THE CONTENTS OF THIS SECTION ARE
THE HIGHEST QUALITY AVAILABLE

INITIAL [illegible] DATE 9/27/02

PAGE NUMBERING SEQUENCE IS INCONSISTENT

Appendix A

Old Alluvium Properties, and Consolidation Sample Property Comparison

Assume: Material is loose unless otherwise indicated by SPT
w_n = 2% for granular material for which no data

Boring Log S-181

Approx. Layer		Laboratory												C_c		C_α			C_r	C_c
Top	Bottom	Top	Bottom	USCS		γ_{dry}	w_n	γ_{total}	LL	PL	I_P	D_{85}	D_{50}	-#200	Terzaghi &Peck (1948)+-	Koppula (1986)	Nakase et al. (1988)	Nakase et al. (1988)	NAFAC DM7.1	Mesri et al. (1990)	Nakase et al. (1988)	Avg
(ft)	(ft)	(ft)	(ft)	field	lab	(pcf)	(%)	(pcf)				(mm)	(mm)	(% passing)								
0	2.5			SM		88		89.8														
2.5	5	2.5	3.5	SW	SC	82	3.06%	84.5	24%	15%	9%	5.47	0.21	41.2%								
		4	5		GW-GM	118	2.10%	120.5	NV	NP		19.11	5.02	6.7%								
5	10			GW		118		120.4														
10	12.5	10.5	12.5	GW	GP-GM	118	2.76%	121.3	NV	NP		16.03	5.96	6.7%								
12.5	15			GW		118		120.4														
15	17.5			GW/SW		105		107.1														
17.5	20	17.5	20	SW	GP-GM	109	3.81%	113.2	NV	NP		27.01	5.54	7.2%								
20	22.5			SW		102		104.0														
22.5	25			SW/GW		105		107.1														
25	27.5			GW/SW		105		107.1														
27.5	30			GW		118		120.4														
30	32.5			GW		118		120.4														
32.5	35	32.5	35	GW	GP-GM	109	4.35%	113.7	NV	NP		17.33	4.13	10.0%								
35	38.5	37.5	38	GW/SW	ML	80	20.44%	96.4	22%	21%	1%	0.23	0.05	58.9%	0.108	0.299	0.056	0.0020	0.0020	0.0046	0.027	0.154
38.5	41	40	41	SM	SM	88	8.40%	95.4	NV	NP		2.39	0.23	25.7%								
41	42.5	41.75	42.25	CL	CL	100	21.94%	121.9	28%	15%	13%	0.3	0.02	51.6%	0.162	0.275	0.181	0.0060	0.0022	0.0062	0.034	0.206
Top of Basalt																				Average	0.031	0.180

Approx. cumulative thickness of clay and plastic silts 5.0

Initial condition of "old

Boring	Porosity (n)	Void Ratio (e)	γ_{dry} (pcf)	Estimate d Degree of
CHEMB-3	0.386	0.629	101.8	101.7
SPT-5	0.397	0.658	99.9	97.5
SPT-3	0.381	0.616	101.8	70.8
Average:	0.388	0.634	101.1	90.0

Data from geotechnical report, e calculated from

Results of Consolidation
(See C_c Determination Calc.

Boring	e_o	C_c'	C_c	Estimate d γ_{dry} (pcf)
SPT-1	0.637	0.088	0.144	101.0
CHEMB-3	0.670	0.100	0.167	99.0
SPT-4	0.654	0.086	0.142	100.0
Average	0.654	0.091	0.151	100.0

Values used in Calculations

Boring Log S-181

γ_{dry}	wn	γ_{total} (pcf)	Cc	Cr	Initial Void Ratio
(pcf)	(%)	(pcf)	Avg	Avg	e_o
100	21.9%	122	0.180	0.031	0.63

MONTGOMERY WATSON

By D. J. Montgomery Date 02/06/01 Client INEEL (CH2MHill) Sheet 1 of 2

Chkd. By P. Crouse Description C_c determination Job No. 2470178

Purpose: Determine (C_c) compression index for "old alluvium" for inclusion in settlement analysis.

Method: Utilize % compression vs applied pressure plots contained in the "Geotechnical Report for the Conceptual Design of the INEEL CERCLA Disposal Facility Waste Area Group 3, Operable Unit 3-13" Rev. 0)

The slopes of the "virgin" and recompression portions of the plot correspond to C_c' and C_r', respectively.

Assume:
- Materials tested from the "old alluvium" retrieved from borings CHM3, SPT 1, and SPT 4 are representative of the "old alluvium" below the landfill.
- G_s for clays = 2.65, & samples are saturated.
- Samples tested were undisturbed.

Calculations: See Figures 1-3 for curves and data used.

$$C_c' = \frac{\Delta \epsilon}{\log P_2/P_1} \checkmark \quad ; \quad C_c = C_c'(1+e_o) \checkmark$$

$$\gamma_{dry} = \frac{G_s}{1+e}\gamma_w \text{ (for saturated soil)} \checkmark$$

equations based on property definitions (Bowles, 1996 & Lambe & Whitman, 1969)

Determine e:

$$\Rightarrow \left[\gamma_{dry} = \frac{G_s}{1+e}\gamma_w\right] \cdot (1+e) \Rightarrow \left[(1+e)\gamma_{dry} = G_s\gamma_w\right] / \gamma_{dry}$$

$$\left[1+e = \frac{G_s\gamma_w}{\gamma_{dry}}\right] - 1 \Rightarrow e = \frac{G_s\gamma_w}{\gamma_{dry}} - 1 \checkmark$$

From: SPT 1 @ 43-44.5' (See Figure 1 attached)

$$C_c' = \frac{.04 - .00}{\log 30/20} = \frac{.04}{.398} = .1005. \checkmark$$

$$e_o = \frac{2.65(62.4)}{101 pcf} - 1 = .637 \Rightarrow C_c = .101(1+.637) = 0.165 \checkmark$$

From CHM3 @ 40-42.5' (See Figure 2 attached)

$$C_c' = \frac{0.121 - 0.049}{\log 30/6} = \frac{0.072}{0.698} = 0.103$$

$$e_o = \frac{2.65(62.4\,pcf)}{99\,pcf} - 1 = 0.670 \Rightarrow C_c = 0.103(1+0.670) = .172$$

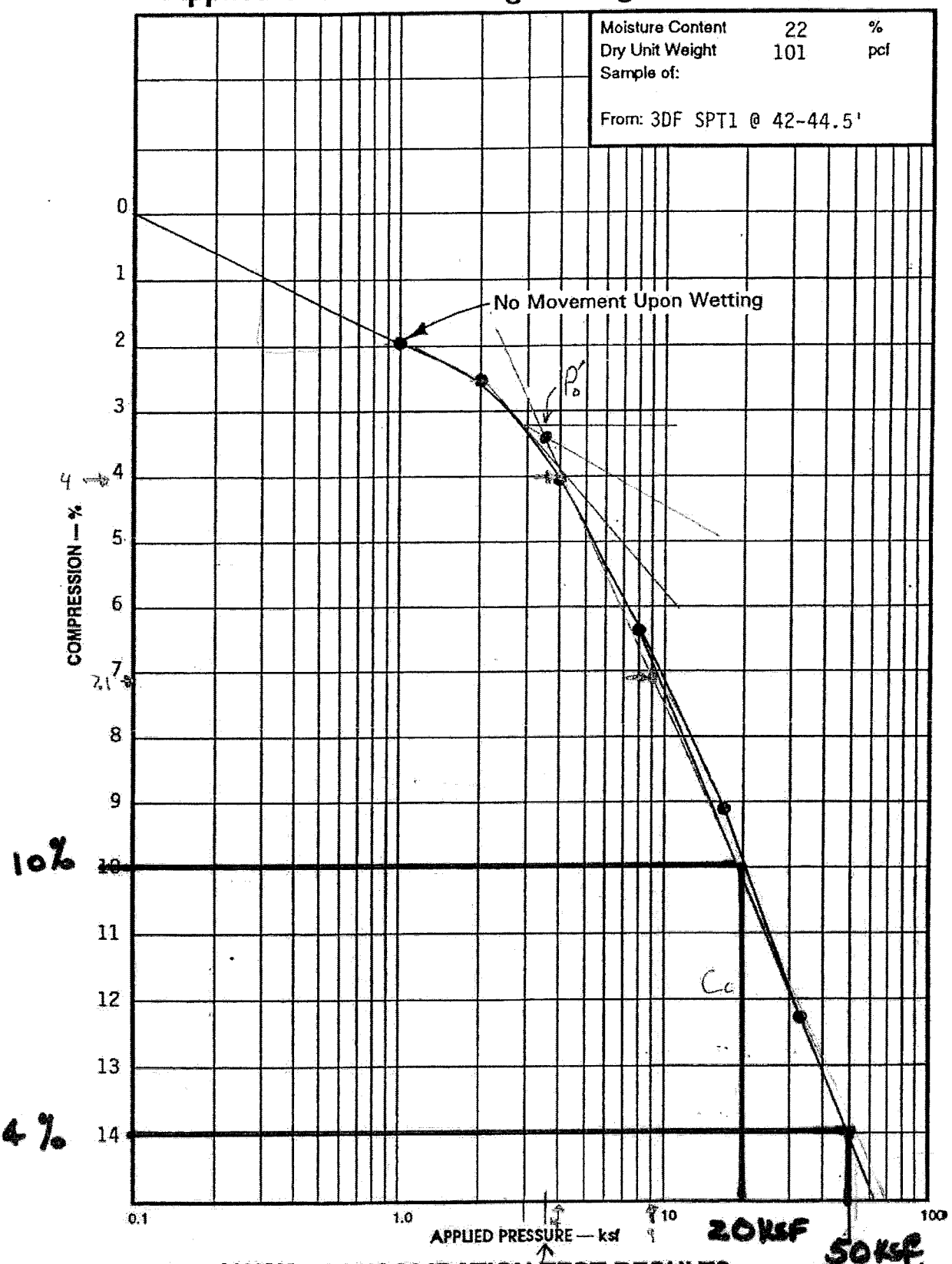
From SPT4 @ 44-48.5' (See Figure 3 attached)

$$C_c' = \frac{0.139 - 0.081}{\log 30/7} = \frac{0.073}{0.632} = 0.092$$

$$e_o = \frac{2.65(62.4\,pcf)}{100\,pcf} - 1 = 0.654 \Rightarrow C_c = 0.092(1+0.654) = 0.152$$

Based on a visual estimation of p_o' and the p_o' calculated (in settlement spreadsheet) based on the boring log for S-181 (SPT-2) the material is normally consolidated.

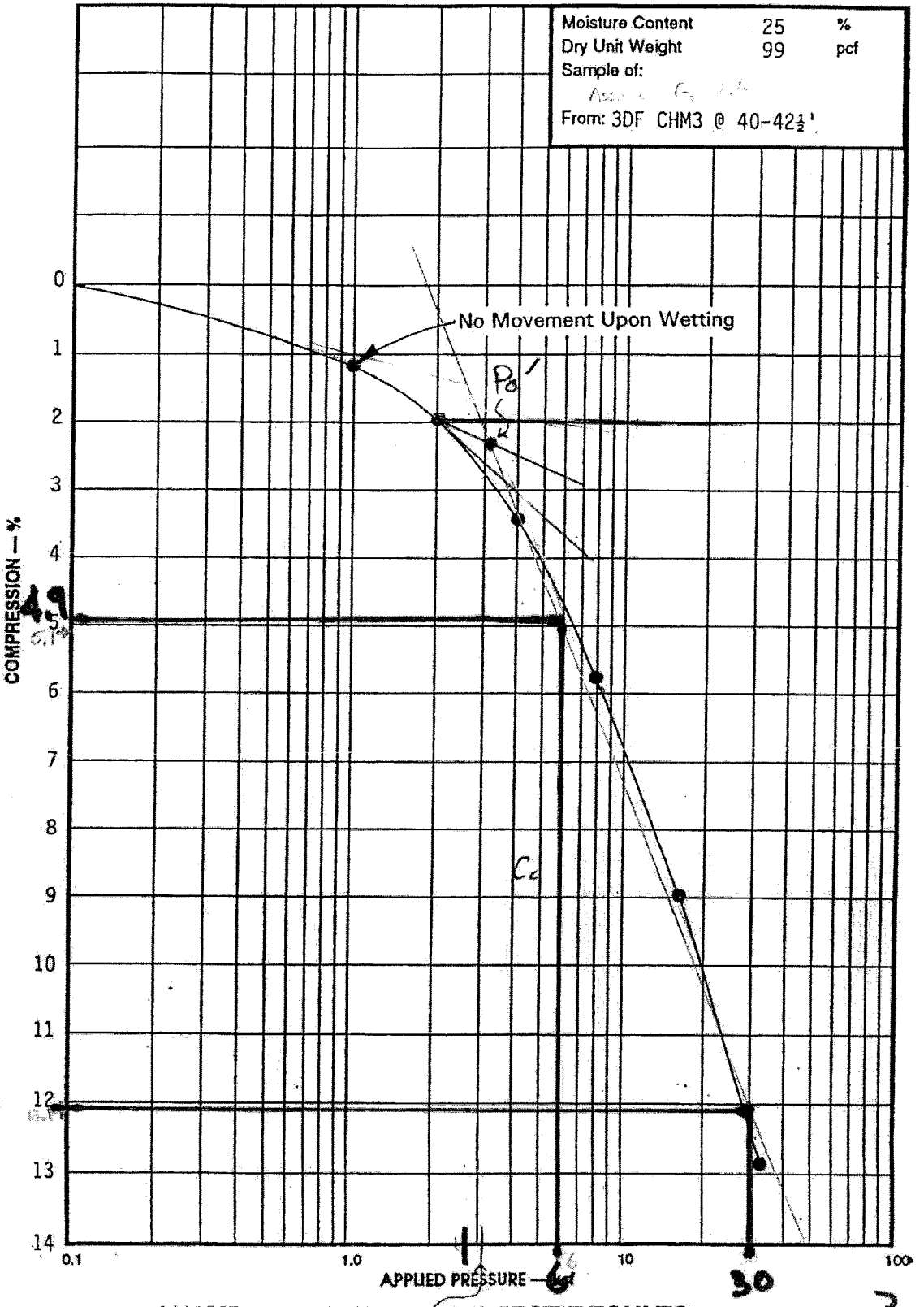
Applied Geotechnical Engineering Consultants, Inc.



Project No. 1000595 CONSOLIDATION TEST RESULTS Figure 1

FIG-1

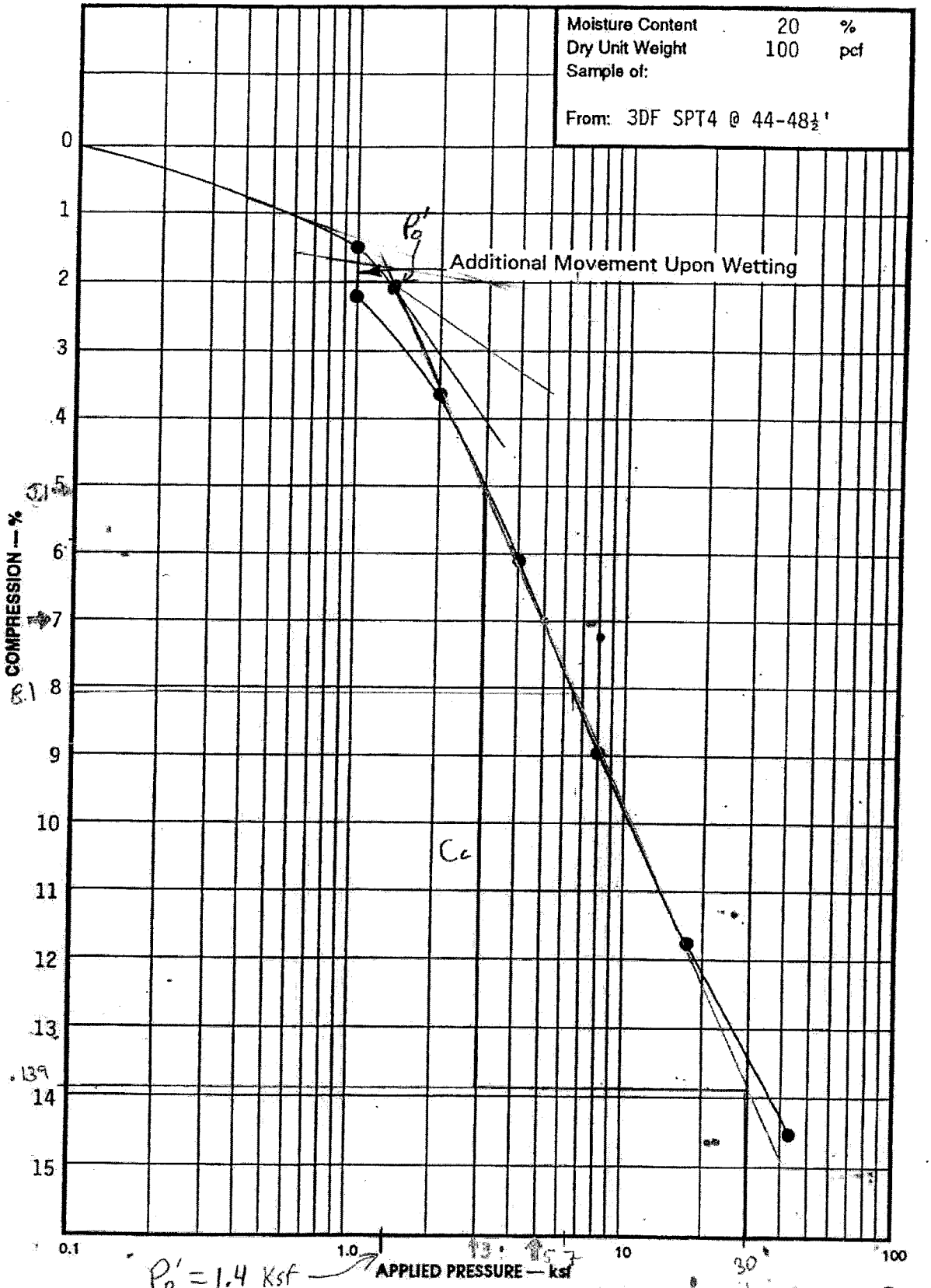
Applied Geotechnical Engineering Consultants, Inc.



Project No. 1000595 **CONSOLIDATION TEST RESULTS** Figure 2

Po = ~~2.8 KSF~~ 3.1 KSF CAB 6-12-01

Applied Geotechnical Engineering Consultants, Inc.



Project No. 1000595 **CONSOLIDATION TEST RESULTS** Figure 3

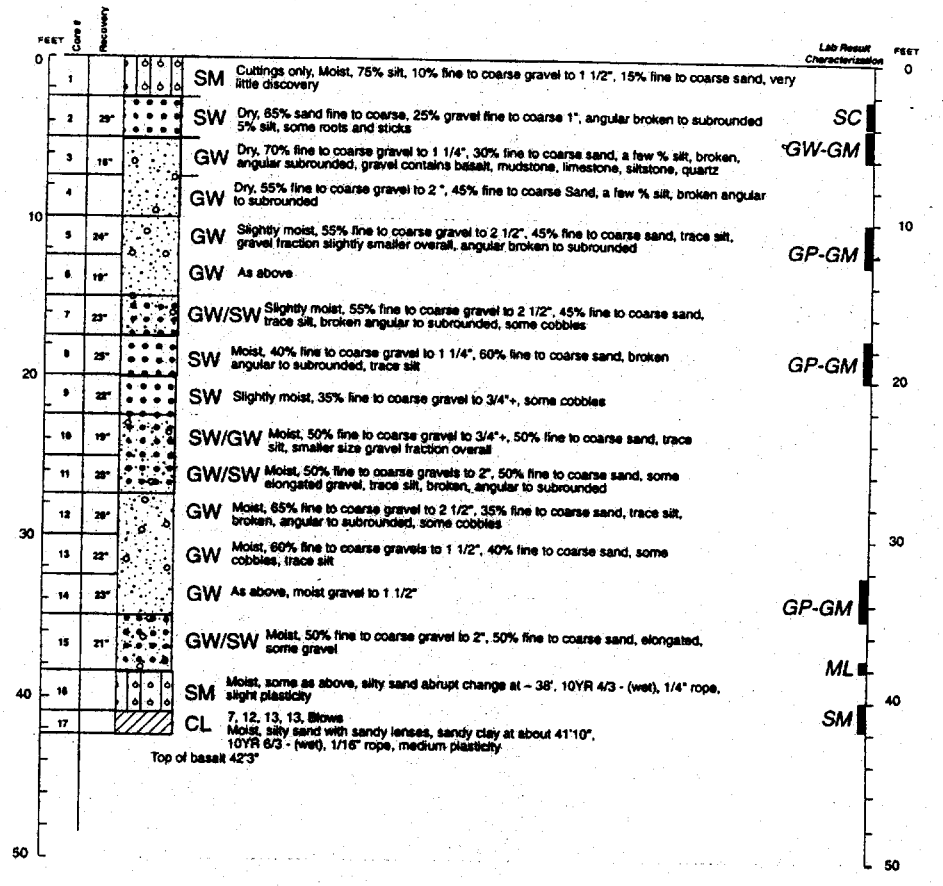
ICPP-BOR-S-181 (SPT-2)

WELL NAME: (SPT-2)
Facility: INTEC
Well Type: Characterization
Well Status: inactive
Year Drilled: 2000
Total Depth: 42'3"

Easting: 294960.7900(27)
Northing: 692296.4496(27)
Longitude:
Latitude:
Completion Depth:

Driller: R. Danielson
Geologist: Cheryl Whitaker
Drill Method: 4.25" ID Hollow Stem Auger
Drill Fluid:
Land Surface: 4921.60'

Todays Date: 8/2/00
Drilling Date: 7/11/00
Water Level: n/a
Water Level Date:
Water Level Access:



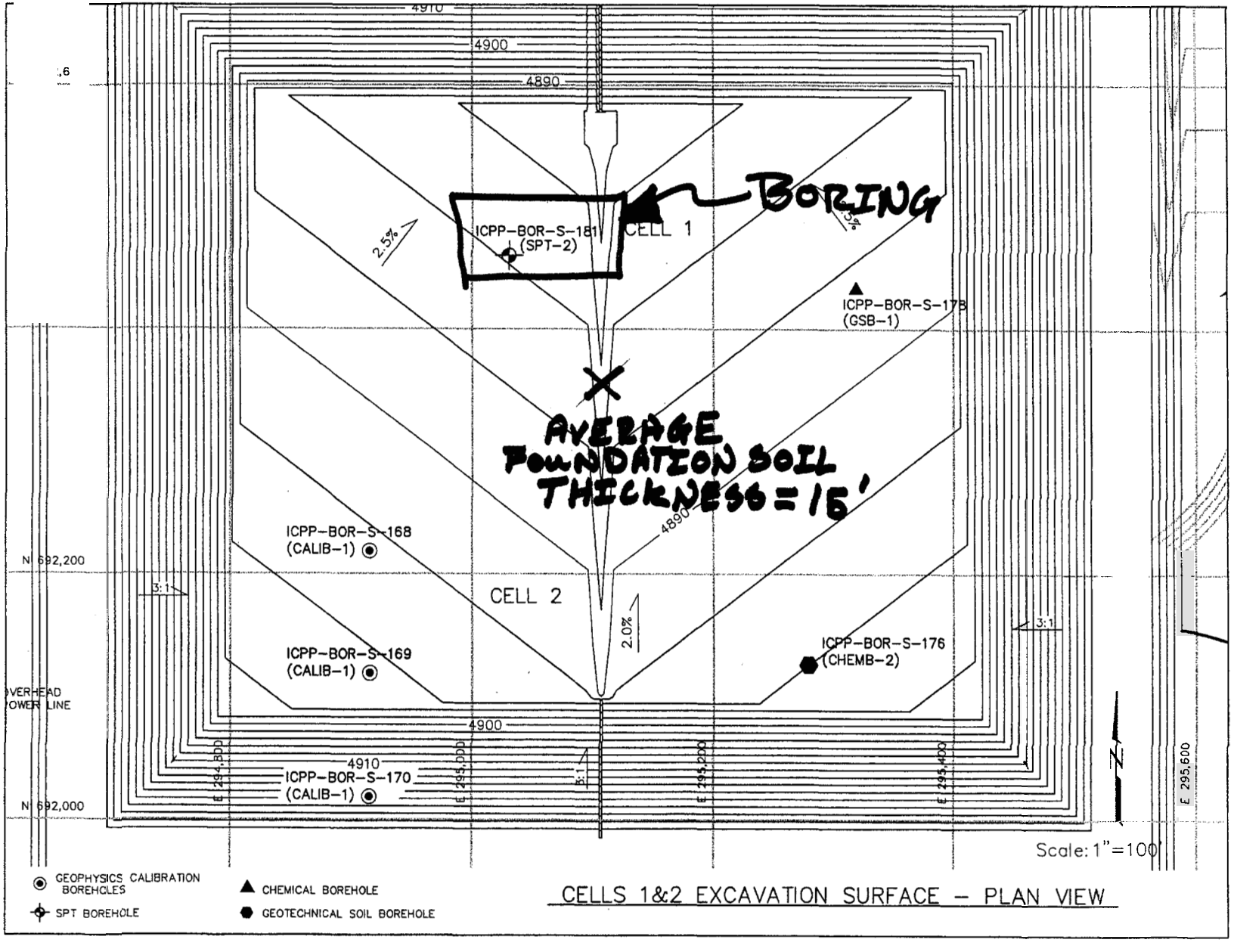

4910
4900
4890
BORING
ICPP-BOR-S-181
(SPT-2)
CELL 1
2.5%
5%
ICPP-BOR-S-178
(GSB-1)
AVERAGE
FOUNDATION SOIL
THICKNESS = 15'
4890
ICPP-BOR-S-168
(CALIB-1)
N 692,200
3:1
CELL 2
2.0%
3:1
ICPP-BOR-S-169
(CALIB-1)
ICPP-BOR-S-176
(CHEMB-2)
OVERHEAD
POWER LINE
4900
4910
ICPP-BOR-S-170
(CALIB-1)
N 692,000
E 294,800
E 295,000
5:1
E 295,200
E 295,400
E 295,600
Scale: 1"=100'
GEOPHYSICS CALIBRATION BOREHOLES
SPT BOREHOLE
CHEMICAL BOREHOLE
GEOTECHNICAL SOIL BOREHOLE
CELLS 1&2 EXCAVATION SURFACE – PLAN VIEW

TABLE 2-5
Correlation equations for soil compressibility/consolidation

Compression index, C_c	Comments	Source/Reference
$C_c = 0.009(w_L - 10)$ (±30% error)	Clays of moderate S_r	Terzaghi and Peck (1967)
$C_c = 0.37(e_o + 0.003w_L + 0.0004w_N - 0.34)$	678 data points	Azzouz et al. (1976)
$C_c = 0.141G_s\left(\frac{\gamma_{sat}}{\gamma_{dry}}\right)^{2.4}$	All clays	Rendon-Herrero (1983)
$C_c = 0.0093w_N$	109 data points	Koppula (1981)
$C_c = -0.0997 + 0.009w_L + 0.0014I_P + 0.0036w_N + 0.1165e_o + 0.0025C_P$	109 data points	Koppula (1981)
$C_c = 0.329[w_NG_s - 0.027w_P + 0.0133I_P(1.192 + C_P/I_P)$	All inorganic clays	Carrier (1985)
$C_c = 0.046 + 0.0104I_P$	Best for $I_P < 50\%$	Nakase et al. (1988)
$C_c = 0.00234w_LG_s$	All inorganic clays	Nagaraj and Srinivasa Murthy (1985, 1986)
$C_c = 1.15(e_o - 0.35)$	All clays	Nishida (1956)
$C_c = 0.009w_N + 0.005w_L$	All clays	Koppula (1986)
$C_c = -0.156 + 0.411e_o + 0.00058w_L$	72 data points	Al-Khafaji and Andersland (1992)
Recompression index, C_r		
$C_r = 0.000463w_LG_s$		Nagaraj and Srinivasa Murthy (1985)
$C_r = 0.00194(I_P - 4.6)$	Best for $I_P < 50\%$	Nakase et al. (1988)
$= 0.05$ to $0.1C_c$	In desperation	
Secondary compression index, C_α		
$C_\alpha = 0.00168 + 0.00033I_P$		Nakase et al. (1988)
$= 0.0001w_N$		NAFAC DM7.1 p. 7.1–237
$C_\alpha = 0.032C_c$	$0.025 < C_\alpha < 0.1$	Mesri and Godlewski (1977)
$= 0.06$ to $0.07C_c$	Peats and organic soil	Mesri (1986)
$= 0.015$ to $0.03C_c$	Sandy clays	Mesri et al. (1990)

Notes: 1. Use w_L, w_P, w_N, I_P as percent, not decimal.
2. One may compute the in situ void ratio as $e_o = w_NG_s$ if $S \rightarrow 100$ percent.
3. C_P = percent clay (usually material finer than 0.002 mm).
4. Equations that use e_o, w_N, and w_L are for both normally and overconsolidated soils.

2.10.8 Compression Index Correlations and Preconsolidation

A reliable estimate of the *effective preconsolidation pressure* p'_c is difficult without performing a consolidation test. There have been a few correlations given for p'_c of which one was given by Nagaraj and Srinivasa Murthy (1985, 1986) for saturated soils preconsolidated by overburden pressure (as opposed to shrinkage or chemical factors):

$$\log_{10} p'_c = 5.97 - 5.32(w_N/w_L) - 0.25\log_{10} p'_o \qquad (2\text{-}50)$$

As an example, for

$$w_N = 25\%; \quad w_L = 50\% \text{ (liquid limit)};$$
$$p'_o = \gamma'_s z = 16 \times 3 \text{ m} = 48 \text{ kPa}$$

From: Bowles, J.E., 1996, *Foundation Analysis and Design*, Fifth Edition, McGraw-Hill Companies, Inc., New York.

Prepared By: Brodie Adams
Date: 03/14/02
Checked By:
Date: 14-May-2002

Title:

Comparison of consolidation samples, in the geotechnical report, DOE/ID-10812, to materials under the ICDF landfill footprint.

Purpose:

Show that the consolidation curves from boreholes SPT-1, SPT-4, and CHM-3 are representative of the old alluvium materials under the *ICDF Landfill.*

Given:

Consolidation tests were performed on:
SPT-1 from 42-44.5'
SPT-4 from 44-48.5'
CHEM-3 from 40-42.5'
Map of boring locations is presented on page 3/16

Method:

Compare the classification of these samples or ones directly adjacent to them to ones in the borings in the ICDF landfill, namely, SPT-2, GSB-1, and CHM-2.

Calculation:

The grain size curve and classification results for CHEM-3, 37.5-40.0', which is directly above the consolidation sample, is presented on, page 9/16. This shows that the material is classified as CL. CHM-2, 42.0-42.5' and GSB-1, 42.5-43.5' are also classified as CL's the results for these are presented on page 15/16 and page 13/16 respectively.

The sample immediately above the consolidation sample in SPT-1, 42-44.5' is classified as a GC (page 4/16), which has similar plasticity to the sample from CHEM-2, 42.0-42.5' (page 15/16) and will be conservative for the samples classified as SM and similar to those classified as CL.

The classification for SPT-4, 46.5-48.75' is classified as an SM. These classification results are shown on page 7/16. This overlaps with the sample used for the consolidation test. SPT-2, 40.0-41.0' is also classified as SM material and is shown on page 11/16.

Conclusion:

The samples from boreholes SPT-1, SPT-4, and CHM-3 used for the consolidation tests cover a range of materials similar to those found under the landfill and the results of the consolidation testing done on samples from these boreholes are acceptable for use in determining the settlement of the ICDF landfill.

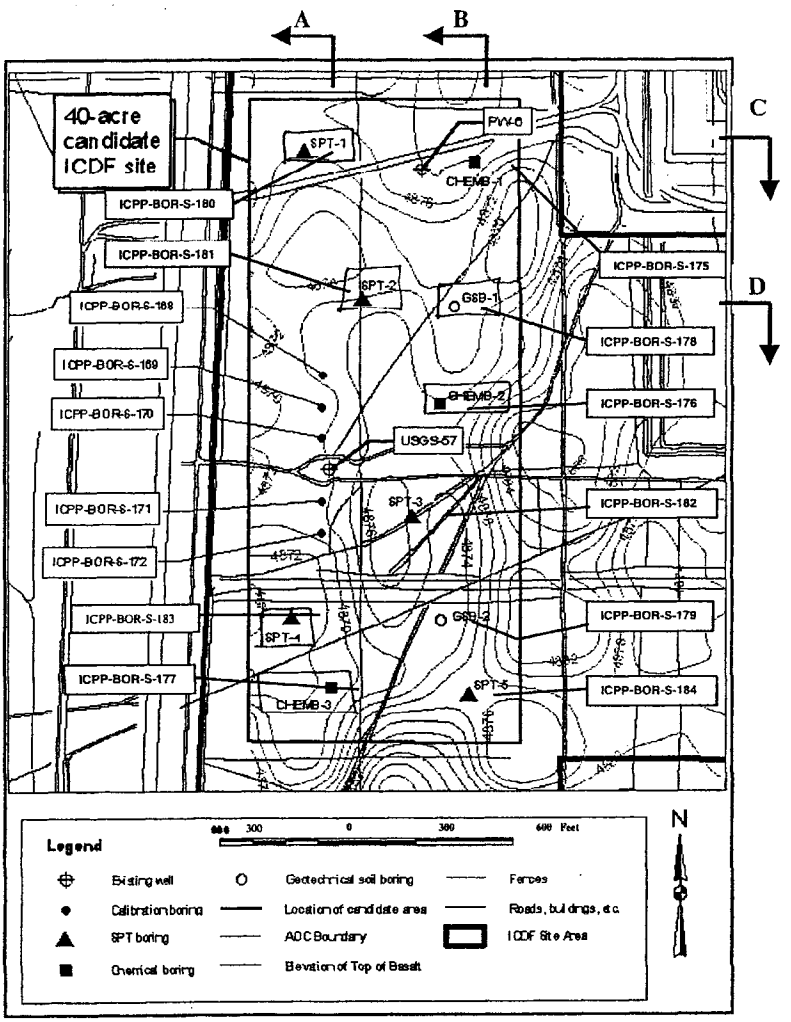
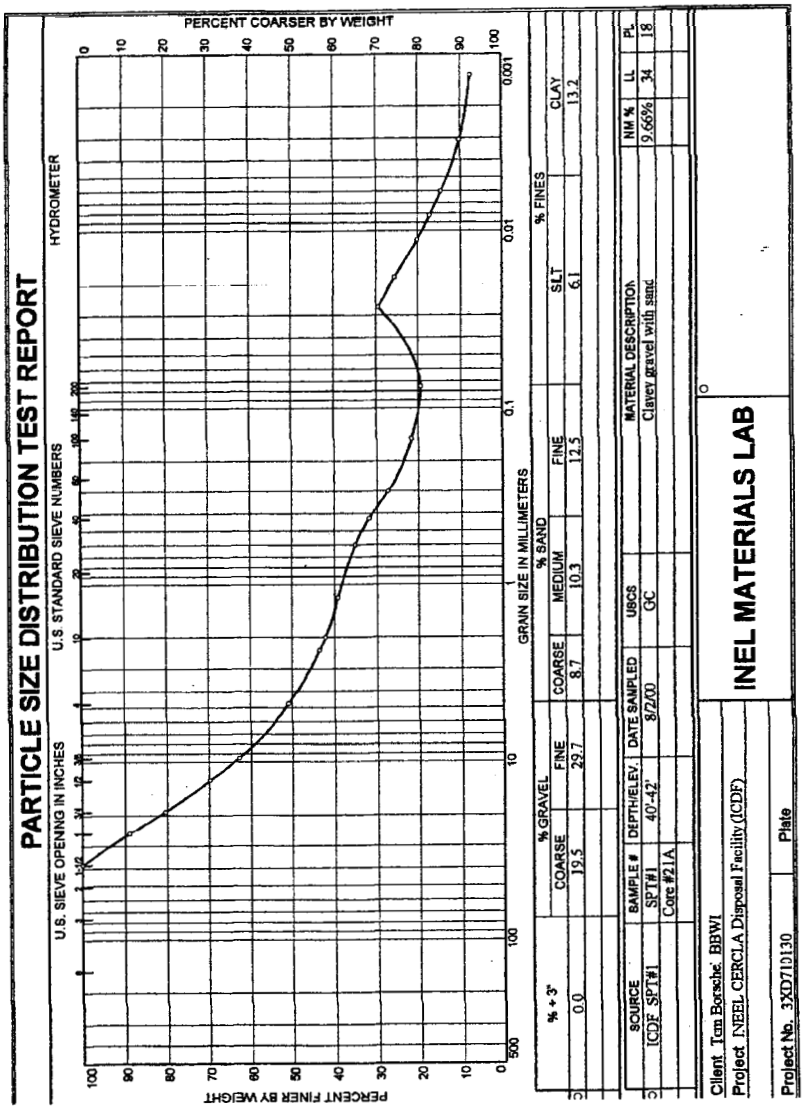


Figure 3-1. Geotechnical borehole locations.


PARTICLE SIZE DISTRIBUTION TEST REPORT
U.S. SIEVE OPENING IN INCHES
U.S STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT COARSER BY WEIGHT
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
% + 3"
% GRAVEL
COARSE
FINE
% SAND
COARSE
MEDIUM
FINE
% FINES
SILT
CLAY
0.0
19.5
29.7
8.7
10.3
12.5
6.1
13.2
SOURCE
SAMPLE #
DEPTH/ELEV.
DATE SAMPLED
USCS
MATERIAL DESCRIPTION
NM %
LL
PL
ICDF SPT#1
SPT#1
40-42'
8/2/00
OC
Clayey gravel with sand
9.66%
34
18
Core #21A
Client Tom Borsche, BBWI
Project INEEL CERCLA Disposal Facility (ICDF)
INEL MATERIALS LAB
Project No. 3XD710130
Plate

GRAIN SIZE DISTRIBUTION TEST DATA

Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF SPT#1
Sample No.: SPT#1 Core #21A
Elev. or Depth: 40'-42' **Sample Length (in./cm.):** 24"
Location: SPT#1
Description: Clayey gravel with sand
Date: 8/2/00 **Natural Moisture:** 9.66%
Liquid Limit: 34 **Plastic Limit:** 18 **USCS Class.:** GC
Testing Remarks:

Mechanical Analysis Data

	Initial
Dry sample and tare=	1760.00
Tare =	0.00
Dry sample weight =	1760.00

Sieve tare method

Sieve	Weight retained	Sieve tare	Percent finer
1.5 inch	0.00	0.00	100.0
1 inch	192.90	0.00	89.0
0.75 inch	151.00	0.00	80.5
0.50 inch	190.00	0.00	69.7
0.375 inch	121.50	0.00	62.8
# 4	210.40	0.00	50.8
# 8	128.10	0.00	43.5
# 10	25.20	0.00	42.1
# 16	50.50	0.00	39.2
# 30	75.20	0.00	35.0
# 40	55.20	0.00	31.8
# 50	80.00	0.00	27.3
# 100	99.10	0.00	21.6
# 200	40.90	0.00	19.3

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 42.1
Weight of hydrometer sample: 74.2
Hygroscopic moisture correction:
Moist weight & tare = 729.60
Dry weight & tare = 650.80
Tare = 0.00
Hygroscopic moisture= 12.1 %
Calculated biased weight= 157.21
Automatic temperature correction
Composite correction at 20 deg C = -3.0

Meniscus correction only= 1.0

INEL MATERIALS LAB

Specific gravity of solids= 2.60
Specific gravity correction factor= 1.012
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	23.0	48.0	49.0	0.0134	49.0	8.3	0.0271	29.4
5.00	23.0	42.0	43.0	0.0134	43.0	9.2	0.0182	25.5
15.00	23.0	33.5	34.5	0.0134	34.5	10.6	0.0112	20.1
30.00	23.0	29.0	30.0	0.0134	30.0	11.4	0.0082	17.2
60.00	23.0	25.0	26.0	0.0134	26.0	12.0	0.0060	14.6
250.00	23.0	18.0	19.0	0.0134	19.0	13.2	0.0031	10.1
1440.00	23.0	14.0	15.0	0.0134	15.0	13.8	0.0013	7.5

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% + 3" = 0.0 % GRAVEL = 49.2 (% coarse = 19.5 % fine = 29.7)
% SAND = 31.5 (% coarse = 8.7 % medium = 10.3 % fine = 12.5)
% SILT = 6.1 % CLAY = 13.2

D_{85}= 22.19 D_{60}= 8.35 D_{50}= 4.46
D_{30}= 0.37 D_{15}= 0.01 D_{10}= 0.00
C_c= 5.4297 C_u= 2776.679

INEL MATERIALS LAB

LIQUID AND PLASTIC LIMIT TEST DATA

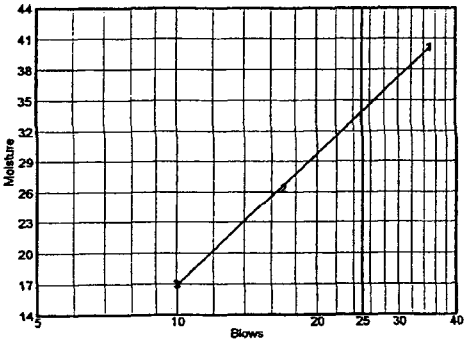
Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF SPT#1
Sample No.: SPT#1 Core #21A
Elev. or Depth: 40'-42' **Sample Length (in./cm.):** 24"
Location: SPT#1
Description: Clayey gravel with sand
Water Content: 9.66% **USCS:** GC **AASHTO:** A-2-6(0)
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	27.25	27.25	25.96			
Dry+Tare	22.63	23.87	23.80			
Tare	11.14	11.07	11.07			
# Blows	35	17	10			
Moisture	40.2	26.4	17.0			

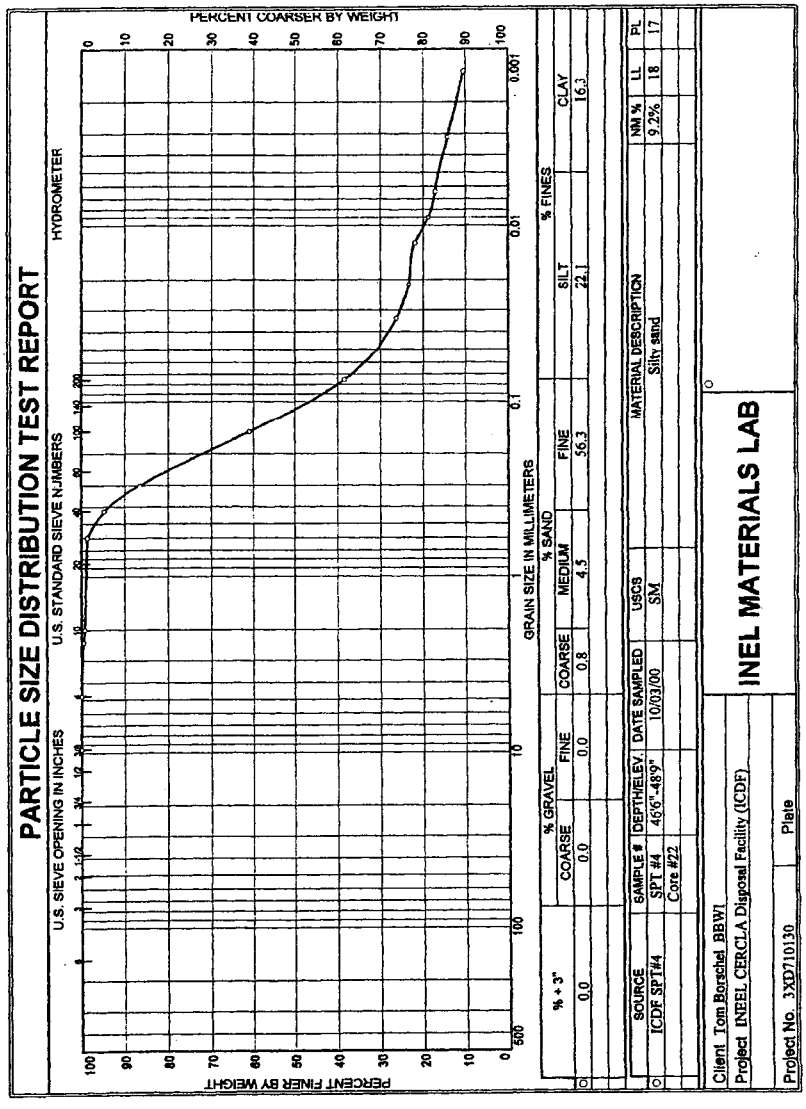


Liquid Limit= 34
Plastic Limit= 18
Plasticity Index= 16

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	8.04	8.50			
Dry+Tare	7.51	7.86			
Tare	4.33	4.44			
Moisture	16.7	18.7			

INEL MATERIALS LAB


PARTICLE SIZE DISTRIBUTION TEST REPORT
U.S. SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
% + 3"
% GRAVEL
COARSE
FINE
% SAND
COARSE
MEDIUM
FINE
% FINES
SILT
CLAY
0.0
0.0
0.0
0.8
4.5
56.3
22.1
16.3
SOURCE
SAMPLE #
DEPTH/ELEV.
DATE SAMPLED
USCS
MATERIAL DESCRIPTION
NM %
LL
PL
ICDF SPT#4
SPT #4
46'6"-48'9"
10/03/00
SM
Silty sand
9.2%
18
17
Core #22
Client Tom Borschel, BBWI
Project INEEL CERCLA Disposal Facility (ICDF)
INEL MATERIALS LAB
Project No. 3XD7110130
Plate

LIQUID AND PLASTIC LIMIT TEST DATA

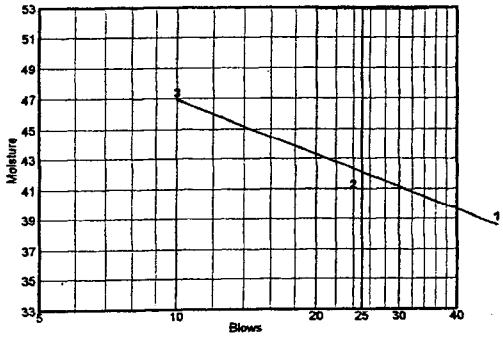
Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF SPT#4
Sample No.: SPT #4 Core #20
Elev. or Depth: 40'-42.5' **Sample Length (in./cm.):** 30"
Location: SPT #4
Description: Lean clay
Water Content: 30.2% **USCS:** CL **AASHTO:** A-7-6(24)
Testing Remarks: Sample tested from 41'6"-42.0'

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	23.63	23.38	26.25			
Dry+Tare	20.11	19.79	21.40			
Tare	11.10	11.10	11.17			
# Blows	49	24	10			
Moisture	39.1	41.3	47.4			



Liquid Limit= 42
Plastic Limit= 19
Plasticity Index= 23

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	7.38	7.15			
Dry+Tare	6.89	6.69			
Tare	4.34	4.34			
Moisture	19.2	19.6			

INEL MATERIALS LAB

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	24.0	66.0	67.0	0.0130	67.0	5.3	0.0212	94.1
5.00	24.0	61.0	62.0	0.0130	62.0	6.1	0.0144	86.7
15.00	24.0	54.0	55.0	0.0130	55.0	7.3	0.0091	76.4
30.00	24.0	48.0	49.0	0.0130	49.0	8.3	0.0068	67.6
60.00	24.0	43.5	44.5	0.0130	44.5	9.0	0.0050	61.0
250.00	24.0	32.5	33.5	0.0130	33.5	10.8	0.0027	44.8
1440.00	24.0	22.0	23.0	0.0130	23.0	12.5	0.0012	29.4

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% + 3" = 0.0 **% GRAVEL** = 0.0
% SAND = 1.8 (**% coarse** = 0.0 **% medium** = 0.1 **% fine** = 1.7)
% SILT = 37.3 **% CLAY** = 60.9

D_{85}= 0.01 D_{60}= 0.00 D_{50}= 0.00
D_{30}= 0.00

INEL MATERIALS LAB

GRAIN SIZE DISTRIBUTION TEST DATA

Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF SPT#4
Sample No.: SPT #4 Core #20
Elev. or Depth: 40'-42.5' **Sample Length (in./cm.):** 30"
Location: SPT #4
Description: Lean clay
Date: 10/03/00 **Natural Moisture:** 30.2%
Liquid Limit: 42 **Plastic Limit:** 19 **USCS Class.:** CL
Testing Remarks: Sample tested from 41'6"-42.0'

Mechanical Analysis Data

	Initial
Dry sample and tare=	131.70
Tare =	0.00
Dry sample weight =	131.70

Sieve tare method

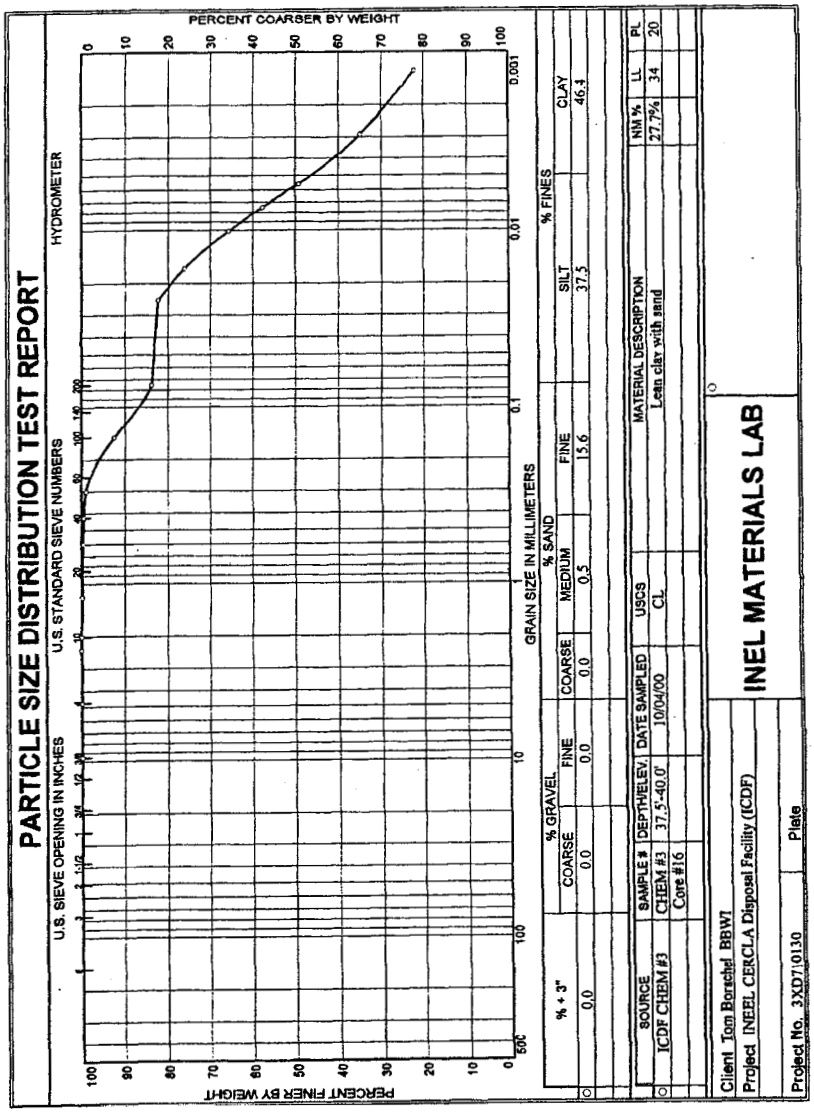
Sieve	Weight retained	Sieve tare	Percent finer
3/8 inch	0.00	0.00	100.0
# 4	0.00	0.00	100.0
# 8	0.00	0.00	100.0
# 10	0.00	0.00	100.0
# 16	0.00	0.00	100.0
# 30	0.10	0.00	99.9
# 40	0.10	0.00	99.9
# 50	0.20	0.00	99.7
# 100	0.50	0.00	99.3
# 200	1.50	0.00	98.2

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 100.0
Weight of hydrometer sample: 70.3
Hygroscopic moisture correction:
Moist weight & tare = 559.00
Dry weight & tare = 540.40
Tare = 0.00
Hygroscopic moisture= 3.4 %
Calculated biased weight= 67.96
Automatic temperature correction
Composite correction at 20 deg C = -3.0

Meniscus correction only= 1.0
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

INEL MATERIALS LAB


PARTICLE SIZE DISTRIBUTION TEST REPORT
U.S. SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT COARSER BY WEIGHT
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
% + 3"
% GRAVEL
COARSE
FINE
% SAND
COARSE
MEDIUM
FINE
% FINES
SILT
CLAY
0.0
0.0
0.0
0.0
0.5
15.6
37.5
46.4
SOURCE
SAMPLE #
DEPTH/ELEV.
DATE SAMPLED
USCS
MATERIAL DESCRIPTION
NM %
LL
PL
ICDF CHEM #3
CHEM #3
37.5'-40.0'
10/04/00
CL
Lean clay with sand
27.7%
34
20
Core #16
Client Tom Borschel BBWI
Project INEEL CERCLA Disposal Facility (ICDF)
INEL MATERIALS LAB
Project No. 3XD710130
Plate

GRAIN SIZE DISTRIBUTION TEST DATA

Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF CHEM #3
Sample No.: CHEM #3 Core #16
Elev. or Depth: 37.5'-40.0' **Sample Length (in./cm.):** 30"
Location: CHEM #3
Description: Lean clay with sand
Date: 10/04/00 **Natural Moisture:** 27.7%
Liquid Limit: 34 **Plastic Limit:** 20 **USCS Class.:** CL
Testing Remarks:

Mechanical Analysis Data

	Initial
Dry sample and tare=	197.50
Tare =	0.00
Dry sample weight =	197.50

Sieve tare method

Sieve	Weight retained	Sieve tare	Percent finer
3/8 inch	0.00	0.00	100.0
# 4	0.00	0.00	100.0
# 8	0.00	0.00	100.0
# 10	0.10	0.00	100.0
# 16	0.20	0.00	99.9
# 30	0.30	0.00	99.7
# 40	0.30	0.00	99.5
# 50	1.30	0.00	98.9
# 100	12.70	0.00	92.5
# 200	17.00	0.00	83.9

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 100.0
Weight of hydrometer sample: 65.0
Hygroscopic moisture correction:
  Moist weight & tare = 634.00
  Dry weight & tare = 614.50
  Tare = 0.00
  Hygroscopic moisture= 3.2 %
Calculated biased weight= 63.00
Automatic temperature correction
  Composite correction at 20 deg C = -4.5

Meniscus correction only= 1.0
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000
Hydrometer type: 152H
  Effective depth L= 16.294964 - 0.164 x Rm

INEL MATERIALS LAB

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	22.0	56.0	57.0	0.0133	57.0	6.9	0.0248	82.4
5.00	22.0	52.0	53.0	0.0133	53.0	7.6	0.0164	76.1
15.00	22.0	45.5	46.5	0.0133	46.5	8.7	0.0101	65.7
30.00	22.0	40.5	41.5	0.0133	41.5	9.5	0.0075	57.8
60.00	22.0	35.0	36.0	0.0133	36.0	10.4	0.0055	49.1
250.00	22.0	26.0	27.0	0.0133	27.0	11.9	0.0029	34.8
1440.00	22.0	18.0	19.0	0.0133	19.0	13.2	0.0013	22.1

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% + 3" = 0.0 **% GRAVEL** = 0.0
% SAND = 16.1 (**% coarse** = 0.0 **% medium** = 0.5 **% fine** = 15.6)
% SILT = 37.5 **% CLAY** = 46.4

D_{85}= 0.09 D_{60}= 0.01 D_{50}= 0.01
D_{30}= 0.00

INEL MATERIALS LAB

LIQUID AND PLASTIC LIMIT TEST DATA

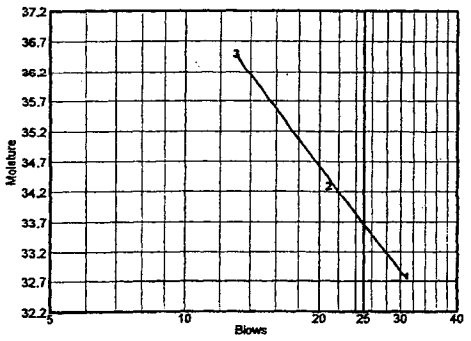
Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF CHEM #3
Sample No.: CHEM #3 Core #16
Elev. or Depth: 37.5'-40.0' **Sample Length (in./cm.):** 30"
Location: CHEM #3
Description: Lean clay with sand
Water Content: 27.7% **USCS:** CL **AASHTO:** A-6(11)
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	28.84	25.36	28.18			
Dry+Tare	24.43	21.71	23.60			
Tare	11.00	11.07	11.04			
# Blows	31	21	13			
Moisture	32.8	34.3	36.5			

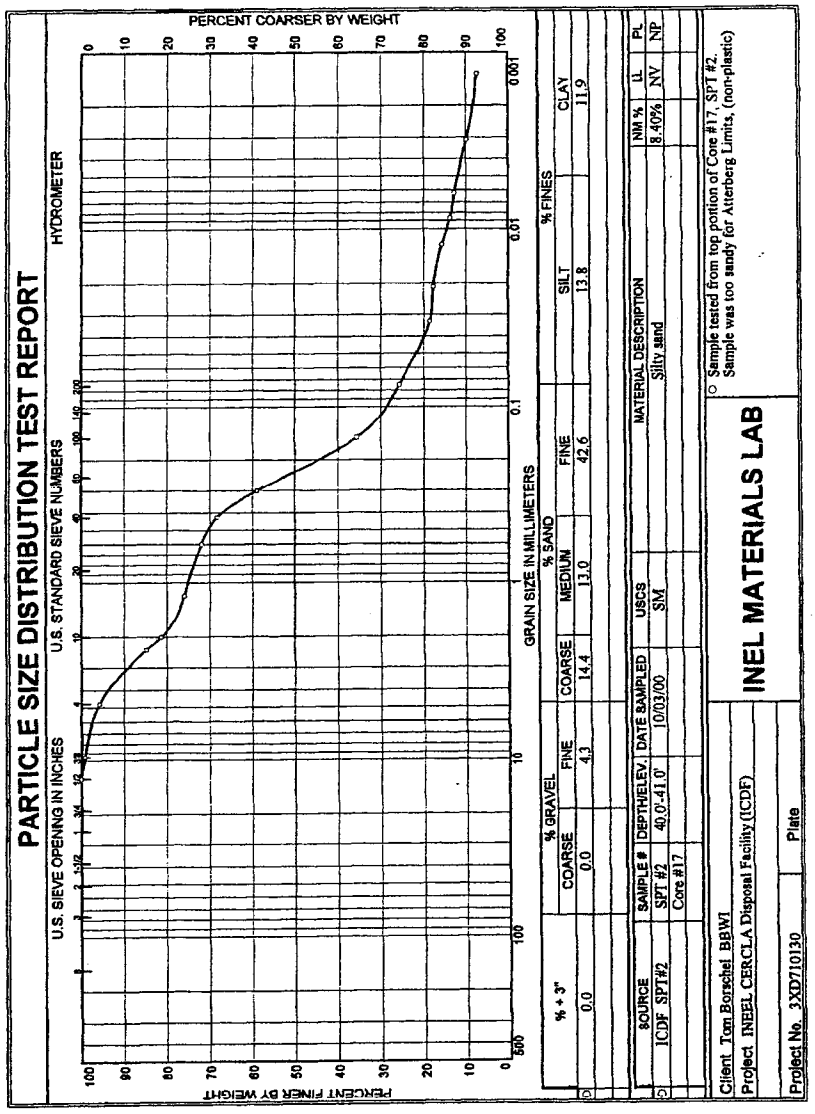


Liquid Limit= 34
Plastic Limit= 20
Plasticity Index= 14

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	8.10	9.42			
Dry+Tare	7.44	8.60			
Tare	4.34	4.33			
Moisture	21.3	19.2			

INEL MATERIALS LAB


PARTICLE SIZE DISTRIBUTION TEST REPORT
U.S. SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT COARSER BY WEIGHT
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
% + 3"
% GRAVEL
COARSE
FINE
% SAND
COARSE
MEDIUM
FINE
% FINES
SILT
CLAY
0.0
0.0
4.3
14.4
13.0
42.6
13.8
11.9
SOURCE
SAMPLE #
DEPTH/ELEV.
DATE SAMPLED
USCS
MATERIAL DESCRIPTION
NM %
LL
PL
ICDF SPT#2
SPT #2
40.0'-41.0'
10/03/00
SM
Silty sand
8.40%
NV
NP
Core #17
Sample tested from top portion of Core #17, SPT #2.
Sample was too sandy for Atterberg Limits, (non-plastic)
Client Tom Borschel, BBWI
Project INEEL CERCLA Disposal Facility (ICDF)
Project No. 23XD710130
Plate
INEL MATERIALS LAB

GRAIN SIZE DISTRIBUTION TEST DATA

Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF SPT#2
Sample No.: SPT #2 Core #17
Elev. or Depth: 40.0'-41.0' **Sample Length (in./cm.):** 12"
Location: SPT #2
Description: Silty sand
Date: 10/03/00 **Natural Moisture:** 8.40%
Liquid Limit: NV **Plastic Limit:** NP **USCS Class.:** SM
Testing Remarks: Sample tested from top portion of Core #17, SPT #2

Mechanical Analysis Data

	Initial
Dry sample and tare=	421.70
Tare =	0.00
Dry sample weight =	421.70

Sieve tare method

Sieve	Weight retained	Sieve tare	Percent finer
1/2 inch	0.00	0.00	100.0
3/8 inch	3.60	0.00	99.2
# 4	14.50	0.00	95.7
# 8	46.60	0.00	84.7
# 10	14.20	0.00	81.3
# 16	21.70	0.00	76.1
# 30	17.50	0.00	72.0
# 40	15.80	0.00	68.3
# 50	39.50	0.00	58.9
# 100	98.20	0.00	35.6
# 200	41.70	0.00	25.7

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 81.3
Weight of hydrometer sample: 83.5
Hygroscopic moisture correction:
Moist weight & tare = 456.60
Dry weight & tare = 452.30
Tare = 0.00
Hygroscopic moisture= 1.0 %
Calculated biased weight= 101.74
Automatic temperature correction
Composite correction at 20 deg C = -3.0

Meniscus correction only= 1.0
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

INEL MATERIALS LAB

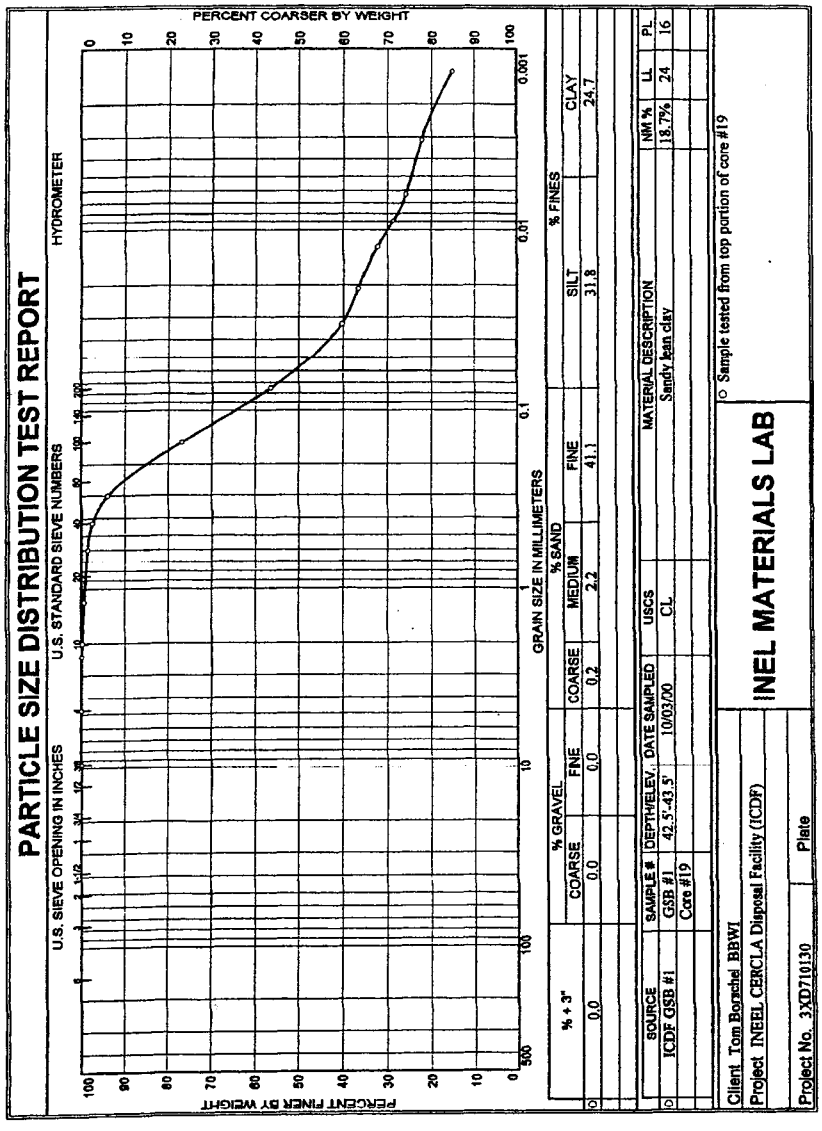
Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	24.0	21.0	22.0	0.0130	22.0	12.7	0.0327	18.6
5.00	24.0	20.0	21.0	0.0130	21.0	12.9	0.0208	17.6
15.00	24.0	18.0	19.0	0.0130	19.0	13.2	0.0122	15.7
30.00	24.0	16.0	17.0	0.0130	17.0	13.5	0.0087	13.7
60.00	24.0	15.0	16.0	0.0130	16.0	13.7	0.0062	12.7
250.00	24.0	12.0	13.0	0.0130	13.0	14.2	0.0031	9.8
1440.00	24.0	9.5	10.5	0.0130	10.5	14.6	0.0013	7.3

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% + 3" = 0.0 **% GRAVEL** = 4.3 **(% coarse** = 0.0 **% fine** = 4.3)
% SAND = 70.0 **(% coarse** = 14.4 **% medium** = 13.0 **% fine** = 42.6)
% SILT = 13.8 **% CLAY** = 11.9

D_{85}= 2.39 D_{60}= 0.31 D_{50}= 0.23
D_{30}= 0.11 D_{15}= 0.01 D_{10}= 0.00
C_C= 12.3972 C_U= 95.5936

INEL MATERIALS LAB


PARTICLE SIZE DISTRIBUTION TEST REPORT
U.S. SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT COARSER BY WEIGHT
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
% + 3"
% GRAVEL
COARSE
FINE
% SAND
COARSE
MEDIUM
FINE
% FINES
SILT
CLAY
0.0
0.0
0.0
0.2
2.2
41.1
31.8
24.7
SOURCE
SAMPLE #
DEPTH/ELEV.
DATE SAMPLED
USCS
MATERIAL DESCRIPTION
NM %
LL
PL
ICDF GSB #1
GSB #1
42.5'-43.5'
10/03/00
CL
Sandy lean clay
18.7%
24
16
Core #19
Sample tested from top portion of core #19
Client Tom Borschel, BBWI
Project INEEL CERCLA Disposal Facility (ICDF)
Project No. 3XD710130
Plate
INEL MATERIALS LAB

GRAIN SIZE DISTRIBUTION TEST DATA

Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF GSB #1
Sample No.: GSB #1 Core #19
Elev. or Depth: 42.5'-43.5' **Sample Length (in./cm.):** 12"
Location: GSB #1 top portion of core
Description: Sandy lean clay
Date: 10/03/00 **Natural Moisture:** 18.7%
Liquid Limit: 24 **Plastic Limit:** 16 **USCS Class.:** CL
Testing Remarks: Sample tested from top portion of core #19

Mechanical Analysis Data

	Initial
Dry sample and tare=	186.70
Tare =	0.00
Dry sample weight =	186.70

Sieve tare method

Sieve	Weight retained	Sieve tare	Percent finer
3/8 inch	0.00	0.00	100.0
# 4	0.00	0.00	100.0
# 8	0.00	0.00	100.0
# 10	0.30	0.00	99.8
# 16	1.00	0.00	99.3
# 30	1.40	0.00	98.6
# 40	1.70	0.00	97.6
# 50	7.00	0.00	93.9
# 100	31.80	0.00	76.9
# 200	38.00	0.00	56.5

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 99.8
Weight of hydrometer sample: 56.5
Hygroscopic moisture correction:
  Moist weight & tare = 625.40
  Dry weight & tare = 614.00
  Tare = 0.00
  Hygroscopic moisture= 1.9 %
Calculated biased weight= 55.58
Automatic temperature correction
  Composite correction at 20 deg C = -3.0

Meniscus correction only= 1.0
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000
Hydrometer type: 152H
  Effective depth L= 16.294964 - 0.164 x Rm

INEL MATERIALS LAB

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	22.0	25.0	26.0	0.0133	26.0	12.0	0.0327	40.3
5.00	22.0	23.0	24.0	0.0133	24.0	12.4	0.0209	36.7
15.00	22.0	20.5	21.5	0.0133	21.5	12.8	0.0123	32.2
30.00	22.0	18.5	19.5	0.0133	19.5	13.1	0.0088	28.6
60.00	22.0	17.0	18.0	0.0133	18.0	13.3	0.0063	25.9
250.00	22.0	15.0	16.0	0.0133	16.0	13.7	0.0031	22.3
1440.00	22.0	11.0	12.0	0.0133	12.0	14.3	0.0013	15.1

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% + 3" = 0.0 **% GRAVEL =** 0.0
% SAND = 43.5 **(% coarse =** 0.2 **% medium =** 2.2 **% fine =** 41.1**)**
% SILT = 31.8 **% CLAY =** 24.7

D_{85}= 0.20 D_{60}= 0.09 D_{50}= 0.06
D_{30}= 0.01

INEL MATERIALS LAB

LIQUID AND PLASTIC LIMIT TEST DATA

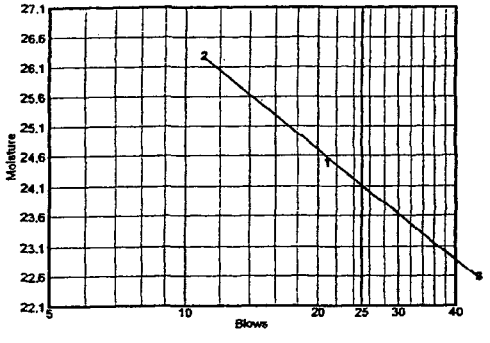
Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF GSB #1
Sample No.: GSB #1 Core #19
Elev. or Depth: 42.5'-43.5' **Sample Length (in./cm.):** 12"
Location: GSB #1 top portion of core
Description: Sandy lean clay
Water Content: 18.7% **USCS:** CL **AASHTO:** A-4(2)
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.29	29.17	30.28			
Dry+Tare	25.72	25.42	26.75			
Tare	11.15	11.17	11.16			
# Blows	21	11	45			
Moisture	24.5	26.3	22.6			

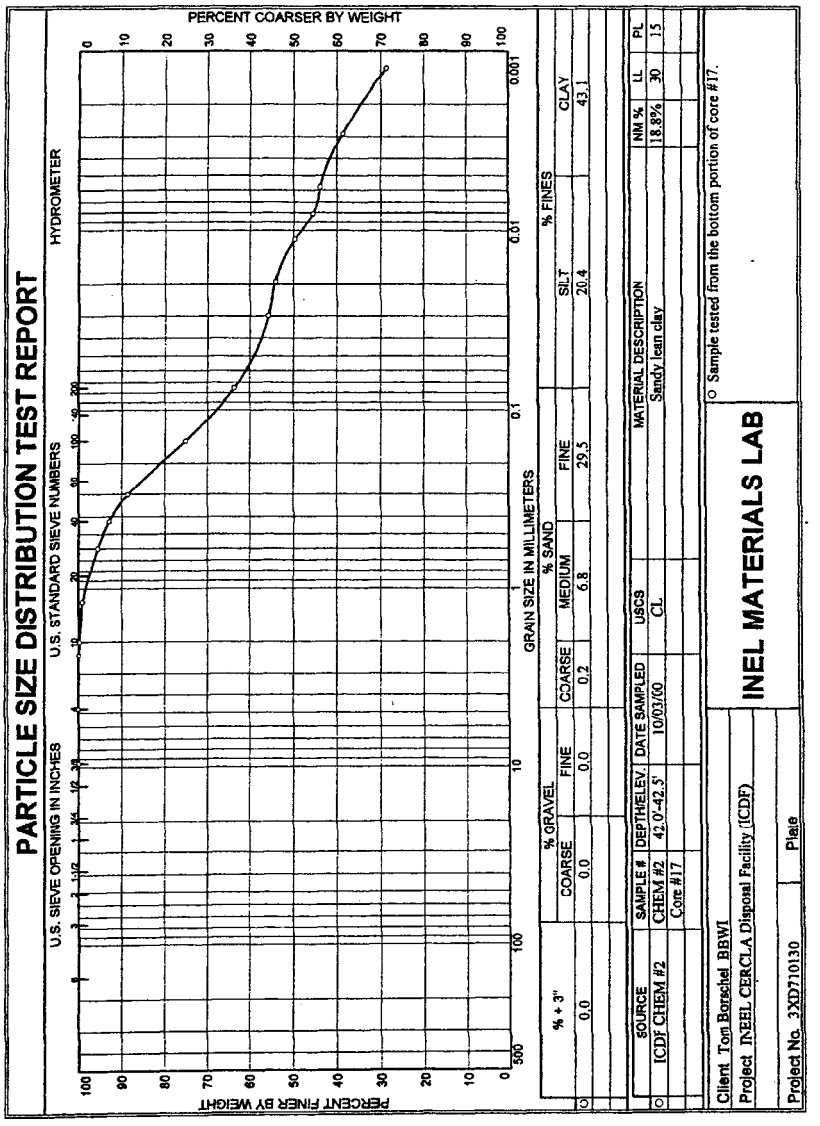


Liquid Limit= 24
Plastic Limit= 16
Plasticity Index= 8

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	9.18	9.28			
Dry+Tare	8.53	8.62			
Tare	4.37	4.36			
Moisture	15.6	15.5			

INEL MATERIALS LAB


PARTICLE SIZE DISTRIBUTION TEST REPORT
U.S. SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT COARSER BY WEIGHT
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
% + 3" | % GRAVEL (COARSE, FINE) | % SAND (COARSE, MEDIUM, FINE) | % FINES (SILT, CLAY)
0.0 | 0.0 | 0.0 | 0.2 | 6.8 | 29.5 | 20.4 | 43.1
SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PL
ICDF CHEM #2 | CHEM #2 | 42.0'-42.5' | 10/03/00 | CL | Sandy lean clay | 18.8% | 30 | 15
Core #17
Sample tested from the bottom portion of core #17.
Client Tom Borschel, BBWI
Project INEEL CERCLA Disposal Facility (ICDF)
Project No. 23XD710130 | Plate
INEL MATERIALS LAB

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	22.0	37.0	38.0	0.0133	38.0	10.1	0.0299	55.7
5.00	22.0	36.0	37.0	0.0133	37.0	10.2	0.0190	54.0
15.00	22.0	33.5	34.5	0.0133	34.5	10.6	0.0112	49.7
30.00	22.0	31.0	32.0	0.0133	32.0	11.0	0.0081	45.5
60.00	22.0	30.0	31.0	0.0133	31.0	11.2	0.0058	43.8
250.00	22.0	27.0	28.0	0.0133	28.0	11.7	0.0029	38.7
1440.00	22.0	21.0	22.0	0.0133	22.0	12.7	0.0012	28.6

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% + 3" = 0.0 % GRAVEL = 0.0
% SAND = 36.5 (% coarse = 0.2 % medium = 6.8 % fine = 29.5)
% SILT = 20.4 % CLAY = 43.1

D_{85}= 0.25 D_{60}= 0.06 D_{50}= 0.01
D_{30}= 0.00

INEL MATERIALS LAB

GRAIN SIZE DISTRIBUTION TEST DATA

Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF CHEM #2
Sample No.: CHEM #2 Core #17
Elev. or Depth: 42.0'-42.5' **Sample Length (in./cm.):** 6"
Location: CHEM #2 Bottom portion of Core #17
Description: Sandy lean clay
Date: 10/03/00 **Natural Moisture:** 18.8%
Liquid Limit: 30 **Plastic Limit:** 15 **USCS Class.:** CL
Testing Remarks: Sample tested from the bottom portion of core #17.

Mechanical Analysis Data

	Initial
Dry sample and tare=	184.00
Tare =	0.00
Dry sample weight =	184.00

Sieve tare method

Sieve	Weight retained	Sieve tare	Percent finer
3/8 inch	0.00	0.00	100.0
# 4	0.00	0.00	100.0
# 8	0.00	0.00	100.0
# 10	0.30	0.00	99.8
# 16	1.50	0.00	99.0
# 30	6.40	0.00	95.5
# 40	4.60	0.00	93.0
# 50	8.30	0.00	88.5
# 100	24.60	0.00	75.2
# 200	21.50	0.00	63.5

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 99.8
Weight of hydrometer sample: 60.0
Hygroscopic moisture correction:
Moist weight & tare = 556.30
Dry weight & tare = 547.20
Tare = 0.00
Hygroscopic moisture= 1.7 %
Calculated biased weight= 59.14
Automatic temperature correction
Composite correction at 20 deg C = -4.5

Meniscus correction only= 1.0
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

INEL MATERIALS LAB

LIQUID AND PLASTIC LIMIT TEST DATA

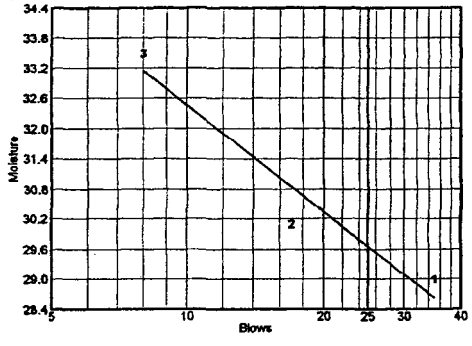
Client: Tom Borschel BBWI
Project: INEEL CERCLA Disposal Facility (ICDF)
Project Number: 3XD710130

Sample Data

Source: ICDF CHEM #2
Sample No.: CHEM #2 Core #17
Elev. or Depth: 42.0'-42.5' **Sample Length (in./cm.):** 6"
Location: CHEM #2 Bottom portion of Core #17
Description: Sandy lean clay
Water Content: 18.8% **USCS:** CL **AASHTO:** A-6(7)
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	26.20	26.40	29.02			
Dry+Tare	22.81	22.86	24.54			
Tare	11.10	11.10	11.17			
# Blows	35	17	8			
Moisture	29.0	30.1	33.5			



Liquid Limit= 30
Plastic Limit= 15
Plasticity Index= 15

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	8.12	7.57			
Dry+Tare	7.63	7.14			
Tare	4.34	4.34			
Moisture	14.9	15.4			

INEL MATERIALS LAB

Appendix B

Soil Bentonite Liner Properties

Borrow Clay Properties

Boring & Sample ID	USCS	w_n (%)	LL	PL	I_P	Retained on #4 Sieve (%)	Passing #200 Sieve (%)	$\gamma_{dry\ (Max)}$ (pcf)	w_{opt} (%)	$\gamma_{dry\ (95\%Max)}$ (pcf)	γ_{total} (95%Max) @ w_{opt} (pcf)	void ratio (G_s=2.65) (e)	C_c Terzaghi& Peck (1948)+- 30%	C_c Koppula (1981)	C_c Nakase et al. (1988)	C_α Nakase et al. (1988)	C_α NAFAC DM7.1	C_α Mesri et al. (1990)	C_c Avg	C_α Avg
3-O #1	CL-ML	8.7%	20	13	7	0.0%	50.0%	110	18%	104.5	123.31	0.58	0.090	0.121	0.119	0.0040	0.0009	0.0033	0.110	0.0027
3-O #2	CL	9.7%	39	14	25	0.0%	86.3%	106	20%	100.7	120.84	0.64	0.261	0.130	0.306	0.0099	0.0010	0.0070	0.232	0.0060
3-Palt #1	CL	12.2%	36	18	18	0.0%	86.0%	107	19%	101.65	120.96	0.63	0.234	0.167	0.233	0.0076	0.0012	0.0063	0.212	0.0051
3-Palt #2	CL	9.2%	34	18	16	0.0%	89.5%	112	18%	106.4	125.55	0.55	0.216	0.167	0.212	0.0070	0.0009	0.0060	0.199	0.0046
3-Q #1	CL	11.1%	37	17	20	0.0%	90.5%	114	16%	108.3	125.63	0.53	0.243	0.158	0.254	0.0083	0.0011	0.0066	0.218	0.0053
3-Q #2	CL	8.0%	28	14	14	0.0%	71.3%						0.162	0.130	0.192	0.0063	0.0008	0.0048	0.161	0.0040
1-O #1	CL	10.4%	33	18	15	0.1%	91.9%	106	18%	100.7	118.83	0.64	0.207	0.167	0.202	0.0066	0.0010	0.0058	0.192	0.0045
1-O #2	CL	11.3%	33	16	17	0.0%	92.6%	105	20%	99.75	119.70	0.66	0.207	0.149	0.223	0.0073	0.0011	0.0058	0.193	0.0047
1-P #1	CL	9.2%	28	18	10	0.0%	77.9%	111	16%	105.45	122.32	0.57	0.162	0.167	0.150	0.0050	0.0009	0.0048	0.160	0.0036
1-P#2	CL	11.4%	38	17	21	0.3%	94.0%	107	19%	101.65	120.96	0.63	0.252	0.158	0.264	0.0086	0.0011	0.0067	0.225	0.0055
1-Q #1	CL	12.7%	44	16	28	0.0%	92.9%	104	19%	98.8	117.57	0.67	0.306	0.149	0.337	0.0109	0.0013	0.0079	0.264	0.0067
1-Q #2	CL	12.6%	36	19	17	0.3%	95.3%	110	20%	104.5	125.40	0.58	0.234	0.177	0.223	0.0073	0.0013	0.0063	0.211	0.0050
	AVERAGE:		33.8	16.5	17.3	0.06%	85%	108.4	18.5%	102.9	121.92	0.61						Average:	0.198	0.005

Clay Liner Properties

CLAY LINER BORROW PIT

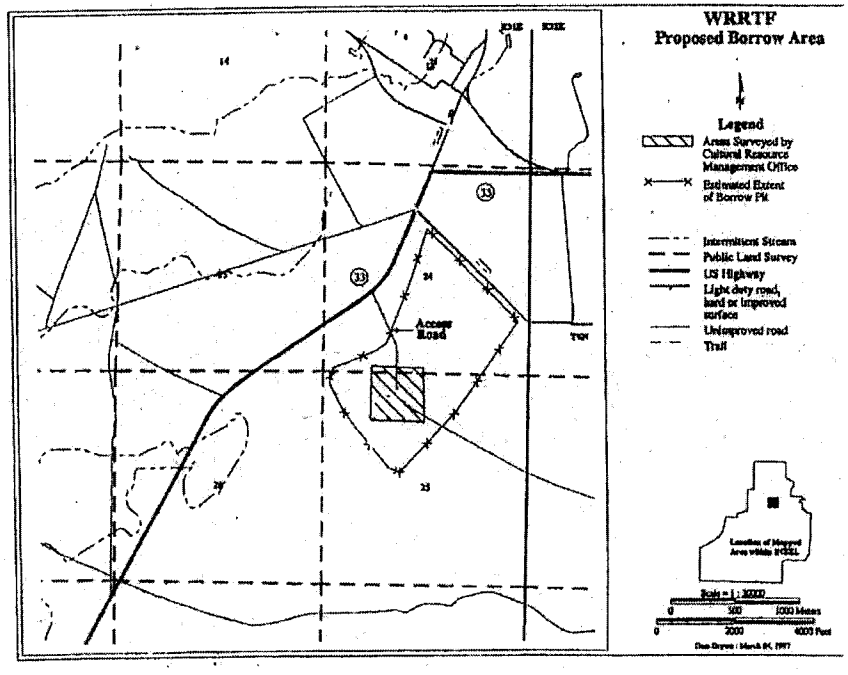


Figure 4-1. Proposed borrow source area at WRRTF.

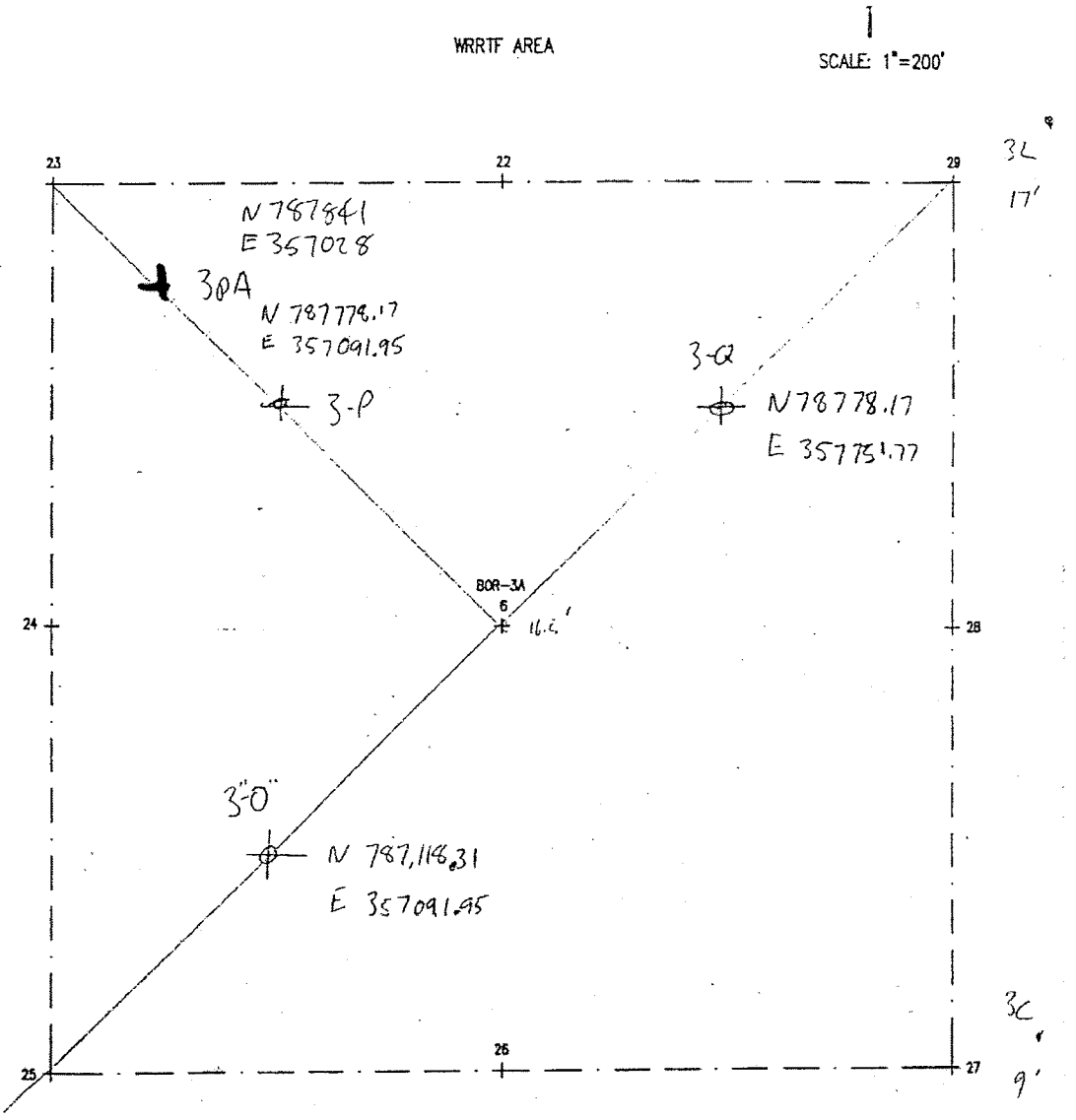
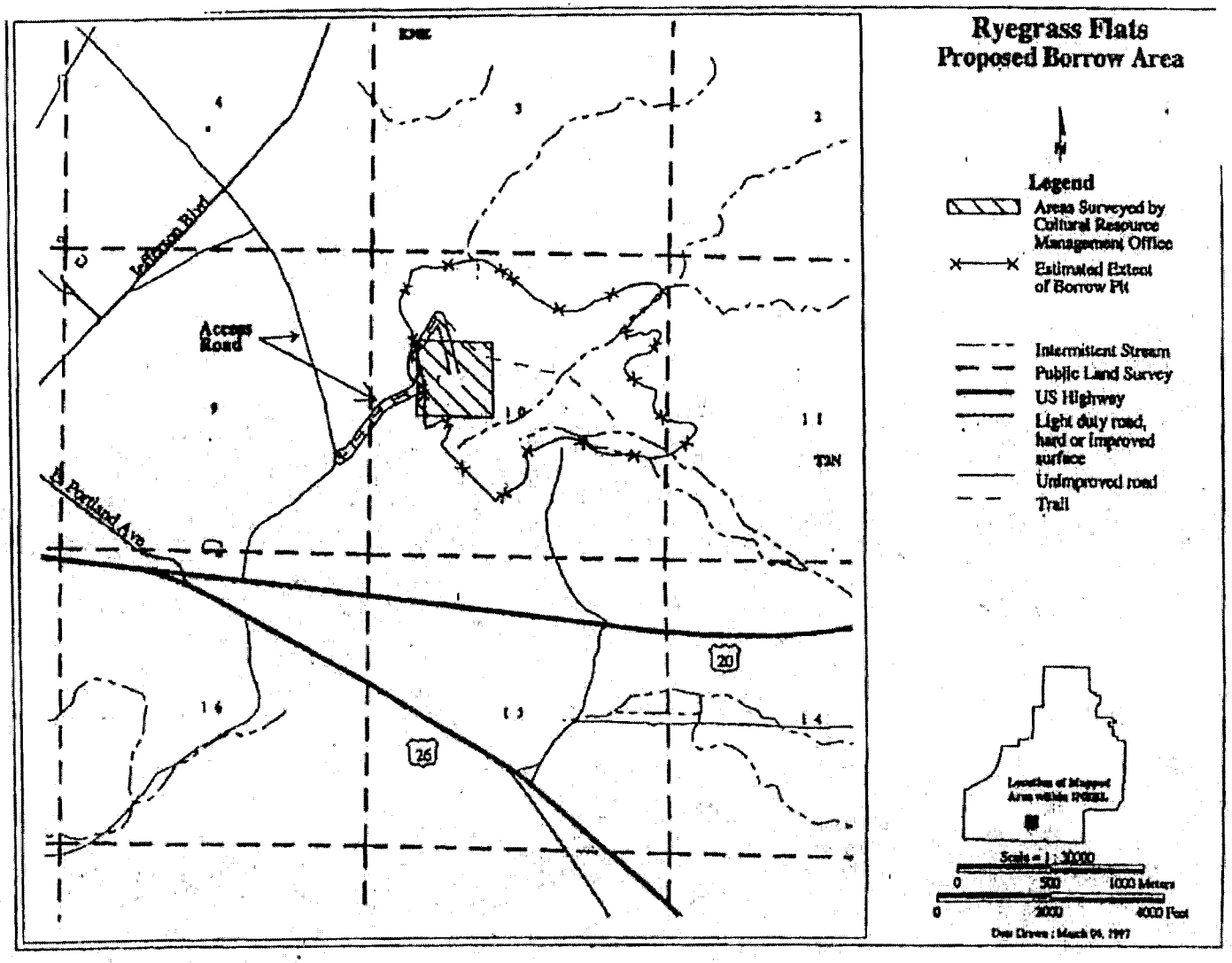


Figure 4-3. WRRTF boring locations.


Ryegrass Flats
Proposed Borrow Area
Legend
Area Surveyed by Cultural Resource Management Office
Estimated Extent of Borrow Pit
Intermittent Stream
Public Land Survey
US Highway
Light duty road, hard or improved surface
Unimproved road
Trail
Access Road
Jefferson Blvd
Portland Ave
T2N
20
26
Scale = 1 : 30000
0
500
1000 Meters
0
2000
4000 Feet

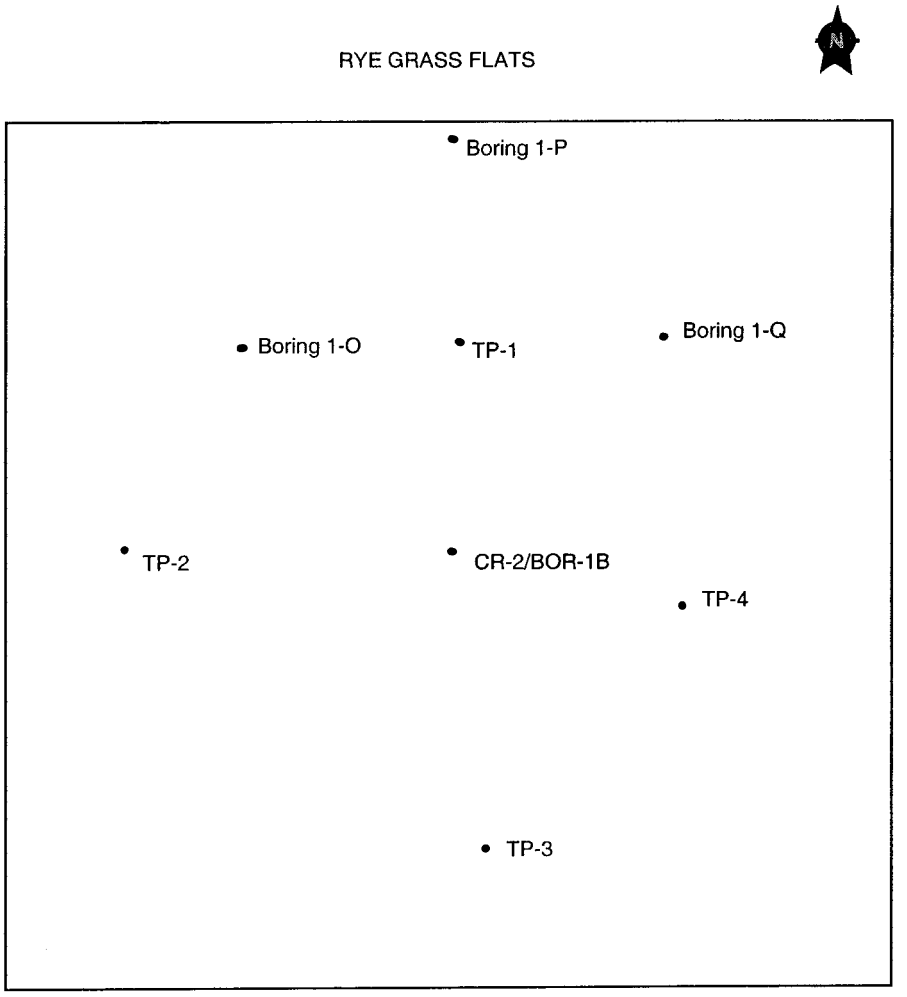
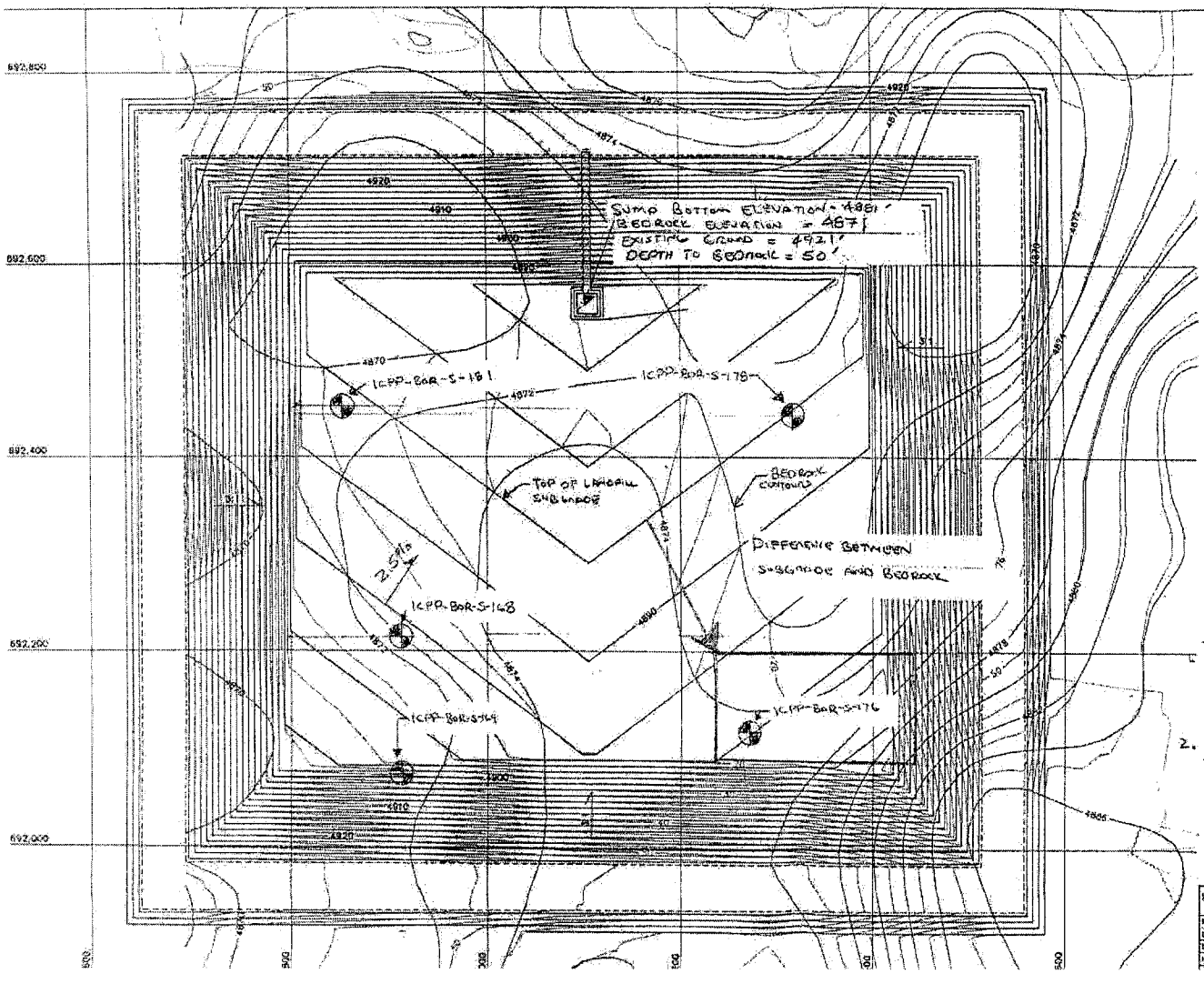


Figure 4-4. Rye Grass Flats boring and test pit locations.

Appendix C

Waste Soil and Cover Properties



REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

DEPTH TO BEDROCK FROM ALLUVIUM

LANDFILL EXCAVATION DEPTH

TABLE 1

Boring	Surface Elevation	Drilled Depth	Geophysics Depth	Diff. (Ft)
ings for Geophysical Study				
ICPP-BOR-S-168	4922	43'-5"	50' 29.5'	15
ICPP-BOR-S-169	4922	48'-10"	49' 26.0'	0.2
ICPP-BOR-S-170	4922	49'-0"	52'	6
ICPP-BOR-S-171	4922	53'-0"	51'	-4
ICPP-BOR-S-172	4922	48'-10"	51'	4
for ICDF Geotechnical Siting				
ICPP-BOR-S-178	4920	44'-3"	48.5 49' 32'	11
ICPP-BOR-S-179	4921	41'-1"	48'	17
ICPP-BOR-S-175	4918	35'-11"	38'	5
ICPP-BOR-S-176	4920	44'-11"	41' 46' 26'	2
ICPP-BOR-S-177	4922	47'-5"	51'	8
ICPP-BOR-S-180	4921	45'-11"	45'	-2
ICPP-BOR-S-181	4921	42'-3"	48' 49' 32.5'	16
ICPP-BOR-S-182	4921	41'-4"	42'	2
ICPP-BOR-S-183	4922	48'-9"	49'	0.5
ICPP-BOR-S-184	4922	42'-2"	45'	7
USGS-57	4922	54'	52'	-4
PW-6	4919	36'	39'	8

Notes

1. BEDROCK CONTOURS PROVIDED BY SAGE EARTH SCIENCE WITH PERMISSION. CONTOURS BASED ON THE PHASE I GEOPHYSICAL SURVEY PERFORMED IN FEBRUARY 2000.
2. TABLE 1 FROM DATA SUMMARIZED IN THIS GEOTECHNICAL REPORT FOR THE CONCEPTUAL DESIGN OF THE INEEL CERCLA DISPOSAL FACILITY AT WASTE AREA GROUP 3 OPERABLE UNIT 3.

SUBCONTRACT NO.	
INITIATOR	
DESIGN PHILIP CROUSE	
DRAWN JANET BOYER	
PROJECT NO.	

INEEL

INTEC
CPP-13
INEEL CERCLA DISPOSAL FACILITY (ICDF)
CALCULATION SHEET - CELLS 1 & 2
DEPTH TO BEDROCK FROM SUBGRADE

MONTGOMERY WATSON

By P. CROUSE Date 03/30/01 Client BBWI Sheet 1 of 2

Chkd By M. Warner Description ICDF LANDFILL WASTE DENSITY Job No. 2470178

PURPOSE: DETERMINE THE AVERAGE DENSITY OF THE WASTE SOIL PLACED IN THE ICDF LANDFILL. THE DENSITY WILL BE USED TO DETERMINE THE MASS OF RADIONUCLIDE CONTAMINANTS THAT WILL BE USED AS SOURCE TERMS IN THE FATE & TRANSPORT MODEL.

REFERENCES: GEOTECHNICAL REPORT FOR CONCEPTUAL DESIGN OF THE INEEL CERCLA DISPOSAL FACILITY AT WASTE AREA GROUP 3, OPERABLE UNIT 3-13, DOE-ID 10812, DEC. 2000.

EDF-ER-267, DRAFT COMPACTION/SUBSIDENCE STUDY, MARCH 2, 2001

METHODOLOGY: THE DENSITY OF THE WASTE PLACED IN THE ICDF LANDFILL WILL VARY DEPENDING ON THE PHYSICAL PROPERTIES OF THE SOIL. ASSUMING THAT THE MAJORITY OF THE WASTE IS SOIL AND WILL HAVE SIMILAR GEOTECHNICAL PROPERTIES AS THE SOIL TESTED AT THE ICDF FACILITY, THE PROCTOR TEST DATA DETERMINED FOR THE ICDF SOILS CAN BE USED TO REPRESENT WASTE PROPERTIES.

RESULTS:

DENSITY OF Waste Soil AND NATURAL WATER = 129.2 lb/FT3

= 2069.6 Kg/m3

DENSITY OF Waste Soil, NATURAL WATER, AND CLEAN WATER ADDED FOR COMPACTION = 133.5 lb/FT3

= 2138.5 kg/m3

MONTGOMERY WATSON

By P CRouse Date 03/30/01 Client BBWI Sheet 2 of 2

Chkd. By C. Burger Description ICDF LANDFILL WASTE Density Job No. 247017B

1. DETERMINE AVERAGE γ_{DRY}, W_{OPT} AND W_{NAT}

DATA FROM ICDF PROCTOR TESTS

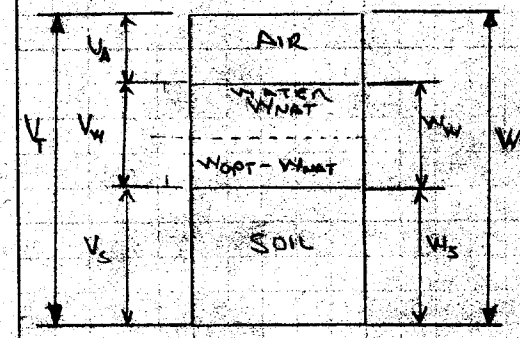
BORING	SAMPLE DEPTH (ft)	MAX DRY DENSITY (pcf)	W_{OPT} (%)	W_{NAT} (%)
CHEM #1	0-2.5	117	13	7.0
CHEM #1	17.5-20.0	134	6	3.5
CHEM #2	25.0-27.5	135	7	5.1
CHEM #3	27.5-30.0	134	8	4.4
GSB #2	30.0-32.5	134	7	5.5
SPT #1	0-2.5	111	14	6.5
SPT #3	17.5-20.0	141	5	3.9
AVERAGE		129.4 pcf	8.6%	5.1%

ASSUME THAT WASTE WILL BE PLACED PLACED AT 90 TO 100% OF THE MAXIMUM DRY DENSITY. SO SAY 95%.

$\gamma_{DRY} = (0.95)(129.4\ lb/ft^3)$

$= 122.9\ lb/ft^3$

PHASE DIAGRAM



$V_T = 510{,}000\ yd^3$ = TOTAL VOLUME OF WASTE SOIL

$W_{NAT} = 5.1\%$ BY WEIGHT = PORTION OF WATER THAT IS WITH WASTE

$W_{OPT} = 18.6\%$ = TOTAL % OF WATER USED TO COMPACT WASTE

2. $\gamma_{TOT} = \frac{W_T}{V_T} = \gamma_{DRY}(1+W_{OPT})$

$W_T = [\gamma_{DRY}(1+W_{OPT})]V_T$

$W_T = [122.9\ lb/ft^3(1+0.086)]510{,}000\ yd^3 \times 27\ ft^3/yd^3$

$= 1{,}837{,}873{,}638\ lbs$

3. $\gamma_{DRY} = \frac{W_S}{V_T}$

$W_S = (\gamma_{DRY})(V_T)$

$= (122.9\ lb/ft^3)(510{,}000\ yd^3)(27\ ft^3/yd^3)$

$= 1692333000\ lbs$

4. $W_{W1} = W_T - W_S$

$= 1{,}837{,}873{,}630\ lb$

$= 145{,}540{,}630\ lb$

PART OF WATER IS NATURAL (CONTAMINATED) AND PART OF WATER IS CLEAN (COMPACTION)

$W = \frac{W_W}{W_S}$

$W_{W(NAT)} = (W_S)(W_{NAT})$

$= (1692333000\ lb)(0.051)$

$= 86308983\ lb.$

5. DENSITY OF CONTAMINATED SOIL & WATER

$\gamma_{CON} = \frac{W_T}{V_T} = W_S + W_{W(NAT)}$

$= \frac{1692333000\ lbs + 86308983\ lb}{510{,}000\ yd^3 \times \frac{27\ ft^3}{yd^3}}$

$= 129.2\ lb/ft^3$

MONTGOMERY WATSON
Mining Group

Project Name: INEEL-ICDF TITLE II DESIGN 90%
Project Number: _____ Sheet: 2 of 6
Prepared By: BG. Adams Date: 9-27-01
Checked By: JE THOMPSON Date: 1 OCT 01

Purpose: Determine the Weighted Average for the unit weight of the prepared INEEL-ICDF Final Cover Designed for the 90% Submittal and compare with the Results of the Weighted average done for the 30% Submittal

Assumptions: Materials in the Cover are either Unsaturated or at the optimum moisture content, based on ASTM D 1557.

Input: RyeGrassFlats Borrow Material = 128.8 pcf (CCI-006) ①
ICDF Alluvium = 133.8 pcf (CCI-007) ①
Compacted Admix clay Liner = 129.8 pcf page 3/6
Fine Sand = 118.4 pcf } Page 4/6
Coarse Sand = 118.4 pcf }
Final Cover Dimensions shown on page 5/6

Calculations:

$$\text{Weighted Average} = \frac{9'(128.8\text{pcf}) + 2'(118.4\text{pcf}) + 2'(118.4\text{pcf}) + 2.5'(133.8\text{pcf}) + 2'(129.8\text{pcf}) + 2'(128.8\text{pcf})}{(9' + 2' + 2' + 2.5' + 2' + 2')}$$

Weighted Average = 127.4 pcf

This Weighted Average is less than that calculated for the 30% Submittal, 133.5pcf, on page 6/6 proving that number to be conservative. Therefor the original number of 133.5pcf will be used for the material properties of the Final Cover.

① Material densities based on CCI-006 and CCI-007 were determined at MTI laboratories in Idaho Falls, ID

CH2M Hill
INEEL

Flexible Wall Hydraulic Conductivity of Shelby Tube Specimens
Table 1

VALUES AVERAGED FOR CLAY LINER VALUE

Sample Identification	Water Content %		Wet Density (Pcf)		Saturation①		Hydraulic Conductivity② (cm/sec)
	Before	After	Before	After	Before	After	
CCI-TP-001③	15	22	126	128	.77	.96	2×10^{-7}
ICDF-TP-2A ③	16	19	132	131	.89	.97	2×10^{-8}
TP-2B ④	17	21	129	130	.85	1.0	3×10^{-8}
ICDF-TP-3 ③	15	19	133	134	.89	1.0	2×10^{-8}
ICDF-TP-4 ③	18	22	124	126	.8	.95	3×10^{-8}
ICDF-TP-5A ③	15	22	125	127	.74	.95	1×10^{-7}
TP-5B ④	15	23	122	125	.69	.94	3×10^{-7}
TP-6 ③	16	18	131	133	.87	.98	6×10^{-9}
ICDF-TP-7A③	17	19	132	133	.91	1.0	7×10^{-9}
TP-7B ④⑤ \							2×10^{-8}
TP-8A ③	17	19	131	132	.90	.99	1×10^{-8}
TP-8B ④⑤ \							1×10^{-8}
TP-9 ③	16	20	129	130	.84	.97	1×10^{-7}
TP-10A ③	15	17	132	133	.87	.97	8×10^{-9}
TP-10B ④⑤ \							2×10^{-8}
TP-11 ③	15	22	122	127	.69	.94	2×10^{-7}
TP-12 ③	16	21	121	126	.69	.92	4×10^{-7}
TP-13A ③	15	21	124	128	.73	.95	4×10^{-7}
TP-13B ④⑤ \							7×10^{-8}
TP-14 ③							2×10^{-8}
TP-15A ③							1×10^{-8}
TP-15B ④⑤ \							4×10^{-8}
TP-16 ③							1×10^{-8}
TP-17 ③							2×10^{-8}

① Specific gravity assumed 2.7 ② Average Saturated Hydraulic Conductivity Using Tap Water
③ Constant volume Hydraulic Conductivity ④ Falling Head Rising Tail Hydraulic Conductivity
⑤ Results Subject to change with test duration

M. Carter and S.P. Bentley Pentech Press, 1991

Table 3.1 TYPICAL VALUES OF NATURAL DENSITY

Material		*Natural density* (kg/m³) *Bulk density**	*Dry density*
Sands and gravels:	very loose	1700–1800	1300–1400
	loose	1800–1900	1400–1500
	medium dense	1900–2100	1500–1800
	dense	2000–2200	1700–2000
	very dense	2200–2300	2000–2200
Poorly-graded sands		1700–1900	1300–1500
Well-graded sands		1800–2300	1400–2200
Well-graded sand/gravel mixtures		1900–2300	1500–2200
Clays:	unconsolidated muds	1600–1700	900–1100
	soft, open-structured	1700–1900	1100–1400
	typical, normally consolidated	1800–2200	1300–1900
	boulder clays (overconsolidated)	2000–2400	1700–2200
Red tropical soils		1700–2100	1300–1800

* Assumes saturated or nearly saturated conditions.

more important than the absolute density. This is defined as:

$$\text{relative density} = \frac{e_{max} - e}{e_{max} - e_{min}} = \frac{\rho_{dmax}}{\rho_d} \cdot \frac{\rho_d - \rho_{dmin}}{\rho_{dmax} - \rho_{dmin}}$$

where ρ_d, ρ_{dmax} and ρ_{dmin} are the dry densities in the field and at the densest and loosest states of compaction

and e, e_{max} and e_{min} are the corresponding voids ratios, respectively.

Because of the difficulty of measuring field densities in sands and gravels, values are usually estimated from standard penetration test results. A classification of relative density and SPT N-values, although widely used, has received repeated criticism.

Work by Gibbs and Holtz (1957) indicated that the relationship between relative density and SPT values depends on the characteristics of sand, whether it is dry or saturated, and on the overburden pressure. This led to the suggestion that correction factors (C_N) for overburden pressure should be applied in the determination of relative density and for foundation calculations.

Recommendations, from a number of sources are given in Table 3.2. Corrected N values (N_1) are obtained using the formula:

$$N_1 = C_N N$$

For clarification purposes it should be noted that although the interpretation of Terzaghi and Peck's (1948) classification, which led

Table 3.2 SUMMARY OF PUBLISHED CORRECTION FACTORS

Reference	*Correction factor* (C_N)	*Units of overburden pressure* (σ'_v)
Gibbs and Holtz (1957) [equation by Teng 1962]	$C_N = \frac{50}{10 + \sigma'_v}$	psi
Peck and Bazaraa (1969)	$C_N = \begin{cases} \frac{4}{1 + 2\sigma'_v} & \bar{\sigma}_v \leq 1.5 \\ \frac{4}{3.25 + 0.5\sigma'_v} & \bar{\sigma}_v > 1.5 \end{cases}$	ksf
Peck, Hanson and Thornburn (1974)	$C_N = 0.77 \log_{10} \frac{20}{\sigma'_v}$	kg/cm² or tsf
Seed (1976)	$C_N = 1 - 1.25 \log_{10} \sigma'_v$	kg/cm² or tsf
Tokimatsu and Yoshimi (1983)	$C_N = \frac{1.7}{0.7 + \sigma'_v}$	kg/cm² or tsf
Liao and Whitman (1986)	$C_N = \sqrt{\frac{1}{\sigma'_v}}$	kg/cm² or tsf
Skempton (1986)	$C_N = \begin{cases} \frac{2}{1 + \sigma'_v} & \text{For fine sands of medium Dr} \\ \frac{3}{2 + \sigma'_v} & \text{For dense, coarse sands when normally consolidated} \\ \frac{1.7}{0.7 + \sigma'_v} & \text{For overconsolidated fine sands} \end{cases}$	kg/cm² or tsf

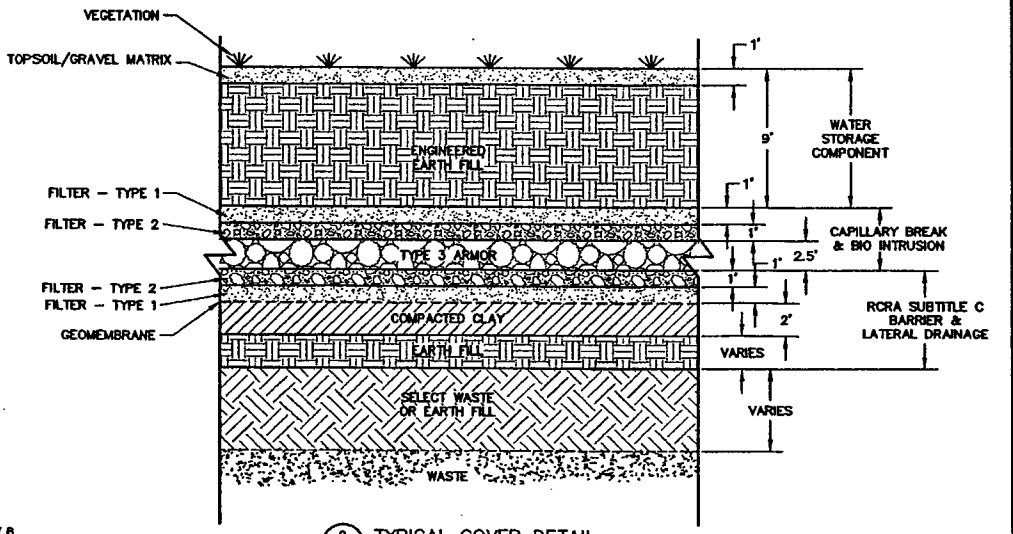
to this particular correction, originated with Gibbs and Holtz (1957), the actual equation for the correction factor can be attributed to Teng (1962).

Although SPT correction factors were discussed at some length by Liao and Whitman (1986), the definitive work on the subject is that of Skempton (1986). Skempton points out that in carrying out the SPT test the energy delivered to the sampler, and therefore the blow count obtained in any given sand deposit at a particular effective overburden pressure, can still vary to a significant extent depending on the method of releasing the hammer, on the type of anvil and on the

C-8

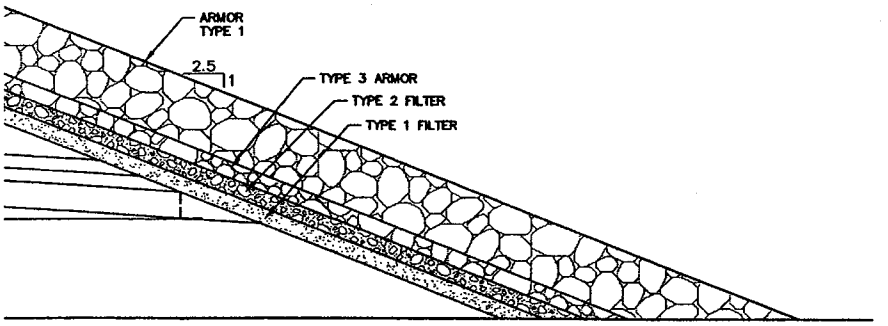
4/6

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE
0	90% DESIGN SUBMITTAL	15 OCTOBER 2001



4947.8

2 C-305 TYPICAL COVER DETAIL



NG GROUND

PRELIMINARY
NOT FOR CONSTRUCTION

INEEL

CH2MHILL MONTGOMERY WATSON

INEEL CERCLA DISPOSAL FACILITY (ICDF)

FINAL COVER
SECTIONS AND DETAILS

SUBCONTRACT NO.	SQ1-566056
REQUESTER:	
DESIGN:	PHILLIP CROUSE
DRAWN:	NICOLE GONZALEZ
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	DAR
EFFECTIVE DATE:	
SIZE	D
CAGE CODE	
DRAWING NUMBER	BR1 TYPE 0 SEC B21 0100 02
DWG-	C-305
REV	0
SCALE: AS SHOWN	
CPP	
SHEET	1 OF 1

Appendix D

Settlement Calculations, Stress at Depth Hand Calculation Check, and Differential Settlement

Assume: Surface loading of cell mound modeled as a rectangular surface load with a ramp loads on top.
Load increase from waste of higher unit weight than soil will be modeled to have infinite extents.
Water table is not present.

Soil Cover γ_{total} =	133.5	(pcf)
Cover Slope Height =	31.2	(ft)
Peak load from Cover Slope(h) =	4165.2	(psf)
One Half the Length of cover slope(B) =	445	(ft)
Width of cover slope (L) =	398.5	(ft)
Unit Weight of Water =	62.4	(pcf)

γ_{total} =	133.5	(pcf)
Waste Height =	27	(ft)
Peak load from Waste =	3604.5	(psf)
1/2 length of landfill top (L) =	478	(ft)
1/2 width of landfill top (W) =	431	(ft)

Calculations: For settlement at center point of Landfill.

		Depth below ground surface																					
Layer	Material	Top	Bottom	Mid-Layer	Thickness	Soil Unit Weight	Waste/Liner Unite Weight	R_L	R_D	Δp' from ramp loads	I	Δp' from load above ground surface and below cover slope (rectangular)	Δp' total	p_o	u	p_o'	$p_{unloaded}'$	p_f'	C_r	C_c	Est. In-situ Void Ratio	Re-consolidation Settlement	Consolidation Settlement	Combined ΔH	
	Waste	(ft)	(ft)	(ft)	H (ft)	γ_{total} (pcf)	γ_{total} (pcf)	(ft)	(ft)	(psf)		(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)			(e_o)	(ft)	(ft)	(ft)	
	Waste	0	2.5	1.25	2.50	89.8	133.5	-	-	0.00	-	0.00	109	224	-	-	-	-	-	-	-	-	-	-	
	Waste	2.5	5	3.75	2.50	84.5	133.5	-	-	0.00	-	0.00	232	436	-	-	-	-	-	-	-	-	-	-	
	Waste	5	7.5	6.25	2.50	120.5	133.5	-	-	0.00	-	0.00	264	737	-	-	-	-	-	-	-	-	-	-	
	Waste	7.5	10	8.75	2.50	120.4	133.5	-	-	0.00	-	0.00	297	1038	-	-	-	-	-	-	-	-	-	-	
	Waste	10	12.5	11.25	2.50	121.3	133.5	-	-	0.00	-	0.00	328	1341	-	-	-	-	-	-	-	-	-	-	
	Waste	12.5	15	13.75	2.50	120.4	133.5	-	-	0.00	-	0.00	361	1642	-	-	-	-	-	-	-	-	-	-	
	Waste	15	17.5	16.25	2.50	107.1	133.5	-	-	0.00	-	0.00	427	1910	-	-	-	-	-	-	-	-	-	-	
	Waste	17.5	20	18.75	2.50	113.2	133.5	-	-	0.00	-	0.00	478	2192	-	-	-	-	-	-	-	-	-	-	
	Waste	20	22.5	21.25	2.50	104.0	133.5	-	-	0.00	-	0.00	551	2453	-	-	-	-	-	-	-	-	-	-	
	Waste	22.5	25	23.75	2.50	107.1	133.5	-	-	0.00	-	0.00	617	2720	-	-	-	-	-	-	-	-	-	-	
	Waste	25	27.5	26.25	2.50	107.1	133.5	-	-	0.00	-	0.00	683	2988	-	-	-	-	-	-	-	-	-	-	
	Waste	27.5	29.5	28.5	2.00	120.4	133.5	-	-	0.00	-	0.00	709	3229	-	-	-	-	-	-	-	-	-	-	Clay Liner
1 [5]	Soil Bentonite Liner	29.5	32.5	31	3.00	120.4	121.9	402.70	600.16	3818.93	0.2499	3603.63	8137	3590	-	2800	-	11727	-	0.198	0.61	-	0.23	0.23	(p_o'=2800psf)
2 [5]	Alluvium	32.5	35.5	34	3.00	113.7		403.14	600.46	3800.96	0.2499	3603.35	7404	3931	0	3931	341	11335	0.031	0.180	0.63	0.06	0.15	0.21	
3 [5]	Alluvium	35.5	38.5	37	3.00	96.4		403.61	600.77	3782.97	0.2499	3603.02	7386	4220	0	4220	630	11606	0.031	0.180	0.63	0.05	0.15	0.19	Assume CL Properties for Settlement
4 [5]	Alluvium	38.5	41.5	40	3.00	95.4		404.09	601.10	3764.98	0.2499	3602.64	7368	4506	0	4506	916	11874	0.031	0.180	0.63	0.04	0.14	0.18	
5 [5]	Alluvium	41.5	44.5	43	3.00	121.9		404.60	601.44	3746.98	0.2498	3602.19	7349	4586	0	4586	998	11935	0.031	0.180	0.63	0.04	0.14	0.18	
6 [5]	Old Alluvium	44.5	47.5	46	3.00	121.9		405.13	601.79	3728.97	0.2498	3601.68	7331	4872	0	4872	1282	12203	0.031	0.180	0.63	0.03	0.13	0.17	CL
																						Total Reconsolidation Settlement =		0.22	
																						Total Consolidation Settlement =		0.94	
																							Total Combined Settlement =		1.2

Notes:

1) Load from waste and cover above initial ground surface model as rectangular load, Boussinesq solution presented in Al-Khafji and Andersland (1992).

2) Cover sloped load modeled as a ramp load. Ramp load stress increase detemined using Boussinesq solution in Bowles (1996), solution originally presented by Vitone and Valsangkar (1986).

3) C_c for sub-landfill "old alluvium" clay is the average of empirical and laboratory values.

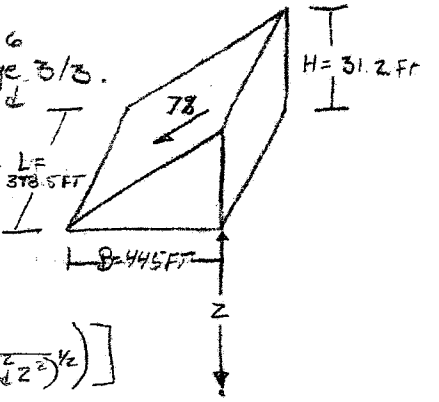
4) C_c for clay liner is the highest of the empirical values.

5) Layers 1-6 are the layers in which settlement occurs

Stress At Depth Hand Calculation Check

Purpose: Check spreadsheet calculation of $\Delta P'$ from ramp load.

Method & Assumptions: see EDF-266
For previous check with 10% slope see page 3/3.
Calculations: $\Delta P'$ from Ramp load



Check layer 1, 295 − 325 FT below surface
Midpoint of layer 31 FT below surface

$\Delta q = \frac{\Delta P'}{4}$ z is at center of 4 ramp stress distributions.

$$\frac{\Delta P'}{4} = \frac{q_o L}{2\pi B}\left[\frac{z R_d}{R_L^2} - \frac{z}{R_L} + \frac{B}{L}\sin^{-1}\left(\frac{BL}{(B^2L^2 + R_d^2 z^2)^{1/2}}\right)\right]$$

where $q_o = h\gamma_z = (31.2\,Ft)(133.5\,lb/ft^3) = 4165.2$ psf

z = depth from ground surface to middle of layer + height of Rectangular load
$z = 31\,FT + 27\,FT = 58\,FT.$

$$\sqrt{R_L^2} = \sqrt{L^2 + z^2} = \sqrt{398.5^2 + 58^2} = \sqrt{162166.25} = \boxed{R_L = 402.7}$$

$$\sqrt{R_d^2} = \sqrt{B^2 + L^2 + z^2} = \sqrt{445^2 + 398.5^2 + 58^2} = \sqrt{360191.25} = \boxed{R_d = 600.16}$$

$$\frac{\Delta P'}{4} = \frac{4165.2(398.5)}{2\pi(445)}\left[\frac{58(600.16)}{402.7^2} - \frac{58}{402.7} + \frac{(445)}{(398.5)}\cdot\sin^{-1}\left(\frac{(445)(398.5)}{((445)^2(398.5)^2 + (600.16)^2(58)^2)^{1/2}}\right)\right]$$

$$= 593.6\left[.215 - .144 + 1.12\sin^{-1}\left(\frac{177332.5}{180716.6}\right)\right]$$

$$\frac{\Delta P}{4} = 593.6(1.613)4 = 3830.4\,psf$$

ΔP from Spreadsheet = 3818.93 psf > Checks

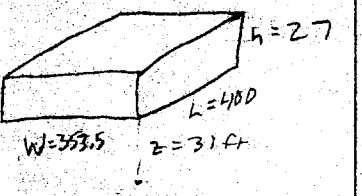
+ 99A

MONTGOMERY WATSON
Mining Group

Project Name: INEEL ICDF
Project Number: 2470178
Prepared By: DJ Montgomery Rev. by CA Burger
Checked By: M. Warner

Sheet: 2 of 2
Date: 2/28/01 Rev 4/11/01
Date: 4/12/01

$\Delta p'$ from rectangular load



check layer 1, depth 29.5 to 32.5 ft
middle layer = 31 ft

$q_o = h\gamma_z = 27\text{ ft}(133.5\text{ pcf}) = 3604.5\text{ psf}$

$$I = \frac{1}{2\pi}\left[\frac{mn}{\sqrt{m^2+n^2+1}}\left(\frac{m^2+n^2+2}{m^2+n^2+m^2n^2+1}\right) + \sin^{-1}\left(\frac{mn}{\sqrt{m^2+n^2+m^2n^2+1}}\right)\right]$$

$m = \frac{W}{z} = \frac{353.5}{31} = 11.4$ ✓ $\quad n = \frac{L}{z} = \frac{400}{31} = 12.9$ ✓

$$I = \frac{1}{2\pi}\left[\frac{(11.4)(12.9)}{\sqrt{11.4^2+12.9^2+1}}\left(\frac{11.4^2+12.9^2+2}{11.4^2+12.9^2+(11.4)^2(12.9)^2+1}\right) + \sin^{-1}\left(\frac{(11.4)(12.9)}{\sqrt{11.4^2+12.9^2+(11.4)^2(12.9)^2+1}}\right)\right]$$

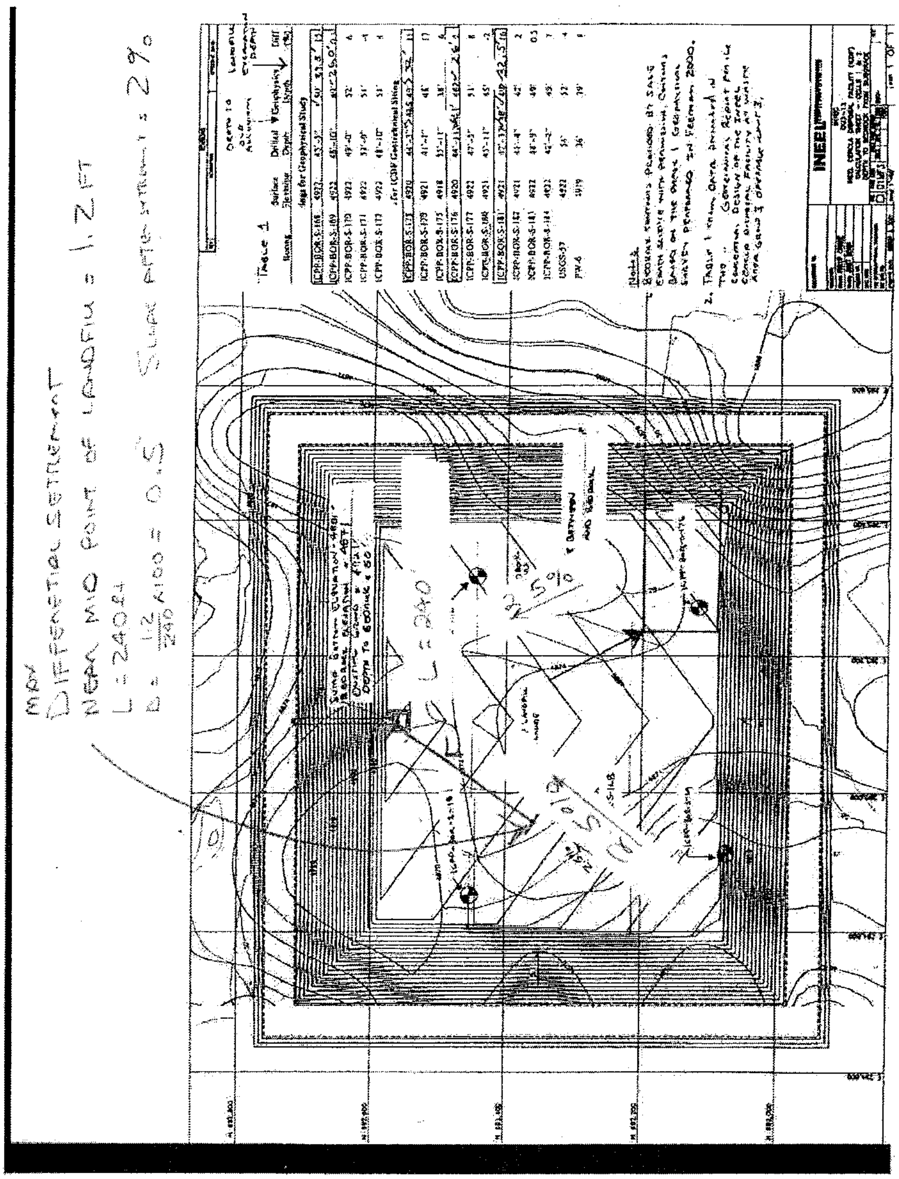
$$= 0.159\left[\frac{147.06}{17.24}\left(\frac{298.4}{21924}\right) + \sin^{-1}\left(\frac{147.06}{148.07}\right)\right]$$

$$= 0.159\left[8.53(0.0136) + 1.454\right] = I = 0.25$$ ✓

$\Delta p' = 4(3604.5\text{ psf})(0.25) = \Delta p' = 3604.5\text{ psf}$ checks

spreadsheet value = 3603 psf

Differential Settlement


MAX
DIFFERENTIAL SETTLEMENT
NEAR MID POINT OF LANDFILL = 1.2 FT
L = 240 ft
Δ = 1.2/240 x100 = 0.5
SLOPE AFTER SETTLEMENT ≈ 2%
L = 240
5%
Table 1

Appendix E

Laboratory Determination of C_c for Soil Bentonite Liner

MONTGOMERY WATSON
Mining Group

Project Name: INEEL-ICDF Title II design 708 sub
Project Number: _____ Sheet: 9 of _____
Prepared By: BG ADAMS Date: 9-23-01
Checked By: JE THOMPSON Date: 9-28-01

TITLE: CALCULATION OF C_c FOR CONSOLIDATION CALCULATIONS OF THE INEEL-ICDF.

OBJECTIVES: DETERMINE C_c FOR MATERIAL FROM SAMPLE CCI-016, TAKEN FROM ADMIX MATERIAL PREPARED FOR THE ICDF TEST PAD COMPACTED ADMIX CLAY LINER.

REFERENCES: RESULTS OF THE CONSOLIDATION TEST, DONE BY SOIL TECHNOLOGY, INC, FOR CCI-016. (Attached)

METHODOLOGY: GRAPHICALLY DETERMINE THE SLOPE OF THE COMPRESION CURVE FOR CCI-016 BETWEEN THE ASSUMED P_o (SETTLEMENT CALCULATIONS, EDF-ER-266) AND THE CALCULATED OVERBURDEN.

ASSUMPTIONS: UNIT WEIGHT OF WASTE AND COVER IS 133.5 pcf
HEIGHT OF WASTE AND COVER IS 90 FT.
MAXIMUM PAST PRESSURE DEVELOPED DURING COMPACTION, σ_p = 2800 psf

INPUT DATA: $\sigma_p = 2800$
$\gamma_{waste} = 133.5$ pcf
$\gamma_{cover} = 133.5$ pcf
$H_{waste} + H_{cover} = 90$ FT

CALCULATIONS:

$$\sigma_p = 2800 \text{ lb/ft}^2 \left(\frac{1 \text{ ton}}{2000 \text{ lb}}\right) = \boxed{1.4 \text{ tsf}}$$

$$\sigma_v = 90 \text{ FT} \left(133.5 \text{ lb/ft}^3\right) = 12015 \text{ lb/ft}^2 \left(\frac{1 \text{ TON}}{2000 \text{ lb}}\right) = 6.0 \text{ tsf}$$

C_c CALCULATED FROM SLOPE ON ATTACHED CONSOLIDATION REPORT. PAGE 3/3.

$$C_c = \frac{0.66 - 0.50}{\text{Log}\left(\frac{2.0}{0.5}\right)} = .1896 \qquad \boxed{C_c = 0.14}$$

CONCLUSION: $C_c = .14$ SHOULD BE USED FOR CALCULATING SETTLEMENT OF THE COMPACTED ADMIX CLAY LINER.

3/4

Jan. 9. 1996 1:40AM No.0054 P. 1

Soil Technology, Inc.
7865 NE Day Road West • Bainbridge Island, WA 98110-4207
(206) 842-8977•Toll Free: (800) 546-5022•Fax: (206) 842-9014

Facsimile Cover Sheet

To: Mike Reimbold
Company: CH2M Hill
Phone: 425-453-5005 ext 5317
Fax: 425-462-5957
Job: 1421

From: Tony Parkins
Date: 9-21-01
No. of Pages: 2
(including this cover page)

Comments: Mike, following e log p curve you requested. Please call if you have any questions.

If you experience problems receiving any or all of the pages faxed to you, please call us for re-transmission.

Jan. 9. 1996 1:41AM No.0054 P. 2

CONSOLIDATION TEST REPORT

Natural Saturation	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
78.9 %	18.6 %	103.0			2.7			0.637

MATERIAL DESCRIPTION

Project No. **Client:** **Remarks:**

Project:

Source: **Sample No.:** CCI016

CONSOLIDATION TEST REPORT

SOIL TECHNOLOGY, INC.

Consol Plot 1