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Particle-Size-Distribution of Nevada Test Site Soils

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INTRODUCTION

The amount of each size particle in a given soil is called the *particle-size distribution* (PSD), and the way it feels to the touch is called the *soil texture*.

Sand, silt, and clay are the three particle sizes of mineral material found in soils. Sand is the largest sized particle and it feels gritty; silt is medium sized and it feels floury; and clay is the smallest and it feels sticky.

Knowing the particle-size distribution of a soil sample helps to understand many soil properties such as how much water, heat, and nutrients the soil will hold, how fast water and heat will move through the soil, and what kind of structure, bulk density and consistence the soil will have.

Furthermore, the native particle-size distribution of the soil in the vicinity of ground zero of a nuclear detonation plays a major role in nuclear fallout. For soils that have a high-sand content, the *near-range* fallout will be relatively high and the *far-range* fallout will be relatively light. Whereas, for soils that have a high-silt and high-clay content, the near-range fallout will be significantly lower and the far-range fallout will be significantly higher.

As part of a program funded by the Defense Threat Reduction Agency (DTRA), the Lawrence Livermore National Laboratory (LLNL) has recently measured the PSDs from the various major areas at the Nevada Test Site where atmospheric detonations and/or nuclear weapon safety tests were performed back in the 50s and 60s. The purpose of this report is to document those results.

RELATIVE SIZE COMPARISON OF SOIL PARTICLES

There is disagreement in the scientific community about the definition of the size ranges of sand, silt, and clay. The US Department of Agriculture (USDA) defines the three major sizes of soil as:

- sand = 2.0 mm - 0.05 mm
- silt = 0.05 - 0.002 mm
- clay = <0.002 mm

Whereas, the International Soil Science Society (ISSS) defines the three major sizes of soil as:

- sand = 2.0 mm - 0.02 mm
- silt = 0.02 - 0.002 mm
- clay = <0.002 mm

Particles greater than 2.0 mm are called stones (or gravels) and are not considered to be soil material.

MEASUREMENT TECHNIQUE

Soil samples (containing a small amount gravel) were collected at approximately 140 different locations at the Nevada Test Site. The coordinates of these locations are listed in Table 1. The University of Arizona's Environmental Research Laboratory, Department of Soil, Water, and Environmental Science measured the PSDs of these soil samples. The measurements were performed using a combination of dry sieving techniques and hydrometric methods.

The initial step in a PSD measurement is to separate the gravel (i.e., particles greater than 2 mm) from the soil component. This was accomplished by passing the soil/gravel sample through a 2-mm mesh. The weight of the gravel and soil components was measured and, from these measurements, the weight fraction of the gravel component was calculated.¹

¹ *It should be noted that the weight fraction of the gravel content of the samples shipped to the University of Arizona was not truly representative of NTS soils. When the soil/gravel samples were collected, we biased the results by throwing away large rocks that would not fit into the sample containers (which were approximately ½ liter). A more accurate measurement of the gravel content was subsequently measured in-situ using much larger samples of the dirt (approximately 5 shovels loads). For these in-situ measurements, we used a 12-inch diameter sieve with a mesh size of 2 mm. A large bucket was placed beneath the sieve to collect the soil component that readily passed through the sieve. Using a portable scale, the gravel and soil weights were measured, from which the weight fraction of the gravel content was calculated.*

The next step in the PSD measurement was to measure the moisture content in the soil. This was accomplished by oven drying a known amount of sample at 105 C (usually overnight) and reweighing after the drying period. The weight fraction of the moisture was determined from the before and after weights of the sample.

For the determination of the clay, silt, and sand fractions by the hydrometer method, a measured amount of oven-dried soil was soaked overnight in water and a dispersing agent (sodium pyrophosphate, $\text{Na}_2\text{P}_2\text{O}_7$, and carbonate, Na_2CO_3). The mixture was transferred to a dispersing cup and mixed for 5 minutes with an electric mixture and then poured into a 1-liter sedimentation cylinder. Distilled water was added to the cylinder to make up the volume up to the mark. After thorough mixing with a plunger, hydrometer readings are taken at 30 seconds, 60 seconds, 90 minutes, and 1440 minutes (i.e., 24 hours) at room temperature. The 30- and 60-second readings were used to compute the weight fraction of the 50 microns or less particles (clay + silt), whereas the 1.5 hour and 24 hour readings were used to compute the clay weight fraction (less than or equal to 2 microns). The total sand fraction was determined by differencing the aforementioned weight fractions.

The five different weight fractions of sand (63-2000 microns) were determined by decanting the suspension after hydrometer reading through a sieve (53 microns), washed, oven dried, and then dry sieved using a stack of sieves and shaker.



Figure 1. Example of a soil sample completely settled.

PSD RESULTS

The results for the PSD measurements for the various areas at NTS are given in Table 2. As can be noted, the weight fraction of the sand as determined by sieving and by hydrometer differ somewhat. This difference is due primarily to the inherent uncertainty associated with each of the measurement techniques. In most cases, the two techniques are expected to agree to within 10%.

It should also be noted that the gravel content in Table 2, as measured by the University of Arizona, is an underestimate of the actual gravel content for reasons previously mentioned. Using the data for the gravel content as obtained by the *in-situ* measurements performed at the Nevada Test Site (NTS), the PSD results obtained by the University of Arizona were renormalized.

Table 3 is a summary of the final normalized PSDs as averaged over each of the various areas at NTS. These results are plotted in Figures 3 through 15.

CONCLUSIONS

Although the Nevada Test Site is a high desert and looks very similar throughout its 1200 square miles, the particle-size-distribution can vary significantly from one area to the next.

REFERENCES

1. Klute, A., *Methods of Soil Analysis, Part 1- Physical and Mineralogical Methods*. SSA Second Ed. Chapter 15. Section 15-5.2.5.1, 1986.
2. Gee, G.W., and J.W. Bauder, *Particle Size Analysis by Hydrometer: A Simplified Method for Routine Textural Analysis and Sensitivity Test of Measurement Parameters*. Soil. Sci. Soc. Am. J 43: 1004-1007, 1979.
3. *Methods of Soil Analysis*, part 1, p 770 , section 43-5.1

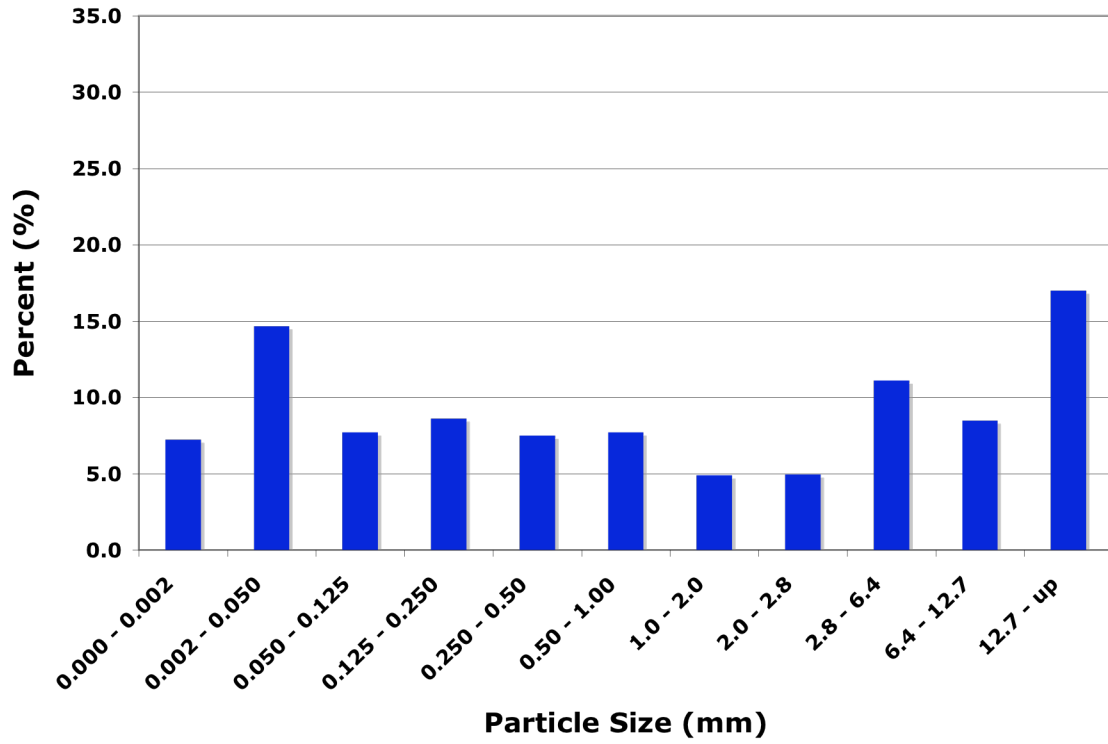


Figure 2. Measured PSD for Area 1 at NTS.

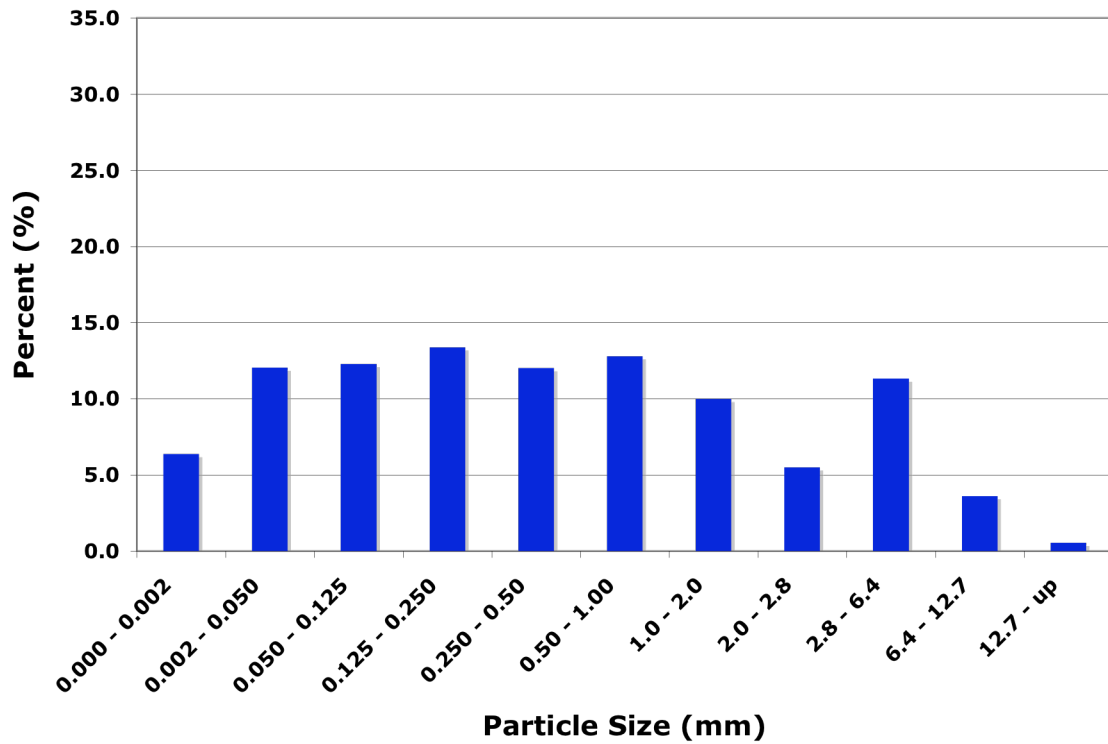


Figure 3. Measured PSD for Area 2 at NTS.

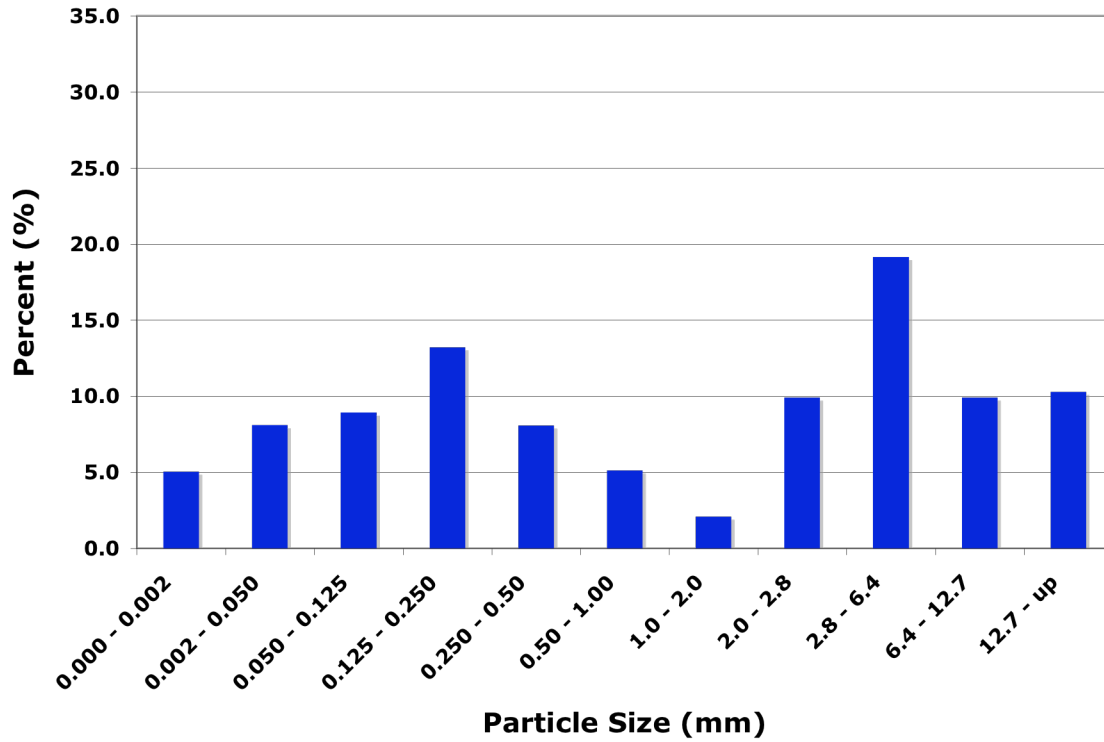


Figure 4. Measured PSD in Area 3 at NTS.

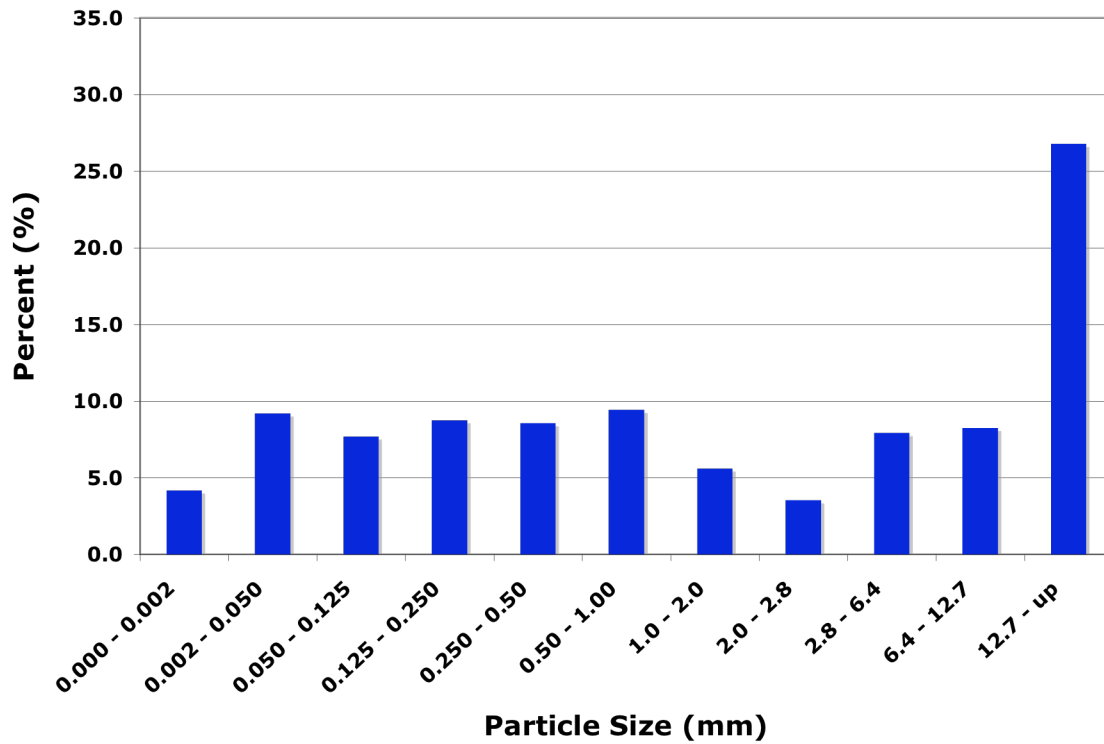


Figure 5. Measured PSD in Area 4 at NTS.

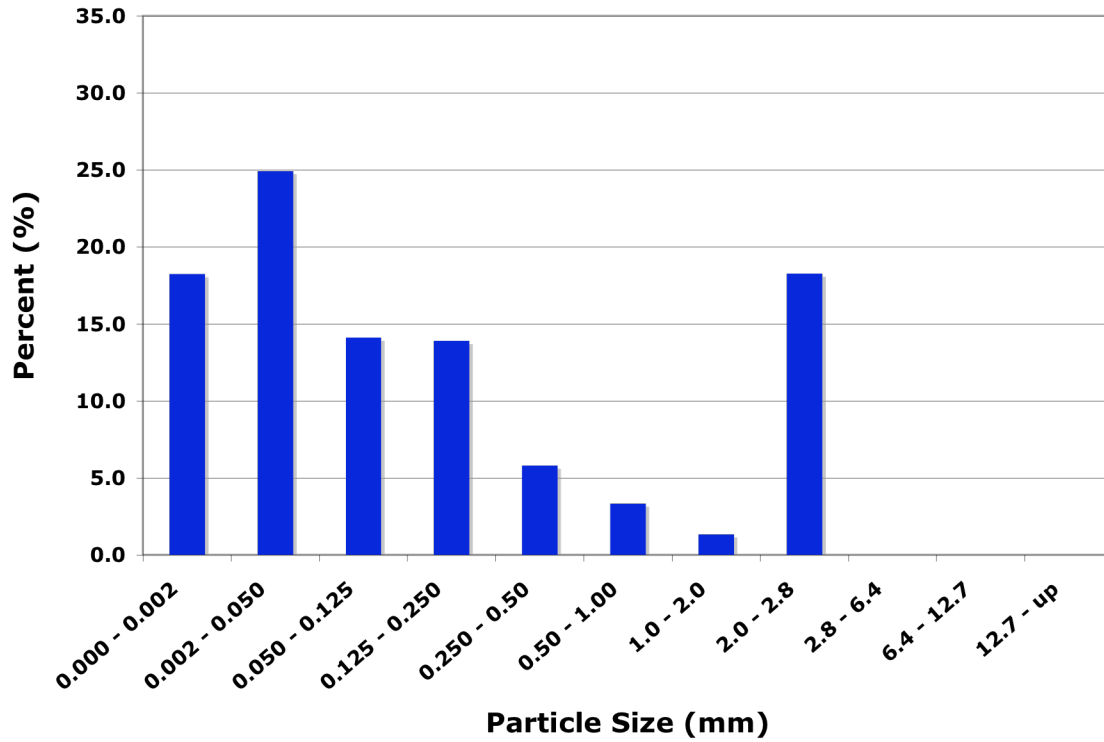


Figure 6. Measured PSD in Area 5 at NTS.

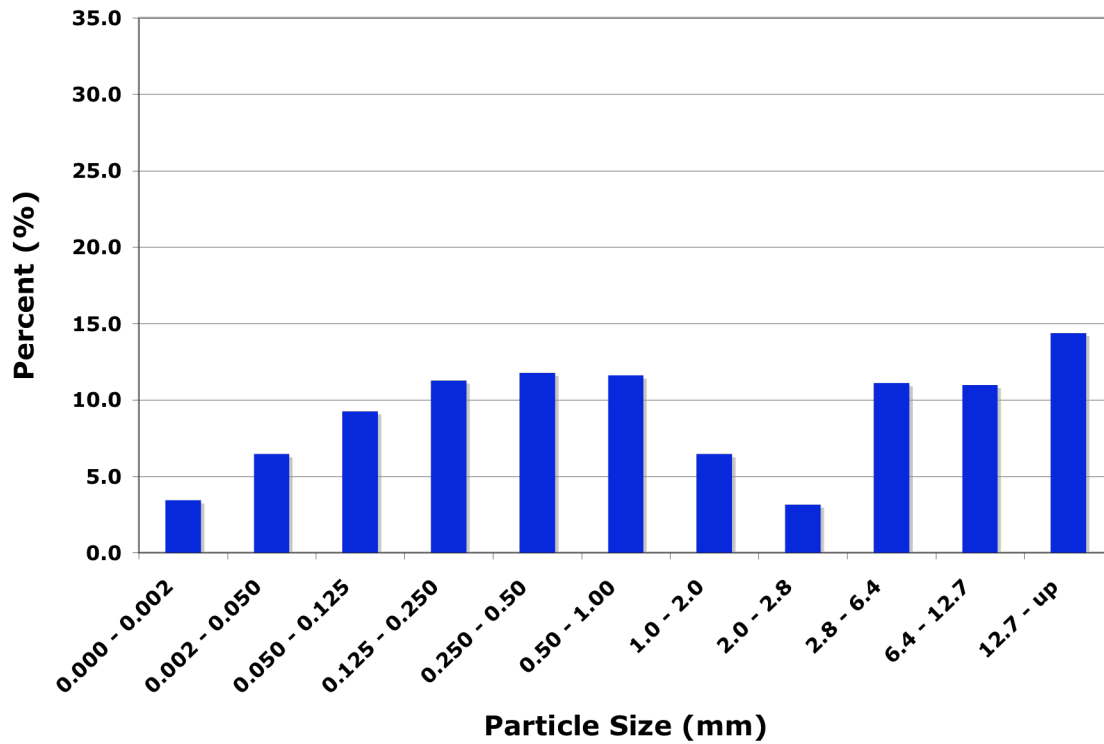


Figure 7. Measured PSD in Area 7 at NTS.

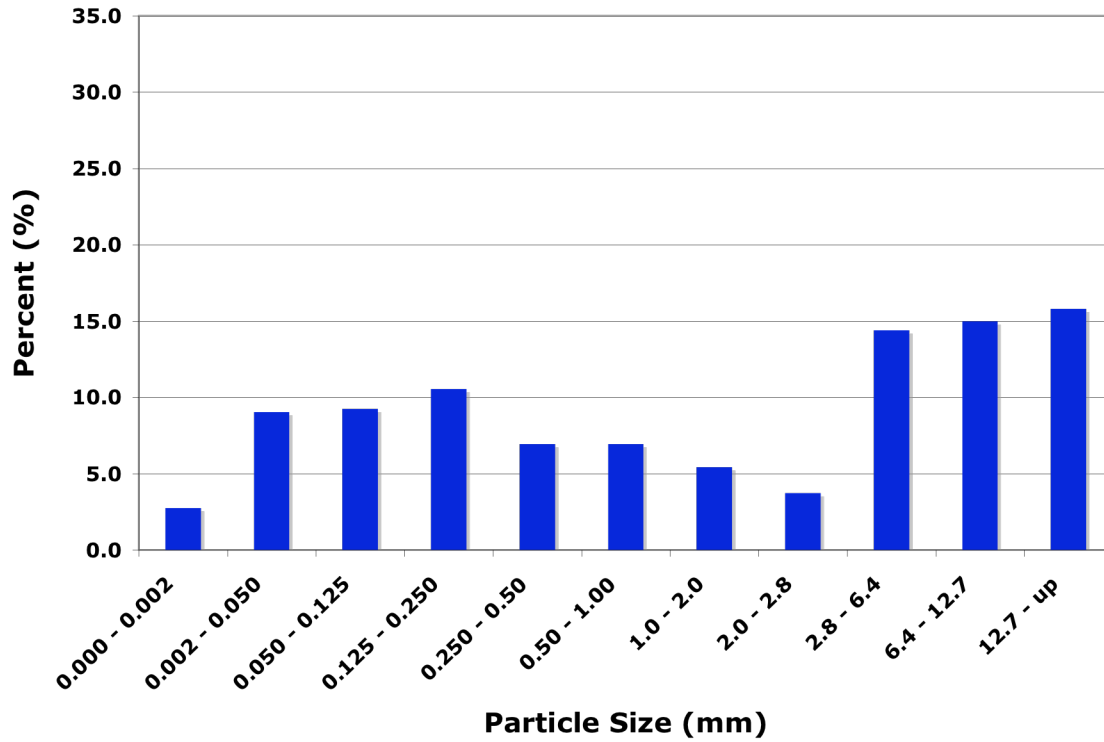


Figure 8. Measured PSD in Area 8 at NTS.

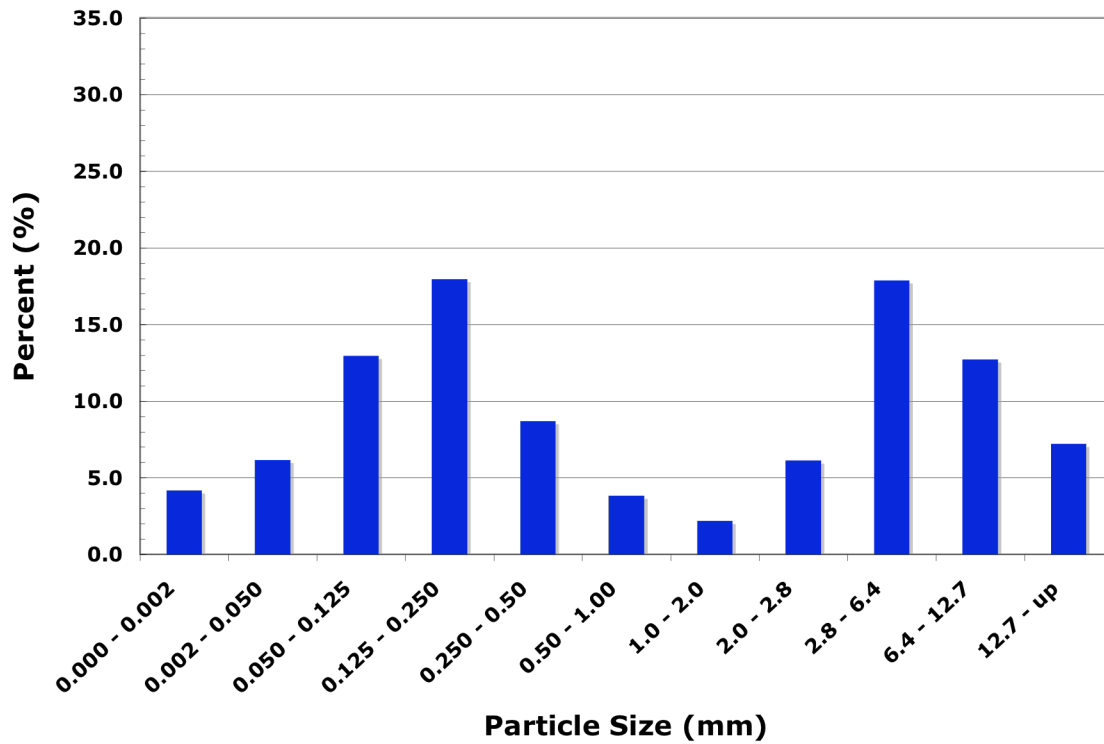


Figure 9. Measured PSD in Area 8 at NTS.

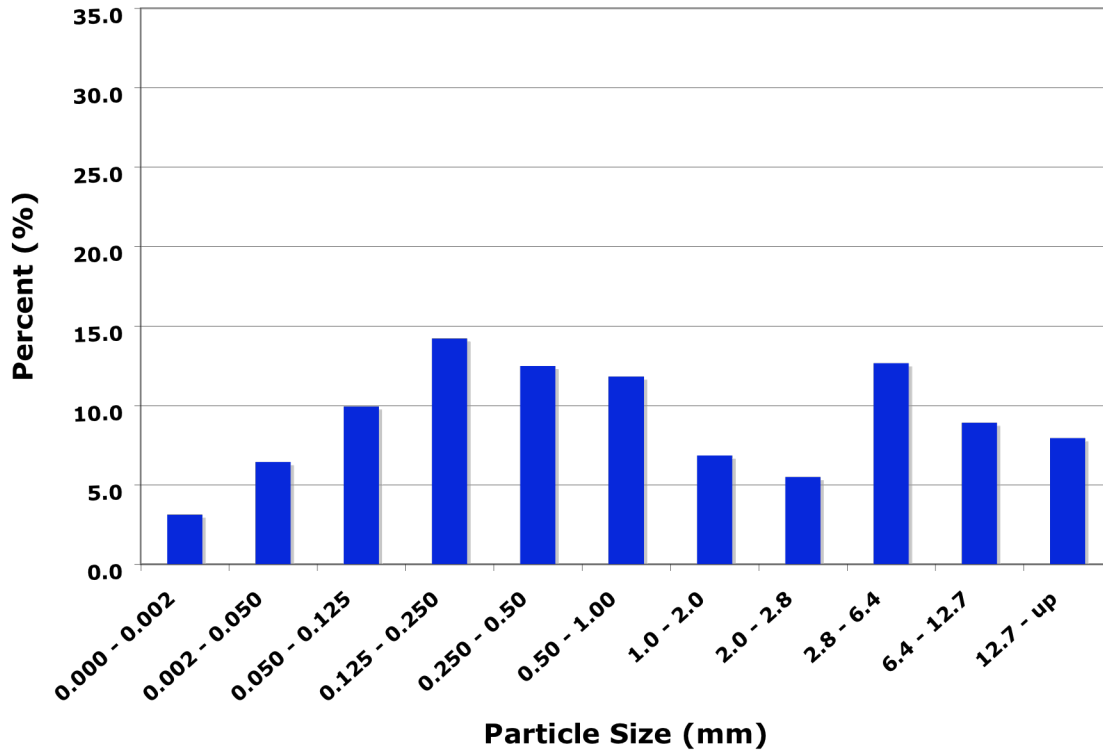


Figure 10. Measured PSD in Area 10 at NTS.

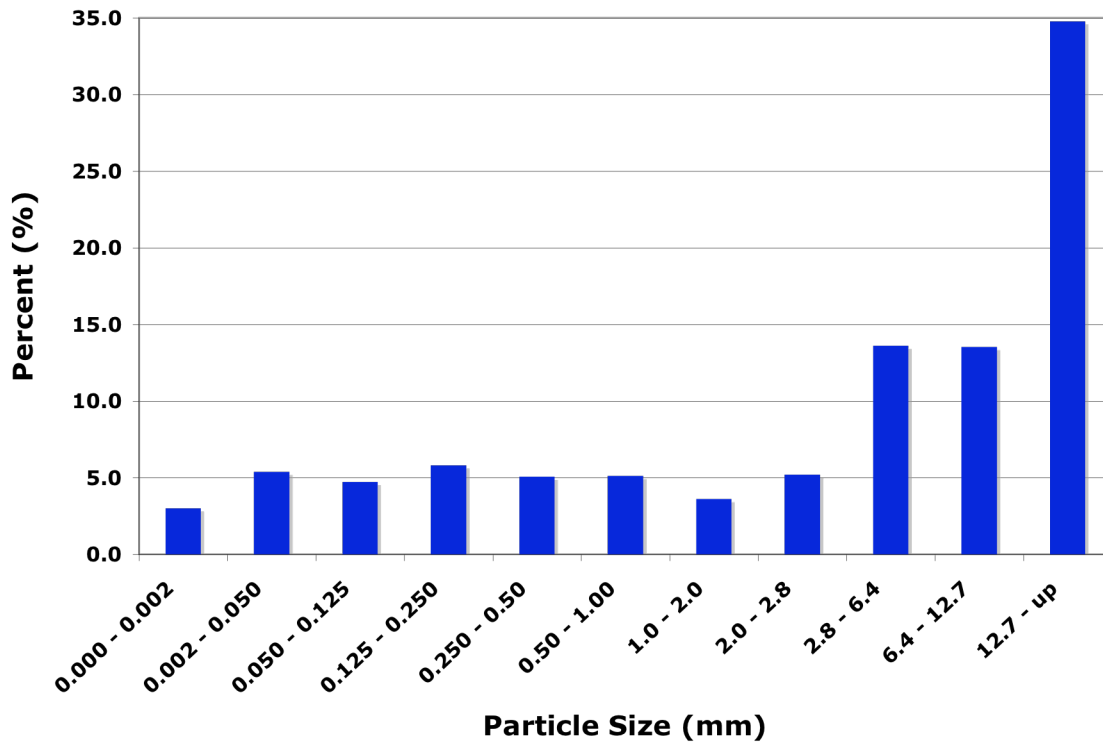


Figure 11. Measured PSD in Area 18 at NTS.

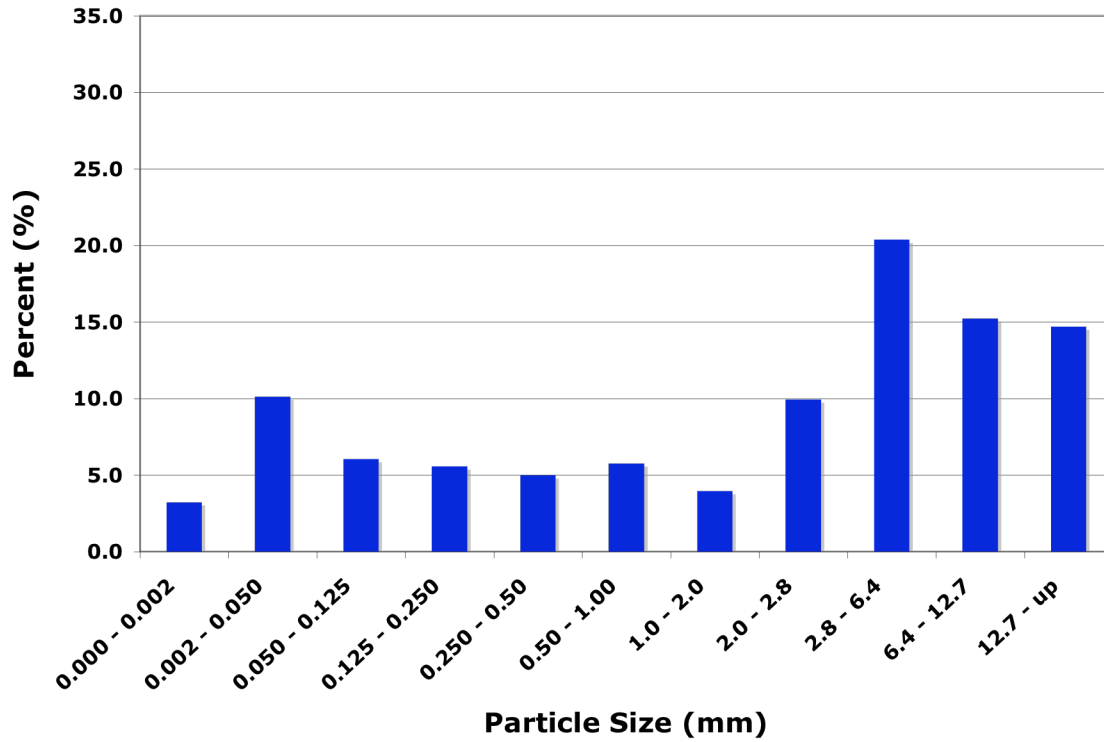


Figure 12. Measured PSD in Area 20 at NTS.

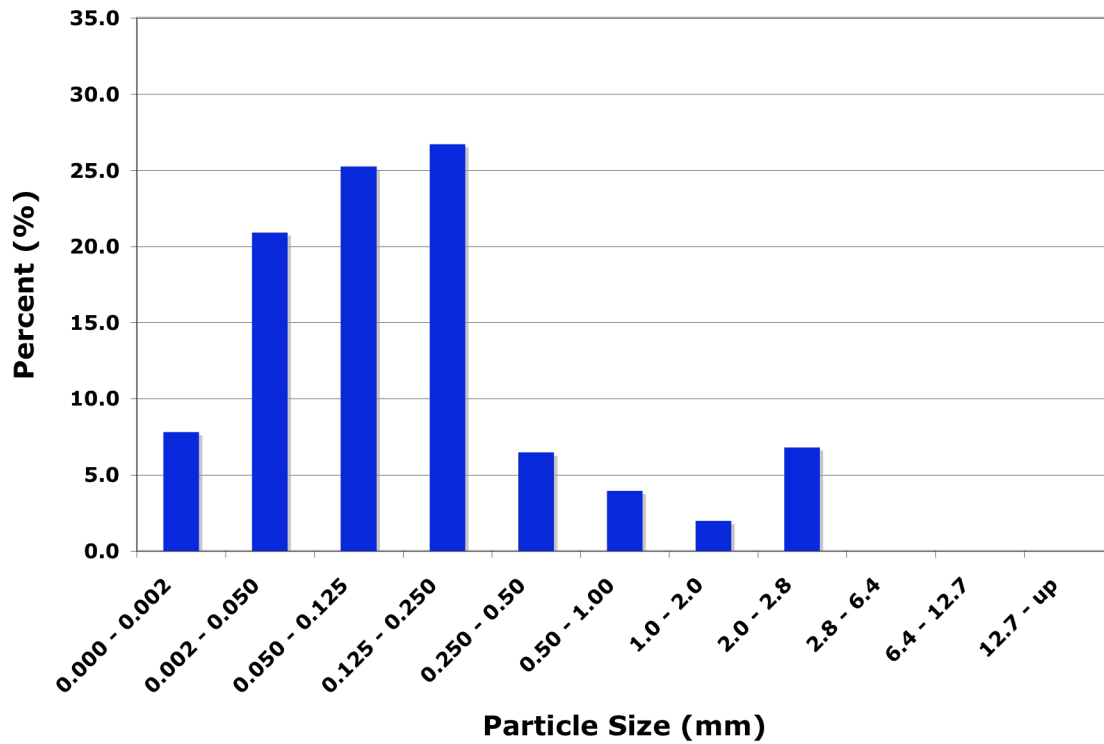


Figure 13. Measured PSD in Area 30 at NT

Table 1. Coordinates of Soil Samples

Sample ID	Area	degrees	min	secs	Latitude	degrees	min	secs	Longitude
1	11	37	3	21	37.05583	116	6	14	116.10389
2	11	37	3	20	37.05556	116	6	11	116.10306
3		37			37.00000	116			116.00000
4		37			37.00000	116			116.00000
5	3	37	2	47	37.04639	116	2	1	116.03361
6		37			37.00000	116			116.00000
7	1	37	3	9	37.05250	116	6	2	116.10056
8	1	37	3	19	37.05528	116	6	14	116.10389
9	1	37	3	8	37.05222	116	6	2	116.10056
10	3	37	2	59	37.04972	116	1	39	116.02750
11	3	37	3	0	37.05000	116	1	41	116.02806
12	3	37	2	59	37.04972	116	1	40	116.02778
13	3	37	2	49	37.04694	116	2	3	116.03417
14	5	37	47	56.5	37.79903	115	56	6.3	115.93508
15	3	37	1	56.8	37.03244	116	1	52.5	116.03125
16	3	37	1	56.6	37.03239	116	1	56.8	116.03244
17	3	37	1	55.9	37.03219	116	1	48.6	116.03017
18	3	37	1	57.5	37.03264	116	2	0.6	116.03350
19	3	37	1	53.4	37.03150	116	1	55.3	116.03203
20	3	37	2	0.6	37.03350	116	1	55.2	116.03200
21	3	37	1	50.7	37.03075	116	1	56.2	116.03228
22	3	37	2	1	37.03361	116	1	53.5	116.03153
23	3	37	2	52.7	37.04797	116	1	10.2	116.01950

24	3	37	2	51.9	37.04775	116	1	18.2	116.02172
25	3	37	2	54.8	37.04856	116	1	7.5	116.01875
26	3	37	2	51.5	37.04764	116	1	16	116.02111
27	7	37	5	14.6	37.08739	116	1	29.7	116.02492
28	7	37	5	9	37.08583	116	1	29.7	116.02492
29	7	37	5	10.6	37.08628	116	1	29.8	116.02494
30	7	37	5	1	37.08361	116	1	20.9	116.02247
31	7	37	5	2.5	37.08403	116	0	57.1	116.01586
32	7	37	5	3.5	37.08431	116	1	20.5	116.02236
33	7	37	5	7.6	37.08544	116	0	59.1	116.01642
34	7	37	5	2.9	37.08414	116	1	16.1	116.02114
35	7	37	5	11.6	37.08656	116	1	1.3	116.01703
36	7	37	5	4.7	37.08464	116	1	22.1	116.02281
37	7	37	5	11.3	37.08647	116	1	7.2	116.01867
38	7	37	5	5.9	37.08497	116	1	24.6	116.02350
39	7	37	5	15.7	37.08769	116	1	10.7	116.01964
40	9	37	8	5.1	37.13475	116	2	29.8	116.04161
41	9	37	8	9.2	37.13589	116	2	16.7	116.03797
42	9	37	8	5.3	37.13481	116	2	27.7	116.04103
43	9	37	8	13.7	37.13714	116	2	20.7	116.03908
44	9	37	8	5.9	37.13497	116	2	24.9	116.04025
45	9	37	8	15	37.13750	116	2	31.1	116.04197
46	9	37	8	6.1	37.13503	116	2	23	116.03972
47	9	37	8	14.9	37.13747	116	2	35.8	116.04328
48	9	37	8	7.4	37.13539	116	2	18.9	116.03858
49	10	37	10	14.2	37.17061	116	2	35.1	116.04308
50		37	7	54	37.13167	116	2	21.5	116.03931
51	9	37	10	13	37.17028	116	2	33.4	116.04261

52	9	37	7	56.1	37.13225	116	2	20.9	116.03914
53	10	37	10	10.8	37.16967	116	2	32	116.04222
54	9	37	7	59	37.13306	116	2	18.9	116.03858
55	10	37	10	9.1	37.16919	116	2	32.8	116.04244
56	9	37	8	0.9	37.13358	116	2	17.9	116.03831
57	4	37	5	40.3	37.09453	116	6	12.1	116.10336
58	9	37	8	2.7	37.13408	116	2	16.7	116.03797
59	4	37	5	40.9	37.09469	116	6	9.5	116.10264
60	9	37	8	5	37.13472	116	2	15.8	116.03772
61	4	37	5	42.8	37.09522	116	6	8.9	116.10247
62	10	37	10	12.8	37.17022	116	2	36	116.04333
63	1	37	3	10.7	37.05297	116	6	2.8	116.10078
64	10	37	10	13.4	37.17039	116	2	37.9	116.04386
65	1	37	3	10	37.05278	116	6	2.5	116.10069
66	10	37	10	13.1	37.17031	116	2	39.9	116.04442
67	20	37	20	40.1	37.34447	116	34	6.5	116.56847
68	10	37	10	12.5	37.17014	116	2	41.4	116.04483
69	20	37	20	39.7	37.34436	116	34	6	116.56833
70	10	37	10	11.9	37.16997	116	2	43.4	116.04539
71	20	37	20	40.3	37.34453	116	34	4.31	116.56786
72	10	37	10	12.7	37.17019	116	2	45	116.04583
73	20	37	20	38.4	37.34400	116	34	5.2	116.56811
74	4	37	5	43.7	37.09547	116	6	15.5	116.10431
75	20	37	20	43.4	37.34539	116	34	15.5	116.57097
76	4	37	5	46.6	37.09628	116	6	15.5	116.10431
77	20	37	20	43.8	37.34550	116	34	15.3	116.57092
78	4	37	5	44.9	37.09581	116	6	17.5	116.10486
79	20	37	20	43.9	37.34553	116	34	15.5	116.57097

80	4	37	5	42.9	37.09525	116	6	18.6	116.10517
81	20	37	20	44.2	37.34561	116	34	15.5	116.57097
82	1	37	3	17.3	37.05481	116	6	30.3	116.10842
83	20	37	19	52.2	37.33117	116	33	46.1	116.56281
84	1	37	3	12.1	37.05336	116	6	22.8	116.10633
85	20	37	17	9.3	37.28592	116	31	22.9	116.52303
86	18	37	7	19.5	37.12208	116	20	5.7	116.33492
87	20	37	17	5.8	37.28494	116	31	22.1	116.52281
88	18	37	7	19.5	37.12208	116	20	5.7	116.33492
89	20	37	17	5.8	37.28494	116	31	22.1	116.52281
90	18	37	7	20.2	37.12228	116	20	7.1	116.33531
91	20	37	17	10.7	37.28631	116	31	22.4	116.52289
92	18	37	7	20.2	37.12228	116	20	7.1	116.33531
93	18	37	7	20.5	37.12236	116	20	2.9	116.33414
94	18	37	7	21.7	37.12269	116	20	7.5	116.33542
95	18	37	7	21.2	37.12256	116	20	2.7	116.33408
96	18	37	7	22.1	37.12281	116	20	7.6	116.33544
97	18	37	7	20.6	37.12239	116	19	59.3	116.33314
98	18	37	6	31.4	37.10872	116	19	9.5	116.31931
99	18	37	7	20.6	37.12239	116	19	59.3	116.33314
100	18	37	6	31.2	37.10867	116	19	9.4	116.31928
101	18	37	7	6.2	37.11839	116	18	17.7	116.30492
102	18	37	7	6.8	37.11856	116	18	18.3	116.30508
103	18	37	7	7	37.11861	116	18	18.5	116.30514
104	18	37	7	4.6	37.11794	116	18	15.2	116.30422
105	30	37	6	42.9	37.11192	116	21	51	116.36417
106	18	37	6	44.6	37.11239	116	21	48.8	116.36356
107	30	37	6	43.4	37.11206	116	21	50.7	116.36408

108	18	37	6	45.2	37.11256	116	21	45.6	116.36267
109	2	37	8	16.9	37.13803	116	7	5.4	116.11817
110	18	37	6	45.7	37.11269	116	21	45.5	116.36264
111	2	37	8	18.8	37.13856	116	7	4.7	116.11797
112	2	37	8	15.7	37.13769	116	7	5	116.11806
113	2	37	8	20.3	37.13897	116	7	4.1	116.11781
114	2	37	8	13.4	37.13706	116	7	5.8	116.11828
115	2	37	8	20.3	37.13897	116	7	4.1	116.11781
116	2	37	8	14.9	37.13747	116	7	8.4	116.11900
117	2	37	8	59.2	37.14978	116	6	30.4	116.10844
118	2	37	8	6.5	37.13514	116	6	58.6	116.11628
119	2	37	8	57	37.14917	116	6	30.4	116.10844
120	2	37	8	6.5	37.13514	116	6	58.6	116.11628
121	2	37	8	58.3	37.14953	116	6	31.6	116.10878
122	2	37	8	3.9	37.13442	116	6	52.9	116.11469
123	30	37	0	25.4	37.00706	116	22	31.5	116.37542
124	30	37	0	26.5	37.00736	116	22	33.5	116.37597
125	30	37	0	33.3	37.00925	116	22	36.3	116.37675
126	30	37	0	36.4	37.01011	116	22	32.7	116.37575
127	8	37	10	52.7	37.18131	116	4	27.3	116.07425
128	8	37	10	52.7	37.18131	116	4	27.3	116.07425
129	8	37	10	38.6	37.17739	116	4	25.4	116.07372
130	8	37	10	38.6	37.17739	116	4	25.4	116.07372
131	8	37	10	51.4	37.18094	116	3	55.5	116.06542
132	8	37	11	16.4	37.18789	116	4	3.7	116.06769
133	8	37	11	16.4	37.18789	116	4	3.7	116.06769
134	8	37	11	18.2	37.18839	116	4	5	116.06806
135	8	37	11	18.2	37.18839	116	4	5	116.06806

136	8	37	10	42.9	37.17858	116	3	5.6	116.05156
137	5	36	47	53.9	36.79831	115	55	46.6	115.92961
138	5	36	47	53.8	36.79828	115	55	46.8	115.92967
139	5	36	48	8.5	36.80236	115	55	42.2	115.92839
140	5	36	48	0	36.80000	115	55	58.1	115.93281
141	5	36	47	34.7	36.79297	115	54	56.2	115.91561

Table 2. Summary of PSD Measurements of Individual Soil Samples

SAMPLE ID	AREA	MOISTURE	GRAVEL	SAND	SILT	CLAY	Very Coarse	Coarse	Medium	Fine	Very Fine
			dry sieving >2.0 mm (%)	Hydrometer (2.0-0.05) mm (%)	Hydrometer (0.05-0.002)mm (%)	Hydrometer <0.002mm (%)	Sand (2.0-1.0)mm (%)	Sand (1.0-0.5)mm (%)	Sand (0.5-0.25)mm (%)	Sand (0.25-0.125)mm (%)	Sand (0.125-0.05)mm (%)
NTS-63	1	4.76	19.4	68.3	19.6	12.1	5.6	13.1	16.3	17.6	12.6
NTS-65	1	9.60	19.9	69.6	21.2	9.2	6.3	10.3	10.7	15.8	13.5
NTS-82	1	6.21	27.4	55.6	29.9	14.5	9.0	12.5	9.8	9.1	9.4
NTS-84	1	6.99	40.8	56.5	29.9	13.6	8.7	10.7	8.4	9.6	11.2
<i>Average</i>		<i>6.9</i>	<i>26.9</i>	<i>62.5</i>	<i>25.1</i>	<i>12.4</i>	<i>7.4</i>	<i>11.6</i>	<i>11.3</i>	<i>13.0</i>	<i>11.6</i>
<i>Normalized</i>			<i>41.6</i>	<i>36.5</i>	<i>14.7</i>	<i>7.2</i>	<i>4.9</i>	<i>7.7</i>	<i>7.5</i>	<i>8.6</i>	<i>7.7</i>
NTS-118	2	0.55	59.6	90.4	6.4	3.2	30.0	24.8	12.7	9.6	8.9
NTS-119	2	4.41	15.7	80.1	13.5	6.4	6.1	10.9	16.8	22.0	17.6
NTS-120	2	1.06	23.1	82.6	11.7	5.7	8.7	16.9	17.1	16.5	14.9
NTS-122	2	1.31	11.0	74.7	18.0	7.3	5.3	9.6	13.7	20.4	19.5
NTS-109	2	1.89	23.6	80.1	14.4	5.5	12.5	18.2	16.1	15.3	12.6
NTS-111	2	4.08	33.8	67.2	25.3	7.4	11.4	13.8	11.0	11.5	12.4
NTS-112	2	3.79	30.0	67.3	16.4	16.3	11.9	15.3	12.8	11.8	10.8
NTS-113	2	1.81	23.1	72.3	19.0	8.7	9.0	12.7	12.4	15.6	16.4
NTS-114	2	2.03	31.0	76.2	16.7	7.1	12.5	17.8	15.0	13.9	12.7
NTS-115	2	0.59	37.6	81.4	13.0	5.7	18.8	17.4	12.7	13.4	13.7
NTS-116	2	2.38	27.8	76.2	14.6	9.2	9.5	12.9	12.9	16.9	16.3
NTS-117	2	5.63	12.3	71.1	14.3	14.7	4.1	8.5	15.1	20.3	16.0
<i>Average</i>		<i>2.5</i>	<i>27.4</i>	<i>76.6</i>	<i>15.3</i>	<i>8.1</i>	<i>11.6</i>	<i>14.9</i>	<i>14.0</i>	<i>15.6</i>	<i>14.3</i>
<i>Normalized</i>			<i>21.0</i>	<i>60.5</i>	<i>12.1</i>	<i>6.4</i>	<i>10.0</i>	<i>12.8</i>	<i>12.0</i>	<i>13.4</i>	<i>12.3</i>

NTS-22	3	4.66	15.1	71.8	23.0	5.2	4.0	10.2	17.1	23.7	17.1
NTS-23	3	4.24	8.7	80.7	12.2	7.0	2.7	8.6	15.8	28.3	23.3
NTS-24	3	6.12	25.0	75.6	16.1	8.3	3.4	9.7	16.0	24.8	21.8
NTS-25	3	2.99	5.8	80.7	12.2	7.0	2.9	8.9	19.5	28.7	21.1
NTS-26	3	5.25	12.2	78.1	14.5	7.4	2.4	6.8	15.2	28.7	23.7
NTS-15	3	8.58	26.8	68.7	14.8	16.6	5.7	17.2	16.4	14.2	8.9
NTS-16	3	8.89	24.0	66.1	19.0	14.9	3.7	7.9	11.7	21.0	13.8
NTS-17	3	5.69	23.4	68.7	18.0	13.3	6.3	12.4	14.3	19.7	11.3
NTS-18	3	4.06	39.8	76.4	15.1	8.5	10.2	16.0	13.6	17.4	12.8
NTS-19	3	2.87	5.2	84.0	9.8	6.3	2.5	6.8	18.2	38.4	16.3
NTS-20	3	4.33	23.2	60.9	23.3	15.8	2.2	6.2	11.1	21.4	15.0
NTS-21	3	5.17	10.8	76.4	14.1	9.4	1.8	6.1	14.7	33.5	17.5
Average		5.2	18.3	74.0	16.0	10.0	4.0	9.7	15.3	25.0	16.9
Normalized			49.3	37.5	8.1	5.1	2.1	5.1	8.1	13.2	8.9
NTS-57	4	4.87	22.0	77.1	14.3	8.6	6.7	14.0	15.1	18.1	15.9
NTS-59	4	4.73	25.2	79.8	13.8	6.4	10.4	16.2	13.6	14.5	15.1
NTS-61	4	7.86	27.5	57.0	26.9	16.1	4.3	9.3	11.7	13.0	11.2
NTS-74	4	3.52	34.5	89.1	8.4	2.5	16.0	26.0	18.4	12.0	7.2
NTS-76	4	3.48	29.3	65.6	25.2	9.2	6.2	11.3	12.1	14.7	14.3
NTS-78	4	7.06	28.4	74.8	18.1	7.1	9.3	14.5	13.7	13.8	11.7
NTS-80	4	4.38	29.9	81.3	13.9	4.8	12.4	18.6	15.0	15.9	14.2
Average		5.1	28.1	75.0	17.2	7.8	9.3	15.7	14.2	14.6	12.8
Normalized			46.5	40.1	9.2	4.2	5.6	9.4	8.6	8.8	7.7
NTS-4	5	1.05	16.7	58.1	29.6	12.4	4.6	11.5	11.3	13.2	10.9
NTS-137	5	7.33	34.3	23.4	37.3	39.3	0.6	0.3	1.0	4.7	11.7
NTS-139	5	6.16	39.0	30.5	45.8	23.7	0.4	0.8	2.0	7.2	12.5
NTS-140	5	4.08	5.1	58.8	18.2	23.0	0.1	0.5	4.3	23.7	25.1
NTS-141	5	5.40	8.7	30.5	42.4	27.1	0.1	0.1	0.7	8.0	16.2
NTS-6	5	0.67	5.8	81.6	9.9	8.5	3.0	8.3	18.5	33.4	15.1
Average		4.1	18.3	47.2	30.5	22.3	1.5	3.6	6.3	15.0	15.2
Normalized			18.3	38.5	24.9	18.2	1.4	3.3	5.8	13.9	14.1
NTS-27	7	2.99	36.0	79.5	14.2	6.3	11.4	19.1	19.7	17.7	13.0
NTS-28	7	2.60	28.3	83.3	12.0	4.7	9.1	16.8	19.0	21.0	18.1

NTS-30	7	1.63	49.4	92.1	4.4	3.4	28.0	34.5	15.9	8.1	6.5
NTS-31	7	4.18	16.8	83.3	12.1	4.5	5.8	17.4	24.4	21.5	15.1
NTS-32	7	3.77	35.6	82.0	12.4	5.6	11.6	19.7	19.1	18.0	14.9
NTS-33	7	4.02	20.7	78.2	15.0	6.9	5.6	12.8	19.3	22.2	19.4
NTS-34	7	2.77	23.6	95.3	3.1	1.6	12.2	28.3	26.3	15.7	9.0
NTS-35	7	6.22	13.7	90.4	7.6	1.9	6.8	15.3	18.5	22.0	20.3
NTS-36	7	5.97	30.4	90.3	6.8	2.8	9.8	19.6	21.2	19.7	15.3
NTS-37	7	6.96	24.6	93.0	7.9	0.1	7.5	16.9	20.3	20.7	17.5
NTS-38	7	5.85	18.7	80.2	13.8	6.0	5.5	11.1	14.8	20.2	20.3
NTS-38 B	7	1.78	27.3	51.5	29.5	19.0	8.4	8.8	7.3	10.6	11.7
NTS-39	7	7.41	28.6	87.8	0.6	11.7	13.1	22.1	19.7	17.4	11.9
Average		4.3	27.2	83.6	10.7	5.7	10.4	18.6	18.9	18.0	14.8
Normalized			39.7	50.4	6.5	3.5	6.5	11.6	11.8	11.3	9.3
NTS-127	8	0.26	55.3	74.7	19.7	5.7	11.0	10.8	8.6	14.2	17.8
NTS-128	8	0.85	14.8	66.8	26.8	6.4	5.0	7.4	7.4	17.8	23.2
NTS-129	8	0.32	35.8	70.8	23.2	6.0	10.4	12.0	9.7	14.9	17.0
NTS-130	8	1.52	13.0	53.8	35.1	11.1	4.9	7.5	7.9	12.5	15.3
NTS-132 A	8	1.47	36.5	83.8	13.0	3.2	4.7	8.5	10.5	27.6	23.7
NTS-132 B	8	0.98	51.7	86.3	9.6	4.1	20.1	18.2	15.2	18.7	11.3
NTS-133	8	0.95	55.6	86.4	9.5	4.1	14.9	17.9	17.3	20.9	12.5
NTS-134	8	1.60	41.0	77.2	17.1	5.7	9.1	10.9	13.4	21.1	15.7
NTS-136	8	1.89	20.0	91.5	6.0	2.5	8.0	19.2	22.4	23.2	13.2
Average		1.1	36.0	76.8	17.8	5.4	9.8	12.5	12.5	19.0	16.6
Normalized			49.0	39.2	9.1	2.8	5.5	6.9	7.0	10.6	9.2
NTS-40	9	5.76	14.0	83.9	9.8	6.4	6.0	11.2	19.4	26.0	15.4
NTS-41	9	2.58	19.8	80.0	12.7	7.3	2.5	4.1	10.4	29.8	29.1
NTS-42	9	3.65	19.3	85.1	11.0	3.9	5.6	9.6	20.2	29.6	16.1
NTS-43	9	5.51	13.6	77.4	13.3	9.3	2.2	5.0	13.5	30.1	22.3
NTS-44	9	4.52	6.8	77.4	13.0	9.6	2.2	5.4	16.2	29.5	19.6
NTS-45	9	6.97	4.7	79.0	9.6	11.4	0.7	3.5	17.8	31.6	17.4
NTS-46	9	4.24	13.7	85.9	5.0	9.1	2.4	3.8	13.8	33.6	22.6
NTS-47	9	5.31	19.1	85.5	6.7	7.8	3.2	9.8	22.7	28.5	14.4
NTS-48	9	5.55	17.7	81.7	12.0	6.3	3.5	5.7	16.6	29.1	18.3
NTS-50	9	3.33	17.9	77.8	15.2	7.0	3.8	6.2	12.5	27.6	20.6

NTS-51	9	3.00	10.7	88.0	8.2	3.8	8.7	16.4	18.3	22.3	15.4
NTS-52	9	5.12	8.8	80.3	10.9	8.8	1.7	2.3	8.5	36.0	23.8
NTS-54	9	4.42	19.7	78.2	12.8	9.0	3.4	4.1	8.4	30.5	26.1
NTS-56	9	3.03	26.1	82.4	13.2	4.5	4.9	5.9	11.9	28.4	25.5
NTS-58	9	2.72	23.6	82.4	10.7	7.0	4.3	4.2	9.2	29.9	28.1
NTS-60	9	3.87	17.5	79.7	12.0	8.2	3.1	4.1	9.3	29.8	26.2
Average		4.3	15.8	81.5	11.0	7.5	3.6	6.3	14.3	29.5	21.3
Normalized			44.0	45.7	6.2	4.2	2.2	3.8	8.7	18.0	13.0
NTS-49	10	2.1586	19.8828	82.8669	11.7353	5.3978	9.9250	17.3250	16.8750	18.0250	11.6500
NTS-53	10	3.2830	18.3486	86.2941	10.1457	3.5602	9.3500	16.3500	18.5750	22.2250	15.1000
NTS-55	10	2.4886	14.4997	85.0030	9.2818	5.7152	6.0750	12.1250	17.4250	23.9750	18.7500
NTS-62	10	3.2145	17.2045	85.1985	10.9496	3.8519	12.2250	20.8500	19.4750	17.2750	12.1000
NTS-64	10	2.7427	22.3808	86.5590	9.9291	3.5119	8.7000	16.4750	19.9750	24.3250	15.4500
NTS-66	10	4.3426	20.0980	86.5590	7.7580	5.6831	12.3750	19.3500	17.1000	17.6500	13.0250
NTS-68	10	11.8946	23.6996	81.3535	13.8773	4.7692	8.2000	15.2000	15.6000	19.6500	14.7000
NTS-70	10	3.2944	12.7135	87.9403	6.3875	5.6722	10.0750	16.6250	18.9250	22.3000	15.2750
NTS-72	10	3.0247	24.2679	85.3565	9.3081	5.3354	12.3750	19.4250	18.6500	19.4500	13.1750
Average		4.0493	19.2328	85.2368	9.9303	4.8330	9.9222	17.0806	18.0667	20.5417	14.3583
Normalized			35.0685	55.3455	6.4479	3.1381	6.8670	11.8212	12.5036	14.2165	9.9372
NTS-86	18	3.9780	18.5683	80.0108	15.2038	4.7855	7.8500	15.4250	15.8500	19.2250	15.9000
NTS-90	18	1.3862	36.7038	72.2876	20.4283	7.2841	11.5000	5.0500	12.0000	17.7250	15.2000
NTS-92	18	16.1124	29.5512	46.3699	26.4993	27.1308	5.3500	7.0500	7.9750	10.4250	8.7250
NTS-93	18	8.4960	8.5880	67.3281	21.4539	11.2180	4.0500	9.5500	14.5000	22.5250	15.8250
NTS-94	18	6.3309	12.9790	77.5138	15.2021	7.2841	6.2500	13.0000	14.4500	19.1000	18.3750
NTS-95	18	0.8305	55.7705	89.0418	7.2082	3.7500	26.4250	20.8000	13.3000	13.8500	10.3750
NTS-97	18	8.9863	16.7873	80.0472	14.6119	5.3409	10.5750	14.5250	16.4500	22.5750	14.1250
NTS-98	18	6.0621	19.1410	82.6353	12.0238	5.3409	9.5250	19.2250	17.3750	20.8750	12.6500
NTS-99	18	0.8660	52.0783	92.7536	3.1580	4.0884	28.3750	26.6500	16.1500	12.1500	6.6250
NTS-100	18	0.9604	29.2994	84.0332	11.5386	4.4282	14.3250	20.9500	15.4750	17.6750	11.8250
NTS-101	18	6.1747	13.8395	85.1312	8.8422	6.0266	11.7500	27.7000	24.7750	12.9250	7.4750
NTS-102	18	9.8529	14.2887	52.6426	28.3016	19.0559	3.4750	8.5750	10.4750	11.7000	13.7500
NTS-103	18	0.9531	32.7175	76.1967	18.6916	5.1117	11.2500	15.7500	13.3250	14.2000	15.5500
NTS-104	18	0.6679	32.4596	93.8857	3.2783	2.8360	10.9000	26.3000	35.0000	15.6750	6.7000
NTS-106	18	11.6248	8.8482	49.4849	29.7984	20.7167	1.4250	1.1250	1.9250	14.8250	21.3750

NTS-108	18	12.3780	8.5355	60.3553	26.4349	13.2098	2.7500	2.5500	2.9750	20.9000	22.3750
Average		5.9788	24.3847	74.3574	16.4172	9.2255	10.3609	14.6391	14.5000	16.6469	13.5531
Normalized			67.1756	24.4074	5.3888	3.0282	3.6282	5.1263	5.0776	5.8294	4.7460
NTS-67	20	1.14	24.3	92.9	4.6	2.5	17.3	23.1	20.4	16.2	9.0
NTS-69	20	2.15	26.9	72.4	20.9	6.7	8.1	16.7	15.6	15.7	11.5
NTS-71	20	8.91	21.9	61.9	30.1	8.0	8.2	16.3	13.8	11.3	8.9
NTS-75	20	6.30	20.9	58.0	29.9	12.1	6.6	9.6	8.1	11.2	14.1
NTS-77	20	5.79	28.0	64.5	27.6	8.0	9.2	10.7	8.2	11.4	16.6
NTS-79	20	5.15	37.7	74.8	19.2	6.0	9.4	16.4	13.7	13.7	14.1
NTS-81	20	0.55	35.7	73.4	23.0	3.5	10.4	14.1	12.0	13.9	16.6
NTS-83	20	6.31	20.1	73.4	20.5	6.0	8.3	8.5	9.4	18.7	20.8
NTS-85	20	10.59	20.8	45.6	42.7	11.6	5.8	5.9	4.3	5.9	14.0
NTS-87	20	11.96	17.8	46.4	36.6	17.0	6.2	8.9	6.9	7.9	11.1
Average		5.9	25.4	66.3	25.5	8.1	8.9	13.0	11.2	12.6	13.7
Normalized			60.3	26.4	10.1	3.2	4.0	5.8	5.0	5.6	6.1
NTS-123	30	1.41	4.1	65.1	25.3	9.6	1.5	1.5	2.6	25.8	30.0
NTS-124	30	1.30	3.6	65.1	26.5	8.4	1.3	2.0	3.1	26.4	27.8
NTS-125	30	0.96	7.7	77.3	16.3	6.4	1.8	2.4	4.1	35.8	26.8
NTS-126	30	3.13	12.4	86.5	9.4	4.1	3.2	11.6	18.6	28.9	19.1
NTS-107	30	11.34	6.3	51.7	34.8	13.6	2.1	1.8	3.2	13.3	19.4
Average		3.6	6.8	69.1	22.4	8.4	1.9	3.9	6.3	26.0	24.6
Normalized			6.8	64.4	20.9	7.8	2.0	4.0	6.5	26.7	25.3

Table 3. Summary of PSD Measurements

	CLAY	SILT	Sand Very Fine	Sand Fine	Sand Medium	Sand Coarse	Sand Very Coarse	Gravel	Gravel	Gravel	Gravel	
(mm) -->	Hydrometer 0.000 - 0.002	Hydrometer 0.002 - 0.050	0.050 - 0.125	0.125 - 0.250	0.250 - 0.50	0.50 - 1.00	1.0 - 2.0	2.0 - 2.8	2.8 - 6.4	6.4 - 12.7	12.7 - up	
Area 1 (%)	7.2315	14.6742	7.7313	8.6277	7.4989	7.7271	4.9093	4.9604	11.1296	8.5035	17.0071	Total
Cumulative	7.2315	21.9056	29.6369	38.2646	45.7634	53.4906	58.3999	63.3603	74.4899	82.9935	100.0006	100.0006
Density	(gms/cc)	1.32										
Area 2 (%)	6.3846	12.0586	12.2892	13.3921	12.0367	12.7995	9.9993	5.5162	11.3475	3.6249	0.5516	100.0002
Cumulative	6.3846	18.4432	30.7324	44.1245	56.1613	68.9607	78.9600	84.4762	95.8237	99.4486	100.0002	
Density	(gms/cc)	1.44										
Area 3 (%)	5.0573	8.1175	8.9396	13.2208	8.0900	5.1495	2.1053	9.9349	19.1603	9.9349	10.2898	99.9999
Cumulative	5.0573	13.1748	22.1144	35.3352	43.4252	48.5747	50.6800	60.6149	79.7752	89.7102	99.9999	
Density	(gms/cc)	1.28										
Area 4 (%)	4.1828	9.2078	7.7055	8.7697	8.5611	9.4426	5.6071	3.5547	7.9297	8.2422	26.7969	100.0000
Cumulative	4.1828	13.3906	21.0961	29.8657	38.4269	47.8695	53.4766	57.0313	64.9610	73.2032	100.0000	
Density	(gms/cc)	1.58										
Area 5 (%)	18.2472	24.9346	14.1126	13.9081	5.8217	3.3333	1.3542	18.2883				100.0000
Cumulative	18.2472	43.1818	57.2944	71.2025	77.0242	80.3575	81.7117	100.0000				
Density	(gms/cc)	1.14										
Area 7 (%)	3.4551	6.4737	9.2619	11.2696	11.7848	11.6335	6.4688	3.1679	11.1069	10.9924	14.3893	100.0039
Cumulative	3.4551	9.9288	19.1907	30.4603	42.2451	53.8786	60.3474	63.5153	74.6222	85.6146	100.0039	
Density	(gms/cc)	1.34										
Area 8 (%)	2.7656	9.0558	9.2484	10.5730	6.9568	6.9476	5.4528	3.7300	14.4100	15.0000	15.8200	99.9600
Cumulative	2.7656	11.8214	21.0698	31.6428	38.5996	45.5472	51.0000	54.7300	69.1400	84.1400	99.9600	

[illegible]