T E C H N I C A L M E M O R A N D U M

Utah Coal Regulatory Program

March 18, 2015

TO: Internal File

THRU: Dana Dean, Associate Director of Mining
Daron Haddock, Coal Program Manager
Priscilla Burton, Team Lead

FROM: Cheryl Parker, Mine Engineer

RE: GEM Engineering, Inc. Swell Factor Calculations Received March 2, 2015 in Response to DO-15A. Alton Coal Development, LLC. Coal Hollow Mine, C/025/0005

SUMMARY:
The GEM Report was provided to Alton Coal Development (ACD) to demonstrate a reduction in the swell factor for the excess spoil. The Division has found the information provided in the GEM Engineering Soils report (GEM report) to be deficient. ACD is required to adhere to the swell factor designs outlined within the approved Mining and Reclamation Plan (MRP) until an adequate demonstration is received.

The GEM Engineering soil report to determine the swell factor for the alluvium and shale is deficient in required ASTM information and -incorrect soil analysis:

1. The GEM report utilized ASTM D1577-12 Modified Proctor Test, while the MRP and Appendix 5-1 TGE Geotechnical report utilized ASTM 698 Standard Proctor. Results from these two tests cannot be directly correlated. A report published in 2003 by Keystone states that 90%-92% of Modified Proctor density is roughly equivalent to the specified 95% Standard Procter density except for fine grained soils (i.e. Clays) where the difference may be significantly larger. The density difference between the tests appears to increase with the percentage of fines in the soil matrix while the optimum moisture content decreases. A Standard Proctor D698 test should have been requested by ACD to allow for the test results to be verified against the results in Appendix 5-1 as proof that the single samples of alluvium and shale are representative samples.
2. No documentation on what procedure was followed to achieve a representative soil sample was documented nor was any information provided on who, where, and how the samples were supplied to GEM Engineering.
3. A shale sample was not analyzed by GEM Engineering. The sample mislabeled in the report as a shale sample is correctly classified as a fatty clay. The same fatty clay that is recorded in the Taylor Geo-Engineering's (TGE) geotechnical report in Appendix 5-1 as being located above the shale in several of the bore logs throughout the site (i.e. CH-01-05 and CH-03-05). When the

tropic shale is exposed to water for an extended period of time and heavily weathered it is then classified as a CH, CL or claystone as stated with supporting information in TGE's report. The shale sample is a clay sample from the site. The clay sample's swell factor also agrees with TGE's report of a 10% swell for the site's clays. No documentation was provided that a shale sample was analyzed. TGE's report shows that shale has a 30% swell, which will remain as the swell factor until proven otherwise. As shown on Dwg 6.3, the Tropic Shale is the predominant overburden strata.

4. GEM's modified Proctor test is missing required information according to ASTM D1577-12
    a. 12.2.1 Method used for test either A, B, or C
    b. 12.2.2 Preparation method (Moist or dry)
    c. 12.2.6 Type of Hammer utilized (manual or mechanical)
    d. 12.2.10 Identification of the sample depth and location.
5. GEM's report improperly classified the alluvium sample as a sandy gravel, while proper ASTM classification with the provided sieve analysis clearly shows the sample as either a silty sand or a clayey sand, detail which cannot be differentiated due to a failure of GEM to classify the fines of the sample as either elastic silt or lean clay. However, this sample is similar to samples collected in TGE's geotechnical report (GT-2 10-11.5 depth and GT-3 10-11.5 depth) which also classify said samples as either silty sand or clayey sand. There are structural strength and water content differences between sands and gravels which are important for stability and swell analysis.

The Division recommends:

1. GEM's report be returned to ACD as deficient and inadequate due to missing documentation and an incomplete and erroneous soil's report.
2. The current swell factor of 33% for shale will be retained. With proper request/documentation from ACD, the clay swell factor may be reduced to 10% from the original 22% in bonding volume calculations.
3. ASTM standards will be utilized for sample collection with documentation provided to the Division as to how those standards were implemented/met
4. A shale sample will need to be collect and tested if ACD wishes to reduce the shale swell factor of 30%.
5. Any future compaction tests will utilize ASTM D698 Standard Proctor Test.

Sincerely,

Cheryl Parker, M.S., P.E.
Mine Engineer

CP/CP
Enclosure
cc: Calculations

Determine if new Soil Data is representative

Excess Spoil Design
3:1 75-120 ft Tall, 2.2% grade top
85% SP
Pg10 TGE Report 10% swell clay
30% swell shale

(1) MRD
Appendix 5-1 TGE Report

CH	MH	CL	SC	SM	
very plastic	very plastic	highly plastic	highly plastic	—	PI
* semi solid	Plastic stiff	semi solid	semisolid	—	LI solid phase
Very stiff	med stiff	—	—	—	unconfined σ
7 29.7 62.4 G S H-S	—	0 20.5 51.1 28.4 G S H C	13 40.7 46 G S H+C	37 silt clay	sieve

* semi = High strength / brittle deformation
plastic = intermediate strength w ≈ PL = stiff / plastic deformation

Bore #	GT-1	GT-1	GT-2	GT2	GT2	GT3	GT5	GT5
depth	10-11.5	20-21.5	10-11.5'	25-26.5'	30-31.5'	10-11.5'	5-6.5'	15-16.5'
w%	12.6	14.4	10.6	27.8	18.5	11.0	18.7	17.2
γ_d (pcf)	111.6						108.3	120.0

* rule of thumb depth should be ≈2 weight

pit 6 | Spoil 36 ft | S. Spoil 41 ft | pond 3

LL	47	69	37	74	63	63
PL	16	17	18	36	19	18
PI	31	52	19	38	44	45

should have geophysical tests see Table 3-14 pg 9-90

33% pass #200 | 37% pass 200

PI	Swell Potential
<15	small
15-24	mod
25-46	great
>46	great

Fill 107 pcf
Sand 105 pcf
Clay 100 pcf
Shale 100 pcf

* Hoofstuk

② Gem engineering Report

		γ_d (pcf)	w%	S	Net
Tropic Shale	Native	96.3		~~11.9~~	
Tropic Shale	Loose	84.8	?	11.9	0.6
Tropic Shale	Compacted	107.2		-11.3	
Alluvium	Native	95.6		—	
Alluvium	Loose	88.7		7.2	
Alluvium	Compacted	114.2	-16.3		-9.1

+ Modified Proctor ≠ Standard Proctor

+ Fatty Clay above shale in Pit 6 & Pit 2 Drill logs (GT-1, CH-01-05, & CH-03-05) - not Shale sample

+ Modified Proctor missing minimum ASTM data
- 12.2.1 Method used A, B, C
- 12.2.2 Preparation method (moist or dry)
- 12.2.6 Type of rammer (manual or mechanical)
- 12.2.10 ID & sample depth?

+ Shale sample matches CH-5-48 & CH-1-3 of App 5-1

+ Alluvium sample similar to SM SC similar w/ GT-2 10-11.5 depth, GT-3 10-11.5 depth

+ improper classification
① more than 50% retain on #200 = Coarse Grained
② 50% or more pass No 4, No 4 = 58.4% passing
③ >12% fines SM or SC

+ Failed to classify fines App 5-1 Sand 105 pcf

SUMMARY

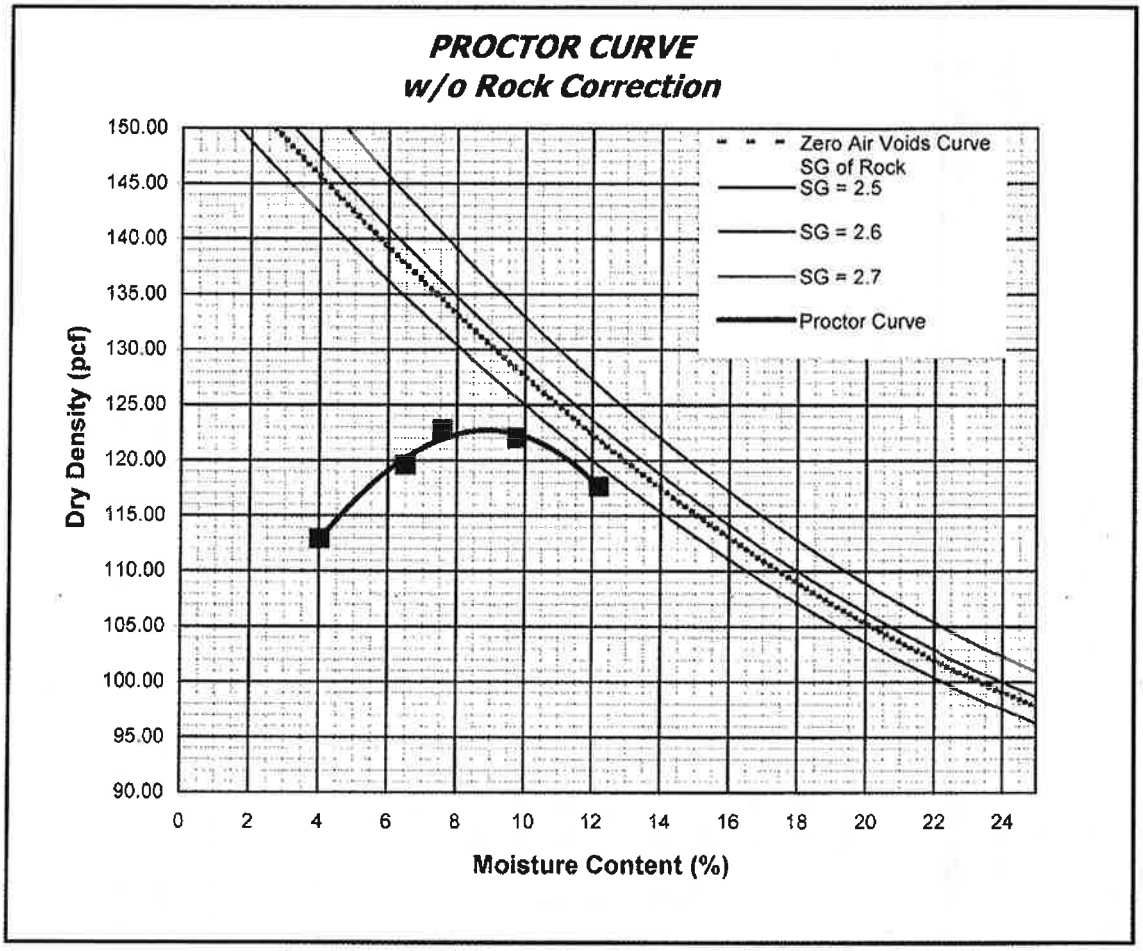
- MRP Appendix 5-1 Geotech Report
  - utilized Standard Proctor (D698)
  - 10% swell in clays & 30% in shale
  - Fill composed of Gaty Clays & Silty/Sc Clay Sand [CH, CL, SC & SM]
  - Optimum Compaction of Standard Proctor
    - Fill = 107
    - Sand = 105
    - Clay = 100
    - Shale = 104

		γ_d pcf	w%
From individual samples	CH-5-48	99.5	20
	CH-1-3	104.9	20.5

  - Design of excess spoil
    - 85% Compaction of Standard Proctor
    - 3:1V Slope
    - 75 - 120 ft tall
    - 2.2% grade across top
- GEM Report
  - utilized inconsistent method, modified Proctor ≠ Standard
  - Tropic shale sample ~~label~~ as Clay ~~Stang~~ sample not shale
    - heavily weathered shale degrades to claystone not shale sample
  - missing ASTM required data from tests
    - See above details
  - improper label/classification of SM/SC as GM of Alluvium
  - Test failed to classify fines of Alluvium

Modified Proctor - Moisture Density Relationship

Client:	**Alton Coal Development**	**Date Sampled:**	**12/30/2014**
Project Name:	**Alton Coal Mine**		
Sample Location:	**On site stock pile**	**Sample Depth:**	
Soil Description:	**Alluvium**	Test Method:	ASTM D 1557 AASHTO T-180



Preliminary Density* 122.5 pcf
Preliminary Moisture* 9.0%

Maximum Dry Density (pcf)	Optimum Moisture
126.5	8.0%

*This sample has 12.47% rock. Therefore, in order to obtain the Maximum Dry Density and the Optimum Moisture values, the preliminary density and moisture are modified by a correction factor.

REMARKS: 107 pcf

GEM ENGINEERING, INC.
485 North Aviation Way ♦ Cedar City, UT 84721
Phone (435) 867-6478 ♦ Fax (435) 867-4372
www.gemengineeringinc.com

Reviewed by:

Amount of Material in Soil Finer than the No. 200 (75μm) Sieve

(ASTM D1140)

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Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/12/2007
By: NB

Sample Info.	Boring No.	GT-2	GT-3						
	Sample								
	Depth	10-11.5	10-11.5						
	Split	No	No						
	Split Sieve*								
	Moist total sample wt. (g)	298.34	352.37						
	Moist coarse fraction (g)								
	Dry split fraction (g)								
	No. 200 Dry wt. retained (g)	179.78	198.58						
	Split sieve* Dry wt. retained (g)								
	Dry total sample wt. (g)	**269.64**	317.54						
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Moisture content (%)								
Split Fraction	Moist soil + tare (g)	438.87	492.21						
	Dry soil + tare (g)	410.17	457.38						
	Tare (g)	140.53	139.84						
	Moisture content (%)	**10.64**	10.97						
	Percent passing split sieve* (%)								
	Percent passing No. 200 sieve (%)	**33.3**	**37.5**						

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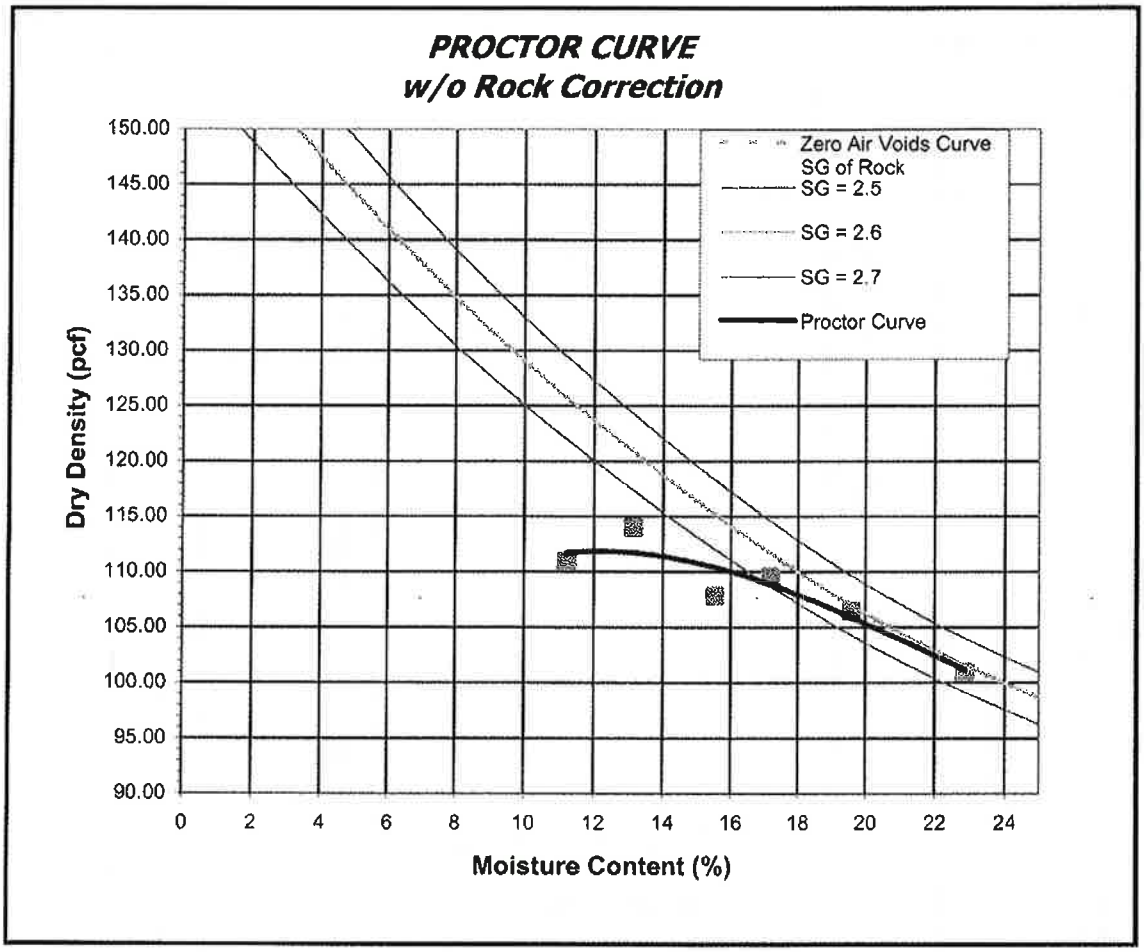
Modified Proctor - Moisture Density Relationship

Client:	**Alton Coal Development**	**Date Sampled:**	**12/30/2014**
Project Name:	**Alton Coal Mine**		
Sample Location:	**On site stock pile**	**Sample Depth:**	
Soil Description:	**Tropic**	Test Method:	ASTM D 1557 AASHTO T-180

Missing Method used A, B, C?

prep method used



Preliminary Density* 112.0 pcf
Preliminary Moisture* 12.0%

Maximum Dry Density (pcf)	Optimum Moisture
112.0	12.0%

REMARKS: 85% 95.2 pcf

GEM ENGINEERING, INC.
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Reviewed by:

Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

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Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/12/2007
By: NB

Boring No.:
Sample: CH-5-48
Depth:
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

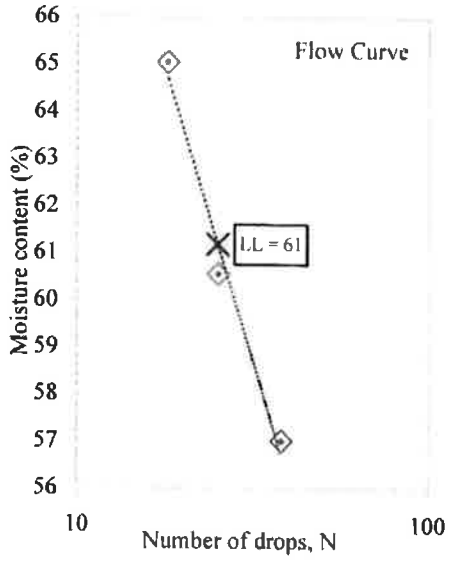
Plastic Limit

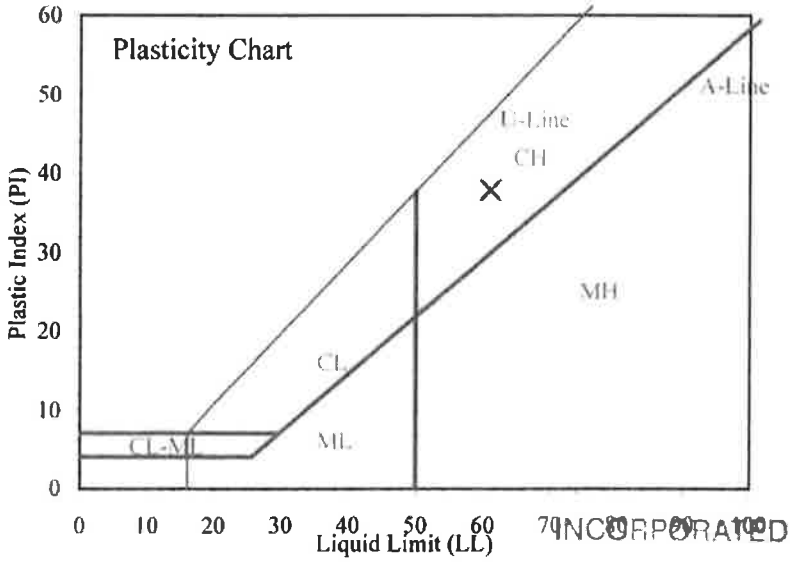
Determination No	1	2				
Wet Soil + Tare (g)	8.58	10.39				
Dry Soil + Tare (g)	7.22	8.71				
Moisture Loss (g)	1.36	1.68				
Tare (g)	1.4	1.39				
Dry Soil (g)	5.82	7.32				
Moisture Content, w (%)	23.37	22.95				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	38	25	18			
Wet Soil + Tare (g)	8.69	9	9.55			
Dry Soil + Tare (g)	6.04	6.13	6.33			
Moisture Loss (g)	2.65	2.87	3.22			
Tare (g)	1.39	1.39	1.38			
Dry Soil (g)	4.65	4.74	4.95			
Moisture Content, w (%)	56.99	60.55	65.05			
One-Point LL (%)		61				

Liquid Limit, LL (%)	**61**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**38**





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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

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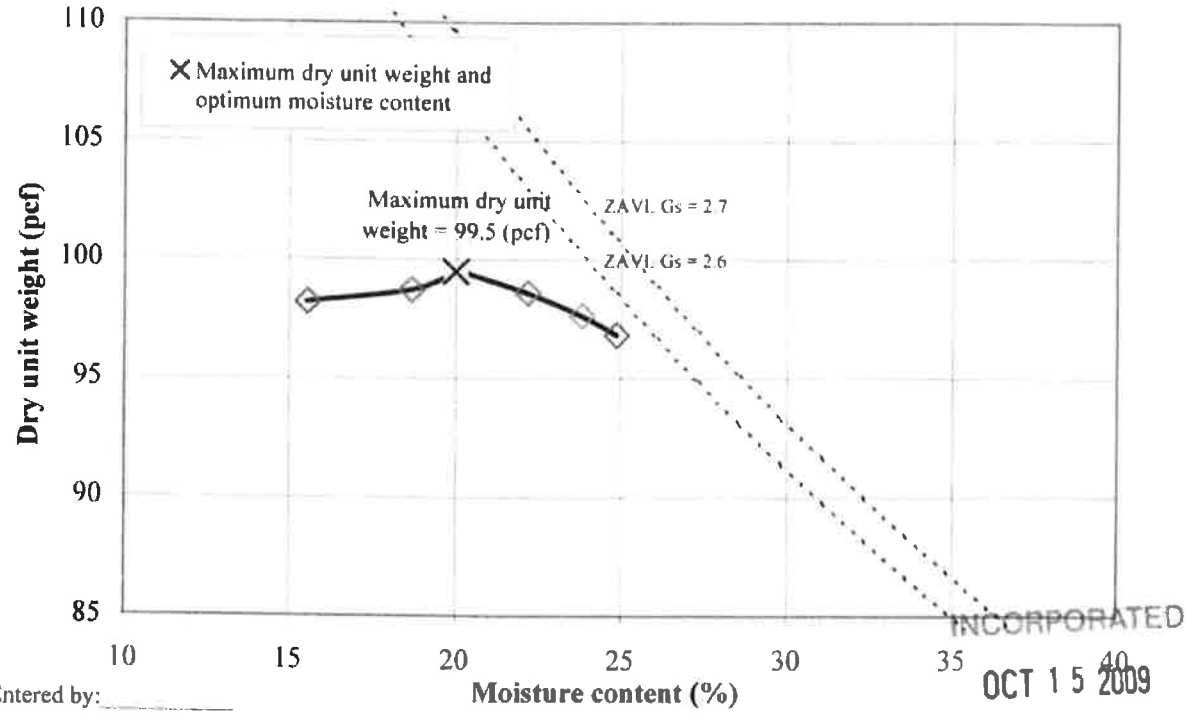
Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/7/2007
By: DKS

Boring No.:
Sample: CH-5-48
Depth:
Sample Description:
Engineering Classification: Not requested
As-received moisture content (%): 5.7
Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Method: ASTM D698 B
Mold volume (ft^3): 0.0333

Optimum moisture content (%): 20
Maximum dry unit weight (pcf): 99.5

Point Number	+10	+12	+14	+16	+18	+20		
Wt. Sample + Mold (g)	5890.6	5946.0	5981.3	5995.8	6002.4	6002.8		
Wt. of Mold (g)	4174.8	**4174.8**	**4174.8**	**4174.8**	**4174.8**	**4174.8**		
Wet Unit Wt., γ_m (pcf)	**113.5**	**117.1**	**119.5**	**120.4**	**120.9**	**120.9**		
Wet Soil + Tare (g)	360.7	316.6	348.1	376.2	414.5	450.5		
Dry Soil + Tare (g)	331.24	288.78	313.48	335.73	364.49	391.25		
Tare (g)	141.8	139.8	140.6	153	154.3	152.8		
Moisture Content, w (%)	**15.6**	**18.7**	**20.0**	**22.1**	**23.8**	**24.8**		
Dry Unit Wt., γ_d (pcf)	**98.2**	**98.7**	**99.5**	**98.6**	**97.6**	**96.8**		



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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

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Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/12/2007
By: NB

Boring No.:
Sample: CH-1-3
Depth:
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

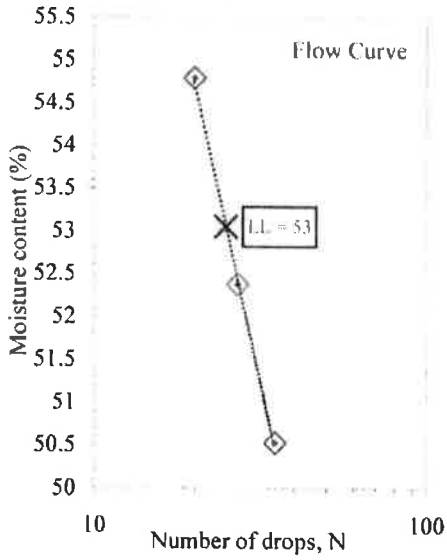
Plastic Limit

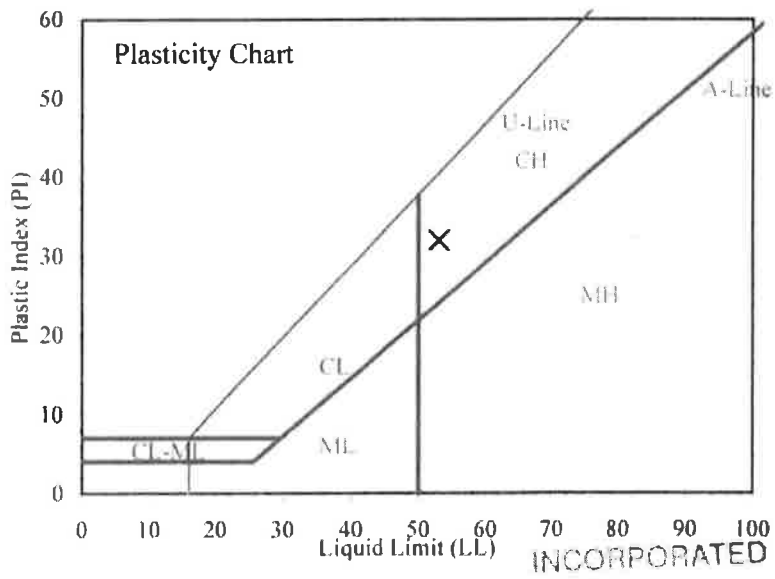
Determination No	1	2				
Wet Soil + Tare (g)	6.44	6.43				
Dry Soil + Tare (g)	5.57	5.57				
Moisture Loss (g)	0.87	0.86				
Tare (g)	1.38	1.39				
Dry Soil (g)	4.19	4.18				
Moisture Content, w (%)	20.76	20.57				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	27	20			
Wet Soil + Tare (g)	8.47	8.11	10.61			
Dry Soil + Tare (g)	6.09	5.8	7.35			
Moisture Loss (g)	2.38	2.31	3.26			
Tare (g)	1.38	1.39	1.4			
Dry Soil (g)	4.71	4.41	5.95			
Moisture Content, w (%)	50.53	52.38	54.79			
One-Point LL (%)		53	53			

Liquid Limit, LL (%)	**53**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**32**





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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/12/2007
By: BRR

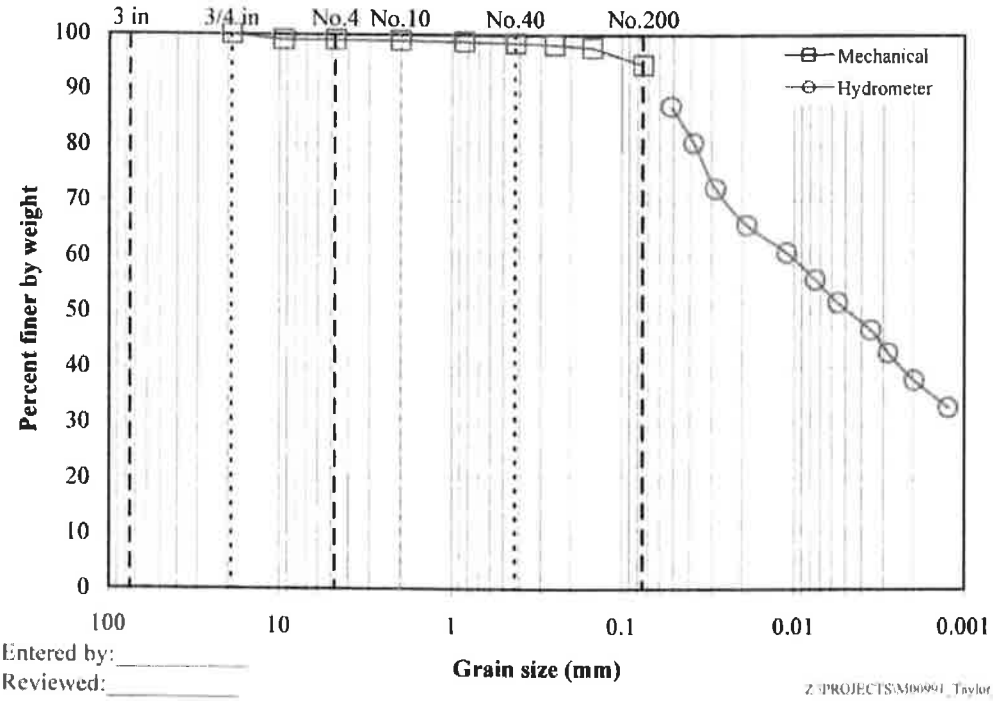
Boring No.:
Sample: CH-1-3
Depth:
Description: Description

Split sieve:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	7774	7397.19
+3/8" Coarse fraction (g):	83.4	79.60
-3/8" Split fraction (g):	356.60	339.30
Hydrometer fraction (g):	62.26	60.20
Split fraction:	0.989	

Moisture data	C.F.(+3/8")	S.F.(-3/8")	Hyd.(-No.10)
Moist soil + tare (g):	224.40	92.06	61.75
Dry soil + tare (g):	220.60	89.05	60.70
Tare (g):	141.00	30.00	30.04
Moisture content (%):	4.77	5.10	3.42

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.164
Gs:	2.65	Assumed	Intercept:	16.3
Composite corr.:	6		α:	1.00
Dispersion period (min):	15		Hyd. fraction:	98.81
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
12"	-	300	-		0.5	16.5	59	0.05190	86.99
8"	-	200	-		1	16.5	55	0.03847	80.43
6"	-	150	-		2	16.5	50	0.02870	72.22
4"	-	100	-		5	16.5	46	0.01887	65.65
3"	-	75	-		15	17	43	0.01112	60.73
1.5"	-	37.5	-		34	17.5	40	0.00754	55.81
3/4"	-	19	100.0		64	18	37.5	0.00557	51.70
3/8"	79.60	9.5	98.9	<=Split	160	19	34.5	0.00357	46.78
No.4	-	4.75	98.9		258	20	32	0.00282	42.68
No.10	0.40	2	98.8	<=Split hyd.	521	21.5	29	0.00199	37.75
No.20	0.10	0.85	98.6		1396	21	26	0.00125	32.83
No.40	0.25	0.425	98.4						
No.60	0.40	0.25	98.2						
No.100	0.75	0.15	97.6						
No.200	2.63	0.075	94.5						



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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

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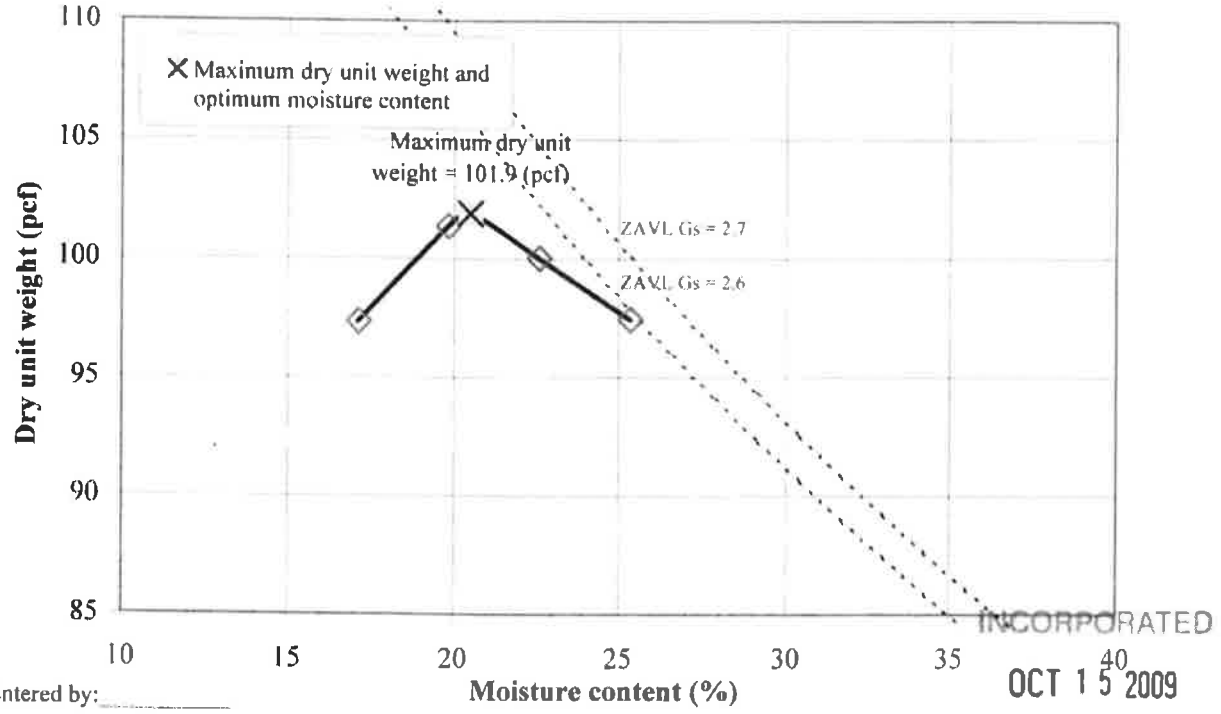
Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/7/2007
By: DKS

Method: ASTM D698 B
Mold volume (ft^3): 0.0333

Boring No.:
Sample: CH-1-3
Depth:
Sample Description:
Engineering Classification: Not requested
As-received moisture content (%): 5.1
Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum moisture content (%): 20.5
Maximum dry unit weight (pcf): 101.9

Point Number	+18	+20	+15	+12				
Wt. Sample + Mold (g)	6110.0	6102.8	6092.8	5905.3				
Wt. of Mold (g)	4256.2	4256.2	4256.2	4181.7				
Wet Unit Wt., γ_m (pcf)	122.6	122.1	121.5	114.0				
Wet Soil + Tare (g)	518.1	584.4	626.4	659.3				
Dry Soil + Tare (g)	455.42	511.67	559.49	586.02				
Tare (g)	177.9	224.6	222	150.7				
Moisture Content, w (%)	22.6	25.3	19.8	17.1				
Dry Unit Wt., γ_d (pcf)	100.0	97.4	101.4	97.3				



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Alton Coal Pile Line A1-A1 - Seismic

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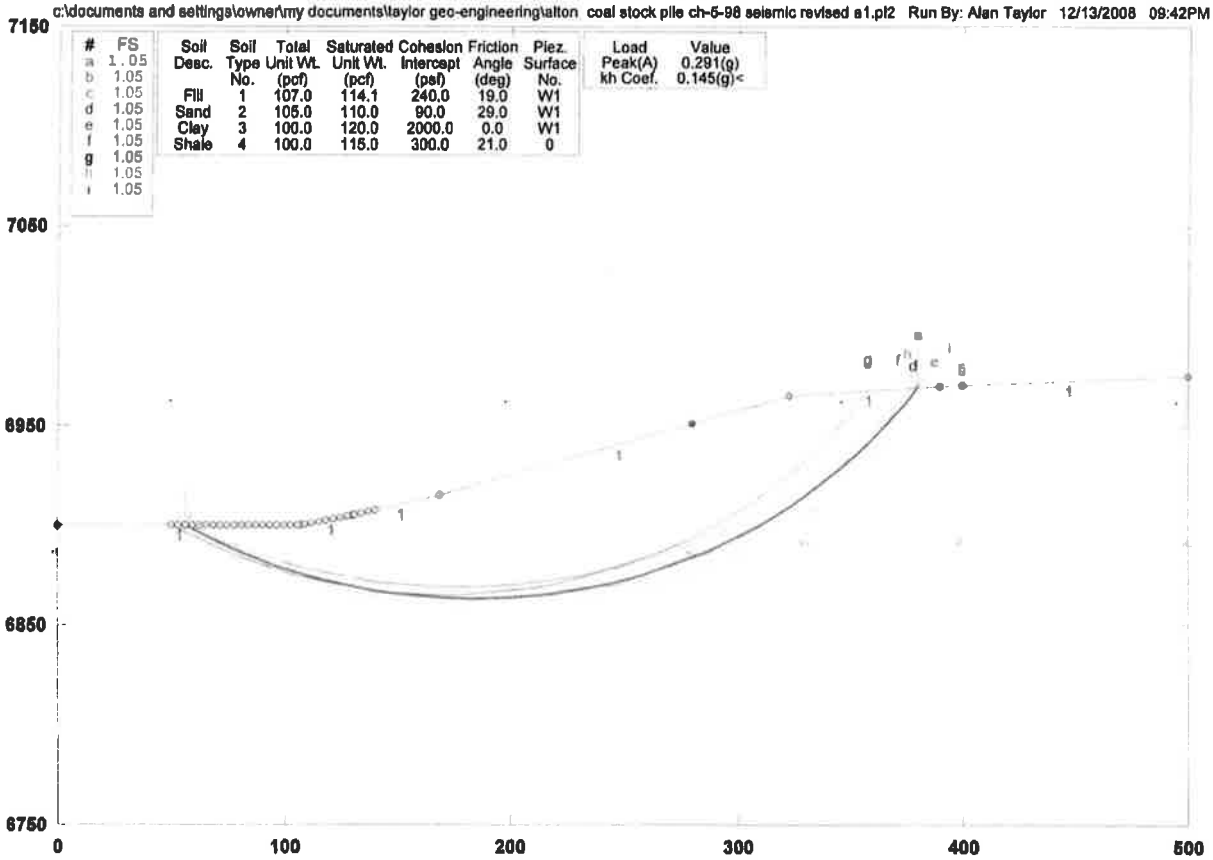
#	FS
a	1.05
b	1.05
c	1.05
d	1.05
e	1.05
f	1.05
g	1.05
h	1.05
i	1.05

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Fill	1	107.0	114.1	240.0	19.0	W1
Sand	2	105.0	110.0	90.0	29.0	W1
Clay	3	100.0	120.0	2000.0	0.0	W1
Shale	4	100.0	115.0	300.0	21.0	0

Load	Value
Peak(A)	0.291(g)
kh Coef.	0.145(g)<



GSTABL7 v.2 FSmin=1.05

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

Figure No. 17

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