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1. Purpose:

To calculate the settlement of the Nuclear Island structure (NI) using empirical method, elastic theory, and consolidation theory

2. Background:

The site geology at Calvert Cliffs Nuclear Power Plant Unit3 Site (CCNPP3) is comprised of deep coastal plain sediments underlain by bedrock at approximately 2,500 ft below the ground surface. The subsurface soils at CCNPP3 consist of silty sand, clayey sand, lean clay, fat clay, silt and high plastic silt. The construction of the NI structure requires site grading, dewatering, excavation and installation.

3. Design Inputs:

1. The original ground water table is at elevation 80 ft; the water table during dewatering process is considered to be at elevation 41.5 ft (Ref. 7); after construction, the water table will increase to 55 ft and this will take about 25 years (Ref. 7), However in this calculation, the ground water level is conservatively considered to stay at 41.5 ft after construction.
2. The bottom of the foundation is at elevation of 41.5 ft (Ref. 7).
3. The NI mat foundation is assumed to be flexible foundation system; this is very conservative for the calculation of differential settlement.
4. The existing ground surface elevation of NI site varies from about 40 ft to over 120 ft, with an average value of about 80 ft. The site will be graded to the elevation of 83 ft (Ref. 7). The changing of stress distribution due to grading and backfilling is considered to be negligible.
5. The NI structure load is 11.76 ksf (Ref. 3).
6. All the soil parameters used in the settlement calculation are adopted from Ref. 4 and Ref. 5.

Table 1: Soil Parameters

Soil Type	Elastic Modulus (psf) (Ref. 4)	Compression Index (Ref. 5)	Recompression Index (Ref. 5)	Initial Void Ratio (Ref. 5)	Coefficient of Consolidation (Ref. 4)
Stratum IIb - Chesapeake Sand					
IIb - 1	2.53E+06	N/A	N/A	N/A	N/A
IIb - 2	1.03E+06	N/A	N/A	N/A	N/A
IIb - 3	2.62E+06	N/A	N/A	N/A	N/A
Stratum IIc - Chesapeake Clay / Silt	2.37E+06	0.947	0.06	1.61	1,913 ft^2 /year
Stratum III - Nanjemoy Sand	3.17E+06	N/A	N/A	N/A	N/A

For the stratum IIc, the average over consolidation ratio is about 4.

4. Methodology:

The NI mat foundation shape is not regular. To simplify the calculation, the foundation shape is simplified to a square shape with the width of about 283 ft. For the comparison purpose, a circular shape foundation with radius of 159.7 ft is also considered in the calculation of total settlement.

Soil profile beneath the NI varies. The boring logs within the footprint of the NI are studied. Based on the boring logs within the NI area, boring B-301 is used to represent the soil profile at the center of the NI and boring B-304 is used to represent the soil profile at the corner of the NI (Ref. 6). B-301 indicates the maximum amount of the clay layer while B-304 indicates less clay material. This scenario will produce maximum differential settlement between the center and edge and maximum total settlement at the center.

The total settlement, St, of a loaded soil has three components, or

$$St = Si + Sc + Ss$$

Where Si = the immediate, or distortion, settlement
Sc = the consolidation settlement
Ss = the secondary settlement

The immediate, or distortion, settlement although not actually elastic, is usually estimated using elastic theory. Two methods are used in the calculation of immediate settlement: theory of elasticity and Schmertmann method. The first method uses the Boussinesq equations to calculate stress distributions below the mat foundation. The thickness of the model is based on the criteria that vertical stresses deviation at the bottom of the model should be less than 10% of the foundation bearing pressure. The settlement is calculated based on the stress distribution using elastic theory. This method assumes that the contact pressure is uniformly distributed and does not consider the fact that the foundation system is stiff. However, it gives reasonable estimation of the total settlement and it is conservative in the estimation of the differential settlement. Schmertmann method is developed to estimate settlement of granular material, and it is based on a physical model of settlement, which has been calibrated using empirical data. The model thickness for Schmertmann method is twice of the equivalent foundation width.

The consolidation settlement is calculated using classical consolidation theory. The vertical stress in the underlying soil increases when the NI structure is installed. The NI loads cause the increase of pore water pressure. The pore water pressure dissipates over time as the pore water comes out from the soil and hence consolidation occurs.

The secondary compression settlement is negligible in sands and in overconsolidated clays. Therefore, it is not included in this calculation.

The final settlement of the NI takes into account different construction stages, including excavation and construction of the NI. Excavation will cause the rebound of the foundation. The dewatering process will not cause significant settlement due to the existence of an impervious layer between the upper aquifer layer and the lower aquifer layer. (Ref. 7)

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5.1. Rebound due to excavation

5.1.1 Summary of results

Summary for Rebound due to excavation

Settlement is based on Boring Log B - 301 (center) and B - 304 (corner)

	Elastic Rebound (in)	Consolidation Rebound (in)	Total Rebound (in)
Center	2.59	5.09	7.68
Corner / Edge	0.48	0.83	1.31

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Rectangular Loading Pattern Stress distribution W=L= 232.99 ft

Soil profile based on boring log B-301

5.1.2. Boussinesq Solution Uniform Loading $\Delta \sigma z = I_{sig} * P$

Original Ground Elev (ft, msl)	94.5	
Water Elev at excavation(ft, msl)	41.5	
Average unit waight of soil (pcf)	110	(Ref. 8)
Upward pressure (psf) q =	5830	

Note: units for elevation, depth is ft, units for stress and modulus is psf, and units for deformation/settlement is in.

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	I_{sig} (center)	$\Delta \sigma z$ (center)	I_{sig} (corner)	$\Delta \sigma z$ (corner)		E**	Thickness	deformation(center)	deformation(corner)
1	IIb1 (SP)	5.00	41.50	31.50	0.25	5829.81	0.25	1457.49		7.59E+06	10.00	9.22E-02	2.30E-02
2	IIb1 (SP)	15.00	31.50	21.50	0.25	5824.86	0.25	1457.34		7.59E+06	10.00	9.21E-02	2.30E-02
3	IIb1 (SP)	24.50	21.50	12.50	0.25	5808.14	0.25	1456.80		7.59E+06	9.00	8.26E-02	2.07E-02
4	IIb2 (SP)	34.00	12.50	2.50	0.25	5773.56	0.25	1455.64		3.09E+06	10.00	2.24E-01	5.65E-02
5	IIb2 (SP)	44.00	2.50	-7.50	0.24	5713.30	0.25	1453.51		3.09E+06	10.00	2.22E-01	5.64E-02
6	IIb3 (SP)	54.00	-7.50	-17.50	0.24	5626.20	0.25	1450.25		7.86E+06	10.00	8.59E-02	2.21E-02
7	IIc (CL / ML)	64.00	-17.50	-27.50	0.24	5512.25	0.25	1445.64		7.11E+06	10.00	9.30E-02	2.44E-02
8	IIc (CL / ML)	74.00	-27.50	-37.50	0.23	5373.43	0.25	1439.55		7.11E+06	10.00	9.07E-02	2.43E-02
9	IIc (CL / ML)	84.00	-37.50	-47.50	0.22	5213.13	0.25	1431.86		7.11E+06	10.00	8.80E-02	2.42E-02
10	IIc (CL / ML)	94.00	-47.50	-57.50	0.22	5035.52	0.24	1422.51		7.11E+06	10.00	8.50E-02	2.40E-02
11	IIc (CL / ML)	104.00	-57.50	-67.50	0.21	4845.09	0.24	1411.45		7.11E+06	10.00	8.18E-02	2.38E-02
12	IIc (CL / ML)	114.00	-67.50	-77.50	0.20	4646.21	0.24	1398.69		7.11E+06	10.00	7.84E-02	2.36E-02
13	IIc (CL / ML)	124.00	-77.50	-87.50	0.19	4442.83	0.24	1384.28		7.11E+06	10.00	7.50E-02	2.34E-02
14	IIc (CL / ML)	134.00	-87.50	-97.50	0.18	4238.40	0.23	1368.27		7.11E+06	10.00	7.15E-02	2.31E-02
15	IIc (CL / ML)	144.00	-97.50	-107.50	0.17	4035.75	0.23	1350.76		7.11E+06	10.00	6.81E-02	2.28E-02
16	IIc (CL / ML)	154.00	-107.50	-117.50	0.16	3837.13	0.23	1331.85		7.11E+06	10.00	6.48E-02	2.25E-02
17	IIc (CL / ML)	164.00	-117.50	-127.50	0.16	3644.25	0.22	1311.68		7.11E+06	10.00	6.15E-02	2.21E-02
18	IIc (CL / ML)	174.00	-127.50	-137.50	0.15	3458.33	0.22	1290.36		7.11E+06	10.00	5.84E-02	2.18E-02
19	IIc (CL / ML)	184.00	-137.50	-147.50	0.14	3280.22	0.22	1268.05		7.11E+06	10.00	5.54E-02	2.14E-02
20	IIc (CL / ML)	194.00	-147.50	-157.50	0.13	3110.42	0.21	1244.88		7.11E+06	10.00	5.25E-02	2.10E-02
21	IIc (CL / ML)	204.00	-157.50	-167.50	0.13	2949.17	0.21	1221.00		7.11E+06	10.00	4.98E-02	2.06E-02
22	IIc (CL / ML)	214.00	-167.50	-177.50	0.12	2796.53	0.21	1196.53		7.11E+06	10.00	4.72E-02	2.02E-02
23	IIc (CL / ML)	224.00	-177.50	-187.50	0.11	2652.38	0.20	1171.62		7.11E+06	10.00	4.48E-02	1.98E-02
24	IIc (CL / ML)	234.00	-187.50	-197.50	0.11	2516.51	0.20	1146.37		7.11E+06	10.00	4.25E-02	1.93E-02
25	IIc (CL / ML)	244.00	-197.50	-207.50	0.10	2388.63	0.19	1120.92		7.11E+06	10.00	4.03E-02	1.89E-02
26	III (SP)	254.00	-207.50	-217.50	0.10	2268.40	0.19	1095.37		9.51E+06	10.00	2.86E-02	1.38E-02
27	III (SP)	264.00	-217.50	-227.50	0.09	2155.44	0.18	1069.81		9.51E+06	10.00	2.72E-02	1.35E-02
28	III (SP)	274.00	-227.50	-237.50	0.09	2049.37	0.18	1044.33		9.51E+06	10.00	2.59E-02	1.32E-02
29	III (SP)	289.00	-237.50	-257.50	0.08	1902.29	0.17	1006.43		9.51E+06	20.00	4.80E-02	2.54E-02
30	III (SP)	309.00	-257.50	-277.50	0.07	1726.65	0.16	956.33		9.51E+06	20.00	4.36E-02	2.41E-02
31	III (SP)	329.00	-277.50	-297.50	0.07	1571.71	0.16	908.39		9.51E+06	20.00	3.97E-02	2.29E-02
32	III (SP)	349.00	-297.50	-317.50	0.06	1434.81	0.15	862.31		9.51E+06	20.00	3.62E-02	2.18E-02
33	III (SP)	369.00	-317.50	-337.50	0.06	1313.59	0.14	817.38		9.51E+06	20.00	3.32E-02	2.06E-02
34	III (SP)	389.00	-337.50	-357.50	0.05	1206.00	0.13	775.54		9.51E+06	20.00	3.04E-02	1.96E-02
35	III (SP)	409.00	-357.50	-377.50	0.05	1110.23	0.13	735.33		9.51E+06	20.00	2.80E-02	1.86E-02
36	III (SP)	429.00	-377.50	-397.50	0.04	1024.77	0.12	697.28		9.51E+06	20.00	2.59E-02	1.76E-02
37	III (SP)	449.00	-397.50	-417.50	0.04	948.28	0.11	661.35		9.51E+06	20.00	2.39E-02	1.67E-02
38	III (SP)	469.00	-417.50	-437.50	0.04	879.62	0.11	627.48		9.51E+06	20.00	2.22E-02	1.58E-02
39	III (SP)	489.00	-437.50	-457.50	0.04	817.82	0.10	595.31		9.51E+06	20.00	2.06E-02	1.50E-02
40	III (SP)	509.00	-457.50	-477.50	0.03	762.04	0.10	565.35		9.51E+06	20.00	1.92E-02	1.43E-02
41	III (SP)	529.00	-477.50	-497.50	0.03	711.56	0.09	537.49		9.51E+06	20.00	1.80E-02	1.36E-02
42	III (SP)	549.00	-497.50	-517.50	0.03	665.76	0.09	511.36		9.51E+06	20.00	1.68E-02	1.29E-02
43	III (SP)	569.00	-517.50	-537.50	0.03	624.10	0.08	486.24		9.51E+06	20.00	1.58E-02	1.23E-02
44	III (SP)	589.00	-537.50	-557.50	0.03	586.10	0.08	462.94		9.51E+06	20.00	1.48E-02	1.17E-02
45	III (SP)	609.00	-557.50	-577.50	0.02	551.38	0.08	441.37		9.51E+06	20.00	1.39E-02	1.11E-02
46	III (SP)	629.00	-577.50	-597.50	0.02	519.56	0.07	420.52		9.51E+06	20.00	1.31E-02	1.06E-02
						8.91%		**7.21%**	**<10%**		total settlement	2.59	0.97

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No.___ of___

Chkd. By_____ Date_____ Proj. No 09-4179

5.1.3 2 to 1 slope stress

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δσz	E**	Thickness	Settlement deformation(center)
1	IIb1 (SP)	5.00	41.50	31.50	5629.32	7.59E+06	10.00	8.90E-02
2	IIb1 (SP)	15.00	31.50	21.50	5257.85	7.59E+06	10.00	8.31E-02
3	IIb1 (SP)	24.50	21.50	12.50	4937.99	7.59E+06	9.00	7.03E-02
4	IIb2 (SP)	34.00	12.50	2.50	4646.45	3.09E+06	10.00	1.80E-01
5	IIb2 (SP)	44.00	2.50	-7.50	4366.60	3.09E+06	10.00	1.70E-01
6	IIb3 (SP)	54.00	-7.50	-17.50	4111.30	7.86E+06	10.00	6.28E-02
7	IIc (CL / ML)	64.00	-17.50	-27.50	3877.75	7.11E+06	10.00	6.54E-02
8	IIc (CL / ML)	74.00	-27.50	-37.50	3663.55	7.11E+06	10.00	6.18E-02
9	IIc (CL / ML)	84.00	-37.50	-47.50	3466.61	7.11E+06	10.00	5.85E-02
10	IIc (CL / ML)	94.00	-47.50	-57.50	3285.15	7.11E+06	10.00	5.54E-02
11	IIc (CL / ML)	104.00	-57.50	-67.50	3117.56	7.11E+06	10.00	5.26E-02
12	IIc (CL / ML)	114.00	-67.50	-77.50	2962.48	7.11E+06	10.00	5.00E-02
13	IIc (CL / ML)	124.00	-77.50	-87.50	2818.69	7.11E+06	10.00	4.76E-02
14	IIc (CL / ML)	134.00	-87.50	-97.50	2685.12	7.11E+06	10.00	4.53E-02
15	IIc (CL / ML)	144.00	-97.50	-107.50	2560.83	7.11E+06	10.00	4.32E-02
16	IIc (CL / ML)	154.00	-107.50	-117.50	2444.97	7.11E+06	10.00	4.13E-02
17	IIc (CL / ML)	164.00	-117.50	-127.50	2336.79	7.11E+06	10.00	3.94E-02
18	IIc (CL / ML)	174.00	-127.50	-137.50	2235.64	7.11E+06	10.00	3.77E-02
19	IIc (CL / ML)	184.00	-137.50	-147.50	2140.92	7.11E+06	10.00	3.61E-02
20	IIc (CL / ML)	194.00	-147.50	-157.50	2052.10	7.11E+06	10.00	3.46E-02
21	IIc (CL / ML)	204.00	-157.50	-167.50	1968.69	7.11E+06	10.00	3.32E-02
22	IIc (CL / ML)	214.00	-167.50	-177.50	1890.26	7.11E+06	10.00	3.19E-02
23	IIc (CL / ML)	224.00	-177.50	-187.50	1816.43	7.11E+06	10.00	3.07E-02
24	IIc (CL / ML)	234.00	-187.50	-197.50	1746.84	7.11E+06	10.00	2.95E-02
25	IIc (CL / ML)	244.00	-197.50	-207.50	1681.17	7.11E+06	10.00	2.84E-02
26	III (SP)	254.00	-207.50	-217.50	1619.14	9.51E+06	10.00	2.04E-02
27	III (SP)	264.00	-217.50	-227.50	1560.48	9.51E+06	10.00	1.97E-02
28	III (SP)	274.00	-227.50	-237.50	1504.95	9.51E+06	10.00	1.90E-02
29	III (SP)	289.00	-237.50	-257.50	1427.06	9.51E+06	20.00	3.60E-02
30	III (SP)	309.00	-257.50	-277.50	1332.26	9.51E+06	20.00	3.36E-02
31	III (SP)	329.00	-277.50	-297.50	1246.61	9.51E+06	20.00	3.15E-02
32	III (SP)	349.00	-297.50	-317.50	1168.96	9.51E+06	20.00	2.95E-02
33	III (SP)	369.00	-317.50	-337.50	1098.34	9.51E+06	20.00	2.77E-02
34	III (SP)	389.00	-337.50	-357.50	1033.94	9.51E+06	20.00	2.61E-02
35	III (SP)	409.00	-357.50	-377.50	975.03	9.51E+06	20.00	2.46E-02
36	III (SP)	429.00	-377.50	-397.50	921.03	9.51E+06	20.00	2.32E-02
37	III (SP)	449.00	-397.50	-417.50	871.38	9.51E+06	20.00	2.20E-02
38	III (SP)	469.00	-417.50	-437.50	825.65	9.51E+06	20.00	2.08E-02
39	III (SP)	489.00	-437.50	-457.50	783.42	9.51E+06	20.00	1.98E-02
40	III (SP)	509.00	-457.50	-477.50	744.36	9.51E+06	20.00	1.88E-02
41	III (SP)	529.00	-477.50	-497.50	708.14	9.51E+06	20.00	1.79E-02
42	III (SP)	549.00	-497.50	-517.50	674.50	9.51E+06	20.00	1.70E-02
43	III (SP)	569.00	-517.50	-537.50	643.21	9.51E+06	20.00	1.62E-02
44	III (SP)	589.00	-537.50	-557.50	614.04	9.51E+06	20.00	1.55E-02
45	III (SP)	609.00	-557.50	-577.50	586.81	9.51E+06	20.00	1.48E-02
46	III (SP)	629.00	-577.50	-597.50	561.36	9.51E+06	20.00	1.42E-02
					9.63%		total settleme	1.95

inch

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No.___ of___

Chkd. By_____ Date_____ Proj. No 09-4179

5.1.4 Circular Loading Pattern

R=159.7 ft

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δ σz (center)	Δ σz (edge)	Thickness	E**	deformation(center)	deformation(edge)
1	IIb1 (SP)	3.75	41.5	34	6005.14	5588.73	7.5	7.59E+06	7.12E-02	6.63E-02
2	IIb1 (SP)	10	34	29	5876.65	4432.23	5	7.59E+06	4.65E-02	3.50E-02
3	IIb1 (SP)	15	29	24	5862.84	3874.38	5	7.59E+06	4.63E-02	3.06E-02
4	IIb1 (SP)	20	24	19	5852.92	3571.60	5	7.59E+06	4.63E-02	2.82E-02
5	IIb1 (SP)	25	19	14	5841.09	3377.79	5	7.59E+06	4.62E-02	2.67E-02
6	IIb1 (SP)	30	14	9	5825.41	3239.12	5	7.59E+06	4.61E-02	2.56E-02
7	IIb2 (SP)	35	9	4	5804.81	3131.88	5	3.09E+06	1.13E-01	6.08E-02
8	IIb2 (SP)	40	4	-1	5778.62	3044.16	5	3.09E+06	1.12E-01	5.91E-02
9	IIb2 (SP)	45	-1	-6	5746.38	2969.33	5	3.09E+06	1.12E-01	5.77E-02
10	IIb2 (SP)	50	-6	-11	5707.82	2903.43	5	3.09E+06	1.11E-01	5.64E-02
11	IIb3 (SP)	55	-11	-16	5662.81	2843.96	5	7.86E+06	4.32E-02	2.17E-02
12	IIb3 (SP)	60	-16	-21	5611.37	2789.27	5	7.86E+06	4.28E-02	2.13E-02
13	IIc (CL / ML)	65	-21	-26	5553.64	2738.20	5	7.11E+06	4.69E-02	2.31E-02
14	IIc (CL / ML)	70	-26	-31	5489.85	2689.97	5	7.11E+06	4.63E-02	2.27E-02
15	IIc (CL / ML)	75	-31	-36	5420.33	2643.97	5	7.11E+06	4.57E-02	2.23E-02
16	IIc (CL / ML)	80	-36	-41	5345.47	2599.80	5	7.11E+06	4.51E-02	2.19E-02
17	IIc (CL / ML)	85	-41	-46	5265.73	2557.11	5	7.11E+06	4.44E-02	2.16E-02
18	IIc (CL / ML)	90	-46	-51	5181.58	2515.66	5	7.11E+06	4.37E-02	2.12E-02
19	IIc (CL / ML)	95	-51	-56	5093.55	2475.27	5	7.11E+06	4.30E-02	2.09E-02
20	IIc (CL / ML)	100	-56	-61	5002.16	2435.78	5	7.11E+06	4.22E-02	2.06E-02
21	IIc (CL / ML)	105	-61	-66	4907.93	2397.09	5	7.11E+06	4.14E-02	2.02E-02
22	IIc (CL / ML)	110	-66	-71	4811.38	2359.10	5	7.11E+06	4.06E-02	1.99E-02
23	IIc (CL / ML)	115	-71	-76	4712.99	2321.74	5	7.11E+06	3.98E-02	1.96E-02
24	IIc (CL / ML)	120	-76	-81	4613.25	2284.97	5	7.11E+06	3.89E-02	1.93E-02
25	IIc (CL / ML)	125	-81	-86	4512.59	2248.73	5	7.11E+06	3.81E-02	1.90E-02
26	IIc (CL / ML)	130	-86	-91	4411.43	2212.99	5	7.11E+06	3.72E-02	1.87E-02
27	IIc (CL / ML)	135	-91	-96	4310.14	2177.73	5	7.11E+06	3.64E-02	1.84E-02
28	IIc (CL / ML)	140	-96	-101	4209.08	2142.93	5	7.11E+06	3.55E-02	1.81E-02
29	IIc (CL / ML)	145	-101	-106	4108.55	2108.57	5	7.11E+06	3.47E-02	1.78E-02
30	IIc (CL / ML)	150	-106	-111	4008.83	2074.65	5	7.11E+06	3.38E-02	1.75E-02
31	IIc (CL / ML)	155	-111	-116	3910.16	2041.15	5	7.11E+06	3.30E-02	1.72E-02
32	IIc (CL / ML)	160	-116	-121	3812.76	2008.08	5	7.11E+06	3.22E-02	1.69E-02
33	IIc (CL / ML)	165	-121	-126	3716.80	1975.42	5	7.11E+06	3.14E-02	1.67E-02
34	IIc (CL / ML)	170	-126	-131	3622.45	1943.17	5	7.11E+06	3.06E-02	1.64E-02
35	IIc (CL / ML)	175	-131	-136	3529.83	1911.35	5	7.11E+06	2.98E-02	1.61E-02
36	IIc (CL / ML)	180	-136	-141	3439.05	1879.93	5	7.11E+06	2.90E-02	1.59E-02
37	IIc (CL / ML)	185	-141	-146	3350.20	1848.94	5	7.11E+06	2.83E-02	1.56E-02
38	IIc (CL / ML)	190	-146	-151	3263.35	1818.36	5	7.11E+06	2.75E-02	1.53E-02
39	IIc (CL / ML)	195	-151	-156	3178.54	1788.20	5	7.11E+06	2.68E-02	1.51E-02
40	IIc (CL / ML)	200	-156	-161	3095.81	1758.47	5	7.11E+06	2.61E-02	1.48E-02
41	IIc (CL / ML)	205	-161	-166	3015.18	1729.15	5	7.11E+06	2.54E-02	1.46E-02
42	IIc (CL / ML)	210	-166	-171	2936.67	1700.26	5	7.11E+06	2.48E-02	1.43E-02
43	IIc (CL / ML)	215	-171	-176	2860.26	1671.80	5	7.11E+06	2.41E-02	1.41E-02
44	IIc (CL / ML)	220	-176	-181	2785.96	1643.76	5	7.11E+06	2.35E-02	1.39E-02
45	IIc (CL / ML)	225	-181	-186	2713.74	1616.14	5	7.11E+06	2.29E-02	1.36E-02
46	IIc (CL / ML)	230	-186	-191	2643.57	1588.96	5	7.11E+06	2.23E-02	1.34E-02
47	IIc (CL / ML)	235	-191	-196	2575.45	1562.20	5	7.11E+06	2.17E-02	1.32E-02
48	IIc (CL / ML)	240	-196	-201	2509.31	1535.87	5	7.11E+06	2.12E-02	1.30E-02
49	IIc (CL / ML)	245	-201	-206	2445.14	1509.97	5	7.11E+06	2.06E-02	1.27E-02
50	IIc (CL / ML)	250	-206	-211	2382.89	1484.49	5	7.11E+06	2.01E-02	1.25E-02
51	III (SP)	255	-211	-216	2322.51	1459.43	5	9.51E+06	1.47E-02	9.21E-03
52	III (SP)	260	-216	-221	2263.97	1434.80	5	9.51E+06	1.43E-02	9.05E-03
53	III (SP)	265	-221	-226	2207.21	1410.59	5	9.51E+06	1.39E-02	8.90E-03
54	III (SP)	270	-226	-231	2152.19	1386.79	5	9.51E+06	1.36E-02	8.75E-03
55	III (SP)	275	-231	-236	2098.86	1363.41	5	9.51E+06	1.32E-02	8.60E-03
56	III (SP)	280	-236	-241	2047.17	1340.44	5	9.51E+06	1.29E-02	8.46E-03
57	III (SP)	285	-241	-246	1997.08	1317.88	5	9.51E+06	1.26E-02	8.31E-03
58	III (SP)	290	-246	-251	1948.53	1295.72	5	9.51E+06	1.23E-02	8.17E-03

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59	III (SP)	295	-251	-256	1901.48	1273.97	5	9.51E+06	1.20E-02	8.04E-03
60	III (SP)	300	-256	-261	1855.88	1252.61	5	9.51E+06	1.17E-02	7.90E-03
61	III (SP)	305	-261	-266	1811.69	1231.64	5	9.51E+06	1.14E-02	7.77E-03
62	III (SP)	310	-266	-271	1768.85	1211.06	5	9.51E+06	1.12E-02	7.64E-03
63	III (SP)	315	-271	-276	1727.34	1190.87	5	9.51E+06	1.09E-02	7.51E-03
64	III (SP)	320	-276	-281	1687.09	1171.05	5	9.51E+06	1.06E-02	7.39E-03
65	III (SP)	325	-281	-286	1648.08	1151.61	5	9.51E+06	1.04E-02	7.27E-03
66	III (SP)	330	-286	-291	1610.25	1132.53	5	9.51E+06	1.02E-02	7.15E-03
67	III (SP)	335	-291	-296	1573.58	1113.82	5	9.51E+06	9.93E-03	7.03E-03
68	III (SP)	340	-296	-301	1538.01	1095.46	5	9.51E+06	9.70E-03	6.91E-03
69	III (SP)	345	-301	-306	1503.52	1077.46	5	9.51E+06	9.49E-03	6.80E-03
70	III (SP)	350	-306	-311	1470.06	1059.80	5	9.51E+06	9.27E-03	6.69E-03
71	III (SP)	355	-311	-316	1437.60	1042.48	5	9.51E+06	9.07E-03	6.58E-03
72	III (SP)	360	-316	-321	1406.11	1025.50	5	9.51E+06	8.87E-03	6.47E-03
73	III (SP)	365	-321	-326	1375.55	1008.85	5	9.51E+06	8.68E-03	6.36E-03
74	III (SP)	370	-326	-331	1345.89	992.52	5	9.51E+06	8.49E-03	6.26E-03
75	III (SP)	375	-331	-336	1317.10	976.52	5	9.51E+06	8.31E-03	6.16E-03
76	III (SP)	380	-336	-341	1289.15	960.82	5	9.51E+06	8.13E-03	6.06E-03
77	III (SP)	385	-341	-346	1262.01	945.43	5	9.51E+06	7.96E-03	5.96E-03
78	III (SP)	390	-346	-351	1235.65	930.34	5	9.51E+06	7.80E-03	5.87E-03
79	III (SP)	395	-351	-356	1210.05	915.55	5	9.51E+06	7.63E-03	5.78E-03
80	III (SP)	400	-356	-361	1185.18	901.05	5	9.51E+06	7.48E-03	5.68E-03
81	III (SP)	405	-361	-366	1161.02	886.83	5	9.51E+06	7.33E-03	5.60E-03
82	III (SP)	410	-366	-371	1137.53	872.89	5	9.51E+06	7.18E-03	5.51E-03
83	III (SP)	415	-371	-376	1114.70	859.23	5	9.51E+06	7.03E-03	5.42E-03
84	III (SP)	420	-376	-381	1092.51	845.84	5	9.51E+06	6.89E-03	5.34E-03
85	III (SP)	425	-381	-386	1070.93	832.70	5	9.51E+06	6.76E-03	5.25E-03
86	III (SP)	430	-386	-391	1049.95	819.83	5	9.51E+06	6.62E-03	5.17E-03
87	III (SP)	435	-391	-396	1029.54	807.21	5	9.51E+06	6.50E-03	5.09E-03
88	III (SP)	440	-396	-401	1009.68	794.83	5	9.51E+06	6.37E-03	5.01E-03
89	III (SP)	445	-401	-406	990.36	782.70	5	9.51E+06	6.25E-03	4.94E-03
90	III (SP)	450	-406	-411	971.56	770.80	5	9.51E+06	6.13E-03	4.86E-03
91	III (SP)	455	-411	-416	953.26	759.14	5	9.51E+06	6.01E-03	4.79E-03
92	III (SP)	460	-416	-421	935.44	747.71	5	9.51E+06	5.90E-03	4.72E-03
93	III (SP)	465	-421	-426	918.10	736.49	5	9.51E+06	5.79E-03	4.65E-03
94	III (SP)	470	-426	-431	901.20	725.50	5	9.51E+06	5.69E-03	4.58E-03
95	III (SP)	475	-431	-436	884.75	714.72	5	9.51E+06	5.58E-03	4.51E-03
96	III (SP)	480	-436	-441	868.72	704.15	5	9.51E+06	5.48E-03	4.44E-03
97	III (SP)	485	-441	-446	853.10	693.78	5	9.51E+06	5.38E-03	4.38E-03
98	III (SP)	490	-446	-451	837.87	683.61	5	9.51E+06	5.29E-03	4.31E-03
99	III (SP)	495	-451	-456	823.04	673.64	5	9.51E+06	5.19E-03	4.25E-03
100	III (SP)	500	-456	-461	808.57	663.86	5	9.51E+06	5.10E-03	4.19E-03
101	III (SP)	505	-461	-466	794.47	654.27	5	9.51E+06	5.01E-03	4.13E-03
102	III (SP)	510	-466	-471	780.71	644.86	5	9.51E+06	4.93E-03	4.07E-03
103	III (SP)	515	-471	-476	767.30	635.63	5	9.51E+06	4.84E-03	4.01E-03
104	III (SP)	520	-476	-481	754.21	626.57	5	9.51E+06	4.76E-03	3.95E-03
105	III (SP)	525	-481	-486	741.45	617.69	5	9.51E+06	4.68E-03	3.90E-03
106	III (SP)	530	-486	-491	728.99	608.98	5	9.51E+06	4.60E-03	3.84E-03
107	III (SP)	535	-491	-496	716.83	600.43	5	9.51E+06	4.52E-03	3.79E-03
108	III (SP)	540	-496	-501	704.96	592.04	5	9.51E+06	4.45E-03	3.74E-03
109	III (SP)	545	-501	-506	693.37	583.81	5	9.51E+06	4.37E-03	3.68E-03
110	III (SP)	550	-506	-511	682.05	575.73	5	9.51E+06	4.30E-03	3.63E-03
111	III (SP)	555	-511	-516	671.00	567.80	5	9.51E+06	4.23E-03	3.58E-03
112	III (SP)	560	-516	-521	660.21	560.02	5	9.51E+06	4.17E-03	3.53E-03
113	III (SP)	565	-521	-526	649.66	552.39	5	9.51E+06	4.10E-03	3.49E-03
114	III (SP)	570	-526	-531	639.36	544.90	5	9.51E+06	4.03E-03	3.44E-03
115	III (SP)	575	-531	-536	629.29	537.54	5	9.51E+06	3.97E-03	3.39E-03
116	III (SP)	580	-536	-541	619.45	530.32	5	9.51E+06	3.91E-03	3.35E-03
117	III (SP)	585	-541	-546	609.84	523.23	5	9.51E+06	3.85E-03	3.30E-03
118	III (SP)	590	-546	-551	600.43	516.27	5	9.51E+06	3.79E-03	3.26E-03
119	III (SP)	595	-551	-556	591.24	509.43	5	9.51E+06	3.73E-03	3.21E-03
120	III (SP)	600	-556	-561	582.25	502.72	5	9.51E+06	3.67E-03	3.17E-03
121	III (SP)	605	-561	-566	573.45	496.14	5	9.51E+06	3.62E-03	3.13E-03
122	III (SP)	610	-566	-571	564.85	489.66	5	9.51E+06	3.56E-03	3.09E-03
123	III (SP)	615	-571	-576	556.44	483.31	5	9.51E+06	3.51E-03	3.05E-03
124	III (SP)	620	-576	-581	548.20	477.07	5	9.51E+06	3.46E-03	3.01E-03
125	III (SP)	625	-581	-586	540.15	470.94	5	9.51E+06	3.41E-03	2.97E-03
126	III (SP)	630	-586	-591	532.26	464.92	5	9.51E+06	3.36E-03	2.93E-03
					9.13%			total settlement	**2.64**	**1.55** inch

* below bottom of foundation
** The elastic modulus are 3 times of the values recommended by Ref.4.

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5.1.5 Vertical stress under circular loading

Radius R is 159.7 ft

q= 5830 psf

Integration Results:

Z (ft, Depth*)	Center Vertical Stress (psf)	Edge Vertical Stress (psf)
3.75	6005.144528	5588.732537
10	5876.654431	4432.234474
15	5862.841838	3874.375149
20	5852.916307	3571.598402
25	5841.092115	3377.792377
30	5825.406393	3239.119139
35	5804.807619	3131.883518
40	5778.615295	3044.160228
45	5746.376412	2969.328597
50	5707.815455	2903.431208
55	5662.810205	2843.963485
60	5611.374567	2789.267073
65	5553.642693	2738.203314
70	5489.85278	2689.966977
75	5420.330382	2643.974705
80	5345.471567	2599.795454
85	5265.72643	2557.105544
90	5181.583421	2515.658735
95	5093.554896	2475.265765
100	5002.164177	2435.780012
105	4907.934289	2397.087253
110	4811.378455	2359.098186
115	4712.992337	2321.742895
120	4613.247941	2284.966676
125	4512.58906	2248.726848
130	4411.428093	2212.99029
135	4310.144083	2177.731508
140	4209.081757	2142.93111
145	4108.551439	2108.574584
150	4008.829623	2074.651317
155	3910.160099	2041.153804
160	3812.755462	2008.076992
165	3716.798912	1975.417755
170	3622.446238	1943.174455
175	3529.827904	1911.346578
180	3439.051175	1879.934444
185	3350.202227	1848.938954
190	3263.348211	1818.361393
195	3178.539227	1788.203261
200	3095.810196	1758.466137
205	3015.182623	1729.151569
210	2936.666223	1700.260986
215	2860.260432	1671.795623
220	2785.95578	1643.756471
225	2713.735142	1616.14423
230	2643.574878	1588.959278
235	2575.445838	1562.201652
240	2509.314286	1535.871033
245	2445.142701	1509.960736
250	2382.890499	1484.48771
255	2322.514669	1459.432542
260	2263.970327	1434.799462
265	2207.211205	1410.586352

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270	2152.190076	1386.790762
275	2098.859119	1363.409919
280	2047.170238	1340.440747
285	1997.075333	1317.87988
290	1948.52653	1295.723685
295	1901.476379	1273.968273
300	1855.878014	1252.609525
305	1811.685296	1231.643105
310	1768.852919	1211.064479
315	1727.336504	1190.868935
320	1687.092668	1171.0516
325	1648.079085	1151.607456
330	1610.254524	1132.531358
335	1573.578881	1113.818049
340	1538.013196	1095.462176
345	1503.519667	1077.458303
350	1470.061651	1059.800927
355	1437.603661	1042.48449
360	1406.111356	1025.503392
365	1375.551531	1008.852002
370	1345.892096	992.5246673
375	1317.102058	976.5157285
380	1289.151499	960.8195241
385	1262.01155	945.4304018
390	1235.654364	930.342726
395	1210.053093	915.5508857
400	1185.181853	901.0493008
405	1161.015702	886.832429
410	1137.530608	872.8947714
415	1114.70342	859.2308776
420	1092.51184	845.8353508
425	1070.934393	832.7028518
430	1049.9504	819.8281029
435	1029.539948	807.2058915
440	1009.683866	794.8310727
445	990.3636932	782.6985725
450	971.5616589	770.8033898
455	953.2606514	759.1405982
460	935.4441963	747.7053482
465	918.0964311	736.4928681
470	901.2020825	725.4984655
475	884.7464436	714.717528
480	868.7153515	704.1455239
485	853.0951668	693.778003
490	837.8727531	683.6105961
495	823.0354569	673.6390163
500	808.5710889	663.8590577
505	794.4679061	654.2665962
510	780.7145934	644.8575888
515	767.3002477	635.628073
520	754.2143607	626.5741664
525	741.4468041	617.6920665
530	728.9878141	608.9780491
535	716.8279771	600.4284682
540	704.9582161	592.039755
545	693.3697771	583.8084166
550	682.0542167	575.7310355
555	671.0033897	567.8042683
560	660.2094374	560.0248445
565	649.6647764	552.3895658
570	639.3620879	544.8953045
575	629.2943074	537.5390027
580	619.4546145	530.3176709
585	609.8364237	523.2283867
590	600.4333754	516.268294
595	591.2393269	509.4346013
600	582.2483442	502.7245808
605	573.4546937	496.1355669
610	564.8528353	489.6649552
615	556.4374139	483.3102012
620	548.2032533	477.068819
625	540.1453491	470.9383802
630	532.258862	464.9165125

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Paul C. Rizzo Associates, Inc.
ENGINEERS & CONSULTANTS

09-4179.02 F-31

By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Sheet No.___ of___

Chkd. By_____ Date_____ Island – Calvert Cliffs Unit 3. Proj. No 09-4179

5.1.6 Boussineseq Values
Rectangular Loading Pattern
Soil profile based on boring log B-301

Below the center Uniform Loading $\Delta \sigma z = I_{sig}*P$

B = Width = 141.4973498 L = Length = 141.4973498

B^2+L^2= 40043

B^2*L^2 = 400860462.3

Z (Depth*)	$B^2+L^2+Z^2$	B^2*L^2/Z^2	$2BLZ(B^2+L^2+Z^2)^{0.5}$	$(B^2+L^2+Z^2)Z^2+B^2L^2$	$B^2+L^2+2Z^2$	I_{sig}
5.00	40068.00	16034418.49	40077022.1	401862162.25	40093.0	**0.25**
15.00	40268.00	1781602.054	120530760.3	409920762.25	40493.0	**0.25**
24.50	40643.25	667822.511	197782064.5	425256573.06	41243.5	**0.25**
34.00	41199.00	346765.1058	276343250.4	448486506.25	42355.0	**0.25**
44.00	41979.00	207056.0239	360990130.2	482131806.25	43915.0	**0.24**
54.00	42959.00	137469.2943	448174815.7	526128906.25	45875.0	**0.24**
64.00	44139.00	97866.32379	538415837.2	581653806.25	48235.0	**0.24**
74.00	45519.00	73203.15235	632200279	650122506.25	50995.0	**0.23**
84.00	47099.00	56811.29	729081302.5	733101006.25	54155.0	**0.22**
94.00	48879.00	45366.73407	832176824.5	832755306.25	57715.0	**0.22**
104.00	50859.00	37061.80309	939169228.8	950951406.25	61675.0	**0.21**
114.00	53039.00	30844.91091	1051305949	1090155306.25	66035.0	**0.20**
124.00	55419.00	26070.52954	1168900743	1252983006.25	70795.0	**0.19**
134.00	57999.00	22324.59692	1292235472	1442290506.25	75955.0	**0.18**
144.00	60779.00	19331.61951	1421562225	1661173806.25	81515.0	**0.17**
154.00	63759.00	16902.53256	1557105635	1912968906.25	87475.0	**0.16**
164.00	66939.00	14904.09214	1699065280	2201251806.25	93835.0	**0.16**
174.00	70319.00	13240.20552	1847618059	2529838506.25	100595.0	**0.15**
184.00	73899.00	11840.16016	2002920497	2902785006.25	107755.0	**0.14**
194.00	77679.00	10650.98476	2165110918	3324387306.25	115315.0	**0.13**
204.00	81659.00	9632.364049	2334311465	3799181406.25	123275.0	**0.13**
214.00	85839.00	8753.176309	2510629950	4331943306.25	131635.0	**0.12**
224.00	90219.00	7989.087656	2694161526	4927689006.25	140395.0	**0.11**
234.00	94799.00	7320.849994	2884990203	5591674506.25	149555.0	**0.11**
244.00	99579.00	6733.076832	3083190178	6329395806.25	159115.0	**0.10**
254.00	104559.00	6213.349592	3288827038	7146588906.25	169075.0	**0.10**
264.00	109739.00	5751.556219	3501958807	8049229806.25	179435.0	**0.09**
274.00	115119.00	5339.395576	3722636868	9043534506.25	190195.0	**0.09**
289.00	123564	4799.517035	4067901508	10721049306.25	207085	**0.08**
309.00	135524	4198.327021	4555050459	13340827506.25	231005	**0.07**
329.00	148284	3703.406863	5073055942	16451268906.25	256525	**0.07**
349.00	161844	3291.109779	5622122910	20113621506.25	283645	**0.06**
369.00	176204	2944.018201	6202415479	24392973306.25	312365	**0.06**
389.00	191364	2649.073574	6814065888	29358252306.25	342685	**0.05**
409.00	207324	2396.329901	7457181351	35082226506.25	374605	**0.05**
429.00	224084	2178.10413	8131849333	41641503906.25	408125	**0.04**
449.00	241644	1988.385287	8838141618	49116532506.25	443245	**0.04**
469.00	260004	1822.416075	9576117462	57591600306.25	479965	**0.04**
489.00	279164	1676.391711	10345826059	67154835306.25	518285	**0.04**
509.00	299124	1547.239907	11147308475	77898205506.25	558205	**0.03**
529.00	319884	1432.45794	11980599164	89917518906.25	599725	**0.03**
549.00	341444	1329.990485	12845727186	103312423506.25	642845	**0.03**
569.00	363804	1238.136966	13742717163	118186407306.25	687565	**0.03**
589.00	386964	1155.480534	14671590057	134646798306.25	733885	**0.03**
609.00	410924	1080.833103	15632363791	152804764506.25	781805	**0.02**
629.00	435684	1013.19242	16625053755	172775313906.25	831325	**0.02**

* below bottom of foundation

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3. Sheet No.___ of___

Chkd. By_____ Date_____ Proj. No 09-4179

Rectangular Loading Pattern

Below the corner — Uniform Loading — $\Delta \sigma z = I_{sig}*P$

B = Width = 282.9946996 L = Length = 282.9946996

B^2+L^2= 160172

B^2*L^2 = 6413767396

Z (Depth*)	$B^2+L^2+Z^2$	B^2*L^2/Z^2	$2BLZ(B^2+L^2+Z^2)^{0.5}$	$(B^2+L^2+Z^2)Z^2+B^2L^2$	$B^2+L^2+2Z^2$	I_{sig}
5.00	160197.00	256550695.8	320541151.1	6417772321.00	160222.0	**0.25**
15.00	160397.00	28505632.87	962223541.7	6449856721.00	160622.0	**0.25**
24.50	160772.25	10685160.18	1573469133	6510270939.06	161372.5	**0.25**
34.00	161328.00	5548241.692	2187360627	6600262564.00	162484.0	**0.25**
44.00	162108.00	3312896.382	2837536775	6727608484.00	164044.0	**0.25**
54.00	163088.00	2199508.709	3492941899	6889332004.00	166004.0	**0.25**
64.00	164268.00	1565861.181	4154732404	7086609124.00	168364.0	**0.25**
74.00	165648.00	1171250.438	4824045735	7320855844.00	171124.0	**0.25**
84.00	167228.00	908080.64	5501907420	7593728164.00	174284.0	**0.25**
94.00	169008.00	725867.7451	6189678379	7907122084.00	177844.0	**0.24**
104.00	170988.00	592988.8495	6888152507	8263173604.00	181804.0	**0.24**
114.00	173168.00	493518.5746	7598454555	8664258724.00	186164.0	**0.24**
124.00	175548.00	417128.4727	8321588315	9112993444.00	190924.0	**0.24**
134.00	178128.00	357193.5507	9058525114	9612233764.00	196084.0	**0.23**
144.00	180908.00	309305.9122	9810202605	10165075684.00	201644.0	**0.23**
154.00	183888.00	270440.521	10577523868	10774855204.00	207604.0	**0.23**
164.00	187068.00	238465.4743	11361356777	11445148324.00	213964.0	**0.22**
174.00	190448.00	211843.2883	12162533651	12179771044.00	220724.0	**0.22**
184.00	194028.00	189442.5625	12981851144	12982779364.00	227884.0	**0.22**
194.00	197808.00	170415.7561	13820070368	13858469284.00	235444.0	**0.21**
204.00	201788.00	154117.8248	14677917213	14811376804.00	243404.0	**0.21**
214.00	205968.00	140050.8209	15556082860	15846277924.00	251764.0	**0.21**
224.00	210348.00	127825.4025	16455224445	16968188644.00	260524.0	**0.20**
234.00	214928.00	117133.5999	17375965858	18182364964.00	269684.0	**0.20**
244.00	219708.00	107729.2293	18318898661	19494302884.00	279244.0	**0.19**
254.00	224688.00	99413.59347	19284583089	20909738404.00	289204.0	**0.19**
264.00	229868.00	92024.89951	20273549134	22434647524.00	299564.0	**0.18**
274.00	235248.00	85430.32921	21286297677	24075246244.00	310324.0	**0.18**
289.00	243693.00	76792.27255	22851039889	26767250449.00	327214.0	**0.17**
309.00	255653.00	67173.23233	25024794775	30823771489.00	351134.0	**0.16**
329.00	268413.00	59254.50981	27301359232	35467058929.00	376654.0	**0.16**
349.00	281973.00	52657.75647	29683546500	40758360769.00	403774.0	**0.15**
369.00	296333.00	47104.29121	32173845611	46762765009.00	432494.0	**0.14**
389.00	311493.00	42385.17718	34774456061	53549199649.00	462814.0	**0.13**
409.00	327453.00	38341.27842	37487319985	61190432689.00	494734.0	**0.13**
429.00	344213.00	34849.66609	40314151622	69763072129.00	528254.0	**0.12**
449.00	361773.00	31814.16459	43256463996	79347565969.00	563374.0	**0.11**
469.00	380133.00	29158.6572	46315592875	90028202209.00	600094.0	**0.11**
489.00	399293.00	26822.26737	49492718139	101893108849.00	638414.0	**0.10**
509.00	419253.00	24755.83851	52788882724	115034253889.00	678334.0	**0.10**
529.00	440013.00	22919.32703	56205009345	129547445329.00	719854.0	**0.09**
549.00	461573.00	21279.84776	59741915219	145532331169.00	762974.0	**0.09**
569.00	483933.00	19810.19146	63400324973	163092399409.00	807694.0	**0.08**
589.00	507093.00	18487.68854	67180881958	182334978049.00	854014.0	**0.08**
609.00	531053.00	17293.32966	71084158142	203371235089.00	901934.0	**0.08**
629.00	555813.00	16211.07872	75110662754	226316178529.00	951454.0	**0.07**

* below bottom of foundation

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No. ___ of ___

Chkd. By _____ Date _____ Proj. No 09-4179

5.1.7 Consolidation Settlement

Structure	Nuclear Island
Location	B-301
BackFill Height (ft)	0
Type of Stress Diagram	Rectangular
Original Ground Elev (ft, msl)	94.5
Bottom of Ftg. Elev (ft, msl)	41.50
Foundation Pressure (psf)	5830
Groundwater Elev (ft, msl)	41.50
CPT/Boring Profile	B-301

Layer	Soil Type	Top Elev (ft msl)	Mid-Layer Elev (ft msl)	**Bottom Elev (ft msl)**	Layer Thick-ness (ft)	Mid-Layer Depth (ft)	Mid-Layer Depth* (ft)	Bottom Layer Depth (ft)	**Layer Unit Weight (pcf)**	Initial Mid-Layer Effective Stress (psf)	Botom Layer Eff. Stress (psf)	**OCR**	Pp (psf)	**Δ σv due to foundation (psf) (rectangular center)**	Δ σv / Inital Stress %	σ final (psf)	σ v average (psf)	Fine Grained Behavior **Cre**	**Cce**
1	SM	94.5	68	41.50	53	26.5	-26.5	53	122	3233	6466		0	0.00	0	3233	3233		
2	SM	41.50	36.5	31.50	10	58	5	63	122	6764	7062		0	5829.81	86	12594	9679		
3	SM	31.50	26.5	21.50	10	68	15	73	122	7360	7658		0	5824.86	79	13185	10272		
4	SM	21.50	17	12.50	9	77.5	24.5	82	122	7926	8194		0	5808.14	73	13734	10830		
5	SM	12.50	7.5	2.50	10	87	34	92	123	8497	8800		0	5773.56	68	14271	11384		
6	SM	2.50	-2.5	-7.50	10	97	44	102	123	9103	9406		0	5713.30	63	14817	11960		
7	SM	-7.50	-12.5	-17.50	10	107	54	112	123	9709	10012		0	5626.20	58	15336	12522		
8	CL	-17.50	-22.5	-27.50	10	117	64	122	104	10220	10428	4	40882	5512.25	54	15733	12977	0.02	0.36
9	CL	-27.50	-32.5	-37.50	10	127	74	132	104	10636	10844	4	42546	5373.43	51	16010	13323	0.02	0.36
10	CL	-37.50	-42.5	-47.50	10	137	84	142	104	11052	11260	4	44210	5213.13	47	16266	13659	0.02	0.36
11	CL	-47.50	-52.5	-57.50	10	147	94	152	104	11468	11676	4	45874	5035.52	44	16504	13986	0.02	0.36
12	CL	-57.50	-62.5	-67.50	10	157	104	162	104	11884	12092	4	47538	4845.09	41	16729	14307	0.02	0.36
13	CL	-67.50	-72.5	-77.50	10	167	114	172	104	12300	12508	4	49202	4646.21	38	16947	14624	0.02	0.36
14	CL	-77.50	-82.5	-87.50	10	177	124	182	104	12716	12924	4	50866	4442.83	35	17159	14938	0.02	0.36
15	CL	-87.50	-92.5	-97.50	10	187	134	192	104	13132	13340	4	52530	4238.40	32	17371	15252	0.02	0.36
16	CL	-97.50	-102.5	-107.50	10	197	144	202	104	13548	13756	4	54194	4035.75	30	17584	15566	0.02	0.36
17	CL	-107.50	-112.5	-117.50	10	207	154	212	104	13964	14172	4	55858	3837.13	27	17802	15883	0.02	0.36
18	CL	-117.50	-122.5	-127.50	10	217	164	222	104	14380	14588	4	57522	3644.25	25	18025	16203	0.02	0.36
19	CL	-127.50	-132.5	-137.50	10	227	174	232	104	14796	15004	4	59186	3458.33	23	18255	16526	0.02	0.36
20	CL	-137.50	-142.5	-147.50	10	237	184	242	104	15212	15420	4	60850	3280.22	22	18493	16853	0.02	0.36
21	CL	-147.50	-152.5	-157.50	10	247	194	252	104	15628	15836	4	62514	3110.42	20	18739	17184	0.02	0.36
22	CL	-157.50	-162.5	-167.50	10	257	204	262	104	16044	16252	4	64178	2949.17	18	18994	17519	0.02	0.36
23	CL	-167.50	-172.5	-177.50	10	267	214	272	104	16460	16668	4	65842	2796.53	17	19257	17859	0.02	0.36
24	CL	-177.50	-182.5	-187.50	10	277	224	282	104	16876	17084	4	67506	2652.38	16	19529	18203	0.02	0.36
25	CL	-187.50	-192.5	-197.50	10	287	234	292	104	17292	17500	4	69170	2516.51	15	19809	18551	0.02	0.36
26	CL	-197.50	-202.5	-207.50	10	297	244	302	104	17708	17916	4	70834	2388.63	13	20097	18903	0.02	0.36
27	SM	-207.50	-212.5	-217.50	10	307	254	312	127	18239	18562		0	2268.40	12	20508	19374		
28	SM	-217.50	-222.5	-227.50	10	317	264	322	127	18885	19208		0	2155.44	11	21041	19963		
29	SM	-227.50	-232.5	-237.50	10	327	274	332	127	19531	19854		0	2049.37	10	21581	20556		
30	SM	-237.50	-247.5	-257.50	20	342	289	352	127	20500	21146		0	1902.29	9	22403	21452		
31	SM	-257.50	-267.5	-277.50	20	362	309	372	127	21792	22438		0	1726.65	8	23519	22656		
32	SM	-277.50	-287.5	-297.50	20	382	329	392	127	23084	23730		0	1571.71	7	24656	23870		
33	SM	-297.50	-307.5	-317.50	20	402	349	412	127	24376	25022		0	1434.81	6	25811	25094		
34	SM	-317.50	-327.5	-337.50	20	422	369	432	127	25668	26314		0	1313.59	5	26982	26325		
35	SM	-337.50	-347.5	-357.50	20	442	389	452	127	26960	27606		0	1206.00	4	28166	27563		
36	SM	-357.50	-367.5	-377.50	20	462	409	472	127	28252	28898		0	1110.23	4	29363	28808		
37	SM	-377.50	-387.5	-397.50	20	482	429	492	127	29544	30190		0	1024.77	3	30569	30057		
38	SM	-397.50	-407.5	-417.50	20	502	449	512	127	30836	31482		0	948.28	3	31785	31311		
39	SM	-417.50	-427.5	-437.50	20	522	469	532	127	32128	32774		0	879.62	3	33008	32568		
40	SM	-437.50	-447.5	-457.50	20	542	489	552	127	33420	34066		0	817.82	2	34238	33829		
41	SM	-457.50	-467.5	-477.50	20	562	509	572	127	34712	35358		0	762.04	2	35474	35093		
42	SM	-477.50	-487.5	-497.50	20	582	529	592	127	36004	36650		0	711.56	2	36716	36360		
43	SM	-497.50	-507.5	-517.50	20	602	549	612	127	37296	37942		0	665.76	2	37962	37629		
44	SM	-517.50	-527.5	-537.50	20	622	569	632	127	38588	39234		0	624.10	2	39212	38900		
45	SM	-537.50	-547.5	-557.50	20	642	589	652	127	39880	40526		0	586.10	1	40467	40173		
46	SM	-557.50	-567.5	-577.50	20	662	609	672	127	41172	41818		0	551.38	1	41724	41448		
47	SM	-577.50	-587.5	-597.50	20	682	629	692	127	42464	43110		0	519.56	1	42984	42724		

*Below bottom of foundation

** Cre=Cr/(1+e0) = 0.06 / (1+1.61)=0.02, Cce = Cc / (1+e0) = 0.947 / (1 + 1.61) = 0.36

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Cv 5.313889 ft^2/day
1913 ft^2/year

Fine Grained Recom-press Settle ment (ft)	Virgin Settle-ment (ft)	Layer	Maximum Thickness of Fine-Grained Layer for rate calcs (ft)	Type drainage path (1, 2)	Time X (days) =>	Time Factor T at Time X 10	20	30	60	360	1800	7200	Settlement (mt) at Time X 10	20	30	60	(1.0 yrs) 360	(5 yrs) 1800	(20 yrs) 7200
		1				0	0	0	0	0	0	0							
		2				0	0	0	0	0	0	0							
		3				0	0	0	0	0	0	0							
		4				0	0	0	0	0	0	0							
		5				0	0	0	0	0	0	0							
		6				0	0	0	0	0	0	0							
		7				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.037		8	190	2		0.005888	0.0117759	0.0176639	0.0353278	0.2119668	1.0598338	4.2393352	0.4406427	0.6231629	0.7632156	1.0793499	2.6438564	4.7874702	5.0890713
0.036		9				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.034		10				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.032		11				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.030		12				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.028		13				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.026		14				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.024		15				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.023		16				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.021		17				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.020		18				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.018		19				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.017		20				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.016		21				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.015		22				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.014		23				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.013		24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.012		25				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.011		26				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		27				0	0	0	0	0	0	0							
		28				0	0	0	0	0	0	0							
		29				0	0	0	0	0	0	0							
		30				0	0	0	0	0	0	0							
		31				0	0	0	0	0	0	0							
		32				0	0	0	0	0	0	0							
		33				0	0	0	0	0	0	0							
		34				0	0	0	0	0	0	0							
		35				0	0	0	0	0	0	0							
		36				0	0	0	0	0	0	0							
		37				0	0	0	0	0	0	0							
		38				0	0	0	0	0	0	0							
		39				0	0	0	0	0	0	0							
		40				0	0	0	0	0	0	0							
		41				0	0	0	0	0	0	0							
		42				0	0	0	0	0	0	0							
		43				0	0	0	0	0	0	0							
		44				0	0	0	0	0	0	0							
		45				0	0	0	0	0	0	0							
		46				0	0	0	0	0	0	0							
		47				0	0	0	0	0	0	0							

Consolidation Settlement 5.089 in

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09-4179.02 F-31

By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No.___ of___

Chkd. By_____ Date_____ Proj. No 09-4179

Rectangular Loading Pattern Stress distribution W=L= 232.99 ft

Soil profile based on boring log B-304

5.1.8 Boussinesq Solution Uniform Loading $\Delta \sigma z = I_{sq} * P$

Original Ground Elev (ft, msl)	68
Water Elev at excavation(ft, msl)	41.5
Average unit waight of soil (pcf)	110 (Ref. 8)
Upward pressure (psf) q =	2915

Note: units for elevation, depth is ft, units for stress and modulus is psf, and units for deformation/settlement is in.

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	I_{sq} (center)	Δ σz (center)	I_{sq} (corner)	Δ σz (corner)	E**	Thickness	deformation(center)	deformation(corner)
1	IIb1 (SP)	5.00	41.50	31.50	0.25	2914.90	0.25	728.75	7.59E+06	10.00	4.61E-02	1.15E-02
2	IIb1 (SP)	15.00	31.50	21.50	0.25	2912.43	0.25	728.67	7.59E+06	10.00	4.60E-02	1.15E-02
3	IIb1 (SP)	25.25	21.50	11.00	0.25	2903.07	0.25	728.37	7.59E+06	10.50	4.82E-02	1.21E-02
4	IIb2 (SP)	35.50	11.00	1.00	0.25	2883.08	0.25	727.69	3.09E+06	10.00	1.12E-01	2.83E-02
5	IIb2 (SP)	45.50	1.00	-9.00	0.24	2850.98	0.25	726.55	3.09E+06	10.00	1.11E-01	2.82E-02
6	IIb3 (SP)	55.50	-9.00	-19.00	0.24	2805.39	0.25	724.82	7.86E+06	10.00	4.28E-02	1.11E-02
7	IIb3 (SP)	65.50	-19.00	-29.00	0.24	2746.47	0.25	722.41	7.86E+06	10.00	4.19E-02	1.10E-02
8	IIb3 (SP)	75.50	-29.00	-39.00	0.23	2675.33	0.25	719.25	7.86E+06	10.00	4.08E-02	1.10E-02
9	IIb3 (SP)	85.50	-39.00	-49.00	0.22	2593.74	0.25	715.28	7.86E+06	10.00	3.96E-02	1.09E-02
10	IIb3 (SP)	95.50	-49.00	-59.00	0.21	2503.83	0.24	710.48	7.86E+06	10.00	3.82E-02	1.08E-02
11	IIc (CL / ML)	105.50	-59.00	-69.00	0.21	2407.85	0.24	704.82	7.11E+06	10.00	4.06E-02	1.19E-02
12	IIc (CL / ML)	115.50	-69.00	-79.00	0.20	2307.95	0.24	698.32	7.11E+06	10.00	3.90E-02	1.18E-02
13	IIc (CL / ML)	125.50	-79.00	-89.00	0.19	2206.08	0.24	690.99	7.11E+06	10.00	3.72E-02	1.17E-02
14	IIc (CL / ML)	135.50	-89.00	-99.00	0.18	2103.91	0.23	682.87	7.11E+06	10.00	3.55E-02	1.15E-02
15	IIc (CL / ML)	145.50	-99.00	-109.00	0.17	2002.83	0.23	674.01	7.11E+06	10.00	3.38E-02	1.14E-02
16	IIc (CL / ML)	155.50	-109.00	-119.00	0.16	1903.90	0.23	664.45	7.11E+06	10.00	3.21E-02	1.12E-02
17	IIc (CL / ML)	165.50	-119.00	-129.00	0.16	1807.95	0.22	654.28	7.11E+06	10.00	3.05E-02	1.10E-02
18	IIc (CL / ML)	175.50	-129.00	-139.00	0.15	1715.55	0.22	643.54	7.11E+06	10.00	2.90E-02	1.09E-02
19	IIc (CL / ML)	185.50	-139.00	-149.00	0.14	1627.11	0.22	632.31	7.11E+06	10.00	2.75E-02	1.07E-02
20	IIc (CL / ML)	195.50	-149.00	-159.00	0.13	1542.84	0.21	620.67	7.11E+06	10.00	2.60E-02	1.05E-02
21	IIc (CL / ML)	205.50	-159.00	-169.00	0.13	1462.87	0.21	608.68	7.11E+06	10.00	2.47E-02	1.03E-02
22	IIc (CL / ML)	215.50	-169.00	-179.00	0.12	1387.18	0.20	596.41	7.11E+06	10.00	2.34E-02	1.01E-02
23	IIc (CL / ML)	225.50	-179.00	-189.00	0.11	1315.74	0.20	583.92	7.11E+06	10.00	2.22E-02	9.86E-03
24	IIc (CL / ML)	235.50	-189.00	-199.00	0.11	1248.41	0.20	571.28	7.11E+06	10.00	2.11E-02	9.64E-03
25	IIc (CL / ML)	245.50	-199.00	-209.00	0.10	1185.06	0.19	558.55	7.11E+06	10.00	2.00E-02	9.43E-03
26	III (SP)	255.50	-209.00	-219.00	0.10	1125.50	0.19	545.77	9.51E+06	10.00	1.42E-02	6.89E-03
27	III (SP)	265.50	-219.00	-229.00	0.09	1069.55	0.18	532.99	9.51E+06	10.00	1.35E-02	6.73E-03
28	III (SP)	275.50	-229.00	-239.00	0.09	1017.01	0.18	520.26	9.51E+06	10.00	1.28E-02	6.56E-03
29	III (SP)	290.50	-239.00	-259.00	0.08	944.17	0.17	501.33	9.51E+06	20.00	2.38E-02	1.27E-02
30	III (SP)	310.50	-259.00	-279.00	0.07	857.17	0.16	476.58	9.51E+06	20.00	2.16E-02	1.20E-02
31	III (SP)	330.50	-279.00	-299.00	0.07	780.42	0.16	452.58	9.51E+06	20.00	1.97E-02	1.14E-02
32	III (SP)	350.50	-299.00	-319.00	0.06	712.60	0.15	429.45	9.51E+06	20.00	1.80E-02	1.08E-02
33	III (SP)	370.50	-319.00	-339.00	0.06	652.54	0.14	407.32	9.51E+06	20.00	1.65E-02	1.03E-02
34	III (SP)	390.50	-339.00	-359.00	0.05	599.21	0.13	386.22	9.51E+06	20.00	1.51E-02	9.75E-03
35	III (SP)	410.50	-359.00	-379.00	0.05	551.74	0.13	366.20	9.51E+06	20.00	1.39E-02	9.24E-03
36	III (SP)	430.50	-379.00	-399.00	0.04	509.37	0.12	347.26	9.51E+06	20.00	1.29E-02	8.76E-03
37	III (SP)	450.50	-399.00	-419.00	0.04	471.43	0.11	329.37	9.51E+06	20.00	1.19E-02	8.31E-03
38	III (SP)	470.50	-419.00	-439.00	0.04	437.38	0.11	312.51	9.51E+06	20.00	1.10E-02	7.89E-03
39	III (SP)	490.50	-439.00	-459.00	0.03	406.72	0.10	296.65	9.51E+06	20.00	1.03E-02	7.49E-03
40	III (SP)	510.50	-459.00	-479.00	0.03	379.04	0.10	281.74	9.51E+06	20.00	9.57E-03	7.11E-03
41	III (SP)	530.50	-479.00	-499.00	0.03	353.99	0.09	267.73	9.51E+06	20.00	8.93E-03	6.76E-03
42	III (SP)	550.50	-499.00	-519.00	0.03	331.25	0.09	254.57	9.51E+06	20.00	8.36E-03	6.42E-03
43	III (SP)	570.50	-519.00	-539.00	0.03	310.56	0.08	242.22	9.51E+06	20.00	7.84E-03	6.11E-03
44	III (SP)	590.50	-539.00	-559.00	0.03	291.70	0.08	230.63	9.51E+06	20.00	7.36E-03	5.82E-03
45	III (SP)	610.50	-559.00	-579.00	0.02	274.45	0.08	219.74	9.51E+06	20.00	6.93E-03	5.55E-03
46	III (SP)	630.50	-579.00	-599.00	0.02	258.64	0.07	209.52	9.51E+06	20.00	6.53E-03	5.29E-03
						8.87%		**7.19%**		total settlement	1.28	0.48

<10%

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09-4179.02 F-31

By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Sheet No.___ of___
Chkd. By_____ Date_____ Island – Calvert Cliffs Unit 3 Proj. No 09-4179

5.1.9 2 to 1 slope stress

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δ σz	E	Thickness	Settlement deformation(center)
1	IIb1 (SP)	5.00	41.50	31.50	2814.6615	7.59E+06	10.00	4.45E-02
2	IIb1 (SP)	15.00	31.50	21.50	2628.92431	7.59E+06	10.00	4.16E-02
3	IIb1 (SP)	25.25	21.50	11.00	2456.99304	7.59E+06	10.50	4.08E-02
4	IIb2 (SP)	35.50	11.00	1.00	2301.39277	3.09E+06	10.00	8.94E-02
5	IIb2 (SP)	45.50	1.00	-9.00	2163.40799	3.09E+06	10.00	8.40E-02
6	IIb3 (SP)	55.50	-9.00	-19.00	2037.47091	7.86E+06	10.00	3.11E-02
7	IIb3 (SP)	65.50	-19.00	-29.00	1922.21874	7.86E+06	10.00	2.93E-02
8	IIb3 (SP)	75.50	-29.00	-39.00	1816.47608	7.86E+06	10.00	2.77E-02
9	IIb3 (SP)	85.50	-39.00	-49.00	1719.22482	7.86E+06	10.00	2.62E-02
10	IIb3 (SP)	95.50	-49.00	-59.00	1629.57952	7.86E+06	10.00	2.49E-02
11	IIc (CL / ML)	105.50	-59.00	-69.00	1546.76724	7.11E+06	10.00	2.61E-02
12	IIc (CL / ML)	115.50	-69.00	-79.00	1470.11078	7.11E+06	10.00	2.48E-02
13	IIc (CL / ML)	125.50	-79.00	-89.00	1399.01481	7.11E+06	10.00	2.36E-02
14	IIc (CL / ML)	135.50	-89.00	-99.00	1332.95423	7.11E+06	10.00	2.25E-02
15	IIc (CL / ML)	145.50	-99.00	-109.00	1271.46454	7.11E+06	10.00	2.15E-02
16	IIc (CL / ML)	155.50	-109.00	-119.00	1214.13357	7.11E+06	10.00	2.05E-02
17	IIc (CL / ML)	165.50	-119.00	-129.00	1160.59456	7.11E+06	10.00	1.96E-02
18	IIc (CL / ML)	175.50	-129.00	-139.00	1110.52035	7.11E+06	10.00	1.87E-02
19	IIc (CL / ML)	185.50	-139.00	-149.00	1063.61829	7.11E+06	10.00	1.80E-02
20	IIc (CL / ML)	195.50	-149.00	-159.00	1019.626	7.11E+06	10.00	1.72E-02
21	IIc (CL / ML)	205.50	-159.00	-169.00	978.307652	7.11E+06	10.00	1.65E-02
22	IIc (CL / ML)	215.50	-169.00	-179.00	939.450868	7.11E+06	10.00	1.59E-02
23	IIc (CL / ML)	225.50	-179.00	-189.00	902.863926	7.11E+06	10.00	1.52E-02
24	IIc (CL / ML)	235.50	-189.00	-199.00	868.373416	7.11E+06	10.00	1.47E-02
25	IIc (CL / ML)	245.50	-199.00	-209.00	835.822176	7.11E+06	10.00	1.41E-02
26	III (SP)	255.50	-209.00	-219.00	805.067502	9.51E+06	10.00	1.02E-02
27	III (SP)	265.50	-219.00	-229.00	775.979578	9.51E+06	10.00	9.79E-03
28	III (SP)	275.50	-229.00	-239.00	748.440104	9.51E+06	10.00	9.44E-03
29	III (SP)	290.50	-239.00	-259.00	709.800572	9.51E+06	20.00	1.79E-02
30	III (SP)	310.50	-259.00	-279.00	662.76791	9.51E+06	20.00	1.67E-02
31	III (SP)	330.50	-279.00	-299.00	620.259653	9.51E+06	20.00	1.57E-02
32	III (SP)	350.50	-299.00	-319.00	581.713564	9.51E+06	20.00	1.47E-02
33	III (SP)	370.50	-319.00	-339.00	546.652103	9.51E+06	20.00	1.38E-02
34	III (SP)	390.50	-339.00	-359.00	514.667563	9.51E+06	20.00	1.30E-02
35	III (SP)	410.50	-359.00	-379.00	485.410168	9.51E+06	20.00	1.23E-02
36	III (SP)	430.50	-379.00	-399.00	458.578468	9.51E+06	20.00	1.16E-02
37	III (SP)	450.50	-399.00	-419.00	433.911542	9.51E+06	20.00	1.10E-02
38	III (SP)	470.50	-419.00	-439.00	411.132629	9.51E+06	20.00	1.04E-02
39	III (SP)	490.50	-439.00	-459.00	390.193902	9.51E+06	20.00	9.85E-03
40	III (SP)	510.50	-459.00	-479.00	370.772147	9.51E+06	20.00	9.36E-03
41	III (SP)	530.50	-479.00	-499.00	352.765176	9.51E+06	20.00	8.90E-03
42	III (SP)	550.50	-499.00	-519.00	336.03884	9.51E+06	20.00	8.48E-03
43	III (SP)	570.50	-519.00	-539.00	320.47452	9.51E+06	20.00	8.09E-03
44	III (SP)	590.50	-539.00	-559.00	305.967018	9.51E+06	20.00	7.72E-03
45	III (SP)	610.50	-559.00	-579.00	292.42278	9.51E+06	20.00	7.38E-03
46	III (SP)	630.50	-579.00	-599.00	279.758376	9.51E+06	20.00	7.06E-03
					9.60%		total settleme	0.96

inch

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09-4179.02 F-31

By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No.___ of___

Chkd. By_____ Date_____ Proj. No 09-4179

5.1.10 Circular Loading Pattern

R=159.7 ft

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δ σz (center)	Δ σz (edge)	Thickness	E**	deformation(center)	deformation(edge)
1	IIb1 (SP)	3.75	41.5	34	3002.57226	2794.36627	7.5	7.59E+06	3.56E-02	3.31E-02
2	IIb1 (SP)	10	34	29	2938.32722	2216.11724	5	7.59E+06	2.32E-02	1.75E-02
3	IIb1 (SP)	15	29	24	2931.42092	1937.18757	5	7.59E+06	2.32E-02	1.53E-02
4	IIb1 (SP)	20	24	19	2926.45815	1785.7992	5	7.59E+06	2.31E-02	1.41E-02
5	IIb1 (SP)	25	19	14	2920.54606	1688.89619	5	7.59E+06	2.31E-02	1.34E-02
6	IIb1 (SP)	30	14	9	2912.7032	1619.55957	5	7.59E+06	2.30E-02	1.28E-02
7	IIb2 (SP)	35	9	4	2902.40381	1565.94176	5	3.09E+06	5.64E-02	3.04E-02
8	IIb2 (SP)	40	4	-1	2889.30765	1522.08011	5	3.09E+06	5.61E-02	2.96E-02
9	IIb2 (SP)	45	-1	-6	2873.18821	1484.6643	5	3.09E+06	5.58E-02	2.88E-02
10	IIb2 (SP)	50	-6	-11	2853.30773	1451.7156	5	3.09E+06	5.54E-02	2.82E-02
11	IIb3 (SP)	55	-11	-16	2831.4051	1421.98174	5	7.86E+06	2.16E-02	1.09E-02
12	IIb3 (SP)	60	-16	-21	2805.38728	1394.63354	5	7.86E+06	2.14E-02	1.06E-02
13	IIb3 (SP)	65	-21	-26	2776.32135	1369.10166	5	7.86E+06	2.12E-02	1.05E-02
14	IIb3 (SP)	70	-26	-31	2744.92639	1344.98349	5	7.86E+06	2.10E-02	1.03E-02
15	IIb3 (SP)	75	-31	-36	2710.16519	1321.98735	5	7.86E+06	2.07E-02	1.01E-02
16	IIb3 (SP)	80	-36	-41	2672.73578	1299.89773	5	7.86E+06	2.04E-02	9.92E-03
17	IIb3 (SP)	85	-41	-46	2632.36322	1278.55277	5	7.86E+06	2.01E-02	9.76E-03
18	IIb3 (SP)	90	-46	-51	2590.79171	1257.82937	5	7.86E+06	1.98E-02	9.60E-03
19	IIb3 (SP)	95	-51	-56	2546.77745	1237.63288	5	7.86E+06	1.94E-02	9.45E-03
20	IIb3 (SP)	100	-56	-61	2501.38209	1217.89001	5	7.86E+06	1.91E-02	9.30E-03
21	IIc (CL / ML)	105	-61	-66	2453.96714	1198.54363	5	7.11E+06	2.07E-02	1.01E-02
22	IIc (CL / ML)	110	-66	-71	2405.58923	1179.54909	5	7.11E+06	2.03E-02	9.95E-03
23	IIc (CL / ML)	115	-71	-76	2356.49617	1160.87145	5	7.11E+06	1.99E-02	9.80E-03
24	IIc (CL / ML)	120	-76	-81	2306.52397	1142.48334	5	7.11E+06	1.95E-02	9.64E-03
25	IIc (CL / ML)	125	-81	-86	2256.29453	1124.36342	5	7.11E+06	1.90E-02	9.49E-03
26	IIc (CL / ML)	130	-86	-91	2205.71405	1106.49514	5	7.11E+06	1.86E-02	9.34E-03
27	IIc (CL / ML)	135	-91	-96	2155.37204	1088.86575	5	7.11E+06	1.82E-02	9.19E-03
28	IIc (CL / ML)	140	-96	-101	2104.54088	1071.46556	5	7.11E+06	1.78E-02	9.04E-03
29	IIc (CL / ML)	145	-101	-106	2054.27572	1054.28729	5	7.11E+06	1.73E-02	8.90E-03
30	IIc (CL / ML)	150	-106	-111	2004.41481	1037.32566	5	7.11E+06	1.69E-02	8.75E-03
31	IIc (CL / ML)	155	-111	-116	1955.08005	1020.5769	5	7.11E+06	1.65E-02	8.61E-03
32	IIc (CL / ML)	160	-116	-121	1906.37773	1004.0385	5	7.11E+06	1.61E-02	8.47E-03
33	IIc (CL / ML)	165	-121	-126	1858.39946	987.708878	5	7.11E+06	1.57E-02	8.34E-03
34	IIc (CL / ML)	170	-126	-131	1811.22312	971.587227	5	7.11E+06	1.53E-02	8.20E-03
35	IIc (CL / ML)	175	-131	-136	1764.91395	955.673289	5	7.11E+06	1.49E-02	8.06E-03
36	IIc (CL / ML)	180	-136	-141	1719.52559	939.967222	5	7.11E+06	1.45E-02	7.93E-03
37	IIc (CL / ML)	185	-141	-146	1675.10111	924.469477	5	7.11E+06	1.41E-02	7.80E-03
38	IIc (CL / ML)	190	-146	-151	1631.67411	909.180696	5	7.11E+06	1.38E-02	7.67E-03
39	IIc (CL / ML)	195	-151	-156	1589.26961	894.10163	5	7.11E+06	1.34E-02	7.55E-03
40	IIc (CL / ML)	200	-156	-161	1547.9051	879.233068	5	7.11E+06	1.31E-02	7.42E-03
41	IIc (CL / ML)	205	-161	-166	1507.59131	864.575784	5	7.11E+06	1.27E-02	7.30E-03
42	IIc (CL / ML)	210	-166	-171	1468.33311	850.130493	5	7.11E+06	1.24E-02	7.17E-03
43	IIc (CL / ML)	215	-171	-176	1430.13022	835.897812	5	7.11E+06	1.21E-02	7.05E-03
44	IIc (CL / ML)	220	-176	-181	1392.97789	821.878236	5	7.11E+06	1.18E-02	6.94E-03
45	IIc (CL / ML)	225	-181	-186	1356.36757	808.072115	5	7.11E+06	1.15E-02	6.82E-03
46	IIc (CL / ML)	230	-186	-191	1321.78744	794.479639	5	7.11E+06	1.12E-02	6.70E-03
47	IIc (CL / ML)	235	-191	-196	1287.72292	781.100826	5	7.11E+06	1.09E-02	6.59E-03
48	IIc (CL / ML)	240	-196	-201	1254.65714	767.935516	5	7.11E+06	1.06E-02	6.48E-03
49	IIc (CL / ML)	245	-201	-206	1222.57135	754.983368	5	7.11E+06	1.03E-02	6.37E-03
50	IIc (CL / ML)	250	-206	-211	1191.44525	742.243855	5	7.11E+06	1.01E-02	6.26E-03
51	III (SP)	255	-211	-216	1161.25733	729.716271	5	9.51E+06	7.33E-03	4.60E-03
52	III (SP)	260	-216	-221	1131.98516	717.399731	5	9.51E+06	7.14E-03	4.53E-03
53	III (SP)	265	-221	-226	1103.6056	705.293176	5	9.51E+06	6.96E-03	4.45E-03
54	III (SP)	270	-226	-231	1076.09504	693.395381	5	9.51E+06	6.79E-03	4.37E-03
55	III (SP)	275	-231	-236	1049.42956	681.70496	5	9.51E+06	6.62E-03	4.30E-03
56	III (SP)	280	-236	-241	1023.58512	670.220373	5	9.51E+06	6.46E-03	4.23E-03
57	III (SP)	285	-241	-246	998.537667	658.93994	5	9.51E+06	6.30E-03	4.16E-03

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58	III (SP)	290	-246	-251	974.233265	647.861842	5	9.51E+06	6.15E-03	4.09E-03
59	III (SP)	295	-251	-256	950.738189	636.984137	5	9.51E+06	6.00E-03	4.02E-03
60	III (SP)	300	-256	-261	927.939007	626.304763	5	9.51E+06	5.85E-03	3.95E-03
61	III (SP)	305	-261	-266	905.842648	615.821552	5	9.51E+06	5.72E-03	3.89E-03
62	III (SP)	310	-266	-271	884.42646	605.532239	5	9.51E+06	5.58E-03	3.82E-03
63	III (SP)	315	-271	-276	863.658252	595.434467	5	9.51E+06	5.45E-03	3.76E-03
64	III (SP)	320	-276	-281	843.546334	585.5258	5	9.51E+06	5.32E-03	3.69E-03
65	III (SP)	325	-281	-286	824.039542	575.803728	5	9.51E+06	5.20E-03	3.63E-03
66	III (SP)	330	-286	-291	805.127262	566.265679	5	9.51E+06	5.08E-03	3.57E-03
67	III (SP)	335	-291	-296	786.78944	556.909025	5	9.51E+06	4.96E-03	3.51E-03
68	III (SP)	340	-296	-301	769.006598	547.731088	5	9.51E+06	4.85E-03	3.46E-03
69	III (SP)	345	-301	-306	751.759834	538.729152	5	9.51E+06	4.74E-03	3.40E-03
70	III (SP)	350	-306	-311	735.030826	529.900464	5	9.51E+06	4.64E-03	3.34E-03
71	III (SP)	355	-311	-316	718.80183	521.242245	5	9.51E+06	4.54E-03	3.29E-03
72	III (SP)	360	-316	-321	703.055678	512.751696	5	9.51E+06	4.44E-03	3.24E-03
73	III (SP)	365	-321	-326	687.775765	504.426001	5	9.51E+06	4.34E-03	3.18E-03
74	III (SP)	370	-326	-331	672.946048	496.262334	5	9.51E+06	4.25E-03	3.13E-03
75	III (SP)	375	-331	-336	658.551029	488.257864	5	9.51E+06	4.15E-03	3.08E-03
76	III (SP)	380	-336	-341	644.57575	480.409762	5	9.51E+06	4.07E-03	3.03E-03
77	III (SP)	385	-341	-346	631.005775	472.715201	5	9.51E+06	3.98E-03	2.98E-03
78	III (SP)	390	-346	-351	617.827182	465.171363	5	9.51E+06	3.90E-03	2.93E-03
79	III (SP)	395	-351	-356	605.026546	457.775443	5	9.51E+06	3.82E-03	2.89E-03
80	III (SP)	400	-356	-361	592.590926	450.52465	5	9.51E+06	3.74E-03	2.84E-03
81	III (SP)	405	-361	-366	580.507851	443.416214	5	9.51E+06	3.66E-03	2.80E-03
82	III (SP)	410	-366	-371	568.735304	436.447386	5	9.51E+06	3.59E-03	2.75E-03
83	III (SP)	415	-371	-376	557.35171	429.615439	5	9.51E+06	3.52E-03	2.71E-03
84	III (SP)	420	-376	-381	546.25592	422.917675	5	9.51E+06	3.45E-03	2.67E-03
85	III (SP)	425	-381	-386	535.457197	416.351426	5	9.51E+06	3.38E-03	2.63E-03
86	III (SP)	430	-386	-391	524.9752	409.914051	5	9.51E+06	3.31E-03	2.59E-03
87	III (SP)	435	-391	-396	514.739974	403.602946	5	9.51E+06	3.25E-03	2.55E-03
88	III (SP)	440	-396	-401	504.841933	397.415536	5	9.51E+06	3.19E-03	2.51E-03
89	III (SP)	445	-401	-406	495.131847	391.349286	5	9.51E+06	3.12E-03	2.47E-03
90	III (SP)	450	-406	-411	485.730829	385.401695	5	9.51E+06	3.06E-03	2.43E-03
91	III (SP)	455	-411	-416	476.630326	379.570299	5	9.51E+06	3.01E-03	2.39E-03
92	III (SP)	460	-416	-421	467.722098	373.852674	5	9.51E+06	2.95E-03	2.36E-03
93	III (SP)	465	-421	-426	459.048216	368.246434	5	9.51E+06	2.90E-03	2.32E-03
94	III (SP)	470	-426	-431	450.601041	362.749233	5	9.51E+06	2.84E-03	2.29E-03
95	III (SP)	475	-431	-436	442.373222	357.358764	5	9.51E+06	2.79E-03	2.25E-03
96	III (SP)	480	-436	-441	434.357676	352.072762	5	9.51E+06	2.74E-03	2.22E-03
97	III (SP)	485	-441	-446	426.547583	346.889001	5	9.51E+06	2.69E-03	2.19E-03
98	III (SP)	490	-446	-451	418.936377	341.805298	5	9.51E+06	2.64E-03	2.16E-03
99	III (SP)	495	-451	-456	411.517728	336.819508	5	9.51E+06	2.60E-03	2.13E-03
100	III (SP)	500	-456	-461	404.235544	331.929529	5	9.51E+06	2.55E-03	2.09E-03
101	III (SP)	505	-461	-466	397.233953	327.133298	5	9.51E+06	2.51E-03	2.06E-03
102	III (SP)	510	-466	-471	390.357297	322.428794	5	9.51E+06	2.46E-03	2.03E-03
103	III (SP)	515	-471	-476	383.650124	317.814036	5	9.51E+06	2.42E-03	2.01E-03
104	III (SP)	520	-476	-481	377.10718	313.287083	5	9.51E+06	2.38E-03	1.98E-03
105	III (SP)	525	-481	-486	370.723402	308.846033	5	9.51E+06	2.34E-03	1.95E-03
106	III (SP)	530	-486	-491	364.493907	304.489025	5	9.51E+06	2.30E-03	1.92E-03
107	III (SP)	535	-491	-496	358.413989	300.214234	5	9.51E+06	2.26E-03	1.89E-03
108	III (SP)	540	-496	-501	352.479108	296.019877	5	9.51E+06	2.22E-03	1.87E-03
109	III (SP)	545	-501	-506	346.634889	291.904208	5	9.51E+06	2.19E-03	1.84E-03
110	III (SP)	550	-506	-511	341.027108	287.865518	5	9.51E+06	2.15E-03	1.82E-03
111	III (SP)	555	-511	-516	335.501695	283.902134	5	9.51E+06	2.12E-03	1.79E-03
112	III (SP)	560	-516	-521	330.104719	280.012422	5	9.51E+06	2.08E-03	1.77E-03
113	III (SP)	565	-521	-526	324.832388	276.194783	5	9.51E+06	2.05E-03	1.74E-03
114	III (SP)	570	-526	-531	319.631044	272.447652	5	9.51E+06	2.02E-03	1.72E-03
115	III (SP)	575	-531	-536	314.647154	268.769501	5	9.51E+06	1.99E-03	1.70E-03
116	III (SP)	580	-536	-541	309.727307	265.158835	5	9.51E+06	1.95E-03	1.67E-03
117	III (SP)	585	-541	-546	304.918212	261.614193	5	9.51E+06	1.92E-03	1.65E-03
118	III (SP)	590	-546	-551	300.216688	258.134147	5	9.51E+06	1.89E-03	1.63E-03
119	III (SP)	595	-551	-556	295.619663	254.717301	5	9.51E+06	1.87E-03	1.61E-03
120	III (SP)	600	-556	-561	291.124172	251.36229	5	9.51E+06	1.84E-03	1.59E-03
121	III (SP)	605	-561	-566	286.727347	248.067783	5	9.51E+06	1.81E-03	1.57E-03
122	III (SP)	610	-566	-571	282.426418	244.832478	5	9.51E+06	1.78E-03	1.54E-03
123	III (SP)	615	-571	-576	278.218707	241.655101	5	9.51E+06	1.76E-03	1.52E-03
124	III (SP)	620	-576	-581	274.101627	238.53441	5	9.51E+06	1.73E-03	1.50E-03
125	III (SP)	625	-581	-586	270.072675	235.46919	5	9.51E+06	1.70E-03	1.49E-03
126	III (SP)	630	-586	-591	266.129431	232.458256	5	9.51E+06	1.68E-03	1.47E-03
					9.13%			total settlement	**1.30**	**0.77** inch

* below bottom of foundation

** The elastic modulus are 3 times of the values recommended by Ref.4.

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5.1.11 Vertical stress under circular loading

Radius R is 159.7

q= 2915

Z (Depth*)	Center Vertical Stress	Edge Vertical Stress
3.75	3002.572264	2794.366268
10	2938.327215	2216.117237
15	2931.420919	1937.187574
20	2926.458153	1785.799201
25	2920.546057	1688.896189
30	2912.703197	1619.559569
35	2902.40381	1565.941759
40	2889.307647	1522.080114
45	2873.188206	1484.664298
50	2853.907727	1451.715604
55	2831.405103	1421.981743
60	2805.687284	1394.633536
65	2776.821346	1369.101657
70	2744.92639	1344.983488
75	2710.165191	1321.987353
80	2672.735784	1299.897727
85	2632.863215	1278.552772
90	2590.791711	1257.829368
95	2546.777448	1237.632882
100	2501.082089	1217.890006
105	2453.967144	1198.543626
110	2405.689227	1179.549093
115	2356.496169	1160.871448
120	2306.623971	1142.483338
125	2256.29453	1124.363424
130	2205.714047	1106.495145
135	2155.072041	1088.865754
140	2104.540879	1071.465555
145	2054.275719	1054.287292
150	2004.414811	1037.325659
155	1955.080049	1020.576902
160	1906.377731	1004.038496
165	1858.399456	987.7088775
170	1811.223119	971.5872273
175	1764.913952	955.6732891
180	1719.525587	939.9672219
185	1675.101113	924.469477
190	1631.674106	909.1806964
195	1589.269613	894.1016303
200	1547.905098	879.2330683
205	1507.591311	864.5757845
210	1468.333112	850.1304929
215	1430.130216	835.8978117
220	1392.97789	821.8782356
225	1356.867571	808.0721148
230	1321.787439	794.4796388
235	1287.722919	781.1008261
240	1254.657143	767.9355165
245	1222.57135	754.9833678
250	1191.445249	742.2438548
255	1161.257334	729.7162708
260	1131.985163	717.3997308
265	1103.605603	705.2931761
270	1076.095038	693.395381
275	1049.42956	681.7049596
280	1023.585119	670.2203734
285	998.5376667	658.9399401
290	974.2632651	647.8618424
295	950.7381893	636.9841367
300	927.9390071	626.3047627
305	905.8426481	615.8215524
310	884.4264596	605.5322393
315	863.6682518	595.4344674
320	843.5463339	585.5257999
325	824.0395425	575.803728
330	805.1272621	566.2656791
335	786.7894405	556.9090247

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340	769.0065981	547.731088
345	751.7598337	538.7291515
350	735.0308257	529.9004636
355	718.8018305	521.2422452
360	703.0556781	512.7516962
365	687.7757655	504.4260008
370	672.9460479	496.2623337
375	658.5510291	488.2578642
380	644.5757497	480.409762
385	631.0057751	472.7152009
390	617.8271822	465.171363
395	605.0265463	457.7754429
400	592.5909263	450.5246504
405	580.5078509	443.4162145
410	568.7653039	436.4473857
415	557.3517101	429.6154388
420	546.2559201	422.9176754
425	535.4671966	416.3514259
430	524.9751999	409.9140515
435	514.769974	403.6029457
440	504.8419328	397.4155363
445	495.1818466	391.3492863
450	485.7808294	385.4016949
455	476.6303257	379.5702991
460	467.7220981	373.8526741
465	459.0482155	368.246434
470	450.6010413	362.7492327
475	442.3732218	357.358764
480	434.3576757	352.072762
485	426.5475834	346.8890015
490	418.9363766	341.8052981
495	411.5177284	336.8195081
500	404.2855445	331.9295288
505	397.233953	327.1332981
510	390.3572967	322.4287944
515	383.6501238	317.8140365
520	377.1071804	313.2870832
525	370.7234021	308.8460332
530	364.4939071	304.4890245
535	358.4139886	300.2142341
540	352.4791081	296.0198775
545	346.6848886	291.9042083
550	341.0271084	287.8655178
555	335.5016948	283.9021341
560	330.1047187	280.0124223
565	324.8323882	276.1947829
570	319.681044	272.4476523
575	314.6471537	268.7695014
580	309.7273072	265.1588354
585	304.9182119	261.6141934
590	300.2166877	258.134147
595	295.6196635	254.7173007
600	291.1241721	251.3622904
605	286.7273469	248.0677834
610	282.4264176	244.8324776
615	278.2187069	241.6551006
620	274.1016266	238.5344095
625	270.0726745	235.4691901
630	266.129431	232.4582563

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Sheet No. ___ of ___

Chkd. By _____ Date _____ Island – Calvert Cliffs Unit 3 Proj. No 09-4179

5.1.12 Consolidation Settlement

Structure	Nuclear Island
Location	B-304
BackFill Height (ft)	0
Type of Stress Diagram	Rectangular
Original Ground Elev (ft, msl)	68
Bottom of Ftg. Elev (ft, msl)	41.50
Foundation Pressure (psf)	2915
Groundwater Elev (ft, msl)	41.50
CPT/Boring Profile	B-304
Boring for Elastic Settlement	B-304

Layer	Soil Type	Top Elev (ft msl)	Mid-Layer Elev (ft msl)	**Bottom Elev (ft msl)**	Layer Thickness (ft)	Mid-Layer Depth (ft)	Mid-Layer Depth* (ft)	Bottom Layer Depth (ft)	**Layer Unit Weight (pcf)**	Initial Mid-Layer Effective Stress (psf)	Bottom Layer Eff. Stress (psf)	**OCR**	Pp (psf)	**Δ σv due to foundation (psf)**	Δ σv / Initial Stress %	σ final (psf)	σ v average (psf)	Fine Grained Behavior **Cre**	**Cce**
1	SM	68	56	44	24	12	-14.5	24	122	1464	2928		0	0.00	0	1464	1464		
2	SM	41.50	36.5	31.50	10	31.5	5	36.5	122	3226	3524		0	728.75	23	3955	3590		
3	SM	31.50	26.5	21.50	10	41.5	15	46.5	122	3822	4120		0	728.67	19	4551	4186		
4	SM	21.50	16.25	11.00	10.5	51.75	25.25	57	122	4433	4746		0	728.37	16	5161	4797		
5	SM	11.00	6	1.00	10	62	35.5	67	123	5049	5352		0	727.69	14	5776	5413		
6	SM	1.00	-4	-9.00	10	72	45.5	77	123	5655	5958		0	726.55	13	6381	6018		
7	SM	-9.00	-14	-19.00	10	82	55.5	87	123	6261	6564		0	724.82	12	6986	6623		
8	SM	-19.00	-24	-29.00	10	92	65.5	97	123	6867	7170		0	722.41	11	7589	7228		
9	SM	-29.00	-34	-39.00	10	102	75.5	107	123	7473	7776		0	719.25	10	8192	7832		
10	SM	-39.00	-44	-49.00	10	112	85.5	117	123	8079	8382		0	715.28	9	8794	8436		
11	SM	-49.00	-54	-59.00	10	122	95.5	127	123	8685	8988		0	710.48	8	9395	9040		
12	CL	-59.00	-64	-69.00	10	132	105.5	137	104	9196	9404	4	36783	704.82	8	9901	9548	0.02	0.36
13	CL	-69.00	-74	-79.00	10	142	115.5	147	104	9612	9820	4	38447	698.32	7	10310	9961	0.02	0.36
14	CL	-79.00	-84	-89.00	10	152	125.5	157	104	10028	10236	4	40111	690.99	7	10719	10373	0.02	0.36
15	CL	-89.00	-94	-99.00	10	162	135.5	167	104	10444	10652	4	41775	682.87	7	11127	10785	0.02	0.36
16	CL	-99.00	-104	-109.00	10	172	145.5	177	104	10860	11068	4	43439	674.01	6	11534	11197	0.02	0.36
17	CL	-109.00	-114	-119.00	10	182	155.5	187	104	11276	11484	4	45103	664.45	6	11940	11608	0.02	0.36
18	CL	-119.00	-124	-129.00	10	192	165.5	197	104	11692	11900	4	46767	654.28	6	12346	12019	0.02	0.36
19	CL	-129.00	-134	-139.00	10	202	175.5	207	104	12108	12316	4	48431	643.54	5	12751	12430	0.02	0.36
20	CL	-139.00	-144	-149.00	10	212	185.5	217	104	12524	12732	4	50095	632.31	5	13156	12840	0.02	0.36
21	CL	-149.00	-154	-159.00	10	222	195.5	227	104	12940	13148	4	51759	620.67	5	13560	13250	0.02	0.36
22	CL	-159.00	-164	-169.00	10	232	205.5	237	104	13356	13564	4	53423	608.68	5	13964	13660	0.02	0.36
23	CL	-169.00	-174	-179.00	10	242	215.5	247	104	13772	13980	4	55087	596.41	4	14368	14070	0.02	0.36
24	CL	-179.00	-184	-189.00	10	252	225.5	257	104	14188	14396	4	56751	583.92	4	14772	14480	0.02	0.36
25	CL	-189.00	-194	-199.00	10	262	235.5	267	104	14604	14812	4	58415	571.28	4	15175	14889	0.02	0.36
26	CL	-199.00	-204	-209.00	10	272	245.5	277	104	15020	15228	4	60079	558.55	4	15578	15299	0.02	0.36
27	SM	-209.00	-214	-219.00	10	282	255.5	287	127	15551	15874		0	545.77	4	16097	15824		
28	SM	-219.00	-224	-229.00	10	292	265.5	297	127	16197	16520		0	532.99	3	16730	16463		
29	SM	-229.00	-234	-239.00	10	302	275.5	307	127	16843	17166		0	520.26	3	17363	17103		
30	SM	-239.00	-249	-259.00	20	317	290.5	327	127	17812	18458		0	501.33	3	18313	18062		
31	SM	-259.00	-269	-279.00	20	337	310.5	347	127	19104	19750		0	476.58	2	19580	19342		
32	SM	-279.00	-289	-299.00	20	357	330.5	367	127	20396	21042		0	452.58	2	20848	20622		
33	SM	-299.00	-309	-319.00	20	377	350.5	387	127	21688	22334		0	429.45	2	22117	21903		
34	SM	-319.00	-329	-339.00	20	397	370.5	407	127	22980	23626		0	407.32	2	23387	23183		
35	SM	-339.00	-349	-359.00	20	417	390.5	427	127	24272	24918		0	386.22	2	24658	24465		
36	SM	-359.00	-369	-379.00	20	437	410.5	447	127	25564	26210		0	366.20	1	25930	25747		
37	SM	-379.00	-389	-399.00	20	457	430.5	467	127	26856	27502		0	347.26	1	27203	27029		
38	SM	-399.00	-409	-419.00	20	477	450.5	487	127	28148	28794		0	329.37	1	28477	28312		
39	SM	-419.00	-429	-439.00	20	497	470.5	507	127	29440	30086		0	312.51	1	29752	29596		
40	SM	-439.00	-449	-459.00	20	517	490.5	527	127	30732	31378		0	296.65	1	31028	30880		
41	SM	-459.00	-469	-479.00	20	537	510.5	547	127	32024	32670		0	281.74	1	32306	32165		
42	SM	-479.00	-489	-499.00	20	557	530.5	567	127	33316	33962		0	267.73	1	33584	33450		
43	SM	-499.00	-509	-519.00	20	577	550.5	587	127	34608	35254		0	254.57	1	34862	34735		
44	SM	-519.00	-529	-539.00	20	597	570.5	607	127	35900	36546		0	242.22	1	36142	36021		
45	SM	-539.00	-549	-559.00	20	617	590.5	627	127	37192	37838		0	230.63	1	37422	37307		
46	SM	-559.00	-569	-579.00	20	637	610.5	647	127	38484	39130		0	219.74	1	38704	38594		
47	SM	-579.00	-589	-599.00	20	657	630.5	667	127	39776	40422		0	209.52	1	39985	39881		

*Below bottom of foundation

** Cre=Cr/(1+e0) = 0.06 / (1+1.61)=0.02, Cce = Cc / (1+e0) = 0.947 / (1 + 1.61) = 0.36

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No. ___ of ___

Chkd. By _____ Date _____ Proj. No 09-4179

Cv 5.3139 ft^2/day
1913 ft^2/year

Fine Grained Recom-press Settle-ment (ft)	Virgin Settle-ment (ft)	Layer	Maximum Thickness of Fine-Grained Layer for rate calcs (ft)	Type drainage path (1, 2)	Time X (days) =>	Time Factor T at Time X: 10	20	30	60	360	1800	5400	Settlement (mt) at Time X: 10	20	30	60	(1.0 yrs) 360	(5 yrs) 1800	(15 yrs) 5400
		1				0	0	0	0	0	0	0							
		2				0	0	0	0	0	0	0							
		3				0	0	0	0	0	0	0							
		4				0	0	0	0	0	0	0							
		5				0	0	0	0	0	0	0							
		6				0	0	0	0	0	0	0							
		7				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		9				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		10				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		11				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.006		12	150	2		0.00945	0.01889	0.02834	0.05668	0.34009	1.70044	5.10133	0.09099	0.12868	0.1576	0.22287	0.53905	0.81951	0.82962
0.006		13				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.006		14				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.006		15				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.005		16				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.005		17				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.005		18				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.004		19				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.004		20				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.004		21				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.004		22				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.004		23				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.004		24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.003		25				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.003		26				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		27				0	0	0	0	0	0	0							
		28				0	0	0	0	0	0	0							
		29				0	0	0	0	0	0	0							
		30				0	0	0	0	0	0	0							
		31				0	0	0	0	0	0	0							
		32				0	0	0	0	0	0	0							
		33				0	0	0	0	0	0	0							
		34				0	0	0	0	0	0	0							
		35				0	0	0	0	0	0	0							
		36				0	0	0	0	0	0	0							
		37				0	0	0	0	0	0	0							
		38				0	0	0	0	0	0	0							
		39				0	0	0	0	0	0	0							
		40				0	0	0	0	0	0	0							
		41				0	0	0	0	0	0	0							
		42				0	0	0	0	0	0	0							
		43				0	0	0	0	0	0	0							
		44				0	0	0	0	0	0	0							
		45				0	0	0	0	0	0	0							
		46				0	0	0	0	0	0	0							
		47				0	0	0	0	0	0	0							

Consolidation Settlement 0.830 in

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5.2. Settlement due to NI load at the center

5.2.1 Summary of results

Summary for settlement at the center due to NI load

Edge settlement is based on Boring Log B - 301

	Immediate Settlement (in)	Consolidation Settlement (in)	Total Settlement (in)
Center	7.91	5.16	13.08

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Chkd. By_____ Date_____ Island – Calvert Cliffs Unit 3 Proj. No 09-4179

Rectangular Loading Pattern Stress distribution W=L= 232.99 ft

Structure Load (psf) = 11760
Excavation (psf) = 5830

Soil profile based on boring log B-301

5.2.2 Boussinesq Solution Uniform Loading $\Delta\sigma z = I_{sig} * P$

Net Pressure (psf) q = 5930

Note: units for elevation, depth is ft, units for stress and modulus is psf, and units for deformation/settlement is in.

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	I_{sig} (center)	$\Delta\sigma z$ (center)	I_{sig} (corner)	$\Delta\sigma z$ (corner)	E	Thickness	deformation(center)	deformation(corner)
1	IIb1 (SP)	5.00	41.50	31.50	0.25	5929.80	0.25	1482.493868	2.53E+06	10.00	2.81E-01	7.03E-02
2	IIb1 (SP)	15.00	31.50	21.50	0.25	5924.78	0.25	1482.334965	2.53E+06	10.00	2.81E-01	7.03E-02
3	IIb1 (SP)	24.50	21.50	12.50	0.25	5907.77	0.25	1481.785196	2.53E+06	9.00	2.52E-01	6.33E-02
4	IIb2 (SP)	34.00	12.50	2.50	0.25	5872.60	0.25	1480.606451	1.03E+06	10.00	6.84E-01	1.72E-01
5	IIb2 (SP)	44.00	2.50	-7.50	0.24	5811.30	0.25	1478.446446	1.03E+06	10.00	6.77E-01	1.72E-01
6	IIb3 (SP)	54.00	-7.50	-17.50	0.24	5722.70	0.25	1475.121156	2.62E+06	10.00	2.62E-01	6.76E-02
7	IIc (CL / ML)	64.00	-17.50	-27.50	0.24	5606.80	0.25	1470.438266	2.37E+06	10.00	2.84E-01	7.45E-02
8	IIc (CL / ML)	74.00	-27.50	-37.50	0.23	5465.60	0.25	1464.243789	2.37E+06	10.00	2.77E-01	7.41E-02
9	IIc (CL / ML)	84.00	-37.50	-47.50	0.22	5302.54	0.25	1456.424241	2.37E+06	10.00	2.68E-01	7.37E-02
10	IIc (CL / ML)	94.00	-47.50	-57.50	0.22	5121.89	0.24	1446.90707	2.37E+06	10.00	2.59E-01	7.33E-02
11	IIc (CL / ML)	104.00	-57.50	-67.50	0.21	4928.20	0.24	1435.659462	2.37E+06	10.00	2.50E-01	7.27E-02
12	IIc (CL / ML)	114.00	-67.50	-77.50	0.20	4725.90	0.24	1422.6858	2.37E+06	10.00	2.39E-01	7.20E-02
13	IIc (CL / ML)	124.00	-77.50	-87.50	0.19	4519.04	0.24	1408.024054	2.37E+06	10.00	2.29E-01	7.13E-02
14	IIc (CL / ML)	134.00	-87.50	-97.50	0.18	4311.10	0.23	1391.741417	2.37E+06	10.00	2.18E-01	7.05E-02
15	IIc (CL / ML)	144.00	-97.50	-107.50	0.17	4104.97	0.23	1373.529511	2.37E+06	10.00	2.08E-01	6.96E-02
16	IIc (CL / ML)	154.00	-107.50	-117.50	0.16	3902.95	0.23	1354.699432	2.37E+06	10.00	1.98E-01	6.86E-02
17	IIc (CL / ML)	164.00	-117.50	-127.50	0.16	3706.76	0.22	1334.17687	2.37E+06	10.00	1.88E-01	6.76E-02
18	IIc (CL / ML)	174.00	-127.50	-137.50	0.15	3517.65	0.22	1312.497513	2.37E+06	10.00	1.78E-01	6.65E-02
19	IIc (CL / ML)	184.00	-137.50	-147.50	0.14	3336.49	0.22	1289.602847	2.37E+06	10.00	1.69E-01	6.53E-02
20	IIc (CL / ML)	194.00	-147.50	-157.50	0.13	3163.77	0.21	1266.23646	2.37E+06	10.00	1.60E-01	6.41E-02
21	IIc (CL / ML)	204.00	-157.50	-167.50	0.13	2999.76	0.21	1241.940889	2.37E+06	10.00	1.52E-01	6.29E-02
22	IIc (CL / ML)	214.00	-167.50	-177.50	0.12	2844.50	0.21	1217.055017	2.37E+06	10.00	1.44E-01	6.16E-02
23	IIc (CL / ML)	224.00	-177.50	-187.50	0.11	2697.87	0.20	1191.712009	2.37E+06	10.00	1.37E-01	6.03E-02
24	IIc (CL / ML)	234.00	-187.50	-197.50	0.11	2559.67	0.20	1166.037745	2.37E+06	10.00	1.30E-01	5.90E-02
25	IIc (CL / ML)	244.00	-197.50	-207.50	0.10	2429.60	0.19	1140.149706	2.37E+06	10.00	1.23E-01	5.77E-02
26	III (SP)	254.00	-207.50	-217.50	0.10	2307.31	0.19	1114.156246	3.17E+06	10.00	8.73E-02	4.22E-02
27	III (SP)	264.00	-217.50	-227.50	0.09	2192.41	0.18	1088.156201	3.17E+06	10.00	8.30E-02	4.12E-02
28	III (SP)	274.00	-227.50	-237.50	0.09	2084.52	0.18	1062.238778	3.17E+06	10.00	7.89E-02	4.02E-02
29	III (SP)	289.00	-237.50	-257.50	0.08	1934.92	0.17	1023.689313	3.17E+06	20.00	1.46E-01	7.75E-02
30	III (SP)	309.00	-257.50	-277.50	0.07	1756.27	0.16	973.2464437	3.17E+06	20.00	1.33E-01	7.37E-02
31	III (SP)	329.00	-277.50	-297.50	0.07	1598.67	0.16	924.2809248	3.17E+06	20.00	1.21E-01	7.00E-02
32	III (SP)	349.00	-297.50	-317.50	0.06	1459.42	0.15	877.1105627	3.17E+06	20.00	1.10E-01	6.64E-02
33	III (SP)	369.00	-317.50	-337.50	0.06	1336.12	0.14	831.9124265	3.17E+06	20.00	1.01E-01	6.30E-02
34	III (SP)	389.00	-337.50	-357.50	0.05	1226.68	0.13	788.8414677	3.17E+06	20.00	9.29E-02	5.97E-02
35	III (SP)	409.00	-357.50	-377.50	0.05	1129.28	0.13	747.9475301	3.17E+06	20.00	8.55E-02	5.66E-02
36	III (SP)	429.00	-377.50	-397.50	0.04	1042.35	0.12	709.2401827	3.17E+06	20.00	7.89E-02	5.37E-02
37	III (SP)	449.00	-397.50	-417.50	0.04	964.54	0.11	672.6612231	3.17E+06	20.00	7.30E-02	5.09E-02
38	III (SP)	469.00	-417.50	-437.50	0.04	894.71	0.11	638.2449425	3.17E+06	20.00	6.77E-02	4.83E-02
39	III (SP)	489.00	-437.50	-457.50	0.04	831.85	0.10	605.8263721	3.17E+06	20.00	6.30E-02	4.59E-02
40	III (SP)	509.00	-457.50	-477.50	0.03	775.11	0.10	575.3477821	3.17E+06	20.00	5.87E-02	4.36E-02
41	III (SP)	529.00	-477.50	-497.50	0.03	723.77	0.09	546.7137163	3.17E+06	20.00	5.48E-02	4.14E-02
42	III (SP)	549.00	-497.50	-517.50	0.03	677.18	0.09	519.8248225	3.17E+06	20.00	5.13E-02	3.94E-02
43	III (SP)	569.00	-517.50	-537.50	0.03	634.80	0.08	494.5607136	3.17E+06	20.00	4.81E-02	3.74E-02
44	III (SP)	589.00	-537.50	-557.50	0.03	596.16	0.08	470.882059	3.17E+06	20.00	4.51E-02	3.57E-02
45	III (SP)	609.00	-557.50	-577.50	0.02	560.83	0.08	448.6320724	3.17E+06	20.00	4.25E-02	3.40E-02
46	III (SP)	629.00	-577.50	-597.50	0.02	528.48	0.07	427.7375332	3.17E+06	20.00	4.00E-02	3.24E-02
						8.91%		**7.21%**		total settlement	7.91	2.95 inch
										differential	4.96	

<10%

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5.2.3 2 to 1 slope stress

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δσz	E	Thickness	Settlement deformation(center)
1	IIb1 (SP)	5.00	41.50	31.50	5725.880849	2.53E+06	10.00	2.72E-01
2	IIb1 (SP)	15.00	31.50	21.50	5348.034711	2.53E+06	10.00	2.54E-01
3	IIb1 (SP)	24.50	21.50	12.50	5022.685994	2.53E+06	9.00	2.14E-01
4	IIb2 (SP)	34.00	12.50	2.50	4726.147756	1.03E+06	10.00	5.51E-01
5	IIb2 (SP)	44.00	2.50	-7.50	4441.502083	1.03E+06	10.00	5.17E-01
6	IIb3 (SP)	54.00	-7.50	-17.50	4181.818272	2.62E+06	10.00	1.92E-01
7	IIc (CL / ML)	64.00	-17.50	-27.50	3944.260718	2.37E+06	10.00	2.00E-01
8	IIc (CL / ML)	74.00	-27.50	-37.50	3726.385318	2.37E+06	10.00	1.89E-01
9	IIc (CL / ML)	84.00	-37.50	-47.50	3526.076354	2.37E+06	10.00	1.79E-01
10	IIc (CL / ML)	94.00	-47.50	-57.50	3341.494939	2.37E+06	10.00	1.69E-01
11	IIc (CL / ML)	104.00	-57.50	-67.50	3171.036657	2.37E+06	10.00	1.61E-01
12	IIc (CL / ML)	114.00	-67.50	-77.50	3013.296585	2.37E+06	10.00	1.53E-01
13	IIc (CL / ML)	124.00	-77.50	-87.50	2867.040247	2.37E+06	10.00	1.45E-01
14	IIc (CL / ML)	134.00	-87.50	-97.50	2731.179391	2.37E+06	10.00	1.38E-01
15	IIc (CL / ML)	144.00	-97.50	-107.50	2604.751688	2.37E+06	10.00	1.32E-01
16	IIc (CL / ML)	154.00	-107.50	-117.50	2486.903637	2.37E+06	10.00	1.26E-01
17	IIc (CL / ML)	164.00	-117.50	-127.50	2376.876131	2.37E+06	10.00	1.20E-01
18	IIc (CL / ML)	174.00	-127.50	-137.50	2273.992197	2.37E+06	10.00	1.15E-01
19	IIc (CL / ML)	184.00	-137.50	-147.50	2177.64656	2.37E+06	10.00	1.10E-01
20	IIc (CL / ML)	194.00	-147.50	-157.50	2087.296716	2.37E+06	10.00	1.06E-01
21	IIc (CL / ML)	204.00	-157.50	-167.50	2002.455286	2.37E+06	10.00	1.01E-01
22	IIc (CL / ML)	214.00	-167.50	-177.50	1922.683424	2.37E+06	10.00	9.74E-02
23	IIc (CL / ML)	224.00	-177.50	-187.50	1847.58513	2.37E+06	10.00	9.35E-02
24	IIc (CL / ML)	234.00	-187.50	-197.50	1776.80233	2.37E+06	10.00	9.00E-02
25	IIc (CL / ML)	244.00	-197.50	-207.50	1710.010597	2.37E+06	10.00	8.66E-02
26	III (SP)	254.00	-207.50	-217.50	1646.915429	3.17E+06	10.00	6.23E-02
27	III (SP)	264.00	-217.50	-227.50	1587.248993	3.17E+06	10.00	6.01E-02
28	III (SP)	274.00	-227.50	-237.50	1530.767282	3.17E+06	10.00	5.79E-02
29	III (SP)	289.00	-237.50	-257.50	1451.534249	3.17E+06	20.00	1.10E-01
30	III (SP)	309.00	-257.50	-277.50	1355.113462	3.17E+06	20.00	1.03E-01
31	III (SP)	329.00	-277.50	-297.50	1267.990426	3.17E+06	20.00	9.60E-02
32	III (SP)	349.00	-297.50	-317.50	1189.007035	3.17E+06	20.00	9.00E-02
33	III (SP)	369.00	-317.50	-337.50	1117.180035	3.17E+06	20.00	8.46E-02
34	III (SP)	389.00	-337.50	-357.50	1051.67028	3.17E+06	20.00	7.96E-02
35	III (SP)	409.00	-357.50	-377.50	991.7581093	3.17E+06	20.00	7.51E-02
36	III (SP)	429.00	-377.50	-397.50	936.8234971	3.17E+06	20.00	7.09E-02
37	III (SP)	449.00	-397.50	-417.50	886.3299474	3.17E+06	20.00	6.71E-02
38	III (SP)	469.00	-417.50	-437.50	839.8113449	3.17E+06	20.00	6.36E-02
39	III (SP)	489.00	-437.50	-457.50	796.8611596	3.17E+06	20.00	6.03E-02
40	III (SP)	509.00	-457.50	-477.50	757.1235344	3.17E+06	20.00	5.73E-02
41	III (SP)	529.00	-477.50	-497.50	720.2858904	3.17E+06	20.00	5.45E-02
42	III (SP)	549.00	-497.50	-517.50	686.0727612	3.17E+06	20.00	5.19E-02
43	III (SP)	569.00	-517.50	-537.50	654.2406282	3.17E+06	20.00	4.95E-02
44	III (SP)	589.00	-537.50	-557.50	624.5735753	3.17E+06	20.00	4.73E-02
45	III (SP)	609.00	-557.50	-577.50	596.8796176	3.17E+06	20.00	4.52E-02
46	III (SP)	629.00	-577.50	-597.50	570.9875878	3.17E+06	20.00	4.32E-02
					9.53%		total settleme	5.94

inch

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Paul C. Rizzo Associates, Inc.
ENGINEERS & CONSULTANTS

09-4179.02 F-31

By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No.___ of___

Chkd. By_____ Date_____ Proj. No 09-4179

5.2.4 Circular Loading Pattern

R=159.7 ft

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δ σz (center)	Δ σz (edge)	Thickness	E	deformation(center)	deformation(edge)
1	IIb1 (SP)	3.75	41.5	34	6108.148723	5684.59416	7.5	2.53E+06	2.17E-01	2.02E-01
2	IIb1 (SP)	10	34	29	5977.454678	4508.25908	5	2.53E+06	1.42E-01	1.07E-01
3	IIb1 (SP)	15	29	24	5963.405163	3940.83098	5	2.53E+06	1.41E-01	9.35E-02
4	IIb1 (SP)	20	24	19	5953.309382	3632.86081	5	2.53E+06	1.41E-01	8.62E-02
5	IIb1 (SP)	25	19	14	5941.282374	3435.7305	5	2.53E+06	1.41E-01	8.15E-02
6	IIb1 (SP)	30	14	9	5925.3276	3294.67864	5	2.53E+06	1.41E-01	7.81E-02
7	IIb2 (SP)	35	9	4	5904.375503	3185.60365	5	1.03E+06	3.44E-01	1.86E-01
8	IIb2 (SP)	40	4	-1	5877.73391	3096.37567	5	1.03E+06	3.42E-01	1.80E-01
9	IIb2 (SP)	45	-1	-6	5844.942045	3020.26048	5	1.03E+06	3.40E-01	1.76E-01
10	IIb2 (SP)	50	-6	-11	5805.719665	2953.23277	5	1.03E+06	3.38E-01	1.72E-01
11	IIb3 (SP)	55	-11	-16	5759.942456	2892.74502	5	2.62E+06	1.32E-01	6.62E-02
12	IIb3 (SP)	60	-16	-21	5707.62456	2837.11042	5	2.62E+06	1.31E-01	6.50E-02
13	IIc (CL / ML)	65	-21	-26	5648.90243	2785.17078	5	2.37E+06	1.43E-01	7.05E-02
14	IIc (CL / ML)	70	-26	-31	5584.018351	2736.10706	5	2.37E+06	1.41E-01	6.93E-02
15	IIc (CL / ML)	75	-31	-36	5513.303459	2689.3259	5	2.37E+06	1.40E-01	6.81E-02
16	IIc (CL / ML)	80	-36	-41	5437.160616	2644.38886	5	2.37E+06	1.38E-01	6.69E-02
17	IIc (CL / ML)	85	-41	-46	5356.047639	2600.9667	5	2.37E+06	1.36E-01	6.58E-02
18	IIc (CL / ML)	90	-46	-51	5270.461353	2558.80897	5	2.37E+06	1.33E-01	6.48E-02
19	IIc (CL / ML)	95	-51	-56	5180.922905	2517.72315	5	2.37E+06	1.31E-01	6.37E-02
20	IIc (CL / ML)	100	-56	-61	5087.964592	2477.56012	5	2.37E+06	1.29E-01	6.27E-02
21	IIc (CL / ML)	105	-61	-66	4992.11841	2438.20367	5	2.37E+06	1.26E-01	6.17E-02
22	IIc (CL / ML)	110	-66	-71	4893.906387	2399.56299	5	2.37E+06	1.24E-01	6.07E-02
23	IIc (CL / ML)	115	-71	-76	4793.832686	2361.56696	5	2.37E+06	1.21E-01	5.98E-02
24	IIc (CL / ML)	120	-76	-81	4692.377409	2324.15993	5	2.37E+06	1.19E-01	5.88E-02
25	IIc (CL / ML)	125	-81	-86	4589.991959	2287.29849	5	2.37E+06	1.16E-01	5.79E-02
26	IIc (CL / ML)	130	-86	-91	4487.095814	2250.94896	5	2.37E+06	1.14E-01	5.70E-02
27	IIc (CL / ML)	135	-91	-96	4384.074513	2215.08539	5	2.37E+06	1.11E-01	5.61E-02
28	IIc (CL / ML)	140	-96	-101	4281.2787	2179.68808	5	2.37E+06	1.08E-01	5.52E-02
29	IIc (CL / ML)	145	-101	-106	4179.024019	2144.74224	5	2.37E+06	1.06E-01	5.43E-02
30	IIc (CL / ML)	150	-106	-111	4077.591709	2110.2371	5	2.37E+06	1.03E-01	5.34E-02
31	IIc (CL / ML)	155	-111	-116	3977.22974	2076.16502	5	2.37E+06	1.01E-01	5.26E-02
32	IIc (CL / ML)	160	-116	-121	3878.154355	2042.52085	5	2.37E+06	9.82E-02	5.17E-02
33	IIc (CL / ML)	165	-121	-126	3780.551895	2009.30142	5	2.37E+06	9.57E-02	5.09E-02
34	IIc (CL / ML)	170	-126	-131	3684.580822	1976.50506	5	2.37E+06	9.33E-02	5.00E-02
35	IIc (CL / ML)	175	-131	-136	3590.373838	1944.13125	5	2.37E+06	9.09E-02	4.92E-02
36	IIc (CL / ML)	180	-136	-141	3498.040046	1912.18032	5	2.37E+06	8.86E-02	4.84E-02
37	IIc (CL / ML)	185	-141	-146	3407.667102	1880.65317	5	2.37E+06	8.63E-02	4.76E-02
38	IIc (CL / ML)	190	-146	-151	3319.323309	1849.55113	5	2.37E+06	8.40E-02	4.68E-02
39	IIc (CL / ML)	195	-151	-156	3233.059625	1818.8757	5	2.37E+06	8.18E-02	4.60E-02
40	IIc (CL / ML)	200	-156	-161	3148.911572	1788.62851	5	2.37E+06	7.97E-02	4.53E-02
41	IIc (CL / ML)	205	-161	-166	3066.901021	1758.81112	5	2.37E+06	7.76E-02	4.45E-02
42	IIc (CL / ML)	210	-166	-171	2987.037857	1729.42498	5	2.37E+06	7.56E-02	4.38E-02
43	IIc (CL / ML)	215	-171	-176	2909.321503	1700.47136	5	2.37E+06	7.37E-02	4.30E-02
44	IIc (CL / ML)	220	-176	-181	2833.742328	1671.95126	5	2.37E+06	7.17E-02	4.23E-02
45	IIc (CL / ML)	225	-181	-186	2760.282915	1643.8654	5	2.37E+06	6.99E-02	4.16E-02
46	IIc (CL / ML)	230	-186	-191	2688.919215	1616.21415	5	2.37E+06	6.81E-02	4.09E-02
47	IIc (CL / ML)	235	-191	-196	2619.621582	1588.99756	5	2.37E+06	6.63E-02	4.02E-02
48	IIc (CL / ML)	240	-196	-201	2552.355698	1562.2153	5	2.37E+06	6.46E-02	3.95E-02
49	IIc (CL / ML)	245	-201	-206	2487.083399	1535.86668	5	2.37E+06	6.30E-02	3.89E-02
50	IIc (CL / ML)	250	-206	-211	2423.763406	1509.95062	5	2.37E+06	6.14E-02	3.82E-02
51	III (SP)	255	-211	-216	2362.35197	1484.46569	5	3.17E+06	4.47E-02	2.81E-02
52	III (SP)	260	-216	-221	2302.803437	1459.41009	5	3.17E+06	4.36E-02	2.76E-02
53	III (SP)	265	-221	-226	2245.070745	1434.78166	5	3.17E+06	4.25E-02	2.72E-02
54	III (SP)	270	-226	-231	2189.105858	1410.57791	5	3.17E+06	4.14E-02	2.67E-02
55	III (SP)	275	-231	-236	2134.860133	1386.79602	5	3.17E+06	4.04E-02	2.62E-02
56	III (SP)	280	-236	-241	2082.284651	1363.43287	5	3.17E+06	3.94E-02	2.58E-02
57	III (SP)	285	-241	-246	2031.330485	1340.48502	5	3.17E+06	3.84E-02	2.54E-02
58	III (SP)	290	-246	-251	1981.948941	1317.94879	5	3.17E+06	3.75E-02	2.49E-02

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59	III (SP)	295	-251	-256	1934.091754	1295.82022	5	3.17E+06	3.66E-02	2.45E-02
60	III (SP)	300	-256	-261	1887.711256	1274.09511	5	3.17E+06	3.57E-02	2.41E-02
61	III (SP)	305	-261	-266	1842.760516	1252.76906	5	3.17E+06	3.49E-02	2.37E-02
62	III (SP)	310	-266	-271	1799.19345	1231.83745	5	3.17E+06	3.41E-02	2.33E-02
63	III (SP)	315	-271	-276	1756.964917	1211.2955	5	3.17E+06	3.33E-02	2.29E-02
64	III (SP)	320	-276	-281	1716.030792	1191.13825	5	3.17E+06	3.25E-02	2.25E-02
65	III (SP)	325	-281	-286	1676.348023	1171.36059	5	3.17E+06	3.17E-02	2.22E-02
66	III (SP)	330	-286	-291	1637.87467	1151.95728	5	3.17E+06	3.10E-02	2.18E-02
67	III (SP)	335	-291	-296	1600.569942	1132.92299	5	3.17E+06	3.03E-02	2.14E-02
68	III (SP)	340	-296	-301	1564.394212	1114.25226	5	3.17E+06	2.96E-02	2.11E-02
69	III (SP)	345	-301	-306	1529.309027	1095.93958	5	3.17E+06	2.89E-02	2.07E-02
70	III (SP)	350	-306	-311	1495.277117	1077.97933	5	3.17E+06	2.83E-02	2.04E-02
71	III (SP)	355	-311	-316	1462.262386	1060.36587	5	3.17E+06	2.77E-02	2.01E-02
72	III (SP)	360	-316	-321	1430.229904	1043.0935	5	3.17E+06	2.71E-02	1.97E-02
73	III (SP)	365	-321	-326	1399.145897	1026.1565	5	3.17E+06	2.65E-02	1.94E-02
74	III (SP)	370	-326	-331	1368.977724	1009.5491	5	3.17E+06	2.59E-02	1.91E-02
75	III (SP)	375	-331	-336	1339.69386	993.265569	5	3.17E+06	2.54E-02	1.88E-02
76	III (SP)	380	-336	-341	1311.263875	977.300133	5	3.17E+06	2.48E-02	1.85E-02
77	III (SP)	385	-341	-346	1283.658403	961.647047	5	3.17E+06	2.43E-02	1.82E-02
78	III (SP)	390	-346	-351	1256.849122	946.300577	5	3.17E+06	2.38E-02	1.79E-02
79	III (SP)	395	-351	-356	1230.80872	931.255018	5	3.17E+06	2.33E-02	1.76E-02
80	III (SP)	400	-356	-361	1205.510872	916.504692	5	3.17E+06	2.28E-02	1.73E-02
81	III (SP)	405	-361	-366	1180.930208	902.043963	5	3.17E+06	2.24E-02	1.71E-02
82	III (SP)	410	-366	-371	1157.042282	887.867237	5	3.17E+06	2.19E-02	1.68E-02
83	III (SP)	415	-371	-376	1133.823547	873.968972	5	3.17E+06	2.15E-02	1.65E-02
84	III (SP)	420	-376	-381	1111.251323	860.343676	5	3.17E+06	2.10E-02	1.63E-02
85	III (SP)	425	-381	-386	1089.303765	846.98592	5	3.17E+06	2.06E-02	1.60E-02
86	III (SP)	430	-386	-391	1067.959841	833.890335	5	3.17E+06	2.02E-02	1.58E-02
87	III (SP)	435	-391	-396	1047.199295	821.051619	5	3.17E+06	1.98E-02	1.55E-02
88	III (SP)	440	-396	-401	1027.002628	808.464539	5	3.17E+06	1.94E-02	1.53E-02
89	III (SP)	445	-401	-406	1007.351064	796.123934	5	3.17E+06	1.91E-02	1.51E-02
90	III (SP)	450	-406	-411	988.2265244	784.024717	5	3.17E+06	1.87E-02	1.48E-02
91	III (SP)	455	-411	-416	969.611606	772.161878	5	3.17E+06	1.84E-02	1.46E-02
92	III (SP)	460	-416	-421	951.4895512	760.530483	5	3.17E+06	1.80E-02	1.44E-02
93	III (SP)	465	-421	-426	933.8442258	749.125679	5	3.17E+06	1.77E-02	1.42E-02
94	III (SP)	470	-426	-431	916.6500942	737.942693	5	3.17E+06	1.74E-02	1.40E-02
95	III (SP)	475	-431	-436	899.9221973	726.976834	5	3.17E+06	1.70E-02	1.38E-02
96	III (SP)	480	-436	-441	883.6161294	716.223492	5	3.17E+06	1.67E-02	1.36E-02
97	III (SP)	485	-441	-446	867.728017	705.67814	5	3.17E+06	1.64E-02	1.34E-02
98	III (SP)	490	-446	-451	852.2444984	695.336335	5	3.17E+06	1.61E-02	1.32E-02
99	III (SP)	495	-451	-456	837.1527031	685.193716	5	3.17E+06	1.58E-02	1.30E-02
100	III (SP)	500	-456	-461	822.4402328	675.246006	5	3.17E+06	1.56E-02	1.28E-02
101	III (SP)	505	-461	-466	808.0951429	665.489008	5	3.17E+06	1.53E-02	1.26E-02
102	III (SP)	510	-466	-471	794.1059244	655.918611	5	3.17E+06	1.50E-02	1.24E-02
103	III (SP)	515	-471	-476	780.4614869	646.530784	5	3.17E+06	1.48E-02	1.22E-02
104	III (SP)	520	-476	-481	767.1511422	637.321579	5	3.17E+06	1.45E-02	1.21E-02
105	III (SP)	525	-481	-486	754.1645881	628.287128	5	3.17E+06	1.43E-02	1.19E-02
106	III (SP)	530	-486	-491	741.4918933	619.423642	5	3.17E+06	1.40E-02	1.17E-02
107	III (SP)	535	-491	-496	729.1234827	610.727413	5	3.17E+06	1.38E-02	1.16E-02
108	III (SP)	540	-496	-501	717.0501238	602.194811	5	3.17E+06	1.36E-02	1.14E-02
109	III (SP)	545	-501	-506	705.2629122	593.822283	5	3.17E+06	1.33E-02	1.12E-02
110	III (SP)	550	-506	-511	693.7532599	585.606353	5	3.17E+06	1.31E-02	1.11E-02
111	III (SP)	555	-511	-516	682.5128818	577.543621	5	3.17E+06	1.29E-02	1.09E-02
112	III (SP)	560	-516	-521	671.5337845	569.63076	5	3.17E+06	1.27E-02	1.08E-02
113	III (SP)	565	-521	-526	660.8082545	561.864515	5	3.17E+06	1.25E-02	1.06E-02
114	III (SP)	570	-526	-531	650.3288476	554.241708	5	3.17E+06	1.23E-02	1.05E-02
115	III (SP)	575	-531	-536	640.0883778	546.759226	5	3.17E+06	1.21E-02	1.03E-02
116	III (SP)	580	-536	-541	630.079908	539.414029	5	3.17E+06	1.19E-02	1.02E-02
117	III (SP)	585	-541	-546	620.2967397	532.203145	5	3.17E+06	1.17E-02	1.01E-02
118	III (SP)	590	-546	-551	610.7324042	525.123668	5	3.17E+06	1.16E-02	9.94E-03
119	III (SP)	595	-551	-556	601.3806533	518.172759	5	3.17E+06	1.14E-02	9.81E-03
120	III (SP)	600	-556	-561	592.2354513	511.347644	5	3.17E+06	1.12E-02	9.68E-03
121	III (SP)	605	-561	-566	583.2909664	504.645611	5	3.17E+06	1.10E-02	9.55E-03
122	III (SP)	610	-566	-571	574.5415631	498.064011	5	3.17E+06	1.09E-02	9.43E-03
123	III (SP)	615	-571	-576	565.9817949	491.600256	5	3.17E+06	1.07E-02	9.30E-03
124	III (SP)	620	-576	-581	557.6063966	485.251818	5	3.17E+06	1.06E-02	9.18E-03
125	III (SP)	625	-581	-586	549.4102779	479.016226	5	3.17E+06	1.04E-02	9.07E-03
126	III (SP)	630	-586	-591	541.3885165	472.891067	5	3.17E+06	1.02E-02	8.95E-03
					9.13%			total settlement	**8.05**	**4.74** inch

* below bottom of foundation

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5.2.5 Vertical stress under circular loading

Radius R is 159.7
q= 5930

Z (Depth*)	Center Vertical Stress	Edge Vertical Stress
3.75	6108.148723	5684.594158
10	5977.454678	4508.259079
15	5963.405163	3940.830983
20	5953.309382	3632.86081
25	5941.282374	3435.730497
30	5925.3276	3294.678644
35	5904.375503	3185.603647
40	5877.73391	3096.375669
45	5844.942045	3020.260476
50	5805.719665	2953.232772
55	5759.942456	2892.74502
60	5707.62456	2837.110419
65	5648.90243	2785.170781
70	5584.018351	2736.107062
75	5513.303459	2689.325901
80	5437.160616	2644.388859
85	5356.047639	2600.966703
90	5270.461353	2558.808971
95	5180.922905	2517.723153
100	5087.964592	2477.560115
105	4992.11841	2438.203672
110	4893.906387	2399.562992
115	4793.832686	2361.566958
120	4692.377409	2324.159929
125	4589.991959	2287.298492
130	4487.095814	2250.948957
135	4384.074513	2215.085394
140	4281.2787	2179.688076
145	4179.024019	2144.742244
150	4077.591709	2110.237103
155	3977.22974	2076.165018
160	3878.154355	2042.520851
165	3780.551895	2009.301422
170	3684.580822	1976.505063
175	3590.373838	1944.131254
180	3498.040046	1912.180318
185	3407.667102	1880.653173
190	3319.323309	1849.551125
195	3233.059625	1818.875701
200	3148.911572	1788.628506
205	3066.901021	1758.811116
210	2987.037857	1729.424982
215	2909.321503	1700.471363
220	2833.742328	1671.951265
225	2760.282915	1643.8654
230	2688.919215	1616.214154
235	2619.621582	1588.997564
240	2552.355698	1562.215304
245	2487.083399	1535.86668
250	2423.763406	1509.950621
255	2362.35197	1484.46569
260	2302.803437	1459.410087
265	2245.070745	1434.781658
270	2189.105858	1410.577911

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275	2134.860133	1386.796024
280	2082.284651	1363.432869
285	2031.330485	1340.485024
290	1981.948941	1317.948791
295	1934.091754	1295.820216
300	1887.711256	1274.095109
305	1842.760516	1252.769059
310	1799.19345	1231.837454
315	1756.964917	1211.295503
320	1716.030792	1191.138248
325	1676.348023	1171.360586
330	1637.87467	1151.957282
335	1600.569942	1132.92299
340	1564.394212	1114.252265
345	1529.309027	1095.939578
350	1495.277117	1077.979331
355	1462.262386	1060.365871
360	1430.229904	1043.093502
365	1399.145897	1026.156496
370	1368.977724	1009.549104
375	1339.69386	993.2655694
380	1311.263875	977.3001334
385	1283.658403	961.6470467
390	1256.849122	946.3005773
395	1230.80872	931.2550175
400	1205.510872	916.5046919
405	1180.930208	902.0439629
410	1157.042282	887.8672374
415	1133.823547	873.9689715
420	1111.251323	860.3436758
425	1089.303765	846.9859196
430	1067.959841	833.8903345
435	1047.199295	821.0516186
440	1027.002628	808.4645388
445	1007.351064	796.123934
450	988.2265244	784.0247172
455	969.611606	772.1618777
460	951.4895512	760.5304828
465	933.8442258	749.1256789
470	916.6600942	737.942693
475	899.9221973	726.9768338
480	883.6161294	716.2234918
485	867.728017	705.6781402
490	852.2444984	695.3363354
495	837.1527031	685.1937164
500	822.4402328	675.2460055
505	808.0951429	665.4890078
510	794.1059244	655.9186109
515	780.4614869	646.5307843
520	767.1511422	637.3215792
525	754.1645881	628.2871277
530	741.4918933	619.4236417
535	729.1234827	610.7274128
540	717.0501238	602.1948108
545	705.2629122	593.8222831
550	693.7532599	585.6063535
555	682.5128818	577.5436211
560	671.5337845	569.6307595
565	660.8082545	561.8645155
570	650.3288476	554.2417077
575	640.0883778	546.7592258
580	630.079908	539.4140289
585	620.2967397	532.2031447
590	610.7324042	525.1236678
595	601.3806533	518.1727591
600	592.2354513	511.3476439
605	583.2909664	504.6456109
610	574.5415631	498.064011
615	565.9817949	491.6002561
620	557.6063966	485.2518177
625	549.4102779	479.0162255
630	541.3885165	472.8910668

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5.2.6 Schmertmann method

Input Global Data		
Footing Width, B	283.0	feet
Elevation of Ground Surface	83.0	feet
Elevation of Base of Footing	41.5	feet
Elevation of Water Table	41.5	feet
Unit Weight of Water, γ_w	62.4	pcf
Bearing Pressure, ΔP	5743	psf
Soil Unit Weight Above Footing Base	145	pcf
Settlement Calculated at end of construction and at time t	50	years

Note: 1. Final gound surface elevation is at 83 ft. Elastic rebound effect is built into the result.
2. water table is 3' lower than 41.5, but it will not affect results very much.
3. This method assumes a backfill to 83 ft, and then excavate to 41.5 ft, which is not exactly true. Therefore this method just gives an indication value and will not be used in the summary.

Input Layer Data

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_t (pcf)
1	41.5	31.5	1265	122
2	31.5	21.5	1265	122
3	21.5	12.5	1265	122
4	12.5	2.5	515	123
5	2.5	-7.5	515	123
6	-7.5	-17.5	1310	123
7	-17.5	-27.5	1185	104
8	-27.5	-37.5	1185	104
9	-37.5	-47.5	1185	104
10	-47.5	-57.5	1185	104
11	-57.5	-67.5	1185	104
12	-67.5	-77.5	1185	104
13	-77.5	-87.5	1185	104
14	-87.5	-97.5	1185	104
15	-97.5	-107.5	1185	104
16	-107.5	-117.5	1185	104
17	-117.5	-127.5	1185	104
18	-127.5	-137.5	1185	104
19	-137.5	-147.5	1185	104
20	-147.5	-157.5	1185	104
21	-157.5	-167.5	1185	104
22	-167.5	-177.5	1185	104
23	-177.5	-187.5	1185	104
24	-187.5	-197.5	1185	104
25	-197.5	-207.5	1185	104
26	-207.5	-217.5	1585	127
27	-217.5	-227.5	1585	127
28	-227.5	-237.5	1585	127
29	-237.5	-257.5	1585	127
30	-257.5	-277.5	1585	127
31	-277.5	-297.5	1585	127
32	-297.5	-317.5	1585	127
33	-317.5	-337.5	1585	127
34	-337.5	-357.5	1585	127
35	-357.5	-377.5	1585	127
36	-377.5	-397.5	1585	127
37	-397.5	-417.5	1585	127
38	-417.5	-437.5	1585	127
39	-437.5	-457.5	1585	127
40	-457.5	-477.5	1585	127
41	-477.5	-497.5	1585	127
42	-497.5	-517.5	1585	127
43	-517.5	-537.5	1585	127
44	-537.5	-557.5	1585	127
45	-557.5	-577.5	1585	127
46	-577.5	-597.5	1585	127
47				
48				
49				
50				
51				
52				

Note: The depth of the water table must be a layer boundary.

Compute Global Values for Axisymmetrical Case			
σ'_{vo} at Elevation	**41.5**	6017.5	psf
Elev. of I_{zp}		-100.0	feet
σ'_{vp} at elevation	**-100.0**	12995.9	psf
I_{zp}		0.566	
C_1		0.50	
C_2		1.50	

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Computed Axisymmetrical Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	41.5	31.5	1265	122	10	36.5	0.12	0.01%	0.02
2	31.5	21.5	1265	122	10	26.5	0.15	0.02%	0.02
3	21.5	12.5	1265	122	9	17	0.18	0.02%	0.02
4	12.5	2.5	515	123	10	7.5	0.21	0.06%	0.07
5	2.5	-7.5	515	123	10	-2.5	0.25	0.07%	0.08
6	-7.5	-17.5	1310	123	10	-12.5	0.28	0.03%	0.04
7	-17.5	-27.5	1185	104	10	-22.5	0.311	0.04%	0.05
8	-27.5	-37.5	1185	104	10	-32.5	0.344	0.04%	0.05
9	-37.5	-47.5	1185	104	10	-42.5	0.377	0.05%	0.05
10	-47.5	-57.5	1185	104	10	-52.5	0.410	0.05%	0.06
11	-57.5	-67.5	1185	104	10	-62.5	0.443	0.05%	0.06
12	-67.5	-77.5	1185	104	10	-72.5	0.476	0.06%	0.07
13	-77.5	-87.5	1185	104	10	-82.5	0.509	0.06%	0.07
14	-87.5	-97.5	1185	104	10	-92.5	0.542	0.07%	0.08
15	-97.5	-107.5	1185	104	10	-102.5	0.562	0.07%	0.08
16	-107.5	-117.5	1185	104	10	-112.5	0.550	0.07%	0.08
17	-117.5	-127.5	1185	104	10	-122.5	0.536	0.06%	0.08
18	-127.5	-137.5	1185	104	10	-132.5	0.523	0.06%	0.08
19	-137.5	-147.5	1185	104	10	-142.5	0.510	0.06%	0.07
20	-147.5	-157.5	1185	104	10	-152.5	0.496	0.06%	0.07
21	-157.5	-167.5	1185	104	10	-162.5	0.483	0.06%	0.07
22	-167.5	-177.5	1185	104	10	-172.5	0.470	0.06%	0.07
23	-177.5	-187.5	1185	104	10	-182.5	0.456	0.06%	0.07
24	-187.5	-197.5	1185	104	10	-192.5	0.443	0.05%	0.06
25	-197.5	-207.5	1185	104	10	-202.5	0.430	0.05%	0.06
26	-207.5	-217.5	1585	127	10	-212.5	0.416	0.04%	0.05
27	-217.5	-227.5	1585	127	10	-222.5	0.403	0.04%	0.04
28	-227.5	-237.5	1585	127	10	-232.5	0.390	0.04%	0.04
29	-237.5	-257.5	1585	127	20	-247.5	0.370	0.03%	0.08
30	-257.5	-277.5	1585	127	20	-267.5	0.343	0.03%	0.07
31	-277.5	-297.5	1585	127	20	-287.5	0.316	0.03%	0.07
32	-297.5	-317.5	1585	127	20	-307.5	0.290	0.03%	0.06
33	-317.5	-337.5	1585	127	20	-327.5	0.263	0.02%	0.06
34	-337.5	-357.5	1585	127	20	-347.5	0.236	0.02%	0.05
35	-357.5	-377.5	1585	127	20	-367.5	0.210	0.02%	0.05
36	-377.5	-397.5	1585	127	20	-387.5	0.183	0.02%	0.04
37	-397.5	-417.5	1585	127	20	-407.5	0.156	0.01%	0.03
38	-417.5	-437.5	1585	127	20	-427.5	0.129	0.01%	0.03
39	-437.5	-457.5	1585	127	20	-447.5	0.103	0.01%	0.02
40	-457.5	-477.5	1585	127	20	-467.5	0.076	0.01%	0.02
41	-477.5	-497.5	1585	127	20	-487.5	0.049	0.00%	0.01
42	-497.5	-517.5	1585	127	20	-507.5	0.023	0.00%	0.00
43	-517.5	-524.5	1585	127	7	-521	0.005	0.00%	0.00
44									
45									
46									
47									
48									
49									
50									
51									
52									

Immediate Settlement **2.3 inches**

Settlement After **50** **year** **3.4 inches**

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5.2.7 Consolidation Settlemen

Structure	Nuclear Island
Location	B-301
BackFill Height (ft)	0
Type of Stress Diagram	Rectangular
Original Ground Elev (ft, msl)	94.5
Bottom of Ftg. Elev (ft, msl)	41.50
Foundation Pressure (psf)	5930
Groundwater Elev (ft, msl)	41.50
CPT/Boring Profile	B-301
Fill Unit Weight (pcf)	145

Fine Grained Behavi

Layer	Soil Type	Top Elev (ft msl)	Mid-Layer Elev (ft msl)	**Bottom Elev (ft msl)**	Layer Thickness (ft)	Mid-Layer Depth (ft)	Mid-Layer Depth* (ft)	Bottom Layer Depth (ft)	**Layer Unit Weight (pcf)**	Initial Mid-Layer Effective Stress (psf)	Bottom Layer Eff. Stress (psf)	**OCR**	Pp (psf)	**Δ σv due to foundation (psf, rectanglular center)**	Δ σv / Initial Stress %	σ final (psf)	σ v average (psf)	**Cre**	**Cce**
1	SM	94.5	68	41.50	53	26.5	-26.5	53	122	3233	6466		0	0.00	0	3233	3233		
2	SM	41.50	36.5	31.50	10	58	5	63	122	6764	7062		0	5929.80	88	12694	9729		
3	SM	31.50	26.5	21.50	10	68	15	73	122	7360	7658		0	5924.78	80	13285	10322		
4	SM	21.50	17	12.50	9	77.5	24.5	82	122	7926	8194		0	5907.77	75	13834	10880		
5	SM	12.50	7.5	2.50	10	87	34	92	123	8497	8800		0	5872.60	69	14370	11434		
6	SM	2.50	-2.5	-7.50	10	97	44	102	123	9103	9406		0	5811.30	64	14915	12009		
7	SM	-7.50	-12.5	-17.50	10	107	54	112	123	9709	10012		0	5722.70	59	15432	12571		
8	CL	-17.50	-22.5	-27.50	10	117	64	122	104	10220	10428	4	40882	5606.80	55	15827	13024	0.02	0.36
9	CL	-27.50	-32.5	-37.50	10	127	74	132	104	10636	10844	4	42546	5465.60	51	16102	13369	0.02	0.36
10	CL	-37.50	-42.5	-47.50	10	137	84	142	104	11052	11260	4	44210	5302.54	48	16355	13704	0.02	0.36
11	CL	-47.50	-52.5	-57.50	10	147	94	152	104	11468	11676	4	45874	5121.89	45	16590	14029	0.02	0.36
12	CL	-57.50	-62.5	-67.50	10	157	104	162	104	11884	12092	4	47538	4928.20	41	16813	14348	0.02	0.36
13	CL	-67.50	-72.5	-77.50	10	167	114	172	104	12300	12508	4	49202	4725.90	38	17026	14663	0.02	0.36
14	CL	-77.50	-82.5	-87.50	10	177	124	182	104	12716	12924	4	50866	4519.04	36	17235	14976	0.02	0.36
15	CL	-87.50	-92.5	-97.50	10	187	134	192	104	13132	13340	4	52530	4311.10	33	17443	15288	0.02	0.36
16	CL	-97.50	-102.5	-107.50	10	197	144	202	104	13548	13756	4	54194	4104.97	30	17653	15601	0.02	0.36
17	CL	-107.50	-112.5	-117.50	10	207	154	212	104	13964	14172	4	55858	3902.95	28	17867	15916	0.02	0.36
18	CL	-117.50	-122.5	-127.50	10	217	164	222	104	14380	14588	4	57522	3706.76	26	18087	16234	0.02	0.36
19	CL	-127.50	-132.5	-137.50	10	227	174	232	104	14796	15004	4	59186	3517.65	24	18314	16555	0.02	0.36
20	CL	-137.50	-142.5	-147.50	10	237	184	242	104	15212	15420	4	60850	3336.49	22	18549	16881	0.02	0.36
21	CL	-147.50	-152.5	-157.50	10	247	194	252	104	15628	15836	4	62514	3163.77	20	18792	17210	0.02	0.36
22	CL	-157.50	-162.5	-167.50	10	257	204	262	104	16044	16252	4	64178	2999.76	19	19044	17544	0.02	0.36
23	CL	-167.50	-172.5	-177.50	10	267	214	272	104	16460	16668	4	65842	2844.50	17	19305	17883	0.02	0.36
24	CL	-177.50	-182.5	-187.50	10	277	224	282	104	16876	17084	4	67506	2697.87	16	19574	18225	0.02	0.36
25	CL	-187.50	-192.5	-197.50	10	287	234	292	104	17292	17500	4	69170	2559.67	15	19852	18572	0.02	0.36
26	CL	-197.50	-202.5	-207.50	10	297	244	302	104	17708	17916	4	70834	2429.60	14	20138	18923	0.02	0.36
27	SM	-207.50	-212.5	-217.50	10	307	254	312	127	18239	18562		0	2307.31	13	20547	19393		
28	SM	-217.50	-222.5	-227.50	10	317	264	322	127	18885	19208		0	2192.41	12	21078	19982		
29	SM	-227.50	-232.5	-237.50	10	327	274	332	127	19531	19854		0	2084.52	11	21616	20574		
30	SM	-237.50	-247.5	-257.50	20	342	289	352	127	20500	21146		0	1934.92	9	22435	21468		
31	SM	-257.50	-267.5	-277.50	20	362	309	372	127	21792	22438		0	1756.27	8	23549	22671		
32	SM	-277.50	-287.5	-297.50	20	382	329	392	127	23084	23730		0	1598.67	7	24683	23884		
33	SM	-297.50	-307.5	-317.50	20	402	349	412	127	24376	25022		0	1459.42	6	25836	25106		
34	SM	-317.50	-327.5	-337.50	20	422	369	432	127	25668	26314		0	1336.12	5	27005	26336		
35	SM	-337.50	-347.5	-357.50	20	442	389	452	127	26960	27606		0	1226.68	5	28187	27574		
36	SM	-357.50	-367.5	-377.50	20	462	409	472	127	28252	28898		0	1129.28	4	29382	28817		
37	SM	-377.50	-387.5	-397.50	20	482	429	492	127	29544	30190		0	1042.35	4	30587	30066		
38	SM	-397.50	-407.5	-417.50	20	502	449	512	127	30836	31482		0	964.54	3	31801	31319		
39	SM	-417.50	-427.5	-437.50	20	522	469	532	127	32128	32774		0	894.71	3	33023	32576		
40	SM	-437.50	-447.5	-457.50	20	542	489	552	127	33420	34066		0	831.85	2	34252	33836		
41	SM	-457.50	-467.5	-477.50	20	562	509	572	127	34712	35358		0	775.11	2	35488	35100		
42	SM	-477.50	-487.5	-497.50	20	582	529	592	127	36004	36650		0	723.77	2	36728	36366		
43	SM	-497.50	-507.5	-517.50	20	602	549	612	127	37296	37942		0	677.18	2	37974	37635		
44	SM	-517.50	-527.5	-537.50	20	622	569	632	127	38588	39234		0	634.80	2	39223	38906		
45	SM	-537.50	-547.5	-557.50	20	642	589	652	127	39880	40526		0	596.16	1	40477	40178		
46	SM	-557.50	-567.5	-577.50	20	662	609	672	127	41172	41818		0	560.83	1	41733	41453		
47	SM	-577.50	-587.5	-597.50	20	682	629	692	127	42464	43110		0	528.48	1	42993	42729		

*Below bottom of foundation

** Cre=Cr/(1+e0) = 0.06 / (1+1.61)=0.02, Cce = Cc / (1+e0) = 0.947 / (1 + 1.61) = 0.36

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No. ___ of ___

Chkd. By _____ Date _____ Proj. No 09-4179

Cv 5.3139 ft^2/day
1913 ft^2/year

ne Grained Recom-press Settle-ment (ft)	Virgin Settle-ment (ft)	Layer	Maximum Thickness of Fine-Grained Layer for rate calcs (ft)	Type drainage path (1, 2)	Time X (days) =>	Time Factor T at Time X: 10	20	30	60	360	1800	7200	Settlement (mt) at Time X: 10	20	30	60	(1.0 yrs) 360	(5 yrs) 1800	(20 yrs) 7200
		1				0	0	0	0	0	0	0							
		2				0	0	0	0	0	0	0							
		3				0	0	0	0	0	0	0							
		4				0	0	0	0	0	0	0							
		5				0	0	0	0	0	0	0							
		6				0	0	0	0	0	0	0							
		7				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.038		8	190	2		0.00589	0.01178	0.01766	0.03533	0.21197	1.05983	4.23934	0.44719	0.63243	0.77456	1.0954	2.68316	4.85864	5.16472
0.036		9				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.034		10				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.032		11				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.030		12				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.028		13				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.026		14				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.025		15				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.023		16				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.021		17				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.020		18				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.019		19				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.017		20				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.016		21				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.015		22				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.014		23				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.013		24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.012		25				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.011		26				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		27				0	0	0	0	0	0	0							
		28				0	0	0	0	0	0	0							
		29				0	0	0	0	0	0	0							
		30				0	0	0	0	0	0	0							
		31				0	0	0	0	0	0	0							
		32				0	0	0	0	0	0	0							
		33				0	0	0	0	0	0	0							
		34				0	0	0	0	0	0	0							
		35				0	0	0	0	0	0	0							
		36				0	0	0	0	0	0	0							
		37				0	0	0	0	0	0	0							
		38				0	0	0	0	0	0	0							
		39				0	0	0	0	0	0	0							
		40				0	0	0	0	0	0	0							
		41				0	0	0	0	0	0	0							
		42				0	0	0	0	0	0	0							
		43				0	0	0	0	0	0	0							
		44				0	0	0	0	0	0	0							
		45				0	0	0	0	0	0	0							
		46				0	0	0	0	0	0	0							
		47				0	0	0	0	0	0	0							

Consolidation Settlemen 5.165 in

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5.3. Settlement due to NI load at the edge

5.3.1 Summary of results

Summary for settlement at the edge due to NI load

Edge settlement is based on Boring Log B - 304

	Immediate Settlement (in)	Consolidation Settlement (in)	Total Settlement (in)
Corner / Edge	2.93	1.64	4.57

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Sheet No.___ of___

Chkd. By_____ Date_____ Island – Calvert Cliffs Unit 3 Proj. No 09-4179

Rectangular Loading Pattern Stress distribution W=L= 232.99 ft

Soil profile based on boring log B-304

5.3.2. Boussinesq Solution Uniform Loading $\Delta\sigma z = I_{sig}{}^{*}P$

Net Pressure (psf) q = 5930

Structure Load (psf) = 11760

Excavation (psf) = 5830

Note: units for elevation, depth is ft, units for stress and modulus is psf, and units for deformation/settlement is in.

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	I_{sig} (center)	$\Delta\sigma z$ (center)	I_{sig} (corner)	$\Delta\sigma z$ (corner)	Settlement E	Thickness	deformation(center)	deformation(corner)
1	IIb1 (SP)	5.00	41.50	31.50	0.25	5929.80	0.25	1482.453868	2.53E+06	10.00	2.81E-01	7.03E-02
2	IIb1 (SP)	15.00	31.50	21.50	0.25	5924.78	0.25	1482.334965	2.53E+06	10.00	2.81E-01	7.03E-02
3	IIb1 (SP)	25.25	21.50	11.00	0.25	5905.72	0.25	1481.717987	2.53E+06	10.50	2.94E-01	7.38E-02
4	IIb2 (SP)	35.50	11.00	1.00	0.25	5865.07	0.25	1480.348182	1.03E+06	10.00	6.83E-01	1.72E-01
5	IIb2 (SP)	45.50	1.00	-9.00	0.24	5799.77	0.25	1478.02705	1.03E+06	10.00	6.76E-01	1.72E-01
6	IIb3 (SP)	55.50	-9.00	-19.00	0.24	5707.03	0.25	1474.50948	2.62E+06	10.00	2.61E-01	6.75E-02
7	IIb3 (SP)	65.50	-19.00	-29.00	0.24	5587.17	0.25	1469.608696	2.62E+06	10.00	2.56E-01	6.73E-02
8	IIb3 (SP)	75.50	-29.00	-39.00	0.23	5442.44	0.25	1463.176688	2.62E+06	10.00	2.49E-01	6.70E-02
9	IIb3 (SP)	85.50	-39.00	-49.00	0.22	5276.46	0.25	1455.10613	2.62E+06	10.00	2.42E-01	6.66E-02
10	IIb3 (SP)	95.50	-49.00	-59.00	0.21	5093.56	0.24	1445.330542	2.62E+06	10.00	2.33E-01	6.62E-02
11	IIc (CL / ML)	105.50	-59.00	-69.00	0.21	4898.30	0.24	1433.82288	2.37E+06	10.00	2.48E-01	7.26E-02
12	IIc (CL / ML)	115.50	-69.00	-79.00	0.20	4695.07	0.24	1420.552819	2.37E+06	10.00	2.38E-01	7.19E-02
13	IIc (CL / ML)	125.50	-79.00	-89.00	0.19	4487.84	0.24	1405.663003	2.37E+06	10.00	2.27E-01	7.12E-02
14	IIc (CL / ML)	135.50	-89.00	-99.00	0.18	4280.00	0.23	1389.164603	2.37E+06	10.00	2.17E-01	7.03E-02
15	IIc (CL / ML)	145.50	-99.00	-109.00	0.17	4074.36	0.23	1371.132478	2.37E+06	10.00	2.06E-01	6.94E-02
16	IIc (CL / ML)	155.50	-109.00	-119.00	0.16	3873.11	0.23	1351.700219	2.37E+06	10.00	1.96E-01	6.84E-02
17	IIc (CL / ML)	165.50	-119.00	-129.00	0.16	3677.91	0.22	1330.965301	2.37E+06	10.00	1.86E-01	6.74E-02
18	IIc (CL / ML)	175.50	-129.00	-139.00	0.15	3489.96	0.22	1309.154537	2.37E+06	10.00	1.77E-01	6.63E-02
19	IIc (CL / ML)	185.50	-139.00	-149.00	0.14	3310.03	0.22	1286.319952	2.37E+06	10.00	1.68E-01	6.51E-02
20	IIc (CL / ML)	195.50	-149.00	-159.00	0.13	3138.61	0.21	1262.635164	2.37E+06	10.00	1.59E-01	6.39E-02
21	IIc (CL / ML)	205.50	-159.00	-169.00	0.13	2975.91	0.21	1238.242313	2.37E+06	10.00	1.51E-01	6.27E-02
22	IIc (CL / ML)	215.50	-169.00	-179.00	0.12	2821.96	0.20	1213.279543	2.37E+06	10.00	1.43E-01	6.14E-02
23	IIc (CL / ML)	225.50	-179.00	-189.00	0.11	2676.61	0.20	1187.879017	2.37E+06	10.00	1.36E-01	6.01E-02
24	IIc (CL / ML)	235.50	-189.00	-199.00	0.11	2539.65	0.20	1162.165414	2.37E+06	10.00	1.29E-01	5.88E-02
25	IIc (CL / ML)	245.50	-199.00	-209.00	0.10	2410.77	0.19	1136.254884	2.37E+06	10.00	1.22E-01	5.75E-02
26	III (SP)	255.50	-209.00	-219.00	0.10	2289.61	0.19	1110.25437	3.17E+06	10.00	8.67E-02	4.20E-02
27	III (SP)	265.50	-219.00	-229.00	0.09	2175.79	0.18	1084.261267	3.17E+06	10.00	8.24E-02	4.10E-02
28	III (SP)	275.50	-229.00	-239.00	0.09	2068.91	0.18	1058.363338	3.17E+06	10.00	7.83E-02	4.01E-02
29	III (SP)	290.50	-239.00	-259.00	0.08	1920.73	0.17	1019.863588	3.17E+06	20.00	1.45E-01	7.72E-02
30	III (SP)	310.50	-259.00	-279.00	0.07	1743.75	0.16	969.5182884	3.17E+06	20.00	1.32E-01	7.34E-02
31	III (SP)	330.50	-279.00	-299.00	0.07	1587.62	0.16	920.6773461	3.17E+06	20.00	1.20E-01	6.97E-02
32	III (SP)	350.50	-299.00	-319.00	0.06	1449.65	0.15	873.6403475	3.17E+06	20.00	1.10E-01	6.61E-02
33	III (SP)	370.50	-319.00	-339.00	0.06	1327.46	0.14	828.6075713	3.17E+06	20.00	1.01E-01	6.27E-02
34	III (SP)	390.50	-339.00	-359.00	0.05	1218.98	0.13	785.6965212	3.17E+06	20.00	9.23E-02	5.95E-02
35	III (SP)	410.50	-359.00	-379.00	0.05	1122.41	0.13	744.9667844	3.17E+06	20.00	8.50E-02	5.64E-02
36	III (SP)	430.50	-379.00	-399.00	0.04	1036.21	0.12	706.4246923	3.17E+06	20.00	7.85E-02	5.35E-02
37	III (SP)	450.50	-399.00	-419.00	0.04	959.04	0.11	670.0356501	3.17E+06	20.00	7.26E-02	5.07E-02
38	III (SP)	470.50	-419.00	-439.00	0.04	889.76	0.11	635.7442418	3.17E+06	20.00	6.74E-02	4.81E-02
39	III (SP)	490.50	-439.00	-459.00	0.03	827.39	0.10	603.4743358	3.17E+06	20.00	6.26E-02	4.57E-02
40	III (SP)	510.50	-459.00	-479.00	0.03	771.08	0.10	573.137465	3.17E+06	20.00	5.84E-02	4.34E-02
41	III (SP)	530.50	-479.00	-499.00	0.03	720.12	0.09	544.6377612	3.17E+06	20.00	5.45E-02	4.12E-02
42	III (SP)	550.50	-499.00	-519.00	0.03	673.86	0.09	517.8757062	3.17E+06	20.00	5.10E-02	3.92E-02
43	III (SP)	570.50	-519.00	-539.00	0.03	631.78	0.08	492.7509279	3.17E+06	20.00	4.78E-02	3.73E-02
44	III (SP)	590.50	-539.00	-559.00	0.03	593.40	0.08	469.1642414	3.17E+06	20.00	4.49E-02	3.55E-02
45	III (SP)	610.50	-559.00	-579.00	0.02	558.31	0.08	447.0190976	3.17E+06	20.00	4.23E-02	3.38E-02
46	III (SP)	630.50	-579.00	-599.00	0.02	526.16	0.07	426.2225738	3.17E+06	20.00	3.98E-02	3.23E-02
						8.87%		**7.19%**		total settlement	7.81	2.93

<10% inch

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By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Sheet No.___ of___

Chkd. By_____ Date_____ Island – Calvert Cliffs Unit 3 Proj. No 09-4179

5.3.3 2 to 1 slope stress

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δ σz	E	Thickness	Settlement deformation(center)
1	IIb1 (SP)	5.00	41.50	31.50	5725.8808	2.53E+06	10.00	2.72E-01
2	IIb1 (SP)	15.00	31.50	21.50	5348.0347	2.53E+06	10.00	2.54E-01
3	IIb1 (SP)	25.25	21.50	11.00	4998.274	2.53E+06	10.50	2.49E-01
4	IIb2 (SP)	35.50	11.00	1.00	4681.7355	1.03E+06	10.00	5.45E-01
5	IIb2 (SP)	45.50	1.00	-9.00	4401.0324	1.03E+06	10.00	5.13E-01
6	IIb3 (SP)	55.50	-9.00	-19.00	4144.8379	2.62E+06	10.00	1.90E-01
7	IIb3 (SP)	65.50	-19.00	-29.00	3910.3798	2.62E+06	10.00	1.79E-01
8	IIb3 (SP)	75.50	-29.00	-39.00	3695.267	2.62E+06	10.00	1.69E-01
9	IIb3 (SP)	85.50	-39.00	-49.00	3497.4282	2.62E+06	10.00	1.60E-01
10	IIb3 (SP)	95.50	-49.00	-59.00	3315.0623	2.62E+06	10.00	1.52E-01
11	IIc (CL / ML)	105.50	-59.00	-69.00	3146.5968	2.37E+06	10.00	1.59E-01
12	IIc (CL / ML)	115.50	-69.00	-79.00	2990.6542	2.37E+06	10.00	1.51E-01
13	IIc (CL / ML)	125.50	-79.00	-89.00	2846.0233	2.37E+06	10.00	1.44E-01
14	IIc (CL / ML)	135.50	-89.00	-99.00	2711.6359	2.37E+06	10.00	1.37E-01
15	IIc (CL / ML)	145.50	-99.00	-109.00	2586.5471	2.37E+06	10.00	1.31E-01
16	IIc (CL / ML)	155.50	-109.00	-119.00	2469.9184	2.37E+06	10.00	1.25E-01
17	IIc (CL / ML)	165.50	-119.00	-129.00	2361.0037	2.37E+06	10.00	1.20E-01
18	IIc (CL / ML)	175.50	-129.00	-139.00	2259.1375	2.37E+06	10.00	1.14E-01
19	IIc (CL / ML)	185.50	-139.00	-149.00	2163.7244	2.37E+06	10.00	1.10E-01
20	IIc (CL / ML)	195.50	-149.00	-159.00	2074.2306	2.37E+06	10.00	1.05E-01
21	IIc (CL / ML)	205.50	-159.00	-169.00	1990.1765	2.37E+06	10.00	1.01E-01
22	IIc (CL / ML)	215.50	-169.00	-179.00	1911.1299	2.37E+06	10.00	9.68E-02
23	IIc (CL / ML)	225.50	-179.00	-189.00	1836.7009	2.37E+06	10.00	9.30E-02
24	IIc (CL / ML)	235.50	-189.00	-199.00	1766.5367	2.37E+06	10.00	8.94E-02
25	IIc (CL / ML)	245.50	-199.00	-209.00	1700.3175	2.37E+06	10.00	8.61E-02
26	III (SP)	255.50	-209.00	-219.00	1637.7531	3.17E+06	10.00	6.20E-02
27	III (SP)	265.50	-219.00	-229.00	1578.5794	3.17E+06	10.00	5.98E-02
28	III (SP)	275.50	-229.00	-239.00	1522.5557	3.17E+06	10.00	5.76E-02
29	III (SP)	290.50	-239.00	-259.00	1443.9511	3.17E+06	20.00	1.09E-01
30	III (SP)	310.50	-259.00	-279.00	1348.2723	3.17E+06	20.00	1.02E-01
31	III (SP)	330.50	-279.00	-299.00	1261.7975	3.17E+06	20.00	9.55E-02
32	III (SP)	350.50	-299.00	-319.00	1183.383	3.17E+06	20.00	8.96E-02
33	III (SP)	370.50	-319.00	-339.00	1112.0573	3.17E+06	20.00	8.42E-02
34	III (SP)	390.50	-339.00	-359.00	1046.991	3.17E+06	20.00	7.93E-02
35	III (SP)	410.50	-359.00	-379.00	987.47249	3.17E+06	20.00	7.48E-02
36	III (SP)	430.50	-379.00	-399.00	932.88862	3.17E+06	20.00	7.06E-02
37	III (SP)	450.50	-399.00	-419.00	882.70856	3.17E+06	20.00	6.68E-02
38	III (SP)	470.50	-419.00	-439.00	836.47101	3.17E+06	20.00	6.33E-02
39	III (SP)	490.50	-439.00	-459.00	793.77353	3.17E+06	20.00	6.01E-02
40	III (SP)	510.50	-459.00	-479.00	754.26375	3.17E+06	20.00	5.71E-02
41	III (SP)	530.50	-479.00	-499.00	717.63207	3.17E+06	20.00	5.43E-02
42	III (SP)	550.50	-499.00	-519.00	683.6056	3.17E+06	20.00	5.18E-02
43	III (SP)	570.50	-519.00	-539.00	651.94302	3.17E+06	20.00	4.94E-02
44	III (SP)	590.50	-539.00	-559.00	622.43033	3.17E+06	20.00	4.71E-02
45	III (SP)	610.50	-559.00	-579.00	594.87722	3.17E+06	20.00	4.50E-02
46	III (SP)	630.50	-579.00	-599.00	569.11395	3.17E+06	20.00	4.31E-02
					9.60%		total settlement	5.87

inch

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Chkd. By_____ Date_____ Proj. No 09-4179

5.3.4 Circular Loading Pattern

R=159.7 ft

Layer	Soil	z* (layer center)	Top Elevation	Bottom Elevation	Δ σz (center)	Δ σz (edge)	Thickness	E	deformation(center)	deformation(edge)
1	IIb1 (SP)	3.75	41.5	34	6108.1487	5684.594158	7.5	2.53E+06	2.17E-01	2.02E-01
2	IIb1 (SP)	10	34	29	5977.4547	4508.259079	5	2.53E+06	1.42E-01	1.07E-01
3	IIb1 (SP)	15	29	24	5963.4052	3940.830983	5	2.53E+06	1.41E-01	9.35E-02
4	IIb1 (SP)	20	24	19	5953.3094	3632.86081	5	2.53E+06	1.41E-01	8.62E-02
5	IIb1 (SP)	25	19	14	5941.2824	3435.730497	5	2.53E+06	1.41E-01	8.15E-02
6	IIb1 (SP)	30	14	9	5925.3276	3294.678644	5	2.53E+06	1.41E-01	7.81E-02
7	IIb2 (SP)	35	9	4	5904.3755	3185.603647	5	1.03E+06	3.44E-01	1.86E-01
8	IIb2 (SP)	40	4	-1	5877.7339	3096.375669	5	1.03E+06	3.42E-01	1.80E-01
9	IIb2 (SP)	45	-1	-6	5844.942	3020.260476	5	1.03E+06	3.40E-01	1.76E-01
10	IIb2 (SP)	50	-6	-11	5805.7197	2953.232772	5	1.03E+06	3.38E-01	1.72E-01
11	IIb3 (SP)	55	-11	-16	5759.9425	2892.74502	5	2.62E+06	1.32E-01	6.62E-02
12	IIb3 (SP)	60	-16	-21	5707.6246	2837.110419	5	2.62E+06	1.31E-01	6.50E-02
13	IIb3 (SP)	65	-21	-26	5648.9024	2785.170781	5	2.62E+06	1.29E-01	6.38E-02
14	IIb3 (SP)	70	-26	-31	5584.0184	2736.107062	5	2.62E+06	1.28E-01	6.27E-02
15	IIb3 (SP)	75	-31	-36	5513.3035	2689.325901	5	2.62E+06	1.26E-01	6.16E-02
16	IIb3 (SP)	80	-36	-41	5437.1606	2644.388859	5	2.62E+06	1.25E-01	6.06E-02
17	IIb3 (SP)	85	-41	-46	5356.0476	2600.966703	5	2.62E+06	1.23E-01	5.96E-02
18	IIb3 (SP)	90	-46	-51	5270.4614	2558.808971	5	2.62E+06	1.21E-01	5.86E-02
19	IIb3 (SP)	95	-51	-56	5180.9229	2517.723153	5	2.62E+06	1.19E-01	5.77E-02
20	IIb3 (SP)	100	-56	-61	5087.9646	2477.560115	5	2.62E+06	1.17E-01	5.67E-02
21	IIc (CL / ML)	105	-61	-66	4992.1184	2438.203672	5	2.37E+06	1.26E-01	6.17E-02
22	IIc (CL / ML)	110	-66	-71	4893.9064	2399.562992	5	2.37E+06	1.24E-01	6.07E-02
23	IIc (CL / ML)	115	-71	-76	4793.8327	2361.566958	5	2.37E+06	1.21E-01	5.98E-02
24	IIc (CL / ML)	120	-76	-81	4692.3774	2324.159929	5	2.37E+06	1.19E-01	5.88E-02
25	IIc (CL / ML)	125	-81	-86	4589.992	2287.298492	5	2.37E+06	1.16E-01	5.79E-02
26	IIc (CL / ML)	130	-86	-91	4487.0958	2250.948957	5	2.37E+06	1.14E-01	5.70E-02
27	IIc (CL / ML)	135	-91	-96	4384.0745	2215.085394	5	2.37E+06	1.11E-01	5.61E-02
28	IIc (CL / ML)	140	-96	-101	4281.2787	2179.688076	5	2.37E+06	1.08E-01	5.52E-02
29	IIc (CL / ML)	145	-101	-106	4179.024	2144.742244	5	2.37E+06	1.06E-01	5.43E-02
30	IIc (CL / ML)	150	-106	-111	4077.5917	2110.237103	5	2.37E+06	1.03E-01	5.34E-02
31	IIc (CL / ML)	155	-111	-116	3977.2297	2076.165018	5	2.37E+06	1.01E-01	5.26E-02
32	IIc (CL / ML)	160	-116	-121	3878.1544	2042.520851	5	2.37E+06	9.82E-02	5.17E-02
33	IIc (CL / ML)	165	-121	-126	3780.5519	2009.301422	5	2.37E+06	9.57E-02	5.09E-02
34	IIc (CL / ML)	170	-126	-131	3684.5808	1976.505063	5	2.37E+06	9.33E-02	5.00E-02
35	IIc (CL / ML)	175	-131	-136	3590.3738	1944.131254	5	2.37E+06	9.09E-02	4.92E-02
36	IIc (CL / ML)	180	-136	-141	3498.04	1912.180318	5	2.37E+06	8.86E-02	4.84E-02
37	IIc (CL / ML)	185	-141	-146	3407.6671	1880.653173	5	2.37E+06	8.63E-02	4.76E-02
38	IIc (CL / ML)	190	-146	-151	3319.3233	1849.551125	5	2.37E+06	8.40E-02	4.68E-02
39	IIc (CL / ML)	195	-151	-156	3233.0596	1818.875701	5	2.37E+06	8.18E-02	4.60E-02
40	IIc (CL / ML)	200	-156	-161	3148.9116	1788.628506	5	2.37E+06	7.97E-02	4.53E-02
41	IIc (CL / ML)	205	-161	-166	3066.901	1758.811116	5	2.37E+06	7.76E-02	4.45E-02
42	IIc (CL / ML)	210	-166	-171	2987.0379	1729.424982	5	2.37E+06	7.56E-02	4.38E-02
43	IIc (CL / ML)	215	-171	-176	2909.3215	1700.471363	5	2.37E+06	7.37E-02	4.30E-02
44	IIc (CL / ML)	220	-176	-181	2833.7423	1671.951265	5	2.37E+06	7.17E-02	4.23E-02
45	IIc (CL / ML)	225	-181	-186	2760.2829	1643.8654	5	2.37E+06	6.99E-02	4.16E-02
46	IIc (CL / ML)	230	-186	-191	2688.9192	1616.214154	5	2.37E+06	6.81E-02	4.09E-02
47	IIc (CL / ML)	235	-191	-196	2619.6216	1588.997564	5	2.37E+06	6.63E-02	4.02E-02
48	IIc (CL / ML)	240	-196	-201	2552.3557	1562.215304	5	2.37E+06	6.46E-02	3.95E-02
49	IIc (CL / ML)	245	-201	-206	2487.0834	1535.86668	5	2.37E+06	6.30E-02	3.89E-02
50	IIc (CL / ML)	250	-206	-211	2423.7634	1509.950621	5	2.37E+06	6.14E-02	3.82E-02
51	III (SP)	255	-211	-216	2362.352	1484.46569	5	3.17E+06	4.47E-02	2.81E-02
52	III (SP)	260	-216	-221	2302.8034	1459.410087	5	3.17E+06	4.36E-02	2.76E-02
53	III (SP)	265	-221	-226	2245.0707	1434.781658	5	3.17E+06	4.25E-02	2.72E-02
54	III (SP)	270	-226	-231	2189.1059	1410.577911	5	3.17E+06	4.14E-02	2.67E-02
55	III (SP)	275	-231	-236	2134.8601	1386.796024	5	3.17E+06	4.04E-02	2.62E-02
56	III (SP)	280	-236	-241	2082.2847	1363.432869	5	3.17E+06	3.94E-02	2.58E-02
57	III (SP)	285	-241	-246	2031.3305	1340.485024	5	3.17E+06	3.84E-02	2.54E-02

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Paul C. Rizzo Associates, Inc.
ENGINEERS & CONSULTANTS

09-4179.02 F-31

By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Sheet No.___ of___

Chkd. By_____ Date_____ Island – Calvert Cliffs Unit 3 Proj. No 09-4179

58	III (SP)	290	-246	-251	1981.9489	1317.948791	5	3.17E+06	3.75E-02	2.49E-02
59	III (SP)	295	-251	-256	1934.0918	1295.820216	5	3.17E+06	3.66E-02	2.45E-02
60	III (SP)	300	-256	-261	1887.7113	1274.095109	5	3.17E+06	3.57E-02	2.41E-02
61	III (SP)	305	-261	-266	1842.7605	1252.769059	5	3.17E+06	3.49E-02	2.37E-02
62	III (SP)	310	-266	-271	1799.1934	1231.837454	5	3.17E+06	3.41E-02	2.33E-02
63	III (SP)	315	-271	-276	1756.9649	1211.295503	5	3.17E+06	3.33E-02	2.29E-02
64	III (SP)	320	-276	-281	1716.0308	1191.138248	5	3.17E+06	3.25E-02	2.25E-02
65	III (SP)	325	-281	-286	1676.348	1171.360586	5	3.17E+06	3.17E-02	2.22E-02
66	III (SP)	330	-286	-291	1637.8747	1151.957282	5	3.17E+06	3.10E-02	2.18E-02
67	III (SP)	335	-291	-296	1600.5699	1132.92299	5	3.17E+06	3.03E-02	2.14E-02
68	III (SP)	340	-296	-301	1564.3942	1114.252265	5	3.17E+06	2.96E-02	2.11E-02
69	III (SP)	345	-301	-306	1529.309	1095.939578	5	3.17E+06	2.89E-02	2.07E-02
70	III (SP)	350	-306	-311	1495.2771	1077.979331	5	3.17E+06	2.83E-02	2.04E-02
71	III (SP)	355	-311	-316	1462.2624	1060.365871	5	3.17E+06	2.77E-02	2.01E-02
72	III (SP)	360	-316	-321	1430.2299	1043.093502	5	3.17E+06	2.71E-02	1.97E-02
73	III (SP)	365	-321	-326	1399.1459	1026.156496	5	3.17E+06	2.65E-02	1.94E-02
74	III (SP)	370	-326	-331	1368.9777	1009.549104	5	3.17E+06	2.59E-02	1.91E-02
75	III (SP)	375	-331	-336	1339.6939	993.2655694	5	3.17E+06	2.54E-02	1.88E-02
76	III (SP)	380	-336	-341	1311.2639	977.3001334	5	3.17E+06	2.48E-02	1.85E-02
77	III (SP)	385	-341	-346	1283.6584	961.6470467	5	3.17E+06	2.43E-02	1.82E-02
78	III (SP)	390	-346	-351	1256.8491	946.3005773	5	3.17E+06	2.38E-02	1.79E-02
79	III (SP)	395	-351	-356	1230.8087	931.2550175	5	3.17E+06	2.33E-02	1.76E-02
80	III (SP)	400	-356	-361	1205.5109	916.5046919	5	3.17E+06	2.28E-02	1.73E-02
81	III (SP)	405	-361	-366	1180.9302	902.0439629	5	3.17E+06	2.24E-02	1.71E-02
82	III (SP)	410	-366	-371	1157.0423	887.8672374	5	3.17E+06	2.19E-02	1.68E-02
83	III (SP)	415	-371	-376	1133.8235	873.9689715	5	3.17E+06	2.15E-02	1.65E-02
84	III (SP)	420	-376	-381	1111.2513	860.3436758	5	3.17E+06	2.10E-02	1.63E-02
85	III (SP)	425	-381	-386	1089.3038	846.9859196	5	3.17E+06	2.06E-02	1.60E-02
86	III (SP)	430	-386	-391	1067.9598	833.8903345	5	3.17E+06	2.02E-02	1.58E-02
87	III (SP)	435	-391	-396	1047.1993	821.0516186	5	3.17E+06	1.98E-02	1.55E-02
88	III (SP)	440	-396	-401	1027.0026	808.4645388	5	3.17E+06	1.94E-02	1.53E-02
89	III (SP)	445	-401	-406	1007.3511	796.123934	5	3.17E+06	1.91E-02	1.51E-02
90	III (SP)	450	-406	-411	988.22652	784.0247172	5	3.17E+06	1.87E-02	1.48E-02
91	III (SP)	455	-411	-416	969.61161	772.1618777	5	3.17E+06	1.84E-02	1.46E-02
92	III (SP)	460	-416	-421	951.48955	760.5304828	5	3.17E+06	1.80E-02	1.44E-02
93	III (SP)	465	-421	-426	933.84423	749.1256789	5	3.17E+06	1.77E-02	1.42E-02
94	III (SP)	470	-426	-431	916.66009	737.942693	5	3.17E+06	1.74E-02	1.40E-02
95	III (SP)	475	-431	-436	899.9222	726.9768338	5	3.17E+06	1.70E-02	1.38E-02
96	III (SP)	480	-436	-441	883.61613	716.2234918	5	3.17E+06	1.67E-02	1.36E-02
97	III (SP)	485	-441	-446	867.72802	705.6781402	5	3.17E+06	1.64E-02	1.34E-02
98	III (SP)	490	-446	-451	852.2445	695.3363354	5	3.17E+06	1.61E-02	1.32E-02
99	III (SP)	495	-451	-456	837.1527	685.1937164	5	3.17E+06	1.58E-02	1.30E-02
100	III (SP)	500	-456	-461	822.44023	675.2460055	5	3.17E+06	1.56E-02	1.28E-02
101	III (SP)	505	-461	-466	808.09514	665.4890078	5	3.17E+06	1.53E-02	1.26E-02
102	III (SP)	510	-466	-471	794.10592	655.9186109	5	3.17E+06	1.50E-02	1.24E-02
103	III (SP)	515	-471	-476	780.46149	646.5307843	5	3.17E+06	1.48E-02	1.22E-02
104	III (SP)	520	-476	-481	767.15114	637.3215792	5	3.17E+06	1.45E-02	1.21E-02
105	III (SP)	525	-481	-486	754.16459	628.2871277	5	3.17E+06	1.43E-02	1.19E-02
106	III (SP)	530	-486	-491	741.49189	619.4236417	5	3.17E+06	1.40E-02	1.17E-02
107	III (SP)	535	-491	-496	729.12348	610.7274128	5	3.17E+06	1.38E-02	1.16E-02
108	III (SP)	540	-496	-501	717.05012	602.1948108	5	3.17E+06	1.36E-02	1.14E-02
109	III (SP)	545	-501	-506	705.26291	593.8222831	5	3.17E+06	1.33E-02	1.12E-02
110	III (SP)	550	-506	-511	693.75326	585.6063535	5	3.17E+06	1.31E-02	1.11E-02
111	III (SP)	555	-511	-516	682.51288	577.5436211	5	3.17E+06	1.29E-02	1.09E-02
112	III (SP)	560	-516	-521	671.53378	569.6307595	5	3.17E+06	1.27E-02	1.08E-02
113	III (SP)	565	-521	-526	660.80825	561.8645155	5	3.17E+06	1.25E-02	1.06E-02
114	III (SP)	570	-526	-531	650.32885	554.2417077	5	3.17E+06	1.23E-02	1.05E-02
115	III (SP)	575	-531	-536	640.08838	546.7592258	5	3.17E+06	1.21E-02	1.03E-02
116	III (SP)	580	-536	-541	630.07991	539.4140289	5	3.17E+06	1.19E-02	1.02E-02
117	III (SP)	585	-541	-546	620.29674	532.2031447	5	3.17E+06	1.17E-02	1.01E-02
118	III (SP)	590	-546	-551	610.7324	525.1236678	5	3.17E+06	1.16E-02	9.94E-03
119	III (SP)	595	-551	-556	601.38065	518.1727591	5	3.17E+06	1.14E-02	9.81E-03
120	III (SP)	600	-556	-561	592.23545	511.3476439	5	3.17E+06	1.12E-02	9.68E-03
121	III (SP)	605	-561	-566	583.29097	504.6456109	5	3.17E+06	1.10E-02	9.55E-03
122	III (SP)	610	-566	-571	574.54156	498.064011	5	3.17E+06	1.09E-02	9.43E-03
123	III (SP)	615	-571	-576	565.98179	491.6002561	5	3.17E+06	1.07E-02	9.30E-03
124	III (SP)	620	-576	-581	557.6064	485.2518177	5	3.17E+06	1.06E-02	9.18E-03
125	III (SP)	625	-581	-586	549.41028	479.0162255	5	3.17E+06	1.04E-02	9.07E-03
126	III (SP)	630	-586	-591	541.38852	472.8910668	5	3.17E+06	1.02E-02	8.95E-03
					9.13%			total settlement	**7.94**	**4.69** inch

* below bottom of foundation

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5.3.5 Vertical stress under circular loading

Radius R is 159.7

q= 5930

Z (Depth*)	Center Vertical Stress	Edge Vertical Stress
3.75	6108.148723	5684.594158
10	5977.454678	4508.259079
15	5963.405163	3940.830983
20	5953.309382	3632.86081
25	5941.282374	3435.730497
30	5925.3276	3294.678644
35	5904.375503	3185.603647
40	5877.73391	3096.375669
45	5844.942045	3020.260476
50	5805.719665	2953.232772
55	5759.942456	2892.74502
60	5707.62456	2837.110419
65	5648.90243	2785.170781
70	5584.018351	2736.107062
75	5513.303459	2689.325901
80	5437.160616	2644.388859
85	5356.047639	2600.966703
90	5270.461353	2558.808971
95	5180.922905	2517.723153
100	5087.964592	2477.560115
105	4992.11841	2438.203672
110	4893.906387	2399.562992
115	4793.832686	2361.566958
120	4692.377409	2324.159929
125	4589.991959	2287.298492
130	4487.095814	2250.948957
135	4384.074513	2215.085394
140	4281.2787	2179.688076
145	4179.024019	2144.742244
150	4077.591709	2110.237103
155	3977.22974	2076.165018
160	3878.154355	2042.520851
165	3780.551895	2009.301422
170	3684.580822	1976.505063
175	3590.373838	1944.131254
180	3498.040046	1912.180318
185	3407.667102	1880.653173
190	3319.323309	1849.551125
195	3233.059625	1818.875701
200	3148.911572	1788.628506
205	3066.901021	1758.811116
210	2987.037857	1729.424982
215	2909.321503	1700.471363
220	2833.742328	1671.951265
225	2760.282915	1643.8654
230	2688.919215	1616.214154
235	2619.621582	1588.997564
240	2552.355698	1562.215304
245	2487.083399	1535.86668

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250	2423.763406	1509.950621
255	2362.35197	1484.46569
260	2302.803437	1459.410087
265	2245.070745	1434.781658
270	2189.105858	1410.577911
275	2134.860133	1386.796024
280	2082.284651	1363.432869
285	2031.330485	1340.485024
290	1981.948941	1317.948791
295	1934.091754	1295.820216
300	1887.711256	1274.095109
305	1842.760516	1252.769059
310	1799.19345	1231.837454
315	1756.964917	1211.295503
320	1716.030792	1191.138248
325	1676.348023	1171.360586
330	1637.87467	1151.957282
335	1600.569942	1132.92299
340	1564.394212	1114.252265
345	1529.309027	1095.939578
350	1495.277117	1077.979331
355	1462.262386	1060.365871
360	1430.229904	1043.093502
365	1399.145897	1026.156496
370	1368.977724	1009.549104
375	1339.69386	993.2655694
380	1311.263875	977.3001334
385	1283.658403	961.6470467
390	1256.849122	946.3005773
395	1230.80872	931.2550175
400	1205.510872	916.5046919
405	1180.930208	902.0439629
410	1157.042282	887.8672374
415	1133.823547	873.9689715
420	1111.251323	860.3436758
425	1089.303765	846.9859196
430	1067.959841	833.8903345
435	1047.199295	821.0516186
440	1027.002628	808.4645388
445	1007.351064	796.123934
450	988.2265244	784.0247172
455	969.611606	772.1618777
460	951.4895512	760.5304828
465	933.8442258	749.1256789
470	916.6600942	737.942693
475	899.9221973	726.9768338
480	883.6161294	716.2234918
485	867.728017	705.6781402
490	852.2444984	695.3363354
495	837.1527031	685.1937164
500	822.4402328	675.2460055
505	808.0951429	665.4890078
510	794.1059244	655.9186109
515	780.4614869	646.5307843
520	767.1511422	637.3215792
525	754.1645881	628.2871277
530	741.4918933	619.4236417
535	729.1234827	610.7274128
540	717.0501238	602.1948108
545	705.2629122	593.8222831
550	693.7532599	585.6063535
555	682.5128818	577.5436211
560	671.5337845	569.6307595
565	660.8082545	561.8645155
570	650.3288476	554.2417077
575	640.0883778	546.7592258
580	630.079908	539.4140289
585	620.2967397	532.2031447
590	610.7324042	525.1236678
595	601.3806533	518.1727591
600	592.2354513	511.3476439
605	583.2909664	504.6456109
610	574.5415631	498.064011
615	565.9817949	491.6002561
620	557.6063966	485.2518177
625	549.4102779	479.0162255
630	541.3885165	472.8910668

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09-4179.02 F-31

By XS Date 10/16/2009 Subject Settlement Analysis on Nuclear Island – Calvert Cliffs Unit 3 Sheet No. ___ of ___

Chkd. By _____ Date _____ Proj. No 09-4179

5.3.6 Consolidation Settlement

Structure	Nuclear Island
Location	B-304
BackFill Height (ft)	0
Type of Stress Diagram	Rectangular
Original Ground Elev (ft, msl)	68
Bottom of Ftg. Elev (ft, msl)	41.50
Foundation Pressure (psf)	5930
Groundwater Elev (ft, msl)	41.50
CPT/Boring Profile	B-304
Boring for Elastic Settlement	B-304

Layer	Soil Type	Top Elev (ft msl)	Mid-Layer Elev (ft msl)	**Bottom Elev (ft msl)**	Layer Thick-ness (ft)	Mid-Layer Depth (ft)	Mid-Layer Depth* (ft)	Bottom Layer Depth (ft)	**Layer Unit Weight (pcf)**	Initial Mid-Layer Effective Stress (psf)	Bottom Layer Eff. Stress (psf)	**OCR**	Pp (psf)	**Δ σv due to foundation (psf, corner of rectangular)**	Δ σv / Initial Stress %	σ final (psf)	σ v average (psf)	**Cre**	**Cce**
																Fine Grained Behavior			
1	SM	68	56	44	24	12	-14.5	24	122	1464	2928		0	0.00	0	1464	1464		
2	SM	41.50	36.5	31.50	10	31.5	5	36.5	122	3226	3524		0	1482.49	46	4708	3967		
3	SM	31.50	26.5	21.50	10	41.5	15	46.5	122	3822	4120		0	1482.33	39	5304	4563		
4	SM	21.50	16.25	11.00	10.5	51.75	25.25	57	122	4433	4746		0	1481.72	33	5915	5174		
5	SM	11.00	6	1.00	10	62	35.5	67	123	5049	5352		0	1480.35	29	6529	5789		
6	SM	1.00	-4	-9.00	10	72	45.5	77	123	5655	5958		0	1478.03	26	7133	6394		
7	SM	-9.00	-14	-19.00	10	82	55.5	87	123	6261	6564		0	1474.51	24	7735	6998		
8	SM	-19.00	-24	-29.00	10	92	65.5	97	123	6867	7170		0	1469.61	21	8336	7602		
9	SM	-29.00	-34	-39.00	10	102	75.5	107	123	7473	7776		0	1463.18	20	8936	8204		
10	SM	-39.00	-44	-49.00	10	112	85.5	117	123	8079	8382		0	1455.11	18	9534	8806		
11	SM	-49.00	-54	-59.00	10	122	95.5	127	123	8685	8988		0	1445.33	17	10130	9407		
12	CL	-59.00	-64	-69.00	10	132	105.5	137	104	9196	9404	4	36783	1433.82	16	10630	9913	0.02	0.36
13	CL	-69.00	-74	-79.00	10	142	115.5	147	104	9612	9820	4	38447	1420.59	15	11032	10322	0.02	0.36
14	CL	-79.00	-84	-89.00	10	152	125.5	157	104	10028	10236	4	40111	1405.68	14	11433	10731	0.02	0.36
15	CL	-89.00	-94	-99.00	10	162	135.5	167	104	10444	10652	4	41775	1389.16	13	11833	11138	0.02	0.36
16	CL	-99.00	-104	-109.00	10	172	145.5	177	104	10860	11068	4	43439	1371.13	13	12231	11545	0.02	0.36
17	CL	-109.00	-114	-119.00	10	182	155.5	187	104	11276	11484	4	45103	1351.70	12	12628	11952	0.02	0.36
18	CL	-119.00	-124	-129.00	10	192	165.5	197	104	11692	11900	4	46767	1331.00	11	13023	12357	0.02	0.36
19	CL	-129.00	-134	-139.00	10	202	175.5	207	104	12108	12316	4	48431	1309.15	11	13417	12762	0.02	0.36
20	CL	-139.00	-144	-149.00	10	212	185.5	217	104	12524	12732	4	50095	1286.32	10	13810	13167	0.02	0.36
21	CL	-149.00	-154	-159.00	10	222	195.5	227	104	12940	13148	4	51759	1262.64	10	14202	13571	0.02	0.36
22	CL	-159.00	-164	-169.00	10	232	205.5	237	104	13356	13564	4	53423	1238.24	9	14594	13975	0.02	0.36
23	CL	-169.00	-174	-179.00	10	242	215.5	247	104	13772	13980	4	55087	1213.28	9	14985	14378	0.02	0.36
24	CL	-179.00	-184	-189.00	10	252	225.5	257	104	14188	14396	4	56751	1187.88	8	15376	14782	0.02	0.36
25	CL	-189.00	-194	-199.00	10	262	235.5	267	104	14604	14812	4	58415	1162.17	8	15766	15185	0.02	0.36
26	CL	-199.00	-204	-209.00	10	272	245.5	277	104	15020	15228	4	60079	1136.25	8	16156	15588	0.02	0.36
27	SM	-209.00	-214	-219.00	10	282	255.5	287	127	15551	15874		0	1110.25	7	16661	16106		
28	SM	-219.00	-224	-229.00	10	292	265.5	297	127	16197	16520		0	1084.26	7	17281	16739		
29	SM	-229.00	-234	-239.00	10	302	275.5	307	127	16843	17166		0	1058.36	6	17901	17372		
30	SM	-239.00	-249	-259.00	20	317	290.5	327	127	17812	18458		0	1019.86	6	18832	18322		
31	SM	-259.00	-269	-279.00	20	337	310.5	347	127	19104	19750		0	969.52	5	20073	19589		
32	SM	-279.00	-289	-299.00	20	357	330.5	367	127	20396	21042		0	920.68	5	21316	20856		
33	SM	-299.00	-309	-319.00	20	377	350.5	387	127	21688	22334		0	873.64	4	22561	22125		
34	SM	-319.00	-329	-339.00	20	397	370.5	407	127	22980	23626		0	828.61	4	23808	23394		
35	SM	-339.00	-349	-359.00	20	417	390.5	427	127	24272	24918		0	785.70	3	25057	24665		
36	SM	-359.00	-369	-379.00	20	437	410.5	447	127	25564	26210		0	744.97	3	26309	25936		
37	SM	-379.00	-389	-399.00	20	457	430.5	467	127	26856	27502		0	706.42	3	27562	27209		
38	SM	-399.00	-409	-419.00	20	477	450.5	487	127	28148	28794		0	670.04	2	28818	28483		
39	SM	-419.00	-429	-439.00	20	497	470.5	507	127	29440	30086		0	635.74	2	30076	29758		
40	SM	-439.00	-449	-459.00	20	517	490.5	527	127	30732	31378		0	603.47	2	31335	31034		
41	SM	-459.00	-469	-479.00	20	537	510.5	547	127	32024	32670		0	573.14	2	32597	32310		
42	SM	-479.00	-489	-499.00	20	557	530.5	567	127	33316	33962		0	544.64	2	33860	33588		
43	SM	-499.00	-509	-519.00	20	577	550.5	587	127	34608	35254		0	517.88	1	35126	34867		
44	SM	-519.00	-529	-539.00	20	597	570.5	607	127	35900	36546		0	492.75	1	36393	36146		
45	SM	-539.00	-549	-559.00	20	617	590.5	627	127	37192	37838		0	469.16	1	37661	37426		
46	SM	-559.00	-569	-579.00	20	637	610.5	647	127	38484	39130		0	447.02	1	38931	38707		
47	SM	-579.00	-589	-599.00	20	657	630.5	667	127	39776	40422		0	426.22	1	40202	39989		

*Below bottom of foundation

** Cre=Cr/(1+e0) = 0.06 / (1+1.61)=0.02, Cce = Cc / (1+e0) = 0.947 / (1 + 1.61) = 0.36

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Cv	5.3139	ft^2/day
	1913	ft^2/year

Fine Grained Recom-press Settle-ment (ft)	Virgin Settle-ment (ft)	Layer	Maximum Thickness of Fine-Grained Layer for rate calcs (ft)	Type drainage path (1, 2)	Time X (days) =>	Time Factor T at Time X: 10	20	30	60	360	1800	5400	Settlement (mt) at Time X: 10	20	30	60	(1.0 yrs) 360	(5 yrs) 1800	(15 yrs) 5400
		1				0	0	0	0	0	0	0							
		2				0	0	0	0	0	0	0							
		3				0	0	0	0	0	0	0							
		4				0	0	0	0	0	0	0							
		5				0	0	0	0	0	0	0							
		6				0	0	0	0	0	0	0							
		7				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		9				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		10				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		11				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.013		12	150	2		0.00945	0.01889	0.02834	0.05668	0.34009	1.70044	5.10133	0.18008	0.25466	0.3119	0.44109	1.06683	1.6219	1.64192
0.012		13				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.011		14				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.011		15				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.010		16				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.010		17				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.009		18				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.009		19				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.008		20				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.008		21				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.008		22				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.007		23				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.007		24				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.007		25				0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.006		26				0	0	0	0	0	0	0	0	0	0	0	0	0	0
		27				0	0	0	0	0	0	0							
		28				0	0	0	0	0	0	0							
		29				0	0	0	0	0	0	0							
		30				0	0	0	0	0	0	0							
		31				0	0	0	0	0	0	0							
		32				0	0	0	0	0	0	0							
		33				0	0	0	0	0	0	0							
		34				0	0	0	0	0	0	0							
		35				0	0	0	0	0	0	0							
		36				0	0	0	0	0	0	0							
		37				0	0	0	0	0	0	0							
		38				0	0	0	0	0	0	0							
		39				0	0	0	0	0	0	0							
		40				0	0	0	0	0	0	0							
		41				0	0	0	0	0	0	0							
		42				0	0	0	0	0	0	0							
		43				0	0	0	0	0	0	0							
		44				0	0	0	0	0	0	0							
		45				0	0	0	0	0	0	0							
		46				0	0	0	0	0	0	0							
		47				0	0	0	0	0	0	0							

Consolidation Settlement 1.642 in

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6. Results:

1. Rebound due to excavation

Table 2: Rebound

	Elastic Rebound (in)	Consolidation Rebound (in)	Total Rebound (in)
Center	2.59	5.09	7.68
Corner / Edge	0.48	0.83	1.31

2. Settlement due to NI structure load (Net Load)

Table 3: Settlement due to NI net load (total structure load – excavated soil weight)

Settlement Summary (inches)	Center (B-301)	Edge (304)
elastic settlement	7.91	2.93
consolidation settlement	5.16	1.64
Secondary settlement	0.00	0.00
Total settlement	13.08	4.57

The total maximum settlement at the center of the nuclear island is about 13 inches; the settlement at the edge is about 5 inches; the maximum differential settlement is about 8 inches. The dewatering process does not cause settlement. It should be noted that differential settlement is believed to be over conservative because the method assumes a flexible foundation system.

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References:

1. Robert D. Holtz, William D. Kovacs, "An Introduction to Geotechnical Engineering," Prentice-Hall, Inc., 1981

2. Donald P. Coduto, " Foundation Design Principles and Practices," Second Edition, Prentice-Hall, Inc., , 2001

3. Paul C. Rizzo Associates, Inc., Calculation NO. 09-4179.01 F-20, "Construction loads, areas and elevations of CCNPP Unit 3 buildings", August 2009

4. Paul C. Rizzo Associates, Inc., Calculation NO. 09-4179.01 F-19, "Elastic Modulus of soil layers CCNPP Unit 3," August 2009

5. Paul C. Rizzo Associates, Inc., Calculation NO. 09-4179.01 F-14, "Consolidation Testing Calvert Cliffs Unit 3," August 2009

6. Paul C. Rizzo Associates, Inc., Calculation NO. 09-4179.01 F-9, "Soil strata – Thickness and Termination Elevations," August 2009

7. CCNPP Unit 3 COL Application Revision 5, FSAR section 2.4 and 2.5

8. Paul C. Rizzo Associates, Inc., Calculation NO. 09-4179.01 F-25, "Bearing Capacity of Safety Related Buildings at CCNPP Unit 3," August 2009

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Attachment A
Stress Distribution Verification
Below the edge of circular load

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Verify the stress distribution by compare theoritical results with integration results

Since there is no close form solution for stress distribution under the edge of a ciucular load, an integration macro is writen to calculate the stress distribution.
The purpose of this calculation is to verify the program by comparing the theritical results with the program results.

Radius R is 159.7 ft, uniform loading of 5830 psf

Circular Loading Pattern

Z (Depth*)	I	Theorical Resultes(center)	Integration Results (center)
3.75	0.999987	5829.92458	6005.144528
10	0.999756	5828.577001	5876.654431
15	0.999182	5825.232335	5862.841838
20	0.998081	5818.813196	5852.916307
25	0.996301	5808.432383	5841.092115
30	0.993707	5793.311875	5825.406393
35	0.990189	5772.799947	5804.807619
40	0.985657	5746.382673	5778.615295
45	0.98005	5713.689663	5746.376412
50	0.973327	5674.494279	5707.815455
55	0.965473	5628.708821	5662.810205
60	0.956497	5576.375462	5611.374567
65	0.946424	5517.653818	5553.642693
70	0.935301	5452.8061	5489.85278
75	0.923187	5382.180803	5420.330382
80	0.910154	5306.195804	5345.471567
85	0.896282	5225.321626	5265.72643
90	0.881658	5140.065481	5181.583421
95	0.866373	5050.956566	5093.554896
100	0.85052	4958.53294	5002.164177
105	0.83419	4863.330153	4907.934289
110	0.817474	4765.87172	4811.378455
115	0.800457	4666.661404	4712.992337
120	0.783221	4566.177229	4613.247941
125	0.765843	4464.86707	4512.58906
130	0.748395	4363.14566	4411.428093
135	0.730942	4261.392813	4310.144083
140	0.713542	4159.95269	4209.081757
145	0.696249	4059.133904	4108.551439
150	0.67911	3959.210301	4008.829623
155	0.662165	3860.422265	3910.160099
160	0.645451	3762.978406	3812.755462
165	0.628998	3667.057507	3716.798912
170	0.612832	3572.810646	3622.446238
175	0.596975	3480.363397	3529.827904
180	0.581444	3389.818058	3439.051175
185	0.566253	3301.25584	3350.202227
190	0.551413	3214.738999	3263.348211
195	0.536932	3130.312864	3178.539227
200	0.522814	3048.007754	3095.810196
205	0.509064	2967.840765	3015.182623
210	0.495681	2889.817427	2936.666223
215	0.482664	2813.933223	2860.260432
220	0.470013	2740.174973	2785.95578
225	0.457722	2668.522093	2713.735142
230	0.445789	2598.947721	2643.574878
235	0.434206	2531.419737	2575.445838
240	0.422968	2465.901662	2509.314286
245	0.412007	2402.353401	2445.142701
250	0.401498	2340.732253	2382.890499
255	0.391251	2280.992936	2322.514669
260	0.381319	2223.088727	2263.970327
265	0.371693	2166.971643	2207.211205

WxL= 282.99 ft x 282.99 ft , uniform loading of 5830 psf

Rectangular Loading Pattern

Z (Depth*)	Edge stress (from integration)
5	1457.49394
10	1457.451827
15	1457.337742
20	1457.116468
25	1456.753609
30	1456.215887
35	1455.471396
40	1454.489827
45	1453.242681
50	1451.703453
55	1449.847788
60	1447.653617
65	1445.101259
70	1442.173494
75	1438.855614
80	1435.135439
85	1431.003316
90	1426.452082
95	1421.477018
100	1416.075769
105	1410.248254
110	1403.996558
115	1397.324811
120	1390.239054
125	1382.747098
130	1374.858378
135	1366.583801
140	1357.93559
145	1348.927136
150	1339.572843
155	1329.88798
160	1319.888539
165	1309.591093
170	1299.012671
175	1288.170628
180	1277.082532
185	1265.766054
190	1254.23887
195	1242.518571
200	1230.622576
205	1218.568064
210	1206.371904
215	1194.0506
220	1181.620239
225	1169.096448
230	1156.494361
235	1143.828587
240	1131.113184
245	1118.361046
250	1105.586888
255	1092.801233
260	1080.016415
265	1067.243572

Z (Depth*)	Theorical Resultes(center)
5.00	1457.49
15.00	1457.34
24.50	1456.80
34.00	1455.64
44.00	1453.51
54.00	1450.25
64.00	1445.64
74.00	1439.55
84.00	1431.86
94.00	1422.51
104.00	1411.45
114.00	1398.69
124.00	1384.28
134.00	1368.27
144.00	1350.76
154.00	1331.85
164.00	1311.68
174.00	1290.36
184.00	1268.05
194.00	1244.88
204.00	1221.00
214.00	1196.53
224.00	1171.62
234.00	1146.37
244.00	1120.92
254.00	1095.37
264.00	1069.81
274.00	1044.33
289.00	1006.43
309.00	956.83
329.00	908.69
349.00	862.31
369.00	817.88
389.00	775.54
409.00	735.33
429.00	697.28
449.00	661.35
469.00	627.48
489.00	595.61
509.00	565.65
529.00	537.49
549.00	511.06
569.00	486.24
589.00	462.94
609.00	441.07
629.00	420.52

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Verify the stress distribution by compare theoritical results with integration results

270	0.362366	2112.59291	2152.190076	270	1054.493254
275	0.353328	2059.903321	2098.859119	275	1041.775422
280	0.344572	2008.853539	2047.170238	280	1029.099463
285	0.336088	1959.394361	1997.075333	285	1016.474193
290	0.327869	1911.476934	1948.52653	290	1003.907878
295	0.319906	1865.052945	1901.476379	295	991.4082376
300	0.312191	1820.074771	1855.878014	300	978.9824687
305	0.304716	1776.495611	1811.685296	305	966.6372569
310	0.297473	1734.269586	1768.852919	310	954.3787948
315	0.290455	1693.351825	1727.336504	315	942.2127998
320	0.283653	1653.698526	1687.092668	320	930.1445322
325	0.277061	1615.267009	1648.079085	325	918.1788132
330	0.270672	1578.015749	1610.254524	330	906.3200443
335	0.264478	1541.904403	1573.578881	335	894.5722254
340	0.258472	1506.893819	1538.013196	340	882.9389734
345	0.252649	1472.946049	1503.519667	345	871.423541
350	0.247002	1440.02434	1470.061651	350	860.0288348
355	0.241525	1408.093134	1437.603661	355	848.7574326
360	0.236212	1377.118047	1406.111356	360	837.6116019
365	0.231058	1347.065861	1375.551531	365	826.5933158
370	0.226056	1317.904496	1345.892096	370	815.7042707
375	0.221201	1289.602993	1317.102058	375	804.9459015
380	0.216489	1262.131485	1289.151499	380	794.3193975
385	0.211914	1235.461172	1262.01155	385	783.8257174
390	0.207472	1209.564291	1235.654364	390	773.4656038
395	0.203159	1184.41409	1210.053093	395	763.2395969
400	0.198968	1159.984794	1185.181853	400	753.1480477
405	0.194897	1136.251578	1161.015702	405	743.1911312
410	0.190942	1113.190536	1137.530608	410	733.368858
415	0.187098	1090.778649	1114.70342	415	723.6810862
420	0.183361	1068.993756	1092.51184	420	714.1275324
425	0.179728	1047.814526	1070.934393	425	704.7077821
430	0.176196	1027.220426	1049.9504	430	695.4212998
435	0.17276	1007.191694	1029.539948	435	686.2674382
440	0.169418	987.7093088	1009.683866	440	677.2454477
445	0.166167	968.7549652	990.3636932	445	668.3544841
450	0.163004	950.311045	971.5616589	450	659.5936172
455	0.159925	932.3605922	953.2606514	455	650.9618383
460	0.156927	914.887287	935.4441963	460	642.4580669
465	0.15401	897.8754214	918.0964311	465	634.0811578
470	0.151168	881.3098758	901.2020825	470	625.8299073
475	0.148401	865.1760959	884.7464436	475	617.7030592
480	0.145705	849.46007	868.7153515	480	609.6993099
485	0.143079	834.1483087	853.0951668	485	601.8173144
490	0.140519	819.2278232	837.8727531	490	594.0556906
495	0.138025	804.686106	823.0354569	495	586.4130238
500	0.135594	790.511112	808.5710889	500	578.8878714
505	0.133223	776.6912395	794.4679061	505	571.4787668
510	0.130912	763.215313	780.7145934	510	564.1842225
515	0.128657	750.072566	767.3002477	515	557.0027346
520	0.126458	737.2526249	754.2143607	520	549.9327849
525	0.124313	724.7454932	741.4468041	525	542.9728449
530	0.12222	712.5415362	728.9878141	530	536.1213778
535	0.120177	700.0314073	716.8279771	535	529.3768415
540	0.118183	689.0063332	704.9582161	540	522.7376908
545	0.116236	677.6575017	693.3697771	545	516.2023796
550	0.114336	666.5766479	682.0542167	550	509.7693632
555	0.11248	655.7557429	671.0033897	555	503.4370996
560	0.110667	645.1870414	660.2094374	560	497.2040518
565	0.108896	634.863071	649.6647764	565	491.068689
570	0.107166	624.7766213	639.3620879	570	485.0294882
575	0.105475	614.9207335	629.2943074	575	479.0849355
580	0.103823	605.2886905	619.4546145	580	473.2335273
585	0.102208	595.8740077	609.8364237	585	467.4737713
590	0.10063	586.6704238	600.4333754	590	461.8041877
595	0.099086	577.6718921	591.2393269	595	456.2233097
600	0.097577	568.8725719	582.2483442	600	450.7296849
605	0.096101	560.2668213	573.4546937	605	445.3218755
610	0.094657	551.8491888	564.8528353	610	439.998459
615	0.093244	543.6144064	556.4374139	615	434.7580291
620	0.091862	535.5573822	548.2032533	620	429.599196
625	0.09051	527.6731943	540.1453491	625	424.5205866
630	0.089186	519.9570837	532.258862	630	419.5208455

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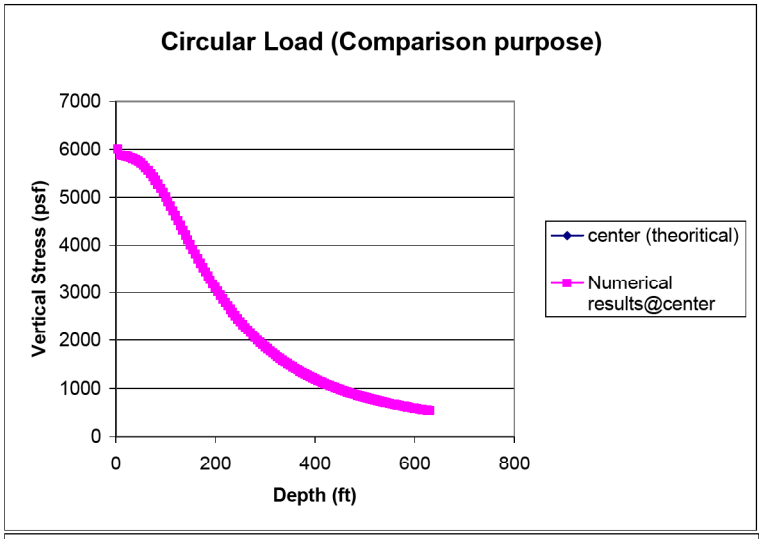

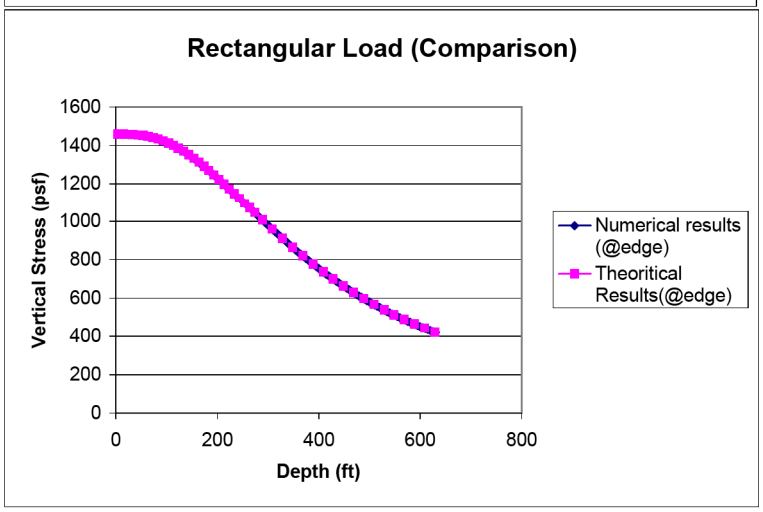

Conslution:
It can be seen that integration results match with the theoritical results, and therefore th macro is reliable.

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Attachment B
References

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7.3 INDUCED STRESSES BENEATH SHALLOW FOUNDATIONS

The bearing pressure from shallow foundations induces a vertical compressive stress in the underlying soils. We call this stress $\Delta\sigma_z$, because it is the change in stress that is superimposed on the initial vertical stress:

$$\boxed{\Delta\sigma_z = I_\sigma(q - \sigma'_{zD})} \tag{7.3}$$

Where:

$\Delta\sigma_z$ = induced vertical stress due to load from foundation

I_σ = stress influence factor

q = bearing pressure along bottom of foundation

σ_{zD}' = vertical effective stress at a depth D below the ground surface

The q term reflects the increase in vertical stress caused by the applied structural load and the weight of the foundation, while the σ_{zD}' term reflects the reduction in vertical stress caused by excavation of soil to build the foundation. Thus, $\Delta\sigma_z$ reflects the net result of these two effects.

Immediately beneath the foundation, the applied load is distributed across the base area of the foundation, so $I_\sigma = 1$. However, as the load propagates through the ground it is spread over an increasingly larger area, so $\Delta\sigma_z$ and I_σ decrease with depth, as shown in Figure 7.2.

Boussinesq's Method

Boussinesq (1885) developed the classic solution for induced stresses in an elastic material due to an applied point load. Newmark (1935) then integrated the Boussinesq equation to produce a solution for I_σ at a depth z_f beneath the corner of a rectangular foundation of width B and length L, as shown in Figure 7.3. This solution produces the following equations:

If $B^2 + L^2 + z_f^2 < B^2L^2/z_f^2$:

$$\boxed{I_\sigma = \frac{1}{4\pi}\left[\left(\frac{2BLz_f\sqrt{B^2+L^2+z_f^2}}{z_f^2(B^2+L^2+z_f^2)+B^2L^2}\right)\left(\frac{B^2+L^2+2z_f^2}{B^2+L^2+z_f^2}\right) + \pi - \sin^{-1}\frac{2BLz_f\sqrt{B^2+L^2+z_f^2}}{z_f^2(B^2+L^2+z_f^2)+B^2L^2}\right]}$$

Otherwise:

$$\boxed{I_\sigma = \frac{1}{4\pi}\left[\left(\frac{2BLz_f\sqrt{B^2+L^2+z_f^2}}{z_f^2(B^2+L^2+z_f^2)+B^2L^2}\right)\left(\frac{B^2+L^2+2z_f^2}{B^2+L^2+z_f^2}\right) + \sin^{-1}\frac{2BLz_f\sqrt{B^2+L^2+z_f^2}}{z_f^2(B^2+L^2+z_f^2)+B^2L^2}\right]}$$

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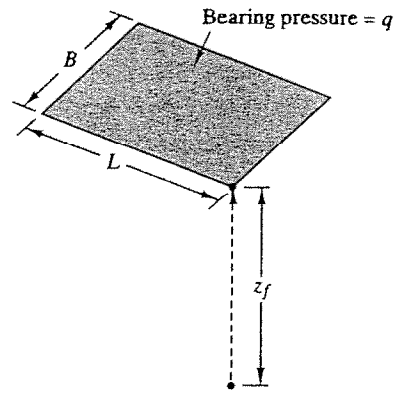

Figure 7.3 Newmark's solution for induced vertical stress beneath the corner of a rectangular footing.

where:

I_σ = strain influence factor at a point beneath the corner of a rectangular foun tion

B = width of the foundation

L = length of the foundation

z_f = vertical distance from the bottom of the foundation to the point (always >

q = bearing pressure

Notes:

1. The $\sin^{-1}$ term must be expressed in radians.
2. Newmark's solution is often presented as a single equation with a $\tan^{-1}$ term, that equation is incorrect when $B^2 + L^2 + z_f^2 < B^2L^2/z_f^2$.
3. It is customary to use B as the shorter dimension and L as the longer dimensio shown in Figure 7.3.

Example 7.1

A 1.2 m × 1.2 m square footing supports a column load of 250 kN. The bottom of this fo is 0.3 m below the ground surface, the groundwater table is at a great depth, and the weight of the soil is 19.0 kN/m³. Compute the induced vertical stress, $\Delta\sigma_z$, at a point below the corner of this footing.

Solution

Unless stated otherwise, we can assume the top of this footing is essentially flush wi ground surface.

$$\sigma'_{zD} = \gamma D - u = (19.0\ \text{kN/m}^3)(0.3\ \text{m}) - 0 = 6\ \text{kPa}$$

$$W_f = (1.2\ \text{m})(1.2\ \text{m})(0.3\ \text{m})(23.6\ \text{kN/m}^3) = 10\ \text{kN}$$

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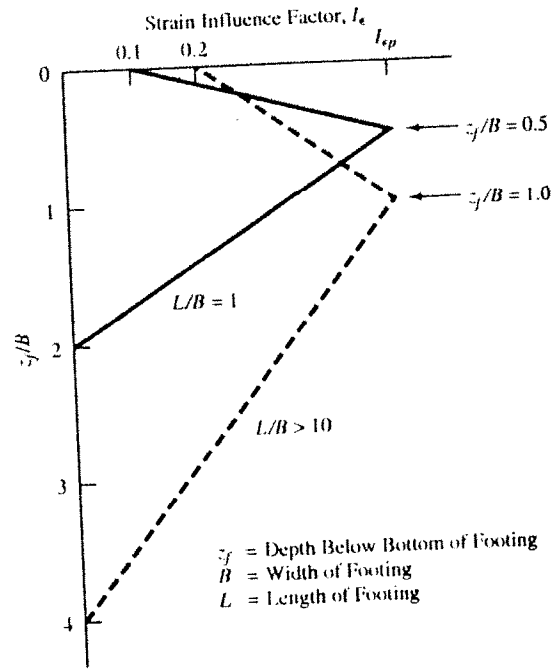

Figure 7.14 Distribution of strain influence factor with depth under square and continuous footings (Adapted from Schmertmann 1978; used with permission of ASCE).

The peak value of the strain influence factor, $I_{\epsilon p}$ is:

$$I_{\epsilon p} = 0.5 + 0.1\sqrt{\frac{q - \sigma'_{zD}}{\sigma'_{zp}}}$$

Where:

$I_{\epsilon p}$ = peak strain influence factor

q = bearing pressure

σ'_{zD} = vertical effective stress at a depth D below the ground surface

σ'_{zp} = initial vertical effective stress at depth of peak strain influence factor (for square and circular foundations ($L/B = 1$), compute σ'_{zp} at a depth of $D+B/2$ below the ground surface; for continuous footings ($L/B \geq 10$), compute it at a depth of $D+B$)

The exact value of I_ϵ at any given depth may be computed using the following equations:

Square and circular foundations:

For $z_f = 0$ to $B/2$: $I_\epsilon = 0.1 + (z_f/B)(2I_{\epsilon p} - 0.2)$

For $z_f = B/2$ to $2B$: $I_\epsilon = 0.667 I_{\epsilon p}(2 - z_f/B)$

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Continuous foundations ($L/B \geq 10$):

For $z_f = 0$ to B: $I_\epsilon = 0.2 + (z_f/B)(I_{\epsilon p} - 0.2)$ (7.21)

For $z_f = B$ to $4B$: $I_\epsilon = 0.333 I_{\epsilon p}(4 - z_f/B)$ (7.22)

Rectangular foundations ($1 < L/B < 10$):

$$I_\epsilon = I_{\epsilon s} + 0.111(I_{\epsilon c} - I_{\epsilon s})(L/B - 1) \tag{7.23}$$

Where:

z_f = depth from bottom of foundation to midpoint of layer
I_ϵ = strain influence factor
$I_{\epsilon c}$ = I_ϵ for a continuous foundation
$I_{\epsilon p}$ = peak I_ϵ from Equation 7.18
$I_{\epsilon s}$ = I_ϵ for a square foundation ≥ 0

The procedure for computing I_ϵ beneath rectangular foundations requires computation of I_ϵ for each layer using the equations for square foundations (based on the $I_{\epsilon p}$ for square foundations) and the I_ϵ for each layer using the equations for continuous foundations (based on the $I_{\epsilon p}$ for continuous foundations), then combining them using Equation 7.23.

Schmertmann's method also includes empirical corrections for the depth of embedment, secondary creep in the soil, and footing shape. These are implemented through the factors C_1, C_2, and C_3:

$$\boxed{C_1 = 1 - 0.5\left(\frac{\sigma'_{zD}}{q - \sigma'_{zD}}\right)} \tag{7.24}$$

$$\boxed{C_2 = 1 + 0.2 \log\left(\frac{t}{0.1}\right)} \tag{7.25}$$

$$\boxed{C_3 = 1.03 - 0.03\, L/B \geq 0.73} \tag{7.26}$$

Where:

δ = settlement of footing
C_1 = depth factor
C_2 = secondary creep factor (see discussion in Section 7.8)
C_3 = shape factor = 1 for square and circular foundations
q = bearing pressure
σ_{zD}' = effective vertical stress at a depth D below the ground surface
I_ϵ = influence factor at midpoint of soil layer
H = thickness of soil layer
E_s = equivalent modulus of elasticity in soil layer
t = time since application of load (yr) ($t \geq 0.1$ yr)
B = foundation width
L = foundation length

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These formulas may be used with any consistent set of units, except that t must be expressed in years. If no time is given, use $t = 50$ yr ($C_2 = 1.54$).

Finally, this information is combined using the following formula to compute the settlement, δ:

$$\boxed{\delta = C_1 C_2 C_3 (q - \sigma'_{zD}) \Sigma \frac{I_\epsilon H}{E_s}} \quad (7.27)$$

Analysis Procedure

The Schmertmann method uses the following procedure:

1. Perform appropriate in-situ tests to define the subsurface conditions.
2. Consider the soil from the base of the foundation to the depth of influence below the base. This depth ranges from $2B$ for square footings or mats to $4B$ for continuous footings. Divide this zone into layers and assign a representative E_s value to each layer. The required number of layers and the thickness of each layer depend on the variations in the E vs. depth profile. Typically 5 to 10 layers are appropriate.
3. Compute the peak strain influence factor, $I_{\epsilon p}$, using Equation 7.18.
4. Compute the strain influence factor, I_ϵ, at the midpoint of each layer. This factor varies with depth as shown in Figure 7.14, but is most easily computed using Equations 7.19 to 7.23.
5. Compute the correction factors, C_1, C_2, and C_3, using Equations 7.24 to 7.26.
6. Compute the settlement using Equation 7.27.

Example 7.6

The results of a CPT sounding performed at McDonald's Farm near Vancouver, British Columbia, are shown in Figure 7.15. The soils at this site consist of young, normally consolidated sands with some interbedded silts. The groundwater table is at a depth of 2.0 m below the ground surface.

A 375 kN/m load is to be supported on a 2.5 m × 30 m footing to be founded at a depth of 2.0 m in this soil. Use Schmertmann's method to compute the settlement of this footing soon after construction and the settlement 50 years after construction.

Solution

Use $E_s = 2.5\, q_c$
1 kPa = 0.01020 kg/cm^2
Depth of influence = $D + 4B = 2.0 + 4(2.5) = 12.0$ m

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Table 6. Summary of elastic modulus for static analysis (high strains)

CCNPP Unit 3 + CLA-1

Stratum	Elastic Modulus (psf)								Recommended Elastic Modulus for high strains (psf) [6]		
	Geophysical - from Vs [1]			Pressuremeter	SPT		Su				
	Avg.	Max	Min		E_1 [2]	E_2 [3]	E_1 [4]	E_2 [5]	Average	Max	Min
Backfill [7]	1.92E+06	-	-	-	-	-	-	-	1.92E+06	-	-
Stratum I Terrace Sand	6.77E+05	1.03E+06	3.19E+05	2.41E+05	5.40E+05	2.80E+05	-	-	4.34E+05	1.03E+06	2.41E+05
Stratum IIa Chesapeake Clay/Silt	1.13E+06	1.55E+06	7.11E+05	6.52E+05	-	-	1.10E+06	1.46E+06	1.09E+06	1.55E+06	6.52E+05
Stratum IIb Chesapeake Cemented Sand											
Layer 1	3.38E+06	5.94E+06	8.25E+05	1.58E+06	3.13E+06	1.19E+06	-	-	2.32E+06	5.94E+06	8.25E+05
Layer 2	1.18E+06	1.58E+06	7.85E+05	1.57E+06	8.64E+05	3.59E+05	-	-	9.95E+05	1.58E+06	3.59E+05
Layer 3	4.84E+06	6.81E+06	2.87E+06	2.20E+06	2.12E+06	8.58E+05	-	-	2.51E+06	6.81E+06	8.58E+05
Stratum IIc Chesapeake Clay/Silt	1.49E+06	1.79E+06	1.19E+06	1.55E+06	-	-	2.48E+06	3.20E+06	2.18E+06	3.20E+06	1.19E+06
Stratum III Nanjemoy Sand	4.24E+06	5.20E+06	3.28E+06	2.50E+06	2.59E+06	9.35E+05	-	-	3.11E+06	5.20E+06	9.35E+05

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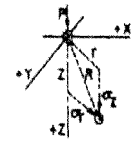
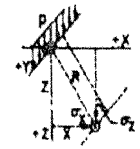
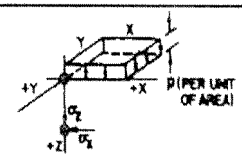
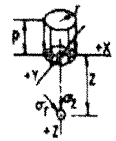
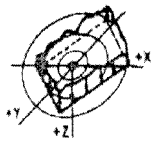
Table A.3. Consolidation Test Results - Unit 3

Area	Boring Number	Depth (ft) From	Depth (ft) To	Soil Layer	Recompression Ratio	Compression Ratio	Initial Void Ratio	Preconsolidation Pressure (tsf)	OCR
Unit 3	B-301A	60	62	Layer 1	0.006	0.043	0.629	15.0	4.5
Unit 3	B-314	13.5	15.5	Layer 1	0.011	0.219	0.86	11.5	22.6
Unit 3	B-315	23.5	25.5	Layer 1	0.012	0.319	0.92	10.1	2.8
				Minimum	**0.006**	**0.043**	**0.63**	**10.1**	**2.8**
				Maximum	**0.012**	**0.319**	**0.92**	**15.0**	**22.6**
				Average	**0.010**	**0.194**	**0.80**	**12.2**	**10.0**
				Standard Deviation	**0.003**	**0.140**	**0.15**	**2.5**	**11.0**
Unit 3	B-321	73.5	75.5	Layer 2	0.003	0.11	0.706	11.9	4.7
Unit 3	B-328	63.5	65.5	Layer 2	0.003	0.106	0.9	2.1	1.0
				Minimum	**0.003**	**0.106**	**0.71**	**2.1**	**1.0**
				Maximum	**0.003**	**0.110**	**0.90**	**11.9**	**4.7**
				Average	**0.003**	**0.108**	**0.80**	**7.0**	**2.8**
				Standard Deviation	**0.000**	**0.003**	**0.14**	**6.9**	**2.6**
Unit 3	B-301A	308	310	Nanjemoy Sand	0.023	0.264	0.73	14.6	1.9
Unit 3	B-301A	328	330	Nanjemoy Sand	0.021	0.417	0.852	14.6	1.8
Unit 3	B-301A	338	340	Nanjemoy Sand	0.092	0.905	1.421	16.4	1.9
				Minimum	**0.021**	**0.264**	**0.73**	**14.6**	**1.8**
				Maximum	**0.092**	**0.905**	**1.42**	**16.4**	**1.9**
				Average	**0.045**	**0.529**	**1.00**	**15.2**	**1.9**
				Standard Deviation	**0.040**	**0.335**	**0.37**	**1.0**	**0.1**
Unit 3	B-316	43.5	45.5	Stratum a	0.033	0.518	0.94	10.0	4.9
Unit 3	B-319	43.5	45.2	Stratum a	0.024	0.505	0.82	12.0	7.5
Unit 3	B-321	23.5	25.5	Stratum a	0.017	0.621	1.03	17.5	15.4
Unit 3	B-333	28.5	30.5	Stratum a	0.043	0.681	1.15	9.6	8.2
Unit 3	B-333	38.5	40.5	Stratum a	0.017	0.505	1.1	14.8	10.3
Unit 3	B-334	23.5	25.5	Stratum a	0.036	0.522	1.12	5.6	5.5
Unit 3	B-334	33.5	34.8	Stratum a	0.013	0.462	1.06	6.3	4.9
				Minimum	**0.013**	**0.462**	**0.82**	**5.6**	**4.9**
				Maximum	**0.043**	**0.681**	**1.15**	**17.5**	**15.4**
				Average	**0.026**	**0.545**	**1.03**	**10.8**	**8.1**
				Standard Deviation	**0.011**	**0.077**	**0.12**	**4.3**	**3.8**
Unit 3	B-301	158.5	159.6	Stratum c- Clay/Silt	0.01	0.485	1.01	20.0	4.5
Unit 3	B-301	163.5	165	Stratum c- Clay/Silt	0.034	1.276	1.82	16.0	3.5
Unit 3	B-301A	198	200	Stratum c- Clay/Silt	0.078	1.415	1.767	19.1	3.6
Unit 3	B-301A	238	240	Stratum c- Clay/Silt	0.041	0.657	1.278	15.0	2.4
Unit 3	B-301A	258	260	Stratum c- Clay/Silt	0.169	0.743	1.484	15.6	2.4
Unit 3	B-301A	268	270	Stratum c- Clay/Silt	0.106	1.229	2.06	16.0	2.3
Unit 3	B-301A	278	280	Stratum c- Clay/Silt	0.1	1.244	2.413	15.0	2.1
Unit 3	B-301A	288	290	Stratum c- Clay/Silt	0.064	0.793	1.461	15.6	2.2
Unit 3	B-301A	298	300	Stratum c- Clay/Silt	0.07	1.725	2.332	21.2	2.8
Unit 3	B-313	93.5	94.7	Stratum c- Clay/Silt	0.01	0.345	1.07	16.0	5.7
Unit 3	B-327	113.5	115.5	Stratum c- Clay/Silt	0.007	0.874	1.34	20.6	5.0
Unit 3	B-344	204	206	Stratum c- Clay/Silt	0.028	0.427	1.044	13.1	2.4
Unit 3	B-344	221.5	223.5	Stratum c- Clay/Silt	0.073	0.883	1.434	20.0	3.5
Unit 3	B-344	241.5	243.5	Stratum c- Clay/Silt	0.083	1.242	2.079	16.0	2.6
Unit 3	B-328	123.5	125.5	Stratum c- Clay/Silt	0.021	0.867	1.54	10.7	3.0
				Minimum	**0.007**	**0.345**	**1.01**	**10.7**	**2.1**
				Maximum	**0.169**	**1.725**	**2.41**	**21.2**	**5.7**
				Average	**0.060**	**0.947**	**1.61**	**16.7**	**3.2**
				Standard Deviation	**0.045**	**0.396**	**0.45**	**2.9**	**1.1**
Unit 3	B-301A	218	220	Stratum c - Sand	0.025	0.365	1.019	14.0	2.4
Unit 3	B-304	98.5	99.5	Stratum c - Sand	0.005	0.512	1.03	20.9	7.6
Unit 3	B-304	138.5	139.3	Stratum c - Sand	0.005	0.279	0.95	16.0	4.4
Unit 3	B-313	123.5	124.3	Stratum c - Sand	0.003	0.405	0.98	23.0	6.6
Unit 3	B-344	181.5	183.5	Stratum c - Sand	0.013	0.219	0.799	12.1	2.5
				Minimum	**0.003**	**0.219**	**0.80**	**12.1**	**2.4**
				Maximum	**0.025**	**0.512**	**1.03**	**23.0**	**7.6**
				Average	**0.010**	**0.356**	**0.96**	**17.2**	**4.7**
				Standard Deviation	**0.009**	**0.113**	**0.09**	**4.6**	**2.4**
Unit 3	B-319	33.5	35.5	Terrace Sand	0.009	0.369	0.85	5.7	4.3
				Minimum					
				Maximum	0.009	0.369	0.85	5.7	4.3
				Average					
				Standard Deviation					

TRUE COPY - NOT ORIGINAL

Ref. 8

by XS Date 10/21/69

LOADING CONDITION	STRESS DIAGRAM	STRESS COMPONENT	EQUATION
POINT LOAD		VERTICAL	$\sigma_z = -\frac{P}{2\pi R^2}\left[\frac{-3r^2 Z}{R^3} + \frac{(1-2\mu)R}{R+Z}\right]$
		HORIZONTAL	$\sigma_r = \frac{P}{2\pi}\left[3\frac{r^2 Z}{R^5} - (1-2\mu)\left(\frac{R-Z}{Rr^2}\right)\right]$
		SHEAR	$\tau_{rz} = \frac{3P}{2\pi} \cdot \frac{rZ^2}{R^5}$
UNIFORM LINE LOAD OF INFINITE LENGTH		VERTICAL	$\sigma_z = \frac{2p}{\pi} \cdot \frac{Z^3}{R^4}$
		HORIZONTAL	$\sigma_x = \frac{2p}{\pi} \cdot \frac{x^2 Z}{R^4}$
		SHEAR	$\tau_{xz} = \frac{2p}{\pi} \cdot \frac{xZ^2}{R^4}$
UNIFORMLY LOADED RECTANGULAR AREA (FIGURE 4)		VERTICAL (BENEATH CORNER OF RECTANGLE)	$\sigma_z = \frac{p}{4\pi}\left[\frac{2XYZ(X^2+Y^2+Z^2)^{1/2}}{Z^2(X^2+Y^2+Z^2)+X^2Y^2} \cdot \frac{X^2+Y^2+2Z^2}{X^2+Y^2+Z^2} + \tan^{-1}\frac{2XYZ(X^2+Y^2+Z^2)^{1/2}}{Z^2(X^2+Y^2+Z^2)-X^2Y^2}\right]$
UNIFORMLY LOADED CIRCULAR AREA (FIGURE 5)		VERTICAL	$\sigma_z = p\left\{1 - \frac{1}{[1+(r/Z)^2]^{3/2}}\right\}$
		HORIZONTAL	$\sigma_r = \frac{p}{2}\left[1+2\mu-2(1+\mu)\left(\frac{Z}{\sqrt{r^2+Z^2}}\right)+\left(\frac{Z}{\sqrt{r^2+Z^2}}\right)^3\right]$
		SHEAR	$\tau_{rz} = 0$ (STRESS COMPONENTS $\sigma_z, \sigma_r, \tau_{rz}$ BENEATH CENTER OF CIRCLE)
IRREGULAR LOAD		VERTICAL	COMPUTED FROM INFLUENCE CHART OF FIGURE 10

ASSUMED CONDITIONS: APPLIED LOADS ARE PERFECTLY FLEXIBLE. FOUNDATION IS SEMI-INFINITE ELASTIC ISOTROPIC SOLID.

FIGURE 2
Formulas for Stresses in Semi-Infinite Elastic Foundation