Permit Application

Lea County, New Mexico

C.K. Disposal E & P Landfill and Processing Facility

Permit No. TBD

Volume II
Part 2

November 2015

PSC Project # 01058015

PARKHILLSMITH&COOPER
PSC

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

MW-20

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

12/28/08
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use _________; Location No. ___________

Do Not Write Below This Line

File Number: CP-993
Trn Number: 415642

Form: wr-20

WLB

2

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505-394-5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789

City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 SW 1/4 NE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M.
in Lea County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System
______ Zone in the ____________ Grant.
U.S.G.S. Quad Map ____________

C. Latitude: 32 d 26 m 14.9172 s Longitude: 103 d 04 m 45.4866 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the
____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-994

I. On land owned by (required): Louisiana Energy Services

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.467.0622
Mailing Address: 921 N. Bivins

City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 12/5/08 ; Completed: 12/5/08 ; Type tools: Air-Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 36 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-994
Trn Number: 415643
Form: wr-20

21.38.32.232

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
Dry				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4 PVC	Sch 40	2	+3	36	39	end cap	26	36

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	5	7-7/8		20 Sacks	Trimie (Bentonite/Cement)
5	23	7-7/8	5		Poured (Bentonite chips)

8. PLUGGING RECORD

Plugging Contractor: ______________________
Address: ______________________
Plugging Method: ______________________
Date Well Plugged: ______________________

Plugging approved by: ______________________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-994
Trn Number: 415643

Form: wr-20

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	10	10	Sandstone, lightly cemented, burnt orange
10	23	13	Caliche, hard, gray
23	34	11	Gravelly sand, chert gravel, red sand matrix
34	36	2	Claystone, dark purple

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

MW-21

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

12/29/08
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use _________; Location No. ___________

Do Not Write Below This Line

File Number: CP-994
Trn Number: 415643

WL B

3

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisianna Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone: ______
Address: P.O. Box 1789
City: Eunice
State: New Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SE 1/4 NE 1/4 NE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ______ feet, Y = ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant. U.S.G.S. Quad Map ______

C. Latitude: 32 d 26 m 21.907 s Longitude: 103 d 04 m 27.079 s

D. East ______ (m), North ______ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ______ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ______ of the ______ Subdivision recorded in ______ County.

G. Other: ______

H. Give State Engineer File Number if existing well: CP-947

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Agent: Shane Currie
Mailing Address: 921 N. Bivins
City: Amarillo
Work Phone: 806.467.0607
Home Phone: 806.076.8220
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/15/07; Completed: 4/03/07; Type tools: Air rotary;
Size of hole: 7-7/8 in.; Total depth of well: 220.5 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: 178.83 ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR [illegible] P 2: 00

Do Not Write Below This Line

File Number: CP-947
Form: wr-20
Trn Number: 376945

21.38.32.224

Monitor

✓

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
178.83	218.1	39.27	Claystone & siltstone	0-5

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	sch 40 PVC	2	0	198.1	198.1	N/A	N/A	
4	sch 40 PVC	2	198.1	218.1	20	PVC end cap	198.1	218.1

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie - bentonite/cement
75	192	7-7/8	43		poured - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ____________
Address: ____________
Plugging Method: ____________
Date Well Plugged: ____________

Plugging approved by: ____________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feet of Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-947
Trn Number: 376945

21.38.32.224

Monitor

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	2	2	SAND, loose, dry, brown-tan
2	25	23	CALICHE, soft, dry, gray
25	30	5	SANDY, gravel, dry, orange to tan
30	130	100	Clay, highly plastic, maroon with gray mottling
130	140	10	siltstone, hard, dry, gray with maroon mottling
140	195	55	Claystone, dry maroon w/ gray mottling
195	205	10	Siltstone, hard, dry gray w/ maroon splotching
205	207	2	claystone, firm dry maroon w/ gray mottling
207	215	8	Siltstone with claystone hard, gray & maroon
215	230	15	claystone, firm dry maroon w/ gray mottling

Do Not Write Below This Line

File Number: CP-947
Form: wr-20

Trn Number: 376945

21.38.32.224

Monitor

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** _________; **Location No.** ___________

Do Not Write Below This Line

File Number: CP-947

Trn Number: 376945

Monitor

21.38.32.224

WLD

4

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Contact: Laurie Wetherell
Address: P.O. Box 1789
City: Eunice
Work Phone: 505.394.5204
Home Phone: ____________
State: __ Zip: ____________

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NE 1/4 NE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ________ feet, Y = ________ feet, N.M. Coordinate System ______ Zone in the ________________ Grant.
U.S.G.S. Quad Map ________

C. Latitude: 32 d 26 m 33.098 s Longitude: 103 d 04 m 27.582 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the ____________ Subdivision recorded in ____________ County.

G. Other: ________________

H. Give State Engineer File Number if existing well: CP-948

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Agent: Shane Currie
Mailing Address: 921 N. Bivins
City: Amarillo
Work Phone: 806.467.0607
Home Phone: 806.676.8220
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/15/07; Completed: 4/03/07; Type tools: Air rotary;
Size of hole: 7-7/8 in.; Total depth of well: 32.2 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 01

Do Not Write Below This Line

File Number: CP-948
Trn Number: 376966

Form: wr-20

Monitor

21.38.32.222

✓

4

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
			DRY	

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	sch 40 PVC	2	0	22.2	22.2	N/A	N/A	
4	sch 40 PVC	2	22.2	32.2	10	PVC end cap	22.2	32.2

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	10	7-7/8	1	2.6	tremie - bentonite/cement
10	19	7-7/8	5	N/A	pour - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-948
Form: wr-20

Trn Number: 376946

Monitor

21.38.32.222

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	3	3	Topsoil - silt loose, dry, brown
3	30	27	Caliche, hard, dry, tan to gray
30	35	5	Clay, highly plastic, dry, maroon & gray

Do Not Write Below This Line

File Number: CP-948
Form: wr-20

Trn Number: 376946

Monitor

21.38.32.222

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

______________ Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** __________; **Location No.** ____________

Do Not Write Below This Line

File Number: CP-948

Trn Number: 376940

Form: wr-20

Monitor

21.38.32.222

WLB

5

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789
City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 NE 1/4 NE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ________ feet, Y = ________ feet, N.M. Coordinate System ________ Zone in the ________ Grant. U.S.G.S. Quad Map ________

C. Latitude: 32 d 26 m 32.895 s Longitude: 103 d 04 m 39.176 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ________ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ________ of the ________ Subdivision recorded in ________ County.

G. Other: ________

H. Give State Engineer File Number if existing well: CP-949

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/16/07; Completed: 4/03/07; Type tools: Air Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 240.9 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 2: 02

Do Not Write Below This Line

File Number: CP-949
Trn Number: 376947
Form: wr-20

page 1 of 4

Monitor

21.38.32.221

5

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
			DRY	

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4.0	sch 40 PVC	2	0	220.9	220.9	N/A	N/A	
4.0	sch 40 PVC	2	220.9	240.9	20	PVC end cap	220.9	240.9

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie - bentonite/cement
75	215	7-7/8	53	N/A	pour - bentonite pellets

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-949
Form: wr-20

Trn Number: 376947

21.38.32.221

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	4	4	SAND, loose, dry, orange to light red
4	30	26	CALICHE, moderately hard, chert, dry orange & red
30	50	20	SANDY, Gravel, chert, dry, tan to light orange
50	115	65	Clay, highly plastic, firm, dry, gray & Maroon
115	125	10	Siltstone, hard, moist, gray
125	180	55	Claystone, dry, maroon w/ gray mottling
180	190	10	Siltstone & claystone interbedded, dry gray
190	235	45	Claystone, hard, dry, maroon w/ gray veining
235	240	5	Siltstone, v. hard to hard, dry, gray
240	245	5	Claystone, hard, dry, maroon w/ gray & green mottling

Do Not Write Below This Line

File Number: CP-949
Form: wr-20

Trn Number: 376947

21.38.32.221

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/07
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** __________; **Location No.** ____________

Do Not Write Below This Line

File Number: CP-949

Trn Number: 376947

Form: wr-20

21.38.32.221

Monitor

WLB

6

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789

City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 SW 1/4 NW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ________ feet, Y = ________ feet, N.M. Coordinate System ________ Zone in the ________ Grant.
U.S.G.S. Quad Map ________

C. Latitude: 32 d 26 m 16.2 s Longitude: 103 d 5 m 21.2 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ________ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ________ of the ________ Subdivision recorded in ________ County.

G. Other: ________

H. Give State Engineer File Number if existing well: CP-959

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins

City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/23/07; Completed: 3/24/07; Type tools: Air Rotary
Size of hole: 7-7/8 in.; Total depth of well: 231 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P [illegible]

Do Not Write Below This Line

File Number: CP-959
Trn Number: 376959
Form: wr-20

page 1 of 4

21.38.32.131

Monitor

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
DRY				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	Sch 40 PVC	2	0	211	211	N/A		
4	Sch 40 PVC	2	211	231	20	PVC end cap	211	231

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	70	7-7/8	1	18	tremie - bentonite/cement
70	205	7-7/8	48		poor - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ____________
Address: ____________
Plugging Method: ____________
Date Well Plugged: ____________

Plugging approved by: ____________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-959
Trn Number: 376959
Form: wr-20

21.38.32.131

Monitor

6

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	2	2	SAND loose moist orange/brown
2	15	13	CALICHE, soft dry tan
15	20	5	Gavelly sand, loose dry orange to tan
20	30	10	claystone w/ siltstone maroon & gray
30	95	65	claystone, dry maroon w/ gray mottling
95	110	15	Claystone w/ siltstone dry maroon & gray
110	130	20	claystone, hard, dry maroon w/ gray mottling
130	135	5	Claystone w/ siltstone dry maroon & gray
135	210	75	claystone, hard dry maroon & gray
210	215	5	siltstone w/ claystone hard, gray & maroon
215	240	25	Claystone, Moderate hard dry maroon & gray

Do Not Write Below This Line

File Number: CP-959
Form: wr-20

Trn Number: 376959

21.38.32.131

Monitor

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use __________; Location No. ___________

Do Not Write Below This Line

File Number: CP-959
Form: wr-20

page 4 of 4

Trn Number: 376959

21.38.32.131

Monitor

WLB

7

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Contact: Laurie Wetherell
Address: P.O. Box 1789
City: Eunice
Work Phone: 505.394.5204
Home Phone: ____________
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SE 1/4 NE 1/4 NW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System ________ Zone in the ____________ Grant. U.S.G.S. Quad Map ____________

C. Latitude: 32 d 26 m 23.387 s Longitude: 103 d 04 m 57.803 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the ____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP958

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Agent: Shane Currie
Mailing Address: 921 N. Bivins
City: Amarillo
Work Phone: 806.467.0607
Home Phone: 806.676.8220
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/20/07; Completed: 3/29/07; Type tools: Air rotary
Size of hole: 7-7/8 in.; Total depth of well: 246.3 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: 217.14 ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 MAR 27 P 2:07

Do Not Write Below This Line

File Number: CP-958
Form: wr-20
Trn Number: 376958

Monitor

21.38.32.124

7

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
217.19	246.3	29.11	claystone w/siltstone	0-5

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	Sch 40 PVC	2	0	226.3	226.3	N/A	N/A	
4	Sch 40 PVC	2	226.3	246.3	20	PVC End Cap	226.3	246.3

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	70	7-7/8	1	18	tremie - cement/bentonite
70	220	7-7/8	43	N/A	pour - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-958
Form: wr-20

Trn Number: 376958

21.38.32.124

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	5	5	SAND, loose, damp, burnt orange
5	35	30	CALICHE, hard, dry light orange to gray
35	40	5	SANDY gravel, gray sand matrix
40	70	30	CLAY, Plastic, firm gray & maroon
70	80	10	claystone w/ siltstone dry maroon & gray
80	225	145	claystone, firm, dry maroon w/ gray mottling
225	245	20	claystone w/ siltstone dry, light red
245	250	5	claystone stiff, dry maroon w/ gray mottling

Do Not Write Below This Line

File Number: CP-958
Trn Number: 376958

Form: wr-20

21.38.32.124

Monitor

7

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad ____; **FWL** ____; **FSL** ____; **Use** ________; **Location No.** ________

Do Not Write Below This Line

File Number: CP-958

Trn Number: 376958

Form: wr-20

page 4 of 4

.21.38.32.124

Monitor

WLB

8

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Contact: Laurie Wetherell
Address: P.O. Box 1789
City: Eunice
Work Phone: 505.394.5204
Home Phone:
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NE 1/4 NW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ______ feet, Y = ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant. U.S.G.S. Quad Map ______

C. Latitude: 32 d 26 m 33.072 s Longitude: 103 d 05 m 2.128 s

D. East ______ (m), North ______ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ___, Map No. ___ of the ______ Hydrographic Survey

F. Lot No. ___, Block No. ___ of Unit/Tract ______ of the ______ Subdivision recorded in ______ County.

G. Other: ______

H. Give State Engineer File Number if existing well: CP-951

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon / LPE
Agent: Shane Currie
Mailing Address: 921 N. Bivins
City: Amarillo
Work Phone: 806.467.0607
Home Phone: 806.676.8220
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/29/07 ; Completed: 3/29/07 ; Type tools: Air Rotary
Size of hole: 7-7/8 in.; Total depth of well: 261.3 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: 243.31 ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
APR 27 P 2:

Do Not Write Below This Line

File Number: CP-951
Form: wr-20

Trn Number: 376949

21.38.32.122

Monitor

8

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
243.31	261.3	17.99	Siltstone, hard, gray	0 - 2

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	sch 40 PVC	2	0	241.3	241.3	N/A	N/A	
4	sch 40 PVC	2	241.3	261.3	20	PVC end cap	241.3	261.3

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie bentonite/cement
75	235	7-7/8	65	—	pour bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 2:03

Do Not Write Below This Line

File Number: CP-951
Form: wr-20

Trn Number: 376949

21.38.32.122

Monitor

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	4	4	SAND loose, dry tan-brown
4	20	16	CALICHE, soft, chert, dry, tan
20	25	5	Gravelly SAND, chert, orange SAND matrix
25	45	20	CLAY, highly plastic, firm, dry maroon
45	65	20	Siltstone, hard, dry, gray
65	120	55	Claystone, hard, dry, maroon w/ gray mottling
120	125	5	claystone, interbedded w/ siltstone maroon
125	240	115	Claystone, dry maroon w/ gray mottling
240	260	20	Siltstone, hard, damp gray
260	265	5	claystone, dry, maroon with gray mottling

Do Not Write Below This Line

File Number: CP-951
Form: wr-20

Trn Number: 376949

21.38.32.122

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/07
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use __________; Location No. ___________

Do Not Write Below This Line

File Number: CP-951

Form: wr-20

Trn Number: 376949

21.38.32.122

Monitor

WLB

9

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Contact: Laurie Wetherell
Address: P.O. Box 1789
City: Eunice
Work Phone: 505.394.5204
Home Phone:
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NE 1/4 NW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ________ feet, Y = ________ feet, N.M. Coordinate System ________ Zone in the ________ Grant. U.S.G.S. Quad Map ________

C. Latitude: 32 d 26 m 32.801 s Longitude: 103 d 04 m 59.861 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ________ of the ________ Subdivision recorded in ________ County.

G. Other: ________

H. Give State Engineer File Number if existing well: CP-950

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Agent: Shane Currie
Mailing Address: 921 N. Bivins
City: Amarillo
Work Phone: 806.467.0607
Home Phone: 806.676.8220
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/21/07; Completed: 3/30/07; Type tools: Air rotary;
Size of hole: 7-7/8 in.; Total depth of well: 22 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: dry ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 2:02

Do Not Write Below This Line

File Number: CP-950
Form: wr-20

Trn Number: 376948

page 1 of 4

Monitor

21.38.32.122

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
DRY				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	SCH 40 PVC	2	0	10.1	10.1	N/A	N/A	
4	SCH 40 PVC	2	10.1	20.1	10.0	PVC end cap	10.1	20.1

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	2	7-7/8	1	0.5	tremie bentonite/cement
2	7	7-7/8	2		pour bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-950

Trn Number: 376948

21.38.32.122

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	2	2	SAND, loose, moist, tan to brown
2	15	13	CALICHE, soft, chert gravel, moist, orange-tan,
15	19	4	Gravelly SAND, light cementation moist red sand
19	22	3	Clay, highly plastic, firm, moist, maroon w/ gray mottling

Do Not Write Below This Line

File Number: CP-950

Trn Number: 376948

Form: wr-20

page 3 of 4

21.38.32.122

Monitor

9

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** __________; **Location No.** ___________

Do Not Write Below This Line

File Number: CP-950

Trn Number: 376948

Monitor

2138.32.122

WLB

10

File Number: ______
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone:
Address: P. O. Box 1789
City: Eunice
State: ___ Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 NE 1/4 NW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M.
in Lea County.

B. X = ______ feet, Y = ______ feet, N.M. Coordinate System
______ Zone in the ______ Grant.
U.S.G.S. Quad Map ______

C. Latitude: 32 d 26 m 33.002 s Longitude: 103 d 05 m 8.300 s

D. East ______ (m), North ______ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ___, Map No. ___ of the ______ Hydrographic Survey

F. Lot No. ___, Block No. ___ of Unit/Tract ______ of the
______ Subdivision recorded in ______ County.

G. Other: ______

H. Give State Engineer File Number if existing well: CP-952

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 2:03

4. DRILLING RECORD

Drilling began: 3/21/07; Completed: 3/29/07; Type tools: Air Rotary
Size of hole: 7-7/8 in.; Total depth of well: 269 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

Do Not Write Below This Line

File Number: CP-952
Trn Number: 376950

Form: wr-20

page 1 of 4

21.38.32.121

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
DRY				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	SCH 40 PVC	2	0	16.9	16.9	N/A	N/A	
4	SCH 40 PVC	2	16.9	26.9	10	PVC End cap	16.9	26.9

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	4	7-7/8	1	1	tremie - Cement/bentonite
4	14	7-7/8	4	N/A	pour - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-952
Form: wr-20

Trn Number: 376950

21.38.32.121

Monitor

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	2	2	SAND, loose, moist, burnt orange
2	20	18	CALICHE, realative soft, chert, dry tan - light orange
20	27	7	Gravelly, SAND, chert gravel burnt orange
27	30	3	clay highly plastic, firm, dry maroon

Do Not Write Below This Line

File Number: CP-952

Trn Number: 376950

21.38.32.121

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** _________; **Location No.** ___________

Do Not Write Below This Line

File Number: CP-952
Form: wr-20

Trn Number: 376950

21.38.32.121

WLB

11

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services — Work Phone: 505.394.5204
Contact: Laurie Wetherell — Home Phone: ______
Address: P.O. Box 1789
City: Eunice — State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NW 1/4 NW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ______ feet, Y = ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant. U.S.G.S. Quad Map ______

C. Latitude: 32 d 26 m 32.999 s Longitude: 103 d 05 m 19.283 s

D. East ______ (m), North ______ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ______ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ______ of the ______ Subdivision recorded in ______ County.

G. Other: ______

H. Give State Engineer File Number if existing well: CP-953

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE — Work Phone: 806.467.0607
Agent: Shane Currie — Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins
City: Amarillo — State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/22/07; Completed: 3/29/07; Type tools: Air Rotary
Size of hole: 7-7/8 in.; Total depth of well: 257.5 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: 241.26 ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 2: 0

Do Not Write Below This Line

File Number: CP-953 — Trn Number: 376952

Form: wr-20 — page 1 of 4

21.38.32.112

Monitor

11

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
241.26	257.5	16.24	Claystone w/interbedded siltstone	0-2

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	Sch 40 PVC	2.	0	237.5	237.5	N/A	N/A	
4	sch 40 PVC	2	237.5	257.5	20	PVC end cap	237.5	257.5

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie - cement/bentonite
75	230	7-7/8	2.5	N/A	pour - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ____________
Address: ____________
Plugging Method: ____________
Date Well Plugged: ____________

Plugging approved by: ____________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-953
Form: wr-20

Trn Number: 376952

Monitor

21.38.32.112

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	5	5	SAND, loose moist burnt orange
5	15	10	CALICHE, hard dry orange
15	35	20	CLAY, high plastic maroon w/ gray mottling
35	50	15	Siltstone, hard dry gray
50	200	150	Claystone, dry, maroon
200	210	10	Claystone, w/ interbedded siltstone, hard dry maroon
210	245	35	Claystone, hard, dry maroon w/ gray splotching
245	255	10	Claystone, w/ interbedded siltstone hard, dry maroon
255	260	5	Claystone, hard, dry maroon gray mottling

Do Not Write Below This Line

File Number: CP-953

Trn Number: 376952

Monitor

21.38.32.112

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

4/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use __________; Location No. ____________

Do Not Write Below This Line

File Number: CP-953

Trn Number: 376952

Monitor

21.38.32.112

WLB

12

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Contact: Laurie Wetherell
Address: P.O. Box 1789
City: Eunice
Work Phone: 505.394.5204
Home Phone: ____________
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 NW 1/4 NW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System ________ Zone in the ____________ Grant. U.S.G.S. Quad Map ____________

C. Latitude: 32 d 26 m 27.646 s Longitude: 103 d 05 m 22.714 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the ____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-954

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon / LPE
Agent: Shane Currie
Mailing Address: 921 N. Bivins
City: Amarillo
Work Phone: 806.467.0607
Home Phone: 806.676.8720
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/22/07; Completed: 3/30/07; Type tools: Air Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 236.4 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 2: 0

Do Not Write Below This Line

File Number: CP-954
Trn Number: 376954
Form: wr-20

page 1 of 4

21.38.32.111

Monitor

12

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
DRY				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	Sch 40 PVC	2	0	216.4	216.4	N/A	N/A	
4	Sch 40 PVC	2	216.4	236.4	20	PVC end cap	216.4	236.4

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	15	7-7/8	1	20	tremie - cement/bentonite
15	210	7-7/8	43		pour - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ____________
Address: ____________
Plugging Method: ____________
Date Well Plugged: ____________

Plugging approved by: ____________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-954
Form: wr-20

Trn Number: 376954

Monitor

21.39.32.111

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	10	10	SAND, fine, loose, moist, burnt orange
10	20	10	CALICHE, soft light orange
20	35	15	Siltstone, hard dry gray
35	45	10	claystone, hard dry maroon w/ gray mottling
45	50	5	claystone w/ interbedded siltstone maroon & gray
50	75	25	claystone, dry, maroon w/ gray mottling
75	85	10	siltstone w/ interbedded claystone
85	105	20	Claystone, hard, dry maroon w/ gray mottling
105	110	5	siltstone w/ interbedded claystone hard dry gray & maroo
110	130	20	Claystone, dry maroon w/ gray mottling
130	160	30	Claystone, with siltstone dry maroon & gray
160	170	10	Claystone, dry maroon to purple w/ gray mottling
170	175	5	siltstone, hard, dry, gray
175	180	5	claystone, hard dry, maroon w/ gray mottling
180	190	10	siltstone w/ claystone dry gray & maroon
190	215	25	Claystone, hard, dry, maroon w/ gray & maroon
215	235	25	siltstone, hard, dry, gray
235	245	10	claystone, hard, dry maroon w/ gray

Do Not Write Below This Line

File Number: CP-954
Form: wr-20

Trn Number: 376954

Monitor

21.39.32.111

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad ____; FWL ____; FSL ____; Use ________; Location No. __________

Do Not Write Below This Line

File Number: CP-954
Form: wr-20

page 4 of 4

Trn Number: 376954

21.39.32.111

Monitor

JLB

13

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505-394-5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789
City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SW 1/4 SW 1/4 NE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System ________ Zone in the ____________ Grant. U.S.G.S. Quad Map ____________

C. Latitude: 32 d 26 m 14.8482 s Longitude: 103 d 04 m 40.2564 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the ____________ Subdivision recorded in ____________ County,

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-995

I. On land owned by (required): Louisiana Energy Services

STATE ENGINEER OFFICE

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.467.0622
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 12/5/08; Completed: 12/5/08; Type tools: Air-Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 38 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-995
Trn Number: 418652
Form: wr-20

21.38.32.233

Monitor

13

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
Dry				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4 PVC	Sch 40	2	+3	38	41	end cap	28	38

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	5	7-7/8		20 Sacks	Trimie (Bentonite/Cement)
5	25	7-7/8	6		Poured (Bentonite chips)

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-995
Trn Number: 418652

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	9	9	Sand, lightly cemented, tan to lt orange
9	24	13	Caliche, relative soft, lt gray
4	36	12	Gravelly sand, chert, tan to lt red matrix
36	38	2	Claystone, purple

Do Not Write Below This Line

File Number: CP-995

Trn Number: 418652

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

MW-22

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

12/29/08
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** __________; **Location No.** ____________

Do Not Write Below This Line

File Number: CP-995

Trn Number: 418652

NLB

14

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505-394-5204
Contact: Laurie Wetherell
Home Phone: ______
Address: P.O. Box 1789

City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SW 1/4 SW 1/4 NE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M.
in Lea County.

B. X = ______ feet, Y = ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.
U.S.G.S. Quad Map ______

C. Latitude: 32 d 26 m 13.383 s Longitude: 103 d 04 m 52.212 s

D. East ______ (m), North ______ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ______ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ______ of the ______ Subdivision recorded in ______ County.

G. Other: ______

H. Give State Engineer File Number if existing well: CP-996

I. On land owned by (required): Louisiana Energy Services

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.467.0622
Mailing Address: 921 N. Bivins

City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 12/5/08; Completed: 12/5/08; Type tools: Air-Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 39 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-996
Trn Number: 418653
Form: wr-20
page 1 of 4
21.38.32.233

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
Dry				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4 PVC	Sch 40	2	+3	39	42	end cap	21	36

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	5	7-7/8		20 Sacks	Trimie (Bentonite/Cement)
5	20	7-7/8	5		Poured (Bentonite chips)

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-996
Trn Number: 418653

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	10	10	Sandstone, lightly cemented, burnt orange
10	21	11	Caliche, soft, lt orange to tan
21	37	16	Gravelly sand, abundant chert, lt orange-tan
37	39	2	Claystone, purple

Do Not Write Below This Line

File Number: CP-996
Trn Number: 418653

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

MW-23

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

12/29/08
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** _________; **Location No.** ___________

Do Not Write Below This Line

File Number: CP-996

Trn Number: 418653

15

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Contact: Laurie Wetherell
Address: P.O. Box 1789
City: Eunice
Work Phone: 505.394.5204
Home Phone: ____________
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SW 1/4 NW 1/4 SW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ________ feet, Y = ________ feet, N.M. Coordinate System ______ Zone in the ________ Grant. U.S.G.S. Quad Map ________

C. Latitude: 32 d 25 m 56.857 s Longitude: 103 d 05 m 23.671 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ________ of the ________ Subdivision recorded in ________ County.

G. Other: ________

H. Give State Engineer File Number if existing well: CP-955

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Agent: Shane Currie
Mailing Address: 921 N. Bivins
City: Amarillo
Work Phone: 806.467.0607
Home Phone: 806.676.5220
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/23/07; Completed: 3/29/07; Type tools: Air Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 236 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 05

Do Not Write Below This Line

File Number: CP-955
Form: wr-20

Trn Number: 376958

page 1 of 4

Monitor

21.38.32.313

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
DRY				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	SCH 40 PVC	2	0	216	216	N/A	N/A	
4	SCH 40 PVC	2	216	236	20	PVC End Cap	216	236

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie - cement / bentonite
75	210	7-7/8	42		pour - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 2: 05

Do Not Write Below This Line

File Number: CP-955
Form: wr-20

Trn Number: 376955

21.38.32.313

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet		Thickness in feet	Color and Type of Material Encountered
From	To		
0	10	10	SAND, loose damp tan
10	30	20	CALICHE, soft chert gravel with orange-pink
30	35	5	SANDY Gravel, chert, dry light red sand
35	55	20	CLAY, highly plastic, firm
55	60	5	Claystone w/ siltstone hard dry maroon & gray
60	220	160	Claystone, dry maroon w/ gray mottling
220	225	5	Siltstone w/ claystone hard, dry gray & maroon
225	240	15	Silty claystone, dry, light red to dark red/maroon

Do Not Write Below This Line

File Number: CP-955 Trn Number: 376955

Monitor 21.38.32.313

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** __________; **Location No.** ____________

Do Not Write Below This Line

File Number: CP-955

Trn Number: 376955

Monitor

21.38.32.313

WLB

16

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505-394-5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789

City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 NE 1/4 SW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M.
in Lea County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System
________ Zone in the ____________ Grant.
U.S.G.S. Quad Map ____________

C. Latitude: 32 d 26 m 1.1718 s Longitude: 103 d 05 m 5.5062 s

D. East ____________ (m), North ____________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the
____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-999

I. On land owned by (required): Louisiana Energy Services

STATE ENGINEER OFFICE
P 1:22

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.467.0622
Mailing Address: 921 N. Bivins

City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 12/4/08 ; Completed: 12/4/08 ; Type tools: Air-Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 43 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-999
Trn Number: 415856

Monitor 21.38.32.321

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
Dry				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4 PVC	Sch 40	2	+3	43	46	end cap	28	43

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	5	7-7/8		20 Sacks	Trimie (Bentonite/Cement)
5	22	7-7/8	5		Poured (Bentonite chips)

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-999 Trn Number: 415856

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet		Thickness	Color and Type of Material Encountered
From	To	in feet	
0	11	11	Sand, lightly cemented, burnt orange
11	29	18	Caliche, relatively soft, gray to lt orange
23	34	11	Gravelly sand, chert gravel, red sand matrix
34	36	2	Claystone, dark purple

Do Not Write Below This Line

File Number: CP-999

Trn Number: 415856

16

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

MW-26

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

12/24/08
(mm/dd/year)

==

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use _________; Location No. ___________

Do Not Write Below This Line

File Number: CP-999
Trn Number: 415856

WLB

17

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505-394-5204
Contact: Laurie Wetherell
Home Phone: ______
Address: P.O. Box 1789
City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NE 1/4 SW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ______ feet, Y = ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.
U.S.G.S. Quad Map ______

C. Latitude: 32 d 26 m 1.071 s Longitude: 103 d 05 m 3.048 s

D. East ______ (m), North ______ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ______ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ______ of the ______ Subdivision recorded in ______ County.

G. Other: ______

H. Give State Engineer File Number if existing well: CP-998

I. On land owned by (required): Louisiana Energy Services

STATE ENGINEER OFFICE
[illegible] P 1:21

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.467.0622
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 12/4/08 ; Completed: 12/4/08 ; Type tools: Air-Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 250 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-998
Trn Number: 418655

Form: wr-20

Monitor

21.38.32.322

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
Dry				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4 PVC	Sch 40	2	+3	250	253	end cap	230	250

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	20	7-7/8		20 Sacks	Trimie (Bentonite/Cement)
20	206	7-7/8	68		Poured (Bentonite chips)

8. PLUGGING RECORD

Plugging Contractor: ____________________
Address: ____________________
Plugging Method: ____________________
Date Well Plugged: ____________________

Plugging approved by: ____________________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-998 Trn Number: 418655

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	12	12	Sand, lightly cemented, burnt orange
12	25	13	Caliche, relatively soft, gray to lt orange
25	36	11	Sandstone, lightly cemented, burnt orange
36	70	34	Claystone, maroon
70	72	2	Siltstone, hard gray
72	153	81	Claystone, light red with maroon to purple
153	215	62	Claystone, maroon to lt red
215	218	3	Siltstone, interbeded w/claystone, gray
218	230	12	Claystone, interbeded siltstone, maroon-gray
230	235	5	Siltstone, interbeded w/claystone, gray
235	250	15	Claystone, lt red to maroon

Do Not Write Below This Line

File Number: CP-998

Trn Number: 418655

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

MW-25

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

12/29/08
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** _________; **Location No.** ___________

Do Not Write Below This Line

File Number: CP-998
Trn Number: 418655

WLB

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505-394-5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789

City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SE 1/4 NE 1/4 SW 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M.
in ____________ County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System ____________ Zone in the ____________ Grant.
U.S.G.S. Quad Map ____________

C. Latitude: 32 d 26 m 1.0998 s Longitude: 103 d 05 m 1.086 s

D. East ____________ (m), North ____________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the ____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-997

I. On land owned by (required): Louisiana Energy Services

STATE ENGINEER OFFICE
1:21

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.467.0622
Mailing Address: 921 N. Bivins

City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 12/4/08; Completed: 12/4/08; Type tools: Air-Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 40 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-997
Trn Number: 418654

Monitor
21.38.32.324

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
Dry				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4 PVC	Sch 40	2	+3	40	43	end cap	25	40

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	5	7-7/8		20 Sacks	Trimie (Bentonite/Cement)
5	20	7-7/8	5		Poured (Bentonite chips)

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-997
Trn Number: 418654

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet		Thickness	Color and Type of Material Encountered
From	To	in feet	
0	11	11	Sandstone, slight cemented, burnt orange
11	29	18	Caliche, soft, gray to lt orange
29	37	8	Gravelly sand, abundant chert, orange sand
37	40	3	Claystone, maroon

Do Not Write Below This Line

File Number: CP-997

Trn Number: 418654

18

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

MW-24

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

12/24/08
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use _________; Location No. ___________

Do Not Write Below This Line

File Number: CP-997

Trn Number: 418654

Form: wr-20

JLB

19

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone: ______
Address: P.O. Box 1789

City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 SE 1/4 SW 1/4 Section: 32 Township: 21S Range: 38E. M.P.M. in Lea County.

B. X = ______ feet, Y = ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.
U.S.G.S. Quad Map ______

C. Latitude: 32 d 25 m 52.499 s Longitude: 103 d 05 m 7.607 s

D. East ______ (m), North ______ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ______ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ______ of the ______ Subdivision recorded in ______ County.

G. Other: ______

H. Give State Engineer File Number if existing well: CP-956

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins

City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/28/07; Completed: 4/3/07; Type tools: Air rotary
Size of hole: 7-7/8 in.; Total depth of well: 237 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
07 APR 27 P 2

Do Not Write Below This Line

File Number: CP-956
Trn Number: 376956

Monitor

21.38.32.341

19

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
DRY				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	sch 40 PVC	2	0	217.1	217.1	N/A	N/A	
4	sch 40 PVC	2	217.1	237.1	20	PVC end cap	217.1	237.1

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie - cement / bentonite
		7 7/8	48	n/a	pour - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ____________
Address: ____________
Plugging Method: ____________
Date Well Plugged: ____________

Plugging approved by: ____________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-956
Form: wr-20

Trn Number: 376956

Monitor

21.38.32.341

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	5	5	SAND, fine, damp, burnt orange
5	25	20	CAliche, soft, dry, gray to tan
25	40	15	SANDY Gravel, chert, dry, burnt orange
40	60	20	Clay firm, dry, maroon w/ gray mottling
60	85	25	claystone w/ siltstone, hard, dry maroon & gray
85	165	80	claystone, dry maroon w/ gray mottling
165	190	25	Claystone w/ siltstone, hard, dry maroon
190	220	30	claystone, hard, dry maroon w/ gray mottling
220	235	15	claystone, w/ siltstone hard, dry light red
235	240	15	claystone, hard, dry, maroon w/ gray mottling

Do Not Write Below This Line

File Number: CP-956
Form: wr-20

Trn Number: 376956

21.38.32.341

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/07
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use __________; Location No. ____________

Do Not Write Below This Line

File Number: CP-956

Trn Number: 376956

Form: wr-20

Monitor

21.38.32.341

WLB

20

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone: ___________
Address: P.O. Box 1789
City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NE 1/4 SE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ________ feet, Y = ________ feet, N.M. Coordinate System ________ Zone in the ________ Grant.
U.S.G.S. Quad Map ________

C. Latitude: 32 d 26 m 5.327 s Longitude: 103 d 04 m 26.985 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ________ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ________ of the ________ Subdivision recorded in ________ County.

G. Other: ________

H. Give State Engineer File Number if existing well: CP-946

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/16/07; Completed: 4/03/07; Type tools: Air Rotary;
Size of hole: 7-7/8 in.; Total depth of well: 225.8 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: 220.49 ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 3:00

Do Not Write Below This Line

File Number: CP-946
Trn Number: 376944

Form: wr-20

Monitor

21.38.32.422

20

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
220.49	225.8	5.31	claystone	0-1

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	sch 40 PVC	2	0	205.8	205.8	N/A	N/A	
4	sch 40 PVC	2	205.8	225.8	20	PVC end cap	205.8	225.8

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie - bentonite/cement
75	200	7-7/8	48	N/A	poured - bentonite pellets

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-946
Form: wr-20

Trn Number: 376944

21.38.32.422

Monitor

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	2	2	SAND, loose dry, burnt orange
2	20	18	CALICHE, Moderately hard, dry gray
20	35	15	Gravely SAND, fine grained light gray
35	70	35	CLAY, highly plastic, firm, dry, maroon
70	80	10	CLAYStone, dry light red cuttings
80	95	15	CLAYStone, dry maroon with gray and green Mottling
95	100	5	Claystone, interbedded siltstone, dry, maroon & gray
100	115	15	Claystone, firm dry maroon & gray
115	125	10	Claystone, interbedded siltstone maroon
125	175	50	claystone, dry maroon
175	185	10	claystone, interbedded w/ siltstone, dry maroon
185	195	10	Siltstone, hard dry gray
195	200	5	Siltstone, hard dry gray
200	215	15	claystone, hard dry maroon
215	220	5	siltstone, damp, gray
220	235	15	claystone, firm, dry, maroon

Do Not Write Below This Line

File Number: CP-946
Form: wr-20

Trn Number: 376944

Monitor

21.38.32.422

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/07
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use __________; Location No. ____________

Do Not Write Below This Line

File Number: CP-946

Trn Number: 376944

Form: wr-20

page 4 of 4

21.38.32.422

Monitor

WLB

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789
City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. SE 1/4 SE 1/4 SE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System ______ Zone in the ____________ Grant. U.S.G.S. Quad Map ____________

C. Latitude: 32 d 25 m 46.785 s Longitude: 103 d 4 m 31.815 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the ____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-945

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Work Phone: 806.467.0607
Agent: SHANE Currie
Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 27 P 1:5

Drilling began: 3/14/07; Completed: 4/3/07; Type tools: Air Rotary
Size of hole: 7 7/8 in.; Total depth of well: 241.2 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

Do Not Write Below This Line

File Number: CP-945
Trn Number: 376887

Form: wr-20

Monitor

21.38.32.444

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
			DRY	

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	sch 40 PVC	2	0	221.2	221.2	N/A	N/A	
4	sch 40 PVC	2	221.2	241.2	20	PVC end cap	221.2	241.2

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	75	7-7/8	1	20	tremie - bentonite/cement
75	215	7-7/8	48	N/A	poured - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ______________
Address: ______________
Plugging Method: ______________
Date Well Plugged: ______________

Plugging approved by: ______________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-945
Trn Number: 376887

to Monitor

21.38.32.444

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	10	10	SAND, fine-grained, loose dry, brown to light orange
10	25	15	Caliche, moderately soft, dry, orange and white
25	60	35	clay, stiff dry, gray and maroon, mottled
60	190	130	claystone, dry maroon
190	200	10	Siltstone, hard damp; light gray
200	260	60	claystone, firm dry maroon

Do Not Write Below This Line

File Number: CP-945 Trn Number: 376887
Form: wr-20

Monitor 21.38.32.444

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

04/24/2007
(mm/dd/year)

==

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use _________; Location No. ___________

Do Not Write Below This Line

File Number: CP-945

Trn Number: 376887

Form: wr-20

page 4 of 4

21.38.32.444

Monitor

WLB

22

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Louisiana Energy Services
Work Phone: 505.394.5204
Contact: Laurie Wetherell
Home Phone: ____________
Address: P.O. Box 1789

City: Eunice
State: NM Zip: 88231

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NW 1/4 SW 1/4 SE 1/4 Section: 32 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ____________ feet, Y = ____________ feet, N.M. Coordinate System ________ Zone in the ____________ Grant. U.S.G.S. Quad Map ____________

C. Latitude: 32 d 25 m 50.439 s Longitude: 103 d 04 m 52.541 s

D. East ____________ (m), North ____________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ____________ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ____________ of the ____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-957

I. On land owned by (required): Lea County, NM

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon/LPE
Work Phone: 806.467.0607
Agent: Shane Currie
Home Phone: 806.676.8220
Mailing Address: 921 N. Bivins

City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 3/20/07; Completed: 4/3/07; Type tools: Air rotary;
Size of hole: 7-7/8 in.; Total depth of well: 231.4 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: DRY ft.

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 APR 2 P 2: 05

Do Not Write Below This Line

File Number: CP-957
Trn Number: 376957

Form: wr-20

page 1 of 4

Monitor 21.38.32.431

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
DRY				

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
4	Sch 40 PVC	2	0	211.4	211.4	N/A	N/A	
4	Sch 40 PVC	2	211.4	231.4	20	PVC end cap	211.4	231.4

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	15	7-7/8	1	20	tremie - cement/bentonite
15	205	7-7/8	48		poured - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ____________
Address: ____________
Plugging Method: ____________
Date Well Plugged: ____________

Plugging approved by: ____________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-957
Form: wr-20

Trn Number: 376957

Monitor

21.38.32.431

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	10	10	SAND fine, loose, dry orange to tan
10	35	25	CALICHE, hard dry, orange & gray
35	40	5	SANDY gravel, maroon
40	85	45	Clay, highly plastic firm dry maroon
85	95	10	Siltstone, hard dry gray
95	105	10	Claystone, light red
105	110	5	Siltstone w/ claystone gray & maroon
110	170	60	claystone, dry maroon w/ gray mottling
170	195	25	Siltstone w/ claystone hard dry gray & maroon
195	220	25	Claystone, dry, maroon
220	230	10	Siltstone w/ Claystone dry gray & maroon
230	240	10	Claystone w/ some silt maroon w/ gray mottling

Do Not Write Below This Line

File Number: CP-957

Trn Number: 376957

Form: wr-20

Monitor

21.38.32.431

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

4/24/2007
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; **FWL** _____; **FSL** _____; **Use** __________; **Location No.** ____________

Do Not Write Below This Line

File Number: CP-957

Trn Number: 376957

Form: wr-20

page 4 of 4

21.38.32.431

Monitor

23

WLB

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Waste Control Specialists, LLC
Work Phone: 888-789-2783
Contact: Mike Burney
Home Phone: 505-394-4300
Address: 9998 W. Highway 176
City: Andrews
State: TX Zip: 79714

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NE 1/4 NW 1/4 Section: 33 Township: 21S Range: 38E N.M.P.M. in ____________ County.

B. X = ________ feet, Y = ________ feet, N.M. Coordinate System ______ Zone in the ____________ Grant.
U.S.G.S. Quad Map ________

C. Latitude: 32 d 26 m 29 s Longitude: 103 d 03 m 58 s

D. East ________ (m), North ________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ____________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ____________ of the
____________ Subdivision recorded in ____________ County.

G. Other: ____________

H. Give State Engineer File Number if existing well: CP-979 >

I. On land owned by (required): Waste Control Specialists, LLC

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2008 MAR -6 P 3 33

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling, L.P.
Work Phone: 806-467-0607
Agent: Shane Currie
Home Phone: 806-676-8220
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 2/20/08 ; Completed: 2/20/08 ; Type tools: Air Rotary Rig
Size of hole: 5 5/8 in.; Total depth of well: 28 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-979
Trn Number: 399475

Form: wr-20
page 1 of 4

Monitor
21.38.33.122

File Number: __________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
			Dry	

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
2	Sch 40 Pvc	2	0	28	28	Pvc end cap	13	28

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	5	5-5/8	20		tremie - bentonite/cement
5	10	5-5/8	2		poured - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: __________
Address: __________
Plugging Method: __________
Date Well Plugged: __________

Plugging approved by: __________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-979

Trn Number: __________

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	0.5	0.5	Surface Soil
0.5	15	14.5	Caliche
15	17	2	Gravelly sand
17	25	8	clayey silty sand
25	28.5	3.5	gray sandstone

Do Not Write Below This Line

File Number: CP-979
Trn Number: ______________

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

03/03/2008
(mm/dd/year)

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use _________; Location No. ___________

Do Not Write Below This Line

File Number: CP-979

Trn Number: ______________

24

OSE FILE NUMBER ________ ________
For OSE Use Only

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD and DRILLING LOG

1. PERMIT HOLDER(S)

Name: WASTE CONTROL SPECIALISTS	Name:
Address: P.O. BOX 1129	Address:
City: ANDREWS	City:
State: TX Zip: 79714	State: Zip:
Phone: (505) 394-4300	Phone:
Contact: MICHAEL BURNEY	
Contact Phone: (505) 394-4300	

2. STATE ENGINEER REFERENCE NUMBERS:

File # CP 975 EXPLORE, Well # C.P. 975

3. LOCATION OF WELL (The Datum Is Assumed To Be WGS 84 Unless Otherwise Specified)

Latitude:	32	Deg	25	Min	45.8	Sec
Longitude:	103	Deg	04	Min	20.4	Sec

(Enter Lat/Long To At Least 1/10th Of A Second)

Datum If Not WGS 84: ______

Santa Rosa

4. DRILLING CONTRACTOR

License Number: WD1184

Name: WEST TEXAS WATER WELL SERVICE Work Phone: (432) 530-2696

Drill Rig Serial Number: 261602

List The Name Of Each Drill Rig Supervisor That Managed On-Site Operations During The Drilling Process:

RONNY KEITH

STATE ENGINEER OFFICE
2008 MAY 14 P 2:

5. DRILLING RECORD

Drilling Began: 1-21-08; Completed: 4-29-08; Drilling Method MUD ROTARY

Diameter Of Bore Hole: 7-7/8 (in);

Total Depth Of Well: 2,020 (ft);

Completed Well Is (Circle One): Shallow [✓ Artesian];

Depth To Water First Encountered: 1,092 (ft);

Depth To Water Upon Completion Of Well: N/A (ft).

Do Not Write Below This Line

TRN Number: 396028 File Number: CP-975

Form: wr-20 May 07

21.38.33.333

Explore

OSE FILE NUMBER ____________ __________
For OSE Use Only

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD and DRILLING LOG

6. RECORD OF CASING

Diameter (inches)	Pounds (per ft.)	Threads (per inch)	Depth (feet)	Length Top to Bottom (feet)	Type of Shoe	Perforations (from to)
13-3/8	48	8	2' AGL	40'		
8-5/8	24	8	3' AGL	1,440'	FLOAT GUIDE	

7. RECORD OF MUDDING AND CEMENTING

Depth (feet)	Hole (diameter)	Mud Used (# of sacks)	Cement (cubic feet)	Method of Placement
0 - 40	17-1/2		35	TRIMMIE
0 - 1,440	12-1/4		574	POSITIVE
1,380-2,020	7-7/8		275	TRIMMIE

Do Not Write Below This Line

Trn Number: ______________ File Number: ______________

OSE FILE NUMBER __________ __________
For OSE Use Only

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

8. LOG OF HOLE. For Each Water Bearing Strata, Estimate The Yield Of The Formation In Gallons Per Minute.

Depth (feet)		Thickness (Feet)	For Water Bearing Strata Enter The Estimated Yield in GPM	Color and Type of Material Encountered
From	To			
			SEE ATTACHED	GEOLOGIC LOG

Enter Method Used To Estimate Yield: N/A

Do Not Write Below This Line

Trn Number: ____________

File Number: ____________

CP-975 Geologic log

	0-6 ft	6	pad fill and fine brown sand	
	6-10 ft	4	white sandy limestone (Mescalero caliche)	Ogallala
	10-29 ft	19	sand, light brown, and brown calcareous sandstone (Gatuña Formation)	? Ogallala
	29-576 ft	547	interbedded sandstone, siltstone, and claystone; reddish-brown to gray; bioturbated (Cooper Canyon Formation)	
	576-708 ft	132	sandstone and siltstone, gray to reddish brown (Trujillo Formation)	
	708-1092 ft	384	interbedded very fine sandstone and siltstone, gray to dark reddish brown (Tecovas Formation)	Dockum
	1092-1384 ft	292	gray, fine sandstone with interbedded reddish brown and weak red siltstone and claystone (Santa Rosa Formation)	
1400	1384-1566 ft	182	reddish brown, very fine sandstone and siltstone, with some fibrous gypsum in lower part (Dewey Lake Formation)	
	1566-1602 ft	34	gray anhydrite beds, with intermediate reddish-brown and gray siltstone (Forty-niner Member of the Rustler Formation)	
	1602-1609 ft	7	gray anhydrite and wavy thin laminae of dolomite (Magenta Dolomite Member of the Rustler Formation)	
	1609-1736 ft	127	gray anhydrite beds, with intermediate halite including anhydrite and polyhalite (Tamarisk Member of the Rustler Formation)	
	1736-1807 ft	71	halite with thin two thin anhydrite beds and basal reddish-brown, very fine sandstone (Los Medaños Member of the Rustler Formation)	
	1807-2020 ft	213	halite with anhydrite/polyhalitic marker beds (MB103 and uppermost MB109) (Salado Formation)	

OSE FILE NUMBER ________ ________
For OSE Use Only

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his or her knowledge and belief, the foregoing is a true and correct record of the above described bore hole. The undersigned further certifies that he or she will file this well record with the Office Of The State Engineer and permit holder within 20 days after completion of the well drilling.

Tommy Keith
Driller

05-12-08
(mm/dd/year)

Do Not Write Below This Line

Trn Number: ____________

File Number: ____________

25

File Number: ____ ____
(For OSE Only)

2-24674
\$20^{00}

NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT TO DRILL AN EXPLORATORY WELL

1. APPLICANT:

Name: Waste Control Specialists LLC
Work Phone: 888-789-2783
Contact: Mike Burney
Home Phone: 505-394-4300
Address: 9998 W. Highway 176
City: Andrews
State: TX Zip: 79714

2. LOCATION OF WELL (A, B, C, or D required, E or F if known):

A. NE 1/4 NW 1/4 NW 1/4 Section: 33 Township: 21S Range: 38E N.M.P.M. in Lea County.

B. X = ____ feet, Y = ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant. U.S.G.S. Quad Map ____

C. Latitude: 32 d 26 m 30.145 s Longitude: 103 d 04 m 10.962 s

D. East ____ (m), North ____ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. ____, Map No. ____ of the ____ Hydrographic Survey

F. Lot No. ____, Block No. ____ of Unit/Tract ____ of the ____ Subdivision recorded in ____ County.

G. Other: ____

H. Give State Engineer File Number of existing well: ____

I. On land owned by (required): Waste Control Specialists LLC

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 DEC 31 A 9:53

3. WELL INFORMATION:

Approximate depth 75 feet; Outside diameter of casing 2 inches.
Name of well driller and driller license number Jose Salas/#1575

4. ADDITIONAL STATEMENT OR EXPLANATIONS:

This piezometer (TP- 63) is being installed to determine the presence or absence of shallow groundwater in the Ogallala/Antlers/Gatuna formations on top of the Triassic Dockum group "red bed clays" in support of licensing activities by Waste Control Specialists LLC. No pumping or use of groundwater is intended; the piezometer is being installed solely to monitor groundwater levels,if any.

RENAMED "PZ-41"

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2008 FEB 29 1:31

Do Not Write Below This Line

File Number: CP-972
Trn Number: 395941

25

File Number: _____ _____
(For OSE Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT TO DRILL AN EXPLORATORY WELL

ACKNOWLEDGEMENT

(I, We) Mike Burney affirm that the
(Please Print)
foregoing statements are true to the best of my knowledge and belief.

Applicant Signature _______________ Applicant Signature _______________

ACTION OF STATE ENGINEER

This application is approvedXXXXXXXXXXXXXXXXXXXXXXXXXX provided it is not exercised to the detriment of any others having existing rights, and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare, and further subject to the following conditions:

see attached conditions of approval

Witness my hand and seal this 2nd day of January, 20 08

John R. D'Antonio, Jr., P.E, State Engineer

By: Kenneth M. Fresquez
Kenneth M. Fresquez, Acting District II Supervisor

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2008 FEB 29 A 11:31

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2007 DEC 31 A 9:58

Do Not Write Below This Line

File Number: CP-972 Trn Number: 395941

Form: wr-07 page 2 of 2

wL/5
WD

26

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

1. OWNER OF WELL

Name: Waste Control Specialists
Work Phone: 888-789-2783
Contact: Mike Burney
Home Phone: 505-394-4300
Address: 9998 W. Highway 176
City: Andrews
State: TX Zip: 79714

2. LOCATION OF WELL (A, B, C, or D required, E or F if known)

A. NE 1/4 NW 1/4 NW 1/4 Section: 33 Township: 21S Range: 38E N.M.P.M. in ______________ County.

B. X = __________ feet, Y = __________ feet, N.M. Coordinate System ______ Zone in the ______________ Grant. U.S.G.S. Quad Map __________

C. Latitude: 32 d 26 m 29 s Longitude: 103 d 04 m .13 . . s

D. East __________ (m), North __________ (m), UTM Zone 13, NAD __ (27 or 83)

E. Tract No. _____, Map No. _____ of the ______________ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract ______________ of the ______________ Subdivision recorded in ______________ County.

G. Other: ______________

H. Give State Engineer File Number if existing well: CP-972

I. On land owned by (required): Waste Control Specialists

STATE ENGINEER OFFICE
2008 FEB 29 A 11:31

3. DRILLING CONTRACTOR

License Number: 1575
Name: Talon Drilling, L.P.
Work Phone: 806-467-0607
Agent: Shane Currie
Home Phone: 806-676-8220
Mailing Address: 921 N. Bivins
City: Amarillo
State: TX Zip: 79107

4. DRILLING RECORD

Drilling began: 1/21/08; Completed: 2/9/08; Type tools: Air Rotary Rig
Size of hole: 5-5/8 in.; Total depth of well: 49 ft.;
Completed well is: Monitor (shallow, artesian);
Depth to water upon completion of well: Dry ft.

Do Not Write Below This Line

File Number: CP-972
Trn Number: 395941

Form: wr-20

Monitor

21.38.33.112

File Number: ____________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

5. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	To	Thickness in feet	Description of water-bearing formation	Estimated Yield (GPM)
			Dry	

6. RECORD OF CASING

Diameter (inches)	Pounds per ft.	Threads per in.	Depth in Feet Top	Bottom	Length (feet)	Type of Shoe	Perforations From	To
2	Sch 40 PVC	2	0	37	37	N/A	N/A	
2	Sch 40 PVC	2	37	49	12	PVC end cap	37	49

7. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	To	Hole Diameter	Sacks of mud	Cubic Feet of Cement	Method of Placement
0	5	5-5/8	20		tremie - bentonite/cement
5	35	5-5/8	6		poured - bentonite chips

8. PLUGGING RECORD

Plugging Contractor: ____________
Address: ____________
Plugging Method: ____________
Date Well Plugged: ____________

Plugging approved by: ____________
State Engineer Representative

No.	Depth in Feet Top	Bottom	Cubic Feetof Cement
1			
2			
3			
4			
5			

Do Not Write Below This Line

File Number: CP-972

Trn Number: 375941

21.38.33.112

Form: wr-20

page 2 of 4

Moriton

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

9. LOG OF HOLE

Depth in Feet From	To	Thickness in feet	Color and Type of Material Encountered
0	2	2	Silty Sand, tan
2	7	5	Caliche, Hard, tan
7	30	23	Caliche, Moderate hard, tan
30	45	15	Silty Sand, tan
45	49	5	clay, reddish

Do Not Write Below This Line

File Number: CP-972
Form: wr-20

Trn Number: 395941

21.38.33.112

Monitor

26

File Number: ______________
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
WELL RECORD

10. ADDITIONAL STATEMENTS OR EXPLANATIONS:

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller: ______________ 02/26/2008 (mm/dd/year)

===

FOR STATE ENGINEER USE ONLY

Quad _____; FWL _____; FSL _____; Use _________; Location No. ___________

Do Not Write Below This Line

File Number: CP-972

Trn Number: 395941

Form: wr-20

21.38.33.112

Monitor

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER
ROSWELL

John R. D'Antonio, Jr., P.E.
State Engineer

1900 WEST SECOND STREET
ROSWELL, NM 88201
Phone: (575) 622-6521
Fax: (575) 623-8559

January 3, 2008

Waste Control Specialists LLC
% Mike Burney
9998 W. Hwy 176
Andrews, TX 79714

RE: CP-971; CP-972; CP-973: CP-974

Greetings:

Enclosed is your copy of the Exploratory / Monitoring Permits, which have been approved subject to the conditions set forth on the approval page thereof.

In accordance with Condition C, a well record shall be filed in this office twenty days after completion of drilling. The well record is proof of completion of well. IT IS YOUR RESPONSIBILITY TO ASSURE THAT THE WELL LOGS BE FILED WITHIN 20 DAYS OF DRILLING OF THE WELLS.

These permits will expire on or before 01/31/09 unless the wells have been drilled and the well logs filed in this office.

Sincerely,

Mjw
for Andy Morley
(575) 622-6521, ext 113

Enclosure

cc: Santa Fe Office

STATE ENGINEER OFFICE
ROSWELL, NEW MEXICO
2008 FEB 29 A 11: 31

NEW MEXICO STATE ENGINEER
PERMIT TO EXPLORE / MONITOR

SPECIFIC CONDITIONS OF APPROVAL

4 No water shall be appropriated and beneficially used under this permit.

B The well shall be drilled by a driller licensed in the State of New Mexico in accordance with Section 72-12-12 New Mexico Statutes Annotated.

C Driller's well record must be filed with the State Engineer within 20 days after the well is drilled or driven. Well record forms will be provided by the State Engineer upon request.

C2 No water shall be diverted from this well except for testing purposes which shall not exceed ten (10) cumulative days, and well shall be plugged or capped on or before 01/31/09, unless a permit to use water from this well is acquired from the Office of the State Engineer.

The well shall be constructed, maintained and operated that each water shall be confined to the aquifer in which it is encountered.

LOG The Point of Diversion CP-972 Monitor Well must be completed and the Well Log filed on or before 01/31/09.

ACTION OF STATE ENGINEER

Notice of Intention Rcvd:		Date Rcvd. Corrected:
Formal Application Rcvd:	12/31/07	Pub. Of Notice Ordered:
Date Returned – Correction:		Affidavit of Pub. Filed:

This application is approved provided it is not exercised to the detriment of any others having existing rights, and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare of the state; and further subject to the specific conditions listed previously.

Witness my hand and seal this 2nd day of January, 2008.

John R. D'Antonio, Jr., P.E., State Engineer

By: Kenneth M. Fresquez

Kenneth M. Fresquez, Acting District II Supervisor

File Nbr: CP-972 Monitor Well

27

WBC **WEAVER BOOS CONSULTANTS, INC.**
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-101

FILE # 95042.10
SHEET 1 OF 1

WATER LEVEL DATA
NE = Not Encountered
NE FT. W.D.
NE FT. AT COMPLETION
____ FT. AT ____ HR. A.D.
____ FT. AT ____ HR. A.D.

Started 11/22/97
Completed 11/22/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico

CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3408.62 (Ft., MSL)
Northing: 9800.52
Easting: 9898.97
Completion Depth: 50.0

STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	Calcareous	Moisture	Munsell	Notes
Dark reddish-brown, fine SAND, some roots, no organics	2.0	No	Dry	7.5YR 5/6	
Reddish-brown, sandy LOAM to poorly cemented loamy SAND, blocky, friable	6.0	No	Dry	7.5YR 6/6	
Pinkish-white, sandy CALICHE, moderately weak structure, friable nodules of caliche	12.0	Moderate	Dry	2.5YR 8/2	
Reddish-brown, loamy fine SAND with moist friable sandy nodules, very few calcareous nodules	21.0				
Light red to pink, calcareous pebbly SAND, pebbles are dominantly quartzite, some rose color banded gniess, little chert, angular. Pebbles increase with depth	34.0	Moderate Moderate	Dry Dry	2.5YR 7/6 5YR 7/4	
Pink, sandy, pebbly fine GRAVEL, dominantly quartzite, well graded, angular	36.0	Slight	Dry	2.5YR 7/3	
Reddish-brown MUDSTONE/CLAYSTONE, sandy, dry, blocky cuttings, some chert pebbles and calcareous clasts, poorly indurated	50.0	Slight	Barely Damp	2.5YR 4/6	
BORING TERMINATED AT 50.0'					

NOTES:
1. Dry monitoring well installed in borehole.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

28

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-102

FILE # 95042.10
SHEET 1 OF 1

WATER LEVEL DATA
NE = Not Encountered

NE FT. W.D.
NE FT. AT COMPLETION
____ FT. AT ____ HR. A.D.
____ FT. AT ____ HR. A.D.

Started 11/20/97
Completed 11/20/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico

CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,392.63 (Ft., MSL)
Northing: 8467.05
Easting: 7193.22
Completion Depth: 50.0

Depth (FT.,bgs)	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT.,bgs)
5.0	Brown, fine to medium SAND with caliche grains, granular structure, some roots, no organics	7.0	No Minor	Dry Dry	7.5YR 4/6 7.5YR 5/6		5.0
10.0 15.0	Brownish-white calcareous fine SAND, some calcareous cement sand nodules, not as floury as other caliche, gritty, abundant coarse sand and chert when wetted	16.0	Yes	Dry	7.5YR 7/3		10.0 15.0
20.0	Pinkish-white sandy CALICHE, many pebbles of hard angular cherty fine sandstone (not friable)	21.0	Yes	Dry	7.5YR 7/3		20.0
25.0	Pink, fine to medium SAND, calcareous very small nodules of caliche and cemented sandstone	26.0	Yes	Dry	2.5YR 7/3		25.0
30.0	White sandy CALICHE with calcareous sand matrix and abundant chert clasts. Clasts are angular, coarse gravel size, brown, white and black, some quartzite	33.0	Yes	Dry	2.5YR 8/2		30.0
35.0	Rose and white PEBBLES, with very little sand, dominantly hard, very angular quartzite. White pebbles are hard limestone with quartzite grains	36.0	Yes	Barely Damp	2.5YR 6/4		35.0
40.0 45.0	Reddish-brown MUDSTONE/CLAYSTONE, slicky, occasionally sandy, micaceous clasts infrequently, poorly indurated		Yes	Barely Damp	2.5YR 4/4		40.0 45.0
50.0	BORING TERMINATED AT 50.0'	50.0	Yes	Barely Damp	2.5YR 4/6		50.0

NOTES:
1. Dry monitoring well installed in borehole.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

29

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-103

FILE # 95042.10

SHEET 1 OF 1

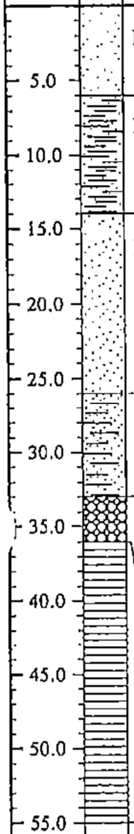
WATER LEVEL DATA
NE = Not Encountered
NE FT. W.D.
NE FT. AT COMPLETION
____ FT. AT ____ HR. A.D.
____ FT. AT ____ HR. A.D.

Started 11/21/97
Completed 11/21/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico

CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,402.54 (Ft., MSL)
Northing: 9711.58
Easting: 8682.07
Completion Depth: 55.0



STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	Calcareous	Moisture	Munsell	Notes
Reddish-brown, sandy LOAM to poorly cemented loamy SAND, blocky, friable		No	Dry	7.5YR 4/6	
		No	Barely Damp	7.5YR 5/6	
Pinkish-white, sandy CALICHE, moderately weak structure, friable nodules of caliche	6.0	Yes	Dry	7.5YR 8/4	
Reddish-brown, loamy fine SAND with moist friable sandy nodules, very few calcareous nodules	14.0	Yes	Dry	7.5YR 7/3	
Light red to pink, calcareous pebbly SAND, pebbles are dominantly quartzite, some rose color banded gniess, little chert, angular. Pebbles increase with depth	26.0	Yes	Dry	7.5YR 8/2	
Rose and white PEBBLES, with very little sand, dominantly hard, very angular quartzite. White pebbles are hard limestone with quartzite grains	33.0	Yes	Dry	2.5YR 7/3	
Reddish-brown MUDSTONE/CLAYSTONE, sticky, occasionally sandy, micaceous clasts infrequently, poorly indurated	36.0	Yes	Barely Damp	2.5YR 4/4	
		Slight	Barely Damp	2.5YR 4/4	
BORING TERMINATED AT 55.0'	55.0	No	Barely Damp	2.5YR 4/6	

Depth (FT.,bgs): 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
⊻ W.D. - WHILE DRILLING ⊻ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

30

WBC **WEAVER BOOS CONSULTANTS, INC.**
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-104

FILE # 95042.10 SHEET 1 OF 1

WATER LEVEL DATA
NE = Not Encountered

NE FT. W.D.
NE FT. AT COMPLETION
____ FT. AT ____ HR. A.D.
____ FT. AT ____ HR. A.D.

Started 11/21/97
Completed 11/21/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico
CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,404.38 (Ft., MSL)
Northing: 8518.93
Easting: 9678.16
Completion Depth: 60.0

Depth (FT.,bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT.,bgs)
		Dark reddish-brown, fine SAND, some roots, no organics	3.0	Slight	Barely Damp	7.5YR 5/4		
5.0		Reddish-brown, sandy LOAM to poorly cemented loamy SAND, blocky, friable	6.0	Slight	Dry	7.5YR 6/4		5.0
10.0 15.0 20.0		Pinkish-white, sandy CALICHE, moderately weak structure, friable nodules of caliche	21.0	Moderate	Dry	2.5YR 8/4		10.0 15.0 20.0
25.0 30.0 35.0 40.0		Light red to pink, calcareous pebbly SAND, pebble are dominantly quartzite, some rose color banded gniess, little chert, angular. Pebbles increase with depth	40.0	Moderate	Dry	2.5YR 8/2		25.0 30.0 35.0 40.0
45.0		Very light brown medium GRAVEL with calcareous sand matrix, gravel is brown when wet, very cherty, angular, white and brown chert, some quartzite	44.0	Moderate	Dry	2.5YR 8/2		45.0
		White to light brown pebbly coarse GRAVEL with some fine calcareous sand matrix. Pebbles are less angular, mostly chert but also gniess and quartzite	46.0	Moderate	Dry	2.5YR 7/4		
50.0 55.0 60.0		Reddish-brown MUDSTONE/CLAYSTONE, sandy, dry, poorly indurated, cuttings are blocky, some chert pebbles and white calcareous clasts	60.0	Moderate Slight Slight	Dry Barely Damp Barely Damp	2.5YR 4/6 2.5YR 5/6 2.5YR 4/4	Pitcher Bell Sample obtained at 60.0'	50.0 55.0 60.0
		BORING TERMINATED AT 60.0'						

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
∇ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-105

FILE # 95042.10

SHEET 1 OF 1

WATER LEVEL DATA
NE = Not Encountered

NE FT. W.D.
NE FT. AT COMPLETION
___ FT. AT ___ HR. A.D.
___ FT. AT ___ HR. A.D.

Started 11/19/97
Completed 11/19/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico

CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,388.07 (Ft., MSL)
Northing: 6609.23
Easting: 7335.60
Completion Depth: 50.0

Depth (FT.,bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT.,bgs)
5.0 10.0		Grayish-brown loamy fine SAND, granular, no organics, few calcareous nodules increasing with depth, small roots, no iron staining, friable cemented sandstone nodules (Windblown Sands)	14.0	Yes	Dry	7.5YR 8/2		5.0 10.0
15.0 20.0 25.0		Pink fine to medium calcareous SAND, with few calcareous nodules that are friable, no other large clasts	28.0	Yes	Dry	7.5YR 7/4		15.0 20.0 25.0
30.0		Pink calcareous fine SAND to very fractured sandy CALICHE, few to no chert or other clasts. Caliche is very hard, not friable (CAPROCK?)	35.0					30.0
35.0		White sandy CALICHE with calcareous sand matrix and abundant chert clasts. Clasts are angular, coarse gravel size, brown, white and black, some quartzite	38.0					35.0
40.0		Rose and white PEBBLES, with very little sand, dominantly hard very angular quartzite. White pebbles are hard limestone with quartzite grains.	44.0	Yes	Dry	7.5YR 7/2		40.0
45.0		Reddish-brown sandy LOAM with pebbles of calcareous cemented sandstone (friable).	47.0					45.0
50.0		Reddish-brown MUDSTONE/CLAYSTONE, sandy, dry, blocky cuttings, some calcareous stains, poor indurated/friable.	50.0	Yes Yes	Dry Dry	2.5YR 6/4 2.5YR 6/4		50.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
- W.D. - WHILE DRILLING
- A.D. - AFTER DRILLING
- HOUR(S) AFTER DRILLING

32

WBC **WEAVER BOOS CONSULTANTS, INC.**
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-106

FILE # 95042.10 SHEET 1 OF 1

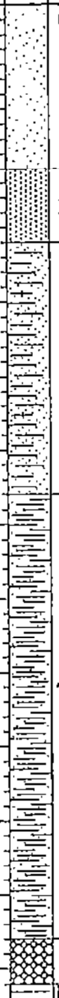
WATER LEVEL DATA
NE = Not Encountered

NE FT. W.D.
NE FT. AT COMPLETION
____ FT. AT ____ HR. A.D.
____ FT. AT ____ HR. A.D.

Started: 11/21/97
Completed: 11/21/97
Driller: Allan Eades
Helper: Freddy
Drilling Method: Air Rotary
Sampling Method: Drill Cuttings

LOCATION: Proposed Lea County Landfill
Eunice, New Mexico
CLIENT: Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,401.06 (Ft., MSL)
Northing: 5968.89
Easting: 9285.60
Completion Depth: 66.5



				SAMPLE DATA				
Depth (FT.,bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	Calcareous	Moisture	Munsell	Notes	Depth (FT.,bgs)
5.0 10.0		Grayish-brown loamy fine SAND, granular, no organics, few calcareous nodules increasing with depth, small roots, no iron staining, friable cemented sandstone nodules (Windblown Sands)	11.0	No	Dry	7.5YR 5/6		5.0 10.0
15.0		Pink fine to medium calcareous SAND, with few calcareous nodules that are friable, no other large clasts	16.0	Moderate	Dry	2.5YR 8/3		15.0
20.0 25.0 30.0		Pink calcareous fine SAND to very fractured sandy CALICHE, few to no chert or other clasts. Caliche is very hard, not friable (CAPROCK?)	33.0	Moderate	Dry	2.5YR 7/6		20.0 25.0 30.0
35.0 40.0 45.0 50.0 55.0 60.0		White sandy CALICHE with calcareous sand matrix and abundant chert clasts. Clasts are angular, coarse gravel size, brown, white and black, some quartzite	63.0	Moderate	Dry	2.5YR 8/3		35.0 40.0 45.0 50.0 55.0 60.0
65.0		Rose and white PEBBLES, with very little sand, dominantly hard very angular quartzite. White pebbles are hard limestone with quartzite grains.	66.0	Moderate	Dry	2.5YR 7/3		65.0
		Reddish-brown MUDSTONE/CLAYSTONE, sandy, dry, blocky cuttings, some calcareous stains, poor indurated/friable.	66.5	Slight	Dry	2.5YR 5/6		
		BORING TERMINATED AT 66.0'						

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
∇ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

33

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-107

FILE # 95042.10

SHEET 1 OF 2

WATER LEVEL DATA
NE = Not Encountered

NE FT. W.D.
NE FT. AT COMPLETION
_____ FT. AT _____ HR. A.D.
_____ FT. AT _____ HR. A.D.

Started: 11/22/97
Completed: 11/22/97
Driller: Allan Eades
Helper: Freddy
Drilling Method: Air Rotary
Sampling Method: Drill Cuttings

LOCATION: Proposed Lea County Landfill
Eunice, New Mexico

CLIENT: Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,405.43 (Ft., MSL)
Northing: 4016.88
Easting: 9228.40
Completion Depth: 92.0

Depth (FT.,bgs)	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	Calcareous	Moisture	Munsell	Notes	Depth (FT.,bgs)
5.0	Reddish-brown, loamy fine SAND to sandy LOAM, blocky, friable, very few organics, grading to light brown loamy SAND	6.0	No	Dry	7.5YR 6/6		5.0
	Reddish-brown, sandy LOAM to poorly cemented loamy SAND, blocky, friable	8.0	No	Dry	7.5YR 5/6		
10.0	Pink, sandy CALICHE, moderately weak with friable nodules of caliche and poorly cemented sand, fewer nodules with depth	13.0	Moderate	Dry	2.5YR 8/3		10.0
15.0 20.0 25.0 30.0	Pink, fine to medium SAND, calcareous very small nodules of caliche and cemented sandstone	31.0	Moderate	Dry	2.5YR 5/6		15.0 20.0 25.0 30.0
35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0	Light red to pink, calcareous pebbly SAND, pebbles are dominantly quartzite, some roase color banded gniess, little chert, angular. Pebbles increase with depth	75.0	Moderate	Dry	2.5YR 6/4		35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0
75.0	Pink, sandy CALICHE with caprock chips (Continued)		Moderate	Dry	2.5YR 8/3		75.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
W.D. - WHILE DRILLING
A.D. - AFTER DRILLING
HOUR(S) AFTER DRILLING

WBC

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-107

FILE # 95042.10

SHEET 2 OF 2

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	SAMPLE DATA Moisture	SAMPLE DATA Munsell	SAMPLE DATA Notes	Depth (FT., bgs)
		(Continued from page 1) Pink, sandy CALICHE with caprock chips						
		Reddish-brown, sandy MUDSTONE/CLAYSTONE, dry, poorly indurated, some small calcareous cemented sandstone nodules, little to no mica	83.0	Moderate	Dry	2.5YR 5/6		
85.0				Slight	Barely Damp	2.5YR 7/3		85.0
90.0				Slight	Barely Damp	2.5YR 5/3		90.0
		BORING TERMINATED AT 92.0'	92.0	No	Barely Damp	2.5YR 5/2		

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
- W.D. - WHILE DRILLING
- A.D. - AFTER DRILLING
- ∇ HOUR(S) AFTER DRILLING

34

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-108

FILE # 95042.10

SHEET 1 OF 3

WATER LEVEL DATA
NE = Not Encountered

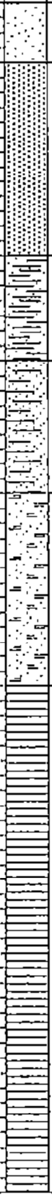
NE FT. W.D.
NE FT. AT COMPLETION
FT. AT HR. A.D.
FT. AT HR. A.D.

Started 11/20/97
Completed 11/20/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico

CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,396.15 (Ft., MSL)
Northing: 9696.33
Easting: 7439.48
Completion Depth: 215.0



STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	Calcareous	Moisture	Munsell	Notes
Brown, fine to medium SAND with caliche grains, granular structure, some roots, no organics	4.0	Yes	Dry	7.5YR 6/3	
Brownish-white calcareous fine SAND, some calcareous cement sand nodules, not as floury as other caliche, gritty, abundant coarse sand and chert when wetted	17.0	Strong	Dry	7.5YR 8/2	
Pinkish-white sandy CALICHE, many pebbles of hard angular cherty fine sandstone (not friable)	24.0	Strong	Dry	2.5YR 8/2	
Pink, very fine SAND, calcareous with occasional pebbles of granite, chert	33.0	Mild	Dry	2.5YR 7/4	
Dark brown sandy CLAYSTONE, weathered, blocky, very few caliche clasts, dry, friable/poorly indurated	46.0	Mild	Dry	2.5YR 6/2	
		Mild	Dry	2.5YR 5/3	
Reddish-brown MUDSTONE/CLAYSTONE, slicky, occasionally sandy, micaceous clasts infrequently, poorly indurated		Mild	Dry	2.5YR 5/2	
		Mild	Dry	2.5YR 5/3	
		Mild	Dry	2.5YR 7/3	Pitcher Bell Sample obtained at 60.0'
		Mild	Dry	2.5YR 4/3	
(Continued)					

NOTES:
1. Backfilled with cuttings to 120', grouted to surf-ce with 95 with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
W.D. - WHILE DRILLING
A.D. - AFTER DRILLING
HOUR(S) AFTER DRILLING

W
B
C

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-108

FILE # 95042.10

SHEET 2 OF 3

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA				Depth (FT., bgs)
				Calcareous	Moisture	Munsell	Notes	
		(Continued from page 1)						
85.0		Reddish-brown MUDSTONE/CLAYSTONE, slicky, occasionally sandy, micaceous clasts infrequently, poorly indurated		Mild	Barely Damp	2.5YR 5/3		85.0
90.0								90.0
95.0								95.0
100.0				Mild	Barely Damp	2.5YR 5/3	Pitcher Bell Sample obtained at 100.0'	100.0
105.0								105.0
110.0								110.0
115.0								115.0
120.0								120.0
				Mild	Barely Damp	2.5YR 4/4		
125.0								125.0
130.0								130.0
135.0				No	Barely Damp	2.5YR 5/6		135.0
140.0								140.0
145.0				No	Barely Damp	2.5YR		145.0
150.0							Pitcher Bell Sample obtained at 150.0'	150.0
155.0								155.0
160.0								160.0
165.0								165.0
170.0		(Continued)		No	Barely Damp	2.5YR 4/3		170.0

NOTES:
1. Backfilled with cuttings to 120', grouted to surf-ce with 95 with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

☿ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

WBC **WEAVER BOOS CONSULTANTS, INC.**
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-108

FILE # 95042.10

SHEET 3 OF 3

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT., bgs)
175.0		(Continued from page 2)						175.0
180.0		Reddish-brown MUDSTONE/CLAYSTONE, slicky, occasionally sandy, micaceous clasts infrequently, poorly indurated						180.0
185.0								185.0
				Mild	Barely Damp	2.5YR 7/2		
190.0								190.0
		Light reddish-gray SILTSTONE, with green laminae, slick, less sandy, poorly indurated, dry	191.0					
195.0				Mild	Barely Damp	2.5YR 7/1		195.0
200.0								200.0
		Reddish-brown CLAYSTONE, dry, poorly indurated, no bedding or laminae	201.0					
205.0				Mild	Barely Damp	2.5YR 5/2		205.0
210.0							Pitcher Bell Sample obtained at 215.0'	210.0
215.0		BORING TERMINATED AT 215.0'	215.0	No	Barely Damp	2.5YR 4/3		215.0

NOTES:
1. Backfilled with cuttings to 120', grouted to surf-ce with 95 with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
☿ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

WBC
WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-109

FILE # 95042.10

SHEET 1 OF 2

WATER LEVEL DATA
NE = Not Encountered

NE FT. W.D.
NE FT. AT COMPLETION
____ FT. AT ____ HR. A.D.
____ FT. AT ____ HR. A.D.

Started 11/21/97
Completed 11/21/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico

CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,404.76 (Ft., MSL)
Northing: 7717.16
Easting: 9920.72
Completion Depth: 120.0

Depth (FT.,bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT.,bgs)
5.0		Grayish-brown loamy fine SAND, granular, no organics, few calcareous nodules increasing with depth, small roots, no iron staining, friable cemented sandstone nodules (windblown sands)	8.0					5.0
10.0 15.0 20.0		Pinkish-white, sandy CALICHE, moderately weak structure, friable nodules of caliche	21.0					10.0 15.0 20.0
25.0 30.0 35.0		Light red to pink, calcareous pebbly SAND, pebbles are dominantly quartzite, some rose color banded gniess, little chert, angular. Pebbles increase with depth	36.0					25.0 30.0 35.0
40.0 45.0 50.0		White, sandy CALICHE with calcareous sand matrix and abundant chert clasts. Clasts are angular, coarse gravel size, brown, white and black, some quartzite	51.0					40.0 45.0 50.0
55.0		Rose and white PEBBLES, with very little sand, dominantly hard, very angular quartzite. White pebbles are hard limestone with quartzite grains	56.0					55.0
60.0 65.0 70.0 75.0		Reddish-brown MUDSTONE/CLAYSTONE, sandy, dry, blocky cuttings, some chert pebbles and calcareous clasts, poorly indurated	76.0					60.0 65.0 70.0 75.0
		Reddish-brown, sandy CLAYSTONE, micaceous with occasional green siltstone beds					Pitcher Bell Sample	

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

WBC
WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-109

FILE # 95042.10

SHEET 2 OF 2

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA				Depth (FT., bgs)
				Calcareous	Moisture	Munsell	Notes	
		(Continued) (Continued from page 1) Reddish-brown, sandy CLAYSTONE, micaceous with occasional green siltstone beds					obtained at 80'	
85.0								85.0
90.0								90.0
95.0								95.0
100.0								100.0
105.0								105.0
110.0								110.0
115.0								115.0
120.0		BORING TERMINATED AT 120'	120.0				Pitcher Bell Sample obtained at 120'	120.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

⊻ W.D. - WHILE DRILLING ⊻ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-110

FILE # 95042.10 SHEET 1 OF 7

WATER LEVEL DATA
NE = Not Encountered
NE FT. W.D.
NE FT. AT COMPLETION
____ FT. AT ____ HR. A.D.
____ FT. AT ____ HR. A.D.

Started 11/17/97
Completed 11/19/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill
Eunice, New Mexico
CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,397.38 (Ft., MSL)
Northing: 7924.34
Easting: 8019.53
Completion Depth: 600.0

STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	Calcareous	Moisture	Munsell	Notes
Yellowish-red to reddish-brown, loamy fine SAND, weak granular structure,	2.0	No	Dry	5YR 5/8	
Reddish-brown, loamy fine SAND to sandy LOAM, blocky, friable, very few organics, grading to light brown loamy SAND		No	Dry	5YR 6/8	
		No	Dry	5YR 6/8	
	11.0				
Pink, sandy CALICHE, moderately weak with friable nodules of caliche and poorly cemented sand, fewer nodules with depth		Strong	Dry	5YR 8/4	
		Mild	Dry	5YR 8/3	
	24.0				
Pink, fine to medium SAND, calcareous very small nodules of caliche and cemented sandstone					
		Mild	Dry	5YR 8/2	
	39.0				
Reddish-brown, pebbly, coarse GRAVEL with loamy sand matrix. Pebbles are predominantly chert, white, red, black and rose quartzite, all angular to subangular	43.0	Mild	Dry	2.5YR 6/4	
Light reddish-brown, CLAYSTONE with trace sand and calcareous cemented sandtone pebbles, cuttings are blocky, some chert					
	49.0	Mild	Dry	2.5YR 6/3	
Reddish-brown, sandy MUDSTONE/CLAYSTONE, dry, poorly indurated, some small calcareous cemented sandstone nodules, little to no mica		Mild	Dry	2.5YR 4/6	
		Mild	Dry	2.5YR 6/3	
		Mild	Dry	2.5YR 4/6	
(Continued)		Mild	Dry	2.5YR 6/4	

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
W.D. - WHILE DRILLING
A.D. - AFTER DRILLING
HOUR(S) AFTER DRILLING

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-110

FILE # 95042.10

SHEET 2 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT., bgs)
		(Continued from page 1) Reddish-brown, sandy MUDSTONE/CLAYSTONE, dry, poorly indurated, some small calcareous cemented sandstone nodules, little to no mica	84.0					
85.0		Reddish-brown, sandy CLAYSTONE, micaceous with occasional green siltstone beds		Minor	Barely Damp	2.5YR 4/4		85.0
90.0							Pitcher Bell Sample obtained at 90'	90.0
95.0								95.0
100.0								100.0
105.0								105.0
110.0			110.0					110.0
		Reddish-brown, sandy MUDSTONE/CLAYSTONE, dry, poorly indurated, some small calcareous cemented sandstone nodules, little to no mica						
115.0				Slight	Barely Damp	2.5YR 4/4		115.0
120.0								120.0
125.0								125.0
130.0				Yes	Barely Damp	2.5YR 3/4		130.0
135.0								135.0
140.0							Pitcher Bell Sample obtained at 140'	140.0
145.0				Yes	Barely Damp	2.5YR 4/4		145.0
150.0								150.0
155.0				No	Barely Damp	2.5YR 4/6		155.0
160.0								160.0
165.0								165.0
170.0		(Continued)						170.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

∇ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

W B C **WEAVER BOOS CONSULTANTS, INC.**
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-110

FILE # 95042.10 SHEET 3 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT., bgs)
175.0		(Continued from page 2)						175.0
180.0		Reddish-brown, sandy MUDSTONE/CLAYSTONE, dry, poorly indurated, some small calcareous cemented sandstone nodules, little to no mica						180.0
185.0								185.0
190.0		Light reddish-brown MUDSTONE, slick, siltier, no bedding	190.0					190.0
195.0				No	Barely Damp	2.5YR 6/3		195.0
200.0								200.0
205.0								205.0
210.0								210.0
		Reddish-brown MUDSTONE/CLAYSTONE, micaceous, no bedding or laminae	211.0					
215.0								215.0
				No	Barely Damp	2.5YR 5/4		
220.0								220.0
225.0				No	Dry	2.5YR 4/6		225.0
230.0							Pitcher Bell Sample obtained at 230'	230.0
235.0								235.0
240.0								240.0
				No	Dry	2.5YR 5/4		
245.0								245.0
250.0				No	Dry	2.5YR 4/6		250.0
255.0								255.0
260.0				No	Dry	2.5YR 6/3		260.0
		(Continued)						

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Endes Drilling and Pump Service.

LEGEND
☿ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

36

WBC **WEAVER BOOS CONSULTANTS, INC.**
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-110

FILE # 95042.10 SHEET 4 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA				Depth (FT., bgs)
				Calcareous	Moisture	Munsell	Notes	
265.0								265.0
		(Continued from page 3)						
270.0				No	Dry	2.5YR 5/6		270.0
275.0		Reddish-brown, MUDSTONE/CLAYSTONE, micaceous, no bedding or laminae						275.0
280.0								280.0
285.0								285.0
290.0				Yes	Dry	2.5YR 5/4		290.0
295.0								295.0
300.0								300.0
305.0								305.0
310.0								310.0
315.0								315.0
320.0								320.0
325.0				No	Dry	2.5YR 4/4		325.0
330.0								330.0
335.0								335.0
340.0								340.0
345.0				Yes	Dry	2.5YR 5/4		345.0
350.0							Pitcher Bell Sample obtained at 350'	350.0
		(Continued)						
355.0								355.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

⊻ W.D. - WHILE DRILLING	⊻ A.D. - AFTER DRILLING	▽ HOUR(S) AFTER DRILLING

W B C

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-110

FILE # 95042.10

SHEET 5 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	SAMPLE DATA Moisture	SAMPLE DATA Munsell	SAMPLE DATA Notes	Depth (FT., bgs)
		(Continued from page 4)						
360.0								360.0
365.0		Reddish-brown, MUDSTONE/CLAYSTONE, micaceous, no bedding or laminae		Minor	Dry	2.5YR 4/4		365.0
370.0								370.0
375.0				Minor	Dry	2.5YR 4/6		375.0
380.0								380.0
385.0								385.0
390.0								390.0
395.0								395.0
400.0								400.0
405.0								405.0
410.0								410.0
415.0								415.0
420.0								420.0
425.0								425.0
430.0								430.0
435.0				Minor	Dry	2.5YR 4/8		435.0
440.0								440.0
445.0		(Continued)						445.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

∇ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

W B C
WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-110

FILE # 95042.10

SHEET 6 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	SAMPLE DATA Moisture	SAMPLE DATA Munsell	SAMPLE DATA Notes	Depth (FT., bgs)
450.0								450.0
		(Continued from page 5)						
455.0		Reddish-brown, MUDSTONE/CLAYSTONE, micaceous, no bedding or laminae						455.0
460.0								460.0
465.0								465.0
470.0								470.0
475.0								475.0
480.0								480.0
485.0								485.0
490.0								490.0
495.0								495.0
500.0								500.0
505.0								505.0
510.0								510.0
515.0								515.0
520.0				Minor	Dry	2.5YR 5/4		520.0
525.0								525.0
530.0								530.0
535.0								535.0
		(Continued)						

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

☿ W.D. - WHILE DRILLING ⊻ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

36

WBC **WEAVER BOOS CONSULTANTS, INC.**
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-110

FILE # 95042.10 SHEET 7 OF 7

Depth (FT., bgs)	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	 Moisture	 Munsell	 Notes	Depth (FT., bgs)
			Minor	Dry	7.5YR 5/4		
-545.0	(Continued from page 6) Reddish-brown, MUDSTONE/CLAYSTONE, micaceous, no bedding or laminae						-545.0
-550.0							-550.0
-555.0			Minor	Dry	2.5YR 4/4		-555.0
-560.0							-560.0
-565.0							-565.0
			Yes	Dry	2.5YR 6/3		
-570.0			Yes	Dry	2.5YR 6/2		-570.0
			Yes	Dry	2.5YR 4/4		
-575.0							-575.0
	Light reddish-gray, clayey SILTSTONE, gritty, sandy, no bedding	576.0					
-580.0			Yes	Dry	2.5YR 6/1		-580.0
-585.0							-585.0
	Reddish-gray, silty SANDSTONE	588.0	Yes	Dry	2.5YR 6/1		
-590.0							-590.0
			Yes	Dry	2.5YR 6/1		
-595.0	Light reddish-gray, silty SANDSTONE	595.0					-595.0
			Yes	Dry	2.5YR 7/1		
-600.0	BORING TERMINATED AT 600 FEET	600.0					-600.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

W B C

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-111

FILE # 95042.10

SHEET 1 OF 7

WATER LEVEL DATA
NE = Not Encountered

598.0 FT. W.D.
_____ FT. AT COMPLETION
_____ FT. AT _____ HR. A.D.
_____ FT. AT _____ HR. A.D.

Started 11/13/97
Completed 11/13/97
Driller Allan Eades
Helper Freddy
Drilling Method Air Rotary
Sampling Method Drill Cuttings

LOCATION Proposed Lea County Landfill

Eunice, New Mexico

CLIENT Camino Real Landfill
Sunland Park, New Mexico

GROUND ELEVATION: 3,404.35 (Ft., MSL)

Northing: 9140.96
Easting: 9138.76

Completion Depth: 598.0

Depth (FT.,bgs)	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT.,bgs)	Calcareous	Moisture	Munsell	Notes	Depth (FT.,bgs)
5.0	Yellowish-red to reddish-brown loamy fine SAND, weak granular structure, friable, very few organics, some roots, increasing caliche nodules with depth and slightly loamier with depth		No	Dry	5YR 5/6		5.0
		8.0					
10.0	Pale red to pinkish-white fine sandy CALICHE, moderately weak, friable nodules of caliche		Strong	Dry	2.5YR 7/2		10.0
		12.0	Mild	Dry	2.5YR 6/6		
15.0	Reddish-brown loamy fine SAND with moist sandy loam nodules, nodules are friable and slightly sticky, very little calcareous concretions						15.0
20.0		20.0	Mild	Dry	2.5YR 6/6		20.0
	Light brown loamy fine SAND, pisolitic, slightly indurated with calcareous concretions and sandy loam nodules, coated with carbonates, some organic matter, one chert pebble						
25.0		25.0					25.0
	Pink to white CALICHE, probably massive, cuttings are very fine, flour-like, few sandy nodules, friable when wet		Strong	Dry	2.5YR 8/1		
30.0							30.0
35.0		35.0	Mild	Dry	2.5YR 8/1		35.0
	Very light brown medium GRAVEL with calcareous sand matrix, gravel is brown when wet, very cherty, angular, white and brown chert, some quartzite	37.0	Mild	Dry	2.5YR 8/3		
40.0	White to light brown pebbly coarse GRAVEL with some fine calcareous sand matrix. Pebbles are less angular, mostly chert but also gniess and quartzite	40.0	Mild	Dry	2.5YR 5/3		40.0
	Reddish-brown MUDSTONE/CLAYSTONE, sandy, dry, poorly indurated, cuttings are blocky, some chert pebbles and white calcareous clasts	44.0	Mild	Dry	2.5YR 4/4		
45.0							45.0
	Reddish-brown sandy MUDSTONE/CLAYSTONE, micaceous, especially biotite, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated						
50.0							50.0
			No	Barely Damp	10R 4/6		
55.0							55.0
60.0							60.0
			Mild	Barely Damp	2.5YR 5/3		
65.0							65.0
70.0							70.0
			Mild	Barely Damp	2.5YR 6/4		
75.0						Pitcher Bell Sample obtained at 80'	75.0
	(Continued)						

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

⊽ W.D. - WHILE DRILLING ⊻ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

WBC
WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-111

FILE # 95042.10

SHEET 2 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT., bgs)
		(Continued from page 1)						
85.0		Reddish-brown sandy, MUDSTONE/CLAYSTONE, micaceous, especially biotite, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated						85.0
				Minor	Barely Damp	2.5YR 5/4		
90.0								90.0
				Slight	Barely Damp	2.5YR 6/3		
95.0								95.0
100.0								100.0
				Yes	Barely Damp	2.5YR 4/4		
105.0								105.0
110.0								110.0
115.0								115.0
				Yes	Barely Damp	2.5YR 5/3		
120.0								120.0
125.0								125.0
130.0								130.0
135.0								135.0
				No	Barely Damp	2.5YR 5/3	Pitcher Bell Sample obtained at 140'	
140.0								140.0
145.0								145.0
150.0								150.0
155.0								155.0
160.0								160.0
165.0								165.0
170.0		(Continued)						170.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

WBC WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-111

FILE # 95042.10

SHEET 3 OF 7

STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA: Calcareous	Moisture	Munsell	Notes
(Continued from page 2)					
Reddish-brown sandy MUDSTONE/CLAYSTONE, micaceous, especially biotite, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated		No	Barely	2.5YR 5/6	
		No	Barely	2.5YR 4/4	
	185.0				
Light reddish-brown, clayey SILTSONE	187.0	No	Dry	2.5YR 6/4	
Red, clayey SILTSTONE		No	Barely Damp	2.5YR 5/6	
	195.0				
Pink, clayey SILTSTONE		No	Barely Damp	7.5YR 7/3	Pitcher Bell Sample obtained at 200'
	211.0				
Reddish-brown, sandy MUDSTONE/CLAYSTONE, micaceous, especially biotite, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated		No	Dry	2.5YR 6/2	
		No	Dry	2.5YR 4/6	
		Yes	Dry	2.5YR 4/4	
(Continued)					

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

37

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-111

FILE # 95042.10

SHEET 4 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	SAMPLE DATA Moisture	SAMPLE DATA Munsell	SAMPLE DATA Notes	Depth (FT., bgs)
265.0		(Continued from page 3)						265.0
270.0								270.0
275.0		Reddish-brown, sandy MUDSTONE/CLAYSTONE, micaceous, especially biotile, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated						275.0
280.0								280.0
285.0								285.0
290.0								290.0
295.0				No	Dry	10R 4/6		295.0
300.0								300.0
305.0								305.0
310.0								310.0
315.0								315.0
320.0								320.0
325.0								325.0
330.0				Yes	Dry	10R 4/4		330.0
335.0								335.0
340.0								340.0
345.0								345.0
350.0								350.0
355.0		(Continued)						355.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
∇ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

WBC
WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-111

FILE # 95042.10

SHEET 5 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	 Moisture	 Munsell	 Notes	Depth (FT., bgs)
		(Continued from page 4)						
360.0								360.0
365.0		Reddish-brown, sandy MUDSTONE/CLAYSTONE, micaceous, especially biotite, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated						365.0
370.0				Minor	Dry	2.5YR 4/6		370.0
375.0								375.0
380.0								380.0
385.0								385.0
390.0				Minor	Dry	2.5YR 5/6		390.0
395.0								395.0
400.0								400.0
405.0								405.0
410.0								410.0
415.0								415.0
420.0								420.0
425.0								425.0
430.0								430.0
435.0				Minor	Dry	2.5YR 4/6		435.0
440.0								440.0
445.0		(Continued)						445.0

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

W B C

WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-111

FILE # 95042.10

SHEET 6 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA				Depth (FT., bgs)
				Calcareous	Moisture	Munsell	Notes	
450.0		(Continued from page 5)						450.0
455.0								455.0
460.0		Reddish-brown, sandy MUDSTONE/CLAYSTONE, micaceous, especially biotile, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated						460.0
465.0								465.0
470.0								470.0
475.0								475.0
480.0								480.0
485.0							Pitcher Bell Sample obtained at 485'	485.0
490.0								490.0
495.0								495.0
500.0								500.0
505.0								505.0
510.0								510.0
515.0								515.0
520.0								520.0
525.0				Minor	Dry	2.5YR 6/4		525.0
530.0								530.0
535.0								535.0
		(Continued)						

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND
∇ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ∇ HOUR(S) AFTER DRILLING

W B C WEAVER BOOS CONSULTANTS, INC.
200 S. MICHIGAN AVENUE, CHICAGO IL, 60604
(312) 922-1030 * * INDIANA (219) 923-9609

LOG OF SOIL BORING NO. B-111

FILE # 95042.10

SHEET 7 OF 7

Depth (FT., bgs)	Lithology Type	STRATA DEPTH SOIL DESCRIPTION GRAPHIC LOG	Strata Depth (FT., bgs)	SAMPLE DATA Calcareous	Moisture	Munsell	Notes	Depth (FT., bgs)
		(Continued from page 6)						
545.0		Reddish-brown, sandy MUDSTONE/CLAYSTONE, micaceous, especially biotite, occasional chert pieces, occasional green siltstone beds, otherwise massive, very few laminae or bedding, moderately indurated						545.0
550.0								550.0
555.0								555.0
560.0								560.0
				Minor	Dry	2.5YR 6/4		
565.0								565.0
		Pink CLAYSTONE	566.0	Minor	Dry	2.5YR 8/3		
		Light reddish-gray, clayey SILTSTONE	568.0					
570.0								570.0
				Yes	Dry	2.5YR 7/1		
575.0								575.0
		Reddish-gray, sandy SILTSTONE	576.0	Yes	Dry	10R 6/1		
580.0								580.0
		Reddish-gray, silty SANDSTONE	581.0					
585.0				Yes	Dry	10R 6/1		585.0
590.0								590.0
595.0								595.0
▽		BORING TERMINATED AT 598 FEET	598.0					

NOTES:
1. Boring grouted after completion with 95% portland cement and 5% bentonite.
2. Drilling Company: Eades Drilling and Pump Service.

LEGEND

▽ W.D. - WHILE DRILLING ▼ A.D. - AFTER DRILLING ▽ HOUR(S) AFTER DRILLING

APPENDIX H.C

SITE BORING LOGS

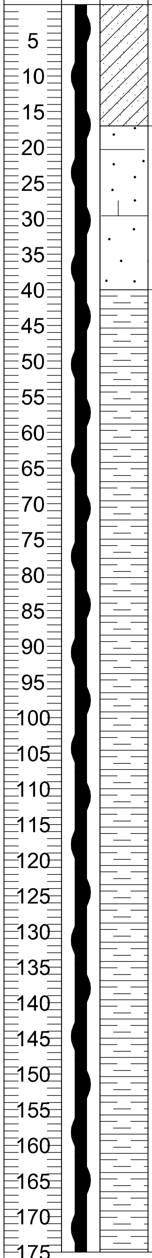
LOG OF BORING NO. BH-01

Project Description: CK Disposal

Location: Eunice, NM
Top of PVC El.: feet MSL
Surface El.: 3382 feet MSL
Completion Depth: 175 feet
Date Boring Started: 5/26/2015
Date Boring Completed: 5/26/2015

Northing: 521233.96
Easting: 924924.72

Depth, feet	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Monitor Well Construction Details	Monitor Well Description
0–17			CLAYEY SAND, brown to reddish brown, moderately well sorted, subrounded, fine to medium grained, slightly moist, none HCL reaction		
17–40			SILTY SAND, with caliche, light brown to white, well sorted, well rounded, very fine to fine grained, dry, strong HCL reaction		
40–175			CLAYSTONE, reddish brown some gray, slightly moist to dry, weak HCL reaction		



Drilling Contractor: HCI Drilling
Drilling Method: Air Rotary
Sampling Method: Cuttings
Geologist: Steven J. Wimmer
Project No.: 15-04-22

Groundwater Observations	
Date	Depth to Water (ft)
5/26/15	Dry

Remarks: 5 1/8" diameter boring; TH60 Atlas Copco Drill Rig

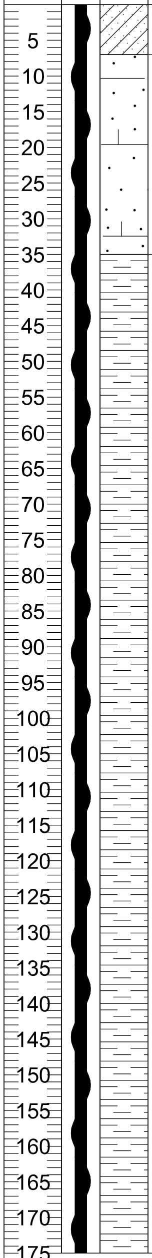
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

▽ Water level at time of drilling.
▼ Water level at end of drilling.
▽ Water level after drilling.

LOG OF BORING NO. BH-02

Project Description: CK Disposal

Depth, feet	Samples	Symbol/USCS	Location: Eunice, NM Top of PVC El.: feet MSL Surface El.: 3391.8 feet MSL Completion Depth: 175 feet Date Boring Started: 5/26/2015 Date Boring Completed: 5/26/2015 MATERIAL DESCRIPTION	Northing: 521273.70 Easting: 928310.35	Monitor Well Construction Details	Monitor Well Description



CLAYEY SAND, brown to reddish brown, moderately well sorted, subrounded, fine to medium grained, slightly moist, none HCL reaction

SILTY SAND, with caliche, light brown to white, well sorted, well rounded, very fine to fine grained, dry, strong HCL reaction

CLAYSTONE, reddish brown with gray, dry, weak HCL reaction, some purple

less gray and purple; slightly moist to dry

Drilling Contractor: HCI Drilling
Drilling Method: Air Rotary
Sampling Method: Cuttings
Geologist: Steven J. Wimmer
Project No.: 15-04-22

Groundwater Observations	
Date	Depth to Water (ft)
5/26/15	Dry

Remarks: 5 1/8" diameter boring; TH60 Atlas Copco Drill Rig

LOG OF BORING NO. BH-02
PAGE 1 of 1

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

▽ Water level at time of drilling.
▼ Water level at end of drilling.
⊻ Water level after drilling.

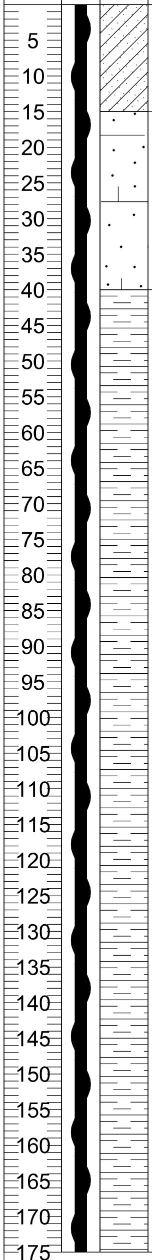
LOG OF BORING NO. BH-03

Project Description: CK Disposal

Location: Eunice, NM
Top of PVC El.: feet MSL
Surface El.: 3386.3 feet MSL
Completion Depth: 175 feet
Date Boring Started: 5/26/2015
Date Boring Completed: 5/26/2015

Northing: 520437.21
Easting: 926605.28

Depth, feet	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Monitor Well Construction Details	Monitor Well Description



CLAYEY SAND, reddish brown, moderately well sorted, subrounded, fine to medium grained, slightly moist, none HCL reaction

SILTY SAND, with caliche, light brown to white, well sorted, well rounded, very fine to fine grained, dry, strong HCL reaction

Quartz and Caliche gravel up to 1" in diameter

CLAYSTONE, reddish brown some gray, slightly moist to dry, weak HCL reaction

medium brown from 130' to 135'

reddish brown to brown

Drilling Contractor: HCI Drilling
Drilling Method: Air Rotary
Sampling Method: Cuttings
Geologist: Steven J. Wimmer
Project No.: 15-04-22

Groundwater Observations	
Date	Depth to Water (ft)
5/26/15	Dry

Remarks: 5 1/8" diameter boring; TH60 Atlas Copco Drill Rig

LOG OF BORING NO. BH-03
PAGE 1 of 1

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

▽ Water level at time of drilling.
▼ Water level at end of drilling.
▽ Water level after drilling.

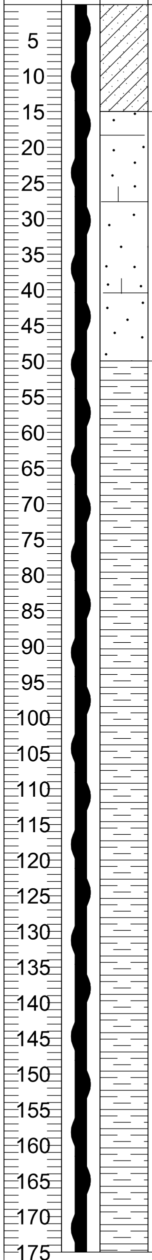
LOG OF BORING NO. BH-04

Project Description: CK Disposal

Location: Eunice, NM
Top of PVC El.: feet MSL
Surface El.: 3374.1 feet MSL
Completion Depth: 175 feet
Date Boring Started: 5/26/2015
Date Boring Completed: 5/26/2015

Northing: 519600.94
Easting: 924941.30

Depth, feet	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Monitor Well Construction Details	Monitor Well Description



CLAYEY SAND, reddish brown, moderately well sorted, subrounded, fine to medium grained, slightly moist, none HCL reaction

SILTY SAND, with caliche, light brown to white, well sorted, well rounded, very fine to fine grained, dry, strong HCL reaction

intermixed reddish brown claystone to 50'

CLAYSTONE, reddish brown to purple, dry, weak HCL reaction

dark brown to reddish brown

Drilling Contractor: HCI Drilling
Drilling Method: Air Rotary
Sampling Method: Cuttings
Geologist: Steven J. Wimmer
Project No.: 15-04-22

Groundwater Observations	
Date	Depth to Water (ft)

Remarks: 5 1/8" diameter boring; TH60 Atlas Copco Drill Rig

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

▽ Water level at time of drilling.
▼ Water level at end of drilling.
▽ Water level after drilling.

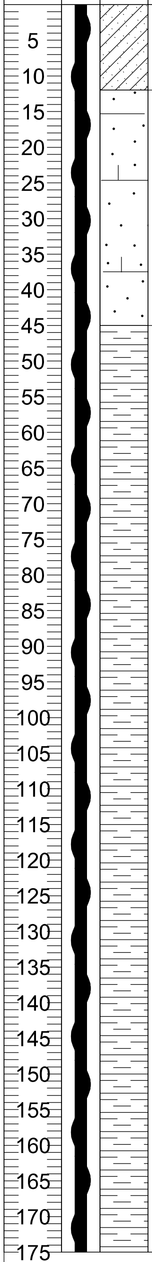
LOG OF BORING NO. BH-05

Project Description: CK Disposal

Location: Eunice, NM
Top of PVC El.: feet MSL
Surface El.: 3386.1 feet MSL
Completion Depth: 175 feet
Date Boring Started: 5/27/2015
Date Boring Completed: 5/27/2015

Northing: 519636.20
Easting: 928326.86

Depth, feet | Samples | Symbol/USCS | MATERIAL DESCRIPTION | Monitor Well Construction Details | Monitor Well Description



CLAYEY SAND, reddish brown, moderately well sorted, subrounded, fine to medium grained, slightly moist, none HCL reaction

SILTY SAND, with caliche, light brown to white, well sorted, well rounded, very fine to fine grained, dry, strong HCL reaction

intermixed gravel to 45'

CLAYSTONE, reddish brown, slightly moist to dry, weak HCL reaction

medium brown, some sand

dark brown to reddish brown

dark brown and purple

reddish brown to dark brown

dark brown and purple

reddish brown

Drilling Contractor: HCI Drilling
Drilling Method: Air Rotary
Sampling Method: Cuttings
Geologist: Steven J. Wimmer
Project No.: 15-04-22

Groundwater Observations	
Date	Depth to Water (ft)

Remarks: 5 1/8" diameter boring; TH60 Atlas Copco Drill Rig

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

▽ Water level at time of drilling.
▼ Water level at end of drilling.
▽ Water level after drilling.

Permit Application

Lea County, New Mexico

C.K. Disposal E & P Landfill and Processing Facility

Permit No. TBD

Attachment I

Sampling and Analysis Plan

November 2015

PSC Project # 01058015

PARKHILLSMITH&COOPER

ATTACHMENT I
SAMPLING AND ANALYSIS PLAN (SAP)

PROPOSED C.K. DISPOSAL E&P LANDFILL AND PROCESSING FACILITY

Eunice, New Mexico

Project No: 15-04-22

Prepared for:

C.K. Disposal LLC

October 2015

Prepared by:

PSC

The CAREL CORPORATION

CONTENTS

Tables

1.0 SAMPLING PROCEDURES

This Sampling and Analysis Plan (SAP) has been prepared for the C.K. Disposal E&P Landfill and Processing Facility.

The following sampling procedures are designed to aid in obtaining the earliest possible detection of a potential fluid release from the Landfill. Chemical analysis of water samples, if present, and comparison to leachate samples and/or samples from a leak detection system will be used to determine whether the water is a result of a release from the facility. The presence of water in the vadose zone monitoring wells may be the result of infiltration from other sources such as surface water during excavation, construction of the landfill cells, or from proximal stormwater detention ponds.

These or equivalent procedures are to be followed by all personnel conducting vadose zone monitoring.

1.1 MONITORING SCHEDULE

After construction begins, the monitoring wells will be monitored on a monthly basis for a period of 12 months. After 12 months, the monitoring frequency will reduce to semi-annual.

1.2 FIELD SETUP

The well-head area should be examined for anything unusual such as damage to the well head, spilled materials, etc., and all observations recorded on the field data sheet. Insect repellent or other topical skin applications that contain organic compounds should not be used by sampling personnel. Plastic sheeting should be placed around the well riser and sample handling area to prevent contact with the surrounding ground.

Sampling equipment should include a calibrated 5-gallon bucket for measuring bailed or purged well fluids and a small glass container for measuring temperature, specific conductance, and pH. A decontamination area should be set up and should include a water bucket, rinsing bucket, phosphate-free detergent, and additional rinsing bottles.

1.3 FIELD MEASUREMENTS

The monitoring wells will be sounded for the presence of water. All measurements should be taken from the top of the well casing and the measurement recorded on field data sheets. If the well is dry the well depth measurement should be recorded with the same electronic device and recorded on the field data sheet. The water-level measuring device should be decontaminated between wells. Water levels or well depths are to be measured and reported to the nearest hundredth of a foot.

1.4 WELL PURGING

Three well volumes of water should be removed from each well in order to obtain a representative sample and not "stagnant" water from the borehole or filter pack. If all water is removed from the well before three well volumes are obtained, purging will be deemed to be complete. Well volumes can be measured with use of a calibrated 5-gallon bucket.

Non-dedicated, reusable purging and sampling equipment is to be decontaminated in accordance with Section 1.10. Appropriate disposable gloves are to be worn during purging and sampling to reduce the possibility of cross-contamination between wells.

1.5 SAMPLE COLLECTION

If the water-level measuring device indicates the presence of water within the well, samples will be collected using a dedicated or disposable sampling bailer. If there is a sufficient quantity of water to allow sample collection, the water will be tested for the field parameters (temperature, specific conductance, and pH) prior to sampling.

The following sampling procedures should be performed:

- The temperature, specific conductance, and pH of a sample collected in a container not used for laboratory analysis should be measured in that order and recorded on the field data sheet.

- The samples should be collected by pouring the water from the bailer directly into each of the required containers.

- Under normal conditions, the sample bottles must be filled in the order of decreasing volatilization sensitivity. Generally, that will be in the following order, as applicable:

  Volatile organic compounds (VOC)
  RCRA Metals
  Other inorganic parameters

Filling VOC sample containers involves extra care. The water should be gently discharged into each vial, until a positive meniscus is formed over the top of the container. After the cap has been placed on the vial and tightened, the vial should be checked for air bubbles by turning it upside down and tapping with your finger. If an air bubble is seen rising to the bottom of the vial, the process outlined above should be repeated. Air bubbles can be eliminated by removing the cap, topping off the vial with water to a positive meniscus, and resealing. If no air bubbles are seen in each vial, the process is complete.

1.6 SAMPLE CONTAINERS AND LABELING

Water samples collected in the field are to be placed into laboratory-cleaned bottles of the appropriate size and construction for the chemical parameters to be analyzed. A list of chemical parameters and corresponding recommended types and sizes of sample containers are shown in Table I.1. Sample containers must be marked as described below.

Sample labels are to be affixed to each sample container and must contain the following information in waterproof ink:

- Project name and number (includes site name)
- Sample and well number
- Date and time of sample collection
- Type of preservatives added
- Special handling instructions

QA/QC samples, such as trip, field, and equipment blanks, will be labeled accordingly.

1.7 SAMPLE PRESERVATION AND SHIPMENT

Groundwater samples should be chilled to about 4°C upon containment in the field and during transport to the testing laboratory. Many constituents to be analyzed require a chemical additive for preservation. Table I.1 shows preservation requirements for organic and inorganic chemical parameters. Groundwater samples collected for organic analysis should be placed in glass bottles that have been specially prepared with the appropriate type and quantity of chemical additive. Samples that are to be analyzed are not to be filtered.

Samples to be shipped are to be packed in a hard-sided insulated shipping container precooled with water ice. The sample containers must be packed to prevent breakage. The water/ice used to pre-cool the shipping container should be discarded and adequate chemical icepacks added to maintain the temperature at about 4°C during the shipment. Dry ice must not be used.

1.8 QUALITY ASSURANCE AND QUALITY CONTROL

To document that sample collection and handling procedures utilized in the field have not affected the quality of the water samples, blanks are to be prepared and analyzed. These blanks consist of one trip blank and one field blank per sampling event.

A trip blank is prepared by filling a water sample container with Type II reagent-grade water, transporting to the site, handling as a sample, and transporting to the laboratory for analysis. A field blank is prepared by filling a sample container with Type II reagent-grade water in the field adjacent to one of the wells being sampled and transporting to the laboratory for analysis. The field blank should be prepared at a downwind well. Field blanks and trip blanks are to be analyzed for VOCs only.

An equipment blank is required if dedicated pumps or disposable bailers are not used. Equipment blanks are used to confirm proper field decontamination procedures on non-dedicated equipment utilized in the field. An equipment blank is prepared in the field immediately following decontamination cleaning procedures on non-dedicated equipment used for purging, sampling, or sample filtration. Field supply deionized water will be passed through the non-dedicated equipment in the same procedure as a water sample. Equipment blanks will be analyzed for VOCs. Equipment blanks shall be collected at a minimum frequency of one blank (1) per ten (10) wells at which non-dedicated purge or sampling equipment are utilized per monitoring event.

1.9 CHAIN-OF-CUSTODY DOCUMENTATION

A chain-of-custody (COC) form must be maintained in order to track possession and handling of samples from field collection through laboratory testing. COC records show the custody of samples at all times. Samples are in custody of an individual when they are either in the individual's sight or locked securely under the individual's control.

COC documentation is maintained on a chain-of-custody record form. Each sample must be logged onto the COC record form as it is collected. Information on the COC record form includes the following.

- Project name and number (includes site name)
- Site location
- Sample number
- Sample date and time
- Sample type
- Number and type of sample containers
- Analyses required
- Sample preservative
- Lab destination
- Carrier/shipping number
- Special instructions
- Spaces for signatures of sampler(s) and everyone assuming sample custody

The COC record must contain the signatures of anyone assuming custody of the samples. Each time custody changes hands, the party releasing the samples should sign under "Relinquished By" and record the date and time. The party receiving the samples should sign under the heading "Received By" and record the date and time. The COC form is typically provided by the analytical laboratory.

If available or required, COC seals can be placed over the shipping container lid or sample container lids to deter sample tampering by unauthorized parties.

1.10 EQUIPMENT DECONTAMINATION

Reusable purging and sampling equipment and measurement instruments coming in contact with the groundwater in wells or in samples are to be decontaminated before use at each well location.

The following decontamination standards or equivalent procedures are to be followed for non-dedicated well purging and sampling equipment. The equipment should be washed with a nonphosphate detergent and rinsed with tap water and Type II reagent-grade water. The sampling equipment should be thoroughly dried before use to ensure that residual cleaning agents are not carried over to the sample.

Disposable bailers and non-dedicated bailer line must be discarded along with disposable health and safety garments. Water and cleaning agents are to be disposed of in accordance with applicable regulations.

1.11 FIELD DOCUMENTATION

Field activities must be thoroughly documented on field data sheets. Below is an outline of the information that should be documented during field activities.

- Project name and number
- Date and time of all activities
- Weather conditions
- Sampling personnel
- Field instrument calibration remarks
- Well identification number
- Description of well condition
- Depth to the well bottom with point of reference (from well records)
- Physical description of groundwater (color, odor, turbidity)
- Sampling equipment and remarks
- Initial temperature, conductivity, and pH measurements
- Sample time and date
- Description of sample
- Quality control remarks

2.0 VADOSE ZONE MONITORING REQUIREMENTS

2.1 ANALYZED CONSTITUENTS

The vadose zone monitoring constituents at the facility will be as specified in Table I.1 of this SAP.

2.2 VERIFICATION RESAMPLING

No later than 30 days after each sampling event, the owner or operator shall determine whether the initial field and laboratory data show evidence that the water encountered is the result of surface water infiltration; or potential impacts from the Landfill. If there is evidence of a potential release (i.e., BTEX or TPH detection), the owner or operator shall notify the Oil Conservation Division (OCD) and conduct a verification resampling event as soon as practical. During the initial monthly sampling, the verification resampling event can coincide with the subsequent monthly sampling event. At the time of verification sampling, fluid samples from the proximal upslope Landfill sump and leak detection system also will be collected and analyzed for the parameters in Table I.1.

In the event that one or more constituents are confirmed through verification resampling in any downgradient well, the Facility will submit an Action Plan to the OCD within approximately 90 days of the confirmation sampling date. The Action Plan will implement the course of action to further investigate the source of a potential release and/or complete any mitigation measures. The resampling and leachate analytical comparison results will also be included within the Action Plan.

2.3 VADOSE ZONE MONITORING RESULT SUBMITTALS

Two (2) copies of an annual vadose zone monitoring report describing sampling and analysis results will be completed and submitted to the OCD no later than ninety (90) days after the facility’s last sampling event in a calendar year. The annual report will include information determined since the previously submitted annual report.

Table I.1
C.K. Disposal E&P Landfill and Processing Facility
Vadose Zone Monitoring Constituents and the Recommended Sampling, Preparation, and Storage Procedures

Constituent	Sampling Container[(1)]	Preservation[(1)]
Field Parameters		
Temperature	Measured in the Field	
Specific Conductance		
pH		
Volatile Organic Compounds (VOC)		
BTEX	3x40 mL VOA Vials	HCL(2)
TPH		
Inorganic Compounds		
TDS	250 mL Clear Plastic	None(2)
Major Cations		
Calcium	250 mL Clear Plastic	Nitric Acid(2) (HNO_3)
Magnesium		
Sodium		
Potassium		
Major Anions		
Bicarbonate	4 oz. Glass Jar	None(2)
Chloride		
Sulfate		
RCRA Metals		
Arsenic	250 mL Clear Plastic	Nitric Acid(2) (HNO_3)
Barium		
Cadmium		
Chromium		
Lead		
Mercury		
Selenium		
Silver		

Notes:
(1) – EPA Sample Container and Preservation List (http://www.epa.gov/region9/lab/container.html)
(2) – Samples should be chilled to ~ 4°C

Permit Application

Lea County, New Mexico

C.K. Disposal E & P Landfill and Processing Facility

Permit No. TBD

Attachment J

Drainage Study

NMAC 19.15.36.13.C(1)&(2)

November 2015
PSC Project # 01058015

PARKHILL SMITH & COOPER

ATTACHEMENT J - DRAINAGE STUDY

APPENDICES

FIGURES

TABLES

1.0 INTRODUCTION

This drainage study is prepared as part of the permit for the C.K. Facility in Lea County, New Mexico. All drainage analysis and design is in accordance with NMAC 19.15.36.

Existing and proposed hydrologic and hydraulic conditions of the site are detailed herein, as well as hydraulic structures design, erosion stability and the management of storm water run-on and run-off from the C. K. Facility site in the event of a 25-year, 24-hour storm event. All hydrologic computations were performed using United States Army Corps HEC-HMS software and SCS unit hydrograph hydrology. Selected appendices are provided following this report with detailed model input and output documents, as well as details for proposed hydraulic structures.

1.1 Summary of Calculation Methods

A. Rational Method Hydrology

Peak flow rates for top-of-waste perimeter channels and let-down channels were calculated using rational method hydrology:

$$\boldsymbol{Q_{25} = CI_{25}A}$$

<u>Where</u>:

- $Q_{25} = Design\ storm\ peak\ flow\ rate\ (cfs)$
- $I_{25} = Design\ storm\ rainfall\ intensity$

$$I_{25} = \frac{P_{25}}{t_c}$$

- $A = Drainage\ Area\ (acres)$
- $P_{25} = Total\ percipitation\ in\ a\ 25 - year, 24 - hour\ storm\ (inches)$

B. SCS Unit Hydrograph Hydrology

Peak flow rates for all drainage areas were calculated using SCS Unit Hydrograph analysis in HEC-HMS. Maximum volume of runoff for all drainage areas was also calculated using the SCS Unit Hydrograph method in HEC-HMS:

$$\boldsymbol{Type - II\ SCS\ Storm}$$

$$25 - yr, 24 - hr\ Storm\ Event = 4.8 - in$$

$$Curve\ numbers\ (CN): Weighted\ by\ area,$$

$$considering\ soil\ type\ \&\ land\ use$$

$$Initial\ Abstraction\ (I_a) = 0.2S$$

$$S = \frac{1000 - 10CN}{CN}$$

C. Time of Concentration

Time of concentration for all watershed analyses, existing and proposed, was calculated using the Natural Resource Conservation Service (NRCS) Time of Concentration method as outlined in SCS Module 206-A hydraulic design manual:

$$\boldsymbol{t_c = t_{sh} + t_{sc} + t_{ch}}$$

Where:

$$t_{sh} = \frac{0.007(n_{ol}L_{sh})^{0.8}}{(P_2)^{0.5}{S_{sh}}^{0.4}}$$

- $t_{sh} = sheet\ flow\ travel\ time\ (hr)$
- $n_{ol} = overland\ flow\ roughness\ coefficient$
- $L_{sh} = sheet\ flow\ length\ (ft)$
- $P_2 = 2\ year, 24 - hr\ rainfall\ depth\ (in)$
- $S_{sh} = sheet\ flow\ slope\ (ftft)$

$$t_{sc} = \frac{L_{sc}}{3600K{S_{SC}}^{0.5}}$$

- $t_{sc} = shallow\ concentrated\ flow\ travel\ time\ (hr)$
- $L_{sc} = shallow\ concentrated\ flow\ length\ (ft)$
- $S_{sc} = shallow\ concentrated\ flow\ slope\ (ftft)$
- $K = 16.13\ for\ unpaved\ surface, 2.32\ for\ paved\ surface$

$$t_{ch} = \frac{L_{ch}}{3600\frac{1.49}{n}R^{2/3}{S_{ch}}^{0.5}}$$

- $t_{ch} = channel\ flow\ travel\ time\ (hr)$
- $L_{ch} = channel\ flow\ length\ (ft)$
- $S_{ch} = channel\ flow\ slope\ (^{ft}/_{ft})$
- $n = Manning's\ roughness\ coefficient$

D. Culvert & Channel Hydraulics

All hydraulic calculations for flow capacity and flow velocity were computed using the Manning's Equation solution algorithm in Bentley FlowMaster computer software:

$$\boldsymbol{Q = \frac{1.49}{n} AR^{2/3}\sqrt{S}}$$

Where:

- $Q = Design\ flow\ rate$
- $n = Manning's\ Roughness\ Coefficient$
- $A = Flow\ area$
- $R = Channel/culvert\ wetted\ perimeter$
- $S = Bed\ Slope$

1.2 Existing Site Hydrology

A. Existing Conditions

The permitted landfill site encompasses 316.97-acres, and is located within an approximate 4,784-acre drainage area. The property is on the south side of New Mexico State Highway 234, approximately 0.65-mile west of the New Mexico-Texas Border, east of Eunice, NM. Prevailing grade across is the site is to the southwest at 0.005-ft/ft with natural grass and mesquite trees serving as the main vegetative cover. The majority of the existing drainage area is undeveloped rural acreage, with some industrial impact in the upper half of the drainage area.

The landfill site lies on a ridge between two (2) sub-drainage areas, both of which drain to an unnamed draw (the Draw) approximately 2.0-mile southwest of the waste footprint. The Draw is not a design consideration for fully-developed landfill hydrology. A proximity to ephemeral water map can be seen in Figure J.9 in Appendix A. Also in Appendix A is a letter of certification from Lea County Floodplain Administrator, Cassie Corley, CFM, stating the permitted landfill is not in a regulated Special Flood Hazard Area (SFHA).

For the purpose of this report, the two (2) existing sub-drainage areas are referred to as DA-01 and DA-02. The two (2) existing drainage areas can be seen in Figure J.1 in Appendix A. A previously constructed berm (by others) immediately north of the C.K. Facility north property line prevents any off-site drainage from entering the permitted landfill facilities. This berm represents the upstream limits of DA-01 and is shown in Figure G-003.

As can be seen in the Figure J.3 (soil map), the majority of the soils in the drainage areas are hydrologic drainage Class B soils. Undeveloped areas of natural grass and mesquite were modeled as 'fair brush' and assigned Natural Resource Conservation Service (NRCS) curve numbers found in SCS Technical Report 55. Industrial areas were also assigned NRCS curve numbers based on an average impervious area of 72%. Asphalt and caliche-paved roads were modeled as impervious areas and assigned a curve number of 98. A soil detail page and weighted curve number analysis can be seen in Appendix A.

B. Existing Drainage Calculations

Existing drainage for the site was analyzed in two (2) separate sub-drainage areas. As can be seen in Figure J.1, each drainage area discharges into the Draw southwest of the permitted landfill site through sheet flow or shallow concentrated flow. No flow is transferred from one drainage area to another, and there are no point discharges from these drainage areas into the Draw.

Because there are no discernable gullies in either DA-01 or DA-02, time of concentration for each existing drainage area was calculated with no consideration for channelized flow. Time of concentration and a weighted NRCS curve number were input into HEC-HMS along with total drainage area acreage. For this analysis, an initial abstraction ratio of 0.2S was applied to both drainage areas. No curve number reduction factor was applied.

An existing hydrologic conditions summary table is shown below, with detailed calculations and model input outlined in Appendix A.

Table J.1 – 25-YEAR HYDROLOGY: EXISTING

DA	Acres	T_c (min)	CN	Peak Flow (cfs)	Average Velocity (ft/s)	Volume (Ac-ft)
1	1117.40	181	54.69	209.30	1.97	484.6
2	3662.80	392	64.71	728.50	2.70	89.8

1.3 Post-Development Site Hydrology

A. Developed Conditions

Once the landfill is fully developed, the waste footprint will cover 141.78-acres of the 316.97-acre property. This waste footprint will have a maximum height above adjacent grade of 143-foot, with sideslopes at 4H:1V.

Construction of the C.K. Facility will alter existing drainage patterns across the site. Once fully developed, drainage from the two (2) existing drainage areas will be divided into ten (10) drainage areas. These drainage areas will contribute to the areas of existing DA-01 and DA-02 which are not disturbed by landfill construction.

The undisturbed areas of existing DA-01 and DA-02 are modeled as proposed areas DA-09 and DA-10. Developed drainage areas DA-01 through DA-08 discharge into DA-09 and DA-10 via drainage structures, which are discussed in §1.4 of this report. The referenced drainage structures ensure that discharge into developed areas DA-09 and DA-10 does not exceed existing volume or flow-rates generated in a 25-year, 24-hour storm event. Fully developed drainage areas can be seen on Figure J.4 in Appendix B.

The final landfill cover is comprised of 3-foot of soil covered with native grasses and vegetation. As such, the final landfill top slope and perimeter slopes were modeled as meadow, and assigned NRCS curve numbers assuming a hydrologic drainage Class B soil.

Areas within the property limits but not impacted by landfill construction were modified from a ‘brush’ cover description to a ‘meadow’ cover description. This modification of curve numbers is based on the assumption that these areas will be mowed periodically, causing natural grass cover to increase.

An area of 28.89-acres was removed from the developed drainage calculations. This area will contain twelve (12) evaporation ponds and will not discharge any surface drainage into the developed drainage structures. The evaporation ponds are each 9.73-ac/ft in size, and have 3.5-foot of freeboard. This results in a surplus storage of 75.40-ac/ft which will fully contain all surface drainage from roads within this 28.89-acre area.

B. Developed Drainage Calculations

Peak flow and total volume of runoff for developed condition hydrology were calculated with SCS unit hydrograph methodology using HEC-HMS software. A 25-year, 24-hour storm event was analyzed which is a total P_{25} = 4.88-inches. An initial abstraction value of 0.2S was applied to all developed drainage areas, with no curve number reduction factor.

Time of concentration was calculated for each drainage area using NRCS time of concentration formulas outlined in SCS module 206-A. Travel times were analyzed for sheet flow, shallow concentrated flow, and channelized flow. A detailed time of concentration calculation sheet can be found in Appendix B.

Comparison points CP-A and CP-B can be seen on Figure J.4. These are locations where developed drainage areas discharge into areas not impacted by construction. Downstream of CP-A and CP-B developed hydrology discharges into the Draw in the same manner of sheet flow and shallow concentrated flow as existing hydrology. A full comparison of existing vs. developed hydrology is discussed in §1.3 of this report.

Below is a fully-developed hydrology summary table with detailed calculations and model input outlined in Appendix B.

Table J.2 – 25-YEAR HYDROLOGY: PROPOSED

DA	Acres	T_c (min)	CN	Peak Flow (cfs)	Average Velocity (ft/s)	Volume (Ac-ft)	
1	35.80	15	57.85	50.50	3.0	4.3	Run-off
2	30.90	24	58.53	31.20	2.3	3.2	Run-off
3	23.70	33	58.91	21.50	1.1	2.6	Run-off
4	23.19	43	73.78	47.30	1.1	6.3	Run-off
5	44.50	9	58.90	66.20	3.0	4.6	Run-off
6	43.75	9	59.69	71.10	3.0	5	Run-off
7	44.70	9	59.70	73.40	3.7	5.1	Run-off
8	45.30	10	60.10	75.50	3.0	5.2	Run-off
9	834.30	146	53.24	165.30	2.0	63	Run-off
10	3662.80	395	64.89	733.00	2.7	488.4	Run-on

*Minimum time of concentration used for hydrologic calculation is 10-min.

1.4 Existing/Post-Development Hydrology Comparison

Existing hydrology produces a total of 574.4-ac/ft. of runoff at a maximum flow rate of 728.5-cfs. There is no concentrated discharge point from any existing drainage area. All flow discharged into the Draw is discharged as sheet flow or shallow concentrated flow. Fully developed drainage will produce a total of 587.7-ac/ft. of discharge into the Draw at a maximum flow rate of 733-cfs.

99.3-ac/ft. of discharge from developed hydrology will be run-off drainage from the C.K. Facility. This will occur initially as sheet flow and shallow concentrated flow and will be intercepted by drainage channels. The flow will then be concentrated in one of two (2) detention ponds which will be constructed on the property. These detention ponds will overflow into drainage areas downstream of the landfill which are not impacted by construction. The two (2) detention pond overflow areas are identified as CP-A and CP-B in the developed hydrology map seen on Figure J.4. Overflow weir construction at these detention ponds ensures that discharge in a 25-year, 24-hour storm event will not exceed flow rates experienced by the downstream watersheds under existing hydrologic conditions.

448-ac/ft of developed hydrology discharge into the Draw will occur as run-on drainage. All run-on drainage will occur as sheet flow and shallow concentrated flow from upstream reaches of existing drainage areas that will not be impacted by construction. Most of the drainage experienced in DA-10 will pass by the landfill without impacting developed hydrology. Any sheet flow or shallow concentrated flow that does impact the landfill will be routed through Detention Pond 1 before it reaches the active working face.

Any precipitation that falls directly onto the active working face will be treated as contaminated surface water and transmitted to the leachate evaporation pond via the leachate collection system. The evaporation pond will store leachate and allow it to naturally evaporate. If the pond nears the high water volume, it will be drained and transported to the onsite liquid waste evaporate ponds as outlined in Section III.4 of this Permit.

1.5 Hydraulic Structure Design

All hydraulic structures are shown on Figures J.6 and J.7 in Appendix C.

A. Channel Design

The three (3) trapezoidal open channels planned for the fully-developed C.K. Facility were designed using the Manning's Formula Friction Solution in the Bentley FlowMaster program. For a given channel, the maximum flow rate calculated using the NRCS unit hydrograph method during developed hydrology calculations was applied to a proposed cross section. Manning's friction coefficient, channel slope, and proposed geometry are input parameters for Bentley FlowMaster, which yields a normal depth and velocity for the proposed geometry based on input parameters. A 6-in freeboard has been applied to every channel depth above the normal depth calculations yielded by Bentley FlowMaster. A Manning's n value of 0.05 was applied to each channel to accurately model re-vegetation of channels with natural grasses following construction.

B. Culvert Design

All culverts were designed similarly using the Manning's formula friction solution in Bentley FlowMaster. A Manning's n value of .015 was applied to each culvert and as peak flow from the upstream channel. All culverts will be constructed of reinforced concrete pipe, reinforced concrete box, or corrugated metal pipe.

C. Weir Design

The broad-crested weirs drainage which serves as overflow crests from the site detention basins into the downstream drainage areas, were also designed using Bentley FlowMaster. Because both weirs will discharge sheet flow into their respective downstream drainage, areas over a crest of 1-foot, no tailwater effects were considered in the broad-crested weir design. Both weirs will have a gravel crest with a minimum crest width of 6-inches.

D. Hydraulic Structure Maintenance

All hydraulic structures should be inspected weekly, and within 48-hrs of any precipitation event. Inspection should ensure that all channels, culverts, and inlet structures are free from obstruction and sediment buildup. Any necessary maintenance identified by an inspection should be initiated within one (1) calendar week of identification.

1.6 Erosion Control

Erosion control will be managed during construction by employing best management practices. An intermediate cover of 6-inches. natural soil will be applied to any exposed working face at the end of each working day.

As each new cell is opened, the perimeter road and perimeter drainage channel will be constructed past the most upstream and downstream extents of new construction to ensure than any run-off drainage will be intercepted and re-routed away from the working face.

As final cover is established, perimeter channels constructed of articulated concrete block mattress will be installed at the top of slope. These channels will minimize sheet flow down the final perimeter slopes, which will have a final 25% grade, by intercepting sheet flow from the top slope and transferring it to one (1) of four (4) let-down channels. These channels will be constructed of articulated concrete block mattress and will transfer storm water runoff from the final cap to the perimeter drainage channel at the toe of slope.

By intercepting sheet flow from the top slope, the maximum sheet flow velocity across the final top slope in a 25-yr, 24-hr storm is 1.61-fps. The corresponding maximum velocity of sheet flow down the perimeter slopes 1.34-fps. Example velocity calculations for final cover slopes can be seen in Appendix C.

Final cover drainage structures are detailed in Figure J.7.

1.7 Conclusions

In conclusion, existing drainage patterns are not adversely affected by development of the C.K. Facility. A 25-yr, 24-hr storm event will be managed by hydraulic structures on the permitted site, which will ensure developed discharge rates into downstream drainage areas are not increased. A 100-yr, 24-hr storm can also be passed through the developed hydraulic structures.

APPENDIX A

EXISTING DRAINAGE

Existing Drainage Curve Number Analysis

Existing Drainage Area 1			
Acres	Percent of Total Area	Description	CN
947.8	84.8%	brush - fair ‘B’	56
134.0	12.0%	brush - fair ‘A’	35
4.4	0.4%	Industrial ‘B’	88
25.0	2.2%	Pavement	98
6.2	0.6%	Industrial – ‘A’	81
1117.4	100.0%	**Weighted Cumulative**	54.69

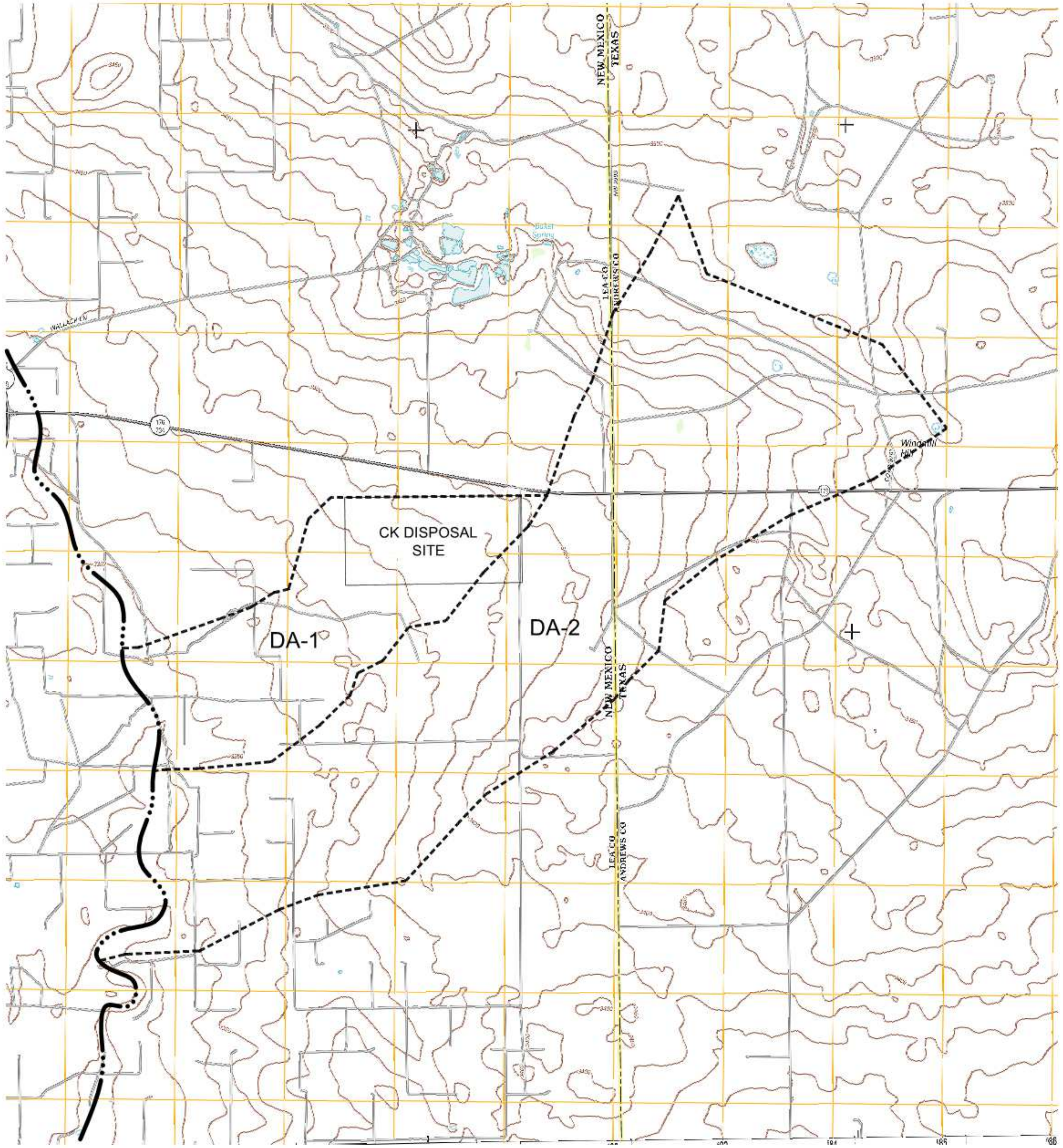
Existing Drainage Area 2			
Acres	Percent of Total Area	Description	CN
2408.5	65.8%	brush - fair ‘B’	56
385.7	10.5%	brush – ‘D’	77
116.2	3.2%	Brush - Fair 'A'	35
18.4	0.5%	Industrial – ‘A’	81
380.3	10.4%	Industrial ‘D’	93
39.4	1.1%	Pavement	98
314.3	8.6%	Industrial – ‘B’	88
3662.8	100.0%	**Weighted Cumulative**	64.71

Existing Drainage Time of Concentration Analysis

Existing Area 1				
DA-1	**Linear Feet**	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.005	0.11	7
t_{sc}	11912	0.005	2.90	174
t_{ch}	-	-	-	-
			Cumulative T_c	181

Existing Area 2				
DA-2	**Linear Feet**	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.1	0.03	2
t_{sc}	26671	0.005	6.50	390
t_{ch}			-	-
			Cumulative T_c	392

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.1. - EXISTING DRAINAGE AREAS.dwg LAYOUT NAME: FIG.J.1 PRINTED: Thursday, November 05, 2015 - 7:45pm USER: TKrueger



N

0 500' 1000'

LEGEND

———	LANDFILL PROPERTY/PERMIT BOUNDARY
- - - - -	EXISTING DRAINAGE AREA
——··——	EPHEMERAL STREAM
DA-1	DRAINAGE AREA LABEL

MAP REFERENCE

United States Geological Survey

North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 13S
10 000-foot ticks: Texas Coordinate System of 1983 (north central zone), New Mexico Coordinate System of 1983 (east zone)

North American Vertical Datum of 1998
Eunice NE, TX-NM
2012

NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015

PSC PARKHILL SMITH & COOPER

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. ___

NEW LANDFILL SITE & PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

KEY PLAN

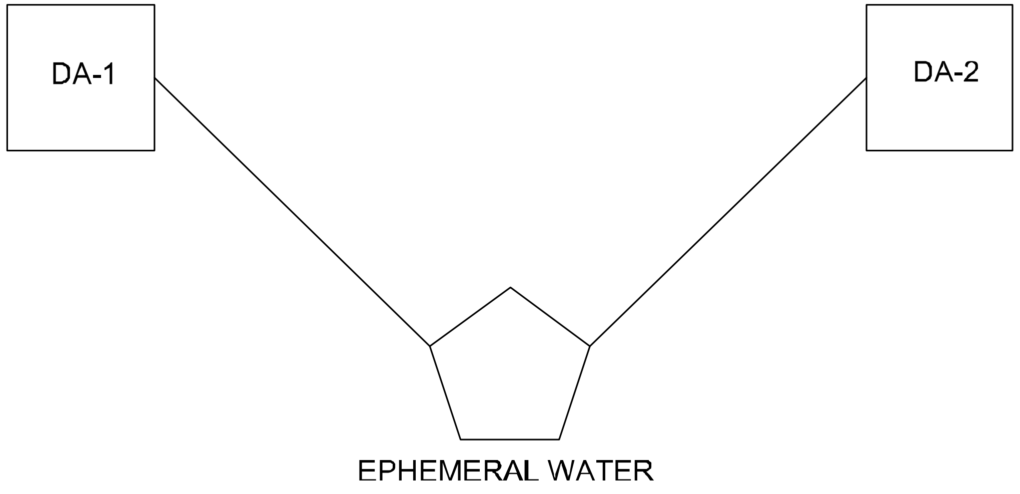
NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO PROJECT NO: 0580.15

EXISTING DRAINAGE AREAS

FIG.J.1

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.2 - EXISTING DRAINAGE SCHEMATIC.dwg LAYOUT NAME: FIG.J.2 PRINTED: Thursday, November 05, 2015 - 7:46pm USER: TKrueger



NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015

LEGEND

☐ DRAINAGE AREA #
△ DETENTION POND
⬠ OUTLET
○ JUNCTION
━ REACH
─ CONNECTION

PSC
PARKHILL SMITH & COOPER

**C. K. DISPOSAL
E & P LANDFILL &
PROCESSING
FACILITY**

NMED PERMIT NO. ___

**NEW LANDFILL SITE
& PROCESSING FACILITY**

LEA COUNTY, NEW MEXICO

KEY PLAN

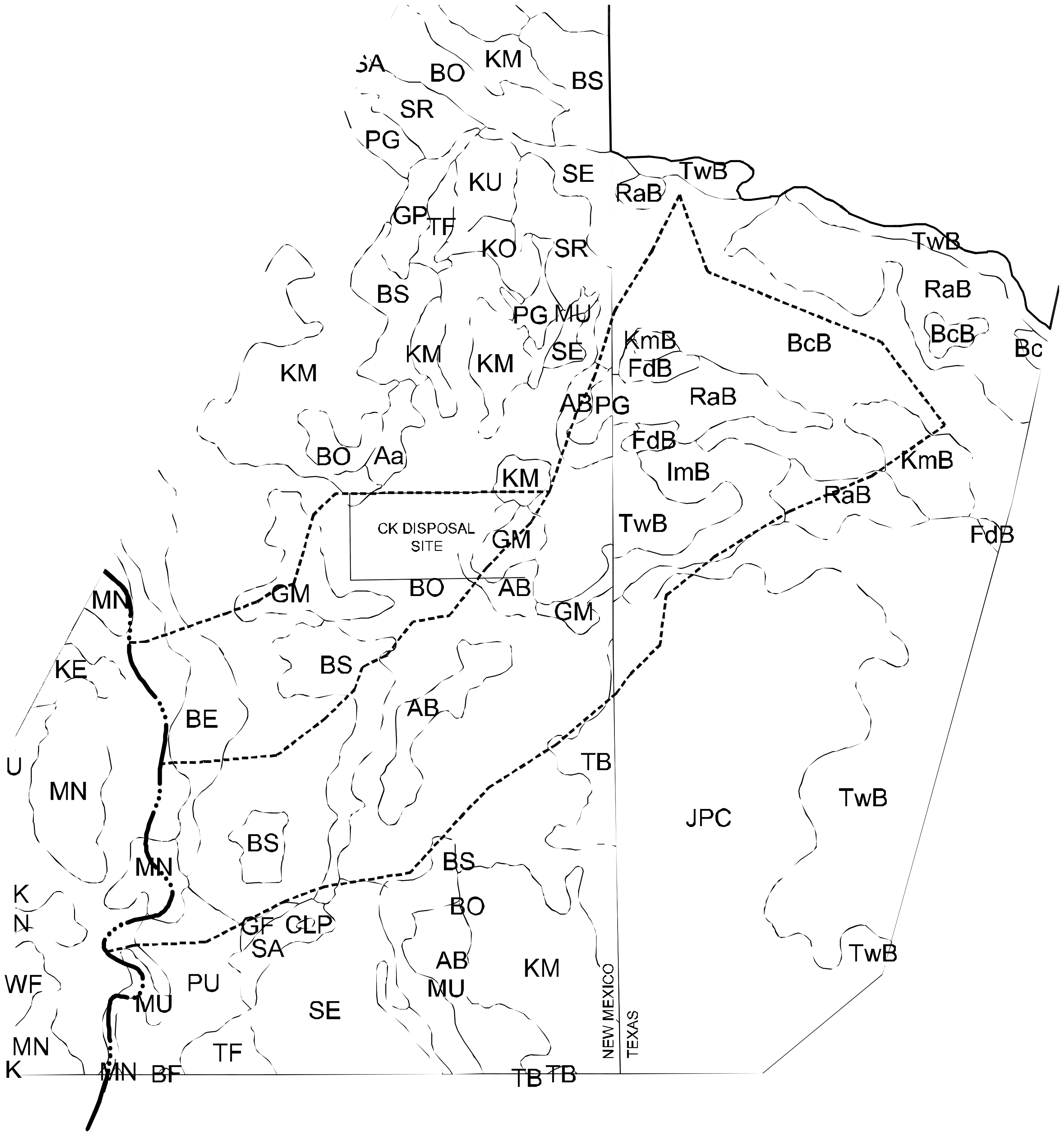
NO	DATE	DESCRIPTION
1	09 23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO
PROJECT NO: 0580.15

**EXISTING DRAINAGE
HEC-HMS SCHEMATIC**

FIG.J.2

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.3 - SOILS MAP.dwg LAYOUT NAME: FIG.J.3 PRINTED: Thursday, November 05, 2015 - 7:46pm USER: TKrueger



N

0 500' 1000'

LEGEND

———	LANDFILL PROPERTY/PERMIT BOUNDARY
- - - - -	EXISTING DRAINAGE AREA
———	SOIL TYPE AREAS
BcB	SOIL TYPE IDENTIFICATIONS
━━•••━━	EPHEMERAL STREAM

MAP REFERENCE

NATURAL RESOURCE CONSERVATION SERVICE
WEB SOIL SURVEY (WSS)
NATIONAL COOPERATIVE SOIL SURVEY

NOTE:
SOILS LEGEND IS ON FOLLOWING PAGE

NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015

PSC
PARKHILL SMITH & COOPER

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. __

NEW LANDFILL SITE & PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

KEY PLAN

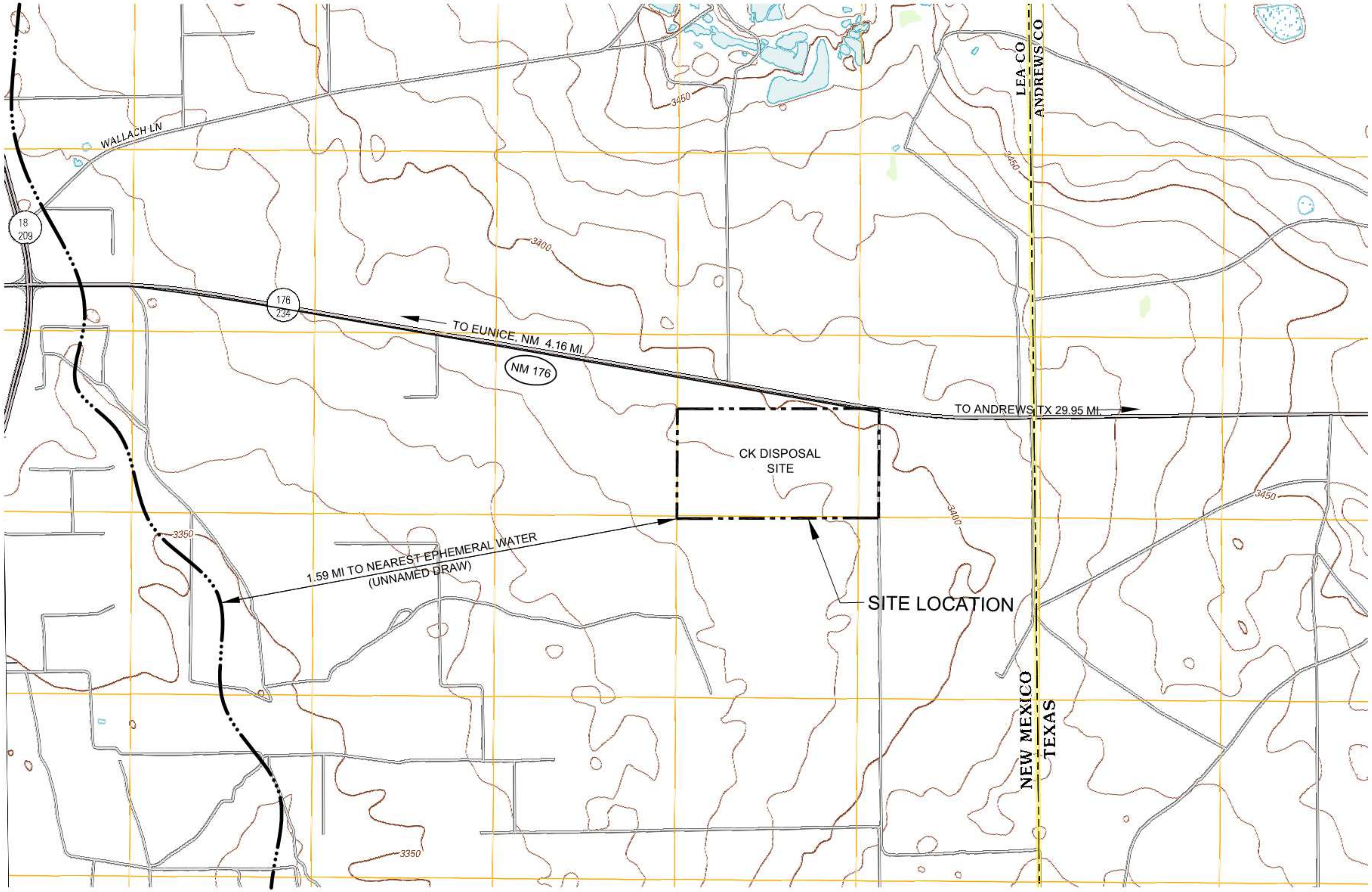
NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO
PROJECT NO: 0580.15

SOILS MAP

FIG.J.3

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.9 - NEAREST EPHEMERAL WATER.dwg LAYOUT NAME: FIG.J.9 PRINTED: Thursday, November 05, 2015 - 7:49pm USER: TKrueger



NICHOLAS N. YBARRA
20683
NEW MEXICO
PROFESSIONAL ENGINEER

Nicholas N. Ybarra
11/6/2015

N

0 2000' 4000'

MAP REFERENCE

United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 13S
10 000-foot ticks: Texas Coordinate System of 1983 (north
central zone), New Mexico Coordinate System of 1983 (east
zone)
North American Vertical Datum of 1998
Eunice NE, TX-NM
2012

LEGEND

— — — SITE BOUNDARY
—•••— EPHEMERAL STREAM

PSC
PARKHILL SMITH & COOPER

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. ___

NEW LANDFILL SITE & PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

KEY PLAN

NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO PROJECT NO: 0580.15

NEAREST EPHEMERAL WATER

FIG.J.9

Soils Classification Chart		
Map Symbol	Soil Name	Hydraulic Rating
BcB	Blakeney and Conger soils	D
FdB	Faskin and Douro soils	B
ImB	Ima loamy fine sand	A
JPC	Jalmar-Penwell association	B
KmB	Kimbrough soils	D
RaB	Ratliff soils	B
TwB	Triomas and Wickett Soils	B
AB	Amarillo-Arvana loamy fine sands assoc.	B
BE	Berino-Cacique loamy fine sands assoc.	B
BF	Berino-Cacique fine sandy loams assoc.	B
BO	Brownfiend-Springer Assoc.	B
BS	Brownfield-Springer assoc. hummocky	B
CLP	Caliche pit	D
GF	Gomez fine sand	A
GM	Gomez loamy fine sand	A
KmB	Kermit soils and dune sand	A
MN	Ratliff-Wink fine sandy loams	B
MU	Mixed alluvial land	A
PG	Portales and fomez fine sandy loams	B
PU	Pyote and maljamar fine sands	A
SA	Sharvana loamy fine sand	D
SE	Simona fine sandy loam	D
SR	Simona Upton assco.	D
TB	Tivoli-Brownfield fine sands	A
TF	Tonuco loamy fine sand	D
WK	Wink loamy fine sand	A

```
Basin: EXIST
     Last Modified Date: 17 September 2015
     Last Modified Time: 18:50:07
     Version: 3.5
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Allow Blending: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: DA-01
     Canvas X: -2360.197368421053
     Canvas Y: 2302.6315789473683
     Area: 1.7
     Downstream: NO NAME DRAW

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 2.2
     Curve Number: 54.69

     Transform: SCS
     Lag: 108.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: DA-02
     Canvas X: 74.01315789473665
     Canvas Y: 740.1315789473683
     From Canvas X: 2434.2105263157896
     From Canvas Y: -1562.5
     Area: 5.72
     Downstream: NO NAME DRAW

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 1.1
     Curve Number: 64.71

     Transform: SCS
     Lag: 235.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Sink: NO NAME DRAW
     Canvas X: -3511.513157894737
     Canvas Y: -1940.7894736842109
```

```
End:

Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
     Maximum View N: 5000.0
     Maximum View S: -5000.0
     Maximum View W: -5000.0
     Maximum View E: 5000.0
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Yes
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Fix Element Locations: No
     Fix Hydrologic Order: No
End:
```

APPENDIX B

DEVELOPED DRAINAGE

Developed Drainage Curve Number Analysis

Developed Drainage Area 1			
Acres	Percent of Total Area	Description	CN
3.2	8.9%	Pavement	98
2.3	6.4%	Meadow - Good 'A'	30
30.3	84.6%	Meadow - Good 'B'	58
35.8	100.0%	**Weighted Cumulative**	57.85

Developed Drainage Area 2			
Acres	Percent of Total Area	Description	CN
29.3	94.8%	Meadow - Good 'B'	58
0.7	2.3%	Meadow - Good 'A'	30
0.9	2.9%	Pavement	98
30.9	100.0%	**Weighted Cumulative**	58.53

Developed Drainage Area 3			
Acres	Percent of Total Area	Description	CN
21.8	92.0%	Meadow- Good 'B'	58
0.8	3.4%	Meadow- Good 'A'	30
1.1	4.6%	Pavement	98
23.7	100.0%	**Weighted Cumulative**	58.91

Devleoped Drainage Area 4			
Acres	Percent of Total Area	Description	CN
9.15	39.5%	Pavement	98
14.0	60.5%	Meadow- Good 'B'	58
23.2	100.0%	**Weighted Cumulative**	73.78

Developed Drainage Area 5			
Acres	Percent of Total Area	Description	CN
1.0	2.2%	Pavement	98
43.5	97.8%	Meadow - Good 'B'	58
44.5	100.0%	**Weighted Cumulative**	58.90

Developed Drainage Area 6			
Acres	Percent of Total Area	Description	CN
41.9	95.8%	Meadow – Good ‘B’	58
1.9	4.2%	Pavement	98
43.8	100.0%	**Weighted Cumulative**	59.69

Developed Drainage Area 7			
Acres	Percent of Total Area	Description	CN
42.8	95.7%	Meadow - Good 'B'	58
1.9	4.3%	Pavement	98
44.7	100.0%	**Weighted Cumulative**	59.70

Developed Drainage Area 8			
Acres	Percent of Total Area	Description	CN
43.7	97.8%	Meadow - Good 'B'	58
1.6	3.6%	Pavement	98
45.3	100.0%	**Weighted Cumulative**	60.21

Developed Drainage Area 9			
Acres	Percent of Total Area	Description	CN
712.3	85.4%	Brush - Good 'B'	58
103.5	12.4%	Brush - Good 'A'	30
18.5	2.2%	Pavement	98
834.3	100.0%	**Weighted Cumulative**	53.24

Developed Drainage Area 10			
Acres	Percent of Total Area	Description	CN
2408.5	65.8%	Brush - Fair ‘B’	56
385.7	10.5%	Brush – ‘D’	77
104.9	2.9%	Brush - Fair 'A'	35
18.4	0.5%	Industrial – ‘A’	81
391.6	10.7%	Industrial ‘D’	93
39.4	1.1%	Pavement	98
314.3	8.6%	Industrial – ‘B’	88
3662.8	100.0%	**Weighted Cumulative**	64.89

Developed Drainage Time of Concentration Analysis

Developed Drainage Area 1				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.005	0.11	7
t_{sc}	0	0.005	0.00	0
t_{ch}	2492	0.005	0.14	9
			Cumulative T_c	15

Developed Drainage Area 2				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.005	0.11	7
t_{sc}	619	0.005	0.15	9
t_{ch}	2277	0.005	0.13	8
			Cumulative T_c	24

Developed Drainage Area 3				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.005	0.11	7
t_{sc}	1799	0.005	0.44	26
t_{ch}	-	-	-	-
			Cumulative T_c	33

Developed Drainage Area 4				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.005	0.11	7
t_{sc}	2479	0.005	0.60	36
t_{ch}	0	-	-	-
			Cumulative T_c	43

Developed Drainage Area 5				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.03	0.05	3
t_{sc}	1336	0.050	0.10	6
t_{ch}	30	0.250	0.00	0
			Cumulative T_c	9

Developed Drainage Area 6				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.030	0.05	3
t_{sc}	1355	0.050	0.10	6
t_{ch}	30	0.250	0.00	0
			Cumulative T_c	9

Developed Drainage Area 7				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.030	0.05	3
t_{sc}	1707	0.050	0.10	6
t_{ch}	30	0.250	0.00	-
			Cumulative T_c	9

Developed Drainage Area 8				
	Linear Feet	**Slope (ft/ft)**	**T_c (Hr)**	**T_c (min)**
t_{sh}	300	0.03	0.05	3
t_{sc}	1566	0.05	0.12	7
t_{ch}	30	0.250	0.00	-
			Cumulative T_c	10

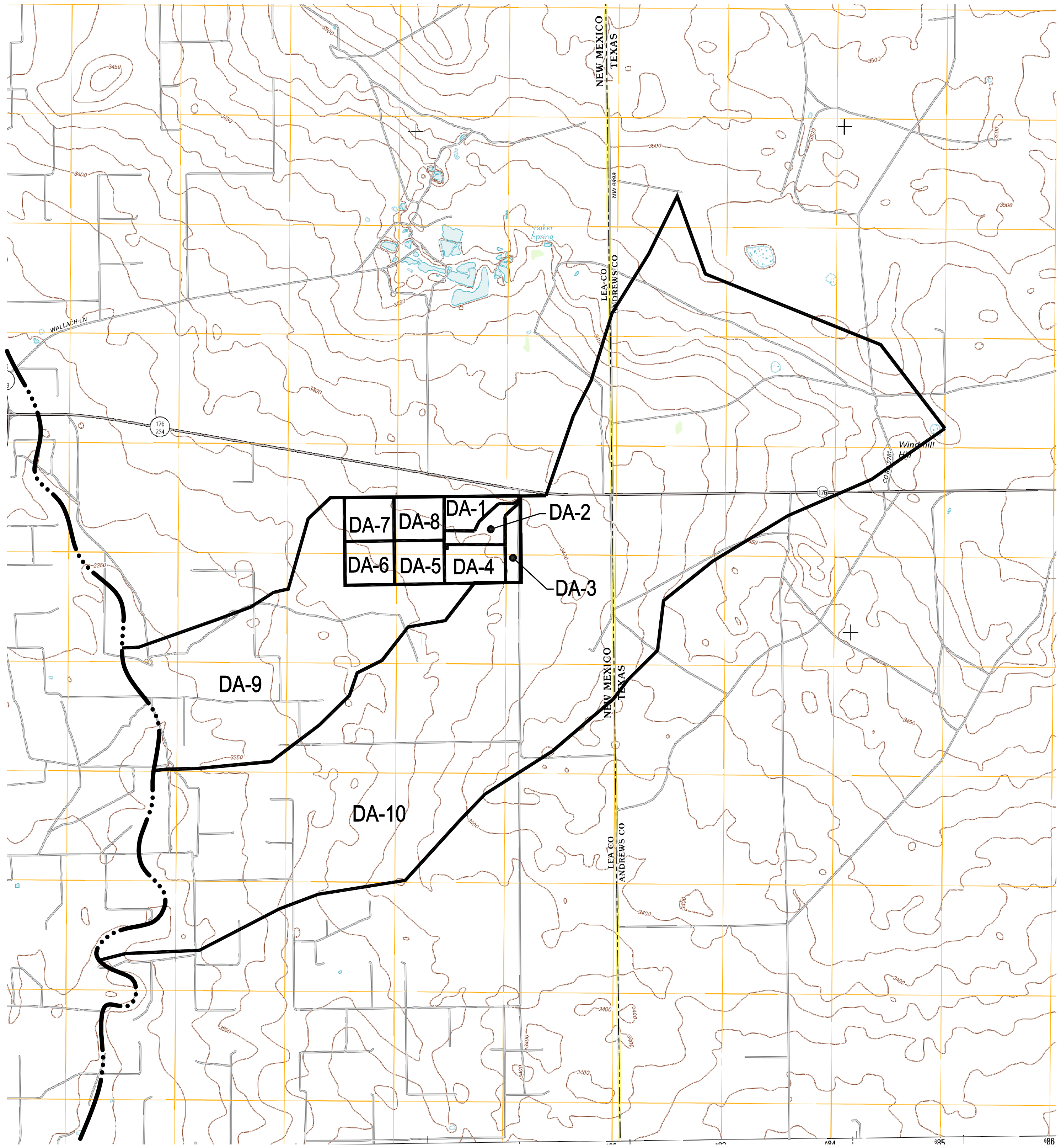
Developed Drainage Area 9

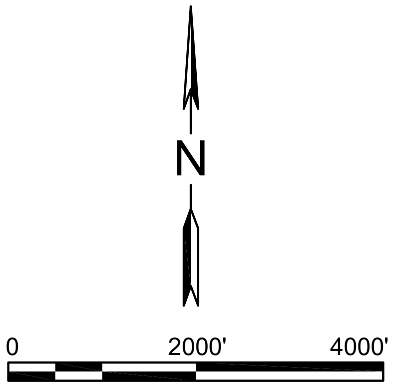
	Linear Feet	Slope (ft/ft)	T_c (Hr)	T_c (min)
t_{sh}	300	0.005	0.11	7
t_{sc}	9520	0.005	2.32	139
t_{ch}	-	-	-	-
			Cumulative T_c	146

Developed Drainage Area 10

	Linear Feet	Slope (ft/ft)	T_c (Hr)	T_c (min)
t_{sh}	300	0.01	0.08	5
t_{sc}	26671	0.005	6.50	390
t_{ch}	-	-	-	-
			Cumulative T_c	395

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.4 - DEVELOPED DRAINAGE AREAS.dwg LAYOUT NAME: FIG.J.4 PRINTED: Thursday, November 05, 2015 - 7:47pm USER: TKrueger





LEGEND

LANDFILL PROPERTY/PERMIT BOUNDARY

PROPOSED DRAINAGE AREA

EPHEMERAL STREAM

DA-1 DRAINAGE AREA LABEL

MAP REFERENCE

United States Geological Survey

North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 13S
10 000-foot ticks: Texas Coordinate System of 1983 (north
central zone), New Mexico Coordinate System of 1983 (east
zone)

North American Vertical Datum of 1998
Eunice NE, TX-NM
2012

NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015

PSC
PARKHILL SMITH & COOPER

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. __

**NEW LANDFILL SITE
& PROCESSING FACILITY**

LEA COUNTY, NEW MEXICO

KEY PLAN

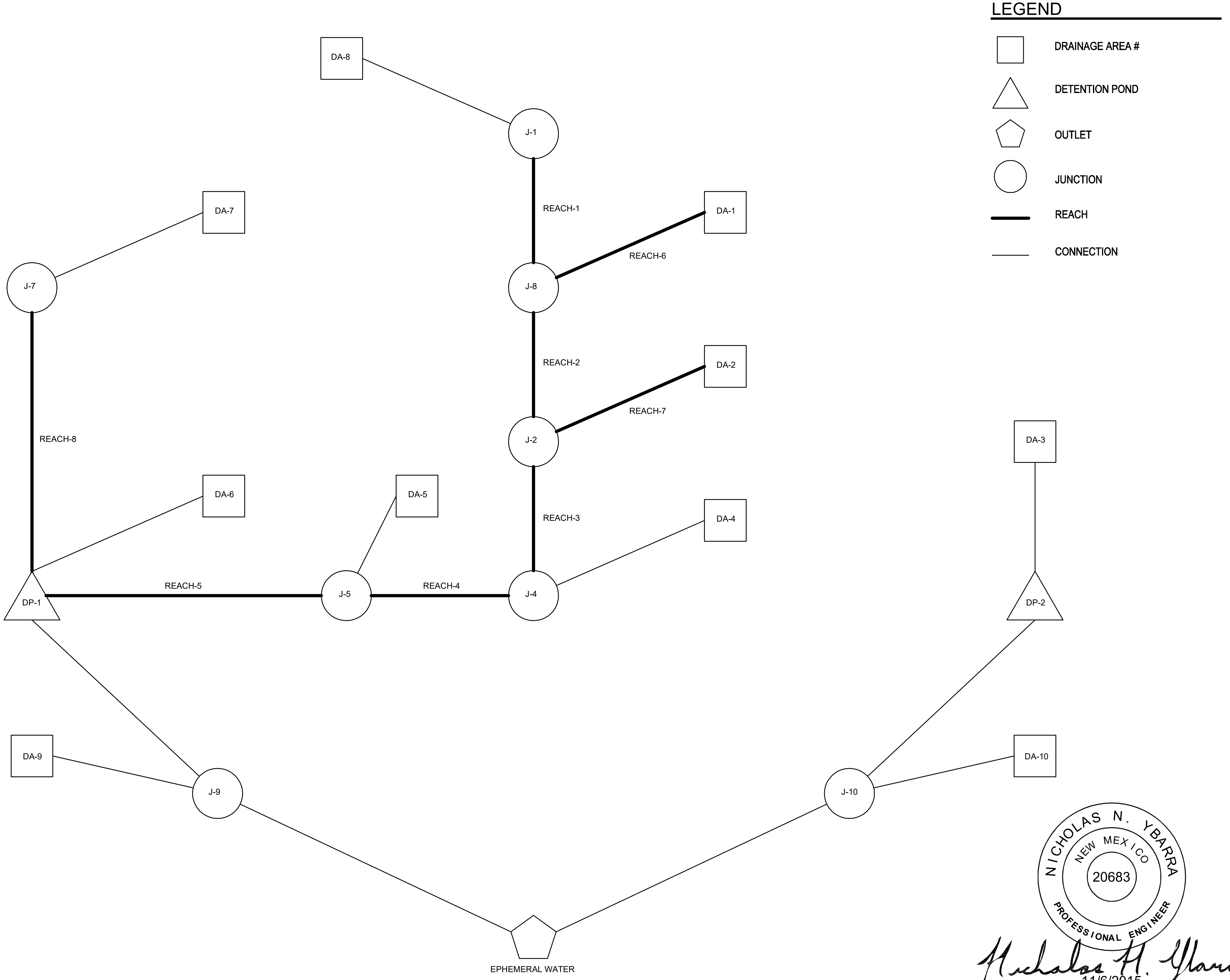
NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO   PROJECT NO: 0580.15

DEVELOPED DRAINAGE AREAS

FIG.J.4

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.5 - DEVELOPED DRAINAGE SCHEMATIC.dwg LAYOUT NAME: FIG.J.5 PRINTED: Thursday, November 05, 2015 - 7:47pm USER: TKrueger



NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015

PARKHILL SMITH & COOPER

THIS DOCUMENT IS RELEASED ON SEPT. 23, 2015 FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF NICHOLAS N. YBARRA, P.E., NEW MEXICO LICENSE 20683. IT IS NOT TO BE USED FOR REGULATORY APPROVAL, CONSTRUCTION, BIDDING OR PERMIT PURPOSES. PARKHILL, SMITH & COOPER, INC.

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. ___

NEW LANDFILL SITE
& PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

KEY PLAN

NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO
PROJECT NO: 0580.15

DEVELOPED DRAINAGE HEC-HMS SCHEMATIC

FIG.J.5

Velocity for Final Cover Top Slope and Perimeter Slope

Top Slope						
P_d	0.7	in		Longest Run	1700	ft
t_c	10	min		Unit Flow Width	1	ft
I	5.9	in/hr		Area	0.039	ac
C	0.5			Slope	0.036	ft/ft
Manning's n	0.03			Q (flow)	0.115	cfs
				y (depth)	0.071	ft
				Velocity	1.614	fps

Perimeter Slope						
P_d	0.7	in		Longest Run	250	ft
t_c	10	min		Unit Flow Width	1	ft
I	5.9	in/hr		Area	0.006	ac
C	0.5			Slope	0.250	ft/ft
Manning's n	0.03			Q (flow)	0.017	cfs
				y (depth)	0.013	ft
				Velocity	1.344	fps

```
Basin: DEVELOPED
     Last Modified Date: 17 September 2015
     Last Modified Time: 18:43:09
     Version: 3.5
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Allow Blending: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: Subbasin-1
     Canvas X: 5738.461538461539
     Canvas Y: 3692.3076923076924
     Area: 0.056
     Downstream: Junction-8

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 8.9
     Curve Number: 57.85

     Transform: SCS
     Lag: 9.15
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-2
     Canvas X: 5507.6923076923085
     Canvas Y: 2507.6923076923076
     Area: 0.048
     Downstream: Reach-7

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 2.9
     Curve Number: 58.53

     Transform: SCS
     Lag: 14.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-3
     Canvas X: 6533.333333333334
     Canvas Y: 1628.5714285714284
     Area: 0.037
     Downstream: Detention 2
```

```
     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 4.6
     Curve Number: 58.91

     Transform: SCS
     Lag: 19.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-4
     Canvas X: 4430.577223088923
     Canvas Y: -257.4102964118565
     Area: 0.036
     Downstream: Junction-4

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 39.5
     Curve Number: 73.78

     Transform: SCS
     Lag: 25.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-5
     Canvas X: 764.8026315789475
     Canvas Y: -312.5
     Area: 0.070
     Downstream: Junction-5

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 2.2
     Curve Number: 58.9

     Transform: SCS
     Lag: 6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-6
     Canvas X: -1932.5657894736842
     Canvas Y: -394.73684210526335
     Area: 0.068
     Downstream: Detention-1
```

```
     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 4.2
     Curve Number: 59.69

     Transform: SCS
     Lag: 6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-7
     Canvas X: -2090.4836193447736
     Canvas Y: 3143.5257410296413
     Area: 0.070
     Downstream: Junction-7

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 4.3
     Curve Number: 59.7

     Transform: SCS
     Lag: 6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-10
     Canvas X: 6190.476190476191
     Canvas Y: -1704.7619047619046
     Area: 5.72
     Downstream: Junction-10

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 1.1
     Curve Number: 64.89

     Transform: SCS
     Lag: 236
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-8
     Canvas X: 1446.1538461538457
     Canvas Y: 3430.7692307692305
     Label X: 6.0
     Label Y: -16.0
```

```
     Area: 0.071
     Downstream: Junction-1

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 3.6
     Curve Number: 60.21

     Transform: SCS
     Lag: 6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Subbasin-9
     Canvas X: -5366.614664586583
     Canvas Y: -1318.252730109204
     Area: 1.30
     Downstream: Junction-9

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 2.2
     Curve Number: 53.24

     Transform: SCS
     Lag: 87.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: Detention-1
     Canvas X: -3037.735849056604
     Canvas Y: -1358.4905660377362
     Rating Table Name: Detention 1
     Downstream: Junction-9

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: Detention 1
     Elevation-Outflow Table: Detention 1
     Primary Table: Elevation-Outflow
End:

Reservoir: Detention 2
     Canvas X: 6533.333333333334
     Canvas Y: 142.85714285714312
     Rating Table Name: Detention 2
     Downstream: Junction-10

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: Detention 2
```

```
     Elevation-Outflow Table: Detention 2
     Primary Table: Elevation-Outflow
End:

Reach: Reach-1
     Canvas X: 3775.3510140405615
     Canvas Y: 2503.90015600624
     From Canvas X: 3712.9485179407166
     From Canvas Y: 3346.3338533541346
     Label X: -67.0
     Label Y: 4.0
     Downstream: Junction-8

     Route: Kinematic Wave
     Channel: Kinematic Wave
     Length: 850
     Energy Slope: 0.005
     Shape: Trapezoid
     Mannings n: 0.05
     Number of Increments: 2
     Width: 5
     Side Slope: 4
     Invert Elevation: 3392.5
     Channel Loss: None
End:

Junction: Junction-1
     Canvas X: 3712.9485179407166
     Canvas Y: 3346.3338533541346
     Label X: -13.0
     Label Y: 34.0
     Downstream: Reach-1
End:

Reach: Reach-2
     Canvas X: 3744.14976599064
     Canvas Y: 1583.4633385335414
     From Canvas X: 3775.3510140405615
     From Canvas Y: 2503.90015600624
     Label X: -74.0
     Label Y: 3.0
     Downstream: Junction-2

     Route: Kinematic Wave
     Channel: Kinematic Wave
     Length: 700
     Energy Slope: 0.005
     Shape: Trapezoid
     Mannings n: 0.05
     Number of Increments: 2
     Width: 5
     Side Slope: 4
     Invert Elevation: 3383.36
     Channel Loss: None
End:

Junction: Junction-2
     Canvas X: 3744.14976599064
     Canvas Y: 1583.4633385335414
     Downstream: Reach-3
End:

Reach: Reach-3
```

```
     Canvas X: 3619.344773790952
     Canvas Y: -928.2371294851791
     From Canvas X: 3744.14976599064
     From Canvas Y: 1583.4633385335414
     Label X: -71.0
     Label Y: 8.0
     Downstream: Junction-4

     Route: Kinematic Wave
     Channel: Kinematic Wave
     Length: 900
     Energy Slope: 0.005
     Shape: Trapezoid
     Mannings n: 0.05
     Number of Increments: 2
     Width: 5
     Side Slope: 4
     Invert Elevation: 3379.86
     Channel Loss: None
End:

Reach: Reach-4
     Canvas X: 1372.8549141965677
     Canvas Y: -1443.0577223088922
     From Canvas X: 3619.344773790952
     From Canvas Y: -928.2371294851791
     Label X: -37.0
     Label Y: 15.0
     Downstream: Junction-5

     Route: Kinematic Wave
     Channel: Kinematic Wave
     Length: 100
     Energy Slope: 0.005
     Shape: Trapezoid
     Mannings n: 0.05
     Number of Increments: 2
     Width: 6
     Side Slope: 4
     Invert Elevation: 3375.36
     Channel Loss: None
End:

Junction: Junction-4
     Canvas X: 3619.344773790952
     Canvas Y: -928.2371294851791
     Downstream: Reach-4
End:

Reach: Reach-5
     Canvas X: -3037.735849056604
     Canvas Y: -1358.4905660377362
     From Canvas X: 1372.8549141965677
     From Canvas Y: -1443.0577223088922
     Label X: -11.0
     Label Y: 14.0
     Downstream: Detention-1

     Route: Kinematic Wave
     Channel: Kinematic Wave
     Length: 1500
     Energy Slope: 0.005
     Shape: Trapezoid
```

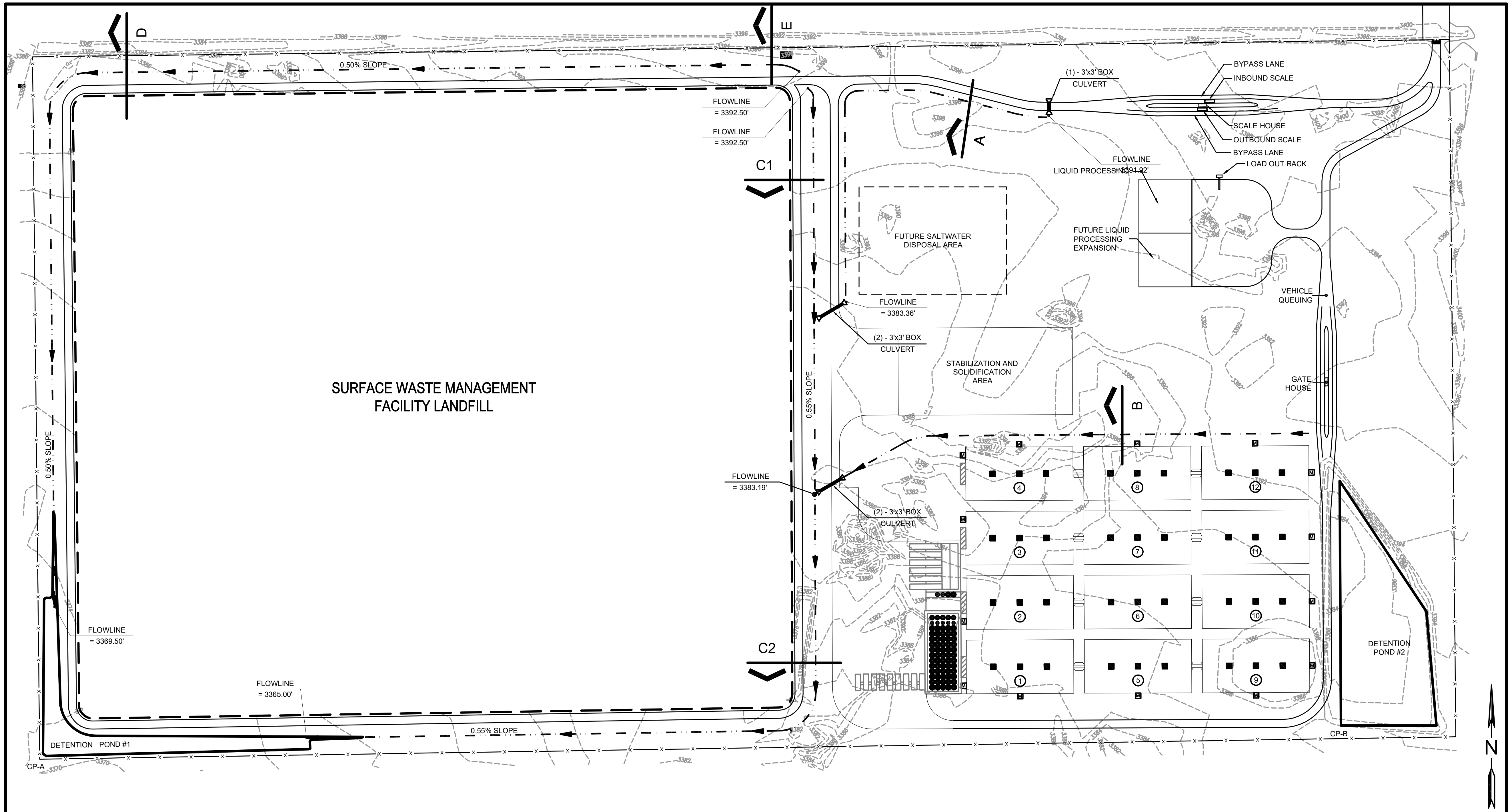
```
     Mannings n: 0.05
     Number of Increments: 2
     Width: 6
     Side Slope: 4
     Invert Elevation: 3379.86
     Channel Loss: None
End:

Junction: Junction-5
     Canvas X: 1372.8549141965677
     Canvas Y: -1443.0577223088922
     Downstream: Reach-5
End:

Reach: Reach-7
     Canvas X: 3744.14976599064
     Canvas Y: 1583.4633385335414
     From Canvas X: 5400.0
     From Canvas Y: 2446.153846153846
     Downstream: Junction-2

     Route: Kinematic Wave
     Channel: Kinematic Wave
     Length: 1900
     Energy Slope: 0.005
     Shape: Trapezoid
     Mannings n: 0.015
     Number of Increments: 2
     Width: 5
     Side Slope: 4
     Invert Elevation: 3389.36
     Channel Loss: None
End:

Junction: Junction-7
     Canvas X: -3088.9235569422776
     Canvas Y: 2488.2995319812794
     Downstream: Reach-8
End:

Reach: Reach-8
     Canvas X: -3037.735849056604
     Canvas Y: -1358.4905660377362
     From Canvas X: -3088.9235569422776
     From Canvas Y: 2488.2995319812794
     Downstream: Detention-1

     Route: Kinematic Wave
     Channel: Kinematic Wave
     Length: 100
     Energy Slope: 0.005
     Shape: Trapezoid
     Mannings n: 0.05
     Number of Increments: 2
     Width: 5
     Side Slope: 4
     Invert Elevation: 13
     Channel Loss: None
End:

Junction: Junction-8
     Canvas X: 3775.3510140405615
     Canvas Y: 2503.90015600624
```

```
     Label X: -94.0
     Label Y: 4.0
     Downstream: Reach-2
End:

Junction: Junction-9
     Canvas X: -3853.3541341653663
     Canvas Y: -2862.714508580343
     Downstream: No-Name Draw
End:

Junction: Junction-10
     Canvas X: 5070.202808112324
     Canvas Y: -2472.698907956318
     Downstream: No-Name Draw
End:

Sink: No-Name Draw
     Canvas X: 842.4336973478939
     Canvas Y: -4485.179407176287
End:

Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
     Maximum View N: 5000.0
     Maximum View S: -5000.0
     Maximum View W: -5000.0
     Maximum View E: 5000.0
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Yes
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Fix Element Locations: No
     Fix Hydrologic Order: No
End:
```

APPENDIX C

DEVELOPED HYDRAULIC STRUCTURES

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.6 - DEVELOPED DRAINAGE STRUCTURES PLAN.dwg LAYOUT NAME: FIG.J.6 PRINTED: Thursday, November 05, 2015 - 7:48pm USER: TKrueger

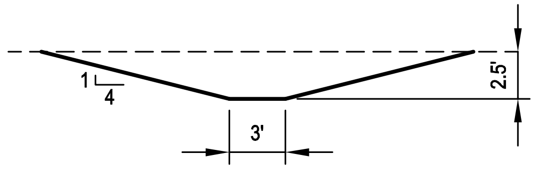


0 400' 800'

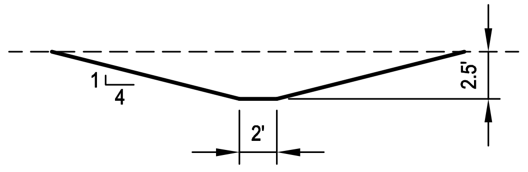
LEGEND

LANDFILL FOOTPRINT

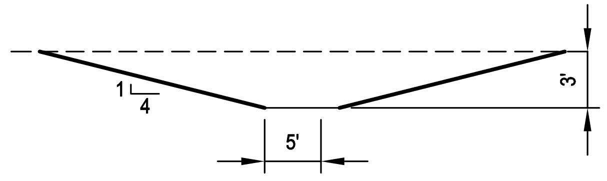
CHANNEL CENTERLINE / DIRECTION OF FLOW



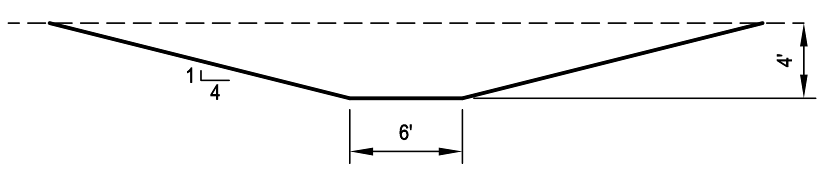
A DRAINAGE CHANNEL A
SCALE: 1" = 10'



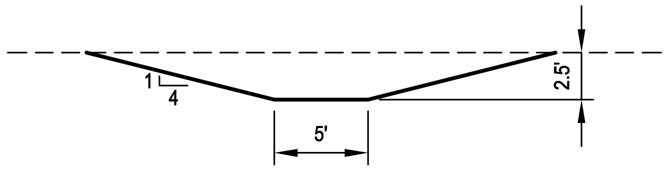
B DRAINAGE CHANNEL B
SCALE: 1" = 10'



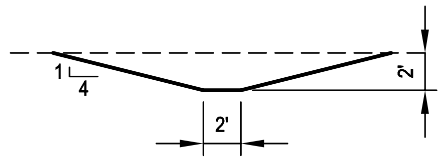
C1 DRAINAGE CHANNEL C1
SCALE: 1" = 10'



C2 DRAINAGE CHANNEL C2
SCALE: 1" = 10'



D DRAINAGE CHANNEL D
SCALE: 1" = 10'



E DRAINAGE CHANNEL E
SCALE: 1" = 10'

NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015

PSC
PARKHILL SMITH & COOPER

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. __

NEW LANDFILL SITE & PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

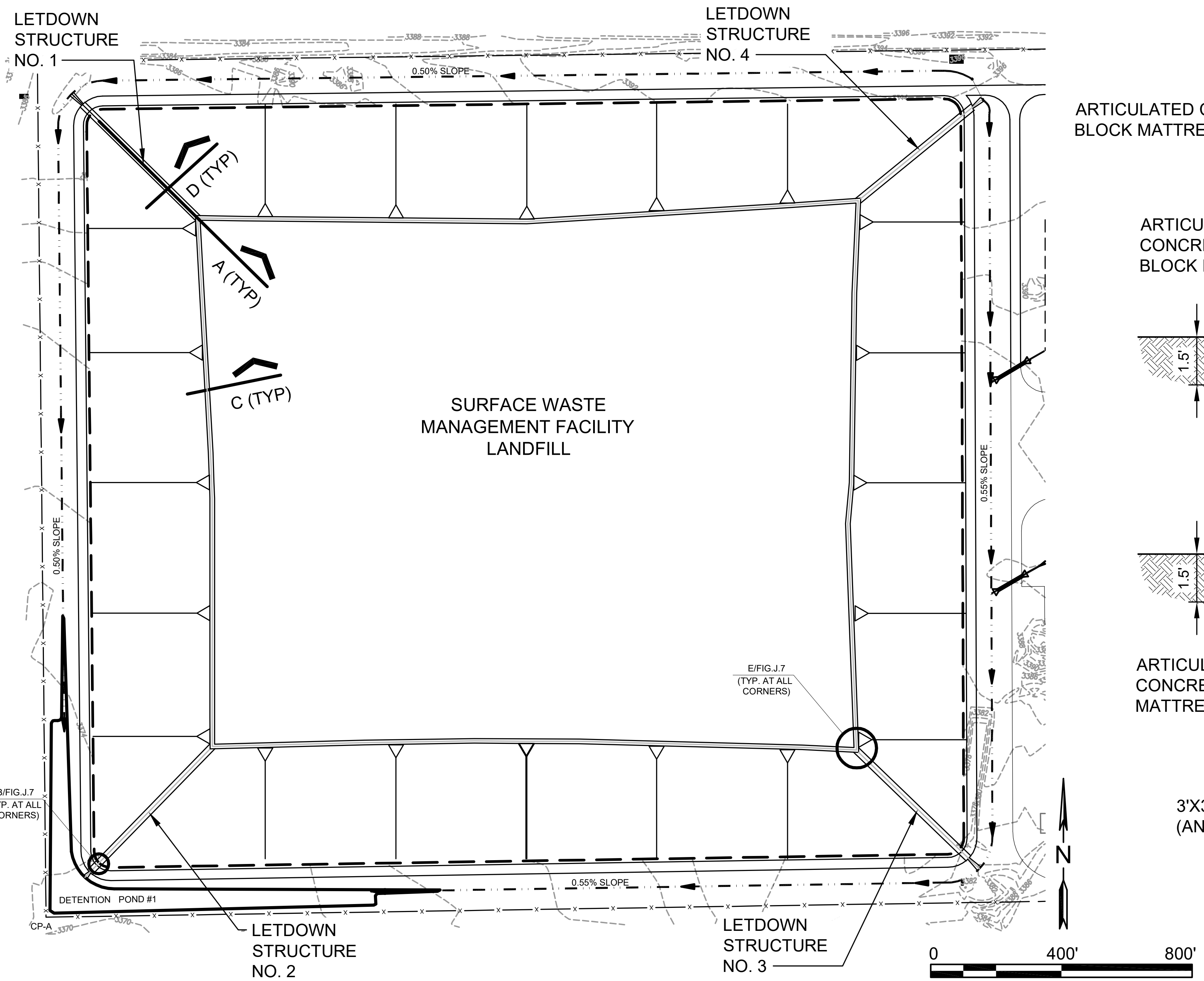
KEY PLAN

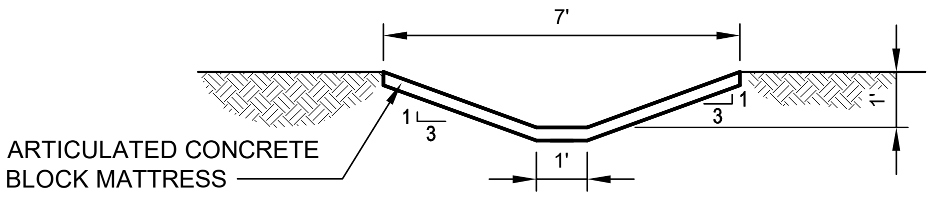
NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO PROJECT NO: 0580.15

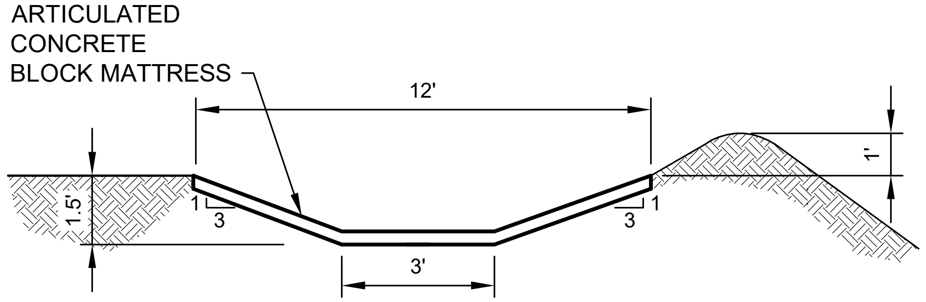
DEVELOPED DRAINAGE STRUCTURES PLAN

FIG.J.6

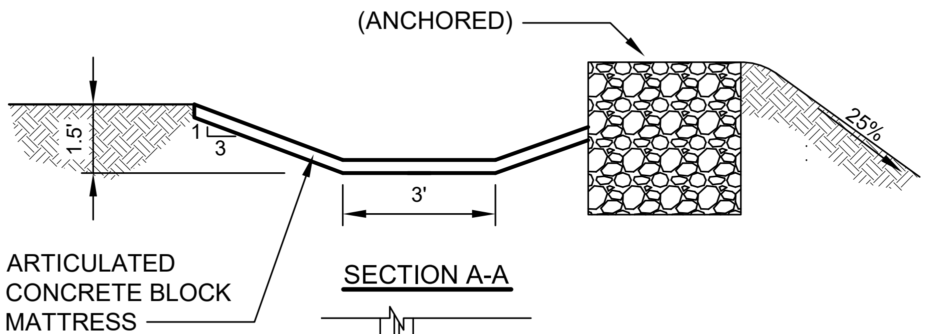




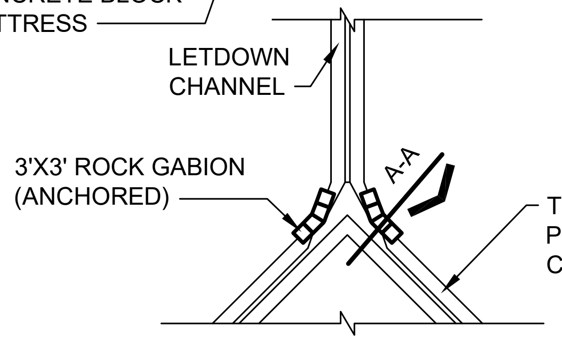
D LETDOWN CHANNEL
NOT TO SCALE



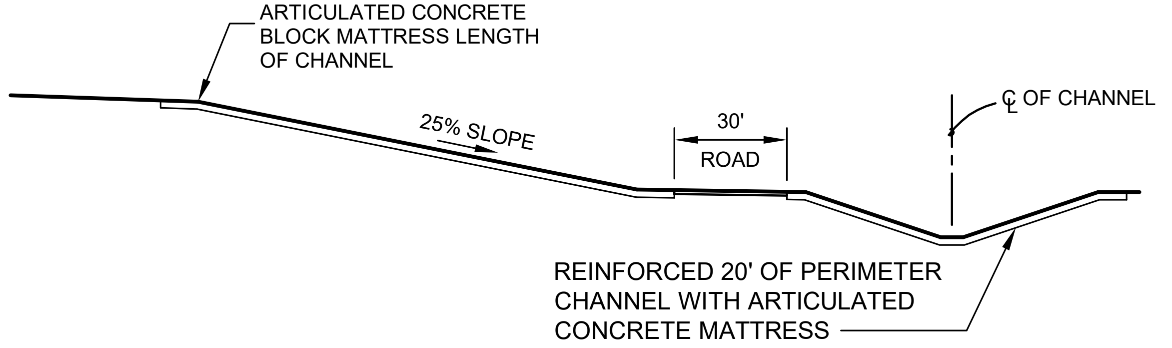
C TYPICAL TOP PERIMETER CHANNEL
NOT TO SCALE



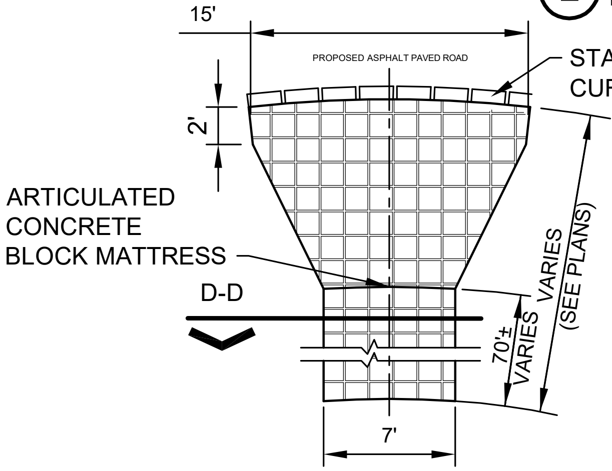
SECTION A-A



E LETDOWN CHANNEL (TYPICAL)
NOT TO SCALE



A SECTION LETDOWN STRUCTURE
NO SCALE:



B OUTFALL SECTION
NO SCALE:

LEGEND

— — —	LANDFILL FOOTPRINT
—·—◄—	CHANNEL CENTERLINE / DIRECTION OF FLOW

NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015

PSC
PARKHILL SMITH & COOPER

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. __

NEW LANDFILL SITE & PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

KEY PLAN

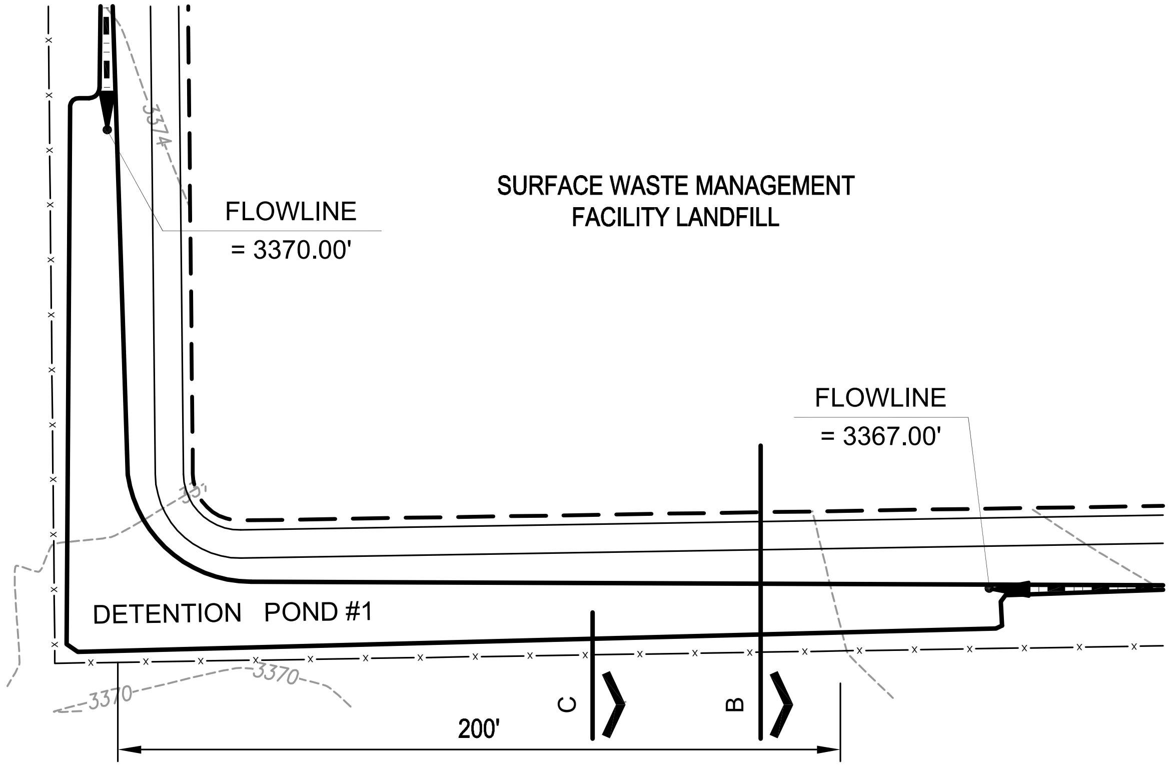
NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

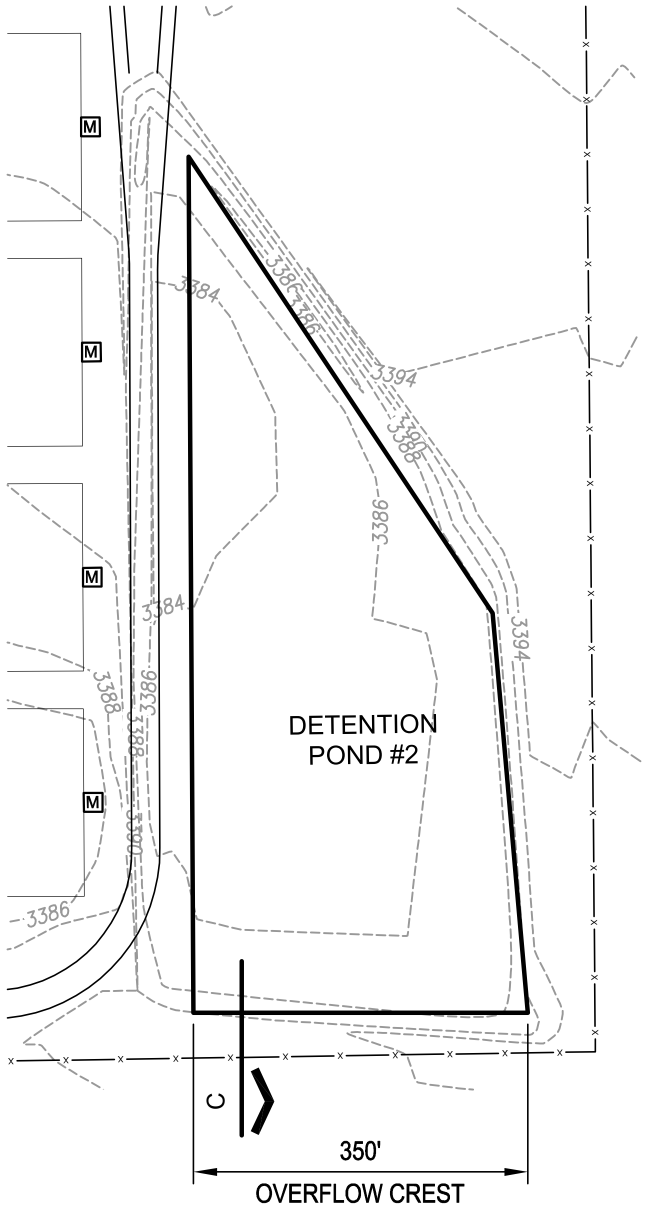
ISSUING OFFICE: EL PASO PROJECT NO: 0580.15

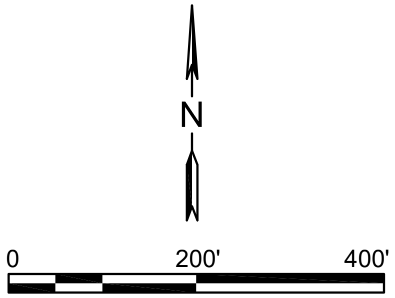
FINAL COVER DRAINAGE STRUCTURE PLAN

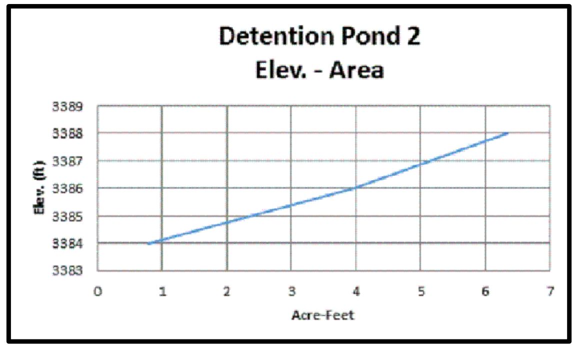
FIG.J.7

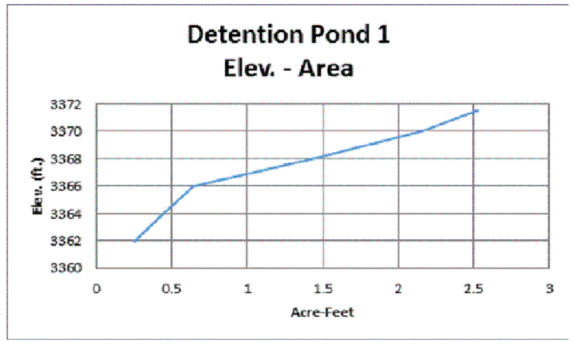
FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\ATT-J\FIG.J.8 - DETENTION POND DETAILS.dwg LAYOUT NAME: FIG.J.8 PRINTED: Thursday, November 05, 2015 - 7:49pm USER: TKrueger





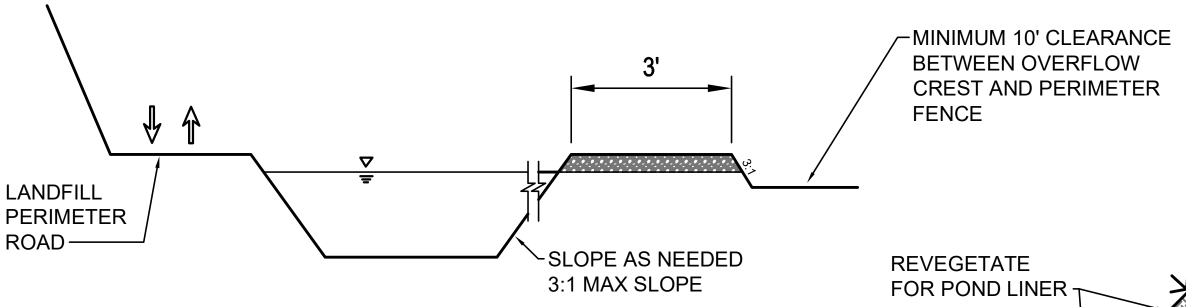



Detention Pond 2
Elev. - Area

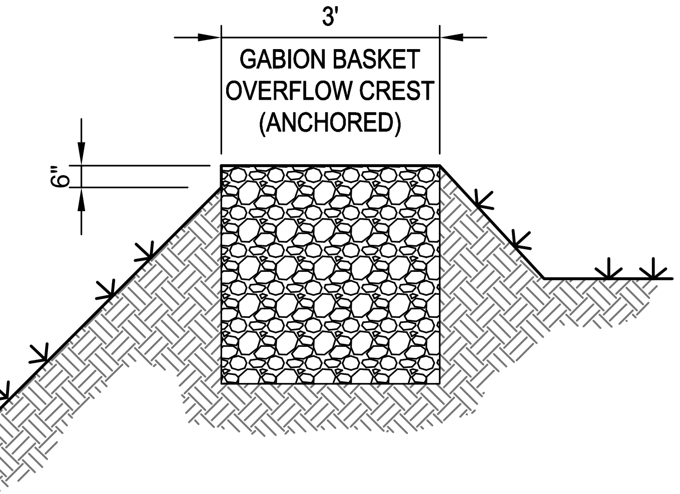

Detention Pond 1
Elev. - Area

NICHOLAS N. YBARRA
20683

Nicholas N. Ybarra
11/6/2015



B SECTION
NO SCALE



C SECTION
NO SCALE

PSC
PARKHILL SMITH & COOPER

C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. __

NEW LANDFILL SITE & PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

KEY PLAN

NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO
PROJECT NO: 0580.15

DETENTION POND & DETAILS

FIG.J.8

APPENDIX D

SELECTED PGS. – REFERENCE MATERIAL

Lea COUNTY new mexico

LEA COUNTY FLOODPLAIN MANAGEMENT

Lorenzo Velasquez CFM Director
Cassie Corley CFM Coordinator
1923 N. Dal Paso Suite A
Hobbs, NM 88240

Phone (575) 391-2983
Phone (575) 391-2976
Fax (575) 397-7413
lvelasquez@leacounty.net
ccorley@leacounty.net

FLOODPLAIN DETERMINATION

Date: August 7, 2015

Owner/Agent: Parkhill Smith & Cooper Phone: 806-473-3675

Property Address: 286 Andrews Hwy, Eunice, NM 88231

Mailing Address: 4222 85th Street, Lubbock, TX 79423

☒ **NON-SFHA**

☐ **PROPERTY IN SFHA**

☐ **PROPERTY PARTIAL SFHA AREA-STRUCTURE NON SFHA**

ZONE: D BFE: N/A

FIRM PANEL: 1700D DATED: 12/16/08

COMMUNITY NFIP NUMBER: 35025

☐ **SITE BUILT**
☐ **ADDITION**
☐ **REAL ESTATE**
☐ **MOBILE HOME**
☐ **INSURANCE**
☐ **COMMERCIAL**
☐ **ADDRESSING**
☐ **RESIDENTIAL**
☐ **BANK**
☐ **MOD**
☐ **OWNER**

COMMENTS: NOT APPROVED TO BUILD UNTIL BUILDING APPLICATION IS SUBMITTED.

ZONE D IS NOT DEFINED AS BEING IN THE SPECIAL FLOOD HAZARD AREA. HOWEVER, THE PROPERTY MAY STILL BE SUBJECT TO LOCAL FLOODING OR OTHER UNMAPPED FLOOD HAZARDS.

NOTE: This information is based on the FIRM for this community. This letter does not imply that the referenced property will or will not be free from flooding or damage. A property not in a Special Flood Hazard Area may be damaged by a flood greater than that predicted on the FIRM. This letter does not create liability on the part of the City, or any officer or employee thereof, for any damage that results from reliance on this information.

County Floodplain Manager Cassie Corley CFM Date 8-7-15

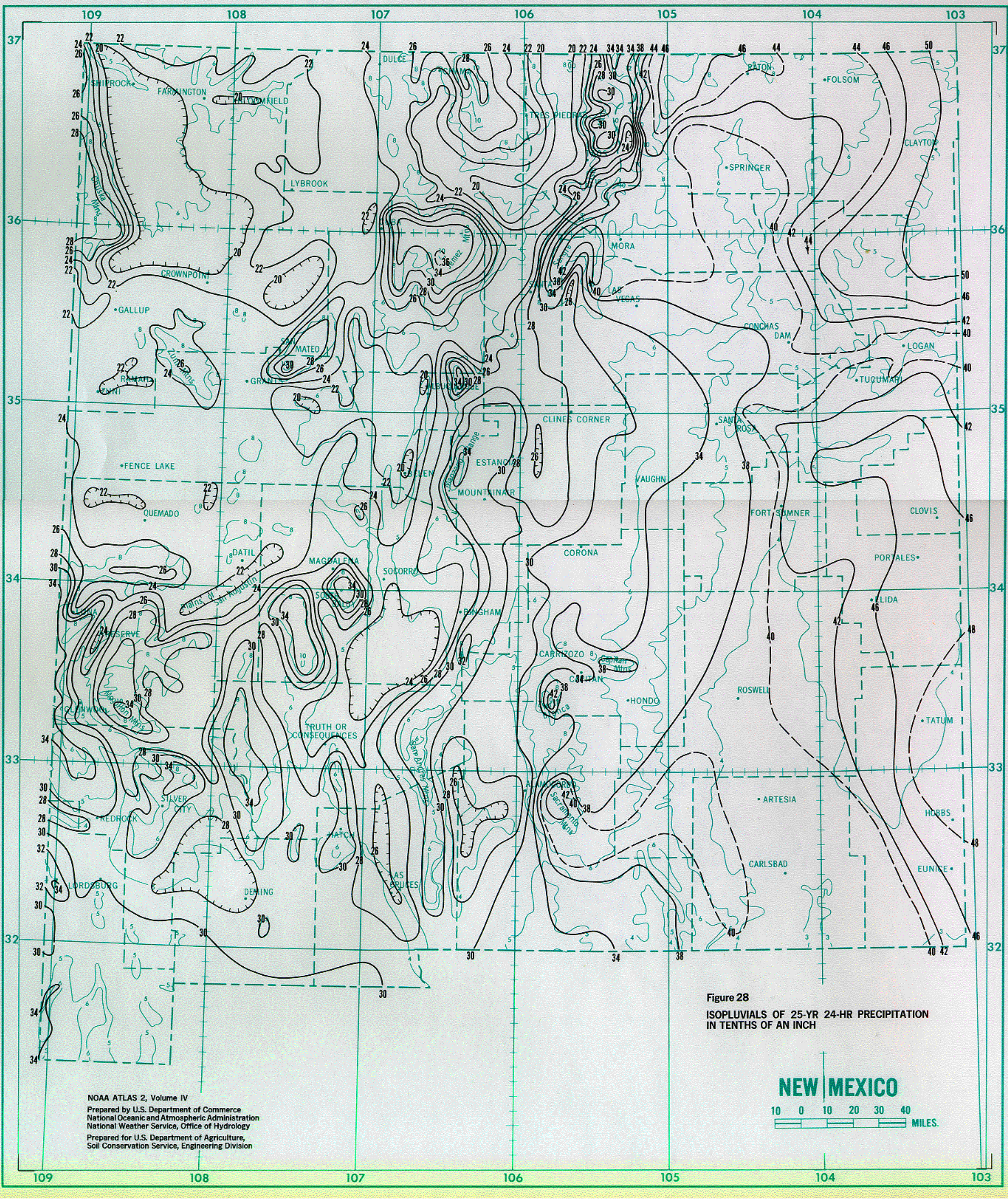


Figure 28

ISOPLUVIALS OF 25-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume IV
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

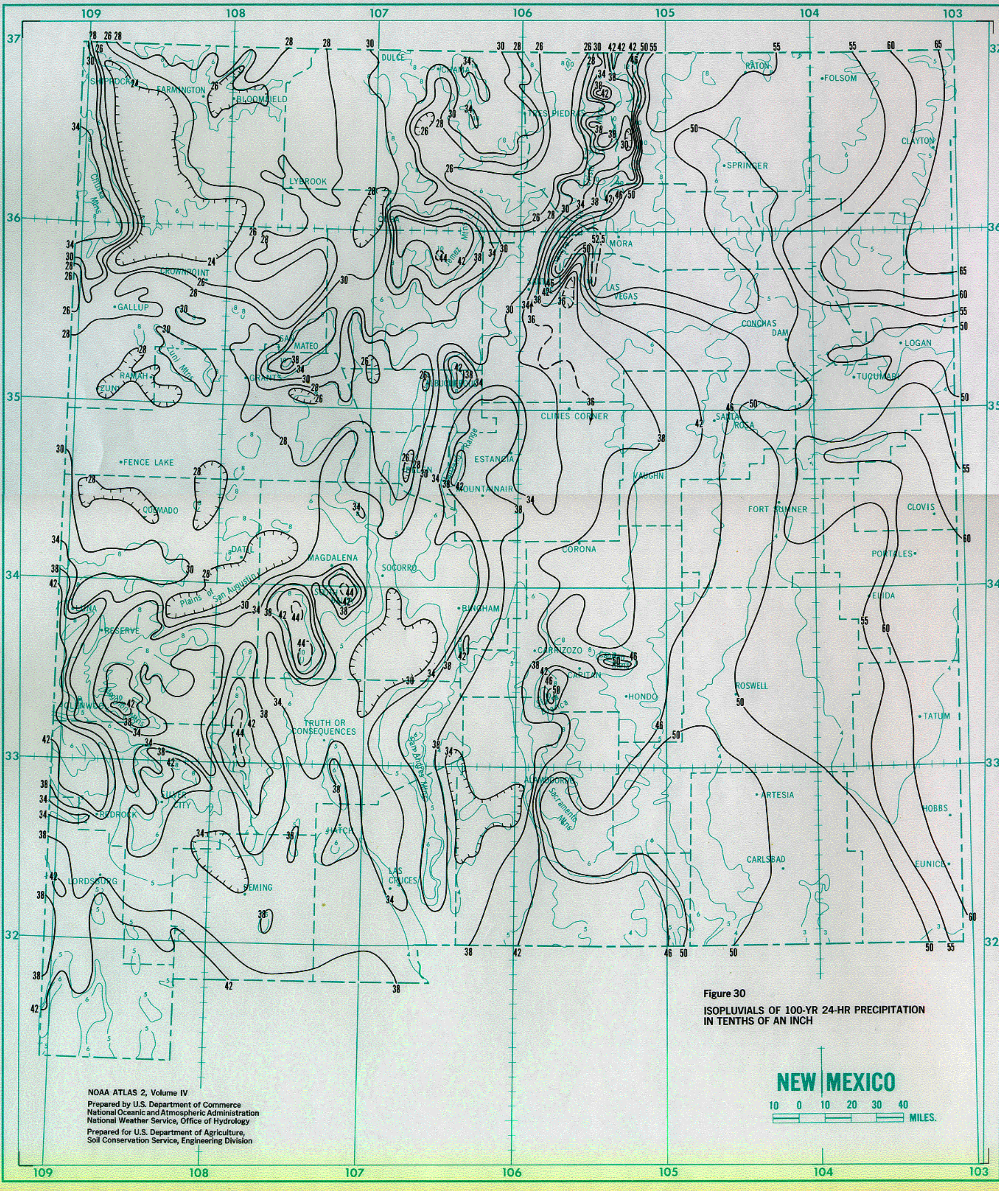


Figure 30

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume IV

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

Permit Application

Lea County, New Mexico

C.K. Disposal E & P Landfill and Processing Facility

Permit No. TBD

Attachment K

Site Operation Plan

NMAC 19.15.36

November 2015

PSC Project # 01058015

PARKHILLSMITH&COOPER

ATTACHMENT K - SITE OPERATION PLAN

TABLES

1.0 INTRODUCTION

This Site Operating Plan (SOP) has been prepared for the proposed facility consistent with NMAC 19.15.36 and includes provisions for site management and site operating personnel to meet the general and site-specific requirements consistent with NMAC 19.15.36. The SOP will remain onsite throughout the active life of the facility and throughout the post-closure care maintenance period.

2.0 PERSONNEL, TRAINING, AND SITE EQUIPMENT

2.1 Personnel

The proposed site will maintain qualified personnel with experience in waste disposal operations and earthmoving construction projects. Personnel will undergo training in H_2S and the contingency plan before beginning work. The following list is the expected site personnel and rank onsite. Table K.1 shows the number of employees needed for each site.

1. General Manager - Responsible for assuring adequate personnel and equipment are available to guarantee facility operations in accordance with the SOP. The landfill general manager is responsible for general facility management and designated as the contact person for regulatory compliance. The manager will have at least three (3) years of supervisory experience in landfill operations. The landfill general manager will obtain and maintain all applicable operator license.
2. Operations Manager - Under direction of landfill general manager and responsible for daily operations and emergency coordination. The landfill operations manager is responsible for coordinating with equipment operators regarding a waste disposal operation including active workface, excavation operations, and placement of intermediate cover. The landfill operations manager will obtain and maintain all applicable operator licenses.
3. Equipment Supervisor - Responsible for safe operation of site and operating facility equipment in a manner that achieves compliance with the SOP. The equipment supervisor must be on alert for any potentially dangerous conditions and careless or improper actions on the part of landfill patrons and visitors while on the premises. This employee will report any such observations directly to the landfill operations manager.
4. Laborer - Directs vehicles to the proper unloading area at the working face, observes unloading, looks for prohibited wastes, and directs vehicles as they maneuver near the active area. The landfill operations manager may assign additional responsibilities to employee(s) as necessary.
5. Other Supplemental Personnel - Onsite as necessary for duties such as cell construction, operation and maintenance of the leachate management system, groundwater monitoring, landfill gas monitoring, site maintenance, and litter cleanup.

Table K.1 – NECESSARY SITE PERSONNEL

Position	Number of Employees
General Manager	1
Operations Manager	1-2
Equipment Supervisor	4-6
Laborer	2-4

2.2 Training and Experience

All personnel will be familiar with the SOP and other permit documents. Annual training events will be conducted for facility personnel, which must include permit conditions, emergencies, proper sampling methods, general operations, and identification of exempt and non-exempt waste and hazardous waste.

2.3 Equipment

Equipment requirements will vary in accordance with the method and scope of activities onsite at a given time. Additional or different units of equipment may be provided as necessary to enhance operational efficiency. Table K.2 lists the types and sizes of equipment provided at the facility.

Table K.2 - LANDFILL FACILITY EQUIPMENT LIST

Equipment Type	Function
Rubber-Tire Loader	Used for earthmoving activities and landfill unit construction, delivery and application of cover material, excavation of soil, and movement of waste.
Compactor	Used for the compaction and movement of waste, application of daily cover, and other workface related activities.
Dozer	Used to move waste and soil short distances, rework sideslope erosion rills, limited waste compaction, and daily cover operations.
Scrapers	Used to excavate future landfill units and daily cover material, transport material from longer distances, apply daily or intermediate cover
Water Truck	Used for dust control and firefighting support.
Motor Grader	Assists in roadway construction, maintenance, grading, and drainage improvements.

In addition to the list in Table K.2, miscellaneous pickups, vans, and other light utility vehicles as well as various pumps, instruments, and safety and training equipment will be onsite as necessary for facility operations. As operations evolve or because of significant volume increases of waste stream, an increase in the number of equipment or additional unspecified equipment may be required to meet the needs of the facility operations.

3.0 GENERAL FACILITY INFORMATION AND OPERATIONAL REQUIREMENTS

3.1 Access Control

Public access to the landfill is controlled by a perimeter fence located along the facility boundary. Access to the landfill is limited to the entrance road from Andrews Highway. All access must enter the site through one (1) of the scalehouse areas.

3.2 Site Security

Site security measures are designed to prevent unauthorized persons from entering the site, protect the facility and equipment from possible damage caused by trespassers, and prevent disruption of facility operations caused by unauthorized site entry. The perimeter fence, consisting of barbed wire, chain link, woven wire, pipe fencing or other suitable materials located along the facility boundary and entrance gate, will control unauthorized entry to the site. A gate constructed of suitable fencing materials will be located on the entrance road, remaining locked when the landfill is not accepting waste.

Site personnel will monitor the entrance during waste acceptance hours but outside of operating hours, the gate will be locked. Entry to the active portion of the site will be restricted to designated personnel, approved waste haulers, and properly identified persons whose entry is authorized by a site representative. Visitors may be allowed on the active area only when accompanied by a site representative.

3.3 Site Signs and Traffic

Once authorized vehicles are onsite, signage will be placed to efficiently direct the vehicles. Waste-hauling vehicles will be directed to the active fill area by the use of these signs. Private, commercial, or public solid waste vehicles are not allowed to access any other areas of the landfill. Roads not used for access to disposal areas will be blocked or marked for no entry. Once vehicles have unloaded the waste, they must depart the site. Site personnel will provide traffic directions if necessary to facilitate safe movement of vehicles.

3.4 Noise Control

Sounding land around the C.K. Facility is used for gas exploration, cattle grazing, industrial, or landfill activities. Noise nuisance will not be a concern for nearby residences or businesses. Due to high volume of gas, oil, industrial, and landfill activities, the proposed site will not greatly increase noise nuisance in the area.

3.5 Odor Control

Potential odor sources associated with the C.K. Facility include the wastes being delivered to the landfill, the open working face, ponded water, and landfill gas. Methods used to control odors include waste management procedures, the placement of cover materials, control of ponded water, leachate, and landfill gas control. H_2S gas is known for a foul odor which can be dangerous at high concentration levels. Loads with high levels of H_2S gas will be treated with calcium hypochlorite to lower H_2S concentrations. The surrounding land is used for gas, oil, industrial, and landfill activities so the proposed site will not greatly increase an odor nuisance in the area. H_2S management plan is included in Appendix A.

3.6 Dust Control

Dust control will be maintained using at least one (1) water wagon. This truck will be used as needed to prevent excess dust release from C.K. Facility. A speed limit throughout C.K. Facility will be posted as 15-mph.

3.7 Minor Spills/Releases

Spills at the C.K. Facility will most commonly involve fuel or other vehicular fluids. C.K. Facility will be equipped with necessary equipment to control and clean fuel, E&P wastes, and other fluid spills. All spills will be controlled, cleaned, and documented immediately.

4.0 C.K. FACILITY OPERATIONS

4.1 Landfill Phasing Plan

C.K. Facility will develop the landfill units in accordance with Attachment B – Engineered Design Plans. The liquid processing area phasing of the C.K. Facility will consist of four (4) phases: Initial Landfill-Produced Water Processing Operation, Jet Out Pit Operation, Expanded Produced Water Processing Operations, and Ultimate Produced Water Processing Facility.

A. Phase I - Initial Landfill-Produced Water Processing Operation

- Initial landfill cell (23.6-acres).
- Four (4) produced water load-out points.
- Tank farm berm (complete).
- Boiler (75HP) running a heat transfer fluid tank farm.
- Four (4) produced water receiving tanks 1,000-barrel capacities each.
- Sixteen (16) settling tanks with 1,000-barrel capacities each.
- One (1) crude oil recovery tank with 1,000-barrel capacity.
- One (1) oil sale tank with 1,000-barrel capacity.
- The mechanical oil/water separation unit.
- Four (4) ponds capable of evaporating 3,000-barrels of liquid per day.

Six (6) barrels per day is the anticipated oil recovery output from Phase I. The oil will be pumped to the heated crude oil recovery tank for further processing and separated before pumped to the oil sales tank.

B. Phase 2 - Jet Out Pit Operation

- Six (6) jet out pits for handling basic sediment and water, tank bottoms, oily drilling muds, and tank wash outs.
- One (1) additional crude oil recovery tank with a 1,000-barrel capacity.
- Installation of the 5-acre stabilization and solidification area.

The oil recovered from the jet out pit will be pumped to a heated crude oil recovery tank installed in the tank farm for processing. Oil recovered from the produced water tanks will also be pumped to this tank. Water recovered from the pit will be pumped to the produced water tanks. Sediments from the pit will be bucket-loaded out of the pit and transferred to the stabilization and solidification area for processing prior to being taken to the landfill.

C. Phase 3 - Expanded Produced Water Processing Operation

- Four (4) produced water load-out points.
- Four (4) additional produced water receiving tanks with 1,000-barrel capacities each.
- Sixteen (16) additional settling tanks with 1,000-barrel capacities each.
- Three (3) additional crude oil recovery tanks with 1,000-barrel capacities each.

- Two (2) additional oil sales tanks with 1,000-barrel capacities each.
- Two (2) additional mechanical/oil water separation units.
- Four (4) additional ponds capable of evaporating 5,000-barrels of liquid per day.

Six (6) barrels per day is the anticipated oil recovery from the expanded produced water processing operation process. This will be pumped to the crude oil recovery tanks for further processing.

D. Phase 4 - Ultimate Produced Water Processing Facility

- Four (4) additional produced water receiving tanks with 1,000-barrel capacities each.
- Sixteen (16) additional settling tanks with 1,000-barrel capacities each.
- One (1) additional oil sales tank with 1,000-barrel capacity.
- One (1) additional mechanical/oil water separation unit.
- Four (4) additional ponds capable of evaporating 4,000-barrels of fluid per day.
- The additional oil recovered from the ultimate produced water processing facility will be pumped to the crude oil recovery tank for further processing.

The totals are eight (8) produced water load out points, sixteen (16) produced water receiving tanks, one (1) boiler, forty-eight (48) settling tanks, five (5) crude oil recovery tanks, four (4) oil sales tanks, four (4) mechanical oil/water separation units, twelve (12) evaporation ponds, six (6) jet out pits and one (1) solidification and stabilization area. Water treatment and reuse facility and saltwater disposal well may be added as necessary during any phase. The addition of these services will be dependent on market conditions and the actual amount of liquid waste being disposed.

The phase development may change based on the needs of the facility. The site development sequence is also subject to change and may be updated to reflect market conditions.

4.2 Waste Characteristics

Oil and gas exploration and production operation exempt oilfield waste will be accepted at the C.K. Facility. Neither hazardous nor non-exempt oilfield waste will not be accepted for processing or disposal. OCD Form C138 - Request for Approval to Accept Solid Waste will be required before any waste is accepted by the C.K. Facility. Wastes failing the paint filter test will be accepted in the liquids processing area on the site. The following are anticipated types of accepted waste:

- Contaminated soil.
- Drilling mud.
- Stabilized tank bottoms.
- Other oilfield activity waste.

4.3 Waste Acceptance

C.K. Facility requires a certification on form C138, signed by the generator or authorized agent, that represents and warrants the oilfield wastes are generated from oil and gas exploration and production operations, are exempt waste and not mixed with non-exempt waste. The operator shall have the option to accept such certifications on a monthly, weekly or per-load basis. The operator shall maintain and make the certificates available for the division inspection. C.K. Facility requires the oilfield waste document, form C138, signed by the generator or authorized agent. This form shall be accompanied by acceptable documentation to determine the oilfield waste is non-hazardous. C.K. Facility requirements may accept non-hazardous, non-oilfield wastes in an emergency if ordered by the Department of Public Safety (DPS). C.K. Facility requires generators to complete form C138 describing the waste, accompanied by the DPS order. C.K. Facility will maintain records reflecting the generator, the location of origin, the location of disposal within the commercial facility, the volume and type of oilfield waste, the date of disposal, and the hauling company for each load or category of oilfield waste accepted at the commercial facility. C.K. Facility will maintain records for a period of not less than five (5) years after the commercial facility closure, subject to division inspection. Disposal at C.K. Facility shall occur only when an attendant is on duty unless loads can be monitored or otherwise isolated for inspection before disposal. C.K. Facility will be secured to prevent unauthorized disposal.

4.4 Prohibited Waste

Only exempt oilfield waste as stated in NMAC 19.15.36.13.F will be accepted at the C.K. Facility. The following wastes are prohibited at the site:

- Regulated non-exempt hazardous waste.
- Non-exempt Naturally Occurring Radioactive Materials (NORM) waste.

Any haulers or generators of the previously mentioned prohibited wastes will be referred to a U.S. EPA RCRA permitted facility.

4.5 Waste Capacity and Site Life

C.K. Facility has an approximate gross airspace of 24,585,056-cubic yards. A contingency of 15% was applied to the total airspace to account for daily and intermediate cover loss, variation in waste density, and other operational losses that may occur during the life of the facility. Approximately 20,897,298-cubic yards of waste capacity remains after the 15% contingency loss. An estimate of 500-cubic yards/day was used for an initial projected incoming waste volume. Table K.3 illustrates the estimated site life per 365-days/year:

Table K.3 – ESTIMATED SITE LIFE

500 cubic yards per day	115 years
1,000 cubic yards per day	57 years
1,500 cubic yards per day	38 years

4.6 Gas Safety

Typical landfill gas expected at municipal solid waste landfills is not normally produced in oilfield waste. C.K. Facility will not have dedicated gas-monitoring wells. Vadose zone monitoring will be conducted in accordance with Attachment H – Vadose Monitoring Plan. Methane and H_2S are both known to produce particular smells. If these are suspected to be in the proposed vadose zone monitoring wells, they will be tested for gas and appropriate measures will be taken.

4.7 Leachate Monitoring

Appendix B will describe the anticipated amount of leachate generated using weather data from Roswell, New Mexico. This was the closest available data for the site and is in a slightly wetter climate which will show a worse case scenario than to be expected per year.

Leachate piping system is at least 6-inches in diameter and sloped at a minimum of 2% to promote positive drainage to each unit sumps. Each unit will be constructed with perforated leachate pipes, textile enclosing the pipe to minimize fines intruding in the pipe. Leak detection layer will be constructed between two (2) HDPE liners monitored in the monthly inspection.

In accordance with NMAC 19.15.36.14.F, liners and leachate collection systems will be designed to ensure performance of the system does not allow for a leachate head accumulation to exceed 12-inches. Attachment E - HELP Model, has demonstrated the head on the proposed liner does not exceed 12-inches. Leachate levels on the floor will be pumped routinely and maintained so the liner head stays below the regulatory threshold. Leachate generation is projected to ultimately approach zero. Due to waste passing the paint filter test before disposal at the solid waste landfill, the leachate will be generated by rainfall. With the dry climate and high evaporation rates of the region, the leachate generation will be zero after the first lift of waste is placed on the liner system. The evaporation rate in the site region and field capacity of the waste offsets the volume of rainfall expected for the site. Leachate will continue to be monitored through the life and post-closure care of the facility to ensure the liner head does not exceed 12-inches.

Leachate sumps will be pumped with portable submersible pumps, vacuum trucks, or other approved equivalent device. Remote level sensors can be equipped to the dedicated submersible pumps for constant monitoring of leachate levels. At a minimum, leachate sumps will be monitored each month and extracted quarterly as protective measures to keep head less than 12-inches on liner.

Leachate will be disposed of in the produced water receiving tanks and processed through the evaporative pond process. If excess leachate is encountered and cannot be disposed of, C.K. Facility will seek alternative OCD-approved facilities for disposal. After closure of the C.K. Facility and following approval by the OCD, the leachate will be transported to the most effective treatment or disposal technology.

Leak detection monitoring of the units and evaporation ponds will be inspected monthly. Any liquids in the leak detection layer will be removed and treated or disposed as leachate. Based on "Leakage through Liners Constructed with Geomembranes, Part 1 – Geomembrane Liners" by J. P. Giroud and R. Bonaparte, the projected leakage rate for HDPE liner at the C.K. Facility will be roughly 10- to 140-gal/acre/day. The average of the projected leakage (75-gal/acre/day) will be anticipated for the site. If excess liquid is found in leak detectors, the OCD will be notified within 24-hours and the facility will start corrective measures including but not limited to:

- Increase liquid level monitoring and frequency of sumps and leak detection layer.
- Testing liquid collected in sump and leak detection layer to isolate a problem.

If excess liquids are found in the evaporative pond leak detection layer, the pond will be drained and site personnel will take action to find the source of the leak. Liquid testing of the liquids in the leak detection layer will be submitted to the OCD. If the source of the leak is found, repairs will be made by qualified liner installers. After repairs are made, monitoring of the leak detection layer will be completed bi-monthly until verified the leak is properly repaired.

4.8 Operating Hours

The C.K. Facility will accept waste 24-hours/day for 7-days/week. Signage will specify operating hours for the site. The site will operate under all weather conditions and the active working face may be relocated during inclement weather to allow for easier access for waste haulers. C.K. Facility may reduce operating hours based on reduction of waste stream. OCD will be notified if operating hours change.

5.0 LIQUIDS PROCESSING

The estimated acceptance rate expected at the C.K. Facility is 9,000-barrels/day. As market conditions and technology changes, the site anticipates the liquid waste acceptance rate to vary. C.K. Facility has been designed to process roughly 12,000-barrels/day. Liquids processing rate will rely on evaporation rates for the region. If evaporation ponds are near capacity, the C.K. Facility will stop collecting liquid waste until evaporation of produced water is reduced for extra capacity. The C.K. Facility shall also treat water for reuse in frack operations.

Produced water will be received in the produced water load-out stations. The produced water will then be transferred to the heated tanks to separate oil, water, and sediments. The separated oil will be transferred to the oil recovery tanks prior to storage in oil sales tanks. Sediments will be transferred to the solidification area until the paint filter test is passed. Once the paint filter test is passed, it can be placed in the solid waste disposal workface area. Water from the site will either be transferred to the evaporation ponds or to the water treatment and reuse area.

6.0 WATER TREATMENT AND REUSE

An alternative to the evaporation of produced water is treatment and reuse of the water. After solids and oil separation activities, water will be diverted to a treatment plant. The end goal of treatment is water that can be sold for use in the oil and gas industry. The plant is expected to receive a peak flow of 12,000-barrels of water a day. Following treatment, 7,140-barrels of water are expected to be available for sale. The following are key constituents of concern for the water treatment facility: Volatiles remaining after oil-water separation, solids, iron and manganese, biological including algae, total dissolved solid, and chlorides. These constituents are known to adversely affect oil and gas operations and the minimization is paramount to the ability to sell the produced water. The proposed plant would utilize a 3-stage treatment process including a stripping tower, greensand filters, and reverse osmosis. As incoming and produced water quality information becomes more readily available, treatment units may adjust to fit the particular application requirements. Treated water will be stored in tanks and sold via a water loadout station.

6.1 Stripping Tower

Volatiles and dissolved gasses can be problematic in other treatment activities as well as oil and gas use. The treatment goal of the stripping tower is to minimize these harmful constituents in effluent water. The stripping tower would be 7-feet in diameter and of packed tower design. The water would enter the tower pressurized to be misted through nozzles at the top of the vessel. The water would then be deposited on packing material to allow maximum contact with the ambient air. Treated water would collect at the bottom of the stripper before continuing on to further treatment. Air would be pulled from the bottom of the stripper, through the packed media bed, and out the top of the stripper. At this time, expected air would simply be off-gassed to the ambient atmosphere. Further air treatment could be incorporated as necessary. Periodic cleansing of the stripping tower would be necessary to maintain an efficient level of treatment. Cleansing water would be deposited in the evaporation ponds onsite. After moving through the stripping tower, water would continue on to filtration.

6.2 Greensand Filters

Filtration of the water is an essential pre-treatment step for further treatment and minimization of solids. Water is expected to be free of readily settle-able solid material but fine solids may still persist. Greensand filtration is known to reduce suspended solids and other metal constituents. Iron and manganese can create other treatment issues as well as corrosion in oil and gas use. Greensand filtration is expected to significantly reduce iron and manganese in the water. Four (4) greensand filters with 8-feet diameters, requiring periodic backwashing, are proposed to treat the water. The system will be designed to operate with one (1) filter out of service for backwashing at a time. Backwash flow will be directed to the evaporation ponds for final disposal. After filtration, the water will be sent to the reverse osmosis (RO) units.

6.3 Reverse Osmosis

High chlorides and dissolved solids are expected in the feedwater. These constituents present corrosion and material degradation issues when used in oil and gas work. The control of these constituents to acceptable levels will be required. RO can significantly reduce dissolved solids by utilizing spiral wound membranes and pressure. Pre-treatment with anti-scalant is required to maintain proper pressure on the membranes. The membranes will be cleaned with a clean, in-place system periodically. Expected recovery on the RO system is 60%. The concentrated water will be deposited in the onsite evaporation ponds. Post-treatment from the RO will be a biocide to reduce any biological growth in post-treatment storage tanks.

BS&W wastes will be separated after discharged in the jet out pit. Solids will settle over time and liquids will be removed and processed. Solids will be transferred to the stabilization and solidification area before ultimately being landfilled.

Drilling mud will be deposited in the stabilization and solidification area and combined with dry soil as needed to accelerate the solidification process. As all other waste in the stabilization and solidification area, the waste must pass the paint filter test before transported to be landfilled.

7.0 INSPECTION AND MAINTENANCE

C.K. Facility staff will conduct inspections of onsite facilities in accordance with Table K.4. If repairs are needed, they will be conducted as soon as is safe to proceed with repairs.

Table K.4 - FACILITY INSPECTIONS

Component	Frequency	Recording Form
Evaporation Spray System Weather Station Plume Height Overspray	Daily	Facility Inspection Form
Landfill Disposal Operations and Location Free Liquids Stormwater Controls Litter, Vectors, Odors Daily Cover	Daily	Facility Inspection Form
Overall Facility Operation Signs Security (fencing/gates) Stormwater Control Systems (run-on/run-off) Access Roads OCD Permit Compliance Construction Activity	Weekly	Facility Inspection Form
Treatment Plant, Tanks, and Sumps Containment Berm Tank Condition Tank Leak Test (annual) Signage Pipe and Valve Condition Sump Condition	Weekly	Facility Inspection Form
Tank Farm and Pump System (Process Area) Containment and Liner Tank Condition Tank Leak Test (annual) Signage Pipe and Valve Condition Sump Condition	Weekly	Facility Inspection Form

Table K.4 - FACILITY INSPECTIONS

Component	Frequency	Recording Form
Pit and Pond Operation Depth of Liquids in Sumps Pond Levees Piping Condition and Status	Weekly	Pond Integrity/Leak Detection Inspection Form
Solid Waste Disposal Landfill Leachate Collection Sump	Monthly	Facility Inspection Form
Pond Containment System Rainfall Wind Speed/Direction Damage Assessment	Quarterly	Pond Integrity/Leak Detection Inspection Form
Landfill and Process Area Vadose Zone Monitoring	Quarterly	Facility Inspection Form

7.1 Evaporative Spray System

Evaporative spray system consists of three (3) mechanical evaporators per evaporation pond. The mechanical evaporators will be inspected daily for plume height and overspray based on the weather station. Facility staff will continuously monitor each evaporator to ensure proper function and prevent overspray from landing outside of the pond area. Evaporators will be adjusted according to current conditions.

7.2 Landfill

Landfill area will be inspected daily by facility staff. Location and size of workface will be inspected by equipment operators and managers of landfill activities to ensure proper size. Staff will inspect for free liquids, storm water, litter, vectors, odors, and daily cover. Any deficiencies will be repaired in a safe and timely manner.

7.3 General Facility Operation

The facility will be inspected weekly including but is not limited to all liquid processing areas, sumps, and landfill. Inspection documentation will be kept in the scalehouse and made available to the OCD upon request.

7.4 Liquid Processing Area

Each week, delivery area, tanks, leak detection, and sumps will be inspected. All piping will be inspected to ensure proper liquid flow. Boiler will be inspected by trained personnel familiar with boiler operation. If issues are found that may endanger workers or the overall system, the liquid processing area shall be shut down until repairs are made. Tanks will be inspected for defects which may present safety hazards or environmental issues. If defects are found, the liquid processing area will be shut down until necessary repairs are made. Leak detection will be inspected weekly to ensure proper functions. If the sump integrity fails, all sump contents and contaminated soils will be landfilled and necessary repairs made before operations can resume.

7.5 Pond Operations

Sump and leak detection systems will be inspected weekly. Liquids will be removed from the primary liner and leak detection system. As needed, the ponds will be cleaned and repaired to ensure proper functionality. If excessive leakage (ie 1.5-feet of water) is found in the leak detection system, the corresponding pond will be drained and the ODC will be notified within 24-hours. Prior to the pond being operational, the following corrective action shall be taken:

- Locate area(s) of leakage.
- Repair liner.
- Monitor sump liquid level on OCD-approved interval.
- Test liquids.

All areas of the site will be inspected after large rainfall event or at least monthly to address any erosion concerns.

APPENDIX A

H_2S MANAGEMENT PLAN

1.0 INTRODUCTION

Hydrogen Sulfide (H_2S) is a colorless, flammable, and hazardous gas that emits a rotten egg smell. H_2S is heavier than air and can collect in lower and enclosed areas. The following sections describe measures to take at the facility securing safety for customers, visitors, workers, general public, and nearby landowners. Training of the personnel will ensue each year for all new and existing employees or if changes have been made to the plan. New employees shall have H_2S training sessions before they can begin working for the facility.

The facility will have designated local emergency contacts as shown in Table K.A.1. A meeting will be scheduled with the local agencies to discuss notification, emergency response procedures and evacuation plans. The H_2S monitoring program will be implemented during the active life of the facility.

Table K.A.1 - EMERGENCY CONTACTS

Agency/Organization	Emergency Number
1. Fire	
Eunice Fire Department	911 or (575) 394-3258
2. Police	
Eunice County Police Department	911 or (575) 394-2112
Lea County Sheriff Department	911 or (575) 396-3611
New Mexico State Police	911 or (575) 392-5580
3. Medical/Ambulance	
Eunice Fire Department	911 or (575) 394-3258
Lea Regional Medical Center 5419 N. Lovington Highway Hobbs, NM 88240	(575) 492-5000
4. Response Firm	
Phoenix Environmental, LLC. 2113 French Drive Hobbs, NM 88240	(575) 391-9685
5. OCD Emergency Response Contacts	
Oil Conservation Division - District 1 1625 N. French Drive Hobbs, NM 88240	(575) 393-6161 (office) (575) 370-3186 (mobile)
Oil Conservation Division - Main Office 1220 South St. Francis Drive Santa Fe, NM 87505	(505) 476-3440
6. State Emergency Response Contacts	
Environmental Emergency (24 hr) (NMED)	(505) 827-9329
New Mexico Environment Department Solid Waste Bureau, Santa Fe	(505) 827-0197
7. Local Emergency Response Contacts	
Lea County Emergency Management	(575) 391-2983
8. Federal Emergency Response Contacts	
National Emergency Response Center (U.S. Coast Guard)	(800) 424-8800
Region VI Emergency Response Hotline (USEPA)	(214) 665-2200

In accordance with NMAC 19.15.36.8.C.8, the prevention and contingency plan will comply with the provisions of NMAC 9.15.11 that apply to surface waste management facilities.

Table K.A.2 - API RECOMMENDED PRACTICE 55

IMMEDIATE ACTION PLAN

Each contingency plan should contain a condensed Immediate Action Plan followed by designated personnel any time they receive notice of a potentially hazardous hydrogen sulfide or sulfur dioxide discharge. For personnel protection (including the general public) and abatement of the discharge, the Immediate Action Plan should include but not be limited to the following provisions:

a. Alert and account for facility personnel.

1. Move away from hydrogen sulfide or sulfur dioxide source and leave affected area.
2. Equip personnel with proper breathing equipment.
3. Alert other affected personnel.
4. Assist personnel in distress.
5. Proceed to designated emergency assembly area.
6. Account for onsite personnel.

b. Take immediate measure to control present or potential hydrogen sulfide or sulfur dioxide discharge and eliminate possible ignition sources. Emergency shutdown procedures should be initiated as necessary to correct or control specific situations. When required action cannot be accomplished in time to prevent exposing operating personnel or public to hazardous concentration of hydrogen sulfide or sulfur dioxide, proceed to the following steps as appropriate for the site specific conditions.

1. Alert the public (directly or through appropriate government agencies) subjected to an atmosphere exposure exceeding 30-ppm^{21} or 10-ppm^{21} of sulfur dioxide.
2. Initiate evacuation operations.
3. Contact the first available designated supervisor on the call list. Notify supervisor of circumstances and whether immediate assistance is needed. The supervisor should notify other supervisors and other appropriate personnel (including public officials) on call list.
4. Make recommendations to public officials regarding blocking unauthorized access to the unsafe area and assist as needed.
5. Make recommendations to public officials regarding evacuating the public and assist.
6. Notify, as required, state and local officials and the National Response Center to comply with release reporting requirements (i.e., 40 *Code* of *Federal Regulations Parts 302* and *355*).
7. Monitor the ambient air in the area of exposure (after following abatement measures) to determine when safe for re-entry.

Emergency Response Planning Guide Level 2 (ERPG-2), refer to Reference 27. ERPG-2 is defined as the maximum airborne concentration below believed that nearly all individuals could be exposed for up to 1-hr without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual’s ability to take protective action.

Note: This sequence should be altered to fit the prevailing situation. Certain actions, especially those dealing with the public, should be coordinated with public officials.

1.1 Emergency Coordinators

In accordance with NMAC 19.15.36.13.N.3, the facility will have a specialist with the responsibility and authority to take responsive measures when an emergency threatens freshwater, public health, safety, or environment.

Table K.A.3 - LIST OF EMERGENCY COORDINATORS

Primary Emergency Coordinator			
Name:	TBD	Work Phone:	(575) TBD
Title:	Facility Manager	Mobile Phone:	(575) TBD
Alternate Emergency Coordinator			
Name:	TBD	Work Phone:	(575) TBD
Title:	Facility Operator	Mobile Phone:	(575) TBD
On-site Emergency Coordinator			
Name:	TBD	Work Phone:	(575) TBD
Title:	Facility Operator	Mobile Phone:	(575) TBD

These emergency contacts will be able to respond 24-hours/day, 7-days/week and the authority required for the implementation of this plan. A facility employee will attempt to contact all emergency contacts until contact is made. The first emergency contact to arrive onsite will assume responsibility for initiating response measures. The higher-ranking emergency contact will assume responsibility if more than one contact responds.

1.2 Monitoring

All oilfield waste loads will be monitored for H_2S upon arriving at the site. OCD Form 138 will be obtained and monitoring results be recorded. The form will be kept in the operating records. Employees will be equipped with monitors in case H_2S gas may be present. These monitors will sound off and light up when H_2S is detected at 10-ppm. If H_2S gas is detected at this concentration, the driver and generator of the waste will be notified and given the option to allow facility employees to treat the onsite load by adding calcium hypochlorite in accordance with Table K.A.4. Calcium hypochlorite will be mixed with the load and continually tested until the H_2S reading is below 1-part/million. After the testing of the load verifies the load is below 1-part/million H_2S, the load will be directed to the correct receiving area. If treatment by facility staff is not allowed, the load will not be accepted and the hauler will leave the facility.

Table K.A.4 - H_2S TREATMENT FOR VEHICLES

H_2S PPM	**$Ca(ClO)_2$ (34.5-ounces x number below)**
<50	1
50-100	1.5
100-150	2
150-200	2.5
200-250	3
250-300	3.5
300-350	4
350-400	4.5
400-450	5
450-500	5.5
500-550	6
550-600	6.5
600-650	7
650-700	7.5
700-750	8
750-800	8.5
800-850	9
850-900	9.5
900-950	10
950-1000	10.5

1.3 Evaporation Pond Monitoring

H_2S monitors will be placed around evaporative ponds in accordance with Attachment B - Engineered Design Plans. These monitors will continuously monitor H_2S levels and wired to communicate with scalehouse personnel. Wind direction, speed, and H_2S concentrations will be recorded two (2) times a day and recorded on the Daily Air and Water Inspection Form. If monitors detect H_2S above 10-ppm, personnel will take a secondary reading downwind of the berm within one (1) hour if the sample can be taken in a safe manner. As soon as is safe, a dissolved oxygen and dissolved sulfides concentration test will be tested of the pond. H_2S readings will be taken at the property boundary downwind of the evaporation pond. If a second consecutive reading is taken over 10 parts per million, the OCD office in Hobbs shall be notified immediately. Monitoring will ensue hourly for the next 24-hours. Pond level will be lowered to achieve better circulation in the pond. If H_2S is detected at more than 20 parts per million at the downwind property boundary, the facility will be evacuated. New Mexico state police, Lea County Sherriff, Lea County Emergency Management, and the ODC will be notified. If mitigation of H_2S is needed, Phoenix Environmental will be contacted to provide response personnel, equipment and supplies. Logs of incidences will be maintained for at least five (5) years at the scalehouse or other secure location and made available to the OCD per request.

1.4 Dissolved Oxygen and pH Monitoring

Daily tests will be taken for pH and dissolved oxygen in all evaporation ponds. Dissolved oxygen and pH play key roles in the treatment and removal of H_2S during the aeration process provided by the mechanical evaporators. Optimum levels for the pH range from 8.2-9.0 and sodium hydroxide will be added as needed to ponds to ensure pH levels remain within the optimum range. As needed, the aeration will be increased to introduce more dissolved oxygen into the evaporation ponds. The optimum level of dissolved oxygen is above 0.5 parts per million.

1.5 H_2S Management Plan Coordination

Organizations listed in this plan will be provided a copy and will familiarize themselves with the plan. They are responsible for identifying the types of emergencies and responses that needed. All organizations are invited to visit the facility and assess the site operations, locations of processing areas, and provide insight on emergency response procedures.

APPENDIX B

CONTINGENCY PLAN

1.0 INTRODUCTION

In accordance with NMAC 19.15.36.13.N, the following sections provide a contingency plan. The plan is designed to minimize hazards to fresh water, public health, safety, or the environment from fires, explosions, or an unplanned sudden or non-sudden release of contaminants or oilfield waste to air, soil, surface water, or ground water. The operator shall carry out plan provisions immediately whenever there is a fire, explosion, or release of contaminants or oilfield waste constituents that could threaten fresh water, public health, safety, or the environment; provided the emergency coordinator may deviate from the plan as necessary in an emergency situation. Emergency coordinators are provided in Table K.B.1 and will act as the contingency plan emergency coordinators. If no emergency contact can be reached, the employee who identified the situation shall follow the necessary steps until an emergency contact is available. Emergency contact may amend the plan during an emergency, as necessary, to protect fresh water, public health, safety, or the environment. Table K.B.2 lists the response agencies and contacts.

Table K.B.1 - LIST OF FACILITY EMERGENCY COORDINATORS

Primary Emergency Coordinator			
Name:	TBD	Work Phone:	(575) TBD
Title:	Facility Manager	Mobile Phone:	(575) TBD
Alternate Emergency Coordinator			
Name:	TBD	Work Phone:	(575) TBD
Title:	Facility Operator	Mobile Phone:	(575) TBD
Onsite Emergency Coordinator			
Name:	TBD	Work Phone:	(575) TBD
Title:	Facility Operator	Mobile Phone:	(575) TBD

Table K.B.2 - EMERGENCY RESPONSE AGENCIES AND CONTACTS

Agency/Organization	**Emergency Number**
1. **Fire**	
Eunice Fire Department	911 or (575) 394-3258
2. **Police**	
Lea County Sheriff Department	911 or (575) 396-8200
New Mexico State Police	911 or (505) 827-3394
3. **Medical/Ambulance**	
Lea County EMS	911
Lea Regional Medical Center	(575) 492-5000
5419 N. Lovington Highway	
Hobbs, NM 88240	
4. **Response Firm**	
Phoenix Environmental, LLC.	(575) 391-9685
2113 N French Drive	
Hobbs, NM 88240	
5. **OCD Emergency Response Contacts**	
Hobbs Oil Conservation Division	(575) 393-6161
1625 N. French Drive	(575) 371-3186 (mobile)
Hobbs, NM 88240	
Santa Fe Oil Conservation Division	(505) 476-3440
1220 South St. Francis Drive	
Santa Fe, NM 87505	
6. **State Emergency Response Contacts**	
Environmental Emergencies (24 hr) (NMED)	(505) 827-9329
New Mexico Environment Department	(505) 827-0197
Solid Waste Bureau, Santa Fe	
7. **Local Emergency Response Contacts**	
Lea County Emergency Management	(575) 391-2983
8. **Federal Emergency Response Contacts**	
National Emergency Response Center	
(U.S. Coast Guard)	(800) 424-8802
Region VI Emergency Response Hotline	
(USEPA)	(214) 665-2200

1.1 Emergency Response Team Coordination

Eunice Police Department, Eunice Fire Department, hospitals, contractor, and local response teams will be given copies of the contingency plan. It is encouraged that the listed organizations familiarize themselves with the contingency plan and make a site visit to become familiar with daily operations as well as provide input regarding the contingency plan.

1.2 Fire Prevention and Preparedness

Employees will be trained before working at the facility and annually thereafter to take preventative measures to avoid fires. This includes regular inspections of incoming waste and vehicles onto the site. Table K.B.3 includes a list of emergency equipment at the surface waste management facility, such as fire-extinguishing systems, spill control equipment, communications and alarm systems, and decontamination equipment, containing a physical description of each item on the list and a brief outline of its capabilities.

Table K.B.3 - EMERGENCY RESPONSE EQUIPMENT LIST[1]

Equipment Description	Quantity	Location	Use(s)
10-lb ABC rated fire extinguisher	2	Gatehouse/Scalehouse[2]	Firefighting
10-lb ABC rated fire extinguisher	2	Trucks	Firefighting
10-lb ABC rated fire extinguisher	1	Heavy equipment	Firefighting
20-lb ABC rated fire extinguisher	1	Oil process tanks	Firefighting
20-lb ABC rated fire extinguisher	1	Oil sales tanks	Firefighting
20-lb ABC rated fire extinguisher	1	Produced water receiving tanks	Firefighting
20-lb ABC rated fire extinguisher	1	Diesel storage tank	Firefighting
Loader	1	Facility	Berm repair
Oil Booms	4	NE corner of pond	Oil containment
Self-contained breathing apparatus	1 per employee	Gatehouse/Scalehouse[2]	Protective gear for employees
Pair leather gloves	1 per employee	Assigned to employee	Protective gear for employees
Nomex coveralls	7 per employee	Assigned to employee	Protective gear for employees
Pair safety glasses	1 per employee	All employee workstations	Protective gear for employees
Round-point wood handle shovels	2	Gatehouse/Scalehouse[2]	Contain spillage, putting out fires
First aid kit	1	Gatehouse/Scalehouse[2]	First aid
First aid kit	1 per vehicle	Facility vehicles	First aid
Eye wash station	1	Produced water receiving tanks	First aid
Portable 2-way radio	1 per employee	Basic unit at the gatehouse/scalehouse[2]	Communications
Cell phones	min. 3	Facility manager Facility operator Facility operator	Communications
Office phone	2	Gatehouse/Scalehouse[2]	Communications
Mobile pressure washer	1	Mobile	Decontaminating equipment

1.3 Implementation

In the event of a fire, explosion, or release of contaminants or oilfield waste constituents, Table K.B.4 shall be followed to assess the emergency. Table K.B.5 shall be followed for notification of the release or fire.

Table K.B.4 - IMPLEMENTATION, ASSESSMENT, AND NOTIFICATION PROCEDURES FOR RELEASES
(BREAKS, LEAKS, SPILLS, RELEASES, FIRES, OR BLOWOUTS)

1. **Notify the EC:** The employee who first becomes aware of the emergency will immediately notify the Primary EC, Alternate EC, and Onsite EC, if necessary. Notification will be made in person, or via telephone, or radio. The responding EC will assume full authority over the situation.
2. **Assess source, amount, and extent of release:** The EC will assess the source, amount and extent of spill or release, or released material resulting from a fire or explosion and determine possible hazards to fresh water, public health, safety, or the environment.
3. **Contain and prevent spread of release:** The EC assessment of the emergency situation will be the basis for attempting to control the release or implementing an evacuation, as well as notifying appropriate state and local authorities if needed.
4. **Notification of emergency authorities:** If deemed safe by the EC, the appropriate C.K. Facility response equipment and personnel will be dispatched to the scene of the release. Personnel will initiate actions within their scope of training to contain the release and prevent the spread and/or windblown dispersion of the release. Depending on the type of release, appropriate equipment may include deployment of absorbents for spills, fire extinguishers, and/or earthmoving equipment.
5. **Notification of emergency authorities:** If the EC assessment indicates a need to notify appropriate state and local emergency authorities, notification will be initiated immediately. OCD will be notified as necessary.
6. **Divert traffic and restrict persons from area:** C.K. Facility personnel not actively involved in release control operations will be restricted from the area until the area is determined safe by the EC and, if appropriate, the on-scene senior emergency authority (i.e., fire, police, hazard, or other official). Vehicular traffic will be diverted away from release response activities until situation is abated.

Table K.B.5 - PART 29: RELEASE NOTIFICATION

19.15.29.7 DEFINITIONS:

A. "Major release" means:

- **(1)** An unauthorized release of a volume, excluding gases, in excess of 25-barrels;
- **(2)** An unauthorized release of a volume that:
    - **(a)** Results in a fire;
    - **(b)** Will reach a watercourse;
    - **(c)** May with reasonable probability endanger public health; or
    - **(d)** Results in substantial damage to property or the environment;
- **(3)** An unauthorized release of gases in excess of 500-MCF; or
- **(4)** Release of a volume that may with reasonable probability be detrimental to water or exceed the standards in Subsections A and B or C of NMAC 19.15.30.9.

B. "Minor release" means an unauthorized release of a volume, greater than 5-barrels but not more than 25-barrels; or greater than 50-MCF but less than 500-MCF of gases.

19.15.29.8	**RELEASE NOTIFICATION:**
A.	The emergency contact shall notify the division of unauthorized release occurring during the drilling, producing, storing, disposing, injecting, transporting, servicing or processing of oil, gases, produced water, condensate or oil field waste including regulated NORM, or other oilfield related chemicals, contaminants or mixture of the chemicals or contaminants, in accordance with the requirements of NMAC 19.15.29.
B.	The emergency contact shall notify the division in accordance with NMAC 19.15.29 with respect to a release from a facility of oil or other water contaminant, in such quantity as may with reasonable probability be detrimental to water or exceed the standards in Subsections A and B, or C of NMAC 19.15.30.9.
19.15.29.9	**REPORTING REQUIREMENTS:** The emergency contact shall provide notification of releases in NMAC 19.15.29.8 as follows:
A.	The person shall report a major release by giving both immediate verbal notice and timely written notice pursuant to Subsections A and B of NMAC 19.15.29.10.
B.	The person shall report a minor release by giving timely written notice pursuant to Subsection B.
19.15.29.10	**CONTENTS OF NOTIFICATION:**
A.	The emergency contact shall provide immediate verbal notification within 24-hrs of discovery to the division district office for the area within which the release takes place. In addition, the person shall provide immediate verbal notification of a release of a volume that may with reasonable probability be detrimental to water or exceed the standards in Subsections A and B or C of 19.15.30.9 NMAC to the division's environmental bureau chief. The notification shall provide the information required on form C-141.
B.	The emergency contact shall provide timely written notification within 15-days to the division district office for the area within which the release occurs by completing and filing form C-141. In addition, the person shall provide timely written notification of a release of a volume that may with reasonable probability be detrimental to water or exceed the standards in Subsections A and B or C of 19.15.30.9 NMAC to the division's environmental bureau chief within 15-days after the release is discovered. The written notification shall verify the prior verbal notification and provide appropriate additions or corrections to the information contained in the prior verbal notification.
19.15.29.11	**CORRECTIVE ACTION:** The emergency contact shall complete division-approved corrective action for releases that endanger public health or the environment. The responsible person shall address releases in accordance with a remediation plan submitted to and approved by the division or with an abatement plan submitted in accordance with 19.15.30 NMAC.

1.4 Evacuation Plan

A generalized fire or threat of fire/explosion or a spill or leak cannot be avoided due to the type of waste accepted at the facility. The following evacuation plan shall be followed for emergencies when site condition constitutes an evacuation of the site:

1. All facility personnel will be contacted by facility radios, cellular devices, or the facility telephone.
2. Any incoming waste loads and vehicles will be diverted away from the area where the emergency is occurring.

3. Incoming waste loads and vehicles will be routed toward facility exits in accordance with Figure A.13.
4. All site personnel will be directed to the liquids processing scalehouse or the landfill scalehouse where the emergency contact will do a headcount to identify any missing persons.
5. Once all personnel are accounted for and assembled, they will assist the emergency contact as needed or evacuate the site upon directions from the emergency contact.

1.5 Notification of Authorities

The emergency coordinator will immediately notify onsite personnel by use of onsite communication systems when there is imminent or an actual emergency situation. The following list of contacts will also be contacted by the emergency contact immediately when there is imminent or an actual emergency situation:

<u>OCD</u>

• Hobbs office	(575) 393-6161
• Mobile phone	(575) 370-3180
• Santa Fe office	(575) 476-3440
• New Mexico State Police	911 or (575) 392-5580
• Lea County Sherriff Department	911 or (575) 396-3611
• Lea County Emergency Management	911 or (575) 391-2983

1.6 Control Procedures

The emergency contact will focus initial efforts on the safety and protection of the facility personnel and the persons using the facility. Control procedures shall only be implemented by the emergency contact once an assessment of situation and the possible hazards to fresh water, public health, safety, or the environment has been completed. No facility personnel or persons utilizing the site shall attempt to contain or control fires, explosions, spills, or leaks beyond their corresponding scope of safety, training, and available equipment.

1.7 Fire Control

Fire control shall not be implemented by facility staff until untrained personnel and customers are a safe distance from the fire. Table K.B.6 shows the control guidelines to be utilized.

Table K.B.6 - FIRE/EXPLOSION: CONTROL GUIDELINES

1. Initiate fire control: The EC and C.K. Facility personnel will initiate response actions within the scope of their training to control the spread of the fire.

2. P.A.S.S. Method: Fires will generally be controlled with ABC-type fire extinguishers using the P.A.S.S. method (Pull pin, Aim nozzle, Squeeze trigger, Sweep from side to side to extinguish).

3. Smother Method: Fires may also be smothered with cover materials (i.e., soil, caliche) when possible to extinguish.

4. Available water sources: Fires may be doused or hosed with available equipment, water truck, etc.

5. Evacuate and notify emergency authorities: If at any time the scope of the fire is beyond the capabilities of C.K. Facility personnel to contain and/or extinguish, the EC will contact the local Fire Department or the Lea County Emergency Management (**Table K.B.2**) for assistance. Personnel and visitors will be instructed to evacuate the area.

6. Monitor situation: The EC will monitor for leaks, pressure buildup, gas generation, or rupture in valves, pipes, or equipment as appropriate (NMAC 19.15.36.13.N(11)).

7. Recordkeeping/reporting: The EC will complete an Incident Report Form (**Appendix C**) and maintain a copy in the Facility Operating Record, readily accessible for OCD inspection.

The EC will meet with personnel and response agencies to assess the cause of the emergency as needed and document the incident. The identified causative agent shall be removed from the facility if re-ignition may occur. Personnel involved with the handling, transportation, and placement of materials will be informed of resultant actions. If needed, the EC will update this contingency plan to mitigate further issues.

1.8 Spills/Release Control

Site personnel will be trained to inspect incoming loads to intercept potential unauthorized wastes or loads of concern. Containment, control, and characterization of the release will be conducted by the EC after all untrained personnel and persons utilizing the site are at a safe distance. Immediately after the emergency situation, the EC will characterize the release to properly contain and control. The EC will then make necessary plans for the separation, storage, if needed, or disposal of wastes, water, or contaminated materials. An incident report will be completed to document the details of the emergency and the resulting action. Table K.B.7 lists the spill/release control guidelines to follow.

Table K.B.7 - SPILL/RELEASE: CONTROL GUIDELINES

1. Initiate control: The EC and C.K. Facility personnel will initiate response actions within the scope of their training to control the spill/release.
2. Removal or segregation: Determine if the material can be safely removed to a designated waste inspection/segregation area for further evaluation. If the materials cannot be safely relocated, contain them for investigation and sampling using the spill control list. If necessary, shut down operations until safe conditions are restored.
3. Contain release: Attempt to contain the release to the smallest area possible. Examples of equipment available for spill containment are non-reactive sorbent materials, oil booms, sand, shovels and heavy equipment. A third-party contractor is also available for emergency response to augment efforts by on-site personnel.
4. Sampling: After isolating the contaminants and contaminated media, inspect them to determine if sampling is appropriate. If appropriate, isolate contaminants in the waste inspection or segregation area, or in designated leak-proof containers, until characterization is complete.
5. Cleanup: After the release has been contained and necessary samples have been obtained, cleanup will be initiated by removing the spilled materials, sorbent materials, soils used for containment, etc.
6. Equipment monitoring: Liners and equipment in use, including valves and pipes, will be monitored for leaks, pressure buildup, gas generation or rupture as appropriate (NMAC 19.15.36.13.N(11)).
7. Verification sampling: Dependent on the type of material spilled, the EC will assess requirements for cleanup verification including the collection of samples for appropriate analytical testing.
8. Disposal or processing: When visual and/or laboratory characterization is complete, determine appropriate processing or disposal procedures for that waste type. Send residuals for disposal to a facility that is approved for managing that type of waste.
9. Evacuate and notify emergency authorities: If at any time the scope of the spill/release is beyond the capabilities of the on-site personnel to contain and/or extinguish it, the EC will contact the local Fire Department or Lea County Emergency Management (**Table K.B.2**) for assistance. Personnel and visitors will be instructed to evacuate the area.
10. Recordkeeping/reporting: The EC will complete an Incident Report Form (**Appendix C**) and maintain a copy in the Facility Operating Record, readily accessible for OCD inspection.

1.9 Equipment Maintenance

All equipment used for the emergency response will be inspected, decontaminated, cleaned, and made ready to use or replaced if necessary immediately following the incident. The EC will verify that equipment has been maintained after the emergency response and will be fit for reuse for the next emergency incident.

1.10 Storage and Treatment of Released Material

Spilled or contaminated material approved to be disposed of at the C.K. Facility may be disposed of following standard operating practices. Hazardous material(s) not approved for disposal at the site will be containerized and stored with the applicable local, state, and federal regulations. Phoenix Environmental may be called upon for 3rd party services as well. No oilfield waste, which may be compatible with the release material shall be treated, stored, or disposed of until all cleanup procedures are complete.

1.11 Plan Amendment

Amendments to the contingency plan will be made within five (5) working days in the event of the facility permit being revised or modified, the plan fails in the event of an emergency, the surface waste management facility changes design, construction, operation, maintenance, or other circumstances in a way that increases the potential for fires, explosions, or releases of oilfield waste constituents that could threaten fresh water, public health, safety, or the environment or change the response necessary in an emergency, the list of emergency coordinators, or their contact information changes, or the list of emergency equipment changes.

APPENDIX C

OCD FORMS

Lea County
C.K. Diposal E&P
Landfill and Processing Facility
Daily Air and Waer Inspection form

DATE:

Morning Ambient Air H_2S

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Sampler and Time							
H_2S Reading (ppm)							
Wind Speed (mph)							
Wind Direction							

Afternoon Ambient Air H_2S

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Sampler and Time							
H_2S Reading (ppm)							
Wind Speed (mph)							
Wind Direction							

Sump Levels

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Morning Sampler and Time							
Morning Pond Level (ft)							
Morning Loading Area							
Morning Cement Slab							
Morning Pump House Sump							
Afternoon Sampler and Time							
Afternoon Loading Area							
Afternoon Pump House							
Wind Direction							

Loading Sump Emptied

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Initials and Time							

Concrete Slab Emptied

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Initials and Time							

Pond Conditions

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Pond Level							
Overflow Color							
Pond Color							
Water Tempurature							
pH							
Dissolved Oxygen							
Total chlorine							
Dissolved H_2S/Sulfides							

Chemicals Added

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Chemical							
Time							
Personnel							
Chemical							
Time							
Personnel							

Manager Signature

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Manager							

C.K. FACILITY
LEACHATE MONITORING FORM

Leachate Level Data				Pumping Data			Notes
Date	Sump I.D.	Time	Monitored By	Date	Company	Volume Pumped (gal)	

C.K. FACILITY
Pond Integrity/Leak Detection Inspection Form

Date: ______________________________ **Inspector(s):** ___________________________________

Time: ______________________________ ___________________________________

Weather:

Temperature ___________________ deg. F Precipitation (last 24 hours) _________________ inches

Skies ______________________________

Wind Speed _____________________mph

Wind Direction ______________________

NOTES:

"D" indicated that a Deficiency has been noted. "P" indicated that a Photograph has been taken. "S" indicated that a Sample has been collected. Complete descriptions of Deficiencies, Photographs, and Samples are provided on attached pages. Items are referenced by Location.

Pond Condition

Location	Item			
	Erosion	Vegetation Establishment	Vectors	Sample

Leak Detection System

Riser #	Deficiency	
	Depth of H_2O	Structural Defect

Extra information or details: ____

____

____

____

____

C.K. FACILITY
INCIDENT REPORT FORM

Type of Incident and General Information

[ ]	Work Related injury/Illness	[ ]	Unsafe Act/Near Miss
[ ]	Property Damage	[ ]	Vandalism/Criminal Activity
[ ]	Vehicular Accident	[ ]	Other ___________________________ (i.e. spill, release, fire, explosion, hot load, etc.)

Employee Name: ______________________________ Job Title: ______________________________

Phone No.: __________________________ Date of Incident: _______Time of Incident: _____ AM/PM

Location of Incident: ______________________________ Weather: __________________________

Date and Time Reported to Management: Date: _______________ Time: _______________AM/PM

Reported to: _______________________ Title: __________ Reported by: ______________________

What was the injury category of incident at the time it was first reported to management?

[ ] N/A/ Employee does not claim an injury associated with this incident.

[ ] Notice Only of Injury, Declined Medical Treatment at this time.

[ ] First Aid done on site, Declined Medical Treatment at this time.

[ ] Medical Treatment. Transported by ______________________ to ______________________.

[ ] Fatality, Employee

(Section below to be filled out by EMPLOYEE)

Employee's Description of Incident

Were you injured? [ ] **yes** [ ] **no**

Type of Injury: ____

Part of Body: ____

In your own words, explain the incident: ____

____

____

____

____

____

Employee Signature: ____

Date: ____

APPENDIX D

EVAPORATION CALCULATIONS

HOBBS LEA CO AP, NEW MEXICO

Period of Record General Climate Summary - Precipitation

Station:(294028) HOBBS FAA AIRPORT														
From Year=1941 To Year=2012														
	Precipitation											Total Snowfall		
	Mean	High	Year	Low	Year	1 Day Max.		>= 0.01 in.	>= 0.10 in.	>= 0.50 in.	>= 1.00 in.	Mean	High	Year
	in.	in.	-	in.	-	in.	dd/yyyy or yyyymmdd	# Days	# Days	# Days	# Days	in.	in.	-
January	0.36	2.09	1949	0.00	1953	0.68	04/1958	3	1	0	0	1.4	9.0	1958
February	0.31	1.02	1958	0.00	1942	0.68	21/1958	3	1	0	0	2.5	21.2	1956
March	0.29	1.41	1958	0.00	1954	0.52	20/1949	2	1	0	0	1.3	13.0	1958
April	0.83	2.26	1942	0.00	2011	1.40	12/1950	4	2	1	0	0.1	0.8	1949
May	1.76	5.02	1954	0.00	2011	1.72	17/1951	6	3	1	0	0.0	0.0	1942
June	0.74	3.19	1950	0.00	2011	1.68	20/1950	3	1	1	0	0.0	0.0	1948
July	1.47	3.49	1948	0.00	1954	1.98	22/1948	5	3	1	0	0.0	0.0	1948
August	1.61	4.08	1954	0.14	2011	2.28	18/1957	6	3	1	1	0.0	0.0	1948
September	2.27	5.84	1949	0.05	1951	2.13	09/1949	4	3	2	1	0.0	0.0	1941
October	1.70	3.81	1941	0.00	1952	1.73	04/1941	5	3	1	0	0.0	0.0	1941
November	0.18	1.07	1952	0.00	1948	0.68	04/1952	2	1	0	0	0.6	7.0	1957
December	0.19	0.89	2011	0.00	1950	0.72	24/2011	1	1	0	0	0.8	8.3	2011
Annual	11.72	18.66	1949	5.06	1956	2.28	19570818	43	22	8	3	6.7	21.2	1956
Winter	0.86	2.50	1949	0.02	2011	0.72	20111224	7	2	0	0	4.7	21.2	1956
Spring	2.89	6.32	1954	0.00	2011	1.72	19510517	11	6	2	1	1.4	13.0	1958
Summer	3.82	9.19	1950	0.36	2011	2.28	19570818	14	7	2	1	0.0	0.0	1948
Fall	4.15	6.25	1949	0.41	1951	2.13	19490909	11	7	3	1	0.6	7.0	1957

Table updated on Oct 31, 2012
For monthly and annual means, thresholds, and sums:
Months with 5 or more missing days are not considered
Years with 1 or more missing months are not considered
Seasons are climatological not calendar seasons

Winter = Dec., Jan., and Feb. Spring = Mar., Apr., and May
Summer = Jun., Jul., and Aug. Fall = Sep., Oct., and Nov.

Western Regional Climate Center, wrcc@dri.edu

Evaporation Stations

Standard daily pan evaporation is measured using the four-foot diameter Class A evaporation pan. The pan water level reading is adjusted when precipitation is measure to obtain the actual evaporation. Most Class A pans are installed above ground, allowing effects such as radiation on the side walls and heat exchnges with the pan material. These effects tend to increase the evaporation totals. The amounts can then be adjusted by multiplying the totals b 0.70 or 0.80 to more closely estimate the evaporation from naturally existing urfaces such as a shallow lake, wet soil or other moist natural surfaces.

Many stations do not measure pan evaportation during winter months. A "0.00" total indicates no measuement is taken.

Stations marked with an asterisk (*) have estimated totals computed from meteorological measurements using a form of the Penman equation.

Click on a State: Arizona, California, Colorado, Hawaii & Pacific Islands, Idaho, Montana, Nevada,
New Mexico, Oregon, Utah, Washington,
Wyoming

ALASKA

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
BROOKS RIVER	1967-1990	0.00	0.00	0.00	0.00	0.00	2.48	2.88	1.63	0.73	0.00	0.00	0.00	7.72
CENTRAL 2	1962-2005	0.00	0.00	0.00	0.00	0.00	3.97	4.00	2.43	2.19	0.00	0.00	0.00	12.59
COPPER CENTER	1961-1982	0.00	0.00	0.00	0.00	0.00	6.03	4.06	3.14	1.71	0.00	0.00	0.00	14.94
JUNEAU AP	1949-2005	0.00	0.00	0.00	0.00	3.33	3.29	3.82	3.14	1.02	0.00	0.00	0.00	14.60
MATANUSKA AES	1917-2005	0.00	0.00	0.00	0.00	4.22	4.44	3.92	3.05	1.83	0.00	0.00	0.00	17.46
MC GRATH WB AIRPORT	1939-2005	0.00	0.00	0.00	0.00	4.20	4.42	3.65	2.29	1.40	0.00	0.00	0.00	15.96
MCKINLEY PARK	1949-2005	0.00	0.00	0.00	0.00	0.00	2.96	2.55	1.75	0.53	0.00	0.00	0.00	7.79
OIL WELL ROAD E P	1967-1974	0.00	0.00	0.00	0.00	0.00	5.17	3.83	2.81	1.40	0.00	0.00	0.00	13.21
OLD EDGERTON	1970-1996	0.00	0.00	0.00	0.00	3.31	4.56	4.16	3.04	1.65	0.00	0.00	0.00	16.72
PALMER AAES	1949-2005	0.00	0.00	0.00	0.00	4.44	4.71	4.12	2.96	1.75	0.00	0.00	0.00	17.98
RAMPART 2	1963-1978	0.00	0.00	0.00	0.00	4.23	4.56	3.79	2.56	1.54	0.00	0.00	0.00	16.68
COLLEGE UNIV EXP STN	1931-2005	0.00	0.00	0.00	0.00	4.25	5.04	4.56	2.82	1.38	0.00	0.00	0.00	18.05

ARIZONA

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
BARTLETT DAM	1939-2005	3.92	4.92	7.10	10.02	13.77	16.21	15.56	13.95	12.10	9.66	5.86	4.47	117.54
BLACK RIVER PUMPS	1948-2005	0.00	0.00	0.00	6.93	8.83	10.12	7.99	7.02	5.70	3.94	0.00	0.00	50.53
DAVIS DAM # 2	1958-1977	7.49	7.46	9.75	12.78	16.71	19.48	19.87	17.91	14.64	12.03	8.40	7.80	154.32
DAVIS DAM	1948-1961	3.54	5.13	7.60	9.30	11.33	13.33	13.14	12.15	9.51	7.24	5.38	3.88	101.53
DOUGLAS	1948-2005	0.00	0.00	0.00	11.34	13.19	13.55	10.66	10.27	8.18	6.44	0.00	0.00	73.63
FORT VALLEY	1909-2005	0.00	0.00	0.00	0.00	5.86	7.37	6.03	4.91	3.35	0.00	0.00	0.00	27.52
GRAND CANYON NATL PARK	1957-1977	0.00	0.00	0.00	0.00	6.94	10.45	8.79	8.12	6.83	4.91	0.00	0.00	46.04
GRAND CANYON N P 2	1976-2005	0.00	0.00	0.00	0.00	7.46	9.80	8.94	7.29	6.10	4.45	0.00	0.00	44.04
HAWLEY LAKE	1967-1988	0.00	0.00	0.00	0.00	7.57	8.55	6.89	5.48	4.68	0.00	0.00	0.00	33.17
MANY FARMS SCHOOL	1951-1975	0.00	3.66	5.45	9.18	12.23	15.14	12.87	10.88	9.40	6.54	3.26	2.16	90.77
MC NARY 2 N	1933-2005	0.00	0.00	0.00	0.00	7.86	8.25	6.60	5.98	4.90	3.97	0.00	0.00	37.56
MESA	1896-2005	3.03	4.02	6.11	8.64	11.33	12.67	13.10	11.87	9.69	6.81	4.15	2.96	94.38
NOGALES 6 N	1952-2005	3.59	4.46	7.01	9.35	11.91	13.31	10.00	8.28	8.06	7.17	4.49	3.57	91.20
PAGE	1957-2005	0.00	2.60	5.84	8.27	10.72	12.86	13.06	11.38	8.42	5.13	2.29	0.00	80.57
ROOSEVELT 1 WNW	1905-2005	2.44	3.54	5.90	8.64	11.96	14.50	14.36	12.27	10.10	6.78	3.68	2.32	96.49
SACATON	1908-2005	3.83	5.15	7.51	10.06	13.56	14.89	13.69	12.05	10.20	7.91	4.94	3.63	107.42
SAFFORD AGRICULTRL CTR	1948-2005	2.63	3.83	7.14	10.54	13.81	15.38	13.13	10.68	8.73	5.90	3.28	2.52	97.57
SAN CARLOS RESERVOIR	1948-2005	2.25	3.27	5.66	8.40	11.70	13.94	13.43	11.40	9.23	6.31	3.53	2.18	91.30
SIERRA ANCHA	1913-1979	2.19	2.93	4.58	6.42	8.97	10.94	10.39	8.88	8.00	6.22	3.50	2.37	75.39
SNOWFLAKE 15 W	1965-1998	0.00	0.00	0.00	0.00	11.03	14.38	11.29	9.12	7.96	6.45	3.40	0.00	63.63
STEWART MOUNTAIN	1948-2005	3.52	4.56	6.94	10.04	13.11	14.27	14.44	13.10	10.69	7.95	4.53	3.08	106.23
TEMPE A S U	1953-2005	1.56	2.93	4.79	7.04	9.44	10.85	10.99	9.92	7.63	5.14	2.56	1.44	74.29
TUCSON UNIV OF ARIZONA	1894-2005	3.25	4.57	6.95	9.88	12.87	14.91	13.17	11.65	10.35	7.81	4.73	3.37	103.51
TUCSON U OF ARIZ # 1	1982-2005	3.94	4.68	7.53	10.57	14.14	16.51	14.61	12.17	10.71	8.05	4.93	3.23	111.07
WAHWEAP	1961-2005	1.95	2.77	6.30	9.42	12.82	14.94	15.26	13.31	10.06	7.06	3.69	2.60	100.18
WHITERIVER 1 SW	1900-2005	1.69	2.94	5.84	8.01	9.92	11.70	9.48	8.47	7.68	5.87	3.51	2.54	77.65
WINKELMAN 6 S	1942-1980	3.12	4.03	7.00	9.98	12.40	13.90	11.19	9.84	9.56	7.51	4.31	2.94	95.78
YUMA CITRUS STATION	1920-2005	3.58	4.36	6.81	9.17	11.75	13.19	13.85	12.28	9.51	6.91	4.43	3.37	99.21

CALIFORNIA

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ANTIOCH PUMP PLANT 3	1955-2005	1.17	1.99	4.25	6.27	8.96	10.84	11.60	10.06	7.77	4.91	2.07	1.22	71.11
AUBURN DAM PROJECT	1972-1984	1.42	1.89	3.13	4.89	7.73	10.08	11.66	10.70	8.08	5.00	1.97	1.36	67.91

TIBER DAM	1952-2005	0.00	0.00	0.00	0.00	4.51	6.46	7.65	5.56	4.34	0.00	0.00	0.00	28.52
VALIER	1911-2005	0.00	0.00	0.00	0.00	5.37	6.49	7.33	5.62	4.72	0.00	0.00	0.00	29.53
WESTERN AG RESEARCH CNT	1965-2005	0.00	0.00	0.00	0.00	5.08	6.03	7.26	6.07	4.14	2.25	0.00	0.00	30.83
YELLOWTAIL DAM	1948-2005	0.00	0.00	0.00	0.00	6.94	8.84	10.60	9.74	6.58	4.86	0.00	0.00	47.56

NEVADA

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
BEOWAWE U OF N RANCH	1972-2005	0.00	0.00	0.00	3.98	7.17	8.68	10.42	9.52	6.97	4.43	0.00	0.00	51.17
BOULDER CITY	1931-2004	3.71	4.68	7.56	10.67	13.79	16.57	16.45	14.41	11.51	8.11	4.87	3.69	116.02
CALIENTE	1928-2005	0.00	0.00	3.97	6.82	8.57	10.58	11.13	9.41	6.89	4.35	1.91	0.00	63.63
CENTRAL NEVADA FIELD LA	1965-1986	0.00	0.00	2.98	5.95	8.69	10.49	12.24	11.31	8.08	4.88	1.73	0.00	66.35
FALLON EXPERIMENT STN	1950-1992	1.34	2.23	4.39	6.15	7.70	8.91	9.87	8.63	6.10	3.90	1.91	1.37	62.50
LAHONTAN	1948-2005	0.00	0.00	0.00	7.18	9.64	11.58	13.75	12.23	7.83	4.51	2.09	0.00	68.81
LOGANDALE	1968-1992	2.55	3.61	5.26	8.96	12.44	14.20	14.38	12.07	8.67	7.66	3.86	2.89	96.55
RUBY LAKE	1948-2005	0.00	0.00	0.00	5.10	7.09	8.90	10.54	9.37	6.51	3.95	0.00	0.00	51.46
RYE PATCH DAM	1948-2005	0.00	0.00	3.71	5.83	7.38	9.23	11.15	10.06	6.95	4.30	0.77	0.00	59.38
SILVERPEAK	1967-2005	0.00	3.84	7.26	10.13	13.60	16.31	17.98	15.92	11.32	6.88	2.94	0.00	106.18
TOPAZ LAKE	1957-2005	0.00	0.00	0.00	7.15	9.11	10.94	12.68	11.56	8.80	5.95	2.79	0.00	68.98

NEW MEXICO

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ABIQUIU DAM	1957-2005	0.00	0.00	6.06	7.43	9.95	11.39	10.52	8.90	7.23	5.30	3.13	2.22	72.13
AGRICULTURAL COLLEGE	1892-1959	3.01	4.00	7.89	10.20	8.65	13.99	12.33	11.16	8.31	6.28	4.35	2.89	93.06
ALAMOGORDO DAM	1939-1975	3.73	4.35	8.21	11.30	12.88	14.43	13.66	11.59	9.17	7.19	4.89	3.46	104.86
ANIMAS	1923-2005	3.87	4.91	8.29	10.78	12.36	14.25	11.60	11.07	8.54	6.71	4.69	3.61	100.68
ARTESIA 6 S	1914-2005	4.38	3.03	7.25	7.66	12.11	13.13	10.86	10.44	9.36	6.34	3.12	0.00	87.68
BITTER LAKES WL REFUGE	1950-2005	2.67	3.93	6.82	9.60	11.31	12.62	11.88	10.16	8.02	5.85	3.53	2.50	88.89
BOSQUE DEL APACHE	1914-2005	3.21	4.20	7.76	10.20	11.61	13.13	11.56	10.36	8.03	6.25	3.66	2.54	92.51
BRANTLEY DAM	1987-2005	4.65	0.00	8.62	11.77	14.61	15.46	14.19	12.22	9.88	7.97	5.77	4.34	109.48
CABALLO DAM	1938-2005	4.42	5.10	8.56	11.37	13.59	14.80	13.08	11.35	9.26	7.27	4.78	3.48	107.06
CAPULIN NATL MONUMENT	1966-1979	0.00	0.00	0.00	0.00	9.08	10.57	9.71	9.18	7.65	0.00	0.00	0.00	46.19
CLOVIS 13 N	1929-2005	3.83	4.12	6.63	8.72	10.15	11.45	11.65	9.55	7.64	5.78	3.95	3.21	86.68
COCHITI DAM	1975-2005	0.00	4.14	6.44	8.48	11.07	12.95	12.38	10.62	8.91	6.29	3.94	2.79	88.01
CONCHAS DAM	1938-2005	0.00	0.00	7.35	8.88	10.29	11.69	11.37	10.06	8.24	6.18	4.04	2.79	80.89
EAGLE NEST	1937-2005	0.00	0.00	0.00	4.91	7.67	7.83	7.07	5.87	5.30	4.31	0.00	0.00	42.96
EL VADO DAM	1923-2005	0.00	0.00	3.61	5.43	7.46	8.84	8.52	6.91	5.66	3.84	1.72	0.00	51.99
ELEPHANT BUTTE DAM	1917-2005	3.47	4.87	8.61	12.22	14.94	16.37	14.15	12.05	9.78	7.70	4.91	3.34	112.41
ESTANCIA	1914-2005	0.00	0.00	3.26	6.79	8.56	9.27	8.61	7.10	5.60	3.82	2.62	0.00	55.63
FARMINGTON AG SCIENCE C	1978-2005	0.00	0.00	0.00	7.97	10.06	12.00	12.52	10.70	8.15	5.41	0.00	0.00	66.81
FLORIDA	1939-1992	3.54	4.81	8.10	10.94	13.03	14.80	11.84	10.10	8.51	6.58	4.57	3.11	99.93
GALLUP RANGER STN	1966-1975	0.00	0.00	0.00	6.61	9.31	12.12	10.50	8.70	7.95	5.07	2.20	0.00	62.46
JEMEZ DAM	1953-2005	0.00	0.00	0.00	9.91	12.27	13.95	14.29	11.45	9.80	6.72	3.65	0.00	82.04
JORNADA EXP RANGE	1925-2005	2.50	4.18	7.24	10.06	11.94	12.85	10.88	9.53	7.82	5.71	3.61	2.50	88.82
LAGUNA	1914-2005	0.00	0.00	0.00	8.47	9.33	11.98	10.76	8.88	6.83	5.00	1.98	0.00	63.23
LAKE AVALON	1914-1979	4.49	5.33	9.42	12.36	14.31	15.16	14.14	12.33	9.25	7.26	4.68	4.20	112.93
LAKE MC MILLAN	1941-1949	0.00	0.00	0.00	13.78	8.14	14.26	13.38	13.45	10.35	6.15	0.00	0.00	79.51
LOS LUNAS 3 SSW	1923-2005	1.87	2.81	5.27	7.77	9.74	10.49	10.06	8.67	6.58	4.64	2.75	2.45	73.10
NARROWS	1948-1964	3.09	5.67	7.62	11.07	13.37	15.44	13.07	11.42	9.97	7.20	4.32	2.64	104.88
NAVAJO DAM	1963-2005	0.00	0.00	0.00	6.58	9.10	11.07	11.24	9.66	7.22	4.74	0.00	0.00	59.61
PORTALES 7 WNW	1934-1960	3.26	4.57	8.24	8.85	10.72	12.16	10.44	9.28	7.95	5.98	4.15	3.53	89.13
HOOD RANGER STN	1954-2005	0.00	0.00	0.00	7.84	9.02	10.81	8.25	6.87	6.12	5.14	2.65	0.00	56.70
ROSWELL WSO AIRPORT	1893-1972	0.00	0.00	0.00	11.29	0.00	15.87	12.11	12.63	7.92	6.97	4.66	4.51	75.96
SANTA FE	1867-1972	0.00	0.00	3.00	7.28	8.73	10.93	9.95	8.26	7.15	5.10	2.50	0.00	62.90
SANTA FE 2	1972-2005	0.00	0.00	0.00	7.10	9.76	11.31	10.36	9.20	7.41	5.08	0.00	0.00	60.22
SHIPROCK	1926-2005	0.00	0.00	0.00	7.84	10.57	14.44	13.17	10.80	9.80	6.54	0.00	0.00	73.16
SOCORRO	1914-2005	0.00	0.00	4.83	7.09	9.17	9.35	8.56	7.57	5.73	4.14	0.00	0.00	56.44
STATE UNIVERSITY	1959-2005	3.00	4.33	7.40	9.90	12.03	12.91	12.05	10.34	8.14	6.17	3.85	2.79	92.91
SUMNER LAKE	1921-2005	0.00	0.00	7.33	10.22	12.35	13.54	13.36	11.16	9.02	6.97	4.92	3.17	92.04
TUCUMCARI 4 NE	1904-2005	0.00	0.00	0.00	9.83	11.53	13.11	13.00	11.13	8.96	6.74	0.00	0.00	74.30
UTE DAM	1965-2005	4.38	4.91	7.53	8.78	10.75	10.49	10.92	9.42	7.56	6.68	4.98	3.04	89.44

OREGON

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ASTOR EXPERIMENT STN	1948-1973	0.56	0.96	1.47	2.21	3.75	3.95	4.65	4.10	2.95	1.65	0.87	0.70	27.82
BEND 7 NE	1991-2005	0.00	0.00	0.00	4.25	6.14	6.69	8.66	7.91	5.42	0.00	0.00	0.00	39.07
CORVALLIS STATE UNIV	1889-2005	0.00	0.00	1.79	2.96	4.59	5.86	7.70	7.07	5.06	2.33	0.96	0.00	38.32
COTTAGE GROVE DAM	1943-2005	0.00	1.27	2.16	3.07	4.56	5.60	7.75	6.70	4.47	2.06	0.82	0.00	38.46
DETROIT DAM	1954-2005	0.19	1.16	1.69	2.51	4.38	5.90	7.68	6.64	4.24	2.05	0.88	0.46	37.78
DORENA DAM	1948-2005	0.00	1.01	1.94	2.95	4.98	6.11	8.19	7.15	4.66	2.01	0.00	0.00	39.00
FERN RIDGE DAM	1943-2005	0.39	0.79	1.92	3.17	5.03	6.21	8.12	7.09	4.76	2.21	0.67	0.34	40.70

Evaporator Water Balance

C.K. Disposal E&P Landfill and Processing Facility

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Rainfall (in.)	0.36	0.31	0.29	0.83	1.76	0.74	1.47	1.61	2.27	1.70	0.18	0.19	**11.71**
Pan Evaporation (in.)	4.49	5.33	9.42	12.36	14.31	15.16	14.14	12.33	9.25	7.26	4.68	4.20	**112.93**
Actual Evaporation (in.)	3.14	3.73	6.59	8.65	10.02	10.61	9.90	8.63	6.48	5.08	3.28	2.94	**79.05**
Net (in.)	-2.78	-3.42	-6.30	-7.82	-8.26	-9.87	-8.43	-7.02	-4.21	-4.10	-3.10	-2.75	**-67.34**
Net Evaporation (bbl/pond)	4,620	5,679	10,465	12,985	13,707	16,388	13,990	11,655	6,980	5,614	5,139	4,565	**111,786**

Notes:

1. *Rainfall obtained from Hobbs FAA Airport and is average monthly rainfall from 1941-2012.*
2. *The input is the maximum monthly produced water than can be introduced to evaporation ponds based on water balance.*
3. *Evaporation rates obtained from Lake Avalon, New Mexico 1914-1979.*
4. *Actual evaporation rates represent 70% of reported pan evaporation rate.*
5. *Pond surface area 1.88 acres.*
6. *Based on the Hobbs Wind Rose, the wind speed in this area is below 14 mph 63% of the time.*
7. *The net evaporation is* ***306.26 bbl/pond per day*** *based off the total for the year of 111,786 bbl/pond.*

Mechanical Evaporation Analysis

Mechanical Evaporation Rate (GPM)	**1-ME**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**12**	**18**	**24**
10	343	**686**	1029	1371	1714	2057	2400	2743	3086	4114	6171	8229
20	686	1371	2057	2743	3429	4114	4800	5486	6171	8229	12343	16457
30	1029	2057	3086	4114	5143	6171	7200	8229	9257	12343	18514	24686
40	1371	2743	4114	5486	6857	8229	9600	10971	12343	16457	24686	32914
50	1714	3429	5143	6857	8571	10286	12000	13714	15429	20571	30857	41143
60	2057	4114	6171	8229	10286	12343	14400	16457	18514	24686	37029	49371

Notes:

1. *Evaporation Rate per Mechanical Evaporator (ME) expressed in bbls per day*
2. *Wind speed <14 MPH 63% of the time.*
3. *US Barrel=42 Gallons*

Minimum Anticipated Mechanical Evaporation Potential

Evaporation by month	January	February	March	April	May	June	July	August	September	October	November	December	Annual BBL	BBL/Day
2-ME@10GPM	21257	19200	21257	20571	21257	20571	21257	21257	20571	21257	20571	21257	250286	**686**
3-ME@10GPM	31886	28800	31886	30857	31886	30857	31886	31886	30857	31886	30857	31886	375429	1029
6-ME@10GPM	63771	57600	63771	61714	63771	61714	63771	63771	61714	63771	61714	63771	750857	2057
9-ME@10GPM	95657	86400	95657	92571	95657	92571	95657	95657	92571	95657	92571	95657	1126286	3086
12-ME@10GPM	127543	115200	127543	123429	127543	123429	127543	127543	123429	127543	123429	127543	1501714	4114
18-ME@10GPM	191314	172800	191314	185143	191314	185143	191314	191314	185143	191314	185143	191314	2252571	6171
24-ME@10GPM	255086	230400	255086	246857	255086	246857	255086	255086	246857	255086	246857	255086	3003429	8229

Permit Application

Lea County, New Mexico

C.K. Disposal E & P Landfill and Processing Facility

Permit No. TBD

Attachment L

Closure Plan/Post-Closure Plan

NMAC 19.15.36.8.C(9) and 19.15.36.18

November 2015

PSC Project # 01058015

PARKHILLSMITH&COOPER

ATTACHMENT L - CLOSURE PLAN AND POST-CLOSURE PLAN

1.0 FINAL CLOSURE ACTIVITIES – NMAC 19.15.36.8.C.(9) and 19.15.36.18

In accordance with NMAC 19.15.36.8.C(9) and 19.15.36.18, a copy of the Closure Plan will be placed in the site operating record. The Closure and Post-Closure Plan will include procedures to take for sequential closure of cells following final acceptance of waste. The oilfield waste processing and disposal infrastructure is anticipated to be developed and operated over time. An outline is provided of the projected phase development; however, the order in which these improvements are constructed may change. The Plan may be modified. Changes must be submitted and approved thirty (30) days prior to the implementation of the change. This plan may also be amended at the request of the OCD per NMAC 19.15.36.18.a(5). The operator shall notify the divisional environmental bureau at least sixty (60) days prior to cessation of operations at the surface waste management facility and provide a proposed schedule for closure. If the division does not provide comments or changes, the C.K. Facility will proceed with closure activities.

1.1 Closure Procedures

A. Processing Area

i. Treatment Plant

After removal of all liquids and solids from the system, the treatment plant will be dismantled. Piping will be removed, cleaned, and recycled for reuse, if possible. If piping is not recoverable, it will be disposed of at an OCD-approved waste facility. After the removal and disposal of all treatment plant equipment, the site will be inspected for contamination. If contamination is present in soil, the soil will be excavated and disposed of at OCD-approved waste facilities. When this is completed, testing for contamination will occur until soil meets requirements listed in NMAC 19.15.36.

ii. Jet Wash Facility

The above-grade installations are to be removed or recycled (if possible), or disposed. The liner and gravel will be dried, removed, and disposed of onsite. The tanks will be cleaned for re-use or disposed of. If the waste capacity has been reached at the C.K. Facility, materials will be disposed of at an OCD-approved waste management facility.

iii. Liquids Removal

Any remaining liquid (including oil and water) in the tanks will be transferred to the evaporation ponds or disposed of at an OCD-approved facility. A mechanical evaporation system will be used in the aid of evaporation for produced water taken to the ponds. To expedite solidification, soils may be introduced by C.K. Facility. Once liquids have completed the solidification process, the solidified material will be transferred to the landfill or to an OCD-approved waste facility.

iv. Evaporation Pond Liner Removal

The C.K. Facility staff will remove all liquids and sludge from the evaporation ponds. Once solidified and passed the paint filter test, the solids will be disposed of at an OCD-approved waste facility.

The evaporation pond liner system will be dried and cleaned per NMAC 19.15.35. After cleaning, the evaporation pond liner system will be removed and disposed of at an OCD-approved facility. If geomembrane liner component of the liner is still in good condition, it may be recycled and reused.

The leak detection pipe will be removed and disposed of at an OCD-approved waste facility.

v. Tank Removal

Liquids will be disposed of in evaporation ponds and sludge will be transferred to the solidification area. Tanks will either be reused, recycled, or disposed of at an OCD-approved waste facility within ninety (90) days of the C.K. Facility closure.

vi. Site Sampling

The site will be sampled in accordance with Chapter 9 of United States Environmental Protection Agency (EPA) publication SW-846 - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, once processing area tanks, equipment, and liners are removed. Sampling must occur before completing any earthwork to ensure accurate test results. Soil samples will be taken along the 150-foot sampling grid provided in Figure A.15. The soil samples will be taken at a depth of 1-foot and another sample at depths ranging between 36 to 42-inches below existing grade. Samples will be evaluated for:

- BTEX.
- TPH.
- Metals and organics listed in Water Quality Control Commission (WQCC) 20.6.2.3103. A&B.

Sample results will be submitted to OCD. Closure activities will not commence until samples indicate no contamination onsite. If contamination above allowable levels is found in the samples taken 36- to 42-inches below ground, staff will excavate to the sampled depth and proceed with sampling procedures.

vii. Final Site Closure – Processing Area

At site sampling completion and indication of no contamination onsite, the C.K. Facility can proceed with closure activities. The evaporation ponds and stabilization and solidification area will be filled with existing berm material and onsite soil, to match top of pond elevations. Once determined no contamination is present at the C.K. Facility at allowable levels, the processing area will be re-graded to the intended final use. Activities conducted during this period include:

- Site grading and re-contouring;
- Site revegetation Submittal of Notice of Intent (NOI) to the EPA for a Construction General Permit;
- CGP and Stormwater Pollution Prevention Plan (SWPPP) implementation; and
- Evaporation and sedimentation pond berm removal and backfilling.

Site seeding will occur per techniques listed in the Final Closure Quality Control Plan (FCQCP). The FCQCP provides soil preparation, seed mix, and seeding techniques. The facility must acquire a minimum of 70% of the natural site coverage.

B. Solid Waste Disposal Area

The final cover system will be a combination of two (2) performance-based liner systems. One (1) design is for the cap and the other for the side slopes. The cap design will follow the design outlined in the NMAC but will replace the drainage layer with a geocomposite liner. The design for the cap is as follows (bottom to top):

- 12-inch foundation layer;
- 60-mil HDPE GML;
- Geocomposite liner;
- 24-inch infiltration layer; and
- 12-inch soil erosion layer.

The side slope design will be a performance-based water balance cover. With the assistance of 4:1 slopes, the majority of water will run off the side slopes and infiltrate cap. The design of the final side slope final cover is as follows (bottom to top):

- 12-inch foundation layer;
- 24-inch infiltration layer; and
- 12-inch soil erosion layer.

Final cover will be installed within one (1) year of achieving the final waste elevations. The overall final grading contours can be found in Attachment B, on sheet C-102. Site seeding will occur per techniques listed in the FCQCP. The FCQCP provides soil preparation, seed mix, and seeding techniques. The facility must acquire a minimum of 70% of the natural site coverage.

C. Building and Structure Removal

All structures onsite will be removed, reused, or disposed of at either a New Mexico Environmental Department municipal solid waste facility or if contaminated, an OCD-approved waste facility.

1.2 POST-CLOSURE PLAN

The post-closure care maintenance will begin upon the completion of final closure requirements set forth in the Closure Plan. Post-closure care will continue for thirty (30) years unless the division approves decreased time. Post-closure care maintenance will consist, at a minimum, of the following requirements:

- Conduct maintenance and/or remediation activities, as needed, to maintain the integrity and effectiveness of the final cover, site vegetation, and drainage control system. Activities may include regrading, placement of additional soil, seeding, and repair of erosion control features. (70% of vegetative natural cover must be achieved).
- Conduct quarterly site inspections.
- Correct any effects of settlement, subsidence, ponded water, erosion, and other events or failures that are detrimental to the integrity of the closed landfill. Corrective measures may include regrading, placement of additional soil, and seeding.
- Control surface run-on and run-off to minimize the erosion of the final cover system. Maintenance may include cleaning of channels and inspection after any storm larger than 24-hour, 25-year.
- Maintain and operate a leachate collection system. The site must demonstrate that leachate no longer poses a threat to fresh water, public health, safety, or the environment.
- Maintain and operate the vadose monitoring system and monitor the vadose zone per Attachment H.

A. Decreasing Post-Closure Care Period

The length of the post-closure care may be decreased by the division if the owner/operator of the C.K. Facility submits to the executive director for review and approval. Submittals must include a document certification, signed by an independent licensed professional engineer, and all applicable documentation necessary to support the certification. This documentation should demonstrate the reduced period is sufficient to protect fresh water, public health, safety, or the environment.

1.3 FINANCIAL ASSURANCE

A. Closure/Post Closure Cost Estimate

As required by NMAC 19.15.36.8.C(9), the cost estimate for closure and post-closure activities described above is presented in current dollars and assumes a third party will perform closure and post closure activities at the site. Preparation of the Cost Estimate also assumes no contamination or remedial activities are required due to releases into the environment. The current estimate for Phase I of C.K. Facility closure construction and post-closure operations is provided in Appendix A. The estimate will also be revised annually upon receiving waste. C.K. Disposal, LLC will choose a financial assurance mechanism according to NMAC 19.15.36.11.E and provide proper documentation to the OCD based on estimates provided.

B. Release of Financial Assurance

Upon completion of the closure activities for the entire site and approval of the division, the owner/operator will request release of the closure portion of the financial assurance. After the post-closure care period, three (3) years for ponds/pits and thirty (30) years for landfill, and the establishment of vegetation onsite, the owner will request the release of the remainder of the financial assurance.

APPENDIX A

COST ESTIMATES

Lea County
C.K. Diposal E&P
Landfill and Processing
Facility

Closure Cost Estimate (assume 23.6 Acres to be closed) **11/6/2015**

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL COST
Landfill Closure				
Engineering				
Topographic Survey	HR	75	$ 115.00	$ 8,700.00
Site Evaluation and Plans	LS	1	$ 30,000.00	$ 30,000.00
Construction Observation	LS	1	$ 56,500.00	$ 56,500.00
Subtotal Engineering Cost				$ 95,200.00
Contingency (10%)	SY	12,000	$ 35.00	$ 9,520.00
Total Engineering	LF	6,900	$ 85.00	$ 104,720.00
Construction				
Cap				
Geomembrane Liner	SF	202,990	$ 0.51	$ 103,600.00
Geocomposite Drainage Layer	SF	202,990	$ 0.55	$ 111,700.00
Infiltration Layer (244inch)	CY	15,036	$ 2.00	$ 30,100.00
Soil Erosion Layer (124inch)	CY	7,518	$ 2.00	$ 15,100.00
Articulated Block Channel	SF	28,000	$ 7.00	$ 196,000.00
Side Slopes				
Infiltration Layer (244inch)	CY	61,307	$ 2.00	$ 122,700.00
Soil Erosion Layer (124inch)	CY	30,653	$ 2.00	$ 61,400.00
Subtotal Construction				$ 640,600.00
Contingency (10% of Subtotal)				$ 64,060.00
Total Construction				$ 704,660.00
Evaporation Pond				
Liquids Transport/Disposal				
Transport Liquid	BBL	286	$1.75	$500
Disposal Liquids	BBL	286	$0.95	$271
Remove/Transport Sludge	TON	4444	$6.50	$28,889
Disposal Sludge	TON	4444	$15.00	$66,667
Liner Removal/Transport	CY	2966	$4.00	$11,862
Disposal Liner	CY	2966	$4.25	$12,603
Pond Backfill and Contouring				
Soil On4site	CY	0	$1.00	$0.00
Place and Compact Soil	CY	11,853	$3.00	$35,557.87
Subtotal Ponds				$156,350.44
Sampling	EACH	360	$200.00	$72,000.00
Seeding acres	AC	22	$1,200.00	$26,412.00
Subtotal				$98,412.00
Site Work				
Tank Removal	LS	1	$25,000	$25,000
Building Removal	LS	1	$25,000	$25,000
Process Equipment Removal	LS	1	$25,000	$25,000
Earthwork	LS	1	$10,000	$10,000
Site Work Subtotal:				$85,000
Total Closure Cost				**$1,149,142**

Lea County
C.K. Diposal E&P
Landfill and Processing
Facility

Post Closure Cost Estimate (Based on 126 Acres Landfill area and a total of 312 Acres for the Entire Site)

11/6/2015

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL COST
Engineering Costs				
Site Inspection and Record Keeping	40	HR	$75	$3,000
Vadose Monitoring/Lab and Report (11 monitoring wells semi4annually)	2	EA	$4,500	$9,000
Subtotal Engineering Costs				$12,000
Construction and Maintenance Costs				
Cap and Sideslope Repairs and Revegetation	40	HR	$75	$3,000
Mowing (final cover twice per year)(1)	126	AC	$50	$6,300
Vadose Monitoring System Maintenance	1	LS	$1,000	$1,000
Perimeter Fence and Gates Maintenance	1	LS	$1,000	$1,000
Access and Rights of Way Maintenance	40	HR	$75	$3,000
Drainage System Cleanout /Repairs	40	HR	$75	$3,000
Subtotal Construction and Maintenance Costs				$17,300
Leachate Management				
Inspection	1	LS	$1,000	$1,000
Leachate Disposal	4	EA	$1,000	$4,000
Subtotal Leachate Management Cost				$5,000
Subtotal Post4Closure Costs				$34,300
Contingency (10% of Subtotal)				$3,430
Third Party Administration & Project Management Costs (3% of Subtotal)				$1,029
Annual Post4Closure Costs				$38,759
30-Year Post Closure Costs				**$1,162,770**

Note: Year 2015 dollars

(1) Based on final cap area of 126-acres at $25 per acre per mow

Permit Application

Lea County, New Mexico
C.K. Disposal E & P Landfill and Processing Facility
Permit No. TBD

Attachment M
Engineering Design Calculations

ROBERT H. HOLDER
NEW MEXICO
20239
PROFESSIONAL ENGINEER

05/12/2016

May 2016 REVISION 2
PSC Project # 01058015

PSC PARKHILLSMITH&COOPER

ATTACHMENT M – ENGINEERING DESIGN CALCULATIONS

APPENDICES

TABLES

1.0 LANDFILL VOLUMETRIC CALCULATIONS

Landfill volumetric calculations were computed based on Attachment B – Engineered Design Plans. Landfill volumetric calculations include waste capacity analysis and the soil material balance. The C.K. Disposal facility has a gross airspace of approximately 24,585,056-cubic yards (yd^3). Assuming a contingency of 15% for variation in waste density and other operational uses, resulting in approximately 20,897,298-cubic yards of waste capacity remaining. A cut/fill analysis was computed for the site which shows a 7,717,488-cubic yard volume of cut. Table 1.1 shows the soil needed onsite for operations (see attached calculations):

Table 1.1 – Soil Necessary for Operations

Soil Type	Cubic Yards
Protective Soil	472,707
Final Cover	928,451
Perimeter Berm	5,124
Daily and Intermediate Cover	4,179,460
TOTAL	5,585,742
Volume of Cut	7,717,4881
Soil Remaining	27.6%

Therefore, the site will have ample soil for use as protective cover, final cover, daily cover, intermediate cover, and waste perimeter berm.

2.0 PIPE STRENGTH CALCULATIONS

Pipe Strength Calculations confirm that solid or perforated pipe made from Schedule 80 polyvinyl chloride (PVC) or high-density polyethylene (HDPE) standard dimension ratio (SDR 11) solid piping will withstand structural loading and other stresses at the C.K. Disposal facility. The basic design approach consists of calculating the leachate collection pipe deflection (which cannot exceed the allowable value), with a minimum factor of safety against failure of 1.0.

Table 2.1 - 6-Inch Diameter Leachate Collection Pipes

Attributes	Schedule 80 PVC	HDPE
Dimension Ratio	16	11.0
Method of Joining	Gasketed	Welded
Outside Diameter (in)	6.625	6.625
Minimum Wall Thickness (in)	0.432	0.602
Nominal Weight/ft (lb/ft)	5.313	4.970
Modulus of Elasticity (psi)	400,000(1)	35,000(2)

(1) Reference 2

(2) Reference 4

2.1 Pipe Strength Calculations for 6-inch Schedule 80 PVC Perforated Pipe

To confirm 6-inch Schedule 80 PVC Perforated Collection Piping can withstand maximum stresses from overlying soil loading, pipes were analyzed for protection against ring deflection, wall buckling, and equipment loading. The following PVC pipe dimensions were used (from Reference 2):

Pipe Nominal Diameter:	6-inch
Pipe Outside Diameter (OD):	6.625-inch
Pipe Wall Thickness (t):	0.432-inch
Pipe Inner Diameter (ID):	5.76-inch
Perforation Hole (/FT):	12 perforation holes
Perforated Hole Diameter (IN):	0.5-in

2.2 Loads Acting on the PVC Leachate Collection Pipe

To calculate total vertical load on pipes (P_T), pressure from each overlying layer was calculated and summed. Each layer includes:

- 3-foot thick final cover
- 1-foot thick intermediate cover
- Fifteen, 10-foot thick layers of waste for 150 feet of total waste thickness
- 2-feet of protective soil layer
- A 1-foot thick leachate collection layer

Based on the known thickness of each layer and assigned unit weights, the pressure exerted by each layer was calculated. The results for P_T are presented in Table 2.2.

Table 2.2 – Pipe Loading Calculation

Layer	Thickness (ft)	Unit Weight (pcf)	Actual Load (psf)
Firm Cover Soil	3	110	330
Intermediate Cover Soils	1	110	110
Waste	150	74	11,100
Protective Soil Layer	2	110	220
Drainage Rock above Pipe	1	130	130
Total Actual Load (P_T)			11,890 psf
			(82.6 psi)

2.3 PVC Correction of Load on Pipe with Perforations

Perforating pipes reduce the effective pipe length available to carry loads and resist deflection. The effect of perforations can be taken into account by using an increased load per nominal unit length of pipe. The increased vertical stress to be used equals:

Static Vertical Load per Unit Length of Pipe (W_c):

$W_c = (P_T)(D_O)/(1-((n)(d)/12))$ (Reference 1)

Where:

P_T = Total Actual Load (psi)

D_O = Outside Diameter of the Pipe (in)

n = Number of Perforated Holes per Foot of Pipe

d = Diameter of Perforated Hole on the Pipe (in)

W_c = [(82.6 psi)(6.625)]/[1-((12)(0.5 in)/12)]

W_c = 1,094.45 lbs/in = 13,133.4 lbs/ft

2.4 PVC Deflection

The standard formula used for solid waste industry applications in calculating flexible pipe deflection under earth loading is developed by Sprangler. This equation, also known as the Modified Iowa formula, is presented together with suggested values for the various constants in Reference 1, and is as follows:

$$\Delta X = \frac{(D_L)(K)(W_c)(r^3)}{(E)(I)+0.061(E')(r^3)}$$ (Reference 1)

Where:

ΔX = horizontal and vertical deflection of the pipe (in)

D_L = conservative value of 1.5, compensating for the lag or time dependent behavior of the soil/pipe systems (dimensionless). (Reference 1)

W_c = vertical load acting on the piper per unit of pipe length (1,094.45 lbs/in).

r = mean radius of the pipe (OD – t) = ((6.625 in – 0.432 in)/2) = 3.1 in

E = modulus of elasticity of the pipe materials (400,000 psi) (Reference 2)

E' = modulus of passive soil resistance in crushed rock (3,000 psi) (Reference 2)

K = bedding constant, reflecting the support the pipe receives from the bottom of the trench (assumes bedding angle = 180°; therefore K = 0.083) (Reference 2)

[Continued on the next page]

[Continued from previous page]

I = moment of inertia of pipe wall per unit of length (in^4/in); for any round pipe

$I = t^3/12$ where t is the average thickness (in) = $((0.432)^3/12) = 0.0067\ in^4/in$

$$\Delta X = \frac{(1.5)(0.083)(1094.45)(3.1^3)}{(400{,}000)(0.0067)+0.061(3{,}000)(3.1^3)}$$

$$\Delta X = \frac{(4{,}059.3\ lbs/in^2)}{(8{,}131.75\ lbs/in)}$$

$$\Delta X = 0.5\ in$$

The percent (%) Ring Deflection (RD) is defined by the following equation:

$\%RD = [\Delta X/(D_i+t)]x100$

Where:

D_i = Internal Pipe Diameter

t = Pipe Wall Thickness

$\%RD = [0.5/(5.76+0.432)]x100$

$\%RD = 8.1\%$

Recognizable reversal of curvature is found in buried PVC pipe at a deflection of 30% (Reference 2); this deflection is a conservative performance limit. The deflection of 8.1% has a factor of safety of 30%/8.1%=3.7.

2.5 PVC Wall Buckling

Wall buckling may govern design of flexible pipes under conditions of loose soil burial, if external load exceeds the pipe material compressive strength. For a circular ring subjected to a uniform external pressure, the critical buckling pressure (P_{cr}) is defined as:

$P_{cr} = 2 \text{ x } \{[(E')/(1-v^2)][(E)(I)/r^3]\}^{0.5}$ (Reference 1)

Where:

P_{cr} = critical buckling pressure, psi

E' = modulus of soil reaction = 3,000 psi

E = modulus of elasticity of pipe = 400,000 psi

v = Poisson's Ratio = 0.38 for PVC pipe (Reference 2)

I = moment of inertia of the pipe wall per unit length = $t^3/12 = 0.0067 \text{ in}^4/\text{in}$

t = pipe wall thickness = 0.432 in

r = mean radius of pipe = 3.1 in

$P_{cr} = 2 \text{ x } \{[(3{,}000 \text{ psi})/(1-(0.38^2)][(400{,}000)(0.0067)/29.79]\}^{0.5}$

$P_{cr} = 2 \text{ x } \{[3{,}506.3][89.96]\}^{0.5}$

P_{cr} = 1,123.3 psi

<u>The factor of safety is then determined</u>:

FS = P_{cr} / Actual Total Load

FS = 1,123.3 psi / 82.6 psi

FS = 13.6

2.6 PVC Equipment Loading

Worst-case conditions would include equipment operating over the leachate collection pipe after 2-feet of protective soil layer has been placed. A loaded CAT 627 Scraper was used conservatively as the piece of equipment operating on top of the leachate collection pipe. The CAT 627 Scraper has the following specifications:

- Tractor Weight = 48,061 lbs
- Scraper Weight = 33,399 lbs
- Soil Load (20 cy) = 48,000 lbs
- Total Weight = 129,460 lbs
- Maximum Weight per Tire = 32,365 lbs (assuming equal distribution)
- D = Tire Width = Approximately 18 inches = 1.5 foot
- M = Tire Contact Length = Approximately 4 inches = 0.33 foot
- Tire Contact Area = (18 inches)(4 inches) = 72 inches^2 = 0.50 foot^2

Superimposed loads distributed over an area during equipment operations are determined from the following equation:

$W_{SD} = (C_s)(p)(F)(B_c)$

Where:

W_{SD} = load on pipe (lbs/ft)

p = intensity of distributed load (lbs/ft^2)

F = impact factor = 1.2, Table 4C.4 (Reference 3)

B_c = outside diameter of pipe (ft) = 6.625 inches = 0.55 foot

C_s = load coefficient = 0.053

C_s is from Table 4C.3 (Reference 3)

The table uses D/2H and M/2H to find the corresponding C_s value.

- D/2H = 1.5 ft / 2(3 ft) = 0.25
- M/2H = 0.33 ft / 2(3 ft) = 0.055

Therefore:

$W_{SD} = (0.053)[(32{,}365 \text{ lbs})/(1.5 \text{ ft})(0.33 \text{ ft})](1.2)(0.55)$

$W_{SD} = 2{,}287 \text{ lbs/ft} = 190 \text{ lbs/in}$

The superimposed load due to equipment loading is less than static loading conditions (W_c) calculated as 1,094.45 lbs/in; therefore the static loading conditions govern.

2.7 Perforated PVC Pipe Loading Summary

The critical design criteria of ring deflection and wall buckling for PVC pipe were evaluated and results are summarize in Table 2.3.

Table 2.3 – PVC Pipe Results

Design Criteria	Critical Value	Actual Value	Factor of Safety
Ring Deflection	30%	8.1%	3.7
Wall Buckling	1,123.26 psi	82.6 psi	13.6

As shown, for each limiting design criterion, the factor of safety is greater than design criteria, thus the performance standard for the selected pipe is adequate.

2.8 6-inch SDR 11.0 HDPE Pipe

To determine the capability of 6-inch HDPE SDR 11.0 perforated collection pipes to withstand maximum stresses from the overlying soil profile, the pipes were analyzed for adequate protection against ring deflection and wall buckling using Reference 4.

Wall buckling occurs if the total external soil pressure exceeds the pipe-soil system's critical buckling pressure, and excessive ring deflection occurs if the vertical strain in the surrounding soil envelope is greater than the allowable ring deflection of the pipe. Standard dimension ratio (SDR) is the ratio of the outside pipe diameter to the pipe wall thickness SDR = OD/t. The dimensions are:

• Pipe Nominal Diameter:	6 inches
• Pipe Outside Diameter (OD):	6.625 inches
• Pipe Wall Thickness (t):	0.602 inch
• Pipe Inner Diameter (ID):	5.35 inches
• SDR:	11.0
• Perforation Hole (/FT):	12 perforation holes
• Perforated Hole Diameter (IN):	0.5 inch

The total actual load is the pressure from each overlying layer of soil and waste:

- 3-foot thick final cover
- 1-foot thick intermediate cover
- Fifteen, 10-foot thick layers of waste for 150 feet of total waste
- 2-feet of protective soil layer
- 1-foot thick leachate collection layer

Based on the known thickness of each layer and assigned unit weights, the pressure that will be exerted by each layer was calculated. The total actual load is the same load applied to the PVC pipe (82.6 psi).

2.9 Correction of Load on Pipe with Perforations (HDPE SDR 11.0)

Perforating pipes reduce the effective length of pipe available to carry loads and resist deflection. The effect of perforations can be taken into account by using an increased load per nominal unit length of the pipe. The increased vertical load per unit length of pipe is calculated as follows:

Static vertical load per unit length of pipe (W_c):

$W_c = (P_T)(D_O)/(1-((n)(d)/12))$ (Reference 1)

Where:

P_T = total actual load (psi)

D_O = outside diameter of the pipe (in)

n = number of perforated holes per foot of pipe = 12

d = diameter of perforated hole on the pipe (in) = 0.5 in

$W_c = [(82.6 \text{ psi})(6.625)]/[1-((12)(0.5 \text{ in})/12)]$

W_c = 1,094.45 lbs/in = 13,133.4 lbs/ft

The design value in psi is found by dividing the design load in lbs/in by the diameter of pipe.

P_D = 1,094.45/6 = 182.4 psi

2.10 HDPE Deflection

The ring deflection of the pipe can be calculated from the following Modified Iowa formula:

$$\Delta X = \frac{(D_L)(K)(W_c)(r^3)}{(E)(I)+0.061(E')(r^3)} \qquad \text{(Reference 1)}$$

Where:

ΔX = ring deflection (in)

D_L = conservative value of 1.5, compensating for the lag or time dependent behavior of the soil/pipe systems (dimensionless). (Reference 1)

K = bedding factor = 0.083 (Reference 2)

W_c = vertical load per unit of pipe length, lb/in (1,094.45 lbs/in).

r = mean radius of the pipe (OD – t) = ((6.625 in – 0.602 in)/2) = 3.0 in

[Continued on next page]

[Continued from previous page]

E = modulus of elasticity = 35,000 psi (Reference 4)

I = moment of inertia = $t^3/12$ (in^4/in) = $((0.602)^3/12)$ = 0.0182

E' = soil modulus = 3,000 psi (Reference 2)

$$\Delta X = \frac{(1.5)(0.083)(1{,}094.45)(3^3)}{(35{,}000)(0.0182)+(0.061)(3{,}000)(3^3)}$$

$$\Delta X = \frac{(3{,}678.99)}{(637.0)+(4{,}941)}$$

$$\Delta X = 0.66 \text{ in}$$

The ring deflection is then used to determine the ring bending strain using the equation:

$$\varepsilon = f_{D\,(}\Delta x/D_{M\,+}\,2C/D_{M)}$$

Where:

ε = wall strain

f_D = deformation shape factor = 6.0 (Reference 5)

Δx = deflection from previous calculation = 0.66in

D_M = mean diameter, in

C = distance from outer fiber to wall centroid, in

C = 0.5(1.06t), where t = wall thickness

C = 0.5 x 1.06 x 0.602 = 0.319 in

$$\varepsilon = 6.0\left(\frac{0.66}{6}\right)\left(\frac{2(0.319)}{6}\right) = 0.07 = 7.0\%$$

The wall strain of 7.0%is less than 8% (Reference 5), which has an acceptable factor of safety of 8%/7.0% = 1.14.

2.11 HDPE Wall Buckling

Wall buckling may govern design of flexible pipes under conditions of loose soil burial, if the external load exceeds the compressive strength of the pipe material. To determine a factor of safety for wall buckling, the pipe critical–collapse differential pressure P_c must be calculated using the following formula (Reference 4):

$P_c = 2.32(E)/SDR^3$ where E is the modulus of elasticity, approximately 35,000 psi

$P_c = (2.32)(35{,}000)/11.0^3 = 61.0$ psi

The critical-collapse pressure can then be used to determine the critical buckling pressure from the following relation (Reference 4):

$$\mathrm{P_{cb}} = 0.0.8\,\sqrt{(\mathrm{E}')(\mathrm{Pc})}$$

Where:

P_{cb} = critical buckling pressure

E' = long term degree of compaction of bedding = 3,000 psi

$$P_{cb} = 0.8\,\sqrt{(3{,}000)(61.00)} = 342.23\ psi$$

The factor of safety is then determined:

$FS = P_{cb} / P_D = 342.23/182.4 = 1.88$

2.12 HDPE Wall Crushing

To determine a factor of safety for wall crushing, the following equations were used (Reference 4):

$S_A = ((SDR-1)/2) \times P_D$

Where:

S_A = actual compressive stress, psi

P_D = total external pressure on top of the pipe, psi

$P_D = W_c/D = 1{,}094.45/6 = 182.4$ psi

For a SDR of 11.0 the actual compressive stress is:

$S_A = ((11.0-1)/2) \times 182.4 = 912$ psi

The factor of safety can then be found using the compressive yield strength of HDPE pipe of 1,500 psi (Reference 4):

FS = 1,500 psi/910 psi = 1.64

2.13 HDPE Equipment Loading

Equipment loading on the HDPE pipe is based on the same assumptions as the PVC pipe calculation; therefore, the static vertical load will govern.

2.14 HDPE Pipe Loading Results

Calculations for ring deflection, wall crushing, and wall buckling due to dead and live loading stresses for the existing and proposed 6-inch laterals were completed and Table 2.4 summarizes the results.

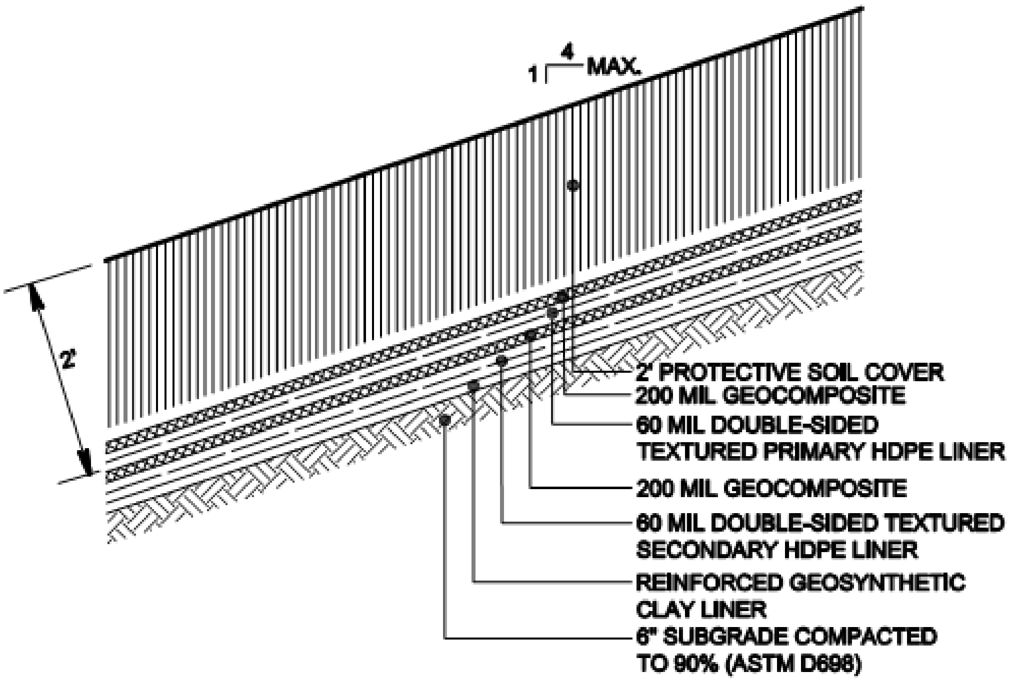
Table 2.4 – SDR 11.0 HDPE Pipe Results Dncs Environmental Solutions

Design Criteria	Critical Value	Actual Value	Factor of Safety
Dead Load Only			
Ring Deflection	8.0%	7%	1.1
Wall Buckling	342.23 psi	182.4 psi	1.88
Wall Crushing	1,500 psi	912 psi	1.64

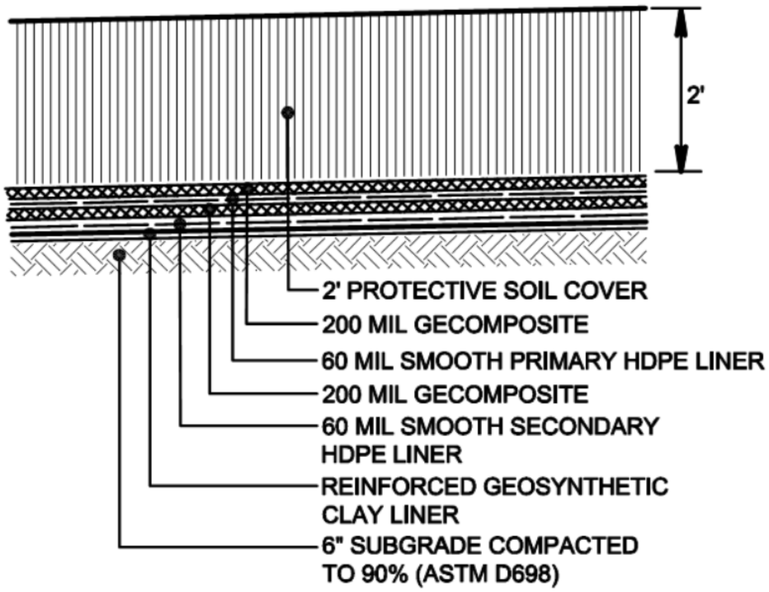
As shown, for each limiting design criterion, the factor of safety is greater than design criteria, thus the performance standard for the HDPE pipes is adequate.

3.0 LINER DESIGN

The liner design for the landfill sideslopes, consists of the following components below the waste:



The liner design for the landfill floor from top to bottom, consists of the following components below the waste:



3.1 Calculation of Tensile Stresses in Geosynthetics and Sideslope Liner Stability

External shear forces will develop on the 4H:1V sideslopes assuming the placement of an initial 2-foot lift of protective soil and 10-foot lift of waste; assuming the lifts are unsupported and no adhesion. Unbalanced forces, due to assumed unsupported placement of the 2-foot protective soil layer and 10-foot waste layer, must be supported by liner components above the interface with the least amount of frictional resistance.

Interface friction angles (Φ) and adhesion (as determined by direct shear testing) for geosynthetics will vary depending on the normal load applied to the geosynthetics. Interface friction angles and adhesion for C.K. Disposal was found based on direct shear testing on similar “silty sand” soil.

Table 3.1 – Geosynthetic Interface Friction Angles and Adhesions,

Sideslope Liner System

Geosynthetic to Geosynthetic Interface	Mohr-Coulomb Failure Envelope	
	Φ	Adhesion
Protective Soil Layer (SM) to Geocomposite	32°	0
Geocomposite to Double-Sided Textured HDPE FML[(1)]	26.3°	0
Double-Sided Textured HDPE FML to Nonwoven Geotextile of GCL	27.3°	0
Nonwoven Geotextile of GCL to Subgrade Soil (undrained)	28.2°	87

(1)Average of direct shear testing values on geocomposite to double-sided texture HDPE FML

Table 3.2 – Geosynthetic Interface Friction Angles and Adhesions, Floor Liner System

Geosynthetic to Geosynthetic Interface	**Mohr-Coulomb Failure Envelope**	
	Φ	**Adhesion**
Protective Soil Layer (SM) to Geocomposite	32°	0
Geocomposite to Smooth HDPE (1)	8° - 12° Average = 10°	0
Geonet to Smooth HDPE FML (1)	5° - 19° Average = 12°	0
Nonwoven Geotextile of GCL to Subgrade Soil (undrained)	28.2°	87

(1)Reference 9

3.2 Tensile Stress in Liner System

Tensile stresses in the liner system were calculated based on the assumption that waste will be placed in 10-foot thick lifts, are unsupported, and have no adhesion. The liner system must support the weight of the 10-foot thick waste lift.

<u>Side Slope Liner Stability</u>

The following calculations were performed with guidance from Reference 6. Using this guide, tensile stresses and shear stresses carried by the upper geomembrane were calculated. Waste will be placed in 10-foot lifts.

$$W_w = ½\gamma_w\ H(H/\tan\beta) + ½\gamma_s H(H/\tan\beta)$$

Where:

W_w = weight of lift per unit width

H = lift height

β = slope angle

γ_w = unit weight of waste

$$W_w = ½(74)(8)(8/\tan 14.04) + ½(110)(2)(2/\tan 14.04) = 10{,}349 \text{ lbs/ft}$$

$$T_w = K_o\sigma_v\tan\Phi_w H$$

$$K_o = 1 - \sin(\Phi_w)$$

$$\sigma_v = 1/2\gamma_w H$$

Where:

T_w = frictional resistance force per unit width

σ_h = horizontal stress of waste lift

Φ_w = waste friction angle

K_o = coefficient of earth pressure at rest

σ_v = vertical stress of waste lift

$T_w = K_o\sigma_v\tan\Phi_w h_w + K_o\sigma_v\tan\Phi_s h_s$

$T_w = (1 – \sin 33)1/2(74)(8)\tan(33)(8) + (1 – \sin(33))(1/2(110)(2))\tan(33)(2)$

T_w = 700 lbs/ft + 65 lbs/ft

T_w = 765 lbs/ft

$$W_{net} = W_w - T_w$$

Where:

W_{net} = net weight of waste

W_{net} = 10,349 lbs/ft – 765 lbs/ft

W_{net} = 9,584 lbs/ft

Given the net weight, we can find the normal and shear force of the weight.

$N = W_{net} \cos\beta = (9{,}584 \text{ lb/ft})\cos(14.04)$

$P = W_{net} \sin\beta = (9{,}584 \text{ lb/ft})\sin(14.04)$

N = 9,297.7 lb/ft

P = 2,323 lb/ft

The critical interface of the liner system occurs at the geocomposite to double-sided textured HDPE interface. F_1 is calculated for gecomposite to protective soil and F_2 is calculated for geocomposite to double-sided textured HDPE.

$F_1 = N\tan\delta_1 = 9{,}297.7 \tan(32)$

$F_2 = N\tan\delta_2 = 9{,}297.2 \tan(26.3)$

F_1 = 5,809.8 lbs/ft

F_2 = 4,595.2 lbs/ft

$F_1 - F_2$ = 5,809.8 lbs/ft – 4,595.2 lbs/ft = 1,212.6 lbs/ft = 101.2 lbs/in

According to Reference 10, there is a direct relationship between the CBR puncture resistance value and the wide width tensile strength of geotextiles. The equation below shows the relationship.

$$T_f = F_p/\pi r$$

Where:

T_f = tensile force per unit width of fabric

F_p = puncture breaking force = 575 lbs for GSE 8oz/yd^2 geotextile

r = radius of puncturing rod = 25 mm = 0.98 in

T_f = 575 lbs/π(0.98 in) = 186.76 lbs/in

F.S. = $(T_f)/(F_1 - F_2)$ = 186.76 lbs/in/101.2 lbs/in = 1.85

The Factor of Safety for the critical interface is 1.85, therefore the liner system is adequate.

3.3 Calculation of Tensile Stresses in Geosynthetics due to Equipment Loading

A Caterpillar D6E dozer or equivalent will be used to place protective soil layer up the sideslope a sufficient distance to accommodate an approximate 10-foot lift of waste placed on the landfill floor.

- Unit weight of protective soil = 110 lbs/ft^3 dry density
- Internal friction angle of protective soil = 33°
- Critical liner interface friction angle occurs between the HDPE geonet and the double-sided textured HDPE liner = 26.3°
- Equipment loading assuming a D6N dozer:
  - Weight = 36,943 lbs
  - Track width = 24 in = 2 feet
  - Pressure distribution, assume a 2H:IV distribution; therefore, width acting on geomembrane = 20 feet
- Tensile forces acting on geomembrane:
  - Protective soil layer, F_{soil}
  - D6E dozer, F_{dozer}
- Total resisting forces:
  - Geonet interface friction, F_{geonet}
  - Soil buttress friction at toe of slope, $F_{buttress}$

The minimum interface friction angle for the liner system is 26.3° and occurs between the geocomposite and the double-sided textured geomembrane.

<u>Tensile forces acting on geomembrane</u>:

F_{soil} = h_{lift} (unsupported slope length) (unit weight of protective soil) (sin(slope angle))

F_{soil} = (2 ft)(70 ft)(110 lbs/ft^3)(sin(14.04°)

Fsoil = 3,736 lbs/ft

F_{dozer} = [(dozer weight) / (width acting on geocomposite)] (sin(14.04°))

F_{dozer} = [0.5(36,943 lbs) / 20 ft] (sin(14.04°))

F_{dozer} = 448 lbs/ft

Total tensile force acting on geocomposite = 3,736 lbs/ft + 448 lbs/ft = 4,184 lbs/ft

Total resisting forces acting on geomembrane:

$F_{geomembrane}$ = (weight of protective soil + weight of dozer) (cos(slope angle)) (tan(interface friction angle))

$F_{geomembrane}$ = [(2 ft)(70 ft)(110 lbs/ft^3) + (36,943 lbs / 20 ft)] (cos 14.04°) (tan 26.3°)

$F_{geomembrane}$ = 8,269 lbs/ft

$F_{buttress}$ = [[cos(internal friction angle of soil)] / [cos(internal friction angle of soil + slope angle)]] [[(unit weight of soil) (thickness of soil)^2 / sin 2 (slope angle)] tan(internal friction angle of soil)]

$F_{buttress}$ = [[cos(33°) / cos(33° + 14.04°)] [(110 lbs/ft^3(2 ft)^2) / sin(2(14.04°))] [tan(33°)]

$F_{buttress}$ = 747 lbs/ft

Total resisting force acting on geomembrane = 8,269 lbs/ft + 747 lbs/ft = 9,016 lbs/ft

To summarize, tensile stress in geocomposite = 4,184 lbs/ft – 9,016 lbs/ft = -4,832 lbs/ft. A negative tensile stress indicates the geocomposite is not in tension.

3.4 Anchor Trench Pullout Analysis

The anchor trench detail is shown in Attachment B, Figure 501 –Liner & Leachate Collection Details. To establish the static equilibrium equation, two imaginary and frictionless pulleys are assumed at the top edge and the bottom corner of the anchor trench. The friction force above a runout geosynthetic is always neglected in the anchor trench.

3.5 Geocomposite: Double-Sided Textured Geomembrane Interface

$\Sigma F_H = 0$ yields the following equation for the calculation of T (where T = geocomposite tensile force per unit width lbs/ft:

$$T = \frac{(Y_s)(d_{cs})(L_{ro})(\tan\delta_c)+[(1-\sin\Theta)((Y_s)(d_{cs}+0.5d_{AT}))d_{AT}+Y_s(d_{cs}+d_{AT})L_{AT}](\tan\delta_c+\tan\delta_f)}{\cos\beta-(\sin\beta)(\tan\delta_c)}$$

Where:

Y_s = unit weight of cover and backfill soil = 110 lbs/cf dry density

d_{cs} = depth of cover soil = 2 feet

L_{ro} = runout length = 2 feet

δ_c = friction angle between the GCC and underlying soil = 28.2°

Θ = internal friction angle of compacted backfill soil in anchor trench = 35°

d_{AT} = depth of anchor trench = 2 feet

L_{AT} = width of anchor trench = 2 feet

δ_f = interface friction angle between the geomembrane and the compacted backfill soil = 32°

β = sideslope angle, measured from horizontal = 14.04°

$$T = \frac{(110\text{lbs/cf})(2')(2')(\tan 28.2°)+[(1-\sin 35°)((110\text{lbs/cf})(2'+0.5(2'))(2')+110\text{lbs/cf}(2'+2')2'](\tan 28.2°+\tan 32°)}{\cos 14.04°-(\sin 14.04°)(\tan 28.2°)}$$

T = 1,884 lbs/ft = 157 lbs/in

The anchor trench can withstand greater yield strength than the geomembrane.

3.6 Geosynthetic Slippage Analysis

To determine the factor of safety for slippage and subsequent tension in the liner geosynthetics, the method of active and passive wedges, shown in Reference 1, was used. This calculation utilizes the passive wedge which supports the sidelsope active wedge, consistent with actual field conditions. These calculations were performed along the geomembrane covered slope. To be conservative, the lowest interface friction angles (residual strength values) for the sideslope liner system; and peak strength values for the floor liner system were used. These values taken are $\delta_A = 20.1°$ for the interface friction angle between the geocomposite and double-sided textured HDPE geomembrane on the sideslope. Interface friction angle between the geonet and smooth HDPE geomembrane on the floor was used. The total height of the active wedge is the maximum height of waste over the liner system sloped portion.

For the purposes of this calculation, the following assumptions and nomenclature were used from the literature:

Table 3.3 – Translational Failure Analysis

W_P =	Total weight of the passive wedge
N_P =	Normal force acting on the bottom of the passive wedge
F_P =	Frictional force acting on the bottom of the passive wedge (parallel to the bottom of the passive wedge)
E_{HP} =	Normal force from the active wedge acting on the passive wedge
E_{VP} =	Frictional force acting on the side of the passive wedge
FS_P =	Factor of safety for the passive wedge
δ_P =	Minimum interface friction angle of multi-layer liner components beneath the passive wedge = 10° (assumed interface friction angle between the geotextile of the GCL and the smooth HDPE geomembrane)
Φ_S =	Friction angle of the solid waste = 33°
a =	Angle of the waste slope, measured from horizontal
Φ =	Angle of the landfill cell subgrade, measured from horizontal = 1.15°
W_A =	Weight of the active wedge
W_T =	Total weight of active and passive wedges
N_A =	Normal force acting on the bottom of the active wedge
F_A =	Frictional force acting on the bottom of the active wedge (parallel to the bottom of the active wedge)
E_{HA} =	Normal force from the active wedge acting on the active wedge, $E_{HA} = E_{HP}$
E_{VA} =	Frictional force acting on the side of the active wedge, $E_{VA} = E_{VP}$
FS_A =	Factor of safety for the active wedge
b =	Horizontal length of active wedge (cell sideslope at maximum depth) = 280 ft

[Continued on next page]

[Continued from previous page]

b_P =	Horizontal length of the passive wedge = 420 feet
h_t =	Total height of the wedges = 140 feet
δ_A =	Minimum interface friction angle of multi-layer liner components beneath the active wedge = 26.3°
β =	Angle of sideslope, measured from the horizontal = 14.04°
FS =	Factor of safety for the entire solid waste mass

The active wedge is considered first:

$W_A = 1/2((b*h_a*y)+(b*h_b*y))$

$W_A = 1/2(280ft*70ft*74(lbs/ft^3)+280\ ft*70\ ft*74(lbs/ft^3))=1{,}450{,}400\ lbs/ft$

The passive wedge is then considered by multiplying the cross sectional area by the unit weight of waste:

$W_P = 1/2(b_P*h_t*y)=W_P=1/2(420ft*140ft*74(lbs/ft^3))=2{,}175{,}600\ lbs/ft$

$W_T = 1{,}450{,}400\ lbs/ft + 2{,}175{,}600\ lbs/ft = 3{,}626{,}000\ lbs/ft$

Factor of safety:

$aFS^3 + bFS^2 + cFS + d = 0$

Where:

$a = W_A \sin\beta \cos\Theta + W_P \cos\beta \sin\Theta = 394{,}155\ lbs/ft$

$b = (W_A\tan\delta_P + W_P\tan\delta_A + W_T\tan\phi_S) \sin\beta \sin\Theta - (W_A\tan\delta_A + W_P\tan\delta_P) \cos\beta \cos\Theta = -1{,}049{,}414\ lbs/ft$

$c = -[W_T\tan\phi_S(\sin\beta \cos\Theta \tan\delta_P + \cos\beta \sin\Theta \tan\delta_A) + (W_A \cos\beta \sin\Theta + W_P \sin\beta \cos\Theta) \tan\delta_A \tan\delta_P] = -174{,}586\ lbs/ft$

$d = W_T \cos\beta \cos\Theta \tan\delta_A \tan\delta_P \tan\phi_S = 199{,}037\ lbs/ft$

and:

β = 14.04° - sideslope angle

Θ = 1.15° - subgrade angle

δ_P = 10° - minimum friction angle of bottom liner system

[Continued on next page]

[Continued from previous page]

δ_A = 26.3° - minimum friction angle of sideslope liner system

$\varnothing_S$ = 33° - friction angle of waste

$aFS^3 + bFS^2 + cFS + d = 0$

$394{,}155FS^3 – 1{,}049{,}414FS^2 – 174{,}586FS + 199{,}037 = 0$

This equation is then solved by trial and error using an Excel spreadsheet. Table 3.4 shows results:

Table 3.4 – Translational Failure Analysis
Factor of Safety Summary

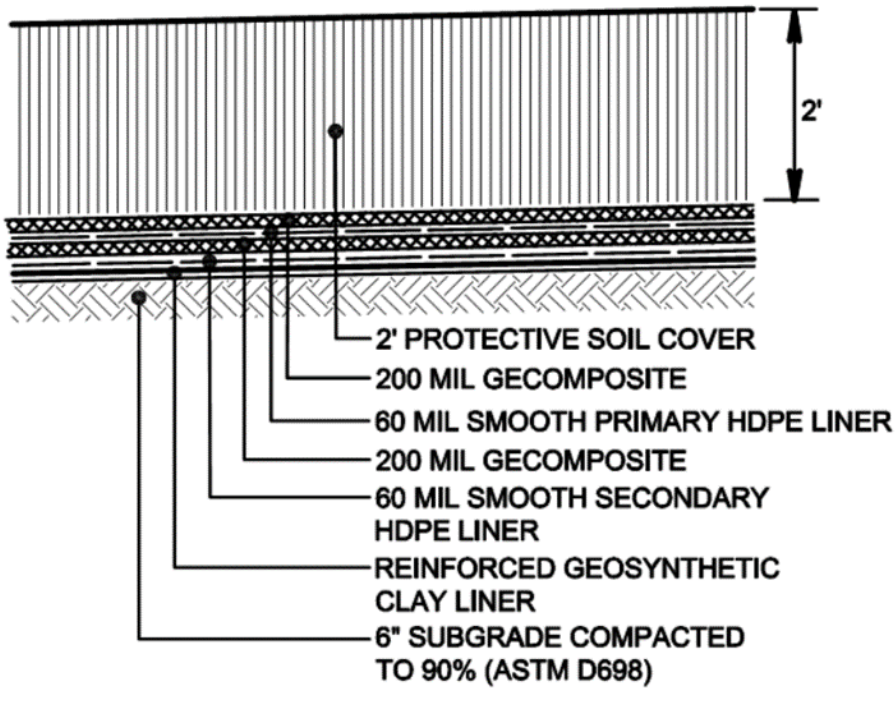
Assumed FS	Result
1	-630,808
2.75	20,075
2.76	-10,105

This factor of safety against translational geosynthetic failure considering active and passive soil wedges is 2.75. This indicates the passive wedge will support the sideslopes active wedge without slipping. Therefore, the geosynthetic liner system is not in tension, and the proposed liner system design is compatible with calculated external forces.

3.7 Minimum Liner Thickness

According to Reference 6, "liner deformation can result from differential setting of subgrade soils, from localized settlement of soft areas beneath the liner, or from other anomalous conditions, wherein settlement places the liner in tension. Adequate thickness must be provided to resist potential damaging deformation within a margin of safety."

The landfill is located on the west flank of a topographic high ridge, locally named Rattlesnake Ridge, otherwise known as the Dockum Red Bed Ridge or Red Bed Ridge. Given the stability of the location and the proposed engineered liner foundation, it is not anticipated that soft areas or sinkholes will be encountered. The landfill liner system consists of a multilayer system shown below. The foundation will be constructed with 6-inches recompacted subgrade (90% of ASTM D698) supporting the liner system. The following is the floor liner system:



For conservatism, only one layer of geomembrane was analyzed to determine the minimum thickness. As stated above, the liner system will be a multiple liner system and is therefore capable of withstanding more forces than just a single liner system. The resulting required thickness that is calculated for a single liner will be a conservative value given the landfill's multiple liner system.

"The required thickness for a synthetic liner can be calculated using the equation below for localized settlement. It is a one-dimensional force balance at equilibrium in the x – direction with the geomembrane tension resolved into its horizontal and vertical components", (Reference 6).

$$t_{reqd} = \frac{\sigma_n x(\tan\delta_u + \tan\delta_L)}{\sigma_{allow}(\cos\beta - \sin\beta\tan\delta_L)}$$

Where:

t = liner thickness (inches)

σ_n = applied overburden pressure = 81.7 psi (See calculations below)

β = angle of force applied to synthetic liner = 45° (Reference 6)

σ_{allow} = liner allowable stress at yield = 2100 psi (Reference 6)

x = mobilized liner deformation = 1.695 inches (See calculation below)

δ_U = friction angle between the liner and the upper interface = 10° (Table 3.2)

δ_L = friction angle between the liner and the lower interface = 12° (Table 3.2)

$\sigma_n = H_w\gamma$

$\sigma_n = H_w\gamma_w + H_s\gamma_s$

Where:

H_w = height of waste = 150 ft

γ_w = unit weight of waste

H_s = height of soil (protective cover, intermediate cover, and final cover)

γ_s = unit weight of waste

$$\sigma_n = (150\text{ ft})(74\text{pcf}) + 6\text{ ft }(110\text{ pcf})$$

$$\sigma_n = 11{,}760\text{ lbs/ft}^2 = 81.7\text{ psi}$$

Using the equation given for 60-mil liner for embedment depth that is provided by Reference 6 we can use the following equation calculate a value for "x".

$$x = 13.15e^{-0.0236\sigma_n}$$

Where:

x = mobilized liner deformation

σ_n = applied overburden pressure = 81.7 psi

$$x = 13.15e^{-0.0236(81.7)}$$

$$x = 1.91$$

Typical values for “x” can range from 2-inches to 10-inches; therefor, a value of x = 2 was used for the calculation. β was estimated to be 45° as the worst case scenario (Reference 6).

$$\mathrm{t_{reqd}} = \frac{81.7\mathrm{psi} * 2\mathrm{in} * (\tan 10° + \tan 12°)}{2100\ \mathrm{psi} * (\cos 45° - \sin 45° \tan 12°)}$$

$$\mathrm{t_{reqd}} = 0.0543\ \mathrm{inches} = 54.3\ \mathrm{mils}$$

Since the calculated minimum liner thickness of 54.3 mils is less than the 60 mils used to calculate embedment depth, the 60 mil liner thickness is acceptable.

FS = (t_{60mil})/(t_{reqd}) = 60 mils/54.3 mils = 1.10

The liner thickness calculation above only assumes a single liner system. The landfill is designed as a multiple Geosynthetic liner system which will add additional liner support.

4.0 EROSION CALCULATIONS

The purpose of erosion calculation is to determine potential soil losses due to wind and rainfall erosion during operations and following final cap installation. Erosion calculations project the soil loss from rainfall at approximately 4.51 tons/acre/year (t/a/y), which is below the NRCS established criterion of 5.0 t/a/y. The wind erosion loss from the site is estimated at 1.2 t/a/y, also below the NRCS established criterion of 2.5 t/a/y. The total soil loss from the site potentially caused by water and wind erosion is calculated at 5.71 t/a/y.

4.1 Rainfall Erosion Loss Calculations

Revised Universal Soil Loss Equations (RUSLE) was used to model rainfall erosion:

$A = R \times K \times LS \times C$

Where:

A = soil loss per unit area, typically in t/a/y

R = rainfall/runoff factor, which varies with location and climate

K = soil erodibility factor, which depends on soil type

LS = topographic factor that accounts for the site slope gradient and length

C = cover factor that accounts for ground cover (bare slope = 1)

	Final Cover Crown	**Final Cover Sideslope**	**Total**
RUSLE Soil Loss	0.19	4.32	4.51

Table 4.1

RUSLE Equation

R	-	Rainfall Value		
	=	45	for this area	Fig 2-1 NRCS Agricultural Handbook #703
K	-	Soil Erodibility Factor		From Soil Survey local soils (silty clay loam) and table 8.4, page 261, Hann, Barfield text
		0.15		
L	-	Slope Length Factor		
	=	$(L/72.6)^M$		eq 4-1, NRCS Agricultural Handbook #703
		L =	horizontal slope length in feet	
		L =	400	
		M =	slope length exponent	table 8.6, page 263, Haan, Barfield text
		M =	0.64	
	=	2.98		
S	-	Slope Factor		
	=	(16.8 sin(Q))- 0.5	for slopes sin Q > 0.09	eq. 4-5 NRCS Agricultural Handbook #703
		Q =	slope angle	
		Q =	14.04 degrees	degrees = 0.24504423 radians
	=	3.58		
C	-	Covering Management Factor		
	=	0.06		see C factor calculation sheet
P	-	Support Practices Factor		
	=	1		Conservative Estimate
A	-	Calculated Soils loss in tons/acre-year		
	=	RKLSCP		
	=	4.32	tons/acre/year	

Table 4.2

C - Factor Calculation

C_{plu} -	prior land use subfactor				
=	1	for rangeland	table 8-10.B, page 271, Hann, Barfield text		
C_{CC} -	canopy cover subfactor		From Soil Survey local soils (sand) and table 8.4, page 261, Hann, Barfield text		
=	1-F_C * exp(-0.1H)		eq 8.52, page 270, Hann, Barfield text		
		F_C = fraction of surface covered by canopy			
	FC =	0.5	conservative estimate		
		H = average canopy height in feet			
	H =	1	conservative estimate for root depth		
=	0.55				
C_{SC} -	surface cover subfactor				
=	$\exp[-bR_C(6/6+R_G))^{0.08}]$		eq. 8.53, page 270, Hann, Barfield text		
	b =	constant			
	b =	4.5			
	R_C =	fraction ground cover	conservative estimate taken and adjusted from value of 1.0 for complete rock covering		
	R_C =	0.5			
		R_G = surface roughness variable	eq. 8.55, page 271, Haan, Barfield text		
		$R_G = (25.4 *R_R-6)*(1-\exp(-0.0015R_S))*(\exp(-0.14P_T))$			
		R_R =	random roughness		
		R_R =	0.8	conservative estimate - Ag. Handbook #703	
		R_S =	total root and buried residue [lb/acre]		
		R_S =	1200	Table 8.10, page 271, Haan, Barfield text	
		P_T =	average yearly rainfall		
		P_T =	11.72	inches	National Weather Service Data
		R_G =	2.32		
=	0.11				
C_{SR} -	surface roughnes subfactor				
=	$\exp(-0.026*R_G)$	R_G = surface roughness variable	eq. 8.62, page 273 in Haan, Barfield text see above for references and equation		
	R_G =	2.32			
=	0.94				
C_{SR} -	soil moisture subfactor				
=	1	for rangeland	see page 273 in Haan, Barfield text		
C -	Cover Management Factor				
=	$C_{PLU}C_{CC}C_{SC}C_{SR}C_{SM}$				
=	0.06	**			

**Recommendations of George Foster of the Agricultural Research Service is to use a minimum value of 0.005. Therefore, if necessary, for conservative estimates, use a C value of 0.005

4.2 Wind Erosion Loss Calculations

Purpose: to estimate the quantity of soil loss as a result of wind using the Wind Erosion Equation (WEQ).

Wind Erosion Equation: E = f(I,K,C,L,V)

Where:

E = potential average annual soil loss (t/a/y)

I = soil erodibility index (t/a/y)

K = ridge roughness factor (0.5-1.0)

C = the climactic factor

L = unsheltered distance along prevailing wind erosion direction across area to be evaluated

V = equivalent vegetative cover

Find I:

The soil onsite primarily consists of silty sands of the soil type SM. The I value for silty sands is listed at 134 t/a/y.

I = 134

Find K:

The ridge roughness factor (K) is a measure of the effect from tilled ridges and planting implements. These reduce erosion by absorbing and deflecting wind energy and trapping blown particles. No wind-breaking ridges are planned for the final cover; therefore, a conservative K value of 1.0 has been chosen.

K = 1.0

Find C:

The climactic factor (C) is based on the average wind velocity and precipitation-evaporation index (PE index). The isolinear map of New Mexico (Agronomy Tech Note 27, June 1992) was used to find the C-value of 150 for the site.

C = 150

Find L:

L represents the longest unsheltered distance along the prevailing wind direction for the area to be evaluated. The prevailing wind direction was determined using data obtained from the New Mexico Climate Center at Hobbs Lea County Airport. There, the prevailing wind is from the south. The longest unsheltered distance is approximately 2,300 feet; therefore,

L = 2,300 feet

Find V:

The equivalent vegetative cover is a value that relates the kind, amount, and orientation of vegetative material to the equivalent in lbs/acre of a small grain residue reference condition. This reference condition is defined as 10-inch long stalks of small grain lying flat in rows spaced 10 inches apart, perpendicular to the direction of the wind.

The landfill vegetation plan required vegetation cover to be seeded per NRCS recommendations with blue and sideoats gramma grasses, as well as dropseed varieties. This plan will yield 1,500 – 2,000 lbs/acre of vegetative cover (assuming good germination and adequate precipitation). When this value is converted to the Blue Gamma equivalent, it yields an equivalent vegetative factor of over 10,000 lbs/acre. A highly conservative factor of 3,000 lbs/acre is therefore used for V.

V = 3,000 lbs/acre

Solve for E:

Using the E-Table, a value of E = 1.2 t/a/y of soil loss due to wind erosion is expected. This value is less than the NRCS recommended maximum value of 2.5 t/a/y.

5.0 SETTLEMENT CALCULATIONS

The final cover slope, liner, and leachate collection piping after settlement must be consistent with the performance specifications for leachate collection and stormwater control. The following calculations show the designed grades for final cover and leachate collection system will allow adequate drainage even after settlement has occurred.

5.1 Foundation Soils Settlement

The methodology for estimating floor potential settlement involves selecting points along the landfill floor surface, then computing settlement at each point, and evaluating the resultant change in surface elevation. Points were conservatively selected from a cross-section where the waste and fill material is thickest. Reference 1 presents a method to determine landfill foundation settlement that evaluates elastic, primary, and secondary settlement. The foundation soils at the C.K. Disposal site are predominately a mixture of sand with varying amounts of fines and clay. Recent laboratory testing evaluated a mixture of sands and silty sand (i.e., USCS Classifications SM) in the excavation area. SM soil properties are used in the following equations.

$$\mathrm{Ze} = \left(\frac{\Delta\sigma}{\mathrm{Ms}}\right)\mathrm{Ho}$$

Where:

Z_e = elastic settlement of soil layer (ft)

H_o = initial thickness of soil layer (ft)

$\Delta\sigma$ =increment of vertical effective stress, lb/ft^2

Ms = constrained modulus of soil, lb/ft^2

The constrained modulus is provided in this equation:

$$M_S = \frac{E_S(1-v_s)}{(1+v_s)(1-2*v_s)}$$

Where:

M_S = constrained modulus of soil, lb/ft^2

E_S = elastic modulus of soil (lb/ft^2) found using Reference 1

E_S = (4,700 psi + 1,600 psi) / 2 = 10,350 (144) = 1,490,400 lbs/ft^2

v_s = Poisson's Ratio for soil = 0.39, found using the same method to estimate the elastic modulus of soil

Elastic Foundation Soil Settlement

Thickness of Waste = 150 feet (assume entire thickness of waste from intermediate cover to top of protective soil layer; this provides a conservative analysis)

Unit Weight of Soil = 110 lb/ft^3 dry density

Unit Weight of Waste = 74 lb/ft^3

$\Delta\sigma$= (waste effective stress) + (protective soil layer effective stress) + (intermediate cover effective stress) + (final cover effective stress)

$\Delta\sigma$= (150ft)(74lb/ft^3)+(2ft)(110lbs/ft^3)+(1ft)(110lbs/ft^3)+(3.0ft)(110lbs/ft^3)=11,760lbs/ft^3

$$M_S = \frac{1{,}490{,}400 \text{ lb/ft}^2 \,(1-0.29)}{(1+0.29)(1-2*0.29)} = 1{,}953{,}090 \text{ lbs/ft}^2$$

H$_o$=150 ft the full thickness of the compressible SM soils; the compressible soil is considered incompressible at the depth of 40 feet.

$$\text{Ze} = \left(\frac{11{,}760}{1{,}953{,}090}\right)40\text{ft} = 0.241\text{ft}$$

The attached spreadsheet has settlement calculations for points shown in Figure 1. The required 2% slope of the leachate collection system is not adversely affected by foundation settlement. Table 5.1 summarizes the foundation soil settlement calculations.

5.2 Waste Settlement Calculations

Estimated waste settlement points on the final cover surface were selected and settlement was computed at each point. Points were selected from Cross-Sections A-A and B-B (Figure 1). Reference 1 presents a method for determining settlement in landfills. This method is based on developed soils consolidation theory, which relates settlement to layer thickness and changes in void ratio.

The primary settlement is estimated using this equation:

$$\Delta H_c = C_c \left(\frac{H_o}{1 + e_o}\right) \log\left(\frac{\sigma'_i}{\sigma'_o}\right)$$

Where:

ΔH_C = primary settlement

$C_C/(1+e_o)$ = 0.006 (Reference 11, Appendix D)

H_O = initial thickness of the waste layer before settlement (assume entire thickness of waste from intermediate cover to the top of protective soil layer; this provides a conservative analysis) = 157 ft

σ_o = previously applied pressure in waste layer (assumed to equal the compaction pressure = 1,000 lbs/ft^2)

σ_i = total overburden pressure applied at the mid-level of the waste layer (lbs/ft^2)

Long-term secondary settlement is estimated by the equation below:

$$\Delta H_s = C_a \left(\frac{H_o}{1 + e_o}\right) \log\left(\frac{t_i}{t_o}\right)$$

Where:

ΔH_S = secondary settlement

C_a = 1/3 [$C_C/(1+e_o)$] = 0.002 (Reference 11, Appendix D)

H_O = waste thickness at start of secondary settlement = $H-H_c$

t_1 = starting time of secondary settlement (1 year)

t_2 = ending time of secondary settlement = assume 30 years

Settlement is estimated at key locations shown on the landfill Cross-Sections A-A and B-B (Figure 1). An example calculation is demonstrated as follows:

Primary Waste Settlement

Maximum Thickness of Waste = 150 feet

$$\Delta H_c = C_c \left(\frac{H_o}{1 + e_o}\right) \log\left(\frac{\sigma_i}{\sigma_o}\right)$$

Where:

$C_C/(1+e_o) = 0.006$

$H_O = 157$ ft

$\sigma_o = 1{,}000$ lbs/ft^2

$\sigma_i = 0.5[(157 \text{ ft})(74 \text{ lbs/ft}^3) + 4.0 \text{ ft } (110 \text{ lbs/ft}^2)] = 6{,}029 \text{ lbs/ft}^2$

$$\Delta H_C = 0.006 \text{ x } 157 \text{ x } \log \frac{6{,}029 \text{ lb/ft}^2}{1{,}000 \text{ lbs/ft}^2}$$

$\Delta H_C = 0.702$ ft

Secondary Waste Settlement

$H_O = 157 \text{ ft} - 0.702 \text{ ft} = 156.298$ ft

$$\Delta H_S = 0.002 \text{ x } 156.298 \text{ x } \log \frac{30 \text{ years}}{1 \text{ year}} = 0.46 \text{ ft}$$

Total waste settlement = 0.735 ft + 0.46 ft = 1.2 ft

The waste settlement is 1.2 ft, which has nominal impact on the corresponding calculations for slope, runoff, etc. A summary of potential waste settlement is provided in Table 5.2.

5.3 Soil Cover Settlement Calculations

The final cover soil layer consisting of vegetative, barrier, and intermediate cover layers will also experience nominal settlement due to its own weight. The method for evaluating settlement of the soil cover and cushion layers is based on this equation:

Primary Soil Settlement

$$\Delta H_p = C_c\left(\frac{H_p}{1+e_s}\right)\log\left(\frac{P_o+\Delta P}{P_o}\right)$$

$C_C/(1+e_o) = 0.0006$

Thickness of Soil = (H) = 3.0 feet of final cover + 1 foot of intermediate cover soil + 2 feet of protective soil layer = 6 feet

Unit Weight of Soil = 110 lbs/ft^3 Dry Density

$\Delta P = (3.0\text{ ft})(110\text{ lbs/ft}^3)+(1\text{ ft})(110\text{ lbs/ft}^3)+(2.0\text{ ft})(110\text{ lbs/ft}^3)=660.0\text{ lbs/ft}^2$

$P_O = (H/2)(110\text{ lbs/ft}^3) = 3.0(110) = 330\text{ lbs/ft}^2$

$$\Delta H_p = (0.006)(6.0\text{ ft})\log\left(\frac{330\frac{\text{lbs}}{\text{ft}^2}+660\frac{\text{lbs}}{\text{ft}^2}}{330\frac{\text{lbs}}{\text{ft}^2}}\right)$$

$\Delta H_P = 0.017$ ft

Secondary Soil Settlement

$$\Delta H_s = C_s\left(\frac{H_o}{1+e_s}\right)\log\left(\frac{t^2}{t^1}\right)$$

$C_A = 1/3[C_C/(1+e_o)] = 0.002$

$H_O = 6.0\text{ ft} – 0.017\text{ ft} = 5.983\text{ ft}$

$\Delta H_S = 0.002\ (5.983\text{ ft})\log 30/1 = 0.018\text{ ft}$

The maximum settlement of the final cover is the sum of primary and secondary settlement at point A21. The soil final cover layer settlement is equal to 0.017 ft + 0.018 ft = 0.035 ft. Table 5.3 summarizes the settlement in the final cover.

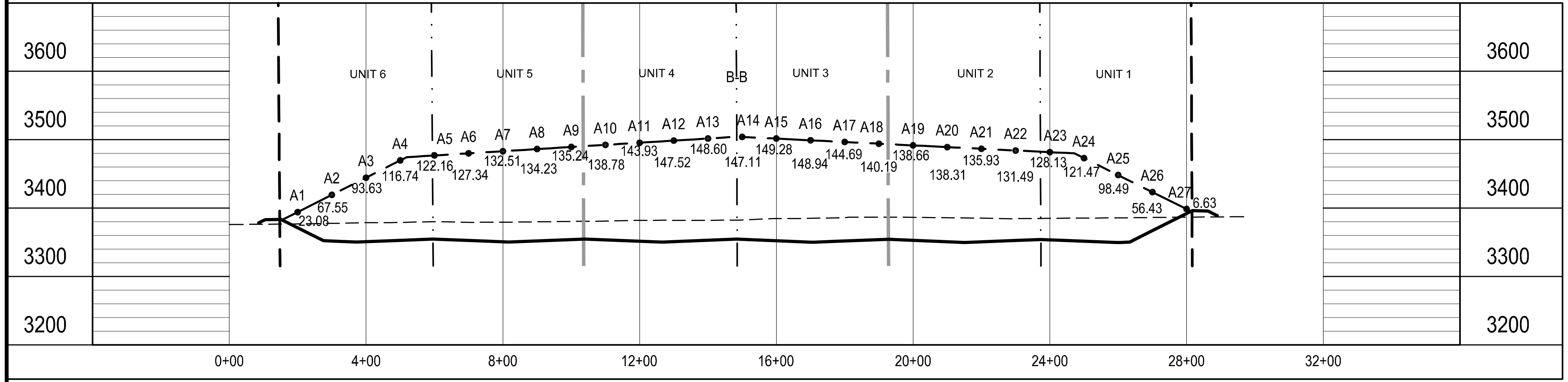
5.4 Conclusion

Settlement projections have been calculated for the landfill foundation, waste mass, and for landfill final soil cover. Settlement estimates include elastic deformation and both primary and secondary consolidation in the foundation soils, waste, and cover materials. The greatest value of projected settlement in both the foundation soils and waste occurs where waste thickness is greatest.

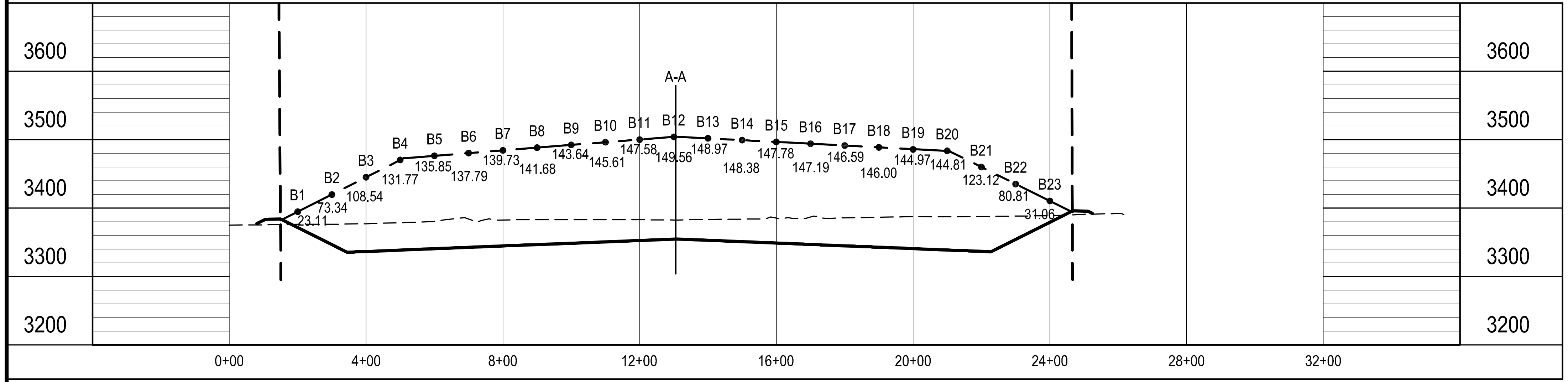
Maximum final settlement of landfill foundation, waste mass, and landfill cover is the sum of primary and secondary settlement. The foundation soil settlement is equal to 0.241 foot, waste settlement is equal to 1.2 feet, and final cover layer settlement is calculated at 0.035 foot. Maximum total settlement that could occur on the final cover is the sum of the foundation soil, waste, and cover settlement (i.e.: 0.241 ft + 1.2 ft + 0.035 ft = 1.476 ft).

The final cover slope, liner, and leachate collection pipe after settlement is adequate and consistent with the performance specifications for leachate collection system and stormwater controls and the New Mexico Oil Conservation Division.

FILE NAME: \\Data1\Projects\2015\0580.15\BIM_CAD\09_PERMIT\Volume III\FIG.III.9.1 - SETTLEMENT POINTS.dwg LAYOUT NAME: FIG.III.9.1 PRINTED: Thursday, May 05, 2016 - 4:11pm USER: TKrueger

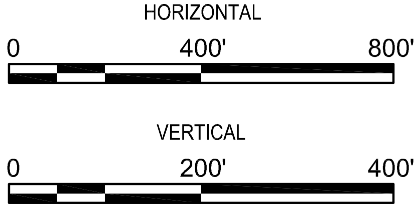


A SECTION A-A
SCALE: 1" = 400'



B SECTION B-B
SCALE: 1" = 400'

SCALES:



LEGEND

▬ ▬ ▬ ▬	LIMIT OF WASTE
– – – – – – –	EXISTING GRADE
────	BASE GRADE
──── – – ────	TOP OF WASTE
B4 ●	SETTLEMENT POINT LOCATION
146.00	DEPTH OF WASTE

PSC PARKHILL SMITH & COOPER

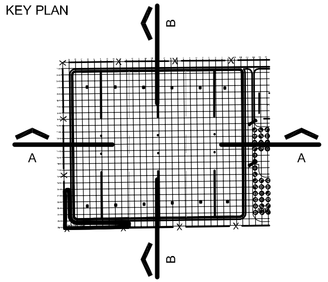
C. K. DISPOSAL E & P LANDFILL & PROCESSING FACILITY

NMED PERMIT NO. ___

NEW LANDFILL SITE
& PROCESSING FACILITY

LEA COUNTY, NEW MEXICO

KEY PLAN



NO	DATE	DESCRIPTION
1	09/23/15	ISSUE FOR REVIEW

ISSUING OFFICE: EL PASO PROJECT NO: 0580.15

SETTLEMENT POINTS

FIGURE 1

Table 5.1

SETTLEMENT AND ANGULAR DISTORTION OF FOUNDATION SOILS BETWEEN POINTS; CROSS SECTION A-A

Point Location	Total Settlement	Distance Between Points	Angular Distortion	Distortion Direction	Design Base Grade Elevation	Design Slope Between Points	Updated Base Grade Elevation	Update Slope Between Points
	(ft)	(ft)	(%)		(ft)	(%)	(ft)	(%)
A1	0.05				3371.16	25.00	3371.11	
		100	0.067	↑				2.43
A2	0.12				3351.85	2.50	3351.73	
		100	0.040	↑				2.46
A3	0.16				3350.94	2.50	3350.78	
		100	0.035	↑				2.46
A4	0.19				3353.01	2.50	3352.82	
		100	0.000	↓				2.50
A5	0.18				3354.84	2.50	3354.66	
		100	0.000	↑				2.50
A6	0.21				3352.76	2.50	3352.55	
		100	0.000	↑				2.50
A7	0.21				3350.67	2.50	3350.46	
		100	0.000	↑				2.50
A8	0.22				3352.05	2.50	3351.83	
		100	0.000	↑				2.50
A9	0.22				3354.13	2.50	3353.91	
		100	0.000	↑				2.50
A10	0.22				3353.68	2.50	3353.46	
		100	0.000	↑				2.50
A11	0.23				3351.62	2.50	3351.39	
		100	0.000	↑				2.50
A12	0.24				3351.12	2.50	3350.88	
		100	0.000	↑				2.50
A13	0.24				3353.13	2.50	3352.89	
		100	0.000	↓				2.50
A14	0.24				3354.46	2.50	3354.22	
		100	0.000	↑				2.50
A15	0.24				3352.32	2.50	3352.08	
		100	0.000	↓				2.50
A16	0.24				3350.18	2.50	3349.94	
		100	0.000	↓				2.50
A17	0.23				3351.95	2.50	3351.72	
		100	0.000	↓				2.50
A18	0.23				3353.98	2.50	3353.75	
		100	0.000	↓				2.50
A19	0.22				3353.03	2.50	3352.81	
		100	0.000	↓				2.50
A20	0.22				3350.91	2.50	3350.69	
		100	0.000	↓				2.50
A21	0.22				3350.81	2.50	3350.59	
		100	0.000	↓				2.50
A22	0.21				3352.77	2.50	3352.56	
		100	0.000	↓				2.50
A23	0.21				3353.65	2.50	3353.44	
		100	0.000	↓				2.50
A24	0.20				3351.62	2.50	3351.42	
		100	0.000	↓				2.50
A25	0.16				3349.62	2.50	3349.46	
		100	-0.001	↓				25.00
A26	0.10				3367.04	25.00	3366.94	
		100	-0.001	↓				25.00
A27	0.02				3392.04	25.00	3392.02	

Table 5.1 Continued

SETTLEMENT AND ANGULAR DISTORTION OF FOUNDATION SOILS BETWEEN POINTS; CROSS SECTION B-B

Point Location	Total Settlement	Distance Between Points	Angular Distortion	Distortion Direction	Design Base Grade Elevation	Design Slope Between Points	Updated Base Grade Elevation	Update Slope Between Points
	(ft)	(ft)	(%)		(ft)	(%)	(ft)	(%)
B1	0.13				3371.57	25	3371.44	
		100	0.203	↑				24.80
B2	0.34				3346.59	25.00	3346.25	
		100	0.142	↑				2.36
B3	0.48				3336.63	2.50	3336.15	
		100	0.094	↑				2.41
B4	0.57				3338.64	2.50	3338.07	
		100	0.016	↑				2.48
B5	0.59				3340.66	2.50	3340.07	
		100	0.008	↑				2.49
B6	0.60				3342.67	2.50	3342.07	
		100	0.008	↑				2.49
B7	0.60				3344.69	2.50	3344.09	
		100	0.008	↑				2.49
B8	0.61				3346.70	2.50	3346.09	
		100	0.008	↑				2.49
B9	0.62				3348.69	2.50	3348.07	
		100	0.008	↑				2.49
B10	0.63				3350.68	2.50	3350.05	
		100	0.008	↑				2.49
B11	0.64				3352.66	2.50	3352.02	
		100	0.008	↑				2.49
B12	0.64				3354.65	2.50	3354.01	
		100	-0.002	↓				2.50
B13	0.64				3352.96	2.50	3352.32	
		100	-0.002	↓				2.50
B14	0.64				3350.95	2.50	3350.31	
		100	-0.002	↓				2.50
B15	0.64				3348.93	2.50	3348.29	
		100	-0.002	↓				2.50
B16	0.63				3346.92	2.50	3346.29	
		100	-0.002	↓				2.50
B17	0.63				3344.90	2.50	3344.27	
		100	-0.002	↓				2.50
B18	0.63				3342.89	2.50	3342.26	
		100	-0.004	↓				2.50
B19	0.62				3340.87	2.50	3340.25	
		100	-0.001	↓				2.50
B20	0.62				3338.86	2.50	3338.24	
		100	-0.088	↓				2.59
B21	0.54				3336.84	2.50	3336.30	
		100	-0.171	↓				25.17
B22	0.37				3354.40	25.00	3354.03	
		100	-0.201	↓				25.20
B23	0.16				3379.40	25.00	3379.24	

Table 5.2

WASTE SETTLEMENT AND ANGULAR DISTORTION BETWEEN POINTS; CROSS SECTION A-A

Point Location	Total Settlement	Distance Between Points	Angular Distortion	Distortion Direction
	(ft)	(ft)	(%)	
A1	0.08			
		100	0.31	↑
A2	0.39			
		100	0.22	↑
A3	0.61			
		100	0.21	↑
A4	0.82			
		100	-0.04	↓
A5	0.78			
		100	0.14	↑
A6	0.92			
		100	0.05	↑
A7	0.97			
		100	0.02	↑
A8	0.99			
		100	0.01	↑
A9	1.00			
		100	0.03	↑
A10	1.03			
		100	0.05	↑
A11	1.08			
		100	0.04	↑
A12	1.12			
		100	0.01	↑
A13	1.13			
		100	0.26	↑
A14	1.39			
		100	-0.25	↓
A15	1.14			
		100	-0.003	↓
A16	1.13			
		100	-0.04	↓
A17	1.09			
		100	-0.04	↓
A18	1.05			
		100	-0.02	↓
A19	1.03			
		100	0.00	↓
A20	1.03			
		100	-0.02	↓
A21	1.00			
		100	-0.04	↓
A22	0.96			
		100	-0.03	↓
A23	0.93			
		100	-0.06	↓
A24	0.86			
		100	-0.21	↓
A25	0.65			
		100	-0.35	↓
A26	0.30			
		100	-0.29	↓
A27	0.01			

Table 5.2 Continued

WASTE SETTLEMENT AND ANGULAR DISTORTION BETWEEN POINTS; CROSS SECTION B-B

Point Location	Total Settlement	Distance Between Points	Angular Distortion	Distortion Direction
	(ft)	(ft)	(%)	
B1	0.08			
		100	0.32	↑
B2	0.40			
		100	0.29	↑
B3	0.69			
		100	0.21	↑
B4	0.90			
		100	0.038	↑
B5	0.94			
		100	0.018	↑
B6	0.96			
		100	0.018	↑
B7	0.97			
		100	0.018	↑
B8	0.99			
		100	0.018	↑
B9	1.01			
		100	0.019	↑
B10	1.03			
		100	0.019	↑
B11	1.05			
		100	0.019	↑
B12	1.07			
		100	-0.006	↓
B13	1.06			
		100	-0.006	↓
B14	1.06			
		100	-0.006	↓
B15	1.05			
		100	-0.006	↓
B16	1.04			
		100	-0.006	↓
B17	1.04			
		100	-0.006	↓
B18	1.03			
		100	-0.010	↓
B19	1.02			
		100	-0.002	↓
B20	1.02			
		100	-0.20	↓
B21	0.82			
		100	-0.36	↓
B22	0.46			
		100	-0.35	↓
B23	0.11			

Table 5.3

SOIL COVER SETTLEMENT AND ANGULAR DISTORTION BETWEEN POINTS; CROSS SECTION A-A

Point Location	Total Settlement	Distance Between Points	Angular Distortion	Distortion Direction
	(ft)	(ft)	(%)	
A1	0.13			
		100	0.26	↑
A2	0.39			
		100	0.15	↑
A3	0.54			
		100	0.13	↑
A4	0.68			
		100	-0.03	↓
A5	0.65			
		100	0.27	↑
A6	0.92			
		100	-0.15	↓
A7	0.77			
		100	0.01	↑
A8	0.78			
		100	0.01	↑
A9	0.79			
		100	0.02	↑
A10	0.81			
		100	0.03	↑
A11	0.84			
		100	0.02	↑
A12	0.86			
		100	0.01	↑
A13	0.86			
		100	0.15	↑
A14	1.01			
		100	-0.14	↓
A15	0.87			
		100	-0.144	↓
A16	0.87			
		100	0.00	↓
A17	0.84			
		100	-0.02	↓
A18	0.82			
		100	-0.03	↓
A19	0.81			
		100	-0.01	↓
A20	0.80			
		100	0.00	↓
A21	0.79			
		100	-0.01	↓
A22	0.76			
		100	-0.03	↓
A23	0.75			
		100	-0.02	↓
A24	0.71			
		100	-0.17	↓
A25	0.57			
		100	-0.24	↓
A26	0.33			
		100	-0.29	↓
A27	0.04			

Table 5.3 Continued

SOIL COVER SETTLEMENT AND ANGULAR DISTORTION BETWEEN POINTS; CROSS SECTION B-B

Point Location	Total Settlement	Distance Between Points	Angular Distortion	Distortion Direction
	(ft)	(ft)	(%)	
B1	0.13			
		100	0.29	↑
B2	0.43			
		100	0.20	↑
B3	0.63			
		100	0.14	↑
B4	0.77			
		100	0.024	↑
B5	0.79			
		100	0.011	↑
B6	0.80			
		100	0.011	↑
B7	0.81			
		100	0.011	↑
B8	0.82			
		100	0.011	↑
B9	0.84			
		100	0.011	↑
B10	0.85			
		100	0.011	↑
B11	0.86			
		100	0.012	↑
B12	0.87			
		100	-0.003	↓
B13	0.87			
		100	-0.003	↓
B14	0.86			
		100	-0.003	↓
B15	0.86			
		100	-0.003	↓
B16	0.86			
		100	-0.003	↓
B17	0.85			
		100	-0.003	↓
B18	0.85			
		100	-0.006	↓
B19	0.84			
		100	-0.001	↓
B20	0.84			
		100	-0.13	↓
B21	0.72			
		100	-0.25	↓
B22	0.47			
		100	-0.29	↓
B23	0.18			

6.0 GEONET COMPRESSION UNDER OVERBURDEN

C.K. Disposal will utilize a 200-mil geonet onsite for leachate collection. The site's leachate collection was modeled using the HELP Model. The HELP Model uses a hydraulic conductivity of 10 cm/sec for the estimated geocomposite flow rate. The geonet has a tendency to compress when subjected to weight and time. Table 6.1 shows how different loading on the geocomposite affects drainage. A sample calculation follows:

- 200-mil geonet
- y_w = 74 pcf
- y_s = 110 pcf
- Maximum height of waste over geocomposite = 160 feet
- 50% compressibility at 20,000 psf

$t_o = t_i + (t_c - t_i)((P_o\text{-}P_i)/(P_t\text{-}P_i))$

Where:

t_o = thickness after loading

t_c = thickness of geonet at 20,000 psf = 0.1 inch

t_i = initial thickness = 0.2 inch

P_O = loading on geocomposite = (160 ft)(74 pcf) + (6 ft)(110 pcf) = 12,500 lbs/ft^2

P_i = initial loading

P_t = total compressibility

$t_o = t_i + (t_c - t_i)((P_o - P_i) / (P_t - P_i))$

$t_o = 0.2 + (0.1 - 0.2)((12{,}500 - 0) / (20{,}000 - 0))$

$t_o = 0.1375$ inch

A factor of safety was assumed to be 1.5 to account for geotextile intrusion, creep deformation, chemical clogging, and biological clogging.

6.1 Transmissivity

T_{FS} = T/FS

Where:

T_{FS} = transmissivity with factor of safety

T = transmissivity of geocomposite

FS = 1.5

T_{FS} = ((5.76E -4 (Tenax Geocomposite testing)) / (1.5)

T_{FS} = 3.84E -4

With maximum soil and waste profile weight applied to the geocomposite, a new hydraulic conductivity valve is calculated.

K = T_{FS} / t

K = (3.84E – 04m^2/s) / (0.1375 in)

K = 10.99 cm/s

6.2 Summary

The assumed hydraulic conductivity of 10 cm/sec used in the HELP model is less than the value calculated after the geocomposite is subjected to the loading of the waste and cover soil. Therefore, the 10 cm/sec is a conservative representation of the C.K. Disposal leachate collection system. Table 6.1 is a detailed summary of the geocomposite compression calculation.

Base/Design Geocomposite:

GSE Fabrinet HF

T = 9.00E-05 m2/s @ 10,000 psf
t = 0.2 in @ unloaded

1. Geocomposite Thickness

Assume the geocomposite will undergo linear compression due to the weight of soil and waste.

Unloaded geocomposite thickness = 0.2 in
Compressibility at 20,000 psf = 50 %

Unit weight of waste = 74.0 pcf = 1,998 lb/CY
Unit weight of soil = 110 pcf

Fill Condition	d_w[1] (ft)	d_s[2] (ft)	P[3] (psf)	t[4] (in)
Interim	40	3	3290	0.22
Interim	80	3	6250	0.17
Interim	120	3	9210	0.15
Final	160	6	12500	0.14

1. d_w is the depth of waste above the geocomposite
2. d_s is the depth of soil above the geocomposite
3. P is the pressure on the geocomposite due to the weight of the waste and soil.
4. t is the thickness of the geocomposite after being subjected to linear compression.

2. Factors of safety for Strength and Environmental Conditions.

Factor of Safety	Fill Condition			
	Interim (40' Waste)	Interim (80' Waste)	Interim (120' Waste)	Final (160' Waste)
Geotextile Intrusion	1.0	1.10	1.10	1.25
Creep Deformation	1.0	1.00	1.00	1.00
Chemical Clogging	1.0	1.10	1.10	1.10
Biological Clogging	1.0	1.10	1.10	1.10
FS Factor	1.00	1.33	1.33	1.50

3. Compute the hydraulic conductivity

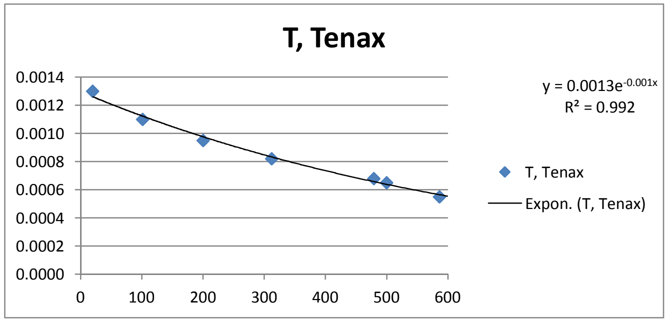
Fill Condition	d_w (ft)	P (psf)	t (in)	T[1] (m^2/s)	FS	T_{FS}[2] (m^2/s)	k[3] (cm/s)
Interim	40	3290	0.22	8.10E-04	1.00	8.10E-04	14.73
Interim	80	6250	0.17	7.08E-04	1.33	5.32E-04	12.41
Interim	120	9210	0.15	6.04E-04	1.33	4.54E-04	11.60
Final	160	12500	0.14	5.76E-04	1.50	3.84E-04	10.99

1. T is the geocomposite Transmissivity value.
2. T_{FS} is the geocomposite Transmissivity taking into account the FS.
3. k is the geocomposite hydraulic conductivity input

$k = T_{FS}/t$

$$y = y_0 + (y_1 - y_0)\frac{x - x_0}{x_1 - x_0}$$

dw	kpa	psf	T, Tenax	T, GSE
0	0.05	1	0.0013	
0	1	21	0.0013	
5	20	418	**0.0013**	
40	102	2,120	**0.0011**	0.000809
80	200	4,177	**0.00095**	
140	312	6,520	0.00082	0.000603
219	479	10,000	0.00068	0.0005
229	500	10,443	**0.00065**	
270	586	12,240	0.00055	0.000404



7.0 GEOTEXTILE RETENTION

Retention design is typically based on an upper limit to the largest geotextile opening size. According to Carrol (1983), the design of the geotextile should have the following relationship:

$O_{95} < (2\text{-}3)\ d_{85}$

Where:

O_{95} = apparent opening size

d_{85} = soil particle size in which 85% of the material by weight is finer

Based on the onsite soil testing, the d_{85} for the soil is approximately 0.2 mm. According to GSE documentation, the apparent opening size for the 8 oz geotextile is 0.1 mm to 0.2 mm.

$O_{95} < (2\text{-}3)\ d_{85}$

$0.2 < (2.5)(0.2)$

$0.2 < 0.5$

7.1 Permittivity

Permittivity is defined by ASTM D4491 as "the volumetric flow rate of water per unit cross-sectional area per unit head under laminar flow conditions in the normal direction through a geotextile." Designers rely primarily on the hydraulic conductivity of the geotextile, which is related to permittivity by the following equation:

$\Psi = K/t$

Where:

Ψ = permittivity of the geotextile (sec^{-1})

K = hydraulic conductivity of the geotextile (m/sec)

t = thickness of the geotextile (m)

According to GSE product specifications for the FabriNet 200-mil geocomposite, they specify the geotextile has a water flow rate of 95 gpm/ft^2

$K = (95\ \text{gpm/ft}^2)(0.133681\ \text{ft}^2/\text{gal})(1\ \text{min} / 60\ \text{sec})(0.3048 / 1\ \text{ft})$

$K = 0.06\ \text{m/s}$

Geotextile thickness = 100 mil = 0.00254 meter

$\Psi = K/t = (0.06\ \text{m/s} / 0.00254\ \text{m}) = 23.6\ \text{sec}^{-1}$

7.2 Porosity (Reference 7)

Reference 7 show that the porosity of geotextiles, geonets or geocomposites can be calculated by the equation below:

n = 1-(M/pt)

Where:

n = porosity

m = mass per unit area = 8 oz/yd^2 = 0.027 g/cm^2

p = density of polymeric compound = 0.94

t = thickness of geosynthetic material = 0.254 cm

Since the density of high density polyethylene is approximately constant around 0.94 g/cm^3, porosity of the material primarily depends on its thickness and mass per unit area. In general, the higher the M/t ratio, the higher the geosynthetic porosity.

n = 1 – (M/pt)

n = 1 – ((0.027 g/cm^2) / (0.94 g/cm^3)(0.254 cm))

n = 0.887

8.0 GEOTECHNICAL DESIGN – SLOPE STABILITY

Final cover slope stability was analyzed under static and pseudo-static conditions for the CK Disposal Facility. Both scenarios were analyzed for circular failure using Bishop and Janbu simplified calculation methods. Janbu simplified analysis was selected as a redundant check of the Bishop simplified method. Both static and pseudo-static scenarios were analyzed using Slide 7.0, a RocScience program. A summary table (below) of the analyses run on the critical cross section of the landfill shows that final cover slope design is adequate for static and pseudo-static conditions.

Table 8.0 – Factor of Safety

	Bishop Simplified	Janbu Simplified
Static		
East Slope	2.544	2.635
West Slope	2.598	2.590
Pseudo-static		
East Slope	1.926	1.919
West Slope	1.900	1.894

8.1 Model Input Parameters

Grab samples from geotechnical drilling investigations were obtained from the site and tested by Terra Testing, LLC in Lubbock, Texas. These soils were identified as "Caliche" Silty Sand, "Red Bed" Sand, and "Sand" Silty Sand. Drilling logs, from the monitor wells drilled at the site, identified clayey sand, silty sand, and claystone. In order to construct the in-situ soil profile, both clayey sand and silty sand were considered to be "Caliche" Silty Sand, which is non-plastic and has a dry density of 102.2-pcf. The full depth of excavation will take place in this soil. Because excavated soil will be used as final cover on side slopes and top slopes, the same soil parameters were applied to final cover slopes. Side slopes will have 4-feet of cover, and top slopes will have 5-feet of cover. A unit weight of 2,000 pounds per cubic yard was converted to 74-pcf and used for waste properties. This value is used consistently throughout this permit application. Because no cohesion information was known about waste profile in final slope conditions, a cohesion value of 0-psf was used for waste analysis.

Reference 8 presented a table outlining descriptive properties of rock. This table listed the typical density of clastic sedimentary rock as 130 to 150-pcf. A typical value of 140-pcf was assumed for claystone identified at this site. A very conservative cohesion value of 2,000-psf was input into the model for the cohesion value of claystone. Reference 8 is attached to this report in Appendix C.

8.2 Static Slope Stability

The East-West cross section of the landfill site was identified as the critical cross section for slope stability analysis. This cross section is also representative of the entire landfill, as geometry is specified as uniform across all side slopes. RocScience Slide 7.0 was used to analyze the east and west side slopes of the East-West cross section. Although side slopes are specified as uniform, slight variations in perimeter drainage channels and transport roadways at the toe of slope warranted that each slope be checked for stability. Detailed Slide 7.0 model input information for static slope stability can be seen in Appendix A, along with Slide 7.0 output graphics.

8.3 Pseudo-static Slope Stability

The model input geometry and slopes identified for static slope stability were utilized for pseudo-static slope stability as well. The mapped Peak Ground Acceleration (PGA) at the site is 0.116 g (where g = 32.2 ft/s^2). A detailed report showing seismic properties of the location was generated at earthquake.usgs.gov and is attached in Appendix C. Per Reference 6 a typical horizontal seismic loading coefficient of 0.5*PGA was used. A conservative k_H of 0.8*PGA was used for this design. A vertical seismic loading coefficient of 0.66*k_H was also applied to the model.

The resulting seismic loading coefficients are $k_H = 0.8$ and $k_v = 0.5$. When these parameters were input to the static slope stability model in Slide 7.0, Factors of Safety greater than 2.0 were resultant for both slopes. A minimum accepted Factor of Safety is 1.1 for pseudo-static slope stability. Detailed Slide 7.0 model input information for pseudo-static slope stability can be seen in Appendix A, along with Slide 7.0 output graphics

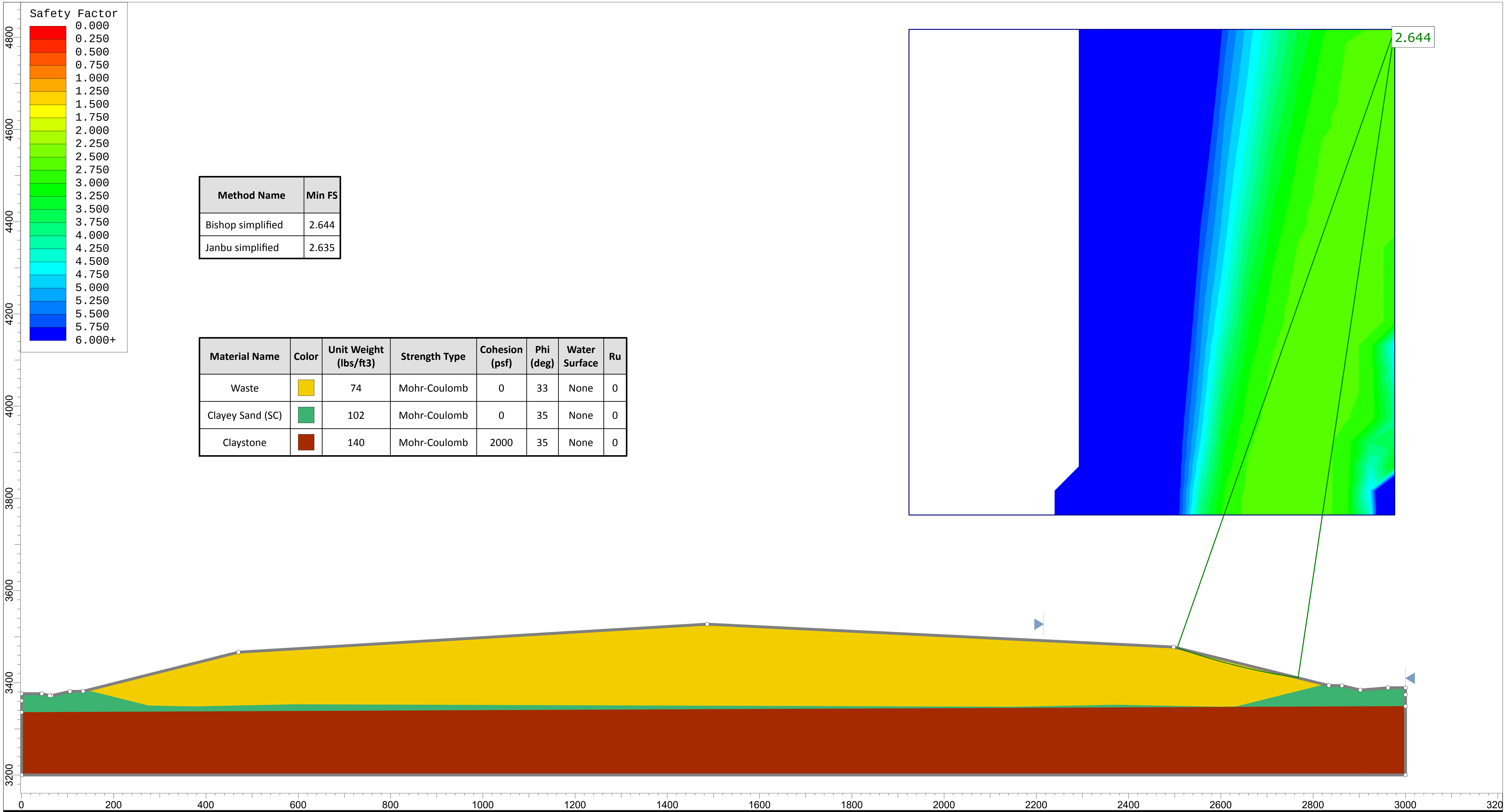
REFERENCES

1. Gray, Donald, Robert M. Koerner, and Xian Quede, *Geotechnical Aspects of Landfill Design and Construction*. New York: Prentice Hall, 2002. Print.
2. *Handbook of PVC Design*. Uni-Bell PVC Pipe Association, 2001. Print.
3. Parametrix, Inc. *Solid Waste Landfill Design Manual.* Washington State Department of Ecology. June 1987. Web. 3 May 2016. <https://fortress.wa.gov/ecy/publications/documents/87013.pdf>.
4. Driscopipe, Inc., *Polyethylene Piping Systems Manual*. 2008.
5. Chevron Phillips Chemical Company LP. *The Performance Pipe Engineering Manual.* CPChem Performance Pipe. Chevron Phillips, 2002. Web. 3 May 2016. <http://www.cpchem.com/en-us/Pages/default.aspx>.
6. Richardson, Clinton P., *Municipal Landfill Design Calculations: An Entry Level Manual of Practice*. California: UBuildABook, LLC, 2009. Print.
7. Bachus, Robert, Mengjia Li, Dhani Narejo, Richard Thiel, and Te-Yang Soong, *GSE Drainage Design Manual.* GSE Environmental, June 2007. Web. 3 May 2016. <https://www.gseworld.com/content/documents/product-sheets/Drainage_Design_Manual.pdf>
8. Koloski, Jon, Signmund Schwarz, and Donald Tubbs. *Geotechnical Properties of Geologic Materials*. Geotechnical Properties of Geologic Materials. 1989. Web. 3 May 2016. http://www.tubbs.com/geotech/geotech.htm
9. Sangeeta, Lewis P., and Hari D. Sharma, *Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation.* New York: John Wiley and Sons. 1994. Print.
10. Koerner, Robert M., *Designing with Geosynthetics*. 6th ed., Vol. 1. 2012. Print.
11. Coduto, Donald P., Man-chu R. Yeung, and William A. Kitch. *Geotechnical Engineering Principles and Practices*. 2nd ed. Upper Saddle River: Pearson Higher Education, 2011. Print.

.

APPENDIX A

STATIC MODEL INPUTS AND OUTPUTS



Method Name	Min FS
Bishop simplified	2.644
Janbu simplified	2.635

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟥	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project CK Disposal Facility, East Slope

Analysis Description Final Cover

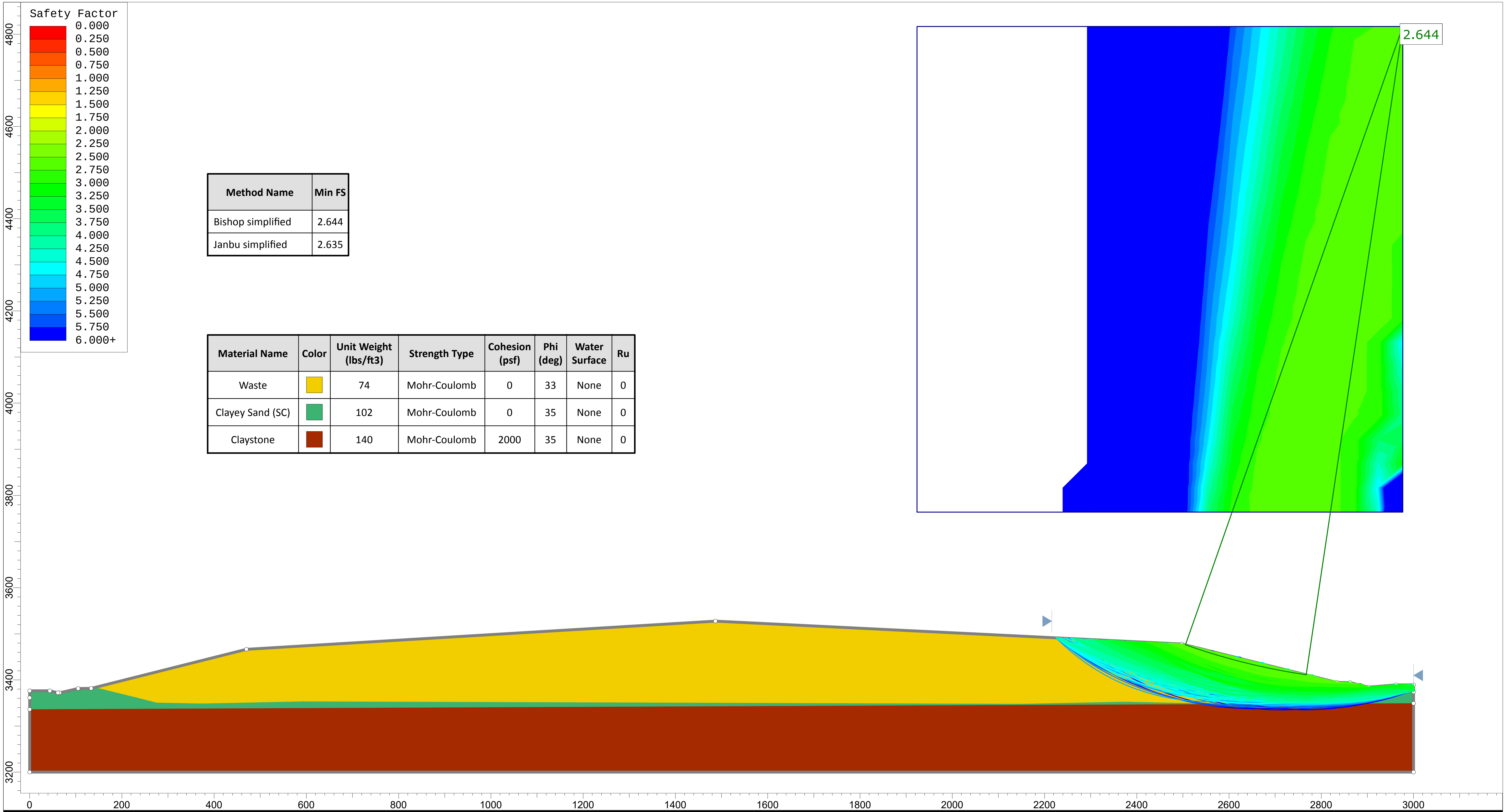
Drawn By

Scale 1:2364

Company Parkhill, Smith & Cooper Inc.

Date 4/19/2016, 5:02:51 PM

File Name EAST SLOPE STATIC.slim



Method Name	Min FS
Bishop simplified	2.644
Janbu simplified	2.635

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟫	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project: CK Disposal Facility, East Slope

Analysis Description: Final Cover

Drawn By:

Scale: 1:2364

Company: Parkhill, Smith & Cooper Inc.

Date: 4/19/2016, 5:02:51 PM

File Name: EAST SLOPE STATIC.slim

Slide Analysis Information

CK Disposal Facility, East Slope

Project Summary

File Name: EAST SLOPE STATIC
Slide Modeler Version: 7.014
Project Title: CK Disposal Facility, East Slope
Analysis: Final Cover
Company: Parkhill, Smith & Cooper Inc.
Date Created: 4/19/2016, 5:02:51 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Slices Type: Vertical

Analysis Methods Used	
	Bishop simplified
	Janbu simplified

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 75
Check malpha < 0.2: Yes
Create Interslice boundaries at intersections with water tables and piezos: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]: 62.4
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 5
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: Yes
Staged pseudostatic method: Effective Stress

Material Properties

Property	Waste	Clayey Sand (SC)	Claystone
Color	🟨	🟩	🟥
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	74	102	140
Cohesion [psf]	0	0	2000
Friction Angle [deg]	33	35	35
Water Surface	None	None	None
Ru Value	0	0	0

Global Minimums

Method: bishop simplified

FS	2.643640
Center:	2976.733, 4816.811
Radius:	1421.530
Left Slip Surface Endpoint:	2505.464, 3475.672
Right Slip Surface Endpoint:	2767.289, 3410.795
Resisting Moment:	9.04137e+007 lb-ft
Driving Moment:	3.42005e+007 lb-ft
Total Slice Area:	1153.23 ft2
Surface Horizontal Width:	261.825 ft
Surface Average Height:	4.40459 ft

Method: janbu simplified

FS	2.634950
Center:	2976.733, 4711.511
Radius:	1323.079
Left Slip Surface Endpoint:	2502.035, 3476.522
Right Slip Surface Endpoint:	2819.884, 3397.762
Resisting Horizontal Force:	112374 lb
Driving Horizontal Force:	42647.6 lb
Total Slice Area:	2221 ft2
Surface Horizontal Width:	317.85 ft
Surface Average Height:	6.98758 ft

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	1741
Number of Invalid Surfaces:	905

Error Codes:

Error Code -102 reported for 6 surfaces
Error Code -106 reported for 35 surfaces
Error Code -107 reported for 12 surfaces
Error Code -1000 reported for 852 surfaces

Method: janbu simplified

Number of Valid Surfaces:	1741
Number of Invalid Surfaces:	905

Error Codes:

Error Code -102 reported for 6 surfaces
Error Code -106 reported for 35 surfaces
Error Code -107 reported for 12 surfaces
Error Code -1000 reported for 852 surfaces

Error Codes

The following errors were encountered during the computation:

-102 = Two surface / slope intersections, but resulting arc is actually outside soil region.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-1000 = No valid slip surfaces are generated at a grid center. Unable to draw a surface.

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 2.64364

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.77986	118.392	-19.2592	Clayey Sand (SC)	15.875	0	6.00498	15.875	22.6708	0	22.6708
2	4.77986	350.528	-19.0552	Clayey Sand (SC)	47.0472	0	17.7964	47.0472	67.1874	0	67.1874
3	4.77986	573.385	-18.8515	Clayey Sand (SC)	77.0329	0	29.139	77.0329	110.01	0	110.01
4	4.77986	786.997	-18.648	Clayey Sand (SC)	105.833	0	40.0331	105.833	151.138	0	151.138
5	4.77986	991.396	-18.4448	Clayey Sand (SC)	133.448	0	50.4789	133.448	190.575	0	190.575
6	5.31874	1299.76	-18.2304	Waste	146.824	0	55.5386	146.824	226.08	0	226.08
7	5.31874	1466.05	-18.0049	Waste	165.773	0	62.7063	165.773	255.258	0	255.258
8	5.31874	1623.24	-17.7796	Waste	183.729	0	69.4985	183.729	282.907	0	282.907
9	5.31874	1771.36	-17.5546	Waste	200.691	0	75.9146	200.691	309.026	0	309.026
10	5.31874	1910.44	-17.3299	Waste	216.661	0	81.9556	216.661	333.617	0	333.617
11	5.31874	2040.51	-17.1055	Waste	231.64	0	87.6216	231.64	356.682	0	356.682
12	5.31874	2161.62	-16.8813	Waste	245.627	0	92.9124	245.627	378.219	0	378.219
13	5.31874	2273.79	-16.6574	Waste	258.625	0	97.8291	258.625	398.234	0	398.234
14	5.31874	2377.04	-16.4338	Waste	270.633	0	102.371	270.633	416.724	0	416.724
15	5.31874	2471.42	-16.2104	Waste	281.651	0	106.539	281.651	433.69	0	433.69
16	5.31874	2556.96	-15.9873	Waste	291.681	0	110.333	291.681	449.134	0	449.134
17	5.31874	2633.68	-15.7644	Waste	300.722	0	113.753	300.722	463.057	0	463.057
18	5.31874	2701.61	-15.5418	Waste	308.776	0	116.8	308.776	475.457	0	475.457
19	5.31874	2760.78	-15.3194	Waste	315.842	0	119.472	315.842	486.339	0	486.339
20	5.31874	2811.22	-15.0972	Waste	321.921	0	121.772	321.921	495.7	0	495.7
21	5.31874	2852.96	-14.8753	Waste	327.014	0	123.698	327.014	503.541	0	503.541
22	5.31874	2886.02	-14.6536	Waste	331.119	0	125.251	331.119	509.862	0	509.862
23	5.31874	2910.44	-14.4321	Waste	334.238	0	126.431	334.238	514.666	0	514.666
24	5.31874	2926.22	-14.2109	Waste	336.371	0	127.238	336.371	517.951	0	517.951
25	5.31874	2933.42	-13.9898	Waste	337.518	0	127.672	337.518	519.715	0	519.715
26	5.31874	2932.03	-13.769	Waste	337.678	0	127.732	337.678	519.964	0	519.964
27	5.31874	2922.1	-13.5484	Waste	336.853	0	127.42	336.853	518.692	0	518.692
28	5.31874	2903.65	-13.328	Waste	335.041	0	126.735	335.041	515.904	0	515.904
29	5.31874	2876.69	-13.1078	Waste	332.243	0	125.676	332.243	511.596	0	511.596
30	5.31874	2841.26	-12.8878	Waste	328.459	0	124.245	328.459	505.769	0	505.769
31	5.31874	2797.37	-12.6679	Waste	323.689	0	122.441	323.689	498.424	0	498.424
32	5.31874	2745.04	-12.4483	Waste	317.932	0	120.263	317.932	489.56	0	489.56
33	5.31874	2684.31	-12.2289	Waste	311.189	0	117.712	311.189	479.177	0	479.177
34	5.31874	2615.18	-12.0096	Waste	303.458	0	114.788	303.458	467.273	0	467.273
35	5.31874	2537.68	-11.7905	Waste	294.74	0	111.49	294.74	453.848	0	453.848
36	5.31874	2451.84	-11.5716	Waste	285.035	0	107.819	285.035	438.904	0	438.904
37	5.31874	2357.66	-11.3529	Waste	274.341	0	103.774	274.341	422.438	0	422.438
38	5.31874	2255.17	-11.1343	Waste	262.659	0	99.3551	262.659	404.449	0	404.449
39	5.31874	2144.39	-10.9159	Waste	249.988	0	94.562	249.988	384.939	0	384.939
40	5.31874	2025.34	-10.6976	Waste	236.328	0	89.3949	236.328	363.905	0	363.905
41	5.31874	1898.03	-10.4796	Waste	221.678	0	83.8533	221.678	341.346	0	341.346
42	5.31874	1762.48	-10.2616	Waste	206.037	0	77.9369	206.037	317.261	0	317.261
43	5.31874	1618.71	-10.0438	Waste	189.404	0	71.6452	189.404	291.651	0	291.651
44	5.31874	1466.74	-9.82619	Waste	171.78	0	64.9786	171.78	264.512	0	264.512
45	5.31874	1306.58	-9.6087	Waste	153.164	0	57.9368	153.164	235.847	0	235.847
46	5.03522	1052.78	-9.39713	Clayey Sand (SC)	140.256	0	53.0541	140.256	200.301	0	200.301
47	5.03522	835.203	-9.19148	Clayey Sand (SC)	111.374	0	42.129	111.374	159.055	0	159.055
48	5.03522	608.108	-8.98595	Clayey Sand (SC)	81.1668	0	30.7027	81.1668	115.916	0	115.916
49	5.03522	371.507	-8.78054	Clayey Sand (SC)	49.633	0	18.7745	49.633	70.8819	0	70.8819
50	5.03522	125.416	-8.57524	Clayey Sand (SC)	16.7711	0	6.34394	16.7711	23.9512	0	23.9512

Global Minimum Query (janbu simplified) - Safety Factor: 2.63495

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.80225	229.894	-20.891	Clayey Sand (SC)	25.1884	0	9.55935	25.1884	35.9701	0	35.9701
2	5.80225	680.472	-20.6223	Clayey Sand (SC)	74.6527	0	28.3317	74.6527	106.607	0	106.607
3	5.80225	1112.68	-20.3541	Clayey Sand (SC)	122.227	0	46.3868	122.227	174.545	0	174.545
4	6.40397	1640.05	-20.0724	Waste	152.572	0	57.9032	152.572	234.925	0	234.925
5	6.40397	1988.25	-19.7775	Waste	185.209	0	70.2894	185.209	285.177	0	285.177
6	6.40397	2318.82	-19.483	Waste	216.285	0	82.0832	216.285	333.029	0	333.029
7	6.40397	2631.86	-19.1891	Waste	245.805	0	93.2864	245.805	378.482	0	378.482
8	6.40397	2927.46	-18.8957	Waste	273.769	0	103.899	273.769	421.541	0	421.541
9	6.40397	3205.71	-18.6029	Waste	300.179	0	113.922	300.179	462.208	0	462.208
10	6.40397	3466.71	-18.3105	Waste	325.039	0	123.357	325.039	500.486	0	500.486
11	6.40397	3710.55	-18.0186	Waste	348.348	0	132.203	348.348	536.378	0	536.378
12	6.40397	3937.3	-17.7273	Waste	370.11	0	140.462	370.11	569.886	0	569.886
13	6.40397	4147.05	-17.4363	Waste	390.325	0	148.134	390.325	601.014	0	601.014
14	6.40397	4339.89	-17.1459	Waste	408.996	0	155.22	408.996	629.762	0	629.762
15	6.40397	4515.89	-16.8559	Waste	426.123	0	161.72	426.123	656.135	0	656.135
16	6.40397	4675.14	-16.5663	Waste	441.707	0	167.634	441.707	680.132	0	680.132
17	6.40397	4817.7	-16.2772	Waste	455.751	0	172.964	455.751	701.757	0	701.757
18	6.40397	4943.66	-15.9885	Waste	468.254	0	177.709	468.254	721.009	0	721.009
19	6.40397	5053.08	-15.7002	Waste	479.218	0	181.87	479.218	737.893	0	737.893
20	6.40397	5146.03	-15.4124	Waste	488.643	0	185.447	488.643	752.406	0	752.406
21	6.40397	5222.59	-15.1249	Waste	496.531	0	188.44	496.531	764.552	0	764.552
22	6.40397	5282.83	-14.8378	Waste	502.881	0	190.85	502.881	774.331	0	774.331
23	6.40397	5326.8	-14.5511	Waste	507.695	0	192.677	507.695	781.744	0	781.744
24	6.40397	5354.57	-14.2648	Waste	510.973	0	193.921	510.973	786.792	0	786.792
25	6.40397	5366.21	-13.9788	Waste	512.714	0	194.582	512.714	789.474	0	789.474
26	6.40397	5361.77	-13.6932	Waste	512.919	0	194.66	512.919	789.791	0	789.791
27	6.40397	5341.31	-13.4079	Waste	511.589	0	194.155	511.589	787.744	0	787.744
28	6.40397	5304.89	-13.123	Waste	508.723	0	193.067	508.723	783.332	0	783.332
29	6.40397	5252.57	-12.8384	Waste	504.321	0	191.397	504.321	776.553	0	776.553
30	6.40397	5184.41	-12.5541	Waste	498.382	0	189.143	498.382	767.409	0	767.409
31	6.40397	5100.44	-12.2702	Waste	490.906	0	186.306	490.906	755.899	0	755.899
32	6.40397	5000.74	-11.9865	Waste	481.894	0	182.885	481.894	742.023	0	742.023
33	6.40397	4885.34	-11.7032	Waste	471.343	0	178.881	471.343	725.778	0	725.778
34	6.40397	4754.29	-11.4201	Waste	459.254	0	174.293	459.254	707.163	0	707.163
35	6.40397	4607.65	-11.1373	Waste	445.626	0	169.121	445.626	686.178	0	686.178
36	6.40397	4445.46	-10.8548	Waste	430.457	0	163.364	430.457	662.823	0	662.823
37	6.40397	4267.75	-10.5726	Waste	413.747	0	157.023	413.747	637.092	0	637.092
38	6.40397	4074.59	-10.2906	Waste	395.494	0	150.095	395.494	608.988	0	608.988
39	6.40397	3866	-10.0088	Waste	375.698	0	142.583	375.698	578.505	0	578.505
40	6.40397	3642.04	-9.72736	Waste	354.356	0	134.483	354.356	545.644	0	545.644
41	6.40397	3402.73	-9.4461	Waste	331.468	0	125.797	331.468	510.401	0	510.401
42	6.40397	3148.12	-9.16508	Waste	307.032	0	116.523	307.032	472.774	0	472.774
43	6.40397	2878.24	-8.88428	Waste	281.046	0	106.661	281.046	432.761	0	432.761
44	6.40397	2593.13	-8.6037	Waste	253.508	0	96.2098	253.508	390.358	0	390.358
45	6.40397	2292.82	-8.32332	Waste	224.416	0	85.169	224.416	345.561	0	345.561
46	6.40397	1977.35	-8.04314	Waste	193.769	0	73.538	193.769	298.371	0	298.371
47	6.40397	1646.75	-7.76316	Waste	161.564	0	61.3158	161.564	248.781	0	248.781
48	6.22271	1206.06	-7.48732	Clayey Sand (SC)	131.131	0	49.766	131.131	187.27	0	187.27
49	6.22271	736.949	-7.21561	Clayey Sand (SC)	80.2256	0	30.4467	80.2256	114.571	0	114.571
50	6.22271	248.818	-6.94406	Clayey Sand (SC)	27.1203	0	10.2925	27.1203	38.7309	0	38.7309

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 2.64364

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	2505.46	3475.67	0	0	0
2	2510.24	3474	9.15869	0	0
3	2515.02	3472.35	35.0204	0	0
4	2519.8	3470.72	75.2752	0	0
5	2524.58	3469.11	127.719	0	0
6	2529.36	3467.51	190.253	0	0
7	2534.68	3465.76	290.916	0	0
8	2540	3464.03	398.653	0	0
9	2545.32	3462.33	511.527	0	0
10	2550.64	3460.64	627.714	0	0
11	2555.96	3458.98	745.5	0	0
12	2561.28	3457.35	863.285	0	0
13	2566.59	3455.73	979.577	0	0
14	2571.91	3454.14	1092.99	0	0
15	2577.23	3452.57	1202.26	0	0
16	2582.55	3451.03	1306.22	0	0
17	2587.87	3449.5	1403.8	0	0
18	2593.19	3448	1494.04	0	0
19	2598.51	3446.52	1576.11	0	0
20	2603.83	3445.06	1649.25	0	0
21	2609.14	3443.63	1712.82	0	0
22	2614.46	3442.22	1766.28	0	0
23	2619.78	3440.83	1809.19	0	0
24	2625.1	3439.46	1841.21	0	0
25	2630.42	3438.11	1862.11	0	0
26	2635.74	3436.79	1871.74	0	0
27	2641.06	3435.48	1870.06	0	0
28	2646.38	3434.2	1857.14	0	0
29	2651.69	3432.94	1833.13	0	0
30	2657.01	3431.7	1798.28	0	0
31	2662.33	3430.48	1752.96	0	0
32	2667.65	3429.29	1697.6	0	0
33	2672.97	3428.12	1632.74	0	0
34	2678.29	3426.96	1559.04	0	0
35	2683.61	3425.83	1477.21	0	0
36	2688.93	3424.72	1388.1	0	0
37	2694.24	3423.63	1292.62	0	0
38	2699.56	3422.56	1191.79	0	0
39	2704.88	3421.52	1086.73	0	0
40	2710.2	3420.49	978.629	0	0
41	2715.52	3419.49	868.798	0	0
42	2720.84	3418.5	758.623	0	0
43	2726.16	3417.54	649.589	0	0
44	2731.48	3416.6	543.271	0	0
45	2736.79	3415.68	441.339	0	0
46	2742.11	3414.78	345.551	0	0
47	2747.15	3413.94	245.327	0	0
48	2752.18	3413.13	162.79	0	0
49	2757.22	3412.33	100.492	0	0
50	2762.25	3411.55	61.0858	0	0
51	2767.29	3410.79	0	0	0

Global Minimum Query (janbu simplified) - Safety Factor: 2.63495

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	2502.03	3476.52	0	0	0
2	2507.84	3474.31	24.1516	0	0
3	2513.64	3472.12	92.4141	0	0
4	2519.44	3469.97	198.775	0	0
5	2525.85	3467.63	377.41	0	0
6	2532.25	3465.33	583.618	0	0
7	2538.65	3463.06	812.074	0	0
8	2545.06	3460.83	1057.75	0	0
9	2551.46	3458.64	1315.9	0	0
10	2557.87	3456.49	1582.09	0	0
11	2564.27	3454.37	1852.14	0	0
12	2570.67	3452.28	2122.18	0	0
13	2577.08	3450.24	2388.6	0	0
14	2583.48	3448.23	2648.07	0	0
15	2589.89	3446.25	2897.53	0	0
16	2596.29	3444.31	3134.18	0	0
17	2602.69	3442.4	3355.49	0	0
18	2609.1	3440.53	3559.19	0	0
19	2615.5	3438.7	3743.27	0	0
20	2621.9	3436.9	3905.97	0	0
21	2628.31	3435.13	4045.78	0	0
22	2634.71	3433.4	4161.46	0	0
23	2641.12	3431.71	4251.99	0	0
24	2647.52	3430.04	4316.62	0	0
25	2653.92	3428.42	4354.82	0	0
26	2660.33	3426.82	4366.32	0	0
27	2666.73	3425.26	4351.09	0	0
28	2673.14	3423.74	4309.33	0	0
29	2679.54	3422.24	4241.46	0	0
30	2685.94	3420.78	4148.17	0	0
31	2692.35	3419.36	4030.36	0	0
32	2698.75	3417.96	3889.16	0	0
33	2705.16	3416.6	3725.94	0	0
34	2711.56	3415.28	3542.31	0	0
35	2717.96	3413.98	3340.07	0	0
36	2724.37	3412.72	3121.28	0	0
37	2730.77	3411.5	2888.22	0	0
38	2737.18	3410.3	2643.4	0	0
39	2743.58	3409.14	2389.52	0	0
40	2749.98	3408.01	2129.56	0	0
41	2756.39	3406.91	1866.68	0	0
42	2762.79	3405.84	1604.27	0	0
43	2769.2	3404.81	1345.97	0	0
44	2775.6	3403.81	1095.6	0	0
45	2782	3402.84	857.227	0	0
46	2788.41	3401.9	635.144	0	0
47	2794.81	3401	433.852	0	0
48	2801.22	3400.13	258.081	0	0
49	2807.44	3399.31	101.319	0	0
50	2813.66	3398.52	1.97501	0	0
51	2819.88	3397.76	0	0	0

List Of Coordinates

External Boundary

X	Y
105.01	3381.21
65	3372.05
61	3372.02
43.9	3376.3
0	3376.3
0	3361
0	3336
0	3200
3000	3200
3000	3349
3000	3374
3000	3389.22
2962.33	3389.22
2902.33	3384.3
2862.33	3393.92
2834.14	3394.23
2497.32	3477.69
1486.5	3527.15
470.02	3466.33
133.49	3381.5

Material Boundary

X	Y
133.49	3381.5
142.75	3381.59
149.94	3381.66
232.606	3361
275.18	3350.36
372.35	3348.37
594.61	3352.96
2150.52	3347.83
2372.79	3352.2
2595.06	3347.69
2633	3348.48
2735.51	3374
2817.33	3394.37
2824.68	3394.31
2834.14	3394.23

Material Boundary

X	Y
142.75	3381.59
142.75	3381.59
146.998	3382.66
468.81	3463.72
1486.54	3524.64
2498.75	3475.1
2820.46	3395.36
2824.68	3394.31

Material Boundary

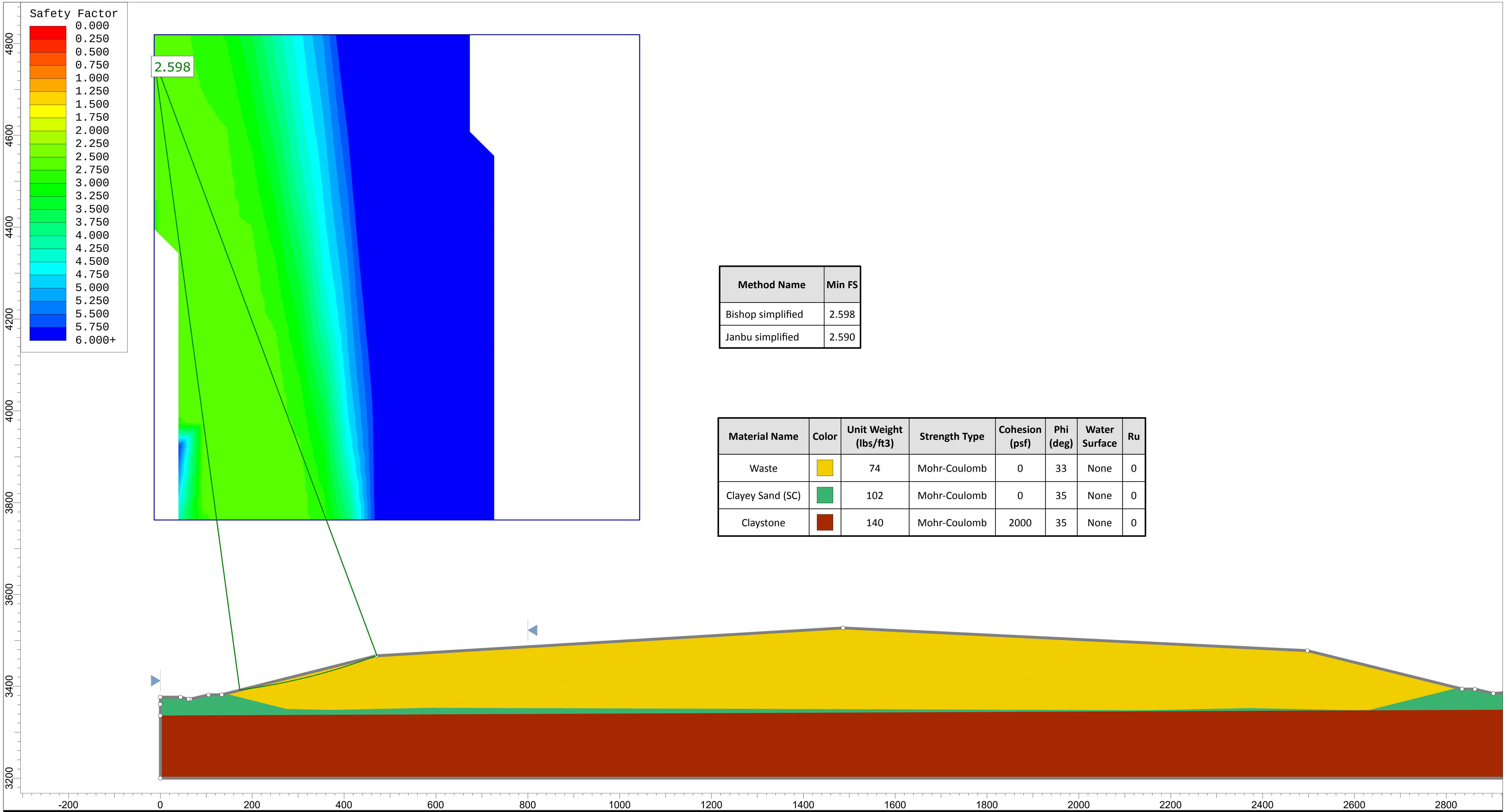
X	Y
594.53	3353.96
594.61	3352.96

Material Boundary

X	Y
2150.44	3348.83
2150.52	3347.83

Material Boundary

X	Y
0	3336
3000	3349

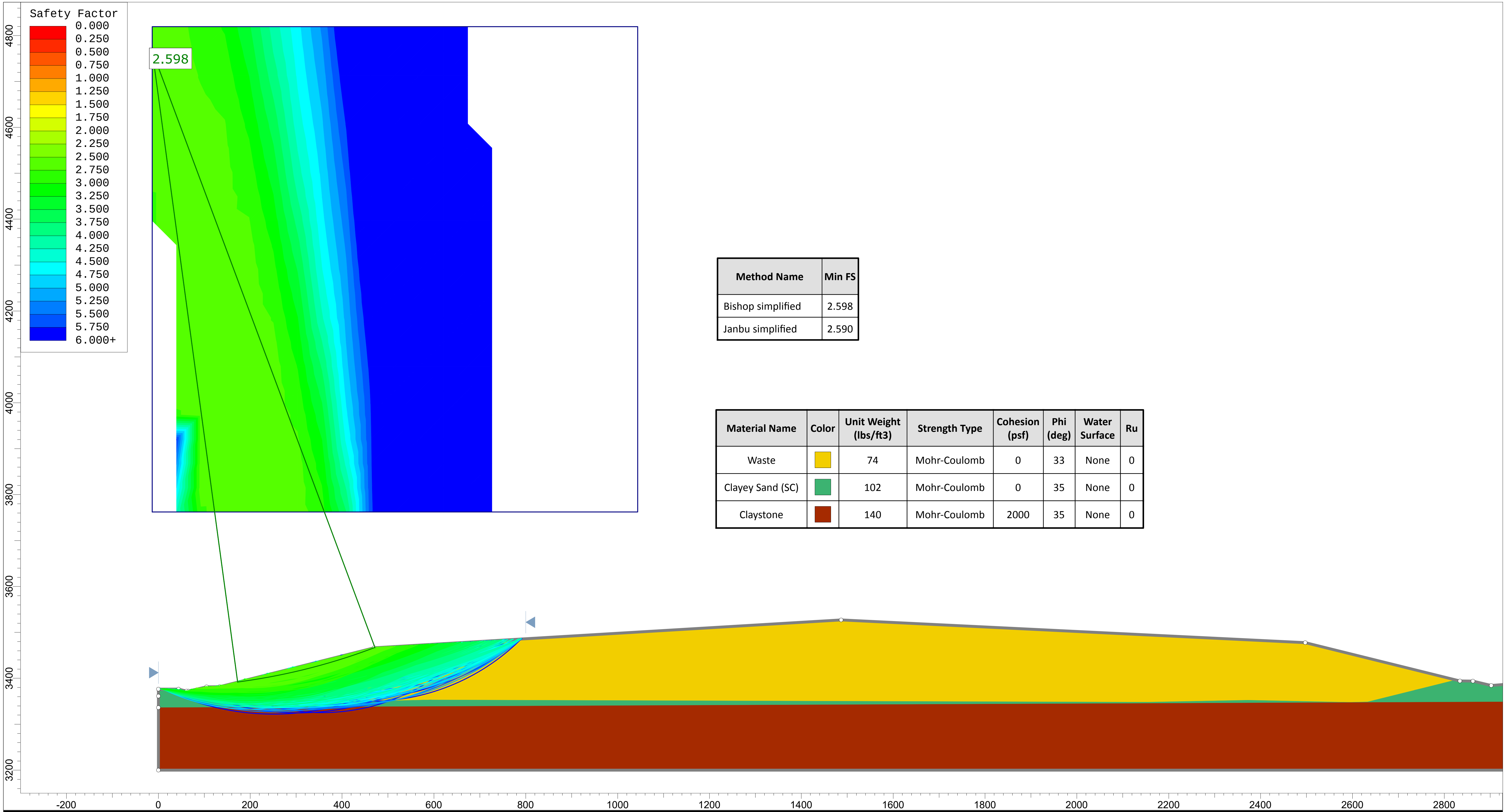


Method Name	Min FS
Bishop simplified	2.598
Janbu simplified	2.590

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟥	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project	CK Disposal Facility, West Slope		
Analysis Description	Final Cover		
Drawn By		*Scale*	1:2375
Company	Parkhill, Smith & Cooper Inc.		
Date	4/19/2016, 5:02:51 PM	*File Name*	WEST SLOPE STATIC.slim



Method Name	Min FS
Bishop simplified	2.598
Janbu simplified	2.590

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟥	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project CK Disposal Facility, West Slope

Analysis Description Final Cover

Drawn By

Scale 1:2375

Company Parkhill, Smith & Cooper Inc.

Date 4/19/2016, 5:02:51 PM

File Name WEST SLOPE STATIC.slim

Slide Analysis Information

CK Disposal Facility, West Slope

Project Summary

File Name: WEST SLOPE STATIC
Slide Modeler Version: 7.014
Project Title: CK Disposal Facility, West Slope
Analysis: Final Cover
Company: Parkhill, Smith & Cooper Inc.
Date Created: 4/19/2016, 5:02:51 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Slices Type: Vertical

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 75
Check malpha < 0.2: Yes
Create Interslice boundaries at intersections with water tables and piezos: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]: 62.4
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 5
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: Yes
Staged pseudostatic method: Effective Stress

Material Properties

Property	Waste	Clayey Sand (SC)	Claystone
Color	🟨	🟩	🟥
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	74	102	140
Cohesion [psf]	0	0	2000
Friction Angle [deg]	33	35	35
Water Surface	None	None	None
Ru Value	0	0	0

Global Minimums

Method: bishop simplified

FS	2.597510
Center:	-13.434, 4766.460
Radius:	1387.612
Left Slip Surface Endpoint:	172.744, 3391.395
Right Slip Surface Endpoint:	471.742, 3466.433
Resisting Moment:	1.33558e+008 lb-ft
Driving Moment:	5.14179e+007 lb-ft
Total Slice Area:	1814.38 ft2
Surface Horizontal Width:	298.998 ft
Surface Average Height:	6.06821 ft

Method: janbu simplified

FS	2.589740
Center:	-13.434, 4713.609
Radius:	1336.888
Left Slip Surface Endpoint:	158.650, 3387.842
Right Slip Surface Endpoint:	463.490, 3464.684
Resisting Horizontal Force:	99219 lb
Driving Horizontal Force:	38312.4 lb
Total Slice Area:	1944.05 ft2
Surface Horizontal Width:	304.84 ft
Surface Average Height:	6.37728 ft

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	1761
Number of Invalid Surfaces:	885

Error Codes:

Error Code -102 reported for 9 surfaces
Error Code -106 reported for 47 surfaces
Error Code -107 reported for 1 surface
Error Code -1000 reported for 828 surfaces

Method: janbu simplified

Number of Valid Surfaces:	1761
Number of Invalid Surfaces:	885

Error Codes:

Error Code -102 reported for 9 surfaces
Error Code -106 reported for 47 surfaces
Error Code -107 reported for 1 surface
Error Code -1000 reported for 828 surfaces

Error Codes

The following errors were encountered during the computation:

-102 = Two surface / slope intersections, but resulting arc is actually outside soil region.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-1000 = No valid slip surfaces are generated at a grid center. Unable to draw a surface.

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 2.59751

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	6.89156	276.425	7.85437	Clayey Sand (SC)	27.0793	0	10.4251	27.0793	38.6725	0	38.6725
2	6.89156	816.889	8.14172	Clayey Sand (SC)	79.9182	0	30.7672	79.9182	114.133	0	114.133
3	6.89156	1332.55	8.42929	Clayey Sand (SC)	130.194	0	50.1226	130.194	185.931	0	185.931
4	5.93104	1492.46	8.69699	Waste	157.397	0	60.5953	157.397	242.366	0	242.366
5	5.93104	1744.86	8.94482	Waste	183.82	0	70.7678	183.82	283.052	0	283.052
6	5.93104	1985.71	9.19282	Waste	208.971	0	80.4505	208.971	321.78	0	321.78
7	5.93104	2215	9.44099	Waste	232.852	0	89.6443	232.852	358.553	0	358.553
8	5.93104	2432.7	9.68935	Waste	255.464	0	98.3496	255.464	393.372	0	393.372
9	5.93104	2638.79	9.93788	Waste	276.809	0	106.567	276.809	426.239	0	426.239
10	5.93104	2833.23	10.1866	Waste	296.888	0	114.297	296.888	457.157	0	457.157
11	5.93104	3016	10.4355	Waste	315.701	0	121.54	315.701	486.125	0	486.125
12	5.93104	3187.07	10.6846	Waste	333.25	0	128.296	333.25	513.148	0	513.148
13	5.93104	3346.41	10.934	Waste	349.535	0	134.565	349.535	538.224	0	538.224
14	5.93104	3494.01	11.1835	Waste	364.559	0	140.349	364.559	561.358	0	561.358
15	5.93104	3629.81	11.4332	Waste	378.32	0	145.647	378.32	582.547	0	582.547
16	5.93104	3753.8	11.6832	Waste	390.82	0	150.459	390.82	601.795	0	601.795
17	5.93104	3865.94	11.9334	Waste	402.06	0	154.787	402.06	619.103	0	619.103
18	5.93104	3966.2	12.1838	Waste	412.041	0	158.629	412.041	634.47	0	634.47
19	5.93104	4054.55	12.4345	Waste	420.762	0	161.987	420.762	647.899	0	647.899
20	5.93104	4130.95	12.6854	Waste	428.224	0	164.859	428.224	659.389	0	659.389
21	5.93104	4195.37	12.9365	Waste	434.428	0	167.248	434.428	668.941	0	668.941
22	5.93104	4247.77	13.188	Waste	439.373	0	169.152	439.373	676.555	0	676.555
23	5.93104	4288.11	13.4396	Waste	443.061	0	170.571	443.061	682.235	0	682.235
24	5.93104	4316.36	13.6915	Waste	445.491	0	171.507	445.491	685.975	0	685.975
25	5.93104	4332.48	13.9437	Waste	446.664	0	171.959	446.664	687.781	0	687.781
26	5.93104	4336.43	14.1962	Waste	446.579	0	171.926	446.579	687.65	0	687.65
27	5.93104	4328.16	14.449	Waste	445.236	0	171.409	445.236	685.581	0	685.581
28	5.93104	4307.64	14.702	Waste	442.635	0	170.407	442.635	681.576	0	681.576
29	5.93104	4274.83	14.9553	Waste	438.777	0	168.922	438.777	675.635	0	675.635
30	5.93104	4229.68	15.209	Waste	433.66	0	166.952	433.66	667.755	0	667.755
31	5.93104	4172.15	15.4629	Waste	427.285	0	164.498	427.285	657.938	0	657.938
32	5.93104	4102.19	15.7172	Waste	419.651	0	161.559	419.651	646.183	0	646.183
33	5.93104	4019.75	15.9717	Waste	410.757	0	158.135	410.757	632.487	0	632.487
34	5.93104	3924.79	16.2266	Waste	400.604	0	154.226	400.604	616.853	0	616.853
35	5.93104	3817.27	16.4819	Waste	389.19	0	149.832	389.19	599.278	0	599.278
36	5.93104	3697.12	16.7374	Waste	376.515	0	144.952	376.515	579.76	0	579.76
37	5.93104	3564.3	16.9933	Waste	362.578	0	139.587	362.578	558.299	0	558.299
38	5.93104	3418.77	17.2496	Waste	347.378	0	133.735	347.378	534.894	0	534.894
39	5.93104	3260.46	17.5062	Waste	330.915	0	127.397	330.915	509.545	0	509.545
40	5.93104	3089.32	17.7632	Waste	313.187	0	120.572	313.187	482.247	0	482.247
41	5.93104	2905.3	18.0205	Waste	294.194	0	113.26	294.194	453.001	0	453.001
42	5.93104	2708.34	18.2782	Waste	273.934	0	105.46	273.934	421.804	0	421.804
43	5.93104	2498.38	18.5363	Waste	252.407	0	97.1727	252.407	388.656	0	388.656
44	5.93104	2275.37	18.7948	Waste	229.61	0	88.3962	229.61	353.554	0	353.554
45	5.93104	2039.24	19.0537	Waste	205.543	0	79.1308	205.543	316.495	0	316.495
46	5.93104	1789.94	19.313	Waste	180.205	0	69.3761	180.205	277.48	0	277.48
47	5.93104	1527.4	19.5727	Waste	153.594	0	59.1312	153.594	236.503	0	236.503
48	5.78585	1173.42	19.8297	Clayey Sand (SC)	129.432	0	49.8293	129.432	184.84	0	184.84
49	5.78585	794.249	20.0838	Clayey Sand (SC)	87.5006	0	33.6863	87.5006	124.958	0	124.958
50	5.78585	368.807	20.3384	Clayey Sand (SC)	40.5804	0	15.6228	40.5804	57.9519	0	57.9519

Global Minimum Query (janbu simplified) - Safety Factor: 2.58974

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	6.5392	261.182	7.53699	Clayey Sand (SC)	27.001	0	10.4261	27.001	38.5604	0	38.5604
2	6.5392	772.586	7.81978	Clayey Sand (SC)	79.7654	0	30.8005	79.7654	113.914	0	113.914
3	6.5392	1262.05	8.10277	Clayey Sand (SC)	130.129	0	50.2479	130.129	185.839	0	185.839
4	6.05072	1531.26	8.37536	Waste	158.495	0	61.2011	158.495	244.054	0	244.054
5	6.05072	1809.16	8.63757	Waste	187.048	0	72.2266	187.048	288.02	0	288.02
6	6.05072	2074.38	8.89995	Waste	214.225	0	82.7207	214.225	329.868	0	329.868
7	6.05072	2326.87	9.16253	Waste	240.029	0	92.6846	240.029	369.6	0	369.6
8	6.05072	2566.63	9.4253	Waste	264.46	0	102.118	264.46	407.22	0	407.22
9	6.05072	2793.61	9.68827	Waste	287.521	0	111.023	287.521	442.73	0	442.73
10	6.05072	3007.79	9.95144	Waste	309.213	0	119.399	309.213	476.131	0	476.131
11	6.05072	3209.13	10.2148	Waste	329.537	0	127.247	329.537	507.424	0	507.424
12	6.05072	3397.62	10.4784	Waste	348.494	0	134.567	348.494	536.615	0	536.615
13	6.05072	3573.2	10.7423	Waste	366.086	0	141.36	366.086	563.702	0	563.702
14	6.05072	3735.86	11.0063	Waste	382.313	0	147.626	382.313	588.688	0	588.688
15	6.05072	3885.55	11.2706	Waste	397.177	0	153.366	397.177	611.576	0	611.576
16	6.05072	4022.24	11.5352	Waste	410.678	0	158.579	410.678	632.364	0	632.364
17	6.05072	4145.89	11.8	Waste	422.817	0	163.266	422.817	651.056	0	651.056
18	6.05072	4256.48	12.065	Waste	433.596	0	167.428	433.596	667.652	0	667.652
19	6.05072	4353.95	12.3303	Waste	443.013	0	171.065	443.013	682.153	0	682.153
20	6.05072	4438.26	12.5959	Waste	451.071	0	174.176	451.071	694.559	0	694.559
21	6.05072	4509.39	12.8618	Waste	457.77	0	176.763	457.77	704.873	0	704.873
22	6.05072	4567.28	13.1279	Waste	463.11	0	178.825	463.11	713.094	0	713.094
23	6.05072	4611.9	13.3943	Waste	467.091	0	180.362	467.091	719.223	0	719.223
24	6.05072	4643.2	13.661	Waste	469.713	0	181.375	469.713	723.262	0	723.262
25	6.05072	4661.13	13.9281	Waste	470.977	0	181.863	470.977	725.206	0	725.206
26	6.05072	4665.65	14.1954	Waste	470.883	0	181.826	470.883	725.061	0	725.061
27	6.05072	4656.72	14.463	Waste	469.43	0	181.265	469.43	722.823	0	722.823
28	6.05072	4634.28	14.731	Waste	466.619	0	180.18	466.619	718.494	0	718.494
29	6.05072	4598.28	14.9993	Waste	462.449	0	178.57	462.449	712.074	0	712.074
30	6.05072	4548.68	15.2679	Waste	456.921	0	176.435	456.921	703.56	0	703.56
31	6.05072	4485.42	15.5369	Waste	450.033	0	173.775	450.033	692.953	0	692.953
32	6.05072	4408.45	15.8062	Waste	441.785	0	170.59	441.785	680.252	0	680.252
33	6.05072	4317.71	16.0759	Waste	432.177	0	166.88	432.177	665.456	0	665.456
34	6.05072	4213.15	16.346	Waste	421.207	0	162.645	421.207	648.566	0	648.566
35	6.05072	4094.72	16.6164	Waste	408.877	0	157.883	408.877	629.58	0	629.58
36	6.05072	3962.35	16.8872	Waste	395.184	0	152.596	395.184	608.495	0	608.495
37	6.05072	3815.98	17.1584	Waste	380.127	0	146.782	380.127	585.31	0	585.31
38	6.05072	3655.56	17.43	Waste	363.706	0	140.441	363.706	560.025	0	560.025
39	6.05072	3481.01	17.702	Waste	345.92	0	133.573	345.92	532.639	0	532.639
40	6.05072	3292.29	17.9745	Waste	326.768	0	126.178	326.768	503.147	0	503.147
41	6.05072	3089.32	18.2473	Waste	306.248	0	118.254	306.248	471.552	0	471.552
42	6.05072	2872.03	18.5206	Waste	284.359	0	109.802	284.359	437.847	0	437.847
43	6.05072	2640.36	18.7943	Waste	261.1	0	100.821	261.1	402.032	0	402.032
44	6.05072	2394.23	19.0684	Waste	236.469	0	91.3099	236.469	364.107	0	364.107
45	6.05072	2133.58	19.343	Waste	210.465	0	81.2688	210.465	324.065	0	324.065
46	6.05072	1858.34	19.6181	Waste	183.085	0	70.6963	183.085	281.907	0	281.907
47	6.05072	1568.42	19.8936	Waste	154.329	0	59.5925	154.329	237.63	0	237.63
48	6.33036	1249.59	20.176	Clayey Sand (SC)	125.727	0	48.5481	125.727	179.542	0	179.542
49	6.33036	766.236	20.4653	Clayey Sand (SC)	76.9857	0	29.7272	76.9857	109.939	0	109.939
50	6.33036	259.346	20.7552	Clayey Sand (SC)	26.0203	0	10.0475	26.0203	37.1578	0	37.1578

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 2.59751

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	172.744	3391.39	0	0	0
2	179.636	3392.35	35.0798	0	0
3	186.528	3393.33	134.587	0	0
4	193.419	3394.35	290.125	0	0
5	199.35	3395.26	429.631	0	0
6	205.281	3396.19	585.119	0	0
7	211.212	3397.15	753.412	0	0
8	217.143	3398.14	931.478	0	0
9	223.074	3399.15	1116.44	0	0
10	229.005	3400.19	1305.55	0	0
11	234.936	3401.26	1496.25	0	0
12	240.867	3402.35	1686.09	0	0
13	246.798	3403.47	1872.79	0	0
14	252.73	3404.61	2054.21	0	0
15	258.661	3405.79	2228.38	0	0
16	264.592	3406.99	2393.46	0	0
17	270.523	3408.21	2547.77	0	0
18	276.454	3409.47	2689.79	0	0
19	282.385	3410.75	2818.13	0	0
20	288.316	3412.05	2931.58	0	0
21	294.247	3413.39	3029.07	0	0
22	300.178	3414.75	3109.68	0	0
23	306.109	3416.14	3172.65	0	0
24	312.04	3417.56	3217.38	0	0
25	317.971	3419	3243.43	0	0
26	323.902	3420.48	3250.5	0	0
27	329.833	3421.98	3238.48	0	0
28	335.764	3423.51	3207.38	0	0
29	341.695	3425.06	3157.4	0	0
30	347.626	3426.65	3088.9	0	0
31	353.557	3428.26	3002.4	0	0
32	359.488	3429.9	2898.57	0	0
33	365.419	3431.57	2778.27	0	0
34	371.35	3433.27	2642.5	0	0
35	377.281	3434.99	2492.46	0	0
36	383.212	3436.75	2329.5	0	0
37	389.143	3438.53	2155.15	0	0
38	395.074	3440.34	1971.1	0	0
39	401.005	3442.18	1779.23	0	0
40	406.937	3444.06	1581.6	0	0
41	412.868	3445.96	1380.42	0	0
42	418.799	3447.88	1178.13	0	0
43	424.73	3449.84	977.299	0	0
44	430.661	3451.83	780.72	0	0
45	436.592	3453.85	591.356	0	0
46	442.523	3455.9	412.362	0	0
47	448.454	3457.98	247.084	0	0
48	454.385	3460.09	99.063	0	0
49	460.171	3462.17	1.71541	0	0
50	465.957	3464.29	-67.7247	0	0
51	471.742	3466.43	0	0	0

Global Minimum Query (janbu simplified) - Safety Factor: 2.58974

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	158.65	3387.84	0	0	0
2	165.189	3388.71	34.8704	0	0
3	171.729	3389.61	134.14	0	0
4	178.268	3390.54	289.969	0	0
5	184.319	3391.43	443.162	0	0
6	190.369	3392.35	615.798	0	0
7	196.42	3393.29	804.161	0	0
8	202.471	3394.27	1004.71	0	0
9	208.521	3395.27	1214.06	0	0
10	214.572	3396.31	1429.03	0	0
11	220.623	3397.37	1646.58	0	0
12	226.674	3398.46	1863.88	0	0
13	232.724	3399.58	2078.24	0	0
14	238.775	3400.73	2287.16	0	0
15	244.826	3401.9	2488.32	0	0
16	250.876	3403.11	2679.58	0	0
17	256.927	3404.34	2858.95	0	0
18	262.978	3405.61	3024.64	0	0
19	269.029	3406.9	3175.03	0	0
20	275.079	3408.22	3308.69	0	0
21	281.13	3409.58	3424.34	0	0
22	287.181	3410.96	3520.92	0	0
23	293.231	3412.37	3597.51	0	0
24	299.282	3413.81	3653.4	0	0
25	305.333	3415.28	3688.06	0	0
26	311.384	3416.78	3701.12	0	0
27	317.434	3418.31	3692.44	0	0
28	323.485	3419.87	3662.01	0	0
29	329.536	3421.46	3610.06	0	0
30	335.586	3423.08	3536.98	0	0
31	341.637	3424.74	3443.35	0	0
32	347.688	3426.42	3329.95	0	0
33	353.739	3428.13	3197.77	0	0
34	359.789	3429.87	3047.96	0	0
35	365.84	3431.65	2881.89	0	0
36	371.891	3433.45	2701.14	0	0
37	377.942	3435.29	2507.45	0	0
38	383.992	3437.16	2302.82	0	0
39	390.043	3439.06	2089.4	0	0
40	396.094	3440.99	1869.59	0	0
41	402.144	3442.95	1645.98	0	0
42	408.195	3444.95	1421.37	0	0
43	414.246	3446.98	1198.78	0	0
44	420.297	3449.03	981.454	0	0
45	426.347	3451.13	772.85	0	0
46	432.398	3453.25	576.648	0	0
47	438.449	3455.41	396.757	0	0
48	444.499	3457.6	237.314	0	0
49	450.83	3459.92	127.247	0	0
50	457.16	3462.29	55.855	0	0
51	463.49	3464.68	0	0	0

List Of Coordinates

External Boundary

X	Y
105.01	3381.21
65	3372.05
61	3372.02
43.9	3376.3
0	3376.3
0	3361
0	3336
0	3200
3000	3200
3000	3349
3000	3374
3000	3389.22
2962.33	3389.22
2902.33	3384.3
2862.33	3393.92
2834.14	3394.23
2497.32	3477.69
1486.5	3527.15
470.02	3466.33
133.49	3381.5

Material Boundary

X	Y
133.49	3381.5
142.75	3381.59
149.94	3381.66
232.606	3361
275.18	3350.36
372.35	3348.37
594.61	3352.96
2150.52	3347.83
2372.79	3352.2
2595.06	3347.69
2633	3348.48
2735.51	3374
2817.33	3394.37
2824.68	3394.31
2834.14	3394.23

Material Boundary

X	Y
142.75	3381.59
142.75	3381.59
146.998	3382.66
468.81	3463.72
1486.54	3524.64
2498.75	3475.1
2820.46	3395.36
2824.68	3394.31

Material Boundary

X	Y
594.53	3353.96
594.61	3352.96

Material Boundary

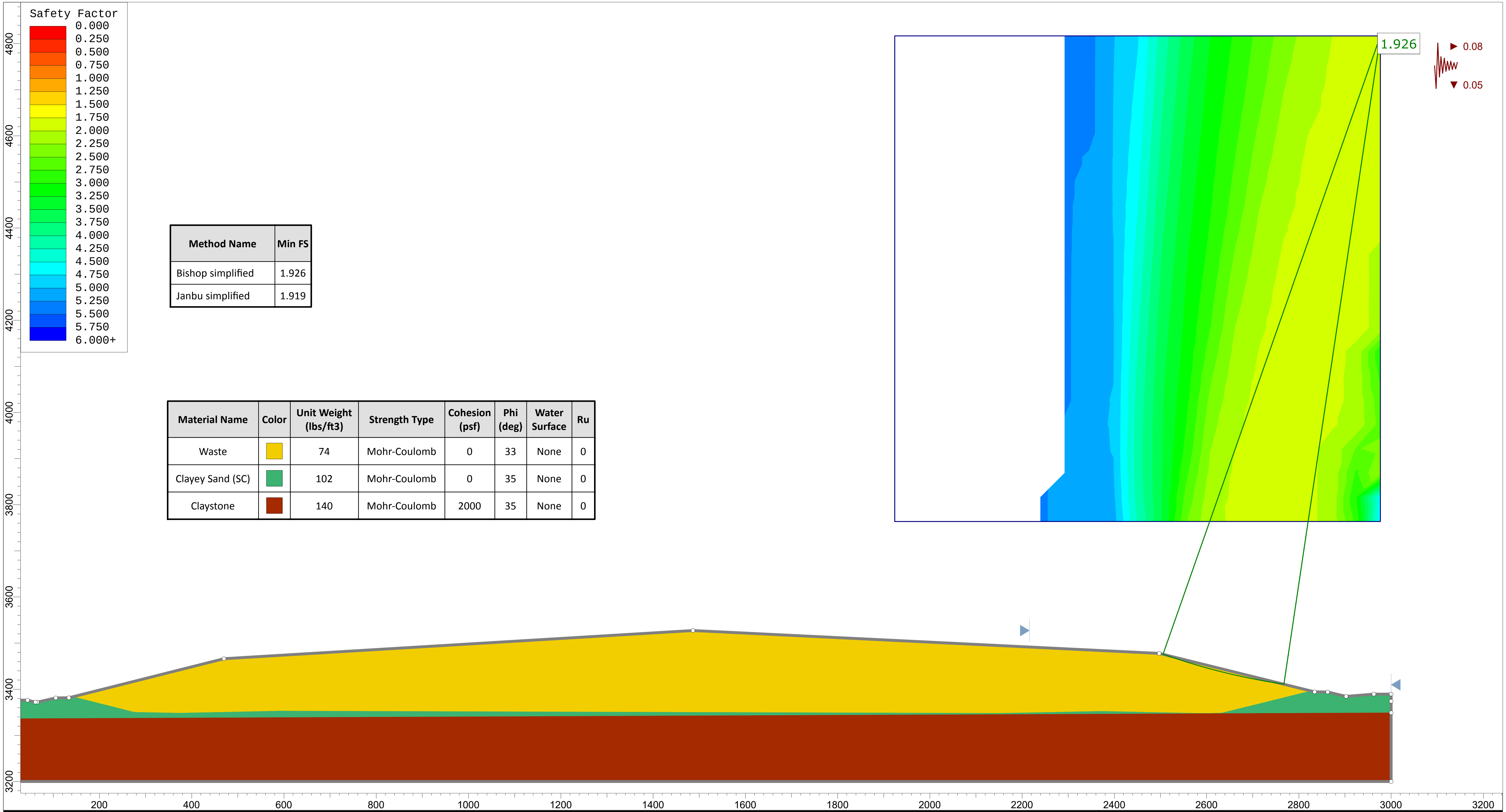
X	Y
2150.44	3348.83
2150.52	3347.83

Material Boundary

X	Y
0	3336
3000	3349

APPENDIX B

PSEUDO – STATIC MODEL INPUTS AND OUTPUTS

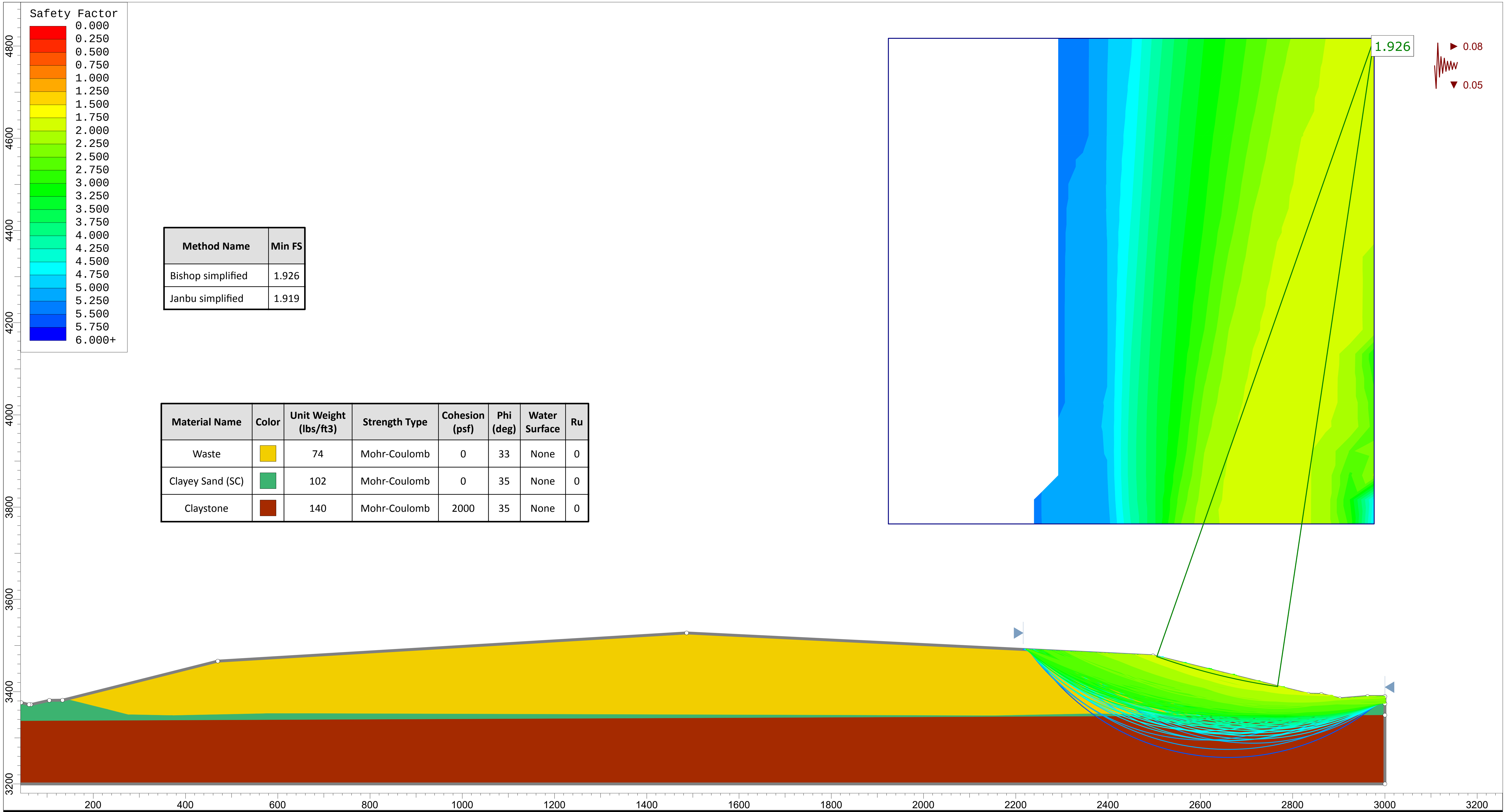


Method Name	Min FS
Bishop simplified	1.926
Janbu simplified	1.919

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟥	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project	CK Disposal Facility, East Slope
Analysis Description	Final Cover
Drawn By	
Scale	1:2364
Company	Parkhill, Smith & Cooper Inc.
Date	4/19/2016, 5:02:51 PM
File Name	EAST SLOPE SEISMIC.slim



Method Name	Min FS
Bishop simplified	1.926
Janbu simplified	1.919

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟫	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project CK Disposal Facility, East Slope

Analysis Description Final Cover

Drawn By

Scale 1:2364

Company Parkhill, Smith & Cooper Inc.

Date 4/19/2016, 5:02:51 PM

File Name EAST SLOPE SEISMIC.slim

Slide Analysis Information
CK Disposal Facility, East Slope

Project Summary

File Name:	EAST SLOPE SEISMIC
Slide Modeler Version:	7.014
Project Title:	CK Disposal Facility, East Slope
Analysis:	Final Cover
Company:	Parkhill, Smith & Cooper Inc.
Date Created:	4/19/2016, 5:02:51 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Left to Right
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
	Bishop simplified
	Janbu simplified

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 5
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: Yes
Staged pseudostatic method: Effective Stress

Loading

Seismic Load Coefficient (Horizontal): 0.08
Seismic Load Coefficient (Vertical): 0.05

Material Properties

Property	Waste	Clayey Sand (SC)	Claystone
Color	🟨	🟩	🟥
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	74	102	140
Cohesion [psf]	0	0	2000
Friction Angle [deg]	33	35	35
Water Surface	None	None	None
Ru Value	0	0	0

Global Minimums

Method: bishop simplified

FS	**1.925620**
Center:	2976.733, 4816.811
Radius:	1421.530
Left Slip Surface Endpoint:	2505.464, 3475.672
Right Slip Surface Endpoint:	2767.289, 3410.795
Resisting Moment:	9.04137e+007 lb-ft
Driving Moment:	4.6953e+007 lb-ft
Total Slice Area:	1153.23 ft2
Surface Horizontal Width:	261.825 ft
Surface Average Height:	4.40459 ft

Method: janbu simplified

FS	**1.919220**
Center:	2976.733, 4711.511
Radius:	1323.079
Left Slip Surface Endpoint:	2502.035, 3476.522
Right Slip Surface Endpoint:	2819.884, 3397.762
Resisting Horizontal Force:	112374 lb
Driving Horizontal Force:	58552 lb
Total Slice Area:	2221 ft2
Surface Horizontal Width:	317.85 ft
Surface Average Height:	6.98758 ft

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	1741
Number of Invalid Surfaces:	905

Error Codes:

Error Code -102 reported for 6 surfaces
Error Code -106 reported for 35 surfaces
Error Code -107 reported for 12 surfaces
Error Code -1000 reported for 852 surfaces

Method: janbu simplified

Number of Valid Surfaces:	1741
Number of Invalid Surfaces:	905

Error Codes:

Error Code -102 reported for 6 surfaces
Error Code -106 reported for 35 surfaces
Error Code -107 reported for 12 surfaces
Error Code -1000 reported for 852 surfaces

Error Codes

The following errors were encountered during the computation:

-102 = Two surface / slope intersections, but resulting arc is actually outside soil region.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-1000 = No valid slip surfaces are generated at a grid center. Unable to draw a surface.

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.92562

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.77986	118.392	-19.2592	Clayey Sand (SC)	15.875	0	8.2441	15.875	23.127	0	23.127
2	4.77986	350.528	-19.0552	Clayey Sand (SC)	47.0472	0	24.4322	47.0472	68.5621	0	68.5621
3	4.77986	573.385	-18.8515	Clayey Sand (SC)	77.0329	0	40.0042	77.0329	112.298	0	112.298
4	4.77986	786.997	-18.648	Clayey Sand (SC)	105.833	0	54.9605	105.833	154.333	0	154.333
5	4.77986	991.396	-18.4448	Clayey Sand (SC)	133.448	0	69.3013	133.448	194.668	0	194.668
6	5.31874	1299.76	-18.2304	Waste	146.824	0	76.2477	146.824	231.479	0	231.479
7	5.31874	1466.05	-18.0049	Waste	165.773	0	86.0881	165.773	261.441	0	261.441
8	5.31874	1623.24	-17.7796	Waste	183.729	0	95.4129	183.729	289.857	0	289.857
9	5.31874	1771.36	-17.5546	Waste	200.691	0	104.221	200.691	316.723	0	316.723
10	5.31874	1910.44	-17.3299	Waste	216.661	0	112.515	216.661	342.041	0	342.041
11	5.31874	2040.51	-17.1055	Waste	231.64	0	120.294	231.64	365.808	0	365.808
12	5.31874	2161.62	-16.8813	Waste	245.627	0	127.557	245.627	388.026	0	388.026
13	5.31874	2273.79	-16.6574	Waste	258.625	0	134.307	258.625	408.693	0	408.693
14	5.31874	2377.04	-16.4338	Waste	270.633	0	140.543	270.633	427.81	0	427.81
15	5.31874	2471.42	-16.2104	Waste	281.651	0	146.265	281.651	445.373	0	445.373
16	5.31874	2556.96	-15.9873	Waste	291.681	0	151.474	291.681	461.385	0	461.385
17	5.31874	2633.68	-15.7644	Waste	300.722	0	156.169	300.722	475.841	0	475.841
18	5.31874	2701.61	-15.5418	Waste	308.776	0	160.351	308.776	488.742	0	488.742
19	5.31874	2760.78	-15.3194	Waste	315.842	0	164.021	315.842	500.09	0	500.09
20	5.31874	2811.22	-15.0972	Waste	321.921	0	167.178	321.921	509.879	0	509.879
21	5.31874	2852.96	-14.8753	Waste	327.014	0	169.823	327.014	518.11	0	518.11
22	5.31874	2886.02	-14.6536	Waste	331.119	0	171.954	331.119	524.782	0	524.782
23	5.31874	2910.44	-14.4321	Waste	334.238	0	173.574	334.238	529.893	0	529.893
24	5.31874	2926.22	-14.2109	Waste	336.371	0	174.682	336.371	533.445	0	533.445
25	5.31874	2933.42	-13.9898	Waste	337.518	0	175.278	337.518	535.432	0	535.432
26	5.31874	2932.03	-13.769	Waste	337.678	0	175.361	337.678	535.855	0	535.855
27	5.31874	2922.1	-13.5484	Waste	336.853	0	174.932	336.853	534.713	0	534.713
28	5.31874	2903.65	-13.328	Waste	335.041	0	173.991	335.041	532.005	0	532.005
29	5.31874	2876.69	-13.1078	Waste	332.243	0	172.538	332.243	527.727	0	527.727
30	5.31874	2841.26	-12.8878	Waste	328.459	0	170.573	328.459	521.879	0	521.879
31	5.31874	2797.37	-12.6679	Waste	323.689	0	168.096	323.689	514.46	0	514.46
32	5.31874	2745.04	-12.4483	Waste	317.932	0	165.106	317.932	505.466	0	505.466
33	5.31874	2684.31	-12.2289	Waste	311.189	0	161.605	311.189	494.898	0	494.898
34	5.31874	2615.18	-12.0096	Waste	303.458	0	157.59	303.458	482.752	0	482.752
35	5.31874	2537.68	-11.7905	Waste	294.74	0	153.062	294.74	469.027	0	469.027

36	5.31874	2451.84	-11.5716	Waste	285.035	0	148.022	285.035	453.721	0	453.721
37	5.31874	2357.66	-11.3529	Waste	274.341	0	142.469	274.341	436.833	0	436.833
38	5.31874	2255.17	-11.1343	Waste	262.659	0	136.402	262.659	418.359	0	418.359
39	5.31874	2144.39	-10.9159	Waste	249.988	0	129.822	249.988	398.298	0	398.298
40	5.31874	2025.34	-10.6976	Waste	236.328	0	122.728	236.328	376.647	0	376.647
41	5.31874	1898.03	-10.4796	Waste	221.678	0	115.12	221.678	353.406	0	353.406
42	5.31874	1762.48	-10.2616	Waste	206.037	0	106.998	206.037	328.569	0	328.569
43	5.31874	1618.71	-10.0438	Waste	189.404	0	98.36	189.404	302.137	0	302.137
44	5.31874	1466.74	-9.82619	Waste	171.78	0	89.2076	171.78	274.105	0	274.105
45	5.31874	1306.58	-9.6087	Waste	153.164	0	79.5401	153.164	244.473	0	244.473
46	5.03522	1052.78	-9.39713	Clayey Sand (SC)	140.256	0	72.8368	140.256	207.482	0	207.482
47	5.03522	835.203	-9.19148	Clayey Sand (SC)	111.374	0	57.838	111.374	164.807	0	164.807
48	5.03522	608.108	-8.98595	Clayey Sand (SC)	81.1668	0	42.151	81.1668	120.144	0	120.144
49	5.03522	371.507	-8.78054	Clayey Sand (SC)	49.633	0	25.7751	49.633	73.4895	0	73.4895
50	5.03522	125.416	-8.57524	Clayey Sand (SC)	16.7711	0	8.70945	16.7711	24.8398	0	24.8398

Global Minimum Query (janbu simplified) - Safety Factor: 1.91922

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.80225	229.894	-20.891	Clayey Sand (SC)	25.1884	0	13.1243	25.1884	36.5921	0	36.5921
2	5.80225	680.472	-20.6223	Clayey Sand (SC)	74.6527	0	38.8974	74.6527	108.5	0	108.5
3	5.80225	1112.68	-20.3541	Clayey Sand (SC)	122.227	0	63.6858	122.227	177.723	0	177.723
4	6.40397	1640.05	-20.0724	Waste	152.572	0	79.4969	152.572	239.848	0	239.848
5	6.40397	1988.25	-19.7775	Waste	185.209	0	96.5022	185.209	291.287	0	291.287
6	6.40397	2318.82	-19.483	Waste	216.285	0	112.694	216.285	340.316	0	340.316
7	6.40397	2631.86	-19.1891	Waste	245.805	0	128.075	245.805	386.937	0	386.937
8	6.40397	2927.46	-18.8957	Waste	273.769	0	142.646	273.769	431.15	0	431.15
9	6.40397	3205.71	-18.6029	Waste	300.179	0	156.407	300.179	472.954	0	472.954
10	6.40397	3466.71	-18.3105	Waste	325.039	0	169.36	325.039	512.347	0	512.347
11	6.40397	3710.55	-18.0186	Waste	348.348	0	181.505	348.348	549.33	0	549.33
12	6.40397	3937.3	-17.7273	Waste	370.11	0	192.844	370.11	583.903	0	583.903
13	6.40397	4147.05	-17.4363	Waste	390.325	0	203.377	390.325	616.063	0	616.063
14	6.40397	4339.89	-17.1459	Waste	408.996	0	213.105	408.996	645.81	0	645.81
15	6.40397	4515.89	-16.8559	Waste	426.123	0	222.029	426.123	673.142	0	673.142
16	6.40397	4675.14	-16.5663	Waste	441.707	0	230.149	441.707	698.059	0	698.059
17	6.40397	4817.7	-16.2772	Waste	455.751	0	237.467	455.751	720.56	0	720.56
18	6.40397	4943.66	-15.9885	Waste	468.254	0	243.981	468.254	740.641	0	740.641
19	6.40397	5053.08	-15.7002	Waste	479.218	0	249.694	479.218	758.303	0	758.303
20	6.40397	5146.03	-15.4124	Waste	488.643	0	254.605	488.643	773.542	0	773.542
21	6.40397	5222.59	-15.1249	Waste	496.531	0	258.715	496.531	786.357	0	786.357
22	6.40397	5282.83	-14.8378	Waste	502.881	0	262.024	502.881	796.745	0	796.745
23	6.40397	5326.8	-14.5511	Waste	507.695	0	264.532	507.695	804.705	0	804.705
24	6.40397	5354.57	-14.2648	Waste	510.973	0	266.24	510.973	810.233	0	810.233
25	6.40397	5366.21	-13.9788	Waste	512.714	0	267.147	512.714	813.329	0	813.329
26	6.40397	5361.77	-13.6932	Waste	512.919	0	267.254	512.919	813.988	0	813.988

27	6.40397	5341.31	-13.4079	Waste	511.589	0	266.561	511.589	812.207	0	812.207
28	6.40397	5304.89	-13.123	Waste	508.723	0	265.068	508.723	807.985	0	807.985
29	6.40397	5252.57	-12.8384	Waste	504.321	0	262.774	504.321	801.316	0	801.316
30	6.40397	5184.41	-12.5541	Waste	498.382	0	259.679	498.382	792.198	0	792.198
31	6.40397	5100.44	-12.2702	Waste	490.906	0	255.784	490.906	780.629	0	780.629
32	6.40397	5000.74	-11.9865	Waste	481.894	0	251.088	481.894	766.603	0	766.603
33	6.40397	4885.34	-11.7032	Waste	471.343	0	245.591	471.343	750.117	0	750.117
34	6.40397	4754.29	-11.4201	Waste	459.254	0	239.292	459.254	731.169	0	731.169
35	6.40397	4607.65	-11.1373	Waste	445.626	0	232.191	445.626	709.752	0	709.752
36	6.40397	4445.46	-10.8548	Waste	430.457	0	224.287	430.457	685.862	0	685.862
37	6.40397	4267.75	-10.5726	Waste	413.747	0	215.581	413.747	659.496	0	659.496
38	6.40397	4074.59	-10.2906	Waste	395.494	0	206.07	395.494	630.65	0	630.65
39	6.40397	3866	-10.0088	Waste	375.698	0	195.756	375.698	599.317	0	599.317
40	6.40397	3642.04	-9.72736	Waste	354.356	0	184.635	354.356	565.492	0	565.492
41	6.40397	3402.73	-9.4461	Waste	331.468	0	172.71	331.468	529.173	0	529.173
42	6.40397	3148.12	-9.16508	Waste	307.032	0	159.977	307.032	490.351	0	490.351
43	6.40397	2878.24	-8.88428	Waste	281.046	0	146.438	281.046	449.022	0	449.022
44	6.40397	2593.13	-8.6037	Waste	253.508	0	132.089	253.508	405.181	0	405.181
45	6.40397	2292.82	-8.32332	Waste	224.416	0	116.931	224.416	358.823	0	358.823
46	6.40397	1977.35	-8.04314	Waste	193.769	0	100.962	193.769	309.938	0	309.938
47	6.40397	1646.75	-7.76316	Waste	161.564	0	84.1821	161.564	258.523	0	258.523
48	6.22271	1206.06	-7.48732	Clayey Sand (SC)	131.131	0	68.3252	131.131	194.525	0	194.525
49	6.22271	736.949	-7.21561	Clayey Sand (SC)	80.2256	0	41.8011	80.2256	119.057	0	119.057
50	6.22271	248.818	-6.94406	Clayey Sand (SC)	27.1203	0	14.1309	27.1203	40.2632	0	40.2632

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.92562

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	2505.46	3475.67	0	0	0
2	2510.24	3474	8.68912	0	0
3	2515.02	3472.35	33.1441	0	0
4	2519.8	3470.72	71.0697	0	0
5	2524.58	3469.11	120.276	0	0
6	2529.36	3467.51	178.678	0	0
7	2534.68	3465.76	282.631	0	0
8	2540	3464.03	393.978	0	0
9	2545.32	3462.33	510.733	0	0
10	2550.64	3460.64	631.023	0	0
11	2555.96	3458.98	753.088	0	0
12	2561.28	3457.35	875.28	0	0
13	2566.59	3455.73	996.063	0	0
14	2571.91	3454.14	1114.01	0	0
15	2577.23	3452.57	1227.81	0	0
16	2582.55	3451.03	1336.25	0	0
17	2587.87	3449.5	1438.24	0	0
18	2593.19	3448	1532.78	0	0
19	2598.51	3446.52	1618.98	0	0
20	2603.83	3445.06	1696.08	0	0
21	2609.14	3443.63	1763.39	0	0
22	2614.46	3442.22	1820.34	0	0
23	2619.78	3440.83	1866.48	0	0
24	2625.1	3439.46	1901.44	0	0
25	2630.42	3438.11	1924.95	0	0
26	2635.74	3436.79	1936.88	0	0
27	2641.06	3435.48	1937.15	0	0
28	2646.38	3434.2	1925.83	0	0
29	2651.69	3432.94	1903.06	0	0
30	2657.01	3431.7	1869.08	0	0
31	2662.33	3430.48	1824.25	0	0
32	2667.65	3429.29	1769.02	0	0
33	2672.97	3428.12	1703.93	0	0
34	2678.29	3426.96	1629.64	0	0
35	2683.61	3425.83	1546.9	0	0
36	2688.93	3424.72	1456.54	0	0
37	2694.24	3423.63	1359.51	0	0
38	2699.56	3422.56	1256.86	0	0
39	2704.88	3421.52	1149.72	0	0
40	2710.2	3420.49	1039.34	0	0
41	2715.52	3419.49	927.05	0	0
42	2720.84	3418.5	814.281	0	0
43	2726.16	3417.54	702.567	0	0
44	2731.48	3416.6	593.534	0	0
45	2736.79	3415.68	488.908	0	0
46	2742.11	3414.78	390.511	0	0
47	2747.15	3413.94	280.882	0	0
48	2752.18	3413.13	190.749	0	0
49	2757.22	3412.33	122.822	0	0
50	2762.25	3411.55	79.9151	0	0
51	2767.29	3410.79	0	0	0

Global Minimum Query (janbu simplified) - Safety Factor: 1.91922

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	2502.03	3476.52	0	0	0
2	2507.84	3474.31	23.26	0	0
3	2513.64	3472.12	88.859	0	0
4	2519.44	3469.97	190.821	0	0
5	2525.85	3467.63	374.056	0	0
6	2532.25	3465.33	585.722	0	0
7	2538.65	3463.06	820.39	0	0
8	2545.06	3460.83	1072.93	0	0
9	2551.46	3458.64	1338.5	0	0
10	2557.87	3456.49	1612.55	0	0
11	2564.27	3454.37	1890.82	0	0
12	2570.67	3452.28	2169.32	0	0
13	2577.08	3450.24	2444.36	0	0
14	2583.48	3448.23	2712.5	0	0
15	2589.89	3446.25	2970.58	0	0
16	2596.29	3444.31	3215.73	0	0
17	2602.69	3442.4	3445.32	0	0
18	2609.1	3440.53	3657	0	0
19	2615.5	3438.7	3848.69	0	0
20	2621.9	3436.9	4018.53	0	0
21	2628.31	3435.13	4164.97	0	0
22	2634.71	3433.4	4286.69	0	0
23	2641.12	3431.71	4382.61	0	0
24	2647.52	3430.04	4451.93	0	0
25	2653.92	3428.42	4494.08	0	0
26	2660.33	3426.82	4508.74	0	0
27	2666.73	3425.26	4495.86	0	0
28	2673.14	3423.74	4455.59	0	0
29	2679.54	3422.24	4388.38	0	0
30	2685.94	3420.78	4294.87	0	0
31	2692.35	3419.36	4175.97	0	0
32	2698.75	3417.96	4032.83	0	0
33	2705.16	3416.6	3866.84	0	0
34	2711.56	3415.28	3679.6	0	0
35	2717.96	3413.98	3473	0	0
36	2724.37	3412.72	3249.12	0	0
37	2730.77	3411.5	3010.29	0	0
38	2737.18	3410.3	2759.1	0	0
39	2743.58	3409.14	2498.34	0	0
40	2749.98	3408.01	2231.05	0	0
41	2756.39	3406.91	1960.52	0	0
42	2762.79	3405.84	1690.26	0	0
43	2769.2	3404.81	1424	0	0
44	2775.6	3403.81	1165.74	0	0
45	2782	3402.84	919.68	0	0
46	2788.41	3401.9	690.281	0	0
47	2794.81	3401	482.226	0	0
48	2801.22	3400.13	300.437	0	0
49	2807.44	3399.31	130.739	0	0
50	2813.66	3398.52	23.3118	0	0
51	2819.88	3397.76	0	0	0

List Of Coordinates

External Boundary

X	Y
105.01	3381.21
65	3372.05
61	3372.02
43.9	3376.3
0	3376.3
0	3361
0	3336
0	3200
3000	3200
3000	3349
3000	3374
3000	3389.22
2962.33	3389.22
2902.33	3384.3
2862.33	3393.92
2834.14	3394.23
2497.32	3477.69
1486.5	3527.15
470.02	3466.33
133.49	3381.5

Material Boundary

X	Y
133.49	3381.5
142.75	3381.59
149.94	3381.66
232.606	3361
275.18	3350.36
372.35	3348.37
594.61	3352.96
2150.52	3347.83
2372.79	3352.2
2595.06	3347.69
2633	3348.48
2735.51	3374
2817.33	3394.37
2824.68	3394.31
2834.14	3394.23

Material Boundary

X	Y
142.75	3381.59
142.75	3381.59
146.998	3382.66
468.81	3463.72
1486.54	3524.64
2498.75	3475.1
2820.46	3395.36
2824.68	3394.31

Material Boundary

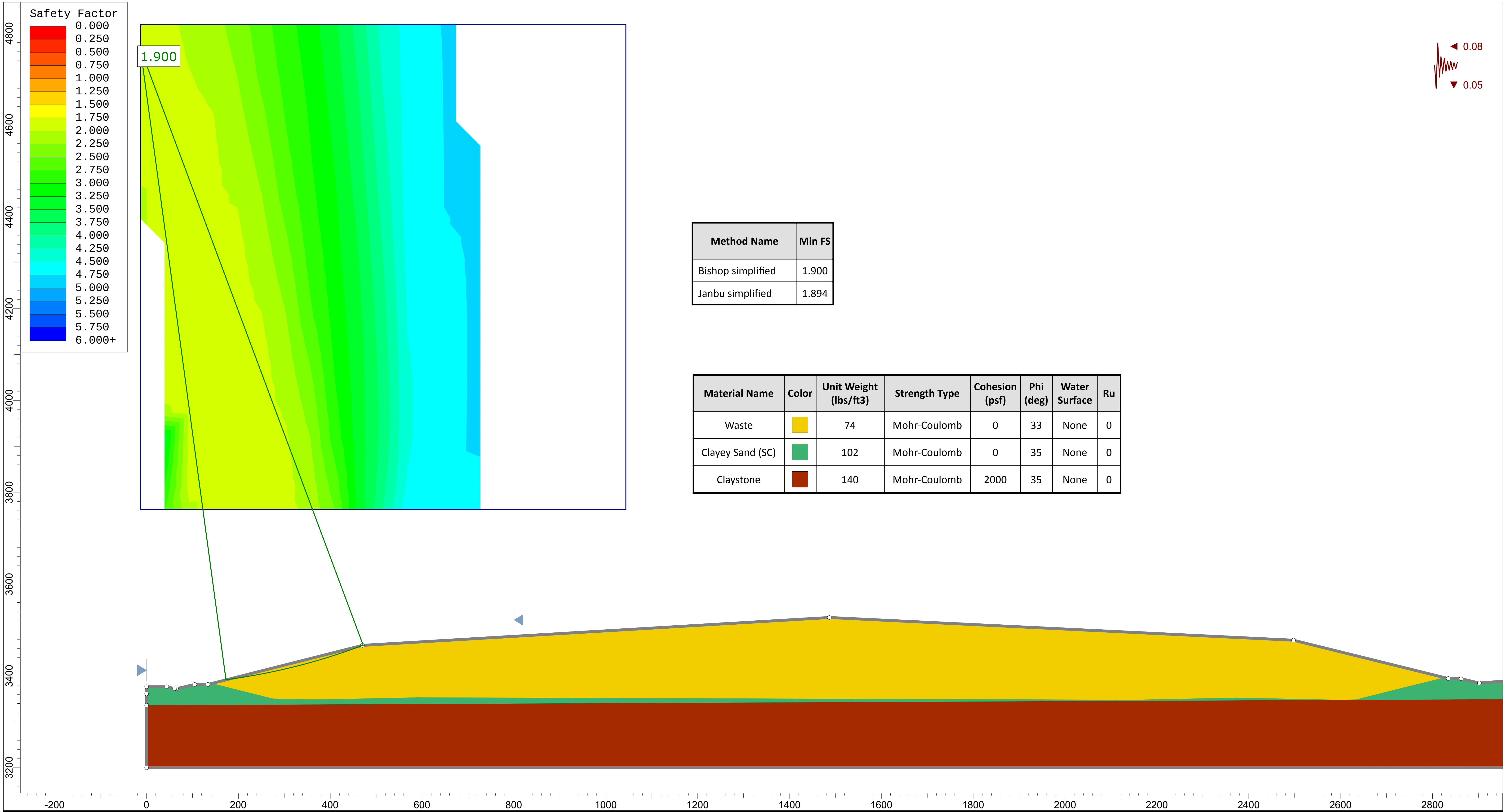
X	Y
594.53	3353.96
594.61	3352.96

Material Boundary

X	Y
2150.44	3348.83
2150.52	3347.83

Material Boundary

X	Y
0	3336
3000	3349

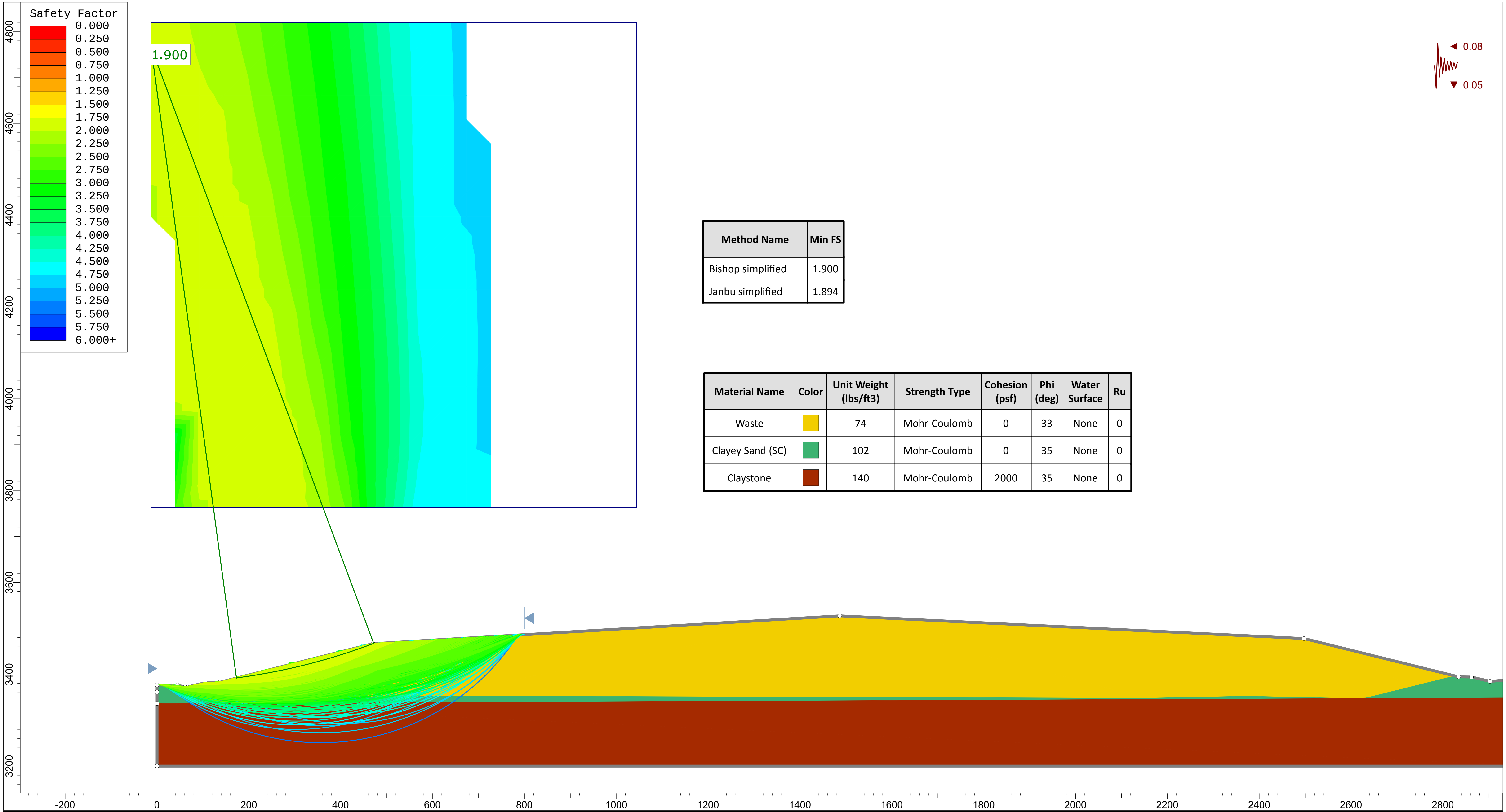


Method Name	Min FS
Bishop simplified	1.900
Janbu simplified	1.894

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟥	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project	CK Disposal Facility, West Slope		
Analysis Description	Final Cover		
Drawn By		*Scale* 1:2375	*Company* Parkhill, Smith & Cooper Inc.
Date	4/19/2016, 5:02:51 PM	*File Name*	WEST SLOPE SEISMIC.slim



Method Name	Min FS
Bishop simplified	1.900
Janbu simplified	1.894

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Waste	🟨	74	Mohr-Coulomb	0	33	None	0
Clayey Sand (SC)	🟩	102	Mohr-Coulomb	0	35	None	0
Claystone	🟥	140	Mohr-Coulomb	2000	35	None	0

SLIDEINTERPRET 7.014

Project	CK Disposal Facility, West Slope
Analysis Description	Final Cover
Drawn By	
Scale	1:2375
Company	Parkhill, Smith & Cooper Inc.
Date	4/19/2016, 5:02:51 PM
File Name	WEST SLOPE SEISMIC.slim

Slide Analysis Information

CK Disposal Facility, West Slope

Project Summary

File Name:	WEST SLOPE SEISMIC
Slide Modeler Version:	7.014
Project Title:	CK Disposal Facility, West Slope
Analysis:	Final Cover
Company:	Parkhill, Smith & Cooper Inc.
Date Created:	4/19/2016, 5:02:51 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
	Bishop simplified
	Janbu simplified

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	5
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	Yes
Staged pseudostatic method:	Effective Stress

Loading

Seismic Load Coefficient (Horizontal):	0.08
Seismic Load Coefficient (Vertical):	0.05

Material Properties

Property	Waste	Clayey Sand (SC)	Claystone
Color	🟨	🟩	🟥
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	74	102	140
Cohesion [psf]	0	0	2000
Friction Angle [deg]	33	35	35
Water Surface	None	None	None
Ru Value	0	0	0

Global Minimums

Method: bishop simplified

FS	1.899610
Center:	-13.434, 4766.460
Radius:	1387.612
Left Slip Surface Endpoint:	172.744, 3391.395
Right Slip Surface Endpoint:	471.742, 3466.433
Resisting Moment:	1.33558e+008 lb-ft
Driving Moment:	7.03084e+007 lb-ft
Total Slice Area:	1814.38 ft2
Surface Horizontal Width:	298.998 ft
Surface Average Height:	6.06821 ft

Method: janbu simplified

FS	1.893970
Center:	-13.434, 4713.609
Radius:	1336.888
Left Slip Surface Endpoint:	158.650, 3387.842
Right Slip Surface Endpoint:	463.490, 3464.684
Resisting Horizontal Force:	99219 lb
Driving Horizontal Force:	52386.9 lb
Total Slice Area:	1944.05 ft2
Surface Horizontal Width:	304.84 ft
Surface Average Height:	6.37728 ft

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	1761
Number of Invalid Surfaces:	885

Error Codes:

Error Code -102 reported for 9 surfaces
Error Code -106 reported for 47 surfaces
Error Code -107 reported for 1 surface
Error Code -1000 reported for 828 surfaces

Method: janbu simplified

Number of Valid Surfaces:	1761
Number of Invalid Surfaces:	885

Error Codes:

Error Code -102 reported for 9 surfaces
Error Code -106 reported for 47 surfaces
Error Code -107 reported for 1 surface
Error Code -1000 reported for 828 surfaces

Error Codes

The following errors were encountered during the computation:

-102 = Two surface / slope intersections, but resulting arc is actually outside soil region.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-1000 = No valid slip surfaces are generated at a grid center. Unable to draw a surface.

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.89961

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	6.89156	276.425	7.85437	Clayey Sand (SC)	27.0793	0	14.2552	27.0793	40.1498	0	40.1498
2	6.89156	816.889	8.14172	Clayey Sand (SC)	79.9182	0	42.0708	79.9182	118.443	0	118.443
3	6.89156	1332.55	8.42929	Clayey Sand (SC)	130.194	0	68.5372	130.194	192.871	0	192.871
4	5.93104	1492.46	8.69699	Waste	157.397	0	82.8575	157.397	251.542	0	251.542
5	5.93104	1744.86	8.94482	Waste	183.82	0	96.7672	183.82	293.67	0	293.67
6	5.93104	1985.71	9.19282	Waste	208.971	0	110.007	208.971	333.737	0	333.737
7	5.93104	2215	9.44099	Waste	232.852	0	122.579	232.852	371.75	0	371.75
8	5.93104	2432.7	9.68935	Waste	255.464	0	134.482	255.464	407.712	0	407.712
9	5.93104	2638.79	9.93788	Waste	276.809	0	145.719	276.809	441.626	0	441.626
10	5.93104	2833.23	10.1866	Waste	296.888	0	156.289	296.888	473.496	0	473.496
11	5.93104	3016	10.4355	Waste	315.701	0	166.193	315.701	503.327	0	503.327
12	5.93104	3187.07	10.6846	Waste	333.25	0	175.431	333.25	531.123	0	531.123
13	5.93104	3346.41	10.934	Waste	349.535	0	184.004	349.535	556.884	0	556.884
14	5.93104	3494.01	11.1835	Waste	364.559	0	191.913	364.559	580.619	0	580.619
15	5.93104	3629.81	11.4332	Waste	378.32	0	199.157	378.32	602.325	0	602.325
16	5.93104	3753.8	11.6832	Waste	390.82	0	205.737	390.82	622.009	0	622.009
17	5.93104	3865.94	11.9334	Waste	402.06	0	211.654	402.06	639.675	0	639.675
18	5.93104	3966.2	12.1838	Waste	412.041	0	216.908	412.041	655.323	0	655.323
19	5.93104	4054.55	12.4345	Waste	420.762	0	221.499	420.762	668.956	0	668.956
20	5.93104	4130.95	12.6854	Waste	428.224	0	225.427	428.224	680.58	0	680.58
21	5.93104	4195.37	12.9365	Waste	434.428	0	228.693	434.428	690.195	0	690.195
22	5.93104	4247.77	13.188	Waste	439.373	0	231.296	439.373	697.804	0	697.804
23	5.93104	4288.11	13.4396	Waste	443.061	0	233.238	443.061	703.409	0	703.409
24	5.93104	4316.36	13.6915	Waste	445.491	0	234.517	445.491	707.014	0	707.014
25	5.93104	4332.48	13.9437	Waste	446.664	0	235.135	446.664	708.619	0	708.619
26	5.93104	4336.43	14.1962	Waste	446.579	0	235.09	446.579	708.227	0	708.227
27	5.93104	4328.16	14.449	Waste	445.236	0	234.383	445.236	705.843	0	705.843
28	5.93104	4307.64	14.702	Waste	442.635	0	233.014	442.635	701.464	0	701.464
29	5.93104	4274.83	14.9553	Waste	438.777	0	230.983	438.777	695.096	0	695.096
30	5.93104	4229.68	15.209	Waste	433.66	0	228.289	433.66	686.737	0	686.737
31	5.93104	4172.15	15.4629	Waste	427.285	0	224.933	427.285	676.392	0	676.392
32	5.93104	4102.19	15.7172	Waste	419.651	0	220.914	419.651	664.062	0	664.062
33	5.93104	4019.75	15.9717	Waste	410.757	0	216.232	410.757	649.747	0	649.747
34	5.93104	3924.79	16.2266	Waste	400.604	0	210.887	400.604	633.45	0	633.45
35	5.93104	3817.27	16.4819	Waste	389.19	0	204.879	389.19	615.171	0	615.171
36	5.93104	3697.12	16.7374	Waste	376.515	0	198.206	376.515	594.913	0	594.913
37	5.93104	3564.3	16.9933	Waste	362.578	0	190.87	362.578	572.676	0	572.676
38	5.93104	3418.77	17.2496	Waste	347.378	0	182.868	347.378	548.46	0	548.46
39	5.93104	3260.46	17.5062	Waste	330.915	0	174.202	330.915	522.267	0	522.267
40	5.93104	3089.32	17.7632	Waste	313.187	0	164.869	313.187	494.1	0	494.1
41	5.93104	2905.3	18.0205	Waste	294.194	0	154.871	294.194	463.956	0	463.956
42	5.93104	2708.34	18.2782	Waste	273.934	0	144.205	273.934	431.839	0	431.839
43	5.93104	2498.38	18.5363	Waste	252.407	0	132.873	252.407	397.748	0	397.748
44	5.93104	2275.37	18.7948	Waste	229.61	0	120.872	229.61	361.683	0	361.683
45	5.93104	2039.24	19.0537	Waste	205.543	0	108.203	205.543	323.646	0	323.646
46	5.93104	1789.94	19.313	Waste	180.205	0	94.8642	180.205	283.636	0	283.636
47	5.93104	1527.4	19.5727	Waste	153.594	0	80.8555	153.594	241.655	0	241.655
48	5.78585	1173.42	19.8297	Clayey Sand (SC)	129.432	0	68.1361	129.432	188.378	0	188.378
49	5.78585	794.249	20.0838	Clayey Sand (SC)	87.5006	0	46.0624	87.5006	127.296	0	127.296
50	5.78585	368.807	20.3384	Clayey Sand (SC)	40.5804	0	21.3625	40.5804	59.0115	0	59.0115

Global Minimum Query (janbu simplified) - Safety Factor: 1.89397

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	6.5392	261.182	7.53699	Clayey Sand (SC)	27.001	0	14.2563	27.001	40.0513	0	40.0513
2	6.5392	772.586	7.81978	Clayey Sand (SC)	79.7654	0	42.1155	79.7654	118.269	0	118.269
3	6.5392	1262.05	8.10277	Clayey Sand (SC)	130.129	0	68.707	130.129	192.863	0	192.863
4	6.05072	1531.26	8.37536	Waste	158.495	0	83.684	158.495	253.402	0	253.402
5	6.05072	1809.16	8.63757	Waste	187.048	0	98.7597	187.048	298.945	0	298.945
6	6.05072	2074.38	8.89995	Waste	214.225	0	113.109	214.225	342.256	0	342.256
7	6.05072	2326.87	9.16253	Waste	240.029	0	126.733	240.029	383.343	0	383.343
8	6.05072	2566.63	9.4253	Waste	264.46	0	139.633	264.46	422.209	0	422.209
9	6.05072	2793.61	9.68827	Waste	287.521	0	151.809	287.521	458.86	0	458.86
10	6.05072	3007.79	9.95144	Waste	309.213	0	163.262	309.213	493.298	0	493.298
11	6.05072	3209.13	10.2148	Waste	329.537	0	173.993	329.537	525.531	0	525.531
12	6.05072	3397.62	10.4784	Waste	348.494	0	184.002	348.494	555.559	0	555.559
13	6.05072	3573.2	10.7423	Waste	366.086	0	193.29	366.086	583.39	0	583.39
14	6.05072	3735.86	11.0063	Waste	382.313	0	201.858	382.313	609.025	0	609.025
15	6.05072	3885.55	11.2706	Waste	397.177	0	209.706	397.177	632.468	0	632.468
16	6.05072	4022.24	11.5352	Waste	410.678	0	216.834	410.678	653.726	0	653.726
17	6.05072	4145.89	11.8	Waste	422.817	0	223.244	422.817	672.8	0	672.8
18	6.05072	4256.48	12.065	Waste	433.596	0	228.935	433.596	689.695	0	689.695
19	6.05072	4353.95	12.3303	Waste	443.013	0	233.907	443.013	704.411	0	704.411
20	6.05072	4438.26	12.5959	Waste	451.071	0	238.162	451.071	716.954	0	716.954
21	6.05072	4509.39	12.8618	Waste	457.77	0	241.699	457.77	727.329	0	727.329
22	6.05072	4567.28	13.1279	Waste	463.11	0	244.518	463.11	735.534	0	735.534
23	6.05072	4611.9	13.3943	Waste	467.091	0	246.62	467.091	741.576	0	741.576
24	6.05072	4643.2	13.661	Waste	469.713	0	248.004	469.713	745.456	0	745.456
25	6.05072	4661.13	13.9281	Waste	470.977	0	248.672	470.977	747.176	0	747.176
26	6.05072	4665.65	14.1954	Waste	470.883	0	248.622	470.883	746.739	0	746.739
27	6.05072	4656.72	14.463	Waste	469.43	0	247.855	469.43	744.149	0	744.149
28	6.05072	4634.28	14.731	Waste	466.619	0	246.371	466.619	739.407	0	739.407
29	6.05072	4598.28	14.9993	Waste	462.449	0	244.169	462.449	732.515	0	732.515
30	6.05072	4548.68	15.2679	Waste	456.921	0	241.25	456.921	723.477	0	723.477
31	6.05072	4485.42	15.5369	Waste	450.033	0	237.614	450.033	712.292	0	712.292
32	6.05072	4408.45	15.8062	Waste	441.785	0	233.259	441.785	698.962	0	698.962
33	6.05072	4317.71	16.0759	Waste	432.177	0	228.186	432.177	683.491	0	683.491
34	6.05072	4213.15	16.346	Waste	421.207	0	222.394	421.207	665.879	0	665.879
35	6.05072	4094.72	16.6164	Waste	408.877	0	215.884	408.877	646.128	0	646.128
36	6.05072	3962.35	16.8872	Waste	395.184	0	208.654	395.184	624.239	0	624.239
37	6.05072	3815.98	17.1584	Waste	380.127	0	200.704	380.127	600.215	0	600.215
38	6.05072	3655.56	17.43	Waste	363.706	0	192.034	363.706	574.055	0	574.055
39	6.05072	3481.01	17.702	Waste	345.92	0	182.643	345.92	545.76	0	545.76
40	6.05072	3292.29	17.9745	Waste	326.768	0	172.531	326.768	515.334	0	515.334
41	6.05072	3089.32	18.2473	Waste	306.248	0	161.696	306.248	482.774	0	482.774
42	6.05072	2872.03	18.5206	Waste	284.359	0	150.139	284.359	448.083	0	448.083
43	6.05072	2640.36	18.7943	Waste	261.1	0	137.859	261.1	411.262	0	411.262
44	6.05072	2394.23	19.0684	Waste	236.469	0	124.854	236.469	372.31	0	372.31
45	6.05072	2133.58	19.343	Waste	210.465	0	111.124	210.465	331.229	0	331.229
46	6.05072	1858.34	19.6181	Waste	183.085	0	96.6673	183.085	288.018	0	288.018
47	6.05072	1568.42	19.8936	Waste	154.329	0	81.4844	154.329	242.678	0	242.678
48	6.33036	1249.59	20.176	Clayey Sand (SC)	125.727	0	66.3828	125.727	182.867	0	182.867
49	6.33036	766.236	20.4653	Clayey Sand (SC)	76.9857	0	40.6478	76.9857	111.92	0	111.92
50	6.33036	259.346	20.7552	Clayey Sand (SC)	26.0203	0	13.7385	26.0203	37.8093	0	37.8093

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.89961

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	172.744	3391.39	0	0	0
2	179.636	3392.35	37.9568	0	0
3	186.528	3393.33	145.764	0	0
4	193.419	3394.35	314.516	0	0
5	199.35	3395.26	458.339	0	0
6	205.281	3396.19	618.532	0	0
7	211.212	3397.15	791.794	0	0
8	217.143	3398.14	974.981	0	0
9	223.074	3399.15	1165.11	0	0
10	229.005	3400.19	1359.35	0	0
11	234.936	3401.26	1555.03	0	0
12	240.867	3402.35	1749.63	0	0
13	246.798	3403.47	1940.81	0	0
14	252.73	3404.61	2126.36	0	0
15	258.661	3405.79	2304.25	0	0
16	264.592	3406.99	2472.59	0	0
17	270.523	3408.21	2629.66	0	0
18	276.454	3409.47	2773.9	0	0
19	282.385	3410.75	2903.9	0	0
20	288.316	3412.05	3018.41	0	0
21	294.247	3413.39	3116.36	0	0
22	300.178	3414.75	3196.82	0	0
23	306.109	3416.14	3259.03	0	0
24	312.04	3417.56	3302.38	0	0
25	317.971	3419	3326.44	0	0
26	323.902	3420.48	3330.93	0	0
27	329.833	3421.98	3315.74	0	0
28	335.764	3423.51	3280.93	0	0
29	341.695	3425.06	3226.72	0	0
30	347.626	3426.65	3153.48	0	0
31	353.557	3428.26	3061.79	0	0
32	359.488	3429.9	2952.36	0	0
33	365.419	3431.57	2826.07	0	0
34	371.35	3433.27	2684.01	0	0
35	377.281	3434.99	2527.4	0	0
36	383.212	3436.75	2357.66	0	0
37	389.143	3438.53	2176.36	0	0
38	395.074	3440.34	1985.27	0	0
39	401.005	3442.18	1786.33	0	0
40	406.937	3444.06	1581.66	0	0
41	412.868	3445.96	1373.55	0	0
42	418.799	3447.88	1164.49	0	0
43	424.73	3449.84	957.133	0	0
44	430.661	3451.83	754.345	0	0
45	436.592	3453.85	559.159	0	0
46	442.523	3455.9	374.806	0	0
47	448.454	3457.98	204.706	0	0
48	454.385	3460.09	52.476	0	0
49	460.171	3462.17	-40.2074	0	0
50	465.957	3464.29	-106.529	0	0
51	471.742	3466.43	0	0	0

Global Minimum Query (janbu simplified) - Safety Factor: 1.89397

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	158.65	3387.84	0	0	0
2	165.189	3388.71	37.7016	0	0
3	171.729	3389.61	145.153	0	0
4	178.268	3390.54	314.039	0	0
5	184.319	3391.43	472.275	0	0
6	190.369	3392.35	650.486	0	0
7	196.42	3393.29	844.808	0	0
8	202.471	3394.27	1051.56	0	0
9	208.521	3395.27	1267.24	0	0
10	214.572	3396.31	1488.53	0	0
11	220.623	3397.37	1712.32	0	0
12	226.674	3398.46	1935.64	0	0
13	232.724	3399.58	2155.74	0	0
14	238.775	3400.73	2370.04	0	0
15	244.826	3401.9	2576.15	0	0
16	250.876	3403.11	2771.85	0	0
17	256.927	3404.34	2955.12	0	0
18	262.978	3405.61	3124.11	0	0
19	269.029	3406.9	3277.19	0	0
20	275.079	3408.22	3412.86	0	0
21	281.13	3409.58	3529.87	0	0
22	287.181	3410.96	3627.1	0	0
23	293.231	3412.37	3703.65	0	0
24	299.282	3413.81	3758.8	0	0
25	305.333	3415.28	3792.03	0	0
26	311.384	3416.78	3802.99	0	0
27	317.434	3418.31	3791.54	0	0
28	323.485	3419.87	3757.72	0	0
29	329.536	3421.46	3701.77	0	0
30	335.586	3423.08	3624.12	0	0
31	341.637	3424.74	3525.41	0	0
32	347.688	3426.42	3406.44	0	0
33	353.739	3428.13	3268.26	0	0
34	359.789	3429.87	3112.08	0	0
35	365.84	3431.65	2939.32	0	0
36	371.891	3433.45	2751.62	0	0
37	377.942	3435.29	2550.8	0	0
38	383.992	3437.16	2338.91	0	0
39	390.043	3439.06	2118.19	0	0
40	396.094	3440.99	1891.1	0	0
41	402.144	3442.95	1660.31	0	0
42	408.195	3444.95	1428.7	0	0
43	414.246	3446.98	1199.37	0	0
44	420.297	3449.03	975.641	0	0
45	426.347	3451.13	761.056	0	0
46	432.398	3453.25	559.375	0	0
47	438.449	3455.41	374.591	0	0
48	444.499	3457.6	210.922	0	0
49	450.83	3459.92	105.918	0	0
50	457.16	3462.29	37.5923	0	0
51	463.49	3464.68	0	0	0

List Of Coordinates

External Boundary

X	Y
105.01	3381.21
65	3372.05
61	3372.02
43.9	3376.3
0	3376.3
0	3361
0	3336
0	3200
3000	3200
3000	3349
3000	3374
3000	3389.22
2962.33	3389.22
2902.33	3384.3
2862.33	3393.92
2834.14	3394.23
2497.32	3477.69
1486.5	3527.15
470.02	3466.33
133.49	3381.5

Material Boundary

X	Y
133.49	3381.5
142.75	3381.59
149.94	3381.66
232.606	3361
275.18	3350.36
372.35	3348.37
594.61	3352.96
2150.52	3347.83
2372.79	3352.2
2595.06	3347.69
2633	3348.48
2735.51	3374
2817.33	3394.37
2824.68	3394.31
2834.14	3394.23

Material Boundary

X	Y
142.75	3381.59
142.75	3381.59
146.998	3382.66
468.81	3463.72
1486.54	3524.64
2498.75	3475.1
2820.46	3395.36
2824.68	3394.31

Material Boundary

X	Y
594.53	3353.96
594.61	3352.96

Material Boundary

X	Y
2150.44	3348.83
2150.52	3347.83

Material Boundary

X	Y
0	3336
3000	3349

APPENDIX C

ROC SCIENCE SUPPORTING DOCUMENTATION

USGS Design Maps Detailed Report

2009 NEHRP Recommended Seismic Provisions (32.43212°N, 103.12518°W)

Site Class D – “Stiff Soil”, Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters and Risk Coefficients

Note: Ground motion values contoured on Figures 22-1, 2, 5, & 6 below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_{SUH} and S_{SD}) and 1.3 (to obtain S_{1UH} and S_{1D}). Maps in the Proposed 2015 NEHRP Provisions are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

Figure 22–1: Uniform–Hazard (2% in 50–Year) Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

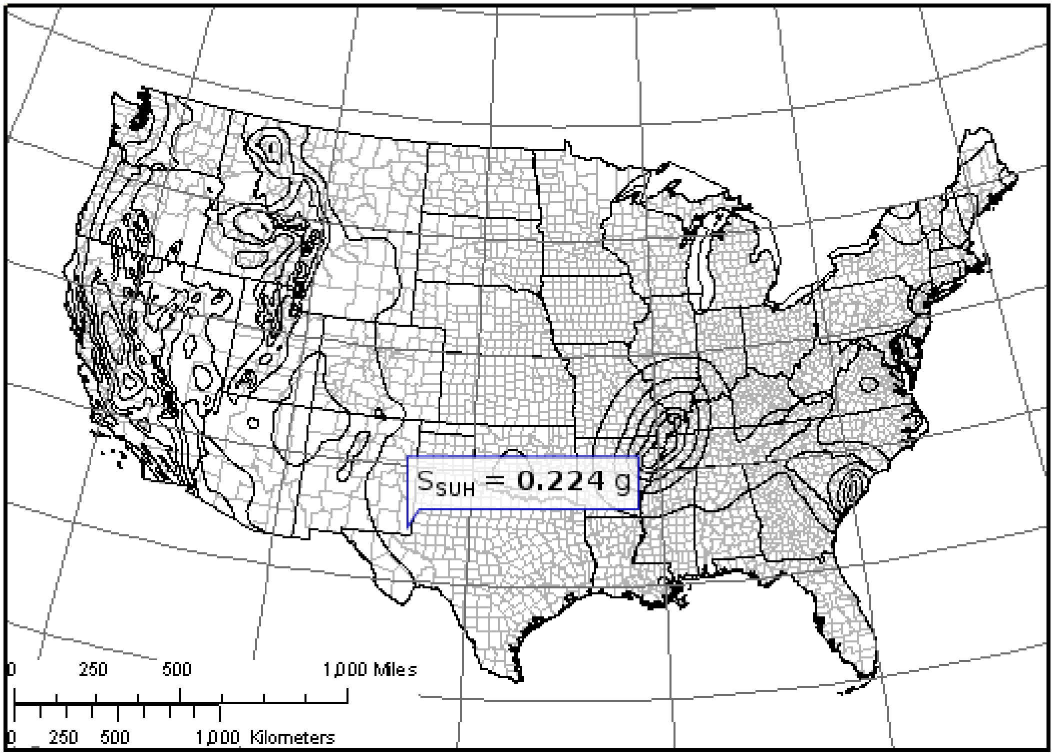


Figure 22–2: Uniform–Hazard (2% in 50–Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

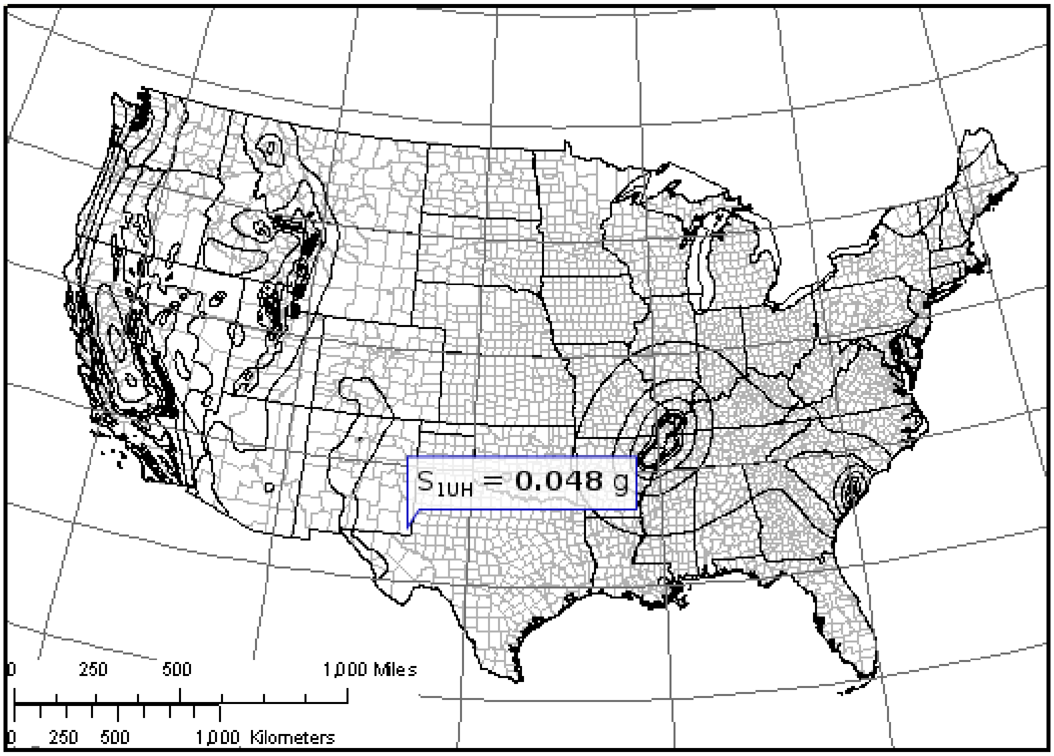

S_{1UH} = **0.048** g
0 250 500 1,000 Miles
0 250 500 1,000 Kilometers

Figure 22–3: Risk Coefficient at 0.2-Second Spectral Response Period

CRS = 0.871

Figure 22–4: Risk Coefficient at 1.0-Second Spectral Response Period

CR1 = 0.907

Figure 22–5: Deterministic Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

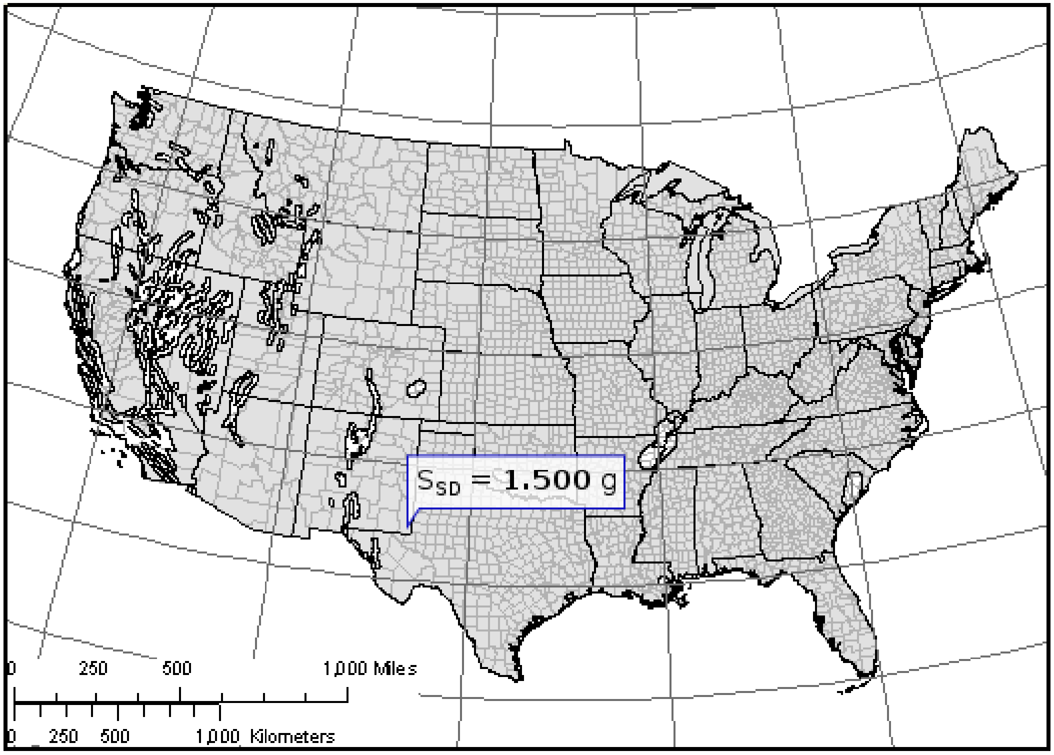
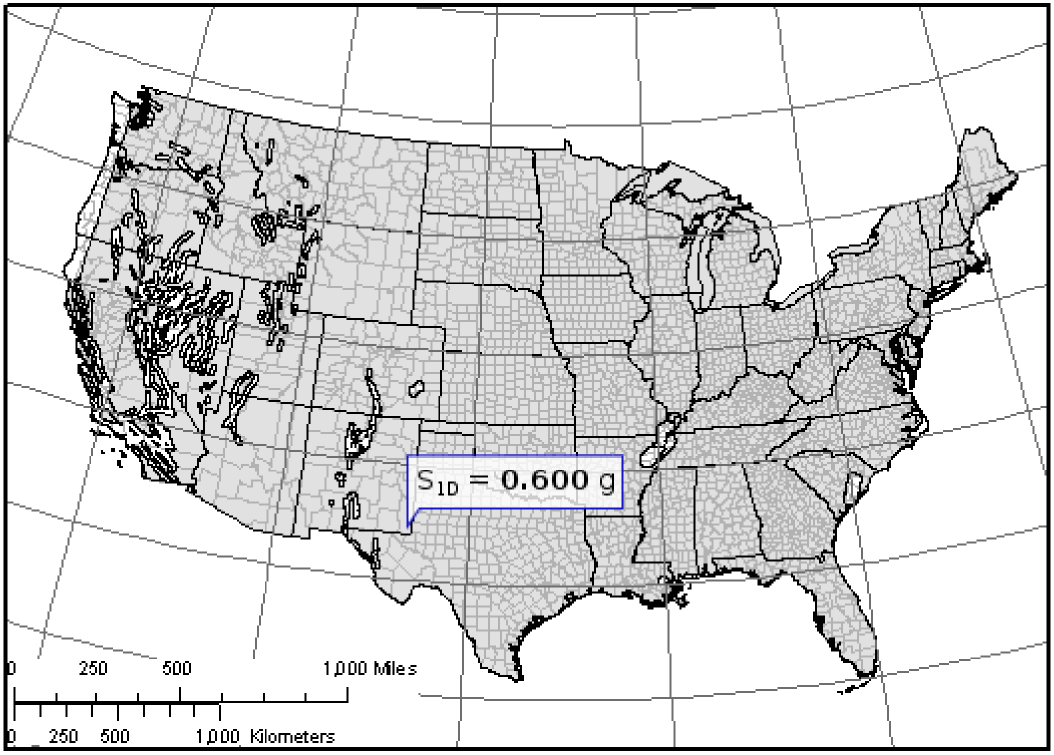


Figure 22–6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients, Risk Coefficients, and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Equation (11.4–1): $C_{RS}S_{SUH}$ = 0.871 x 0.224 = 0.195 g

Equation (11.4–2): S_{SD} = 1.500 g

S_S ≡ “Lesser of values from Equations (11.4–1) and (11.4–2)” = 0.195 g

Equation (11.4–3): $C_{R1}S_{1UH}$ = 0.907 x 0.048 = 0.044 g

Equation (11.4–4): S_{1D} = 0.600 g

S_1 ≡ “Lesser of values from Equations (11.4–3) and (11.4–4)” = 0.044 g

Table 11.4–1: Site Coefficient F_a

Site Class	Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.195 g, F_a = 1.600

Table 11.4–2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1–Second Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.044 g, F_v = 2.400

Equation (11.4–5): $S_{MS} = F_aS_S = 1.600 \text{ x } 0.195 = 0.312 \text{ g}$

Equation (11.4–6): $S_{M1} = F_vS_1 = 2.400 \text{ x } 0.044 = 0.105 \text{ g}$

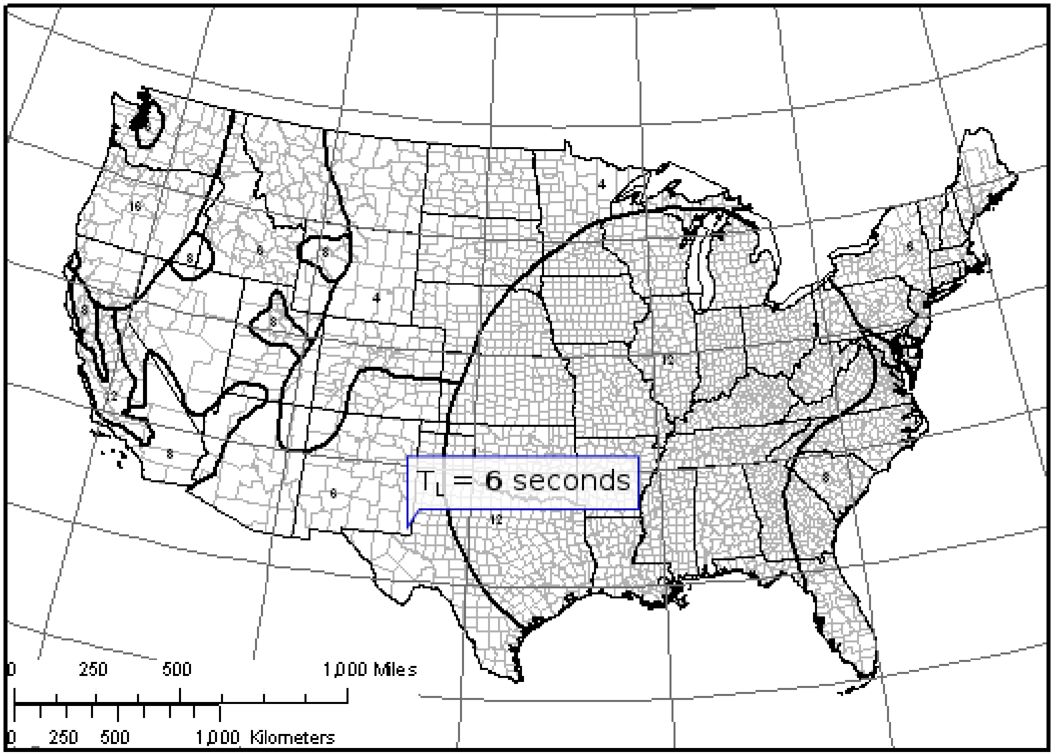
Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4–7): $S_{DS} = ⅔\, S_{MS} = ⅔ \text{ x } 0.312 = 0.208 \text{ g}$

Equation (11.4–8): $S_{D1} = ⅔\, S_{M1} = ⅔ \text{ x } 0.105 = 0.070 \text{ g}$

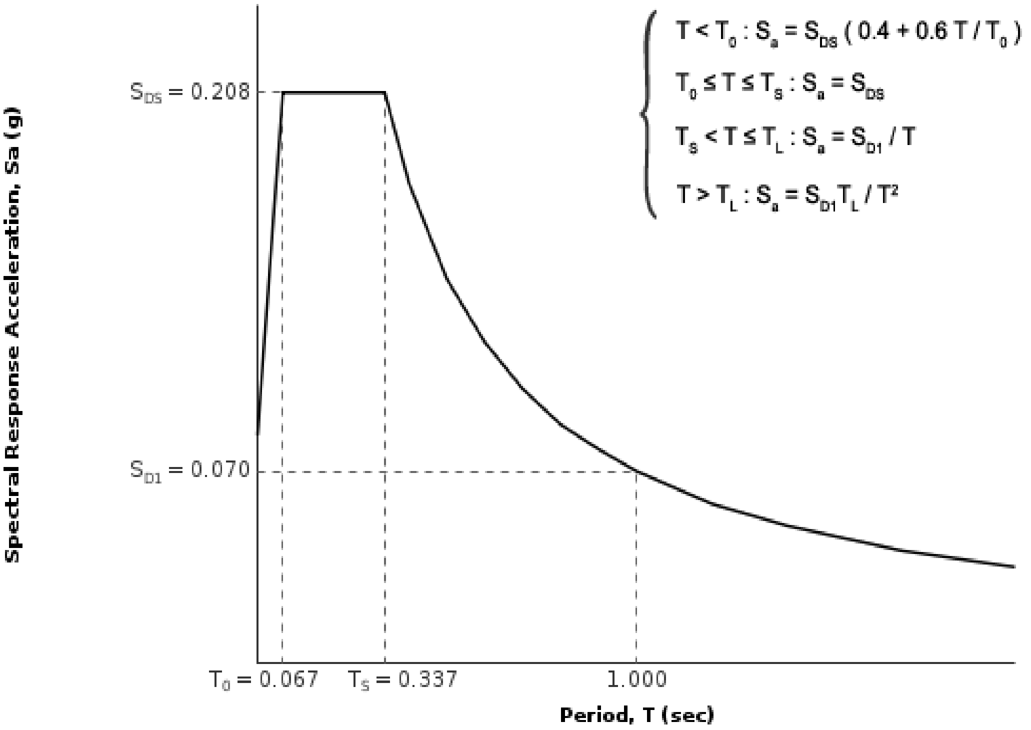
Section 11.4.5 — Design Response Spectrum

Figure 22–7: Long–period Transition Period, T_L (s)



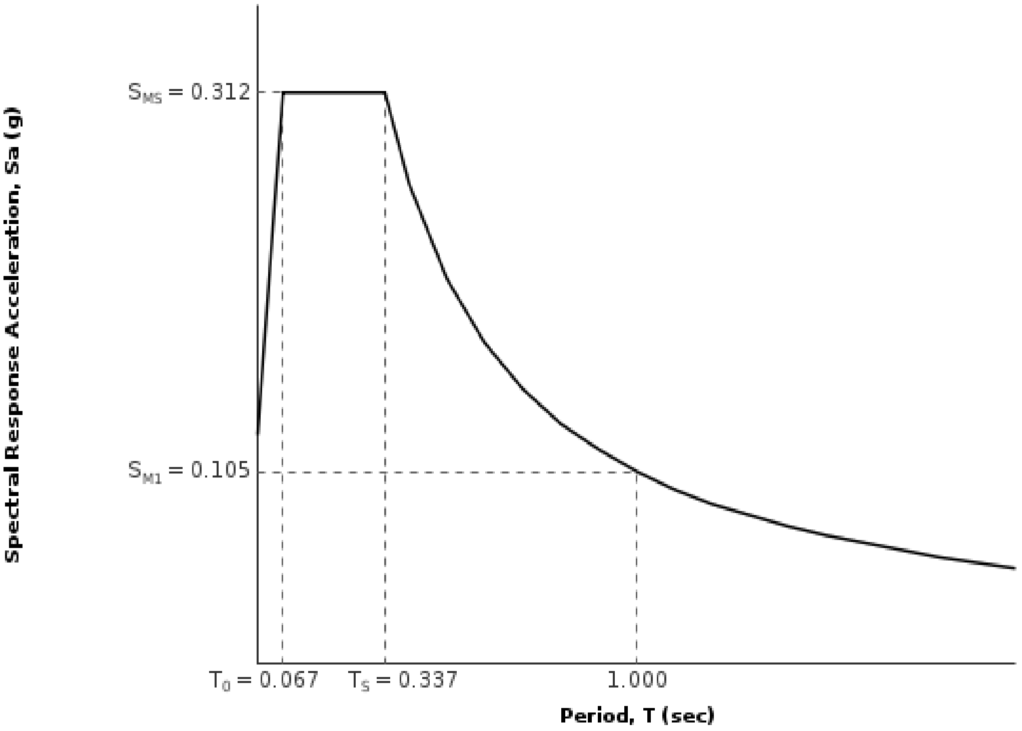
T_L = **6** seconds

Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.116 g, F_{PGA} = 1.567

Mapped PGA PGA = 0.116 g

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.567 \text{ x } 0.116 = 0.183 \text{ g}$

Engineering Geology in Washington, Volume 1

Washington Division of Geology and Earth Resources Bulletin 78, 1989

Geotechnical Properties of Geologic Materials

by

JON W. KOLOSKI, GeoEngineers, Inc.

SIGMUND D. SCHWARZ, S D Schwarz and Associates

DONALD W. TUBBS, Tubbs Geosciences

INTRODUCTION

Engineering geologists and geotechnical engineers are an intregal part of the design team for virtually all modern engineering projects that involve site characterization and geotechnical design. Evaluation of alternative project sites or specific site selection usually requires data collection, analysis and explanation of physical site conditions to other members of a project design team. Because of the need to develop a mutual understanding of geologic conditions and the resulting implications for design criteria, a common understanding of the relationship between geologic origin and geotechnical properties is essential. It is imperative that the geologist and engineer work in close cooperation to assure the best product quality.

Traditionally, the geologist's role has focused on identification of the geologic origin and distribution of earth materials. This includes both physical classification and interpretation of the processes of emplacement and modification. The product of a geologist's work within a project design team is often primarily qualitative, usually a map with appropriate descriptions. Such data must be translated into a quantitative form usable in engineering analysis and in design development and evaluation. The translation and quantification of geologic data for engineering purposes occurs over a wide range of scales. Discussion of the distribution of geologic materials and processes commonly involves a megascopic scale of feet or miles, while many engineering properties are discussed in microscopic context. A mutual understanding of terms, units and properties is essential for geologists and engineers to communicate effectively.

This paper relates the geologic characteristics and origin of earth materials commonly found in Washington to certain geotechnical properties. Four tables are presented in which descriptive and interpretive properties of soil and rock materials are correlated with their genetic classification.

The information presented in the tables is useful to indicate the general range of values for typical geotechnical properties, but is no substitute for site-specific laboratory and field information. The tables will be of some direct benefit to students and to geotechnical professionals who are new to the Pacific Northwest; among those with local experience they will serve mainly as a basis for ongoing argument.

The properties indicated in the tables are those most relevant to geotechnical considerations. The values presented in the tables are based on a compilation of published and unpublished information and do not represent original research. These data have been compiled from field and laboratory tests performed over many years by engineers, geologists and geophysicists in both the government and private sectors.

Because of the extremely variable nature of geologic materials, the ranges presented in the tables should be considered representative, but not necessarily all inclusive. Where ranges are indicated, we estimate that roughly two-thirds of field or laboratory observations will fall within the indicated ranges. Some geologic categories are not described in the tables; for example, the tables include no discussion of fill materials or landslide deposits because it is the writers' opinion that these materials are too variable to be meaningfully included. Not all pertinent geotechnical properties are listed and some engineering projects will require information on properties not included in the tables. The design team collectively must evaluate what geological conditions might affect, or be affected by, the engineering project.

DESCRIPTION OF TABLES

The four tables include summaries of descriptive and interpretive properties of soil and rock. The vertical organization of the tables is based on the genetic classification of the materials; descriptive and interpretive properties of general interest for engineering considerations are presented in the horizontal headings. Unified Soil Classification System (USCS) symbols are shown for soil materials and Unified Rock Classification System (URCS) symbols are indicated for rock materials. These classification systems are summarized in Figures 1 and 2. A generalized explanation of terms is presented below, but is not intended to rigorously define either the geologic categories or the geotechnical properties.

Table 1. Descriptive properties of soil; see Table 5 for classification

Classification		Grain	Sorting	Dry	Friction	Cohesion	Permeability	Storage	Seismic	Resistivity
Geologic	USCS	Size		Density	angle			capacity	velocity	
				(pcf)	(deg)	(psf)	(fpm)		(fps x 1000)	(ohm-m x 1000)
ALLUVIAL										
High Energy	GW,GP, GM	Med-Coarse	Med-Good	115-130	30-35	0	0.01-10	0.1-0.3	1.5-5dry 5-7.5wet	0.3-30dry 0.2-20wet
Low Energy	ML,SM, SP,SW	Fine-Med	Med-Good	90-115	15-30	0-500	0.0001-0.1	0.05-0.2	1-4dry 3.5-6wet	0.01-10dry 0.001-1wet
COLLUVIAL	. . . . Variable . . . . Reflects parent material									
EOLIAN										
Dune Sand	SP	Medium	Very Good	90-110	30-35	0	0.01-0.1	0.1-0.3	1-2.5	0.5-100
Loess	ML, SM	Fine	Med-Good	80-100	20-30	500-1000	0.001-0.01	0.05-0.1	0.75-2.5	0.01-2
GLACIAL										

Till	SM, ML	Fine-Med	Poor	120-140	35-45	1000-4000	0-0.001	0-0.01	3.5-10	0.01-5
Outwash	GW,GP, SW,SP, SM	Med-Coarse	Poor-Good	115-130	30-40	0-1000	0.01-10	0.01-0.3	4-6dry 5-8.5wet	0.2-10dry 0.1-5wet
Glaciolacustrine	ML, SM,SP	Fine-Med	Good	100-120	15-35	0-3000	0-0.1	0-0.1	2.5-8.5	0.001-2
LACUSTRINE										
Inorganic	ML,SM, MH	Fine	Good	70-100	5-20	0-200	0.0001-0.1	0.05-0.3	1-2.5	0.001-0.5
Organic	OL, PT	Fine-Med	Poor-Good	10-70	0-10	0-200	0.0001-1.0	0.05-0.8	0.5-1.5	0.001-0.5
MARINE										
High Energy	SW,GW, SP	Med-Coarse	Med-Good	115-130	25-35	0	0.001-1.0	0.1-0.3	5-6	0-2
Low Energy	ML,SM, MH	Fine-Med	Med-Good	70-115	0-25	0-200	0.0001-0.1	0.05-0.3	2.5-5	0-0.5
RESIDUAL	. . . . Variable . . . . Reflects parent material									
VOLCANIC										
Tephra	ML,SM	Fine-Med	Poor-Good	80-120	20-35	0-1000	0.0001-0.1	0.05-0.2	0.5-6	0.5-100
Lahar	SM,SW, GM	Fine-Coarse	Poor	80-130	25-40	0-1000	0.001-0.1	0.05-0.2	3.5-9	0.01-5

Table 2. Interpretive properties of soil; see Table 5 for classification

Classification		Relative	Excavation	Moisture	Foundation	Cut	Seismic	Common
Geologic	USCS	erodibility	difficulty	sensitivity	support	slopes	hazards	uses
					(psf)	(%)		
ALLUVIAL								
High Energy	GW,GP, GM	Low	Low	Low	1500-2000	50-65	Low-Med	Aggregate, Fill
Low Energy	ML,SM, SP,SW	Med-High	Low	Med-High	500-1500	25-50	Med-High	Fill
COLLUVIAL	. . . . Variable . . . . Reflects parent material							
EOLIAN								
Dune Sand	SP	High	Low	Low	500-1000	20-30	Low-Med	Fill, Industrial
Loess	ML,SM	Very High	Low	High	500-1000	25-50	Low-Med	
GLACIAL								
Till	SM,ML	Low-Med	Med-High	High	1500-5000	50-100	Low	Fill
Outwash	GW,GP, SW,SP, SM	Low-Med	Low-Med	Low-Med	1500-3000	50-70	Low	Aggregate, Fill

Glaciolacustrine	ML,SM, SP	Med-High	Medium	High	1000-2000	25-50	Med-High	Fill, Industrial
LACUSTRINE	ML,SM, MH,OL, PT	High	Low	High	0-500	0-25	High	PT: Soil additive
MARINE								
High Energy	SW,GW, SP	Medium	Low	Low	1000-2000	25-60	Low-Med	Fill
Low Energy	ML,SM, MH	High	Low	Med-High	0-500	0-25	High	Fill
RESIDUAL	. . . . Variable . . . . Reflects parent material							
VOLCANIC								
Tephra	ML,SM	Low-High	Low	Low-High	500-1500	20-50	Low-Med	Fill, Industrial
Lahar	SM,GM	Med-High	Low-Med	Low-High	500-1500	25-50	Low-Med	Fill

Table 3. Descriptive properties of rock; see Table 6 for classification

Classification		Density	Compressive	Discontinuities	Permeability	Storage	Seismic	Resistivity
Geologic	URCS		strength			capacity	velocity	
		(pcf)	(psi x 1000)				(fps x 1000)	(ohm-m x 1000)
IGNEOUS								
Intrusive	OAAA - OCEB	150-200	3-30	Joints	Low	Low	12-20	0.5-20
Extrusive	OAAA - ODEE	120-200	1-30	Joints, Voids, Flow Features	Low-High	Low-High	6-18	0.01-5
METAMORPHIC								
High Grade	OAAA - OCED	150-200	3-25	Joints, Foliation	Low	Low	12-20	0.05-20
Low Grade	OBAA - OEEE	150-200	0.5-15	Joints, Foliation	Low	Low	2.5-14	0.001-10
SEDIMENTARY								
Clastic	OBCC - OEEE	130-150	1-15	Joints, Bedding	Low-Med	Low-Med	5-14	0.001-10
Chemical	OBCB - ODEC	140-160	2-15	Joints, Bedding, Voids	Low-High	Low	4-15	0.05-50
Organic	OCCD - ODEE	80-100	0.5-5	Joints, Bedding, Voids	Low-Med	:Low	1.5-5.5	0.05 1

Table 4. Interpretive properties of rock; see Table 6 for classification

Classification		Excavation	Resistance	Foundation	Stability	Common
Geologic	URCS	difficulty	to weathering	support	in cuts	uses
IGNEOUS						
Intrusive	OAAA - OCEB	High	High	Good	Good	Riprap, Aggregate, Building stone
Extrusive	OAAA - ODEE	Med-High	Med-High	Usually Good	Med-Good	Riprap, Aggregate, Building stone
METAMORPHIC						
High Grade	OAAA - OCED	High	High	Good	Good	Riprap, Aggregate, Building stone, Industrial
Low Grade	OBAA - OEEE	Low-High	Low-Med	Usually Good	Poor-Good	Fill
SEDIMENTARY						
Clastic	OBCC - OEEE	Low-High	Low-Med	Usually Good	Poor-Good	Building stone, Industrial
Chemical	OBCB - ODEC	Med-High	Low-High	Usually Good	Poor-Good	Riprap, Aggregate, Industrial, Building stone
Organic	OCCD - ODEE	Low-Med	Low	Poor	Poor	Fuel

Table 5. Unified Soil Classification System; from American Society for Testing and Materials, 1985

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO.200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSES NO.4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS	SILT AND CLAY LIQUID LIMIT LESS THAN 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY

MORE THAN 50% PASSES NO.200 SIEVE	SILT AND CLAY LIQUID LIMIT 50 OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

Table 6. Unified Rock Classification System, from Williamson, 1984

DEGREE OF WEATHERING	REPRESENTATIVE		A	Micro Fresh State (MFS)	
			B	Visually Fresh State (VFS)	
	ALTERED		C	Stained State (STS)	
	WEATHERED	>GRAVEL SIZE	D	Partly Decomposed State (PDS)	
		<SAND SIZE	E	Completely Decomposed State (CDS)	
ESTIMATED STRENGTH	REACTION TO IMPACT OF 1 LB BALLPEEN HAMMER		A	"Rebounds" (Elastic) (RQ)	>15000 psi *(2)*
			B	"Pits" (Tensional) (PQ)	8000 - 15000 psi *(2)*
			C	"Dents" (Compression) (DQ)	3000 - 8000 psi *(2)*
			D	"Craters" (Shears) (CQ)	1000 - 3000 psi *(2)*
	REMOLDING *(1)*		E	"Moldable" (Friable) (MQ)	<1000 psi *(2)*
DISCONTINUITIES	VERY LOW PERMEABILITY		A	Solid (Random Breakage) (SRB)	
			B	Solid (Preferred Breakage) (SPB)	
			C	Solid (Latant Planes of Separation) (LPS)	
	MAY TRANSMIT WATER		D	Nonintersecting Open Planes (2-D)	
			E	Intersecting Open Planes (3-D)	
UNIT WEIGHT			A	Greater than 160 pcf	
			B	150 - 160 pcf	
			C	140 - 150 pcf	
			D	130 - 140 pcf	
			E	Less than 130 pcf	
(1) Strength estimated by soil mechanics techniques			*(2) Approximate unconfined compressive strength*		
SYMBOL NOTATION: AAAA IN ORDER WEATHERING, STRENGTH, DISCONTINUITIES, WEIGHT					

"O" IS USED AS A POSITION HOLDER

EXPLANATION OF TERMS

Soils

o Alluvial: Sediment deposited by streams.

- High Energy: Generally coarse sediment such as coarse sand, gravel, cobbles and boulders that have been deposited by fast moving water.

- Low Energy: Generally fine-grained soil such as fine sand and silt deposited by slow moving water.

o Colluvial: Generally heterogeneous soil aggregates that have been transported and deposited by mass wasting processes such as landslides, rockfalls and avalanches.

o Eolian: Sediment transported and deposited by wind.

- Dune Sand: Sand-size sediment; typically deposited in dune forms.

- Loess: Fine-grained sediment; generally fine sand and silt.

o Glacial: Material deposited by or in association with glaciers.

- Till: Heterogeneous mixture of various particle sizes deposited directly by glacial ice.

- Outwash: High-energy sediment deposited by glacial meltwater.

- Glaciolacustrine: Low-energy sediment deposited in ice-marginal lakes.

o Lacustrine: Sediment deposited in lakes.

- Nonorganic: Sediment composed primarily of silt, sand and clay.

- Organic: Peat and other predominantly organic sediment.

o Marine: Sediment deposited in a marine environment.

- High Energy: Generally coarse-grained material such as gravel and sand deposited by strong waves or currents.

- Low Energy: Generally fine-grained material such as silt and sand.

o Residual: Soil developed in place as the result of weathering or chemical decomposition of parent material.

o Volcanic: Deposits derived from volcanoes or other eruptive sources.

- Tephra: Airborne volcanic ejecta such as volcanic bombs, cinders and ash.

- Lahar: Mudflow composed largely of volcanic debris, or having primarily a volcanic origin.

Bedrock

o Igneous: Rock formed by solidification from a molten state.

- Intrusive: Rock such as granite that has solidified from a molten state below the ground surface.

- Extrusive: Rock such as basalt that has solidified after reaching the ground surface.

o Metamorphic: Rock derived from pre-existing rock by mineralogical and textural changes.

- High Grade: Metamorphic rock that has little resemblance to the original parent rock type.

- Low Grade: Metamorphic rock that is similar to the original parent rock type.

o Sedimentary: Rock deposited as sediment and subsequently lithified.

- Clastic: Rock such as shale, sandstone and conglomerate formed from fragments of pre-existing rocks.

- Chemical: Rock such as limestone formed by chemical precipitation.

- Organic: Rock such as coal formed largely or exclusively from organic material.

Descriptive Properties

o USCS: Unified Soil Classification System (ASTM D 2487).

o URCS: Unified Rock Classification System (Williamson, 1984).

o Grain Size: The general category of particle sizes corresponding to terms used in the USCS.

o Sorting: Segregation by grain sizes. "Poor" means a wide range of grain sizes such as silty sandy gravel; "good" means a narrow range of grain sizes such as sand. No specific percentages are implied.

o Dry Density: Dry weight in pounds per cubic foot.

o Friction Angle: Angle of internal shearing resistance (phi) expressed in degrees.

o Cohesion: That part of the shear strength of soil or rock which does not depend on interparticle friction.

o Permeability (Hydraulic Conductivity): The ease with which water will move through soil interstices, expressed in feet per minute. For rock, variability is so great that it is expressed in the tables in dimensionless relative terms only. Negligible permeability is expressed as 0.

o Storage Capacity (Specific Yield): The volume of water that will drain from a unit volume of an unconfined aquifer.

o Seismic Velocity: Compressional seismic wave velocity in thousands of feet per second.

o Resistivity: Electrical resistance to direct current expressed in terms of thousands of ohm-meters.

o Compressive Strength: Load per unit area under which an unconfined block of rock fails (unconfined compressive strength), expressed in pounds per square inch.

o Discontinuities: Surfaces or voids that interrupt otherwise homogeneous rock masses.

Interpretive Properties

o Relative Erodibility: Susceptibility to erosion in terms of sediment yield per unit area.

o Excavation Difficulty: The relative difficulty of excavation by heavy equipment.

o Moisture Sensitivity: Susceptibility to significant changes in physical properties due to changes in water content. In general, sensitivity increases with increasing silt or clay content.

o Foundation Support: Typical allowable bearing value for shallow spread foundations, expressed in pounds per square foot. Assumes conventional cast-in-place concrete footings with embedment adequate for frost protection. Expressed in dimensionless relative terms only for rock.

o Cut Slopes (Soil): Typical maximum inclination for permanent cut slopes less than 15 feet in height. Assumes no destabilizing factors such as adverse structural/stratigraphic or ground water conditions.

o Stability in Cut Slopes (Rock): Relative stability of permanent cut slopes. Assumes no destabilizing factors such as adverse structural/stratigraphic or ground water conditions.

o Seismic Hazards: Relative association with earthquake-induced damage.

o Common Uses: Typical applications of economic importance.

o Resistance to Weathering: Relative resistance to mechanical or chemical deterioration.

DISCUSSION

Descriptive Properties

o The Unified Soil Classification System (USCS) does not recognize particles larger than 3 inches in diameter. Common usage extends it to materials including cobbles (3 to 12 inches) and boulders (greater than 12 inches).

o Cohesion is the result of soil structure and/or cementation. Some finite cohesion is generally present in loess, due to its unique granular structure and the common occurrence of minor cementation. Cohesion in till is a result of ice consolidation and a wide range of particle sizes, including a significant fraction of silt.

o Permeability differences reflect variations in gradation between geologic materials. Very high permeability is associated with high-energy alluvial deposits or glacial outwash where coarse, open-work gravel is common. Permeability in these deposits can vary greatly over short horizontal and vertical distances. Extremely low permeability is associated with poorly to moderately sorted materials that are ice-consolidated and contain a substantial fraction of silt and clay.

o Storage capacity reflects the volume of void space and the content of silt or clay within a soil deposit. Storage capacity is very small for poorly sorted or ice-consolidated, fine-grained materials such as till and glaciolacustrine deposits.

o Seismic velocities in soil can be affected by water content. Coarse-grained soils display significantly higher velocities when water saturated. Less velocity increase is associated with finer-grained soils. The electrical resistivity of soil and rock decreases with water content. Geophysical values are differentiated between wet and dry conditions where differences are significant and data is available.

Interpretive Properties

o Erodibility is closely related to slope, vegetative cover, water concentration and numerous other factors in addition to geologic characteristics.

o Excavation difficulty is discussed in more detail in handbooks published by Caterpillar, Inc. (1987a, b). Note that the table entries for this category refer to unrestricted excavation. Restricted excavations such as trenches are normally more difficult than open cuts. Substantial variations from the indicated values should be expected based on site-specific factors.

o Satisfactory foundation performance includes consideration of numerous factors in addition to the indicated bearing values. These factors include settlement performance, general stability and effects of and on adjacent manmade or natural features.

o The design of safe cut slopes must consider site-specific details of soil and water conditions and their relationship to risk. For example, a maintenance risk is much less significant than a life-threatening risk. Therefore, rather than relying on physical properties, risk will often dictate slope design.

o Seismic hazards can be manifested in the form of ground shaking, liquefaction, ground rupture or displacement (e.g., landslides induced by seismic shaking). The extent to which the indicated geologic classifications are associated with seismic hazards is expressed in relative terms.

o Moisture sensitivity varies considerably within each geologic classification. For example, low-energy alluvial deposits characterized by clean, free-draining sand are not particularly moisture-sensitive while low-energy alluvial soils containing a substantial fraction of silt are extremely moisture-sensitive. Although not included as a specific interpretive category for rock, moisture sensitivity can also be important. The moisture sensitivity of rock is generally proportional to the amount of clay or silt produced by mechanical or chemical decomposition.

ACKNOWLEDGEMENTS

The writers wish to express appreciation to their colleagues in the geotechnical professions who over the years have shared information regarding geotechnical properties of geologic materials. Several organizations (GeoEngineers, Inc., Geo-Recon International Ltd., Shannon & Wilson, Inc., and the U.S. Army Corps of Engineers) made available to us specific information from their files. GeoEngineers, Inc., also provided assistance in manuscript preparation.

We are particularly grateful to Mr. George Yamane for his helpful review and comments during the

preparation of this paper.

REFERENCES

American Society for Testing and Materials, 1985, D 2487-83, Classification of Soils for Engineering Purposes: Annual Book of ASTM Standards, Vol. 04.08, pp 395-408.

Caterpillar Inc., 1987a, Caterpillar Performance Handbook, Edition 18: Caterpillar Inc., Peoria, 768 p.

Caterpillar Inc., 1987b, Caterpillar Performance Handbook, Hydraulic Excavators: Caterpillar Inc., Peoria, 176 p.

Williamson, D.A., 1984, Unified Rock Classification System: Bulletin, Association of Engineering Geologists, Vol. 21, No. 3, pp 345-354.

Return to Tubbs Geosciences' Library

APPENDIX D

GEOTECHNICAL ENGINEERING PRINCIPLES AND PRACTICES EXCERPT

TABLE 10.4 Typical Consolidation Properties of Saturated Normally Consolidated Sandy Soils at Various Relative Densities[a]

	$C_c/(1+e_0)$					
Soil Type	$D_r = 0\%$	$D_r = 20\%$	$D_r = 40\%$	$D_r = 60\%$	$D_r = 80\%$	$D_r = 100\%$
Medium to coarse sand, some fine gravel (SW)	–	–	0.005	–	–	–
Medium to coarse sand (SW/SP)	0.010	0.008	0.006	0.005	0.003	0.002
Fine to coarse sand (SW)	0.011	0.009	0.007	0.005	0.003	0.002
Fine to medium sand (SW/SP)	0.013	0.010	0.008	0.006	0.004	0.003
Fine sand (SP)	0.015	0.013	0.010	0.008	0.005	0.003
Fine sand with trace fine to coarse silt (SP-SM)	–	–	0.011	–	–	–
Find sand with little fine to coarse silt (SM)	0.017	0.014	0.012	0.009	0.006	0.003
Fine sand with some fine to coarse silt (SM)	–	–	0.014	–	–	–

[a] Adapted from Burmister, 1962.

tests on samples reconstituted to various relative densities. Engineers can estimate the in situ relative density using the methods described in Chapter 4, then select an appropriate $C_c/(1 + e_0)$ from this table. Note that all of these values are "very slightly compressible" as defined in Table 10.2.

For saturated overconsolidated sands, $C_r/(1 + e_0)$ is typically about one-third of the values listed in Table 10.4, which makes such soils nearly incompressible. Compacted fills can be considered to be overconsolidated, as can soils that have clear geologic evidence of preloading, such as glacial tills. Therefore, many settlement analyses simply consider the compressibility of such soils to be zero. If it is unclear whether a soil is normally consolidated or overconsolidated, it is conservative to assume it is normally consolidated.

Very few consolidation tests have been performed on gravelly soils, but the compressibility of these soils is probably equal to or less than those for sand, as listed in Table 10.4.

Another characteristic of sands and gravels is their high hydraulic conductivity, which means any excess pore water drains very quickly. Thus, the rate of consolidation is very fast, and typically occurs nearly as fast as the load is applied. Thus, if the load is due to a newly placed fill, the consolidation of these soils may have little practical significance.

However, there are at least two cases where consolidation of coarse-grained soils can be very important and needs more careful consideration:

1. **Loose sandy soils subjected to dynamic loads, such as those from an earthquake.** They can experience very large and irregular settlements that can cause serious damage. Kramer (1996) discusses methods of evaluating this problem.