Calculation Cover Sheet

Project/Task Saltstone Disposal Unit 6	**Calculation No.** K-CLC-Z-00023	**Project /Task No.** SDU6
Title Soil Design Parameters from Field and laboratory Testing for Saltstone Disposal Unit 6	**Functional Classification** PS	**Sheet 1 of 57**
	Discipline Geotechnical	
Calc Level ☒ Type 1 ☐ Type 2	**Type 1 Calc Status** ☐ Preliminary ☒ Confirmed	
Computer Program No. Excel 2010 ☐ N/A	**Version / Release No.** N/A	
Purpose and Objective The reduction and evaluation of field and laboratory data and the development of soil engineering design parameters are performed for the determination of soil engineering properties at the Saltstone Disposal Unit 6 site.	**DC/RO** UNCLASSIFIED DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION ADC & Reviewing Official [signature] (Name) Date: 3/20/12	

Summary of Conclusion

The recommended soil design parameters are given in Section 6.

Revisions

Rev. #	Revision Description
0	Original

Sign Off

Rev. #	Originator (Print) Sign / Date	Verification / Checking Method	Verifier/Checker (Print) Sign/Date	Manager (Print) Sign / Date
0	Michael J. Hasek [signature] 03/19/2012	☐ Design Check (GS/PS Only) ☒ Document Review ☐ Qualification Testing ☐ Alternate Calculation ☐ Operational Testing	Rucker J. Williams [signature] 3-19-12	Nick Kennedy [signature] 3-20-12
		☐ Design Check (GS/PS Only) ☒ Document Review ☐ Qualification Testing ☐ Alternate Calculation ☐ Operational Testing		

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Release to Outside Agency (Print) N/A	**Signature**	**Date**
Security Classification of the Calculation Unclassified		

Table of Contents

1. Introduction

The purpose of this calculation is to provide soil design properties for the 375-ft diameter foundation of the Saltstone Disposal Unit No. 6 vault located in Z-area (Figure 1). Geotechnical test data were obtained from field exploration and testing and laboratory testing. Field tests that were performed included cone penetration tests (CPT), seismic cone penetration tests (SCPT), and standard penetration tests (SPT) (Figure 2). Soil samples were recovered for laboratory testing using a fixed piston tube sampler and a split spoon sampler. The laboratory tests included consolidated undrained triaxial compression, consolidation, moisture content, Atterberg limits, unit weight, and grain size distribution. The data from the test results were reduced, correlated, and summarized and the soil design properties are presented for the design of the tank foundation.

2. Input Data

Input data was obtained from the results of field exploration and testing and laboratory testing. The data obtained from the CPT included cone tip stress (q_c), corrected cone tip stress (q_t), excess pore pressure (u_2), sleeve stress (f_s) and the SCPT provided an additional test - shear wave and compressive wave velocities in the soil. The estimated unit weight based on the soil behavior type (SBT) index was also derived from the CPT data. Blow counts were obtained from the SPT, which simultaneously retrieved split spoon soil samples for descriptions and laboratory index tests.

Index tests included Atterberg limits, grain size distribution, and moisture content. Undisturbed samples were retrieved from boreholes using both a fixed-piston sampler and a Shelby thin-walled tube sampler. Soils were extracted from the tubes and tested in triaxial compression in the laboratory to determine the total cohesion and total friction angle and the effective cohesion and effective friction angle (c and ϕ and c' and ϕ', respectively) and the total and dry unit weight (γ_t and γ_d, respectively) and the natural moisture content (w_n). Consolidation tests were performed to obtain the initial void ratio (e_o), compression index (C_c), the recompression index (treated as synonymous with swelling index) (C_r), and the preconsolidation stress (σ'_p) for use in settlement analysis.

3. Assumptions

The following aspects are assumed for the design calculation:

1. The blow count (N) as generated in the field maintains an energy efficiency of 60% and is equal to N_{60}, and
2. The swelling index (C_s) used in older reports is approximately defined as the recompression index (C_r).

4. Methods and Calculations

4.1 Cone Penetration Test

The locations and penetration depths of the Cone Penetration Tests (CPT) are given in Table 1. The CPT yields data that is used to calculate numerous values, such as uncorrected tip stress (q_c), corrected tip stress (q_t), sleeve stress (f_s), pore pressure (u_2), and friction ratio (F_R). For the purpose of determining soil properties, the corrected and normalized tip stress (q_{t1}) is expressed as follows:

$$q_{t1} = C_Q \cdot q_t$$

$$C_Q = (p_a/\sigma'_{vo})^{0.5}$$ (Liao and Whitman, 1986)

p_a = reference pressure in same units as σ'_{vo}
(100 kPa ≈ 1 atm ≈ 1 ton/ft^2 = 2000 lb/ft^2)
σ'_{vo} = effective vertical stress

All of the CPT data is found in the report by Lankelma, Inc. (2012). The values are compared to the unit weights of the triaxial and consolidation specimens.

4.2 Standard Penetration Test

The locations and penetration depths of the Standard Penetration Tests (SPT) are given in Table 2. Soil samples obtained during the tests are listed in Tables 3 and 4. The method of measurement for the SPT, referred to as the blow count, is performed by summing the two middle (6-inch) drive intervals during the SPT test. It requires normalization to 1 ton/ft^2 to account for the variation in vertical overburden stress. It is determined as:

$$N_1 = C_N \cdot N$$

N = measured blow count
C_N = normalization coefficient

$$C_N = (p_a/\sigma'_{vo})^{0.5}$$ (Liao and Whitman, 1986)

p_a = reference pressure in same units as σ'_{vo}

(100 kPa ≈ 1 atm ≈ 1 ton/ft^2 = 2000 lb/ft^2)
σ'_{vo} = effective vertical stress

It was assumed that no energy correction is necessary for the blow count because the SPT hammer operates at an energy ratio above 60%. Therefore:

$$N = N_{60}$$

and $$N_{1,60} = N_1$$

4.3 Shear Strength Properties

Undisturbed soil samples were used for determining the shear strength properties of the soils. The samples were retrieved from the boreholes and depths as listed in Table 5. Isotropically-consolidated triaxial compression tests were performed in the laboratory. The shear strength data was compared to the effective friction angle that was calculated using relationships that have been established between the effective friction angle and the CPT and the SPT. Estimates of the effective friction angle (ϕ') for granular, cohesionless soil can be obtained by the following relationships based on the normalized, corrected tip stress (q_{t1}) of the CPT as follows:

$$\phi' = 17.6 + 11.0 \cdot \log(q_{t1})$$ (Kulhawy and Mayne, 1990)

Friction angle relationships that are based on the SPT blow count include:

$$\phi' = 27.1 + 0.3 \cdot N_{1,60} - 0.00054 \cdot (N_{1,60})^2$$ (Peck, Hanson, and Thornburn, 1974)

$$\phi' = \tan^{-1} \cdot [N_{60}/(12.2 + 20.3 \cdot (\sigma'_o/p_a)]^{0.34}$$ (Schmertmann, 1975)

$$\phi' = (20 \cdot N_{1,60})^{0.5} + 20$$ (Hatanaka and Uchida, 1996)

The variables are defined as: N_{60} = energy-corrected blow count
$N_{1,60}$ = normalized, energy-corrected blow count
σ'_o = effective vertical stress
p_a = reference pressure in same units as σ'_o
(100 kPa ≈ 1 atm ≈ 1 ton/ft^2 = 2000 lb/ft^2)

Total and effective cohesion and friction angle were obtained from isotropically consolidated undrained triaxial tests with pore pressure measurements per ASTM D 4767.

4.4 Consolidation Test

Consolidation tests were performed on undisturbed tube samples. The pre-consolidation pressure (σ'_p) was determined using the Casagrande method (ASTM D 2435). Other properties included the initial void ratio (e_o), over-consolidation ratio (OCR), compression index (C_c), re-compression index (C_r), and C_c/C_r.

4.5 Unit Weight and Moisture Content

The total and dry unit weights (based on the subcontractor's procedure TP-4) (AMEC, 2012) and the moisture content (ASTM D 2216) were determined from the triaxial compression specimens, the hydraulic conductivity specimen, and the consolidation specimens. The disturbed soils obtained from the split spoon sampler (Tables 3 and 4) were used to determine only moisture content. Moisture content from the split spoon samples is not considered to be accurate because the soils of lesser cohesion become very disturbed during the dynamic driving process and there is a redistribution of moisture within the soil. In addition, the total unit weight was estimated using the CPT data based on the soil behavior type (SBT) classification as discussed in Lunne et al. (2001).

4.6 Atterberg Limits

Atterberg limit tests (liquid limit and plastic limit) were performed in accordance with ASTM D 4318.

4.7 Grain Size Distribution

The grain size proportions and distribution of the disturbed soil from the split spoon sampler were determined according to ASTM D 422. Both the sieve and hydrometer tests were performed.

4.8 Hydraulic Conductivity

One hydraulic conductivity test was performed per the test standard ASTM D 5084.

4.9 Soil Layer Definitions

Soil layers were defined as contained in Calculation No. K-CLC-Z00022 and are presented in Table 6.

5. Results

5.1 Shear Strength Properties

The shear strength properties derived from the CPT, SPT, and isotropically-consolidated triaxial compression tests (AMEC, 2012) yielded values of total cohesion and total friction angle and effective cohesion and effective friction angle. The effective friction angle was calculated using four different methods in addition to the triaxial test results. As shown in Figure 3 (Boreholes B01 and B03 and CPT C16), the effective friction angles from the triaxial tests are in good agreement with the Kulhawy and Mayne (1990) method using the CPT. The Kulhawy and Mayne method is also in best agreement with the SPT-based method by Hatanaka and Uchida (1996). Based on the agreement of these, the effective friction angle estimated by Hatanaka and Uchida is assumed to hold true for soils below the final depth of the CPT. Likewise, Figure 4 (Borehole B04 and CPT C11) shows good agreement between the Kulhawy and Mayne method and the Hatanaka and Uchida method.

Figure 5 (Z-SDU6-C05) shows one effective friction angle value from a triaxial test plotted relative to the effective friction angle curve using the method of Kulhawy and Mayne. As with the previous, this shows good agreement.

The effective friction angle envelope shown in Figure 6 was developed from the CPT-based friction angle determination. This provides an upper bound effective friction angle from the ground surface to an elevation of about 144 ft, MSL (depth of about 137 ft). The friction angles range from 21 to 36 degrees. Effective friction angles below 137 ft can be estimated from the Hatanaka and Uchida relationship as shown in Figure 4. Very high friction angles occur and a limit is placed on these. Subsequently, the upper bound envelope is shown in Figure 4 with a maximum effective friction angle of 40 degrees.

The results of the triaxial tests are given in Table 7 for specimens tested at different depths. Additional strength data was obtained from adjacent projects in Z-Area, including Vaults 2, 3, and 5 and is included in Tables 8 and 9. Section 6 contains a summary of the strength data and the recommendations for design parameters and Figures 4 and 6 contain the effective friction angles.

5.2 Unit Weight and Moisture Content

The total unit weight determined from the soil specimens compares favorably with the total unit weights determined from the CPT SBT classification (Robertson). This is shown in Figures 7 and 8. The unit weight and moisture content for the test specimens are given in Table 10 in addition to data obtained from the undeveloped 6/7 area. More unit weight and moisture content data was available from testing at Vault 2 (WSRC, 2006) and Vaults 3 and 5 (SRNS, 2010) as shown in Tables 11 and 12, respectively. The ranges of total unit weight are given in Section 6 with the recommended values for design parameters.

5.3 Grain Size Distribution

The grain size distribution of the soils is given in Tables 13 and 14. Table 13 presents the proportions according to sieve size, whereas Table 14 presents the soil proportions by the grain categories – gravel, sand, silt, clay, and the percentage finer than the #200 sieve. Gravel content ranges from 0 to 28%, sand content ranges from 2 to 94%, and the less than #200 sieve (fines) ranges from 6 to 98%. Not all analyses differentiated between the silt and clay fractions. The D50 for the soils ranged from 0.002 to 0.520 mm. The grain size data is not used in the design for the tank foundation.

5.4 Atterberg Limits

The Atterberg limits were determined for some of the SDU 6 soils and are given in Table 15 with the USCS classification. The Atterberg limits were useful for determining the soil type.

5.5 Consolidation Properties

Consolidation properties were obtained from five sources for comparison with the consolidation properties of the soil from SDU 6 and SDU 6/7 that are given in Table 16. The additional consolidation properties were from the Z-area sites of Vault 1 (Table 17), SDU Vault 2 (Table 18), SDU Vaults 3 and 5 (Table 19), a previous investigation for SDU 6 that was designated SDU6/7 (Table 16), and the Defense Waste Processing Facility in S-Area (Table 20). The ranges of e_o, C_c, and C_r and C_s are given in Section 6.

5.6 Hydraulic Conductivity

The hydraulic conductivity of one sample from Z-SDU6-B02, FPT02 from 47 to 49 ft yielded a hydraulic conductivity of 8.5 x 10^{-8} cm/sec.

5.7 Groundwater Elevation

The groundwater depth was estimated at about 60 ft below the ground surface. This is based on work performed at the SDU67 site near the SDU6 site. Inclusive of a seasonal watertable fluctuation, the watertable elevation ranges from about 215 to 221 ft MSL. Observation wells installed in February 2012 north of Vault 2 indicated a water elevation of 215 ft, MSL (undocumented source).

6. Conclusions and Recommendations

Based on the results from field and laboratory testing, the following conclusions and recommendations are made with respect to soil design parameters for the foundation of the SDU 6 storage tank:

1. The effective friction angle varies with depth as shown in Figures 4 and 6.

2. The ranges of total cohesion, total friction angle, effective cohesion, total unit weight, and consolidation properties are included in the following table with the recommended design value in parentheses.

Layer	γ_t (lb/ft^3)	e_o	σ'_p (lb/ft^2)	C_c	C_r and C_s	ϕ (deg)	c (lb/ft^2)	c′ (lb/ft^2)
S1/S2	110 - 130 (123)	0.57 - 0.65 (0.63)	6000 – 14600 (10200)	0.04 - 0.10 (0.06)	0.005 - 0.009 (0.007)	8 - 36 (32)	250 - 2808 (725)	50 - 440 (275)
C2	93 - 122 (106)	1.25 - 1.99 (1.35)	3700 – 16800 (4500)	0.37 - 1.23 (0.58)	0.05 - 0.14 (0.10)	9 - 15 (11)	640 - 1230 (950)	0 - 376 (175)
S3	107 - 124 (116)	0.57 - 1.62 (0.76)	(3400 – 26000 (6600)	0.030 - 0.80 (0.23)	0.008 - 0.083 (0.03)	---	---	---
S4	114 - 122 (119)	0.92, 0.92 (0.92)	23200, 31800 (27500)	0.196, 0.361 (0.28)	0.016, 0.023 (0.02)	11 (11)	1526 (500)	566 (175)

3. The watertable is approximately 60 ft below the ground surface.

7. References

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ASTM D 2216-10. Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. American Society for Testing and Materials.

ASTM D 2435-11. Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading. American Society for Testing and Materials.

ASTM D 4318-10. Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. American Society for Testing and Materials.

ASTM D 4767-11. Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils. American Society for Testing and Materials.

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Table 1. Locations of Seismic Cone Penetration Tests Performed at SDU 6.

SCPT No.	SRS Northing (feet)	SRS Easting (feet)	Ground Elevation (feet, MSL)	Total Depth (feet)
Z-SDU6-C01	77413.3	66270.1	281.9	98.72
Z-SDU6-C02	77448.1	66350.4	281.4	97.09
Z-SDU6-C03	77478.3	66494.3	281.6	102.27
Z-SDU6-C04	77503.3	66578.8	281.8	97.51
Z-SDU6-C05	77624.5	66594.9	278.1	97.00
Z-SDU6-C06	77587.6	66472.8	278.6	97.00
Z-SDU6-C07	77546.9	66357.1	279.4	97.04
Z-SDU6-C08	77511.4	66258.9	279.7	97.92
Z-SDU6-C09	77621.8	66210.4	278.3	86.42
Z-SDU6-C10	77644.2	66285.6	278.0	102.93
Z-SDU6-C11	77663.3	66354.1	277.6	96.98
Z-SDU6-C12	77682.6	66452.6	277.7	91.77
Z-SDU6-C13	77722.6	66523.4	276.3	92.52
Z-SDU6-C14	77720.6	66180.9	277.3	98.84
Z-SDU6-C15	77748.2	66249.8	276.8	98.62
Z-SDU6-C16	77772.2	66312.2	276.7	96.50
Z-SDU6-C17	77796.3	66393.3	276.0	90.80
Z-SDU6-C18	77819.4	66471.7	275.6	92.50
Z-SDU6-C19	77869.3	66155.6	276.4	112.60
Z-SDU6-C20	77895.0	66236.9	276.0	127.81
Z-SDU6-C21	77920.9	66321.6	276.3	131.77
Z-SDU6-C22	77947.5	66415.1	276.5	129.72
Z-SDU6-C23	77967.7	66482.5	275.5	89.95

Table 2. Locations of Standard Penetration Tests (SPT) and Undisturbed Sampling Boreholes (UD) at SDU 6.

Borehole No.	Borehole Type	SRS Northing (ft)	SRS Easting (ft)	Ground Elevation (ft, MSL)	Total Depth (ft)
Z-SDU6-B01	UD	77771.3	66309.1	276.6	127.6
Z-SDU6-B02A	UD	77625.3	66594.8	278.0	75.0
Z-SDU6-B02B	UD	77629.2	66588.9	278.1	131.0
Z-SDU6-B03	SPT	77769.6	66304.5	276.5	158.0
Z-SDU6-B04	SPT	77663.9	66351.1	277.9	307.5

Table 3. Disturbed Soil Samples from Standard Penetration Test Split Spoon Sampler at SDU 6 Borehole Z-SDU6-**B03**.

Borehole No.	Sample No.	Sampling Depth (ft)		Elev. (ft, MSL)	
		from	to	from	to
Z-SDU6-B03	SS01	12.0	14.0	264.5	262.5
Z-SDU6-B03	SS02	14.0	16.0	262.5	260.5
Z-SDU6-B03	SS03	16.0	18.0	260.5	258.5
Z-SDU6-B03	SS04	23.0	25.0	253.5	251.5
Z-SDU6-B03	SS05	25.0	27.0	251.5	249.5
Z-SDU6-B03	SS06	27.0	29.0	249.5	247.5
Z-SDU6-B03	SS07	29.0	31.0	247.5	245.5
Z-SDU6-B03	SS08	31.0	33.0	245.5	243.5
Z-SDU6-B03	SS09	33.0	35.0	243.5	241.5
Z-SDU6-B03	SS10	35.0	37.0	241.5	239.5
Z-SDU6-B03	SS11	37.0	39.0	239.5	237.5
Z-SDU6-B03	SS12	39.0	41.0	237.5	235.5
Z-SDU6-B03	SS13	42.0	44.0	234.5	232.5
Z-SDU6-B03	SS14	48.0	50.0	228.5	226.5
Z-SDU6-B03	SS15	53.0	55.0	223.5	221.5
Z-SDU6-B03	SS16	58.0	60.0	218.5	216.5
Z-SDU6-B03	SS17	63.0	65.0	213.5	211.5
Z-SDU6-B03	SS18	68.0	70.0	208.5	206.5
Z-SDU6-B03	SS19	73.0	75.0	203.5	201.5
Z-SDU6-B03	SS20	78.0	80.0	198.5	196.5
Z-SDU6-B03	SS21	83.0	85.0	193.5	191.5
Z-SDU6-B03	SS22	88.0	90.0	188.5	186.5
Z-SDU6-B03	SS23	93.0	95.0	183.5	181.5
Z-SDU6-B03	SS24	98.0	100.0	178.5	176.5
Z-SDU6-B03	SS25	103.0	105.0	173.5	171.5
Z-SDU6-B03	SS26	108.0	110.0	168.5	166.5
Z-SDU6-B03	SS27	113.0	115.0	163.5	161.5
Z-SDU6-B03	SS28	118.0	120.0	158.5	156.5
Z-SDU6-B03	SS29	123.0	125.0	153.5	151.5
Z-SDU6-B03	SS30	128.0	130.0	148.5	146.5
Z-SDU6-B03	SS31	133.0	135.0	143.5	141.5
Z-SDU6-B03	SS33	143.0	145.0	133.5	131.5
Z-SDU6-B03	SS34	148.0	150.0	128.5	126.5

Table 4. Disturbed Soil Samples from Standard Penetration Test Split Spoon Sampler at SDU 6 Borehole Z-SDU6-**B04**.

Borehole No.	Sample No.	Sampling Depth (ft)		Elev. (ft, MSL)	
		from	to	from	to
Z-SDU6-B04	SS01	14.0	16.0	263.9	261.9
Z-SDU6-B04	SS02	16.0	18.0	261.9	259.9
Z-SDU6-B04	SS03	18.0	20.0	259.9	257.9
Z-SDU6-B04	SS04	20.0	22.0	257.9	255.9
Z-SDU6-B04	SS05	22.0	24.0	255.9	253.9
Z-SDU6-B04	SS06	24.0	26.0	253.9	251.9
Z-SDU6-B04	SS07	26.0	28.0	251.9	249.9
Z-SDU6-B04	SS08	28.0	30.0	249.9	247.9
Z-SDU6-B04	SS09	30.0	32.0	247.9	245.9
Z-SDU6-B04	SS10	32.0	34.0	245.9	243.9
Z-SDU6-B04	SS11	34.0	36.0	243.9	241.9
Z-SDU6-B04	SS12	36.0	38.0	241.9	239.9
Z-SDU6-B04	SS13	38.0	40.0	239.9	237.9
Z-SDU6-B04	SS14	40.0	42.0	237.9	235.9
Z-SDU6-B04	SS15	43.0	45.0	234.9	232.9
Z-SDU6-B04	SS16	48.0	50.0	229.9	227.9
Z-SDU6-B04	SS17	53.0	55.0	224.9	222.9
Z-SDU6-B04	SS18	58.0	60.0	219.9	217.9
Z-SDU6-B04	SS19	63.0	65.0	214.9	212.9
Z-SDU6-B04	SS20	68.0	70.0	209.9	207.9
Z-SDU6-B04	SS21	73.0	75.0	204.9	202.9
Z-SDU6-B04	SS22	78.0	80.0	199.9	197.9
Z-SDU6-B04	SS23	83.0	85.0	194.9	192.9
Z-SDU6-B04	SS24	88.0	90.0	189.9	187.9
Z-SDU6-B04	SS25	93.0	95.0	184.9	182.9
Z-SDU6-B04	SS26	98.0	100.0	179.9	177.9
Z-SDU6-B04	SS27	103.0	105.0	174.9	172.9
Z-SDU6-B04	SS28	108.0	110.0	169.9	167.9
Z-SDU6-B04	SS29	113.0	115.0	164.9	162.9
Z-SDU6-B04	SS30	118.0	120.0	159.9	157.9
Z-SDU6-B04	SS31	123.0	125.0	154.9	152.9
Z-SDU6-B04	SS32	128.0	130.0	149.9	147.9
Z-SDU6-B04	SS33	133.0	135.0	144.9	142.9
Z-SDU6-B04	SS34	138.0	140.0	139.9	137.9

Table 5. Undisturbed Soil Samples at SDU 6.

Borehole No.	Sample No.	Planned Sampling Depth (ft)		Actual Sampling Depth (ft)		Soil Recovery (%)	Actual Sampling Elev. (ft, MSL)	
		from	to	from	to		from	to
Z-SDU6-B01	ST01	13.0	15.0	13.0	14.4	53	263.6	262.2
Z-SDU6-B01	ST02	15.0	17.0	15.0	16.6	95	261.6	259.6
Z-SDU6-B01	FPT01	22.0	24.0	22.0	24.0	100	254.6	252.6
Z-SDU6-B01	ST03	35.0	37.0	35.0	36.3	100	241.6	240.3
Z-SDU6-B01	ST04	48.25	50.25	48.25	50.25	100	228.6	226.6
Z-SDU6-B01	ST05	51.1	53.1	51.1	53.1	100	225.5	223.5
Z-SDU6-B01	ST06	58.0	60.0	58.0	60.0	100	218.6	216.6
Z-SDU6-B01	ST07	71.0	73.0	71.0	73.0	38	205.6	203.6
Z-SDU6-B01	ST08	73.2	75.2	73.2	75.2	58	203.4	201.4
Z-SDU6-B01	FPT02	82.0	84.0	82.0	84.0	100	194.6	192.6
Z-SDU6-B01	ST09	92.0	94.0	92.0	92.6	0	184.6	184.0
-SDU6-B01	ST10	115.1	117.1	115.1	115.8	100	161.5	160.8
Z-SDU6-B01	ST11	126.1	127.6	126.1	127.6	100	150.5	149.0
Z-SDU6-B02A	ST01	9.7	10.7	9.7	10.0	100	268.3	268.0
Z-SDU6-B02A	ST02	10.5	12.5	10.5	11.0	100	267.5	267.0
Z-SDU6-B02A	ST03	16.0	18.0	16.0	16.3	75	262.0	261.7
Z-SDU6-B02A	ST04	16.5	18.5	16.5	16.8	83	261.5	261.2
Z-SDU6-B02A	ST05	23.0	25.0	23.0	23.6	53	255.0	254.4
Z-SDU6-B02A	FPT01	44.0	46.0	44.0	46.0	96	234.0	232.0
Z-SDU6-B02A	FPT02	47.0	49.0	47.0	49.0	100	231.0	229.0
Z-SDU6-B02A	ST06	58.0	60.0	58.0	58.5	67	220.0	219.5
Z-SDU6-B02B	FP01	75.0	77.0	75.0	77.0	100	203.1	201.1
Z-SDU6-B02B	FP02	85.0	87.0	85.0	85.3	17	193.1	192.8

Table 6. Elevations and Thicknesses of Major Soil Layers at SDU 6.

		Top Elev. (ft)					Thickness (ft)			
BH/CPT	Surface Elev. (ft)	C2	S3	S4	GC	Congaree	C2	S3	S4	GC
Z-SDU6-B02B	278.1	234	227	191	---	---	7	36	---	---
Z-SDU6-B03	276.5	232	217	188	164	146	15	29	24	18
Z-SDU6-B04	277.9	236	232	191	165	145	4	41	26	20
Z-SDU6-C01	281.9	233	226	190	---	---	7	36	---	---
Z-SDU6-C02	281.4	233	227	190	---	---	6	37	---	---
Z-SDU6-C03	281.6	233	225	190	---	---	8	35	---	---
Z-SDU6-C04	281.8	236	229	190	---	---	7	39	---	---
Z-SDU6-C05	278.1	235	226	187	---	---	9	39	---	---
Z-SDU6-C06	278.6	234	227	189	---	---	7	38	---	---
Z-SDU6-C07	279.4	237	230	191	---	---	7	39	---	---
Z-SDU6-C08	279.7	236	230	186	---	---	6	44	---	---
Z-SDU6-C09	278.3	237	230	194	---	---	7	36	---	---
Z-SDU6-C10	278.0	237	230	190	---	---	7	40	---	---
Z-SDU6-C11	277.6	238	233	186	---	---	5	47	---	---
Z-SDU6-C12	277.7	239	234	188	---	---	5	46	---	---
Z-SDU6-C13	276.3	234	228	188	---	---	6	40	---	---
Z-SDU6-C14	277.3	234	222	181	---	---	12	41	---	---
Z-SDU6-C15	276.8	232	217	192	---	---	15	25	---	---
Z-SDU6-C16	276.7	234	216	184	---	---	18	32	---	---
Z-SDU6-C17	276.0	235	219	187	---	---	16	32	---	---
Z-SDU6-C18	275.6	235	217	186	---	---	18	31	---	---
Z-SDU6-C19	276.4	235	227	183	---	---	8	44	---	---
Z-SDU6-C20	276.0	226	219	176	---	---	7	43	---	---
Z-SDU6-C21	276.3	233	225	182	---	---	8	43	---	---
Z-SDU6-C22	276.5	237	230	187	---	---	7	43	---	---
Z-SDU6-C23	275.5	238	233	190	---	---	5	43	---	---

Table 7. Results of Isotropically-Consolidated Undrained Triaxial Test with Pore Pressure Measurement at SDU 6.

Borehole/Sample No.	Depth Range (ft)	Layer	ϕ (deg)	c (lb/ft^2)	ϕ' (deg)	c′ (lb/ft^2)
Z-SDU6-B01/FP01	22.0 to 24.0	S1/S2	32	1180	36	440
Z-SDU6-B01/ST05	51.1 to 53.1	C2	15	640	32	0
Z-SDU6-B02/FP01	44.0 to 46.0	C2	11	1230	31	180

Table 8. Results of Isotropically-Consolidated Undrained Triaxial Test with Pore Pressure Measurement at Vault 2 (Washington Savannah River Co. 2006).

Borehole No.	Layer	ϕ (deg)	c (lb/ft^2)	ϕ' (deg)	c′ (lb/ft^2)
Z-V2-B2U-ST1	S1/2	deleted	300	33	250
Z-V2-B2U-ST2	S1/2	35	1700	30	380
Z-V2-B2U-ST3	S1/2	36	250	33	50
Z-V2-B2U-ST4	S1/2	26	250	32	260
Z-V2-B1U-PS1	S4	11	1526	26	566

Table 9. Results of Isotropically-Consolidated Undrained Triaxial Test with Pore Pressure Measurement at Vaults 3 and 5 (Savannah River Nuclear Solutions, 2010).

Borehole No.	Layer	ϕ (deg)	c (lb/ft^2)	ϕ' (deg)	c′ (lb/ft^2)
Z-V3V5-B1-ST1	S1/2	31	2606	33	137
Z-V3V5-B1-ST3	S1/2	8	2808	29	299
Z-V3V5-B4-ST1	S1/2	10	2462	34	322
Z-V3V5-B4-ST3	S1/2	---	---	33	357
Z-V3V5-B4-ST4	C2	9	1041	25	376

Table 10. Unit Weights and Moisture Contents at SDU 6 and SDU 6/7.

Borehole No.	Layer	γ_t (lb/ft^3)	w_n (%)	γ_d (lb/ft^3)
Z-SDU6-B01/FP01	S1/S2	116	32.9	87
Z-SDU6-B01/FP01	S1/S2	116	33.8	86
Z-SDU6-B01/FP01	S1/S2	127	21.4	105
Z-SDU6-B01/ST05	C2	105	56.9	67
Z-SDU6-B01/ST05	C2	95	82.8	52
Z-SDU6-B01/ST05	C2	112	36.4	82
Z-SDU6-B02/FPT01	C2	122	21.8	100
Z-SDU6-B02/FPT01	C2	121	21.7	99
Z-SDU6-B02/FPT01	C2	119	26.5	94
Z-SDU6-B02/FPT02	C2	117	30.0	90
Z-SDU6-B01/ST06	C2	112	37.3	81
Z-SDU6-B01/ST06	C2	95	67.6	56
Z-SD67-B01/ST04	C2	108	45.2	74
Z-SD67-B06/ST05	C2	106	41.9	75

Table 11. Unit Weights and Moisture Contents at Vault 2 (Washington Savannah River Co. 2006).

Borehole No.	Layer	γ_t (lb/ft^3)	w_n (%)	γ_d (lb/ft^3)
Z-V2-B1U-ST1	S1/2	120	13.6	106
Z-V2-B1U-ST2	S1/2	117	17.2	100
Z-V2-B1U-ST2	S1/2	118	16.7	102
Z-V2-B1U-ST3	S1/2	124	17.0	106
Z-V2-B1U-ST4	S1/2	119	15.4	103
Z-V2-B1U-ST4	S1/2	120	17.7	102
Z-V2-B2U-ST1	S1/2	126	20.2	104
Z-V2-B2U-ST1	S1/2	127	19.8	106
Z-V2-B2U-ST1	S1/2	130	16.1	112
Z-V2-B2U-ST2	S1/2	129	15.7	111
Z-V2-B2U-ST2	S1/2	132	14.1	116
Z-V2-B2U-ST3	S1/2	126	16.4	108
Z-V2-B2U-ST3	S1/2	124	14.6	108
Z-V2-B2U-ST3	S1/2	126	14.6	110
Z-V2-B2U-ST4	S1/2	117	17.8	99
Z-V2-B2U-ST4	S1/2	121	19.3	102
Z-V2-B2U-ST4	S1/2	120	19.8	100
Z-V2-B3U-ST1	S1/2	127	14.9	111

Borehole No.	Layer	γ_t (lb/ft^3)	w_n (%)	γ_d (lb/ft^3)
Z-V2-B3U-ST3	S1/2	116	11.6	104
Z-V2-B1U-ST5	C2	101	45.3	70
Z-V2-B1U-ST5	C2	103	48.7	69
Z-V2-B1U-ST7	S3	124	17.7	105
Z-V2-B1U-PS1	S4	122	32.4	93
Z-V2-B1U-PS1	S4	118	34.9	88
Z-V2-B1U-PS1	S4	117	35.5	87
Z-V2-B1U-PS1	S4	122	25.7	97
Z-V2-B1U-PS3	S4	114	32.6	86

Table 12. Unit Weights and Moisture Contents at Vaults 3 and 5 (Savannah River Nuclear Solutions, 2010).

Borehole-Sample No.	Layer	γ_t (lb/ft^3)	w_n (%)	γ_d (lb/ft^3)
Z-V3V5-B1-ST2	S1/2	110.0	14.0	96.6
Z-V3V5-B4-ST2	S1/2	120.8	13.9	106.1
Z-V3V5-B1-ST1	S1/2	117.2	11.7	104.9
Z-V3V5-B1-ST1	S1/2	117.2	14.2	102.6
Z-V3V5-B1-ST1	S1/2	119.6	12.4	106.4
Z-V3V5-B4-ST1	S1/2	129.1	19.1	108.4
Z-V3V5-B4-ST1	S1/2	130.1	19.1	109.2
Z-V3V5-B4-ST1	S1/2	128.7	19.8	107.4
Z-V3V5-B4-ST2	S1/2	123.2	15.8	106.4
Z-V3V5-B4-ST5	C2	93.6	69.1	55.4
Z-V3V5-B1-ST5	C2	122.0	17.9	103.5
Z-V3V5-B4-ST4	C2	103.8	50.3	69.1
Z-V3V5-B4-ST5	C2	92.8	64.3	56.5
Z-V3V5-B4-ST6	S3	118.6	29.8	91.4
Z-V3V5-B1-ST4	S3	106.9	13.3	94.4
Z-V3V5-B4-ST6	S3	115.3	33.2	86.5

Table 13. Summary of Grain Size Distribution.

Boring No.	Sample No.	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	#200 (%)	D_{50} (mm)	USCS
Z-SDU6-B01	ST02	0.6	62.4			37.0	0.209	SC
Z-SDU6-B01	FPT01	0.0	15.2			84.8		
Z-SDU6-B01	ST03	0.0	90.0			10.0	0.327	
Z-SDU6-B01	ST04	0.0	55.5	8.9	35.6	44.5	0.108	SC
Z-SDU6-B01	ST05	2.3	32.8	13.9	51.0	64.9	0.002	
Z-SDU6-B01	ST06	0.0	63.9	9.2	26.9	36.1	0.335	SC
Z-SDU6-B01	ST08	0.0	89.1			10.9	0.172	
Z-SDU6-B01	FPT02	0.0	91.4			8.6	0.305	
Z-SDU6-B01	ST11	0.0	74.0			26.0	0.246	
Z-SDU6-B02A	FPT01	0.0	75.1			24.9	0.278	
Z-SDU6-B02A	FPT02	0.0	59.8	9.2	31.0	40.2	0.131	
Z-SDU6-B02A	ST02	0.0	54.8	10.0	35.2	45.2	0.115	SC
Z-SDU6-B02B	FPT03	0.0	69.8			30.2	0.234	
Z-SDU6-B03	SS01	0.0	66.6			33.4	0.225	
Z-SDU6-B03	SS02	0.5	72.6			26.9	0.351	
Z-SDU6-B03	SS03	2.2	49.8	9.6	38.4	48.0	0.105	SC
Z-SDU6-B03	SS04	0.0	58.0			42.0	0.245	
Z-SDU6-B03	SS05	0.0	58.7			41.3	0.146	
Z-SDU6-B03	SS06	0.0	16.5			83.5		CH
Z-SDU6-B03	SS07	0.0	76.7			23.3	0.243	
Z-SDU6-B03	SS08	2.7	72.5			24.8	0.248	
Z-SDU6-B03	SS09	10.0	53.6			36.4	0.223	
Z-SDU6-B03	SS10	0.0	78.6			21.4	0.373	
Z-SDU6-B03	SS11	0.0	76.1			23.9	0.255	
Z-SDU6-B03	SS12	0.0	84.3			15.7	0.280	
Z-SDU6-B03	SS13	0.0	76.5			23.5	0.243	
Z-SDU6-B03	SS14	0.0	56.9	8.0	35.1	43.1	0.147	SC
Z-SDU6-B03	SS15	0.0	39.6			60.4		
Z-SDU6-B03	SS16	0.0	63.3	14.7	22.0	36.7	0.297	SC
Z-SDU6-B03	SS17	0.0	92.4			7.6	0.366	
Z-SDU6-B03	SS18	0.0	93.1			6.9	0.314	
Z-SDU6-B03	SS19	0.0	84.0			16.0	0.186	
Z-SDU6-B03	SS20	0.0	92.7			7.3	0.294	
Z-SDU6-B03	SS21	0.0	90.3			9.7	0.391	
Z-SDU6-B03	SS22	0.0	63.9			36.1	0.091	
Z-SDU6-B03	SS23	0.5	48.4			51.1		
Z-SDU6-B03	SS24	23.6	26.2			50.2		
Z-SDU6-B03	SS25	6.2	43.8	34.0	16.0	50.0	0.075	ML
Z-SDU6-B03	SS26	6.3	75.7	12.9	5.1	18.0	0.122	
Z-SDU6-B03	SS27	1.0	40.8			58.2		
Z-SDU6-B03	SS28	0.0	61.3			38.7	0.103	
Z-SDU6-B03	SS29	0.0	3.7			96.3		MH

Boring No.	Sample No.	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	#200 (%)	D_{50} (mm)	USCS
Z-SDU6-B03	SS30	0.0	53.0			47.0	0.098	
Z-SDU6-B03	SS31	0.0	91.4			8.6	0.352	
Z-SDU6-B03	SS33	0.0	89.7			10.3	0.254	
Z-SDU6-B03	SS34	0.0	87.8			12.2	0.153	
Z-SDU6-B04	SS01	0.3	80.3			19.4	0.520	
Z-SDU6-B04	SS02	0.2	83.1			16.7	0.222	
Z-SDU6-B04	SS03	0.8	85.8			13.4	0.228	
Z-SDU6-B04	SS04	0.0	52.8			47.2	0.137	
Z-SDU6-B04	SS05	0.0	56.4			43.6	0.156	
Z-SDU6-B04	SS06	0.0	77.2			22.8	0.342	
Z-SDU6-B04	SS07	0.0	75.5			24.5	0.338	
Z-SDU6-B04	SS08	0.0	81.2			18.8	0.361	SC
Z-SDU6-B04	SS09	0.5	80.1			19.4	0.297	
Z-SDU6-B04	SS10	0.0	87.7			12.3	0.293	
Z-SDU6-B04	SS11	0.0	92.1			7.9	0.482	
Z-SDU6-B04	SS12	0.0	88.6			11.4	0.455	
Z-SDU6-B04	SS13	0.3	87.3			12.4	0.474	
Z-SDU6-B04	SS14	0.0	83.0			17.0	0.396	
Z-SDU6-B04	SS15	0.0	68.0			32.0	0.166	
Z-SDU6-B04	SS16	0.0	86.1			13.9	0.286	
Z-SDU6-B04	SS17	0.0	84.2	7.0	8.8	15.8	0.264	
Z-SDU6-B04	SS18	0.0	76.5			23.5	0.277	
Z-SDU6-B04	SS19	0.0	91.2	4.5	4.3	8.8	0.352	SP-SM
Z-SDU6-B04	SS20	0.0	92.2			7.8	0.351	
Z-SDU6-B04	SS21	0.0	85.4			14.6	0.219	
Z-SDU6-B04	SS22	0.0	93.6			6.4	0.413	
Z-SDU6-B04	SS23	0.0	90.0			10.0	0.295	
Z-SDU6-B04	SS24	0.0	65.6			34.4	0.092	
Z-SDU6-B04	SS25	4.9	44.7			50.4		
Z-SDU6-B04	SS26	27.9	19.3	37.9	14.9	52.8	0.067	ML
Z-SDU6-B04	SS27	4.2	21.0			74.8		
Z-SDU6-B04	SS28	19.4	44.3	22.7	13.6	36.3	0.120	SC
Z-SDU6-B04	SS29	0.5	55.2			44.3	0.107	
Z-SDU6-B04	SS30	0.5	66.8			32.7	0.139	
Z-SDU6-B04	SS31	0.0	1.8			98.2		MH
Z-SDU6-B04	SS32	0.0	68.6			31.4	0.198	
Z-SDU6-B04	SS33	0.0	91.0			9.0	0.252	
Z-SDU6-B04	SS34	0.0	90.3			9.7	0.238	

Table 14. Grain Size Distribution.

Boring No.	Sample No.	Percentage Less than Sieve Size										
		5/8 in	3/8 in	1/4 in	#4	#10	#20	#40	#60	#100	#140	0.005 (mm)
Z-SDU6-B01	ST02	100	100	99.7	99.4	97.3	90.2	71.3	54.4	43.8	39.5	
Z-SDU6-B01	FPT01	100	100	100	100	100	99.5	97.5	95.0	91.4	88.0	
Z-SDU6-B01	ST03	100	100	100	100	100	99.3	76.0	24.8	11.2	10.3	
Z-SDU6-B01	ST04	100	100	100	100	99.8	98.0	92.5	75.5	61.9	49.5	35.6
Z-SDU6-B01	ST05	100	100	98.5	97.7	97.2	95.2	85.8	78.5	74.7	69.1	51.0
Z-SDU6-B01	ST06	100	100	100	100	99.9	92.9	59.5	42.8	39.5	37.6	26.9
Z-SDU6-B01	ST08	100	100	100	100	99.9	98.7	93.8	81.0	38.1	16.8	
Z-SDU6-B01	FPT02	100	100	100	100	98.7	87.0	68.2	38.3	16.5	10.4	
Z-SDU6-B01	ST11	100	100	100	100	99.7	92.8	76.0	50.8	34.2	29.1	
Z-SDU6-B02A	FPT01	100	100	100	100	97.6	85.4	68.3	45.4	29.0	26.0	
Z-SDU6-B02A	FPT02	100	100	100	100	100	99.1	90.1	75.9	55.8	43.1	31.0
Z-SDU6-B02A	ST02	100	100	100	100	99.9	97.1	84.9	70.6	55.8	48.7	35.2
Z-SDU6-B02B	FPT03	100	100	100	100	98.6	94.9	82.2	53.5	33.3	30.7	
Z-SDU6-B03	SS01	100	100	100	100	98.3	88.4	66.8	52.3	42.3	37.0	
Z-SDU6-B03	SS02	100	100	99.8	99.5	98.7	90.4	57.8	40.1	32.1	28.9	
Z-SDU6-B03	SS03	100	100	98.6	97.8	97.0	89.0	70.6	59.9	53.2	50.1	38.4
Z-SDU6-B03	SS04	100	100	100	100	99.7	89.4	61.8	50.2	45.8	43.6	
Z-SDU6-B03	SS05	100	100	100	100	100	96.6	81.7	65.3	50.6	45.1	
Z-SDU6-B03	SS06	100	100	100	100	100	99.7	97.9	95.7	91.8	87.6	
Z-SDU6-B03	SS07	100	100	100	100	98.7	87.5	60.7	50.8	33.8	26.8	
Z-SDU6-B03	SS08	100	100	98.3	97.3	93.6	81.5	64.5	50.3	35.0	28.4	
Z-SDU6-B03	SS09	100	96.7	92.6	90.0	83.0	74.1	61.7	52.0	43.3	38.7	
Z-SDU6-B03	SS10	100	100	100	100	99.6	86.2	55.6	36.2	25.7	22.4	
Z-SDU6-B03	SS11	100	100	100	100	99.7	92.6	74.7	49.0	30.0	25.5	
Z-SDU6-B03	SS12	100	100	100	100	99.9	98.6	84.5	41.0	19.2	16.6	
Z-SDU6-B03	SS13	100	100	100	100	99.7	94.4	74.8	51.4	30.6	25.1	
Z-SDU6-B03	SS14	100	100	100	100	99.7	96.4	85.9	58.3	50.2	45.3	35.1
Z-SDU6-B03	SS15	100	100	100	100	100	96.7	79.3	72.0	69.4	64.4	
Z-SDU6-B03	SS16	100	100	100	100	100	95.4	64.0	45.8	41.8	39.0	22.0
Z-SDU6-B03	SS17	100	100	100	100	99.4	90.0	57.1	32.4	11.5	8.2	
Z-SDU6-B03	SS18	100	100	100	100	99.5	91.5	66.2	36.4	10.5	7.7	
Z-SDU6-B03	SS19	100	100	100	100	99.5	96.4	85.0	67.9	36.2	20.5	
Z-SDU6-B03	SS20	100	100	100	100	99.0	87.8	66.3	41.4	15.0	9.0	
Z-SDU6-B03	SS21	100	100	100	100	98.8	84.0	54.0	30.7	15.7	11.4	
Z-SDU6-B03	SS22	100	100	100	100	99.7	95.7	91.1	89.4	83.5	61.5	
Z-SDU6-B03	SS23	100	100	99.7	99.5	99.0	98.4	97.4	96.0	91.5	72.7	
Z-SDU6-B03	SS24	96.1	82.1	77.1	76.4	71.4	68.8	67.4	66.0	62.0	55.7	
Z-SDU6-B03	SS25	100	100	96.6	93.8	84.3	78.7	75.8	71.4	64.8	57.5	16.0
Z-SDU6-B03	SS26	100	95.1	94.1	93.7	93.6	93.3	93.0	91.6	74.3	33.6	5.1
Z-SDU6-B03	SS27	100	99.0	99.0	99.0	98.4	96.0	91.0	82.4	69.3	62.3	
Z-SDU6-B03	SS28	100	100	100	100	98.5	93.6	86.7	77.8	65.1	51.0	

Boring No.	Sample No.	Percentage Less than Sieve Size										
		5/8 in	3/8 in	1/4 in	#4	#10	#20	#40	#60	#100	#140	0.005 (mm)
Z-SDU6-B03	SS29	100	100	100	100	100	99.8	99.4	98.7	98.0	97.2	
Z-SDU6-B03	SS30	100	100	100	100	99.6	98.2	93.1	81.2	60.6	51.4	
Z-SDU6-B03	SS31	100	100	100	100	99.3	92.3	59.6	33.9	14.6	9.7	
Z-SDU6-B03	SS33	100	100	100	100	100	99.7	95.0	48.6	16.9	12.0	
Z-SDU6-B03	SS34	100	100	100	100	100	99.2	93.6	75.8	48.2	18.0	
Z-SDU6-B04	SS01	100	100	99.9	99.7	97.5	79.8	39.8	29.6	23.7	20.8	
Z-SDU6-B04	SS02	100	100	99.9	99.8	99.1	91.6	72.9	55.4	32.0	22.4	
Z-SDU6-B04	SS03	100	100	99.5	99.2	98.3	90.0	72.0	54.4	29.7	19.5	
Z-SDU6-B04	SS04	100	100	100	100	99.9	94.8	84.8	72.5	51.9	48.1	
Z-SDU6-B04	SS05	100	100	100	100	99.8	94.0	83.5	71.9	48.7	44.4	
Z-SDU6-B04	SS06	100	100	100	100	99.5	83.0	55.8	43.1	29.8	23.7	
Z-SDU6-B04	SS07	100	100	100	100	99.7	85.9	58.1	41.1	29.8	25.5	
Z-SDU6-B04	SS08	100	100	100	100	99.8	88.2	57.6	35.4	23.4	19.9	
Z-SDU6-B04	SS09	100	100	99.7	99.5	97.6	88.3	71.9	39.7	22.9	20.3	
Z-SDU6-B04	SS10	100	100	100	100	99.6	95.0	79.2	37.8	17.3	13.8	
Z-SDU6-B04	SS11	100	100	100	100	99.8	88.4	41.7	19.7	11.8	9.0	
Z-SDU6-B04	SS12	100	100	100	100	98.6	80.8	46.9	29.7	17.6	13.4	
Z-SDU6-B04	SS13	100	100	99.8	99.7	97.6	85.5	43.7	24.3	17.3	14.0	
Z-SDU6-B04	SS14	100	100	100	100	97.7	71.2	52.0	36.2	23.1	18.9	
Z-SDU6-B04	SS15	100	100	100	100	99.9	98.8	91.3	62.6	47.2	36.1	
Z-SDU6-B04	SS16	100	100	100	100	100	99.1	87.3	38.4	20.2	15.8	
Z-SDU6-B04	SS17	100	100	100	100	99.9	99.8	95.8	45.1	21.3	17.5	8.8
Z-SDU6-B04	SS18	100	100	100	100	99.8	92.5	74.5	44.9	30.2	25.0	
Z-SDU6-B04	SS19	100	100	100	100	99.4	91.5	60.0	33.0	14.7	10.4	4.3
Z-SDU6-B04	SS20	100	100	100	100	98.7	85.8	59.3	33.0	13.5	9.3	
Z-SDU6-B04	SS21	100	100	100	100	99.8	98.6	93.9	62.5	19.6	15.7	
Z-SDU6-B04	SS22	100	100	100	100	98.6	81.7	51.4	26.7	11.3	7.8	
Z-SDU6-B04	SS23	100	100	100	100	99.3	89.3	66.2	42.0	19.3	12.5	
Z-SDU6-B04	SS24	100	100	100	100	100	99.9	99.7	99.3	95.2	63.2	
Z-SDU6-B04	SS25	100	96.5	95.7	95.1	93.5	92.8	92.1	90.3	84.8	69.7	
Z-SDU6-B04	SS26	90.3	73.9	72.8	72.1	70.1	69.1	68.3	67.2	64.7	59.0	14.9
Z-SDU6-B04	SS27	100	100	97.5	95.8	91.2	88.7	87.1	86.2	84.0	80.4	
Z-SDU6-B04	SS28	90.6	83.1	81.4	80.6	80.0	79.1	77.8	75.0	62.1	44.2	13.6
Z-SDU6-B04	SS29	100	100	99.7	99.5	94.3	85.6	76.7	67.2	56.2	49.8	
Z-SDU6-B04	SS30	100	100	99.7	99.5	91.9	80.1	70.8	63.1	52.8	40.0	
Z-SDU6-B04	SS31	100	100	100	100	99.9	99.8	99.7	99.5	99.2	98.8	
Z-SDU6-B04	SS32	100	100	100	100	99.4	95.5	84.3	61.6	39.3	34.0	
Z-SDU6-B04	SS33	100	100	100	100	95.7	83.5	66.8	49.5	18.6	10.8	
Z-SDU6-B04	SS34	100	100	100	100	99.8	97.4	83.0	53.8	18.9	11.8	

Table 15. Atterberg Limits and USCS at SDU 6.

Borehole No.	Layer	LL (%)	PL (%)	PI (%)	USCS
Z-SDU6-B01	S1/S2	53	24	29	SC
Z-SDU6-B02A	S1/S2	49	24	25	SC
Z-SDU6-B03	S1/S2	58	26	32	SC
Z-SDU6-B03	S1/S2	73	34	39	CH
Z-SDU6-B04	S1/S2	45	21	24	SC
Z-SDU6-B01	C2	104	30	74	SC
Z-SDU6-B03	C2	99	38	61	SC
Z-SDU6-B03	S4	92	33	59	SC
Z-SDU6-B03	S4	43	39	4	ML
Z-SDU6-B03	S4	104	56	48	MH
Z-SDU6-B01	S4	114	44	70	SC
Z-SDU6-B04	S4	43	33	10	ML
Z-SDU6-B04	S4	32	22	10	SC
Z-SDU6-B04	S4	110	51	59	MH

Table 16. Results of Consolidation Tests at SDU 6 and SDU 6/7.

Borehole No.	Depth Range (ft)	Layer	σ'_{vo} (lb/ft^2)	σ'_p (lb/ft^2)	e_o	OCR	C_c	C_r	C_c/C_r
Z-SDU6-B01	48.0 to 50.0	C2	5635	4500	1.27	0.80	0.37	0.10	3.7
Z-SD67-B01	49.0 to 51.0	C2	5750	4100	1.99	0.71	0.74	0.13	5.5
Z-SD67-B02	51.0 to 53.0	C2	5980	3700	1.25	0.62	0.42	0.07	10.6
Z-SDU6-B01	58.0 to 60.0	S3	6785	3600	1.06	0.53	0.25	0.04	6.2

Table 17. Results of Consolidation Tests at the Z-Area Saltstone Disposal Site (Vault 1) (Mueser Rutledge, 1986).

Borehole No.	Layer	σ'_{vo} (lb/ft^2)	σ'_p (lb/ft^2)	e_o	OCR	C_c	C_r	C_c/C_r
Z-219U	C2	9200	10600	1.017	1.15	0.429	0.063	6.8
Z-224U	C2	7200	15000	1.213	2.08	0.476	0.032	15
Z-225U	C2	7600	13200	1.675	1.74	1.118	0.214	5.2
Z-211U	S3a	9600	5400	1.616	0.56	0.800	0.060	13

Table 18. Results of Consolidation Tests at Vault 2 (Washington Savannah River Co., 2006).

Borehole No.	Layer	σ'_{vo} (lb/ft^2)	σ'_p (lb/ft^2)	e_o	OCR	C_c	C_r	C_c/C_r
Z-V2-B1U-ST2	S1/2	3600	7300	0.653	2.0	0.071	0.007	9.7
Z-V2-B1U-ST2a	S1/2	3600	3000	0.622	0.8	0.056	0.009	6.6
Z-V2-B1U-ST4	S1/2	5500	7200	0.609	1.3	0.101	0.008	12.7
Z-V2-B1U-ST4a	S1/2	5500	4500	0.628	0.8	0.069	0.008	8.5
Z-V2-B1U-ST5	C2	7600	8400	1.378	1.1	0.781	0.102	7.6
Z-V2-B1U-ST5a	C2	7600	7800	1.391	1.0	0.725	0.083	8.7
Z-V2-B1U-ST7	S3	10600	7200	0.571	0.7	0.071	0.012	5.8
Z-V2-B1U-PS1	S4	12600	11600	0.92	0.9	0.196	0.023	8.4
Z-V2-B1U-PS3	S4	14800	15900	0.921	1.1	0.361	0.016	23.3

Table 19. Results of Consolidation Tests at Vaults 3 and 5 (Savannah River Nuclear Solutions, 2010).

Borehole/Sample No.	Layer	σ'_{vo} (lb/ft^2)	σ'_p (lb/ft^2)	e_o	OCR	C_c	C_r	C_c/C_r
Z-V3V5-B4-ST2	S1/2	3800	7000	0.57	1.8	0.036	0.0050	7.3
Z-V3V5-B4-ST4	C2	6100	6100	1.44	1.0	0.48	0.075	6.4
Z-V3V5-B4-ST5	C2	6200	4300	1.98	0.7	0.51	0.136	3.8
Z-V3V5-B1-ST4	S3	6000	3400	0.60	0.6	0.051	0.0083	6.1
Z-V3V5-B1-ST5	S3	6300	8000	0.75	1.3	0.030	0.0083	3.6
Z-V3V5-B4-ST6	S3	7800	5000	0.81	0.6	0.725	0.083	8.7

Table 20. Results of Consolidation Tests at the S-Area DWPF (Mueser Rutledge, 1984).

Borehole No.	Layer	σ'_{vo} (lb/ft^2)	σ'_p (lb/ft^2)	e_o	OCR	C_c	C_r	C_c/C_r
47	C2	7800	9000	---	1.15	0.86	0.09	9.6
6A	C2	7000	12400	---	1.77	0.73	0.07	10
90	C2	6400	13600	---	2.12	1.23	0.05	25
7	C2	8400	13200	---	1.57	0.98	0.12	8.2
6	S3a	10800	26000	---	2.41	0.26	0.02	13

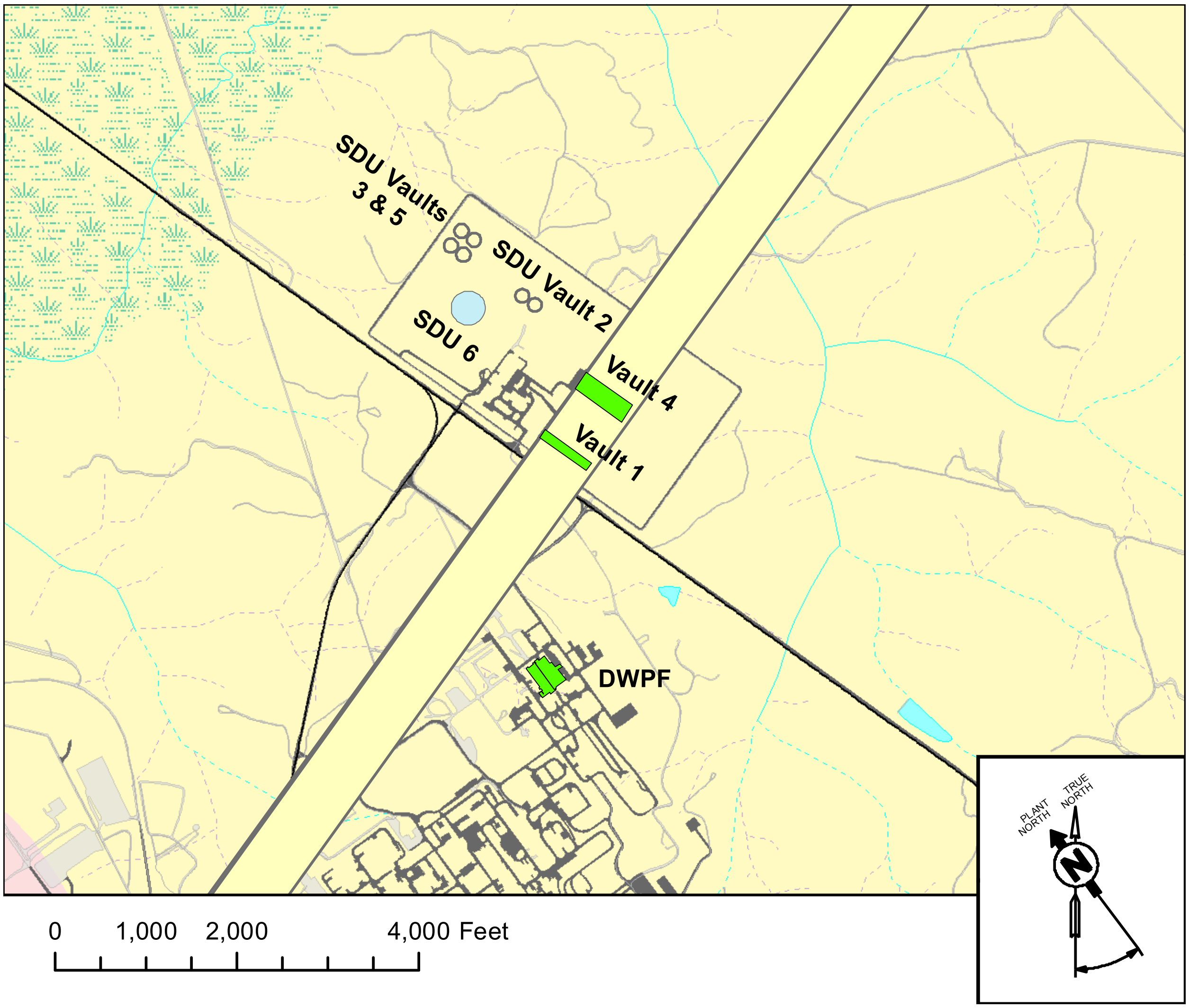

Figure 1. Z-Area Vault Sites.

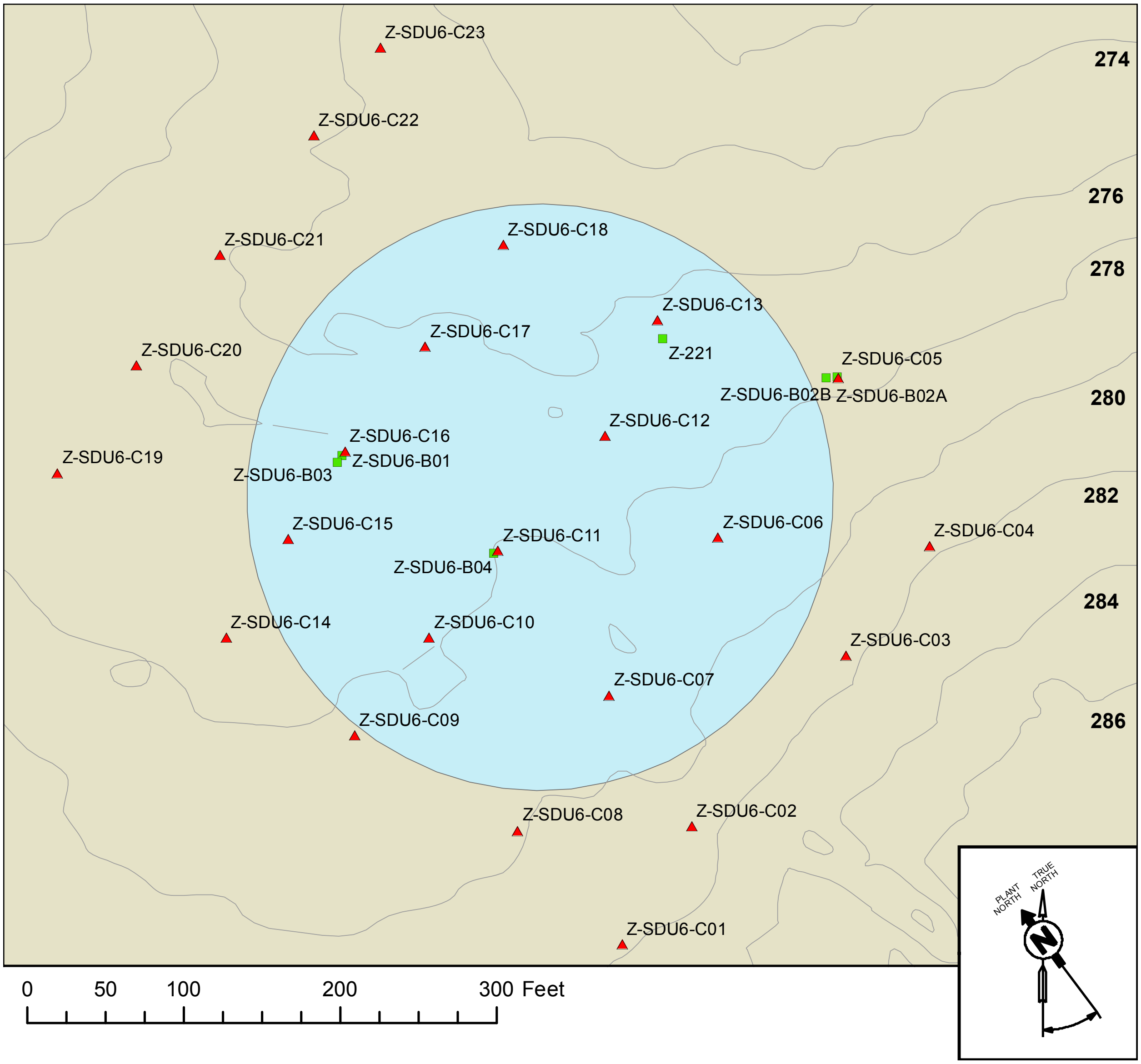

Figure 2. SDU 6 Exploration and Testing Locations.

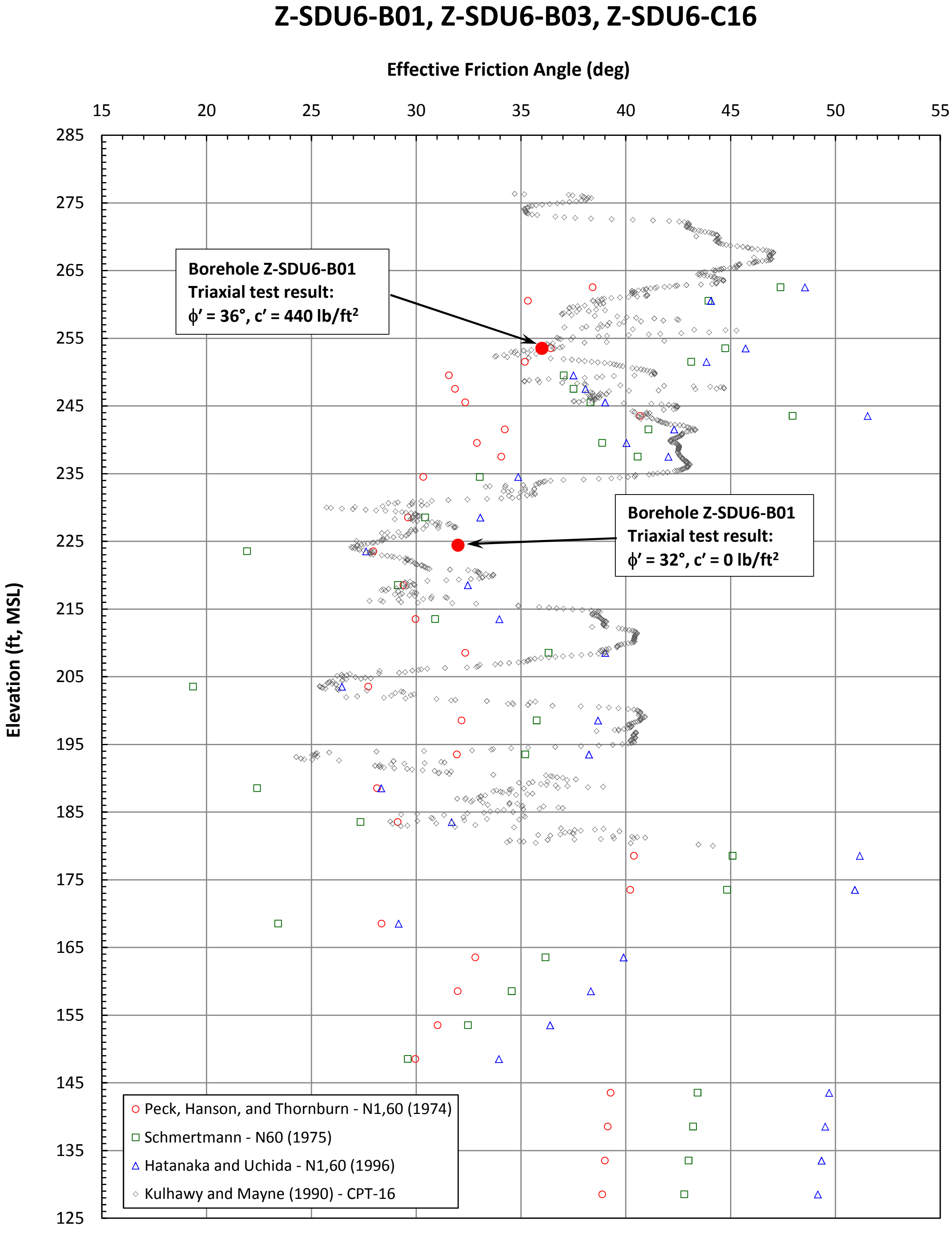

Figure 3. Relationship Between Effective Friction Angle Calculated Using Methods Based on Standard Penetration Blow Count and Cone Tip Penetration Resistance and Compared to Effective Friction Angle from Triaxial Tests.

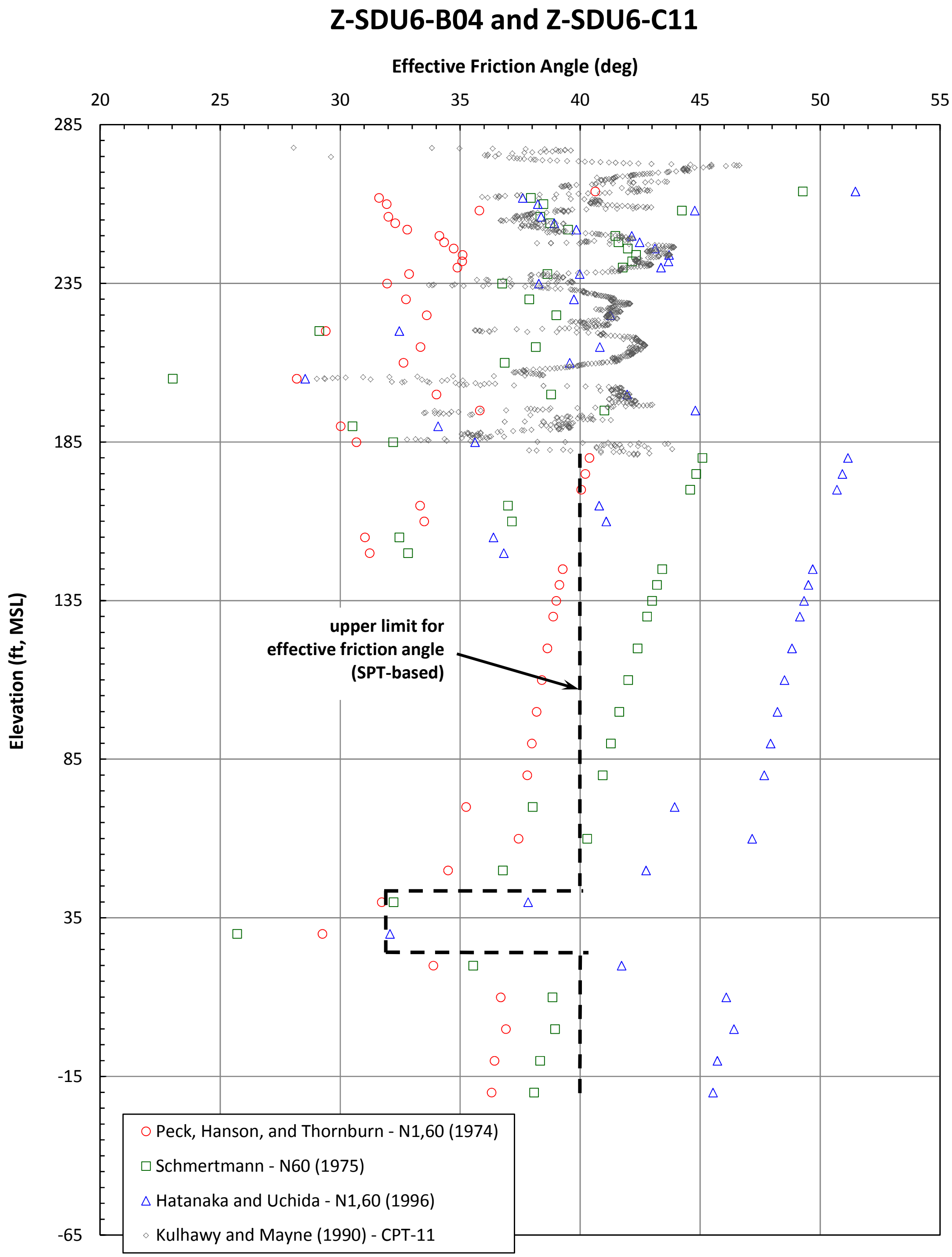

Figure 4. Effective Friction Angle Correlated to $N_{1,60}$ and Cone Penetration Tip Resistance (q_{t1}) for Deep Standard Penetration Test Borehole Showing Effective Friction Angle Envelope.

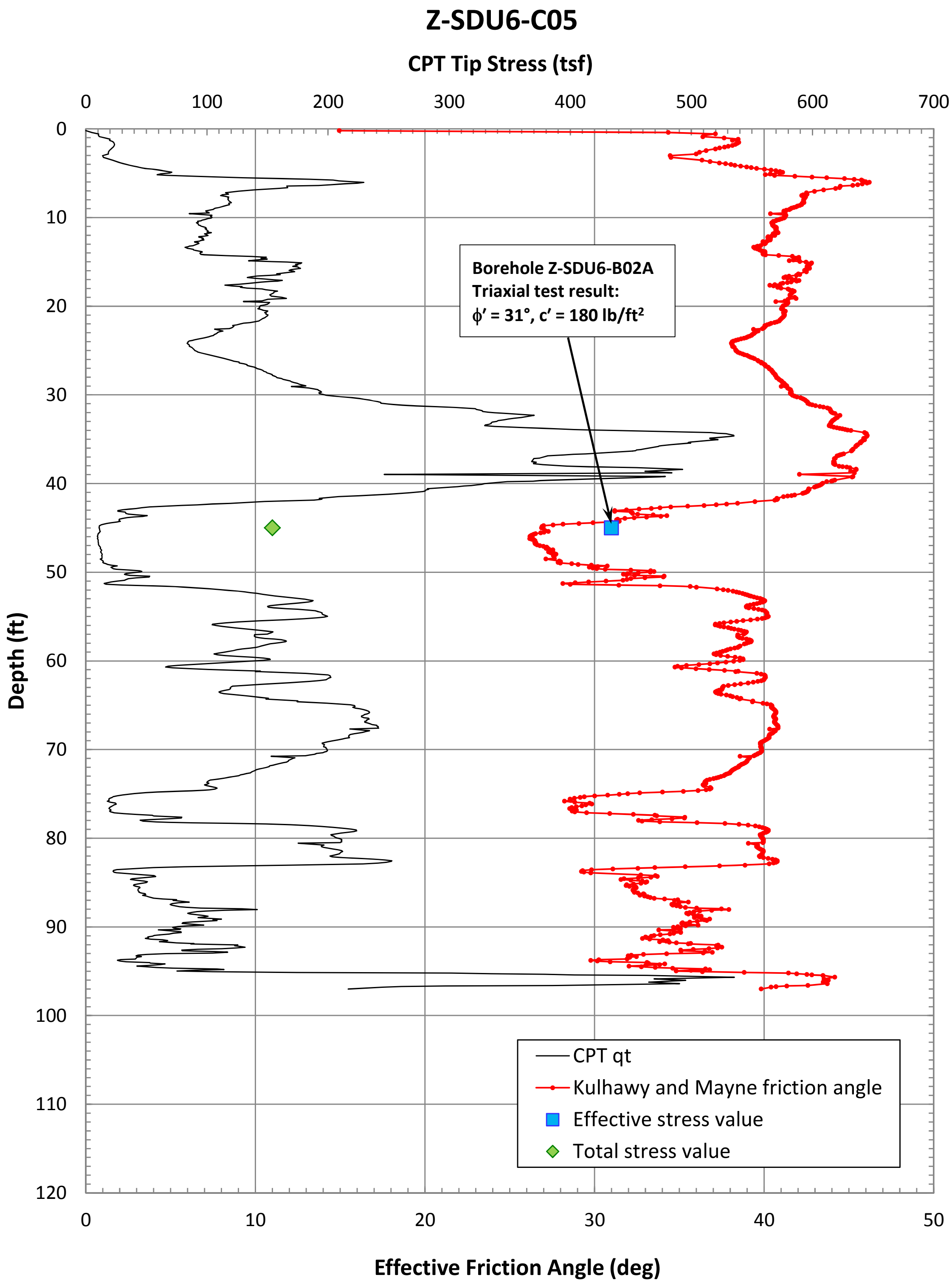

Figure 5. Relationship Between Effective Friction Angle Calculated Using Method of Kulhawy and Mayne (1990) as Compared to Effective Friction Angle from Triaxial Test.

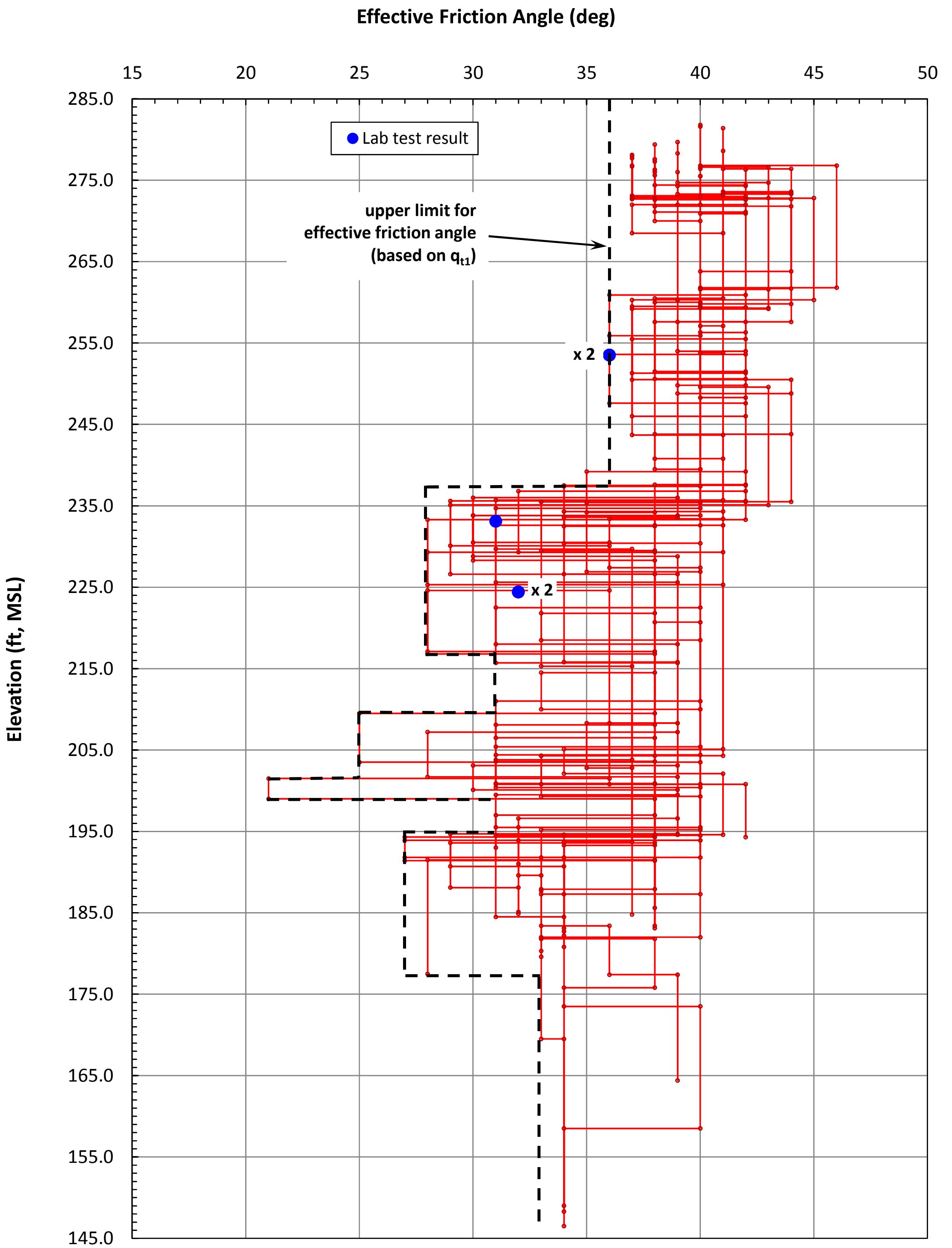

Figure 6. Effective Friction Angle Envelope Formed from Twenty-three CPTs Based on Method of Kulhawy and Mayne (1990) using q_{t1}.

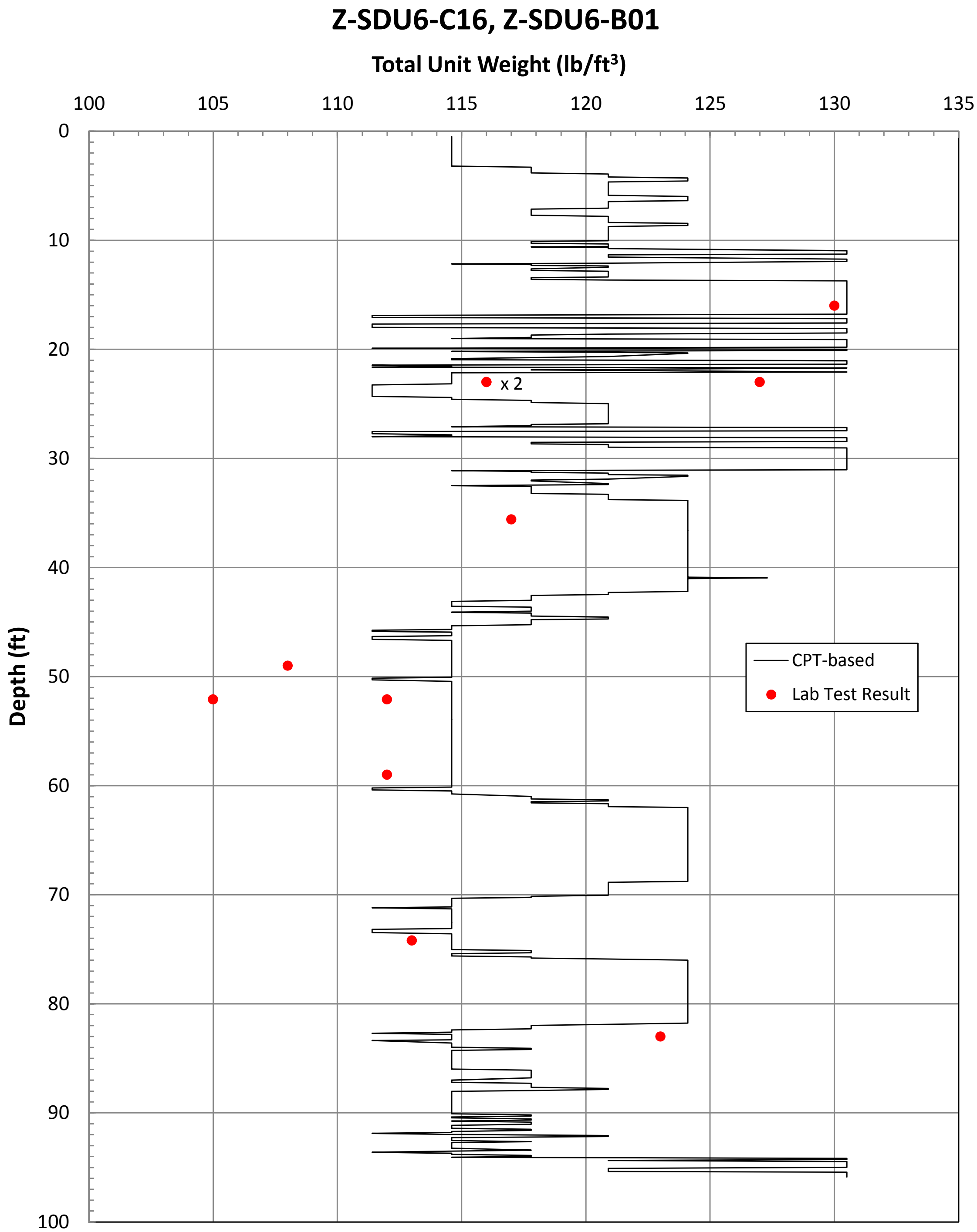

Figure 7. Total Unit Weight from Laboratory Test Results of Samples from Borehole Z-SDU6-B01 Compared to CPT-based Total Unit Weight Determined from CPT Z-SDU6-C16.

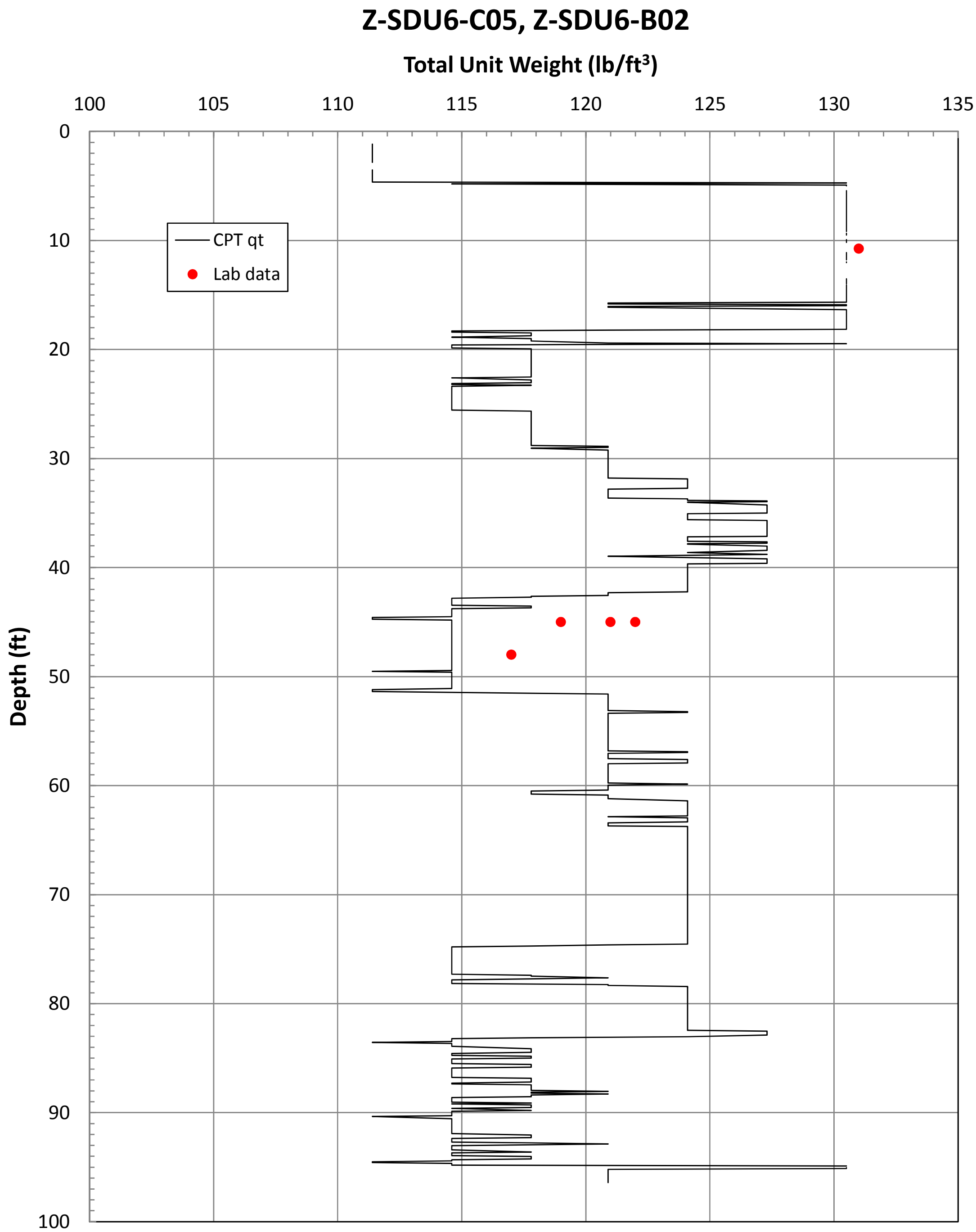

Figure 8. Total Unit Weight from Laboratory Test Results of Samples from Borehole Z-SDU6-B02 Compared to CPT-based Total Unit Weight Determined from CPT Z-SDU6-C05.

Appendix A: Boring Logs

(23 pages)

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

Savannah River NUCLEAR SOLUTIONS

BORING NUMBER Z-SDU6-B01

PAGE 1 OF 4

CLIENT Savannah River Remediation

PROJECT NAME Saltstone Disposal Unit 6

PROJECT NUMBER

PROJECT LOCATION Z-Area

DATE STARTED 12/20/11 COMPLETED 12/23/11

GROUND ELEVATION 276.6 ft HOLE SIZE 6 inches

DRILLING CONTRACTOR SAEDACCO

COORDINATES:NORTH 77771.3 EAST 66309.1

DRILLING METHOD Mud rotary

LOGGED BY M. Hasek CHECKED BY [signature]

NOTES UD

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
0						Mud rotary drill.		275
5								270
10								265
	ST-01		9/17					
15						Mud rotary drill.		
	ST-02		18/19					260
						Mud rotary drill.		
20								255
	FP-01		24/24					
25						Mud rotary drill.		250
30								245
35								

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:17 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B01

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
35	ST-03		26/16					
						Mud rotary drill.		240
40								
								235
45								
								230
50	ST-04		27.5/24					
						Mud rotary drill.		
	ST-05		27/24					225
						Mud rotary drill.		
55								
								220
60	ST-06		27/24					
						Mud rotary drill.		
								215
65								
								210
70								
	ST-07		9/24					205
						Mud rotary drill.		
75	ST-08		14/24					

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B01

CLIENT Savannah River Remediation

PROJECT NAME Saltstone Disposal Unit 6

PROJECT NUMBER

PROJECT LOCATION Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
75						Mud rotary drill.		200
80								195
	FP-02		24/24					
85						Mud rotary drill.		190
90								185
	ST-09		0/7			Mud rotary drill.		
95								180
100								175
105								170
110								165
115								

(Continued Next Page)

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B01

CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
115	ST-10		8.5/8					
						Mud rotary drill.		160
120								
								155
125								
	ST-11		20/18					150
						Mud rotary drill.		
						Bottom of borehole at 128.0 feet.		
								145
								140
								135
								130
								125

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B02A

CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 12/27/11 COMPLETED 12/29/11
GROUND ELEVATION 278 ft HOLE SIZE 6 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES:NORTH 77625.3 EAST 66594.8
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES UD

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
0						Mud rotary drill.		
5								275
10	ST-01		4/4					270
	ST-02		6/6			Mud rotary drill.		
						Mud rotary drill.		
15								265
	ST-03		3/4			Mud rotary drill.		
	ST-04		2.5/3			Mud rotary drill.		
20								260
	ST-05		4/7.5			Mud rotary drill.		255
25								
30								250
35								245

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:17 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS™

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B02A

PAGE 2 OF 2

CLIENT Savannah River Remediation

PROJECT NAME Saltstone Disposal Unit 6

PROJECT NUMBER

PROJECT LOCATION Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
35						Mud rotary drill. *(continued)*		
								240
40								
								235
45	FP-01		23/24					
						Mud rotary drill.		
	FP-02		24/24					230
50						Mud rotary drill.		
								225
55								
	ST-06		4/6					220
						Mud rotary drill.		
60								
								215
65								
								210
70								
								205
75								

Bottom of borehole at 75.0 feet.

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B02B

CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 12/29/11 **COMPLETED** 01/05/12
GROUND ELEVATION 278.1 ft **HOLE SIZE** 6 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77629.2 **EAST** 66588.9
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek **CHECKED BY** [signature]
NOTES UD

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
0						Mud rotary drill.		
								275
5								
								270
10								
								265
15								
								260
20								
								255
25								
								250
30								
								245
35								

(Continued Next Page)

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B02B

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
35						Mud rotary drill.		
								240
40								
								235
45								
								230
50								
								225
55								
								220
60								
								215
65								
								210
70								
								205
75								

(Continued Next Page)

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B02B

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
75	FP-01		24/24					
						Mud rotary drill.		200
80								
								195
85	FP-02		4/24					
						Mud rotary drill.		190
90								
								185
95								
								180
100								
								175
105								
								170
110								
								165
115								

(Continued Next Page)

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B02B

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
115						Mud rotary drill. *(continued)*		
120								160
125								155
130								150
						Bottom of borehole at 131.0 feet.		145
								140
								135
								130
								125

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

Savannah River NUCLEAR SOLUTIONS

BORING NUMBER Z-SDU6-B03

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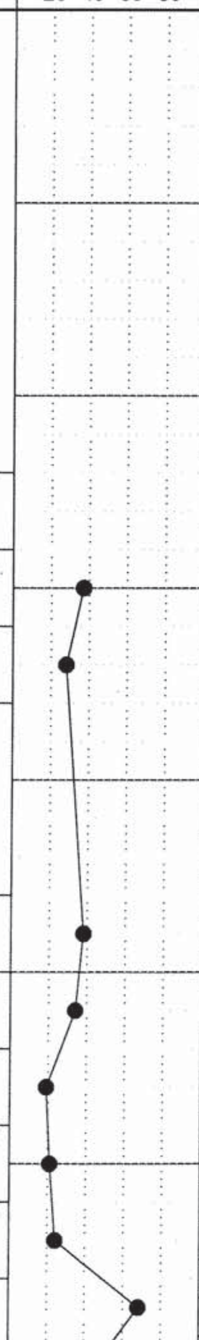
CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 01/05/12 COMPLETED 01/11/12
GROUND ELEVATION 276.5 ft HOLE SIZE 4 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77769.6 EAST 66304.5
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES SPT

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
0						Mud rotary drill.		275
5								270
10								265
	SS-01		14/24			Red silty Sand (SM), sand fine to medium, subangular to subround, low plasticity, moist, dense, with few brownish yellow mottles.		
15	SS-02		18/24	10-17-20-23 (37)		Red silty Sand (SM), sand fine to medium, subangular to subround, low plasticity, moist, medium dense.		
	SS-03		19/24	9-12-16-23 (28)		Red sandy Silt (ML), sand portion fine to medium and subangular to subround, med. plasticity, moist, medium dense.		260
20						Mud rotary drill.		255
25	SS-04		20/24	10-19-19-24 (38)		Yellowish red clayey Silt (MH) (upper 7 in), high plasticity, trace sand (fine to medium, subangular), moist, dense; Yellowish red silty Sand (SM) (lower 13 in), fine to medium, subangular, low plasticity, moist, dense.		
	SS-05		21/24	10-18-16-19 (34)		Red clayey Silt (MH) (upper 3 in), high plasticity, moist; Red sandy Silt (ML) (lower 18 in), sand fine and subangular, low plasticity, moist, hard, brownish yellow mottle bottom 1 in.		250
	SS-06		21.5/24	9-7-12-17 (19)		Red sandy Silt (ML) (upper 8 in), sand fine to medium and subangular, moist, very stiff; Reddish yellow clayey Silt (MH) (lower 13 in), high plasticity, moist, very stiff.		
30	SS-07		18/24	5-8-13-17 (21)		Reddish yellow silty Sand (SM) (upper 14 in), sand subangular and fine with trace medium, subangular, low plasticity, moist, very stiff; Red sandy Silt (SM) (lower 4 in), very low plasticity, moist.		245
	SS-08		19/24	12-12-12-12 (24)		Reddish yellow silty Sand (SM), sand subangular and fine, very low plasticity, moist, medium dense.		
35	SS-09		18/18	10-18-50 (68)		Reddish yellow silty Sand (SM) (upper 5 in), fine to medium, subangular, low plasticity, moist; Red sandy Clay (CL) (upper mid 3 in), high plasticity, moist; white fat Clay (CH) (lower mid 7 in), high plasticity,		



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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

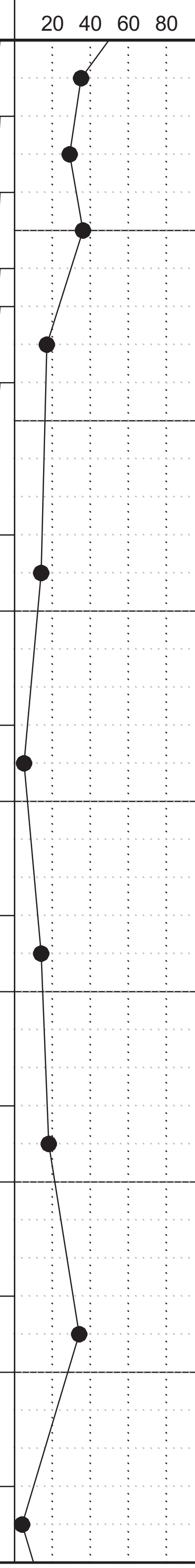
BORING NUMBER Z-SDU6-B03

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Material Description	Elevation (ft)
35	SS-10	X	19/24	10-15-20-27 (35)	Clay (CH) (lower 4 in), little fine to medium sand and subangular, high plasticity, moist.	240
	SS-11	X	20/24	10-13-16-16 (29)	Reddish yellow silty Sand (SM) (upper 2 in), fine to medium, subangular, low plasticity, moist; white sandy Clay (CL/CH) (upper mid 2 in), sand fine to medium and subangular, high plasticity, moist; Red with white alternating layers silty Sand (SM) (lower 15 in), fine to medium, subangular, low plasticity, moist, dense.	
40	SS-12	X	20/24	11-15-21-27 (36)	Red and yellowish red poorly graded Sand (SP) (lower 17.5 in), fine with trace medium, subangular, nonplastic, moist, medium dense; white Clay (CL/CH) (upper 2.5 in), little sand (fine, subangular), high plasticity; moist.	
					Red silty Sand (SM), fine, subangular, nonplastic grading to reddish yellow silty sand with lower silt content with depth; moist, dense.	235
	SS-13	X	13/24	7-7-10-11 (17)	Mud rotary drill.	
45					Reddish yellow silty Sand (SM) (upper 3 in), sand fine and subangular, low plasticity, moist, medium dense; Red silty Sand (SM) (lower 10 in), sand fine and subangular, medium plasticity, moist, medium dense.	
					Mud rotary drill.	230
50	SS-14	X	24/24	5-6-8-12 (14)	Yellow fat Clay (CH), high plasticity, moist, few very fine sand, stiff.	
					Mud rotary drill.	225
55	SS-15	X	24/24	2-2-3-6 (5)	Light greenish gray interlayered fat Clay (CH) (high plasticity, moist, no sand) with clayey Sand (SC) grading to sandier clay with depth (CL) (lower 10 in), sand fine to medium and subangular to subround, moist, medium soft.	
					Mud rotary drill.	220
60	SS-16	X	24/24	5-7-7-8 (14)	Light greenish gray fat Clay (CH), high plasticity, moist; grading to light greenish gray clayey Sand (SC) below 12 inches, fine to medium, subangular, moist, stiff.	
					Mud rotary drill.	215
65	SS-17	X	17/24	5-7-11-11 (18)	Light yellowish brown poorly graded Sand (SP), fine (mostly) to medium, subangular, non-plastic, wet, few black inclusions throughout up to 5 mm, medium dense.	
					Mud rotary drill.	210
70	SS-18	X	19/24	15-15-19-23 (34)	Yellowish red poorly graded Sand (SP) grading to reddish yellow with depth, fine (mostly) to medium, subangular, non-plastic, trace silt, wet, dense.	
					Mud rotary drill.	205
75	SS-19	X	24/24	2-2-2-3 (4)	Yellowish brown poorly graded Sand (SP) (upper 13 in), fine to medium, subangular to subrounded, nonplastic, wet, very loose, few pale yellow zones to 25 mm; grading to red clayey Sand (SC) (lower 11 in), sand fine to	

Blow Count (blows/ft)



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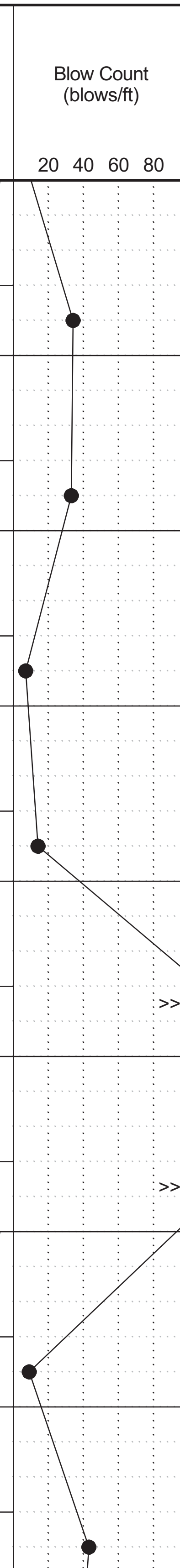
Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B03

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Elevation (ft)
75						medium and subangular to subround, low plasticity, wet, very loose. Mud rotary drill.	200
80	SS-20	X	18/24	3-13-21-32 (34)		Yellow poorly graded Sand (SP), fine, trace medium sand, little silt, nonplastic, wet, dense; few black zones (6 mm to 12 mm) throughout upper 11 in, hard zone 9 to 10.5 in from bottom.	
						Mud rotary drill.	195
85	SS-21	X	16/24	15-16-17-13 (33)		Strong brown well-graded Sand (SW), fine to medium, subangular to subround, trace fines, nonplastic, wet, dense, lower 13 in pale yellow with few black areas up to 8 mm.	
						Mud rotary drill.	190
90	SS-22	X	24/24	3-3-4-6 (7)		Pale yellow Silt (MH), medium to high plasticity, trace clay, wet, medium soft.	
						Mud rotary drill.	185
95	SS-23	X	24/24	9-7-7-7 (14)		Pale yellow clayey Silt (ML/MH), little sand, fine to coarse, angular to subangular; few gravel, angular to subangular up to 25 mm, hard; wet, weak HCl, medium plasticity, stiff.	
						Mud rotary drill.	180
100	SS-24	X	11/11.5	23-104/6"		Pale yellow clayey Silt (MH), little sand, fine to coarse, angular to subangular; few white gravel, angular to subangular up to 35 mm, hard (silica cementation ?); wet, weak HCl, medium plasticity, very dense.	
						Mud rotary drill.	175
105	SS-25	X	17/17	21-47-50/5"		Pale yellow well-graded Sand (SW) (upper 5 in), fine to medium, clean, nonplastic, wet. Pale yellow Silt (ML) (lower 14 in) with trace white gravel, gravel subangular, weak HCl, hard, few sand; rock in tip of spoon, angular, hard, cemented silt/very fine sand.	
						Mud rotary drill.	170
110	SS-26	X	17/24	6-5-4-9 (9)		Pale yellow to very pale brown silty Sand (SM), sand fine, low plasticity, wet, loose; one inch rock layers at 7 and 12 inches from bottom.	
						Mud rotary drill.	165
115	SS-27	X	24/24	11-19-24-46 (43)		Greenish gray silty Sand (SM), fine; white shell fragments, fine to medium, 25% of soil, moderate HCl; very low plasticity, moist, dense.	



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BORING NUMBER Z-SDU6-B03

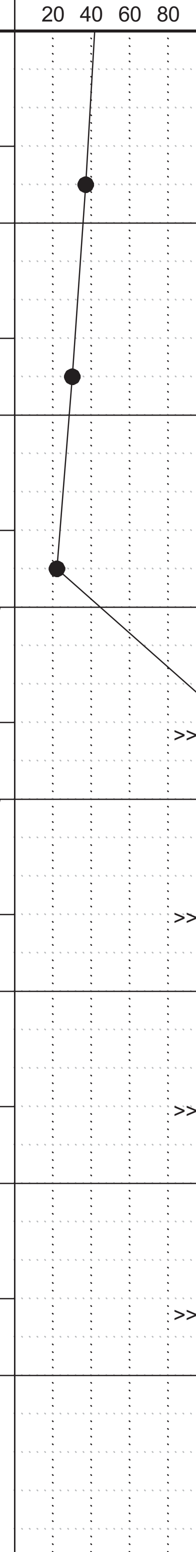
Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Elevation (ft)
115						Mud rotary drill.	160
120	SS-28		24/24	17-18-19-26 (37)		Greenish gray silty Sand (SM), fine; white shell fragments, 90% of soil at top grading to 5% at bottom, weak HCl; very low plasticity, moist, dense; grades to dark greenish gray towards bottom.	
						Mud rotary drill.	155
125	SS-29		24/24	10-13-17-40 (30)		Dark greenish gray fat Clay (CH), high plasticity, trace fine sand, moist, very stiff.	
						Mud rotary drill.	150
130	SS-30		24/24	9-10-12-18 (22)		Greenish black silty fine Sand (SM) grading to dark greenish gray fat Clay with depth; upper sand angular to subangular, low plasticity, moist, medium dense/very stiff, grading to high plasticity with trace fine sand with depth, moist, trace mica throughout.	
						Mud rotary drill.	145
135	SS-31		8/8	63-50/2"		Greenish black well graded Sand (SW) with areas of greenish gray Sand (SW), trace silt, well-graded, sand fine to medium and angular to subangular, wet, very dense; fat Clay (CH) (upper 1 in) with dark greenish gray Gravel piece, 30 mm, subangular.	
						Mud rotary drill.	140
140	SS-32		0/2	50/2"		No recovery. Very dense.	
						Mud rotary drill.	135
145	SS-33		0/2.5	50/3"		Dark greenish gray, poorly graded fine Sand, trace silt, angular to subangular, nonplastic, wet (sample from shoe), very dense.	
						Mud rotary drill.	130
150	SS-34		10/10	54-50/4"		Gray poorly graded Sand (SP) (lower 4 in), fine, angular to subangular, nonplastic, wet, very dense; Very dark gray fat Clay (CH) (mid 4 in), high plasticity, wet, hard, trace fine sand; upper 2 in waste soil.	
155						Mud rotary drill.	125

Blow Count (blows/ft)



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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B03

CLIENT Savannah River Remediation

PROJECT NAME Saltstone Disposal Unit 6

PROJECT NUMBER

PROJECT LOCATION Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
155						Mud rotary drill. *(continued)*		120
						Bottom of borehole at 157.0 feet.		115 110 105 100 95 90 85

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS™

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B04

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CLIENT Savannah River Remediation

PROJECT NAME Saltstone Disposal Unit 6

PROJECT NUMBER

PROJECT LOCATION Z-Area

DATE STARTED 01/11/12 COMPLETED 01/26/12

GROUND ELEVATION 277.9 ft HOLE SIZE 4 inches

DRILLING CONTRACTOR SAEDACCO

COORDINATES: NORTH 77663.9 EAST 66351.1

DRILLING METHOD Mud rotary

LOGGED BY M. Hasek CHECKED BY [signature]

NOTES SPT

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
0						Mud rotary drill.		
								275
5								
								270
10								
								265
15	SS-01		18/24	17-22-23-20 (45)		Red silty well graded Sand (SW-SM), mostly fine sand, little medium sand, subangular, well graded, moist, dense.		
	SS-02		15/24	7-8-7-9 (15)		Red sandy Silt (ML), trace clay, fine sand subangular, low plasticity; upper 4 in trace subround medium sand, moist, medium dense.		
								260
20	SS-03		13/24	6-6-11-18 (17)		Red silty Sand (SM), upper 2 in medium sand, subround, nonplastic, moist; lower 11 in silty poorly graded Sand (SP-SM), fine sand, angular to subangular, nonplastic, moist, medium dense.		
	SS-04		20/24	15-15-18-24 (33)		Red clayey, sandy Silt (MH) (lower 18 in), little sand, little clay, sand fine to medium and subangular, medium plasticity, moist, hard, upper 2 in preferentially sorted during SPT.		
	SS-05		18/24	8-9-10-15 (19)		Red clayey Silt (MH), few sand fine to medium and subangular to subround, medium plasticity, moist, very stiff, few yellow mottles, yellow layer from 12 to 15 in above bottom.		255
25	SS-06		19/24	8-10-11-15 (21)		Red sandy Silt (ML), few clay, some sand fine to medium and subangular to subround, medium plasticity, moist, very stiff, few yellow mottles.		
	SS-07		18/24	8-11-13-17 (24)		Red silty poorly graded Sand (SP-SM), trace clay, medium sand, poorly graded, subangular to subround, low plasticity, few yellow mottles, moist, medium dense.		
								250
30	SS-08		16/24	7-15-16-18 (31)		Red silty Sand (SM), some silt, trace clay, fine to medium sand subangular to subround, low plasticity, few yellow mottles, moist, dense.		
	SS-09		18/24	12-15-18-31 (33)		Red silty Sand (SM), some silt, trace clay, fine to medium sand subangular to subround, low plasticity, few yellow mottles, moist, dense.		
	SS-10		14/24	11-17-19-27 (36)		Red silty Sand (SM) grading to yellowish red poorly graded Sand (SP) with depth, sand fine and angular to subangular, trace fines, nonplastic, moist, dense.		245
35			15/24	14-17-22-30				

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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

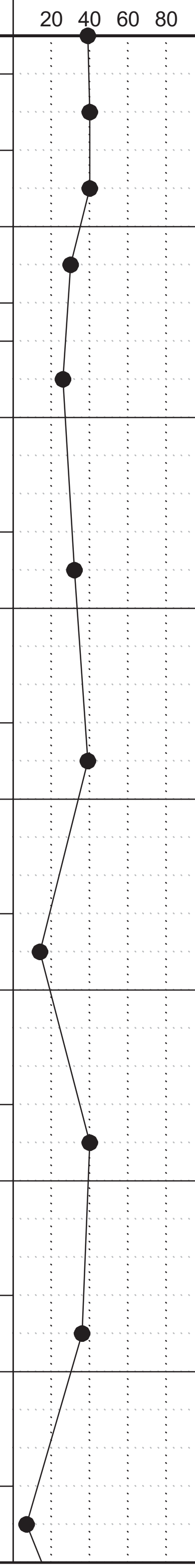
BORING NUMBER Z-SDU6-B04

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Elevation (ft)
35	SS-11	X	15/24	(39)		Reddish yellow poorly graded Sand (SP), medium sand, subangular to subround, trace fine sand, trace silt, nonplastic, moist, dense. *(continued)*	
	SS-12	X	12/24	13-19-21-26 (40)		Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, dense.	240
40	SS-13	X	10/24	6-17-23-31 (40)		Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, dense.	
	SS-14	X	15/24	16-12-18-24 (30)		Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, medium dense; Dark red at 0 to 3 in from bottom and 5 to 5.5 in from bottom.	
						Mud rotary drill.	235
45	SS-15	X	15/24	9-13-13-15 (26)		Reddish yellow sandy Clay (CL), fine sand, subangular to subround, trace silt, low plasticity, moist, very stiff; upper 2 in and lower 3 in yellow fat Clay (CH), few fine sand.	
						Mud rotary drill.	230
50	SS-16	X	12/24	11-14-18-26 (32)		Brownish yellow clayey poorly graded Sand (SP-SC), fine sand, angular to subangular, little clay, low plasticity, moist, dense; sandy clay peds throughout up to 8 mm.	
						Mud rotary drill.	225
55	SS-17	X	13/24	13-17-22-30 (39)		Brownish yellow poorly graded Sand (SP), fine sand, subangular, trace clay, nonplastic, moist, dense; sandy clay peds throughout up to 10 mm.	
						Mud rotary drill.	220
60	SS-18	X	18/24	9-7-7-20 (14)		Yellow clayey poorly graded Sand (SP-SC), fine sand, angular to subangular, low plasticity, grading to sandy Clay with depth (CL), medium plasticity, moist, medium dense/stiff.	
						Mud rotary drill.	215
65	SS-19	X	14/24	14-17-23-31 (40)		Brownish yellow poorly graded Sand (SP), fine to medium sand, angular to subangular, trace clay, nonplastic, moist, dense.	
						Mud rotary drill.	210
70	SS-20	X	12/24	12-16-20-26 (36)		Brownish yellow silty poorly graded Sand (SP-SM), fine (mostly) to medium sand, subangular, very low plasticity, wet, dense; lower 2.5 in dark yellowish brown, mostly fine sand, subangular.	
						Mud rotary drill.	205
75	SS-21	X	24/24	5-2-5-3 (7)		Dark brownish gray silty poorly graded Sand (SP-SM) (upper 4 in), sand fine to medium, subangular, nonplastic, wet; Dark gray fat Clay (CH) (13 to 16 in from bottom), trace fine sand, high plasticity, wet; Brownish yellow sandy	

Blow Count (blows/ft)



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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

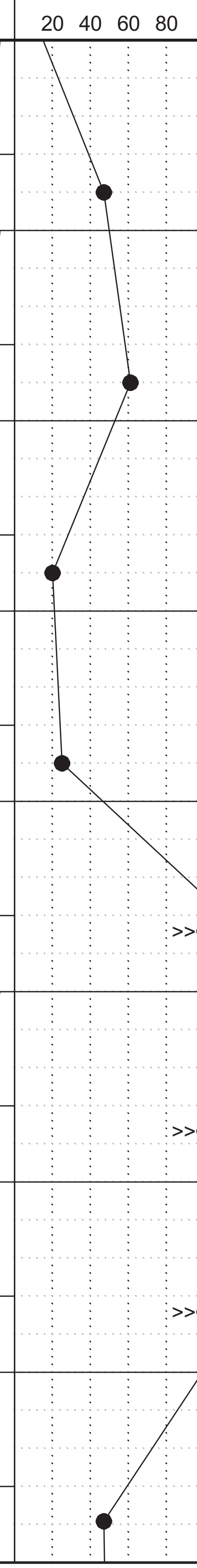
BORING NUMBER Z-SDU6-B04

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Elevation (ft)
75						Clay (CL) (lower 13 in), few fine sand, angular to subangular, high plasticity, wet, loose/medium soft.	
						Mud rotary drill.	200
80	SS-22		18/24	12-20-27-44 (47)		Brownish yellow poorly graded Sand (SP) (upper 3 in), medium, angular, nonplastic, wet; Pale yellow to brownish yellow poorly graded Sand (SP) (middle 12 in), fine to medium sand, angular to subangular, nonplastic, wet, dense; Weak red poorly graded Sand (SP) (lower 3 in), fine to medium, angular to subangular, nonplastic, wet.	
						Mud rotary drill.	195
85	SS-23		13/24	18-28-33-30 (61)		Brownish yellow to pale yellow poorly graded Sand (SP), fine (mostly) to medium, subangular to subround, nonplastic, wet, very dense.	
						Mud rotary drill.	190
90	SS-24		24/24	8-8-12-17 (20)		Pale yellow clayey Silt (ML/MH), few clay, moderatetly plastic, wet, very stiff, weak HCl Rx; trace white gravel, subangular, very hard, up to 25 mm.	
						Mud rotary drill.	185
95	SS-25		24/24	11-13-12-26 (25)		Pale brown clayey Silt (ML/MH), few sand, moderatetly plastic, wet, very stiff, weak HCl Rx; fractured rock and few gravel, very hard, angular to subangular, very hard, up to 25 mm.	
						Mud rotary drill.	180
100	SS-26		10/10	22-50/4"		Pale yellow clayey Silt (MH), medium plasticity, very weak HCl Rx, moist, hard; white rock layer from 5 to 6.5 in from bottom, very hard arenaceous carbonate, strong HCl Rx; few white gravel, subangular to subround, very hard.	
						Mud rotary drill.	175
105	SS-27		21/16	9-22-50/4"		Pale yellow clayey Silt (MH), medium to high plasticity, weak to strong HCl Rx, moist, hard; tip packed with hard, weathered rock (2 in).	
						Mud rotary drill.	170
110	SS-28		10/10	29-50/4"		Greenish gray clayey Silt (ML/MH), medium to high plasticity, strong HCl Rx, moist, hard; Greenish gray rock 1 in thick from 4 to 5 in from bottom, fractured, hard, weak HCl Rx.	
						Mud rotary drill.	165
115	SS-29		24/22	12-19-28-50/4" (47)		Greenish gray clayey Sand (SC), mostly sand-sized white and dark brown shell fragments (fragments up to 5 mm), little clay, medium plasticity, medium to strong HCl Rx, moist, dense.	

Blow Count (blows/ft)



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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

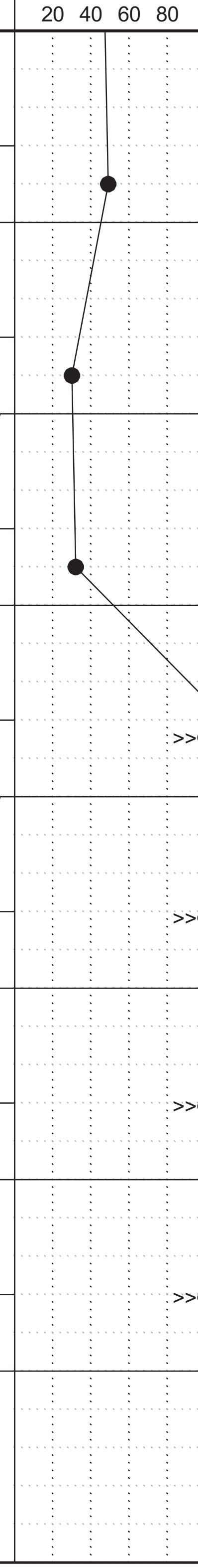
BORING NUMBER Z-SDU6-B04

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Elevation (ft)
115						Mud rotary drill.	
120	SS-30		24/24	14-21-28-50 (49)		Greenish gray clayey Sand (SC), mostly sand-sized white and dark brown shell fragments (fragments up to 5 mm), little clay, medium plasticity, medium to strong HCl Rx, moist, dense; light greenish gray upper 11 in.	160
						Mud rotary drill.	
125	SS-31		24/24	8-10-20-48 (30)		Greenish black sandy Clay (CL) (upper 12 in), trace silt; some sand, mostly fine and angular, few medium subangular; silty laminations < 3 mm thick from 11 to 15 in from bottom, high plasticity, moist, very stiff; Dark greenish gray sandy Clay (CH) (lower 12 in), high plasticity, moist, very stiff.	155
						Mud rotary drill.	
130	SS-32		24/24	8-14-18-23 (32)		Greenish black sandy Clay (CL) (upper 12 in); some fine angular sand, few subangular to subround medium sand, medium plasticity, moist, hard.	150
						Mud rotary drill.	
135	SS-33		11/11	21-50/5"		Dark greenish gray sandy Clay (CL/CH) (upper 2 in), high plasticity, wet; Dark greenish gray well graded Sand (SW) (lower 9.5 in), mostly subangular fine sand, few subround medium sand, trace clay, nonplastic, wet, very dense.	145
						Mud rotary drill.	
140	SS-34		2/4	50/4"		Greenish gray well graded Sand (SW), trace clay, fine sand, angular to subangular, nonplastic, wet, very dense.	140
						Mud rotary drill.	
145	SS-35		0/2	50/2"		Dark greenish gray poorly graded Sand (SP), mostly subangular fine sand, few subangular to subround medium sand, trace silt, nonplastic, wet, very dense.	135
						Mud rotary drill.	
150	SS-36		0/2	50/2"		Dark gray poorly graded Sand (SP), fine sand, subangular, nonplastic, wet, very dense.	130
						Mud rotary drill.	
155							125

Blow Count (blows/ft)



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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B04

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
155						Mud rotary drill. *(continued)*		
	SS-37		3/4	50/4"		Greenish black well graded Sand (SW), fine to medium sand, subangular, trace silt, nonplastic, wet, very dense.	>>	120
160						Mud rotary drill.		
								115
165								
	SS-38		0/3	50/3"		Grayish brown poorly graded Sand (SP), fine sand, angular to subangular, trace medium sand, trace silt, nonplastic, wet, very dense.	>>	110
170						Mud rotary drill.		
								105
175								
	SS-39		2/4	50/4"		Black well graded silty Sand (SW-SM), fine to medium sand, subangular to subround; little silt, trace clay, nonplastic, wet, very dense.	>>	100
180						Mud rotary drill.		
								95
185								
	SS-40		8/11	50-50/5"		Gray poorly graded Sand (SP), fine to medium, angular to subangular, nonplastic, wet, black inclusions (lignite?) up to 30% of sample, very dense.	>>	90
190						Mud rotary drill.		
								85
195								

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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B04

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6
PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
195						Mud rotary drill. *(continued)*		
	SS-41		0/2	50/2"		Dark grayish brown poorly graded Sand (SP), medium, subangular, nonplastic, wet, very dense.	>>	80
200						Mud rotary drill.		75
205								70
	SS-42		11/18	47-27-50 (77)		Greenish gray poorly graded Sand (SP), medium sand, subangular; little fine sand, angular to subangular; nonplastic, wet, very dense.		
210						Mud rotary drill.		65
215								60
	SS-43		6/10	32-50/4"		Dark greenish gray poorly graded Sand (SP), medium, subangular; little fine sand, subangular; nonplastic, wet, very dense, slightly sulfurous; lower 1 in cohesive, medium sand.	>>	
220						Mud rotary drill.		55
225								50
	SS-44		16/22	29-26-46-50/4" (72)		Dark gray poorly graded Sand (SP), medium sand, subangular; trace fine sand, nonplastic, wet, very dense; dark gray clayey poorly graded Sand (SP-SC), 7.5 to 10 in from bottom, medium sand, subangular, little clay, trace fine sand, low plasticity.		
230						Mud rotary drill.		45
235								

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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

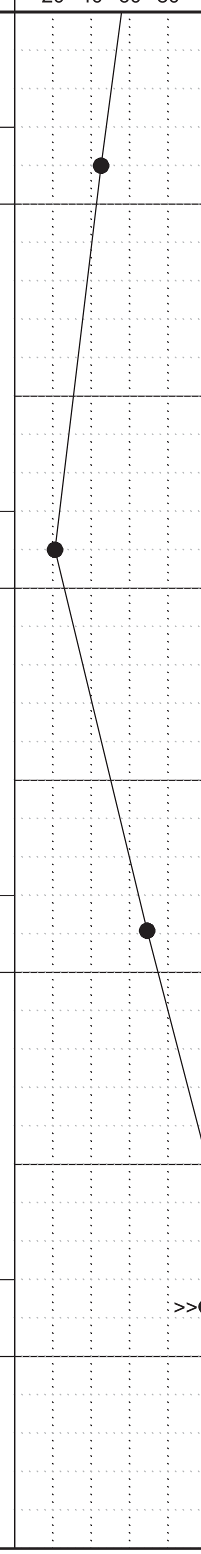
BORING NUMBER Z-SDU6-B04

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Elevation (ft)
235						Mud rotary drill. *(continued)*	
240	SS-45	X	0/24	12-18-27-50 (45)		Dark gray sandy Silt (ML), very fine sand, low plasticity, wet, hard.	40
245						Mud rotary drill.	35
250	SS-46	X	24/24	7-8-13-21 (21)		Grayish green clayey Sand (SC), fine to predominantly medium sand, subangular, low plasticity, moist, medium dense, slightly sulfurous.	30
255						Mud rotary drill.	25
260	SS-47	X	16/22	21-32-37 (69)		Dark gray poorly graded Sand (SP), sand predominatly fine to medium, subangular, trace silt, trace clay, nonplastic, wet, very dense.	20
265						Mud rotary drill.	15
270	SS-48	X	15/17	25-38-50/5"		Gray silty poorly graded Sand (SP-SM), predominantly fine to medium sand, angular to subangular, little mica, few silt, trace clay, nonplastic, wet, very dense, moderately sulfurous.	10
275						Mud rotary drill.	5

Blow Count (blows/ft)



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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

BORING NUMBER Z-SDU6-B04

CLIENT Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

PROJECT NUMBER **PROJECT LOCATION** Z-Area

Depth (ft)	Sample Type Number	Sample Interval	In. Recovered / In. Driven	Blow Counts (N value)	Graphic Log	Material Description	Blow Count (blows/ft) 20 40 60 80	Elevation (ft)
275						Mud rotary drill. *(continued)*		
	SS-49		10/18	33-55-50 (105)		Gray poorly graded Sand (SP), fine to predomantly medium, subangular to subround, trace mica, nonplastic, wet, very dense, slightly sulfurous.	>>	0
280						Mud rotary drill.		
285								-5
	SS-50		7/10	44-50/4"		Light gray poorly graded Sand (SP), medium sand, subangular, trace fine sand, trace kaolin, few mica, wet, very dense.	>>	-10
290						Mud rotary drill.		
295								-15
	SS-51		4/5	50/5"		Light gray poorly graded Sand (SP), medium, subangular, trace mica, nonplastic, wet, very dense.	>>	-20
300						Mud rotary drill.		
305								-25
						Bottom of borehole at 307.0 feet.		-30
								-35