APPENDIX T
LANDFILL CONSTRUCTION AND SETTLEMENT, PIPE STRENGTH AND SLOPE STABILITY CALCULATIONS

T-1: Pipe Strength Calculations

T-2: Leachate Collection Pipe Differential Settlement Calculations

T-3: Geotechnical and Stability Evaluation

Appendix T-1
Pipe Strength Calculations

HDPE SDR-17

HDPE SDR-11

Schedule 80 PVC

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	DJR
PROJECT:	SEVEN MILE CREEK SEC. 2 NE EXPANSION FEASIBILITY RPT.	CHK:	DKS
SUBJECT:	PIPE STRENGTH	DATE:	6/17/2019
PROJECT NO.	190275		

T-1a HDPE SDR-17 PIPE STRENGTH CALCULATIONS

Purpose: To evaluate the pipe strength of 6" diameter, SDR 17 HDPE leachate collection piping in the base system of the Seven Mile Creek Sector 2 Landfill using designed properties and parameters

Approach: Use referenced formulas to determine the loads applied to leachate collection piping and determine whether the applied loads are within the required factor of safety for the pipe to adequately perform throughout its service life.

References:
Plastics Pipe Institute 2nd Edition Handbook of PE Pipe, Buried PE Pipe Design.
ISCO Industries, Typical Properties and Dimension Charts, (Attachment 1).
"Soil Reaction for Buried Flexible Pipe", Amster K. Howard, U.S. Bureau of Reclamation.
HDPE Leachate Collection Pipe Design by Fundamentals of Mechanics", Harrison and Watkins, 1996, Nineteenth International Madison Waste Conference.
Sevan Mile Creek Landfill Plan of Operation, Base Grades and Final Grades Drawings, 2015.

Assumptions:
1.) Live loads are negligible above the piping.
2.) All installed SDR 17 HDPE piping meets the specifications of ASTM F714; "Standard Specification for Polyethylene (PE) Plastic Pipe, based on outside diameter".
3.) Base Grade Elevation = 900 ft msl, Final Cover Elevation = 1124 ft msl.
4.) The maximum fill height over pipes is 223 feet. This consists of 2.5 feet of bedding gravel, 215 feet of waste, 0.5 feet of grading layer material, 2 feet of clay, 2.5 feet of rooting zone, and 0.5 feet of topsoil.
4.) Waste unit weight is 90 PCF based on final waste grades (after settlement of intermediate waste grades).

Calculations: **Pipe Loading** $P_y = DL + LL$

where,
P_y= Pipe Load, lb/in^2
DL= Dead Load, lb/in^2
LL = Live Load, lb/in^2

Dead Load $DL = \sum \frac{\gamma_{fill} * H_{fill}}{144}$

where,
γ_{fill} = Fill Unit Weight, lb/in^3
H_{fill}= Height of Fill, ft
DL = Dead Load, lb/in^2

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A summary of the height and unit weight of all material covering the leachate collection pipe at its maximum depth is provided below:

Calculations: (Cont.)

Fill Type	Height, H_{fill} (ft)	Unit Weight, γ_{fill} (pcf)	Dead Load (psi)
Topsoil	0.50	105	0.36
Rooting Zone	2.50	120	2.08
Clay	2.00	130	1.81
Grading Layer	0.50	125	0.43
Waste	215	90	134.38
Pipe Bedding Material	2.50	135	2.34
Total	**223.00**	**-**	**141.41**

In our case the live load (LL) = 0, due to limited live loads above the piping after placement.

Therefore,

$$P_y = DL = 141.41 \text{ lb/in}^2$$

Deflection

A deflection of 5 to 7.5% has become the standard for limiting deflection in flexible pipes. Based on Figure 7.16 in Uni-Bell, 1992, a vertical strain of greater than 5% will never be reached for flexible pipe bedded in compacted gravel, independent of vertical soil pressure. At 90% compaction the vertical strain will always be less than 2%. The height of fill over the pipe is not a factor when the pipe is well bedded in gravel.

Wall Crushing

$$\sigma = \frac{T}{A}$$

where,

A = Area of Pipe Wall, in^2/in
T = Wall Thrust, lb/in
σ = Compressive Stress, lb/in^2

and,

$$T = \frac{P_y * D_o}{2}$$

With 6" diameter HDPE SDR-17 leachate collection piping,

Outer Diameter of Pipe (D_o) = 6.625 in.
Min. Pipe Wall Thickness (A) = 0.390 in.
(from Attachment 1)

CALCULATION SHEET

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	DJR
PROJECT:	SEVEN MILE CREEK SEC. 2 NE EXPANSION FEASIBILITY RPT.	CHK:	DKS
SUBJECT:	PIPE STRENGTH	DATE:	6/17/2019
PROJECT NO.	190275		

Calculations:
(Cont.)

DL, psi	141.41
LL, psi	0
P_y, psi	141.41
D_0, in	6.625
T, lb/in	468.41
A, in^2/in	0.390
σ, psi	1201.05
$\sigma_{allowable}$, psi	1600
Factor of Safety	1.33

Result: The calculated maximum compressive stress for in-place SDR-17 HDPE leachate collection pipes is 1201.05 psi. This is below the maximum allowable compressive stress of 1600 psi, by a safety factor of 1.33. The factor of safety against wall crushing of the pipe is acceptable for the existing HDPE SDR-17 6” diameter pipes.

ISCO INDUSTRIES
800-345-ISCO
www.isco-pipe.com

HIGH DENSITY POLYETHYLENE PIPE
Typical Physical Properties***

Property	**Specification**	**Unit**	**Nominal Value**
Material Designation	PPI / ASTM		PE 3408
Material Classification	ASTM D-1248		III C 5 P34
Cell Classification	**ASTM D3350-99**		**345464C**
-Density (3)	ASTM D-1505	gm/cm3	0.955
-Melt Index (4)	ASTM D-1238 (216 kg/190¡C)	gm/10 min.	0.11*
-Flex Modulus (5)	ASTM D-790	psi	135,000
-Tensile Strength (4)	ASTM D-638	psi	3,200
PENT (6)	ASTM F-1473	Hours	>100
-HDB @73¡ F (4)	ASTM D-2837	psi	1,600
-HDB @ 140 Deg F	ASTM D-2837	psi	800
-U-V Stabilizer (C)	ASTM D-1603	% C	2.5
Hardness	ASTM D-2240	Shore “D”	65
Compressive Strength (yield)	ASTM D-695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2”/min.)	psi	3,200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5,000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
PENT (6)	ASTM F-1473	Hours	>100
(Cond. A, B, C: Mold. Slab)	ASTM D-1693	Fo, Hours	>5,000
(Compressed Ring - pipe)	ASTM F-1248	Fo, Hours	>3,500
Slow Crack Growth	Battelle Method	Days to Failure	>64
Impact Strength (IZOD) (.125Ó Thick)	ASTM D-256 (Method A)	In-lb / in notch	42
Linear Thermal Expansion Coef.	ASTM D-696	in / in/¡F	1.2x10-4
Thermal Conductivity	ASTM D-177	BTU-in/ft2/ hrs/ degreesF	2.7
Brittleness Temp.	ASTM D-746	degrees F	< -180
Vicat Soft. Temp.	ASTM D-1525	degrees F	257
Heat Fusion Cond.	ASTM D-1525	@ psi degrees F	75 @ 400

*** This list of typical physical properties is intended for basic characterization of the material and does not represent specific determinations of specifications. The physical properties values reported herein were determined on compression molded specimens prepared in accordance with Procedure C of ASTM D 1928 and may differ from specimens taken from pipe.
** Tests were discontinued because no failures and no indication of stress crackinitiation.
* Average Melt Index value with a standard deviation of 0.01

This document reports accurate and reliable information to the best of our knowledge but our suggestions and recommendations cannot be guaranteed because the conditions of the use are beyond our control. The user of such information assumes all risk connected with the use thereof. Chevron Phillips Chemical Co. and its subsidiaries assume no responsibility for the use of information presented herein and hereby expressly disclaims all liability in regards to such use.

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 7 (267psi)			DR 7.3 (254psi)			DR 9 (200psi)			DR 11 (160psi)			DR 13.5 (128psi)			DR 15.5 (110psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.05"	0.150"	0.732"	0.184	0.144"	0.745"	0.178	0.117"	0.803"	0.150	0.095"	0.848"	0.125	---	---	---	---	---	---
1"	1.315"	0.188"	0.917"	0.289	0.180"	0.933"	0.279	0.146"	1.005"	0.234	0.120"	1.062"	0.197	---	---	---	---	---	---
1 1/4"	1.66"	0.237"	1.157"	0.460	0.227"	1.178"	0.444	0.184"	1.269"	0.372	0.151"	1.340"	0.312	---	---	---	---	---	---
1 1/2"	1.90"	0.271"	1.325"	0.603	0.260"	1.348"	0.582	0.211"	1.452"	0.488	0.173"	1.534"	0.409	---	---	---	---	---	---
2"	2.375"	0.339"	1.656"	0.943	0.325"	1.685"	0.762	0.264"	1.816"	0.762	0.216"	1.917"	0.639	0.176"	2.002"	0.531	0.153"	2.050"	0.467
3"	3.500"	0.500"	2.440"	2.047	0.479"	2.484"	1.656	0.389"	2.676"	1.656	0.318"	2.825"	1.387	0.259"	2.950"	1.153	0.226"	3.021"	1.015
4"	4.500"	0.643"	3.137"	3.384	0.616"	3.193"	2.737	0.500"	3.440"	2.737	0.409"	3.633"	2.294	0.333"	3.793"	1.906	0.290"	3.885"	1.678
5"	5.375"	0.768"	3.747"	4.830	0.736"	3.814"	4.663	0.597"	4.109"	3.903	0.489"	4.339"	3.272	0.398"	4.531"	2.718	0.347"	4.640"	2.396
5"	5.563"	0.795"	3.878"	5.172	0.762"	3.947"	4.182	0.618"	4.253"	4.182	0.506"	4.491"	3.505	0.412"	4.689"	2.912	0.359"	4.802"	2.564
6"	6.625"	0.946"	4.619"	7.336	0.908"	4.701"	5.932	0.736"	5.064"	5.932	0.602"	5.348"	4.971	0.491"	5.585"	4.130	0.427"	5.719"	3.637
7"	7.125"	1.018"	4.967"	8.195	0.976"	5.056"	8.200	0.792"	5.447"	6.863	0.648"	5.752"	5.750	0.528"	6.006"	4.779	0.460"	6.150"	3.985
8"	8.625"	1.232"	6.013"	12.433	1.182"	6.120"	10.054	0.958"	6.593"	10.054	0.784"	6.963"	8.425	0.639"	7.271"	7.001	0.556"	7.445"	6.164
10"	10.750"	1.536"	7.494"	19.314	1.473"	7.628"	15.618	1.194"	8.218"	15.618	0.977"	8.678"	13.089	0.796"	9.062"	10.875	0.694"	9.280"	9.576
12"	12.750"	1.821"	8.889"	27.170	1.747"	9.047"	21.970	1.417"	9.747"	21.970	1.159"	10.293"	18.412	0.944"	10.748"	15.298	0.823"	11.006"	13.471
14"	14.000"	2.000"	9.760"	32.758	1.918"	9.934"	26.489	1.556"	10.702"	26.489	1.273"	11.302"	22.199	1.037"	11.801"	18.445	0.903"	12.085"	16.242
16"	16.00"	2.286"	11.154"	42.786	2.192"	11.353"	34.598	1.778"	12.231"	34.598	1.455"	12.916"	28.994	1.185"	13.487"	24.092	1.032"	13.812"	21.214
18"	18.00"	2.571"	12.549"	54.151	2.466"	12.773"	43.788	2.000"	13.760"	43.788	1.636"	14.531"	36.696	1.333"	15.173"	30.491	1.161"	15.538"	26.849
20"	20.00"	2.857"	13.943"	66.853	2.740"	14.192"	54.059	2.222"	15.289"	54.059	1.818"	16.145"	45.304	1.481"	16.859"	37.643	1.290"	17.265"	33.146
22"	22.00"	3.143"	15.337"	80.170	3.014"	15.611"	65.412	2.444"	16.818"	65.412	2.000"	17.760"	54.818	1.630"	18.545"	45.548	1.419"	18.991"	40.107
24"	24.00"	3.429"	16.731"	96.267	3.288"	17.030"	92.988	2.667"	18.347"	77.845	2.182"	19.375"	65.237	1.778"	20.231"	54.206	1.548"	20.717"	47.731
26"	26.00"	---	---	---	3.562"	18.449"	110.192	2.889"	19.876"	92.050	2.364"	20.989"	76.563	1.926"	21.917"	63.617	1.677"	22.444"	56.018
28"	28.00"	---	---	---	---	---	---	3.111"	21.404"	106.750	2.545"	22.604"	88.795	2.074"	23.603"	73.781	1.806"	24.170"	64.967
30"	30.00"	---	---	---	---	---	---	3.333"	22.933"	121.633	2.727"	24.218"	101.934	2.222"	25.289"	84.697	1.935"	25.897"	74.580
32"	32.00"	---	---	---	---	---	---	3.556"	24.462"	139.452	2.909"	25.833"	116.670	2.370"	26.975"	96.367	2.065"	27.623"	84.855
34"	34.00"	---	---	---	---	---	---	---	---	---	3.091"	27.447"	130.930	2.519"	28.661"	109.332	2.194"	29.350"	96.209
36"	36.00"	---	---	---	---	---	---	---	---	---	3.273"	29.062"	146.780	2.667"	30.347"	121.960	2.323"	31.076"	107.395
42"	42.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.111"	35.404"	166.800	2.710"	36.255"	146.176
48"	48.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.556"	40.462"	217.895	3.097"	41.435"	175.891
54"	54.00"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.484"	46.614"	242.649
63"	62.99"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 17 (100psi)			DR 19 (89psi)			DR 21 (80psi)			DR 26 (65psi)			DR 32.5 (50psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.050"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1"	1.315"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/4"	1.660"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/2"	1.900"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2"	2.375"	0.140"	2.079"	0.429	---	---	---	---	---	---	---	---	---	---	---	---
3"	3.500"	0.206"	3.064"	0.932	---	---	---	---	---	---	---	---	---	---	---	---
4"	4.500"	0.265"	3.939"	1.540	0.237"	3.998"	1.387	0.214"	4.046"	1.262	0.173"	4.133"	1.030	0.138"	4.206"	0.831
5"	5.375"	0.316"	4.705"	2.197	0.283"	4.775"	1.980	0.256"	4.832"	1.801	0.207"	4.937"	1.470	0.165"	5.024"	1.186
5"	5.563"	0.327"	4.869"	2.353	0.293"	4.942"	2.120	0.265"	5.001"	1.929	0.214"	5.109"	1.574	0.171"	5.200"	1.270
6"	6.625"	0.390"	5.799"	3.338	0.349"	5.886"	3.007	0.315"	5.956"	2.736	0.255"	6.085"	2.233	0.204"	6.193"	1.801
7"	7.125"	0.419"	6.236"	3.860	0.375"	6.330"	3.478	0.339"	6.406"	3.165	0.274"	6.544"	2.582	0.219"	6.660"	2.083
8"	8.625"	0.507"	7.549"	5.657	0.454"	7.663"	5.097	0.411"	7.754"	4.637	0.332"	7.922"	3.784	0.265"	8.062"	3.053
10"	10.750"	0.632"	9.409"	8.788	0.566"	9.551"	7.918	0.512"	9.665"	7.204	0.413"	9.873"	5.878	0.331"	10.049"	4.742
12"	12.750"	0.750"	11.160"	12.362	0.671"	11.327"	11.138	0.607"	11.463"	10.134	0.490"	11.710"	8.269	0.392"	11.918"	6.671
14"	14.000"	0.824"	12.254"	14.905	0.737"	12.438"	13.429	0.667"	12.587"	12.218	0.538"	12.858"	9.970	0.431"	13.087"	8.044
16"	16.00"	0.941"	14.005"	19.467	0.842"	14.215"	17.540	0.762"	14.385"	15.959	0.615"	14.695"	13.022	0.492"	14.956"	10.506
18"	18.00"	1.059"	15.755"	24.638	0.947"	15.992"	22.199	0.857"	16.183"	20.198	0.692"	16.532"	16.480	0.554"	16.826"	13.296
20"	20.00"	1.176"	17.506"	30.418	1.053"	17.768"	27.406	0.952"	17.981"	24.936	0.769"	18.369"	20.346	0.615"	18.695"	16.415
22"	22.00"	1.294"	19.256"	36.805	1.158"	19.545"	33.162	1.048"	19.779"	30.172	0.846"	20.206"	24.619	0.677"	20.565"	19.863
24"	24.00"	1.412"	21.007"	43.801	1.263"	21.322"	39.465	1.143"	21.577"	35.907	0.923"	22.043"	29.299	0.738"	22.434"	23.638
26"	26.00"	1.529"	22.758"	51.406	1.368"	23.099"	46.316	1.238"	23.375"	42.141	1.000"	23.880"	34.385	0.800"	24.304"	27.742
28"	28.00"	1.647"	24.508"	59.618	1.474"	24.876"	53.716	1.333"	25.173"	48.874	1.077"	25.717"	39.879	0.862"	26.174"	32.174
30"	30.00"	1.765"	26.259"	68.439	1.579"	26.653"	61.664	1.429"	26.971"	56.105	1.154"	27.554"	45.779	0.923"	28.043"	36.934
32"	32.00"	1.882"	28.009"	77.869	1.684"	28.429"	70.160	1.524"	28.770"	63.835	1.231"	29.391"	52.086	0.985"	29.913"	42.023
34"	34.00"	2.000"	29.760"	87.907	1.789"	30.206"	79.204	1.619"	30.568"	72.064	1.308"	31.228"	58.814	1.046"	31.782"	47.440
36"	36.00"	2.118"	31.511"	98.553	1.895"	31.983"	88.796	1.714"	32.366"	80.791	1.385"	33.065"	65.922	1.108"	33.652"	53.186
42"	42.00"	2.471"	36.762"	134.141	2.211"	37.314"	120.861	2.000"	37.760"	109.966	1.615"	38.575"	89.727	1.292"	39.260"	72.392
48"	48.00"	2.824"	42.014"	175.205	2.526"	42.644"	157.857	2.286"	43.154"	143.629	1.846"	44.086"	117.194	1.477"	44.869"	94.552
54"	54.00"	3.176"	47.266"	222.547	2.842"	47.975"	199.791	2.571"	48.549"	182.298	2.077"	49.597"	148.324	1.662"	50.478"	119.668
63"	62.99"	---	---	---	---	---	---	3.000"	56.631"	247.800	2.423"	57.854"	202.010	1.938"	58.881"	162.980

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	DJR
PROJECT:	SEVEN MILE CREEK SEC. 2 NE EXPANSION FEASIBILITY RPT.	CHK:	DKS
SUBJECT:	PIPE STRENGTH	DATE:	6/17/2019
PROJECT NO.	190275		

T-1b HDPE SDR-11 PIPE STRENGTH CALCULATIONS

Purpose: To evaluate the pipe strength of 6" diameter, SDR 11 HDPE leachate collection piping in the base system of the Seven Mile Creek Sector 2 Landfill using designed properties and parameters

Approach: Use referenced formulas to determine the loads applied to leachate collection piping and determine whether the applied loads are within the required factor of safety for the pipe to adequately perform throughout its service life.

References: Plastics Pipe Institute 2nd Edition Handbook of PE Pipe, Buried PE Pipe Design.
ISCO Industries, Typical Properties and Dimension Charts, (Attachment 1).
"Soil Reaction for Buried Flexible Pipe", Amster K. Howard, U.S. Bureau of Reclamation.
HDPE Leachate Collection Pipe Design by Fundamentals of Mechanics", Harrison and Watkins, 1996, Nineteenth International Madison Waste Conference.
Sevan Mile Creek Landfill Plan of Operation, Base Grades and Final Grades Drawings, 2015.

Assumptions:
1.) Live loads are negligible above the piping.
2.) All installed SDR 11 HDPE piping meets the specifications of ASTM F714; "Standard Specification for Polyethylene (PE) Plastic Pipe, based on outside diameter".
3.) Base Grade Elevation = 902 ft msl, Final Cover Elevation = 1166 ft msl.
4.) The maximum fill height over pipes is 263 feet. This consists of 2.5 feet of bedding gravel, 255 feet of waste, 0.5 feet of grading layer material, 2 feet of clay, 2.5 feet of rooting zone, and 0.5 feet of topsoil.
4.) Waste unit weight is 90 PCF based on final waste grades (after settlement of intermediate waste grades).

Calculations: **Pipe Loading** $P_y = DL + LL$

where,

P_y= Pipe Load, lb/in^2
DL= Dead Load, lb/in^2
LL = Live Load, lb/in^2

Dead Load

$$DL = \sum \frac{\gamma_{fill} * H_{fill}}{144}$$

where,

γ_{fill} = Fill Unit Weight, lb/in^3
H_{fill}= Height of Fill, ft
DL = Dead Load, lb/in^2

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	DJR
PROJECT:	SEVEN MILE CREEK SEC. 2 NE EXPANSION FEASIBILITY RPT.	CHK:	DKS
SUBJECT:	PIPE STRENGTH	DATE:	6/17/2019
PROJECT NO.	190275		

Calculations: (Cont.)

A summary of the height and unit weight of all material covering the leachate collection pipe at its maximum depth is provided below:

Fill Type	Height, H_{fill} (ft)	Unit Weight, γ_{fill} (pcf)	Dead Load (psi)
Topsoil	0.50	105	0.36
Rooting Zone	2.50	120	2.08
Clay	2.00	130	1.81
Grading Layer	0.50	125	0.43
Waste	255	90	159.38
Pipe Bedding Material	2.50	135	2.34
Total	**263.00**	**-**	**166.41**

In our case the live load (LL) = 0, due to limited live loads above the piping after placement.

Therefore,

$$P_y = DL = 166.41 \text{ lb/in}^2$$

Deflection

A deflection of 5 to 7.5% has become the standard for limiting deflection in flexible pipes. Based on Figure 7.16 in Uni-Bell, 1992, a vertical strain of greater than 5% will never be reached for flexible pipe bedded in compacted gravel, independent of vertical soil pressure. At 90% compaction the vertical strain will always be less than 2%. The height of fill over the pipe is not a factor when the pipe is well bedded in gravel.

Wall Crushing

$$\sigma = \frac{T}{A}$$

where,

A = Area of Pipe Wall, in^2/in
T = Wall Thrust, lb/in
σ = Compressive Stress, lb/in^2

and,

$$T = \frac{P_y * D_o}{2}$$

With 6" diameter HDPE SDR-11 leachate collection piping,

Outer Diameter of Pipe (D_o) = 6.625 in.
Min. Pipe Wall Thickness (A) = 0.602 in.
(from Attachment 1)

CALCULATION SHEET

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	DJR
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Calculations:
(Cont.)

DL, psi	166.41
LL, psi	0
P_y, psi	166.41
D_0, in	6.625
T, lb/in	551.22
A, in^2/in	0.602
σ, psi	915.65
$\sigma_{allowable}$, psi	1600
Factor of Safety	1.75

Result: The calculated maximum compressive stress for in-place SDR-11 HDPE leachate collection pipes is 915.65 psi. This is below the maximum allowable compressive stress of 1600 psi, by a safety factor of 1.75. The factor of safety against wall crushing of the pipe is acceptable for the existing and proposed HDPE SDR-11 6” diameter pipes.

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HIGH DENSITY POLYETHYLENE PIPE
Typical Physical Properties***

Property	**Specification**	**Unit**	**Nominal Value**
Material Designation	PPI / ASTM		PE 3408
Material Classification	ASTM D-1248		III C 5 P34
Cell Classification	**ASTM D3350-99**		**345464C**
-Density (3)	ASTM D-1505	gm/cm3	0.955
-Melt Index (4)	ASTM D-1238 (216 kg/190¡C)	gm/10 min.	0.11*
-Flex Modulus (5)	ASTM D-790	psi	135,000
-Tensile Strength (4)	ASTM D-638	psi	3,200
PENT (6)	ASTM F-1473	Hours	>100
-HDB @73¡ F (4)	ASTM D-2837	psi	1,600
-HDB @ 140 Deg F	ASTM D-2837	psi	800
-U-V Stabilizer (C)	ASTM D-1603	% C	2.5
Hardness	ASTM D-2240	Shore “D”	65
Compressive Strength (yield)	ASTM D-695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2”/min.)	psi	3,200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5,000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
PENT (6)	ASTM F-1473	Hours	>100
(Cond. A, B, C: Mold. Slab)	ASTM D-1693	Fo, Hours	>5,000
(Compressed Ring - pipe)	ASTM F-1248	Fo, Hours	>3,500
Slow Crack Growth	Battelle Method	Days to Failure	>64
Impact Strength (IZOD) (.125Ó Thick)	ASTM D-256 (Method A)	In-lb / in notch	42
Linear Thermal Expansion Coef.	ASTM D-696	in / in/¡F	1.2x10-4
Thermal Conductivity	ASTM D-177	BTU-in/ft2/ hrs/ degreesF	2.7
Brittleness Temp.	ASTM D-746	degrees F	< -180
Vicat Soft. Temp.	ASTM D-1525	degrees F	257
Heat Fusion Cond.	ASTM D-1525	@ psi degrees F	75 @ 400

*** This list of typical physical properties is intended for basic characterization of the material and does not represent specific determinations of specifications. The physical properties values reported herein were determined on compression molded specimens prepared in accordance with Procedure C of ASTM D 1928 and may differ from specimens taken from pipe.
** Tests were discontinued because no failures and no indication of stress crackinitiation.
* Average Melt Index value with a standard deviation of 0.01

This document reports accurate and reliable information to the best of our knowledge but our suggestions and recommendations cannot be guaranteed because the conditions of the use are beyond our control. The user of such information assumes all risk connected with the use thereof. Chevron Phillips Chemical Co. and its subsidiaries assume no responsibility for the use of information presented herein and hereby expressly disclaims all liability in regards to such use.

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 7 (267psi)			DR 7.3 (254psi)			DR 9 (200psi)			DR 11 (160psi)			DR 13.5 (128psi)			DR 15.5 (110psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.05"	0.150"	0.732"	0.184	0.144"	0.745"	0.178	0.117"	0.803"	0.150	0.095"	0.848"	0.125	---	---	---	---	---	---
1"	1.315"	0.188"	0.917"	0.289	0.180"	0.933"	0.279	0.146"	1.005"	0.234	0.120"	1.062"	0.197	---	---	---	---	---	---
1 1/4"	1.66"	0.237"	1.157"	0.460	0.227"	1.178"	0.444	0.184"	1.269"	0.372	0.151"	1.340"	0.312	---	---	---	---	---	---
1 1/2"	1.90"	0.271"	1.325"	0.603	0.260"	1.348"	0.582	0.211"	1.452"	0.488	0.173"	1.534"	0.409	---	---	---	---	---	---
2"	2.375"	0.339"	1.656"	0.943	0.325"	1.685"	0.762	0.264"	1.816"	0.762	0.216"	1.917"	0.639	0.176"	2.002"	0.531	0.153"	2.050"	0.467
3"	3.500"	0.500"	2.440"	2.047	0.479"	2.484"	1.656	0.389"	2.676"	1.656	0.318"	2.825"	1.387	0.259"	2.950"	1.153	0.226"	3.021"	1.015
4"	4.500"	0.643"	3.137"	3.384	0.616"	3.193"	2.737	0.500"	3.440"	2.737	0.409"	3.633"	2.294	0.333"	3.793"	1.906	0.290"	3.885"	1.678
5"	5.375"	0.768"	3.747"	4.830	0.736"	3.814"	4.663	0.597"	4.109"	3.903	0.489"	4.339"	3.272	0.398"	4.531"	2.718	0.347"	4.640"	2.396
5"	5.563"	0.795"	3.878"	5.172	0.762"	3.947"	4.182	0.618"	4.253"	4.182	0.506"	4.491"	3.505	0.412"	4.689"	2.912	0.359"	4.802"	2.564
6"	6.625"	0.946"	4.619"	7.336	0.908"	4.701"	5.932	0.736"	5.064"	5.932	0.602"	5.348"	4.971	0.491"	5.585"	4.130	0.427"	5.719"	3.637
7"	7.125"	1.018"	4.967"	8.195	0.976"	5.056"	8.200	0.792"	5.447"	6.863	0.648"	5.752"	5.750	0.528"	6.006"	4.779	0.460"	6.150"	3.985
8"	8.625"	1.232"	6.013"	12.433	1.182"	6.120"	10.054	0.958"	6.593"	10.054	0.784"	6.963"	8.425	0.639"	7.271"	7.001	0.556"	7.445"	6.164
10"	10.750"	1.536"	7.494"	19.314	1.473"	7.628"	15.618	1.194"	8.218"	15.618	0.977"	8.678"	13.089	0.796"	9.062"	10.875	0.694"	9.280"	9.576
12"	12.750"	1.821"	8.889"	27.170	1.747"	9.047"	21.970	1.417"	9.747"	21.970	1.159"	10.293"	18.412	0.944"	10.748"	15.298	0.823"	11.006"	13.471
14"	14.000"	2.000"	9.760"	32.758	1.918"	9.934"	26.489	1.556"	10.702"	26.489	1.273"	11.302"	22.199	1.037"	11.801"	18.445	0.903"	12.085"	16.242
16"	16.00"	2.286"	11.154"	42.786	2.192"	11.353"	34.598	1.778"	12.231"	34.598	1.455"	12.916"	28.994	1.185"	13.487"	24.092	1.032"	13.812"	21.214
18"	18.00"	2.571"	12.549"	54.151	2.466"	12.773"	43.788	2.000"	13.760"	43.788	1.636"	14.531"	36.696	1.333"	15.173"	30.491	1.161"	15.538"	26.849
20"	20.00"	2.857"	13.943"	66.853	2.740"	14.192"	54.059	2.222"	15.289"	54.059	1.818"	16.145"	45.304	1.481"	16.859"	37.643	1.290"	17.265"	33.146
22"	22.00"	3.143"	15.337"	80.170	3.014"	15.611"	65.412	2.444"	16.818"	65.412	2.000"	17.760"	54.818	1.630"	18.545"	45.548	1.419"	18.991"	40.107
24"	24.00"	3.429"	16.731"	96.267	3.288"	17.030"	92.988	2.667"	18.347"	77.845	2.182"	19.375"	65.237	1.778"	20.231"	54.206	1.548"	20.717"	47.731
26"	26.00"	---	---	---	3.562"	18.449"	110.192	2.889"	19.876"	92.050	2.364"	20.989"	76.563	1.926"	21.917"	63.617	1.677"	22.444"	56.018
28"	28.00"	---	---	---	---	---	---	3.111"	21.404"	106.750	2.545"	22.604"	88.795	2.074"	23.603"	73.781	1.806"	24.170"	64.967
30"	30.00"	---	---	---	---	---	---	3.333"	22.933"	121.633	2.727"	24.218"	101.934	2.222"	25.289"	84.697	1.935"	25.897"	74.580
32"	32.00"	---	---	---	---	---	---	3.556"	24.462"	139.452	2.909"	25.833"	116.670	2.370"	26.975"	96.367	2.065"	27.623"	84.855
34"	34.00"	---	---	---	---	---	---	---	---	---	3.091"	27.447"	130.930	2.519"	28.661"	109.332	2.194"	29.350"	96.209
36"	36.00"	---	---	---	---	---	---	---	---	---	3.273"	29.062"	146.780	2.667"	30.347"	121.960	2.323"	31.076"	107.395
42"	42.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.111"	35.404"	166.800	2.710"	36.255"	146.176
48"	48.00"	---	---	---	---	---	---	---	---	---	---	---	---	3.556"	40.462"	217.895	3.097"	41.435"	175.891
54"	54.00"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.484"	46.614"	242.649
63"	62.99"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

PE 3608/3408 IPS HDPE PIPE SIZES

Pressure Rating		DR 17 (100psi)			DR 19 (89psi)			DR 21 (80psi)			DR 26 (65psi)			DR 32.5 (50psi)		
Nominal Size	Actual O.D.	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf	Min. wall	Average I.D.	Weight lb/lf
3/4"	1.050"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1"	1.315"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/4"	1.660"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1 1/2"	1.900"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2"	2.375"	0.140"	2.079"	0.429	---	---	---	---	---	---	---	---	---	---	---	---
3"	3.500"	0.206"	3.064"	0.932	---	---	---	---	---	---	---	---	---	---	---	---
4"	4.500"	0.265"	3.939"	1.540	0.237"	3.998"	1.387	0.214"	4.046"	1.262	0.173"	4.133"	1.030	0.138"	4.206"	0.831
5"	5.375"	0.316"	4.705"	2.197	0.283"	4.775"	1.980	0.256"	4.832"	1.801	0.207"	4.937"	1.470	0.165"	5.024"	1.186
5"	5.563"	0.327"	4.869"	2.353	0.293"	4.942"	2.120	0.265"	5.001"	1.929	0.214"	5.109"	1.574	0.171"	5.200"	1.270
6"	6.625"	0.390"	5.799"	3.338	0.349"	5.886"	3.007	0.315"	5.956"	2.736	0.255"	6.085"	2.233	0.204"	6.193"	1.801
7"	7.125"	0.419"	6.236"	3.860	0.375"	6.330"	3.478	0.339"	6.406"	3.165	0.274"	6.544"	2.582	0.219"	6.660"	2.083
8"	8.625"	0.507"	7.549"	5.657	0.454"	7.663"	5.097	0.411"	7.754"	4.637	0.332"	7.922"	3.784	0.265"	8.062"	3.053
10"	10.750"	0.632"	9.409"	8.788	0.566"	9.551"	7.918	0.512"	9.665"	7.204	0.413"	9.873"	5.878	0.331"	10.049"	4.742
12"	12.750"	0.750"	11.160"	12.362	0.671"	11.327"	11.138	0.607"	11.463"	10.134	0.490"	11.710"	8.269	0.392"	11.918"	6.671
14"	14.000"	0.824"	12.254"	14.905	0.737"	12.438"	13.429	0.667"	12.587"	12.218	0.538"	12.858"	9.970	0.431"	13.087"	8.044
16"	16.00"	0.941"	14.005"	19.467	0.842"	14.215"	17.540	0.762"	14.385"	15.959	0.615"	14.695"	13.022	0.492"	14.956"	10.506
18"	18.00"	1.059"	15.755"	24.638	0.947"	15.992"	22.199	0.857"	16.183"	20.198	0.692"	16.532"	16.480	0.554"	16.826"	13.296
20"	20.00"	1.176"	17.506"	30.418	1.053"	17.768"	27.406	0.952"	17.981"	24.936	0.769"	18.369"	20.346	0.615"	18.695"	16.415
22"	22.00"	1.294"	19.256"	36.805	1.158"	19.545"	33.162	1.048"	19.779"	30.172	0.846"	20.206"	24.619	0.677"	20.565"	19.863
24"	24.00"	1.412"	21.007"	43.801	1.263"	21.322"	39.465	1.143"	21.577"	35.907	0.923"	22.043"	29.299	0.738"	22.434"	23.638
26"	26.00"	1.529"	22.758"	51.406	1.368"	23.099"	46.316	1.238"	23.375"	42.141	1.000"	23.880"	34.385	0.800"	24.304"	27.742
28"	28.00"	1.647"	24.508"	59.618	1.474"	24.876"	53.716	1.333"	25.173"	48.874	1.077"	25.717"	39.879	0.862"	26.174"	32.174
30"	30.00"	1.765"	26.259"	68.439	1.579"	26.653"	61.664	1.429"	26.971"	56.105	1.154"	27.554"	45.779	0.923"	28.043"	36.934
32"	32.00"	1.882"	28.009"	77.869	1.684"	28.429"	70.160	1.524"	28.770"	63.835	1.231"	29.391"	52.086	0.985"	29.913"	42.023
34"	34.00"	2.000"	29.760"	87.907	1.789"	30.206"	79.204	1.619"	30.568"	72.064	1.308"	31.228"	58.814	1.046"	31.782"	47.440
36"	36.00"	2.118"	31.511"	98.553	1.895"	31.983"	88.796	1.714"	32.366"	80.791	1.385"	33.065"	65.922	1.108"	33.652"	53.186
42"	42.00"	2.471"	36.762"	134.141	2.211"	37.314"	120.861	2.000"	37.760"	109.966	1.615"	38.575"	89.727	1.292"	39.260"	72.392
48"	48.00"	2.824"	42.014"	175.205	2.526"	42.644"	157.857	2.286"	43.154"	143.629	1.846"	44.086"	117.194	1.477"	44.869"	94.552
54"	54.00"	3.176"	47.266"	222.547	2.842"	47.975"	199.791	2.571"	48.549"	182.298	2.077"	49.597"	148.324	1.662"	50.478"	119.668
63"	62.99"	---	---	---	---	---	---	3.000"	56.631"	247.800	2.423"	57.854"	202.010	1.938"	58.881"	162.980

NOTE:

- Items highlighted in Blue indicates standard stocking items that are more readily available.
- Pressures are based on using water at 23°C (73°F).
- Average inside diameter calculated using nominal OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
- Service factors should be utilized to compensate for the effect of liquids other than water, and for other temperatures.
- Other piping sizes or DR's may be available upon request.
- Standard Lengths: 40' for 2"-24" / 50' for 26" and larger / Coils available for 3/4"-6"(8" by special order)

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	DJR
PROJECT:	SEVEN MILE CREEK SEC. 2 NE EXPANSION FEASIBILITY RPT.	CHK:	DKS
SUBJECT:	PIPE STRENGTH	DATE:	6/17/2019
PROJECT NO.	190275		

T-1c SCHEDULE 80 PVC PIPE STRENGTH CALCULATIONS

Purpose: To evaluate the pipe strength of 6" diameter, Schedule 80 PVC leachate collection piping in the base system of the Seven Mile Creek Sector 2 Landfill using designed properties and parameters

Approach: Use referenced formulas to determine the loads applied to leachate collection piping and determine whether the applied loads are within the required factor of safety for the pipe to adequately perform throughout its service life.

References: Plastics Pipe Institute 2nd Edition Handbook of PE Pipe, Buried PE Pipe Design.
ISCO Industries, Typical Properties and Dimension Charts, (Attachment 1).
"Soil Reaction for Buried Flexible Pipe", Amster K. Howard, U.S. Bureau of Reclamation.
HDPE Leachate Collection Pipe Design by Fundamentals of Mechanics", Harrison and Watkins, 1996, Nineteenth International Madison Waste Conference.
Sevan Mile Creek Landfill Plan of Operation, Base Grades and Final Grades Drawings, 2015.

Assumptions:
1.) Live loads are negligible above the piping.
2.) All installed PVC Schedule 80 piping meets the specifications of ASTM D1785; "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120"
3.) Base Grade Elevation = 912 ft msl, Final Cover Elevation = 1166 ft msl.
4.) The maximum fill height over pipes is 253 feet. This consists of 1.0 feet of bedding gravel, 253 feet of waste, 0.5 feet of grading layer material, 2 feet of clay, 2.5 feet of rooting zone, and 0.5 feet of topsoil.
4.) Waste unit weight is 90 PCF based on final waste grades (after settlement of intermediate waste grades).

Calculations: **Pipe Loading** $P_y = DL + LL$

where,

P_y= Pipe Load, lb/in^2
DL= Dead Load, lb/in^2
LL = Live Load, lb/in^2

Dead Load $DL = \sum \frac{\gamma_{fill} * H_{fill}}{144}$

where,

γ_{fill} = Fill Unit Weight, lb/in^3
H_{fill}= Height of Fill, ft
DL = Dead Load, lb/in^2

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A summary of the height and unit weight of all material covering the leachate collection pipe at its maximum depth is provided below:

Calculations: (Cont.)

Fill Type	Height, H_{fill} (ft)	Unit Weight, γ_{fill} (pcf)	Dead Load (psi)
Topsoil	0.50	105	0.36
Rooting Zone	2.50	120	2.08
Clay	2.00	130	1.81
Grading Layer	0.50	125	0.43
Waste	246.5	90	154.06
Pipe Bedding Material	1.00	135	0.94
Total	**253.00**	**-**	**159.69**

In our case the live load (LL) = 0, due to limited live loads above the piping after placement.

Therefore,

$$P_y = DL = 159.69 \text{ lb/in}^2$$

Deflection

A deflection of 5 to 7.5% has become the standard for limiting deflection in flexible pipes. Based on Figure 7.16 in Uni-Bell, 1992, a vertical strain of greater than 5% will never be reached for flexible pipe bedded in compacted gravel, independent of vertical soil pressure. At 90% compaction the vertical strain will always be less than 2%. The height of fill over the pipe is not a factor when the pipe is well bedded in gravel.

Wall Crushing

$$\sigma = \frac{T}{A}$$

where,

A = Area of Pipe Wall, in^2/in
T = Wall Thrust, lb/in
σ = Compressive Stress, lb/in^2

and,

$$T = \frac{P_y * D_o}{2}$$

With 6" diameter HDPE SDR-11 leachate collection piping,

Outer Diameter of Pipe (D_o) = 6.625 in.
Min. Pipe Wall Thickness (A) = 0.432 in.
(from Attachment 1)

CALCULATION SHEET

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Calculations:
(Cont.)

DL, psi	159.69
LL, psi	0
P_y, psi	159.69
D_0, in	6.625
T, lb/in	528.96
A, in^2/in	0.432
σ, psi	1224.46
$\sigma_{allowable}$, psi	9600
Factor of Safety	7.84

Result: The calculated maximum compressive stress for in-place Schedule 80 PVC leachate collection pipes is 1224.46 psi. This is below the maximum allowable compressive stress of 9600 psi, by a safety factor of 7.84. The factor of safety against wall crushing of the pipe is acceptable for the existing Schedule 80 PVC 6” diameter pipes.

PVC Pipe Specifications, Sizes & Pressure Ratings

PVC Pipe Physical Properties		
GENERAL	**Value**	**Test Method**
Cell Classification	12454	ASTM D1784
Maximum Service Temp.	140°F	
Color	White, Dark Gray	
Specific Gravity, (g/cu.cm @ 73°F)	1.40 +/-.02	ASTM D792
Water Absorption % increase 24 hrs @ 25°C	0.05	ASTM D570
Hardness, Rockwell	110 - 120	ASTM D785
Poisson's Ratio @ 73°F	0.410	
Hazen-Williams Factor	C =150	
MECHANICAL		
Tensile Strength, psi @ 73°F	7,450	ASTM D638
Tensile Modulus of Elasticity, psi @ 73°F	420,000	ASTM D638
Flexural Strength, psi @ 73°F	14,450	ASTM D790
Flexural Modulus, psi @ 73°F	360,000	ASTM D790
Compressive Strength, psi @ 73°F	9,600	ASTM D695
Izod Impact, notched, ft-lb/in @ 73°F	0.75	ASTM D256
THERMAL		
Coefficient of Linear Expansion (in/in/°F)	2.9×10^{-5}	ASTM D696
Coefficient of Thermal Conductivity (Cal.)(cm)/(cm2)(Sec.)(°C) BTU/in/hr/ft.2/°F Watt/m/°K	 3.5×10^{-4} 1.02 0.147	ASTM C177
Heat Deflection Temperature Under Load (264 psi, annealed)	170	ASTM D648
Specific Heat, Cal./°C/gm	0.25	ASTM D2766
ELECTRICAL		
Dielectric Strength, volts/mil	1,413	ASTM D149
Dielectric Constant, 60Hz, 30°F	3.70	ASTM D150
Volume Resistivity, ohm/cm @ 95°C	1.2×10^{12}	ASTM D257
Harvel PVC Pipe is non-electrolytic		
FIRE PERFORMANCE		
Flammability Rating	V-0	UL-94
Flame Spread Index	<10	
Flame Spread	0-25	ULC
Smoke Generation	80-225	ULC
Flash Ignition Temp.	730°F	
Average Time of Burning (sec.)	<5	ASTM D635
Average Extent of Burning (mm)	<10	
Burning Rate (in/min)	Self Extinguishing	

Softening Starts (approx.)	250°F	
Material Becomes Viscous	350°F	
Material Carbonizes	425°F	
Limiting Oxygen Index (LOI)	43	ASTM D2863
Clean Room Materials Flammability Test	N/A	FM 4910

SCHEDULE 40 & 80 - DIMENSIONS

Schedule 40 Dimensions

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nom. Wt./Ft.	Max. W.P. PSI**
1/8"	0.405	0.249	0.068	0.051	810
1/4"	0.540	0.344	0.088	0.086	780
3/8"	0.675	0.473	0.091	0.115	620
1/2"	0.840	0.602	0.109	0.170	600
3/4"	1.050	0.804	0.113	0.226	480
1"	1.315	1.029	0.133	0.333	450
1-1/4"	1.660	1.360	0.140	0.450	370
1-1/2"	1.900	1.590	0.145	0.537	330
2"	2.375	2.047	0.154	0.720	280
2-1/2"	2.875	2.445	0.203	1.136	300
3"	3.500	3.042	0.216	1.488	260
3-1/2"	4.000	3.521	0.226	1.789	240
4"	4.500	3.998	0.237	2.118	220
5"	5.563	5.016	0.258	2.874	190
6"	6.625	6.031	0.280	3.733	180
8"	8.625	7.942	0.322	5.619	160
10"	10.750	9.976	0.365	7.966	140
12"	12.750	11.889	0.406	10.534	130
14"	14.000	13.073	0.437	12.462	130
16"	16.000	14.940	0.500	16.286	130
18"	18.000	16.809	0.562	20.587	130
20"	20.000	18.743	0.593	24.183	120
24"	24.000	22.544	0.687	33.652	120

Schedule 80 Dimensions

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nom. Wt./Ft.	Max. W.P. PSI**
1/8"	.405	.195	0.095	0.063	1230
1/4"	.540	.282	0.119	0.105	1130
3/8"	.675	.403	0.126	0.146	920
1/2"	.840	.526	0.147	0.213	850
3/4"	1.050	.722	0.154	0.289	690

1"	1.315	.936	0.179	0.424	630
1-1/4"	1.660	1.255	0.191	0.586	520
1-1/2"	1.900	1.476	0.200	0.711	470
2"	2.375	1.913	0.218	0.984	400
2-1/2"	2.875	2.290	0.276	1.500	420
3"	3.500	2.864	0.300	2.010	370
3-1/2"	4.000	3.326	0.318	2.452	350
4"	4.500	3.786	0.337	2.938	320
5"	5.563	4.768	0.375	4.078	290
6"	6.625	5.709	0.432	5.610	280
8"	8.625	7.565	0.500	8.522	250
10"	10.750	9.493	0.593	12.635	230
12"	12.750	11.294	0.687	17.384	230
14"	14.000	12.410	0.750	20.852	220
16"	16.000	14.213	0.843	26.810	220
18"	18.000	16.014	0.937	33.544	220
20"	20.000	17.814	1.031	41.047	220
24"	24.000	21.418	1.218	58.233	210

SCHEDULE 120 - DIMENSIONS

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nom. Wt./Ft.	Max. W.P. PSI**
1/2"	.840	.480	0.170	0.236	1010
3/4"	1.050	.690	0.170	0.311	770
1"	1.315	.891	0.200	0.464	720
1-1/4"	1.660	1.204	0.215	0.649	600
1-1/2"	1.900	1.423	0.225	0.787	540
2"	2.375	1.845	0.250	1.111	470
2-1/2"	2.875	2.239	0.300	1.615	470
3"	3.500	2.758	0.350	2.306	440
4"	4.500	3.574	0.437	3.713	430
6"	6.625	5.434	0.562	7.132	370
8"	8.625	7.189	0.718	11.277	380

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Appendix T-2
Leachate Collection Pipe Differential Settlement Calculations

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SUBJECT:	PIPE DIFFERENTIAL SETTLEMENT	DATE:	6/12/19
PROJECT NO.	190275		

LEACHATE COLLECTION PIPE DIFFERENTIAL SETTLEMENT CALCULATIONS

OBJECTIVE:

Demonstrate that the leachate piping as designed in the approved Plan of Operations, and the proposed leachate piping in the Sector 2 Northeast Expansion (the expansion) Feasibility Report, will withstand the potential long-term differential settlement that may be imposed during the waste filling operations of the landfill with the expansion. This is intended to comply with NR 504.06(6)(c). This analysis checks that a minimum slope of 0.5 percent is maintained after settlement has occurred in all leachate collection pipes exceeding 1,200 feet in length (from the end of each cleanout to the toe of the opposite slope).

METHODOLOGY:

The total settlement of the landfill is a combination of elastic settlement in granular soil (i.e., sand and gravel) and primary and secondary consolidation settlement of fine-grained soils (i.e., clay or silt). NR 504.06(6) requires consideration of 100 percent of primary consolidation settlement and a 100-year timeframe to calculate secondary consolidation settlement. Attachment 1 includes the supporting documentation for the calculations within this document.

In the vertical overlay portion of the expansion, the north-south critical cross section of the worst-case leachate line is noted, that shows both the greatest overbearing pressure on a pipe point (maximum height of waste) and the least pressure on the pipe point (lowest height of waste along the primary leachate line). Subsurface conditions were fairly consistent in the borings, as a result this overbearing differential was deemed the critical component for determining “worst-case” conditions. This was then evaluated for the subsurface conditions for a minimum of 100-year time frame to reflect both primary and secondary settlement.

In the horizontal expansion portion of the expansion, the critical cross section is through the leachate pipe located further to the west. This is due to the greater overbearing pressure differential. The process described above was repeated for this leachate pipe.

Similar to the last time this differential settlement calculation was conducted (2015 Sector 2 Vertical Expansion Plan of Operation, Seven Mile Creek Landfill, submitted by Cornerstone

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Environmental Group, LLC), the Schmertmann Method was used to calculate elastic settlement of granular soils due to landfill loading. The calculations from the 2015 Plan of Operation are included as **Attachment 2** to this calculation to show past methodology and results. This method calculates settlement using one-dimensional elastic modulus of subsurface soil layers and performs a simplified triangular strain distribution. The soil below the landfill was divided into layers and elastic settlement of each layer was computed. Subsurface soil layers and types used at the points evaluated were taken from the nearest soil boring at each point. A description of the calculation methodology, assumptions, and results are noted below and in the attachments.

ASSUMPTIONS:

Overbearing conditions:

- The weight of the landfill mass is applied instantaneously.
- The loaded area is assumed to be 500 feet by 500 feet to adequately characterized a large mass of weight impacting the piping over a larger area.
- Considerations of pre-existing conditions that would have already applied long-term loading of subsurface layers was applied. Only the change or addition in overburden capacity from vertical landfill cross-section was considered in this analysis.

CALCULATION:

1. **Critical cross-sections and four critical points that are on those sections.**

   Vertical Overlay Portion: The eastern leachate collection pipe in Phase 13A is most critical because it passes through the points of the greatest waste thickness difference. The peak load/landfill height point is labeled P13A-1 and the minimum load/landfill height point at the toe of slope at the north end of the Phase is labeled P13A-2 on the attached figures.

   Horizontal Expansion Portion: The western leachate pipe in Phase 14A is the most critical because it passes through the points of the greatest waste thickness difference. The peak load/landfill height point is labeled P14-1 and the minimum load/landfill height point at the toe of slope at the north end of the Phase is labeled P14-2 on the attached figures.

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2. Determine fill (waste) thickness at each of the points.

Cross sections showing the leachate piping and soil layers above are noted in the attachments. These correlate with top of final cover points and base grade points of the leachate collection trench. These points are summarized in the table below:

Point No.	Base Grade Elevation (ft. msl)	Final Cover Elevation (ft. msl)	Thickness (feet)
P13A-1	900.02	1162.78	262.76
P13A-2	896.00	961.78	65.78
P14-1	910.00	1033.87	123.87
P14-2	901.62	969.04	67.42

3. Determine the applied stress at each of the points.

$$\sigma_n = \sum \gamma_n H_n$$

Where: σ_n = applied pressure, psf
γ_n = unit weight of soil, pcf
H_n = existing ground elevation (EG) minus top of base grade (BG) elevation, ft

a. Create representative fill profile (shown in attachments).
b. Determine effective stress applied at the top of liner (AKA base grades), at each of the designated points (noted in attachments). Note that densities and unit rates in this calculation are consistent with pipe strength calculations performed as part of this expansion Feasibility Report technical calculations performed elsewhere.
c. A summary of the effective stress applied at each point is summarized in the table below:

Point No.	Effective Stress (psf)
P13A-1	23,986
P13A-2	6,078
P14-1	11,489
P14-2	6,404

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4. Determine in-situ (pre-excavation) pressure at each of the points.

$$\sigma_{n'} = \gamma_n H_n$$

Where: $\sigma_{n'}$ = in-situ pressure, psf
γ_n = unit weight of soil, pcf
H_n = existing ground elevation (EG) minus top of base grade (BG) elevation, ft

The in-situ pressure at each of the points is summarized in the table below:

Point No.	γ_n	EG (ft. MSL)	BG (ft. MSL)	H_n	$\sigma_{n'}$
P13A-1	120	917.0	900.0	17.0	2,040
P13A-2	120	918.5	896.0	22.5	2700
P14-1	120	931.7	910.0	21.7	2,604
P14-2	120	928.2	901.6	26.6	3,192

The existing ground, and base grade elevations can be found in the attachments of this calculation.

5. Determine change in stress at the top of liner elevation between initial site conditions and future vertical expansion.

$$\sigma_{\Delta} = \sigma_n - \sigma_{n'}$$

Where: σ_{Δ} = change in stress, psf
σ_n = applied stress, psf
$\sigma_{n'}$ = in-situ stress, psf

Point No.	σ_n (psf)	$\sigma_{n'}$ (psf)	σ_{Δ} (psf)
P13A-1	23,986	2,040	21,946
P13A-2	6,258	2,700	3,558
P14-1	11,489	2,604	8,885
P14-2	6,404	3,192	3,212

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6. Determine Modulus of Elasticity

Assumptions (based on Das, 2004 Foundation Engineering, Table 5.6 – attached)

Material	Modulus of Elasticity (E) PSF
Compacted Clay (stiff clay)	1,400,000
Loose sand	216,000
Low end medium dense sand	360,000
High end medium dense sand	576,000
Dense sand	1,008,000
Silty sand	288,000

Note: Primary consolidation of the 4' thick clay liner will be negligible because of initial compactive efforts to 90% of modified proctor. Elastic settlement is considered by assigning a modulus of elasticity.

7. Determine Modulus of Elasticity at each of the points

Conservative assumptions are utilized for density of sand. For points with a greater waste overburden, a lower modulus of elasticity was selected. For points with lesser waste overburden, a lower modulus of elasticity was selected. These assumptions will result in conservative estimates of differential settlement. In the tables below, and the corresponding boring logs in the attachments, BLS stands for "feet below top of liner surface," BGS stands for "feet below ground surface (at time of boring)."

The following tables summarize the subsurface profile assumptions for each of the four points being analyzed in this calculation:

Point P13A-1:

(subsurface conditions modeled from boring TB-38, water elevation at 876.1, water depth (d) = 24.0 ft BLS)

Depth (FT BLS)	Material	Elasticity (PSF)	Boring Depth (Ft)
0.0-4.0	Compacted clay	1,440,000	16.6-20.6
4.0-18.9	High end medium Dense sand	576,000	20.6-35.5
18.9-25.9	Dense sand	1,008,000	35.5-42.5
25.9 +	Sandstone	-	42.5-50.2

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Note: TB-39 is the closest boring but only goes to depth of 18.5 feet, which is only 2.2 feet below the top of base grade. TB-38 is the nearest boring with adequate depth for settlement analysis. TB-38 provides a conservative analysis of settlement at P13A-1.

Point P13A-2:

(subsurface conditions modeled from boring TB-70, water elevation at 875.4, water depth (d) = 24.6 BLS)

Depth (FT BLS)	Material	Elasticity (PSF)	Boring Depth (Ft)
0.0-4.0	Compacted clay	1,440,000	19.4-23.4
4.0-29.6	High end medium Dense sand	576,000	23.4-49.0
29.6+	Sandstone	-	49.0+

Note: The top of the weathered bedrock stratum is conservatively modeled as the top of bedrock at this location, since this will provide the greatest differential settlement when compared to point P13A-1.

Point P14-1:

(subsurface conditions modeled from boring TB-83, water elevation at 901.3, water depth (d) = 8.7 BLS)

Depth (FT BLS)	Material	Elasticity (PSF)	Boring Depth (Ft)
0.0-4.0	Compacted clay	1,440,000	14.3-18.3
4.0-4.7	Loose sand	216,000	18.3-19.0
4.7-15.7	Low end medium dense sand	360,000	19.0-30.0
15.7+	Sandstone	-	30.0+

Note: The weathered bedrock stratum is conservatively modeled as low end medium dense sand at this location, since this will provide the greatest differential settlement when compared to point P14-2.

Point P14-2:

(subsurface conditions modeled from boring TB-69, water elevation at 880.0, water depth (d) = 21.6 BLS)

Depth (FT BLS)	Material	Elasticity (PSF)	Boring Depth (Ft)
0.0-4.0	Compacted clay	1,440,000	23.4-27.4
4.0-31.6	High end medium dense sand	576,000	27.4-55.0
31.6+	Sandstone	-	55.0+

Note: The top of the weathered bedrock stratum is conservatively modeled as the top of bedrock at this location, since this will provide the greatest differential settlement when compared to point P14-1.

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8. Determine Settlement of each of the points using Schmertmann Method (Calculations Attached)

Point P13A-1	= 1.48927 inches
Point P13A-2	= 0.233354 inches
P13A Differential	= 1.255916 inches (0.10467 feet)

Point P14-1	= 0.590635 inches
Point P14-2	= 0.210416 inches
P14 Differential	= 0.380219 inches (0.03168 feet)

9. Calculate the long term pipe slope due to differential settlement

Horizontal distance between points P13A-1 and P13A-2 is approximately 820 feet.

$$\text{Change in slope} = \frac{(0.10467 \text{ feet})}{820 \text{ feet}} = 0.013\%$$

The leachate collection pipes in Phase 13A were installed with a slope of 0.52%. With the predicted differential settlement included, the slope after settlement would equal 0.507% which is greater than the minimum 0.50% required.

Horizontal distance between points P14-1 and P14-2 is approximately 850 feet.

$$\text{Change in slope} = \frac{(0.03168 \text{ feet})}{850 \text{ feet}} = 0.005\%$$

The proposed leachate collection pipes in the horizontal expansion portions of the Sector 2 Northeast Expansion area shall have a minimum slope of 0.505% to account for the predicted differential settlement.

CONCLUSION:

This calculation demonstrates that the leachate collection pipes, after 100-years of estimated differential settlement, will still be greater than the required 0.50%.

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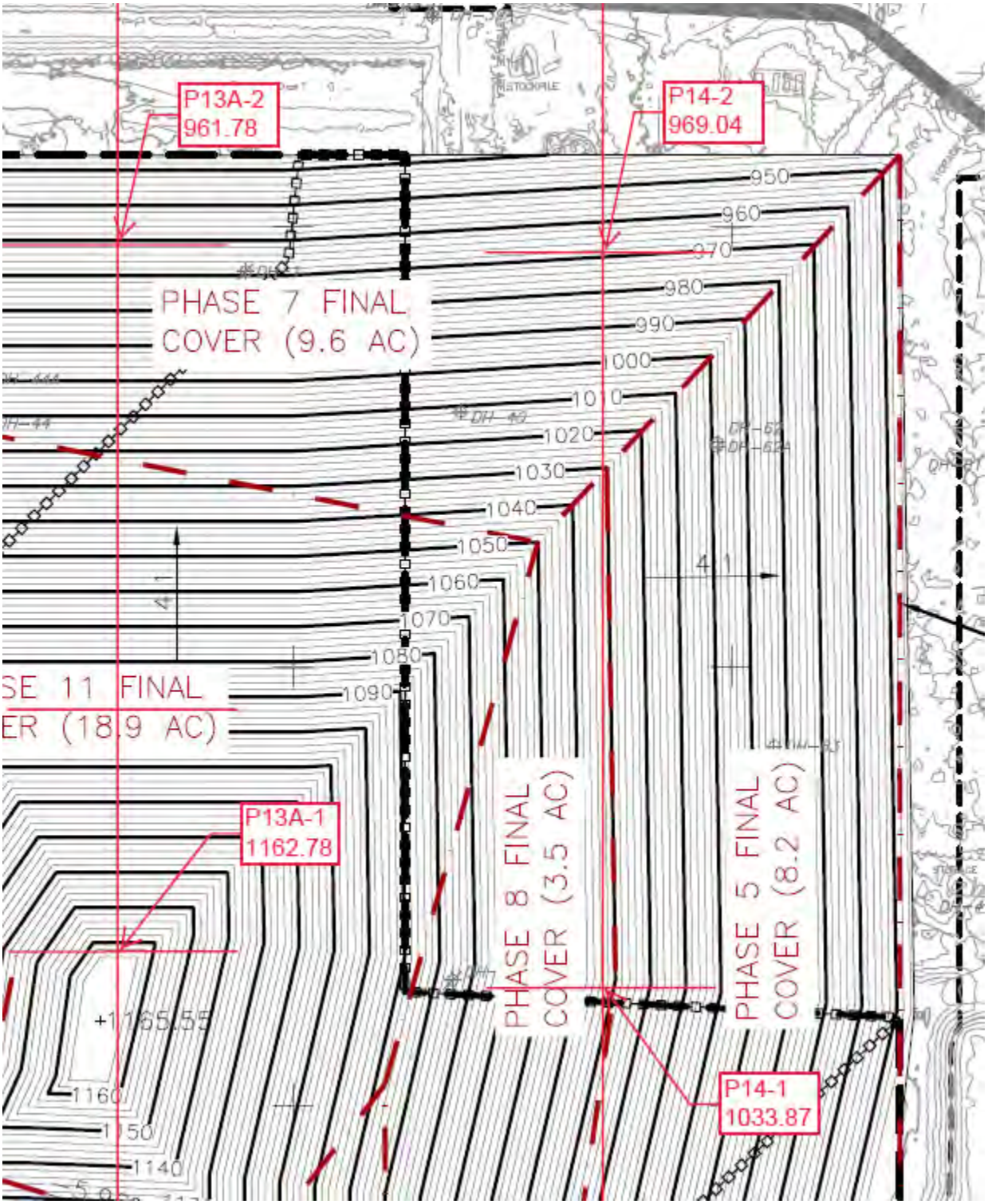
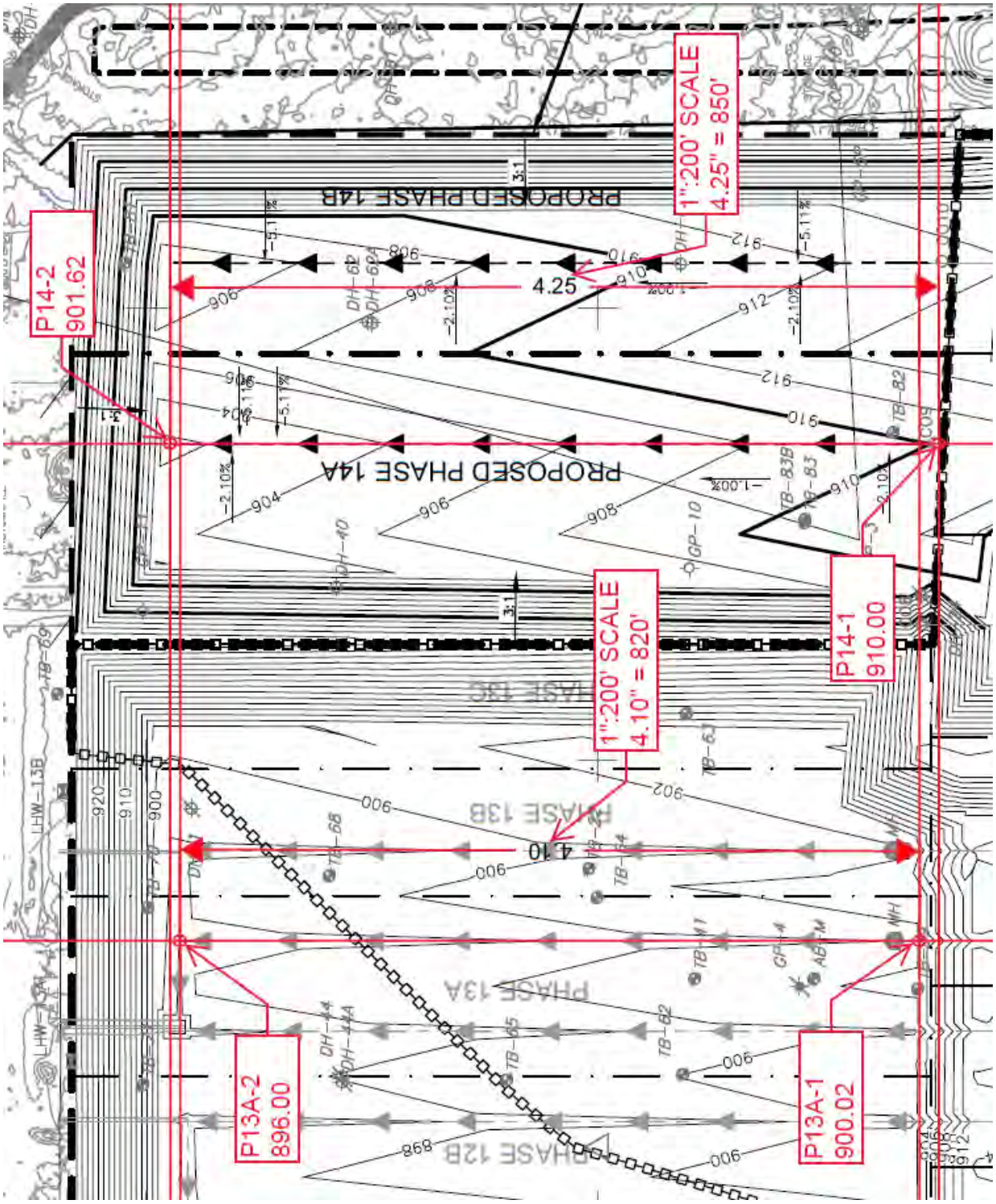
ATTACHMENT 1

FINAL COVER GRADES FIGURE
BASE GRADES FIGURE
PHASE 13 INITIAL CONDITIONS FIGURE
SECTOR 2 NORTHEAST EXPANSION INITIAL CONDITIONS FIGURE
P13A-1 – MAX HEIGHT CONDITION CROSS SECTION
P13A-2 – MAX HEIGHT CONDITION CROSS SECTION
P14-1 – MAX HEIGHT CONDITION CROSS SECTION
P14-2 – MAX HEIGHT CONDITION CROSS SECTION
MAX HEIGHT CONDITION LOADING ABOVE BASE GRADE TABLES
TB-38 SOIL BORING LOG
TB-69 SOIL BORING LOG
TB-70 SOIL BORING LOG
TB-83 SOIL BORING LOG
SCHMERTMANN SETTLEMENT CALCULATIONS
SCHMERTMANN METHOD DESCRIPTION

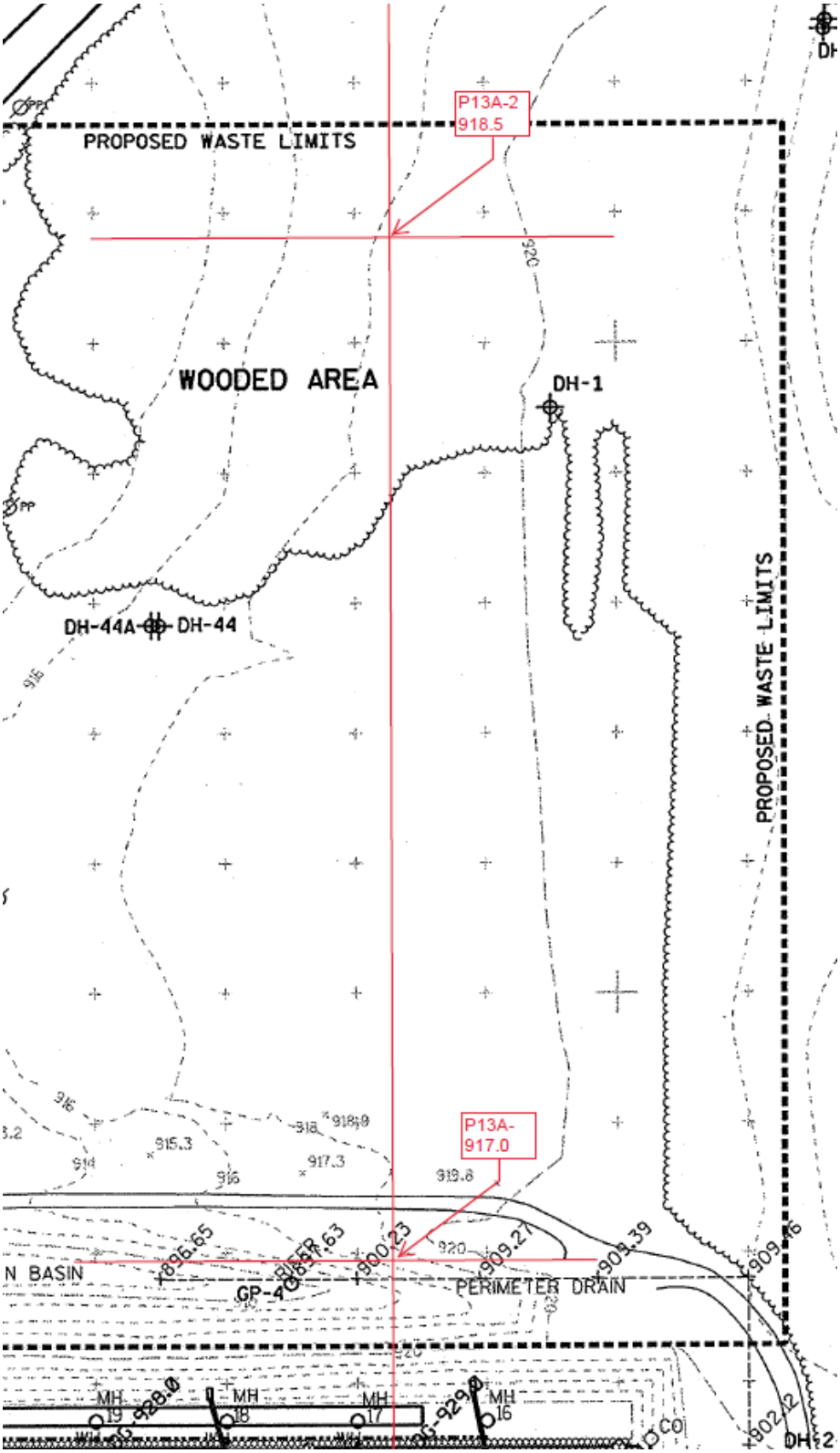
FINAL COVER GRADES FIGURE



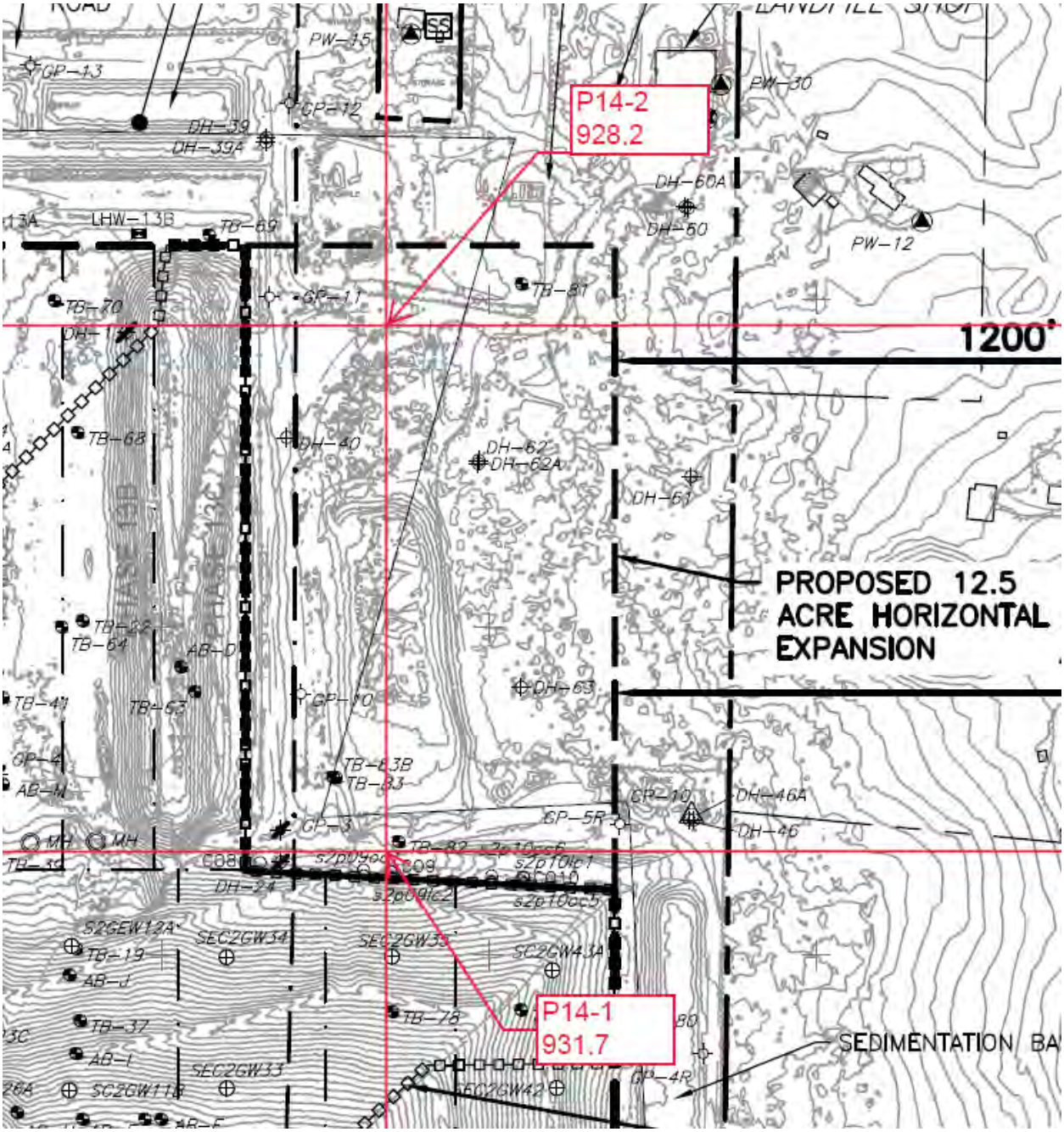
BASE GRADES FIGURE



PHASE 13 INITIAL CONDITIONS FIGURE



SECTOR 2 NORTHEAST EXPANSION INITIAL CONDITIONS FIGURE



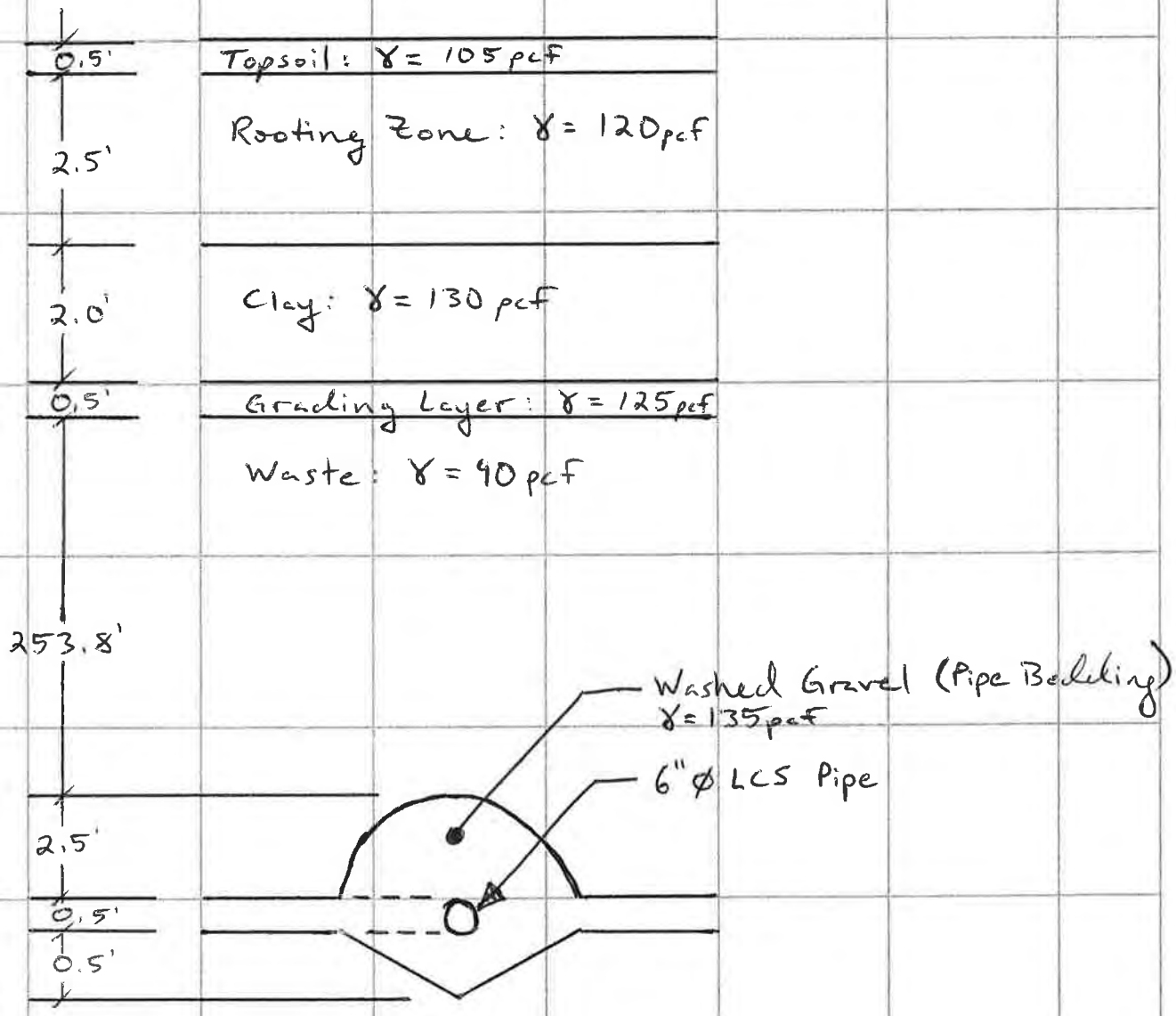
Client Name: ADS SMCL Project Name: Feasibility

Subject: Settlement Project #: 190275

cornerstone
A TETRA TECH COMPANY

Designed By: DR Date: 6-17-19 Checked By: DKS Date: 6/19/19 Sheet No. 1 of 4

P13A-1



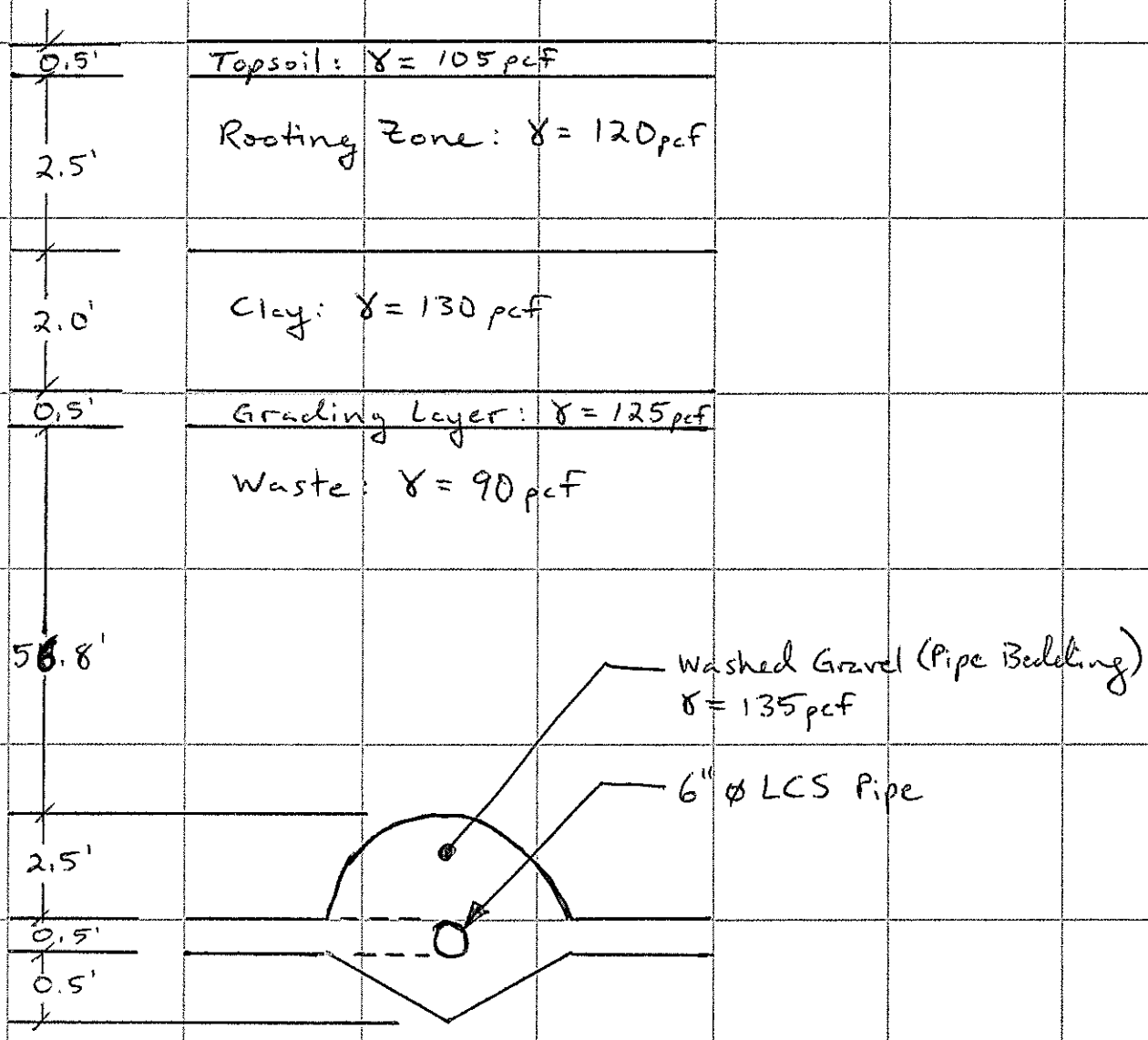
Client Name: ADS SMCL Project Name: Feasibility

Subject: Settlement Project #: 190275

cornerstone
A TETRA TECH COMPANY

Designed By: DR Date: 6-17-19 Checked By: DKS Date: 6/19/19 Sheet No. 2 of 4

P13A-2



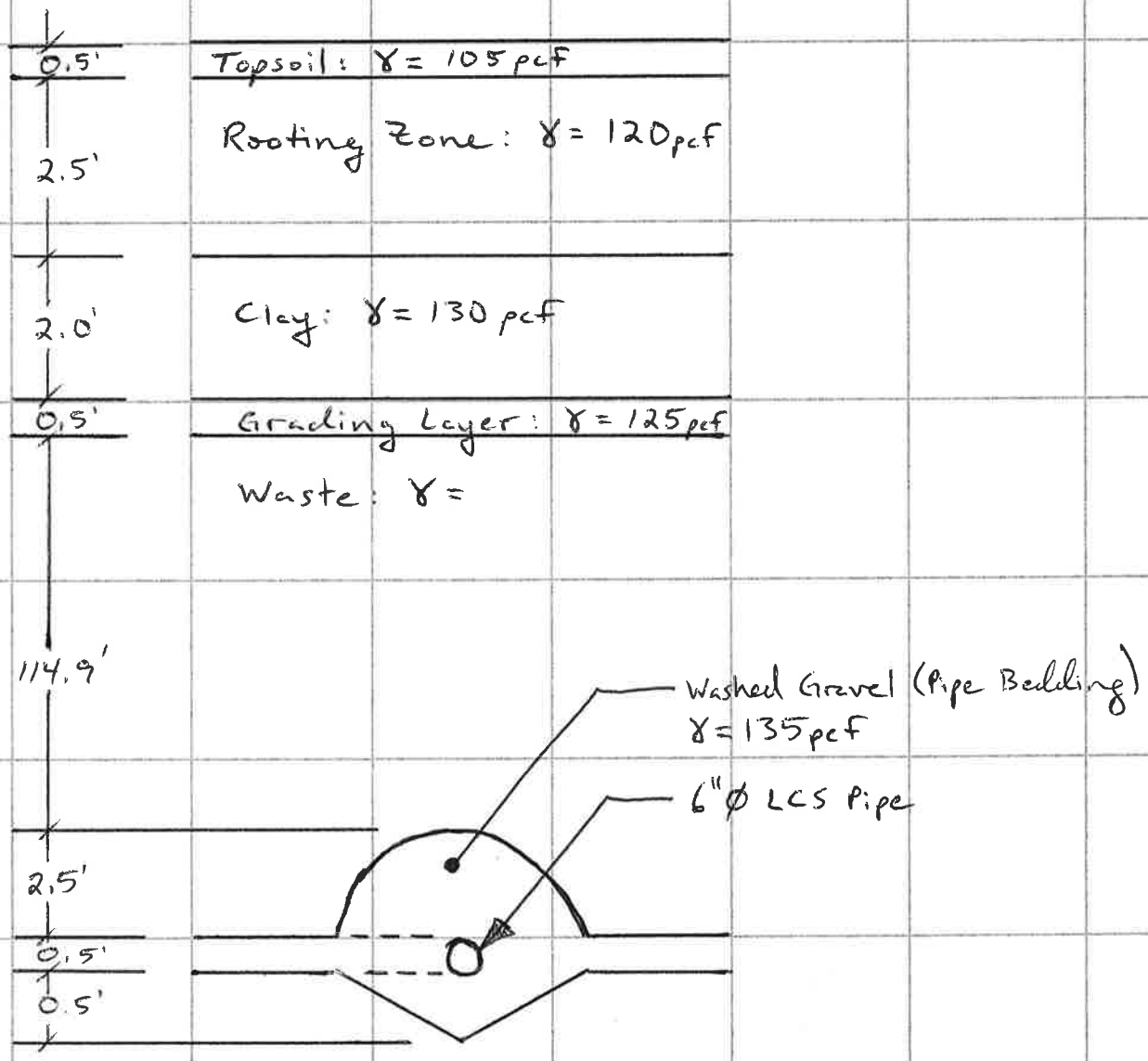
Client Name: ADS SMCL Project Name: Feasibility

Subject: Settlement Project #: 190275

cornerstone
A TETRA TECH COMPANY

Designed By: DR Date: 6-17-19 Checked By: DKS Date: 6/19/19 Sheet No. 3 of 4

P14-1



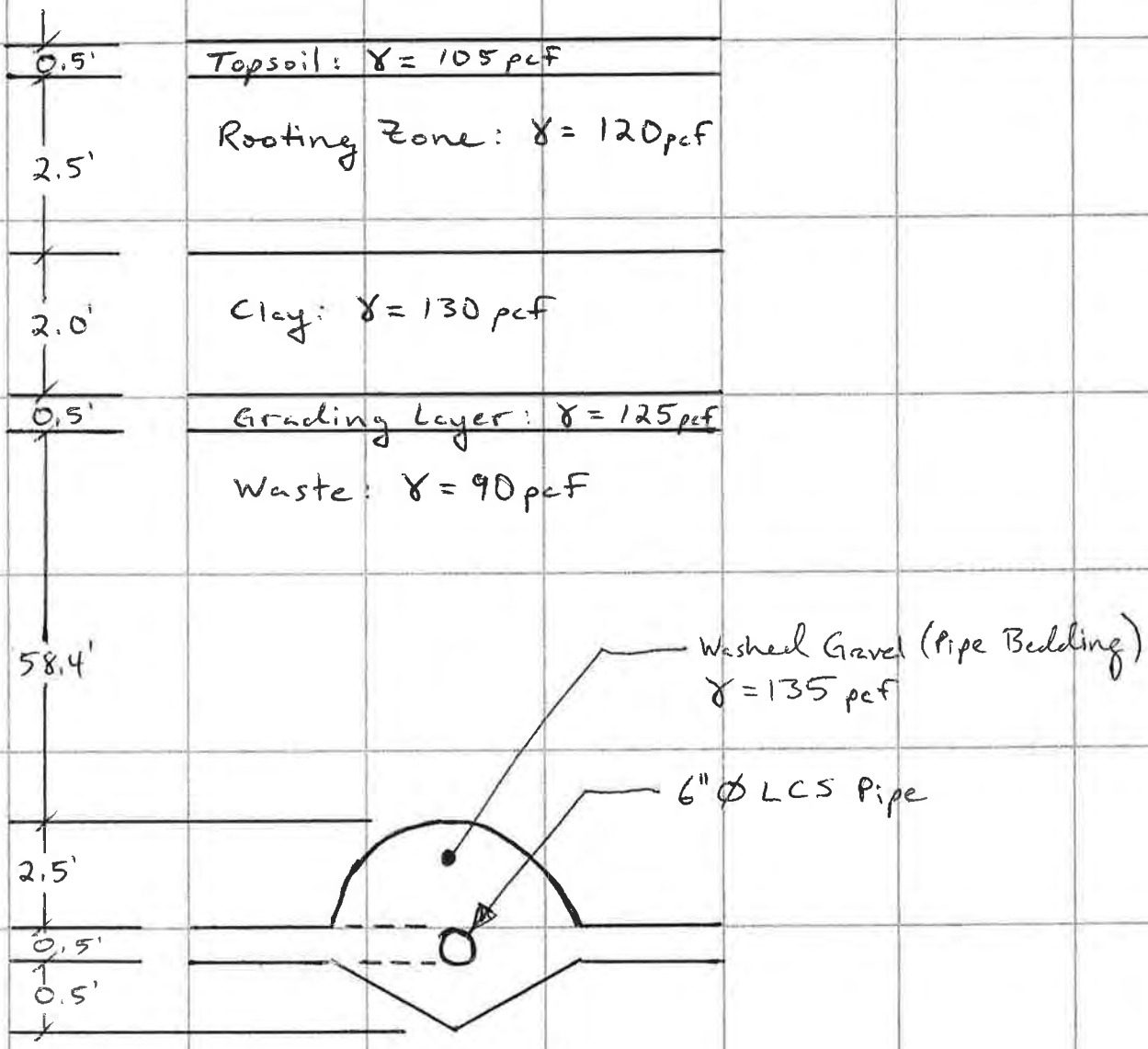
Client Name: ADS SMCL Project Name: Feasibility

Subject: Settlement Project #: 190275

cornerstone
A TETRA TECH COMPANY

Designed By: DR Date: 6-17-19 Checked By: DKS Date: 6/19/19 Sheet No. 4 of 4

P14-2



P13A-1

Stratum	Thickness (ft)	Density (pcf)	Pressure (psf)
Topsoil	0.50	105	53
Rooting Zone	2.50	120	300
Clay	2.00	130	260
Grading Layer	0.50	125	63
Waste	253.8	90	22,838
Pipe Bedding Material	3.50	135	473
		TOTAL	23,986

P13A-2

Stratum	Thickness (ft)	Density (pcf)	Pressure (psf)
Topsoil	0.50	105	53
Rooting Zone	2.50	120	300
Clay	2.00	130	260
Grading Layer	0.50	125	63
Waste	56.8	90	5,110
Pipe Bedding Material	3.50	135	473
		TOTAL	6,258

P14-1

Stratum	Thickness (ft)	Density (pcf)	Pressure (psf)
Topsoil	0.50	105	53
Rooting Zone	2.50	120	300
Clay	2.00	130	260
Grading Layer	0.50	125	63
Waste	114.9	90	10,341
Pipe Bedding Material	3.50	135	473
		TOTAL	11,489

P14-2

Stratum	Thickness (ft)	Density (pcf)	Pressure (psf)
Topsoil	0.50	105	53
Rooting Zone	2.50	120	300
Clay	2.00	130	260
Grading Layer	0.50	125	63
Waste	58.4	90	5,256
Pipe Bedding Material	3.50	135	473
		TOTAL	6,404

BORING NO. TB-38

SURFACE ELEV. 912.6 FT.

AYRES ASSOCIATES

SAMPLE NUMBER	BLOWS ON SAMPLER (140 lbs – 2" O.D. – FALLING 30") 6"	6"	per ft	SAMPLE TYPE	CLASSIFICATION AND REMARKS	Moisture	UNIFIED CLASSIFICAT'N	POCKET PEN. READING (T.S.F.)	GEOLOGY	DEPTH	ELEV.
					Topsoil 0.3'						HOLLOW STEM AUGER
1	7 11	5	16 R 1.2	X	Sand, Brn.-yel-brn., M-F, w/trc. silt,	M	SP SP		Alluvium		
2	10 13	11	24 R 1.1	X		D	SP			10	
3	11 12	13	25 R 1.2	X	Sand, yel-brn., M-F, w/trc. silt trc./gravel	D	SP				16.6' bgs (0' BLS)
4	8 18	16	34 R 1.2	X						20	20.6' bgs (4.0' BLS)
5	7 13	14	27 R 1.2	X	Mottled - As above						
6	9 19	17	36 R 1.1	X	Mottled - A.A.					30	
7	13 23	21	44 R 1.0	X	Mottled - A.A.	M/W					35.5' bgs (18.9' BLS)
8	100/.8		100 R0.8'	X	Weathered Sandstone	W.				40	42.5' bgs (25.9' BLS)
9	100/.3		100 R0.3'	X	Sand, yel-brn., M.F., w/Trc. silt, and Sandstone chips. Note: Drills Rough 42.0-50.0	W	SP		Residuum	50	
10	100/.2		100 R0.2'	X	E.O.B. 50.2						
										60	

Top of Base Liner, Bottom of Base Liner

High end medium dense sand

Dense sand

— KEY —

C = ROCK CORE
A = AUGER SAMPLE
X = SPLIT SPOON
S = SHELBY TUBE
=
=

PROJECT Seven Mile L.F
DATE(S) DRILLLED 4-11-85
LOCATION 26+01 N, 14+35 E
GROUNDWATER: 36.5 FT. BELOW G.S. AT ELEV. OF 876.1
DRILLERS: M.P for W.T.O JOB NO. 4731.00
DATE

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Onyx-Superior Seven Mile Creek Landfill	3097	TB-69

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Boart Longyear - D. Morris	11/7/2002	11/7/2002	4 1/4" HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TB-69	880.0 Feet MSL	925.0 Feet MSL	8.0 Inches

Boring Location or Local Grid Origin (Check if estimated: ☐)
State Plane S/C/N
NE 1/4 of SE 1/4 of Section 8, T 27 N, R 8 W

Lat. ___ ° ___ ' ___ "
Long. ___ ° ___ ' ___ "

Local Grid Location (If applicable)
3598.05 Feet ☒ N ☐ S
2073.31 Feet ☒ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
618045450	Eau Claire	18	Town of Seymour

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 GS	24			Topsoil										Alluvium
			2	Dark yellow brown fine sand, some silt 10YR3/4	SP-SM									
			4											
2 SS	24 15	16 12 20 22	6	Yellow brown fine sand, some silt 10YR5/6	SP-SM					M				Alluvium
			8											
3 SS	24 17	14 15 17 17	10	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					M				Alluvium
			12											
			14											
4 SS	24 12	11 13 16 25	16	Yellow brown fine sand, some silt 10YR5/4	SP-SM					M				Alluvium
			18											
5 SS	24 15	11 13 15 20	20	Yellow brown fine sand, some silt 10YR5/6	SP-SM					M				Alluvium
			22	3" silt lense at 21'	ML									
				Yellow brown fine sand, some silt 10YR5/6	SP-SM									
			24											

23.4 BGS
(0.0 BLS)

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Frank Maenner Firm Ayres Associates Tel: Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completions of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number TB-69 Use only as an attachment to Form 4400-122.

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
6 SS	24 17	7 12 16 27	26	Yellow brown fine sand, some silt 10YR5/6	SP-SM					M				Alluvium
			28											
7 SS	24 18	13 22 29 36	30 32 34	Very pale brown fine sand, some silt 10YR7/4	SP-SM					M				Alluvium
8 SS	24 12	17 29 41 49	36 38	Very pale brown fine sand, some silt 10YR7/4	SP-SM					M				Alluvium
9 SS	24 16	29 19 31 39	40 42 44	Pale brown fine sand, some silt 10YR6/3	SP-SM					M				Alluvium
10 SS	24 12	19 16 22 31	46 48	Yellow brown fine sand, some silt 10YR5/4	SP-SM					W				Alluvium
11 SS	24 10	5 9 26 28	50 52 54	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					W				Alluvium
12 SS	18 12	23 39 50	56 58	Light gray fine sand, some silt, few weakly cemented sandstone chips 10YR7/2						W				Residual
13 SS	12 4	28 50	60	Light yellow brown friable sandstone 10YR6/4						W				Residual

End of Boring at 61' (elevation = 864.0); Boring backfilled with 3/8" bentonite chips

27.4 BGS (4.0 BLS)

high end medium dense sand

45.0 BGS (21.6 BLS)

55.0 BGS (31.6 BLS)

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 4-97

All abandonment work shall be performed in accordance with the provisions of Chapters NR 811, NR 812 or 141, Wis. Admin. Code, whichever is applicable.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location — County: Eau Claire

NE 1/4 of SE 1/4 of Sec. 8 ; T. 27 N; R. 8 ☐ E ☒ W

(If Applicable) _____ Gov't Lot _____ Grid Number

Grid Location: 3598.05 ft. ☒ N. ☐ S., 2073.31 ft. ☒ E. ☐ W.

Civil Town Name: Seymour

Street Address of Well:

City, Village: Town of Seymour

(2) FACILITY NAME Onyx-Superior Seven Mile Creek Landfill

Original Well Owner (If Known):

Present Well Owner: Onyx - Seven Mile Creek Landfill

Street or Route: 8001 Olson Drive

City, State, Zip Code: Eau Claire, WI 54703

Facility Well No. and/or Name (If Applicable): TB-69

WI Unique Well No.:

Reason For Abandonment: Test Boring

Date of Abandonment: 11/07/02

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On (Date) _____

☐ Monitoring Well
☐ Water Well
☒ Drillhole
☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify) _____

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft) (From groundsurface) _____ Casing Diameter (in.) _____ Casing Depth (ft.) _____

Lower Drillhole Diameter (in.) _____

Was Well Annular Space Grouted? ☐ Yes ☐ No ☐ Unknown
If Yes, To What Depth? _____ Feet

(4) Depth to Water (Feet) 43.0

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain NA

Was Casing Cut Off Below Surface?	☐ Yes	☐ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☒ Conductor Pipe - Gravity ☐ Conductor Pipe - Pumped
☐ Dump Bailer ☐ Other (Explain)

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete) Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite
☐ Bentonite-Cement Grout

(7)

Sealing Material Used	From (Ft.)	To (Ft.)		Mix Ratio or Mud Weight
Bentonie Chips	Surface	61.0	27 Bags	

(8) Comments _____

(9) Name of Person or Firm Doing Sealing Work
Ayres Associates w/ Boart Longyear

Signature of Person Doing Work: Frank Maenner — Date Signed: June 4, 2003

Street or Route: 3433 Oakwood Hills Parkway — Telephone Number: (715) 834-3161

City, State, Zip Code: Eau Claire, WI 54702

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Onyx-Superior Seven Mile Creek Landfill	3097	TB-70

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Boart Longyear - M. Mueller	11/11/2002	11/11/2002	4 1/4" HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TB-70	875.4 Feet MSL	919.4 Feet MSL	8.0 Inches

Boring Location or Local Grid Origin (Check if estimated: ☐)
State Plane S/C/N
NE 1/4 of SE 1/4 of Section 8, T 27 N, R 8 W

Lat. ___ ° ___ ' ___ "
Long. ___ ° ___ ' ___ "

Local Grid Location (If applicable)
☒ N 3498.041 Feet ☐ S ☒ E 1836.94 Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
618045450	Eau Claire	18	Town of Seymour

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 GS	24			Topsoil						M				Alluvium
			2	Brown fine sand with silt 10YR4/3	SM									
2 SS	24 20	7 8 9 8	4 6 8	Yellow brown fine sand with silt 10YR6/6	SM					M				Alluvium
3 SS	24 18	3 7 10 15	10 12	Brown fine sand, some silt 10YR5/3	SP-SM					M				Alluvium
4 SS	24 17	7 8 7 9	14 16 18	Yellow brown fine sand, some silt 10YR5/4	SP-SM					M				Alluvium
				3" brown silt lense at 15'	ML									
				Yellow brown fine sand, some silt 10YR5/4	SP-SM									
5 SS	24 12	1 2 5 11	20 22 24	Yellow brown fine sand, some silt 10YR5/4	SP-SM					M				
				3" brown silt with clay lense at 20'	ML									
				Yellow brown fine sand, some silt 10YR5/4	SP-SM									

Bottom of base liner

Top of Base Liner (900.0 ft msl)

19.4 bgs (0.0 BLS)

23.4 bgs (4.0 BLS)

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Frank Maenner	Ayres Associates

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completions of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number TB-70 Use only as an attachment to Form 4400-122.

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
6 SS	24 14	10 21 25 29	26, 28	Very pale brown fine sand, some silt 10YR7/3	SP-SM					M				Alluvium
7 SS	24 15	10 11 19 29	30, 32	Very pale brown fine sand, some silt 10YR7/3	SP-SM					M				Alluvium
8 SS	24 14	13 23 36 44	34, 36, 38	brown fine sand, some silt 10YR6/3	SP-SM					M				Alluvium
9 SS	24 18	12 14 19 25	40, 42	Very pale brown fine sand, some silt 10YR7/3	SP-SM					W				Alluvium
10 SS	24 12	4 13 19 29	44, 46, 48	Yellow brown fine to medium sand, little silt 10YR5/6	SP		▼			W				Alluvium
11 SS	24 14	3 4 7 9	50, 52	Yellow brown fine sand, some silt, trace weakly cemented sandstone chips 10YR5/4						W				Residual
12 SS	24 13	8 4 7 7	54, 56	Yellow brown fine to medium sand, little silt, trace weakly cemented sandstone chips 10YR5/4						W				Residual

End of Boring at 56' (elevation = 863.4); Boring backfilled with 3/8" bentonite chips

High end medium dense sand

44.0 bgs (24.6 BLS)

49.0 bgs (29.6 BLS)

Weathered sandstone

56.0 bgs (36.6 BLS)

State of Wisconsin
Department of Natural Resources

WELL/DRILLHOLE/BOREHOLE ABANDONMENT
Form 3300-5B Rev. 4-97

All abandonment work shall be performed in accordance with the provisions of Chapters NR 811, NR 812 or 141, Wis. Admin. Code, whichever is applicable.

(1) GENERAL INFORMATION

Well/Drillhole/Borehole Location — County: Eau Claire

NE 1/4 of SE 1/4 of Sec. 8 ; T. 27 N; R. 8 ☐ E ☒ W

(If Applicable) Gov't Lot _____ Grid Number _____

Grid Location: 3498.041 ft. ☒ N. ☐ S., 1836.94 ft. ☒ E. ☐ W.

Civil Town Name: Seymour

Street Address of Well:

City, Village: Town of Seymour

(2) FACILITY NAME Onyx-Superior Seven Mile Creek Landfill

Original Well Owner (If Known):

Present Well Owner: Onyx - Seven Mile Creek Landfill

Street or Route: 8001 Olson Drive

City, State, Zip Code: Eau Claire, WI 54703

Facility Well No. and/or Name (If Applicable): TB-70

WI Unique Well No.:

Reason For Abandonment: Test Boring

Date of Abandonment: 11/11/02

WELL/DRILLHOLE/BOREHOLE INFORMATION

(3) Original Well/Drillhole/Borehole Construction Completed On (Date) _____

☐ Monitoring Well
☐ Water Well
☒ Drillhole
☐ Borehole

Construction Report Available? ☒ Yes ☐ No

Construction Type:
☒ Drilled ☐ Driven (Sandpoint) ☐ Dug
☐ Other (Specify) _____

Formation Type:
☒ Unconsolidated Formation ☐ Bedrock

Total Well Depth (ft) (From groundsurface) _____ Casing Diameter (in.) _____ Casing Depth (ft.) _____

Lower Drillhole Diameter (in.) _____

Was Well Annular Space Grouted? ☐ Yes ☐ No ☐ Unknown
If Yes, To What Depth? _____ Feet

(4) Depth to Water (Feet) _____

Pump & Piping Removed?	☐ Yes	☐ No	☒ Not Applicable
Liner(s) Removed?	☐ Yes	☐ No	☒ Not Applicable
Screen Removed?	☐ Yes	☐ No	☒ Not Applicable
Casing Left in Place?	☐ Yes	☒ No	

If No, Explain NA

Was Casing Cut Off Below Surface?	☐ Yes	☐ No
Did Sealing Material Rise to Surface?	☒ Yes	☐ No
Did Material Settle After 24 Hours?	☐ Yes	☒ No
If Yes, Was Hole Retopped?	☐ Yes	☐ No

(5) Required Method of Placing Sealing Material
☒ Conductor Pipe - Gravity ☐ Conductor Pipe - Pumped
☐ Dump Bailer ☐ Other (Explain)

(6) Sealing Materials
☐ Neat Cement Grout
☐ Sand-Cement (Concrete) Grout
☐ Concrete
☐ Clay-Sand Slurry
☐ Bentonite-Sand Slurry
☒ Chipped Bentonite

For monitoring wells and monitoring well boreholes only
☐ Bentonite Pellets
☐ Granular Bentonite
☐ Bentonite-Cement Grout

(7)

Sealing Material Used	From (Ft.)	To (Ft.)		Mix Ratio or Mud Weight
Bentonite Chips	Surface	56.0	26 Bags	

(8) Comments _____

(9) Name of Person or Firm Doing Sealing Work
Ayres Associates w/ Boart Longyear

Signature of Person Doing Work: Frank Maenner
Date Signed: June 4, 2003

Street or Route: 3433 Oakwood Hills Parkway
Telephone Number: (715) 834-3161

City, State, Zip Code: Eau Claire, WI 54702

(10) FOR DNR OR COUNTY USE ONLY

Date Received/Inspected	District/County
Reviewer/Inspector	☐ Complying Work ☐ Noncomplying Work
Follow-up Necessary	

DNR/COUNTY

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Seven Mile Creek Landfill	3097	TB-83

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Randy Radke Cascade	12/10/2018	12/10/2018	sonic

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	924.3 Feet MSL	6.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 367,771 N, 1,645,267 E S /Ⓒ/N
NW 1/4 of SW 1/4 of Section 9, T 27 N, R 8 W
Lat ___ ° ___ ' ___ "
Long ___ ° ___ ' ___ "
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
618045450	Eau Claire	18	City of Eau Claire and Town of Seymour

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 CS	60 60		1 2	SILTY SAND (SM), dark yellowish-brown (10YR 4/4), dry, loose (alluvium)	SM									
			3 4 5	POORLY GRADED SAND (SP), yellowish-brown (10YR 5/6), fine grained sand, dry, loose (alluvium)	SP									
2 CS	60 60		6	SANDY SILT (ML), yellowish-brown (10YR 5/6), dry, very stiff (alluvium)	ML									
			7 8	POORLY GRADED SAND (SP), yellowish-brown (10YR 5/6), dry, loose (alluvium)	SP									
				SILTY SAND (SM), brownish yellow (10YR 5/6), dry, medium dense (alluvium)	SM									
			9 10 11 12	POORLY GRADED SAND (SP), brownish yellow (10YR 6/6), dry, loose (alluvium)	SP									
3 CS	60 60													

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	Tel:
	Cornerstone Environmental Group 8413 Excelsior Dr. Suite 160 Madison, WI 53717	Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number TB-83 Use only as an attachment to Form 4400-122.

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			13	POORLY GRADED SAND (SP), brownish yellow (10YR 6/6), dry, very loose (alluvium)										
			14							14.3 BGS (0.0 BLS)				
4 CS	60 60		15		SP									
			16											
			17											
			18							18.3 BGS (4.0 BLS)				
			19	HIGHLY WEATHERED SANDSTONE, fine to medium grained sand with little silt and caly, yellowish brown (10YR 5/8) to pale yellow (10YR 8/3), dry, 1" rock fragments (residual)	19.0 BGS (4.7 BLS)		loose sand			14.7	NV	NP	9.5	Shelby Tube pushed 11 inches at 19 feet in adjacent boring TB-83B Lab classified as SP-SM.
5 CS	60 60		20											
			21											
			22							16.7	NV	NP	48.3	Shelby Tube pushed 8 inches at 22 feet in adjacent boring TB-83B Lab classified as SC.
			23	HIGHLY WEATHERED CLAYEY SANDSTONE, mottled red and gray wet @ 23', seem of pale yellow sandstone from 23' to 24'										
			24				low end medium dense sand							
6 CS	60 60		25	strong brown (7.5YR 5/8) from 25' to 27', switched drill rods from 6" diameter to 4" @ 25'										
			26											
			27	white (7.5YR 8/1) to pinkish white (7.5YR 8/2) from 27' to 30'										
			28	firmer drilling 28'-30'										
			29											
			30	Bottom of boring @ 30 feet bgs 894.3 ft msl						30.0 BGS (15.7 BLS)				

Schmertmann settlement calculator

Schmertmann method

The Schmertmann method (1970) calculates settlement from layer stiffness data or cone tip bearing resistances, q_c obtained from a Cone Penetration Test (CPT). The method proposed a simplified triangular strain distribution and calculates the settlement accordingly. A time factor can also be included to account for time dependent (creep) effects.

The equation for settlement is:

$$\delta = C_1 C_t \Delta P \sum_{i=1}^{n} \frac{\Delta z_i}{E_{si}} I_{zi}$$

Where

C_1 = the correction to account for strain relief from excavated soil, $1 - \frac{\sigma_{od}'}{2\Delta P}$

σ_{cd}' = effective overburden pressure at bottom of the footing

ΔP = the net applied footing pressure (equation)

C_t = correction for time-dependent creep,

t = time (years)

E_{si} = one-dimensional elastic modulus of soil layer i

Δz_i = thickness of soil layer

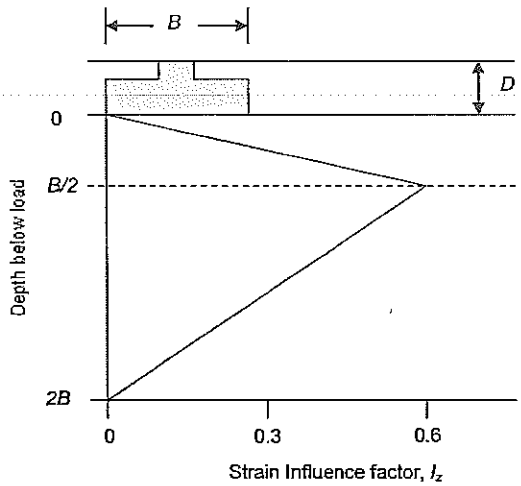
I_{zi} = the influence factor at the centre of soil layer i as described below.

Influence factors

The influence factor, I_z is based on an approximation of strain distributions below the footing. There are two possible formulations for I_z; the original 1970 approximation and the improved 1978 approximation.

1970 formulation

This is described in Schmertmann (1970). The strain influence factor I_z increases linearly from zero at the bottom of the footing to a maximum of 0.6 at a depth of &frac12 B below the footing where B is the footing width. The strain influence factor then decreases linearly to zero at a depth of 2B below the footing bottom. This distribution is shown below.



Strain influence factors from Schmertmann (1970)

1978 formulation

This is described in Schmertmann et al (1978). With this method, the peak value for I_z is calculated by

$$I_{zp} = 0.5 + 0.1\left(\frac{\Delta P}{\sigma_{op}'}\right)$$

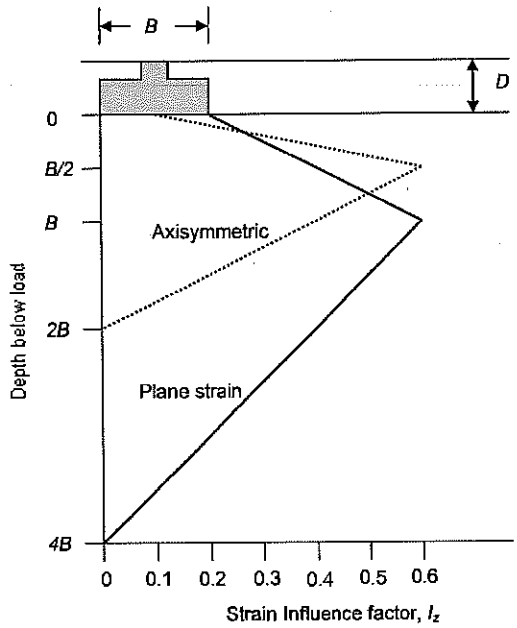
Where σ_{op}' is the effective overburden pressure at the depth of I_{zp}.

The depth of I_{zp} depends on the shape of the load. For an axisymmetric load (a circle or a square), I_{zp} occurs at a depth of $B/2$. For the plane strain case (length of the load is > 10x the width), the I_{zp} occurs at a depth of B. The values for I_z (shown in the figure below) are calculated as follows:

Axisymmetric: I_z varies linearly from 0.1 at the bottom of the footing to I_{zp} at a depth of $B/2$. The strain influence factor then decreases to zero at a depth of $2B$.

Plane strain: I_z varies linearly from 0.2 at the bottom of the footing to I_{zp} at a depth of B. The strain influence factor then decreases to zero at a depth of $4B$.

In the Schmertmann calculator, I_z is calculated using the axisymmetric equations for circle and square loads. For rectangular loads in which the length is greater than ten times the width, the plane strain approach is used. For rectangular loads in which the length is less than ten times the width, a linear interpolation between the axisymmetric and plane strain case is performed, dependent on the length to width ratio.



Strain influence factors from Schmertmann et al. (1978).

Stiffness conversion

The elastic modulus E_s can be estimated from the results of a Cone Penetration test:

$E_s = 2.0q_c$ (1970 formulation)

$E_s = 2.5q_c$ (1978 formulation, axisymmetric footing)

$E_s = 3.5q_c$ (1978 formulation, plane strain footing)

where q_c is the cone tip bearing resistance. If the 1978 formulation is being used, the value for E_s is calculated to be between the axisymmetric case and plane strain case if the length of the load is less than ten times the width.

Subdividing layers

The accuracy of the Schmertmann method improves when the strain profile is sampled more densely. If the soil profile is fairly homogeneous, it is tedious to specify many layers with the same properties in order to improve the accuracy. For these reasons, the Schmertmann calculator will automatically subdivide layers so that each sub-layer has a thickness of approximately B/10.

References

Schmertmann, J.H. (1970). Static cone to compute static settlement over sand. *ASCE Journal of Soil Mechanics & Foundations Division*, **96** (3), 1011-1043.

Schmertmann, J.H., Hartmann, J.P. and Brown, P.R. (1978). Improved strain influence factor diagrams, *ASCE Journal of the Geotechnical Engineering Division*, **104** (GT8), 1131-1135.

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A TETRA TECH COMPANY

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	DJR
PROJECT:	SEVEN MILE CREEK FEASIBILITY REPORT	CHK:	DKS
SUBJECT:	PIPE DIFFERENTIAL SETTLEMENT	DATE:	6/12/19
PROJECT NO.	190275		

ATTACHMENT 2
Soil Settlement Calculations from 2015 Plan of Operation

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CLIENT:	ADVANCED DISPOSAL SERVICES	PRE:	BJP
PROJECT:	SEVEN MILE CREEK FEASIBILITY REPORT	CHK:	JFF 9/9/2014
SUBJECT:	PIPE DIFFERENTIAL SETTLEMENT	DATE:	8/26/14
PROJECT NO.	140370		

LEACHATE COLLECTION PIPE DIFFERENTIAL SETTLEMENT CALCULATIONS

OBJECTIVE:

Demonstrate that the leachate piping as designed in the approved Plan of Operations will withstand the potential long-term differential settlement that may be imposed during the waste filling operations of the landfill with the new vertical expansion. This is intended to comply with NR 504.06(6)(c). This analysis checks that a minimum slope of 0.5 percent is maintained after settlement has occurred in all leachate collection pipes exceeding 1,200 feet in length (from the end of each cleanout to the toe of the opposite slope).

METHODOLOGY:

A minimum of one exploratory soil boring was drilled to determine subsurface conditions as part of previous landfill permitting conditions. The sampling included split spoon samples with Standard Penetration Testing at 5 foot intervals and nominally undisturbed Shelby Tube samples at significant fine-grained layers.

The total settlement of the landfill is a combination of elastic settlement in granular soil (i.e., sand and gravel) and primary and secondary consolidation settlement of fine-grained soils (i.e., clay or silt). NR 504.06(6) requires consideration of 100 percent of primary consolidation settlement and a 100-year timeframe to calculate secondary consolidation settlement.

The north-south critical cross section of the worst-case leachate line is noted, that shows both the greatest overbearing pressure on a pipe point (maximum height of waste) and the least pressure on the pipe point (lowest height of waste along the primary leachate line). Subsurface conditions were fairly consistent in the borings, as a result this overbearing differential was deemed the critical component for determining “worst-case” conditions. This was then evaluated for the subsurface conditions for a minimum of 100-year time frame to reflect both primary and secondary settlement.

Similar to the last time this differential settlement calculation was conducted [(Plan Modification for the Plan of Operations at Seven Mile Creek Landfill, dated August 2011, submitted by Ayres Associates and calculations are included as an attachment to this calculation to show past

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PROJECT:	SEVEN MILE CREEK FEASIBILITY REPORT	CHK:	JFF 9/9/2014
SUBJECT:	PIPE DIFFERENTIAL SETTLEMENT	DATE:	8/26/14
PROJECT NO.	140370		

methodology and results)], the Schmertmann Method was used to calculate elastic settlement of granular soils due to landfill loading. This method calculates settlement using one-dimensional elastic modulus of subsurface soil layers and performs a simplified triangular strain distribution. The soil below the landfill was divided into layers and elastic settlement of each layer was computed. Subsurface soil layers and types used at the two points evaluated were taken from the nearest soil boring at each point. A description of the calculation methodology, assumptions, and results are noted below and in the attachments.

Assumptions
Overbearing conditions:

- The weight of the landfill mass is applied instantaneously
- The loaded area is assumed to be 500 feet by 500 feet to adequately characterized a large mass of weight impacting the piping over a larger area
- Considerations of pre-existing conditions that would have already applied long-term loading of subsurface layers was applied. Only the change or addition in overburden capacity from vertical landfill cross-section was considered in this analysis.

CALCULATION:

1. Critical cross-section and two critical points that are on that section.

   The leachate collection pipe in Phase 12 is most critical because it passes through the points of the greatest waste thickness difference. These points are labeled “A” (peak load/landfill height) and “B” northern toe of the liner, on the attached figures.

2. Determine fill (waste) thickness at points A and B

   Cross sections showing the leachate piping and soil layers above are noted in the attachments. These correlate with top of final cover points and base grade points of the leachate trench.

3. Determine the applied pressure of points A and B.
   a. Create representative fill profile (noted in attachments).
   b. Determine effective stress applied at the top of liner (AKA base grades), where differential settlement is the concern at points A and B. (noted in attachments). Note that densities and unit rates in this calculation are consistent with pipe strength calculations performed

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SUBJECT:	PIPE DIFFERENTIAL SETTLEMENT	DATE:	8/26/14
PROJECT NO.	140370		

as part of this vertical expansion Feasibility Report technical calculations performed elsewhere.

4. Determine in-situ (pre-excavation) pressure at points A and B.

Point A: Initial Elevation (see attachment) = 916 MSL
Top of Liner = 898'
Cut Depth = 18'
General Fill = 120 PCF

σ_{0A}' = 18' x 120 PCF = <u>2,160 PSF</u>

Point B: Initial Elevation (see attachment) = 912 MSL
Top of Liner = 898'
Cut Depth = 14'
General Fill = 120 PCF

σ_{0B}' = 14' x 120 PCF = <u>1,680 PSF</u>

5. Determine change in stress at the top of liner elevation between initial site conditions and future vertical expansion.

Point A

Applied Pressure = 12,908 PSF (See attachments)
Initial Pressure = 2,160 PSF (Part 4 above)
Change in pressure = 10,748 PSF

Point A

Applied Pressure = 4,198 PSF (See attachments)
Initial Pressure = 1,680 PSF (Part 4 above)
Change in pressure = 2,518 PSF

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PROJECT NO.	140370		

6. Determine Modulus of Elasticity

Assumptions (based on Das, 2004 Foundation Engineering, Table 5.6 – attached)

Material	Modulus of Elasticity (E) PSF
Compacted Clay (stiff clay)	1,400,000
Low end medium dense sand	360,000
High end medium dense sand	576,000
Dense sand	1,008,000
Silty sand	288,000

Note: Primary consolidation of the 4' thick clay liner will be negligible because of initial compactive efforts to 90% of modified proctor. Elastic settlement is considered by assigning a modulus of elasticity.

7. Determine Modulus of Elasticity at Profiles A and B

Point A (subsurface conditions modeled from boring TB-38, water elevation at 876.1, water depth (d) = 36.5

Depth (FT BLS)	Material	Elasticity (PSF)	Boring Depth (Ft)
0-4	Compacted clay	1,440,000	-
4-22	High end med. Dense sand	576,000	19-41
22-32	Dense sand	1,008,000	41-51
32+	sandstone		

Point B (subsurface conditions modeled from boring TB-72, water elevation at 873.6, water depth (d) = 39.0

Depth (FT BLS)	Material	Elasticity (PSF)	Boring Depth (Ft)
0-4	Compacted clay	1,440,000	-
4-34	High end med. Dense sand	576,000	19-53
34+	Sandstone		

8. Determine Settlement of Point A and Point B using Schmertmann Method (Calculations Attached)

Point A = 1.18 inches
Point B = 0.37 inches

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PROJECT NO.	140370		

Differential Settlement Between A and B

1.18 – 0.37 = 0. 81 inches

9. Calculate the change in slope due to differential settlement

Horizontal distance between points A and B is 800 feet

$$\text{Change in slope} = \frac{(0.81 \text{ inches}/12 \text{ inches/foot})}{800 \text{ feet}} = 0.01\%$$

CONCLUSION:

The leachate collection trench shall account for 0.01% of differential settlement and still maintain a 0.5% required minimum slope. Therefore the final design slope for the leachate trench must be 0.01% + 0.5% = 0.51%.

This is the same slope as noted in the August 2011 Plan Mod to the Plan of Operations (noted in Appendix B attached) as prepared by Ayres Associates/TRC. Therefore, no further modifications to design are needed as the existing leachate design meets the intent of this analysis.

REFERENCES:

Schmertmann, J.H (1970). Static cone to compute static settlement over sand. ASCE Journal of Soil Mechanics and Foundations Division, 96 (3), 1011-1043.

Schmertmann, J.H., Hartmann, J.P. and Brown, P.R. (1978). Improved strain influence factor diagrams, ASCE Journal of Geotechnical Engineering Division, 104 (GT8), 1131-1135.

Das, Braja M. *Principals of Foundation Engineering*. 2004

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SUBJECT:	PIPE DIFFERENTIAL SETTLEMENT	DATE:	8/26/14
PROJECT NO.	140370		

ATTACHMENTS

CONDITION A AND B FINAL COVER GRADES FIGURE
CONDITION A AND B BASE GRADES FIGURE
CONDITION A AND B INITIAL CONDITIONS FIGURE
CONDTION A – MAX HEIGHT CONDITION CROSS SECTION
CONDITION A – MAX HEIGHT CONDITION LOADING ABOVE BASE GRADE
CONDTION B – LOWEST HEIGHT CONDITION CROSS SECTION
CONDITION B – LOWEST HEIGHT CONDITION LOADING ABOVE BASE GRADE
TB-38 SOIL BORING LOG (CONDITION A)
TB-72 SOIL BORING LOG (CONDITION B)
SCHMERTMANN SETTLEMENT CALCULATION CONDITION A
SCHMERTMANN SETTLEMENT CALCULATION CONDITION B
SCHMERTMANN METHOD DESCRIPTION
Appendix B – Soil Settlement Calculations from August 2011 Plan Modification by Ayres Associates

LEGEND

- PROPERTY BOUNDARY
- 100-YEAR FLOODPLAIN DELINEATION
- PERMITTED SOLID WASTE BOUNDARY
- PHASE BOUNDARY
- 1030 PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- 1020 EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- EXISTING FENCE
- EXISTING WATER SUPPLY WELL
- GP EXISTING GAS PROBE
- DH-4R EXISTING GROUNDWATER MONITORING WELL
- DH-33-33A EXISTING MONITORING WELL & PIEZOMETER
- TB-16 EXISTING SOIL BORING LOCATION
- DH-50 ABANDONED GROUNDWATER MONITORING WELL

NOTE

1. AERIAL TOPOGRAPHIC SURVEY PERFORMED BY AYRES AND ASSOCIATES ON MAY 8, 2013.
2. PROPERTY BOUNDARIES ARE FROM CORNERSTONE ENVIRONMENTAL GROUP VERTICAL EXPANSION INITIAL SITE REPORT (2014).
3. EXISTING GAS PROBES ARE FROM AYRES AND ASSOCIATES HORIZONTAL AND VERTICAL EXPANSION FEASIBILITY REPORT (NOVEMBER 2003).
4. EXISTING MONITORING WELLS, EXCEPT FOR DH-40 & DH-51, ARE FROM AYRES AND ASSOCIATES HORIZONTAL AND VERTICAL EXPANSION FEASIBILITY REPORT (NOVEMBER 2003).
5. MONITORING WELLS DH-40 AND DH-51 ARE FROM AYRES AND ASSOCIATES SECTOR 2-PLAN OF OPERATIONS-PLAN MODIFICATION (AUGUST 2011).
6. EXISTING SOIL BORING LOCATIONS ARE FROM AYRES AND ASSOCIATES HORIZONTAL AND VERTICAL EXPANSION FEASIBILITY REPORT (NOVEMBER 2003).
7. EXISTING PRIVATE WATER SUPPLY WELLS ARE FROM CORNERSTONE ENVIRONMENTAL GROUP VERTICAL EXPANSION INITIAL SITE REPORT (2014).
8. PROPOSED SUBBASE GRADES ARE FROM AYRES AND ASSOCIATES SECTOR 2-PLAN OF OPERATIONS-PLAN MODIFICATION (AUGUST 2011).

N

0 100 200
SCALE IN FEET

DRAFT

REV.	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 03/04/14 | DRAWN BY SRC | DESIGNED BY JCK | CHECKED BY – | APPROVED BY –

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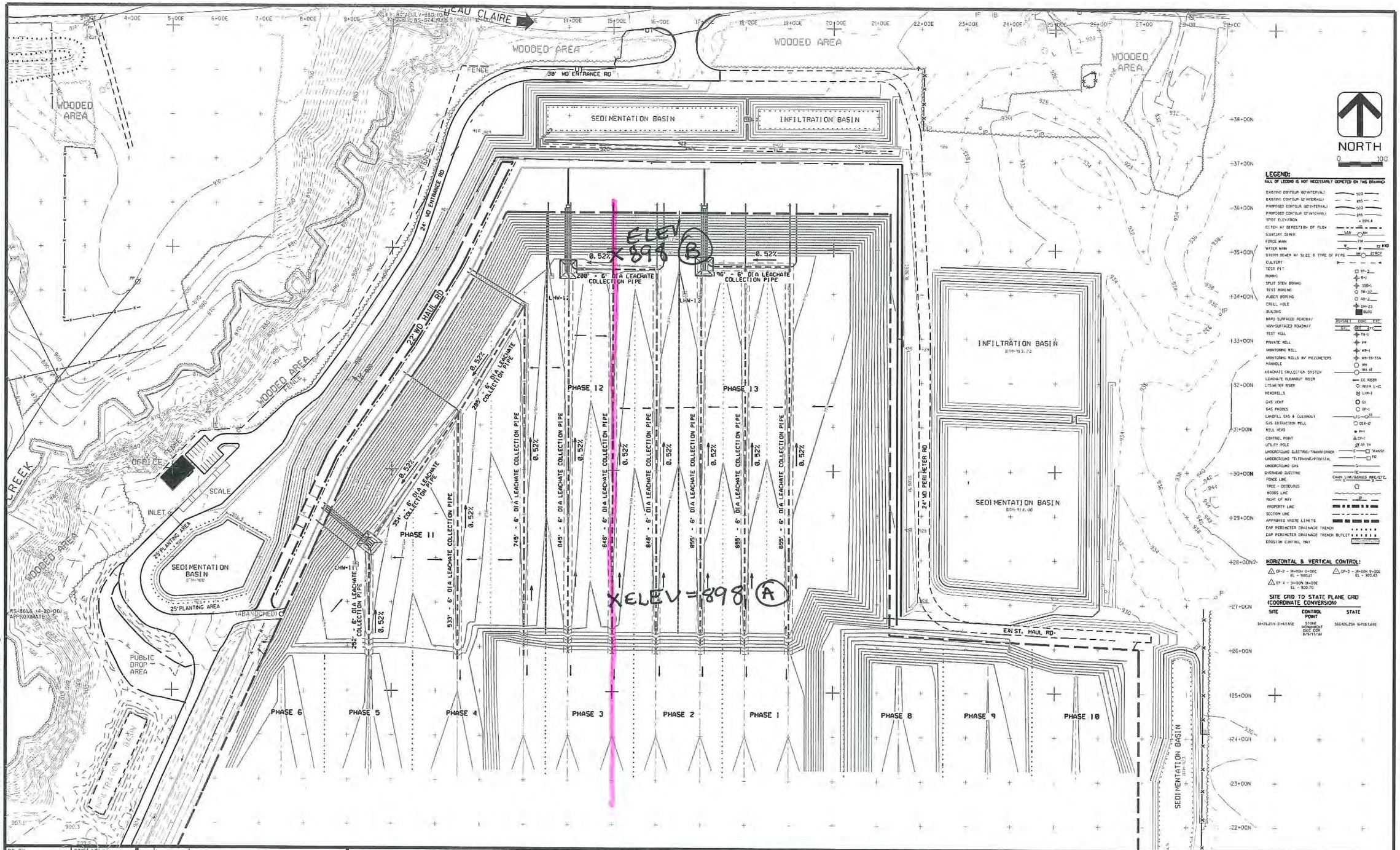
ADVANCED DISPOSAL SERVICES
SEVEN MILE CREEK LANDFILL
EAU CLAIRE, WISCONSIN

FEASIBILITY STUDY
FINAL COVER GRADES

SHEET NO. **30**
PROJECT NO. 130517



DR. BY T. SHUPERT	BOOK NO.		
CHK. BY S. BISCHOFF	JOB NO. 19-0255.10		
DATE AUGUST, 2011	SCALE AS SHOWN	NO.	DATE / REVISION

VEOLIA ES SEVEN MILE CREEK LANDFILL
SECTOR 2 - PLAN OF OPERATIONS - PLAN MODIFICATION
EAU CLAIRE, WISCONSIN

VEOLIA ENVIRONMENTAL SERVICES

AYRES ASSOCIATES
Eau Claire, Wisconsin

LEACHATE COLLECTION SYSTEM

DRAWING NO. 5

8/29/2011
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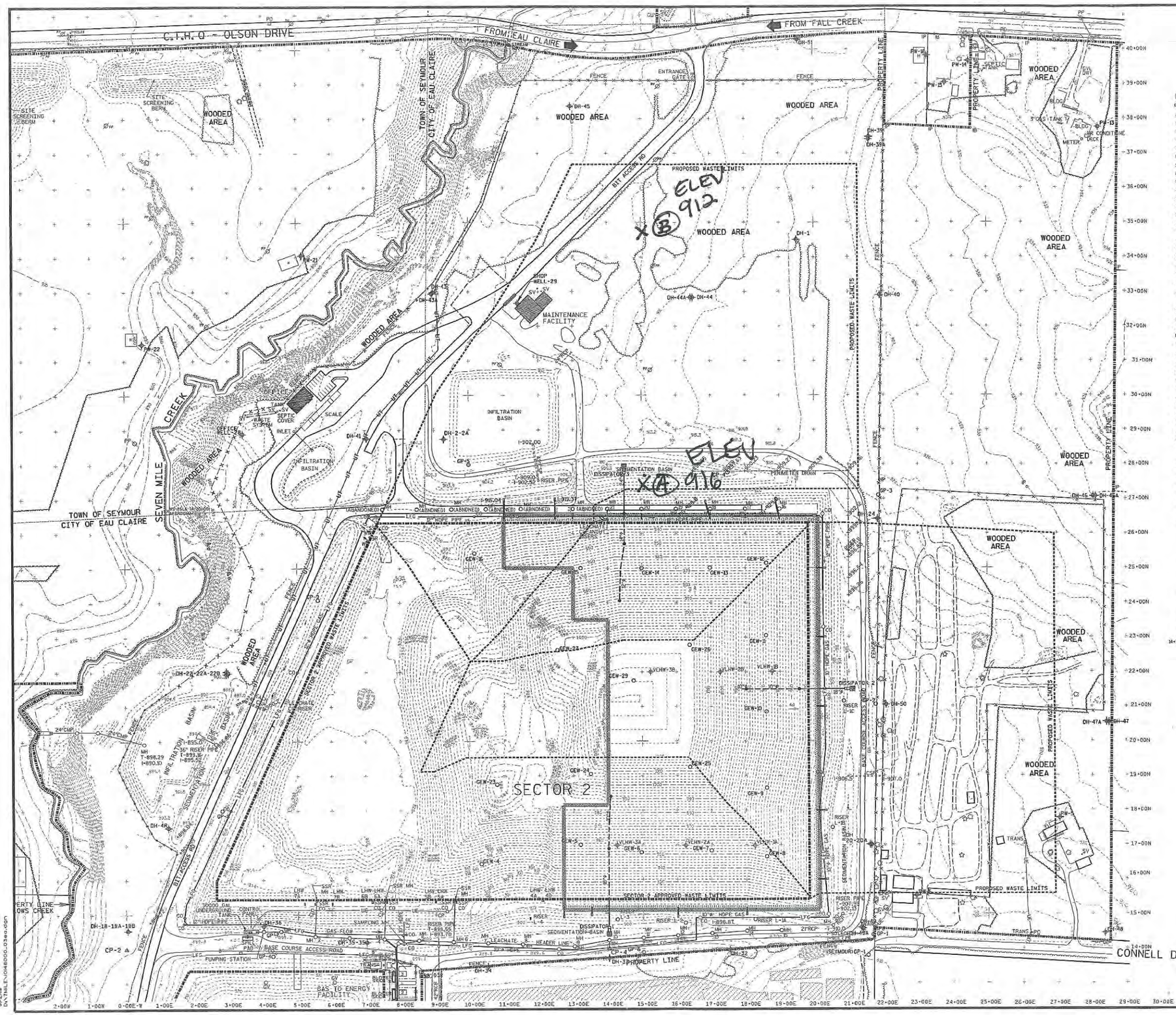
W:\Bentley_V8i\WorkSpace\Projects\Engineering_Services\plugins\ES_Standards.tbl
W:\EIV\CAD\7MILE\Plan of Operation\2011 plan mod\19018480POO_08LC.dgn



LEGEND:

(ALL OF LEGEND IS NOT NECESSARILY DEPICTED ON THIS DRAWING)

- EXISTING CONTOUR (10' INTERVAL)
- EXISTING CONTOUR (2' INTERVAL)
- PROPOSED CONTOUR (10' INTERVAL)
- PROPOSED CONTOUR (2' INTERVAL)
- SPOT ELEVATION
- DITCH W/ DIRECTION OF FLOW
- SANITARY SEWER
- FORCE MAIN
- WATER MAIN
- STORM SEWER W/ SIZE & TYPE OF PIPE
- CULVERT
- TEST PIT
- BORING
- SPLIT STEM BORING
- TEST BORING
- AUGER BORING
- BUILDING
- HARD SURFACED ROADWAY
- NON-SURFACED ROADWAY
- TEST WELL
- PRIVATE WELL
- MONITORING WELL
- MONITORING WELLS W/ PIEZOMETERS
- MANHOLE
- LEACHATE COLLECTION SYSTEM
- LEACHATE CLEANOUT RISER
- LYSIMETER RISER
- HEADWELLS
- GAS VENT
- GAS PROBES
- LANDFILL GAS & CLEANOUT
- GAS EXTRACTION WELL
- WELL HEAD
- CONTROL POINT
- UTILITY POLE
- UNDERGROUND ELECTRIC/TRANSFORMER
- UNDERGROUND TELEPHONE/PEDESTAL
- UNDERGROUND GAS
- OVERHEAD ELECTRIC
- FENCE LINE
- TREE - DECIDUOUS
- WOODS LINE
- RIGHT OF WAY
- PROPERTY LINE
- SECTION LINE
- APPROVED WASTE LIMITS
- EXTENT OF CAPPED AREA
- PROPOSED WASTE LIMITS

NOTES:

1) SITE CONTOURS BASED ON:
AERIAL FLIGHT BY KIM OF OCTOBER 1, 2003
LATEST AYRES SURVEY OF JUNE 30, 2004

HORIZONTAL & VERTICAL CONTROL:

CP-2 - 14+00N 0+00E
EL = 900.17

CP 4 - 14+00N 16+00E
EL = 900.70

SITE GRID TO STATE PLANE GRID (COORDINATE CONVERSION)

SITE	CONTROL POINT	STATE
14+26.25N 21+67.63E	STONE MONUMENT (SEC COR 8/9/17/18)	366426.25N 1643867.63E

DR. BY: GJS
CHK. BY: V.G. SCHMIDT
FILE NAME: 1018800_OSEA.DGN
JOB NO.: 38-1481.00
SCALE: AS SHOWN
DATE: OCTOBER - 2004

NO.	DATE	REVISION

PLAN OF OPERATION
SECTOR 2 - HORIZONTAL & VERTICAL EXPANSION
ONYX SEVEN MILE CREEK LANDFILL
EAU CLAIRE, WISCONSIN

ONYX

AYRES ASSOCIATES
Eau Claire, Wisconsin

EXISTING SITE PLAN

DRAWING NO. 3

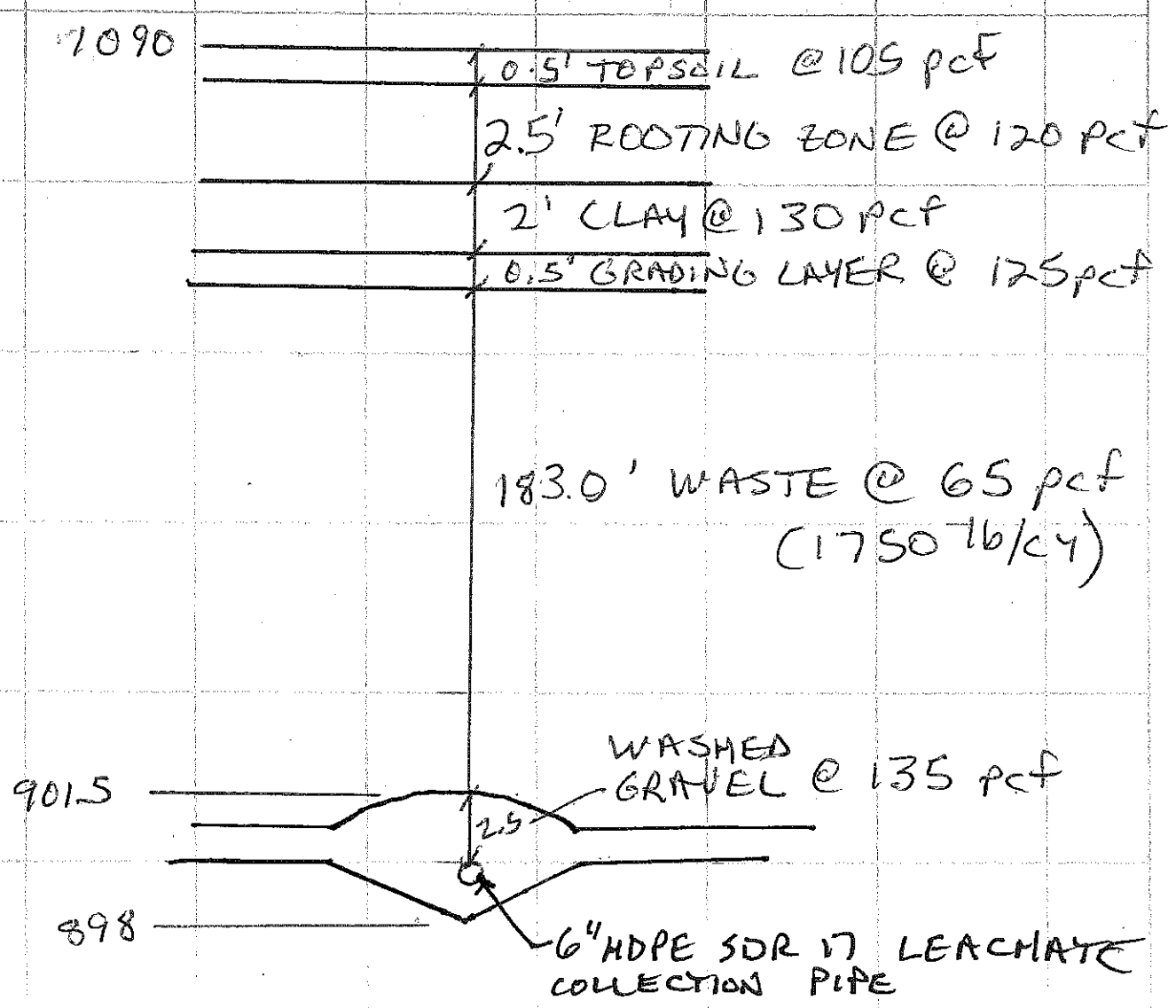
10/18/2004
eEsia
DATMILE\1018800_OSea.dgn

Client Name: SMC Project Name: FEASIBILITY

Subject SOIL SETTLEMENT Project #:

CORNERSTONE Environmental Group, LLC

Designed By: BJP Date: 8-22-14 Checked By: JFP Date: 9-8-14 Sheet No. ____ of ____



(A) MAXIMUM HEIGHT CONDITION

Dead Load Calculations - Point A, Max Height Conditions Over Liner on Leachate Line
Seven Mile Creek, Soil Settlement Calculation

Stratum	Thickness (ft)	Density (pcf)	Pressure (psf)
Topsoil	0.50	105	53
Rooting Zone	2.50	120	300
Clay	2.00	130	260
Grading Layer	0.50	125	63
Waste	183.00	65	11,895
Pipe Bedding Material	2.50	135	338
		TOTAL	12,908

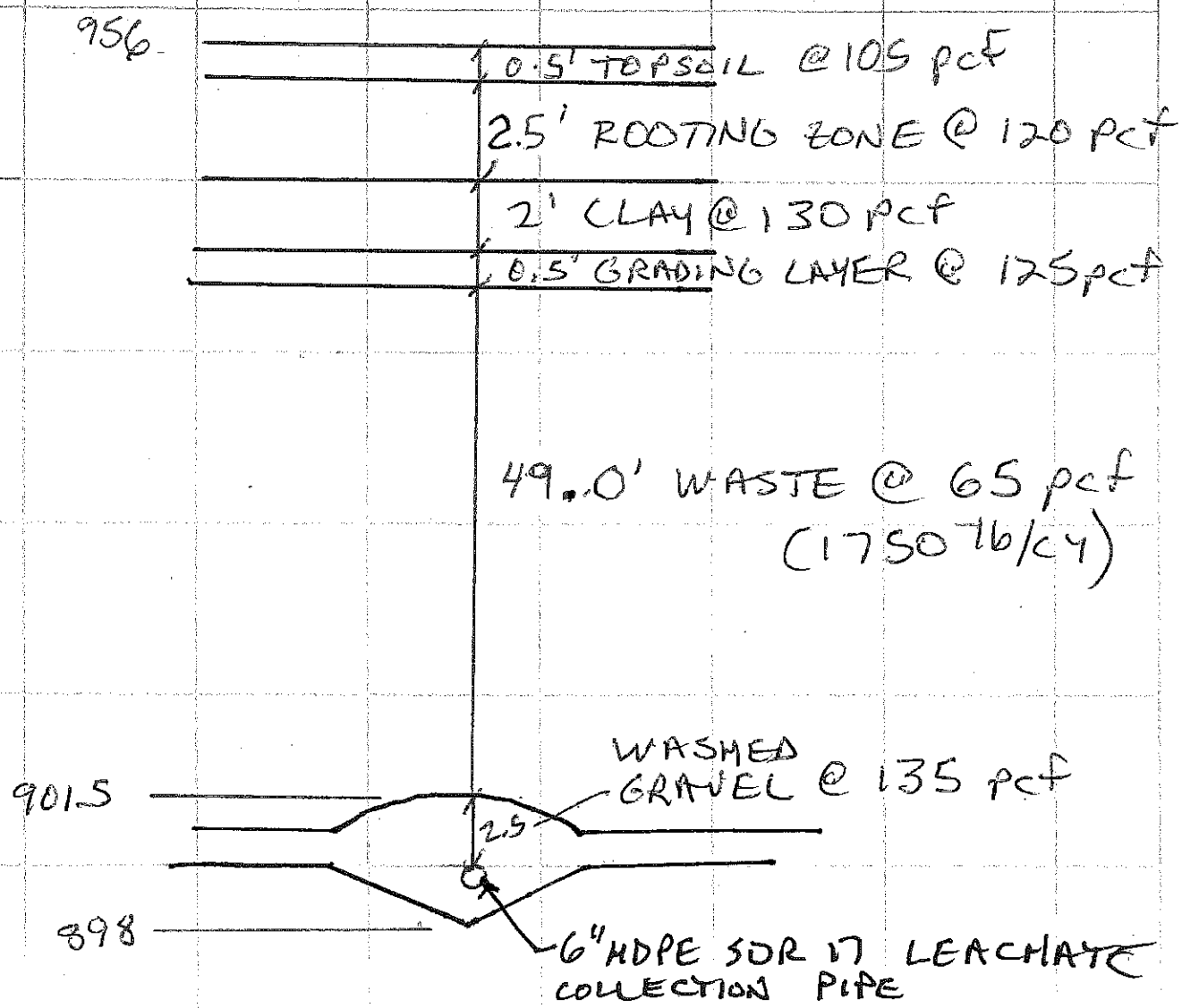
Waste density = 1,750 lb/CY
Pipe bedding material is max over liner, worst case loading on liner.

Client Name: SMC Project Name: FEASIBILITY

Subject SOIL SETTLEMENT Project #:

CORNERSTONE Environmental Group, LLC

Designed By: BJP Date: 8-22-14 Checked By: JFF Date: 9-9-14 Sheet No. ____ of ____



(B) LOWEST HEIGHT CONDITION

Dead Load Calculations - Point B, Min Height Conditions Over Liner on Leachate Line
Seven Mile Creek, Soil Settlement Calculation

Stratum	Thickness (ft)	Density (pcf)	Pressure (psf)
Topsoil	0.50	105	53
Rooting Zone	2.50	120	300
Clay	2.00	130	260
Grading Layer	0.50	125	63
Waste	49.00	65	3,185
Pipe Bedding Material	2.50	135	338
		TOTAL	4,198

Waste density = 1,750 lb/CY
Pipe bedding material is max over liner, worst case loading on liner.

(A)

BORING NO. TB-38

SURFACE ELEV. 912.6 FT.

AYRES ASSOCIATES

SAMPLE NUMBER	BLOWS ON SAMPLER (140 lbs – 2" O.D. – FALLING 30") 6"	6"	per ft	SAMPLE TYPE	CLASSIFICATION AND REMARKS	Moisture	UNIFIED CLASSIFICATN	POCKET PEN. READING (T.S.F)	GEOLOGY	DEPTH	ELEV.
					Topsoil 0.3'						HOLLOW STEM AUGER
					Sand, Brn.-yel-brn., M-F, w/trc. silt,		SP				
1	7 11	5	16 R 1.2	X		M	SP				
2	10 13	11	24 R 1.1	X		D	SP			10	
3	11 12	13	25 R1.2	X	Sand, yel-brn., M-F, w/Trc. silt trc./gravel	D	SP				TOP OF LINER
4	8 18	16	34 R1.2	X						20	BOTTOM LINER
5	7 13	14	27 R1.2	X	Mottled - As above				Alluvium		
6	9 19	17	36 R1.1	X	Mottled - A.A.					30	
7	13 23	21	44 R.1.6	X	Mottled - A.A.	M/W					▽ =
8	100/.8		100 R0.8'	X	Weathered Sandstone	W.				40	
9	100/.3		100 R0.3'	X	Sand, yel-brn., M.F., w/Trc. silt, and Sandstone chips. Note: Drills Rough 42.0-50.0	W	SP		Residuum	50	
10	100/.2		100 R0.2'	X	E.O.B. 50.2						
										60	

—KEY—

C = ROCK CORE
A = AUGER SAMPLE
X = SPLIT SPOON
S = SHELBY TUBE
=
=

PROJECT Seven Mile L.F
DATE(S) DRILLLED 4-11-85
LOCATION 26+01 N, 14+35 E
GROUNDWATER: 36.5 FT. BELOW G.S. AT ELEV. OF 876.1
DRILLERS: M.P for W.T.O. JOB NO. 4731.00
DATE

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

B

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Onyx-Superior Seven Mile Creek Landfill	3097	TB-72

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Boart Longyear - M. Mueller	11/12/2002	11/12/2002	4 1/4" HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TB-72	873.6 Feet MSL	912.6 Feet MSL	8.0 Inches

Boring Location or Local Grid Origin (Check if estimated: ☐)
State Plane S/C/N
NE 1/4 of SE 1/4 of Section 8, T 27 N, R 8 W

Lat. ___ ° ___ ' ___ "
Long. ___ ° ___ ' ___ "

Local Grid Location (If applicable)
☒ N 3502.619 Feet ☐ S ☒ E 1401.762 Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
618045450	Eau Claire	18	Town of Seymour

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 GS	24			Topsoil						M				Alluvium
			2	Dark gray brown fine sand with silt 10YR4/2	SM									
2 SS	24 22	3 5 6 11	4 6 8	Yellow brown fine sand with silt 10YR5/4	SM					M				Alluvium
3 SS	24 18	6 7 13 14	10 12	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					M				Alluvium
4 SS	24 19	7 8 10 12	14 16 18	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					M				Alluvium
45 SS	24 16	5 10 15 17	20 22 24	Pale brown fine sand, some silt 10YR6/3	SP-SM					M				Alluvium

TOP OF LINER

BOTTOM OF LINER

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Frank Maenner Firm Ayres Associates

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completions of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number TB-72 Use only as an attachment to Form 4400-122.

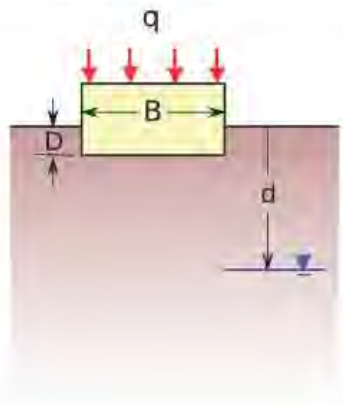
Sample Number and Type	Length Att & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
6 SS	24 15	8 9 17 19	26 28	Light gray fine sand, some silt 10YR7/2	SP-SM					M				Alluvium
7 SS	24 18	10 13 16 19	30 32	Very pale brown fine sand, some silt 10YR7/3	SP-SM					M				Alluvium
8 SS	24 16	9 13 21 27	34 36 38	Light brown gray fine sand, some silt 10YR6/2	SP-SM					M				Alluvium
9 SS	24 11	5 7 8 9	40 42	Brown fine sand, some silt 10YR5/3	SP-SM		▼			W				Alluvium
10 SS	24	2 3 8 12	44 46 48 50	Yellow brown fine sand, some silt 10YR5/4	SP-SM					W				Alluvium
11 SS	24 12	4 6 8 9	52	Light yellow brown fine sand, some silt, trace friable sandstone chips 10YR6/4						W				Residual
				End of Boring at 53' (elevation = 859.6); Boring backfilled with 3/8" bentonite chips										

Schmertmann settlement calculator

Input | Results | Help

Units: kPa ksf tsf

Load, q:	10.748	ksf
Depth, D:	.00001	ft
Lengh, L:	500	ft
Width, B:	500	ft
Water table depth, d:	36.5	ft
Time:	100	years



Layer	Thickness (ft)	E_s (ksf)	γ_{moist} (kp/ft^3)	γ_{sat} (kp/ft^3)
1	4	1440	0.13	0.13
2	18	576	0.12	0.12
3	10	1008	0.12	0.12

+ Add Layer − Subtract layer

☑ Use Es ☑ Use Modified Schmertmann (1978) ☑ Subdivide Layers

Compute Settlement = 1.18 inches

Rocscience Inc.

Settle^{3D} 2.0

Analysis of consolidation and settlement under foundations, embankments and surface loads.

Settle^{3D} 2.0 includes three additional empirical methods:

- Peck, Hanson and Thornburn
- D'Appolonia
- Schultze and Sherif

Get a fully functional trial version here!

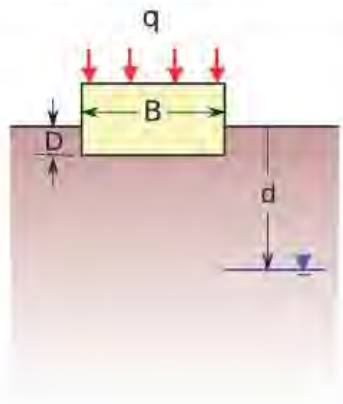
Settlement at Point A

Schmertmann settlement calculator

Input | Results | Help

Units: kPa ksf tsf

Load, q:	2.68	ksf
Depth, D:	.00001	ft
Lengh, L:	500	ft
Width, B:	500	ft
Water table depth, d:	39	ft
Time:	100	years



Layer	Thickness (ft)	E_s (ksf)	γ_{moist} (kp/ft^3)	γ_{sat} (kp/ft^3)
1	4	1440	0.13	0.13
2	30	576	0.12	0.12

+ Add Layer − Subtract layer

☑ Use Es ☑ Use Modified Schmertmann (1978) ☑ Subdivide Layers

Compute Settlement = 0.372 inches

Rocscience Inc.

Settle^{3D} 2.0

Analysis of consolidation and settlement under foundations, embankments and surface loads.

Settle^{3D} 2.0 includes three additional empirical methods:

- Peck, Hanson and Thornburn
- D'Appolonia
- Schultze and Sherif

Get a fully functional trial version here!

```
Settlement at Point B
```

Schmertmann settlement calculator

Schmertmann method

The Schmertmann method (1970) calculates settlement from layer stiffness data or cone tip bearing resistances, q_c obtained from a Cone Penetration Test (CPT). The method proposed a simplified triangular strain distribution and calculates the settlement accordingly. A time factor can also be included to account for time dependent (creep) effects.

The equation for settlement is:

$$\delta = C_1 C_t \Delta P \sum_{i=1}^{n} \frac{\Delta z_i}{E_{si}} I_{zi}$$

Where

C_1 = the correction to account for strain relief from excavated soil, $1 - \frac{\sigma_{od}'}{2\Delta P}$

σ_{cd}' = effective overburden pressure at bottom of the footing

ΔP = the net applied footing pressure (equation)

C_t = correction for time-dependent creep,

t = time (years)

E_{si} = one-dimensional elastic modulus of soil layer i

Δz_i = thickness of soil layer

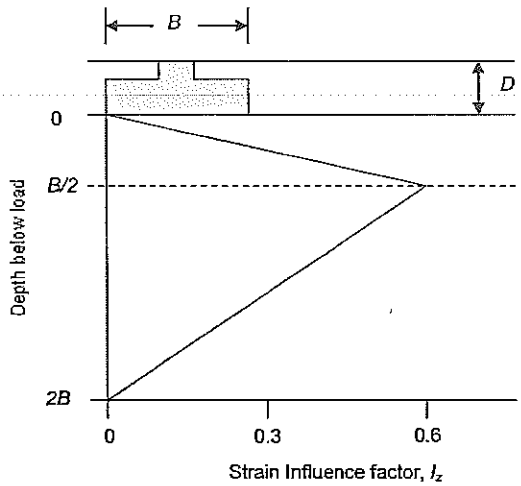
I_{zi} = the influence factor at the centre of soil layer i as described below.

Influence factors

The influence factor, I_z is based on an approximation of strain distributions below the footing. There are two possible formulations for I_z; the original 1970 approximation and the improved 1978 approximation.

1970 formulation

This is described in Schmertmann (1970). The strain influence factor I_z increases linearly from zero at the bottom of the footing to a maximum of 0.6 at a depth of &frac12 B below the footing where B is the footing width. The strain influence factor then decreases linearly to zero at a depth of 2B below the footing bottom. This distribution is shown below.



Strain influence factors from Schmertmann (1970)

1978 formulation

This is described in Schmertmann et al (1978). With this method, the peak value for I_z is calculated by

$$I_{zp} = 0.5 + 0.1\left(\frac{\Delta P}{\sigma_{op}'}\right)$$

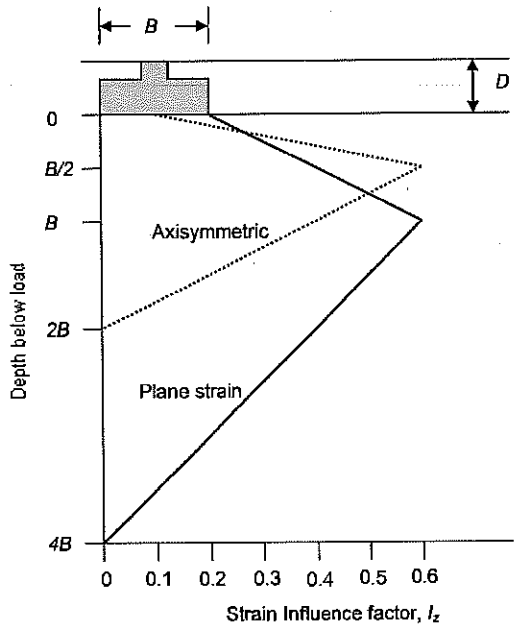
Where σ_{op}' is the effective overburden pressure at the depth of I_{zp}.

The depth of I_{zp} depends on the shape of the load. For an axisymmetric load (a circle or a square), I_{zp} occurs at a depth of $B/2$. For the plane strain case (length of the load is > 10x the width), the I_{zp} occurs at a depth of B. The values for I_z (shown in the figure below) are calculated as follows:

Axisymmetric: I_z varies linearly from 0.1 at the bottom of the footing to I_{zp} at a depth of $B/2$. The strain influence factor then decreases to zero at a depth of $2B$.

Plane strain: I_z varies linearly from 0.2 at the bottom of the footing to I_{zp} at a depth of B. The strain influence factor then decreases to zero at a depth of $4B$.

In the Schmertmann calculator, I_z is calculated using the axisymmetric equations for circle and square loads. For rectangular loads in which the length is greater than ten times the width, the plane strain approach is used. For rectangular loads in which the length is less than ten times the width, a linear interpolation between the axisymmetric and plane strain case is performed, dependent on the length to width ratio.



Strain influence factors from Schmertmann et al. (1978).

Stiffness conversion

The elastic modulus E_s can be estimated from the results of a Cone Penetration test:

$E_s = 2.0q_c$ (1970 formulation)

$E_s = 2.5q_c$ (1978 formulation, axisymmetric footing)

$E_s = 3.5q_c$ (1978 formulation, plane strain footing)

where q_c is the cone tip bearing resistance. If the 1978 formulation is being used, the value for E_s is calculated to be between the axisymmetric case and plane strain case if the length of the load is less than ten times the width.

Subdividing layers

The accuracy of the Schmertmann method improves when the strain profile is sampled more densely. If the soil profile is fairly homogeneous, it is tedious to specify many layers with the same properties in order to improve the accuracy. For these reasons, the Schmertmann calculator will automatically subdivide layers so that each sub-layer has a thickness of approximately B/10.

References

Schmertmann, J.H. (1970). Static cone to compute static settlement over sand. *ASCE Journal of Soil Mechanics & Foundations Division*, **96** (3), 1011-1043.

Schmertmann, J.H., Hartmann, J.P. and Brown, P.R. (1978). Improved strain influence factor diagrams, *ASCE Journal of the Geotechnical Engineering Division*, **104** (GT8), 1131-1135.

Appendix B

Soil Settlement Calculations

From August 2011 Plan Modification to Plan of Operations
Submitted by Ayres Associates

744 Heartland Trail
PO Box 8923 (53708)
Madison, WI 53717

608.831.4444 PHONE
608.831.3334 FAX

www.TRCsolutions.com

June 15, 2011

Mr. Jeff Ellerd, P.E.
Regional Engineer
Veolia ES Solid Waste Midwest, LLC
1375 - 7th Avenue
Newport, MN 55055

Subject: Veolia ES Seven Mile Creek Landfill, Differential Settlement Calculations

Dear Mr. Ellerd:

As you requested, TRC Environmental Corporation has performed differential settlement calculations for the base liner of Sector 2 of the Veolia ES Seven Mile Creek Landfill. These calculations are based on design parameters provided by Veolia ES, including verbal communications regarding descriptions of on-site soils, in-place waste density, and liner and final cover configurations; field boring logs prepared by Wisconsin Test Drilling, Inc.; and the following plan view drawings prepared by Ayers Associates, dated August 2010: Top Peak (Elevation 1094.0), Proposed Base Grades, and Proposed Modified Subbase Grades With Ground Water Contours.

The results of the attached calculations indicate that a minimum base grade slope within the leachate collection pipe trench of 0.51% is necessary to meet the NR 504.06(6)(c) requirement that the minimum slope on all leachate collection pipes and associated pipe trenches at the base of the landfill shall be designed and constructed to be greater than 0.5% after accounting for primary and secondary settlement of the subgrade.

If you have questions or concerns regarding these calculations, please contact Doug Genthe at (608) 662-5162.

Sincerely,
TRC Environmental Corporation

WISCONSIN
Douglas R. Genthe
E-27604
Madison, WI
PROFESSIONAL ENGINEER

6-15-11

Todd W. Martin
Project Manager

Douglas R. Genthe, P.E.
Director, Land Based Services

Attachments: Differential Settlement Calculations

I:\WPMSN\PJT1\06680\01\001\L0668001001-001.DOCX

RMT Corporate Headquarters • 744 Heartland Trail, Madison, WI 53717

PROJECT/PROPOSAL NAME/LOCATION: Veolia ES Seven Mile Creek LF		PROJECT/PROPOSAL NO. 06680.01.001
SUBJECT: Differential Settlement		
PREPARED BY: Scott Inman	DATE: 6/14/11	FINAL ☐
CHECKED BY: S. Jorgensen	DATE: 6/14/11	REVISION ☐

Purpose

Calculate differential settlement to verify the liner slope is in compliance with NR 504.06 (6)(c).

Calculations

① Critical Cross Section and two critical points on that section

The leachate collection pipe in Phase 12 is most critical because it passes beneath the points of greatest waste thickness difference. The two points are labeled Ⓐ landfill peak, and Ⓑ northern toe of the liner.

② Determine Fill (waste) thickness at Points A & B.
Thickness = Bottom of final cover − top of gravel (1' over top of liner). See profiles on next 2 pages.

Point A = 1089 − 899 = 190 ft
Point B = 985 − 894.5 = 89.5 ft

③ Determine applied pressure at points A & B

a) Create representative fill profiles (next 2 pages)

b) Determine effective stress applied at the top of liner (base grades) where differential settlement is the concern at points A&B, based on the following assumptions.

Material	Unit Weight, pcf	
Topsoil	105	
silty sand, uncompacted general fill	110	
compacted clay	130	
compacted silty sand	125	
Waste	65	(Veolia phone call 6/14/11)
Gravel Drainage layer	130	1,750 lb/CY

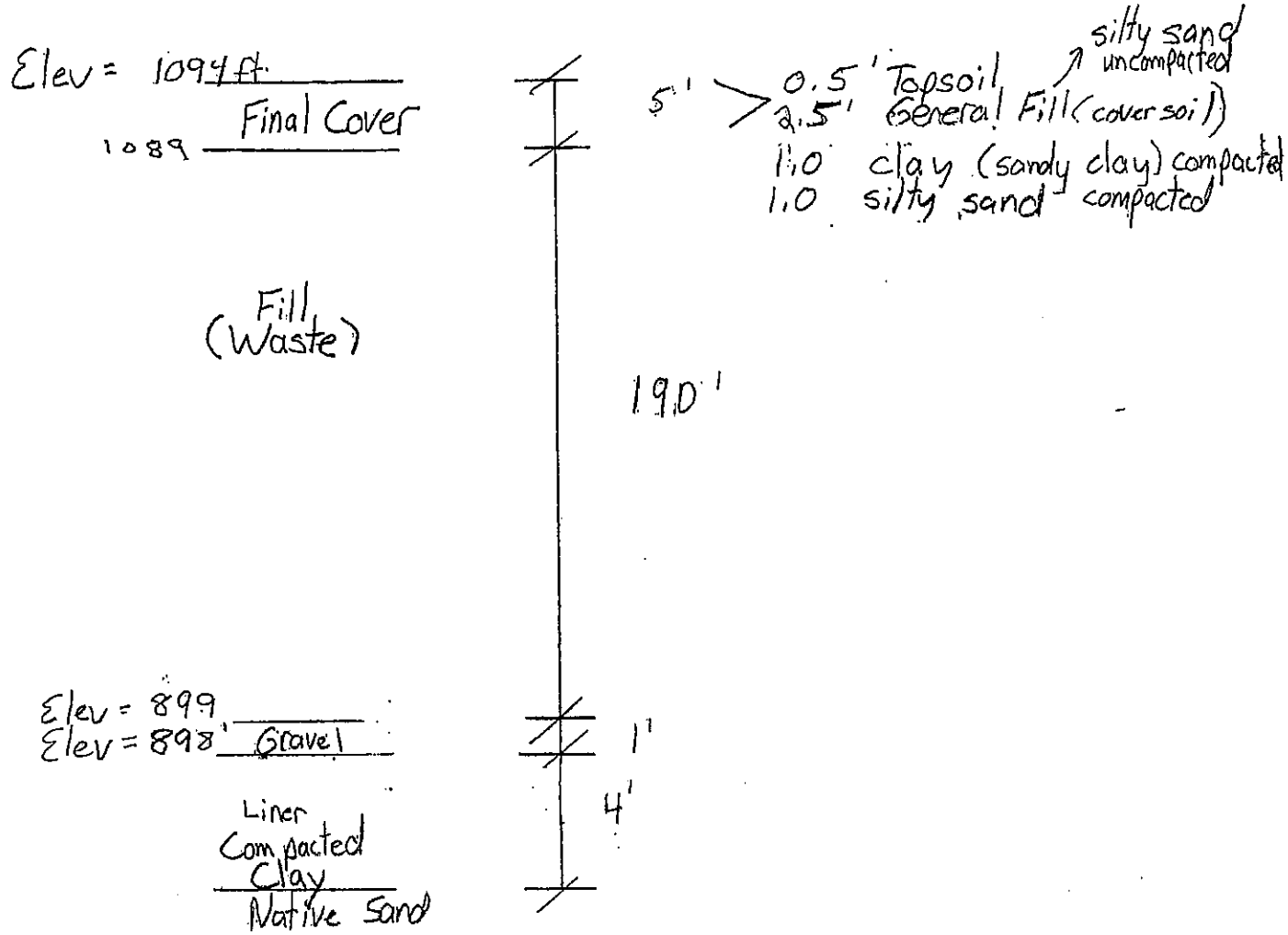
2/24

RMT Corporate Headquarters • 744 Heartland Trail, Madison, WI 53717

SHEET 2 OF 5

PROJECT/PROPOSAL NAME/LOCATION: Veolia ES Seven Mile Creek LF		PROJECT/PROPOSAL NO. 06680.01.001
SUBJECT: Differential Settlement		
PREPARED BY: Scott Inman	DATE: 6/14/11	FINAL ☐
CHECKED BY: J. Jorgensen	DATE: 6/14/11	REVISION ☐

Fill Profile at Point (A)



Pressure at top of liner

$$\sigma_A' = (105\,pcf \times 0.5') + (110\,pcf \times 2.5') + (130\,pcf \times 1.0') + (125\,pcf \times 1.0') + (65\,pcf \times 19.0') + (130\,pcf \times 1')$$

$$\sigma_A' = 13{,}063\,psf$$

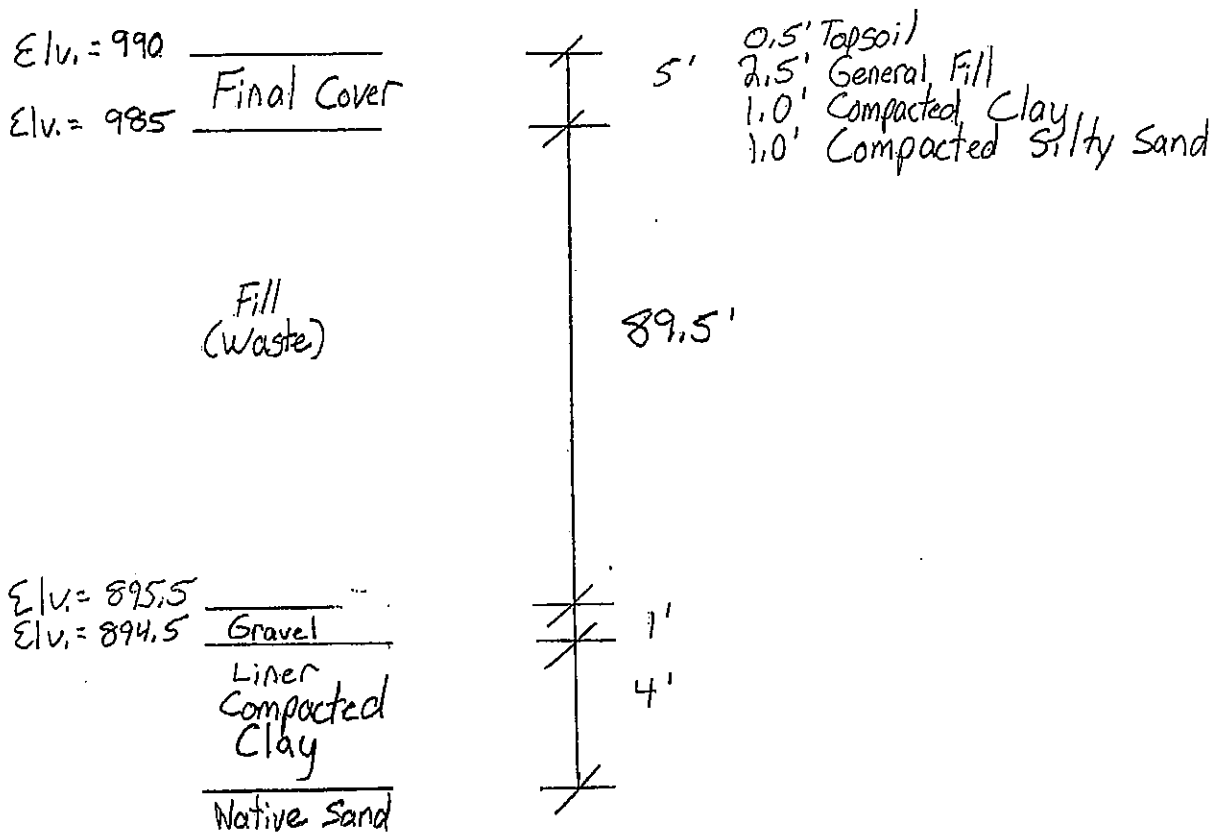
3/24

RMT Corporate Headquarters • 744 Heartland Trail, Madison, WI 53717

SHEET 3 OF 5

PROJECT/PROPOSAL NAME/LOCATION: Veolia ES Seven Mile Creek LF		PROJECT/PROPOSAL NO. 06680.01.001
SUBJECT: Differential Settlement		
PREPARED BY: Scott Inman	DATE: 6/14/11	FINAL ☐
CHECKED BY: S. Sayman	DATE: 6/14/11	REVISION ☐

Fill Profile at Point (B)



Pressure at top of liner

$$\sigma_B' = (105pcf \times 0.5') + (110pcf \times 2.5') + (130pcf \times 1.0') + (125pcf \times 1.0') + (65pcf \times 89.5') + (130pcf \times 1.0')$$

$$\sigma_B' = 6{,}530 \text{ psf}$$

7/24

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SHEET 4 OF 5

PROJECT/PROPOSAL NAME/LOCATION: Veolia ES Seven Mile Creek LF		PROJECT/PROPOSAL NO. 06680.01.001
SUBJECT: Differential Settlement		
PREPARED BY: Scott Inman	DATE: 6/14/11	FINAL ☐
CHECKED BY: S. Jongsma	DATE: 6/14/11	REVISION ☐

④ Determine in-situ (pre-excavation) pressure at Points A & B

Point (A) Initial elev. = 915.4
Top of Liner elev = 898.0
Cut depth = 17.4

$\sigma_{OA}' = 17.4' \times 120\ pcf = \underline{2,088\ psf}$

Point (B) Initial elev. = 912.6
Top of Liner elev. = 894.5
Cut depth = 18.1'

$\sigma_{OB}' = 18.1' \times 120\ pcf = \underline{2,172\ psf}$

⑤ Determine change in stress at top of liner elevation between existing overburden and future expected fill

Point A Applied pressure = 13,063 psf
Existing pressure = 2,088 psf
Change in pressure = 10,975 psf

Point B Applied pressure = 6,530 psf
Existing pressure = 2,172 psf
Change in pressure = 4,358 psf

⑥ Determine Modulus of Elasicity Values:

Use the following assumptions:

based on Table 5.6 Das, 2004 Foundation Engineering

Material	Modulus of elasticity
compacted clay → stiff clay	1,440,000 psf
low end medium dense sand	360,000 psf
high end medium dense sand	576,000 psf
dense sand	1,008,000 psf
silty sand	288,000 psf

Assume primary consolidation of the 4' clay liner is negligible because the material will be compacted to 90% modified proctor. Elastic settlement is considered by assigning a modulus of elasticity.

5/24

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SHEET 5 OF 5

PROJECT/PROPOSAL NAME/LOCATION: Veolia ES Seven Mile Creek LF		PROJECT/PROPOSAL NO. 06680.01.001
SUBJECT: Differential Settlement		
PREPARED BY: Scott Inman	DATE: 6/14/11	FINAL ☐
CHECKED BY: S. Jarpenter	DATE: 6/14/11	REVISION ☐

⑦ Determine Modulus of Elasticity profiles at A & B.

Point A:
based on boring MW-38
(assume surface elev = 916)
Water Elev = 877

Depth (below top liner)	Material	Es, psf	Boring MW-38 Depth
0-4	compacted clay	1,440,000	—
4-21	high end med. dense sand	576,000	23-40
21-26	dense sand	1,008,000	40-45
26-39	silty sand	288,000	45-58
39+	incompressible sandstone		

Point B:
Water Elev = 874

Depth (below top liner)	Material	Es, psf	Boring Depth	
0-4	compacted clay	1,440,000	—	
4-17	high end med. dense sand	576,000	22-35	TB7n
17-22	dense sand	1,008,000	35-40	
22-44	low end med. dense sand	360,000	40-53	
44-54	high end med. dense sand	576,000	51-60	
54-56	dense sand	1,008,000	60-70	TB6i
			70-72	

⑧ Determine Settlement at PT A & PT B using Schmertmann Method (attached)

Point (A) = 1.58 inches

Point (B) = 0.89 inches

⑨ Differential Settlement between points A & B

1.58 inch − 0.89 inches = 0.69 inches

⑩ Calculate change in slope due to differential settlement
– Horizontal Distance between A and B = 750'

$$\Delta \text{ slope} = \frac{(0.69 \text{ in}/12)}{750} = 0.01\%$$

Conclusion: The leachate collection pipe slope shall account for 0.01% of differential settlement, and still maintain a 0.5% slope; therefore the final design slope for the leachate collection pipe must be: 0.01 + 0.5 = 0.51% or greater.

6/24

SETTLEMENT ANALYSIS OF SHALLOW FOUNDATIONS
Schmertmann Method

Date June 14, 2011
Identification Point A

Input		Results	
Units	E E or SI		
Shape	sq SQ, CI, CO, or RE	q =	10975 lb/ft^2
B =	500 ft	delta =	1.58 in
L =	500 ft		
D =	0 ft		
Dw =	21 ft		
gamma =	120 lb/ft^3		

Depth to Soil Layer Top (ft)	Bottom (ft)	Es (lb/ft^2)	zf (ft)	Lepsilon	strain (%)	delta (in)
0.0	0.0					
0.0	1.0	1440000	0.5	0.101	0.0770	0.0092
1.0	2.0	1440000	1.5	0.103	0.0784	0.0094
2.0	3.0	1440000	2.5	0.105	0.0799	0.0096
3.0	4.0	1440000	3.5	0.107	0.0814	0.0098
4.0	5.0	576000	4.5	0.109	0.2071	0.0249
5.0	6.0	576000	5.5	0.111	0.2108	0.0253
6.0	7.0	576000	6.5	0.113	0.2145	0.0257
7.0	8.0	576000	7.5	0.115	0.2182	0.0262
8.0	9.0	576000	8.5	0.116	0.2219	0.0266
9.0	10.0	576000	9.5	0.118	0.2256	0.0271
10.0	11.0	576000	10.5	0.120	0.2292	0.0275
11.0	12.0	576000	11.5	0.122	0.2329	0.0280
12.0	13.0	576000	12.5	0.124	0.2366	0.0284
13.0	14.0	576000	13.5	0.126	0.2403	0.0288
14.0	15.0	576000	14.5	0.128	0.2440	0.0293
15.0	16.0	576000	15.5	0.130	0.2477	0.0297
16.0	17.0	576000	16.5	0.132	0.2514	0.0302
17.0	18.0	576000	17.5	0.134	0.2550	0.0306
18.0	19.0	576000	18.5	0.136	0.2587	0.0310
19.0	20.0	576000	19.5	0.138	0.2624	0.0315
20.0	21.0	576000	20.5	0.140	0.2661	0.0319
21.0	22.0	1008000	21.5	0.142	0.1542	0.0185
22.0	23.0	1008000	22.5	0.144	0.1563	0.0188
23.0	24.0	1008000	23.5	0.145	0.1584	0.0190
24.0	25.0	1008000	24.5	0.147	0.1605	0.0193
25.0	26.0	1008000	25.5	0.149	0.1626	0.0195
26.0	27.0	288000	26.5	0.151	0.5764	0.0692
27.0	28.0	288000	27.5	0.153	0.5838	0.0701
28.0	29.0	288000	28.5	0.155	0.5912	0.0709
29.0	30.0	288000	29.5	0.157	0.5985	0.0718
30.0	31.0	288000	30.5	0.159	0.6059	0.0727
31.0	32.0	288000	31.5	0.161	0.6133	0.0736
32.0	33.0	288000	32.5	0.163	0.6206	0.0745
33.0	34.0	288000	33.5	0.165	0.6280	0.0754
34.0	35.0	288000	34.5	0.167	0.6354	0.0762
35.0	36.0	288000	35.5	0.169	0.6428	0.0771
36.0	37.0	288000	36.5	0.171	0.6501	0.0780
37.0	38.0	288000	37.5	0.173	0.6575	0.0789
38.0	39.0	288000	38.5	0.174	0.6649	0.0798

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WISCONSIN TEST DRILLING, INC.

FIELD BORING LOG

Sheet 1 Of 1

SCHOFIELD, WISCONSIN

FOR Ayres 7 Mile Landfill

LOCATION Eau Claire, WI Elev.

Job No. 1413

Boring No. MW-38

GROUND WATER: While drilling ____ Time after drilling ____; Before casing removal ____ Depth to water ____; After casing removal ____ Depth to cave-in ____

Start 10-5-88
Unit 805
Chief LF

Casing/Probe ____ Weight 140# Drop 30"

Sample No.	Moisture	Blows on Sampler 0/6	6/12	Sample Recovery	Total Blows	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Blows on Casing Size	Probe Size	Drilling Method
						TOPSOIL - Dk.Brn 0.8' SAND, W/Silt SP/SM					HSA
						Red to Brown M-F SAND SP					
1	M	9	7								
		10		1.3	17						
2	M	10	5								
		9		1.2	14						
						12.5' Red to Brown M-F SAND, Trace Silt SP/SM					
3	M	7	10								
		11		1.1	21						
4	M	4	18								
		19		1.2	37						
5	M	9	9								
		18		1.1	27						
6	M	12	12								
		17		1.1	29						
						33.0' Red to Brown M-F SAND, W/Silt & Clay, Trace Gravel, With Sandstone SP/SM					
7	M	18	10								
		21		1.0	31						
8	M	24	18								
		26		1.0	44						
						45.0' Gray to Brown Silty SAND SP/SM					
9	M	0	0								
		15		1.4	15						

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WISCONSIN TEST DRILLING, INC.

SCHOFIELD, WISCONSIN

FIELD BORING LOG

Sheet 2 Of 2

FOR Ayres 7 Mile Landfill

LOCATION Eau Claire, WI Elev.

Job No. 1413

Boring No. MW-38

GROUND WATER: While drilling ____ Time after drilling ____; Before casing removal ____ Depth to water ____; After casing removal ____ Depth to cave-in ____

Start 10-5-88
Unit 805
Chief LE

Casing/Probe ____ Weight 140# Drop 30"

Sample No.	Makers	Blows on Sampler 0/6	6/12	Sample Recovery	Total Blows	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Blows on Casing Size	Probe Size	Drilling Method
10	M	5	8								
		12		14	20						HSA
11	W	11	10								
		10		12	20						
						Brown M-F SAND (58.0') SP					
12	W	100/1.0		10	100						
13		100/.1		0		SANDSTONE (64.0')					

E.O.B. @ 71.0'

Well Set @ 69.0'

Cement/Bentonite Grouted 38.5'

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater ☐ Waste Management ☒ Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Onyx-Superior Seven Mile Creek Landfill	3097	TB-67

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Boart Longyear - M. Mueller	11/12/2002	11/12/2002	4 1/4" HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TB-67	875.2 Feet MSL	910.2 Feet MSL	8.0 Inches

Boring Location or Local Grid Origin (Check if estimated: ☐)
State Plane S/C/N
NE 1/4 of SE 1/4 of Section 8, T 27 N, R 8 W

Lat. ___ ° ___ ' ___ "
Long. ___ ° ___ ' ___ "

Local Grid Location (if applicable)
☒ N ☒ E
3305.36 Feet ☐ S 1399.787 Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
618045450	Eau Claire	18	Town of Seymour

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
1 GS	24			Topsoil										Alluvium
			2	Yellow brown fine sand, some silt 10YR5/4	SP-SM									
2 SS	24 19	3 5 7 13	4	Light yellow brown silt with fine sand 10YR6/4	SM					M				Alluvium
			6	6" Brown silt with clay lense at 5'	ML									
			8	Light yellow brown silt with fine sand 10YR6/4	SM									
3 SS	24 20	4 9 9 10	10	Yellow brown silt with fine sand 10YR5/4	SM					M				Alluvium
				2" brown silt with clay lense at 10'	ML									
			12	Yellow brown silt with fine sand 10YR5/4	SM									
4 SS	24 20	5 14 26 27	14 16	Pale brown silt with fine sand 10YR6/3	SM					M				Alluvium
			18											
5 SS	24 18	9 12 30 38	20	Pale brown fine sand, some silt 10YR6/3	SP-SM					M				Alluvium
			22											
			24											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Frank Niemann
Firm: Ayres Associates
Tel
Fax.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completions of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number TB-67 Use only as an attachment to Form 4400-122.

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
6 SS	24 16	8 17 30 44	26 28	Pale brown fine sand, some silt 10YR6/3	SP-SM					M				Alluvium
7 SS	24 16	9 16 23 30	30 32	Very pale brown fine sand, some silt 10YR7/3	SP-SM					M				Alluvium
8 SS	24 15	13 16 30 36	34 36 38	Pale brown fine sand, some silt 10YR6/3	SP-SM					W				Alluvium
9 SS	24 13	3 7 12 14	40 42	Light yellow brown fine sand, some silt, little medium sand 10YR6/4	SP-SM					W				Alluvium
10 SS	24 14	9 7 7 14	44 46 48	Light yellow brown fine sand, some silt, trace friable sandstone chips 10YR6/4						W				Residual
11 SS	24 16	3 6 9 13	50 52	Pale brown fine sand, some silt, trace poorly cemented sandstone chips 10YR6/3						W				Residual
12 SS	24 12	4 7 9 15	54 56	Pale brown fine sand, some silt, trace coarse sand 10YR6/3						W				Residual
				End of Boring at 56' (elevation = 854.2); Boring backfilled with 3/8" bentonite chips										

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midwest engineering services, inc.

SOIL BORING LOG: TB - 67

Project: 7-Mile Creek Landfill
Location: Eau Claire, Wisconsin

Project No.: 4-13213
Drill Date: March 3, 2011
Drilled by: JB

DEPTH/EL. (feet)		VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 910.4	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1	909.4							
2	908.4							
3	907.4							
4	906.4							
5	905.4							
6	904.4							
7	903.4							
8	902.4							
9	901.4	Drilled without sampling						
10	900.4							
11	899.4							
12	898.4							
13	897.4							
14	896.4							
15	895.4							
16	894.4							
17	893.4							
18	892.4							
19	891.4							
20	890.4							
21	889.4							
22	888.4							
23	887.4							
24	886.4							
25	885.4							
26	884.4							
27	883.4							
28	882.4							
29	881.4							
30	880.4							
31	879.4							
32	878.4							
33	877.4							
34	876.4							
35	875.4							
36	874							
37	873.4							
38	872							
39	871							
40	870							
41	869							
42	868							

WATER LEVEL OBSERVATIONS:

During drilling: 51± feet (EL 859.4±) (▼)
Upon completion: None Observed
Depth/Delay: N/A
Caved at: 36.5± feet (EL 873.9±)

ADDITIONAL COMMENTS:

-No groundwater observed in borehole upon completion.

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

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midwest engineering services, inc.

SOIL BORING LOG: TB - 67

Project: 7-Mile Creek Landfill
Location: Eau Claire, Wisconsin

Project No.: 4-13213
Drill Date: March 3, 2011
Drilled by: JB

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 910.4	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
43 867.4							
44 866.4							
45 865.4	Drilled without sampling						
46 864.4							
47 863.4							
48 862.4							
49 861.4							
50 860.4							
51 859.4							▼
52 858.4		1-SS	30			15	
53 857.4							
54 856.4							
55 855.4							
56 854.4		2-SS	23			16	
57 853.4							
58 852.4	Light brown SAND, occasional sandstone fragments, trace silt, wet						
59 851.4	(Possible weathered sandstone)						
60 850.4	(SP)						
61 849.4		3-SS	22			16	
62 848.4							
63 847.4							
64 846.4							
65 845.4							
66 844.4		4-SS	29			17	
67 843.4							
68 842.4							
69 841.4							
70 840.4							
71 839.4		5-SS	38			20	
72 838.4							
73 837.4	END OF BORING @ 72± FEET						
74 836.4							
75 835.4							
76 834.4							
77 833.4							
78 832.4							
79 831.4							
80 830.4							
81 829							
82 828							

WATER LEVEL OBSERVATIONS:

During drilling: 51± feet (EL 859.4±) (▼)
Upon completion: None Observed
Depth/Delay: N/A
Caved at: 36.5± feet (EL 873.9±)

ADDITIONAL COMMENTS:

-No groundwater observed in borehole upon completion.

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater [ ] Waste Management [X]
Remediation/Redevelopment [ ] Other [ ]

Page 1 of 2

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Cross-Superior Seven Mile Creek Landfill	3097	TB-72

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Method
Resart Longyear - M. Mueller	11/12/2002	11/12/2002	4 1/4" HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TB-72	873.6 Feet MSL	912.6 Feet MSL	8.0 Inches

Boring Location or Local Grid Origin (Check if estimated: [ ])
State Plane S/C/N
Lat ° ' "
Long ° ' "
NE 1/4 of SE 1/4 of Section 8, T 27 N, R 8 W
Local Grid Location (If applicable)
[X] N [X] E
3502.619 Feet [ ] S 1401.767 Feet [ ] W

Facility ID	County	County Code	Civil Town/City/or Village
618045450	Eau Claire	18	Town of Seymour

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD Comments
1 GS	24			Topsoil						M				Alluvium
			2	Dark gray brown fine sand with silt 10YR4/2	SM									
2 SS	24 22	3 5 6 11	4 6 8	Yellow brown fine sand with silt 10YR5/4	SM					M				Alluvium
3 SS	24 18	6 7 13 14	10 12	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					M				Alluvium
4 SS	24 19	7 8 10 12	14 16 18	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					M				Alluvium
45 SS	24 16	5 10 15 17	20 22 24	Pale brown fine sand, some silt 10YR6/3	SP-SM					M				Alluvium

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Frank Maenner Firm Ayres Associates

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completions of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMEN
Form 4400-122A Rev. 5-97

Boring Number TB-72 Use only as an attachment to Form 4400-122 Page 2 of 2

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	RQD	RQD Comments
6 SS	24 15	8 9 17 19	26 28	Light gray fine sand, some silt 10YR7/2	SP-SM					M				Alluvium
7 SS	24 18	10 13 16 19	30 32	Very pale brown fine sand, some silt 10YR7/3	SP-SM					M				Alluvium
8 SS	24 16	9 13 21 27	34 36 38	Light brown gray fine sand, some silt 10YR6/2	SP-SM					M				Alluvium
9 SS	24 11	5 7 8 9	40 42	Brown fine sand, some silt 10YR5/3	SP-SM					W				Alluvium
10 SS	24	2 3 8 12	44 46 48 50	Yellow brown fine sand, some silt 10YR5/4	SP-SM					W				Alluvium
11 SS	24 12	4 6 8 9	52	Light yellow brown fine sand, some silt, trace friable sandstone chips 10YR6/4						W				Residual

End of Boring at 53' (elevation = 859.6); Boring backfilled with 3/8" bentonite chips

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-92

Route To: Watershed/Wastewater [ ] Waste Management [X]
Remediation/Redevelopment [ ] Other [ ]

Page 1 of 2

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Onyx-Superior Seven Mile Creek Landfill	3097	TB-62

Boring Drilled By (Firm name and name of crew chief)	Date Drilling Started	Date Drilling Completed	Drilling Meth
Beart Longyear - M. Mueller	11/14/2002	11/14/2002	4 1/4" HS

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
		TB-62	876.4 Feet MSL	915.4 Feet MSL	8.0 Inches

Boring Location or Local Grid Origin (Check if estimated: [ ])
State Plane S/C/N
NW 1/4 of SE 1/4 of Section 8, T 27 N, R 8 W

Lat ° ' "
Long. ° ' "

Local Grid Location (If applicable)
2907.18 Feet [X] N [ ] S 1652.30 Feet [X] [ ]

Facility ID	County	County Code	Civil Town/City/or Village
61 804 5450	Eau Claire	18	Town of Seymour

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	RQD	RQD Comments
1 GS	24		2	Topsoil Dark yellow brown silt with fine sand 10YR4/4	SM					M				Alluvium
2 SS	24 20	6 8 11 10	4 6 8	Yellow brown silt with fine sand 10YR5/4	SM					M				Alluvium
3 SS	24 19	4 14 14 15	10 12	Yellow brown fine sand, some silt 10YR5/4	SP-SM					M				Alluvium
4 SS	24 18	5 19 23 23	14 16 18	Yellow brown fine sand, some silt 10YR5/8	SP-SM					M			5.0	Alluvium
5 SS	24 18	7 13 20 23	20 22 24	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					M				Alluvium

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Frank Mauermann

Firm Ayres Associates

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A Rev. 5-97

Boring Number TB-62 Use only as an attachment to Form 4400-122 Page 2 of 2

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	RQD	RCD Comments
6 SS	24 18	8 20 25 31	26 28	Light yellow brown fine sand, some silt 10YR6/4	SP-SM					M				Alluvium
7 SS	24 18	11 34 45 50/.2	30 32	Pale brown fine sand, some silt 10YR6/3	SP-SM					M				Alluvium
				Light gray friable weathered sandstone 10YR7/2										
8 SS	6 5	50/.4	34 36 38	Light gray friable weathered sandstone 10YR7/2						M				Residual
9 SS	12 8	45 50/.2	40 42	Light gray friable weathered sandstone 10YR7/2						W				Residual
10 SS	6 5	50/.4	44 46 48	Light gray friable weathered sandstone 10YR7/2						W				Residual
11 SS	6 4	50/.3	50 52	Light gray friable weathered sandstone 10YR7/2						W				Residual
12 SS	6 5	50/.4	54 56	Light brown gray friable weathered sandstone 10YR6/2						W				Residual
				End of Boring at 56' (elevation = 859.4); Boring backfilled with 3/8" bentonite chips										

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(p) Measures shall be proposed to prevent accidental discharges at the leachate loadout station from entering groundwater or surface water. Unless an alternate method is approved by the department, the leachate loading station shall be paved with a concrete or asphalt pad and sloped to a catch basin to direct all spills back into the leachate holding tank.

(q) All manholes and enclosed structures for leachate and gas control systems shall be designed to allow for proper venting and access control. For landfills designed with active gas recovery systems, these devices shall be designed to minimize air intrusion into the landfill.

(r) All control systems such as pumps, valves and meters shall be designed to be operated from the ground surface.

(s) All leachate and groundwater collection systems shall be designed to accurately monitor the volume of liquid removed by the system.

(t) A minimum one foot thick granular drainage blanket shall be placed on top of the geomembrane component of a composite liner and on top of the clay component of a clay liner. For composite lined landfills, if the drainage blanket contains gravel greater than 1/4 inch, then a nonwoven geotextile shall be installed below the drainage blanket. The geotextile shall have a minimum weight of 12 oz/yd^2 and shall be certified to be needle-free. The granular drainage blanket shall contain no more than 5% material by weight which passes the number 200 sieve.

(tm) Leachate collection blankets shall have a minimum hydraulic conductivity of 1 cm/sec for any site that accepts any amount of municipal solid waste and 1×10^{-2} cm/sec for landfills which do not accept municipal solid waste. The gradation of the granular drainage blanket and associated hydraulic conductivity shall be selected to maintain the maximum head in the drain within the drain thickness.

(u) All major horizontal clay lined phases above the saturated zone shall be designed with a collection basin lysimeter to monitor the unsaturated zone except for composite lined landfills.

(6) ADDITIONAL REQUIREMENTS FOR LANDFILLS WITH EXTENDED COLLECTION LINES. (a) Landfills shall meet the requirements of pars. (b) to (f) where they will accept municipal solid waste and contain leachate collection lines that exceed 1,200 feet from the end of each cleanout to the toe of the opposite slope. Where the requirements of this subsection differ from other requirements of this chapter, these requirements shall take precedence.

(b) The maximum length of leachate collection lines from the access point at one end to the toe of the opposite slope may not exceed 2,000 feet.

(c) The minimum slope on all leachate collection pipes and associated pipe trenches at the base of the landfill shall be designed and constructed to be 0.5% after accounting for primary and secondary settlement of the subgrade. The minimum design slope shall be selected following computation of 100% of the primary consolidation settlement and the secondary consolidation settlement of the compressible materials beneath the facility, which includes, as applicable, in-situ soil, added geologic material, structural fill material, and compacted clay liner. Secondary settlement shall be calculated using a 100-year time frame.

(d) Pipe bedding material shall be composed of coarse, uniform gravel with a hydraulic conductivity that is greater than or equal to the hydraulic conductivity of the leachate collection blanket specified in s. NR 504.06 (5) (tm), in addition to meeting the other requirements of s. NR 504.06 (5) (e).

(e) The maximum anticipated construction, operation and post-closure overburden loads over the leachate collection piping shall be calculated and utilized in selecting the pipe material and wall thickness, based on 6-inch pipe diameter and an appropriate in-field consolidated density.

(f) All components of the leachate collection system shall incorporate all of the following design features:

1. Sweep bends at all changes of alignment, using a minimum radius of 10 pipe diameters, consisting of prefabricated PVC sweep bends or smooth pipe bends or prefabricated sweep bends for HDPE or other pipe materials.

2. Pipe alignments that minimize horizontal and vertical alignment changes for the entire leachate collection pipe length.

3. Elimination or minimization of obstructions or artifacts of construction which impose drag on pipe cleaning jetter hose or nozzles.

(7) COMPOSITE-LINED LANDFILLS USING GCLs. Use of GCLs in construction of a composite liner may not be used except in landfills which do not accept municipal solid waste, unless the GCL is used as a pad for the upper surface of the 4 foot clay component of a composite liner for a municipal solid waste landfill. The GCL and soil barrier layer components of a barrier system shall meet all of the following requirements:

(a) The hydraulic performance of the GCL shall be assessed by the use of compatibility testing. The testing protocol shall be provided to the department for review and concurrence prior to the initiation of compatibility testing. The compatibility testing shall utilize percolation fluids that simulate the leachate that will be produced by the landfill.

(b) The GCL shall meet the specifications of s. NR 504.07 (4) (a) 1. to 11.

(c) The GCL shall be underlain by a soil barrier layer that is a minimum of 2 feet thick and that meets the specifications of s. NR 504.07 (4) (a) 12. to 17.

History: Cr. Register, January, 1988, No. 385, eff. 2-6-88; r. and recr., Register, June, 1995, No. 486, eff. 7-1-96; am. (5) (t) and (t), Register, August, 1997, No. 500; CR 04-077: cr. (5) (cm), (dm), (j) 4., 5., (tm) and (6), am. (5) (d), (e), and (t) Register November 2005 No. 599, eff. 12-1-05; CR 05-020: cr. (7) Register January 2006 No. 601, eff. 2-1-06; correction made under s. 13.93 (2m) (b) 1., Stats., Register January 2006 No. 601; CR 06-026: am. (5) (dm) and (e), Register December 2006 No. 612, eff. 1-1-07.

NR 504.07 Minimum design and construction criteria for final cover systems. (1) GENERAL. (a) All final cover systems shall be designed to minimize leachate generation by limiting the amount of percolation through the cap system, reduce landfill maintenance by stabilizing the final surface through design of compatible slopes and establishment of vegetation, account for differential settlement and other stresses on the capping layer, minimize the climatic effects of freeze-thaw and desiccation on the clay capping layer of the final cover system, and provide removal of leachate and venting of gas from those landfills which accept wastes with a high moisture content or which readily biodegrade.

(b) All new landfills and expansions of existing landfills shall be designed with a final cover system meeting the requirements in subs. (2) to (9) unless it is established to the satisfaction of the department that portions of the final cover system are not needed based on the proposed waste types and the proposed design. The geomembrane component in sub. (5) does not apply to landfills designed exclusively for the disposal of high volume industrial waste, or to other landfills which are not designed to accept municipal solid waste unless the landfill is composite lined.

(c) Any phases of an existing landfill which have been designed and constructed with a composite liner shall be designed and constructed with a final cover system meeting the requirements in subs. (2) to (9), except that the requirement for the geomembrane layer in sub. (5) does not apply to composite lined phases of existing landfills which have completed final cover placement by July 1, 1996.

(d) Landfills which accept papermill sludges or other industrial solid wastes with high water contents and low strength may propose alternate final cover systems if the strength of the waste

Table 5.6 Elastic Parameters of Various Soils

Type of soil	Modulus of elasticity, E_s MN/m²	Modulus of elasticity, E_s lb/in²	Poisson's ratio, μ_s
Loose sand	10.5–24.0	1500–3500	0.20–0.40
Medium dense sand	17.25–27.60	2500–4000	0.25–0.40
Dense sand	34.50–55.20	5000–8000	0.30–0.45
Silty sand	10.35–17.25	1500–2500	0.20–0.40
Sand and gravel	69.00–172.50	10,000–25,000	0.15–0.35
Soft clay	4.1–20.7	600–3000	
Medium clay	20.7–41.4	3000–6000	0.20–0.50
Stiff clay	41.4–96.6	6000–14,000	

istic assumptions have to be made. Table 5.6 shows the approximate ranges of the elastic parameters for various soils.

Several investigators have correlated the values of the modulus of elasticity, E_s, with the field standard penetration number, N_{60} and the cone penetration resistance, q_c. Mitchell and Gardner (1975) compiled a list of these correlations. Schmertmann (1970) indicated that the modulus of elasticity of sand may be given by

$$\frac{E_s}{p_a} = 8N_{60} \tag{5.55}$$

where N_{60} = standard penetration resistance (see Chapter 2)
p_a = atmospheric pressure ≈ 100 kN/m² ($\approx$2000 lb/ft²)

Similarly,

$$E_s = 2q_c \tag{5.56}$$

where q_c = static cone penetration resistance

Schmertmann and Hartman (1978) further suggested that the following correlations may be used with the strain influence factors described in Section 5.9:

$$E_s = 2.5q_c \quad \text{(for square and circular foundations)} \tag{5.57}$$

and

$$E_s = 3.5q_c \quad \text{(for strip foundations)} \tag{5.58}$$

[*Note:* Any consistent set of units may be used in Eqs. (5.56)–(5.58).]

The modulus of elasticity of normally consolidated clays may be estimated as

$$E_s = 250c_u \text{ to } 500c_u \tag{5.59}$$

and for overconsolidated clays as

$$E_s = 750c_u \text{ to } 1000c_u \tag{5.60}$$

where c_u = undrained cohesion of clay soil

Appendix T-3
Geotechnical and Stability Evaluation

APPENDIX T-3
GEOTECHNICAL AND STABILITY EVALUATION

The geotechnical and stability evaluation for the proposed Sector 2 Northeast Expansion has been performed in accordance with Wisconsin Department of Natural Resources Chapter NR 514.07 (1)(b) and (8)(b). Settlement calculations were prepared for the proposed expansion and included in Appendix T-2. This evaluation pertains to the geotechnical and stability evaluation of the foundation, liner system and final cover of the proposed expansion. The NR 514.07 (1)(b) regulation requires, "a safety factor of at least 1.3 is used to assess stability."

No changes have been made to the design of the foundation, liner system or final cap components included in the 2015 Plan of Operation for the Sector 2 Vertical Expansion, therefore the stability analyses for the new proposed Sector 2 Northeast Expansion only address the stability of the foundation and liner system of the expansion area. The previous final cap stability analysis is applicable for this proposed northeast expansion and can be found in Sections 1.5 and 1.6 of Appendix F.3 of this Appendix T-3a.

The structural integrity of the site foundation and liner system are discussed in Sections 1.1 – 1.3 while the slope stability of the subbase and liner system are discussed in Section 1.4. Specifications for design of materials are discussed in Section 1.5.

1.1 Structural Integrity of the Site

The existing site for the proposed expansion is physically stable based upon investigations summarized in Section 7.1.9.

No man-made sub-surface features, such as underground mines, sinkholes, unstable areas, etc. exist within the existing site area, nor does research into existing records show the presence of such features.

The site is not located in a seismic zone per Section 7.1.7

1.2 Structural Integrity of the Foundation

The foundation of the landfill below the expansion area consists of approximately ten to thirty feet of sandy in-situ soil above weathered bedrock. The excavation of future cells will remove much of the soil and all the way to bedrock in some locations. Above the in-situ

soil, a prepared subgrade surface and liner system is constructed and certified in accordance with the Construction Quality Assurance Plan (CQA Plan).

The perimeter berm is constructed using structural fill soil in accordance with the placement specifications listed in the CQA Plan. These specifications include requirements for maximum lift thickness, minimum compaction density and testing to assure the required density has been achieved.

1.3 Structural Integrity of the Liner Components and Liner System

The liner components consist of the following from top to bottom:

- 12-inches of Granular Drainage Layer
- 12 oz/sy Nonwoven Geotextile
- 60 mil HDPE Geomembrane (smooth on floor of Phases 1 through 10; textured elsewhere)
- 4-foot of Clay Soil Liner

Specifications for these materials have been developed and are included in the CQA Plan to promote the structural integrity of these components and the liner system. The specifications include material properties, shear strength testing, construction requirements and testing. Construction quality assurance procedures and testing, which are utilized to evaluate whether materials meet the required specifications and are constructed to the appropriate requirements, are included in the CQA Plan which shall be included the Plan of Operations.

1.4 Slope Stability Analyses

The following slope stability analyses were conducted as part of this evaluation.

- Foundation
- Liner System

The foundation slope stability was evaluated as a global cross section condition considering failure occurring through the perimeter berm, subbase soil and waste. The foundation stability analyses were performed by comparing existing geologic sections, existing surface, and proposed subgrade plan to determine the extent of soil. Below the proposed subgrade,

the soil thickness is zero to 10 feet. In much of the area, the subgrade lies on or within weathered bedrock.

1.5.1 Selection of Cross Sections for Slope Stability Evaluation

The most critical cross section locations for the proposed expansion were selected for slope stability evaluation. Two cross section locations were selected at the locations shown in Figure T-1, one North-South cross section, and one East-West cross section. The East-West cross section was evaluated for final build-out conditions and an interim build-out condition as described below.

North-South cross section # 1 located at E 1645220 was selected as the critical cross section for the liner system under final build-out conditions due to the small perimeter berm combined with a liner slope in the direction of potential liner failure.

East-West cross section #2 located at N 367720 was selected as the critical cross section for the foundation and liner system under final build-out conditions and for interim conditions. This location is where the maximum interim 3:1 waste slope height will potentially be located in the event that only the west side of the expansion (Phase 14A) is constructed and filled.

1.5.2 Material Properties

The material properties used for the slope stability analyses of the Sector 2 Northeast Expansion were the same as used for the Stability Analysis in the 2015 Plan of Operation for the Sector 2 Vertical Expansion. The properties are described in the following narrative and additional documentation is provided in the 2015 stability analysis in Appendix T-3a. In the following paragraphs, when describing the shear strength of materials, the letter "c" refers to cohesive strength and ϕ refers to the friction angle.

1. Waste unit weight – a unit weight of 90 lb/ft^3 was used based on typical waste density for the facility.

2. Waste strength – the waste strength developed by Eid in Municipal Solid Waste Slope Failure: Waste and Foundation Soil Properties, ASCE Journal of Geotechnical and Geoenvironmental Engineering (2000) was used with a c = 300 psf, ϕ = 33°. An interim waste slope of 3:1 up to the proposed vertical expansion top of waste grades was assumed for the interim slope stability analyses. Other slope stability analyses were evaluated for the proposed final grades.

3. Perimeter berm unit weight – a soil unit weight of 125 lb/ft^3 based on the typical density of compacted soil.

4. The insitu soil was assumed to have a unit weight of 125 lb/ft3 and a conservative shear strength of c = 0 psf, $\phi = 30^o$ based on suggested values for loose clayey sand with blow counts in the range of 10 per Table 5.3 of Soil Strength and Slope Stability, J. Michael Duncan and Stephen G. Wright, 2005 (see Appendix T-3a).

5. Liner strength final conditions - a liner shear strength of c = 0 psf, $\phi = 11^o$ was assumed for the nonwoven geotextile / smooth 60 mil HDPE geomembrane interface, which is the most critical interface of the existing Phase 3 liner components, based on review of the Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces GRI Report #30, by George R. Koerner and Dhani Narejo, dated June 2005 (see Appendix T-3a).

6. Liner strength interim conditions – the existing Phase 12A was tested and found to have a shear strength of c = 74 psf, $\phi = 17.9^o$ for the textured geomembrane / geotextile interface, the weakest interface (see Appendix T-3a). The shear strength assumed for the unconstructed liner system in Phase 14 was conservatively assumed to be c = 0 psf, $\phi = 12.6^o$. This value was determined to be the minimum shear strength required to obtain a factor of safety of 1.30 by trial and error. A friction angle of 12.5 degrees will be required in Phase 14A prior to waste acceptance in Phase 14B.

1.5.3 Procedures for Slope Stability Analyses

The stability analyses of the berm, global foundation and liner system were performed using SLOPEW analysis software version 8.11.1.7283 of GeoStudio 2012 developed by GEO-SLOPE International Ltd. Analyses involving the perimeter berm and global stability were analyzed as a circular failure while analyses involving the liner system were analyzed as a block failure analysis with the failure occurring through the liner system. The failure analysis was performed using Spencer's method with optimization and searches for the critical failure surface using both entrance and exit line segments or block segments through which the failure can begin. For each analysis, many potential failure surface iterations were evaluated. The search segments were varied to ensure they extend beyond the critical surface which in turn assures that the most critical failure surface with the

lowest factor of safety for each analysis is evaluated. The foundation analyses were run for both block and circular failures to identify the most critical scenario. The liner analyses were analyzed using the entry exit method which resulted in a critical block failure surface as expected due to the low shear strength of the liner interface. This was followed by a specified block matching this surface and allowing the program to optimize the surface to determine the surface with the lowest factor of safety.

1.5.4 Results of Slope Stability Analyses

Results of the slope stability analyses are summarized in Table 1 including the type of analysis, failure surface, shear strength considered, and calculated factor of safety. All slope stability results meet the minimum required factors of safety. Outputs for the foundation and liner system stability analyses are provided in Appendix T-3b. Outputs for the final cover system are included in the Stability Analysis in the 2015 Plan of Operation for the Sector 2 Vertical Expansion report included in Appendix T-3a.

Table 1 – Results of the Slope Stability Analyses

Analysis #	Cross Section	Description	Peak Shear Strength	Computed Factor of Safety
1	1	North – South Section Foundation Analysis	c = 0 psf, $\phi = 30^o$	2.69
2	1	North -South Section Liner Failure with 4:1 Final Slope	c = 0 psf, $\phi = 11^o$	1.56
3	2	East-West Section Foundation Analysis Failure	c = 0 psf, $\phi = 30^o$	>8
4	2	East-West Section Liner Failure with 4:1 Final Slope	c = 0 psf, $\phi = 11^o$	1.55
5	2	East-West Section Liner Failure with 3:1 Interim Slope*	c = 0 psf, $\phi = 12.6^o$	1.30

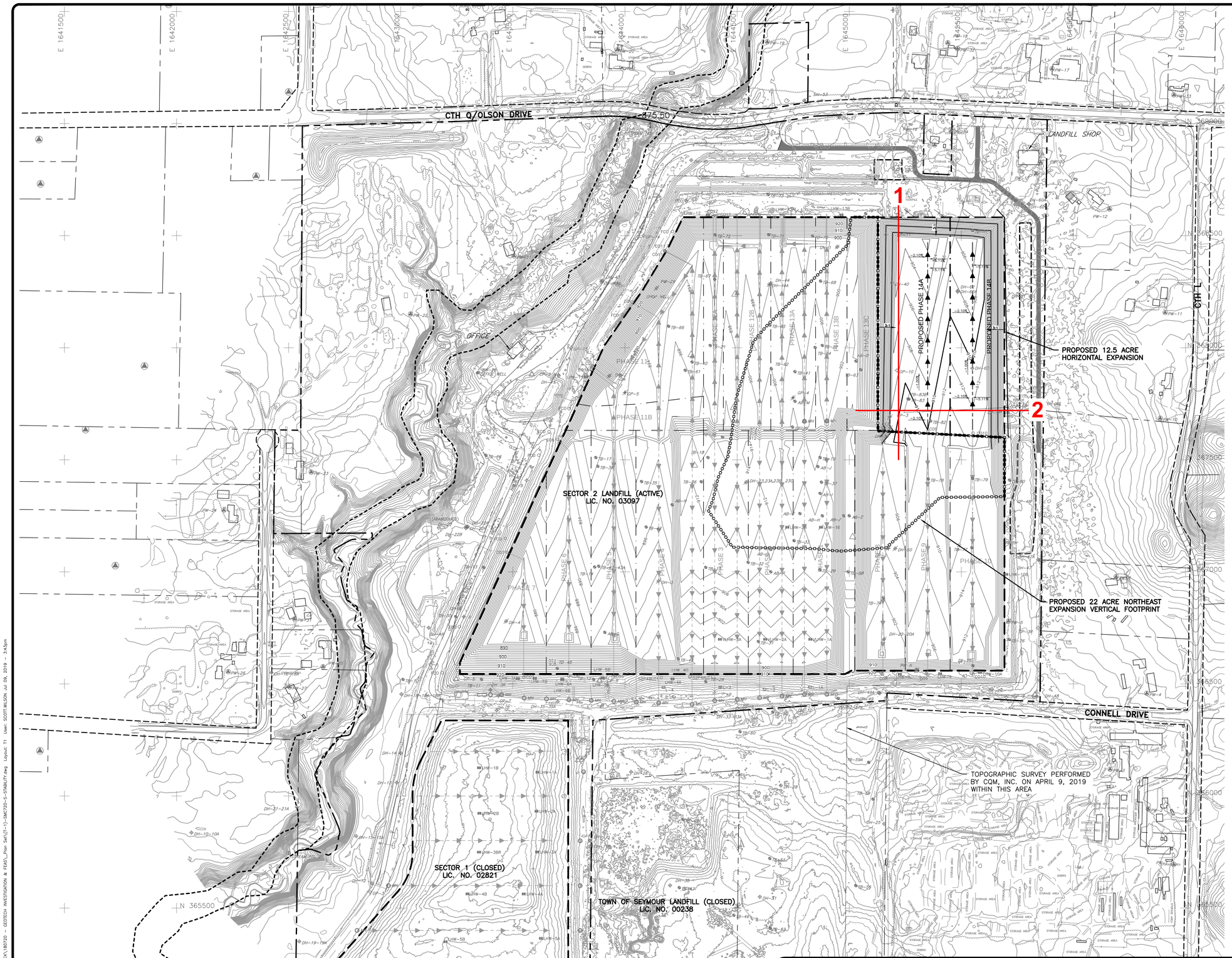
*A liner interface friction angle of 12.6 degrees will be required if Phase 14A is filled before moving into Phase 14B.

Note: Test value results of shear strength for final cover (c & ϕ), shall be equivalent to the shear strength values listed in the table according to the formula $t = c + N \tan(\phi)$ where N = the effective load for the failure section.

1.6 Material Specifications

The shear strength values in Table 1 shall be incorporated in the shear strength testing requirements section of the CQA Plan during Plan of Operations. Liner interfaces should be tested at normal loads 5,000 psf, 10,000 psf and 15,000 psf while final cover interfaces should be tested at normal loads of 150 psf, 300 psf and 500 psf. In the event the shear strength test values are below the values used in Table 1, additional slope stability analyses can be performed to show the minimum required factors of safety will be achieved.

FIGURE T-1
CROSS SECTION LOCATIONS FOR SLOPE STABILITY ANALYSES



LEGEND

- PROPERTY BOUNDARY
- ROAD RIGHT-OF-WAY
- PERMITTED SOLID WASTE BOUNDARY
- PHASE BOUNDARY
- APPROXIMATE 100-YEAR FLOODPLAIN DELINEATION
- EXISTING EDGE OF WOODS/SHRUBS
- 1030 PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- PROPOSED LEACHATE COLLECTION PIPELINE
- 1030 APPROVED 10' CONTOUR
- APPROVED 2' CONTOUR
- 1000 EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- EXISTING LEACHATE COLLECTION PIPELINE
- DH-33 EXISTING GROUNDWATER MONITORING WELL
- PW-8 EXISTING PRIVATE WELL
- GP-13 EXISTING GAS PROBE
- CO12 EXISTING LEACHATE CLEANOUT
- LHW-11 EXISTING LEACHATE HEADWELL
- B-68 SOIL BORING LOCATION
- MH EXISTING MANHOLE
- DH-44 ABANDONED MONITORING WELL
- PW-5 ABANDONED PRIVATE WELL
- GP-3 ABANDONED GAS PROBE
- LHW-2B ABANDONED LEACHATE HEADWELL
- PROPOSED NORTHEAST EXPANSION HORIZONTAL FOOTPRINT
- PROPOSED NORTHEAST EXPANSION VERTICAL FOOTPRINT
- PROPOSED STORM WATER BASIN
- PROPOSED ROAD
- SLOPE STABILITY CROSS SECTION LOCATION

NOTES:

1. DRONE SURVEY PERFORMED BY CQM ON APRIL 9, 2019 WITHIN AREA SHOWN ON MAP AND SUPPLEMENTED BY TOPOGRAPHIC SURVEY PERFORMED BY SRMC ON APRIL 6, 2017.
2. PROPERTY BOUNDARIES AND ROAD RIGHT-OF-WAYS ARE FROM DRAWINGS CREATED BY AYRES ASSOCIATES WITH SUPPLEMENTAL DATA FROM EAU CLAIRE COUNTY'S GIS DEPARTMENT. CTH Q/OLSON ROAD OVER SEVEN MILE CREEK WAS REDESIGNED AND REBUILT IN LATE 2018. THE ROAD WAS STRAIGHTENED AND RAISED. UPDATES TO THE ROAD CONFIGURATION ON DRAWINGS WILL BE PROVIDED ONCE ADDITIONAL SURVEY INFORMATION AND/OR AERIAL PHOTOGRAPHY IS PROVIDED.
3. BASE GRADES IN THE EXISTING SECTOR 2 LANDFILL FOOTPRINT ARE FROM AYRES AND ASSOCIATES SECTOR 2-PLAN OF OPERATION-PLAN MODIFICATION (AUGUST 2011) AND SECTOR 2 -HORIZONTAL & VERTICAL EXPANSION (OCTOBER 2004).
4. THIS FIGURE CREATED FROM SHEET 27 OF THE 2019 FEASIBILITY REPORT.

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REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 7/9/2019
DRAWN BY SSW/SRC
DESIGNED BY SSW
CHECKED BY DH
APPROVED BY DR

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ADVANCED DISPOSAL
SEVEN MILE CREEK LANDFILL
EAU CLAIRE, WISCONSIN
FEASIBILITY REPORT
SECTOR 2-NORTHEAST EXPANSION
CROSS SECTION LOCATIONS FOR SLOPE STABILITY ANALYSIS

SHEET NO.
T-1
PROJECT NO.
180720

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APPENDIX T-3A
SLOPE STABILITY ANALYSIS FROM THE 2015 PLAN OF OPERATION FOR THE SECTOR 2 VERTICAL EXPANSION

APPENDIX F
GEOTECHNICAL AND STABILITY EVALUATION

The geotechnical and stability evaluation for the proposed vertical expansion has been performed in accordance with Wisconsin Department of Natural Resources Chapter NR 514.07 (1)(b) and (8)(b). Settlement calculations were prepared for the proposed vertical expansion and submitted previously in the Appendix Q of 2014 Feasibility Report for the Sector 2 Expansion, dated October 2014. This evaluation pertains to the geotechnical and stability evaluation of the foundation, liner system and final cover of the proposed vertical expansion. The NR 514.07 (1)(b) regulation requires, "a safety factor of at least 1.3 is used to assess stability."

The structural integrity of the site foundation, liner system and final cap components are discussed in Sections 1.1 – 1.4. Slope stability of the subbase, liner system and final cover system are discussed in Section 1.5. Specifications for design of materials are discussed in Section 1.6.

1.1 Structural Integrity of the Site

The existing site for the proposed vertical expansion is physically stable based upon investigations summarized in Sections 5.2.1 and 5.2.3 of the 2014 Feasibility Report for the Sector 2 Expansion.

No man-made sub-surface features, such as underground mines, sinkholes, unstable areas, etc. exist within the existing site area, nor does research into existing records show the presence of such features.

The site is not located in a seismic zone per Section 5.2.1.8 of the October 2014 Feasibility Report and correspondence from the Wisconsin Geological and Natural History in Appendix B of the same report.

1.2 Structural Integrity of the Foundation

The foundation of the landfill below the vertical expansion area consists of approximately ten to thirty feet of sandy insitu soil. Above the insitu soil, a prepared subgrade surface and liner system was constructed and certified in accordance with the Construction Quality Control Plan (CQA Plan).

The perimeter berm is constructed using structural fill soil in accordance with the placement specifications listed in the CQA Plan. These specifications include requirements for maximum lift thickness, minimum compaction density and testing to assure the required density has been achieved.

1.3 Structural Integrity of the Liner Components and Liner System

The liner components consist of the following from top to bottom:

- 12″ or 18″ of Granular Drainage Layer
- 8 oz/sy or 12 oz/sy Nonwoven Geotextile
- 60 mil HDPE Geomembrane (smooth on floor of Phases 1 through 10; textured elsewhere)
- 4-foot or 5-foot Clay Soil Liner

Specifications for these materials have been developed and are included in the CQA Plan to assure the structural integrity of these components and the liner system. The specifications include material properties, shear strength testing, construction requirements and testing. The CQA Plan in Appendix D includes construction quality assurance procedures and testing to assure that the materials meet the required specifications and are constructed to the appropriate requirements.

1.4 Structural Integrity of the Final Cap Components and Final Cap System

The proposed final cap components consist of the following from top to bottom:

- 6″ Vegetative Soil Layer
- 30-inch Protective Soil Layer
- Double-sided Geocomposite
- 40 mil Textured LLDPE Geomembrane
- 24-inch Barrier Soil
- 6″ Soil Grading Layer

Specifications for these materials have been developed and are included in the CQA Plan to assure the structural integrity of these components and the final cap system. The specifications include material properties, shear strength testing, construction requirements and testing. The CQA Plan in Appendix D includes construction quality assurance procedures and testing to assure that the materials meet the required specifications and are constructed to the appropriate requirement.

1.5 Slope Stability Analyses

The following slope stability analyses were conducted as part of this evaluation.

- Foundation
- Liner System
- Final Cover System

The foundation slope stability was evaluated as a global cross section condition considering failure occurring through the perimeter berm, subbase soil and waste.

Analyses of the perimeter berm only were found to be more critical than global analyses through waste and the foundation; therefore the perimeter berm was also analyzed.

1.5.1 Selection of Cross Sections for Slope Stability Evaluation

The most critical cross section locations of the proposed expansion were selected for slope stability evaluation. Three cross sections were selected at locations shown in Figure 1.

Cross section #1 located at E 1,644,400 was selected at the most critical location for the foundation stability for final conditions where the insitu foundation soil is thickest based on a review of the geologic cross sections, weathered bedrock elevations and soil borings contained in the 2014 Feasibility Report for the Sector 2 Vertical Expansion. The boring logs revealed that the insitu soils consist of predominantly sandy material having SP and SM USCS classifications with blow counts typically in the range of 10 to 20 per foot with a very occasional noncontinuous layer in the range of 8 to 9. A few, very thin, scattered silt lenses were also encountered however these would have no impact on slope stability. No area with soft soil of concern was encountered based on review of the soil borings. Therefore, the critical cross section was selected where the insitu soil thickness is the greatest below the soil liner subbase and perpendicular to the proposed final grades, which results in the greatest driving force for the stability analysis. The bottom of insitu soil / top of weathered

bedrock was input at elevation ranging from 832.5 on the south side to elevation 875 on the north side based on the information from geologic cross sections C-C′ and K-K′ (Sheet No. 7) and top of weathered bedrock encountered at borings DH-33 (el 832.5) and TB-32, TB-29, TB-47, TB-48. The weathered bedrock assumed for the stability cross section is conservative in terms of depth and sketched on section C-C′ provided in Appendix F.1.

Cross section #2 located at N 367,750 was selected as the critical cross section for the foundation and liner system under interim conditions. This location is where the maximum interim 3:1 waste slope height will potentially be located.

Cross section # 1 located at E 1,644,400 was selected as the critical cross section for the liner system under final build-out conditions due to the small perimeter berm combined with a liner slope in the direction of potential liner failure.

The final cap was analyzed as an infinite slope.

1.5.2 Material Properties

The following material properties were used for the slope stability analyses:

1. Waste unit weight – a unit weight of 90 lb/ft^3 was used based on typical waste density for the facility.

2. Waste strength – the waste strength developed by Eid in Municipal Solid Waste Slope Failure: Waste and Foundation Soil Properties, ASCE Journal of Geotechnical and Geoenvironmental Engineering (2000) was used with a c = 300 psf, $\phi = 33^o$. An interim waste slope of 3:1 up to the proposed vertical expansion top of waste grades was assumed for the interim slope stability analyses. Other slope stability analyses were evaluated for the proposed final grades.

3. Perimeter berm unit weight – a soil unit weight of 125 lb/ft^3 based on the typical density of compacted soil.

4. The insitu soil was assumed to have a unit weight of 125 lb/ft3 and a conservative shear strength of c = 0 psf, $\phi = 30^o$ based on suggested values for loose clayey sand with blow counts in the range of 10 per Table 5.3 of Soil Strength and Slope Stability, J. Michael Duncan and Stephen G. Wright, 2005 (see Appendix F.1).

5. Liner strength final conditions - a liner shear strength of c = 0 psf, $\phi = 11^o$ was assumed for the nonwoven geotextile / smooth 60 mil HDPE geomembrane interface, which is the most critical interface of the existing Phase 3 liner components, based on review of the Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces GRI Report #30, by George R. Koerner and Dhani Narejo, dated June 2005 (see Appendix F.1).

6. Liner strength interim conditions – the existing phase 12A was tested and found to have a shear strength of c = 74 psf, $\phi = 17.9^o$ for the textured geomembrane / geotextile interface, the weakest interface (see Appendix F.1). The shear strength assumed for the unconstructed liner system in Phase 13 was conservatively assumed to be c = 0 psf, $\phi = 7.2^o$ which was found to be the minimum shear strength required to obtain a factor of safety of 1.3 by trial and error.

7. Since the protective cover source is not currently known, no shear strength can be assumed; therefore all final cap analyses were backsolved to determine the required shear strength to satisfy the minimum required factor of safety.

1.5.3 Procedures for Slope Stability Analyses

The stability analyses of the berm, global foundation and liner system were performed using SLOPEW analysis software version 8.11.1.7283 of GeoStudio 2012 developed by GEO-SLOPE International Ltd. Analyses involving the perimeter berm and global stability were analyzed as a circular failure while analyses involving the liner system were analyzed as a block failure analysis with the failure occurring through the liner system. The failure analysis was performed using Spencer's method with optimization and searches for the critical failure surface using both entrance and exit line segments or block segments through which the failure can begin. For each analysis 1,000 potential failure surface iterations were evaluated. The search segments were varied to ensure they extend beyond the critical surface which in turn assures that the most critical failure surface with the lowest factor of safety for each analysis is evaluated. The foundation analyses for Section 1 were run for both block and circular failures to identify the most critical scenario. The liner analysis for Section 2 was analyzed using the entry exit method which resulted in a critical block failure surface as expected due to the low shear strength of the liner interface.

The final cover system slope stability analysis was performed according to the infinite slope method to determine the required shear strength to achieve a factor of safety of 1.30 for the

4H:1V final slopes. The following analyses were conducted due to the potential variation in moisture condition (liquid head) for the final cap.

1. Stability analysis of interfaces below the final cap geomembrane with no head
2. Stability analysis of the cover soil / geocomposite interface above the final cap geomembrane with a head equal to the geocomposite
3. Stability analysis of the cover soil / geocomposite interface above the final cap geomembrane with the cover soil fully saturated

The degree of saturation of the cover soil shall be determined based on the permeability of the cover soil and capacity of the geocomposite at the time of construction to determine if the required computed shear strength is required to satisfy final cover stability analysis no. 2 or no. 3 in Appendix F3. If the geocomposite capacity is adequate to transmit the percolation through the final cap cover soil, final cover stability analysis no. 2 would govern and if not, final cover stability analysis no. 3 would govern. Calculations for the geocomposite capacity are included in Appendix F3 for the longest final slope segment to a location where the geocomposite outlets. The calculations show that for a 200 mil geocomposite and maximum slope length of 224 feet, the maximum final cover soil permeability would be 3.23×10^{-5} cm/sec assuming a factor of safety of 1.5 and reduction factors totaling 2.4. In the event that the results of the final cover shear strength testing do not meet final cover analysis no. 3 and the final cover permeability exceeds 3.23×10^{-5} cm/sec, the geocomposite design can be modified by reducing the flow length to the outlet, using a geocomposite with a greater transmissivity or a combination of these alternatives.

Calculations for the 2014 cap construction and interface shear test results are also included in Appendix F.3 to demonstrate that the final cover design and construction materials were adequate to achieve a slope stability factor of safety of 1.4 under fully saturated conditions.

1.5.4 Results of Slope Stability Analyses

Results of the slope stability analyses are summarized in Table 1 including the type of analysis, failure surface, shear strength considered, and calculated factor of safety. All slope stability results meet the minimum required factors of safety. Outputs for the foundation and liner system stability analyses are provided in Appendix F.2.

Results for the final cover infinite slope stability analysis are included in Appendix F.3. The results of these analyses show the shear strength of the final cap interfaces required to meet the minimum factors of safety.

Table 1 – Results of the Slope Stability Analyses

Analysis #	Cross Section	Description	Peak Shear Strength	Computed Factor of Safety
1	1	Foundation Analysis with Circular Failure	c = 0 psf, $\phi = 30^o$	3.361
2	1	Foundation Analysis with Block Failure	c = 0 psf, $\phi = 30^o$	3.143
3	2	Liner Failure with 3:1 Interim Waste Slope	c = 0 psf, $\phi = 7.2^o$	1.313
4	1	Liner Failure with 4:1 Final Slope	c = 0 psf, $\phi = 7.2^o$	1.650
Final Cover #1	Infinite Slope	Below Cap Geomembrane with No Saturation	c = 0 psf, $\phi = 18.0^o$	1.30
Final Cover #2	Infinite Slope	Above Cap Geomembrane with Head = Geocomposite	c = 0 psf, $\phi = 18.1^o$	1.30
Final Cover #3	Infinite Slope	Above Cap Geomembrane Fully Saturated Cover Soil	c = 0 psf, $\phi = 32.2^o$	1.30

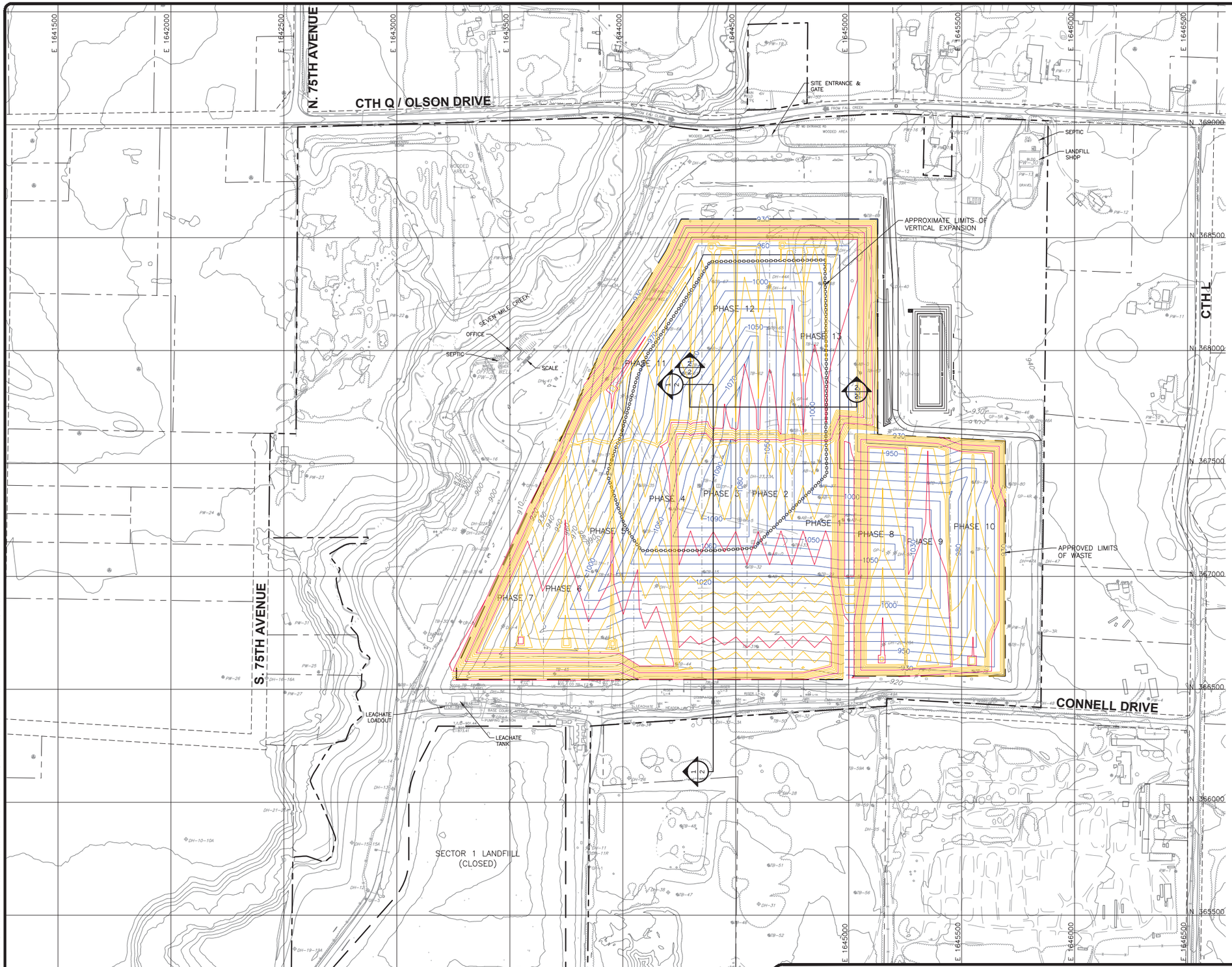
Note: Test value results of shear strength for final cover (c & ϕ), shall be equivalent to the shear strength values listed in the table according to the formula $t = c + N \tan(\phi)$ where N = the effective load listed in the calculations (325 psf, 324 psf and 169 psf for final cover analyses 1, 2 and 3 respectively).

1.6 Material Specifications

Shear strength testing requirements have been incorporated in the Construction Quality Assurance Plan in Appendix D to assure materials used for construction will meet the assumed shear strength values in Table 1 used for the slope stability analyses to achieve the minimum required factors of safety. Liner interfaces should be tested at normal loads 5,000 psf, 10,000 psf and 15,000 psf while final cover interfaces should be tested at normal loads of

150 psf, 300 psf and 500 psf. In the event the shear strength test values are below the values used in Table 1, additional slope stability analyses can be performed to show the minimum required factors of safety will be achieved.

FIGURE 1
CROSS SECTION LOCATIONS FOR SLOPE STABILITY ANALYSES



N

0 200 400

SCALE IN FEET

LEGEND

- PROPERTY BOUNDARY
- ROAD RIGHT-OF-WAY
- APPROXIMATE LIMITS OF VERTICAL EXPANSION
- PERMITTED SOLID WASTE BOUNDARY
- PHASE BOUNDARY
- 1030 EXISTING 10' CONTOUR
- 1030 FINISHED GRADE 10' CONTOUR
- 1030 TOP OF LINER 10' CONTOUR
- TOP OF LINER 2' CONTOUR
- EXISTING FENCE
- GP-4R EXISTING GAS PROBE
- DH-4R EXISTING WATER TABLE WELL
- DH-33-33A EXISTING WATER TABLE (DH-33) & PIEZOMETER (DH-33A)
- TB-16 EXISTING SOIL BORING LOCATION
- TP-4 EXISTING TEST PIT
- PW-1 EXISTING PRIVATE WELL (WITH NUMBER)
- EXISTING PRIVATE WELL (UN-NUMBERED)
- GP-11 PROPOSED GAS PROBE
- DH-4R ABANDONED WATER TABLE WELL
- PW-6 ABANDONED PRIVATE WELL
- GP-2 ABANDONED GAS PROBE

NOTES

1. AERIAL TOPOGRAPHIC SURVEY PERFORMED BY SRMC ON APRIL 2, 2015.
2. PROPERTY BOUNDARIES ARE FROM AYRES ASSOCIATES AND EAU CLAIRE COUNTY GIS DEPARTMENT.
3. BASE GRADES ARE FROM:
   - 3.1. PHASE 11-12A, 13 AND NORTH PORTIONS OF PHASES 1-9 BASE FROM PLAN OF OPERATIONS-PLAN MODIFICATION BY AYERS ASSOCIATES (AUGUST 2011).
   - 3.2. PHASE 12B BASE FROM RECORD DRAWINGS FOR PHASE 12B LINER BY CQM (DECEMBER 2014).
   - 3.3. PHASE 10 FROM CQM DOCUMENTATION FILE A-4 (OCTOBER 2008).
   - 3.4. SOUTH PORTION OF PHASES 1-9 FROM AYRES ASSOCIATES RECORD DRAWINGS IN PDF FORMAT.
4. THE CONTOURS WITHIN THE SECTOR 2 SOLID WASTE BOUNDARY REPRESENT THE TOP OF THE APPROVED CLAY LINER.

File: X:\PROJECTS\SEVEN MILE CREEK\2015 Projects\150652 - Plan of Operation (also see 140727)\MASAC STABILITY FIG.dwg Layout: 01 SLOPE STABILITY X-SECTIONS User: hlenz,dechoge Aug 31, 2015 - 3:58pm

1" 1/2" 0" 1"

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 09/02/15 | DRAWN BY TAD | DESIGNED BY JGW | CHECKED BY JCO | APPROVED BY MT

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ADVANCED DISPOSAL SERVICES
SEVEN MILE CREEK LANDFILL
EAU CLAIRE, WISCONSIN

PLAN OF OPERATION
SECTOR 2-VERTICAL EXPANSION
SLOPE STABILITY CROSS SECTION LOCATIONS

FIGURE **1**

PROJECT NO. 150652

APPENDIX F.1
MATERIAL PROPERTIES USED FOR SLOPE STABILITY ANALYSES

Table 5.3 Relationship Among Relative Density, SPT Blow Count, and Angle of Internal Friction for Clean Sands

State of packing	Relative density, D_r (%)	SPT blow count, N^a (blows/ft)	Angle of internal friction ϕ'^b (deg)
Very loose	< 20	< 4	< 30
Loose	20–40	4–10	30–35
Compact	40–60	10–30	35–40
Dense	60–80	30–50	40–45
Very dense	> 80	> 50	> 45

Source: Meyerhof (1956).

[a]$N = 15 + (N' - 15)/2$ for $N' > 15$ in saturated very fine or silty sand, where N is the blow count corrected for dynamic pore pressure effects during the SPT, and N' is the measured blow count.

[b]Reduce ϕ' by 5° for clayey sand; increase ϕ' by 5° for gravelly sand.

Appendix Table 1. Summary of interface shear strengths.

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
HDPE-S	Granular Soil	1a	21	0	162	0.93	1b	17	0	128	0.92
HDPE-S	Cohesive Soil										
	Saturated	1c	11	7	79	0.94	1d	11	0	59	0.95
	Unsaturated	1c	22	0	44	0.93	1d	18	0	32	0.93
HDPE-S	NW-NP GT	1e	11	0	149	0.93	1f	9	0	82	0.96
HDPE-S	Geonet	1g	11	0	196	0.90	1h	9	0	118	0.93
HDPE-S	Geocomposite	1i	15	0	36	0.97	1j	12	0	30	0.93
HDPE-T	Granular Soil	2a	34	0	251	0.98	2b	31	0	239	0.96
HDPE-T	Cohesive Soil										
	Saturated	2c	18	10	167	0.93	2d	16	0	150	0.90
	Unsaturated	2c	19	23	62	0.91	2d	22	0	35	0.93
HDPE-T	NW-NP GT	2e	25	8	254	0.96	2f	17	0	217	0.95
HDPE-T	Geonet	2g	13	0	31	0.99	2h	10	0	27	0.99
HDPE-T	Geocomposite	2i	26	0	168	0.95	2j	15	0	164	0.94
LLDPE-S	Granular Soil	3a	27	0	6	1.00	3b	24	0	9	1.00
LLDPE-S	Cohesive Soil	3c	11	12.4	12	0.94	3d	12	3.7	9	0.93
LLDPE-S	NW-NP GT	3e	10	0	23	0.63	3f	9	0	23	0.49
LLDPE-S	Geonet	3g	11	0	9	0.99	3h	10	0	9	1.00
LLDPE-T	Granular Soil	4a	26	7.7	12	0.95	4b	25	5.2	12	0.95
LLDPE-T	Cohesive Soil	4c	21	5.8	12	1.00	4d	13	7.0	9	0.98
LLDPE-T	NW-NP GT	4e	26	8.1	9	1.00	4f	17	9.5	9	0.96
LLDPE-T	Geonet	4g	15	3.6	6	0.97	4h	11	0	6	0.98
PVC-S	Granular Soil	5a	26	0.4	6	0.99	5b	19	0	6	0.99
PVC-S	Cohesive Soil	5c	22	0.9	11	0.88	5d	15	0	9	0.95
PVC-S	NW-NP GT	5e	20	0	89	0.91	5f	16	0	83	0.74
PVC-S	NW-HB GT	5g	18	0	3	1.00	5h	12	0.1	3	1.00
PVC-S	Woven GT	5i	17	0	6	0.54	5j	7	0	6	0.93
PVC-S	Geonet	5k	18	0.1	3	1.00	5l	16	0.6	3	1.00

Undrained strengths of compacted clays. Values of c and ϕ (total stress shear strength parameters) for the as-compacted condition can be determined by performing UU triaxial tests on specimens at their compaction water contents. Undrained strength envelopes for compacted, partially saturated clays tested are curved, as discussed in Chapter 3. Over a given range of stresses, however, a curved strength envelope can be approximated by a straight line and can be characterized in terms of c and ϕ. When this is done, it is especially important that the range of pressures used in the tests correspond to the range of pressures in the field conditions being evaluated. Alternatively, if the computer program used accommodates nonlinear strength envelopes, the strength test data can be represented directly.

Values of total stress c and ϕ for compacted clays vary with compaction water content and density. An example is shown in Figure 5.20 for compacted Pittsburgh sandy clay. The range of confining pressures used in these tests was 1.0 to 6.0 tons/ft^2. The value of c, the total stress cohesion intercept from UU tests, increases with dry density but is not much affected by compaction water content. The value of ϕ, the total stress friction angle, decreases as compaction water content increases, but is not so strongly affected by dry density.

If compacted clays are allowed to age prior to testing, they become stronger, apparently due to thixotropic effects. Therefore, undrained strengths measured using freshly compacted laboratory test specimens provide a conservative estimate of the strength of the fill a few weeks or months after compaction.

MUNICIPAL SOLID WASTE

Waste materials have strengths comparable to the strengths of soils. Strengths of waste materials vary depending on the amounts of soil and sludge in the waste, as compared to the amounts of plastic and other materials that tend to interlock and provide tensile strength (Eid et al., 2000). Larger amounts of materials that interlock increase the strength of the waste. Although solid waste tends to decompose or degrade with time, Kavazanjian (2001) indicates that the strength after degradation is similar to the strength before degradation.

Kavazanjian et al. (1995) used laboratory test data and back analysis of stable slopes to develop the lower-bound strength envelope for municipal solid waste shown in Figure 5.21. The envelope is horizontal with a constant strength c = 24 kPa, ϕ = 0 at normal pressures less than 37 kPa. At pressures greater than 37 kPa, the envelope is inclined at ϕ = 33° with c = 0.

Eid et al. (2000) used results of large-scale direct shear tests (300 to 1500 mm shear boxes) and back analysis of failed slopes in waste to develop the range of strength envelopes show in Figure 5.22. All three envelopes (lower bound, average, and upper bound) are inclined at ϕ = 35°. The average envelope shown in Figure 5.22 corresponds to c = 25 kPa, and the lowest of the envelopes corresponds to c = 0.

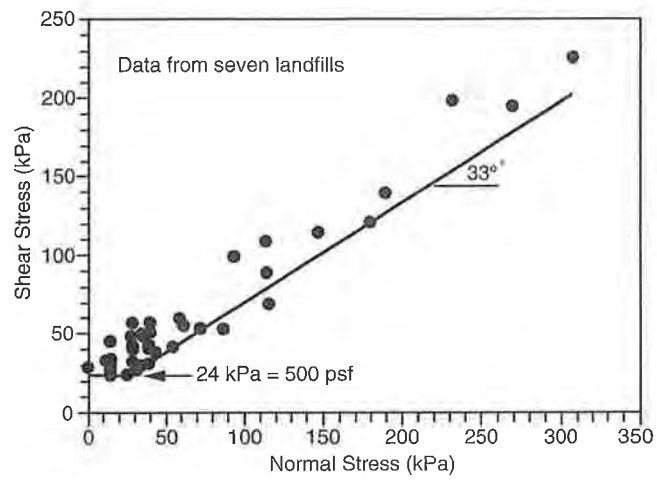


Figure 5.21 Shear strength envelope for municipal solid waste based on large-scale direct shear tests and back analysis of stable slopes. (After Kavazanjian et al., 1995.)

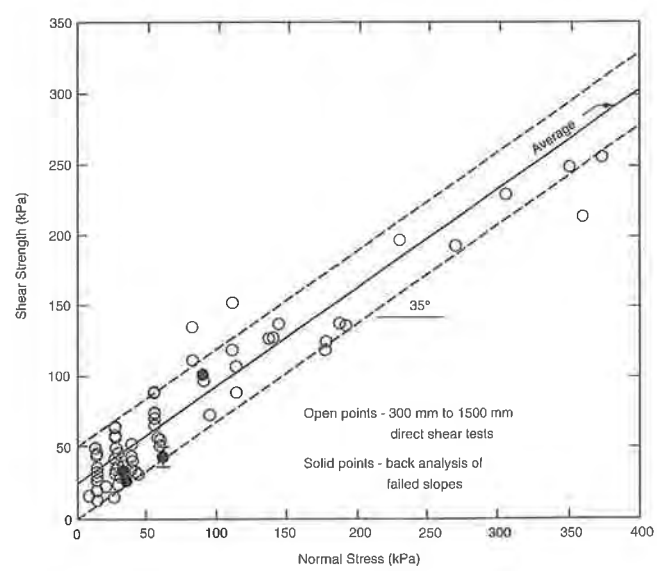
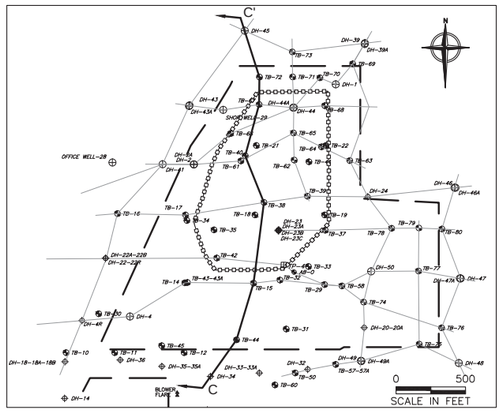


Figure 5.22 Range of shear strength envelopes for municipal solid waste based on large-scale direct shear tests and back analysis of failed slopes. (After Eid et al., 2000.)



CROSS SECTION LOCATOR MAP

SOIL CLASSIFICATIONS:

	SYMBOL	HATCHING	* DESCRIPTION	NAME	COLOR	MUNSELL COLOR RANGE
ALLUVIUM	SP		FINE TO MEDIUM SAND	POORLY GRADED SANDS OR GRAVELLY SANDS LITTLE OR NO FINES (<5% FINES)	DARK BROWN TO WHITE	10YR4/3–10YR8/1
	SP–SM		FINE TO MEDIUM SILTY SAND	POORLY GRADED SILTY SANDS FEW FINES (5%–12% FINES)	DARK BROWN TO LIGHT BROWN GRAY	7.5YR4/4–2.5Y6/2
	SM		SANDY SILT TO SILTY SAND	SILTY SANDS FINE TO MEDIUM (>12% FINES)	VERY DARK GRAY BROWN TO VERY PALE BROWN	10YR3/2–10YR7/3
	ML		SILT	INORGANIC SILTS AND VERY FINE SANDS WITH SLIGHT PLASTICITY	BROWN TO YELLOW BROWN	10YR5/3–10YR5/4
	CL–ML		SILT W/ CLAY	SILTY INORGANIC CLAYS LOW PLASTICITY	DARK YELLOW BROWN TO YELLOW BROWN	10YR4/4–10YR6/4
	CL		CLAY W/ SILT	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	DARK BROWN TO OLIVE GRAY	7.5YR3/4–5Y4/3
	CH		CLAY	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS	DARK RED BROWN	5YR3/4
RESIDUAL	CLAYEY SHALE				RED–GRAY TO OLIVE	5YR5/2–5Y4/4
	WEATHERED SANDSTONE(>50 BLOWCOUNTS AND/OR FIELD CLASSIFICATION OF SS FRAGMENTS)				RED–YELLOW TO WHITE	7.5YR6/6–5Y8/1
	COMPETENT SANDSTONE(AUGER REFUSAL)				LIGHT GRAY TO YELLOW BROWN	10YR7/2–10YR5/4

GRAIN SIZE DATA:

LL/PL/PI	LIQUID LIMIT/PLASTIC LIMIT/PLASTIC INDEX
% G/S/F	PERCENT GRAVEL/SAND/FINES

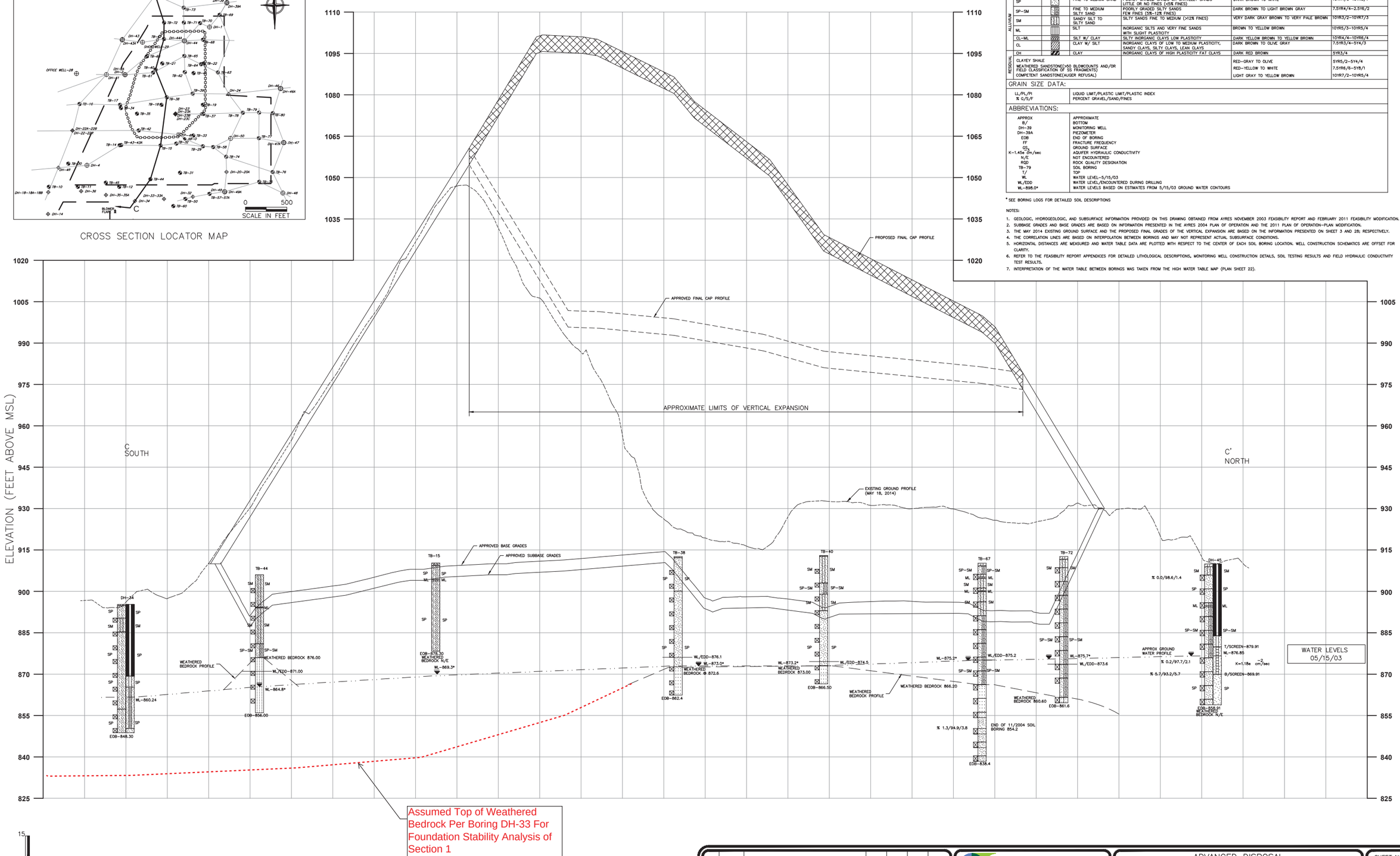
ABBREVIATIONS:

APPROX	APPROXIMATE
B/	BOTTOM
DH–39	MONITORING WELL
DH–39A	PIEZOMETER
EOB	END OF BORING
FF	FRACTURE FREQUENCY
GS_0	GROUND SURFACE
K–1.45e -2m/sec	AQUIFER HYDRAULIC CONDUCTIVITY
N/E	NOT ENCOUNTERED
RQD	ROCK QUALITY DESIGNATION
TB–79	SOIL BORING
T/	TOP
WL	WATER LEVEL–5/15/03
WL/EDD	WATER LEVEL/ENCOUNTERED DURING DRILLING
WL–898.0*	WATER LEVELS BASED ON ESTIMATES FROM 5/15/03 GROUND WATER CONTOURS

* SEE BORING LOGS FOR DETAILED SOIL DESCRIPTIONS

NOTES:

1. GEOLOGIC, HYDROGEOLOGIC, AND SUBSURFACE INFORMATION PROVIDED ON THIS DRAWING OBTAINED FROM AYRES NOVEMBER 2003 FEASIBILITY REPORT AND FEBRUARY 2011 FEASIBILITY MODIFICATION.
2. SUBBASE GRADES AND BASE GRADES ARE BASED ON INFORMATION PRESENTED IN THE AYRES 2004 PLAN OF OPERATION AND THE 2011 PLAN OF OPERATION–PLAN MODIFICATION.
3. THE MAY 2014 EXISTING GROUND SURFACE AND THE PROPOSED FINAL GRADES OF THE VERTICAL EXPANSION ARE BASED ON THE INFORMATION PRESENTED ON SHEET 3 AND 28; RESPECTIVELY.
4. THE CORRELATION LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
5. HORIZONTAL DISTANCES ARE MEASURED AND WATER TABLE DATA ARE PLOTTED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION. WELL CONSTRUCTION SCHEMATICS ARE OFFSET FOR CLARITY.
6. REFER TO THE FEASIBILITY REPORT APPENDICES FOR DETAILED LITHOLOGICAL DESCRIPTIONS, MONITORING WELL CONSTRUCTION DETAILS, SOIL TESTING RESULTS AND FIELD HYDRAULIC CONDUCTIVITY TEST RESULTS.
7. INTERPRETATION OF THE WATER TABLE BETWEEN BORINGS WAS TAKEN FROM THE HIGH WATER TABLE MAP (PLAN SHEET 22).



REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 10/17/2014 — DRAWN BY SRC — DESIGNED BY SRC — CHECKED BY JCO — APPROVED BY MJT

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ADVANCED DISPOSAL
SEVEN MILE CREEK LANDFILL
EAU CLAIRE, WISCONSIN
FEASBILITY REPORT
SECTOR 2-VERTICAL EXPANSION
GEOLOGIC CROSS SECTION C-C'

SHEET NO. **07**

PROJECT NO. 140370

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APPENDIX F.2
SLOPE STABILITY OUTPUTS FOR FOUNDATION AND LINER SYSTEM

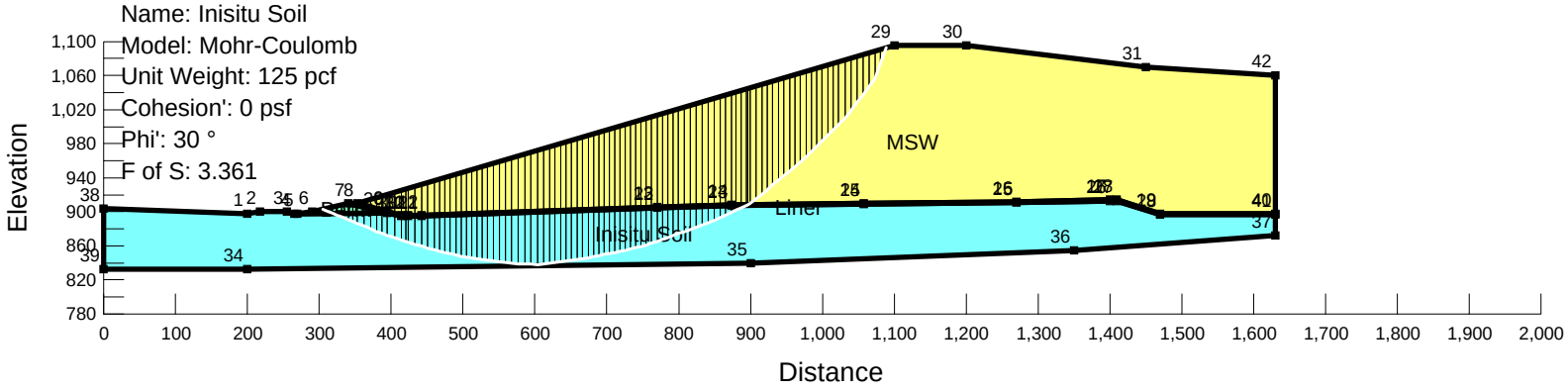
Section 1 - Section 1 Foundation Circular Failure at E 1,644,400 Under Final Build-out oOnditions

Name: MSW
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °

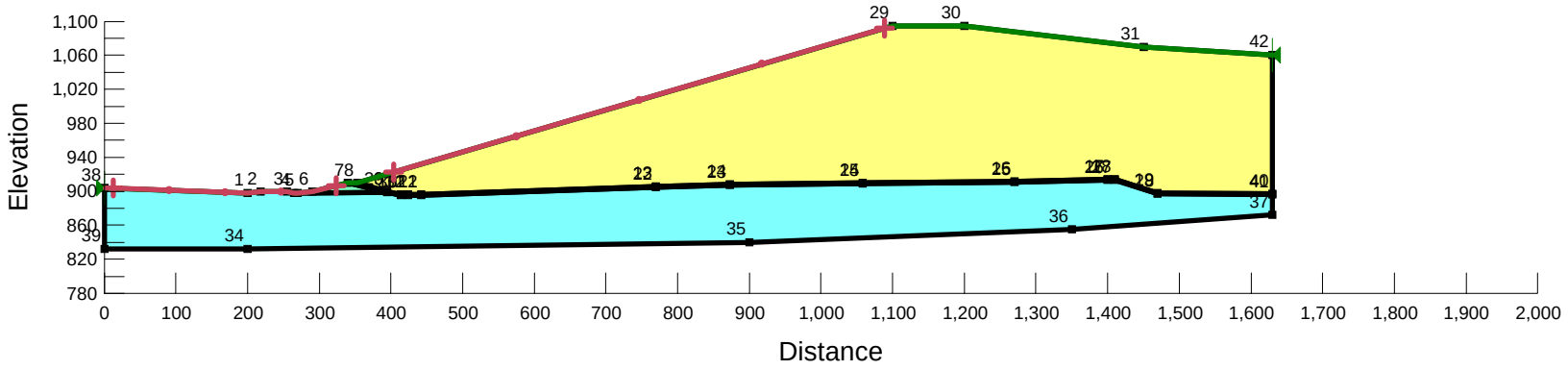
Name: Liner
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °

Name: Berm
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °

Name: Inisitu Soil
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
F of S: 3.361



Section 1 - Section 1 Foundation Circular Failure at E 1,644,400



SLOPE/W Analysis

Report generated using GeoStudio 2012. Copyright © 1991-2013 GEO-SLOPE International Ltd.

File Information

Created By: Obermeyer, Justin
Last Edited By: Walker, James
Revision Number: 95
File Version: 8.2
Tool Version: 8.12.3.7901
Date: 10/8/2015
Time: 8:16:15 AM
File Name: Section 1 Foundation Circular Failure.gsz
Directory: C:\Users\james.walker\Documents\Advanced\Seven Mile Creek Modification\Stability Calculations\
Last Solved Date: 10/8/2015
Last Solved Time: 8:16:23 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

SLOPE/W Analysis

Description: Seven Mile Creek Section 1 Foundation Circular Failure
Kind: SLOPE/W
Method: Spencer
Settings
- Lambda
  - Lambda 1: -1
  - Lambda 2: -0.8
  - Lambda 3: -0.6
  - Lambda 4: -0.4
  - Lambda 5: -0.2
  - Lambda 6: 0
  - Lambda 7: 0.2
  - Lambda 8: 0.4
  - Lambda 9: 0.6
  - Lambda 10: 0.8
  - Lambda 11: 1
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No

Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 100
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 1,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 20
Ending Optimization Points: 30
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °
Phi-B: 0 °

Liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Inisitu Soil

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (12.8813, 903.6136) ft
Left-Zone Right Coordinate: (323.6903, 906.7381) ft

Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (404.097, 922.6545) ft
Right-Zone Right Coordinate: (1,089.0243, 1,092.2818) ft
Right-Zone Increment: 4
Radius Increments: 2

Slip Surface Limits

Left Coordinate: (0, 904) ft
Right Coordinate: (1,630, 1,060) ft

Points

	X (ft)	Y (ft)
Point 1	200	898
Point 2	218	900
Point 3	255	900
Point 4	265	898
Point 5	270	898
Point 6	290	900
Point 7	340	910
Point 8	353	910
Point 9	395	900
Point 10	414	896
Point 11	424	896
Point 12	442	896
Point 13	770	906
Point 14	873	908
Point 15	1,058	910
Point 16	1,270	912
Point 17	1,400	914
Point 18	1,410	914
Point 19	1,470	898
Point 20	395	899
Point 21	442	895
Point 22	770	905
Point 23	873	907
Point 24	1,058	909
Point 25	1,270	911
Point 26	1,400	913
Point 27	1,410	913
Point 28	1,470	897
Point 29	1,100	1,095
Point 30	1,200	1,095
Point 31	1,450	1,070
Point 32	424	895
Point 33	414	895
Point 34	200	832.5

Point 35	900	840
Point 36	1,350	855
Point 37	1,630	872.6
Point 38	0	904
Point 39	0	832.5
Point 40	1,630	897.42
Point 41	1,630	896.42
Point 42	1,630	1,060

Regions

	Material	Points	Area (ft²)
Region 1	Liner	7,8,9,10,11,12,13,14,15,16,17,18,19,40,41,28,27,26,25,24,23,22,21,32,33,20	1,327.5
Region 2	MSW	8,29,30,31,42,40,19,18,17,16,15,14,13,12,11,10,9	1.6446e+005
Region 3	Berm	5,6,7,20	665
Region 4	Inisitu Soil	1,2,3,4,5,20,33,32,21,22,23,24,25,26,27,28,41,37,36,35,34,39,38	97,345

Current Slip Surface

Slip Surface: 76
F of S: 3.361
Volume: 80,598.727 ft³
Weight: 8,072,133.5 lbs
Resisting Moment: 2.884547e+009 lbs-ft
Activating Moment: 8.5833063e+008 lbs-ft
Resisting Force: 4,682,975 lbs
Activating Force: 1,393,574.6 lbs
F of S Rank: 1
Exit: (305.32959, 903.06592) ft
Entry: (1,089.0243, 1,092.2818) ft
Radius: 382.99156 ft
Center: (606.64893, 1,410.7888) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	308.64743	901.89664	0	291.17946	154.82286	100
Slice 2	315.28311	899.55809	0	834.67737	443.80583	100
Slice 3	321.68874	897.30061	0	1,351.891	780.51463	0
Slice 4	327.86431	895.1242	0	1,862.2295	1,075.1587	0

Slice 5	335.47605	892.46641	0	2,481.5412	1,432.7185	0
Slice 6	343.25	889.76922	0	3,019.0699	1,743.0608	0
Slice 7	349.75	887.51403	0	3,355.6152	1,937.3654	0
Slice 8	357.56918	884.80114	0	3,836.5909	2,215.0568	0
Slice 9	366.70755	881.63057	0	4,461.9968	2,576.135	0
Slice 10	375.84592	878.45999	0	5,087.4027	2,937.2133	0
Slice 11	384.06133	875.79595	0	5,497.7839	3,174.147	0
Slice 12	391.35377	873.63845	0	5,931.4658	3,424.5334	0
Slice 13	399.75	871.15439	0	6,436.1402	3,715.9073	0
Slice 14	409.25	868.34378	0	7,011.8072	4,048.2688	0
Slice 15	417.48935	865.90614	0	7,541.101	4,353.8567	0
Slice 16	422.48935	864.50146	0	7,711.7641	4,452.3891	0
Slice 17	428.5	863.01999	0	8,076.6022	4,663.0285	0
Slice 18	437.5	860.80171	0	8,622.8898	4,978.4278	0
Slice 19	446.58583	858.56228	0	9,179.9807	5,300.0643	0
Slice 20	455.75748	856.30169	0	9,747.8748	5,627.9382	0
Slice 21	464.01935	854.45103	0	10,018.914	5,784.4224	0
Slice 22	471.37145	853.0103	0	10,412.667	6,011.7563	0
Slice 23	478.72355	851.56957	0	10,806.421	6,239.0901	0
Slice 24	486.07565	850.12883	0	11,200.175	6,466.424	0
Slice 25	493.42775	848.6881	0	11,593.929	6,693.7578	0
Slice 26	500.77985	847.24737	0	11,987.682	6,921.0917	0
Slice 27	508.13527	846.0725	0	11,984.927	6,919.5006	0
Slice 28	515.49402	845.1635	0	12,295.16	7,098.6139	0
Slice 29	522.85277	844.2545	0	12,605.393	7,277.7271	0
Slice 30	530.21153	843.3455	0	12,915.626	7,456.8403	0
Slice 31	538.08669	842.51236	0	13,054.023	7,536.7438	0
Slice 32	546.47826	841.75509	0	13,365.691	7,716.6852	0
	554.86984	840.99781	0	13,677.359	7,896.6267	0

Slice 33						
Slice 34	563.26141	840.24054	0	13,989.026	8,076.5682	0
Slice 35	571.9968	839.56197	0	14,162.96	8,176.9885	0
Slice 36	581.076	838.96213	0	14,467.825	8,353.0026	0
Slice 37	590.23187	838.5716	0	14,482.559	8,361.5096	0
Slice 38	599.46443	838.3904	0	14,731.112	8,505.0117	0
Slice 39	607.89725	838.6192	0	14,335.302	8,276.4905	0
Slice 40	615.9262	839.27255	0	14,465.157	8,351.4625	0
Slice 41	624.0036	840.08008	0	14,323.056	8,269.4202	0
Slice 42	631.7336	841.02724	0	14,384.512	8,304.9016	0
Slice 43	639.4636	841.97439	0	14,445.967	8,340.3831	0
Slice 44	647.1936	842.92155	0	14,507.423	8,375.8645	0
Slice 45	654.9236	843.86871	0	14,568.879	8,411.346	0
Slice 46	662.6536	844.81586	0	14,630.334	8,446.8275	0
Slice 47	670.3836	845.76302	0	14,691.79	8,482.3089	0
Slice 48	677.9191	846.8532	0	14,490.15	8,365.8919	0
Slice 49	685.2601	848.0864	0	14,506.985	8,375.6116	0
Slice 50	692.6011	849.3196	0	14,523.82	8,385.3313	0
Slice 51	699.9421	850.5528	0	14,540.655	8,395.0511	0
Slice 52	707.2831	851.786	0	14,557.49	8,404.7708	0
Slice 53	714.6241	853.0192	0	14,574.325	8,414.4906	0
Slice 54	721.95279	854.36439	0	14,415.557	8,322.8259	0
Slice 55	729.26917	855.82157	0	14,404.722	8,316.5702	0
Slice 56	736.58555	857.27875	0	14,393.887	8,310.3146	0
Slice 57	743.90193	858.73593	0	14,383.052	8,304.059	0
Slice 58	751.21831	860.19311	0	14,372.217	8,297.8033	0

Slice 59	758.65738	862.06231	0	13,810.882	7,973.7166	0
Slice 60	766.21912	864.34352	0	13,710.156	7,915.5621	0
Slice 61	773.73729	866.61158	0	13,608.666	7,856.9669	0
Slice 62	781.21187	868.8665	0	13,506.413	7,797.931	0
Slice 63	788.68645	871.12141	0	13,404.16	7,738.8952	0
Slice 64	796.16103	873.37633	0	13,301.907	7,679.8593	0
Slice 65	803.63561	875.63124	0	13,199.653	7,620.8235	0
Slice 66	811.54598	878.10573	0	12,987.101	7,498.106	0
Slice 67	819.89212	880.79977	0	12,853.453	7,420.9443	0
Slice 68	828.23828	883.49383	0	12,719.805	7,343.7827	0
Slice 69	836.58443	886.18787	0	12,586.157	7,266.6211	0
Slice 70	844.93057	888.88193	0	12,452.509	7,189.4594	0
Slice 71	853.27673	891.57597	0	12,318.861	7,112.2978	0
Slice 72	861.33735	894.45162	0	11,873.307	6,855.057	0
Slice 73	869.11245	897.50886	0	11,690.142	6,749.3064	0
Slice 74	876.47043	900.40209	0	11,515.862	6,648.6861	0
Slice 75	883.41129	903.1313	0	11,350.469	6,553.196	0
Slice 76	890.35214	905.8605	0	11,185.075	6,457.706	0
Slice 77	895.13011	907.73924	0	11,297.112	2,195.936	0
Slice 78	898.13562	908.92104	0	10,934.248	7,656.2429	300
Slice 79	903.9059	912.51025	0	9,603.1986	6,724.232	300
Slice 80	911.82187	918.11535	0	9,401.0448	6,582.6824	300
Slice 81	919.50923	923.48245	0	9,150.181	6,407.0257	300
Slice 82	927.19658	928.84955	0	8,899.3173	6,231.369	300
Slice 83	934.88392	934.21665	0	8,648.4535	6,055.7124	300
Slice 84	942.57128	939.58375	0	8,397.5898	5,880.0557	300

Slice 85	950.25863	944.95085	0	8,146.726	5,704.399	300
Slice 86	957.94597	950.31795	0	7,895.8623	5,528.7423	300
Slice 87	965.63333	955.68505	0	7,644.9985	5,353.0856	300
Slice 88	973.25809	961.48646	0	7,060.4709	4,943.795	300
Slice 89	980.82028	967.72219	0	6,756.9932	4,731.2976	300
Slice 90	988.38246	973.95792	0	6,453.5155	4,518.8002	300
Slice 91	995.94465	980.19365	0	6,150.0377	4,306.3028	300
Slice 92	1,003.5068	986.42938	0	5,846.56	4,093.8054	300
Slice 93	1,011.069	992.66511	0	5,543.0823	3,881.308	300
Slice 94	1,018.6312	998.90084	0	5,239.6045	3,668.8106	300
Slice 95	1,026.8503	1,006.2939	0	4,654.5232	3,259.1322	300
Slice 96	1,035.7262	1,014.8442	0	4,231.1297	2,962.6689	300
Slice 97	1,044.276	1,023.7698	0	3,585.2838	2,510.4428	300
Slice 98	1,052.4999	1,033.0708	0	3,124.3559	2,187.6975	300
Slice 99	1,060.7239	1,042.3718	0	2,663.4279	1,864.9523	300
Slice 100	1,068.9478	1,051.6728	0	2,202.4999	1,542.207	300
Slice 101	1,077.0509	1,065.3129	0	1,054.3275	738.24808	300
Slice 102	1,085.0332	1,083.2922	0	286.2205	200.41375	300

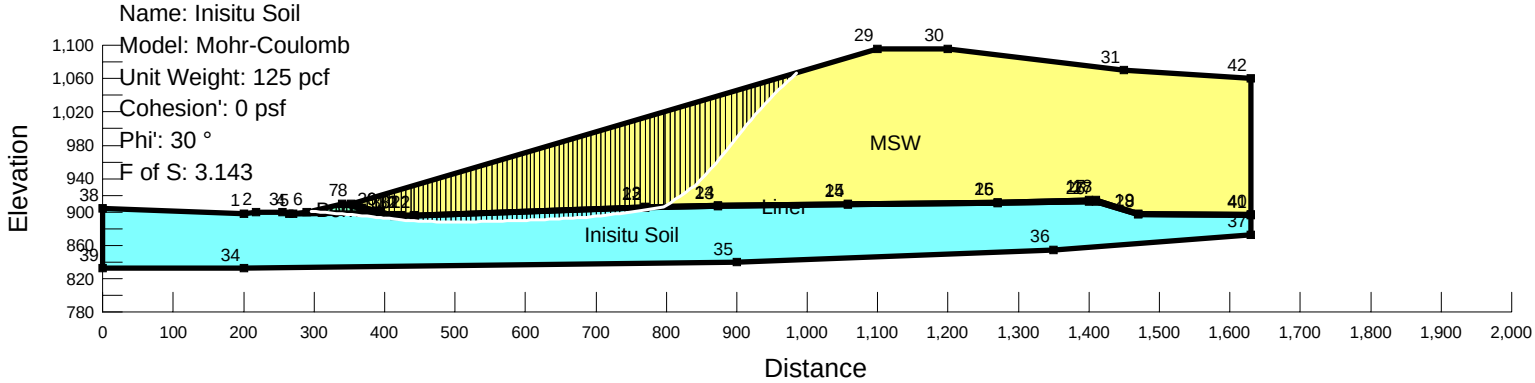
Section 1 - Foundation Failure Analysis at E 1,644,400
Under Final Build-out Conditions

Name: MSW
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °

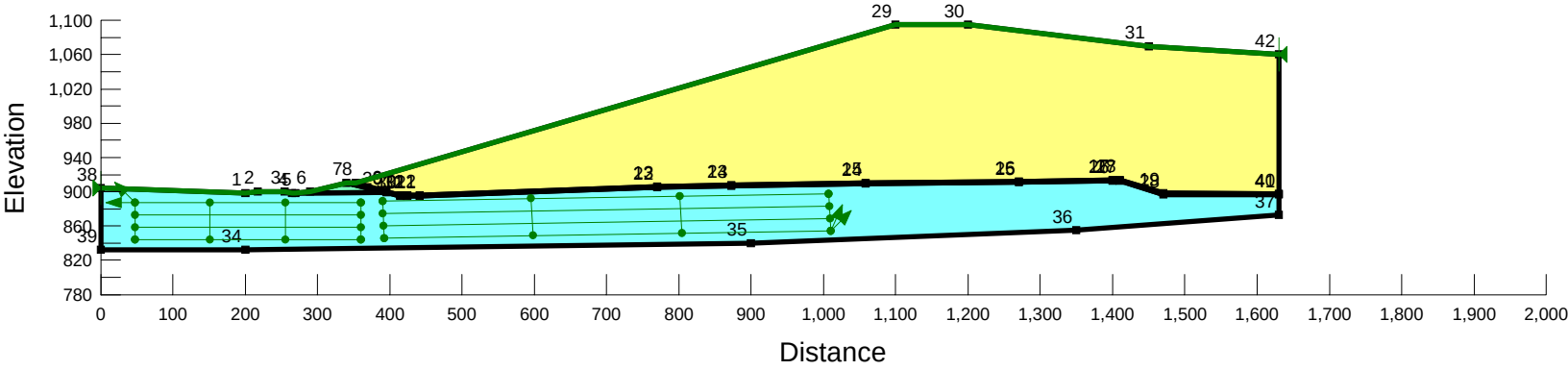
Name: Liner
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °

Name: Berm
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °

Name: Inisitu Soil
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
F of S: 3.143



Section 1 - Foundation Block Failure Analysis at E 1,644,400
Under Final Build-out Conditions



SLOPE/W Analysis

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File Information

Created By: Obermeyer, Justin
Last Edited By: Walker, James
Revision Number: 94
File Version: 8.2
Tool Version: 8.12.3.7901
Date: 10/8/2015
Time: 8:27:23 AM
File Name: Section 1 Foundation Block Failure.gsz
Directory: C:\Users\james.walker\Documents\Advanced\Seven Mile Creek Modification\Stability Calculations\
Last Solved Date: 10/8/2015
Last Solved Time: 8:27:37 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

SLOPE/W Analysis

Description: Seven Mile Creek Section 1 Foundation Block Failure
Kind: SLOPE/W
Method: Spencer
Settings
- Lambda
  - Lambda 1: -1
  - Lambda 2: -0.8
  - Lambda 3: -0.6
  - Lambda 4: -0.4
  - Lambda 5: -0.2
  - Lambda 6: 0
  - Lambda 7: 0.2
  - Lambda 8: 0.4
  - Lambda 9: 0.6
  - Lambda 10: 0.8
  - Lambda 11: 1
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No

Slip Surface Option: Block
Critical slip surfaces saved: 1
Restrict Block Crossing: No
Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 100
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 1,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 20
Ending Optimization Points: 30
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °
Phi-B: 0 °

Liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Inisitu Soil

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 904) ft
Right Coordinate: (1,630, 1,060) ft

Slip Surface Block

Left Grid

Upper Left: (47.6378, 887.3483) ft
Lower Left: (47.6378, 843.7746) ft
Lower Right: (360.5327, 843.7746) ft
X Increments: 3
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 2

Right Grid

Upper Left: (390.3033, 888.8862) ft
Lower Left: (392.7335, 845.8251) ft
Lower Right: (1,010.0175, 854.5399) ft
X Increments: 3
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 2

Points

	X (ft)	Y (ft)
Point 1	200	898
Point 2	218	900
Point 3	255	900
Point 4	265	898
Point 5	270	898
Point 6	290	900
Point 7	340	910
Point 8	353	910
Point 9	395	900
Point 10	414	896
Point 11	424	896
Point 12	442	896
Point 13	770	906
Point 14	873	908
Point 15	1,058	910
Point 16	1,270	912
Point 17	1,400	914
Point 18	1,410	914
Point 19	1,470	898
Point 20	395	899
Point 21	442	895
Point 22	770	905
Point 23	873	907
Point 24	1,058	909
Point 25	1,270	911
Point 26	1,400	913
Point 27	1,410	913

Point 28	1,470	897
Point 29	1,100	1,095
Point 30	1,200	1,095
Point 31	1,450	1,070
Point 32	424	895
Point 33	414	895
Point 34	200	832.5
Point 35	900	840
Point 36	1,350	855
Point 37	1,630	872.6
Point 38	0	904
Point 39	0	832.5
Point 40	1,630	897.42
Point 41	1,630	896.42
Point 42	1,630	1,060

Regions

	Material	Points	Area (ft²)
Region 1	Liner	7,8,9,10,11,12,13,14,15,16,17,18,19,40,41,28,27,26,25,24,23,22,21,32,33,20	1,327.5
Region 2	MSW	8,29,30,31,42,40,19,18,17,16,15,14,13,12,11,10,9	1.6446e+005
Region 3	Berm	5,6,7,20	665
Region 4	Inisitu Soil	1,2,3,4,5,20,33,32,21,22,23,24,25,26,27,28,41,37,36,35,34,39,38	97,345

Current Slip Surface

Slip Surface: 2,305
F of S: 3.143
Volume: 43,893.285 ft³
Weight: 4,094,068.3 lbs
Resisting Moment: 5.9665453e+008 lbs-ft
Activating Moment: 1.9006168e+008 lbs-ft
Resisting Force: 2,386,779.7 lbs

Activating Force: 759,570.97 lbs
F of S Rank: 1
Exit: (295.66913, 901.13383) ft
Entry: (985.20921, 1,066.5712) ft
Radius: 323.99483 ft
Center: (614.98676, 1,102.1303) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	299.02909	900.88641	0	132.92555	70.677767	100
Slice 2	305.74901	900.39158	0	378.88658	201.45757	100
Slice 3	312.46893	899.89675	0	624.84762	332.23737	100
Slice 4	319.18884	899.40192	0	870.80865	463.01717	100
Slice 5	327.0955	898.82382	0	1,159.1882	616.35131	100
Slice 6	335.8211	898.18921	0	1,474.1405	851.0954	0
Slice 7	343.25	897.6489	0	1,658.973	957.80851	0
Slice 8	349.75	897.17616	0	1,722.471	994.46911	0
Slice 9	353.6207	896.89464	0	1,769.5917	1,021.6742	0
Slice 10	357.76011	896.53744	0	1,892.7011	1,092.7515	0
Slice 11	364.79754	895.91331	0	2,083.3816	1,202.841	0
Slice 12	371.83496	895.28919	0	2,274.0622	1,312.9304	0
Slice 13	378.87239	894.66506	0	2,464.7427	1,423.0199	0
Slice 14	385.54332	894.06219	0	2,651.1332	1,530.6324	0
Slice 15	391.84778	893.48057	0	2,825.2672	1,631.1688	0
Slice 16	396.64955	893.03758	0	2,959.6211	1,708.738	0
Slice 17	402.22433	892.55929	0	3,102.143	1,791.0231	0
Slice 18	410.07477	891.90708	0	3,316.5727	1,914.8242	0
Slice 19	419	891.16557	0	3,600.1255	2,078.5334	0
Slice 20	427.27445	890.47812	0	3,891.9454	2,247.0157	0
Slice 21	433.82335	889.93404	0	4,122.9094	2,380.3628	0
Slice 22	439.5489	889.58536	0	4,212.9185	2,432.3296	0
Slice 23	445.1626	889.40984	0	4,371.7262	2,524.0173	0
Slice 24	451.4878	889.21207	0	4,553.7727	2,629.1219	0
Slice 25	457.813	889.0143	0	4,735.8192	2,734.2265	0
	464.1382	888.81653	0	4,917.8657	2,839.3311	0

Slice 26						
Slice 27	470.4634	888.61876	0	5,099.9122	2,944.4357	0
Slice 28	476.7886	888.42099	0	5,281.9587	3,049.5403	0
Slice 29	483.5046	888.31781	0	5,392.325	3,113.2603	0
Slice 30	490.6114	888.30922	0	5,566.4556	3,213.7946	0
Slice 31	497.7182	888.30064	0	5,740.5861	3,314.3289	0
Slice 32	504.825	888.29206	0	5,914.7167	3,414.8633	0
Slice 33	511.9318	888.28347	0	6,088.8473	3,515.3976	0
Slice 34	519.0386	888.27489	0	6,262.9778	3,615.9319	0
Slice 35	526.37196	888.3721	0	6,354.0789	3,668.5292	0
Slice 36	533.93188	888.5751	0	6,509.8407	3,758.4583	0
Slice 37	541.4918	888.7781	0	6,665.6025	3,848.3874	0
Slice 38	549.05172	888.9811	0	6,821.3643	3,938.3165	0
Slice 39	556.61164	889.1841	0	6,977.1261	4,028.2456	0
Slice 40	563.8441	889.36011	0	7,144.0872	4,124.6407	0
Slice 41	570.7491	889.50914	0	7,291.3629	4,209.6703	0
Slice 42	577.6541	889.65816	0	7,438.6386	4,294.7	0
Slice 43	584.5591	889.80719	0	7,585.9143	4,379.7297	0
Slice 44	591.4414	889.99137	0	7,694.8822	4,442.6423	0
Slice 45	598.301	890.21073	0	7,831.3979	4,521.4597	0
Slice 46	604.46483	890.4029	0	7,960.6315	4,596.0727	0
Slice 47	609.93287	890.5679	0	8,070.8014	4,659.6794	0
Slice 48	616.29389	890.77664	0	8,181.1274	4,723.3761	0
Slice 49	623.54786	891.02911	0	8,322.6899	4,805.1073	0
Slice 50	630.80184	891.28159	0	8,464.2525	4,886.8385	0
Slice 51	638.05581	891.53406	0	8,605.8151	4,968.5697	0

Slice 52	644.90088	891.81589	0	8,685.2118	5,014.4094	0
Slice 53	651.33705	892.12707	0	8,798.9895	5,080.099	0
Slice 54	657.77322	892.43826	0	8,912.7672	5,145.7885	0
Slice 55	664.20938	892.74944	0	9,026.5448	5,211.4781	0
Slice 56	670.64555	893.06062	0	9,140.3225	5,277.1677	0
Slice 57	677.08172	893.37181	0	9,254.1002	5,342.8572	0
Slice 58	683.51998	893.7317	0	9,304.0207	5,371.6789	0
Slice 59	689.96033	894.1403	0	9,404.839	5,429.8864	0
Slice 60	696.59934	894.68474	0	9,355.4575	5,401.3759	0
Slice 61	703.43703	895.36503	0	9,430.1308	5,444.4886	0
Slice 62	710.27472	896.04532	0	9,504.8041	5,487.6012	0
Slice 63	717.11241	896.72561	0	9,579.4775	5,530.7139	0
Slice 64	723.95009	897.40589	0	9,654.1508	5,573.8266	0
Slice 65	730.78778	898.08618	0	9,728.8241	5,616.9392	0
Slice 66	737.62547	898.76647	0	9,803.4974	5,660.0519	0
Slice 67	744.46316	899.44676	0	9,878.1708	5,703.1645	0
Slice 68	751.56833	900.29473	0	9,787.4392	5,650.7807	0
Slice 69	758.941	901.31038	0	9,831.9986	5,676.5071	0
Slice 70	766.31367	902.32603	0	9,876.558	5,702.2334	0
Slice 71	773.30895	903.28969	0	9,917.5738	5,725.9139	0
Slice 72	779.92685	904.20136	0	9,955.046	5,747.5485	0
Slice 73	785.6887	905.00473	0	9,970.9866	5,756.7518	0
Slice 74	792.2311	905.93167	0	9,913.9288	1,927.0726	0
Slice 75	797.29114	906.64859	0	10,071.876	7,052.4037	300
Slice 76	801.81932	908.86473	0	8,328.159	5,831.4397	300
Slice 77	808.93455	913.022	0	8,149.9012	5,706.6223	300

Slice 78	816.04978	917.17927	0	7,971.6435	5,581.8049	300
Slice 79	823.16502	921.33653	0	7,793.3858	5,456.9875	300
Slice 80	830.28025	925.4938	0	7,615.1281	5,332.1701	300
Slice 81	837.39548	929.65107	0	7,436.8704	5,207.3527	300
Slice 82	844.38757	934.77865	0	6,446.1421	4,513.6373	300
Slice 83	851.25653	940.87655	0	6,151.544	4,307.3575	300
Slice 84	858.41011	947.5059	0	5,680.8449	3,977.7704	300
Slice 85	865.84834	954.6667	0	5,333.0394	3,734.2344	300
Slice 86	873.28656	961.8275	0	4,985.2339	3,490.6983	300
Slice 87	880.72479	968.9883	0	4,637.4284	3,247.1623	300
Slice 88	888.39293	976.88907	0	4,064.7317	2,846.1558	300
Slice 89	896.291	985.5298	0	3,645.2538	2,552.4342	300
Slice 90	904.18907	994.17053	0	3,225.776	2,258.7127	300
Slice 91	911.17348	1,001.5449	0	2,957.3676	2,070.7711	300
Slice 92	917.24425	1,007.653	0	2,660.3951	1,862.8287	300
Slice 93	923.31502	1,013.761	0	2,363.4225	1,654.8863	300
Slice 94	929.65304	1,019.8582	0	2,134.3652	1,494.4986	300
Slice 95	936.25831	1,025.9447	0	1,839.4247	1,287.979	300
Slice 96	942.86359	1,032.0311	0	1,544.4841	1,081.4594	300
Slice 97	949.46886	1,038.1176	0	1,249.5436	874.93984	300
Slice 98	956.01527	1,043.7018	0	1,043.4571	730.63655	300
Slice 99	962.50281	1,048.7839	0	802.32271	561.79241	300
Slice 100	968.99035	1,053.866	0	561.18829	392.94827	300
Slice 101	975.47789	1,058.9481	0	320.05386	224.10413	300
Slice 102	981.96544	1,064.0302	0	78.919439	55.259986	300

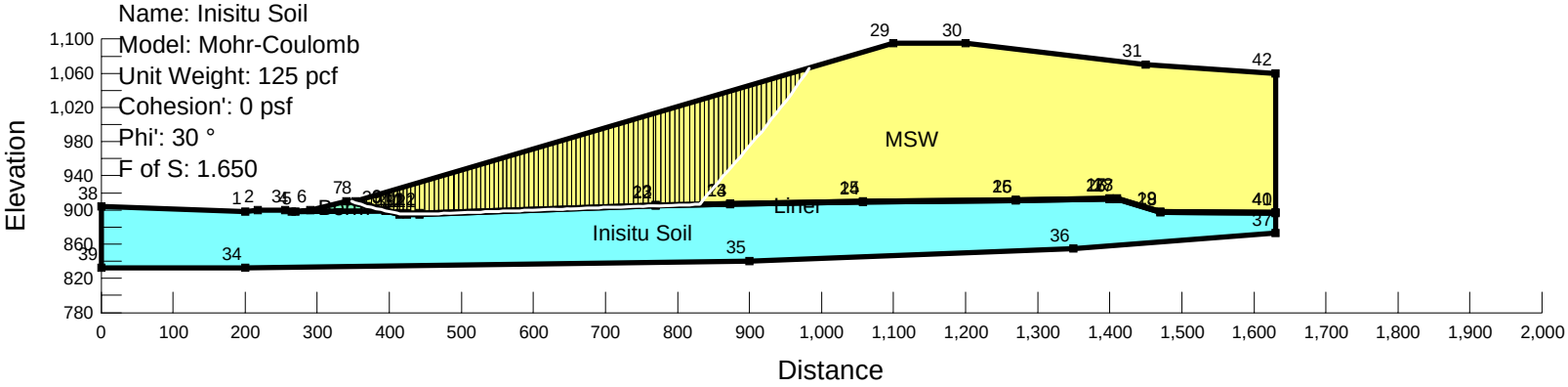
Section 1 - Liner Failure Analysis at E 1,644,400
Under Final Build-out Conditions

Name: MSW
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °

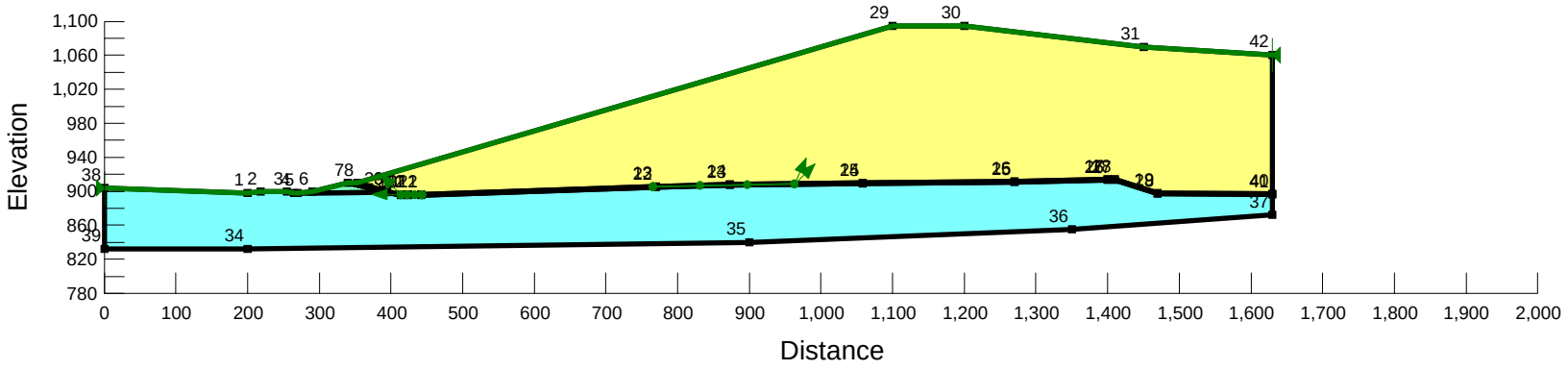
Name: Liner
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °

Name: Berm
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °

Name: Inisitu Soil
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
F of S: 1.650



Section 1 - Liner Failure Analysis at E 1,644,400
Under Final Build-out Conditions



SLOPE/W Analysis

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File Information

Created By: Obermeyer, Justin
Last Edited By: Walker, James
Revision Number: 93
File Version: 8.2
Tool Version: 8.12.3.7901
Date: 10/8/2015
Time: 8:33:32 AM
File Name: Section 1 Liner Failure.gsz
Directory: C:\Users\james.walker\Documents\Advanced\Seven Mile Creek Modification\Stability Calculations\
Last Solved Date: 10/8/2015
Last Solved Time: 8:33:47 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

SLOPE/W Analysis

Description: Seven Mile Creek Section 1 Liner Failure
Kind: SLOPE/W
Method: Spencer
Settings
- Lambda
  - Lambda 1: -1
  - Lambda 2: -0.8
  - Lambda 3: -0.6
  - Lambda 4: -0.4
  - Lambda 5: -0.2
  - Lambda 6: 0
  - Lambda 7: 0.2
  - Lambda 8: 0.4
  - Lambda 9: 0.6
  - Lambda 10: 0.8
  - Lambda 11: 1
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No

Slip Surface Option: Block
Critical slip surfaces saved: 1
Restrict Block Crossing: No
Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 100
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 1,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 20
Ending Optimization Points: 30
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °
Phi-B: 0 °

Liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Inisitu Soil

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 904) ft
Right Coordinate: (1,630, 1,060) ft

Slip Surface Block

Left Grid

Upper Left: (413.9677, 895.9436) ft
Lower Left: (413.9677, 895.1927) ft
Lower Right: (443.6802, 895.1349) ft
X Increments: 3
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 2

Right Grid

Upper Left: (765.5249, 905.7519) ft
Lower Left: (765.5784, 904.9329) ft
Lower Right: (963.49, 908.1397) ft
X Increments: 3
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 2

Points

	X (ft)	Y (ft)
Point 1	200	898
Point 2	218	900
Point 3	255	900
Point 4	265	898
Point 5	270	898
Point 6	290	900
Point 7	340	910
Point 8	353	910
Point 9	395	900
Point 10	414	896
Point 11	424	896
Point 12	442	896
Point 13	770	906
Point 14	873	908
Point 15	1,058	910
Point 16	1,270	912
Point 17	1,400	914
Point 18	1,410	914
Point 19	1,470	898
Point 20	395	899
Point 21	442	895
Point 22	770	905
Point 23	873	907
Point 24	1,058	909
Point 25	1,270	911
Point 26	1,400	913
Point 27	1,410	913

Point 28	1,470	897
Point 29	1,100	1,095
Point 30	1,200	1,095
Point 31	1,450	1,070
Point 32	424	895
Point 33	414	895
Point 34	200	832.5
Point 35	900	840
Point 36	1,350	855
Point 37	1,630	872.6
Point 38	0	904
Point 39	0	832.5
Point 40	1,630	897.42
Point 41	1,630	896.42
Point 42	1,630	1,060

Regions

	Material	Points	Area (ft²)
Region 1	Liner	7,8,9,10,11,12,13,14,15,16,17,18,19,40,41,28,27,26,25,24,23,22,21,32,33,20	1,327.5
Region 2	MSW	8,29,30,31,42,40,19,18,17,16,15,14,13,12,11,10,9	1.6446e+005
Region 3	Berm	5,6,7,20	665
Region 4	Inisitu Soil	1,2,3,4,5,20,33,32,21,22,23,24,25,26,27,28,41,37,36,35,34,39,38	97,345

Current Slip Surface

Slip Surface: 2,305
F of S: 1.650
Volume: 42,431.659 ft³
Weight: 3,835,185.3 lbs
Resisting Moment: 2.8575144e+008 lbs-ft
Activating Moment: 1.732105e+008 lbs-ft
Resisting Force: 1,014,522.9 lbs

Activating Force: 614,754.03 lbs
F of S Rank: 1
Exit: (347.80857, 910) ft
Entry: (982.56916, 1,065.9174) ft
Radius: 300.55537 ft
Center: (652.28294, 1,107.2208) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	350.40428	909.29566	0	99.875413	19.413814	0
Slice 2	356.7778	907.56621	0	404.9171	78.707911	0
Slice 3	364.3334	905.516	0	815.24965	158.46848	0
Slice 4	371.4723	903.81931	0	1,137.4717	221.1021	0
Slice 5	378.1945	902.47614	0	1,426.3824	277.26065	0
Slice 6	384.9167	901.13296	0	1,715.2931	333.41921	0
Slice 7	391.6389	899.78979	0	2,004.2038	389.57776	0
Slice 8	397.6706	898.58459	0	2,266.2825	440.5207	0
Slice 9	403.0118	897.51735	0	2,501.5293	486.24803	0
Slice 10	408.353	896.45012	0	2,736.776	531.97536	0
Slice 11	412.5118	895.87456	0	2,710.0767	526.78555	0
Slice 12	416.5	895.76215	0	2,805.4682	545.32777	0
Slice 13	421.5	895.62123	0	2,939.3181	571.34556	0
Slice 14	426.99027	895.46649	0	3,086.2924	599.91447	0
Slice 15	432.9708	895.29794	0	3,246.3911	631.03451	0
Slice 16	438.95133	895.12938	0	3,406.4899	662.15455	0
Slice 17	445.32659	895.14781	0	3,483.2766	677.08039	0
Slice 18	452.06738	895.35234	0	3,617.2447	703.12114	0
Slice 19	458.77896	895.55599	0	3,750.6639	729.05521	0
Slice 20	465.49055	895.75964	0	3,884.0832	754.98929	0
Slice 21	472.20214	895.96328	0	4,017.5024	780.92336	0
Slice 22	478.91372	896.16693	0	4,150.9217	806.85743	0
Slice 23	485.62531	896.37058	0	4,284.3409	832.79151	0
Slice 24	489.58875	896.4894	0	4,366.8832	848.83611	0
Slice 25	493.25614	896.5974	0	4,437.5551	862.57334	0
	499.37561	896.7794	0	4,559.6968	886.31526	0

Slice 26						
Slice 27	505.49509	896.9614	0	4,681.8384	910.05719	0
Slice 28	511.61456	897.1434	0	4,803.98	933.79911	0
Slice 29	517.73404	897.3254	0	4,926.1216	957.54103	0
Slice 30	523.85351	897.5074	0	5,048.2632	981.28296	0
Slice 31	529.97299	897.6894	0	5,170.4048	1,005.0249	0
Slice 32	536.09246	897.8714	0	5,292.5464	1,028.7668	0
Slice 33	542.16064	898.05445	0	5,411.7352	1,051.9348	0
Slice 34	548.17751	898.23855	0	5,531.1392	1,075.1445	0
Slice 35	554.19439	898.42265	0	5,650.5432	1,098.3543	0
Slice 36	560.21126	898.60675	0	5,769.9471	1,121.5641	0
Slice 37	566.26573	898.79475	0	5,887.9111	1,144.494	0
Slice 38	572.35779	898.98665	0	6,008.0712	1,167.8507	0
Slice 39	578.44985	899.17855	0	6,128.2312	1,191.2075	0
Slice 40	584.54191	899.37045	0	6,248.3913	1,214.5642	0
Slice 41	590.63397	899.56235	0	6,368.5513	1,237.921	0
Slice 42	597.01141	899.75653	0	6,499.7143	1,263.4165	0
Slice 43	603.67423	899.95299	0	6,632.9285	1,289.3107	0
Slice 44	610.33705	900.14945	0	6,766.1427	1,315.2049	0
Slice 45	616.99987	900.34591	0	6,899.3568	1,341.0991	0
Slice 46	623.66269	900.54237	0	7,032.571	1,366.9933	0
Slice 47	630.283	900.74195	0	7,161.0876	1,391.9744	0
Slice 48	636.8608	900.94465	0	7,291.4307	1,417.3106	0
Slice 49	643.28729	901.14503	0	7,416.569	1,441.635	0
Slice 50	649.56246	901.34308	0	7,540.2898	1,465.6839	0
Slice 51	655.83764	901.54112	0	7,664.0105	1,489.7327	0

Slice 52	662.11281	901.73918	0	7,787.7312	1,513.7816	0
Slice 53	668.38799	901.93721	0	7,911.4644	1,537.8329	0
Slice 54	674.66316	902.13524	0	8,035.1885	1,561.8824	0
Slice 55	680.93834	902.33326	0	8,158.9126	1,585.932	0
Slice 56	687.21351	902.53129	0	8,282.6367	1,609.9815	0
Slice 57	693.86461	902.73176	0	8,422.7631	1,637.2193	0
Slice 58	700.89164	902.93469	0	8,563.8317	1,664.6403	0
Slice 59	707.91866	903.13761	0	8,704.9004	1,692.0612	0
Slice 60	714.94569	903.34054	0	8,845.969	1,719.4822	0
Slice 61	721.80477	903.54524	0	8,976.6783	1,744.8895	0
Slice 62	728.49593	903.75171	0	9,109.2297	1,770.6549	0
Slice 63	735.18708	903.95819	0	9,241.7811	1,796.4203	0
Slice 64	741.87823	904.16466	0	9,374.3325	1,822.1857	0
Slice 65	748.79445	904.38155	0	9,507.7123	1,848.1121	0
Slice 66	755.93575	904.60885	0	9,648.2534	1,875.4305	0
Slice 67	763.07705	904.83615	0	9,788.7945	1,902.7489	0
Slice 68	768.32385	904.98264	0	9,936.652	1,931.4895	0
Slice 69	773.25117	905.07918	0	10,040.435	1,951.6628	0
Slice 70	779.75352	905.20659	0	10,176.518	1,978.1147	0
Slice 71	786.25587	905.33399	0	10,312.601	2,004.5666	0
Slice 72	792.75823	905.46139	0	10,448.684	2,031.0185	0
Slice 73	799.26058	905.5888	0	10,584.768	2,057.4704	0
Slice 74	805.76293	905.7162	0	10,720.851	2,083.9223	0
Slice 75	812.6726	905.98533	0	10,712.551	2,082.309	0
Slice 76	819.9896	906.3962	0	10,830.089	2,105.1561	0
Slice 77	827.3066	906.80707	0	10,947.627	2,128.0032	0

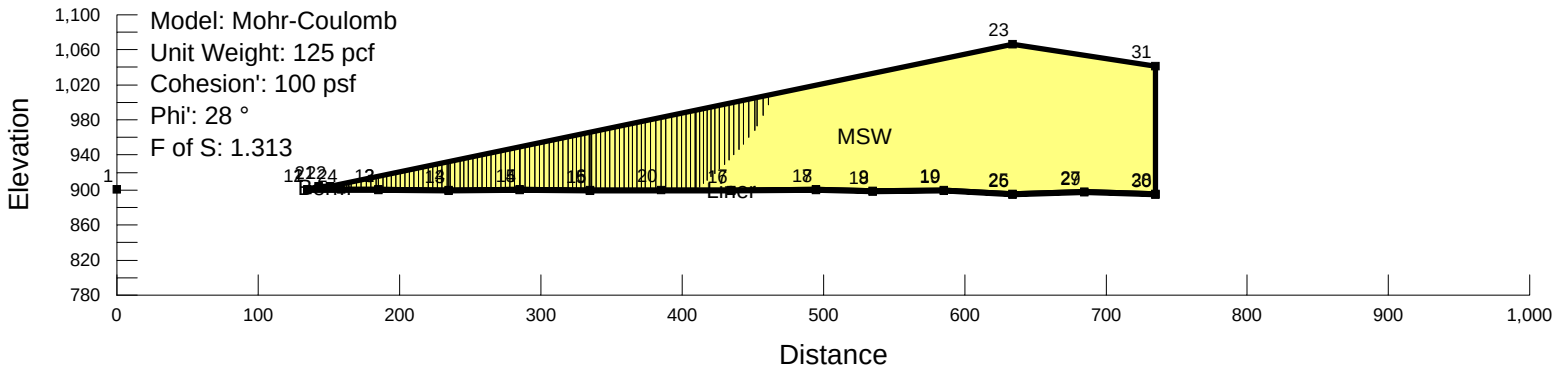
Slice 78	834.2573	910.29828	0	6,806.4276	4,765.9119	300
Slice 79	840.75419	916.78251	0	6,523.5878	4,567.8654	300
Slice 80	847.16356	923.17939	0	6,244.558	4,372.4866	300
Slice 81	853.57294	929.57628	0	5,965.5282	4,177.1078	300
Slice 82	859.98231	935.97316	0	5,686.4984	3,981.729	300
Slice 83	866.17651	942.08019	0	5,481.592	3,838.2521	300
Slice 84	872.15554	947.89736	0	5,227.3464	3,660.2273	300
Slice 85	878.13456	953.71454	0	4,973.1007	3,482.2026	300
Slice 86	884.11359	959.53171	0	4,718.855	3,304.1779	300
Slice 87	889.97199	965.28055	0	4,432.9025	3,103.9517	300
Slice 88	895.70977	970.96105	0	4,184.9535	2,930.336	300
Slice 89	901.44755	976.64155	0	3,937.0045	2,756.7203	300
Slice 90	907.18533	982.32205	0	3,689.0556	2,583.1045	300
Slice 91	912.92311	988.00255	0	3,441.1066	2,409.4888	300
Slice 92	919.5812	994.78035	0	3,073.5444	2,152.1189	300
Slice 93	927.1596	1,002.6555	0	2,731.4185	1,912.5598	300
Slice 94	934.23234	1,010.0449	0	2,396.5221	1,678.0628	300
Slice 95	940.79941	1,016.9488	0	2,096.9989	1,468.3344	300
Slice 96	947.36649	1,023.8526	0	1,797.4757	1,258.606	300
Slice 97	953.93356	1,030.7565	0	1,497.9525	1,048.8776	300
Slice 98	960.38611	1,038.172	0	1,058.6614	741.28266	300
Slice 99	966.72412	1,046.0993	0	725.01182	507.65874	300
Slice 100	973.06214	1,054.0265	0	391.36228	274.03482	300
Slice 101	979.40015	1,061.9538	0	57.712734	40.410891	300

Section 2 - Liner Failure Analysis at N 367,750
Under 3H:1V Waste Slope Interim Conditions

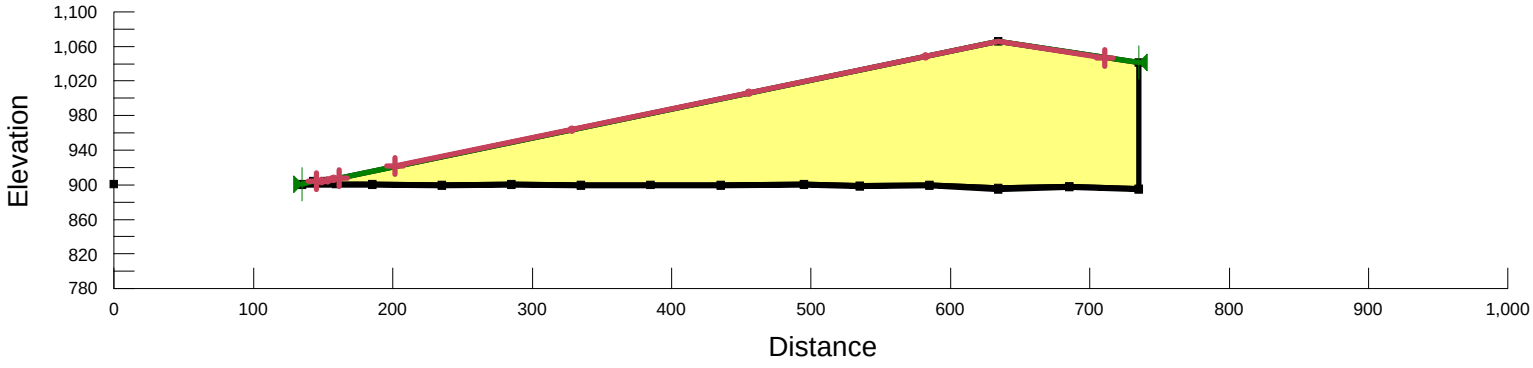
Name: MSW
Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °

Name: Liner
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 7.2 °

Name: Berm
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
F of S: 1.313



Section 2 - Liner Failure Analysis at N 367,750
Under 3H:1V Waste Slope Interim Conditions



SLOPE/W Analysis

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File Information

Created By: Obermeyer, Justin
Last Edited By: Walker, James
Revision Number: 105
File Version: 8.2
Tool Version: 8.12.3.7901
Date: 10/8/2015
Time: 8:40:40 AM
File Name: Interim Section 2 Liner Failure.gsz
Directory: C:\Users\james.walker\Documents\Advanced\Seven Mile Creek Modification\Stability Calculations\
Last Solved Date: 10/8/2015
Last Solved Time: 8:40:48 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

SLOPE/W Analysis

Description: Seven Mile Creek Section 2 Liner Failure
Kind: SLOPE/W
Method: Spencer
Settings
- Lambda
  - Lambda 1: -1
  - Lambda 2: -0.8
  - Lambda 3: -0.6
  - Lambda 4: -0.4
  - Lambda 5: -0.2
  - Lambda 6: 0
  - Lambda 7: 0.2
  - Lambda 8: 0.4
  - Lambda 9: 0.6

Lambda 10: 0.8
Lambda 11: 1
PWP Conditions Source: (none)
Slip Surface
Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 100
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 1,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 20
Ending Optimization Points: 30
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 35 °
Phi-B: 0 °

Liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 7.2 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (144.8819, 904.54) ft
Left-Zone Right Coordinate: (161.4733, 908.0411) ft
Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (201.7077, 921.4909) ft
Right-Zone Right Coordinate: (710.8396, 1,046.9803) ft
Right-Zone Increment: 4
Radius Increments: 2

Slip Surface Limits

Left Coordinate: (135, 900.54) ft
Right Coordinate: (735, 1,041) ft

Points

	X (ft)	Y (ft)
Point 1	0	900.79
Point 2	135	900.54
Point 3	185	901.04
Point 4	235	899.99
Point 5	285	901.07
Point 6	335	899.99
Point 7	435	899.79
Point 8	495	900.57
Point 9	535	898.93
Point 10	585	899.78
Point 11	135	899.54
Point 12	185	900.04
Point 13	235	898.99
Point 14	285	900.07
Point 15	335	898.99
Point 16	435	898.79
Point 17	495	899.57
Point 18	535	897.93
Point 19	585	898.78
Point 20	385	899.87
Point 21	143	904.54
Point 22	151	904.54
Point 23	634	1,066
Point 24	159	900.78
Point 25	634	896
Point 26	634	895

Point 27	685	898.2
Point 28	735	895.3
Point 29	685	897.2
Point 30	735	894.3
Point 31	735	1,041

Regions

	Material	Points	Area (ft²)
Region 1	Liner	2,24,3,4,5,6,20,7,8,9,10,25,27,28,30,29,26,19,18,17,16,15,14,13,12,11	599
Region 2	Berm	2,21,22,24	62.08
Region 3	MSW	22,23,31,28,27,25,10,9,8,7,20,6,5,4,3,24	57,022

Current Slip Surface

Slip Surface: 76
F of S: 1.313
Volume: 15,533.356 ft³
Weight: 1,407,300.7 lbs
Resisting Moment: 51,005,082 lbs-ft
Activating Moment: 38,864,702 lbs-ft
Resisting Force: 248,319.22 lbs
Activating Force: 189,314.91 lbs
F of S Rank: 1
Exit: (146.13508, 904.54) ft
Entry: (464.3824, 1,009.2993) ft
Radius: 170.75107 ft
Center: (280.69498, 1,014.7445) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	147.35131	903.99841	0	201.15816	106.95769	100
Slice 2	149.78377	902.91523	0	426.01188	226.51453	100
Slice 3	152.83795	901.5552	0	749.95636	398.75887	100
Slice 4	155.77407	900.24774	0	734.82887	92.830474	0
Slice 5	157.27312	899.76273	0	697.41502	88.104006	0
Slice 6	158.337	899.77337	0	710.87598	89.80452	0

Slice 7	160.73221	899.79732	0	770.9105	97.388645	0
Slice 8	164.19664	899.83197	0	874.20204	110.4374	0
Slice 9	167.66106	899.86661	0	977.49357	123.48616	0
Slice 10	171.12549	899.90125	0	1,080.7851	136.53491	0
Slice 11	174.61268	899.93613	0	1,184.7556	149.66943	0
Slice 12	178.12265	899.97123	0	1,289.4049	162.88973	0
Slice 13	181.63282	900.00634	0	1,394.056	176.11023	0
Slice 14	184.194	900.03195	0	1,470.4271	185.75814	0
Slice 15	186.5628	900.00718	0	1,562.9122	197.44172	0
Slice 16	189.68839	899.94154	0	1,666.1601	210.48496	0
Slice 17	192.81398	899.87591	0	1,769.4079	223.5282	0
Slice 18	195.93958	899.81027	0	1,872.6558	236.57144	0
Slice 19	199.06517	899.74463	0	1,975.9037	249.61468	0
Slice 20	202.19818	899.67886	0	2,079.3912	262.6882	0
Slice 21	205.41081	899.61139	0	2,185.5237	276.09585	0
Slice 22	208.69251	899.54246	0	2,293.9242	289.79002	0
Slice 23	211.97109	899.47361	0	2,402.2257	303.47168	0
Slice 24	215.24967	899.40476	0	2,510.5272	317.15334	0
Slice 25	218.52825	899.33591	0	2,618.8286	330.83499	0
Slice 26	221.80683	899.26706	0	2,727.1301	344.51665	0
Slice 27	225.08541	899.19821	0	2,835.4316	358.19831	0
Slice 28	228.48378	899.12684	0	2,947.6902	372.37987	0
Slice 29	232.00194	899.05296	0	3,063.9058	387.06131	0
Slice 30	234.38051	899.01479	0	3,119.4031	394.07226	0

Slice 31	235.49935	899.01256	0	3,154.144	398.46105	0
Slice 32	237.66853	899.04764	0	3,191.1194	403.13213	0
Slice 33	241.00818	899.11978	0	3,286.7304	415.2106	0
Slice 34	244.20602	899.18885	0	3,378.2815	426.7762	0
Slice 35	247.26205	899.25486	0	3,465.7729	437.82894	0
Slice 36	250.31808	899.32087	0	3,553.2643	448.88167	0
Slice 37	253.47889	899.38914	0	3,643.7552	460.31332	0
Slice 38	256.74446	899.45968	0	3,737.2455	472.1239	0
Slice 39	260.01004	899.53022	0	3,830.7359	483.93448	0
Slice 40	263.27561	899.60074	0	3,924.2368	495.7464	0
Slice 41	266.5827	899.67218	0	4,018.8972	507.70479	0
Slice 42	269.9313	899.74452	0	4,114.7724	519.81663	0
Slice 43	273.2799	899.81685	0	4,210.6397	531.92749	0
Slice 44	276.6285	899.88918	0	4,306.5069	544.03835	0
Slice 45	279.9771	899.96151	0	4,402.3742	556.1492	0
Slice 46	283.3257	900.03384	0	4,498.2415	568.26006	0
Slice 47	285.14415	900.0669	0	4,622.1715	583.91605	0
Slice 48	287.00871	900.02663	0	4,684.0528	591.73348	0
Slice 49	290.44882	899.95231	0	4,797.8957	606.11518	0
Slice 50	293.88822	899.87801	0	4,911.726	620.4953	0
Slice 51	297.32761	899.80372	0	5,025.5564	634.87541	0
Slice 52	300.767	899.72943	0	5,139.3867	649.25553	0
Slice 53	304.15837	899.65618	0	5,251.6274	663.43483	0
Slice 54	307.5017	899.58396	0	5,362.2786	677.41332	0

Slice 55	310.84503	899.51175	0	5,472.9297	691.39181	0
Slice 56	314.18837	899.43953	0	5,583.5808	705.3703	0
Slice 57	317.5317	899.36732	0	5,694.232	719.34879	0
Slice 58	320.87503	899.2951	0	5,804.8831	733.32728	0
Slice 59	324.0125	899.22733	0	5,908.721	746.44505	0
Slice 60	326.94411	899.16401	0	6,005.7456	758.70211	0
Slice 61	329.87572	899.10068	0	6,102.7702	770.95917	0
Slice 62	332.80732	899.03736	0	6,199.7948	783.21623	0
Slice 63	334.63656	899.00165	0	6,236.1477	787.80866	0
Slice 64	335.41544	898.99297	0	6,261.0674	790.95675	0
Slice 65	337.44193	898.98512	0	6,303.7858	796.35335	0
Slice 66	340.66404	898.97867	0	6,403.7928	808.98717	0
Slice 67	343.88615	898.97223	0	6,503.7998	821.62099	0
Slice 68	347.23805	898.96552	0	6,607.8354	834.76374	0
Slice 69	350.71975	898.95856	0	6,715.8995	848.41541	0
Slice 70	354.20145	898.9516	0	6,823.9636	862.06707	0
Slice 71	357.46338	898.94507	0	6,925.2066	874.85704	0
Slice 72	360.50555	898.93899	0	7,019.6286	886.78531	0
Slice 73	363.54772	898.9329	0	7,114.0505	898.71358	0
Slice 74	366.58988	898.92682	0	7,208.4725	910.64185	0
Slice 75	369.63205	898.92074	0	7,302.8945	922.57012	0
Slice 76	372.67422	898.91465	0	7,397.3165	934.49839	0
Slice 77	375.99608	898.90801	0	7,500.4197	947.52336	0
Slice 78	379.59765	898.9008	0	7,612.2042	961.64502	0

Slice 79	383.19922	898.8936	0	7,723.9886	975.76668	0
Slice 80	386.8098	898.88638	0	7,836.105	989.93027	0
Slice 81	390.56285	898.87887	0	7,952.6991	1,004.6595	0
Slice 82	394.44936	898.8711	0	8,073.4391	1,019.9125	0
Slice 83	398.01854	898.95294	0	8,014.6208	1,012.4821	0
Slice 84	401.27038	899.12438	0	8,091.3079	1,022.1699	0
Slice 85	404.52223	899.29583	0	8,167.995	1,031.8577	0
Slice 86	407.77408	899.46728	0	8,244.6821	1,041.5456	0
Slice 87	409.49989	899.69182	0	5,612.8636	709.06956	0
Slice 88	410.96673	901.73038	0	3,986.2411	2,791.1961	300
Slice 89	413.70064	905.52986	0	3,853.7699	2,698.4388	300
Slice 90	416.42125	909.3419	0	3,683.815	2,579.435	300
Slice 91	419.12855	913.1665	0	3,551.0089	2,486.4432	300
Slice 92	421.83585	916.9911	0	3,418.2028	2,393.4513	300
Slice 93	424.86535	921.36682	0	3,185.8307	2,230.7427	300
Slice 94	428.21705	926.29368	0	3,016.5512	2,112.2119	300
Slice 95	431.58191	931.66945	0	2,546.1505	1,782.8338	300
Slice 96	434.95994	937.49415	0	2,356.18	1,649.815	300
Slice 97	438.33796	943.31885	0	2,166.2094	1,516.7962	300
Slice 98	441.71599	949.14355	0	1,976.2389	1,383.7774	300
Slice 99	445.36605	956.02868	0	1,550.142	1,085.4211	300
Slice 100	449.28815	963.97423	0	1,307.6721	915.64183	300
Slice 101	452.1934	970.71385	0	785.11724	549.74501	300
Slice 102	455.2996	979.3941	0	612.38924	428.79956	300

Slice 103	459.1918	991.30544	0	202.39348	141.71744	300
Slice 104	462.6522	1,003.3013	0	-68.577847	-48.018725	300

APPENDIX F.3
FINAL COVER SLOPE STABILITY AND GEOCOMPOSITE CALCULATIONS

Prep By: JGW
Date: 08/28/15

Chkd By: JCO
Date: 08/28/15

SEVEN MILE CREEK LANDFILL
PROJECT # 150652

FINAL COVER SLOPE STABILITY ANALYSIS FOR 1.30 FACTOR OF SAFETY

REQUIRED:

Calculate the required shear strength to achieve a factor of safety of 1.30 for the final cover 4:1 slopes using the infinite slope mythology and peak interface shear test results.

SOLUTION:

Description	Stability Calculations		
	Below Cap FML	**Above Cap FML, Geocomposite Thickness Saturated Conditions**	**Above Cap FML, Fully Saturated Protective Cover**
Sideslope Slope, s	4:1	4:1	4:1
Sideslope Slope, s	25 %	25 %	25 %
Sideslope Slope, β	14.04 deg	14.04 deg	14.04 deg
Drainage Material Depth, t	2.5 feet	2.5 feet	2.5 feet
Depth of Saturation, h	0.0 feet	0.0167 feet	2.5 feet
Drainage Material Unit Weight, γ	130 pcf	130 pcf	130 pcf
Cohesion, C	0 psf	0 psf	0 psf
Assumed Shear Strength to Achieve Required Factor of Safety , ϕ	**18.0 deg**	**18.1 deg**	**32.0 deg**
Seismic Coefficient, n	0.0 g	0.0 g	0.000 g
Applied Normal Load, $N = \gamma \times t$	325 psf	325 psf	325 psf
Effective Normal Load, $N = \gamma \times t - (h*62.4)$	325 psf	324 psf	169 psf
DRIVING FORCES, $Fd = \gamma \times t \times \sin(\beta) \times (1+n)$	78.8 psf	78.8 psf	78.8 psf
RESISTANT FORCES, $Fr = C + (((\gamma \times t) - (h \times 62.4)) \times \cos(\beta) \times \tan(\phi))$	102.5 psf	102.5 psf	102.5 psf
Factor of Safety, FS = Fr / Fd	**1.30**	**1.301**	**1.300**

CONCLUSION:

The required shear strengths to achieve a factor of safety of 1.30 are calculated above and considered to be the minimum shear strength required for the final cap. Once the cover soil is selected, a calculation should be performed if the equivalent shear strength of the geocomposite / cover soil interface, $Fr = c + N \times \tan(\phi)$ is less than 32.0^{O} to show that the geocoposite will have adequate drainage capacity so that no head build-up above the geocomposite occurs.

SEVEN MILE CREEK LANDFILL
PROJECT # 150652

EVALUATION OF FINAL CAP GEOCOMPOSITE CAPACITY

REQUIRED:

Evaluate the assumed cover soil permeability for the final cap geocomposite capacity considering the maximum flow length for the geocomposite to an outlet.

CALCULATE DESIGN FLOW RATE:

Maximum design flow rate to the geocomposite is the horizontal slope area of the geocomposite (in direction of landfill slope) multiplied by the percolation into the geocomposite. Percolation is assumed to be limited by the soil cover permeability.

Design flow rate, Qd = kia, where:

k = assumed soil cover permeability =	3.23E-05	cm / sec	=	1.06E-06	ft / sec
i = gradient = 1 for vertical flow =	1				
a = geocomposite drainage area equal to maximum slope length (l) x 1 foot unit width =	224.0	ft^2 / ft			
H = maximum height between geocomposite drainage outlets = l / 4	56.0	ft			
Design flow rate, Qd =	2.37E-04	ft^3 / ft -sec	=	0.106	gal / ft - min

SOLUTION:

Determine capacity of geocomposite per unit width

Qc = T x i x w

where:

T = transmissivity of geocomposite

i = gradient

w = unit width = 1.0 foot

Transmissivity for 200 mil DS 8 oz/sy geocomposite for 100 hour testing = 3.20E-04 m^2 / sec

Apply Reduction Factors to transmissivity per GRI GC8

Reduction factor for creep RFcr =	1.1
Reduction factor for chemical clogging RFcc =	1.1
Reduction factor for biological clogging RFbc =	2.0
Total reduction factor, RF = RDcc x RFbc =	2.4

Transmissivity with reduction factors =	1.32E-04	m^2 / sec	=	1.42E-03	ft^2 / sec
i = gradient for flow of geocomposite =	0.25				
Qc =	3.56E-04	ft^3 / ft -sec	=	0.160	gal / ft - min
Factor of Safety, FS = Qc / Qd =	**1.50**				

CONCLUSION: the maximu final cover soil permeability for the geocomposite capacity = 3.23 x 10^{-5} cm/sec

Summary of Seven Mile Creek Landfill 2014 Final Cap Shear Test Results

ASTM Test	Inteface / Normal Load (psf)	Shear Strength	
		C (psf)	ϕ (deg)
D5321	Cover Soil vs Skaps TN220-2-8 DS Geocomposite	44	33.3
D5321	Skaps TN220-2-8 DS Geocomposite vs Agru 40 mil LLDPE dull side (psf)	217	28.5
D6243	Agru 40 mil LLDPE shiny side down vs Bentomat ST GCL woven side (psf)	14	36
D6243	Bentomat ST GCL nonwoven side vs Brick borrow barrier soil (psf)	303	16.9

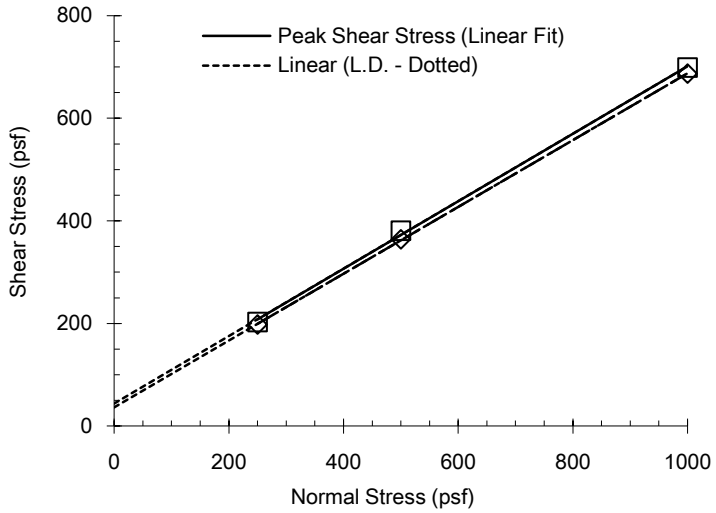
Interface Friction Test Report

Client: **Advanced Disposal Systems**
Project: **Seven Mile Creek Landfill**
Date: 08-13-2014 to 08-15-2014

TRI Log#: E2388-32-03
Test Method: ASTM D5321

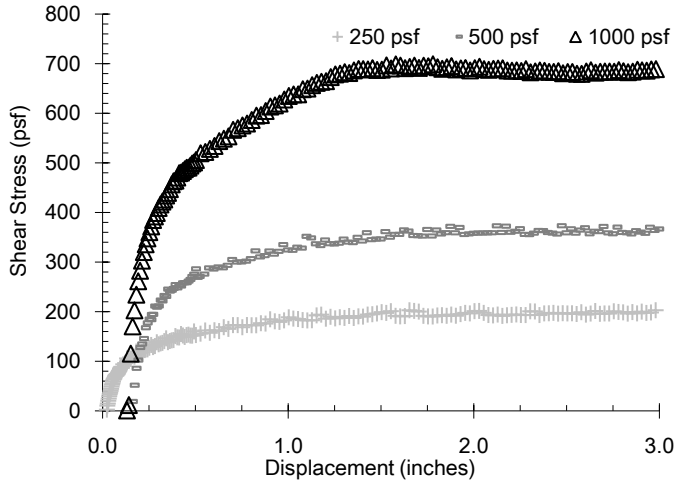
Richard Lacey, P.E. 08/15/2014
Quality Review/Date

Tested Interface: On Site Cover Soil v Skaps Industries TN220-2-8 DS Geocomposite



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	33.3	33.1
Y-intercept or Adhesion (psf):	44	36

Shearing occurred at the interface.



Test Conditions

Upper Box &	On Site Cover Soil placed at 104.3 pcf at 11.7% w.c.
Lower Box	Skaps Industries TN220-2-8 Geocomposite
Box Dimensions:	12"x12"x4"
Interface Conditioning:	Interface soaked and loading applied for a minimum of 16 hours prior to shear.
Test Condition:	Wet
Shearing Rate:	0.04 inches/minute

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	10	13	18
Normal Stress (psf)	250	500	1000
Corrected Peak Shear Stress (psf)	203	381	699
Corrected Large Displacement Shear Stress (psf)	198	364	687
Peak Secant Angle (degrees)	39.1	37.3	34.9
Large Displacement Secant Angle (degrees)	38.4	36.1	34.5

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

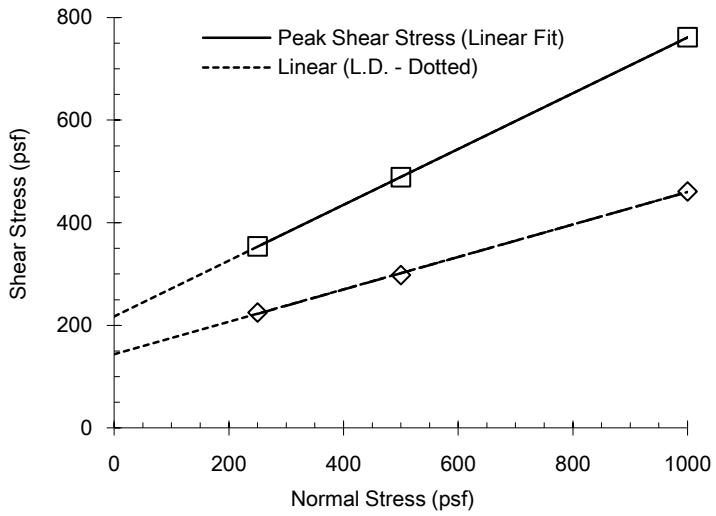
Interface Friction Test Report

Client: **Advanced Disposal Systems**
Project: **Seven Mile Creek Landfill**
Date: 08-12-2014 to 08-13-2014

TRI Log#: E2388-32-03
Test Method: ASTM D5321

Richard Lacey, P.E. 08/13/2014
Quality Review/Date

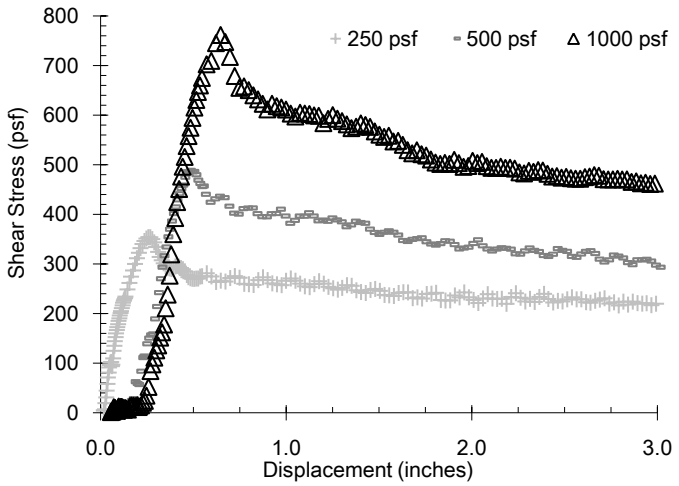
Tested Interface: Skaps Industries TN220-2-8 DS Geocomposite v Agru 40-mil LLDPE Microspike Geomembrane (G14C277073)



Test Results

	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	28.5	17.6
Y-intercept or Adhesion (psf):	217	144

Shearing occurred at the interface.



Test Conditions

Upper Box & Lower Box: Skaps Industries TN220-2-8 Geocomposite

Lower Box: Agru 40-mil LLDPE Microspike Geomembrane - dull side up

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 16 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.20 inches/minute

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	10	13	18
Normal Stress (psf)	250	500	1000
Corrected Peak Shear Stress (psf)	354	489	762
Corrected Large Displacement Shear Stress (psf)	225	298	461
Peak Secant Angle (degrees)	54.8	44.3	37.3
Large Displacement Secant Angle (degrees)	42.0	30.8	24.7
Asperity (mils)	24.2	23.4	23.6

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

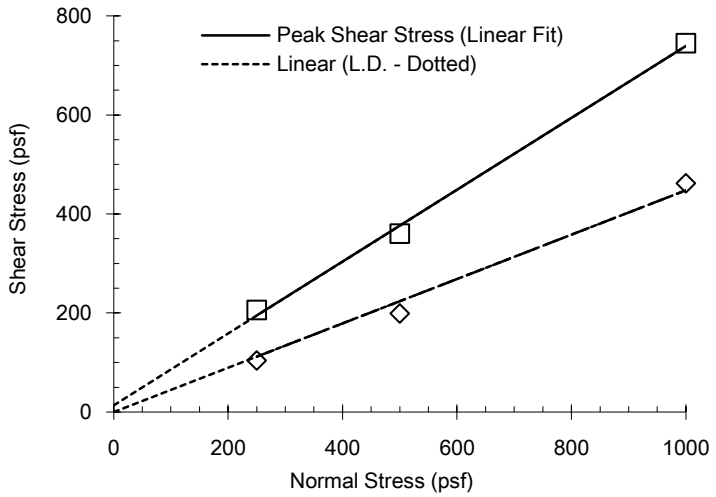
Interface Friction Test Report

Client: **Advanced Disposal Systems**
Project: **Seven Mile Creek Landfill**
Date: 08-14-2014 to 08-18-2014

TRI Log#: E2388-32-03
Test Method: ASTM D6243

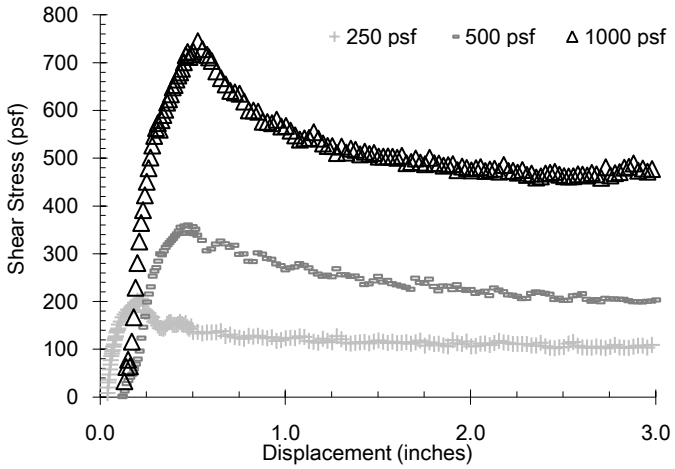
John Allen, P.E. 08/19/2014
Quality Review/Date

Tested Interface: Bentomat ST GCL (4811) v Agru 40-mil LLDPE Microspike Geomembrane (G14C277073)



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	36.0	24.1
Y-intercept or Adhesion (psf):	14	0

Shearing occurred at the interface. The large displacement friction angle regression analysis was adjusted to fit a zero y-intercept.



Test Conditions

Upper Box & Lower Box: Bentomat ST GCL-woven side down; Agru 40-mil LLDPE Microspike Geomembrane - shiny side up

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 24 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	10	13	18
Normal Stress (psf)	250	500	1000
Corrected Peak Shear Stress (psf)	206	360	745
Corrected Large Displacement Shear Stress (psf)	104	199	462
Peak Secant Angle (degrees)	39.5	35.8	36.7
Large Displacement Secant Angle (degrees)	22.6	21.7	24.8
Asperity (mils)	23.4	23.6	24.4

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

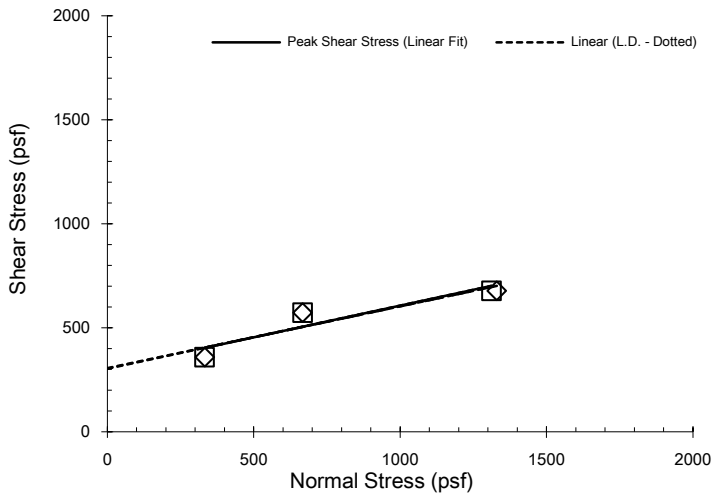
Interface Friction Test Report

Client: **Advanced Disposal Systems**
Project: **Seven Mile Creek Landfill**
Date: 08-15-2014 to 08-18-2014

TRI Log#: E2388-32-03
Test Method: ASTM D6243

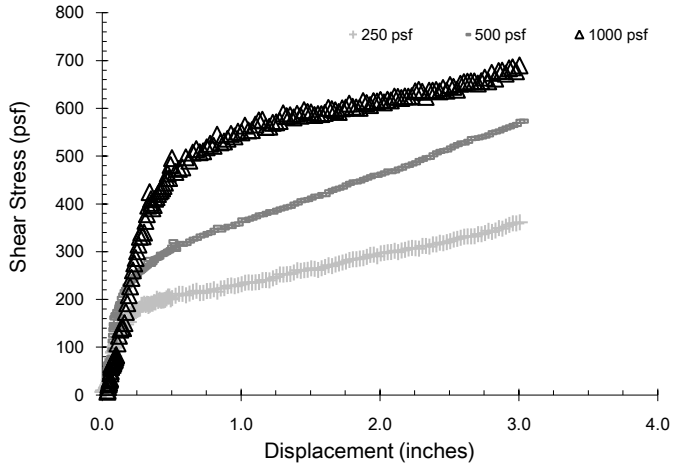
John M. Allen, P.E., 08/19/2014
Quality Review/Date

Tested Interface: Bentomat ST GCL (4811) vs. Brick Borrow -Upper Barrier Soil



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	16.9	16.5
Y-intercept or Adhesion (psf):	303	306

Shearing occurred at the interface. An area correction was applied.



Test Conditions	
Upper Box &	Bentomat ST GCL (non-woven side down)
Lower Box	Brick Borrow Upper Barrier Soil remolded to 90% of maximum dry density at the optimum moisture content +4% or 106.6 pcf at 15.8%
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked and loading applied for a minimum of 24 hours prior to shear.
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

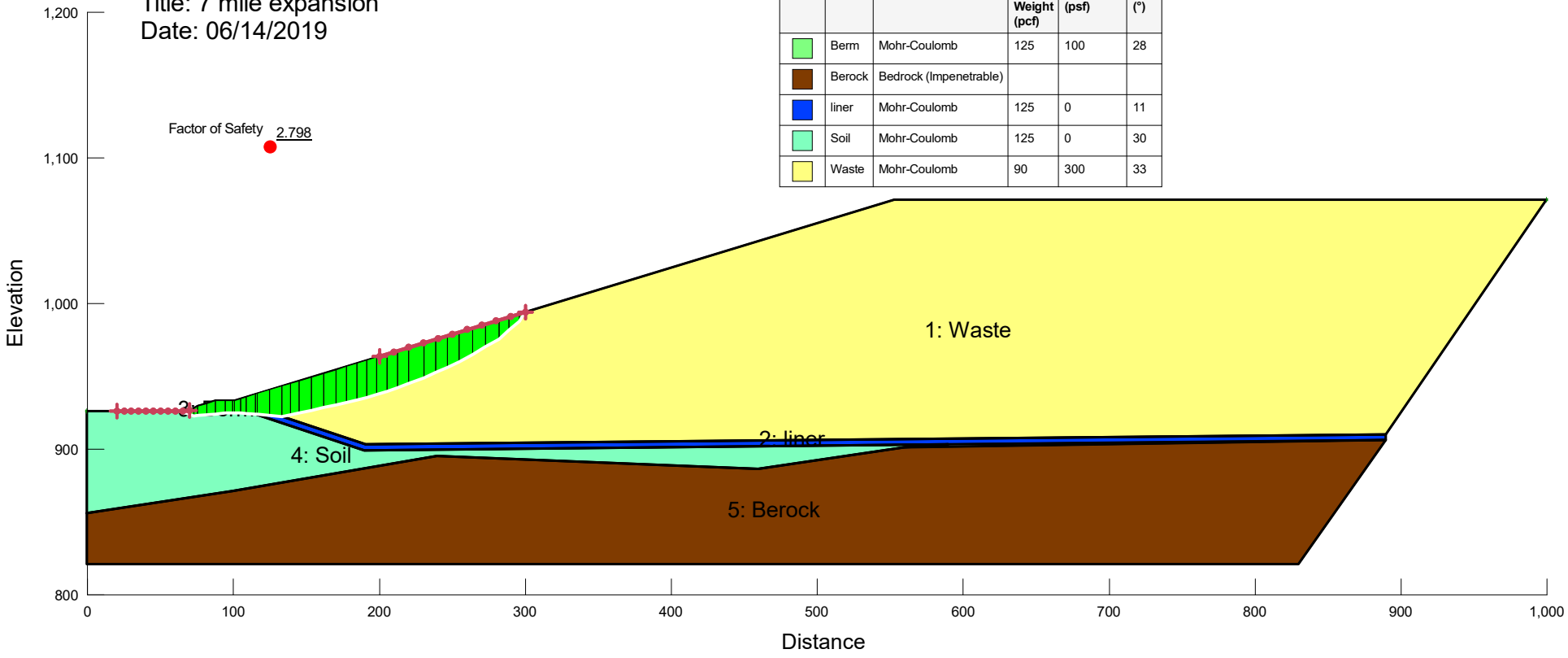
Test Data			
Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	10	13	18
Area Corrected Normal Stress (psf)	332	667	1312
Area Corrected Peak Shear Stress (psf)	359	573	678
Area Corrected Large Displacement Normal Stress (psf)	333	667	1330
Area Corrected Large Displacement Shear Stress (psf)	359	573	678
Peak Secant Angle (degrees)	47.2	40.7	27.3
Large Displacement Secant Angle (degrees)	47.2	40.7	27.0
Asperity (mils)	- -	- -	- -

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

APPENDIX T-3B
SLOPE STABILITY OUTPUTS FOR FOUNDATION AND LINER SYSTEM

File Version: 9.00
Title: 7 mile expansion
Date: 06/14/2019

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Berm	Mohr-Coulomb	125	100	28
	Berock	Bedrock (Impenetrable)			
	liner	Mohr-Coulomb	125	0	11
	Soil	Mohr-Coulomb	125	0	30
	Waste	Mohr-Coulomb	90	300	33



Slope Stability

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File Information

File Version: 9.00
Title: 7 mile expansion
Created By: Hullings, Donald
Last Edited By: Hullings, Donald
Revision Number: 11
Date: 06/14/2019
Time: 01:57:04 PM
Tool Version: 9.0.5.16316
File Name: North-South - circular waste.gsz
Directory: C:\Users\donald.hullings\Desktop\
Last Solved Date: 06/19/2019
Last Solved Time: 05:40:47 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Slope Stability

Description: N-S Section
Kind: SLOPE/W
Method: Spencer
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
F of S Calculation Option: Constant
Advanced
Geometry Settings
Minimum Slip Surface Depth: 0.1 ft
Number of Slices: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Waste

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 33 °
Phi-B: 0 °

liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Soil

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Berock

Model: Bedrock (Impenetrable)

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (20, 926.3959) ft
Left-Zone Right Coordinate: (70, 926.644) ft
Left-Zone Increment: 10
Right Type: Range
Right-Zone Left Coordinate: (200, 963.7731) ft
Right-Zone Right Coordinate: (300, 994.304) ft
Right-Zone Increment: 10
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-0.4962, 926.3959) ft
Right Coordinate: (999.5038, 1,071.3959) ft

Points

	X	Y
Point 1	-0.4962 ft	926.3959 ft
Point 2	69.5038 ft	926.3959 ft
Point 3	75.5038 ft	929.3959 ft
Point 4	87.5038 ft	933.3959 ft
Point 5	100.5038 ft	933.3959 ft
Point 6	552.5038 ft	1,071.3959 ft
Point 7	999.5038 ft	1,071.3959 ft
Point 8	99.5038 ft	929.3959 ft
Point 9	108.5038 ft	926.3959 ft
Point 10	190.5038 ft	903.3959 ft
Point 11	889.5038 ft	910.3959 ft
Point 12	189.5038 ft	899.3959 ft
Point 13	589.5038 ft	903.3959 ft
Point 14	889.5038 ft	906.3959 ft
Point 15	-0.4962 ft	856.3959 ft
Point 16	99.5038 ft	871.3959 ft
Point 17	239.5038 ft	895.3959 ft
Point 18	459.5038 ft	886.3959 ft
Point 19	559.5038 ft	901.3959 ft
Point 20	829.5038 ft	821.3959 ft
Point 21	-0.4962 ft	821.3959 ft

Regions

	Material	Points	Area
Region 1	Waste	5,6,7,11,10	1.0642e+05 ft²

Region 2	liner	3,4,5,10,11,14,13,12,9,8	3,258.5 ft²
Region 3	Berm	2,3,8,9	94.5 ft²
Region 4	Soil	1,2,9,12,13,19,18,17,16,15	12,957 ft²
Region 5	Berock	15,16,17,18,19,14,20,21	60,145 ft²

Current Slip Surface

Slip Surface: 606
Factor of Safety: 2.798
Volume: 4,193.4662 ft³
Weight: 390,361.49 lbf
Resisting Moment: 89,241,469 lbf·ft
Activating Moment: 31,895,281 lbf·ft
Resisting Force: 266,411.96 lbf
Activating Force: 95,185.803 lbf
Slip Rank: 1 of 606 slip surfaces
Exit: (63.054855, 926.3959) ft
Entry: (299.73056, 994.22177) ft
Radius: 115.8141 ft
Center: (101.92365, 1,236.3152) ft

Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength
Slice 1	66.279328 ft	925.23667 ft	0 psf	187.7173 psf	108.37863 psf	0 psf
Slice 2	71.0846 ft	923.50912 ft	0 psf	595.45429 psf	343.7857 psf	0 psf
Slice 3	74.0846 ft	923.07014 ft	0 psf	710.95626 psf	410.47079 psf	0 psf
Slice 4	78.5038 ft	923.47288 ft	0 psf	876.39262 psf	505.98552 psf	0 psf
Slice 5	84.5038 ft	924.01969 ft	0 psf	1,060.3535 psf	612.19539 psf	0 psf
Slice 6	90.8834 ft	924.6011 ft	0 psf	1,113.3439 psf	642.78937 psf	0 psf
Slice 7	96.8834 ft	924.92364 ft	0 psf	1,118.9372 psf	646.01871 psf	0 psf
Slice 8	100.0038 ft	924.94096 ft	0 psf	1,116.6499 psf	644.69814 psf	0 psf
Slice 9	102.7346 ft	924.95612 ft	0 psf	1,151.915 psf	665.05846 psf	0 psf
Slice 10	106.7346 ft	924.83038 ft	0 psf	1,289.8887 psf	744.71761 psf	0 psf

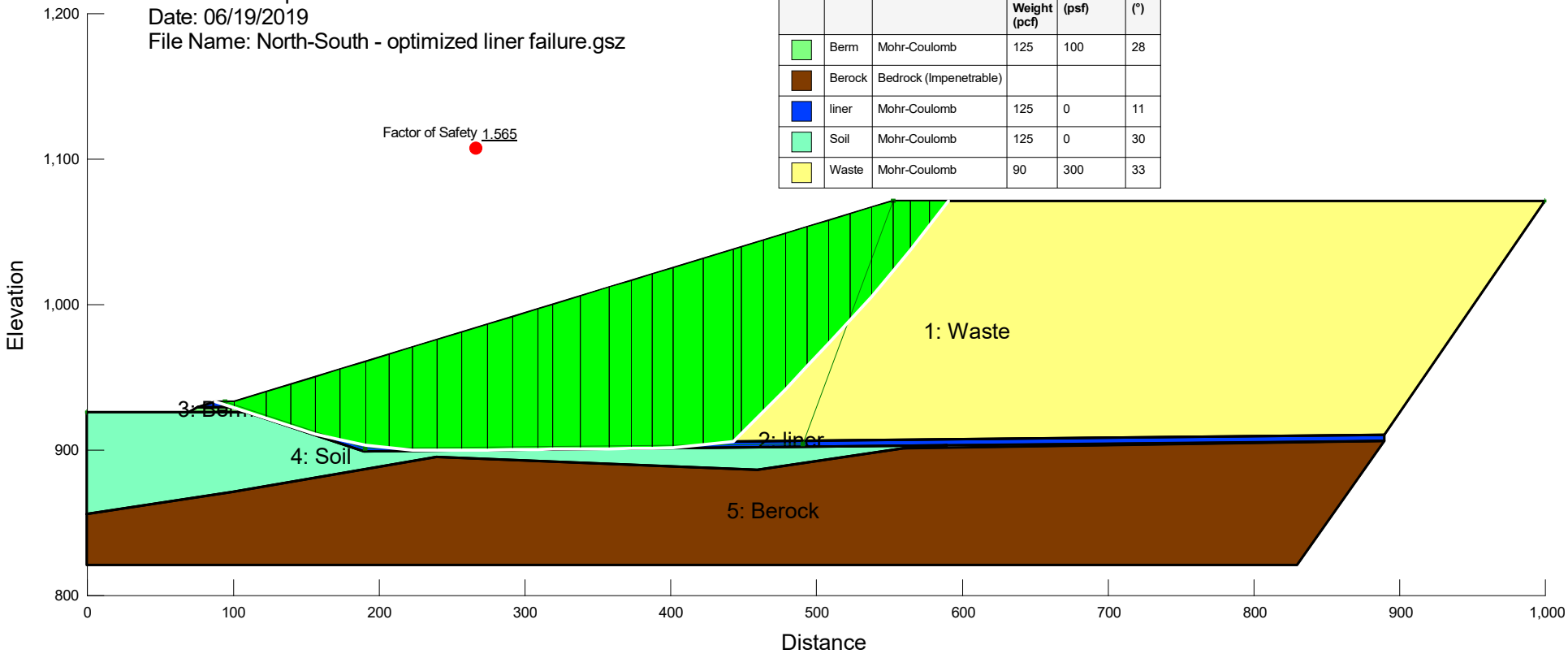
Slice 11	111.84078 ft	924.43176 ft	0 psf	1,433.9285 psf	827.87903 psf	0 psf
Slice 12	115.79098 ft	924.12337 ft	0 psf	1,467.7111 psf	285.29413 psf	0 psf
Slice 13	120.53467 ft	923.68525 ft	0 psf	1,613.1638 psf	313.56728 psf	0 psf
Slice 14	128.79563 ft	922.90475 ft	0 psf	1,853.6592 psf	360.31485 psf	0 psf
Slice 15	135.99545 ft	923.15723 ft	0 psf	1,825.9951 psf	1,185.8151 psf	300 psf
Slice 16	142.066 ft	924.42843 ft	0 psf	1,876.2604 psf	1,218.4577 psf	300 psf
Slice 17	149.25302 ft	925.92947 ft	0 psf	1,937.0969 psf	1,257.9654 psf	300 psf
Slice 18	157.62465 ft	927.6746 ft	0 psf	2,007.1318 psf	1,303.4466 psf	300 psf
Slice 19	165.99628 ft	929.41973 ft	0 psf	2,077.1666 psf	1,348.9278 psf	300 psf
Slice 20	173.72492 ft	931.1704 ft	0 psf	2,085.9269 psf	1,354.6168 psf	300 psf
Slice 21	180.81055 ft	932.9266 ft	0 psf	2,120.4338 psf	1,377.0258 psf	300 psf
Slice 22	187.89618 ft	934.6828 ft	0 psf	2,154.9407 psf	1,399.4348 psf	300 psf
Slice 23	194.82532 ft	936.5977 ft	0 psf	2,107.6604 psf	1,368.7307 psf	300 psf
Slice 24	201.59797 ft	938.6713 ft	0 psf	2,107.1784 psf	1,368.4177 psf	300 psf
Slice 25	208.74498 ft	941.0274 ft	0 psf	2,046.2078 psf	1,328.8229 psf	300 psf
Slice 26	216.26632 ft	943.666 ft	0 psf	2,018.5509 psf	1,310.8623 psf	300 psf
Slice 27	225.255 ft	947.0369 ft	0 psf	1,927.5825 psf	1,251.7867 psf	300 psf
Slice 28	234.52073 ft	950.89052 ft	0 psf	1,798.1552 psf	1,167.7357 psf	300 psf
Slice 29	242.5962 ft	954.49455 ft	0 psf	1,709.969 psf	1,110.4669 psf	300 psf
Slice 30	250.67167 ft	958.09858 ft	0 psf	1,621.7829 psf	1,053.1981 psf	300 psf
Slice 31	259.22608 ft	962.52917 ft	0 psf	1,386.6767 psf	900.51835 psf	300 psf
Slice 32	268.25945 ft	967.7863 ft	0 psf	1,203.8695 psf	781.80202 psf	300 psf
Slice 33	277.29282 ft	973.04343 ft	0 psf	1,021.0624 psf	663.08569 psf	300 psf
				679.1471 psf	441.04328 psf	300 psf

Slice 34	285.30388 ft	978.71625 ft	0 psf			
Slice 35	292.29262 ft	984.80475 ft	0 psf	420.5735 psf	273.12363 psf	300 psf
Slice 36	297.75878 ft	991.03538 ft	0 psf	50.252165 psf	32.634138 psf	300 psf

Seven Mile Creek Landfill

Title: 7 mile expansion
Date: 06/19/2019
File Name: North-South - optimized liner failure.gsz

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Berm	Mohr-Coulomb	125	100	28
	Berock	Bedrock (Impenetrable)			
	liner	Mohr-Coulomb	125	0	11
	Soil	Mohr-Coulomb	125	0	30
	Waste	Mohr-Coulomb	90	300	33



Slope Stability

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File Information

File Version: 9.00
Title: 7 mile expansion
Created By: Hullings, Donald
Last Edited By: Hullings, Donald
Revision Number: 17
Date: 06/19/2019
Time: 05:38:22 PM
Tool Version: 9.0.5.16316
File Name: North-South - optimized liner failure.gsz
Directory: C:\Users\donald.hullings\Desktop\
Last Solved Date: 06/19/2019
Last Solved Time: 05:38:26 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Slope Stability

Description: N-S Section
Kind: SLOPE/W
Method: Spencer
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Fully-Specified
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
F of S Calculation Option: Constant
Advanced
Geometry Settings
Minimum Slip Surface Depth: 0.1 ft
Number of Slices: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Waste

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 33 °
Phi-B: 0 °

liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Soil

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Berock

Model: Bedrock (Impenetrable)

Fully Specified Slip Surfaces

Fully Specified Slip Surface 1

	X	Y
	94.5038 ft	933.3959 ft
	190.5038 ft	901.3959 ft
	490.5038 ft	904.3959 ft
	552.5038 ft	1,071.3959 ft

Slip Surface Limits

Left Coordinate: (-0.4962, 926.3959) ft
Right Coordinate: (999.5038, 1,071.3959) ft

Points

	X	Y
Point 1	-0.4962 ft	926.3959 ft
Point 2	69.5038 ft	926.3959 ft
Point 3	75.5038 ft	929.3959 ft
Point 4	87.5038 ft	933.3959 ft
Point 5	100.5038 ft	933.3959 ft
Point 6	552.5038 ft	1,071.3959 ft
Point 7	999.5038 ft	1,071.3959 ft
Point 8	99.5038 ft	929.3959 ft
Point 9	108.5038 ft	926.3959 ft
Point 10	190.5038 ft	903.3959 ft
Point 11	889.5038 ft	910.3959 ft
Point 12	189.5038 ft	899.3959 ft
Point 13	589.5038 ft	903.3959 ft
Point 14	889.5038 ft	906.3959 ft
Point 15	-0.4962 ft	856.3959 ft
Point 16	99.5038 ft	871.3959 ft
Point 17	239.5038 ft	895.3959 ft
Point 18	459.5038 ft	886.3959 ft
Point 19	559.5038 ft	901.3959 ft
Point 20	829.5038 ft	821.3959 ft
Point 21	-0.4962 ft	821.3959 ft

Regions

	Material	Points	Area
Region 1	Waste	5,6,7,11,10	1.0642e+05 ft²
Region 2	liner	3,4,5,10,11,14,13,12,9,8	3,258.5 ft²

Region 3	Berm	2,3,8,9	94.5 ft²
Region 4	Soil	1,2,9,12,13,19,18,17,16,15	12,957 ft²
Region 5	Berock	15,16,17,18,19,14,20,21	60,145 ft²

Current Slip Surface

Slip Surface: 2
Factor of Safety: 1.565
Volume: 38,682.64 ft³
Weight: 3,522,431 lbf
Resisting Moment: 2.6750832e+08 lbf·ft
Activating Moment: 1.7096536e+08 lbf·ft
Resisting Force: 947,014.66 lbf
Activating Force: 605,262.54 lbf
Slip Rank: 1 of 2 slip surfaces
Exit: (87.571496, 933.3959) ft
Entry: (590.51765, 1,071.3959) ft
Radius: 256.96355 ft
Center: (292.31821, 1,105.8959) ft

Slip Slices

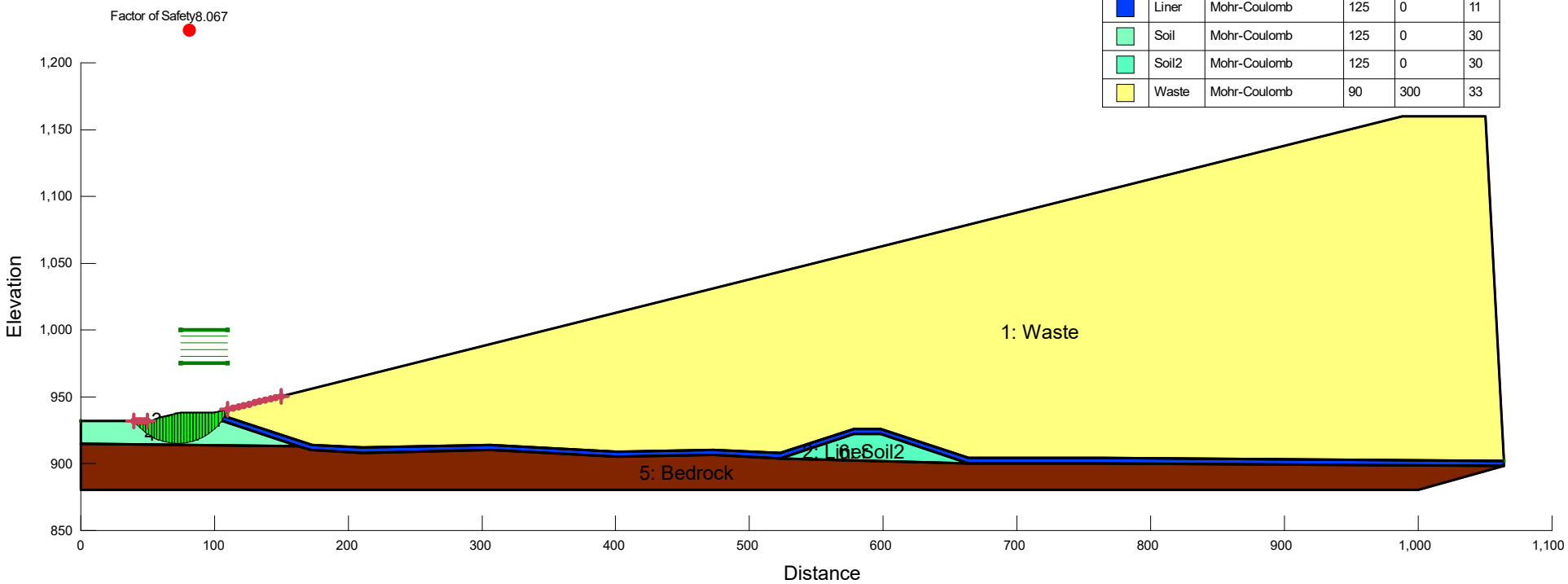
	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength
Slice 1	94.037648 ft	931.24728 ft	0 psf	315.10878 psf	61.250942 psf	0 psf
Slice 2	111.43825 ft	925.46528 ft	0 psf	1,365.9152 psf	265.50703 psf	0 psf
Slice 3	130.80928 ft	919.10365 ft	0 psf	2,648.3466 psf	514.78642 psf	0 psf
Slice 4	147.68242 ft	913.64715 ft	0 psf	3,757.4429 psf	730.37291 psf	0 psf
Slice 5	164.7152 ft	909.02903 ft	0 psf	4,550.2418 psf	884.47741 psf	0 psf
Slice 6	181.99835 ft	905.22933 ft	0 psf	5,389.7752 psf	1,047.6662 psf	0 psf
Slice 7	198.75345 ft	902.49077 ft	0 psf	5,903.2103 psf	1,147.4678 psf	0 psf
Slice 8	214.88975 ft	900.83333 ft	0 psf	6,605.5394 psf	1,283.9868 psf	0 psf
Slice 9	231.38843 ft	900.02135 ft	0 psf	6,928.148 psf	1,346.6955 psf	0 psf
Slice 10	248.24947 ft	900.05485 ft	0 psf	7,406.6842 psf	1,439.7136 psf	0 psf
Slice 11	265.40035 ft	900.16118 ft	0 psf	7,860.2034 psf	1,527.8688 psf	0 psf

Slice 12	282.84105 ft	900.34035 ft	0 psf	8,335.1546 psf	1,620.1899 psf	0 psf
Slice 13	300.28175 ft	900.51952 ft	0 psf	8,810.1058 psf	1,712.5111 psf	0 psf
Slice 14	313.99755 ft	900.7052 ft	0 psf	9,147.8146 psf	1,778.155 psf	0 psf
Slice 15	328.52391 ft	900.86898 ft	0 psf	9,582.7381 psf	1,862.6956 psf	0 psf
Slice 16	348.02731 ft	901.00748 ft	0 psf	10,122.262 psf	1,967.5685 psf	0 psf
Slice 17	365.4252 ft	901.1896 ft	0 psf	10,565.831 psf	2,053.7895 psf	0 psf
Slice 18	380.01943 ft	901.40835 ft	0 psf	10,953.677 psf	2,129.1792 psf	0 psf
Slice 19	394.35708 ft	901.62325 ft	0 psf	11,334.795 psf	2,203.261 psf	0 psf
Slice 20	411.87745 ft	902.74627 ft	0 psf	11,345.273 psf	2,205.2977 psf	0 psf
Slice 21	432.58055 ft	904.77742 ft	0 psf	11,665.553 psf	2,267.5539 psf	0 psf
Slice 22	445.65605 ft	908.62335 ft	0 psf	7,330.3855 psf	4,760.408 psf	300 psf
Slice 23	455.98577 ft	919.00793 ft	0 psf	7,056.1944 psf	4,582.3462 psf	300 psf
Slice 24	471.19732 ft	934.11638 ft	0 psf	6,447.474 psf	4,187.0385 psf	300 psf
Slice 25	486.18476 ft	949.6582 ft	0 psf	5,590.4479 psf	3,630.4793 psf	300 psf
Slice 26	500.94809 ft	965.6334 ft	0 psf	4,947.2877 psf	3,212.8062 psf	300 psf
Slice 27	515.71141 ft	981.6086 ft	0 psf	4,304.1276 psf	2,795.1331 psf	300 psf
Slice 28	530.47474 ft	997.5838 ft	0 psf	3,660.9675 psf	2,377.4601 psf	300 psf
Slice 29	545.1801 ft	1,014.3003 ft	0 psf	2,836.3871 psf	1,841.9713 psf	300 psf
Slice 30	558.5088 ft	1,030.1863 ft	0 psf	2,103.3374 psf	1,365.9233 psf	300 psf
Slice 31	571.01476 ft	1,045.8565 ft	0 psf	1,194.0176 psf	775.40413 psf	300 psf
Slice 32	584.01669 ft	1,062.8828 ft	0 psf	319.43533 psf	207.44373 psf	300 psf

Seven Mile Creek Landfill

Date: 06/27/2019
File Name: east-west foundation.gsz

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock	Bedrock (Impenetrable)			
	Berm	Mohr-Coulomb	125	100	28
	Liner	Mohr-Coulomb	125	0	11
	Soil	Mohr-Coulomb	125	0	30
	Soil2	Mohr-Coulomb	125	0	30
	Waste	Mohr-Coulomb	90	300	33



SLOPE/W Analysis

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File Information

File Version: 9.00
Created By: Hullings, Donald
Last Edited By: Hullings, Donald
Revision Number: 46
Date: 06/27/2019
Time: 01:06:22 PM
Tool Version: 9.0.5.16316
File Name: east-west foundation.gsz
Directory: C:\Users\donald.hullings\Desktop\7 mile\

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Advanced
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Slices: 30
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 100
  - Tolerable difference in F of S: 0.001

Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Waste

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 33 °
Phi-B: 0 °

Liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Soil

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Soil2

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (40, 932) ft
Left-Zone Right Coordinate: (50, 932) ft
Left-Zone Increment: 10
Right Type: Range
Right-Zone Left Coordinate: (110, 940.5) ft
Right-Zone Right Coordinate: (150, 950.5) ft

Right-Zone Increment: 10
Radius Increments: 5

Slip Surface Limits

Left Coordinate: (0, 932) ft
Right Coordinate: (1,064, 902) ft

Points

	X	Y
Point 1	0 ft	932 ft
Point 2	53 ft	932 ft
Point 3	59 ft	934 ft
Point 4	75 ft	938 ft
Point 5	100 ft	938 ft
Point 6	988 ft	1,160 ft
Point 7	1,050 ft	1,160 ft
Point 8	100 ft	934 ft
Point 9	106 ft	932 ft
Point 10	163 ft	913 ft
Point 11	173 ft	914 ft
Point 12	211 ft	912 ft
Point 13	306 ft	914 ft
Point 14	401 ft	909 ft
Point 15	473 ft	910.4 ft
Point 16	523 ft	907.8 ft
Point 17	578 ft	926 ft
Point 18	172 ft	910 ft
Point 19	211 ft	908 ft
Point 20	306 ft	910 ft
Point 21	401 ft	905 ft
Point 22	473 ft	906.4 ft
Point 23	523 ft	903.8 ft
Point 24	578 ft	922 ft
Point 25	1,000 ft	880 ft
Point 26	0 ft	915 ft
Point 27	0 ft	880 ft
Point 28	598 ft	926 ft
Point 29	664 ft	904 ft
Point 30	764 ft	904 ft
Point 31	1,064 ft	902 ft
Point 32	598 ft	922 ft
Point 33	664 ft	900 ft
Point 34	764 ft	900 ft
Point 35	1,064 ft	898 ft

Regions

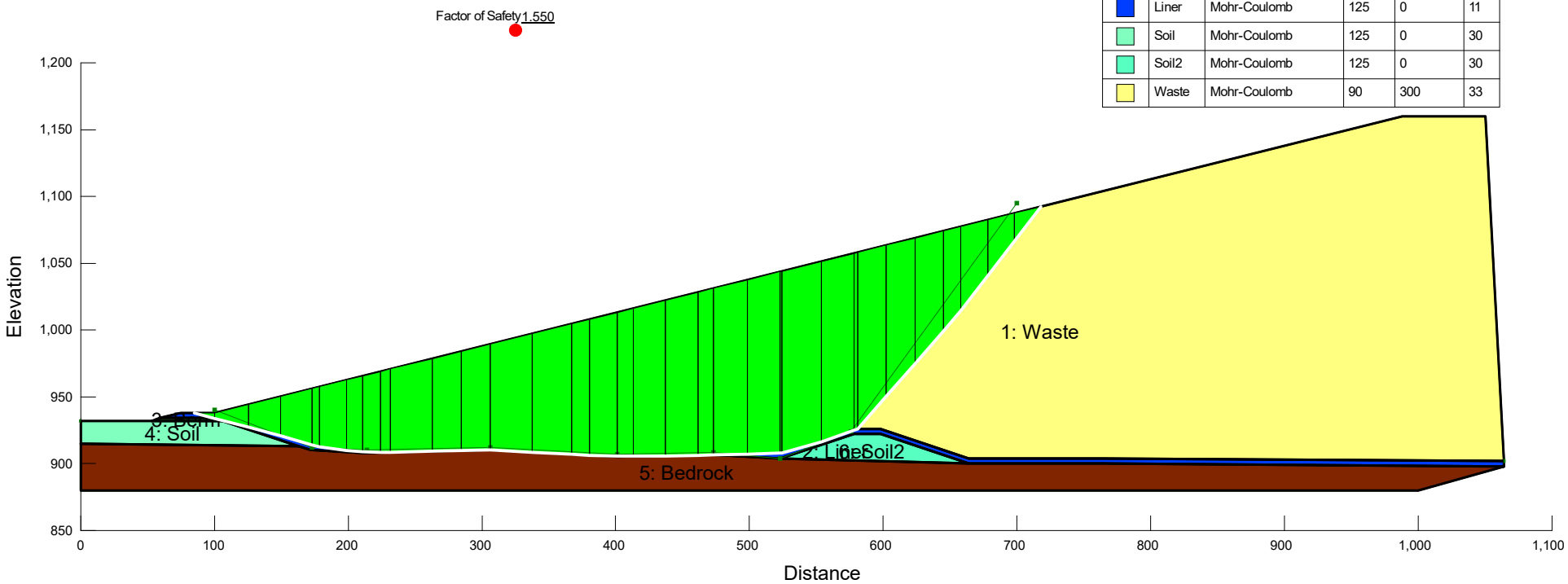
	Material	Points	Area

Region 1	Waste	5,6,7,31,30,29,28,17,16,15,14,13,12,11	1.4065e+05 ft²
Region 2	Liner	3,4,5,11,12,13,14,15,16,17,28,29,30,31,35,34,33,32,24,23,22,21,20,19,18,10,9,8	4,001 ft²
Region 3	Berm	2,3,8,9	94 ft²
Region 4	Soil	1,2,9,10,26	2,392.5 ft²
Region 5	Bedrock	26,10,18,19,20,21,22,23,33,34,35,25,27	25,641 ft²
Region 6	Soil2	23,24,32,33	1,607.6 ft²

Date: 06/27/2019
File Name: east-west optimized liner 1.gsz

Seven Mile Creek Landill

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Bedrock	Bedrock (Impenetrable)			
	Berm	Mohr-Coulomb	125	100	28
	Liner	Mohr-Coulomb	125	0	11
	Soil	Mohr-Coulomb	125	0	30
	Soil2	Mohr-Coulomb	125	0	30
	Waste	Mohr-Coulomb	90	300	33



SLOPE/W Analysis

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File Information

File Version: 9.00
Created By: Hullings, Donald
Last Edited By: Hullings, Donald
Revision Number: 26
Date: 06/27/2019
Time: 01:10:47 PM
Tool Version: 9.0.5.16316
File Name: east-west optimized liner 1.gsz
Directory: C:\Users\donald.hullings\Desktop\7 mile\
Last Solved Date: 06/27/2019
Last Solved Time: 01:10:50 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Fully-Specified
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Advanced
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Slices: 30
- Factor of Safety Convergence Settings

Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Waste

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 33 °
Phi-B: 0 °

Liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 11 °
Phi-B: 0 °

Berm

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °

Soil

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Bedrock

Model: Bedrock (Impenetrable)

Soil2

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

Fully Specified Slip Surfaces

Fully Specified Slip Surface 1

	X	Y
	100 ft	940 ft

	173 ft	912 ft
	214 ft	910 ft
	306 ft	912 ft
	401 ft	907 ft
	473 ft	908.4 ft
	523 ft	903.8 ft
	576 ft	924 ft
	700 ft	1,095 ft

Slip Surface Limits

Left Coordinate: (0, 932) ft
Right Coordinate: (1,064, 902) ft

Points

	X	Y
Point 1	0 ft	932 ft
Point 2	53 ft	932 ft
Point 3	59 ft	934 ft
Point 4	75 ft	938 ft
Point 5	100 ft	938 ft
Point 6	988 ft	1,160 ft
Point 7	1,050 ft	1,160 ft
Point 8	100 ft	934 ft
Point 9	106 ft	932 ft
Point 10	163 ft	913 ft
Point 11	173 ft	914 ft
Point 12	211 ft	912 ft
Point 13	306 ft	914 ft
Point 14	401 ft	909 ft
Point 15	473 ft	910.4 ft
Point 16	523 ft	907.8 ft
Point 17	578 ft	926 ft
Point 18	172 ft	910 ft
Point 19	211 ft	908 ft
Point 20	306 ft	910 ft
Point 21	401 ft	905 ft
Point 22	473 ft	906.4 ft
Point 23	523 ft	903.8 ft
Point 24	578 ft	922 ft
Point 25	1,000 ft	880 ft
Point 26	0 ft	915 ft

Point 27	0 ft	880 ft
Point 28	598 ft	926 ft
Point 29	664 ft	904 ft
Point 30	764 ft	904 ft
Point 31	1,064 ft	902 ft
Point 32	598 ft	922 ft
Point 33	664 ft	900 ft
Point 34	764 ft	900 ft
Point 35	1,064 ft	898 ft

Regions

	Material	Points	Area
Region 1	Waste	5,6,7,31,30,29,28,17,16,15,14,13,12,11	1.4065e+05 ft²
Region 2	Liner	3,4,5,11,12,13,14,15,16,17,28,29,30,31,35,34,33,32,24,23,22,21,20,19,18,10,9,8	4,001 ft²
Region 3	Berm	2,3,8,9	94 ft²
Region 4	Soil	1,2,9,10,26	2,392.5 ft²
Region 5	Bedrock	26,10,18,19,20,21,22,23,33,34,35,25,27	25,641 ft²
Region 6	Soil2	23,24,32,33	1,607.6 ft²

Current Slip Surface

Slip Surface: 2
Factor of Safety: 1.550
Volume: 51,190.629 ft³
Weight: 4,657,794.9 lbf
Resisting Moment: 3.3781247e+08 lbf·ft
Activating Moment: 2.1786324e+08 lbf·ft
Resisting Force: 1,121,340 lbf
Activating Force: 723,267.94 lbf
Slip Rank: 1 of 2 slip surfaces
Exit: (84.774829, 938) ft
Entry: (717.97184, 1,092.493) ft
Radius: 307.09139 ft
Center: (370.79198, 1,123.3652) ft

Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength
Slice 1	92.387414 ft	935.96283 ft	0 psf	265.42532 psf	51.593456 psf	0 psf

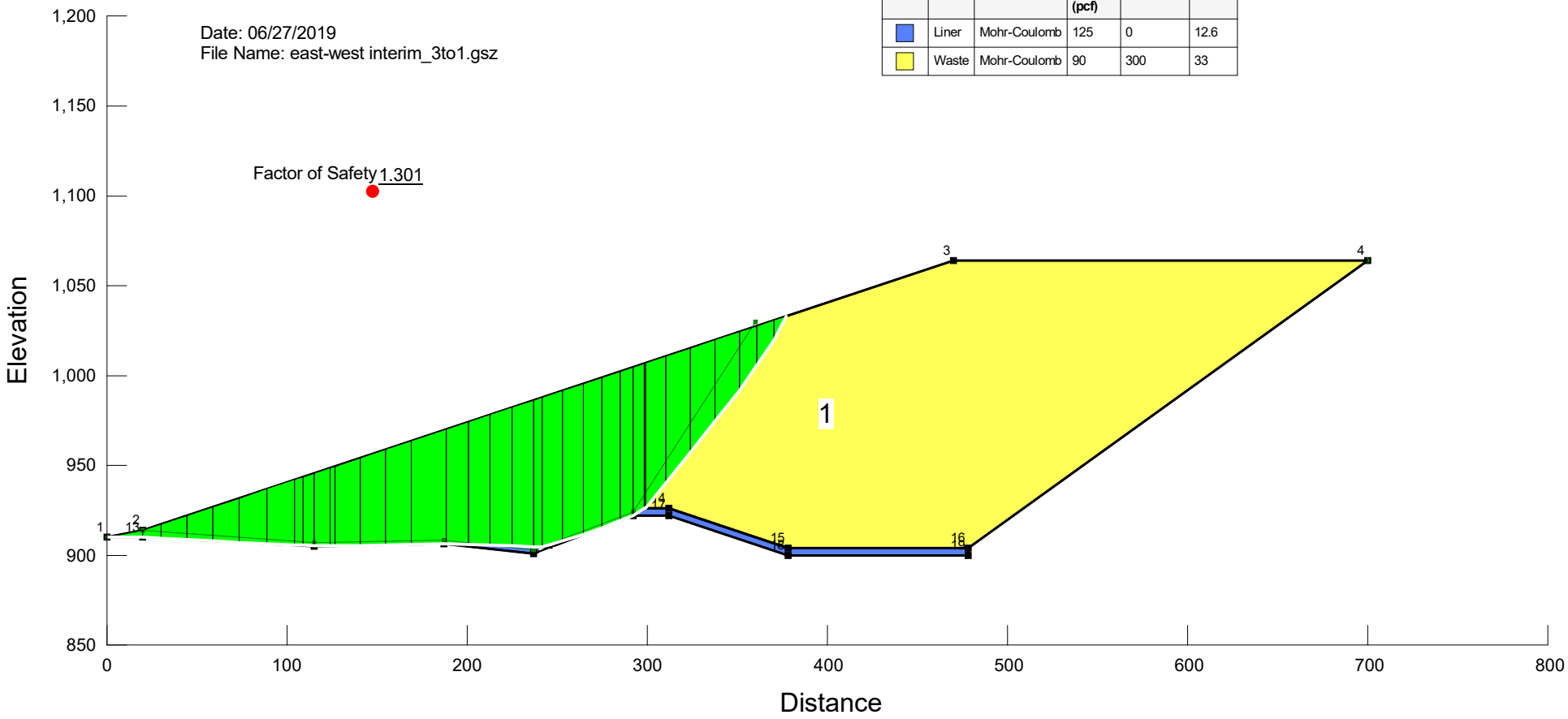
Slice 2	112.65849 ft	930.53817 ft	0 psf	1,126.0524 psf	218.88242 psf	0 psf
Slice 3	137.40994 ft	923.91454 ft	0 psf	2,333.6962 psf	453.6246 psf	0 psf
Slice 4	161.25145 ft	917.32239 ft	0 psf	3,572.4176 psf	694.40763 psf	0 psf
Slice 5	175.84905 ft	913.15254 ft	0 psf	4,391.3106 psf	853.5843 psf	0 psf
Slice 6	188.8687 ft	911.00025 ft	0 psf	4,825.1711 psf	937.91825 psf	0 psf
Slice 7	205.01965 ft	909.32876 ft	0 psf	5,321.894 psf	1,034.4714 psf	0 psf
Slice 8	217.48761 ft	908.63445 ft	0 psf	5,714.4156 psf	1,110.7699 psf	0 psf
Slice 9	227.85991 ft	908.35495 ft	0 psf	5,882.9589 psf	1,143.5314 psf	0 psf
Slice 10	247.2352 ft	908.76285 ft	0 psf	6,298.2422 psf	1,224.2543 psf	0 psf
Slice 11	273.54435 ft	909.31672 ft	0 psf	6,858.8616 psf	1,333.2276 psf	0 psf
Slice 12	295.18145 ft	909.77224 ft	0 psf	7,315.5348 psf	1,421.9959 psf	0 psf
Slice 13	321.79355 ft	909.16876 ft	0 psf	8,193.8512 psf	1,592.7233 psf	0 psf
Slice 14	352.3033 ft	907.56298 ft	0 psf	9,060.3608 psf	1,761.1557 psf	0 psf
Slice 15	373.75387 ft	906.43401 ft	0 psf	9,656.0943 psf	1,876.9546 psf	0 psf
Slice 16	390.74412 ft	905.8728 ft	0 psf	9,950.0729 psf	1,934.0982 psf	0 psf
Slice 17	407.06495 ft	905.54377 ft	0 psf	10,327.051 psf	2,007.3753 psf	0 psf
Slice 18	425.11885 ft	905.5618 ft	0 psf	10,588.905 psf	2,058.2746 psf	0 psf
Slice 19	449.43035 ft	905.9417 ft	0 psf	11,019.857 psf	2,142.0432 psf	0 psf
Slice 20	467.37645 ft	906.29065 ft	0 psf	11,344.78 psf	2,205.2018 psf	0 psf
Slice 21	485.75012 ft	906.73153 ft	0 psf	11,600.231 psf	2,254.8565 psf	0 psf
Slice 22	510.75012 ft	907.4206 ft	0 psf	11,935.281 psf	2,319.9836 psf	0 psf
Slice 23	523.6759 ft	907.79787 ft	0 psf	12,118.38 psf	2,355.5745 psf	0 psf
Slice 24	539.0066 ft	911.9804 ft	0 psf	11,193.504 psf	2,175.7968 psf	0 psf
Slice 25	565.8307 ft	920.55075 ft	0 psf	10,848.203 psf	2,108.6771 psf	0 psf
Slice 26	579.4164 ft	925.4713 ft	0 psf	10,730.199 psf	2,085.7393 psf	0 psf
Slice 27	591.53431 ft	938.16998 ft	0 psf	6,690.9839 psf	4,345.1758 psf	300 psf
Slice 28	612.93044 ft	962.5335 ft	0 psf	5,704.4088 psf	3,704.4864 psf	300 psf

Slice 29	634.31968 ft	986.88917 ft	0 psf	4,699.7557 psf	3,052.0571 psf	300 psf
Slice 30	651.5472 ft	1,006.8274 ft	0 psf	3,788.7205 psf	2,460.4239 psf	300 psf
Slice 31	668.06206 ft	1,027.572 ft	0 psf	2,769.5248 psf	1,798.5504 psf	300 psf
Slice 32	688.02597 ft	1,053.5404 ft	0 psf	1,629.4868 psf	1,058.2011 psf	300 psf
Slice 33	707.98988 ft	1,079.5088 ft	0 psf	445.07153 psf	289.03283 psf	300 psf

Seven Mile Creek Landfill

Date: 06/27/2019
File Name: east-west interim_3to1.gsz

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Liner	Mohr-Coulomb	125	0	12.6
	Waste	Mohr-Coulomb	90	300	33



Slope Stability

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File Information

File Version: 9.00
Title: East-West Interim
Created By: Hullings, Donald
Last Edited By: Hullings, Donald
Revision Number: 11
Date: 06/27/2019
Time: 03:59:11 PM
Tool Version: 9.0.5.16316
File Name: east-west interim_3to1.gsz
Directory: C:\Users\donald.hullings\Desktop\7 mile\
Last Solved Date: 06/27/2019
Last Solved Time: 03:59:14 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Slope Stability

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions from: (none)
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Fully-Specified
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °

Tension Crack Option: (none)
Distribution
F of S Calculation Option: Constant
Advanced
Geometry Settings
Minimum Slip Surface Depth: 0.1 ft
Number of Slices: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Liner

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 12.6 °
Phi-B: 0 °

Waste

Model: Mohr-Coulomb
Unit Weight: 90 pcf
Cohesion': 300 psf
Phi': 33 °
Phi-B: 0 °

Fully Specified Slip Surfaces

Fully Specified Slip Surface 1

	X	Y
	20 ft	914 ft
	115 ft	907 ft
	187 ft	908.4 ft
	237 ft	902.8 ft
	292 ft	924 ft
	360 ft	1,030 ft

Slip Surface Limits

Left Coordinate: (0, 910) ft

Right Coordinate: (700, 1,064) ft

Points

	X	Y
Point 1	0 ft	910 ft
Point 2	20 ft	914 ft
Point 3	470 ft	1,064 ft
Point 4	700 ft	1,064 ft
Point 5	115 ft	909 ft
Point 6	187 ft	910.4 ft
Point 7	237 ft	904.8 ft
Point 8	292 ft	926 ft
Point 9	292 ft	922 ft
Point 10	237 ft	900.8 ft
Point 11	187 ft	906.4 ft
Point 12	115 ft	905 ft
Point 13	20 ft	910 ft
Point 14	312 ft	926 ft
Point 15	378 ft	904 ft
Point 16	478 ft	904 ft
Point 17	312 ft	922 ft
Point 18	378 ft	900 ft
Point 19	478 ft	900 ft

Regions

	Material	Points	Area
Region 1	Waste	2,3,4,16,15,14,8,7,6,5	54,194 ft²
Region 2	Liner	1,2,5,6,7,8,14,15,16,19,18,17,9,10,11,12,13	1,872 ft²

Current Slip Surface

Slip Surface: 2
Factor of Safety: 1.301
Volume: 18,107.558 ft³
Weight: 1,664,686.1 lbf
Resisting Moment: 88,033,053 lbf·ft
Activating Moment: 67,640,596 lbf·ft
Resisting Force: 432,455.46 lbf
Activating Force: 332,348.06 lbf
Slip Rank: 1 of 2 slip surfaces
Exit: (0, 910) ft
Entry: (377.19706, 1,033.0657) ft
Radius: 200.6934 ft

Center: (160.76, 1,054.76) ft

Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength
Slice 1	0.583505 ft	910 ft	0 psf	14.594764 psf	3.2623162 psf	0 psf
Slice 2	10.583505 ft	910 ft	0 psf	266.82113 psf	59.641588 psf	0 psf
Slice 3	25.11459 ft	909.73081 ft	0 psf	697.46173 psf	155.90117 psf	0 psf
Slice 4	37.405715 ft	909.08391 ft	0 psf	1,148.1178 psf	256.63473 psf	0 psf
Slice 5	51.758785 ft	908.32849 ft	0 psf	1,684.2903 psf	376.48349 psf	0 psf
Slice 6	66.111855 ft	907.57306 ft	0 psf	2,230.0783 psf	498.48157 psf	0 psf
Slice 7	81.005739 ft	906.78917 ft	0 psf	2,804.4443 psf	626.86756 psf	0 psf
Slice 8	96.458764 ft	905.9783 ft	0 psf	3,405.0601 psf	761.12111 psf	0 psf
Slice 9	106.6077 ft	905.558 ft	0 psf	3,712.9469 psf	829.94196 psf	0 psf
Slice 10	112.01047 ft	905.47719 ft	0 psf	3,915.6895 psf	875.2603 psf	0 psf
Slice 11	119.51062 ft	905.31359 ft	0 psf	4,182.3385 psf	934.86342 psf	0 psf
Slice 12	125.28266 ft	905.21983 ft	0 psf	4,338.9796 psf	969.87684 psf	0 psf
Slice 13	133.59112 ft	905.36149 ft	0 psf	4,559.0754 psf	1,019.0741 psf	0 psf
Slice 14	147.68521 ft	905.63555 ft	0 psf	4,974.5417 psf	1,111.9418 psf	0 psf
Slice 15	161.7793 ft	905.9096 ft	0 psf	5,382.4348 psf	1,203.1167 psf	0 psf
Slice 16	178.65938 ft	906.19331 ft	0 psf	5,876.3976 psf	1,313.5305 psf	0 psf
Slice 17	194.55587 ft	906.14572 ft	0 psf	6,469.8939 psf	1,446.1926 psf	0 psf
Slice 18	206.68276 ft	905.75717 ft	0 psf	6,819.0853 psf	1,524.2461 psf	0 psf
Slice 19	218.80966 ft	905.36862 ft	0 psf	7,154.6779 psf	1,599.26 psf	0 psf
Slice 20	230.93655 ft	904.98007 ft	0 psf	7,476.1991 psf	1,671.1285 psf	0 psf
Slice 21	239.31414 ft	904.71165 ft	0 psf	7,733.3647 psf	1,728.6118 psf	0 psf
				6,826.6356 psf	1,525.9338 psf	0 psf

Slice 22	247.34629 ft	906.32815 ft	0 psf			
Slice 23	258.78228 ft	909.70946 ft	0 psf	6,885.9901 psf	1,539.2012 psf	0 psf
Slice 24	269.62293 ft	913.37466 ft	0 psf	6,677.4893 psf	1,492.5957 psf	0 psf
Slice 25	279.86822 ft	917.32375 ft	0 psf	6,655.2856 psf	1,487.6326 psf	0 psf
Slice 26	288.49543 ft	920.64915 ft	0 psf	6,642.1229 psf	1,484.6904 psf	0 psf
Slice 27	295.22328 ft	924 ft	0 psf	6,058.4025 psf	1,354.2134 psf	0 psf
Slice 28	298.65892 ft	926.1348 ft	0 psf	5,185.7877 psf	3,367.6899 psf	300 psf
Slice 29	304.516 ft	933.15795 ft	0 psf	3,689.9248 psf	2,396.2652 psf	300 psf
Slice 30	317.02552 ft	948.65573 ft	0 psf	3,114.9484 psf	2,022.8711 psf	300 psf
Slice 31	330.75513 ft	965.8746 ft	0 psf	2,516.5565 psf	1,634.2709 psf	300 psf
Slice 32	344.48473 ft	983.09347 ft	0 psf	1,898.1646 psf	1,232.6825 psf	300 psf
Slice 33	356.09651 ft	998.70647 ft	0 psf	1,183.5987 psf	768.638 psf	300 psf
Slice 34	365.59048 ft	1,012.7136 ft	0 psf	651.00868 psf	422.76998 psf	300 psf
Slice 35	373.76726 ft	1,026.3914 ft	0 psf	26.542007 psf	17.236581 psf	300 psf