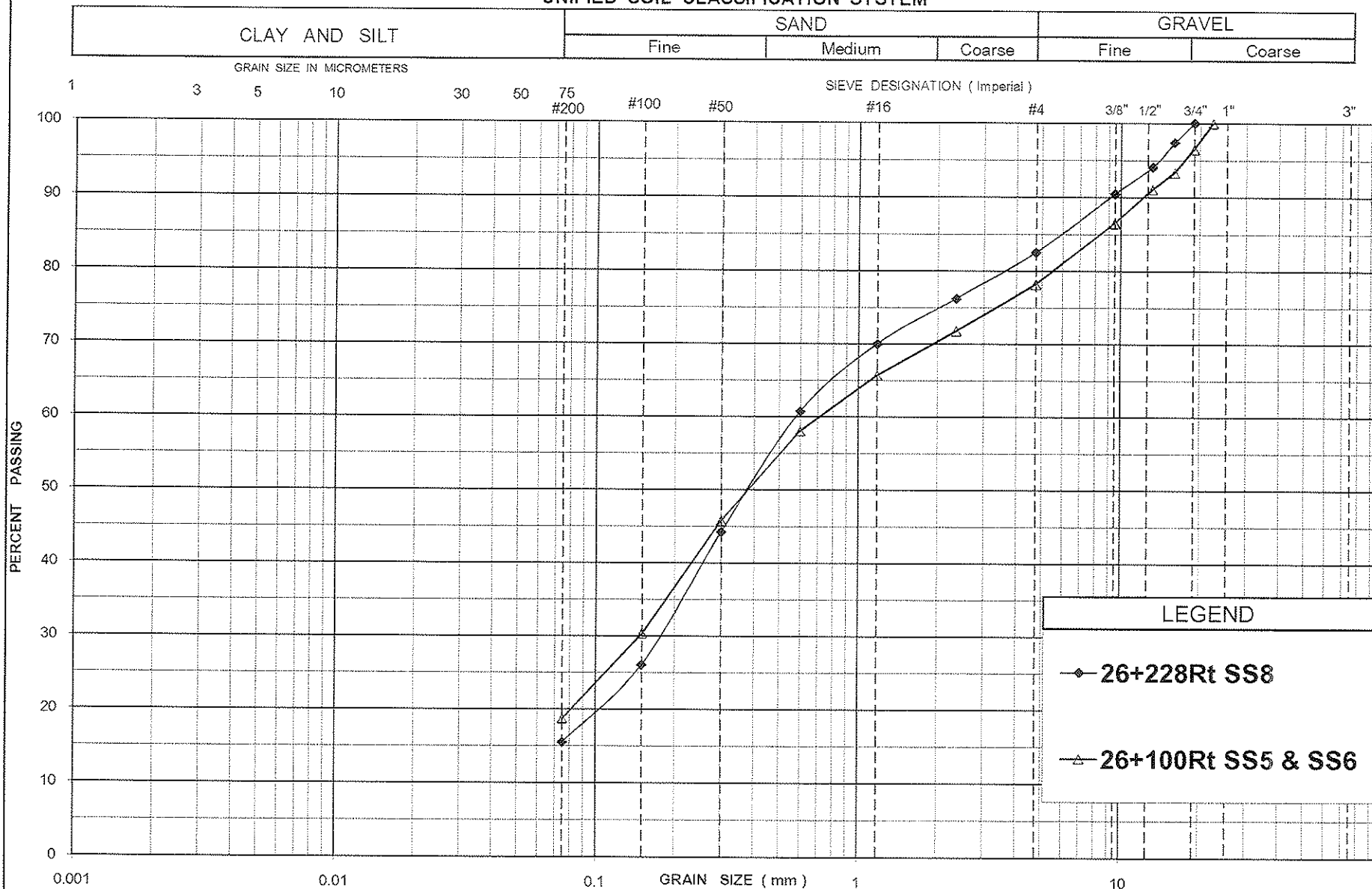
**GRAIN SIZE DISTRIBUTION**  
SAND with traces to some clay and gravel

FIGURE No. B-6

REF. No. SPT 1211

DATE AUGUST 2008

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER  
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GRAIN SIZE DISTRIBUTION  
SAND with some gravel and silt

FIGURE No. B-7  
REF. No. SPT 1211  
DATE AUGUST 2008

# Appendix C

## Site Photographs





Photograph 1. Looking east



Photograph 2. Looking west





Photgraph 3. Looking west



Photograph 4. Bottom of the embankment

## Appendix D

# Explanation of Terms Used in 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						

**FOUNDATION DESIGN REPORT  
PROPOSED WIDENING OF HIGHWAY 17 FROM  
STATION 26+100 TO 26+240  
FROM 9.5 KM EAST OF HIGHWAY 533  
EASTERLY 14.9 KM  
MATTAWA, ONTARIO  
G.W.P. 173-98-00; AGREEMENT NO. 5006-E-0040  
GEOCRES NO. 31L-126**

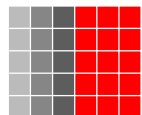
**Prepared For:**

**D. M. WILLS ASSOCIATES**

**Prepared by:**

**SHAHEEN & PEAKER  
A Division of Coffey Geotechnics, Inc.**

**Project: SPT1211A  
November 24, 2008**



**shaheen & peaker**



**20 Meteor Drive  
Toronto, Ontario  
M9W 1A4  
Tel: (416) 213-1255  
Fax: (416) 213-1260**

**EMAIL: [info@shaheenpeaker.ca](mailto:info@shaheenpeaker.ca)**

## Table of Contents

<b>5. DISCUSSION AND RECOMMENDATIONS</b>	<b>8</b>
5.1 Embankment Stability .....	8
5.2 Settlement of the New Embankment.....	8
5.3 Construction Considerations .....	9
<b>6. CLOSURE</b>	<b>11</b>

**APPENDIX E: TYPICAL CROSS SECTIONS**

**APPENDIX F: SLOPE STABILITY ANALYSES RESULTS**

**APPENDIX G: OPSD**

**APPENDIX H: LIMITATIONS OF REPORT**



**FOUNDATION DESIGN REPORT  
PROPOSED WIDENING OF HIGHWAY 17  
FROM STATION 26+100 TO 26+240 FROM 9.5 KM  
EAST OF HIGHWAY 533, EASTERLY 14.9 KM, MATTAWA, ONTARIO  
G.W.P. 173-98-00; AGREEMENT NO. 5006-E-0040**

## **5. DISCUSSION AND RECOMMENDATIONS**

A new truck passing lane will be constructed on the right side of Highway 17 (i.e. on the south side) between Stations 25+100 and 27+500. Relatively high fill widening is proposed between about Stations 26+100 and 26+240 within this section of Highway 17. The proposed widening typical cross-sections are shown in Appendix E.

The cross-sections presented indicate that the grade raise due to widening will be of the order of about 2.0 m. The side slopes will be 2H:1V mirroring the existing embankment side slopes. The grade of the existing road will remain the same.

### **5.1 EMBANKMENT STABILITY**

As the existing slopes are standing at 2H:1V side slopes without any signs of instability, and since the road will only be widened without any change in the highway grade, problems with instability due to foundation failures are not anticipated.

A foundation stability analysis was however performed at Station 26+125, where based on the cross sections provided in Appendix E, the embankment is relatively high (i.e. about 5.0 m high above the o.g. level). As well, according to Borehole 26+125 findings, the soils above the refusal elevation are relatively deeper (i.e. 5.7 m deep). Stability analysis was also performed at Station 26+228 based on the findings of Borehole 26+228 and cross sections provided to us for this station. The results of the analysis are shown in Appendix F. The minimum recorded factor of safety is of the order of 1.3, which is considered acceptable, in view of the fact that there are no known problems with instability in this stretch of the highway. As well, the predicted failure mode is of a shallow nature.

### **5.2 SETTLEMENT OF THE NEW EMBANKMENT**

Based on the borehole data and the proposed widening configurations, as shown in Appendix E, the estimated maximum settlement due to additional stresses is of the order of 60 mm at Station 26+125. This assumes that the organic or otherwise unsuitable soils under the existing embankment was properly stripped when the highway was built and that such soils will be properly stripped under the widened section, as per MTO convention. It is anticipated that the magnitude of the settlements along the widened section of the highway would decrease with increasing and decreasing stations (i.e., to the east and west of this

station). As the majority of the foundation soils are of a granular nature, the foundation settlements would be completed rather rapidly (i.e. almost immediately). However, due to the presence of silt/clayey silt layers in some of the boreholes, as well to effect the settlement of the embankment fills under their own weight, we recommend that paving of the road after the construction be delayed for about six to eight weeks after raising the grade to its full height. Consideration should also be given to a minor surcharge of about 0.5 m during this period, if and where feasible.

### 5.3 CONSTRUCTION CONSIDERATIONS

At the time of our investigation, the groundwater level was very close to the existing o.g. levels. The boreholes show the presence of peat and other organic soils. All the organic and otherwise unsuitable soils will need to be removed and replaced with suitable soils, as per established MTO practice. As depending on the time of construction, the excavation and backfilling may partially or totally take place below the groundwater level, it is recommended a suitable granular material be used for backfilling below the o.g. levels and to at least about 0.4 m above the o.g. level.

The following stripping depths can be used for preliminary estimating purposes, at the borehole locations. It should however be pointed out that the thickness of unsuitable soils frequently varies in between and beyond borehole locations and may be thicker in depressed areas.

Table 5.3.1  
Anticipated Stripping Depths for Preliminary Estimating Purposes

Borehole No.	Estimated Stripping Depth (m)	Type of Soil
26+050 Rt	0.25	Peat
26+100 Rt	0.4 0.4-0.7 0.7-1.4	Peat Sandy Silt with organics Organic Silt with Peat seams
26+125 Rt	n/a*	n/a*
26+150 Rt	0.7	Peat
26+190 Rt	**0.6+	Organic Silt
26+200 Rt	n/a*	n/a*
26+228 Rt	n/a*	n/a*
26+245 Rt	0.3	Peaty topsoil

\*Borehole drilled from the top of embankment. Organic soils appear to have been properly stripped from beneath the embankment prior to its construction but will likely be present beyond the toe of the embankments. As well, they may also be present under the embankment near the toe.

\*\*Under the driveway.



Excavations and backfilling will need to be carried out in short sections to prevent instability of the existing embankments. The process of excavation and backfilling of each sufficiently narrow section (e.g. 3 to 4 m wide sections) should be carried out concurrently. After stripping, the exposed subgrade should be inspected and approved by an experienced geotechnical engineer appointed by the QEV. The first lift of the backfill may be thicker than usual backfill thickness of 0.3 m (e.g. possibly about 0.5 m thick), depending on the site conditions at the time of construction. As well, it is anticipated that some dewatering consisting of gravity drainage by means of ditches and pumping from filtered sumps will likely be required to facilitate the construction. It is also recommended that during the construction test pits be dug to determine if organics soils are present under the toe portion of the existing embankment, which needs to be removed and replaced. All of this work should be carried out under the direction and supervision of the QEV. We recommend that an NSSP be issued for this purpose.

The face of the existing slope should be properly prepared for the widening, including benching as per MTO procedures in accordance with OPSD 208.010, as shown in Appendix G.

It should be noted that the existing embankment in this area was partially constructed with rockfill (see BH26+125 Rt). During the widening, where rockfill is exposed, the rockfill should be properly chinked prior to placement of any fill on top. Also, adjacent to any exposed rockfill, a minimum 0.5 m of Granular 'B' Type II should be placed on the side prior to the placement of the earth fill for the widening. This Granular 'B' Type II will act as a filter between the coarse rockfill and the finer grained earth fill, which will reduce the amount of soil loss into the voids in the rockfill.

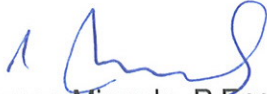

The fill used for the widening should consist of suitable materials which should be placed and compacted as per MTO standards. In as much as possible, within the upper 2 m the fill should match the existing for the purpose of minimizing differential frost heave.

Proper erosion control measures should be implemented on the face of the newly constructed slopes, both during the construction and permanently. This can be achieved by prompt seed and cover (OPSS 572) or sodding (OPSS 571).


## 6. CLOSURE

The Limitations of Report, as quoted in Appendix H, are an integral part of this report.

### SHAHEEN & PEAKER

  
Ramon Miranda, P.Eng.  
  
Zuhtu S. Ozden, P.Eng.



  
K. R. Peaker, Ph.D., P.Eng.

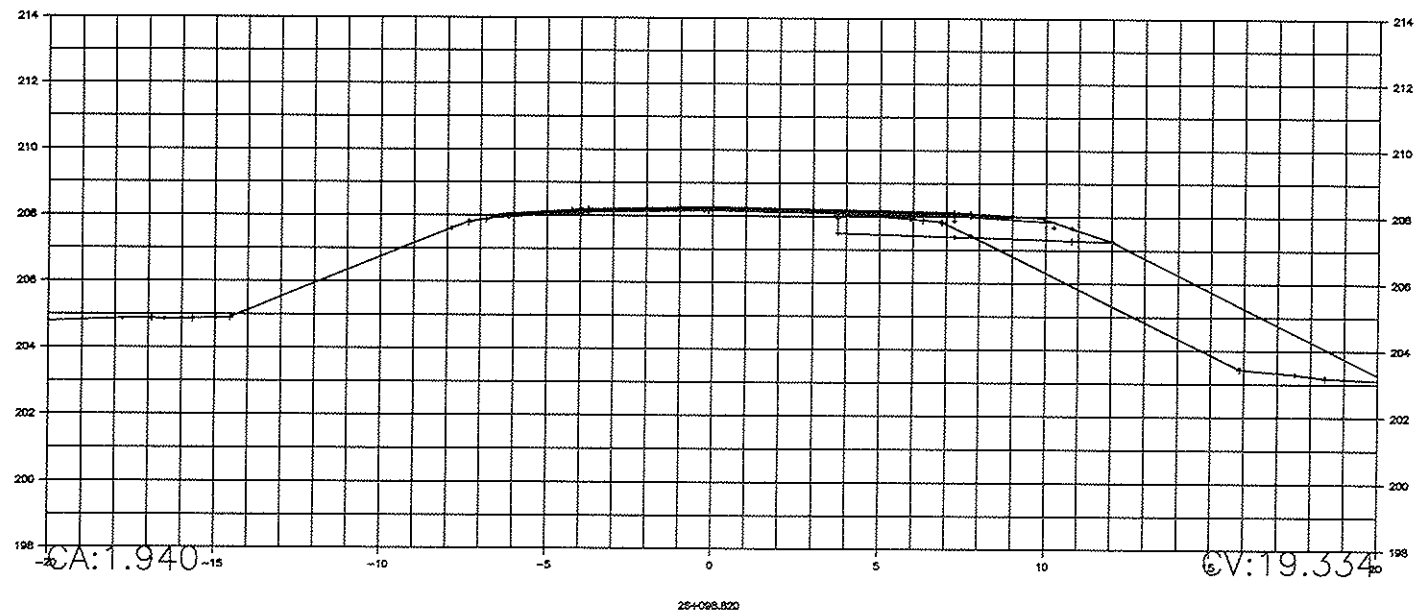
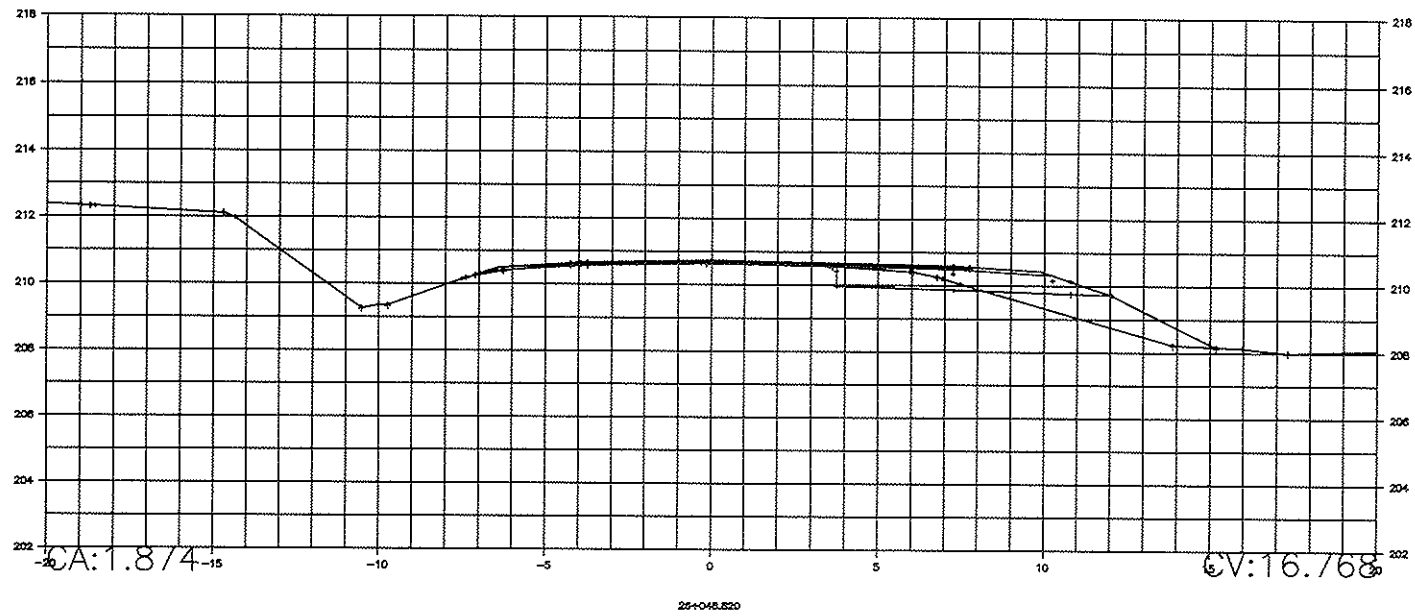


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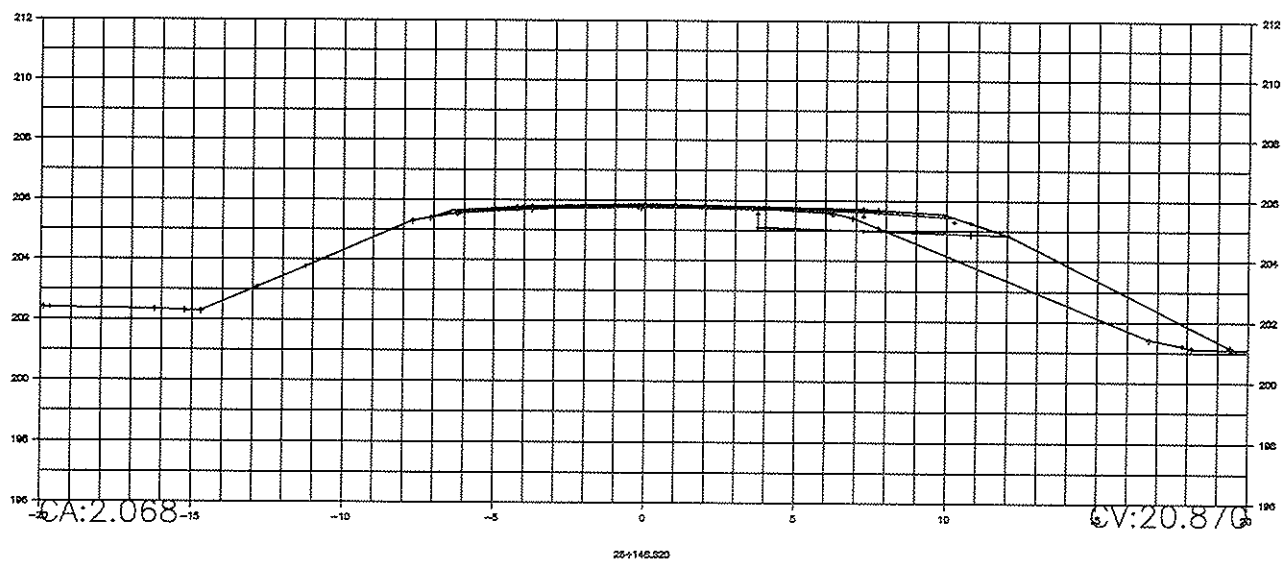
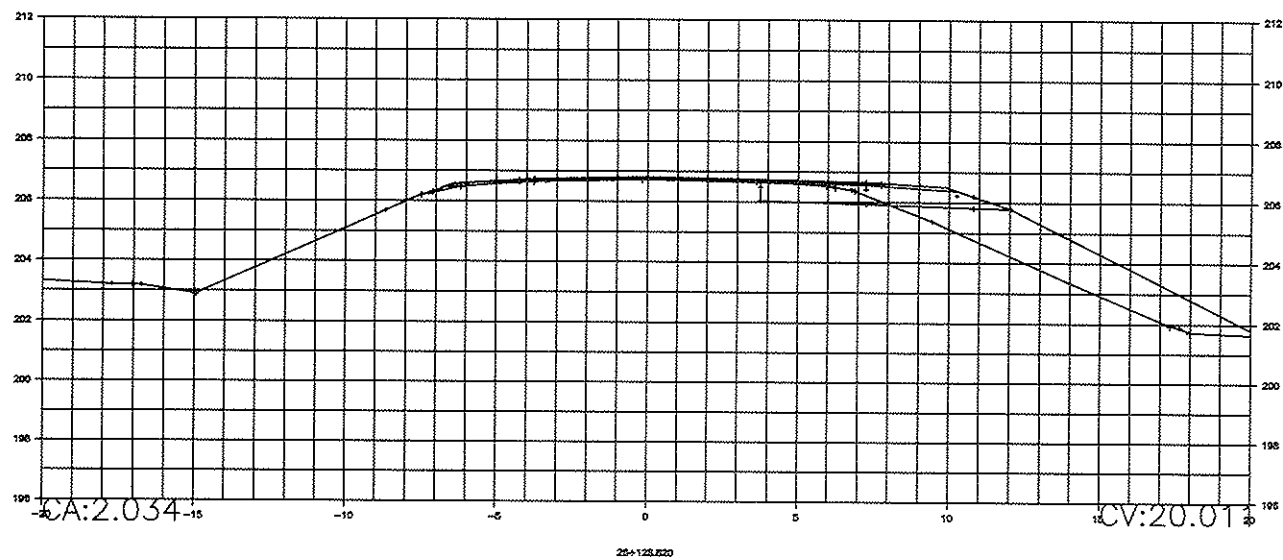
# Appendix E

## Typical Cross Sections

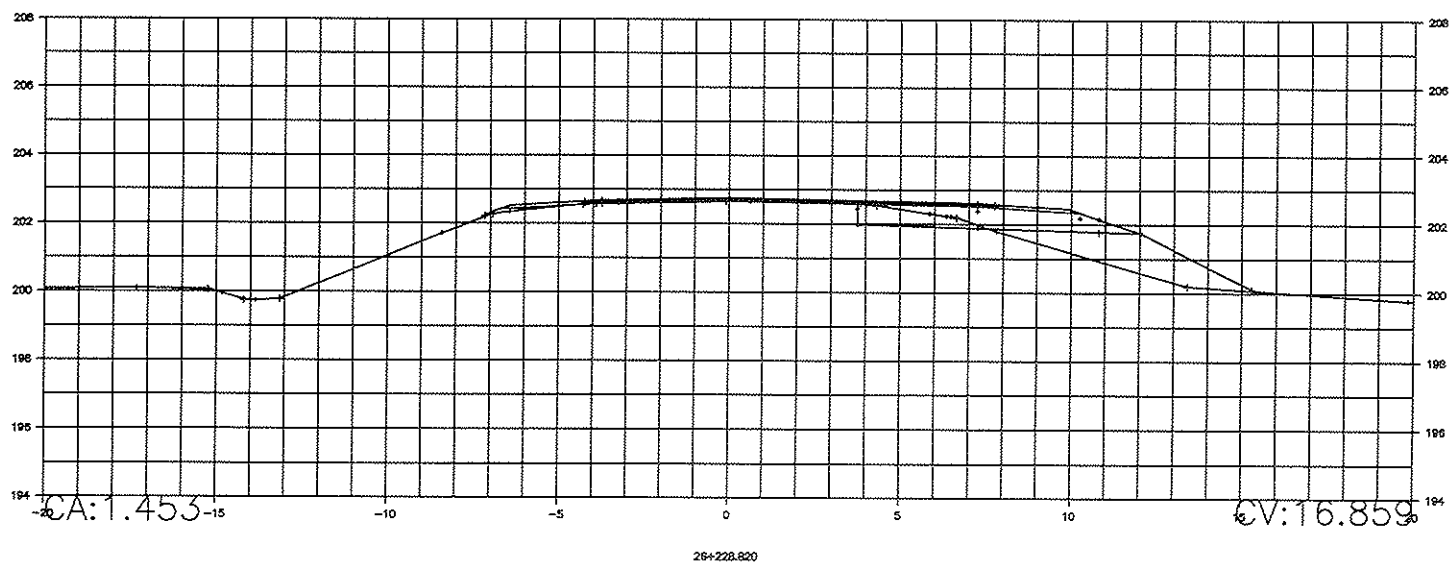
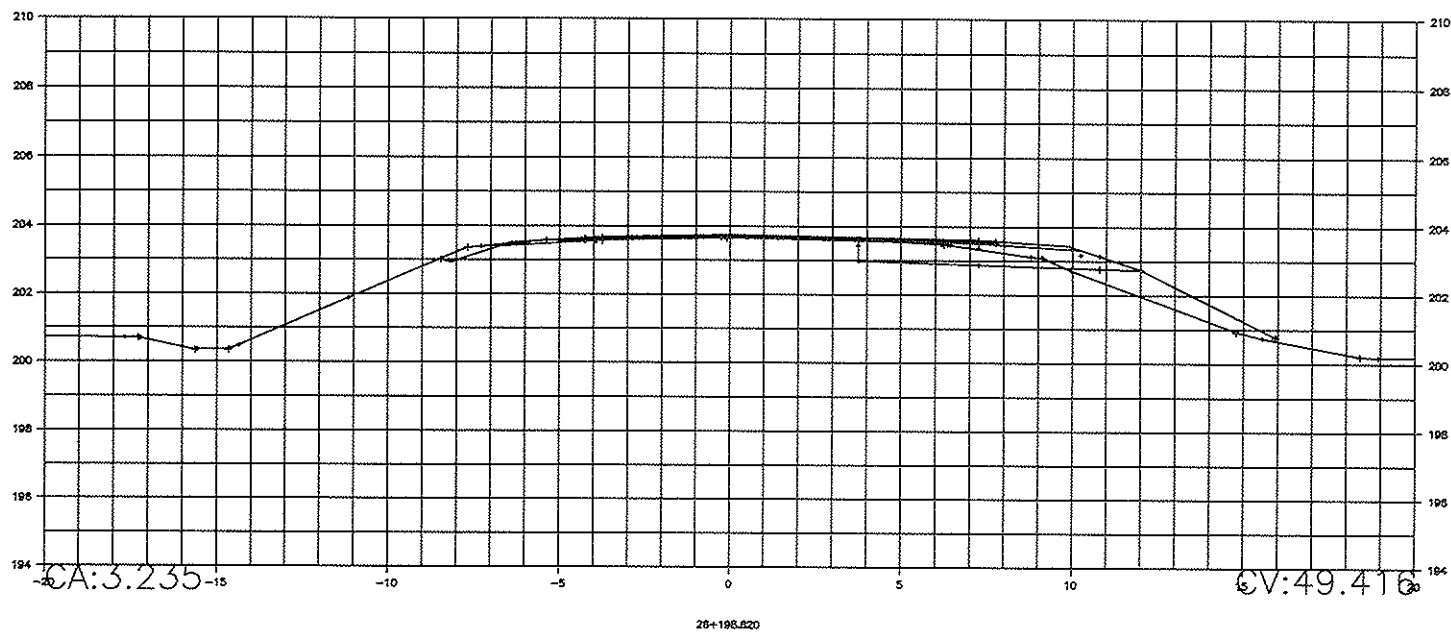
# Appendix E. Typical Cross Sections



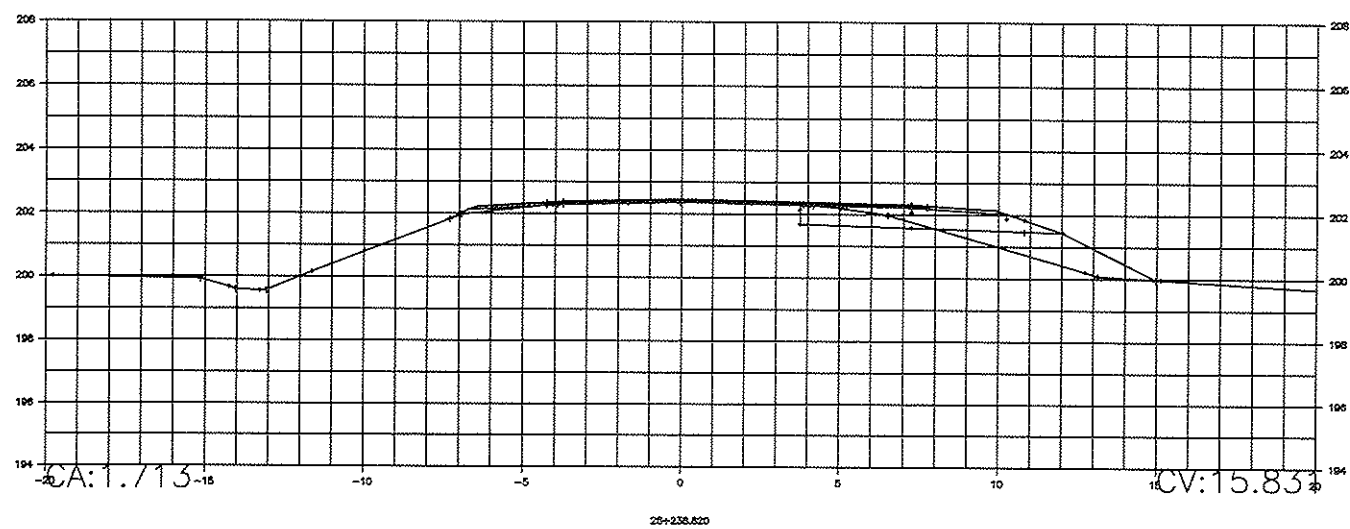
## Appendix E. Typical Cross Sections



## Appendix E. Typical Cross Sections



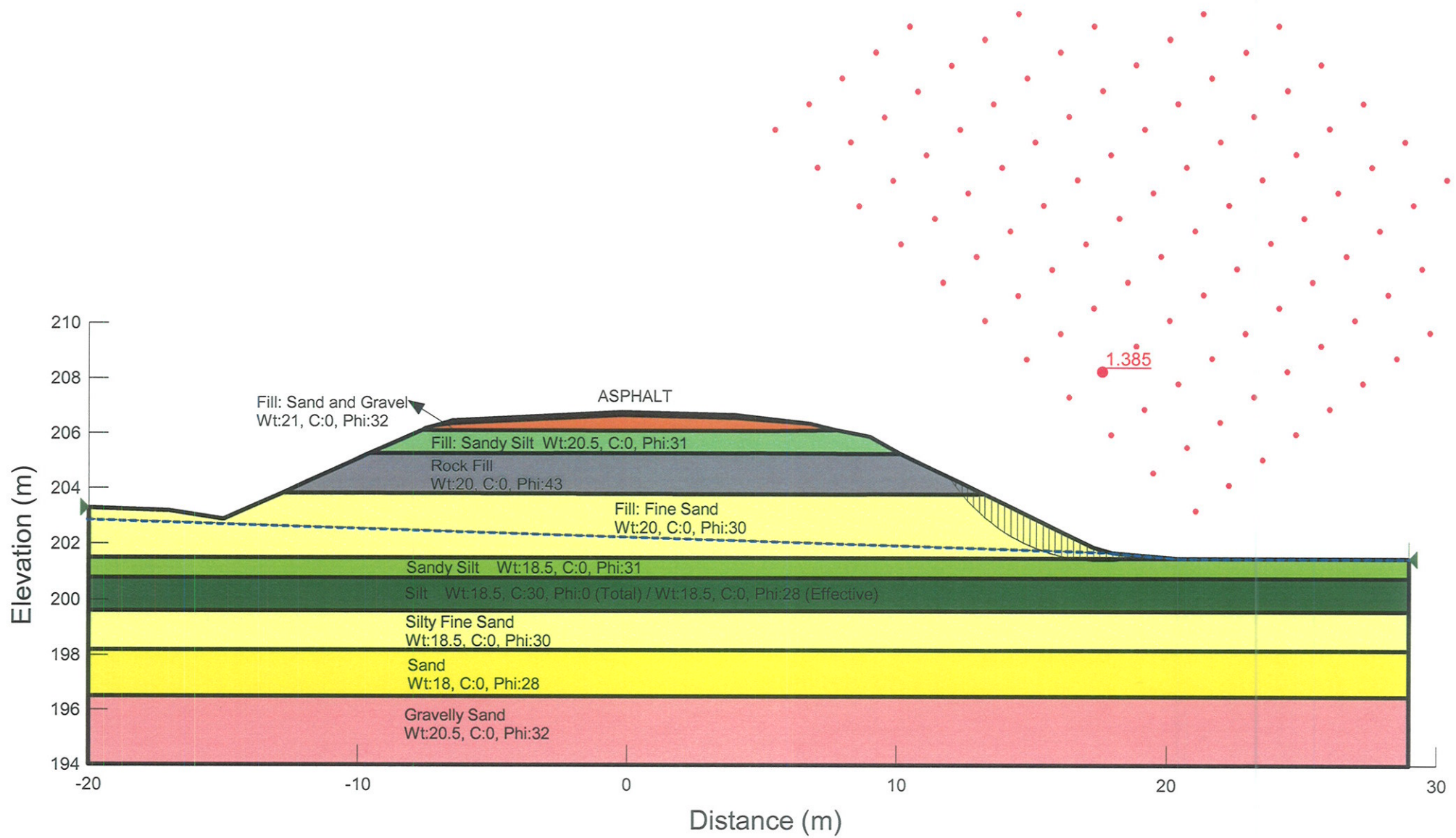
## Appendix E. Typical Cross Sections



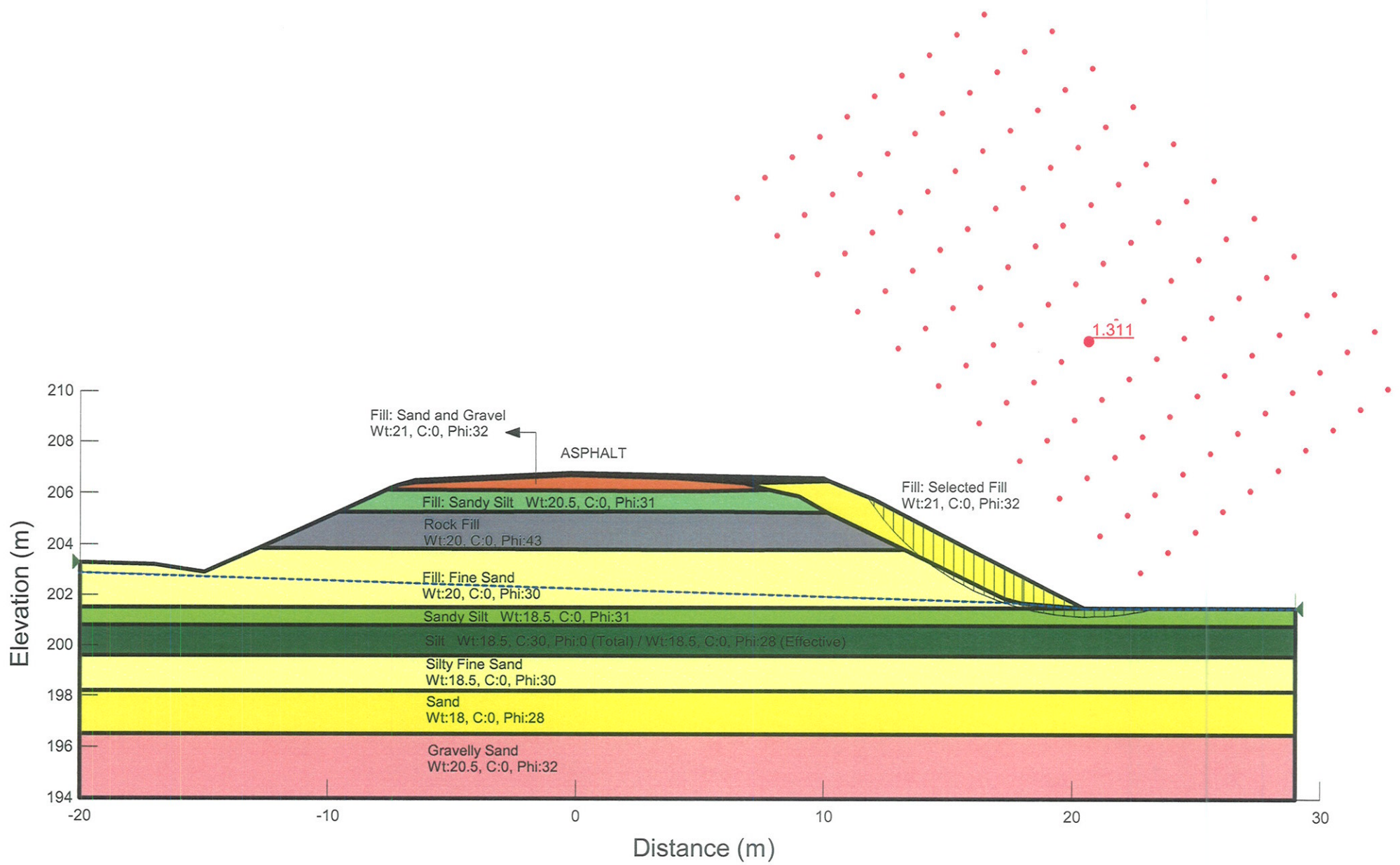
# Appendix F

## Slope Stability Analyses Results

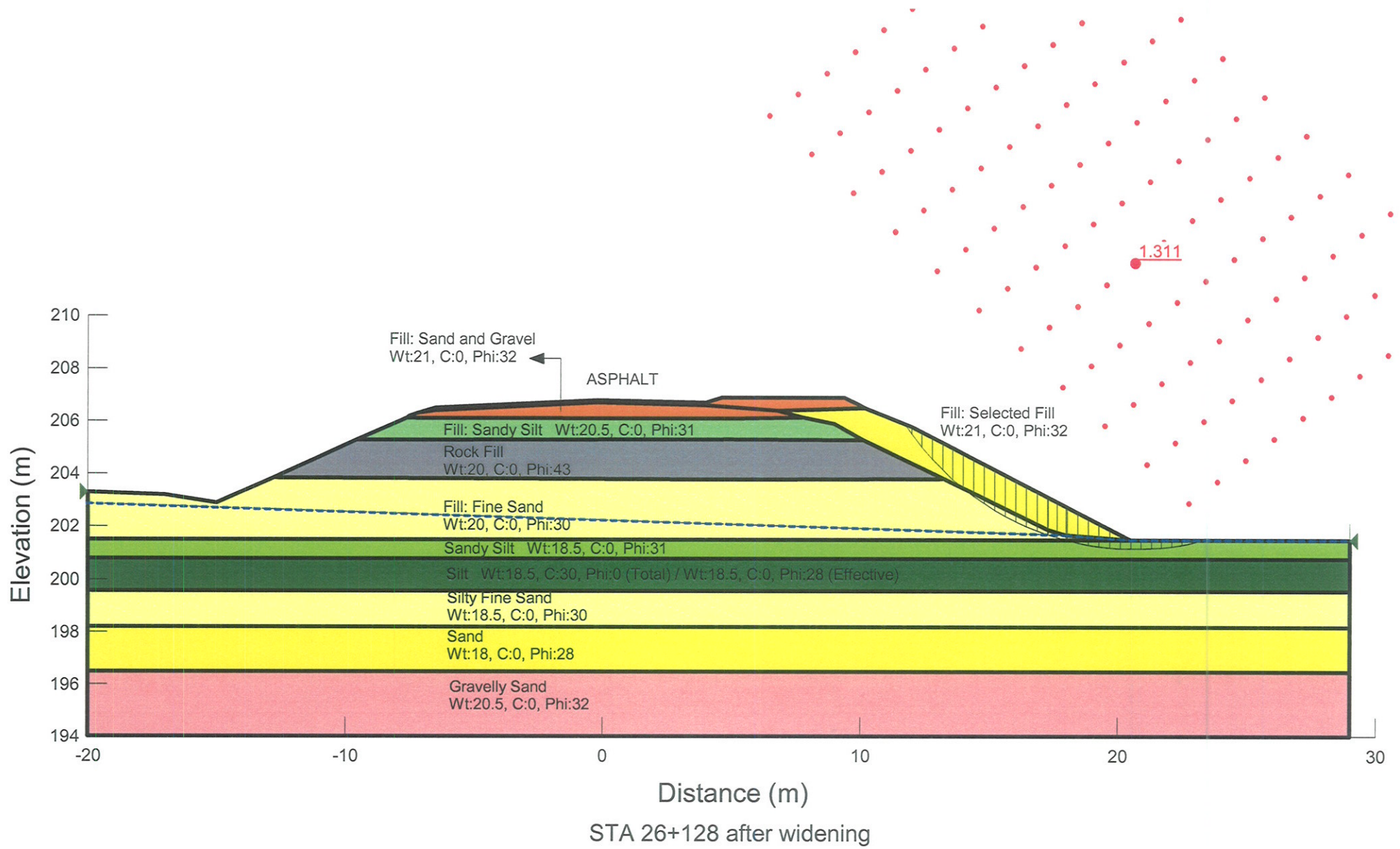




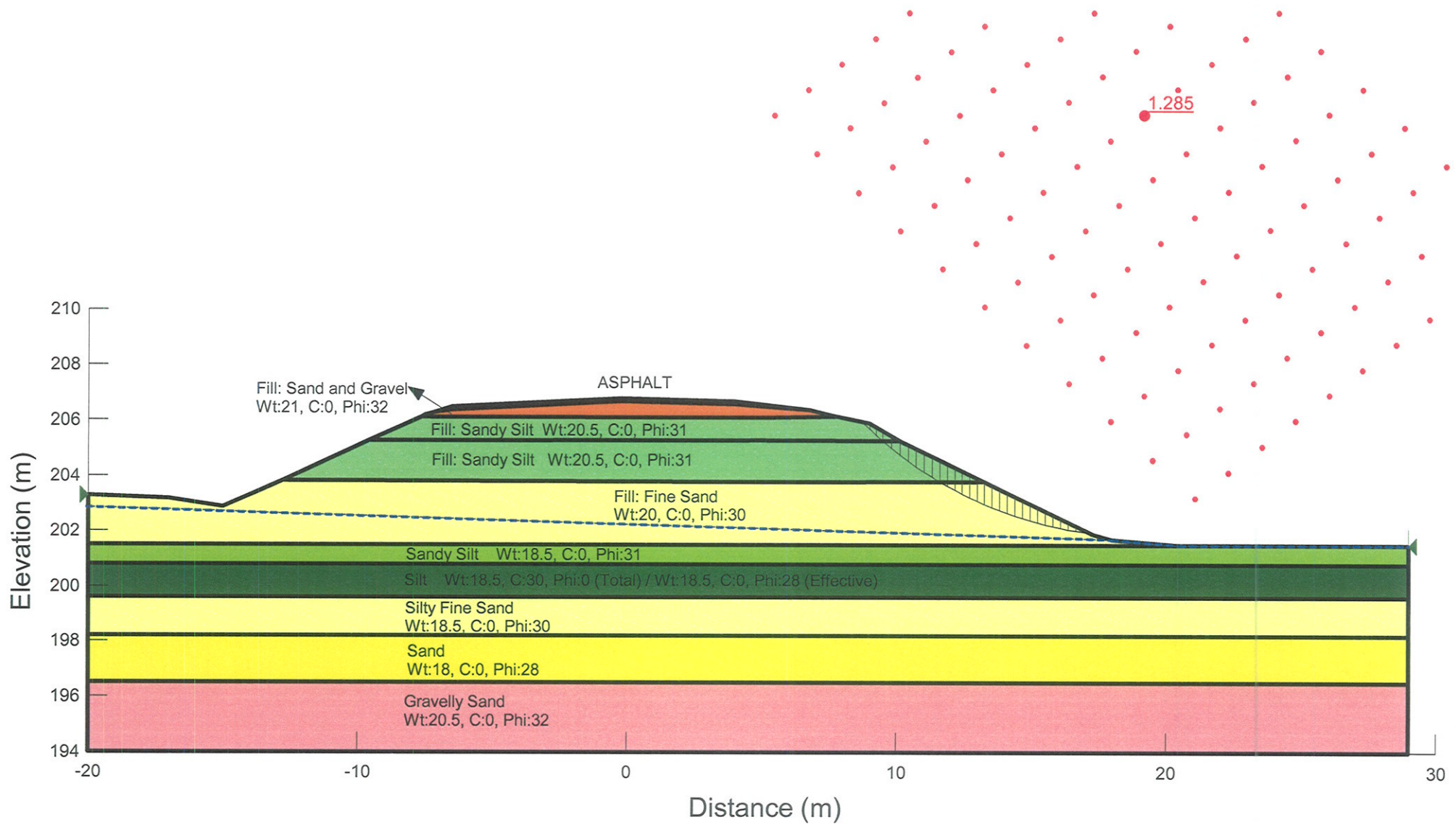
STA 22+128 before widening



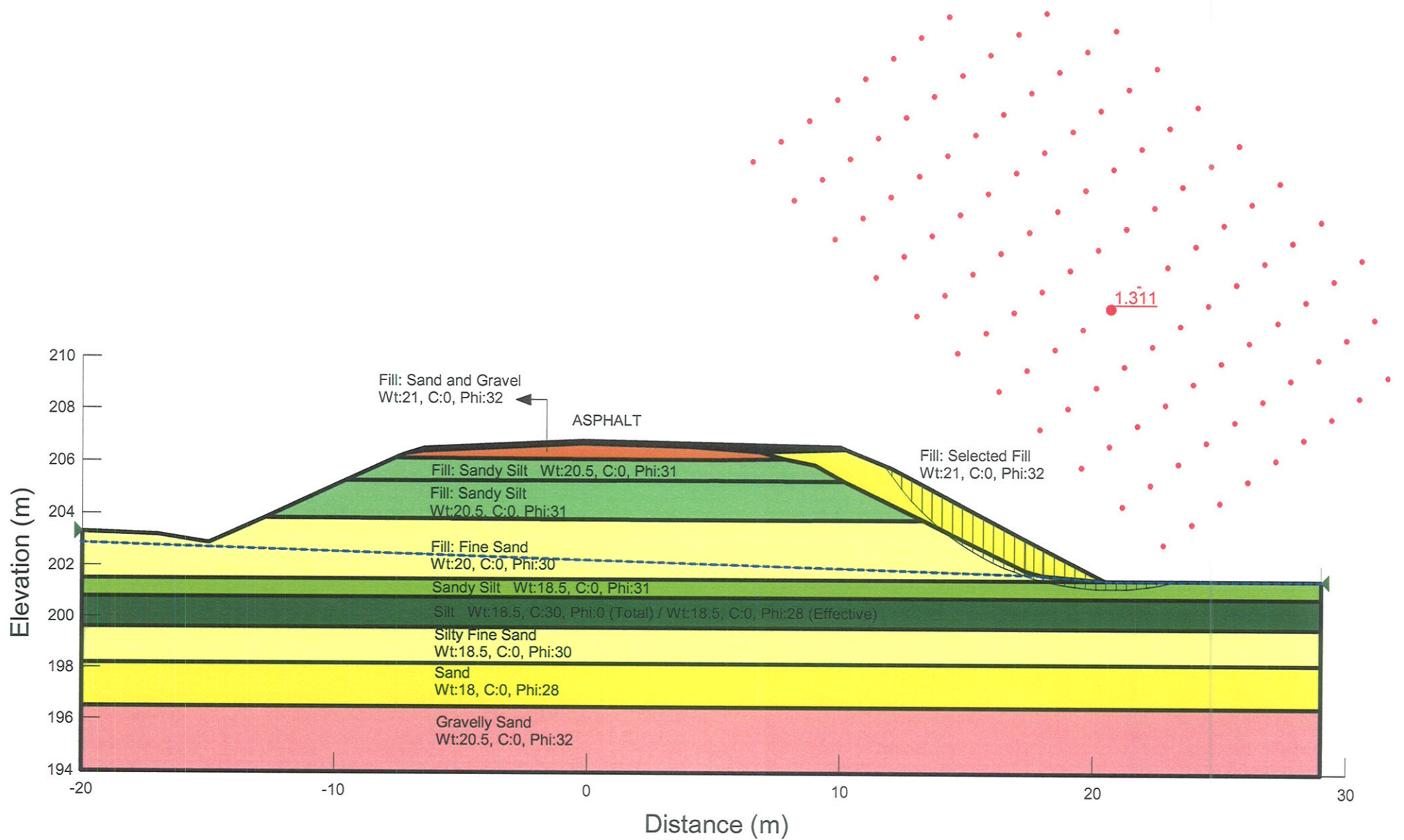
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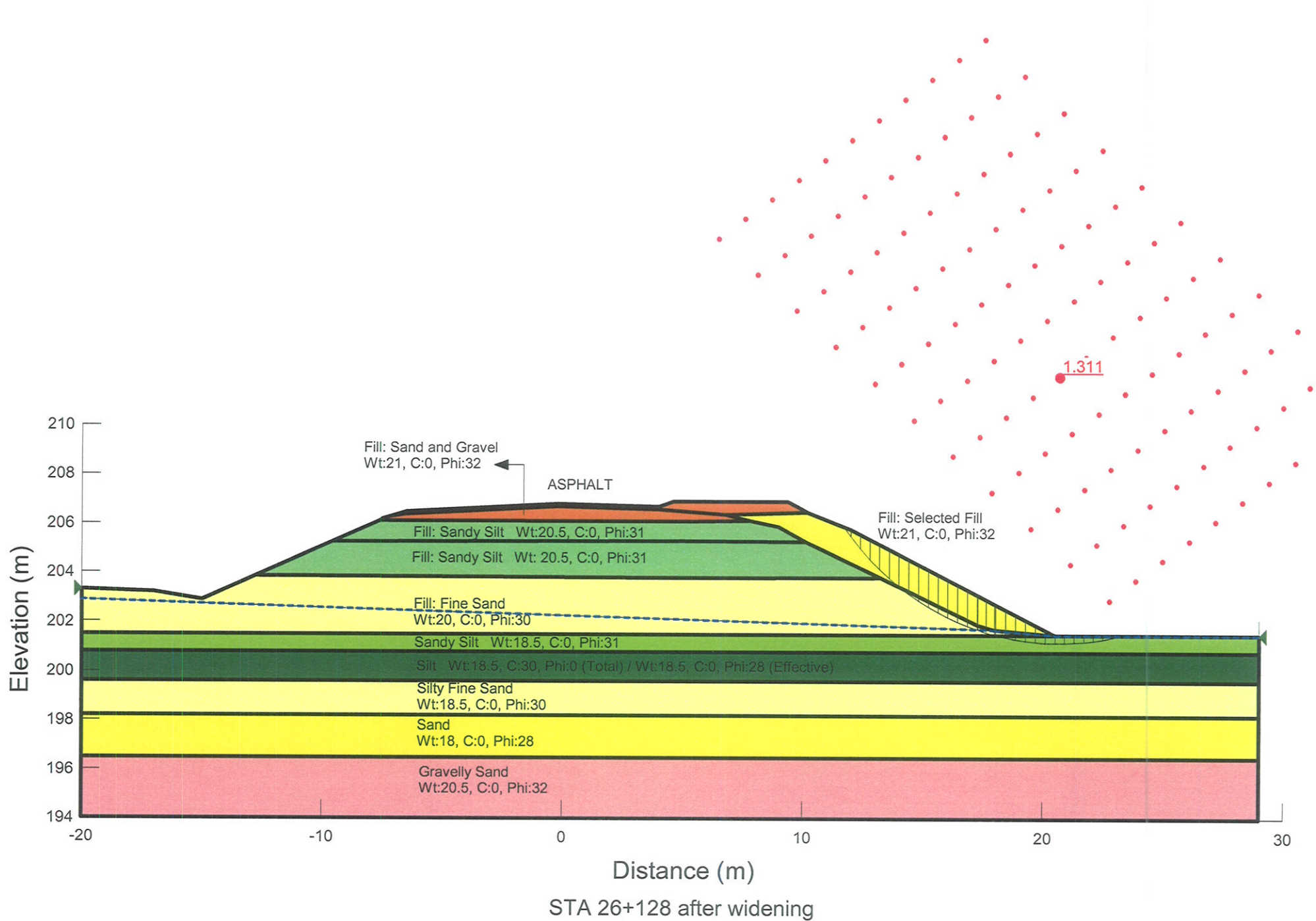




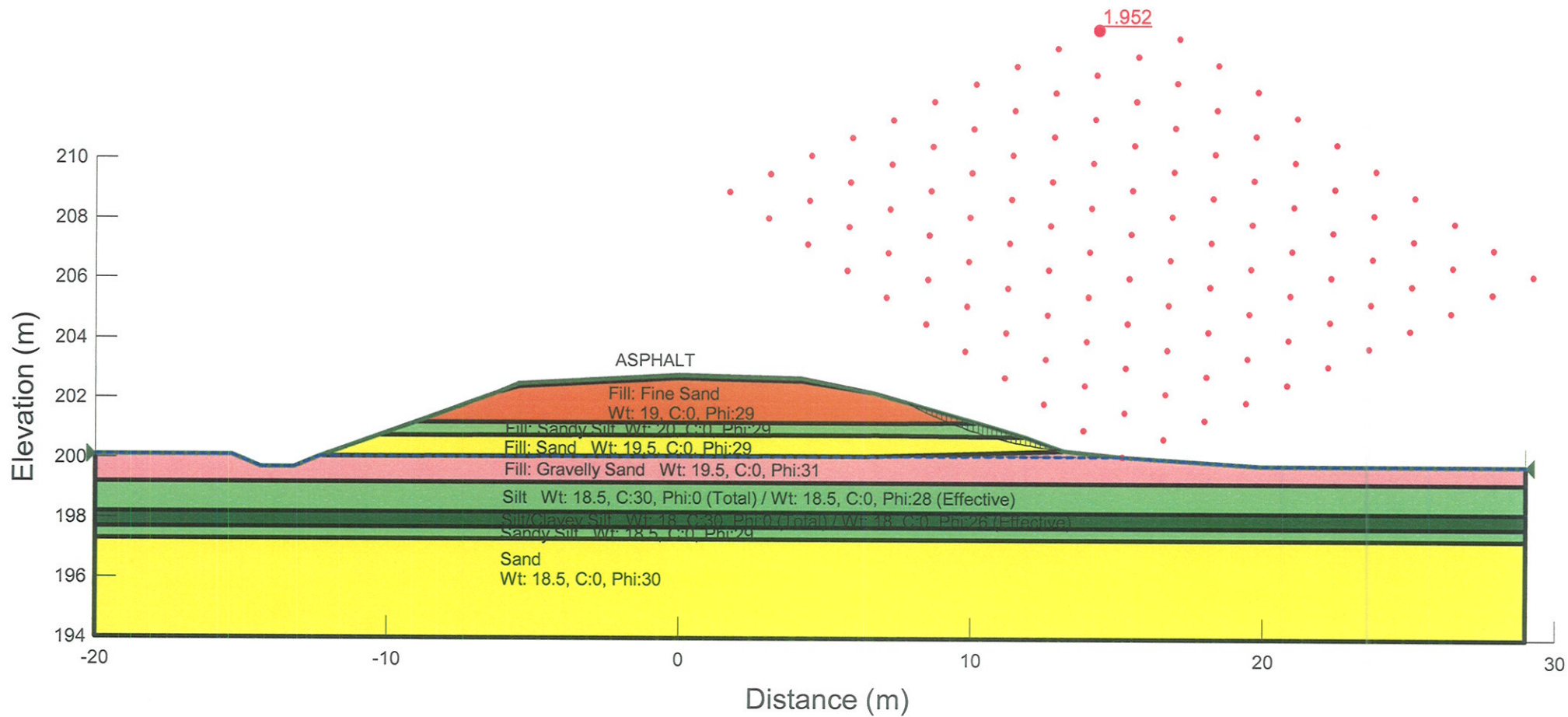
STA 22+128 before widening



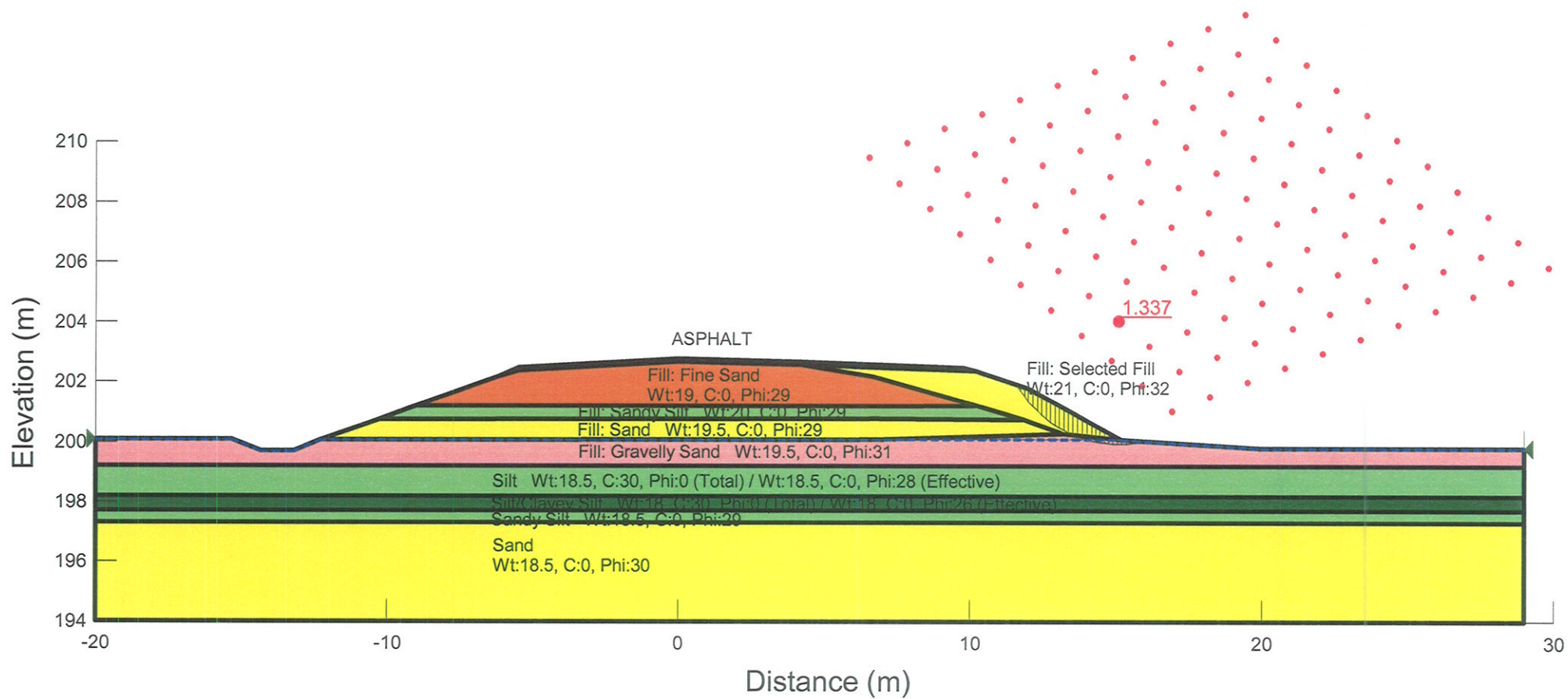
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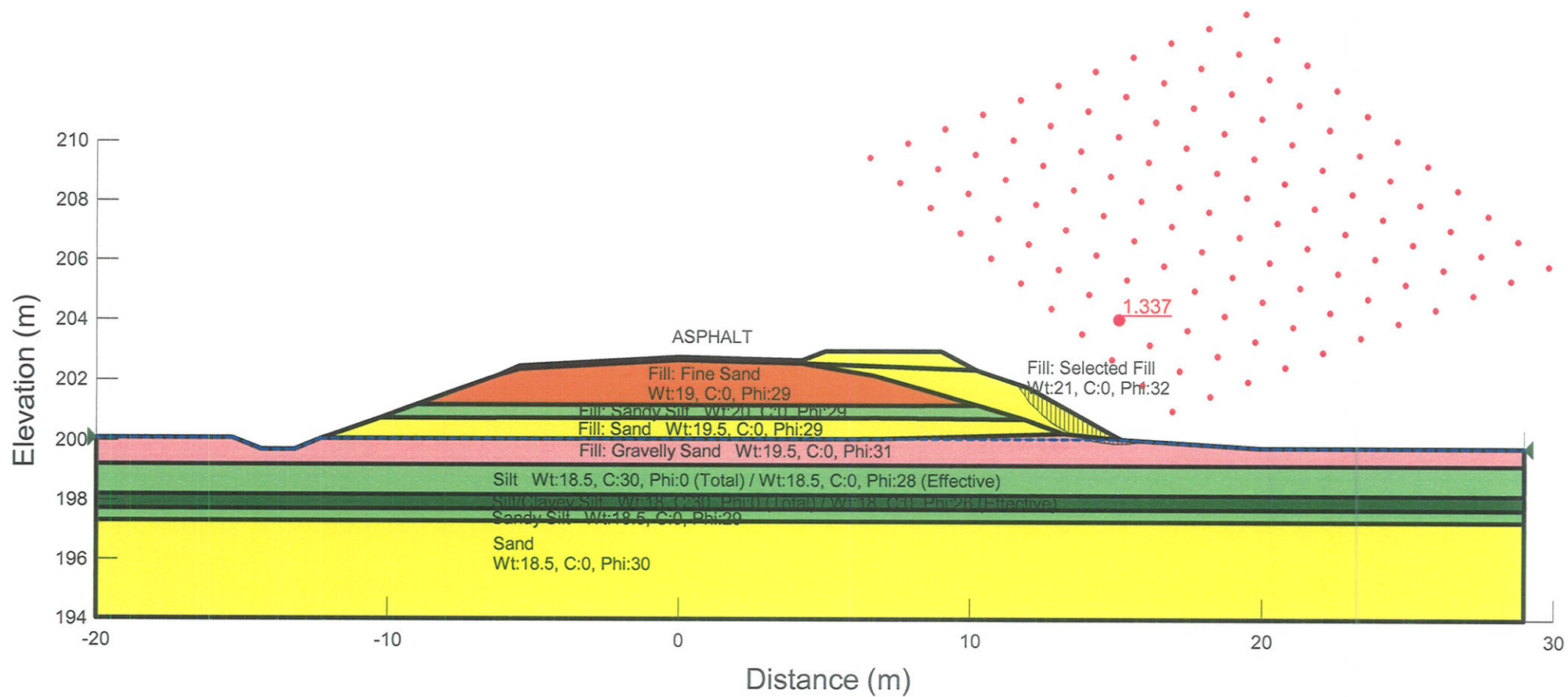


STA 26+228 before widening



STA 26+228 after widening

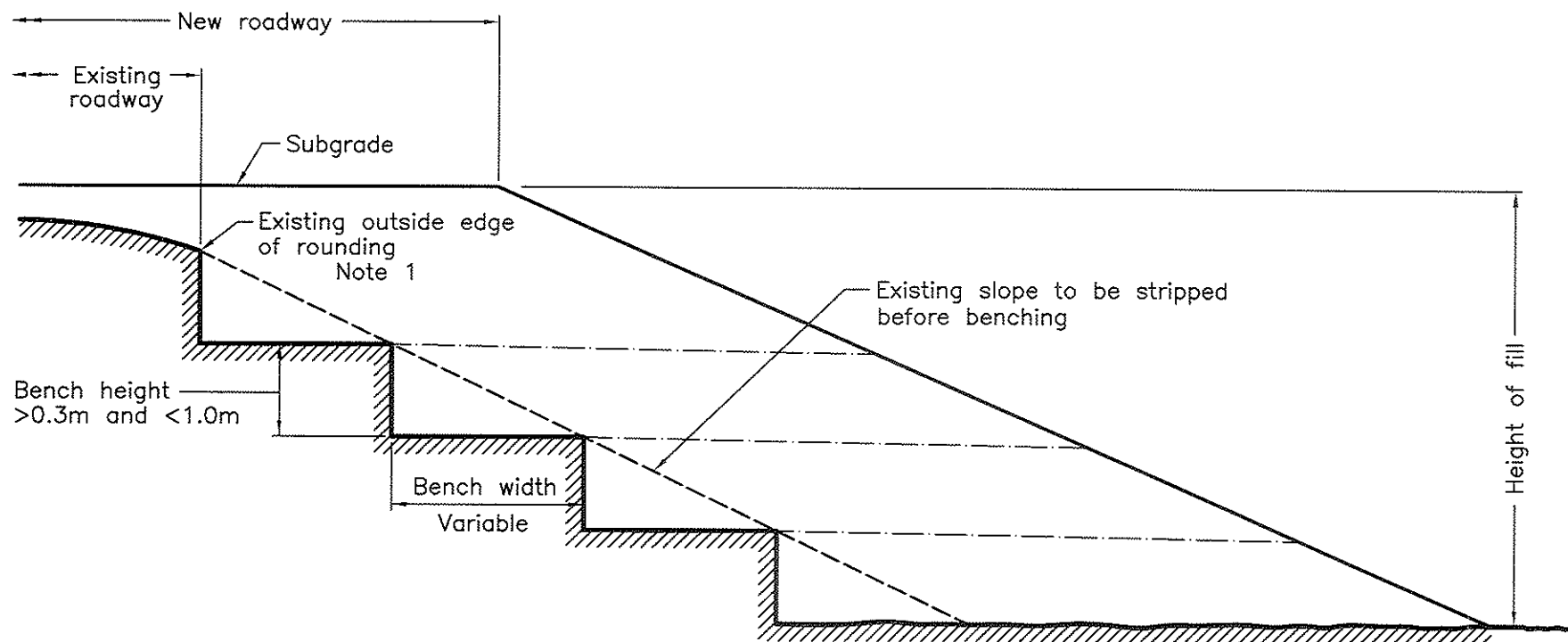




STA 26+228 after widening

# Appendix G

## OPSD



**NOTES:**

- 1 When the subgrade is below the existing outside edge of rounding, benching shall be carried out below the point where the subgrade intersects the existing slope.
- A Benching is not required on existing slopes flatter than 3H:1V.

- B Benches are to be excavated one level at a time and the compacted fill brought up before the next benching level is excavated.

ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2003 Rev 1

**BENCHING OF EARTH SLOPES**



**OPSD - 208.010**

# Appendix H

## 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 Shaheen & Peaker, A Division of Coffey Geotechnics Inc. at the time of preparation. Unless otherwise agreed in writing by Shaheen & Peaker, 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. Shaheen & Peaker accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.