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Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-16**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76	7		0	288	1	7	1.5	1.0	0.75	1.1	2.64	23	100	32		0.259	Non-Liq.	0.00	0.00
5	1.52		14	1	513	0.67	9	1.5	1.0	0.75	1	1.98	21	90	30		0.289	Non-Liq.	0.00	0.00
7.5	2.29	4		1	644	1	4	1.5	1.0	0.75	1.1	1.76	9	96	15	0.167	0.343	0.58	1.91	0.57
10	3.05		21	1	776	0.67	14	1.5	1.0	0.80	1	1.61	27	45	38		0.377	Non-Liq.	0.00	0.00
12.5	3.81	13		1	907	1	13	1.5	1.0	0.80	1.1	1.48	25	29	34		0.401	Non-Liq.	0.00	0.00
15	4.57		18	1	1039	0.67	12	1.5	1.0	0.85	1	1.39	21	30	29	0.391	0.418	1.11	0.00	0.00
17.5	5.33	6		1	1170	1	6	1.5	1.0	0.85	1.1	1.31	11	28	17	0.184	0.431	0.51	1.78	0.53
20	6.10		18	0	1302	0.67	12	1.5	1.0	0.95	1	1.24	21	100	31		0.440	Non-Liq.	0.00	0.00
25	7.62	6		1	1565	1	6	1.5	1.0	0.95	1.1	1.13	11	95	18	0.192	0.450	0.51	1.78	1.07
30	9.14		28	1	1828	0.67	19	1.5	1.0	0.95	1	1.05	28	35	38		0.452	Non-Liq.	0.00	0.00
35	10.67	4		0	2091	1	4	1.5	1.0	1.00	1.1	0.98	6	95	13	0.138	0.446	0.37	0.00	0.00
40	12.19		16	0	2354	0.67	11	1.5	1.0	1.00	1	0.92	15	90	23	0.250	0.432	0.69	0.00	0.00
45	13.72	16		0	2617	1	16	1.5	1.0	1.00	1.1	0.87	23	95	33		0.413	Non-Liq.	0.00	0.00
50	15.24		14	1	2880	0.67	9	1.5	1.0	1.00	1	0.83	12	35	19	0.205	0.391	0.63	1.64	0.98

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **3.16**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer	C_E	0.5 to 1.0
	Safety Hammer		0.7 to 1.2
	Automatic-trip Donut type Hammer		0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch	C_B	1
	6 inch		1.05
	8 inch		1.15
Rod Length	10 feet to 13 feet	C_R	0.75
	13 feet to 19.8 ft.		0.85
	19.8 ft. to 33 ft.		0.95
	33 ft. to 98 ft.		1
	> 98 ft.		<1.0
Sampling Method	Standard Sampler	C_L	1
	Sampler without liners		1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-17**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections														
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	Corrected SPT	Fines Content	SPT Clean Sands	Cyclical Resistance	Cyclical Stress	Factor of Safety	Volumetric Strain (%)	Induced Subsidence (inch)
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR			
2.5	0.76	5		0	288	1	5	1.5	1.0	0.75	1.1	2.64	16	100	25	0.276	0.259	Non-Liq.	0.00	0.00
5	1.52		7	1	513	0.67	5	1.5	1.0	0.75	1	1.98	10	88	18	0.189	0.289	0.78	1.78	0.53
7.5	2.29	3		1	644	1	3	1.5	1.0	0.75	1.1	1.76	7	85	13	0.139	0.343	0.48	2.30	0.69
10	3.05		13	1	776	0.67	9	1.5	1.0	0.80	1	1.61	17	45	25	0.285	0.377	0.90	1.21	0.36
12.5	3.81	14		1	907	1	14	1.5	1.0	0.80	1.1	1.48	27	30	36		0.401	Non-Liq.	0.00	0.00
15	4.57		19	1	1039	0.67	13	1.5	1.0	0.85	1	1.39	23	30	31		0.418	Non-Liq.	0.00	0.00
17.5	5.33	5		1	1170	1	5	1.5	1.0	0.85	1.1	1.31	9	30	15	0.165	0.431	0.46	1.91	0.57
20	6.10		23	0	1302	0.67	15	1.5	1.0	0.95	1	1.24	27	100	38		0.440	Non-Liq.	0.00	0.00
25	7.62	1		1	1565	1	1	1.5	1.0	0.95	1	1.13	2	95	7	0.079	0.450	0.21	3.53	2.12
30	9.14		9	1	1828	0.67	6	1.5	1.0	0.95	1	1.05	9	95	16	0.171	0.452	0.45	1.91	1.15
35	10.67	4		0	2091	1	4	1.5	1.0	1.00	1.1	0.98	6	95	13	0.138	0.446	0.37	0.00	0.00
40	12.19		6	0	2354	0.67	4	1.5	1.0	1.00	1	0.92	6	95	12	0.126	0.432	0.35	0.00	0.00
45	13.72	21		0	2617	1	21	1.5	1.0	1.00	1.1	0.87	30	95	41		0.413	Non-Liq.	0.00	0.00
50	15.24		13	0	2880	0.67	9	1.5	1.0	1.00	1	0.83	11	95	18	0.195	0.391	0.59	0.00	0.00

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **5.42**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer Safety Hammer Automatic-trip Donut type Hammer	C_E	0.5 to 1.0 0.7 to 1.2 0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch 6 inch 8 inch	C_B	1 1.05 1.15
Rod Length	10 feet to 13 feet 13 feet to 19.8 ft. 19.8 ft. to 33 ft. 33 ft. to 98 ft. > 98 ft.	C_R	0.75 0.85 0.95 1 <1.0
Sampling Method	Standard Sampler Sampler without liners	C_L	1 1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-18**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76	6		0	288	1	6	1.5	1.0	0.75	1.1	2.64	20	100	29	0.357	0.259	Non-Liq.	0.00	0.00
5	1.52		16	0	513	0.67	11	1.5	1.0	0.75	1	1.98	24	100	34		0.289	Non-Liq.	0.00	0.00
7.5	2.29	3		1	644	1	3	1.5	1.0	0.75	1.1	1.76	7	94	13	0.139	0.343	0.48	2.30	0.69
10	3.05		25	1	776	0.67	17	1.5	1.0	0.80	1	1.61	32	35	44		0.377	Non-Liq.	0.00	0.00
12.5	3.81	7		1	907	1	7	1.5	1.0	0.80	1.1	1.48	14	25	20	0.212	0.401	0.63	1.64	0.49
15	4.57		16	1	1039	0.67	11	1.5	1.0	0.85	1	1.39	19	30	27	0.311	0.418	0.89	1.14	0.34
17.5	5.33	5		1	1170	1	5	1.5	1.0	0.85	1.1	1.31	9	33	16	0.170	0.431	0.47	1.91	0.57
20	6.10		8	0	1302	0.67	5	1.5	1.0	0.95	1	1.24	9	100	16	0.177	0.440	0.48	0.00	0.00
25	7.62	1		1	1565	1	1	1.5	1.0	0.95	1	1.13	2	85	7	0.079	0.450	0.21	3.53	2.12
30	9.14		8	1	1828	0.67	5	1.5	1.0	0.95	1	1.05	8	95	15	0.158	0.452	0.42	2.00	1.20
35	10.67	5		0	2091	1	5	1.5	1.0	1.00	1.1	0.98	8	95	15	0.159	0.446	0.42	0.00	0.00
40	12.19		11	0	2354	0.67	7	1.5	1.0	1.00	1	0.92	10	95	17	0.186	0.432	0.51	0.00	0.00
45	13.72	6		0	2617	1	6	1.5	1.0	1.00	1.1	0.87	9	95	15	0.166	0.413	0.48	0.00	0.00
50	15.24		17	0	2880	0.67	11	1.5	1.0	1.00	1	0.83	14	95	22	0.241	0.391	0.74	0.00	0.00

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **5.42**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer Safety Hammer Automatic-trip Donut type Hammer	C_E	0.5 to 1.0 0.7 to 1.2 0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch 6 inch 8 inch	C_B	1 1.05 1.15
Rod Length	10 feet to 13 feet 13 feet to 19.8 ft. 19.8 ft. to 33 ft. 33 ft. to 98 ft. > 98 ft.	C_R	0.75 0.85 0.95 1 <1.0
Sampling Method	Standard Sampler Sampler without liners	C_L	1 1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-19**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76		13	0	288	0.67	9	1.5	1.0	0.75	1	2.64	26	100	36		0.259	Non-Liq.	0.00	0.00
5	1.52	8		1	513	1	8	1.5	1.0	0.75	1.1	1.98	20	90	28	0.356	0.289	1.47	0.00	0.00
7.5	2.29		8	1	644	0.67	5	1.5	1.0	0.75	1	1.76	11	70	18	0.191	0.343	0.67	1.78	0.53
10	3.05	4		1	776	1	4	1.5	1.0	0.80	1.1	1.61	8	53	15	0.164	0.377	0.52	1.91	0.57
12.5	3.81		12	1	907	0.67	8	1.5	1.0	0.80	1	1.48	14	35	22	0.242	0.401	0.72	1.43	0.43
15	4.57	16		1	1039	1	16	1.5	1.0	0.85	1.1	1.39	31	30	41		0.418	Non-Liq.	0.00	0.00
17.5	5.33		19	1	1170	0.67	13	1.5	1.0	0.85	1	1.31	21	25	28	0.342	0.431	0.95	1.07	0.32
20	6.10	13		1	1302	1	13	1.5	1.0	0.95	1.1	1.24	25	22	32		0.440	Non-Liq.	0.00	0.00
25	7.62		13	1	1565	0.67	9	1.5	1.0	0.95	1	1.13	14	25	20	0.215	0.450	0.57	1.64	0.98
30	9.14	6		1	1828	1	6	1.5	1.0	0.95	1.1	1.05	10	100	17	0.181	0.452	0.48	1.84	1.10
35	10.67		14	0	2091	0.67	9	1.5	1.0	1.00	1	0.98	14	100	22	0.234	0.446	0.63	0.00	0.00
40	12.19	7		0	2354	1	7	1.5	1.0	1.00	1.1	0.92	11	100	18	0.192	0.432	0.53	0.00	0.00
45	13.72		9	0	2617	0.67	6	1.5	1.0	1.00	1	0.87	8	100	14	0.157	0.413	0.45	0.00	0.00
50	15.24	10		0	2880	1	10	1.5	1.0	1.00	1.1	0.83	14	100	22	0.234	0.391	0.71	0.00	0.00

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **3.95**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer	C_E	0.5 to 1.0
	Safety Hammer		0.7 to 1.2
	Automatic-trip Donut type Hammer		0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch	C_B	1
	6 inch		1.05
	8 inch		1.15
Rod Length	10 feet to 13 feet	C_R	0.75
	13 feet to 19.8 ft.		0.85
	19.8 ft. to 33 ft.		0.95
	33 ft. to 98 ft.		1
	> 98 ft.		<1.0
Sampling Method	Standard Sampler	C_L	1
	Sampler without liners		1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-20**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76	5		0	288	1	5	1.5	1.0	0.75	1.1	2.64	16	100	25	0.276	0.259	Non-Liq.	0.00	0.00
5	1.52		17	1	513	0.67	11	1.5	1.0	0.75	1	1.98	25	95	35		0.289	Non-Liq.	0.00	0.00
7.5	2.29	3		1	644	1	3	1.5	1.0	0.75	1.1	1.76	7	98	13	0.139	0.343	0.48	2.30	0.69
10	3.05		8	1	776	0.67	5	1.5	1.0	0.80	1	1.61	10	40	17	0.188	0.377	0.59	1.78	0.53
12.5	3.81	7		1	907	1	7	1.5	1.0	0.80	1.1	1.48	14	40	21	0.233	0.401	0.69	1.50	0.45
15	4.57		35	1	1039	0.67	23	1.5	1.0	0.85	1	1.39	41	30	53		0.418	Non-Liq.	0.00	0.00
17.5	5.33	1		1	1170	1	1	1.5	1.0	0.85	1	1.31	2	30	7	0.077	0.431	0.21	3.53	1.06
20	6.10		9	0	1302	0.67	6	1.5	1.0	0.95	1	1.24	11	100	18	0.192	0.440	0.52	0.00	0.00
25	7.62	1		1	1565	1	1	1.5	1.0	0.95	1	1.13	2	35	7	0.079	0.450	0.21	3.53	2.12
30	9.14		8	0	1828	0.67	5	1.5	1.0	0.95	1	1.05	8	95	15	0.158	0.452	0.42	0.00	0.00
35	10.67	5		0	2091	1	5	1.5	1.0	1.00	1.1	0.98	8	95	15	0.159	0.446	0.42	0.00	0.00
40	12.19		3	0	2354	0.67	2	1.5	1.0	1.00	1	0.92	3	95	8	0.092	0.432	0.25	0.00	0.00
45	13.72	24		0	2617	1	24	1.5	1.0	1.00	1.1	0.87	35	95	47		0.413	Non-Liq.	0.00	0.00
50	15.24		10	1	2880	0.67	7	1.5	1.0	1.00	1	0.83	8	35	15	0.162	0.391	0.50	1.91	1.15

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **6.00**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer Safety Hammer Automatic-trip Donut type Hammer	C_E	0.5 to 1.0 0.7 to 1.2 0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch 6 inch 8 inch	C_B	1 1.05 1.15
Rod Length	10 feet to 13 feet 13 feet to 19.8 ft. 19.8 ft. to 33 ft. 33 ft. to 98 ft. > 98 ft.	C_R	0.75 0.85 0.95 1 <1.0
Sampling Method	Standard Sampler Sampler without liners	C_L	1 1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-21**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76	8		0	288	1	8	1.5	1.0	0.75	1.1	2.64	26	100	36		0.259	Non-Liq.	0.00	0.00
5	1.52		10	1	513	0.67	7	1.5	1.0	0.75	1	1.98	15	69	23	0.251	0.289	1.04	0.00	0.00
7.5	2.29	2		1	644	1	2	1.5	1.0	0.75	1.1	1.76	4	98	10	0.111	0.343	0.39	2.60	0.78
10	3.05		30	1	776	0.67	20	1.5	1.0	0.80	1	1.61	39	45	51		0.377	Non-Liq.	0.00	0.00
12.5	3.81	16		1	907	1	16	1.5	1.0	0.80	1.1	1.48	31	46	43		0.401	Non-Liq.	0.00	0.00
15	4.57		44	1	1039	0.67	29	1.5	1.0	0.85	1	1.39	52	30	65		0.418	Non-Liq.	0.00	0.00
17.5	5.33	7		1	1170	1	7	1.5	1.0	0.85	1.1	1.31	13	19	17	0.186	0.431	0.51	1.78	0.53
20	6.10		16	0	1302	0.67	11	1.5	1.0	0.95	1	1.24	19	100	28	0.336	0.440	0.91	0.00	0.00
25	7.62	6		1	1565	1	6	1.5	1.0	0.95	1.1	1.13	11	96	18	0.192	0.450	0.51	1.78	1.07
30	9.14		16	0	1828	0.67	11	1.5	1.0	0.95	1	1.05	16	100	24	0.270	0.452	0.71	0.00	0.00
35	10.67	7		0	2091	1	7	1.5	1.0	1.00	1.1	0.98	11	100	19	0.200	0.446	0.54	0.00	0.00
40	12.19		9	0	2354	0.67	6	1.5	1.0	1.00	1	0.92	8	100	15	0.162	0.432	0.45	0.00	0.00
45	13.72	2		0	2617	1	2	1.5	1.0	1.00	1.1	0.87	3	100	8	0.093	0.413	0.27	0.00	0.00
50	15.24		14	1	2880	0.67	9	1.5	1.0	1.00	1	0.83	12	80	19	0.206	0.391	0.63	1.64	0.98

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **3.37**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer Safety Hammer Automatic-trip Donut type Hammer	C_E	0.5 to 1.0 0.7 to 1.2 0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch 6 inch 8 inch	C_B	1 1.05 1.15
Rod Length	10 feet to 13 feet 13 feet to 19.8 ft. 19.8 ft. to 33 ft. 33 ft. to 98 ft. > 98 ft.	C_R	0.75 0.85 0.95 1 <1.0
Sampling Method	Standard Sampler Sampler without liners	C_L	1 1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-22**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76		18	0	288	0.67	12	1.5	1.0	0.75	1	2.64	36	100	48		0.259	Non-Liq.	0.00	0.00
5	1.52	5		1	513	1	5	1.5	1.0	0.75	1.1	1.98	12	70	20	0.212	0.289	0.88	1.64	0.49
7.5	2.29		5	1	644	0.67	3	1.5	1.0	0.75	1	1.76	7	70	13	0.140	0.343	0.49	2.30	0.69
10	3.05	4		1	776	1	4	1.5	1.0	0.80	1.1	1.61	8	30	14	0.157	0.377	0.50	2.00	0.60
12.5	3.81		28	1	907	0.67	19	1.5	1.0	0.80	1	1.48	33	35	45		0.401	Non-Liq.	0.00	0.00
15	4.57	11		1	1039	1	11	1.5	1.0	0.85	1.1	1.39	21	30	29	0.395	0.418	1.13	0.00	0.00
17.5	5.33		32	1	1170	0.67	21	1.5	1.0	0.85	1	1.31	36	25	44		0.431	Non-Liq.	0.00	0.00
20	6.10	12		1	1302	1	12	1.5	1.0	0.95	1.1	1.24	23	25	30		0.440	Non-Liq.	0.00	0.00
25	7.62		7	1	1565	0.67	5	1.5	1.0	0.95	1	1.13	8	85	14	0.152	0.450	0.40	2.00	1.20
30	9.14	12		1	1828	1	12	1.5	1.0	0.95	1.1	1.05	20	100	29	0.361	0.452	0.95	1.00	0.60
35	10.67		5	0	2091	0.67	3	1.5	1.0	1.00	1	0.98	5	100	11	0.118	0.446	0.32	0.00	0.00
40	12.19	4		1	2354	1	4	1.5	1.0	1.00	1.1	0.92	6	90	12	0.133	0.432	0.37	2.30	1.38
45	13.72		7	0	2617	0.67	5	1.5	1.0	1.00	1	0.87	6	100	12	0.134	0.413	0.39	0.00	0.00
50	15.24	5		0	2880	1	5	1.5	1.0	1.00	1.1	0.83	7	100	13	0.143	0.391	0.44	0.00	0.00

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **4.96**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer Safety Hammer Automatic-trip Donut type Hammer	C_E	0.5 to 1.0 0.7 to 1.2 0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch 6 inch 8 inch	C_B	1 1.05 1.15
Rod Length	10 feet to 13 feet 13 feet to 19.8 ft. 19.8 ft. to 33 ft. 33 ft. to 98 ft. > 98 ft.	C_R	0.75 0.85 0.95 1 <1.0
Sampling Method	Standard Sampler Sampler without liners	C_L	1 1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-23**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76	4		0	288	1	4	1.5	1.0	0.75	1.1	2.64	13	100	21	0.224	0.259	Non-Liq.	0.00	0.00
5	1.52		26	1	513	0.67	17	1.5	1.0	0.75	1	1.98	39	35	51		0.289	Non-Liq.	0.00	0.00
7.5	2.29	2		1	644	1	2	1.5	1.0	0.75	1.1	1.76	4	75	10	0.111	0.343	0.39	2.60	0.78
10	3.05		19	1	776	0.67	13	1.5	1.0	0.80	1	1.61	25	24	31		0.377	Non-Liq.	0.00	0.00
12.5	3.81	12		1	907	1	12	1.5	1.0	0.80	1.1	1.48	24	25	31		0.401	Non-Liq.	0.00	0.00
15	4.57		34	1	1039	0.67	23	1.5	1.0	0.85	1	1.39	40	30	51		0.418	Non-Liq.	0.00	0.00
17.5	5.33	4		1	1170	1	4	1.5	1.0	0.85	1.1	1.31	7	30	13	0.143	0.431	0.39	2.15	0.65
20	6.10		7	0	1302	0.67	5	1.5	1.0	0.95	1	1.24	8	100	15	0.162	0.440	0.44	0.00	0.00
25	7.62	4		1	1565	1	4	1.5	1.0	0.95	1.1	1.13	7	40	14	0.146	0.450	0.39	2.15	1.29
30	9.14		12	0	1828	0.67	8	1.5	1.0	0.95	1	1.05	12	100	19	0.209	0.452	0.55	0.00	0.00
35	10.67	5		0	2091	1	5	1.5	1.0	1.00	1.1	0.98	8	100	15	0.159	0.446	0.42	0.00	0.00
40	12.19		6	0	2354	0.67	4	1.5	1.0	1.00	1	0.92	6	100	12	0.126	0.432	0.35	0.00	0.00
45	13.72	2		0	2617	1	2	1.5	1.0	1.00	1.1	0.87	3	95	8	0.093	0.413	0.27	0.00	0.00
50	15.24		100	1	2880	0.67	67	1.5	1.0	1.00	1	0.83	84	25	98		0.391	Non-Liq.	0.00	0.00

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **2.72**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer Safety Hammer Automatic-trip Donut type Hammer	C_E	0.5 to 1.0 0.7 to 1.2 0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch 6 inch 8 inch	C_B	1 1.05 1.15
Rod Length	10 feet to 13 feet 13 feet to 19.8 ft. 19.8 ft. to 33 ft. 33 ft. to 98 ft. > 98 ft.	C_R	0.75 0.85 0.95 1 <1.0
Sampling Method	Standard Sampler Sampler without liners	C_L	1 1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-24**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections							Corrected	Fines	SPT Clean	Cyclical	Cyclical	Factor	Volumetric	Induced
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	SPT	Content	Sands	Resistance	Stress	of	Strain (%)	Subsidence
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR	Safety		(inch)
2.5	0.76		15	0	288	0.67	10	1.5	1.0	0.75	1	2.64	30	100	41		0.259	Non-Liq.	0.00	0.00
5	1.52	8		0	513	1	8	1.5	1.0	0.75	1.1	1.98	20	100	28	0.356	0.289	1.47	0.00	0.00
7.5	2.29		5	1	644	0.67	3	1.5	1.0	0.75	1	1.76	7	40	13	0.140	0.343	0.49	2.30	0.69
10	3.05	4		1	776	1	4	1.5	1.0	0.80	1.1	1.61	8	30	14	0.157	0.377	0.50	2.00	0.60
12.5	3.81		10	1	907	0.67	7	1.5	1.0	0.80	1	1.48	12	35	19	0.208	0.401	0.62	1.64	0.49
15	4.57	9		1	1039	1	9	1.5	1.0	0.85	1.1	1.39	18	30	25	0.281	0.418	0.80	1.28	0.38
17.5	5.33		14	1	1170	0.67	9	1.5	1.0	0.85	1	1.31	16	25	22	0.237	0.431	0.66	1.50	0.45
20	6.10	4		0	1302	1	4	1.5	1.0	0.95	1.1	1.24	8	100	14	0.155	0.440	0.42	0.00	0.00
25	7.62		8	1	1565	0.67	5	1.5	1.0	0.95	1	1.13	9	30	15	0.159	0.450	0.42	2.00	1.20
30	9.14	10		1	1828	1	10	1.5	1.0	0.95	1.1	1.05	16	30	24	0.262	0.452	0.69	1.35	0.81
35	10.67		14	1	2091	0.67	9	1.5	1.0	1.00	1	0.98	14	30	21	0.223	0.446	0.60	1.57	0.94
40	12.19	4		0	2354	1	4	1.5	1.0	1.00	1.1	0.92	6	100	12	0.133	0.432	0.37	0.00	0.00
45	13.72		13	0	2617	0.67	9	1.5	1.0	1.00	1	0.87	11	100	19	0.202	0.413	0.58	0.00	0.00
50	15.24	5		1	2880	1	5	1.5	1.0	1.00	1.1	0.83	7	30	13	0.137	0.391	0.42	2.30	1.38

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **6.95**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer	C_E	0.5 to 1.0
	Safety Hammer		0.7 to 1.2
	Automatic-trip Donut type Hammer		0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch	C_B	1
	6 inch		1.05
	8 inch		1.15
Rod Length	10 feet to 13 feet	C_R	0.75
	13 feet to 19.8 ft.		0.85
	19.8 ft. to 33 ft.		0.95
	33 ft. to 98 ft.		1
	> 98 ft.		<1.0
Sampling Method	Standard Sampler	C_L	1
	Sampler without liners		1.1 to 1.3

Liquefaction Evaluation and Settlement Calculation

Project Name: **Black Rock 5-6**
Project No.: **LE11138**
Location: **B-25**

Maximum Credible Earthquake	7
Design Ground Motion	0.40 g
Total Unit Weight,	115 pcf
Water Unit Weight,	62.4 pcf
Depth to Groundwater	4 ft
Hammer Effenciency	90
Required Factor of Safety	1.0

Boring Data						Sampling Corrections															
Depth		Blow Counts		Liquefiable	Overburden	Sampler	SPT	Energy	Borehole	Rod	Liner	Overburden	Corrected SPT	Fines Content	SPT Clean Sands	Cyclical Resistance	Cyclical Stress	Factor of Safety	Volumetric Strain (%)	Induced Subsidence (inch)
(ft)	(m)	SPT	Mod. Cal.	Soil (0 / 1)	Pressure	Diameter	N_m	C_E	C_B	C_R	C_L	C_N	$(N_1)_{60}$	%	$(N_1)_{60CS}$	$CRR_{M7.5}$	CSR			
2.5	0.76		12	0	288	0.67	8	1.5	1.0	0.75	1	2.64	24	100	34		0.259	Non-Liq.	0.00	0.00
5	1.52	6		1	513	1	6	1.5	1.0	0.75	1.1	1.98	15	100	23	0.248	0.269	1.02	0.00	0.00
7.5	2.29		2	1	644	0.67	1	1.5	1.0	0.75	1	1.76	3	99	8	0.090	0.343	0.31	2.90	0.87
10	3.05	8		1	776	1	8	1.5	1.0	0.80	1.1	1.61	17	30	24	0.271	0.377	0.86	1.28	0.38
12.5	3.81		21	1	907	0.67	14	1.5	1.0	0.80	1	1.48	25	35	35		0.401	Non-Liq.	0.00	0.00
15	4.57	28		1	1039	1	28	1.5	1.0	0.85	1.1	1.39	54	30	68		0.418	Non-Liq.	0.00	0.00
17.5	5.33		14	1	1170	0.67	9	1.5	1.0	0.85	1	1.31	16	25	22	0.237	0.431	0.66	1.50	0.45
20	6.10	3		0	1302	1	3	1.5	1.0	0.95	1.1	1.24	6	100	12	0.130	0.440	0.35	0.00	0.00
25	7.62		23	1	1565	0.67	15	1.5	1.0	0.95	1	1.13	25	75	35		0.450	Non-Liq.	0.00	0.00
30	9.14	4		1	1828	1	4	1.5	1.0	0.95	1.1	1.05	7	32	13	0.135	0.452	0.36	2.30	1.38
35	10.67		13	0	2091	0.67	9	1.5	1.0	1.00	1	0.98	13	100	20	0.220	0.446	0.59	0.00	0.00
40	12.19	2		0	2354	1	2	1.5	1.0	1.00	1.1	0.92	3	100	9	0.095	0.432	0.26	0.00	0.00
45	13.72		11	1	2617	0.67	7	1.5	1.0	1.00	1	0.87	10	75	17	0.179	0.413	0.52	1.84	1.10
50	15.24	15		1	2880	1	15	1.5	1.0	1.00	1.1	0.83	21	30	29	0.358	0.391	1.09	0.00	0.00

Based on *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, Technical Report NCEER-97-0022, December 31, 1997.

Total Settlement **4.19**

Corrections to SPT (Modified from Skempton, 1986) as listed by Robertson and Wride.

Factor	Equipment Variable	Term	Correction
Overburden Pressure		C_N	$(P_a/\sigma_{VO})^{0.5}$ C_N<=2
Energy Ratio	Donut Hammer Safety Hammer Automatic-trip Donut type Hammer	C_E	0.5 to 1.0 0.7 to 1.2 0.8 to 1.3
Borehole Diameter	2.6 inch to 6 inch 6 inch 8 inch	C_B	1 1.05 1.15
Rod Length	10 feet to 13 feet 13 feet to 19.8 ft. 19.8 ft. to 33 ft. 33 ft. to 98 ft. > 98 ft.	C_R	0.75 0.85 0.95 1 <1.0
Sampling Method	Standard Sampler Sampler without liners	C_L	1 1.1 to 1.3

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-1**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.17**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
0	0.00														
0.05	0.16	**43.79**	**1.21**	2.78	0.009	115	82.78	1.85	1.15	94.9	0.260	0.159	0.731	0.00	0.00
0.1	0.33	**42.74**	**1.63**	3.83	0.019	115	80.79	2.05	1.37	110.8	0.260	0.207	0.947	0.00	0.00
0.15	0.49	**38.99**	**1.918**	4.93	0.029	120	73.71	2.21	1.69	124.8	0.260	0.261	1.196	0.00	0.00
0.2	0.66	**31.98**	**2.087**	6.54	0.039	120	60.45	2.39	2.28	138.1	0.260	0.325	1.490	0.00	0.00
0.25	0.82	**29.17**	**2.259**	7.76	0.048	120	55.14	2.50	2.79	153.7	0.260	0.417	1.915	0.00	0.00
0.3	0.98	**27.76**	**2.258**	8.14	0.058	120	52.48	2.56	3.06	160.7	0.260	0.466	2.140	0.00	0.00
0.35	1.15	**24.74**	**1.797**	7.27	0.068	120	46.77	2.56	3.10	145.2	0.260	0.365	1.674	0.00	0.00
0.4	1.31	**19.89**	**1.071**	5.39	0.078	120	37.60	2.54	2.96	111.2	0.260	0.208	0.954	0.00	0.00
0.45	1.48	**14.6**	**1.06**	7.27	0.088	120	35.97	2.61	3.37	121.1	0.260	0.245	1.127	0.00	0.00
0.5	1.64	**12.96**	**1.015**	7.84	0.098	120	32.88	2.68	3.88	127.6	0.260	0.273	1.257	0.00	0.00
0.55	1.80	**13.82**	**1.176**	8.52	0.107	120	35.44	2.71	4.09	145.1	0.259	0.364	1.675	0.00	0.00
0.6	1.97	**15.15**	**1.325**	8.76	0.117	120	38.87	2.71	4.10	159.6	0.259	0.458	2.106	0.00	0.00
0.65	2.13	**17.56**	**1.356**	7.73	0.127	120	43.94	2.65	3.63	159.6	0.259	0.458	2.107	0.00	0.00
0.7	2.30	**16.77**	**1.267**	7.56	0.137	120	42.26	2.67	3.76	158.8	0.259	0.453	2.084	0.00	0.00
0.75	2.46	**14.92**	**1.045**	7.01	0.147	120	37.88	2.69	3.90	147.7	0.259	0.380	1.748	0.00	0.00
0.8	2.62	**12.43**	**0.777**	6.26	0.157	120	31.89	2.71	4.10	130.9	0.259	0.289	1.330	0.00	0.00
0.85	2.79	**9.76**	**0.527**	5.41	0.167	120	25.41	2.75	4.41	112.2	0.259	0.211	0.974	0.00	0.00
0.9	2.95	**7.92**	**0.507**	6.41	0.176	120	14.97	2.73	4.21	63.1	0.259	0.103	0.477	0.00	0.00
0.95	3.12	**10.13**	**0.587**	5.81	0.186	120	19.15	2.64	3.58	68.6	0.259	0.110	0.508	0.00	0.00
1	3.28	**11.92**	**0.684**	5.75	0.196	120	22.53	2.61	3.36	75.7	0.259	0.120	0.555	0.00	0.00
1.05	3.44	**9.71**	**0.64**	6.60	0.206	120	18.36	2.72	4.18	76.6	0.258	0.122	0.562	0.00	0.00
1.1	3.61	**8.95**	**0.469**	5.25	0.216	120	16.92	2.69	3.92	66.3	0.258	0.107	0.495	0.00	0.00
1.15	3.77	**7.76**	**0.295**	3.81	0.226	120	14.67	2.65	3.66	53.7	0.258	0.094	0.436	0.00	0.00
1.2	3.94	**5.55**	**0.169**	3.05	0.235	120	10.49	2.72	4.13	43.3	0.258	0.086	0.398	0.00	0.00
1.25	4.10	**3.04**	**0.216**	7.13	0.242	120	5.75	3.18	8.94	51.4	0.261	0.093	0.423	0.00	0.00
1.3	4.27	**5.1**	**0.264**	5.19	0.247	120	9.64	2.91	5.82	56.1	0.267	0.096	0.432	0.00	0.00
1.35	4.43	**5.59**	**0.345**	6.18	0.252	120	10.57	2.94	6.10	64.5	0.272	0.105	0.461	0.00	0.00
1.4	4.59	**5.92**	**0.374**	6.33	0.256	120	11.19	2.93	6.04	67.6	0.276	0.109	0.469	0.00	0.00
1.45	4.76	**6.31**	**0.306**	4.86	0.261	120	11.93	2.84	5.15	61.4	0.281	0.102	0.431	0.00	0.00
1.5	4.92	**6.56**	**0.405**	6.18	0.266	120	12.40	2.91	5.76	71.4	0.285	0.114	0.476	0.00	0.00
1.55	5.09	**5.63**	**0.438**	7.80	0.270	120	10.64	3.03	7.11	75.7	0.290	0.120	0.495	0.00	0.00
1.6	5.25	**6.87**	**0.364**	5.31	0.275	120	12.99	2.86	5.29	68.7	0.294	0.110	0.447	0.00	0.00
1.65	5.41	**6.86**	**0.311**	4.54	0.280	120	12.97	2.82	4.94	64.0	0.298	0.104	0.418	0.00	0.00
1.7	5.58	**5.38**	**0.292**	5.44	0.285	120	10.17	2.96	6.30	64.1	0.302	0.105	0.413	0.00	0.00
1.75	5.74	**5.93**	**0.265**	4.48	0.289	120	11.21	2.88	5.47	61.3	0.305	0.101	0.396	0.00	0.00
1.8	5.91	**10.96**	**0.24**	2.20	0.294	120	26.88	2.59	3.30	88.6	0.309	0.145	0.558	0.00	0.00
1.85	6.07	**10.77**	**0.266**	2.48	0.299	120	26.84	2.64	3.56	95.6	0.312	0.161	0.615	0.00	0.00
1.9	6.23	**10.62**	**0.238**	2.25	0.304	120	26.30	2.62	3.45	90.9	0.316	0.150	0.566	0.00	0.00
1.95	6.40	**10.47**	**0.244**	2.34	0.308	120	26.12	2.64	3.58	93.5	0.319	0.156	0.584	0.00	0.00
2	6.56	**9.37**	**0.235**	2.51	0.313	120	23.94	2.70	4.02	96.2	0.322	0.163	0.603	0.00	0.00
2.05	6.73	**7.55**	**0.21**	2.79	0.318	120	14.27	2.69	3.95	56.4	0.325	0.097	0.355	0.00	0.00
2.1	6.89	**6.71**	**0.176**	2.63	0.322	120	12.68	2.73	4.20	53.3	0.328	0.094	0.342	0.00	0.00
2.15	7.05	**7.11**	**0.163**	2.30	0.327	120	13.44	2.68	3.83	51.5	0.331	0.093	0.334	0.00	0.00
2.2	7.22	**6.43**	**0.173**	2.70	0.332	120	12.16	2.76	4.46	54.2	0.334	0.095	0.339	0.00	0.00
2.25	7.38	**4.53**	**0.161**	3.56	0.337	120	8.56	2.97	6.43	55.1	0.336	0.096	0.339	0.00	0.00
2.3	7.55	**6.64**	**0.203**	3.06	0.341	120	12.55	2.79	4.73	59.3	0.339	0.099	0.350	0.00	0.00
2.35	7.71	**8.79**	**0.192**	2.19	0.346	120	16.62	2.61	3.37	56.0	0.341	0.096	0.337	0.00	0.00
2.4	7.87	**11.15**	**0.132**	1.19	0.351	120	18.30	2.56	3.12	57.1	0.344	0.097	0.337	0.00	0.00
2.45	8.04	**12.43**	**0.14**	1.13	0.355	120	20.27	2.51	2.84	57.6	0.346	0.098	0.337	0.00	0.00
2.5	8.20	**12.71**	**0.293**	2.31	0.360	120	31.34	2.61	3.38	105.9	0.349	0.190	0.651	0.00	0.00
2.55	8.37	**8.42**	**0.275**	3.27	0.365	120	15.92	2.75	4.37	69.6	0.351	0.111	0.379	0.00	0.00
2.6	8.53	**6.09**	**0.15**	2.47	0.370	120	11.51	2.80	4.80	55.2	0.353	0.096	0.323	0.00	0.00
2.65	8.69	**7.56**	**0.146**	1.94	0.374	120	14.29	2.66	3.74	53.4	0.355	0.094	0.316	0.00	0.00
2.7	8.86	**5.5**	**0.167**	3.04	0.379	120	10.40	2.90	5.74	59.7	0.357	0.100	0.333	0.00	0.00
2.75	9.02	**4.67**	**0.144**	3.09	0.384	120	8.83	2.98	6.50	57.4	0.359	0.098	0.324	0.00	0.00
2.8	9.19	**11.13**	**0.212**	1.91	0.389	120	27.65	2.63	3.51	97.0	0.361	0.165	0.544	0.00	0.00
2.85	9.35	**18.22**	**0.153**	0.84	0.393	115	28.26	2.32	2.02	57.2	0.363	0.097	0.320	2.90	0.06
2.9	9.51	**27.5**	**0.29**	1.06	0.397	115	42.42	2.22	1.72	72.9	0.365	0.116	0.379	2.90	0.06
2.95	9.68	**27.3**	**0.377**	1.38	0.401	115	41.89	2.29	1.93	80.7	0.367	0.129	0.419	2.40	0.05
3	9.84	**37.94**	**0.32**	0.85	0.406	115	57.90	2.05	1.38	79.6	0.369	0.127	0.410	2.40	0.05
3.05	10.01	**49.64**	**0.465**	0.94	0.410	115	75.36	1.98	1.28	96.5	0.371	0.164	0.526	2.30	0.05
3.1	10.17	**49.27**	**0.66**	1.34	0.414	115	74.41	2.09	1.43	106.4	0.373	0.192	0.614	2.00	0.04
3.15	10.33	**38.04**	**0.733**	1.93	0.419	115	57.15	2.28	1.88	107.2	0.374	0.195	0.620	1.84	0.04
3.2	10.50	**27.61**	**0.59**	2.14	0.423	115	41.27	2.42	2.38	98.1	0.376	0.168	0.532	2.40	0.05
3.25	10.66	**25.77**	**0.433**	1.68	0.427	115	38.32	2.38	2.22	85.0	0.378	0.137	0.433	2.60	0.05

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: LE11138 **Sounding Location:** CPT-1
Project Name: Cal Energy Black Rock 5-6

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.17**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
3.3	10.83	**27.01**	**0.287**	1.07	0.432	115	39.97	2.25	1.78	71.3	0.380	0.114	0.358	3.10	0.06
3.35	10.99	**24.64**	**0.296**	1.20	0.436	115	36.28	2.31	1.98	72.0	0.381	0.115	0.359	2.60	0.05
3.4	11.15	**21.95**	**0.406**	1.85	0.440	115	32.16	2.46	2.59	83.4	0.383	0.134	0.417	2.70	0.05
3.45	11.32	**24.44**	**0.176**	0.72	0.445	115	35.63	2.20	1.67	59.5	0.384	0.100	0.309	3.10	0.06
3.5	11.48	**31.28**	**0.276**	0.89	0.449	115	45.39	2.15	1.56	70.9	0.386	0.113	0.350	2.70	0.05
3.55	11.65	**34.01**	**0.389**	1.15	0.453	115	49.11	2.19	1.64	80.5	0.387	0.129	0.396	2.70	0.05
3.6	11.81	**33.79**	**0.481**	1.43	0.458	115	48.56	2.25	1.80	87.2	0.389	0.142	0.435	2.70	0.05
3.65	11.98	**34.43**	**0.487**	1.42	0.462	115	49.25	2.24	1.78	87.6	0.390	0.142	0.436	2.70	0.05
3.7	12.14	**49.57**	**0.45**	0.91	0.466	115	70.58	2.00	1.30	91.8	0.391	0.152	0.463	2.40	0.05
3.75	12.30	**59.39**	**0.67**	1.13	0.471	115	84.17	2.00	1.30	109.1	0.393	0.201	0.609	2.00	0.04
3.8	12.47	**61.45**	**0.817**	1.33	0.475	115	86.70	2.03	1.35	116.7	0.394	0.228	0.689	2.00	0.04
3.85	12.63	**66**	**0.905**	1.37	0.479	115	92.70	2.02	1.33	123.1	0.395	0.253	0.764	1.91	0.04
3.9	12.80	**76.15**	**0.99**	1.30	0.483	115	106.47	1.96	1.25	133.2	0.397	0.300	0.901	1.77	0.03
3.95	12.96	**82.33**	**1.093**	1.33	0.488	115	114.61	1.94	1.23	141.2	0.398	0.342	1.024	1.61	0.00
4	13.12	**81.89**	**1.108**	1.36	0.492	115	113.49	1.95	1.24	140.9	0.399	0.340	1.016	1.69	0.00
4.05	13.29	**71.28**	**1.108**	1.56	0.496	115	98.36	2.04	1.35	133.1	0.400	0.299	0.892	1.62	0.03
4.1	13.45	**63.77**	**1.061**	1.67	0.501	115	87.61	2.10	1.45	126.8	0.401	0.269	0.801	1.77	0.03
4.15	13.62	**59.2**	**0.959**	1.62	0.505	115	80.99	2.11	1.48	119.8	0.403	0.240	0.710	1.84	0.04
4.2	13.78	**63.39**	**0.908**	1.44	0.509	115	86.35	2.06	1.38	119.2	0.404	0.238	0.702	1.77	0.03
4.25	13.94	**70.17**	**1.03**	1.47	0.514	115	95.19	2.03	1.34	127.9	0.405	0.275	0.809	1.91	0.04
4.3	14.11	**69.11**	**1.134**	1.64	0.518	115	93.36	2.07	1.41	131.2	0.406	0.290	0.852	1.70	0.03
4.35	14.27	**62.91**	**1.07**	1.70	0.522	115	84.63	2.11	1.48	125.2	0.407	0.263	0.770	1.84	0.04
4.4	14.44	**59.48**	**0.957**	1.61	0.527	115	79.69	2.12	1.49	118.4	0.408	0.234	0.685	1.91	0.04
4.45	14.60	**56.04**	**0.91**	1.63	0.531	115	74.77	2.14	1.53	114.5	0.409	0.220	0.641	2.00	0.04
4.5	14.76	**51.64**	**0.99**	1.92	0.535	115	68.62	2.22	1.71	117.2	0.410	0.230	0.668	2.15	0.04
4.55	14.93	**50.94**	**1.176**	2.31	0.540	115	67.42	2.28	1.88	126.7	0.411	0.269	0.781	1.63	0.03
4.6	15.09	**36.93**	**1.109**	3.01	0.544	115	48.68	2.46	2.58	125.5	0.412	0.264	0.764	2.15	0.04
4.65	15.26	**35**	**0.919**	2.63	0.548	115	45.96	2.44	2.48	114.1	0.413	0.218	0.630	2.15	0.04
4.7	15.42	**82.85**	**1.11**	1.34	0.552	115	108.36	1.96	1.26	136.0	0.414	0.314	0.905	1.70	0.03
4.75	15.58	**101.14**	**1.713**	1.70	0.557	115	131.77	1.98	1.27	167.2	0.415	0.515	1.481	1.48	0.00
4.8	15.75	**97.7**	**2.145**	2.20	0.561	115	126.80	2.07	1.40	178.0	0.416	0.604	1.734	1.18	0.00
4.85	15.91	**62.17**	**1.815**	2.92	0.565	115	80.38	2.30	1.94	155.7	0.416	0.431	1.234	1.40	0.00
4.9	16.08	**57.64**	**1.253**	2.18	0.570	115	74.24	2.23	1.74	129.3	0.417	0.281	0.803	0.00	0.00
4.95	16.24	**109.87**	**1.423**	1.30	0.574	115	140.98	1.87	1.16	163.9	0.418	0.489	1.396	1.33	0.00
5	16.40	**109.84**	**1.641**	1.50	0.578	115	140.41	1.92	1.20	169.2	0.419	0.530	1.510	1.33	0.00
5.05	16.57	**84.43**	**1.821**	2.16	0.583	115	107.53	2.11	1.48	159.0	0.420	0.454	1.290	1.48	0.00
5.1	16.73	**51.19**	**1.576**	3.08	0.587	115	64.96	2.38	2.22	144.5	0.421	0.361	1.023	1.71	0.00
5.15	16.90	**27.32**	**1.271**	4.66	0.591	115	46.20	2.62	3.47	160.5	0.421	0.464	1.314	0.00	0.00
5.2	17.06	**17.98**	**0.843**	4.69	0.596	115	30.19	2.76	4.48	135.4	0.422	0.311	0.878	0.00	0.00
5.25	17.22	**10.48**	**0.508**	4.85	0.600	115	17.47	2.97	6.37	111.2	0.423	0.208	0.587	0.00	0.00
5.3	17.39	**11.13**	**0.398**	3.58	0.604	115	18.42	2.86	5.34	98.4	0.424	0.168	0.474	0.00	0.00
5.35	17.55	**28.97**	**0.361**	1.25	0.609	115	36.10	2.32	2.03	73.3	0.424	0.117	0.328	2.60	0.05
5.4	17.72	**54.68**	**0.529**	0.97	0.613	115	67.90	2.03	1.34	91.2	0.425	0.151	0.423	2.40	0.05
5.45	17.88	**76.21**	**0.955**	1.26	0.617	115	94.31	1.99	1.29	121.3	0.426	0.246	0.689	1.91	0.04
5.5	18.04	**88.71**	**1.264**	1.43	0.622	115	109.40	1.98	1.27	139.3	0.426	0.332	0.928	1.71	0.03
5.55	18.21	**105.05**	**1.483**	1.41	0.626	115	129.10	1.92	1.21	156.6	0.427	0.437	1.221	1.49	0.00
5.6	18.37	**107.81**	**1.662**	1.54	0.630	115	132.04	1.95	1.23	163.0	0.428	0.483	1.347	1.41	0.00
5.65	18.54	**99.39**	**1.715**	1.73	0.634	115	121.31	2.01	1.31	158.7	0.428	0.452	1.258	1.57	0.00
5.7	18.70	**78.17**	**1.5**	1.92	0.639	115	95.09	2.11	1.48	140.8	0.429	0.340	0.944	1.63	0.03
5.75	18.86	**60.08**	**1.138**	1.90	0.643	115	72.84	2.19	1.65	120.4	0.429	0.242	0.673	2.00	0.04
5.8	19.03	**51.14**	**0.788**	1.54	0.647	115	61.79	2.19	1.64	101.5	0.430	0.177	0.491	2.30	0.05
5.85	19.19	**44.3**	**0.676**	1.53	0.652	115	53.35	2.24	1.76	94.1	0.431	0.157	0.436	2.60	0.05
5.9	19.36	**38.32**	**0.901**	2.35	0.656	115	46.00	2.41	2.35	108.1	0.431	0.197	0.546	2.15	0.04
5.95	19.52	**25.93**	**0.971**	3.75	0.660	115	39.27	2.61	3.39	133.0	0.432	0.299	0.826	0.00	0.00
6	19.69	**13.19**	**0.622**	4.72	0.665	115	19.84	2.91	5.82	115.5	0.432	0.223	0.616	0.00	0.00
6.05	19.85	**11.02**	**0.536**	4.87	0.669	115	16.47	2.99	6.63	109.1	0.433	0.201	0.554	0.00	0.00
6.1	20.00	**18.73**	**0.527**	2.82	0.673	115	27.83	2.65	3.63	100.9	0.433	0.176	0.483	0.00	0.00
6.15	20.18	**20.28**	**0.576**	2.84	0.678	115	29.93	2.62	3.47	103.9	0.434	0.184	0.507	0.00	0.00
6.2	20.34	**11.56**	**0.593**	5.13	0.682	115	16.95	2.99	6.67	113.1	0.434	0.215	0.589	0.00	0.00
6.25	20.51	**12.18**	**0.512**	4.21	0.686	115	17.75	2.92	5.91	104.9	0.435	0.187	0.514	0.00	0.00
6.3	20.67	**13.12**	**0.593**	4.52	0.691	115	19.00	2.92	5.86	111.3	0.435	0.208	0.571	0.00	0.00
6.35	20.83	**11.6**	**0.531**	4.58	0.695	115	16.69	2.97	6.39	106.7	0.436	0.193	0.528	0.00	0.00
6.4	21.00	**12.03**	**0.498**	4.14	0.699	115	17.21	2.93	5.99	103.0	0.436	0.182	0.497	0.00	0.00
6.45	21.16	**13.84**	**0.577**	4.17	0.703	115	19.67	2.88	5.52	108.5	0.437	0.199	0.543	0.00	0.00
6.5	21.33	**14.66**	**0.801**	5.47	0.708	115	20.71	2.94	6.09	126.2	0.437	0.267	0.728	0.00	0.00
6.55	21.49	**13.66**	**0.719**	5.27	0.712	115	19.18	2.96	6.27	120.2	0.438	0.242	0.659	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-1**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.17**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
6.6	21.65	**13.3**	**0.721**	5.43	0.716	115	18.56	2.98	6.49	120.4	0.438	0.242	0.660	0.00	0.00
6.65	21.82	**13.99**	**0.772**	5.52	0.721	115	19.41	2.97	6.37	123.6	0.438	0.256	0.695	0.00	0.00
6.7	21.98	**14.72**	**0.781**	5.31	0.725	115	20.30	2.94	6.08	123.5	0.439	0.255	0.693	0.00	0.00
6.75	22.15	**14.23**	**0.74**	5.20	0.729	115	19.51	2.95	6.17	120.4	0.439	0.242	0.658	0.00	0.00
6.8	22.31	**13.76**	**0.707**	5.14	0.734	115	18.75	2.96	6.28	117.9	0.440	0.232	0.630	0.00	0.00
6.85	22.47	**13.76**	**0.701**	5.10	0.738	115	18.64	2.96	6.28	117.1	0.440	0.229	0.622	0.00	0.00
6.9	22.64	**13.56**	**0.688**	5.08	0.742	115	18.27	2.96	6.35	116.0	0.440	0.225	0.610	0.00	0.00
6.95	22.80	**11.19**	**0.732**	6.55	0.747	115	14.99	3.11	8.04	120.5	0.441	0.243	0.657	0.00	0.00
7	22.97	**13.67**	**0.728**	5.33	0.751	115	18.20	2.98	6.51	118.5	0.441	0.235	0.635	0.00	0.00
7.05	23.13	**45.95**	**0.434**	0.95	0.755	115	51.40	2.13	1.51	77.5	0.441	0.123	0.333	2.60	0.05
7.1	23.29	**57.14**	**0.397**	0.70	0.760	115	63.74	1.97	1.27	80.8	0.442	0.129	0.349	2.60	0.05
7.15	23.46	**51**	**0.478**	0.94	0.764	115	56.73	2.09	1.44	81.5	0.442	0.130	0.352	2.40	0.05
7.2	23.62	**46.45**	**0.519**	1.12	0.768	115	51.52	2.17	1.59	82.1	0.442	0.132	0.355	2.60	0.05
7.25	23.79	**31.63**	**0.56**	1.77	0.773	115	34.99	2.43	2.43	85.0	0.442	0.137	0.370	2.70	0.05
7.3	23.95	**15.85**	**0.486**	3.07	0.777	115	20.40	2.78	4.66	95.0	0.443	0.160	0.430	0.00	0.00
7.35	24.11	**9.94**	**0.352**	3.55	0.781	115	12.72	3.01	6.83	86.9	0.443	0.141	0.380	0.00	0.00
7.4	24.28	**8.45**	**0.221**	2.62	0.785	115	10.76	3.00	6.79	73.0	0.443	0.116	0.313	0.00	0.00
7.45	24.44	**7.71**	**0.206**	2.68	0.790	115	9.76	3.05	7.34	71.7	0.444	0.114	0.307	0.00	0.00
7.5	24.61	**8.02**	**0.247**	3.08	0.794	115	10.10	3.07	7.57	76.4	0.444	0.122	0.327	0.00	0.00
7.55	24.77	**8.59**	**0.337**	3.93	0.798	115	10.76	3.10	7.97	85.8	0.444	0.139	0.373	0.00	0.00
7.6	24.93	**19.26**	**0.381**	1.98	0.803	115	23.99	2.61	3.39	81.3	0.444	0.130	0.349	0.00	0.00
7.65	25.10	**26.64**	**0.408**	1.53	0.807	115	28.83	2.46	2.59	74.6	0.444	0.119	0.318	2.90	0.06
7.7	25.26	**26.67**	**0.401**	1.51	0.811	115	28.79	2.46	2.57	74.0	0.445	0.118	0.316	2.90	0.06
7.75	25.43	**23.41**	**0.553**	2.37	0.816	115	57.76	2.61	3.39	195.8	0.445	0.778	2.086	0.00	0.00
7.8	25.59	**24.37**	**0.455**	1.87	0.820	115	26.16	2.55	3.03	79.3	0.445	0.126	0.339	2.70	0.05
7.85	25.75	**37.6**	**0.39**	1.04	0.824	115	40.26	2.24	1.78	71.6	0.445	0.114	0.306	2.90	0.06
7.9	25.92	**44.74**	**0.458**	1.03	0.829	115	47.78	2.18	1.61	76.9	0.445	0.122	0.327	2.70	0.05
7.95	26.08	**47.11**	**0.827**	1.76	0.833	115	50.18	2.30	1.94	97.6	0.446	0.166	0.446	2.00	0.04
8	26.25	**43.42**	**0.732**	1.69	0.837	115	46.13	2.32	2.00	92.5	0.446	0.154	0.411	2.15	0.04
8.05	26.41	**58.49**	**0.583**	1.00	0.842	115	61.99	2.07	1.41	87.3	0.446	0.142	0.380	2.30	0.05
8.1	26.57	**56.43**	**0.519**	0.92	0.846	115	59.65	2.07	1.40	83.4	0.446	0.134	0.358	2.40	0.05
8.15	26.74	**49.68**	**0.609**	1.23	0.850	115	52.38	2.19	1.64	85.7	0.446	0.139	0.371	2.60	0.05
8.2	26.90	**44.28**	**0.693**	1.57	0.854	115	46.57	2.29	1.93	89.9	0.446	0.147	0.394	2.15	0.04
8.25	27.07	**38.69**	1	2.59	0.859	115	40.59	2.48	2.67	108.5	0.446	0.199	0.531	2.40	0.05
8.3	27.23	**32.69**	**0.848**	2.60	0.863	115	34.21	2.54	2.98	102.0	0.446	0.179	0.478	2.30	0.05
8.35	27.40	**38.8**	**0.568**	1.47	0.867	115	40.50	2.33	2.04	82.5	0.447	0.132	0.353	2.40	0.05
8.4	27.56	**54.96**	**0.539**	0.98	0.872	115	57.23	2.10	1.45	83.1	0.447	0.133	0.356	2.40	0.05
8.45	27.72	**70.37**	**0.697**	0.99	0.876	115	73.09	2.01	1.32	96.3	0.447	0.163	0.436	2.30	0.05
8.5	27.89	**87.34**	**0.883**	1.01	0.880	115	90.50	1.94	1.23	111.6	0.447	0.209	0.559	1.91	0.04
8.55	28.05	**71.32**	**1.221**	1.71	0.885	115	73.72	2.16	1.58	116.4	0.447	0.227	0.605	2.00	0.04
8.6	28.22	**48.07**	**1.237**	2.58	0.889	115	49.57	2.41	2.36	117.2	0.447	0.230	0.613	2.00	0.04
8.65	28.38	**34.2**	**1.182**	3.46	0.893	115	84.25	2.61	3.37	283.5	0.447	2.200	5.871	0.00	0.00
8.7	28.54	**28.85**	**1.317**	4.57	0.898	115	32.14	2.74	4.27	137.2	0.447	0.320	0.855	0.00	0.00
8.75	28.71	**32.94**	**0.881**	2.68	0.902	115	33.72	2.55	3.06	103.2	0.447	0.182	0.487	0.00	0.00
8.8	28.87	**53.84**	**0.739**	1.37	0.906	115	54.98	2.20	1.67	91.7	0.447	0.152	0.405	2.60	0.05
8.85	29.04	**77.63**	**1.13**	1.46	0.911	115	79.09	2.09	1.44	114.0	0.447	0.218	0.581	1.91	0.04
8.9	29.20	**97.62**	**1.579**	1.62	0.915	115	99.22	2.05	1.37	136.0	0.447	0.314	0.837	1.64	0.03
8.95	29.36	**104.06**	**1.746**	1.68	0.919	115	105.52	2.04	1.36	143.3	0.447	0.354	0.944	1.50	0.03
9	29.53	**120.69**	**1.884**	1.56	0.924	115	122.10	1.97	1.27	154.7	0.447	0.425	1.133	1.57	0.00
9.05	29.69	**121.75**	**2.039**	1.68	0.928	115	122.88	1.99	1.29	158.8	0.447	0.452	1.207	1.57	0.00
9.1	29.86	**113.05**	**2.015**	1.78	0.932	115	113.84	2.04	1.35	153.8	0.447	0.418	1.117	1.42	0.00
9.15	30.02	**98.37**	**1.88**	1.91	0.936	115	98.83	2.10	1.46	144.1	0.447	0.358	0.957	1.64	0.03
9.2	30.18	**90.05**	**1.509**	1.68	0.941	115	90.26	2.09	1.44	129.8	0.447	0.283	0.756	1.71	0.03
9.25	30.35	**115.73**	**1.326**	1.15	0.945	115	115.74	1.90	1.19	137.3	0.447	0.321	0.857	1.64	0.03
9.3	30.51	**131.7**	**1.816**	1.38	0.949	115	131.41	1.91	1.20	157.9	0.447	0.446	1.191	1.50	0.00
9.35	30.68	**113.83**	**1.955**	1.72	0.954	115	113.32	2.03	1.34	151.5	0.447	0.403	1.077	1.71	0.00
9.4	30.84	**94.88**	**1.865**	1.97	0.958	115	94.24	2.13	1.50	141.6	0.446	0.344	0.920	1.71	0.03
9.45	31.00	**85.77**	**1.423**	1.66	0.962	115	85.00	2.11	1.47	124.7	0.446	0.261	0.696	1.78	0.04
9.5	31.17	**82.94**	**1.261**	1.52	0.967	115	82.01	2.09	1.44	118.3	0.446	0.234	0.625	1.84	0.04
9.55	31.33	**116.18**	**1.371**	1.18	0.971	115	114.63	1.91	1.20	137.3	0.446	0.321	0.858	1.64	0.03
9.6	31.50	**124.27**	**1.695**	1.37	0.975	115	122.34	1.93	1.22	149.3	0.446	0.390	1.042	1.57	0.00
9.65	31.66	**121.89**	**2.038**	1.67	0.980	115	119.73	2.00	1.30	155.9	0.446	0.432	1.157	1.64	0.00
9.7	31.82	**110.51**	**1.855**	1.68	0.984	115	108.31	2.03	1.35	145.9	0.446	0.369	0.986	1.71	0.03
9.75	31.99	**108.19**	**1.645**	1.52	0.988	115	105.81	2.01	1.31	139.1	0.446	0.330	0.884	1.78	0.04
9.8	32.15	**100.1**	**1.685**	1.69	0.993	115	97.68	2.07	1.40	136.5	0.445	0.317	0.848	1.64	0.03
9.85	32.32	**85.5**	**1.671**	1.96	0.997	115	83.25	2.16	1.58	131.6	0.445	0.292	0.782	1.84	0.04

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-1**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.17**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
9.9	32.48	**71.98**	**1.403**	1.95	1.001	115	69.94	2.22	1.71	119.8	0.445	0.240	0.643	2.15	0.04
9.95	32.64	**66.57**	**1.217**	1.83	1.005	115	64.54	2.23	1.73	111.9	0.445	0.210	0.563	2.30	0.05
10	32.81	**61.41**	**1.141**	1.86	1.010	115	59.41	2.26	1.82	108.3	0.445	0.198	0.531	2.40	0.05
10.05	32.97	**56.84**	**1.055**	1.86	1.014	115	54.87	2.29	1.90	104.4	0.445	0.186	0.498	1.91	0.04
10.1	33.14	**47.03**	**1.015**	2.16	1.018	115	45.31	2.39	2.29	103.5	0.444	0.183	0.492	2.30	0.05
10.15	33.30	**42.01**	**0.973**	2.32	1.023	115	40.39	2.45	2.54	102.7	0.444	0.181	0.485	2.40	0.05
10.2	33.46	**27.86**	**0.767**	2.76	1.027	115	27.13	2.65	3.66	99.3	0.444	0.171	0.460	0.00	0.00
10.25	33.63	**17.11**	**0.638**	3.73	1.031	115	16.59	2.92	5.88	97.5	0.444	0.166	0.447	0.00	0.00
10.3	33.79	**16.05**	**0.444**	2.77	1.036	120	15.49	2.87	5.39	83.5	0.443	0.134	0.361	0.00	0.00
10.35	33.96	**13.75**	**0.567**	4.13	1.041	120	13.21	3.03	7.14	94.3	0.443	0.158	0.425	0.00	0.00
10.4	34.12	**14.11**	**0.735**	5.21	1.046	120	13.50	3.09	7.79	105.1	0.443	0.188	0.506	0.00	0.00
10.45	34.28	**14.22**	**0.94**	6.62	1.050	120	13.54	3.15	8.61	116.6	0.442	0.228	0.614	0.00	0.00
10.5	34.45	**13.74**	**0.907**	6.61	1.055	120	13.02	3.17	8.81	114.7	0.442	0.221	0.595	0.00	0.00
10.55	34.61	**10.8**	**0.697**	6.46	1.060	120	10.19	3.26	10.12	103.2	0.442	0.182	0.492	0.00	0.00
10.6	34.78	**8.1**	**0.444**	5.49	1.064	120	7.61	3.35	11.46	87.2	0.441	0.142	0.383	0.00	0.00
10.65	34.94	**6.59**	**0.278**	4.23	1.069	120	6.16	3.39	12.12	74.7	0.441	0.119	0.321	0.00	0.00
10.7	35.10	**5.5**	**0.231**	4.21	1.074	120	5.12	3.49	13.90	71.2	0.440	0.114	0.307	0.00	0.00
10.75	35.27	**5.08**	**0.201**	3.97	1.079	120	4.71	3.53	14.59	68.7	0.440	0.110	0.299	0.00	0.00
10.8	35.43	**5.31**	**0.16**	3.02	1.083	120	4.90	3.44	13.06	64.0	0.440	0.104	0.283	0.00	0.00
10.85	35.60	**4.96**	**0.159**	3.21	1.088	120	4.56	3.50	14.12	64.4	0.439	0.105	0.285	0.00	0.00
10.9	35.76	**5.22**	**0.171**	3.28	1.093	120	4.78	3.48	13.67	65.3	0.439	0.106	0.288	0.00	0.00
10.95	35.93	**5.55**	**0.199**	3.59	1.098	120	5.06	3.46	13.40	67.7	0.438	0.109	0.296	0.00	0.00
11	36.09	**5.98**	**0.23**	3.85	1.102	120	5.43	3.44	12.95	70.3	0.438	0.112	0.306	0.00	0.00
11.05	36.25	**7.48**	**0.291**	3.90	1.107	120	6.76	3.32	11.05	74.7	0.438	0.119	0.324	0.00	0.00
11.1	36.42	**8.92**	**0.346**	3.88	1.112	120	8.02	3.24	9.77	78.4	0.437	0.125	0.341	0.00	0.00
11.15	36.58	**9.56**	**0.387**	4.05	1.116	120	8.56	3.22	9.48	81.2	0.437	0.130	0.355	0.00	0.00
11.2	36.75	**9.45**	**0.412**	4.37	1.121	120	8.43	3.24	9.85	83.1	0.436	0.133	0.364	0.00	0.00
11.25	36.91	**9.92**	**0.403**	4.07	1.126	120	8.81	3.20	9.31	82.1	0.436	0.131	0.360	0.00	0.00
11.3	37.07	**9.94**	**0.4**	4.03	1.131	120	8.79	3.20	9.30	81.7	0.435	0.131	0.358	0.00	0.00
11.35	37.24	**9.78**	**0.394**	4.03	1.135	120	8.61	3.21	9.43	81.2	0.435	0.130	0.356	0.00	0.00
11.4	37.40	**9.47**	**0.376**	3.98	1.140	120	8.31	3.23	9.62	79.9	0.434	0.127	0.350	0.00	0.00
11.45	37.57	**9.39**	**0.362**	3.86	1.145	120	8.20	3.23	9.60	78.8	0.434	0.125	0.345	0.00	0.00
11.5	37.73	**9.34**	**0.346**	3.71	1.149	120	8.13	3.22	9.53	77.4	0.433	0.123	0.339	0.00	0.00
11.55	37.89	**8.87**	**0.313**	3.53	1.154	120	7.68	3.23	9.75	74.9	0.433	0.119	0.328	0.00	0.00
11.6	38.06	**8.51**	**0.297**	3.49	1.159	120	7.34	3.25	10.03	73.7	0.432	0.117	0.323	0.00	0.00
11.65	38.22	**8.43**	**0.274**	3.25	1.164	120	7.24	3.24	9.89	71.6	0.432	0.114	0.315	0.00	0.00
11.7	38.39	**7.76**	**0.236**	3.05	1.168	120	6.64	3.27	10.32	68.5	0.431	0.110	0.304	0.00	0.00
11.75	38.55	**7.64**	**0.236**	3.09	1.173	120	6.51	3.29	10.53	68.6	0.431	0.110	0.305	0.00	0.00
11.8	38.71	**8.01**	**0.248**	3.10	1.178	120	6.80	3.27	10.20	69.4	0.430	0.111	0.308	0.00	0.00
11.85	38.88	**7.92**	**0.259**	3.27	1.183	120	6.70	3.29	10.51	70.4	0.430	0.112	0.312	0.00	0.00
11.9	39.04	**7.81**	**0.248**	3.18	1.187	120	6.58	3.29	10.55	69.4	0.429	0.111	0.309	0.00	0.00
11.95	39.21	**7.44**	**0.229**	3.08	1.192	120	6.24	3.31	10.87	67.8	0.429	0.109	0.303	0.00	0.00
12	39.37	**7.13**	**0.209**	2.94	1.197	120	5.96	3.32	11.10	66.1	0.428	0.107	0.298	0.00	0.00
12.05	39.53	**7.12**	**0.199**	2.80	1.201	120	5.93	3.32	10.98	65.1	0.427	0.106	0.295	0.00	0.00
12.1	39.70	**7.07**	**0.199**	2.82	1.206	120	5.86	3.32	11.10	65.1	0.427	0.106	0.295	0.00	0.00
12.15	39.86	**7.01**	**0.198**	2.83	1.211	120	5.79	3.33	11.22	65.0	0.426	0.106	0.295	0.00	0.00
12.2	40.03	**7.04**	**0.198**	2.82	1.216	120	5.79	3.33	11.21	64.9	0.426	0.105	0.295	0.00	0.00
12.25	40.19	**7.09**	**0.195**	2.75	1.220	120	5.81	3.32	11.10	64.5	0.425	0.105	0.294	0.00	0.00
12.3	40.35	**7.16**	**0.197**	2.76	1.225	120	5.84	3.32	11.05	64.6	0.425	0.105	0.295	0.00	0.00
12.35	40.52	**7.12**	**0.195**	2.74	1.230	120	5.79	3.33	11.12	64.4	0.424	0.105	0.295	0.00	0.00
12.4	40.68	**7.17**	**0.192**	2.68	1.235	120	5.81	3.32	11.02	64.0	0.423	0.104	0.294	0.00	0.00
12.45	40.85	**7.26**	**0.175**	2.41	1.239	120	5.86	3.29	10.59	62.1	0.423	0.102	0.288	0.00	0.00
12.5	41.01	**7.17**	**0.197**	2.75	1.244	120	5.76	3.33	11.17	64.4	0.422	0.105	0.296	0.00	0.00
12.55	41.17	**8.4**	**0.264**	3.15	1.249	120	6.73	3.28	10.34	69.6	0.421	0.111	0.315	0.00	0.00
12.6	41.34	**11.26**	**0.366**	3.25	1.253	120	8.98	3.14	8.47	76.1	0.421	0.121	0.343	0.00	0.00
12.65	41.50	**15.56**	**0.405**	2.60	1.258	120	12.37	2.95	6.17	76.4	0.420	0.121	0.345	0.00	0.00
12.7	41.67	**17.2**	**0.422**	2.46	1.263	120	13.62	2.89	5.62	76.5	0.420	0.122	0.346	0.00	0.00
12.75	41.83	**16.75**	**0.488**	2.92	1.267	115	13.22	2.95	6.17	81.5	0.419	0.130	0.371	0.00	0.00
12.8	41.99	**19.99**	**0.475**	2.38	1.272	115	15.72	2.82	5.00	78.6	0.418	0.125	0.357	0.00	0.00
12.85	42.16	**21.35**	**0.439**	2.06	1.276	115	16.73	2.76	4.49	75.1	0.418	0.119	0.341	0.00	0.00
12.9	42.32	**32.51**	**0.402**	1.24	1.280	115	27.93	2.43	2.44	68.3	0.417	0.110	0.313	0.00	0.00
12.95	42.49	**30.37**	**0.489**	1.61	1.284	115	26.05	2.52	2.88	75.1	0.417	0.119	0.342	0.00	0.00
13	42.65	**18.61**	**0.522**	2.81	1.289	115	14.44	2.90	5.70	82.4	0.416	0.132	0.378	0.00	0.00
13.05	42.81	**15.02**	**0.431**	2.87	1.293	115	11.62	3.00	6.72	78.1	0.415	0.124	0.357	0.00	0.00
13.1	42.98	**13.76**	**0.422**	3.07	1.297	115	10.61	3.05	7.36	78.1	0.415	0.124	0.357	0.00	0.00
13.15	43.14	**16.55**	**0.374**	2.26	1.302	115	12.71	2.90	5.72	72.7	0.414	0.116	0.333	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-1**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.17**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
13.2	43.31	**23.57**	**0.508**	2.16	1.306	115	18.05	2.75	4.34	78.3	0.414	0.125	0.359	0.00	0.00
13.25	43.47	**32.27**	**0.641**	1.99	1.310	115	24.63	2.60	3.35	82.4	0.413	0.132	0.381	0.00	0.00
13.3	43.64	**40.87**	**0.731**	1.79	1.315	115	34.65	2.44	2.49	86.2	0.412	0.139	0.403	2.70	0.05
13.35	43.80	**52.06**	**0.565**	1.09	1.319	115	44.07	2.22	1.73	76.2	0.412	0.121	0.351	2.90	0.06
13.4	43.96	**61.86**	**0.306**	0.50	1.323	115	52.28	1.98	1.28	66.8	0.411	0.108	0.312	2.90	0.06
13.45	44.13	**61.25**	**0.31**	0.51	1.328	115	51.68	1.99	1.29	66.6	0.410	0.107	0.312	2.90	0.06
13.5	44.29	**43.07**	**0.755**	1.76	1.332	115	36.28	2.42	2.39	86.7	0.410	0.141	0.409	2.60	0.05
13.55	44.46	**26.6**	**0.791**	2.98	1.336	115	19.91	2.79	4.69	93.4	0.409	0.156	0.454	0.00	0.00
13.6	44.62	**13.73**	**0.527**	3.84	1.341	115	10.24	3.12	8.24	84.4	0.408	0.136	0.397	0.00	0.00
13.65	44.78	**10.5**	**0.164**	1.56	1.345	115	7.81	3.05	7.31	57.1	0.408	0.097	0.285	0.00	0.00
13.7	44.95	**10.18**	**0.161**	1.58	1.349	115	7.55	3.07	7.56	57.0	0.407	0.097	0.285	0.00	0.00
13.75	45.11	**9.05**	**0.173**	1.91	1.353	115	6.69	3.17	8.87	59.3	0.406	0.099	0.292	0.00	0.00
13.8	45.28	**8.47**	**0.17**	2.01	1.358	115	6.24	3.22	9.54	59.5	0.406	0.100	0.293	0.00	0.00
13.85	45.44	**8.05**	**0.153**	1.90	1.362	115	5.91	3.24	9.82	58.0	0.405	0.098	0.289	0.00	0.00
13.9	45.60	**7.87**	**0.133**	1.69	1.366	115	5.76	3.23	9.70	55.9	0.404	0.096	0.284	0.00	0.00
13.95	45.77	**8.39**	**0.147**	1.75	1.371	115	6.12	3.20	9.30	57.0	0.404	0.097	0.287	0.00	0.00
14	45.93	**9.47**	**0.173**	1.83	1.375	115	6.89	3.15	8.54	58.8	0.403	0.099	0.293	0.00	0.00
14.05	46.10	**8.83**	**0.179**	2.03	1.379	115	6.40	3.21	9.37	60.0	0.402	0.100	0.297	0.00	0.00
14.1	46.26	**8.67**	**0.179**	2.07	1.384	115	6.27	3.22	9.59	60.1	0.402	0.100	0.298	0.00	0.00
14.15	46.42	**8.95**	**0.278**	3.11	1.388	115	6.45	3.30	10.67	68.8	0.401	0.110	0.328	0.00	0.00
14.2	46.59	**12.36**	**0.401**	3.25	1.392	115	8.88	3.15	8.55	75.9	0.400	0.121	0.360	0.00	0.00
14.25	46.75	**22.22**	**0.449**	2.02	1.397	115	15.91	2.78	4.63	73.6	0.399	0.117	0.350	0.00	0.00
14.3	46.92	**19.89**	**0.454**	2.28	1.401	115	14.20	2.86	5.30	75.2	0.399	0.120	0.358	0.00	0.00
14.35	47.08	**14.46**	**0.516**	3.57	1.405	115	10.29	3.11	7.99	82.2	0.398	0.132	0.395	0.00	0.00
14.4	47.24	**14.44**	**0.565**	3.92	1.410	115	10.24	3.13	8.31	85.1	0.397	0.137	0.412	0.00	0.00
14.45	47.41	**14.84**	**0.447**	3.01	1.414	115	10.50	3.05	7.38	77.4	0.397	0.123	0.370	0.00	0.00
14.5	47.57	**15.34**	**0.375**	2.45	1.418	115	10.82	2.99	6.65	72.0	0.396	0.115	0.345	0.00	0.00
14.55	47.74	**12.38**	**0.393**	3.18	1.423	115	8.70	3.15	8.61	74.9	0.395	0.119	0.359	0.00	0.00
14.6	47.90	**9.87**	**0.325**	3.30	1.427	115	6.92	3.27	10.32	71.4	0.395	0.114	0.344	0.00	0.00
14.65	48.06	**8.57**	**0.243**	2.84	1.431	115	5.99	3.32	10.99	65.8	0.394	0.107	0.323	0.00	0.00
14.7	48.23	**8.07**	**0.201**	2.49	1.435	115	5.62	3.33	11.12	62.5	0.393	0.103	0.312	0.00	0.00
14.75	48.39	**8.31**	**0.189**	2.28	1.440	115	5.77	3.29	10.59	61.1	0.392	0.101	0.308	0.00	0.00
14.8	48.56	**8.14**	**0.19**	2.34	1.444	115	5.64	3.31	10.89	61.4	0.392	0.101	0.309	0.00	0.00
14.85	48.72	**8.25**	**0.211**	2.56	1.448	115	5.70	3.32	11.09	63.2	0.391	0.103	0.316	0.00	0.00
14.9	48.88	**8.39**	**0.277**	3.31	1.453	115	5.78	3.37	11.86	68.5	0.390	0.110	0.336	0.00	0.00
14.95	49.05	**11.7**	**0.301**	2.58	1.457	115	8.03	3.14	8.48	68.1	0.389	0.109	0.335	0.00	0.00
15	49.21	**10.63**	**0.507**	4.77	1.461	115	7.27	3.34	11.31	82.3	0.389	0.132	0.404	0.00	0.00
15.05	49.38	**16.93**	**0.613**	3.62	1.466	115	11.55	3.06	7.42	85.8	0.388	0.139	0.426	0.00	0.00
15.1	49.54	**25.03**	**0.588**	2.35	1.470	115	17.03	2.79	4.70	80.1	0.387	0.128	0.393	0.00	0.00
15.15	49.70	**26.8**	**0.549**	2.05	1.474	115	18.18	2.73	4.22	76.7	0.387	0.122	0.377	0.00	0.00
15.2	49.87	**27.71**	**0.58**	2.09	1.479	115	18.74	2.72	4.17	78.1	0.386	0.124	0.384	0.00	0.00
15.25	50.03	**18.91**	**0.448**	2.37	1.483	115	12.75	2.91	5.82	74.3	0.385	0.118	0.366	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-2**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.41**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
0	0.00														
0.05	0.16	**26.97**	**0.688**	2.57	0.009	115	50.98	1.92	1.21	61.8	0.260	0.102	0.467	0.00	0.00
0.1	0.33	**26.57**	**0.762**	2.88	0.019	115	50.23	2.06	1.38	69.3	0.260	0.111	0.508	0.00	0.00
0.15	0.49	**26.61**	**1.241**	4.68	0.028	115	50.30	2.28	1.88	94.5	0.260	0.159	0.727	0.00	0.00
0.2	0.66	**18.11**	**1.36**	7.52	0.038	120	34.23	2.58	3.21	109.7	0.260	0.203	0.931	0.00	0.00
0.25	0.82	**21.77**	**1.54**	7.09	0.048	120	41.15	2.54	2.99	122.9	0.260	0.253	1.159	0.00	0.00
0.3	0.98	**22.79**	**1.712**	7.52	0.058	120	43.08	2.57	3.17	136.7	0.260	0.318	1.458	0.00	0.00
0.35	1.15	**20.58**	**1.607**	7.82	0.068	120	48.67	2.50	2.78	135.2	0.260	0.310	1.424	0.00	0.00
0.4	1.31	**18.31**	**1.426**	7.80	0.078	120	44.16	2.55	3.04	134.4	0.260	0.306	1.405	0.00	0.00
0.45	1.48	**16.93**	**1.289**	7.63	0.087	120	41.35	2.58	3.23	133.6	0.260	0.302	1.386	0.00	0.00
0.5	1.64	**14.89**	**1.195**	8.04	0.097	120	37.36	2.65	3.68	137.5	0.260	0.322	1.479	0.00	0.00
0.55	1.80	**13.73**	**1.164**	8.49	0.107	120	35.21	2.71	4.09	144.1	0.259	0.358	1.647	0.00	0.00
0.6	1.97	**15.65**	**1.22**	7.81	0.117	120	39.43	2.67	3.75	148.0	0.259	0.382	1.756	0.00	0.00
0.65	2.13	**16.13**	**1.138**	7.07	0.127	120	40.23	2.64	3.57	143.8	0.259	0.356	1.640	0.00	0.00
0.7	2.30	**14.4**	**0.913**	6.35	0.137	120	36.06	2.65	3.64	131.3	0.259	0.290	1.337	0.00	0.00
0.75	2.46	**12.2**	**0.727**	5.97	0.146	120	31.03	2.69	3.93	121.9	0.259	0.249	1.145	0.00	0.00
0.8	2.62	**10.86**	**0.597**	5.51	0.156	120	27.86	2.71	4.10	114.1	0.259	0.218	1.006	0.00	0.00
0.85	2.79	**9.29**	**0.529**	5.71	0.166	120	17.56	2.63	3.50	61.4	0.259	0.102	0.468	0.00	0.00
0.9	2.95	**8.1**	**0.438**	5.42	0.176	120	15.31	2.67	3.77	57.7	0.259	0.098	0.451	0.00	0.00
0.95	3.12	**7.14**	**0.369**	5.18	0.186	120	13.50	2.71	4.06	54.9	0.259	0.095	0.440	0.00	0.00
1	3.28	**6.3**	**0.307**	4.89	0.196	120	11.91	2.75	4.35	51.8	0.259	0.093	0.429	0.00	0.00
1.05	3.44	**6.12**	**0.303**	4.96	0.205	120	11.57	2.78	4.59	53.2	0.258	0.094	0.434	0.00	0.00
1.1	3.61	**7.86**	**0.333**	4.25	0.215	120	14.86	2.66	3.75	55.7	0.258	0.096	0.443	0.00	0.00
1.15	3.77	**8.17**	**0.341**	4.18	0.225	120	15.44	2.66	3.73	57.6	0.258	0.098	0.452	0.00	0.00
1.2	3.94	**7.55**	**0.315**	4.18	0.235	120	14.27	2.70	4.01	57.2	0.258	0.097	0.450	0.00	0.00
1.25	4.10	**6.6**	**0.266**	4.04	0.242	120	12.48	2.75	4.34	54.2	0.261	0.095	0.432	0.00	0.00
1.3	4.27	**5.44**	**0.253**	4.66	0.246	120	10.28	2.86	5.31	54.6	0.267	0.095	0.426	0.00	0.00
1.35	4.43	**5.25**	**0.269**	5.14	0.251	120	9.92	2.91	5.76	57.1	0.272	0.097	0.428	0.00	0.00
1.4	4.59	**4.88**	**0.231**	4.74	0.256	120	9.22	2.92	5.85	54.0	0.276	0.095	0.408	0.00	0.00
1.45	4.76	**3.87**	**0.119**	3.08	0.261	120	7.32	2.89	5.61	41.0	0.281	0.084	0.357	0.00	0.00
1.5	4.92	**3.99**	**0.181**	4.55	0.265	120	7.54	2.99	6.63	50.0	0.285	0.092	0.383	0.00	0.00
1.55	5.09	**4.16**	**0.283**	6.82	0.270	120	7.86	3.09	7.86	61.8	0.290	0.102	0.420	0.00	0.00
1.6	5.25	**5.45**	**0.396**	7.28	0.275	120	10.30	3.03	7.06	72.7	0.294	0.116	0.470	0.00	0.00
1.65	5.41	**14.73**	**0.381**	2.59	0.279	120	35.14	2.52	2.89	101.6	0.298	0.178	0.712	2.30	0.05
1.7	5.58	**18.94**	**0.265**	1.40	0.284	120	34.54	2.36	2.17	74.9	0.302	0.119	0.471	2.70	0.05
1.75	5.74	**22.11**	**0.23**	1.04	0.289	115	40.02	2.24	1.76	70.5	0.305	0.113	0.440	2.90	0.06
1.8	5.91	**21.17**	**0.299**	1.42	0.293	115	38.03	2.33	2.05	78.0	0.309	0.124	0.479	2.60	0.05
1.85	6.07	**23.46**	**0.215**	0.92	0.297	115	41.84	2.19	1.64	68.8	0.313	0.110	0.421	2.90	0.06
1.9	6.23	**21.47**	**0.217**	1.01	0.301	115	38.02	2.25	1.80	68.3	0.316	0.110	0.414	3.10	0.06
1.95	6.40	**15.46**	**0.254**	1.65	0.306	115	27.18	2.49	2.72	74.0	0.319	0.118	0.439	3.10	0.06
2	6.56	**15.16**	**0.198**	1.31	0.310	120	26.45	2.44	2.51	66.3	0.323	0.107	0.396	3.10	0.06
2.05	6.73	**15.07**	**0.159**	1.06	0.315	115	26.11	2.40	2.31	60.4	0.326	0.101	0.368	3.10	0.06
2.1	6.89	**14.36**	**0.127**	0.89	0.319	115	24.71	2.38	2.25	55.5	0.329	0.096	0.348	3.10	0.06
2.15	7.05	**14.44**	**0.084**	0.58	0.324	120	24.67	2.30	1.95	48.1	0.332	0.090	0.324	3.10	0.06
2.2	7.22	**12.15**	**0.173**	1.43	0.329	120	20.61	2.56	3.09	63.7	0.334	0.104	0.371	0.00	0.00
2.25	7.38	**6.59**	**0.193**	2.93	0.333	120	12.46	2.78	4.58	57.1	0.337	0.097	0.344	0.00	0.00
2.3	7.55	**5.85**	**0.219**	3.75	0.338	120	11.06	2.89	5.61	62.0	0.340	0.102	0.359	0.00	0.00
2.35	7.71	**7.39**	**0.139**	1.89	0.343	120	13.97	2.63	3.52	49.2	0.342	0.091	0.317	0.00	0.00
2.4	7.87	**13.48**	**0.197**	1.47	0.347	120	22.23	2.54	2.97	66.0	0.345	0.107	0.369	0.00	0.00
2.45	8.04	**13.89**	**0.278**	2.01	0.352	120	33.26	2.53	2.94	97.9	0.347	0.167	0.575	0.00	0.00
2.5	8.20	**7.23**	**0.256**	3.55	0.357	120	13.67	2.82	4.95	67.6	0.349	0.109	0.371	0.00	0.00
2.55	8.37	**7.42**	**0.245**	3.31	0.362	120	14.03	2.80	4.74	66.5	0.352	0.107	0.364	0.00	0.00
2.6	8.53	**10.16**	**0.29**	2.86	0.366	120	19.21	2.65	3.63	69.8	0.354	0.112	0.376	0.00	0.00
2.65	8.69	**9.73**	**0.169**	1.74	0.371	120	24.32	2.64	3.61	87.8	0.356	0.143	0.479	0.00	0.00
2.7	8.86	**12.67**	**0.113**	0.89	0.376	120	20.09	2.47	2.62	52.6	0.358	0.094	0.311	0.00	0.00
2.75	9.02	**8.92**	**0.207**	2.33	0.381	120	16.86	2.65	3.67	61.9	0.360	0.102	0.338	0.00	0.00
2.8	9.19	**7.29**	**0.177**	2.43	0.385	120	13.78	2.75	4.34	59.8	0.362	0.100	0.329	0.00	0.00
2.85	9.35	**7.46**	**0.199**	2.67	0.390	120	14.10	2.77	4.50	63.5	0.364	0.104	0.340	0.00	0.00
2.9	9.51	**6.93**	**0.234**	3.38	0.395	120	13.10	2.86	5.32	69.6	0.366	0.111	0.363	0.00	0.00
2.95	9.68	**15.08**	**0.16**	1.06	0.399	115	23.21	2.45	2.53	58.7	0.368	0.099	0.320	3.53	0.07
3	9.84	**31.27**	**0.253**	0.81	0.403	115	47.87	2.11	1.48	70.8	0.370	0.113	0.365	2.70	0.05
3.05	10.01	**39.14**	**0.412**	1.06	0.408	115	59.60	2.10	1.45	86.5	0.372	0.140	0.450	2.40	0.05
3.1	10.17	**49.21**	**0.596**	1.21	0.412	115	74.54	2.06	1.38	103.0	0.373	0.182	0.580	2.00	0.04
3.15	10.33	**59.4**	**0.754**	1.27	0.416	115	89.51	2.01	1.31	117.4	0.375	0.231	0.733	2.00	0.04
3.2	10.50	**59.24**	**0.865**	1.46	0.421	115	88.80	2.05	1.37	122.1	0.377	0.249	0.788	1.76	0.03
3.25	10.66	**59.4**	**0.894**	1.51	0.425	115	88.59	2.06	1.39	123.1	0.379	0.254	0.799	1.76	0.03

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-2**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.41**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
3.3	10.83	**53.9**	**0.908**	1.69	0.429	115	79.98	2.13	1.51	120.6	0.380	0.243	0.763	1.91	0.04
3.35	10.99	**47.62**	**0.847**	1.78	0.434	115	70.31	2.19	1.63	114.8	0.382	0.221	0.689	2.00	0.04
3.4	11.15	**43.31**	**0.73**	1.69	0.438	115	63.63	2.20	1.67	106.6	0.383	0.193	0.599	2.30	0.05
3.45	11.32	**43.28**	**0.72**	1.67	0.442	115	63.28	2.20	1.67	105.7	0.385	0.190	0.588	2.30	0.05
3.5	11.48	**41.32**	**0.632**	1.53	0.446	115	60.12	2.19	1.65	99.5	0.386	0.172	0.529	2.30	0.05
3.55	11.65	**39.63**	**0.603**	1.53	0.451	115	57.38	2.21	1.69	97.0	0.388	0.165	0.507	2.40	0.05
3.6	11.81	**45.03**	**0.549**	1.22	0.455	115	64.89	2.11	1.47	95.2	0.389	0.160	0.491	2.30	0.05
3.65	11.98	**53.66**	**0.462**	0.86	0.459	115	76.97	1.96	1.25	95.9	0.391	0.162	0.495	2.30	0.05
3.7	12.14	**68.61**	**0.733**	1.07	0.464	115	97.95	1.93	1.22	119.4	0.392	0.238	0.725	1.84	0.04
3.75	12.30	**61.05**	**1.017**	1.67	0.468	115	86.75	2.10	1.45	126.0	0.394	0.266	0.807	1.77	0.03
3.8	12.47	**49.99**	**1.011**	2.03	0.472	115	70.71	2.22	1.72	121.8	0.395	0.248	0.750	2.00	0.04
3.85	12.63	**40.59**	**0.766**	1.89	0.477	115	57.16	2.27	1.86	106.3	0.396	0.192	0.578	1.84	0.04
3.9	12.80	**39.64**	**0.606**	1.53	0.481	115	55.57	2.22	1.72	95.7	0.397	0.162	0.485	2.40	0.05
3.95	12.96	**48.52**	**0.429**	0.89	0.485	115	67.71	2.01	1.31	88.8	0.399	0.145	0.434	2.40	0.05
4	13.12	**75.63**	**0.732**	0.97	0.490	115	105.08	1.88	1.17	123.0	0.400	0.253	0.754	1.77	0.03
4.05	13.29	**91.22**	**1.051**	1.15	0.494	115	126.19	1.87	1.16	146.6	0.401	0.373	1.109	1.48	0.00
4.1	13.45	**99.86**	**1.257**	1.26	0.498	115	137.54	1.87	1.16	159.7	0.402	0.459	1.361	1.40	0.00
4.15	13.62	**105.9**	**1.448**	1.37	0.503	115	145.23	1.88	1.17	169.8	0.403	0.535	1.583	1.25	0.00
4.2	13.78	**105.54**	**1.48**	1.41	0.507	115	144.12	1.89	1.18	169.8	0.404	0.535	1.579	1.25	0.00
4.25	13.94	**95.98**	**1.395**	1.46	0.511	115	130.51	1.93	1.22	159.0	0.406	0.454	1.335	1.48	0.00
4.3	14.11	**98.78**	**1.293**	1.31	0.516	115	133.75	1.89	1.18	157.8	0.407	0.445	1.306	1.40	0.00
4.35	14.27	**107.29**	**1.327**	1.24	0.520	115	144.67	1.85	1.14	165.5	0.408	0.501	1.467	1.25	0.00
4.4	14.44	**129.03**	**1.705**	1.32	0.524	115	173.27	1.81	1.12	193.7	0.409	0.755	2.204	0.90	0.00
4.45	14.60	**148.21**	**2.119**	1.43	0.528	115	198.21	1.80	1.11	219.6	0.410	1.065	3.100	0.00	0.00
4.5	14.76	**152.02**	**2.009**	1.32	0.533	115	202.48	1.77	1.09	219.7	0.411	1.067	3.097	0.05	0.00
4.55	14.93	**147.64**	**2.055**	1.39	0.537	115	195.86	1.80	1.10	216.2	0.412	1.020	2.955	0.15	0.00
4.6	15.09	**141.27**	**2.098**	1.49	0.541	115	186.66	1.83	1.13	211.0	0.413	0.953	2.755	0.44	0.00
4.65	15.26	**143.09**	**2.2**	1.54	0.546	115	188.31	1.84	1.14	214.2	0.414	0.994	2.865	0.44	0.00
4.7	15.42	**128.28**	**1.936**	1.51	0.550	115	168.16	1.87	1.16	194.9	0.415	0.768	2.210	0.93	0.00
4.75	15.58	**108.85**	**1.674**	1.54	0.554	115	142.13	1.92	1.21	172.0	0.415	0.554	1.589	1.33	0.00
4.8	15.75	**87.07**	**1.472**	1.69	0.559	115	113.25	2.02	1.33	150.4	0.416	0.396	1.135	1.70	0.00
4.85	15.91	**67.12**	**1.241**	1.85	0.563	115	86.97	2.13	1.51	131.5	0.417	0.291	0.833	1.77	0.03
4.9	16.08	**60.17**	**1.082**	1.80	0.567	115	77.67	2.16	1.57	121.9	0.418	0.248	0.709	1.91	0.04
4.95	16.24	**59.65**	**0.922**	1.55	0.572	115	76.70	2.12	1.49	114.1	0.419	0.218	0.621	1.91	0.04
5	16.40	**60.21**	**0.935**	1.56	0.576	115	77.13	2.12	1.49	114.7	0.420	0.220	0.626	1.91	0.04
5.05	16.57	**60.26**	**0.96**	1.60	0.580	115	76.91	2.13	1.50	115.6	0.421	0.224	0.634	1.91	0.04
5.1	16.73	**68.07**	**0.946**	1.39	0.585	115	86.56	2.05	1.37	118.3	0.421	0.234	0.662	1.78	0.04
5.15	16.90	**92.38**	**1.066**	1.16	0.589	115	117.04	1.89	1.18	138.6	0.422	0.327	0.925	1.63	0.03
5.2	17.06	**123.44**	**1.494**	1.21	0.593	115	155.82	1.82	1.12	174.7	0.423	0.576	1.623	1.19	0.00
5.25	17.22	**129.2**	**1.783**	1.38	0.597	115	162.50	1.85	1.14	185.8	0.424	0.677	1.905	1.04	0.00
5.3	17.39	**122.92**	**1.831**	1.49	0.602	115	154.05	1.89	1.18	181.4	0.424	0.636	1.787	1.19	0.00
5.35	17.55	**135.38**	**1.871**	1.38	0.606	115	169.06	1.84	1.13	191.8	0.425	0.736	2.066	0.95	0.00
5.4	17.72	**141.33**	**1.959**	1.39	0.610	115	175.86	1.83	1.13	198.1	0.426	0.803	2.249	0.81	0.00
5.45	17.88	**138.94**	**1.857**	1.34	0.615	115	172.28	1.82	1.12	193.3	0.426	0.751	2.102	0.95	0.00
5.5	18.04	**134.57**	**1.524**	1.13	0.619	115	166.28	1.78	1.09	181.5	0.427	0.636	1.776	1.04	0.00
5.55	18.21	**135.7**	**1.68**	1.24	0.623	115	167.09	1.81	1.11	185.6	0.428	0.674	1.880	1.04	0.00
5.6	18.37	**130.02**	**1.645**	1.27	0.628	115	159.55	1.83	1.13	179.7	0.428	0.619	1.725	1.12	0.00
5.65	18.54	**130.37**	**1.592**	1.22	0.632	115	159.43	1.82	1.12	178.2	0.429	0.606	1.686	1.12	0.00
5.7	18.70	**135.75**	**1.716**	1.27	0.636	115	165.45	1.81	1.12	184.9	0.430	0.668	1.854	1.04	0.00
5.75	18.86	**130.11**	**2.068**	1.59	0.641	115	158.04	1.90	1.19	188.1	0.430	0.699	1.939	1.12	0.00
5.8	19.03	**97.85**	**2.34**	2.39	0.645	115	118.46	2.12	1.49	176.4	0.431	0.590	1.634	1.34	0.00
5.85	19.19	**56.33**	**2.095**	3.72	0.649	115	67.97	2.42	2.41	164.1	0.431	0.491	1.358	1.64	0.00
5.9	19.36	**27.5**	**1.55**	5.64	0.654	115	42.08	2.71	4.09	172.2	0.432	0.555	1.533	0.00	0.00
5.95	19.52	**19.15**	**1.027**	5.37	0.658	115	29.11	2.82	4.93	143.4	0.432	0.354	0.977	0.00	0.00
6	19.69	**18.01**	**0.763**	4.24	0.662	115	27.20	2.77	4.54	123.4	0.433	0.255	0.701	0.00	0.00
6.05	19.85	**17.13**	**0.753**	4.40	0.667	115	25.70	2.80	4.79	123.1	0.434	0.253	0.697	0.00	0.00
6.1	20.00	**17.71**	**0.682**	3.85	0.670	115	26.41	2.75	4.40	116.2	0.434	0.226	0.621	0.00	0.00
6.15	20.18	**19.08**	**0.806**	4.23	0.675	115	28.26	2.76	4.42	125.0	0.435	0.262	0.718	0.00	0.00
6.2	20.34	**16.83**	**0.742**	4.41	0.679	115	24.77	2.81	4.91	121.5	0.435	0.247	0.677	0.00	0.00
6.25	20.51	**19.06**	**0.87**	4.57	0.684	115	27.87	2.78	4.65	129.5	0.436	0.282	0.772	0.00	0.00
6.3	20.67	**19.82**	**0.878**	4.43	0.688	115	28.80	2.76	4.48	129.1	0.436	0.280	0.767	0.00	0.00
6.35	20.83	**17.62**	**0.92**	5.22	0.692	115	25.45	2.85	5.26	134.0	0.437	0.304	0.830	0.00	0.00
6.4	21.00	**18.72**	**0.995**	5.32	0.697	115	26.87	2.84	5.14	138.2	0.437	0.326	0.889	0.00	0.00
6.45	21.16	**17.75**	**1.083**	6.11	0.701	115	25.32	2.90	5.72	144.9	0.437	0.363	0.989	0.00	0.00
6.5	21.33	**17.82**	**1.127**	6.33	0.705	115	25.26	2.91	5.84	147.5	0.438	0.378	1.030	0.00	0.00
6.55	21.49	**16.55**	**1.077**	6.51	0.710	115	23.32	2.95	6.20	144.6	0.438	0.361	0.983	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-2**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.41**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
6.6	21.65	**17.6**	**1.101**	6.26	0.714	115	24.65	2.92	5.89	145.1	0.439	0.364	0.990	0.00	0.00
6.65	21.82	**17**	**1.171**	6.89	0.718	115	23.67	2.96	6.33	149.8	0.439	0.393	1.067	0.00	0.00
6.7	21.98	**17.17**	**1.216**	7.09	0.723	115	23.76	2.97	6.40	152.2	0.439	0.408	1.107	0.00	0.00
6.75	22.15	**15.28**	**1.094**	7.17	0.727	115	21.02	3.01	6.90	145.1	0.440	0.364	0.987	0.00	0.00
6.8	22.31	**16.07**	**0.83**	5.17	0.731	115	21.98	2.90	5.72	125.8	0.440	0.265	0.718	0.00	0.00
6.85	22.47	**24.21**	**0.606**	2.51	0.736	115	59.18	2.59	3.24	192.0	0.441	0.738	1.998	0.00	0.00
6.9	22.64	**23.35**	**0.516**	2.21	0.740	115	26.39	2.59	3.26	85.9	0.441	0.139	0.376	0.00	0.00
6.95	22.80	**13.86**	**0.483**	3.49	0.744	115	18.62	2.85	5.25	97.9	0.441	0.167	0.452	0.00	0.00
7	22.97	**10**	**0.362**	3.62	0.748	115	13.36	2.99	6.67	89.1	0.442	0.146	0.393	0.00	0.00
7.05	23.13	**10.72**	**0.35**	3.27	0.753	115	14.24	2.94	6.11	87.0	0.442	0.141	0.381	0.00	0.00
7.1	23.29	**9.44**	**0.368**	3.90	0.757	115	12.47	3.04	7.20	89.8	0.442	0.147	0.397	0.00	0.00
7.15	23.46	**9.16**	**0.323**	3.53	0.761	115	12.03	3.03	7.08	85.1	0.443	0.137	0.370	0.00	0.00
7.2	23.62	**9.11**	**0.32**	3.52	0.766	115	11.90	3.03	7.12	84.7	0.443	0.137	0.368	0.00	0.00
7.25	23.79	**9.18**	**0.343**	3.74	0.770	115	11.92	3.05	7.29	87.0	0.443	0.141	0.380	0.00	0.00
7.3	23.95	**11.99**	**0.412**	3.44	0.774	115	15.48	2.92	5.91	91.5	0.443	0.151	0.407	0.00	0.00
7.35	24.11	**12.05**	**0.404**	3.36	0.779	115	15.47	2.91	5.85	90.5	0.444	0.149	0.400	0.00	0.00
7.4	24.28	**13.36**	**0.261**	1.96	0.783	115	17.06	2.74	4.30	73.4	0.444	0.117	0.314	0.00	0.00
7.45	24.44	**10.6**	**0.306**	2.89	0.787	115	13.46	2.93	6.03	81.2	0.444	0.130	0.348	0.00	0.00
7.5	24.61	**9.21**	**0.379**	4.12	0.792	115	11.63	3.08	7.72	89.8	0.444	0.147	0.395	0.00	0.00
7.55	24.77	**29.29**	**0.522**	1.78	0.796	115	31.92	2.46	2.59	82.7	0.445	0.133	0.356	0.00	0.00
7.6	24.93	**12.81**	**0.592**	4.63	0.800	115	16.01	2.99	6.61	105.8	0.445	0.190	0.510	0.00	0.00
7.65	25.10	**19.39**	**0.378**	1.95	0.805	115	24.10	2.60	3.36	80.9	0.445	0.129	0.346	0.00	0.00
7.7	25.26	**10.49**	**0.53**	5.06	0.809	115	12.97	3.09	7.85	101.8	0.445	0.178	0.477	0.00	0.00
7.75	25.43	**11.61**	**0.334**	2.88	0.813	115	14.28	2.91	5.78	82.5	0.445	0.132	0.354	0.00	0.00
7.8	25.59	**40.1**	**0.467**	1.17	0.818	115	43.12	2.25	1.78	77.0	0.446	0.122	0.328	2.90	0.06
7.85	25.75	**52.53**	**0.636**	1.21	0.822	115	56.33	2.16	1.57	88.4	0.446	0.144	0.386	2.40	0.05
7.9	25.92	**74.47**	**1.03**	1.39	0.826	115	79.65	2.07	1.41	112.4	0.446	0.212	0.567	1.91	0.04
7.95	26.08	**89.58**	**1.428**	1.60	0.830	115	95.57	2.06	1.38	132.0	0.446	0.294	0.786	1.64	0.03
8	26.25	**85.19**	**1.578**	1.85	0.835	115	90.65	2.12	1.49	135.1	0.446	0.309	0.826	1.71	0.03
8.05	26.41	**89.18**	**1.718**	1.93	0.839	115	94.65	2.12	1.49	140.8	0.446	0.339	0.907	1.71	0.03
8.1	26.57	**88.54**	**1.754**	1.98	0.843	115	93.73	2.13	1.51	141.5	0.447	0.344	0.918	1.71	0.03
8.15	26.74	**83.54**	**1.523**	1.83	0.848	115	88.21	2.12	1.50	132.1	0.447	0.294	0.786	1.78	0.04
8.2	26.90	**97.35**	**1.521**	1.57	0.852	115	102.53	2.03	1.34	137.3	0.447	0.321	0.856	1.78	0.04
8.25	27.07	**117.78**	**1.924**	1.64	0.856	115	123.74	1.98	1.28	158.3	0.447	0.449	1.198	1.57	0.00
8.3	27.23	**126.66**	**2.339**	1.85	0.861	115	132.73	2.00	1.30	172.9	0.447	0.560	1.496	1.42	0.00
8.35	27.40	**120.63**	**2.464**	2.04	0.865	115	126.10	2.05	1.37	172.8	0.447	0.560	1.493	1.20	0.00
8.4	27.56	**113.22**	**2.348**	2.08	0.869	115	118.06	2.07	1.41	166.4	0.447	0.508	1.356	1.34	0.00
8.45	27.72	**106.28**	**2.215**	2.09	0.874	115	110.55	2.09	1.45	159.8	0.447	0.460	1.226	1.42	0.00
8.5	27.89	**101.21**	**1.94**	1.92	0.878	115	105.02	2.08	1.43	149.8	0.447	0.393	1.047	1.50	0.00
8.55	28.05	**106.93**	**1.834**	1.72	0.882	115	110.68	2.03	1.35	149.0	0.447	0.388	1.033	1.71	0.00
8.6	28.22	**115.69**	**2.04**	1.77	0.887	115	119.45	2.02	1.33	158.3	0.447	0.449	1.197	1.64	0.00
8.65	28.38	**124.61**	**2.28**	1.83	0.891	115	128.35	2.01	1.31	168.4	0.447	0.524	1.397	1.50	0.00
8.7	28.54	**112.05**	**2.21**	1.97	0.895	115	115.14	2.07	1.40	160.6	0.447	0.465	1.241	1.34	0.00
8.75	28.71	**107.94**	**2.069**	1.92	0.899	115	110.65	2.07	1.40	154.9	0.447	0.426	1.135	1.42	0.00
8.8	28.87	**108.84**	**2.11**	1.94	0.904	115	111.30	2.07	1.40	156.2	0.448	0.434	1.157	1.42	0.00
8.85	29.04	**96.96**	**1.96**	2.02	0.908	115	98.92	2.12	1.49	147.4	0.448	0.378	1.007	1.64	0.00
8.9	29.20	**86.14**	**1.654**	1.92	0.912	115	87.67	2.14	1.53	134.4	0.447	0.306	0.816	1.78	0.04
8.95	29.36	**84.62**	**1.551**	1.84	0.917	115	85.92	2.13	1.52	130.4	0.447	0.286	0.763	1.78	0.04
9	29.53	**84.58**	**1.488**	1.76	0.921	115	85.68	2.12	1.50	128.1	0.447	0.276	0.735	1.78	0.04
9.05	29.69	**83.81**	**1.545**	1.85	0.925	115	84.70	2.14	1.53	129.7	0.447	0.283	0.754	1.84	0.04
9.1	29.86	**82.1**	**1.636**	2.00	0.930	115	82.78	2.17	1.60	132.2	0.447	0.295	0.786	1.84	0.04
9.15	30.02	**74.61**	**1.38**	1.85	0.934	115	75.06	2.18	1.62	121.4	0.447	0.247	0.657	1.91	0.04
9.2	30.18	**81.46**	**1.439**	1.77	0.938	115	81.76	2.14	1.53	124.9	0.447	0.261	0.697	1.84	0.04
9.25	30.35	**100.75**	**1.643**	1.63	0.943	115	100.89	2.05	1.37	137.8	0.447	0.324	0.863	1.57	0.03
9.3	30.51	**100.35**	**1.646**	1.64	0.947	115	100.26	2.05	1.37	137.6	0.447	0.322	0.859	1.57	0.03
9.35	30.68	**92.81**	**1.744**	1.88	0.951	115	92.51	2.12	1.49	137.6	0.447	0.322	0.860	1.71	0.03
9.4	30.84	**80.59**	**1.644**	2.04	0.956	115	80.15	2.19	1.64	131.2	0.447	0.290	0.774	1.84	0.04
9.45	31.00	**60.81**	**1.257**	2.07	0.960	115	60.34	2.28	1.90	114.5	0.447	0.220	0.586	1.78	0.04
9.5	31.17	**46.31**	**1.311**	2.83	0.964	115	45.85	2.47	2.61	119.5	0.447	0.239	0.638	2.15	0.04
9.55	31.33	**26.51**	**0.982**	3.71	0.969	115	27.37	2.73	4.23	115.7	0.447	0.224	0.599	0.00	0.00
9.6	31.50	**32.31**	**0.677**	2.10	0.973	115	31.85	2.51	2.82	89.7	0.447	0.147	0.393	2.40	0.05
9.65	31.66	**49.75**	**0.612**	1.23	0.977	115	48.93	2.21	1.70	83.3	0.446	0.134	0.357	2.70	0.05
9.7	31.82	**72.65**	**0.902**	1.24	0.981	115	71.29	2.08	1.43	101.6	0.446	0.178	0.475	2.00	0.04
9.75	31.99	**89.43**	**1.335**	1.50	0.986	115	87.57	2.07	1.40	122.3	0.446	0.250	0.669	1.78	0.04
9.8	32.15	**88.84**	**1.785**	2.01	0.990	115	86.80	2.16	1.57	136.3	0.446	0.315	0.844	1.78	0.04
9.85	32.32	**74.5**	**2.073**	2.79	0.994	115	72.63	2.31	2.00	145.0	0.446	0.363	0.972	1.57	0.03

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-2**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.41**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
9.9	32.48	**43.62**	**2.008**	4.61	0.999	115	43.68	2.64	3.58	156.2	0.446	0.434	1.162	0.00	0.00
9.95	32.64	**25.85**	**1.328**	5.14	1.003	115	25.77	2.85	5.20	133.9	0.445	0.303	0.813	0.00	0.00
10	32.81	**20.75**	**1.072**	5.17	1.008	120	20.59	2.93	5.97	123.0	0.445	0.253	0.678	0.00	0.00
10.05	32.97	**21.3**	**1.1**	5.17	1.012	120	21.04	2.92	5.89	124.0	0.445	0.257	0.690	0.00	0.00
10.1	33.14	**21.44**	**1.202**	5.61	1.017	120	21.08	2.94	6.13	129.2	0.445	0.281	0.753	0.00	0.00
10.15	33.30	**22.2**	**1.282**	5.78	1.022	120	21.72	2.94	6.11	132.7	0.444	0.297	0.798	0.00	0.00
10.2	33.46	**20.84**	**1.115**	5.35	1.027	120	20.30	2.94	6.13	124.4	0.444	0.259	0.696	0.00	0.00
10.25	33.63	**18.14**	**0.924**	5.10	1.031	120	17.59	2.98	6.54	115.0	0.444	0.221	0.595	0.00	0.00
10.3	33.79	**14.93**	**0.755**	5.06	1.036	120	14.41	3.05	7.38	106.3	0.443	0.192	0.516	0.00	0.00
10.35	33.96	**12.6**	**0.56**	4.45	1.041	120	12.11	3.09	7.80	94.4	0.443	0.158	0.426	0.00	0.00
10.4	34.12	**11.8**	**0.541**	4.59	1.046	120	11.29	3.13	8.27	93.3	0.443	0.156	0.419	0.00	0.00
10.45	34.28	**13.94**	**0.712**	5.11	1.050	120	13.27	3.09	7.80	103.5	0.442	0.183	0.494	0.00	0.00
10.5	34.45	**17.01**	**1.084**	6.38	1.055	120	16.12	3.08	7.64	123.2	0.442	0.254	0.685	0.00	0.00
10.55	34.61	**20.77**	**1.345**	6.48	1.060	120	19.60	3.01	6.86	134.5	0.442	0.306	0.828	0.00	0.00
10.6	34.78	**20.39**	**1.405**	6.89	1.064	120	19.16	3.04	7.17	137.3	0.441	0.321	0.867	0.00	0.00
10.65	34.94	**17.37**	**1.194**	6.88	1.069	120	16.25	3.10	7.88	128.0	0.441	0.275	0.744	0.00	0.00
10.7	35.10	**14.9**	**0.975**	6.55	1.074	120	13.87	3.14	8.45	117.3	0.440	0.230	0.623	0.00	0.00
10.75	35.27	**14.15**	**0.886**	6.27	1.079	120	13.12	3.15	8.58	112.5	0.440	0.212	0.576	0.00	0.00
10.8	35.43	**12.09**	**0.825**	6.83	1.083	120	11.16	3.24	9.80	109.4	0.440	0.202	0.547	0.00	0.00
10.85	35.60	**11.56**	**0.821**	7.11	1.088	120	10.62	3.27	10.26	109.0	0.439	0.200	0.544	0.00	0.00
10.9	35.76	**13.93**	**0.908**	6.52	1.093	120	12.75	3.17	8.88	113.2	0.439	0.215	0.584	0.00	0.00
10.95	35.93	**15.29**	**1.006**	6.58	1.098	120	13.93	3.14	8.45	117.8	0.438	0.232	0.631	0.00	0.00
11	36.09	**13.31**	**0.874**	6.57	1.102	120	12.08	3.20	9.20	111.1	0.438	0.208	0.565	0.00	0.00
11.05	36.25	**11.94**	**0.728**	6.10	1.107	120	10.79	3.22	9.56	103.1	0.438	0.182	0.496	0.00	0.00
11.1	36.42	**11.69**	**0.673**	5.76	1.112	120	10.52	3.22	9.49	99.8	0.437	0.172	0.471	0.00	0.00
11.15	36.58	**12.46**	**0.655**	5.26	1.116	120	11.16	3.17	8.81	98.4	0.437	0.168	0.460	0.00	0.00
11.2	36.75	**12.95**	**0.566**	4.37	1.121	120	11.55	3.11	7.99	92.3	0.436	0.153	0.419	0.00	0.00
11.25	36.91	**14.36**	**0.594**	4.14	1.126	120	12.75	3.05	7.32	93.4	0.436	0.156	0.426	0.00	0.00
11.3	37.07	**14.11**	**0.572**	4.06	1.131	120	12.48	3.05	7.36	91.9	0.435	0.152	0.417	0.00	0.00
11.35	37.24	**14.55**	**0.551**	3.79	1.135	120	12.82	3.03	7.03	90.1	0.435	0.148	0.406	0.00	0.00
11.4	37.40	**15.41**	**0.589**	3.83	1.140	120	13.52	3.01	6.81	92.1	0.434	0.153	0.419	0.00	0.00
11.45	37.57	**14.92**	**0.606**	4.06	1.145	120	13.03	3.04	7.16	93.3	0.434	0.156	0.428	0.00	0.00
11.5	37.73	**14.13**	**0.56**	3.97	1.149	120	12.29	3.05	7.37	90.6	0.433	0.149	0.410	0.00	0.00
11.55	37.89	**14.1**	**0.538**	3.82	1.154	120	12.22	3.05	7.28	89.0	0.433	0.145	0.401	0.00	0.00
11.6	38.06	**13.81**	**0.549**	3.98	1.159	120	11.92	3.07	7.53	89.8	0.432	0.147	0.406	0.00	0.00
11.65	38.22	**13.94**	**0.55**	3.95	1.164	120	11.98	3.06	7.48	89.6	0.432	0.147	0.406	0.00	0.00
11.7	38.39	**13.51**	**0.537**	3.98	1.168	120	11.56	3.08	7.69	88.9	0.431	0.145	0.402	0.00	0.00
11.75	38.55	**13.37**	**0.493**	3.69	1.173	120	11.40	3.07	7.53	85.8	0.431	0.139	0.384	0.00	0.00
11.8	38.71	**12.86**	**0.452**	3.52	1.178	120	10.92	3.07	7.60	83.0	0.430	0.133	0.369	0.00	0.00
11.85	38.88	**12.6**	**0.44**	3.50	1.183	120	10.65	3.08	7.71	82.2	0.430	0.132	0.365	0.00	0.00
11.9	39.04	**12.2**	**0.421**	3.45	1.187	120	10.28	3.10	7.87	80.9	0.429	0.129	0.359	0.00	0.00
11.95	39.21	**11.69**	**0.407**	3.49	1.192	120	9.81	3.12	8.16	80.1	0.429	0.128	0.355	0.00	0.00
12	39.37	**11.26**	**0.388**	3.45	1.197	120	9.41	3.13	8.37	78.8	0.428	0.125	0.350	0.00	0.00
12.05	39.53	**10.89**	**0.37**	3.40	1.201	120	9.06	3.15	8.55	77.5	0.427	0.123	0.344	0.00	0.00
12.1	39.70	**10.51**	**0.355**	3.38	1.206	120	8.71	3.17	8.77	76.5	0.427	0.122	0.340	0.00	0.00
12.15	39.86	**10.17**	**0.339**	3.34	1.211	120	8.40	3.18	8.96	75.3	0.426	0.120	0.335	0.00	0.00
12.2	40.03	**10.05**	**0.323**	3.22	1.216	120	8.27	3.18	8.95	74.0	0.426	0.118	0.330	0.00	0.00
12.25	40.19	**10.08**	**0.324**	3.22	1.220	120	8.26	3.18	8.96	74.0	0.425	0.118	0.330	0.00	0.00
12.3	40.35	**10.22**	**0.374**	3.66	1.225	120	8.34	3.21	9.32	77.8	0.425	0.124	0.348	0.00	0.00
12.35	40.52	**12.4**	**0.42**	3.39	1.230	120	10.08	3.10	7.92	79.9	0.424	0.127	0.359	0.00	0.00
12.4	40.68	**14.13**	**0.498**	3.53	1.235	120	11.45	3.05	7.37	84.4	0.423	0.136	0.383	0.00	0.00
12.45	40.85	**15.45**	**0.5**	3.24	1.239	120	12.47	3.00	6.71	83.7	0.423	0.134	0.379	0.00	0.00
12.5	41.01	**13.35**	**0.523**	3.92	1.244	120	10.73	3.11	8.04	86.3	0.422	0.140	0.395	0.00	0.00
12.55	41.17	**13.66**	**0.535**	3.92	1.249	120	10.94	3.10	7.94	86.8	0.421	0.141	0.399	0.00	0.00
12.6	41.34	**13.16**	**0.534**	4.06	1.253	120	10.50	3.13	8.27	86.9	0.421	0.141	0.400	0.00	0.00
12.65	41.50	**13.36**	**0.487**	3.65	1.258	120	10.62	3.10	7.87	83.6	0.420	0.134	0.381	0.00	0.00
12.7	41.67	**14.33**	**0.472**	3.30	1.263	120	11.35	3.04	7.22	81.9	0.420	0.131	0.373	0.00	0.00
12.75	41.83	**14.36**	**0.51**	3.55	1.268	120	11.33	3.06	7.45	84.4	0.419	0.136	0.387	0.00	0.00
12.8	41.99	**12.24**	**0.517**	4.23	1.272	120	9.62	3.18	8.92	85.8	0.418	0.139	0.396	0.00	0.00
12.85	42.16	**12.13**	**0.562**	4.64	1.277	120	9.50	3.20	9.32	88.5	0.418	0.145	0.413	0.00	0.00
12.9	42.32	**13.29**	**0.63**	4.74	1.282	120	10.37	3.17	8.88	92.0	0.417	0.152	0.436	0.00	0.00
12.95	42.49	**13.07**	**0.648**	4.96	1.286	120	10.16	3.19	9.16	93.0	0.416	0.155	0.444	0.00	0.00
13	42.65	**12.86**	**0.748**	5.82	1.291	120	9.96	3.24	9.87	98.3	0.416	0.168	0.483	0.00	0.00
13.05	42.81	**11.58**	**0.688**	5.95	1.296	115	8.94	3.30	10.66	95.3	0.415	0.160	0.461	0.00	0.00
13.1	42.98	**9.61**	**0.506**	5.27	1.300	115	7.39	3.35	11.55	85.4	0.414	0.138	0.397	0.00	0.00
13.15	43.14	**8.09**	**0.389**	4.82	1.304	115	6.20	3.42	12.64	78.4	0.414	0.125	0.360	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-2**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.41**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
13.2	43.31	**9.89**	**0.454**	4.60	1.308	115	7.56	3.31	10.84	81.9	0.413	0.131	0.379	0.00	0.00
13.25	43.47	**9.69**	**0.414**	4.28	1.313	115	7.38	3.30	10.75	79.3	0.413	0.126	0.365	0.00	0.00
13.3	43.64	**8.62**	**0.345**	4.01	1.317	115	6.54	3.35	11.45	74.9	0.412	0.119	0.345	0.00	0.00
13.35	43.80	**9.12**	**0.346**	3.80	1.321	115	6.90	3.31	10.82	74.7	0.411	0.119	0.344	0.00	0.00
13.4	43.96	**10.51**	**0.403**	3.84	1.326	115	7.93	3.24	9.84	78.0	0.411	0.124	0.361	0.00	0.00
13.45	44.13	**11.22**	**0.433**	3.86	1.330	115	8.44	3.21	9.44	79.6	0.410	0.127	0.369	0.00	0.00
13.5	44.29	**10.91**	**0.416**	3.82	1.334	115	8.18	3.23	9.61	78.6	0.409	0.125	0.364	0.00	0.00
13.55	44.46	**10.5**	**0.408**	3.89	1.339	115	7.84	3.25	9.96	78.1	0.409	0.124	0.363	0.00	0.00
13.6	44.62	**12.09**	**0.511**	4.23	1.343	115	9.00	3.21	9.34	84.1	0.408	0.135	0.395	0.00	0.00
13.65	44.78	**17.91**	**0.681**	3.80	1.347	115	13.29	3.01	6.88	91.5	0.407	0.151	0.443	0.00	0.00
13.7	44.95	**30.4**	**0.988**	3.25	1.352	115	22.49	2.77	4.51	101.4	0.407	0.177	0.519	0.00	0.00
13.75	45.11	**26.07**	**1.034**	3.97	1.356	115	19.23	2.88	5.50	105.7	0.406	0.190	0.558	0.00	0.00
13.8	45.28	**23.3**	**1.259**	5.41	1.360	115	17.13	3.01	6.84	117.2	0.405	0.230	0.676	0.00	0.00
13.85	45.44	**25.51**	**1.206**	4.73	1.365	115	18.69	2.94	6.09	113.8	0.405	0.217	0.639	0.00	0.00
13.9	45.60	**33.71**	**1.139**	3.38	1.369	115	24.63	2.74	4.33	106.6	0.404	0.193	0.569	0.00	0.00
13.95	45.77	**35.45**	**1.122**	3.17	1.373	115	25.82	2.71	4.06	104.8	0.403	0.187	0.553	0.00	0.00
14	45.93	**19.89**	**0.896**	4.51	1.378	115	14.44	3.02	7.02	101.3	0.403	0.177	0.523	0.00	0.00
14.05	46.10	**12.11**	**0.521**	4.31	1.382	115	8.76	3.22	9.58	83.9	0.402	0.135	0.401	0.00	0.00
14.1	46.26	**9.82**	**0.302**	3.08	1.386	115	7.08	3.25	9.90	70.1	0.401	0.112	0.333	0.00	0.00
14.15	46.42	**12.2**	**0.337**	2.76	1.390	115	8.77	3.12	8.13	71.3	0.401	0.114	0.339	0.00	0.00
14.2	46.59	**12.81**	**0.711**	5.56	1.395	115	9.18	3.27	10.22	93.9	0.400	0.157	0.468	0.00	0.00
14.25	46.75	**22.39**	**0.889**	3.97	1.399	115	16.00	2.95	6.20	99.3	0.399	0.171	0.511	0.00	0.00
14.3	46.92	**55.02**	**0.732**	1.33	1.403	115	45.15	2.27	1.85	83.4	0.398	0.134	0.401	2.30	0.05
14.35	47.08	**62.86**	**1.175**	1.87	1.408	115	51.51	2.31	1.99	102.3	0.398	0.180	0.538	2.00	0.04
14.4	47.24	**60.34**	**1.416**	2.35	1.412	115	49.37	2.39	2.28	112.3	0.397	0.212	0.636	2.00	0.04
14.45	47.41	**73.29**	**1.255**	1.71	1.416	115	59.87	2.24	1.76	105.2	0.396	0.188	0.567	2.40	0.05
14.5	47.57	**84.68**	**0.737**	0.87	1.421	115	69.07	2.00	1.30	90.1	0.396	0.148	0.446	2.40	0.05
14.55	47.74	**56.46**	**1.102**	1.95	1.425	115	45.98	2.36	2.17	99.7	0.395	0.172	0.520	2.15	0.04
14.6	47.90	**41.29**	**1.2**	2.91	1.429	115	28.89	2.64	3.61	104.4	0.394	0.186	0.562	0.00	0.00
14.65	48.06	**48.07**	**1.252**	2.61	1.434	115	39.03	2.50	2.78	108.4	0.393	0.198	0.601	2.40	0.05
14.7	48.23	**59.19**	**1.441**	2.44	1.438	115	47.99	2.41	2.36	113.2	0.393	0.215	0.653	2.15	0.04
14.75	48.39	**94.38**	**1.548**	1.64	1.442	115	76.40	2.14	1.53	117.1	0.392	0.229	0.698	1.91	0.04
14.8	48.56	**158.61**	**2.179**	1.38	1.447	115	128.21	1.92	1.21	155.0	0.391	0.426	1.299	1.47	0.00
14.85	48.72	**124.26**	**2.553**	2.06	1.451	115	100.29	2.12	1.50	150.0	0.391	0.394	1.202	1.54	0.00
14.9	48.88	**107.21**	**2.364**	2.21	1.455	115	86.40	2.19	1.64	141.9	0.390	0.346	1.058	1.77	0.00
14.95	49.05	**101.77**	**2.164**	2.13	1.459	115	81.90	2.20	1.66	135.6	0.389	0.312	0.956	1.84	0.04
15	49.21	**100.02**	**2.144**	2.15	1.464	115	80.37	2.20	1.68	134.7	0.388	0.308	0.944	1.84	0.04
15.05	49.38	**91.07**	**2.09**	2.30	1.468	115	73.07	2.26	1.81	132.5	0.388	0.296	0.911	2.00	0.04
15.1	49.54	**80.94**	**1.778**	2.20	1.472	115	64.85	2.28	1.89	122.4	0.387	0.251	0.773	1.69	0.03
15.15	49.70	**77.81**	**1.327**	1.71	1.477	115	62.25	2.22	1.72	107.0	0.386	0.194	0.599	2.30	0.05
15.2	49.87	**74.85**	**1.037**	1.39	1.481	115	59.79	2.18	1.61	96.4	0.385	0.163	0.506	2.40	0.05
15.25	50.03	**70.48**	**0.988**	1.40	1.485	115	56.22	2.20	1.67	94.0	0.385	0.157	0.487	2.40	0.05

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-3**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.09**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
0	0.00														
0.05	0.16	**34.22**	**0.749**	2.21	0.009	115	64.69	1.81	1.12	72.2	0.260	0.115	0.527	0.00	0.00
0.1	0.33	**33.87**	**1.279**	3.79	0.019	115	64.03	2.10	1.45	92.8	0.260	0.154	0.708	0.00	0.00
0.15	0.49	**30.28**	**1.651**	5.47	0.029	120	57.24	2.31	1.97	112.6	0.260	0.213	0.976	0.00	0.00
0.2	0.66	**24.9**	**1.852**	7.45	0.039	120	47.07	2.50	2.77	130.2	0.260	0.285	1.308	0.00	0.00
0.25	0.82	**21.75**	**1.812**	8.35	0.048	120	50.60	2.46	2.58	130.5	0.260	0.287	1.316	0.00	0.00
0.3	0.98	**18.16**	**1.664**	9.18	0.058	120	44.03	2.57	3.12	137.4	0.260	0.321	1.475	0.00	0.00
0.35	1.15	**15.85**	**1.447**	9.14	0.068	120	39.28	2.62	3.46	136.0	0.260	0.314	1.442	0.00	0.00
0.4	1.31	**16.35**	**1.484**	9.09	0.078	120	40.72	2.64	3.55	144.6	0.260	0.361	1.658	0.00	0.00
0.45	1.48	**18.18**	**1.522**	8.39	0.088	120	44.69	2.60	3.33	148.9	0.260	0.387	1.777	0.00	0.00
0.5	1.64	**16.76**	**1.431**	8.55	0.098	120	41.93	2.65	3.63	152.0	0.260	0.407	1.869	0.00	0.00
0.55	1.80	**15.53**	**1.343**	8.66	0.107	120	39.46	2.69	3.91	154.3	0.259	0.422	1.939	0.00	0.00
0.6	1.97	**13.83**	**1.205**	8.72	0.117	120	35.79	2.74	4.28	153.2	0.259	0.414	1.905	0.00	0.00
0.65	2.13	**11.8**	**1.089**	9.25	0.127	120	22.31	2.66	3.68	82.1	0.259	0.132	0.605	0.00	0.00
0.7	2.30	**15.94**	**1.231**	7.73	0.137	120	40.49	2.69	3.91	158.2	0.259	0.448	2.064	0.00	0.00
0.75	2.46	**18.26**	**1.275**	6.99	0.147	120	45.39	2.63	3.51	159.5	0.259	0.457	2.105	0.00	0.00
0.8	2.62	**16.68**	**1.161**	6.97	0.157	120	42.03	2.67	3.76	157.8	0.259	0.446	2.053	0.00	0.00
0.85	2.79	**14.55**	**1.037**	7.14	0.167	120	37.47	2.72	4.18	156.5	0.259	0.436	2.010	0.00	0.00
0.9	2.95	**11.42**	**0.876**	7.68	0.176	120	21.59	2.68	3.89	83.9	0.259	0.135	0.622	0.00	0.00
0.95	3.12	**9.78**	**0.722**	7.39	0.186	120	18.49	2.73	4.22	78.0	0.259	0.124	0.573	0.00	0.00
1	3.28	**9.37**	**0.639**	6.83	0.196	120	17.71	2.73	4.23	74.9	0.259	0.119	0.550	0.00	0.00
1.05	3.44	**8.51**	**0.595**	7.00	0.206	120	16.09	2.78	4.64	74.6	0.258	0.119	0.547	0.00	0.00
1.1	3.61	**7.15**	**0.487**	6.82	0.216	120	13.52	2.84	5.14	69.5	0.258	0.111	0.514	0.00	0.00
1.15	3.77	**7.74**	**0.439**	5.68	0.226	120	14.63	2.77	4.56	66.7	0.258	0.108	0.497	0.00	0.00
1.2	3.94	**7.25**	**0.459**	6.34	0.235	120	13.71	2.84	5.15	70.5	0.258	0.113	0.520	0.00	0.00
1.25	4.10	**6.99**	**0.493**	7.06	0.242	120	13.21	2.90	5.65	74.7	0.261	0.119	0.542	0.00	0.00
1.3	4.27	**7.62**	**0.638**	8.39	0.247	120	14.40	2.93	5.98	86.2	0.267	0.139	0.624	0.00	0.00
1.35	4.43	**10.02**	**0.584**	5.84	0.252	120	18.94	2.74	4.26	80.8	0.272	0.129	0.567	0.00	0.00
1.4	4.59	**18.07**	**0.417**	2.31	0.256	120	34.16	2.49	2.73	93.2	0.276	0.155	0.671	2.70	0.05
1.45	4.76	**18.61**	**0.376**	2.03	0.261	115	35.18	2.45	2.52	88.8	0.281	0.145	0.616	2.60	0.05
1.5	4.92	**18.44**	**0.415**	2.26	0.265	115	34.83	2.48	2.69	93.7	0.285	0.157	0.654	2.70	0.05
1.55	5.09	**49.89**	**0.487**	0.98	0.269	115	93.48	1.92	1.21	113.0	0.290	0.214	0.881	1.90	0.04
1.6	5.25	**53.11**	**0.636**	1.20	0.274	115	98.73	1.96	1.25	123.4	0.294	0.255	1.034	1.80	0.00
1.65	5.41	**48.27**	**0.796**	1.65	0.278	115	89.03	2.09	1.43	127.4	0.298	0.272	1.089	1.71	0.00
1.7	5.58	**36.35**	**0.744**	2.05	0.282	115	66.53	2.24	1.78	118.4	0.302	0.234	0.926	2.15	0.04
1.75	5.74	**27.25**	**0.547**	2.01	0.286	115	49.50	2.33	2.06	102.2	0.306	0.179	0.699	2.00	0.04
1.8	5.91	**22.36**	**0.246**	1.10	0.291	115	40.31	2.25	1.79	72.2	0.309	0.115	0.443	2.90	0.06
1.85	6.07	**16.42**	**0.2**	1.22	0.295	115	29.39	2.39	2.27	66.6	0.313	0.107	0.410	2.90	0.06
1.9	6.23	**13.36**	**0.263**	1.97	0.299	115	23.74	2.59	3.24	76.8	0.316	0.122	0.460	0.00	0.00
1.95	6.40	**10.42**	**0.361**	3.47	0.304	120	19.70	2.63	3.50	69.0	0.320	0.111	0.412	0.00	0.00
2	6.56	**9.96**	**0.388**	3.90	0.309	120	18.83	2.68	3.87	72.9	0.323	0.116	0.429	0.00	0.00
2.05	6.73	**9.84**	**0.283**	2.88	0.314	120	18.60	2.61	3.36	62.5	0.326	0.103	0.376	0.00	0.00
2.1	6.89	**11.01**	**0.237**	2.16	0.318	120	27.16	2.61	3.39	92.0	0.329	0.152	0.553	0.00	0.00
2.15	7.05	**11.82**	**0.277**	2.35	0.323	120	29.16	2.61	3.39	98.9	0.332	0.170	0.611	0.00	0.00
2.2	7.22	**14.16**	**0.151**	1.07	0.328	120	24.05	2.44	2.46	59.2	0.335	0.099	0.354	3.53	0.07
2.25	7.38	**13.9**	**0.191**	1.38	0.332	120	23.44	2.50	2.78	65.2	0.337	0.106	0.374	3.53	0.07
2.3	7.55	**13.84**	**0.135**	0.98	0.337	120	23.17	2.43	2.44	56.5	0.340	0.097	0.340	3.53	0.07
2.35	7.71	**12.5**	**0.258**	2.07	0.342	120	30.39	2.57	3.16	96.0	0.342	0.162	0.565	0.00	0.00
2.4	7.87	**9.02**	**0.317**	3.52	0.347	120	17.05	2.73	4.20	71.6	0.345	0.114	0.395	0.00	0.00
2.45	8.04	**7.35**	**0.253**	3.45	0.351	120	13.89	2.80	4.78	66.4	0.347	0.107	0.368	0.00	0.00
2.5	8.20	**11.69**	**0.155**	1.33	0.356	120	19.05	2.57	3.18	60.5	0.350	0.101	0.343	0.00	0.00
2.55	8.37	**17.08**	**0.139**	0.82	0.360	115	27.66	2.32	2.03	56.0	0.352	0.096	0.326	3.10	0.06
2.6	8.53	**19.55**	**0.166**	0.85	0.365	115	31.47	2.28	1.89	59.6	0.354	0.100	0.336	2.90	0.06
2.65	8.69	**15.67**	**0.265**	1.69	0.369	115	25.08	2.53	2.92	73.3	0.357	0.117	0.390	2.70	0.05
2.7	8.86	**13.63**	**0.351**	2.58	0.374	120	33.79	2.62	3.47	117.2	0.359	0.230	0.764	0.00	0.00
2.75	9.02	**11.97**	**0.373**	3.12	0.378	120	22.63	2.63	3.49	79.0	0.361	0.126	0.416	0.00	0.00
2.8	9.19	**15.56**	**0.267**	1.72	0.383	115	24.45	2.54	2.99	73.2	0.363	0.116	0.383	0.00	0.00
2.85	9.35	**14.82**	**0.255**	1.72	0.388	120	23.14	2.56	3.11	72.0	0.365	0.115	0.375	0.00	0.00
2.9	9.51	**14.57**	**0.353**	2.43	0.392	120	35.74	2.60	3.30	117.8	0.367	0.232	0.755	0.00	0.00
2.95	9.68	**14.39**	**0.38**	2.65	0.397	120	35.71	2.63	3.49	124.6	0.368	0.260	0.841	0.00	0.00
3	9.84	**28.52**	**0.226**	0.80	0.401	115	43.77	2.14	1.54	67.2	0.370	0.108	0.349	2.90	0.06
3.05	10.01	**46.67**	**0.443**	0.95	0.406	115	71.24	2.01	1.31	93.4	0.372	0.156	0.499	2.40	0.05
3.1	10.17	**39.26**	**0.55**	1.40	0.410	115	59.62	2.17	1.60	95.6	0.374	0.161	0.514	2.40	0.05
3.15	10.33	**45.03**	**0.62**	1.38	0.414	115	68.02	2.12	1.50	102.0	0.376	0.179	0.567	2.15	0.04
3.2	10.50	**56.43**	**0.784**	1.39	0.419	115	84.80	2.05	1.38	116.6	0.377	0.228	0.719	1.84	0.04
3.25	10.66	**49.77**	**0.945**	1.90	0.423	115	74.41	2.19	1.63	121.6	0.379	0.247	0.778	2.00	0.04

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-3**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.09**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
3.3	10.83	**38.88**	**0.851**	2.19	0.427	115	57.83	2.31	1.98	114.6	0.381	0.220	0.689	1.84	0.04
3.35	10.99	**37.9**	**0.804**	2.13	0.431	115	56.09	2.31	1.98	111.3	0.382	0.208	0.650	1.84	0.04
3.4	11.15	**46.94**	**0.378**	0.81	0.436	115	69.13	1.98	1.27	87.9	0.384	0.143	0.445	2.40	0.05
3.45	11.32	**60.98**	**0.691**	1.14	0.440	115	89.36	1.98	1.27	113.7	0.386	0.217	0.670	2.00	0.04
3.5	11.48	**91.19**	**1.092**	1.20	0.444	115	132.98	1.86	1.16	153.9	0.387	0.419	1.291	1.38	0.00
3.55	11.65	**112.06**	**1.338**	1.20	0.449	115	162.63	1.80	1.11	180.2	0.389	0.624	1.915	1.00	0.00
3.6	11.81	**119.92**	**1.478**	1.24	0.453	115	173.21	1.79	1.10	190.7	0.390	0.725	2.219	0.84	0.00
3.65	11.98	**125.56**	**1.464**	1.17	0.457	115	180.50	1.76	1.08	195.0	0.391	0.769	2.345	0.54	0.00
3.7	12.14	**120.61**	**1.665**	1.38	0.462	115	172.57	1.83	1.13	194.9	0.393	0.768	2.333	0.88	0.00
3.75	12.30	**117.73**	**1.84**	1.57	0.466	115	167.67	1.88	1.17	196.1	0.394	0.781	2.363	1.02	0.00
3.8	12.47	**96.84**	**1.764**	1.82	0.470	115	137.28	1.99	1.28	176.1	0.395	0.588	1.772	1.40	0.00
3.85	12.63	**80.67**	**1.377**	1.71	0.475	115	113.84	2.02	1.33	151.3	0.397	0.402	1.209	1.69	0.00
3.9	12.80	**72.14**	**1.062**	1.48	0.479	115	101.34	2.01	1.32	133.5	0.398	0.301	0.902	0.00	0.00
3.95	12.96	**86.77**	**1.157**	1.34	0.483	115	121.35	1.93	1.21	147.4	0.399	0.378	1.128	1.54	0.00
4	13.12	**96.56**	**1.283**	1.33	0.488	115	134.44	1.89	1.18	159.0	0.400	0.454	1.351	1.40	0.00
4.05	13.29	**96.6**	**1.302**	1.35	0.492	115	133.91	1.90	1.19	159.0	0.402	0.454	1.348	1.40	0.00
4.1	13.45	**103.03**	**1.445**	1.41	0.496	115	142.20	1.89	1.18	168.1	0.403	0.522	1.544	1.33	0.00
4.15	13.62	**114.61**	**1.69**	1.48	0.501	115	157.50	1.88	1.17	184.1	0.404	0.660	1.949	1.10	0.00
4.2	13.78	**126.59**	**1.953**	1.55	0.505	115	173.21	1.87	1.16	200.5	0.405	0.830	2.443	0.90	0.00
4.25	13.94	**130.55**	**2.123**	1.63	0.509	115	177.87	1.87	1.17	207.4	0.406	0.910	2.672	0.75	0.00
4.3	14.11	**126.9**	**2.088**	1.65	0.513	115	172.17	1.89	1.18	202.8	0.407	0.855	2.505	0.90	0.00
4.35	14.27	**125.23**	**2.041**	1.63	0.518	115	169.20	1.89	1.18	199.6	0.408	0.819	2.393	0.90	0.00
4.4	14.44	**127.25**	**1.748**	1.38	0.522	115	171.21	1.83	1.13	193.4	0.409	0.753	2.195	0.90	0.00
4.45	14.60	**133.75**	**1.896**	1.42	0.526	115	179.22	1.83	1.13	202.1	0.410	0.847	2.462	0.77	0.00
4.5	14.76	**116.5**	**1.974**	1.70	0.531	115	155.47	1.93	1.22	189.0	0.411	0.707	2.051	1.18	0.00
4.55	14.93	**130.43**	**1.901**	1.46	0.535	115	173.36	1.85	1.14	198.0	0.412	0.802	2.320	0.93	0.00
4.6	15.09	**121.35**	**1.677**	1.38	0.539	115	160.64	1.85	1.15	184.2	0.413	0.661	1.907	1.11	0.00
4.65	15.26	**128.74**	**1.712**	1.33	0.544	115	169.75	1.82	1.12	190.8	0.414	0.726	2.089	0.93	0.00
4.7	15.42	**140.62**	**1.921**	1.37	0.548	115	184.68	1.81	1.11	205.3	0.415	0.885	2.543	0.62	0.00
4.75	15.58	**152.59**	**2.028**	1.33	0.552	115	199.62	1.78	1.09	217.4	0.416	1.036	2.970	0.05	0.00
4.8	15.75	**161.65**	**2.154**	1.33	0.557	115	210.65	1.76	1.08	227.4	0.417	1.173	3.355	0.00	0.00
4.85	15.91	**164.17**	**2.138**	1.30	0.561	115	213.11	1.75	1.07	228.4	0.418	1.188	3.393	0.00	0.00
4.9	16.08	**167.94**	**2.157**	1.29	0.565	115	217.17	1.74	1.07	231.3	0.419	1.231	3.508	0.00	0.00
4.95	16.24	**175.99**	**2.263**	1.29	0.570	115	226.71	1.73	1.06	239.7	0.419	1.361	3.870	0.00	0.00
5	16.40	**184.91**	**2.427**	1.31	0.574	115	237.31	1.72	1.05	250.0	0.420	1.533	4.350	0.00	0.00
5.05	16.57	**189.69**	**2.611**	1.38	0.578	115	242.53	1.73	1.06	257.2	0.421	1.661	4.706	0.00	0.00
5.1	16.73	**193.2**	**2.808**	1.46	0.582	115	246.10	1.75	1.07	263.4	0.422	1.779	5.029	0.00	0.00
5.15	16.90	**193.21**	**2.832**	1.47	0.587	115	245.21	1.75	1.07	263.1	0.423	1.773	5.003	0.00	0.00
5.2	17.06	**187.63**	**2.689**	1.44	0.591	115	237.26	1.75	1.07	254.7	0.423	1.617	4.555	0.00	0.00
5.25	17.22	**181.01**	**2.487**	1.38	0.595	115	228.06	1.75	1.07	244.3	0.424	1.436	4.038	0.00	0.00
5.3	17.39	**167.9**	**2.225**	1.33	0.600	115	210.78	1.76	1.08	227.2	0.425	1.171	3.287	0.00	0.00
5.35	17.55	**149.79**	**2.477**	1.66	0.604	115	187.37	1.87	1.16	217.1	0.426	1.031	2.890	0.52	0.00
5.4	17.72	**121.41**	**2.16**	1.78	0.608	115	151.33	1.95	1.24	187.8	0.426	0.696	1.946	1.19	0.00
5.45	17.88	**63.76**	**1.667**	2.62	0.613	115	79.19	2.27	1.84	146.1	0.427	0.370	1.034	1.41	0.00
5.5	18.04	**18.38**	**1.146**	6.24	0.617	115	29.79	2.85	5.27	156.9	0.428	0.439	1.224	0.00	0.00
5.55	18.21	**10.57**	**0.456**	4.32	0.621	115	17.01	2.94	6.14	104.4	0.428	0.186	0.518	0.00	0.00
5.6	18.37	**8.8**	**0.209**	2.38	0.626	115	14.07	2.86	5.36	75.4	0.429	0.120	0.333	0.00	0.00
5.65	18.54	**11.36**	**0.264**	2.33	0.630	115	18.03	2.76	4.45	80.2	0.430	0.128	0.355	0.00	0.00
5.7	18.70	**11.79**	**0.504**	4.28	0.634	115	18.59	2.91	5.78	107.5	0.430	0.195	0.542	0.00	0.00
5.75	18.86	**12.2**	**0.592**	4.86	0.639	115	19.10	2.93	6.04	115.3	0.431	0.223	0.617	0.00	0.00
5.8	19.03	**12.41**	**0.575**	4.64	0.643	115	19.30	2.92	5.87	113.3	0.431	0.215	0.595	0.00	0.00
5.85	19.19	**12**	**0.65**	5.42	0.647	115	18.54	2.98	6.48	120.2	0.432	0.241	0.666	0.00	0.00
5.9	19.36	**9.58**	**0.501**	5.24	0.652	115	14.70	3.05	7.34	108.0	0.432	0.197	0.544	0.00	0.00
5.95	19.52	**8.58**	**0.349**	4.07	0.656	115	13.08	3.03	7.09	92.7	0.433	0.154	0.424	0.00	0.00
6	19.69	**8.91**	**0.328**	3.69	0.660	115	13.50	2.99	6.65	89.8	0.434	0.147	0.405	0.00	0.00
6.05	19.85	**8.71**	**0.406**	4.67	0.664	115	13.11	3.07	7.50	98.4	0.434	0.169	0.463	0.00	0.00
6.1	20.00	**9.78**	**0.48**	4.91	0.668	115	14.63	3.04	7.16	104.8	0.435	0.187	0.514	0.00	0.00
6.15	20.18	**10.2**	**0.526**	5.16	0.673	115	15.15	3.04	7.17	108.6	0.435	0.199	0.546	0.00	0.00
6.2	20.34	**10.98**	**0.658**	6.00	0.677	115	16.21	3.05	7.37	119.4	0.436	0.238	0.653	0.00	0.00
6.25	20.51	**11.73**	**0.87**	7.42	0.682	115	17.21	3.09	7.85	135.1	0.436	0.310	0.846	0.00	0.00
6.3	20.67	**11.16**	**0.944**	8.47	0.686	115	16.27	3.15	8.61	140.1	0.437	0.336	0.917	0.00	0.00
6.35	20.83	**10.96**	**0.898**	8.20	0.690	115	15.88	3.15	8.60	136.6	0.437	0.317	0.865	0.00	0.00
6.4	21.00	**11.36**	**0.911**	8.03	0.695	115	16.35	3.14	8.38	137.0	0.438	0.319	0.870	0.00	0.00
6.45	21.16	**11.2**	**0.985**	8.80	0.699	115	16.02	3.17	8.84	141.6	0.438	0.344	0.937	0.00	0.00
6.5	21.33	**16.22**	**0.543**	3.35	0.703	115	23.06	2.76	4.48	103.2	0.438	0.182	0.496	0.00	0.00
6.55	21.49	**35.85**	**0.531**	1.48	0.708	115	41.43	2.32	2.01	83.4	0.439	0.134	0.364	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-3**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.09**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
6.6	21.65	**23.29**	**0.822**	3.53	0.712	115	32.71	2.65	3.68	120.2	0.439	0.242	0.656	0.00	0.00
6.65	21.82	**13.09**	**0.713**	5.45	0.716	115	18.28	2.98	6.56	119.9	0.440	0.241	0.653	0.00	0.00
6.7	21.98	**9.78**	**0.619**	6.34	0.721	115	13.57	3.14	8.40	114.0	0.440	0.218	0.590	0.00	0.00
6.75	22.15	**15.08**	**0.509**	3.38	0.725	115	20.80	2.80	4.81	100.1	0.440	0.173	0.469	0.00	0.00
6.8	22.31	**19.91**	**0.6**	3.02	0.729	115	27.30	2.67	3.80	103.9	0.441	0.184	0.498	0.00	0.00
6.85	22.47	**16.18**	**0.662**	4.09	0.733	115	22.06	2.83	5.09	112.2	0.441	0.211	0.572	0.00	0.00
6.9	22.64	**15.78**	**0.531**	3.37	0.738	115	21.39	2.79	4.72	100.9	0.441	0.176	0.474	0.00	0.00
6.95	22.80	**17.95**	**0.51**	2.84	0.742	115	24.19	2.70	4.00	96.8	0.442	0.164	0.444	0.00	0.00
7	22.97	**13.09**	**0.658**	5.03	0.746	115	17.54	2.98	6.48	113.7	0.442	0.217	0.585	0.00	0.00
7.05	23.13	**27.83**	**0.743**	2.67	0.751	115	31.23	2.58	3.20	100.0	0.442	0.173	0.466	0.00	0.00
7.1	23.29	**52.3**	**0.644**	1.23	0.755	115	58.51	2.15	1.55	90.7	0.443	0.149	0.402	2.40	0.05
7.15	23.46	**71.39**	**0.408**	0.57	0.759	115	79.65	1.85	1.14	90.9	0.443	0.150	0.404	2.15	0.04
7.2	23.62	**72.93**	**0.671**	0.92	0.764	115	81.13	1.96	1.25	101.2	0.443	0.176	0.474	2.15	0.04
7.25	23.79	**65.49**	**0.942**	1.44	0.768	115	72.65	2.12	1.49	107.9	0.444	0.197	0.529	2.00	0.04
7.3	23.95	**58.06**	**0.836**	1.44	0.772	115	64.23	2.16	1.57	100.9	0.444	0.176	0.472	2.30	0.05
7.35	24.11	**44.96**	**0.524**	1.17	0.777	115	49.60	2.19	1.65	81.9	0.444	0.131	0.352	2.70	0.05
7.4	24.28	**33.61**	**0.792**	2.36	0.781	115	36.98	2.49	2.70	99.8	0.444	0.172	0.462	2.60	0.05
7.45	24.44	**34**	**0.7**	2.06	0.785	115	37.30	2.45	2.51	93.6	0.445	0.156	0.419	2.60	0.05
7.5	24.61	**34.82**	**0.651**	1.87	0.790	115	38.10	2.41	2.36	90.0	0.445	0.148	0.396	2.60	0.05
7.55	24.77	**35**	**0.467**	1.34	0.794	115	38.19	2.32	2.03	77.4	0.445	0.123	0.330	2.60	0.05
7.6	24.93	**43.56**	**0.329**	0.76	0.798	115	47.40	2.11	1.47	69.5	0.445	0.111	0.298	2.70	0.05
7.65	25.10	**56.23**	**0.582**	1.04	0.803	115	61.02	2.09	1.43	87.5	0.446	0.142	0.381	2.30	0.05
7.7	25.26	**62.53**	**0.838**	1.34	0.807	115	67.68	2.12	1.49	101.1	0.446	0.176	0.471	2.15	0.04
7.75	25.43	**75.73**	**1.059**	1.40	0.811	115	81.75	2.07	1.40	114.6	0.446	0.220	0.588	1.84	0.04
7.8	25.59	**92.24**	**1.387**	1.51	0.815	115	99.31	2.03	1.34	132.8	0.446	0.298	0.796	1.84	0.04
7.85	25.75	**92.59**	**1.563**	1.69	0.820	115	99.42	2.06	1.39	138.1	0.446	0.325	0.869	1.64	0.03
7.9	25.92	**89.84**	**1.613**	1.80	0.824	115	96.21	2.09	1.44	138.4	0.446	0.326	0.872	1.64	0.03
7.95	26.08	**95.25**	**1.669**	1.75	0.828	115	101.74	2.07	1.40	142.0	0.447	0.346	0.925	1.57	0.03
8	26.25	**103.5**	**1.764**	1.71	0.833	115	110.27	2.03	1.34	148.3	0.447	0.383	1.023	1.71	0.00
8.05	26.41	**108.29**	**1.921**	1.78	0.837	115	115.07	2.03	1.34	154.6	0.447	0.424	1.131	1.64	0.00
8.1	26.57	**104.32**	**1.964**	1.89	0.841	115	110.57	2.06	1.39	153.8	0.447	0.418	1.116	1.42	0.00
8.15	26.74	**91.66**	**1.857**	2.03	0.846	115	96.90	2.13	1.50	145.7	0.447	0.368	0.981	1.64	0.03
8.2	26.90	**80.54**	**1.647**	2.05	0.850	115	84.93	2.17	1.60	135.5	0.447	0.312	0.831	1.84	0.04
8.25	27.07	**72.64**	**1.364**	1.88	0.854	115	76.41	2.18	1.61	123.3	0.447	0.254	0.678	1.91	0.04
8.3	27.23	**72.77**	**1.364**	1.88	0.859	115	76.35	2.18	1.61	123.2	0.447	0.254	0.676	1.91	0.04
8.35	27.40	**80.73**	**1.451**	1.80	0.863	115	84.49	2.13	1.52	128.1	0.448	0.276	0.734	1.84	0.04
8.4	27.56	**82.88**	**1.562**	1.89	0.867	115	86.52	2.14	1.53	132.4	0.448	0.296	0.788	1.78	0.04
8.45	27.72	**75.7**	**1.484**	1.96	0.872	115	78.83	2.18	1.62	127.8	0.448	0.274	0.730	1.91	0.04
8.5	27.89	**80.95**	**1.564**	1.93	0.876	115	84.09	2.16	1.56	131.6	0.448	0.292	0.778	1.84	0.04
8.55	28.05	**84.67**	**1.617**	1.91	0.880	115	87.74	2.14	1.53	134.2	0.448	0.305	0.812	1.78	0.04
8.6	28.22	**85.9**	**1.751**	2.04	0.884	115	88.80	2.15	1.56	138.8	0.448	0.329	0.876	1.78	0.04
8.65	28.38	**80.16**	**1.77**	2.21	0.889	115	82.66	2.20	1.67	138.2	0.448	0.325	0.866	1.84	0.04
8.7	28.54	**70.44**	**1.603**	2.28	0.893	115	72.46	2.25	1.81	130.9	0.448	0.288	0.768	2.00	0.04
8.75	28.71	**62.3**	**1.348**	2.17	0.897	115	63.94	2.28	1.88	120.2	0.448	0.241	0.643	1.71	0.03
8.8	28.87	**61.1**	**1.212**	1.99	0.902	115	62.55	2.26	1.83	114.2	0.448	0.218	0.582	2.30	0.05
8.85	29.04	**69.63**	**1.273**	1.83	0.906	115	71.12	2.19	1.65	117.4	0.448	0.230	0.614	2.00	0.04
8.9	29.20	**81.25**	**1.508**	1.86	0.910	115	82.79	2.15	1.55	128.3	0.448	0.277	0.736	1.84	0.04
8.95	29.36	**86.37**	**1.633**	1.89	0.915	115	87.80	2.14	1.52	133.7	0.448	0.302	0.805	1.78	0.04
9	29.53	**76.25**	**1.542**	2.02	0.919	115	77.33	2.20	1.66	128.2	0.448	0.276	0.735	1.91	0.04
9.05	29.69	**70.31**	**1.229**	1.75	0.923	115	71.14	2.18	1.62	115.2	0.448	0.222	0.592	2.00	0.04
9.1	29.86	**80.43**	**1.025**	1.28	0.928	115	81.19	2.05	1.36	110.8	0.448	0.206	0.550	1.84	0.04
9.15	30.02	**99.41**	**0.976**	0.98	0.932	115	100.11	1.90	1.19	119.2	0.448	0.238	0.633	1.84	0.04
9.2	30.18	**76.22**	**1.185**	1.56	0.936	115	76.58	2.12	1.50	114.6	0.448	0.220	0.586	1.91	0.04
9.25	30.35	**55.85**	**1.159**	2.08	0.941	115	55.99	2.31	1.98	110.9	0.448	0.207	0.551	1.91	0.04
9.3	30.51	**51.51**	**0.931**	1.81	0.945	115	51.52	2.30	1.95	100.2	0.448	0.174	0.463	2.00	0.04
9.35	30.68	**54.88**	**0.498**	0.91	0.949	115	54.76	2.10	1.45	79.3	0.448	0.126	0.337	2.60	0.05
9.4	30.84	**63.19**	**0.671**	1.06	0.954	115	62.91	2.09	1.43	89.9	0.447	0.148	0.393	2.30	0.05
9.45	31.00	**57.68**	**0.988**	1.72	0.958	115	57.30	2.25	1.79	102.6	0.447	0.181	0.481	2.40	0.05
9.5	31.17	**45.46**	**1.032**	2.27	0.962	115	45.06	2.41	2.35	105.9	0.447	0.190	0.508	2.30	0.05
9.55	31.33	**39.41**	**0.883**	2.24	0.966	115	38.97	2.46	2.55	99.5	0.447	0.172	0.458	2.40	0.05
9.6	31.50	**35.23**	**1.022**	2.90	0.971	115	34.76	2.57	3.14	109.0	0.447	0.201	0.535	0.00	0.00
9.65	31.66	**21.3**	**1.087**	5.11	0.975	115	21.84	2.90	5.73	125.1	0.447	0.262	0.699	0.00	0.00
9.7	31.82	**15.18**	**1.118**	7.37	0.980	120	15.49	3.13	8.35	129.3	0.447	0.281	0.751	0.00	0.00
9.75	31.99	**13.28**	**0.965**	7.27	0.985	120	13.49	3.18	8.99	121.3	0.446	0.246	0.657	0.00	0.00
9.8	32.15	**12.45**	**0.835**	6.71	0.989	120	12.59	3.19	9.05	113.9	0.446	0.217	0.581	0.00	0.00
9.85	32.32	**12.54**	**0.681**	5.44	0.994	120	12.62	3.13	8.26	104.2	0.446	0.185	0.496	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-3**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.09**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
9.9	32.48	**12.33**	**0.609**	4.94	0.998	115	12.35	3.11	8.04	99.4	0.446	0.171	0.458	0.00	0.00
9.95	32.64	**11.63**	**0.598**	5.15	1.003	115	11.60	3.15	8.51	98.8	0.445	0.170	0.454	0.00	0.00
10	32.81	**13.52**	**0.657**	4.86	1.007	120	13.42	3.07	7.58	101.7	0.445	0.178	0.477	0.00	0.00
10.05	32.97	**12.8**	**0.648**	5.07	1.012	120	12.65	3.11	8.01	101.3	0.445	0.177	0.474	0.00	0.00
10.1	33.14	**11.33**	**0.605**	5.35	1.017	120	11.14	3.17	8.87	98.8	0.445	0.170	0.455	0.00	0.00
10.15	33.30	**9.84**	**0.581**	5.91	1.022	120	9.63	3.26	10.12	97.5	0.444	0.166	0.446	0.00	0.00
10.2	33.46	**10.57**	**0.7**	6.63	1.026	120	10.30	3.26	10.16	104.6	0.444	0.186	0.501	0.00	0.00
10.25	33.63	**10.79**	**0.811**	7.52	1.031	120	10.47	3.29	10.58	110.7	0.444	0.206	0.555	0.00	0.00
10.3	33.79	**9.88**	**0.745**	7.55	1.036	120	9.54	3.33	11.19	106.8	0.443	0.193	0.520	0.00	0.00
10.35	33.96	**8.49**	**0.518**	6.11	1.040	120	8.16	3.34	11.38	92.9	0.443	0.154	0.416	0.00	0.00
10.4	34.12	**8.29**	**0.486**	5.87	1.045	120	7.93	3.34	11.42	90.6	0.443	0.149	0.402	0.00	0.00
10.45	34.28	**9.54**	**0.561**	5.89	1.050	120	9.09	3.28	10.48	95.3	0.442	0.160	0.433	0.00	0.00
10.5	34.45	**10.88**	**0.772**	7.10	1.055	120	10.32	3.28	10.43	107.6	0.442	0.196	0.529	0.00	0.00
10.55	34.61	**13.9**	**0.983**	7.08	1.059	120	13.12	3.18	9.03	118.6	0.442	0.235	0.635	0.00	0.00
10.6	34.78	**15.33**	**1.034**	6.75	1.064	120	14.41	3.14	8.38	120.7	0.441	0.244	0.658	0.00	0.00
10.65	34.94	**16.49**	**1.04**	6.31	1.069	120	15.43	3.09	7.81	120.5	0.441	0.243	0.656	0.00	0.00
10.7	35.10	**16.93**	**1.013**	5.99	1.073	120	15.77	3.07	7.53	118.7	0.441	0.235	0.637	0.00	0.00
10.75	35.27	**18.06**	**0.958**	5.31	1.078	120	16.75	3.01	6.87	115.0	0.440	0.221	0.600	0.00	0.00
10.8	35.43	**17.03**	**0.884**	5.19	1.083	120	15.73	3.03	7.07	111.2	0.440	0.208	0.563	0.00	0.00
10.85	35.60	**16.21**	**0.833**	5.14	1.088	120	14.90	3.05	7.28	108.4	0.439	0.199	0.539	0.00	0.00
10.9	35.76	**16.83**	**0.77**	4.58	1.092	120	15.41	3.00	6.76	104.2	0.439	0.185	0.503	0.00	0.00
10.95	35.93	**16.33**	**0.717**	4.39	1.097	120	14.88	3.00	6.79	101.1	0.439	0.176	0.479	0.00	0.00
11	36.09	**14.9**	**0.748**	5.02	1.102	120	13.52	3.08	7.66	103.5	0.438	0.183	0.499	0.00	0.00
11.05	36.25	**13.2**	**0.736**	5.58	1.107	120	11.93	3.16	8.66	103.3	0.438	0.182	0.497	0.00	0.00
11.1	36.42	**11.88**	**0.645**	5.43	1.111	120	10.69	3.19	9.18	98.1	0.437	0.168	0.458	0.00	0.00
11.15	36.58	**10.44**	**0.533**	5.11	1.116	120	9.35	3.24	9.76	91.3	0.437	0.151	0.412	0.00	0.00
11.2	36.75	**9.66**	**0.455**	4.72	1.121	120	8.62	3.25	9.99	86.1	0.436	0.139	0.381	0.00	0.00
11.25	36.91	**9.54**	**0.438**	4.60	1.125	120	8.48	3.25	10.01	84.8	0.436	0.137	0.374	0.00	0.00
11.3	37.07	**9.28**	**0.407**	4.39	1.130	120	8.21	3.26	10.05	82.6	0.435	0.132	0.363	0.00	0.00
11.35	37.24	**9.14**	**0.373**	4.09	1.135	120	8.05	3.25	9.93	80.0	0.435	0.128	0.350	0.00	0.00
11.4	37.40	**9.56**	**0.402**	4.21	1.140	120	8.39	3.24	9.76	81.9	0.434	0.131	0.360	0.00	0.00
11.45	37.57	**10.27**	**0.466**	4.54	1.144	120	8.97	3.22	9.59	86.1	0.434	0.139	0.383	0.00	0.00
11.5	37.73	**11.16**	**0.51**	4.57	1.149	120	9.71	3.19	9.12	88.6	0.433	0.145	0.398	0.00	0.00
11.55	37.89	**11.13**	**0.487**	4.38	1.154	120	9.65	3.18	9.01	86.9	0.433	0.141	0.389	0.00	0.00
11.6	38.06	**10.77**	**0.472**	4.39	1.159	120	9.30	3.20	9.25	85.9	0.432	0.139	0.384	0.00	0.00
11.65	38.22	**10.83**	**0.465**	4.30	1.163	120	9.31	3.19	9.16	85.3	0.432	0.138	0.380	0.00	0.00
11.7	38.39	**10.91**	**0.476**	4.37	1.168	120	9.34	3.20	9.20	85.9	0.431	0.139	0.384	0.00	0.00
11.75	38.55	**12.93**	**0.585**	4.53	1.173	120	11.03	3.13	8.36	92.2	0.431	0.153	0.423	0.00	0.00
11.8	38.71	**18.8**	**0.59**	3.14	1.177	120	15.97	2.89	5.58	89.2	0.430	0.146	0.404	0.00	0.00
11.85	38.88	**11.56**	**0.635**	5.50	1.182	115	9.78	3.24	9.76	95.5	0.430	0.161	0.446	0.00	0.00
11.9	39.04	**13.16**	**0.762**	5.80	1.186	120	11.09	3.20	9.21	102.1	0.429	0.179	0.497	0.00	0.00
11.95	39.21	**15.37**	**0.889**	5.79	1.191	120	12.90	3.14	8.38	108.2	0.429	0.198	0.550	0.00	0.00
12	39.37	**15.11**	**0.949**	6.29	1.196	120	12.63	3.17	8.79	111.1	0.428	0.208	0.578	0.00	0.00
12.05	39.53	**18.59**	**0.991**	5.33	1.201	120	15.48	3.04	7.23	111.9	0.428	0.210	0.587	0.00	0.00
12.1	39.70	**17.41**	**1.061**	6.10	1.205	120	14.44	3.11	8.01	115.6	0.427	0.224	0.625	0.00	0.00
12.15	39.86	**16.26**	**1.099**	6.76	1.210	120	13.44	3.16	8.75	117.5	0.426	0.231	0.646	0.00	0.00
12.2	40.03	**16.4**	**1.072**	6.54	1.215	120	13.50	3.15	8.60	116.1	0.426	0.225	0.631	0.00	0.00
12.25	40.19	**17.87**	**1.117**	6.25	1.220	120	14.65	3.11	8.03	117.6	0.425	0.231	0.649	0.00	0.00
12.3	40.35	**18.08**	**0.911**	5.04	1.224	120	14.77	3.05	7.26	107.2	0.425	0.195	0.547	0.00	0.00
12.35	40.52	**26.5**	**0.956**	3.61	1.229	120	21.56	2.81	4.87	105.1	0.424	0.188	0.528	0.00	0.00
12.4	40.68	**23.74**	**0.739**	3.11	1.233	115	19.25	2.81	4.90	94.3	0.424	0.158	0.445	0.00	0.00
12.45	40.85	**17.41**	**0.648**	3.72	1.238	115	14.07	2.98	6.56	92.3	0.423	0.153	0.432	0.00	0.00
12.5	41.01	**12.28**	**0.675**	5.50	1.242	120	9.88	3.23	9.70	95.9	0.422	0.162	0.457	0.00	0.00
12.55	41.17	**11.96**	**0.705**	5.90	1.247	120	9.59	3.26	10.16	97.5	0.422	0.166	0.470	0.00	0.00
12.6	41.34	**11.65**	**0.598**	5.14	1.252	120	9.31	3.24	9.82	91.4	0.421	0.151	0.428	0.00	0.00
12.65	41.50	**11.29**	**0.442**	3.92	1.257	120	8.99	3.19	9.08	81.6	0.420	0.130	0.370	0.00	0.00
12.7	41.67	**11.04**	**0.373**	3.38	1.261	120	8.75	3.16	8.75	76.6	0.420	0.122	0.346	0.00	0.00
12.75	41.83	**12.49**	**0.474**	3.80	1.266	120	9.87	3.14	8.41	83.0	0.419	0.133	0.379	0.00	0.00
12.8	41.99	**18.77**	**0.647**	3.45	1.271	120	14.77	2.94	6.14	90.7	0.419	0.149	0.426	0.00	0.00
12.85	42.16	**17.26**	**0.746**	4.33	1.275	115	13.54	3.04	7.18	97.2	0.418	0.165	0.472	0.00	0.00
12.9	42.32	**30.04**	**0.708**	2.36	1.280	120	23.47	2.66	3.75	88.0	0.417	0.143	0.410	0.00	0.00
12.95	42.49	**52.77**	**0.517**	0.98	1.284	115	45.27	2.19	1.64	74.3	0.417	0.118	0.338	2.70	0.05
13	42.65	**61.45**	**0.549**	0.90	1.288	115	52.63	2.11	1.47	77.5	0.416	0.123	0.354	2.60	0.05
13.05	42.81	**62.75**	**0.675**	1.08	1.293	115	53.66	2.15	1.55	83.2	0.415	0.133	0.383	2.60	0.05
13.1	42.98	**61.29**	**0.738**	1.21	1.297	115	52.32	2.19	1.63	85.5	0.415	0.138	0.397	2.60	0.05
13.15	43.14	**62.71**	**0.651**	1.04	1.301	115	53.44	2.14	1.53	82.0	0.414	0.131	0.378	2.60	0.05

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-3**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **4.09**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
13.2	43.31	**63.74**	**0.606**	0.95	1.306	115	54.23	2.11	1.48	80.3	0.414	0.128	0.370	2.60	0.05
13.25	43.47	**58.55**	**0.747**	1.28	1.310	115	49.73	2.22	1.72	85.4	0.413	0.138	0.398	2.70	0.05
13.3	43.64	**62.18**	**0.685**	1.10	1.314	115	52.73	2.16	1.58	83.2	0.412	0.133	0.386	2.60	0.05
13.35	43.80	**61.9**	**0.833**	1.35	1.319	115	52.41	2.22	1.70	89.4	0.412	0.146	0.424	2.60	0.05
13.4	43.96	**57.24**	**1.003**	1.75	1.323	115	48.38	2.31	2.00	96.6	0.411	0.164	0.476	2.15	0.04
13.45	44.13	**59.91**	**1.06**	1.77	1.327	115	50.56	2.30	1.96	98.9	0.410	0.170	0.494	2.00	0.04
13.5	44.29	**67.55**	**0.711**	1.05	1.331	115	56.91	2.12	1.50	85.1	0.410	0.137	0.400	2.40	0.05
13.55	44.46	**69.89**	**0.819**	1.17	1.336	115	58.79	2.14	1.53	89.8	0.409	0.147	0.429	2.40	0.05
13.6	44.62	**63.13**	**1.072**	1.70	1.340	115	53.02	2.27	1.87	99.1	0.408	0.170	0.498	1.91	0.04
13.65	44.78	**62.21**	**0.781**	1.26	1.344	115	52.16	2.20	1.66	86.8	0.408	0.141	0.412	2.60	0.05
13.7	44.95	**64.22**	**0.816**	1.27	1.349	115	53.76	2.19	1.65	88.5	0.407	0.144	0.423	2.60	0.05
13.75	45.11	**67.23**	**0.711**	1.06	1.353	115	56.19	2.13	1.51	84.7	0.406	0.137	0.401	2.40	0.05
13.8	45.28	**65.6**	**0.746**	1.14	1.357	115	54.74	2.16	1.57	85.7	0.406	0.139	0.407	2.60	0.05
13.85	45.44	**58.13**	**0.586**	1.01	1.362	115	48.43	2.17	1.60	77.4	0.405	0.123	0.363	2.70	0.05
13.9	45.60	**35.21**	**0.702**	2.00	1.366	115	29.29	2.53	2.94	86.0	0.404	0.139	0.411	2.60	0.05
13.95	45.77	**19.59**	**0.663**	3.39	1.370	115	14.30	2.95	6.23	89.1	0.404	0.146	0.431	0.00	0.00
14	45.93	**15.73**	**0.399**	2.54	1.375	115	11.44	2.98	6.47	74.1	0.403	0.118	0.349	0.00	0.00
14.05	46.10	**12.88**	**0.258**	2.00	1.379	115	9.34	3.01	6.90	64.5	0.402	0.105	0.311	0.00	0.00
14.1	46.26	**11.01**	**0.187**	1.70	1.383	115	7.96	3.06	7.41	58.9	0.402	0.099	0.294	0.00	0.00
14.15	46.42	**10.33**	**0.182**	1.76	1.388	115	7.44	3.10	7.92	58.9	0.401	0.099	0.295	0.00	0.00
14.2	46.59	**10.35**	**0.248**	2.40	1.392	115	7.44	3.17	8.77	65.2	0.400	0.106	0.315	0.00	0.00
14.25	46.75	**11.39**	**0.521**	4.58	1.396	115	8.16	3.27	10.29	83.9	0.400	0.135	0.403	0.00	0.00
14.3	46.92	**20.26**	**0.948**	4.68	1.401	115	14.47	3.03	7.13	103.1	0.399	0.182	0.544	0.00	0.00
14.35	47.08	**43.47**	**1.322**	3.04	1.405	115	30.94	2.63	3.53	109.4	0.398	0.202	0.604	0.00	0.00
14.4	47.24	**58.87**	**1.528**	2.60	1.409	115	48.21	2.43	2.43	117.2	0.397	0.230	0.689	0.00	0.00
14.45	47.41	**160.54**	**2.443**	1.52	1.413	115	131.28	1.94	1.23	162.0	0.397	0.476	1.430	1.47	0.00
14.5	47.57	**191.57**	**3.307**	1.73	1.418	115	156.42	1.93	1.22	191.1	0.396	0.729	2.196	0.00	0.00
14.55	47.74	**202.74**	**3.74**	1.85	1.422	115	165.28	1.94	1.23	203.0	0.395	0.858	2.589	0.00	0.00
14.6	47.90	**209.24**	**3.796**	1.82	1.426	115	170.33	1.93	1.21	206.7	0.395	0.901	2.724	0.00	0.00
14.65	48.06	**209.08**	**3.735**	1.79	1.431	115	169.94	1.92	1.21	205.5	0.394	0.887	2.685	0.00	0.00
14.7	48.23	**193.51**	**3.668**	1.90	1.435	115	157.05	1.96	1.25	197.0	0.393	0.791	2.399	0.00	0.00
14.75	48.39	**167.92**	**3.356**	2.00	1.439	115	136.07	2.02	1.33	180.9	0.392	0.630	1.915	0.00	0.00
14.8	48.56	**141.42**	**3.062**	2.17	1.444	115	114.43	2.10	1.45	166.1	0.392	0.506	1.542	1.40	0.00
14.85	48.72	**139.47**	**3.421**	2.45	1.448	115	112.68	2.14	1.54	173.4	0.391	0.565	1.723	1.40	0.00
14.9	48.88	**218.11**	**4.423**	2.03	1.452	115	175.96	1.95	1.24	218.9	0.390	1.055	3.225	0.00	0.00
14.95	49.05	**292**	**5.291**	1.81	1.457	115	235.22	1.84	1.13	266.9	0.390	1.849	5.662	0.00	0.00
15	49.21	**296.83**	**5.597**	1.89	1.461	115	238.75	1.85	1.14	272.9	0.389	1.970	6.043	0.00	0.00
15.05	49.38	**296.12**	**5.789**	1.96	1.465	115	237.83	1.86	1.15	274.5	0.388	2.004	6.158	0.00	0.00
15.1	49.54	**277.31**	**5.466**	1.97	1.470	115	222.40	1.88	1.17	260.6	0.387	1.725	5.313	0.00	0.00
15.15	49.70	**240.56**	**4.723**	1.97	1.474	115	192.64	1.92	1.21	232.4	0.387	1.247	3.847	0.00	0.00
15.2	49.87	**208.27**	**3.977**	1.91	1.478	115	166.54	1.95	1.24	206.2	0.386	0.896	2.769	0.00	0.00
15.25	50.03	**179.41**	**3.637**	2.03	1.482	115	143.25	2.01	1.32	188.4	0.385	0.702	2.174	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-4**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.02**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
0	0.00														
0.05	0.16	**30.95**	**0.519**	1.69	0.009	115	58.51	1.74	1.06	62.3	0.260	0.102	0.470	0.00	0.00
0.1	0.33	**35.61**	**1.062**	3.00	0.019	115	67.32	2.00	1.30	87.4	0.260	0.142	0.651	0.00	0.00
0.15	0.49	**33.52**	**1.295**	3.88	0.028	115	63.36	2.15	1.56	99.0	0.260	0.170	0.780	0.00	0.00
0.2	0.66	**27.23**	**1.541**	5.67	0.038	120	51.47	2.38	2.22	114.5	0.260	0.220	1.007	0.00	0.00
0.25	0.82	**24.88**	**1.607**	6.47	0.048	120	47.03	2.48	2.65	124.5	0.260	0.260	1.191	0.00	0.00
0.3	0.98	**25.46**	**1.919**	7.55	0.058	120	48.13	2.55	3.02	145.5	0.260	0.366	1.682	0.00	0.00
0.35	1.15	**24.9**	**1.992**	8.01	0.068	120	47.07	2.59	3.29	154.9	0.260	0.426	1.956	0.00	0.00
0.4	1.31	**22.95**	**1.972**	8.61	0.078	120	54.96	2.53	2.95	161.9	0.260	0.475	2.180	0.00	0.00
0.45	1.48	**22.86**	**2.038**	8.93	0.087	120	55.48	2.57	3.13	173.9	0.260	0.569	2.614	0.00	0.00
0.5	1.64	**24.77**	**1.902**	7.69	0.097	120	58.81	2.51	2.83	166.4	0.260	0.508	2.336	0.00	0.00
0.55	1.80	**27.16**	**1.86**	6.86	0.107	120	51.34	2.58	3.19	163.5	0.259	0.487	2.238	0.00	0.00
0.6	1.97	**24.3**	**1.916**	7.90	0.117	120	58.73	2.56	3.07	180.6	0.259	0.628	2.888	0.00	0.00
0.65	2.13	**22.06**	**1.87**	8.49	0.127	120	54.65	2.62	3.46	189.0	0.259	0.708	3.256	0.00	0.00
0.7	2.30	**19.12**	**1.73**	9.06	0.137	120	48.68	2.69	3.95	192.3	0.259	0.741	3.412	0.00	0.00
0.75	2.46	**16.71**	**1.412**	8.46	0.146	120	42.93	2.72	4.13	177.3	0.259	0.599	2.757	0.00	0.00
0.8	2.62	**11.67**	**1.053**	9.04	0.156	120	22.06	2.70	4.01	88.6	0.259	0.145	0.666	0.00	0.00
0.85	2.79	**8.05**	**0.766**	9.53	0.166	120	15.22	2.84	5.11	77.8	0.259	0.124	0.571	0.00	0.00
0.9	2.95	**5.59**	**0.569**	10.20	0.176	120	10.57	2.98	6.55	69.2	0.259	0.111	0.511	0.00	0.00
0.95	3.12	**5.82**	**0.551**	9.49	0.186	120	11.00	2.96	6.34	69.8	0.259	0.112	0.515	0.00	0.00
1	3.28	**9.07**	**0.621**	6.86	0.196	120	17.15	2.74	4.31	73.9	0.259	0.118	0.542	0.00	0.00
1.05	3.44	**8.67**	**0.659**	7.61	0.205	120	16.39	2.80	4.81	78.8	0.258	0.126	0.580	0.00	0.00
1.1	3.61	**7.44**	**0.574**	7.73	0.215	120	14.06	2.87	5.39	75.8	0.258	0.120	0.556	0.00	0.00
1.15	3.77	**4.94**	**0.445**	9.03	0.225	120	9.34	3.06	7.41	69.2	0.258	0.111	0.512	0.00	0.00
1.2	3.94	**5.92**	**0.412**	6.97	0.235	120	11.19	2.93	6.04	67.6	0.258	0.109	0.503	0.00	0.00
1.25	4.10	**5.92**	**0.462**	7.82	0.242	120	11.19	2.98	6.51	72.8	0.261	0.116	0.529	0.00	0.00
1.3	4.27	**6.14**	**0.532**	8.68	0.246	120	11.61	3.01	6.81	79.0	0.267	0.126	0.563	0.00	0.00
1.35	4.43	**7.59**	**0.446**	5.89	0.251	120	14.35	2.82	5.00	71.7	0.272	0.114	0.502	0.00	0.00
1.4	4.59	**10.24**	**0.741**	7.24	0.256	120	19.36	2.80	4.81	93.2	0.276	0.155	0.670	0.00	0.00
1.45	4.76	**15.37**	**0.487**	3.18	0.261	120	37.06	2.55	3.04	112.7	0.281	0.213	0.905	0.00	0.00
1.5	4.92	**34.22**	**0.408**	1.20	0.265	120	64.59	2.10	1.46	94.0	0.285	0.157	0.657	2.30	0.05
1.55	5.09	**34.76**	**0.374**	1.08	0.270	115	65.08	2.07	1.40	91.4	0.290	0.151	0.621	2.15	0.04
1.6	5.25	**29.82**	**0.402**	1.35	0.274	115	55.39	2.19	1.63	90.5	0.294	0.149	0.605	2.40	0.05
1.65	5.41	**23.12**	**0.493**	2.14	0.278	115	42.61	2.40	2.32	98.8	0.298	0.170	0.679	2.30	0.05
1.7	5.58	**22.36**	**0.401**	1.80	0.283	115	40.90	2.37	2.19	89.4	0.302	0.146	0.579	2.40	0.05
1.75	5.74	**25.2**	**0.396**	1.58	0.287	115	45.74	2.29	1.93	88.2	0.306	0.144	0.561	2.15	0.04
1.8	5.91	**25.75**	**0.414**	1.61	0.291	115	46.39	2.30	1.93	89.7	0.309	0.147	0.567	2.15	0.04
1.85	6.07	**30.06**	**0.292**	0.98	0.296	115	53.76	2.11	1.48	79.5	0.313	0.127	0.483	2.60	0.05
1.9	6.23	**26.31**	**0.273**	1.04	0.300	115	46.71	2.18	1.62	75.6	0.316	0.120	0.453	2.70	0.05
1.95	6.40	**21.1**	**0.372**	1.77	0.304	115	37.20	2.40	2.30	85.5	0.320	0.138	0.515	2.60	0.05
2	6.56	**12.54**	**0.324**	2.59	0.308	115	30.86	2.60	3.35	103.4	0.323	0.183	0.675	0.00	0.00
2.05	6.73	**7.1**	**0.271**	3.82	0.313	120	13.42	2.80	4.76	63.9	0.326	0.104	0.382	0.00	0.00
2.1	6.89	**5.79**	**0.221**	3.82	0.318	120	10.95	2.88	5.47	59.9	0.329	0.100	0.362	0.00	0.00
2.15	7.05	**6.36**	**0.132**	2.08	0.323	120	12.02	2.69	3.91	47.0	0.332	0.089	0.320	0.00	0.00
2.2	7.22	**6.86**	**0.146**	2.13	0.327	120	12.97	2.67	3.80	49.2	0.335	0.091	0.324	0.00	0.00
2.25	7.38	**5.53**	**0.184**	3.33	0.332	120	10.45	2.87	5.44	56.9	0.337	0.097	0.343	0.00	0.00
2.3	7.55	**4.86**	**0.152**	3.13	0.337	120	9.19	2.91	5.82	53.5	0.340	0.094	0.330	0.00	0.00
2.35	7.71	**4.4**	**0.069**	1.57	0.342	120	8.32	2.79	4.73	39.3	0.343	0.083	0.288	0.00	0.00
2.4	7.87	**4.76**	**0.169**	3.56	0.346	120	9.00	2.96	6.35	57.2	0.345	0.097	0.337	0.00	0.00
2.45	8.04	**5.15**	**0.11**	2.14	0.351	120	9.74	2.81	4.89	47.6	0.347	0.090	0.308	0.00	0.00
2.5	8.20	**7.12**	**0.102**	1.44	0.356	120	18.24	2.71	4.07	74.2	0.350	0.118	0.402	0.00	0.00
2.55	8.37	**4.86**	**0.088**	1.81	0.360	120	9.19	2.81	4.85	44.6	0.352	0.087	0.295	0.00	0.00
2.6	8.53	**3.3**	**0.088**	2.68	0.365	120	6.24	3.07	7.51	46.9	0.354	0.089	0.300	0.00	0.00
2.65	8.69	**2.39**	**0.147**	6.18	0.370	120	4.52	3.42	12.66	57.2	0.356	0.097	0.326	0.00	0.00
2.7	8.86	**4.01**	**0.224**	5.60	0.375	120	7.58	3.18	9.02	68.3	0.358	0.110	0.365	0.00	0.00
2.75	9.02	**16.2**	**0.297**	1.84	0.379	115	25.59	2.54	2.99	76.6	0.361	0.122	0.403	2.70	0.05
2.8	9.19	**21.29**	**0.346**	1.63	0.383	115	33.44	2.42	2.38	79.4	0.363	0.127	0.416	2.70	0.05
2.85	9.35	**51.9**	**0.584**	1.13	0.388	115	81.05	2.01	1.31	106.3	0.365	0.192	0.627	2.15	0.04
2.9	9.51	**67.74**	**0.778**	1.15	0.392	115	105.21	1.93	1.22	127.9	0.367	0.275	0.893	1.75	0.03
2.95	9.68	**69.48**	**0.981**	1.42	0.396	115	107.32	1.98	1.28	137.0	0.369	0.319	1.032	1.75	0.00
3	9.84	**70.76**	**0.993**	1.41	0.400	115	108.71	1.98	1.27	138.0	0.371	0.324	1.044	1.69	0.00
3.05	10.01	**65.15**	**1.024**	1.58	0.405	115	99.55	2.04	1.35	134.6	0.372	0.307	0.983	1.60	0.03
3.1	10.17	**51.94**	**1.008**	1.94	0.409	115	78.95	2.17	1.61	126.8	0.374	0.270	0.859	1.91	0.04
3.15	10.33	**37.48**	**1.066**	2.85	0.413	115	56.67	2.39	2.29	129.8	0.376	0.283	0.898	1.84	0.04
3.2	10.50	**23.69**	**0.713**	3.01	0.418	115	35.63	2.56	3.10	110.5	0.378	0.206	0.649	0.00	0.00
3.25	10.66	**23.71**	**0.589**	2.49	0.422	115	35.48	2.51	2.81	99.9	0.379	0.173	0.543	2.30	0.05

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-4**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.02**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
3.3	10.83	**46.07**	**0.696**	1.51	0.426	115	68.59	2.15	1.55	106.1	0.381	0.191	0.598	2.15	0.04
3.35	10.99	**40.06**	**0.363**	0.91	0.431	115	59.35	2.06	1.39	82.5	0.383	0.132	0.412	2.40	0.05
3.4	11.15	**44.4**	**0.449**	1.01	0.435	115	65.45	2.05	1.38	90.2	0.384	0.148	0.460	2.15	0.04
3.45	11.32	**65.51**	**0.605**	0.93	0.439	115	96.09	1.90	1.19	113.9	0.386	0.218	0.673	1.84	0.04
3.5	11.48	**87.96**	**1.008**	1.15	0.444	115	128.39	1.86	1.16	148.3	0.387	0.384	1.181	1.46	0.00
3.55	11.65	**94.27**	**1.242**	1.32	0.448	115	136.94	1.88	1.17	160.9	0.389	0.467	1.433	1.38	0.00
3.6	11.81	**94.88**	**1.331**	1.41	0.452	115	137.17	1.90	1.19	163.5	0.390	0.487	1.488	1.40	0.00
3.65	11.98	**98.79**	**1.291**	1.31	0.457	115	142.14	1.87	1.16	165.2	0.392	0.499	1.521	1.32	0.00
3.7	12.14	**101.35**	**1.407**	1.39	0.461	115	145.14	1.88	1.17	170.3	0.393	0.539	1.637	1.24	0.00
3.75	12.30	**103.97**	**1.615**	1.56	0.465	115	148.20	1.91	1.20	178.0	0.394	0.604	1.828	1.24	0.00
3.8	12.47	**95.97**	**1.543**	1.61	0.470	115	136.17	1.95	1.24	168.6	0.396	0.526	1.585	1.40	0.00
3.85	12.63	**91.09**	**1.37**	1.51	0.474	115	128.65	1.94	1.23	158.8	0.397	0.452	1.359	1.47	0.00
3.9	12.80	**106.35**	**1.509**	1.42	0.478	115	149.53	1.88	1.17	175.2	0.398	0.580	1.737	1.24	0.00
3.95	12.96	**102.01**	**1.463**	1.44	0.482	115	142.78	1.90	1.19	169.5	0.400	0.533	1.592	1.32	0.00
4	13.12	**91.39**	**1.351**	1.48	0.487	115	127.35	1.94	1.23	156.9	0.401	0.439	1.307	1.48	0.00
4.05	13.29	**83.01**	**1.205**	1.45	0.491	115	115.16	1.97	1.26	145.2	0.402	0.364	1.082	1.62	0.00
4.1	13.45	**71.02**	**1.139**	1.61	0.495	115	98.10	2.05	1.37	134.3	0.403	0.305	0.903	0.00	0.00
4.15	13.62	**49.71**	**1.099**	2.21	0.500	115	68.37	2.26	1.83	124.9	0.404	0.261	0.770	0.00	0.00
4.2	13.78	**27.76**	**0.872**	3.15	0.504	115	38.01	2.55	3.06	116.3	0.405	0.226	0.666	0.00	0.00
4.25	13.94	**20.55**	**0.87**	4.24	0.508	115	38.85	2.64	3.56	138.2	0.406	0.325	0.955	0.00	0.00
4.3	14.11	**19.98**	**0.834**	4.18	0.513	115	37.77	2.64	3.61	136.2	0.408	0.315	0.922	0.00	0.00
4.35	14.27	**30.73**	**0.514**	1.68	0.517	115	41.55	2.35	2.11	87.8	0.409	0.143	0.417	0.00	0.00
4.4	14.44	**83.56**	**0.835**	1.00	0.521	115	112.52	1.87	1.16	130.3	0.410	0.286	0.832	0.00	0.00
4.45	14.60	**95.98**	**1.084**	1.13	0.526	115	128.71	1.86	1.15	148.2	0.411	0.383	1.111	1.48	0.00
4.5	14.76	**102.67**	**1.318**	1.29	0.530	115	137.12	1.88	1.17	160.1	0.412	0.462	1.337	1.40	0.00
4.55	14.93	**100.67**	**1.494**	1.49	0.534	115	133.91	1.93	1.22	163.0	0.413	0.483	1.395	1.40	0.00
4.6	15.09	**89.72**	**1.526**	1.70	0.539	115	118.86	2.01	1.31	155.7	0.414	0.431	1.244	1.63	0.00
4.65	15.26	**84.89**	**1.443**	1.70	0.543	115	112.01	2.03	1.33	149.5	0.415	0.391	1.125	1.70	0.00
4.7	15.42	**90.39**	**1.502**	1.66	0.547	115	118.80	2.00	1.30	154.5	0.415	0.423	1.215	1.63	0.00
4.75	15.58	**104.78**	**1.723**	1.65	0.551	115	137.17	1.95	1.24	170.7	0.416	0.542	1.554	1.40	0.00
4.8	15.75	**107.89**	**1.815**	1.68	0.556	115	140.70	1.95	1.24	175.0	0.417	0.579	1.654	1.33	0.00
4.85	15.91	**111.43**	**1.826**	1.64	0.560	115	144.75	1.94	1.23	177.4	0.418	0.600	1.711	1.26	0.00
4.9	16.08	**114.72**	**1.861**	1.63	0.564	115	148.46	1.93	1.21	180.3	0.419	0.625	1.781	1.26	0.00
4.95	16.24	**116.05**	**1.882**	1.62	0.569	115	149.61	1.92	1.21	181.4	0.420	0.635	1.804	1.26	0.00
5	16.40	**117.03**	**1.886**	1.61	0.573	115	150.30	1.92	1.21	181.7	0.421	0.638	1.809	1.19	0.00
5.05	16.57	**116.51**	**1.851**	1.59	0.577	115	149.07	1.92	1.21	179.9	0.421	0.621	1.759	1.26	0.00
5.1	16.73	**118.95**	**1.737**	1.46	0.582	115	151.63	1.89	1.18	178.4	0.422	0.608	1.717	1.19	0.00
5.15	16.90	**124.25**	**1.653**	1.33	0.586	115	157.80	1.85	1.14	180.1	0.423	0.623	1.757	1.12	0.00
5.2	17.06	**131.67**	**1.691**	1.29	0.590	115	166.61	1.82	1.12	186.6	0.424	0.684	1.925	1.04	0.00
5.25	17.22	**134.2**	**1.761**	1.31	0.595	115	169.20	1.82	1.12	189.7	0.424	0.715	2.010	0.95	0.00
5.3	17.39	**131.63**	**1.84**	1.40	0.599	115	165.36	1.85	1.14	188.9	0.425	0.707	1.984	1.04	0.00
5.35	17.55	**126.14**	**1.62**	1.29	0.603	115	157.89	1.83	1.13	178.8	0.426	0.611	1.712	1.12	0.00
5.4	17.72	**122.78**	**1.802**	1.47	0.608	115	153.14	1.89	1.18	180.0	0.427	0.622	1.740	1.19	0.00
5.45	17.88	**117.78**	**1.971**	1.68	0.612	115	146.39	1.94	1.23	180.0	0.427	0.622	1.738	1.26	0.00
5.5	18.04	**115.19**	**1.967**	1.71	0.616	115	142.66	1.95	1.25	177.6	0.428	0.601	1.676	1.34	0.00
5.55	18.21	**111.85**	**1.917**	1.72	0.621	115	138.05	1.97	1.26	173.6	0.429	0.566	1.577	1.34	0.00
5.6	18.37	**105.55**	**1.788**	1.70	0.625	115	129.82	1.98	1.27	165.5	0.429	0.502	1.394	1.49	0.00
5.65	18.54	**96.05**	**1.638**	1.71	0.629	115	117.73	2.01	1.32	154.9	0.430	0.426	1.181	1.63	0.00
5.7	18.70	**85.21**	**1.755**	2.06	0.633	115	104.09	2.11	1.47	153.0	0.430	0.413	1.145	1.57	0.00
5.75	18.86	**67.74**	**1.828**	2.70	0.638	115	82.47	2.26	1.84	151.6	0.431	0.404	1.118	1.34	0.00
5.8	19.03	**39.22**	**1.609**	4.11	0.642	115	47.59	2.56	3.11	148.2	0.432	0.383	1.058	0.00	0.00
5.85	19.19	**18.72**	**1.192**	6.37	0.646	115	28.96	2.87	5.41	156.8	0.432	0.438	1.210	0.00	0.00
5.9	19.36	**11.19**	**0.732**	6.55	0.651	115	17.20	3.06	7.41	127.4	0.433	0.272	0.750	0.00	0.00
5.95	19.52	**8.72**	**0.45**	5.17	0.655	115	13.31	3.09	7.76	103.4	0.433	0.183	0.503	0.00	0.00
6	19.69	**7.81**	**0.424**	5.44	0.659	115	11.85	3.15	8.53	101.0	0.434	0.176	0.484	0.00	0.00
6.05	19.85	**7.84**	**0.421**	5.38	0.664	115	11.81	3.15	8.50	100.5	0.434	0.174	0.479	0.00	0.00
6.1	20.00	**7.48**	**0.382**	5.11	0.668	115	11.20	3.15	8.61	96.5	0.435	0.164	0.449	0.00	0.00
6.15	20.18	**7**	**0.361**	5.17	0.672	115	10.41	3.19	9.05	94.3	0.435	0.158	0.433	0.00	0.00
6.2	20.34	**6.93**	**0.376**	5.43	0.677	115	10.24	3.21	9.34	95.6	0.436	0.161	0.442	0.00	0.00
6.25	20.51	**7.98**	**0.402**	5.04	0.681	115	11.72	3.13	8.33	97.6	0.436	0.166	0.455	0.00	0.00
6.3	20.67	**7.51**	**0.417**	5.56	0.685	115	10.96	3.18	9.04	99.1	0.437	0.170	0.465	0.00	0.00
6.35	20.83	**7.02**	**0.452**	6.45	0.690	115	10.18	3.25	10.04	102.2	0.437	0.179	0.489	0.00	0.00
6.4	21.00	**5.96**	**0.455**	7.65	0.694	115	8.59	3.37	11.87	101.9	0.438	0.179	0.486	0.00	0.00
6.45	21.16	**5.83**	**0.433**	7.44	0.698	115	8.35	3.38	11.95	99.8	0.438	0.172	0.469	0.00	0.00
6.5	21.33	**5.54**	**0.372**	6.73	0.702	115	7.89	3.38	11.92	94.0	0.439	0.157	0.428	0.00	0.00
6.55	21.49	**4.63**	**0.283**	6.13	0.707	115	6.55	3.44	12.97	85.0	0.439	0.137	0.372	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-4**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.02**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
6.6	21.65	**4.49**	**0.237**	5.29	0.711	115	6.31	3.42	12.65	79.9	0.439	0.127	0.346	0.00	0.00
6.65	21.82	**4.59**	**0.231**	5.05	0.715	115	6.42	3.40	12.32	79.1	0.440	0.126	0.342	0.00	0.00
6.7	21.98	**4.95**	**0.247**	5.00	0.720	115	6.88	3.36	11.73	80.7	0.440	0.129	0.349	0.00	0.00
6.75	22.15	**6.2**	**0.425**	6.87	0.724	115	8.56	3.35	11.43	97.9	0.441	0.167	0.453	0.00	0.00
6.8	22.31	**11.88**	**0.453**	3.82	0.728	115	16.31	2.93	5.98	97.5	0.441	0.166	0.449	0.00	0.00
6.85	22.47	**25.34**	**0.388**	1.53	0.733	115	28.78	2.46	2.59	74.4	0.441	0.118	0.320	2.90	0.06
6.9	22.64	**30.77**	**0.529**	1.72	0.737	115	34.85	2.42	2.40	83.7	0.442	0.135	0.363	2.70	0.05
6.95	22.80	**33.34**	**0.67**	2.01	0.741	115	37.65	2.44	2.46	92.7	0.442	0.154	0.416	2.60	0.05
7	22.97	**39.56**	**0.512**	1.30	0.746	115	44.54	2.26	1.82	81.3	0.442	0.130	0.350	2.90	0.06
7.05	23.13	**45.56**	**0.669**	1.47	0.750	115	51.15	2.24	1.78	91.0	0.443	0.150	0.404	2.60	0.05
7.1	23.29	**48.3**	**0.883**	1.83	0.754	115	54.07	2.28	1.90	102.6	0.443	0.181	0.486	1.91	0.04
7.15	23.46	**52.54**	**1.297**	2.47	0.759	115	58.65	2.34	2.10	123.1	0.443	0.253	0.682	1.84	0.04
7.2	23.62	**46.28**	**1.596**	3.45	0.763	115	51.51	2.49	2.70	139.2	0.444	0.331	0.890	2.00	0.04
7.25	23.79	**22.92**	**1.275**	5.57	0.767	115	29.88	2.82	4.95	148.0	0.444	0.382	1.025	0.00	0.00
7.3	23.95	**9.66**	**0.445**	4.61	0.772	115	12.52	3.08	7.71	96.6	0.444	0.164	0.440	0.00	0.00
7.35	24.11	**7.47**	**0.304**	4.08	0.776	115	9.63	3.16	8.71	83.9	0.444	0.135	0.362	0.00	0.00
7.4	24.28	**19.41**	**0.53**	2.73	0.780	115	24.88	2.68	3.85	95.9	0.445	0.162	0.435	0.00	0.00
7.45	24.44	**12.45**	**0.597**	4.80	0.784	115	15.87	3.00	6.76	107.2	0.445	0.195	0.522	0.00	0.00
7.5	24.61	**12.22**	**0.597**	4.89	0.789	115	15.49	3.02	6.92	107.2	0.445	0.194	0.521	0.00	0.00
7.55	24.77	**17.26**	**0.537**	3.11	0.793	115	21.76	2.76	4.49	97.8	0.445	0.167	0.447	0.00	0.00
7.6	24.93	**20.08**	**0.516**	2.57	0.797	115	25.18	2.66	3.71	93.5	0.446	0.156	0.418	0.00	0.00
7.65	25.10	**41.09**	**0.384**	0.94	0.802	115	44.62	2.18	1.62	72.1	0.446	0.115	0.307	0.00	0.00
7.7	25.26	**42.64**	**0.578**	1.36	0.806	115	46.17	2.26	1.82	84.2	0.446	0.135	0.362	0.00	0.00
7.75	25.43	**25.66**	**0.771**	3.01	0.810	115	31.67	2.62	3.45	109.3	0.446	0.201	0.539	0.00	0.00
7.8	25.59	**22.2**	**0.607**	2.74	0.815	115	27.25	2.65	3.63	99.0	0.446	0.170	0.455	0.00	0.00
7.85	25.75	**19.02**	**0.526**	2.77	0.819	115	23.22	2.71	4.07	94.4	0.447	0.158	0.423	0.00	0.00
7.9	25.92	**14.5**	**0.554**	3.82	0.823	115	17.61	2.90	5.70	100.4	0.447	0.174	0.465	0.00	0.00
7.95	26.08	**19.17**	**0.421**	2.20	0.828	115	23.16	2.65	3.65	84.5	0.447	0.136	0.363	0.00	0.00
8	26.25	**20.64**	**0.481**	2.33	0.832	115	24.81	2.64	3.58	88.8	0.447	0.145	0.387	0.00	0.00
8.05	26.41	**35.54**	**0.305**	0.86	0.836	115	37.78	2.22	1.73	65.2	0.447	0.106	0.282	3.10	0.06
8.1	26.57	**42.63**	**0.638**	1.50	0.841	115	45.21	2.29	1.92	87.0	0.447	0.141	0.377	2.30	0.05
8.15	26.74	**36.74**	**1.037**	2.83	0.845	115	38.86	2.52	2.87	111.7	0.447	0.210	0.559	2.00	0.04
8.2	26.90	**23.55**	**0.87**	3.70	0.849	115	27.73	2.73	4.18	116.0	0.447	0.225	0.600	0.00	0.00
8.25	27.07	**35.82**	**0.714**	2.00	0.853	115	37.70	2.43	2.46	92.6	0.448	0.154	0.410	2.60	0.05
8.3	27.23	**94.03**	**1.126**	1.20	0.858	115	98.70	1.96	1.25	123.8	0.448	0.256	0.683	1.84	0.04
8.35	27.40	**94.93**	**1.311**	1.38	0.862	115	99.40	2.00	1.30	129.4	0.448	0.282	0.750	1.84	0.04
8.4	27.56	**94.54**	**1.179**	1.25	0.866	115	98.74	1.97	1.27	125.2	0.448	0.262	0.699	1.84	0.04
8.45	27.72	**89.99**	**1.428**	1.59	0.871	115	93.76	2.06	1.39	130.3	0.448	0.286	0.761	1.71	0.03
8.5	27.89	**66.75**	**1.329**	1.99	0.875	115	69.37	2.23	1.73	120.3	0.448	0.242	0.644	2.15	0.04
8.55	28.05	**57.61**	**1.012**	1.76	0.879	115	59.73	2.24	1.77	105.7	0.448	0.190	0.506	2.40	0.05
8.6	28.22	**77.74**	**0.639**	0.82	0.884	115	80.40	1.93	1.22	98.1	0.448	0.168	0.446	2.15	0.04
8.65	28.38	**84.56**	**0.731**	0.87	0.888	115	87.24	1.92	1.20	105.0	0.448	0.188	0.499	2.00	0.04
8.7	28.54	**74.94**	**1.078**	1.44	0.892	115	77.13	2.10	1.45	111.8	0.448	0.210	0.559	1.91	0.04
8.75	28.71	**72.68**	**1.268**	1.75	0.897	115	74.62	2.16	1.58	118.1	0.448	0.233	0.621	2.00	0.04
8.8	28.87	**84.46**	**1.41**	1.67	0.901	115	86.51	2.10	1.46	126.3	0.448	0.267	0.712	1.78	0.04
8.85	29.04	**86.18**	**1.578**	1.83	0.905	115	88.06	2.12	1.50	132.2	0.448	0.295	0.785	1.78	0.04
8.9	29.20	**92.8**	**1.633**	1.76	0.910	115	94.60	2.09	1.44	136.0	0.448	0.314	0.835	1.71	0.03
8.95	29.36	**91.46**	**1.532**	1.68	0.914	115	93.01	2.08	1.42	132.2	0.448	0.295	0.784	1.71	0.03
9	29.53	**105.19**	**1.477**	1.41	0.918	115	106.72	1.98	1.28	136.6	0.448	0.317	0.843	1.78	0.04
9.05	29.69	**131.67**	**1.783**	1.36	0.923	115	133.28	1.90	1.19	158.8	0.448	0.453	1.205	1.42	0.00
9.1	29.86	**140.53**	**2.251**	1.60	0.927	115	141.92	1.94	1.23	173.9	0.448	0.569	1.515	1.34	0.00
9.15	30.02	**133.16**	**2.381**	1.79	0.931	115	134.16	1.99	1.29	172.4	0.448	0.557	1.482	1.42	0.00
9.2	30.18	**116.57**	**2.099**	1.80	0.935	115	117.17	2.03	1.34	157.4	0.448	0.442	1.178	1.64	0.00
9.25	30.35	**118.44**	**1.657**	1.40	0.940	115	118.78	1.95	1.24	147.1	0.448	0.376	1.002	1.64	0.00
9.3	30.51	**106.18**	**1.664**	1.57	0.944	115	106.24	2.02	1.33	140.8	0.448	0.339	0.904	1.78	0.04
9.35	30.68	**68.47**	**1.444**	2.11	0.948	115	68.35	2.25	1.80	122.7	0.448	0.252	0.671	2.15	0.04
9.4	30.84	**58.01**	**1.053**	1.82	0.953	115	57.78	2.26	1.83	105.7	0.448	0.190	0.506	2.40	0.05
9.45	31.00	**57.69**	**0.82**	1.42	0.957	115	57.33	2.20	1.66	95.0	0.447	0.160	0.425	2.40	0.05
9.5	31.17	**61.54**	**1.203**	1.96	0.961	115	61.02	2.26	1.84	112.2	0.447	0.211	0.563	1.78	0.04
9.55	31.33	**44.62**	**1.427**	3.20	0.966	115	44.14	2.52	2.85	125.8	0.447	0.265	0.707	1.84	0.04
9.6	31.50	**20.65**	**1.001**	4.85	0.970	120	21.28	2.90	5.67	120.7	0.447	0.244	0.650	0.00	0.00
9.65	31.66	**12.49**	**0.47**	3.77	0.975	120	12.81	3.02	7.00	89.7	0.447	0.147	0.393	0.00	0.00
9.7	31.82	**10.69**	**0.219**	2.05	0.980	120	10.91	2.94	6.15	67.1	0.447	0.108	0.289	0.00	0.00
9.75	31.99	**9.59**	**0.298**	3.11	0.985	120	9.74	3.09	7.83	76.3	0.446	0.121	0.324	0.00	0.00
9.8	32.15	**9.37**	**0.27**	2.89	0.989	120	9.47	3.09	7.77	73.6	0.446	0.117	0.313	0.00	0.00
9.85	32.32	**9.88**	**0.293**	2.97	0.994	120	9.94	3.07	7.59	75.4	0.446	0.120	0.321	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-4**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.02**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
9.9	32.48	**10.16**	**0.372**	3.67	0.998	115	10.18	3.11	8.10	82.4	0.446	0.132	0.353	0.00	0.00
9.95	32.64	**9.8**	**0.431**	4.40	1.003	115	9.77	3.18	8.94	87.4	0.445	0.142	0.380	0.00	0.00
10	32.81	**10.22**	**0.432**	4.23	1.007	120	10.15	3.15	8.58	87.1	0.445	0.141	0.379	0.00	0.00
10.05	32.97	**11.19**	**0.572**	5.12	1.012	120	11.06	3.16	8.76	96.8	0.445	0.164	0.441	0.00	0.00
10.1	33.14	**13.77**	**0.719**	5.23	1.017	120	13.54	3.09	7.77	105.3	0.445	0.189	0.506	0.00	0.00
10.15	33.30	**14.25**	**0.863**	6.06	1.022	120	13.95	3.12	8.14	113.6	0.444	0.216	0.581	0.00	0.00
10.2	33.46	**13.78**	**0.833**	6.05	1.026	120	13.43	3.13	8.33	111.8	0.444	0.210	0.564	0.00	0.00
10.25	33.63	**12.15**	**0.703**	5.79	1.031	120	11.79	3.17	8.85	104.3	0.444	0.186	0.499	0.00	0.00
10.3	33.79	**12.77**	**0.798**	6.25	1.036	120	12.33	3.17	8.89	109.7	0.443	0.203	0.545	0.00	0.00
10.35	33.96	**17.06**	**1.086**	6.37	1.040	120	16.40	3.07	7.56	124.0	0.443	0.257	0.693	0.00	0.00
10.4	34.12	**18.98**	**1.233**	6.50	1.045	120	18.16	3.04	7.19	130.5	0.443	0.287	0.773	0.00	0.00
10.45	34.28	**19.49**	**1.221**	6.27	1.050	120	18.56	3.02	6.98	129.5	0.442	0.282	0.760	0.00	0.00
10.5	34.45	**18.25**	**1.059**	5.81	1.055	120	17.31	3.02	7.02	121.4	0.442	0.246	0.665	0.00	0.00
10.55	34.61	**15.93**	**0.975**	6.12	1.059	120	15.04	3.09	7.82	117.6	0.442	0.231	0.625	0.00	0.00
10.6	34.78	**15.21**	**0.966**	6.36	1.064	120	14.29	3.12	8.20	117.2	0.441	0.230	0.621	0.00	0.00
10.65	34.94	**14.13**	**0.883**	6.25	1.069	120	13.22	3.15	8.53	112.8	0.441	0.213	0.577	0.00	0.00
10.7	35.10	**13.18**	**0.809**	6.14	1.073	120	12.28	3.17	8.85	108.7	0.441	0.199	0.540	0.00	0.00
10.75	35.27	**13.35**	**0.806**	6.04	1.078	120	12.38	3.16	8.75	108.3	0.440	0.198	0.537	0.00	0.00
10.8	35.43	**14.15**	**0.769**	5.44	1.083	120	13.07	3.11	8.09	105.7	0.440	0.190	0.515	0.00	0.00
10.85	35.60	**13.81**	**0.72**	5.22	1.088	120	12.70	3.11	8.09	102.8	0.439	0.181	0.491	0.00	0.00
10.9	35.76	**12.49**	**0.67**	5.37	1.092	120	11.43	3.16	8.75	100.0	0.439	0.173	0.470	0.00	0.00
10.95	35.93	**10.99**	**0.57**	5.19	1.097	120	10.02	3.21	9.39	94.1	0.439	0.157	0.428	0.00	0.00
11	36.09	**11.6**	**0.519**	4.48	1.102	120	10.53	3.15	8.58	90.3	0.438	0.148	0.404	0.00	0.00
11.05	36.25	**12.78**	**0.553**	4.33	1.107	120	11.55	3.10	7.96	91.9	0.438	0.152	0.415	0.00	0.00
11.1	36.42	**12.72**	**0.566**	4.45	1.111	120	11.45	3.11	8.10	92.7	0.437	0.154	0.420	0.00	0.00
11.15	36.58	**12.14**	**0.582**	4.80	1.116	120	10.88	3.15	8.63	93.9	0.437	0.157	0.429	0.00	0.00
11.2	36.75	**11.77**	**0.625**	5.32	1.121	120	10.50	3.20	9.20	96.6	0.436	0.164	0.448	0.00	0.00
11.25	36.91	**12.67**	**0.686**	5.42	1.125	120	11.26	3.17	8.87	99.9	0.436	0.173	0.472	0.00	0.00
11.3	37.07	**12.09**	**0.675**	5.59	1.130	120	10.70	3.20	9.28	99.2	0.435	0.171	0.468	0.00	0.00
11.35	37.24	**11.91**	**0.644**	5.41	1.135	120	10.49	3.20	9.27	97.3	0.435	0.166	0.454	0.00	0.00
11.4	37.40	**11.85**	**0.628**	5.30	1.140	120	10.40	3.20	9.25	96.2	0.434	0.163	0.447	0.00	0.00
11.45	37.57	**11.53**	**0.619**	5.37	1.144	120	10.08	3.22	9.49	95.6	0.434	0.161	0.443	0.00	0.00
11.5	37.73	**11.78**	**0.645**	5.48	1.149	120	10.25	3.21	9.46	96.9	0.433	0.165	0.453	0.00	0.00
11.55	37.89	**11.99**	**0.632**	5.28	1.154	120	10.39	3.20	9.24	96.0	0.433	0.162	0.447	0.00	0.00
11.6	38.06	**11.5**	**0.598**	5.21	1.159	120	9.93	3.22	9.46	93.9	0.432	0.157	0.433	0.00	0.00
11.65	38.22	**11.34**	**0.583**	5.15	1.163	120	9.75	3.22	9.53	92.9	0.432	0.155	0.427	0.00	0.00
11.7	38.39	**11.44**	**0.578**	5.06	1.168	120	9.79	3.21	9.44	92.4	0.431	0.153	0.424	0.00	0.00
11.75	38.55	**11.09**	**0.569**	5.14	1.173	120	9.46	3.23	9.71	91.8	0.431	0.152	0.421	0.00	0.00
11.8	38.71	**10.8**	**0.589**	5.46	1.177	120	9.17	3.26	10.14	93.0	0.430	0.155	0.429	0.00	0.00
11.85	38.88	**10.89**	**0.633**	5.82	1.182	120	9.21	3.28	10.36	95.5	0.430	0.161	0.446	0.00	0.00
11.9	39.04	**12.38**	**0.588**	4.75	1.187	120	10.43	3.17	8.84	92.2	0.429	0.153	0.425	0.00	0.00
11.95	39.21	**19.64**	**0.618**	3.15	1.192	120	16.48	2.88	5.47	90.2	0.429	0.148	0.412	0.00	0.00
12	39.37	**21.04**	**0.608**	2.89	1.196	115	17.59	2.83	5.03	88.5	0.428	0.145	0.403	0.00	0.00
12.05	39.53	**18.8**	**0.547**	2.91	1.200	115	15.66	2.88	5.47	85.7	0.428	0.139	0.386	0.00	0.00
12.1	39.70	**18.75**	**0.496**	2.65	1.205	115	15.57	2.86	5.27	82.1	0.427	0.131	0.367	0.00	0.00
12.15	39.86	**14.85**	**0.602**	4.06	1.209	115	12.28	3.06	7.45	91.5	0.427	0.151	0.423	0.00	0.00
12.2	40.03	**24.25**	**0.382**	1.58	1.214	120	19.98	2.63	3.51	70.1	0.426	0.112	0.313	0.00	0.00
12.25	40.19	**40.51**	**0.758**	1.87	1.218	115	35.69	2.44	2.49	88.7	0.426	0.145	0.406	2.60	0.05
12.3	40.35	**34.66**	**0.996**	2.88	1.222	115	28.36	2.65	3.63	103.0	0.425	0.182	0.510	0.00	0.00
12.35	40.52	**56.38**	**0.842**	1.50	1.227	115	49.49	2.26	1.83	90.8	0.425	0.150	0.420	2.00	0.04
12.4	40.68	**46.86**	**1.15**	2.46	1.231	115	41.06	2.47	2.60	106.8	0.424	0.193	0.543	2.40	0.05
12.45	40.85	**43.17**	**1.564**	3.62	1.235	115	34.95	2.64	3.59	125.3	0.423	0.263	0.741	0.00	0.00
12.5	41.01	**58.71**	**1.092**	1.86	1.239	115	51.27	2.31	1.98	101.7	0.423	0.178	0.501	2.00	0.04
12.55	41.17	**80.05**	**0.791**	0.99	1.244	115	69.78	2.03	1.34	93.7	0.422	0.157	0.442	2.40	0.05
12.6	41.34	**67**	**0.679**	1.02	1.248	115	58.31	2.10	1.46	85.1	0.422	0.137	0.388	2.40	0.05
12.65	41.50	**49.01**	**0.949**	1.94	1.252	115	42.58	2.39	2.26	96.2	0.421	0.163	0.461	2.30	0.05
12.7	41.67	**22.73**	**0.747**	3.29	1.257	115	18.09	2.85	5.24	94.8	0.421	0.159	0.452	0.00	0.00
12.75	41.83	**15.02**	**0.377**	2.51	1.261	115	11.91	2.95	6.25	74.5	0.420	0.118	0.336	0.00	0.00
12.8	41.99	**12.88**	**0.188**	1.46	1.266	120	10.18	2.91	5.75	58.5	0.419	0.099	0.281	0.00	0.00
12.85	42.16	**9.35**	**0.196**	2.10	1.270	120	7.36	3.14	8.44	62.1	0.419	0.102	0.291	0.00	0.00
12.9	42.32	**7.8**	**0.172**	2.21	1.275	120	6.12	3.25	9.97	61.0	0.418	0.101	0.288	0.00	0.00
12.95	42.49	**7.52**	**0.167**	2.22	1.280	120	5.88	3.27	10.32	60.7	0.417	0.101	0.288	0.00	0.00
13	42.65	**7.19**	**0.183**	2.55	1.285	120	5.60	3.33	11.20	62.7	0.417	0.103	0.295	0.00	0.00
13.05	42.81	**7.69**	**0.256**	3.33	1.289	115	5.97	3.35	11.56	69.0	0.416	0.111	0.317	0.00	0.00
13.1	42.98	**8.43**	**0.274**	3.25	1.293	115	6.52	3.30	10.73	69.9	0.415	0.112	0.321	0.00	0.00
13.15	43.14	**7.92**	**0.341**	4.31	1.298	115	6.10	3.40	12.34	75.3	0.415	0.120	0.344	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-4**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **3.02**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
13.2	43.31	**18.49**	**0.378**	2.05	1.302	115	14.20	2.83	5.05	71.8	0.414	0.114	0.329	0.00	0.00
13.25	43.47	**42.34**	**0.449**	1.06	1.306	115	36.02	2.30	1.94	69.7	0.414	0.111	0.322	2.60	0.05
13.3	43.64	**43.61**	**0.597**	1.37	1.311	115	37.04	2.35	2.11	78.1	0.413	0.124	0.359	2.60	0.05
13.35	43.80	**40.25**	**0.813**	2.02	1.315	115	34.13	2.48	2.66	90.8	0.412	0.150	0.433	2.70	0.05
13.4	43.96	**36.46**	**0.984**	2.70	1.319	115	27.64	2.64	3.58	99.0	0.412	0.170	0.494	0.00	0.00
13.45	44.13	**21.3**	**0.719**	3.38	1.323	115	16.09	2.90	5.74	92.4	0.411	0.153	0.445	0.00	0.00
13.5	44.29	**19.34**	**0.65**	3.36	1.328	115	14.57	2.94	6.13	89.4	0.410	0.146	0.425	0.00	0.00
13.55	44.46	**18.86**	**0.741**	3.93	1.332	115	14.16	3.00	6.69	94.8	0.410	0.159	0.463	0.00	0.00
13.6	44.62	**19.84**	**0.872**	4.40	1.336	115	14.85	3.01	6.82	101.2	0.409	0.176	0.514	0.00	0.00
13.65	44.78	**19.71**	**0.907**	4.60	1.341	115	14.70	3.02	7.00	102.9	0.408	0.181	0.530	0.00	0.00
13.7	44.95	**20.65**	**0.982**	4.76	1.345	115	15.35	3.01	6.91	106.1	0.408	0.191	0.559	0.00	0.00
13.75	45.11	**22.27**	**1.225**	5.50	1.349	115	16.50	3.03	7.06	116.5	0.407	0.227	0.665	0.00	0.00
13.8	45.28	**22.83**	**1.333**	5.84	1.354	115	16.87	3.04	7.16	120.7	0.406	0.244	0.715	0.00	0.00
13.85	45.44	**21.39**	**1.259**	5.89	1.358	115	15.75	3.06	7.49	117.9	0.406	0.233	0.684	0.00	0.00
13.9	45.60	**22.07**	**1.249**	5.66	1.362	115	16.20	3.04	7.23	117.2	0.405	0.230	0.676	0.00	0.00
13.95	45.77	**23.28**	**1.418**	6.09	1.367	115	17.03	3.04	7.26	123.6	0.404	0.256	0.754	0.00	0.00
14	45.93	**21.94**	**1.251**	5.70	1.371	115	16.00	3.05	7.31	117.0	0.404	0.229	0.677	0.00	0.00
14.05	46.10	**20.36**	**1.103**	5.42	1.375	115	14.80	3.06	7.49	111.0	0.403	0.207	0.613	0.00	0.00
14.1	46.26	**17.23**	**0.966**	5.61	1.380	115	12.49	3.14	8.45	105.6	0.402	0.189	0.562	0.00	0.00
14.15	46.42	**12.8**	**0.716**	5.60	1.384	115	9.25	3.27	10.21	94.4	0.401	0.158	0.470	0.00	0.00
14.2	46.59	**11.98**	**0.692**	5.78	1.388	115	8.63	3.31	10.81	93.3	0.401	0.155	0.463	0.00	0.00
14.25	46.75	**13.25**	**0.752**	5.68	1.393	115	9.52	3.26	10.08	95.9	0.400	0.162	0.483	0.00	0.00
14.3	46.92	**16.6**	**0.958**	5.78	1.397	115	11.88	3.17	8.83	104.9	0.399	0.187	0.559	0.00	0.00
14.35	47.08	**18.9**	**1.143**	6.05	1.401	115	13.49	3.13	8.33	112.3	0.399	0.212	0.634	0.00	0.00
14.4	47.24	**20.9**	**1.328**	6.36	1.405	115	14.87	3.11	8.03	119.3	0.398	0.238	0.714	0.00	0.00
14.45	47.41	**23.16**	**1.364**	5.89	1.410	115	16.43	3.05	7.30	120.0	0.397	0.241	0.723	0.00	0.00
14.5	47.57	**21.59**	**1.358**	6.29	1.414	115	15.27	3.10	7.86	120.1	0.397	0.241	0.725	0.00	0.00
14.55	47.74	**21.1**	**1.293**	6.13	1.418	115	14.88	3.10	7.90	117.5	0.396	0.231	0.695	0.00	0.00
14.6	47.90	**22.11**	**1.38**	6.24	1.423	115	15.54	3.09	7.75	120.5	0.395	0.243	0.733	0.00	0.00
14.65	48.06	**19.38**	**1.187**	6.13	1.427	115	13.58	3.13	8.34	113.3	0.394	0.215	0.651	0.00	0.00
14.7	48.23	**20.42**	**0.84**	4.12	1.431	115	14.27	3.00	6.80	97.0	0.394	0.165	0.500	0.00	0.00
14.75	48.39	**30.9**	**0.8**	2.59	1.436	115	21.52	2.72	4.17	89.7	0.393	0.147	0.446	0.00	0.00
14.8	48.56	**31.52**	**0.814**	2.58	1.440	115	21.89	2.72	4.11	90.0	0.392	0.148	0.450	0.00	0.00
14.85	48.72	**37.8**	**1.002**	2.65	1.444	115	26.17	2.66	3.69	96.5	0.391	0.163	0.498	0.00	0.00
14.9	48.88	**53.3**	**0.86**	1.62	1.449	115	43.05	2.34	2.07	89.0	0.391	0.146	0.444	2.30	0.05
14.95	49.05	**58.87**	**0.682**	1.16	1.453	115	47.48	2.21	1.70	80.8	0.390	0.129	0.395	2.70	0.05
15	49.21	**52.89**	**0.913**	1.73	1.457	115	42.60	2.36	2.15	91.4	0.389	0.151	0.463	2.30	0.05
15.05	49.38	**48.86**	**0.837**	1.72	1.462	115	39.29	2.38	2.25	88.4	0.389	0.144	0.443	2.40	0.05
15.1	49.54	**42.06**	**1.167**	2.78	1.466	115	28.69	2.63	3.55	101.7	0.388	0.178	0.547	0.00	0.00
15.15	49.70	**42.53**	**0.958**	2.25	1.470	115	34.10	2.51	2.82	96.1	0.387	0.163	0.501	2.30	0.05
15.2	49.87	**67.9**	**1.021**	1.51	1.474	115	54.36	2.23	1.75	95.2	0.386	0.160	0.495	2.60	0.05
15.25	50.03	**126.39**	**1.41**	1.12	1.479	115	101.04	1.94	1.23	123.8	0.386	0.256	0.793	1.84	0.04

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-5**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **2.27**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
0	0.00														
0.05	0.16	**31.11**	**0.783**	2.53	0.009	115	58.81	1.89	1.18	69.2	0.260	0.111	0.508	0.00	0.00
0.1	0.33	**31.79**	**1.099**	3.47	0.019	115	60.09	2.08	1.42	85.2	0.260	0.138	0.631	0.00	0.00
0.15	0.49	**29.62**	**1.321**	4.47	0.028	115	55.99	2.24	1.76	98.5	0.260	0.169	0.774	0.00	0.00
0.2	0.66	**26.69**	**1.332**	5.00	0.038	120	50.45	2.34	2.08	104.7	0.260	0.187	0.857	0.00	0.00
0.25	0.82	**25.87**	**1.493**	5.78	0.048	120	48.90	2.43	2.42	118.4	0.260	0.234	1.075	0.00	0.00
0.3	0.98	**26.46**	**1.696**	6.42	0.058	120	50.02	2.48	2.67	133.7	0.260	0.302	1.387	0.00	0.00
0.35	1.15	**21.71**	**1.715**	7.91	0.068	120	51.17	2.49	2.74	140.1	0.260	0.336	1.542	0.00	0.00
0.4	1.31	**18.67**	**1.481**	7.95	0.078	120	45.06	2.55	3.05	137.6	0.260	0.322	1.481	0.00	0.00
0.45	1.48	**16.15**	**1.068**	6.63	0.087	120	38.88	2.55	3.02	117.3	0.260	0.230	1.057	0.00	0.00
0.5	1.64	**15.42**	**1.113**	7.23	0.097	120	38.03	2.61	3.38	128.6	0.260	0.278	1.277	0.00	0.00
0.55	1.80	**15.7**	**1.385**	8.83	0.107	120	39.94	2.69	3.94	157.2	0.259	0.441	2.029	0.00	0.00
0.6	1.97	**16.59**	**1.488**	8.98	0.117	120	42.32	2.70	3.99	168.9	0.259	0.528	2.427	0.00	0.00
0.65	2.13	**16.6**	**1.422**	8.58	0.127	120	42.33	2.70	3.98	168.5	0.259	0.525	2.414	0.00	0.00
0.7	2.30	**15.71**	**1.381**	8.80	0.137	120	40.62	2.74	4.26	173.0	0.259	0.562	2.586	0.00	0.00
0.75	2.46	**13.66**	**1.338**	9.81	0.146	120	25.82	2.68	3.82	98.6	0.259	0.169	0.779	0.00	0.00
0.8	2.62	**12.03**	**1.188**	9.89	0.156	120	22.74	2.73	4.19	95.3	0.259	0.161	0.740	0.00	0.00
0.85	2.79	**10.16**	**1.041**	10.26	0.166	120	19.21	2.80	4.78	91.8	0.259	0.152	0.700	0.00	0.00
0.9	2.95	**8.2**	**0.857**	10.47	0.176	120	15.50	2.88	5.51	85.4	0.259	0.138	0.636	0.00	0.00
0.95	3.12	**5.98**	**0.633**	10.61	0.186	120	11.30	2.99	6.65	75.1	0.259	0.119	0.551	0.00	0.00
1	3.28	**4.87**	**0.546**	11.24	0.196	120	9.21	3.09	7.77	71.5	0.259	0.114	0.526	0.00	0.00
1.05	3.44	**5.3**	**0.577**	10.91	0.205	120	10.02	3.07	7.52	75.3	0.258	0.120	0.553	0.00	0.00
1.1	3.61	**8.52**	**0.68**	7.99	0.215	120	16.11	2.84	5.12	82.4	0.258	0.132	0.610	0.00	0.00
1.15	3.77	**10.43**	**0.815**	7.82	0.225	120	19.72	2.78	4.66	91.8	0.258	0.152	0.702	0.00	0.00
1.2	3.94	**10.2**	**0.827**	8.12	0.235	120	19.28	2.82	4.92	94.9	0.258	0.159	0.737	0.00	0.00
1.25	4.10	**9.03**	**0.777**	8.62	0.242	120	17.07	2.88	5.50	93.9	0.261	0.157	0.716	0.00	0.00
1.3	4.27	**6.58**	**0.61**	9.29	0.246	120	12.44	3.01	6.80	84.6	0.267	0.136	0.610	0.00	0.00
1.35	4.43	**5.04**	**0.419**	8.33	0.251	120	9.53	3.06	7.47	71.2	0.272	0.114	0.499	0.00	0.00
1.4	4.59	**9.77**	**0.264**	2.71	0.256	120	24.52	2.66	3.68	90.3	0.276	0.148	0.641	0.00	0.00
1.45	4.76	**12.68**	**0.255**	2.02	0.261	120	23.97	2.58	3.22	77.2	0.281	0.123	0.521	0.00	0.00
1.5	4.92	**12.19**	**0.318**	2.61	0.265	120	29.70	2.58	3.19	94.9	0.285	0.159	0.666	0.00	0.00
1.55	5.09	**4.79**	**0.38**	7.95	0.270	120	9.05	3.09	7.82	70.8	0.290	0.113	0.465	0.00	0.00
1.6	5.25	**4.67**	**0.377**	8.09	0.275	120	8.83	3.11	8.07	71.2	0.294	0.114	0.461	0.00	0.00
1.65	5.41	**10.6**	**0.47**	4.44	0.279	120	20.04	2.67	3.77	75.4	0.298	0.120	0.480	0.00	0.00
1.7	5.58	**8.72**	**0.516**	5.93	0.284	120	16.48	2.82	4.99	82.2	0.302	0.132	0.520	0.00	0.00
1.75	5.74	**27.27**	**0.424**	1.56	0.289	120	49.32	2.26	1.84	90.8	0.305	0.150	0.584	2.00	0.04
1.8	5.91	**50.17**	**0.572**	1.14	0.293	115	90.07	1.98	1.27	114.3	0.309	0.219	0.845	1.91	0.04
1.85	6.07	**41.05**	**0.785**	1.92	0.298	115	73.16	2.19	1.65	120.7	0.313	0.243	0.929	2.00	0.04
1.9	6.23	**33.68**	**0.786**	2.34	0.302	115	59.60	2.32	2.01	119.6	0.316	0.239	0.903	1.73	0.03
1.95	6.40	**27.84**	**0.606**	2.18	0.306	115	48.91	2.36	2.16	105.8	0.319	0.190	0.710	2.15	0.04
2	6.56	**33.86**	**0.353**	1.05	0.310	115	59.08	2.10	1.45	85.6	0.323	0.138	0.512	2.40	0.05
2.05	6.73	**39.75**	**0.304**	0.77	0.315	115	68.88	1.96	1.26	86.5	0.326	0.140	0.514	2.40	0.05
2.1	6.89	**29.68**	**0.51**	1.72	0.319	115	51.08	2.28	1.89	96.5	0.329	0.164	0.593	2.00	0.04
2.15	7.05	**19.8**	**0.685**	3.47	0.323	115	47.64	2.55	3.01	143.4	0.332	0.354	1.274	1.74	0.00
2.2	7.22	**12.67**	**0.643**	5.08	0.328	120	23.95	2.70	4.03	96.5	0.335	0.163	0.583	0.00	0.00
2.25	7.38	**9.19**	**0.615**	6.70	0.333	120	17.37	2.90	5.66	98.4	0.337	0.169	0.596	0.00	0.00
2.3	7.55	**9.7**	**0.406**	4.19	0.338	120	18.34	2.74	4.32	79.2	0.340	0.126	0.443	0.00	0.00
2.35	7.71	**13.07**	**0.264**	2.03	0.342	120	31.51	2.55	3.04	95.7	0.342	0.162	0.563	0.00	0.00
2.4	7.87	**10.13**	**0.168**	1.66	0.347	120	24.89	2.60	3.32	82.7	0.345	0.133	0.458	0.00	0.00
2.45	8.04	**9.2**	**0.152**	1.66	0.352	120	22.95	2.64	3.57	82.0	0.347	0.131	0.451	0.00	0.00
2.5	8.20	**12.39**	**0.29**	2.35	0.357	120	30.67	2.62	3.44	105.6	0.350	0.190	0.647	0.00	0.00
2.55	8.37	**12.22**	**0.218**	1.79	0.361	120	29.54	2.56	3.08	90.9	0.352	0.150	0.508	0.00	0.00
2.6	8.53	**12.25**	**0.243**	1.99	0.366	120	29.96	2.59	3.25	97.3	0.354	0.166	0.558	0.00	0.00
2.65	8.69	**8.71**	**0.305**	3.51	0.371	120	16.47	2.76	4.48	73.7	0.356	0.117	0.393	0.00	0.00
2.7	8.86	**8.19**	**0.276**	3.38	0.375	120	15.48	2.78	4.61	71.3	0.358	0.114	0.379	0.00	0.00
2.75	9.02	**6.46**	**0.198**	3.07	0.380	120	12.21	2.85	5.19	63.4	0.360	0.104	0.343	0.00	0.00
2.8	9.19	**4.79**	**0.148**	3.10	0.385	120	9.05	2.97	6.42	58.1	0.362	0.098	0.323	0.00	0.00
2.85	9.35	**3.86**	**0.162**	4.21	0.390	120	7.30	3.14	8.44	61.6	0.364	0.102	0.333	0.00	0.00
2.9	9.51	**2.61**	**0.116**	4.46	0.394	120	4.93	3.33	11.18	55.2	0.366	0.096	0.312	0.00	0.00
2.95	9.68	**2.66**	**0.13**	4.91	0.399	120	5.03	3.35	11.51	57.9	0.368	0.098	0.318	0.00	0.00
3	9.84	**2.98**	**0.129**	4.35	0.404	120	5.63	3.28	10.34	58.2	0.370	0.098	0.317	0.00	0.00
3.05	10.01	**11.08**	**0.235**	2.12	0.408	120	27.97	2.67	3.79	106.0	0.371	0.191	0.613	0.00	0.00
3.1	10.17	**7.32**	**0.326**	4.46	0.413	120	13.84	2.93	6.02	83.3	0.373	0.134	0.428	0.00	0.00
3.15	10.33	**8.28**	**0.191**	2.31	0.418	120	15.65	2.72	4.12	64.4	0.375	0.105	0.334	0.00	0.00
3.2	10.50	**15.38**	**0.377**	2.46	0.423	120	37.77	2.60	3.32	125.3	0.376	0.263	0.833	0.00	0.00
3.25	10.66	**17.02**	**0.609**	3.58	0.427	120	42.97	2.67	3.79	163.0	0.378	0.483	1.523	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-5**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **2.27**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
3.3	10.83	**97.48**	**1.106**	1.14	0.432	115	144.24	1.82	1.12	162.1	0.380	0.476	1.496	1.23	0.00
3.35	10.99	**127.16**	**1.66**	1.31	0.436	115	187.22	1.79	1.10	205.6	0.381	0.888	2.779	0.23	0.00
3.4	11.15	**136.76**	**1.476**	1.08	0.440	115	200.37	1.71	1.04	208.9	0.383	0.928	2.892	0.47	0.00
3.45	11.32	**136.87**	**1.973**	1.44	0.445	115	199.56	1.80	1.11	221.2	0.384	1.086	3.373	0.00	0.00
3.5	11.48	**123.07**	**1.942**	1.58	0.449	115	178.57	1.86	1.16	206.5	0.386	0.899	2.780	0.65	0.00
3.55	11.65	**108.38**	**1.791**	1.66	0.453	115	156.51	1.92	1.20	188.6	0.387	0.704	2.168	1.08	0.00
3.6	11.81	**98.16**	**1.567**	1.60	0.458	115	141.08	1.94	1.22	172.8	0.389	0.560	1.718	1.31	0.00
3.65	11.98	**88.31**	**1.37**	1.55	0.462	115	126.33	1.96	1.25	158.0	0.390	0.447	1.367	1.47	0.00
3.7	12.14	**84.51**	**1.278**	1.52	0.466	115	120.33	1.97	1.26	151.5	0.391	0.403	1.229	1.54	0.00
3.75	12.30	**69.88**	**1.144**	1.64	0.471	115	99.04	2.05	1.37	136.1	0.393	0.314	0.954	1.61	0.03
3.8	12.47	**56.74**	**1.082**	1.91	0.475	115	80.05	2.17	1.59	126.9	0.394	0.270	0.817	1.84	0.04
3.85	12.63	**43.31**	**0.901**	2.08	0.479	115	60.83	2.28	1.88	114.6	0.395	0.220	0.663	1.77	0.03
3.9	12.80	**36.29**	**0.634**	1.75	0.483	115	50.74	2.29	1.92	97.3	0.397	0.166	0.498	2.00	0.04
3.95	12.96	**39.37**	**0.555**	1.41	0.488	115	54.80	2.20	1.68	92.0	0.398	0.152	0.457	2.60	0.05
4	13.12	**57.25**	**0.818**	1.43	0.492	115	79.34	2.08	1.43	113.1	0.399	0.214	0.641	1.91	0.04
4.05	13.29	**97.39**	**1.275**	1.31	0.496	115	134.39	1.89	1.18	158.3	0.400	0.449	1.338	1.40	0.00
4.1	13.45	**125.3**	**1.658**	1.33	0.501	115	172.15	1.82	1.12	192.7	0.401	0.745	2.215	0.90	0.00
4.15	13.62	**137.34**	**2.001**	1.46	0.505	115	187.89	1.82	1.12	211.2	0.403	0.956	2.831	0.36	0.00
4.2	13.78	**131.34**	**1.921**	1.47	0.509	115	178.92	1.84	1.14	203.2	0.404	0.860	2.542	0.75	0.00
4.25	13.94	**124.93**	**1.927**	1.55	0.514	115	169.47	1.87	1.16	197.1	0.405	0.792	2.333	0.90	0.00
4.3	14.11	**122.4**	**1.958**	1.60	0.518	115	165.34	1.89	1.18	195.1	0.406	0.770	2.264	1.03	0.00
4.35	14.27	**108.35**	**1.878**	1.74	0.522	115	145.76	1.95	1.24	181.2	0.407	0.633	1.856	1.25	0.00
4.4	14.44	**101.27**	**1.051**	1.04	0.527	115	135.67	1.82	1.12	151.7	0.408	0.405	1.183	1.40	0.00
4.45	14.60	**87.39**	**1.224**	1.40	0.531	115	116.60	1.95	1.24	145.0	0.409	0.364	1.060	1.62	0.00
4.5	14.76	**62.68**	**1.253**	2.00	0.535	115	83.29	2.17	1.59	132.4	0.410	0.296	0.861	1.84	0.04
4.55	14.93	**45.66**	**1.088**	2.39	0.540	115	60.43	2.32	2.02	122.2	0.411	0.250	0.724	1.77	0.03
4.6	15.09	**34.29**	**0.83**	2.42	0.544	115	45.20	2.42	2.40	108.7	0.412	0.199	0.577	2.30	0.05
4.65	15.26	**36.43**	**0.551**	1.52	0.548	115	47.84	2.27	1.86	89.1	0.413	0.146	0.421	2.15	0.04
4.7	15.42	**47.66**	**0.508**	1.07	0.552	115	62.34	2.09	1.43	89.2	0.414	0.146	0.421	2.30	0.05
4.75	15.58	**52.73**	**0.742**	1.41	0.557	115	68.70	2.13	1.51	103.5	0.415	0.183	0.527	2.15	0.04
4.8	15.75	**48.45**	**0.89**	1.84	0.561	115	62.88	2.23	1.75	110.1	0.416	0.204	0.586	2.30	0.05
4.85	15.91	**42.13**	**0.812**	1.93	0.565	115	54.47	2.29	1.93	105.2	0.416	0.188	0.539	1.91	0.04
4.9	16.08	**40.75**	**0.754**	1.85	0.570	115	52.49	2.30	1.93	101.5	0.417	0.177	0.507	2.00	0.04
4.95	16.24	**47.73**	**0.55**	1.16	0.574	115	61.24	2.11	1.48	90.6	0.418	0.149	0.426	2.30	0.05
5	16.40	**64.69**	**0.722**	1.12	0.578	115	82.70	2.00	1.30	107.6	0.419	0.196	0.557	2.15	0.04
5.05	16.57	**71.67**	**0.99**	1.38	0.583	115	91.28	2.03	1.34	122.2	0.420	0.250	0.709	1.91	0.04
5.1	16.73	**76.04**	**1.074**	1.42	0.587	115	96.49	2.02	1.32	127.6	0.421	0.273	0.775	1.84	0.04
5.15	16.90	**78.64**	**1.058**	1.35	0.591	115	99.42	1.99	1.29	128.3	0.421	0.276	0.782	1.84	0.04
5.2	17.06	**77.74**	**1.178**	1.52	0.596	115	97.93	2.03	1.35	131.7	0.422	0.293	0.827	1.84	0.04
5.25	17.22	**72.99**	**1.235**	1.70	0.600	115	91.61	2.09	1.43	131.2	0.423	0.290	0.818	1.71	0.03
5.3	17.39	**59.66**	**1.214**	2.04	0.604	115	74.62	2.21	1.69	125.8	0.424	0.265	0.747	2.00	0.04
5.35	17.55	**46.3**	**1.058**	2.29	0.609	115	57.70	2.33	2.03	117.3	0.424	0.230	0.647	1.84	0.04
5.4	17.72	**43.12**	**0.775**	1.80	0.613	115	53.55	2.28	1.89	101.2	0.425	0.176	0.495	1.91	0.04
5.45	17.88	**58.18**	**0.891**	1.53	0.617	115	72.00	2.14	1.52	109.7	0.426	0.203	0.569	2.00	0.04
5.5	18.04	**62.9**	**1.002**	1.60	0.622	115	77.57	2.12	1.50	116.2	0.426	0.226	0.632	1.91	0.04
5.55	18.21	**92.62**	**1.307**	1.41	0.626	115	113.82	1.96	1.26	142.9	0.427	0.351	0.981	1.71	0.03
5.6	18.37	**99.25**	**1.511**	1.53	0.630	115	121.55	1.97	1.26	153.0	0.428	0.413	1.152	1.57	0.00
5.65	18.54	**99.71**	**1.597**	1.60	0.634	115	121.70	1.98	1.28	155.4	0.428	0.429	1.195	1.57	0.00
5.7	18.70	**100.07**	**1.527**	1.53	0.639	115	121.73	1.97	1.26	153.3	0.429	0.415	1.154	1.57	0.00
5.75	18.86	**102.74**	**1.771**	1.73	0.643	115	124.55	2.00	1.30	161.6	0.429	0.473	1.312	1.57	0.00
5.8	19.03	**89.39**	**2.039**	2.28	0.647	115	108.01	2.13	1.51	163.3	0.430	0.485	1.344	1.49	0.00
5.85	19.19	**58.87**	**2.132**	3.62	0.652	115	70.90	2.40	2.33	164.9	0.431	0.497	1.376	1.57	0.00
5.9	19.36	**32.96**	**1.628**	4.94	0.656	115	50.24	2.62	3.43	172.3	0.431	0.556	1.538	0.00	0.00
5.95	19.52	**17.2**	**1.069**	6.22	0.660	115	26.05	2.90	5.68	147.9	0.432	0.381	1.053	0.00	0.00
6	19.69	**12.67**	**0.684**	5.40	0.665	115	19.06	2.97	6.36	121.3	0.432	0.246	0.679	0.00	0.00
6.05	19.85	**12.05**	**0.621**	5.16	0.669	115	18.01	2.97	6.44	116.0	0.433	0.225	0.621	0.00	0.00
6.1	20.00	**13.04**	**0.682**	5.23	0.673	115	19.38	2.95	6.21	120.3	0.433	0.242	0.665	0.00	0.00
6.15	20.18	**12.64**	**0.692**	5.48	0.678	115	18.65	2.98	6.49	121.1	0.434	0.245	0.674	0.00	0.00
6.2	20.34	**11.33**	**0.655**	5.79	0.682	115	16.61	3.03	7.14	118.6	0.434	0.235	0.646	0.00	0.00
6.25	20.51	**10.25**	**0.702**	6.86	0.686	115	14.94	3.12	8.21	122.6	0.435	0.252	0.690	0.00	0.00
6.3	20.67	**10.24**	**0.695**	6.79	0.691	115	14.83	3.12	8.21	121.8	0.435	0.248	0.679	0.00	0.00
6.35	20.83	**10.72**	**0.605**	5.65	0.695	115	15.43	3.06	7.39	113.9	0.436	0.218	0.595	0.00	0.00
6.4	21.00	**11.53**	**0.675**	5.86	0.699	115	16.49	3.04	7.22	119.0	0.436	0.237	0.647	0.00	0.00
6.45	21.16	**9.22**	**0.66**	7.17	0.703	115	13.11	3.18	9.03	118.4	0.437	0.234	0.640	0.00	0.00
6.5	21.33	**9.76**	**0.583**	5.98	0.708	115	13.79	3.11	8.11	111.8	0.437	0.210	0.573	0.00	0.00
6.55	21.49	**12.15**	**0.701**	5.78	0.712	115	17.06	3.02	7.02	119.9	0.438	0.240	0.655	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-5**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **2.27**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
6.6	21.65	**14.35**	**0.898**	6.26	0.716	115	20.03	2.99	6.64	133.0	0.438	0.299	0.814	0.00	0.00
6.65	21.82	**17.11**	**1.197**	7.00	0.721	115	23.74	2.97	6.37	151.2	0.438	0.401	1.092	0.00	0.00
6.7	21.98	**17.26**	**1.31**	7.59	0.725	115	23.80	2.99	6.63	157.7	0.439	0.445	1.210	0.00	0.00
6.75	22.15	**16.36**	**1.274**	7.79	0.729	115	22.43	3.02	6.94	155.6	0.439	0.430	1.169	0.00	0.00
6.8	22.31	**16.86**	**1.267**	7.52	0.734	115	22.98	3.00	6.72	154.5	0.440	0.423	1.148	0.00	0.00
6.85	22.47	**19.05**	**1.127**	5.92	0.738	115	25.81	2.89	5.57	143.8	0.440	0.357	0.967	0.00	0.00
6.9	22.64	**22**	**0.916**	4.17	0.742	115	29.64	2.74	4.27	126.4	0.440	0.268	0.726	0.00	0.00
6.95	22.80	**17.02**	**0.69**	4.06	0.747	115	22.80	2.82	4.96	113.1	0.441	0.214	0.580	0.00	0.00
7	22.97	**12.8**	**0.559**	4.37	0.751	115	17.05	2.95	6.18	105.4	0.441	0.189	0.511	0.00	0.00
7.05	23.13	**12.99**	**0.531**	4.09	0.755	115	17.20	2.93	5.96	102.5	0.441	0.180	0.487	0.00	0.00
7.1	23.29	**12.8**	**0.511**	4.00	0.760	115	16.85	2.93	5.98	100.7	0.442	0.175	0.473	0.00	0.00
7.15	23.46	**7.92**	**0.524**	6.63	0.764	115	10.37	3.26	10.05	104.2	0.442	0.185	0.500	0.00	0.00
7.2	23.62	**6.97**	**0.447**	6.42	0.768	115	9.07	3.30	10.77	97.7	0.442	0.167	0.450	0.00	0.00
7.25	23.79	**6.83**	**0.436**	6.39	0.773	115	8.84	3.31	10.93	96.6	0.442	0.164	0.442	0.00	0.00
7.3	23.95	**11.69**	**0.334**	2.86	0.777	115	15.05	2.88	5.55	83.5	0.443	0.134	0.362	0.00	0.00
7.35	24.11	**11.21**	**0.455**	4.06	0.781	115	14.35	2.99	6.69	95.9	0.443	0.162	0.437	0.00	0.00
7.4	24.28	**7.87**	**0.541**	6.88	0.785	115	10.02	3.28	10.43	104.5	0.443	0.186	0.501	0.00	0.00
7.45	24.44	**8.36**	**0.586**	7.02	0.790	115	10.59	3.26	10.17	107.7	0.444	0.196	0.527	0.00	0.00
7.5	24.61	**25.93**	**0.523**	2.02	0.794	115	28.29	2.54	2.98	84.3	0.444	0.136	0.365	2.60	0.05
7.55	24.77	**28.98**	**0.666**	2.30	0.798	115	31.53	2.54	2.95	93.1	0.444	0.155	0.417	2.40	0.05
7.6	24.93	**40.31**	**0.617**	1.53	0.803	115	43.74	2.31	1.98	86.6	0.444	0.140	0.377	2.30	0.05
7.65	25.10	**52.54**	**0.669**	1.28	0.807	115	56.86	2.17	1.59	90.5	0.444	0.149	0.400	2.40	0.05
7.7	25.26	**31.79**	**0.875**	2.76	0.811	115	34.31	2.56	3.07	105.2	0.445	0.188	0.505	0.00	0.00
7.75	25.43	**20.25**	**0.566**	2.80	0.816	115	24.83	2.69	3.91	97.0	0.445	0.165	0.442	0.00	0.00
7.8	25.59	**29.56**	**0.642**	2.17	0.820	115	31.74	2.52	2.86	90.8	0.445	0.150	0.401	0.00	0.00
7.85	25.75	**22.04**	**0.687**	3.12	0.824	115	26.74	2.69	3.93	105.0	0.445	0.188	0.503	0.00	0.00
7.9	25.92	**18.05**	**0.492**	2.73	0.829	115	21.78	2.73	4.22	91.8	0.445	0.152	0.407	0.00	0.00
7.95	26.08	**14.58**	**0.453**	3.11	0.833	115	17.50	2.85	5.20	91.0	0.446	0.150	0.402	0.00	0.00
8	26.25	**9.38**	**0.362**	3.86	0.837	115	11.20	3.08	7.72	86.5	0.446	0.140	0.375	0.00	0.00
8.05	26.41	**6.7**	**0.305**	4.56	0.842	115	7.96	3.28	10.34	82.3	0.446	0.132	0.353	0.00	0.00
8.1	26.57	**22.66**	**0.452**	2.00	0.846	115	55.44	2.59	3.26	180.5	0.446	0.627	1.676	0.00	0.00
8.15	26.74	**33.01**	**0.829**	2.51	0.850	115	34.81	2.53	2.90	101.0	0.446	0.176	0.470	2.30	0.05
8.2	26.90	**21.23**	**0.769**	3.62	0.854	115	24.85	2.76	4.44	110.4	0.446	0.205	0.548	0.00	0.00
8.25	27.07	**35.5**	**0.58**	1.64	0.859	115	37.24	2.39	2.25	84.0	0.446	0.135	0.361	2.60	0.05
8.3	27.23	**52.2**	**0.552**	1.06	0.863	115	54.63	2.13	1.52	83.1	0.446	0.133	0.356	2.60	0.05
8.35	27.40	**66.75**	**0.756**	1.13	0.867	115	69.68	2.07	1.40	97.3	0.447	0.166	0.442	2.15	0.04
8.4	27.56	**69.91**	**1.172**	1.68	0.872	115	72.79	2.16	1.57	114.6	0.447	0.220	0.588	2.00	0.04
8.45	27.72	**77.75**	**1.456**	1.88	0.876	115	80.76	2.16	1.57	127.0	0.447	0.270	0.722	1.84	0.04
8.5	27.89	**88.48**	**1.716**	1.94	0.880	115	91.68	2.13	1.51	138.5	0.447	0.327	0.874	1.71	0.03
8.55	28.05	**104.82**	**2.024**	1.93	0.885	115	108.34	2.08	1.41	153.2	0.447	0.415	1.107	1.50	0.00
8.6	28.22	**120.23**	**2.265**	1.89	0.889	115	123.97	2.03	1.34	166.0	0.447	0.506	1.349	1.57	0.00
8.65	28.38	**120.38**	**2.359**	1.96	0.893	115	123.82	2.04	1.36	168.2	0.447	0.522	1.394	1.27	0.00
8.7	28.54	**134.4**	**2.41**	1.80	0.898	115	137.91	1.98	1.28	176.0	0.447	0.587	1.567	1.42	0.00
8.75	28.71	**145.55**	**2.569**	1.77	0.902	115	149.00	1.95	1.24	185.3	0.447	0.672	1.793	1.27	0.00
8.8	28.87	**141.37**	**2.636**	1.87	0.906	115	144.37	1.98	1.28	184.1	0.447	0.661	1.763	1.27	0.00
8.85	29.04	**114.76**	**2.266**	1.98	0.911	115	116.92	2.06	1.39	162.3	0.447	0.478	1.275	1.34	0.00
8.9	29.20	**90.91**	**1.757**	1.94	0.915	115	92.40	2.13	1.50	139.0	0.447	0.330	0.880	1.71	0.03
8.95	29.36	**80.49**	**1.719**	2.14	0.919	115	81.62	2.20	1.66	135.2	0.447	0.310	0.827	1.84	0.04
9	29.53	**64.4**	**1.683**	2.62	0.924	115	65.15	2.33	2.04	133.2	0.447	0.300	0.800	1.71	0.03
9.05	29.69	**34.37**	**1.389**	4.04	0.928	115	37.04	2.65	3.67	135.8	0.447	0.313	0.835	0.00	0.00
9.1	29.86	**22.33**	**0.895**	4.01	0.932	115	23.96	2.80	4.79	114.7	0.447	0.220	0.588	0.00	0.00
9.15	30.02	**15**	**0.672**	4.48	0.937	120	16.01	2.98	6.53	104.5	0.447	0.186	0.497	0.00	0.00
9.2	30.18	**11.55**	**0.738**	6.40	0.942	120	12.27	3.18	8.99	110.3	0.447	0.205	0.547	0.00	0.00
9.25	30.35	**30.28**	**0.775**	2.56	0.946	115	30.27	2.58	3.21	97.3	0.446	0.166	0.443	0.00	0.00
9.3	30.51	**52.13**	**0.879**	1.69	0.950	115	51.99	2.28	1.88	97.5	0.446	0.166	0.444	2.00	0.04
9.35	30.68	**70.37**	**0.839**	1.19	0.955	115	70.02	2.08	1.42	99.2	0.446	0.171	0.456	2.00	0.04
9.4	30.84	**77.18**	**1.41**	1.83	0.959	115	76.63	2.17	1.59	122.2	0.446	0.250	0.667	1.91	0.04
9.45	31.00	**66.04**	**1.605**	2.43	0.963	115	65.42	2.31	1.97	128.7	0.446	0.278	0.743	1.71	0.03
9.5	31.17	**63.96**	**1.474**	2.31	0.967	115	63.22	2.30	1.95	123.3	0.446	0.254	0.680	1.71	0.03
9.55	31.33	**72.95**	**1.523**	2.09	0.972	115	71.94	2.23	1.74	125.3	0.446	0.263	0.703	2.00	0.04
9.6	31.50	**88.7**	**1.643**	1.85	0.976	115	87.28	2.13	1.51	132.2	0.446	0.295	0.789	1.78	0.04
9.65	31.66	**120.15**	**2.031**	1.69	0.980	115	117.97	2.01	1.31	154.8	0.446	0.425	1.138	1.64	0.00
9.7	31.82	**117.71**	**2.553**	2.17	0.985	115	115.32	2.10	1.45	166.8	0.446	0.512	1.370	1.34	0.00
9.75	31.99	**61.89**	**2.643**	4.27	0.989	115	60.50	2.51	2.80	169.3	0.445	0.531	1.422	1.42	0.00
9.8	32.15	**27.96**	**1.901**	6.80	0.994	120	28.14	2.90	5.71	160.8	0.445	0.466	1.250	0.00	0.00
9.85	32.32	**18.05**	**1.199**	6.65	0.999	120	18.08	3.05	7.28	131.6	0.445	0.292	0.783	0.00	0.00

Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-5**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **2.27**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
9.9	32.48	**15.05**	**0.858**	5.71	1.003	115	15.01	3.07	7.58	113.8	0.445	0.217	0.582	0.00	0.00
9.95	32.64	**14.57**	**0.798**	5.48	1.007	115	14.47	3.08	7.62	110.2	0.445	0.204	0.549	0.00	0.00
10	32.81	**14.15**	**0.805**	5.69	1.012	120	13.98	3.10	7.91	110.6	0.444	0.206	0.553	0.00	0.00
10.05	32.97	**13.86**	**0.761**	5.50	1.017	120	13.63	3.10	7.91	107.9	0.444	0.197	0.528	0.00	0.00
10.1	33.14	**12.53**	**0.847**	6.77	1.021	120	12.27	3.20	9.22	113.1	0.444	0.214	0.577	0.00	0.00
10.15	33.30	**12.13**	**0.88**	7.26	1.026	120	11.82	3.23	9.70	114.7	0.443	0.220	0.593	0.00	0.00
10.2	33.46	**11.48**	**0.823**	7.18	1.031	120	11.14	3.25	10.00	111.4	0.443	0.209	0.562	0.00	0.00
10.25	33.63	**10.76**	**0.761**	7.08	1.035	120	10.39	3.28	10.37	107.7	0.443	0.196	0.529	0.00	0.00
10.3	33.79	**9.67**	**0.628**	6.50	1.040	120	9.30	3.30	10.73	99.8	0.442	0.172	0.465	0.00	0.00
10.35	33.96	**8.05**	**0.533**	6.63	1.045	120	7.70	3.39	12.15	93.6	0.442	0.156	0.422	0.00	0.00
10.4	34.12	**7.04**	**0.449**	6.39	1.050	120	6.71	3.45	13.12	88.0	0.442	0.143	0.387	0.00	0.00
10.45	34.28	**6.47**	**0.444**	6.87	1.054	120	6.14	3.51	14.25	87.5	0.441	0.142	0.384	0.00	0.00
10.5	34.45	**6.12**	**0.426**	6.97	1.059	120	5.78	3.54	14.90	86.1	0.441	0.139	0.377	0.00	0.00
10.55	34.61	**6.21**	**0.509**	8.21	1.064	120	5.84	3.58	15.61	91.1	0.441	0.150	0.407	0.00	0.00
10.6	34.78	**9.56**	**0.755**	7.91	1.069	120	8.95	3.37	11.84	105.9	0.440	0.190	0.516	0.00	0.00
10.65	34.94	**11.13**	**0.882**	7.93	1.073	120	10.37	3.31	10.87	112.7	0.440	0.213	0.578	0.00	0.00
10.7	35.10	**10.04**	**0.829**	8.27	1.078	120	9.31	3.37	11.76	109.5	0.440	0.202	0.548	0.00	0.00
10.75	35.27	**10.23**	**0.77**	7.54	1.083	120	9.45	3.33	11.25	106.3	0.439	0.192	0.521	0.00	0.00
10.8	35.43	**11.89**	**0.763**	6.42	1.087	120	10.93	3.23	9.67	105.8	0.439	0.190	0.517	0.00	0.00
10.85	35.60	**10.59**	**0.819**	7.74	1.092	120	9.70	3.33	11.20	108.6	0.438	0.199	0.541	0.00	0.00
10.9	35.76	**9.53**	**0.754**	7.92	1.097	120	8.69	3.38	12.06	104.8	0.438	0.187	0.509	0.00	0.00
10.95	35.93	**7.84**	**0.653**	8.34	1.102	120	7.12	3.49	13.86	98.7	0.438	0.169	0.461	0.00	0.00
11	36.09	**7.17**	**0.544**	7.60	1.106	120	6.48	3.51	14.24	92.3	0.437	0.153	0.417	0.00	0.00
11.05	36.25	**5.92**	**0.465**	7.87	1.111	120	5.33	3.62	16.37	87.2	0.437	0.142	0.387	0.00	0.00
11.1	36.42	**7.03**	**0.478**	6.81	1.116	120	6.30	3.49	13.98	88.1	0.436	0.144	0.392	0.00	0.00
11.15	36.58	**8.58**	**0.481**	5.61	1.121	120	7.66	3.35	11.51	88.1	0.436	0.144	0.393	0.00	0.00
11.2	36.75	**8.21**	**0.493**	6.01	1.125	120	7.30	3.39	12.17	88.8	0.435	0.145	0.397	0.00	0.00
11.25	36.91	**8.39**	**0.493**	5.88	1.130	120	7.42	3.38	11.94	88.7	0.435	0.145	0.397	0.00	0.00
11.3	37.07	**7.87**	**0.479**	6.10	1.135	120	6.94	3.42	12.64	87.7	0.435	0.143	0.392	0.00	0.00
11.35	37.24	**8.14**	**0.492**	6.05	1.139	120	7.14	3.40	12.37	88.4	0.434	0.144	0.396	0.00	0.00
11.4	37.40	**9.76**	**0.504**	5.17	1.144	120	8.53	3.28	10.41	88.8	0.434	0.145	0.399	0.00	0.00
11.45	37.57	**9.58**	**0.475**	4.96	1.149	120	8.34	3.28	10.41	86.8	0.433	0.141	0.388	0.00	0.00
11.5	37.73	**9.33**	**0.473**	5.08	1.154	120	8.09	3.30	10.71	86.6	0.433	0.140	0.387	0.00	0.00
11.55	37.89	**9.47**	**0.502**	5.31	1.158	120	8.18	3.31	10.81	88.4	0.432	0.144	0.398	0.00	0.00
11.6	38.06	**9.45**	**0.522**	5.53	1.163	120	8.13	3.32	11.02	89.5	0.432	0.147	0.405	0.00	0.00
11.65	38.22	**9.08**	**0.502**	5.54	1.168	120	7.78	3.34	11.34	88.2	0.431	0.144	0.398	0.00	0.00
11.7	38.39	**8.83**	**0.463**	5.25	1.172	120	7.53	3.34	11.37	85.6	0.431	0.138	0.383	0.00	0.00
11.75	38.55	**8.45**	**0.449**	5.32	1.177	120	7.18	3.37	11.80	84.7	0.430	0.136	0.378	0.00	0.00
11.8	38.71	**8.24**	**0.424**	5.15	1.182	120	6.97	3.37	11.90	82.9	0.430	0.133	0.370	0.00	0.00
11.85	38.88	**8.07**	**0.398**	4.94	1.187	120	6.80	3.38	11.93	81.1	0.429	0.130	0.360	0.00	0.00
11.9	39.04	**7.94**	**0.381**	4.81	1.191	120	6.66	3.38	11.99	79.9	0.428	0.127	0.355	0.00	0.00
11.95	39.21	**8.09**	**0.396**	4.90	1.196	120	6.76	3.38	11.94	80.8	0.428	0.129	0.360	0.00	0.00
12	39.37	**8.18**	**0.385**	4.71	1.201	120	6.81	3.36	11.73	79.9	0.427	0.127	0.356	0.00	0.00
12.05	39.53	**7.96**	**0.373**	4.69	1.206	120	6.60	3.38	11.97	79.0	0.427	0.126	0.352	0.00	0.00
12.1	39.70	**7.78**	**0.353**	4.54	1.210	120	6.43	3.38	12.07	77.6	0.426	0.123	0.345	0.00	0.00
12.15	39.86	**7.65**	**0.341**	4.46	1.215	120	6.30	3.39	12.18	76.7	0.426	0.122	0.342	0.00	0.00
12.2	40.03	**7.52**	**0.332**	4.42	1.220	120	6.17	3.40	12.33	76.0	0.425	0.121	0.339	0.00	0.00
12.25	40.19	**7.48**	**0.33**	4.42	1.224	120	6.11	3.40	12.41	75.8	0.424	0.120	0.339	0.00	0.00
12.3	40.35	**7.03**	**0.292**	4.16	1.229	120	5.72	3.43	12.77	73.1	0.424	0.116	0.327	0.00	0.00
12.35	40.52	**6.64**	**0.275**	4.15	1.234	120	5.38	3.46	13.36	71.9	0.423	0.115	0.323	0.00	0.00
12.4	40.68	**6.88**	**0.297**	4.32	1.239	120	5.55	3.45	13.22	73.4	0.423	0.117	0.330	0.00	0.00
12.45	40.85	**8.47**	**0.298**	3.52	1.243	120	6.81	3.29	10.64	72.5	0.422	0.115	0.326	0.00	0.00
12.5	41.01	**7.38**	**0.311**	4.22	1.248	120	5.91	3.41	12.52	74.0	0.421	0.118	0.333	0.00	0.00
12.55	41.17	**6.63**	**0.255**	3.85	1.253	120	5.29	3.45	13.24	70.1	0.421	0.112	0.317	0.00	0.00
12.6	41.34	**6.89**	**0.245**	3.56	1.258	120	5.48	3.41	12.58	68.9	0.420	0.110	0.314	0.00	0.00
12.65	41.50	**6.86**	**0.241**	3.52	1.262	120	5.43	3.42	12.62	68.6	0.420	0.110	0.313	0.00	0.00
12.7	41.67	**6.59**	**0.241**	3.66	1.267	120	5.20	3.45	13.22	68.8	0.419	0.110	0.314	0.00	0.00
12.75	41.83	**6.62**	**0.239**	3.62	1.272	120	5.21	3.45	13.16	68.5	0.418	0.110	0.313	0.00	0.00
12.8	41.99	**6.52**	**0.235**	3.61	1.276	120	5.11	3.46	13.35	68.2	0.418	0.110	0.313	0.00	0.00
12.85	42.16	**6.44**	**0.231**	3.59	1.281	120	5.03	3.47	13.51	67.9	0.417	0.109	0.312	0.00	0.00
12.9	42.32	**6.29**	**0.225**	3.58	1.286	120	4.89	3.48	13.80	67.5	0.416	0.109	0.311	0.00	0.00
12.95	42.49	**6.38**	**0.237**	3.72	1.291	120	4.94	3.49	13.83	68.4	0.416	0.110	0.315	0.00	0.00
13	42.65	**7.1**	**0.243**	3.43	1.295	120	5.48	3.41	12.44	68.2	0.415	0.109	0.315	0.00	0.00
13.05	42.81	**6.35**	**0.245**	3.87	1.300	115	4.89	3.50	14.12	69.0	0.414	0.111	0.318	0.00	0.00
13.1	42.98	**6.28**	**0.21**	3.35	1.304	115	4.82	3.48	13.71	66.0	0.414	0.107	0.308	0.00	0.00
13.15	43.14	**6.76**	**0.234**	3.47	1.308	115	5.17	3.44	13.08	67.6	0.413	0.109	0.314	0.00	0.00

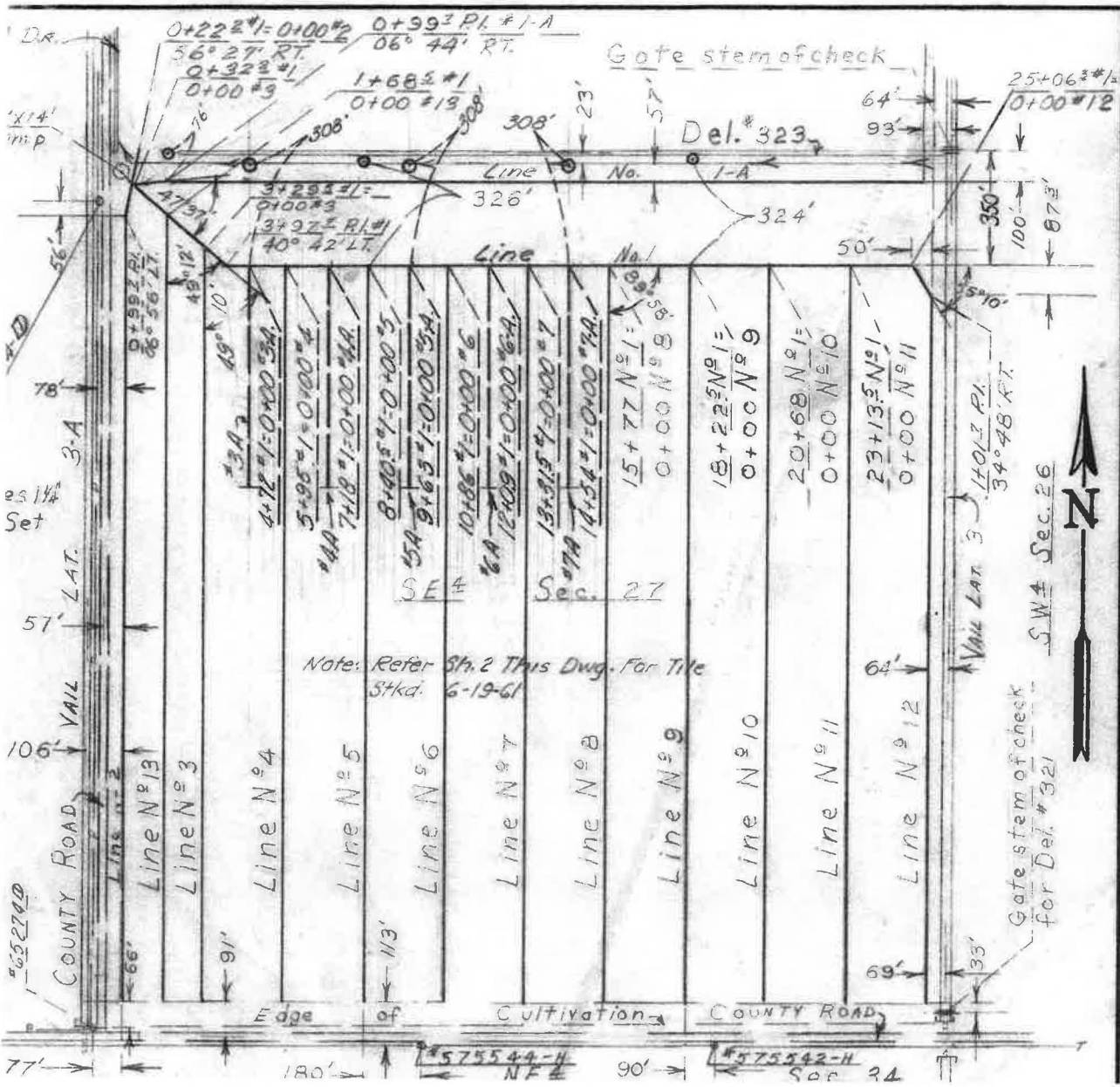
Settlement Due to Liquefaction
(Saturated Sands)

Project No.: **LE11138** **Sounding Location:** **CPT-5**
Project Name: **Cal Energy Black Rock 5-6**

Depth to Water Table: **4.0 ft** **Total Estimated Settlement:** **2.27**
PGA: **0.40 g** Required FS: **1.0**
Estimated Earthquake Magnitude: **7.0** Limiting Qc1n-cs for liquefiable soils: **164**
Magnitude Scaling Factor: 1.19 Limiting Ic for liquefiable soils: **2.55**

Depth (m)	Depth (ft)	Qc (tsf)	Friction (tsf)	Friction Ratio (%)	Effective Stress (tsf)	Estimated Density (pcf)	Q_{C1N}	Ic	Kc	$(Q_{C1N})_{CS}$	CSR	$CRR_{7.5}$	FS	Vol Strain (%)	Liquifiable Settlement (in)
13.2	43.31	**7**	**0.383**	5.48	1.313	115	5.33	3.53	14.68	78.3	0.413	0.125	0.360	0.00	0.00
13.25	43.47	**10.77**	**0.497**	4.62	1.317	115	8.18	3.27	10.29	84.1	0.412	0.135	0.392	0.00	0.00
13.3	43.64	**13.04**	**0.69**	5.30	1.321	115	9.87	3.22	9.57	94.5	0.411	0.158	0.459	0.00	0.00
13.35	43.80	**12.98**	**0.697**	5.37	1.326	115	9.79	3.23	9.68	94.7	0.411	0.159	0.462	0.00	0.00
13.4	43.96	**13.31**	**0.651**	4.90	1.330	115	10.01	3.20	9.20	92.1	0.410	0.153	0.444	0.00	0.00
13.45	44.13	**13.78**	**0.552**	4.01	1.334	115	10.33	3.13	8.33	86.0	0.409	0.139	0.406	0.00	0.00
13.5	44.29	**9.57**	**0.472**	4.94	1.338	115	7.15	3.35	11.55	82.6	0.409	0.132	0.386	0.00	0.00
13.55	44.46	**9.09**	**0.496**	5.46	1.343	115	6.77	3.40	12.41	84.0	0.408	0.135	0.395	0.00	0.00
13.6	44.62	**9.78**	**0.537**	5.50	1.347	115	7.26	3.37	11.87	86.2	0.407	0.139	0.408	0.00	0.00
13.65	44.78	**9.57**	**0.583**	6.10	1.351	115	7.08	3.41	12.51	88.6	0.407	0.145	0.424	0.00	0.00
13.7	44.95	**11.43**	**0.571**	5.00	1.356	115	8.43	3.28	10.38	87.6	0.406	0.142	0.418	0.00	0.00
13.75	45.11	**10.27**	**0.506**	4.93	1.360	115	7.55	3.33	11.13	84.0	0.405	0.135	0.398	0.00	0.00
13.8	45.28	**11.04**	**0.462**	4.19	1.364	115	8.09	3.25	10.01	81.0	0.405	0.129	0.381	0.00	0.00
13.85	45.44	**10.76**	**0.522**	4.86	1.369	115	7.86	3.30	10.77	84.7	0.404	0.136	0.403	0.00	0.00
13.9	45.60	**11.35**	**0.677**	5.97	1.373	115	8.27	3.33	11.23	92.8	0.403	0.154	0.457	0.00	0.00
13.95	45.77	**11.33**	**0.786**	6.94	1.377	115	8.23	3.37	11.91	98.0	0.403	0.167	0.496	0.00	0.00
14	45.93	**11.05**	**0.847**	7.67	1.382	115	8.00	3.41	12.57	100.5	0.402	0.175	0.518	0.00	0.00
14.05	46.10	**12.79**	**0.889**	6.96	1.386	115	9.23	3.32	11.10	102.5	0.401	0.180	0.535	0.00	0.00
14.1	46.26	**11.83**	**0.882**	7.46	1.390	115	8.51	3.38	11.98	101.9	0.401	0.179	0.531	0.00	0.00
14.15	46.42	**10.61**	**0.684**	6.45	1.395	115	7.61	3.39	12.19	92.7	0.400	0.154	0.460	0.00	0.00
14.2	46.59	**9.51**	**0.548**	5.77	1.399	115	6.80	3.42	12.62	85.8	0.399	0.139	0.414	0.00	0.00
14.25	46.75	**9.69**	**0.464**	4.79	1.403	115	6.91	3.36	11.72	81.0	0.399	0.129	0.387	0.00	0.00
14.3	46.92	**9.28**	**0.487**	5.25	1.407	115	6.59	3.41	12.49	82.3	0.398	0.132	0.395	0.00	0.00
14.35	47.08	**10.53**	**0.397**	3.77	1.412	115	7.46	3.27	10.22	76.3	0.397	0.121	0.364	0.00	0.00
14.4	47.24	**10.56**	**0.36**	3.41	1.416	115	7.46	3.24	9.87	73.6	0.396	0.117	0.352	0.00	0.00
14.45	47.41	**10**	**0.309**	3.09	1.420	115	7.04	3.25	9.97	70.2	0.396	0.112	0.338	0.00	0.00
14.5	47.57	**11.81**	**0.562**	4.76	1.425	115	8.29	3.27	10.33	85.6	0.395	0.138	0.418	0.00	0.00
14.55	47.74	**15.23**	**0.812**	5.34	1.429	115	10.66	3.19	9.15	97.5	0.394	0.166	0.503	0.00	0.00
14.6	47.90	**15.21**	**0.904**	5.95	1.433	115	10.61	3.22	9.58	101.7	0.394	0.178	0.539	0.00	0.00
14.65	48.06	**17.02**	**1.033**	6.07	1.438	115	11.84	3.18	9.03	106.9	0.393	0.194	0.588	0.00	0.00
14.7	48.23	**43.84**	**1.331**	3.04	1.442	115	30.40	2.64	3.57	108.6	0.392	0.199	0.606	0.00	0.00
14.75	48.39	**40.64**	**1.435**	3.53	1.446	115	28.10	2.71	4.06	114.2	0.391	0.218	0.665	0.00	0.00
14.8	48.56	**72.32**	**1.716**	2.37	1.451	115	58.38	2.34	2.08	121.2	0.391	0.246	0.750	0.00	0.00
14.85	48.72	**99.81**	**1.88**	1.89	1.455	115	80.45	2.16	1.58	127.4	0.390	0.272	0.833	0.00	0.00
14.9	48.88	**112.38**	**2.205**	1.96	1.459	115	90.44	2.14	1.53	138.5	0.389	0.327	1.001	1.69	0.00
14.95	49.05	**119.85**	**2.519**	2.10	1.464	115	96.31	2.14	1.53	147.8	0.389	0.380	1.167	1.61	0.00
15	49.21	**108.59**	**2.644**	2.44	1.468	115	87.14	2.22	1.71	149.2	0.388	0.389	1.196	1.77	0.00
15.05	49.38	**110.01**	**2.494**	2.27	1.472	115	88.15	2.19	1.65	145.3	0.387	0.365	1.125	1.77	0.00
15.1	49.54	**138.96**	**2.638**	1.90	1.477	115	111.18	2.07	1.40	155.1	0.386	0.427	1.318	1.38	0.00
15.15	49.70	**179.52**	**3.511**	1.96	1.481	115	143.42	2.00	1.30	186.3	0.386	0.681	2.107	0.00	0.00
15.2	49.87	**207.63**	**4.454**	2.15	1.485	115	165.64	1.99	1.29	213.1	0.385	0.980	3.035	0.00	0.00
15.25	50.03	**218.97**	**4.824**	2.20	1.489	115	174.43	1.98	1.28	223.3	0.384	1.115	3.461	0.00	0.00

APPENDIX F



Line No.	Outlet Elev.	Footage Staked	Tile Installed 8"	6"	5"	4"
1	763.80	2506	1256	1255		
1-A	764.05	2410				2410
2	764.05	2491				2541
3	764.50	2290				2444
4	764.94	2246				2340
5	765.30	2246				2300
6	765.60	2246				2297
7	766.00	2246				2297
8	766.35	2246				2296
9	766.75	2246				2290
10	767.10	2246				2297
11	767.50	2246				2299
12	768.00	2271				2299
13	764.20	2394				2324
3A	764.75	670				670
4A	765.10	670				670
5A	765.50	670				670
6A	765.85	670				670
7A	766.20	670				670

Const. F.B. 4832 1-3A By Murphy Date 6-29-56
Installed By La Bolsa Date 7-3-56
Gravel Used West Mesa Tile Used Red Clay
Plotted By Reeder Chkd. By JLS Well Book SCS
Const. F.B. 5067 11 By Miller Date 6-5-58
Installed By La Bolsa Date 6-5-58
Gravel Used West Mesa Tile Used Red Clay
Plotted By RLP Chkd. By Well Book
References:

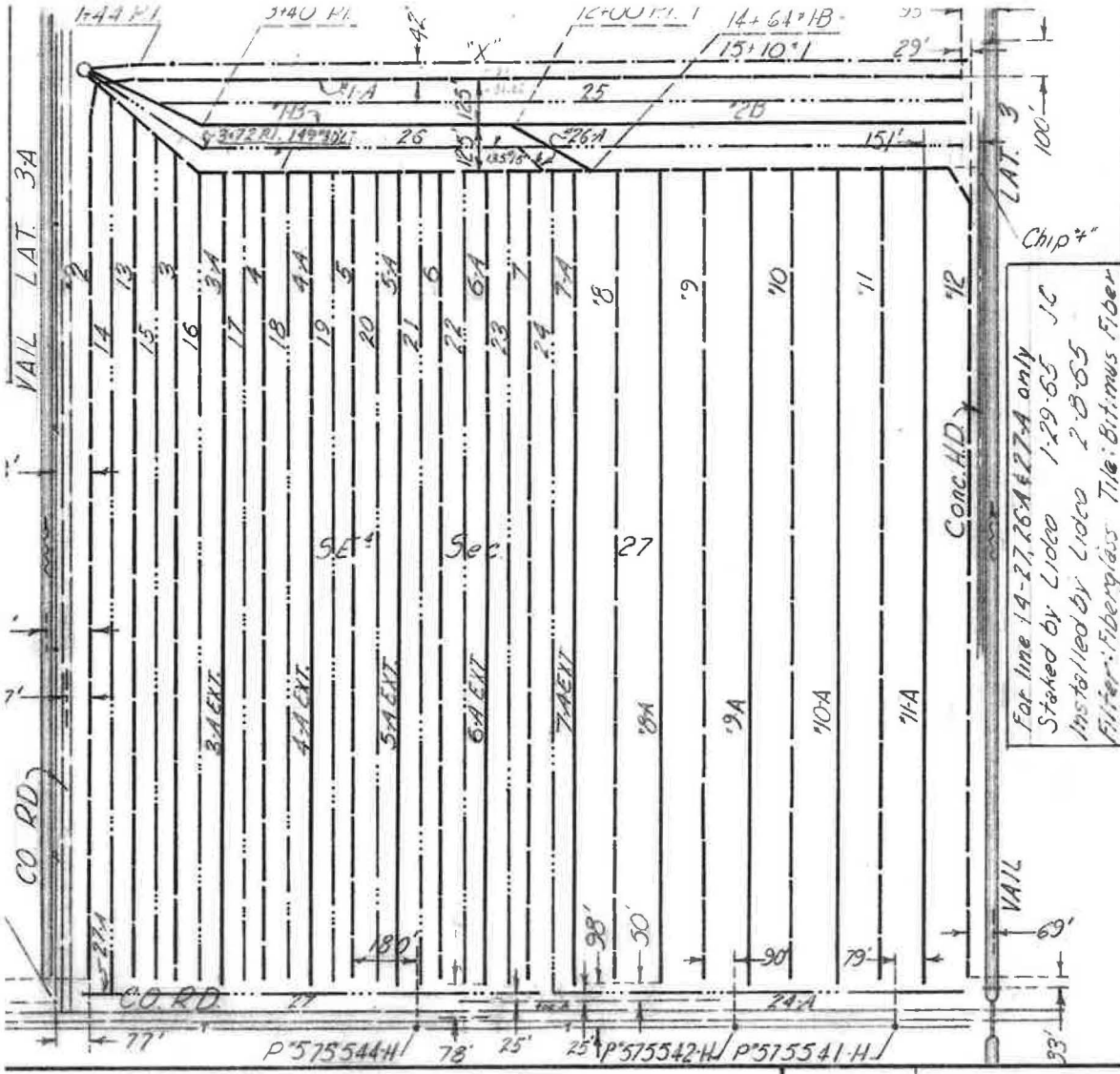
IMPERIAL IRRIGATION DISTRICT
ENGINEERING DEPARTMENT
IMPERIAL, CALIFORNIA

TILE DRAIN CONSTRUCTION

SE¼ SECTION 27

John Elmore Jr. Property T. 11 S.—R. 13 E.

Scale: 1" = 400' Sh. 1 of 3 Shs. TD 1859



LINE NO.	TILE SIZE	LENGTH	O.P.	Outlet Elev.	OUTLET STA. 0+00 =	FOOTAGE		8"	6"	4"
1-B				765.40		1464			1464	
2-B				767.20	12+00 #1B	1264			1264	
3A Ext.				766.60	6+70 #3A	1591				1591
4A Ext.				766.85	6+70 #4A	1591				1591
5A Ext.				767.30	6+70 #5A	1591				1591
6A Ext.				767.70	6+70 #6A	1591				1591
7A Ext.				768.20	6+70 #7A	1591				1591
8A				767.50	17+00 #1	2261				2261
9A				767.90	19+45 #1	2261				2261
10A				768.30	21+91 #1	2261				2261
11-A				768.60	24+36 #1	2261				2261
X						2433				2433
14						2490				2490
15						2330				2330
16						2241				2241
17						2241				2241
18						2241				2241
19						2241				2241
20						2241				2241
21						2241				2241
22						2241				2241
23						2241				2241
24						2296				2296
25						2297				2297
26				763.50		2480			1253	1227
26-A					12+53 #26	85			85	
24A						1142				1142
27						1183				1183
27-A						80				80

STAKED BY G.B. & J. Engr. DATE 6-19-61 F.B.
PLOTTED JB CH'K'D. JS INSTALLED BY Elmore
GRAVEL Fiberglass Filter TILE Orangeburg DATE 7-61
STAKED BY Lidco DATE 12-16-64 F.B.
PLOTTED JC CH'K'D RH MV INSTALLED BY Lidco
GRAVEL Fiberglass TILE Orangeburg DATE 12-25-64

LEGEND

———	Existing Tile
———	Stk'd. 6-19-61
—·—·—	Stk'd. 12-16-64
—··—	Stk'd. 1-29-65
O.P.	OVERPOUR
	HEAD DITCH
	FIELD ROAD
	FIELD WASTE

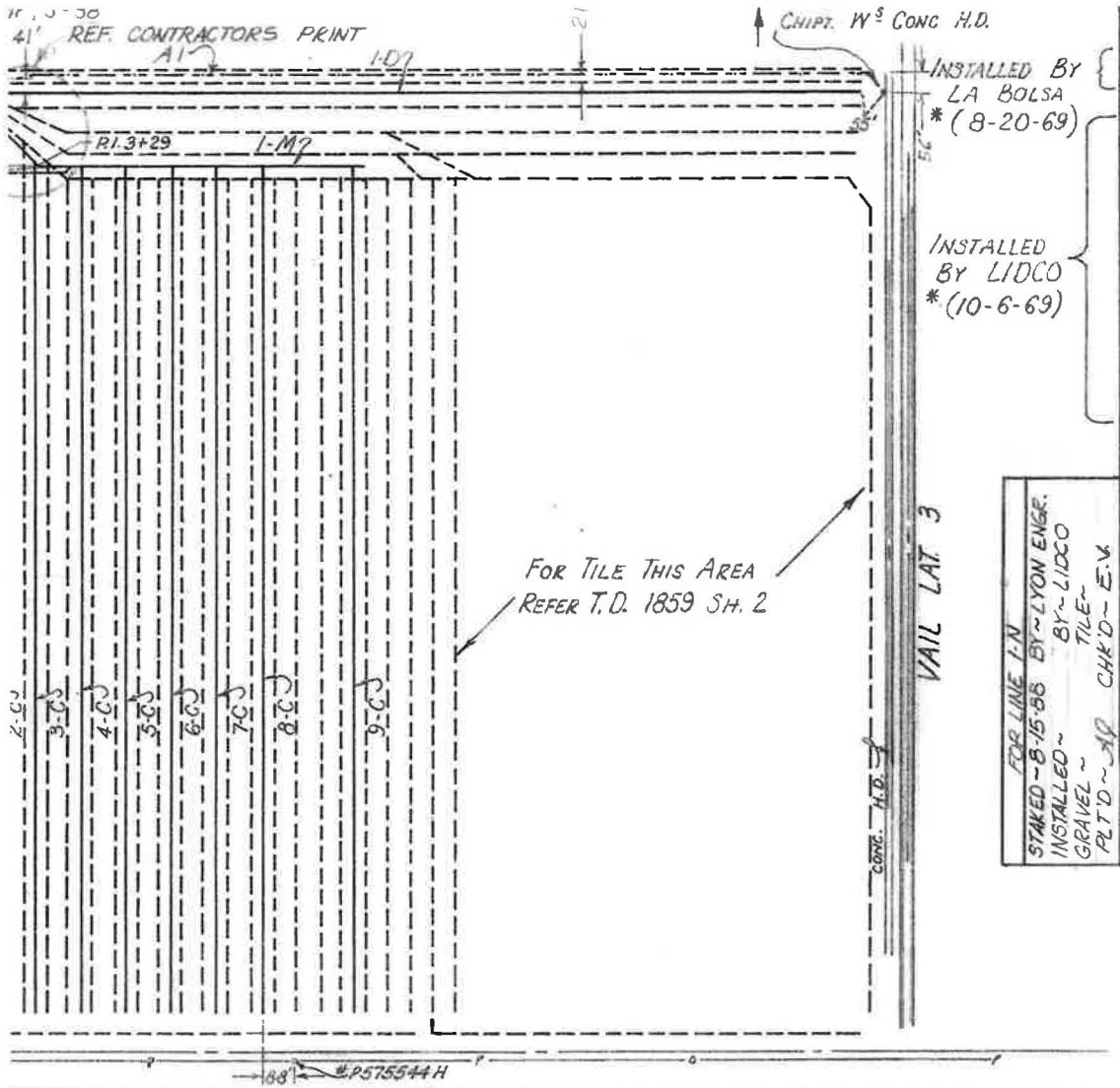
REFERENCES: Exist. Tile T.D. 1859-1

IMPERIAL IRRIGATION DISTRICT
ENGINEERING DEPARTMENT
IMPERIAL, CALIFORNIA

TILE DRAIN CONSTRUCTION
SE¼ Sec. 27
PROP. J. Elmore Jr. T. 11 S.-R. 13 E.
SCALE 1" = 400' SH. 2 OF 3 SHS. TD 1859

ISSUE 4		
ISSUE 3	Const. Stks. 5-25-65	JC
ISSUE 2	Const. Stks. 4-23-65	JC
ISSUE 1	Const Stks 9-7-61	JB

F.B.



FOR LINE 1-N
STAKED ~ 8-15-88 BY ~ LYON ENGR.
INSTALLED ~ BY ~ LIDCO
GRAVEL ~ TILE ~
PLT'D ~ CHK'D ~ E.V.

LINE NO.	TILE SIZE	LENGTH	O.P.		OUTLET STA. 0+00 =	FOOTAGE		8"	6"	4"
1-M					SUMP	1200		1200		
1-D					0+50 1-M	2400				2400
1-C					0+26 1-M	2500				2500
2-C						2378				2378
3-C					3+13 1-M	2260				2260
4-C					4+39 1-M	2244				2244
5-C					5+61 1-M	2244				2244
6-C					6+83 1-M	2244				2244
7-C					8+05 1-M	2244				2244
8-C					9+27 1-M	2244				2244
9-C					11+71 1-M	2244				2244
A-1					0+99 1-A					2350
1-N					±0+83 *1-M	436				

STAKED BY RIDDLE & ASSOC. DATE 7-3-69 F.B.
PLOTTED LC CH'K'D. S INSTALLED BY LIDCO & LA BOLSA
GRAVEL WEST MESA TILE RED CLAY & KUDU DATE * SEE ABOVE
STAKED BY SKILLMAN DATE 10-13-83 F.B.
PLOTTED M.E. CH'K'D. F.H. INSTALLED BY BOLSA
GRAVEL WEST MESA TILE PLASTIC DATE 10-29-83

LEGEND	
— — —	EXISTING TILE
———	STKD 7-3-69
— · — ·	STKD 10-13-83
— · · —	STK'D 8-15-88
O.P.	OVERPOUR
═══	HEAD DITCH
═══	FIELD ROAD
→—→	FIELD WASTE

REFERENCES:

IMPERIAL IRRIGATION DISTRICT
ENGINEERING DEPARTMENT
IMPERIAL, CALIFORNIA

TILE DRAIN CONSTRUCTION
SE 1/4 SEC. 27

PROP. SMITH T. 11 S.-R. 13 E.

SCALE 1" = 400' SH. 3 OF 3 SHS. TD 1859

ISSUE 4	
ISSUE 3	CONST. STKS. 8-29-89 AQ
ISSUE 2	CONST STKS 6-27-84 ME
ISSUE 1	CONST. STKS. 3-6-70 LC

F.B.

APPENDIX G

APPENDIX H

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ENGP Attachment DRR 52 2009
Geotechnical Investigation

APPENDIX B

Geotechnical Study

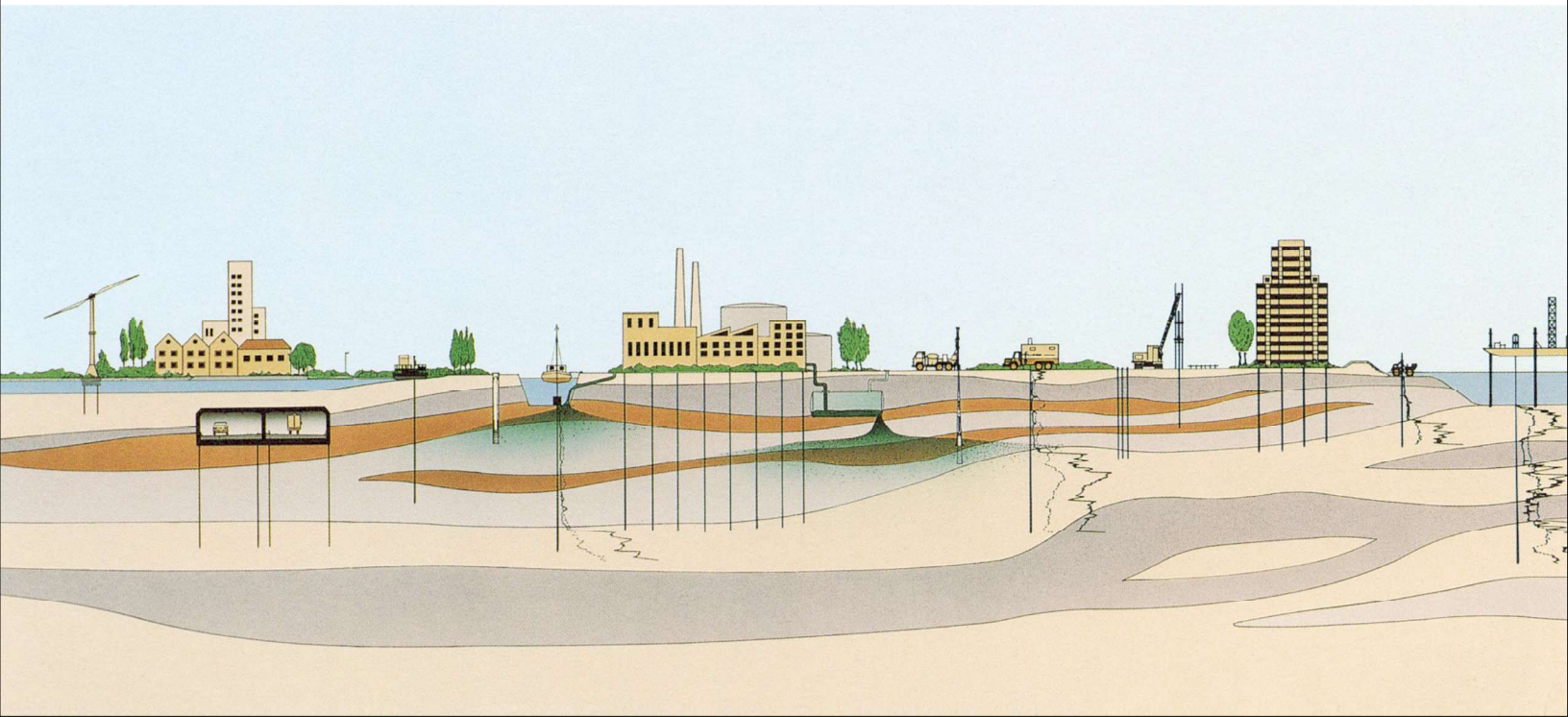
FUGRO WEST, INC.

GEOTECHNICAL STUDY

PROPOSED BLACK ROCK UNITS 1, 2 & 3 SINGLE FLASH GEOTHERMAL PLANT CALIPATRIA, CALIFORNIA

Prepared for:
CalEnergy Operating Corporation

January 2009
Fugro Project No. 3652.001



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January 20, 2009
Project No. 3652.001

CalEnergy Operating Corporation
7030 Gentry Road
Calipatria, California 92233

Attention: Mr. George Furmanski, Senior Project Engineer

Subject: Geotechnical Study for the Proposed Black Rock Units 1, 2 & 3, Single Flash Geothermal Plant, Calipatria, California

Dear Mr. Furmanski:

Fugro herewith presents our geotechnical study and input relative to development of the Black Rock Units 1, 2 & 3 Single Flash Geothermal Plant in Calipatria, California. The purpose of this study was to provide the initial geotechnical engineering efforts for the development of the proposed geothermal power plant.

From a geotechnical perspective, we consider the development of the project to be feasible. The proposed site for the development of the geothermal power plant is currently undeveloped and used for agriculture. The primary geotechnical considerations for development of the site include the impact of potentially high seismically-induced settlements on the proposed structures, mitigating potentially liquefiable soils beneath the project area, and establishing seismic design criteria for structural design of the turbine/genrators, cooling towers and other critical structures.

We look forward to working with CalEnergy Operating Corporation in the development of this project. Please call if further information is required or if we can answer any questions.

Sincerely,

FUGRO WEST, INC.

Jon M. Everett, P.E., G.E.
Principal Geotechnical Engineer

Craig D. Prentice, P.G., C.E.G.
Principal Engineering Geologist

Copies Submitted: (2) Addressee and Pdf

LIST OF ACRONYMS AND ABBREVIATIONS

ACI	American Concrete Institute
ASTM	ASTM International
bpf	blows per foot
CalEnergy	CalEnergy Operating Corporation
CBC	California Building Code
CDSM	Cement Deep Soil Mixing
CGS	California Geologic Survey
CPT	cone penetration test
DLE	Design Level Earthquake
HSA	hollow-stem auger
IBC	International Building Code
mV	millivolt
MW	megawatt
NAD83	North American Datum 83
NAVD88	North American Vertical Datum 88
PGA	peak ground acceleration
ppm	parts per million
psf	pounds per cubic foot
psf	pounds per square foot
R-value	Resistance-value
RW	rotary wash
SAF	San Andreas Fault
sec	second
SPT	standard penetration test
USA	Underground Service Alert

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

CalEnergy Operating Corporation (CalEnergy) plans to construct a geothermal power plant comprising three separate units known as Black Rock 1, 2 and 3. The facility will be located on a 160-acre parcel located approximately 5 miles west of Calipatria in Imperial County, California. The approximate location of the site is depicted in Figure 1-1 (Vicinity Map).

Each unit of the proposed facility will consist of a generating area and a production area having identical structural and mechanical components. Each unit will have a gross output of 59 mega watts (MW) and a net output of 53 MW, resulting in a gross combined output of 177 MW and a net combined output of 159 MW for the entire facility. Based on preliminary equipment loading data furnished by CalEnergy, we understand that the largest structural loads will be at the Cooling Tower (7.6 million pounds [lbs]) and the Condenser/Turbine/Generator structure (1 million lbs). Various elements of the project will serve all three units. These common elements include a control building, fire water and purge water storage tanks, pipe support structures, a stormwater retention basin, and site access roads. The features of the proposed facility are depicted in Figure 1-2 (Site Layout). A list of the proposed major structures and loads, as provided by CalEnergy, is presented in Figure 1-3.

1.2 FUGRO SERVICES

To aid CalEnergy in the development and design of the proposed Black Rock Units 1, 2 and 3 Geothermal Power Plant, Fugro conducted a geotechnical study to provide data and recommendation relative to site grading and foundation design. The findings and recommendations for this study, described herein, are applicable for the project description and project components as known to Fugro as of September 2008. Fugro's recommendations are based, in part, on our general knowledge of the project area and recent and historical subsurface explorations that have been conducted in the proposed geothermal power plant area. Pertinent data and results from previous studies applicable to the project were reviewed for this study. This report supersedes any prior reports or memoranda prepared by Fugro for this proposed project.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of our study was to explore subsurface conditions at the project site to aid in the design of the proposed facility. The scope of work included the following:

1.3.1 Data Review, Site Reconnaissance, and Access Coordination

In preparation for the field exploration program, Fugro reviewed boring and CPT logs and report data from the previous geotechnical study performed by Geotechnics on the north half of the site, project plans for the current development provided by CalEnergy, and other documents, maps, and existing geologic literature relevant to the site. Fugro also visited the site to meet with CalEnergy to locate and stake the borings and CPTs in the field in advance of mobilizing the drilling crews.

1.3.2 Field Exploration

The field exploration program was completed by Fugro in October, 2008, and consisted of 30 borings and 21 cone penetration test (CPT) soundings. The explorations were concentrated at the planned locations of major plant components. Further details regarding the field exploration program are presented in Section 3.0 and in Appendix A.

1.3.3 Laboratory Testing

Laboratory testing was performed on selected soil samples obtained during the field exploration program. The types and numbers of tests were chosen to help classify and characterize the subsurface soil and evaluate its engineering properties with respect to the proposed construction. Further details regarding the laboratory testing program are presented in Section 4.0 and in Appendix B.

1.3.4 Geotechnical Analyses and Evaluation

Using the data obtained from the field exploration and laboratory testing programs together with preliminary design and loading information provided by CalEnergy, Fugro performed geotechnical analyses and evaluations regarding the following topics:

- Geohazards evaluation consisting of fault rupture, liquefaction potential, seismically-induced settlement, lateral movements, and expansive/collapsible soils ;
- Ground motions for use in seismic design of structures;
- Allowable bearing pressure and settlement analyses for various structural elements assuming shallow footing or mat foundations;
- Ground improvement procedures to mitigate excessive settlement;
- Axial and lateral capacities for driven pile foundations;
- Slope stability for berms or levees;
- Slab and pavement design parameters for various vehicle loading conditions; and
- Corrosion potential for buried concrete and metal.

1.3.5 Engineering Report

Fugro has compiled the results of the geotechnical analyses and evaluations into this report for use by the design team. The report includes recommendations for the following information:

- Summary of soil and groundwater conditions observed during subsurface exploration at the site;
- Geohazard evaluation;
- California Geologic Survey (CGS) ground motion parameters for seismic design from published references including ground acceleration, mapped geologic units, and nearby faults;
- Criteria for temporary excavations and support, and dewatering, where appropriate;
- Suitability of onsite materials for use as fill or backfill material;

- Site preparation including overexcavation recommendations, stabilization measures, and grading and compaction requirements for fill placement;
- Design of ground improvement procedures where appropriate;
- Design of shallow foundations, where appropriate, including foundation preparation recommendations, maximum allowable bearing pressures and potential settlement, resistance to lateral loads, passive soil pressures, and friction coefficients;
- Design of deep foundations, where appropriate, including pile tip elevations, allowable axial and uplift capacities, lateral load capacity, and pile construction recommendations;
- Static and dynamic lateral earth pressures for retaining walls;
- Requirements for imported soils and fill materials placed behind retaining walls;
- An assessment of slope stability during saturated conditions for the existing levee along the western border of the site;
- Expansion potential of onsite soils;
- Design of flexible pavement sections for facility driveways and access roads; and
- Corrosion potential (pH, resistivity, sulfate, chlorides) for buried concrete and metal.

Fugro understands that the proposed stormwater retention basin will be unlined, but is intended to rely primarily on evaporation for disposal of accumulated stormwater. Also, sewage will be contained in temporary holding tanks prior to collection for offsite disposal, rather than through an on-site septic and leach field system. Therefore, the percolation characteristics of site soils were not addressed in this report.

1.4 AUTHORIZATION

This geotechnical study was authorized by CalEnergy in their Consulting Agreement with Fugro dated October 2, 2008.

1.5 LIMITATIONS

The conclusions and professional opinions presented in this report were developed by Fugro solely for CalEnergy for use during the design of foundations and other improvements to be constructed at the project site. Although information contained in this report may be of some use for other purposes, it may not contain sufficient information for other parties or uses. If any changes are made to the project as described in this report, the conclusions and recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this report are modified or validated in writing by Fugro.

The scope of services did not include any environmental assessments for the presence or absence of hazardous/toxic materials in the soil, surface water, groundwater, or atmosphere. Any statements, or absence of statements, in this report or data presented herein regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous/toxic assessment.

In performing our professional services, we have used generally accepted geologic and geotechnical engineering principles and have applied that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers currently practicing in this or similar localities. No other warranty, express or implied, is made as to the professional advice included in this report. We recommend that Fugro be retained to review and comment on the geotechnical aspects of the project plans and specifications before they are finalized.

Users of this report should recognize that the construction process is an integral design component with respect to the geotechnical aspects of a project, and that geotechnical engineering is an inexact science due to the variability of natural and man-induced processes, which can produce unanticipated or changed conditions. Proper geotechnical observation and testing during construction are imperative in allowing the geotechnical engineer the opportunity to verify assumptions made during the design process. Therefore, we advise that Fugro be retained during site grading and foundation construction to observe compliance with the design concepts and geotechnical recommendations and to allow design changes in the event that subsurface conditions, or methods of construction, differ from those anticipated.

2.0 SITE DESCRIPTION

The project site is located on a 160-acre parcel approximately 5 miles west of Calipatria in Imperial County, California. As depicted on Figure 1-2, the site is bordered by McKendry Road to the north, Boyle Road to the east, Peterson Road to the south and Severe Road to the west. The site is divided into two 80-acre parcels separated a dirt road running in the east-west direction through the middle of the property. At the time of Fugro's field investigation in October 2008, the site was undeveloped and was being used for cultivation of alfalfa.

Generally, the site is relatively flat with a gentle downward gradient from southeast to northwest. The four roads that form the perimeter of the site, and the access road through the middle of the site, are all slightly higher in elevation than the adjacent cultivated fields, which vary in elevation from approximately -221 feet at the southeast corner to -229 feet at the northwest corner. The access road along the west side of the site separates the property from a drainage canal situated between the access road and Severe Road, and thereby functions as a levee or dike preventing the drainage canal water from flowing on to the site. The top of the access road/levee is about 4 to 8 feet above the adjacent fields.

3.0 FIELD EXPLORATION

3.1 PRIOR SUBSURFACE EXPLORATION PROGRAM

A geotechnical investigation was performed on the north half of the site for a project formerly known as the Salton Sea Unit No. 6 geothermal power plant. The report was prepared by Geotechnics, dated February 5, 2002 (Project No. 0673-002-00, Document No. 02-0022). This document, together with the Addendum to Geotechnical Investigation prepared by Geotechnics, dated March 27, 2002 (Project No. 0673-002-02, document No. 02-0296), was provided to Fugro by Tobey-Wade Consulting (Tobey-Wade) as authorized by CalEnergy. This project was postponed and eventually abandoned in favor of the currently proposed facility.

A brief review of the Geotechnics report indicates that the investigation included nine electric CPT soundings to depths ranging from 50 to 100 feet, and two hollow-stem-auger (HSA) borings ranging in depth from 58 to 77 feet. The locations of explorations performed as part of the Geotechnics study are shown on Figure 3-1. Geotechnics found that the site was underlain by loose sands and soft silts and clays susceptible to liquefaction and settlement and recommended that ground improvement methods (e.g., stone columns or vibroflotation) plus driven concrete pile foundations be used to support the facility structures.

As shown on Figure 3-1, the previous exploration program by Geotechnics (2002) for the former Salton Sea Unit No. 6 project provided only partial coverage of the currently proposed area of Black Rock Units 1, 2 and 3 power plant. Therefore, an additional exploration program was requested by CalEnergy and performed by Fugro.

3.2 FUGRO EXPLORATION PROGRAM

Overview. The field exploration program completed by Fugro for the Black Rock Units 1, 2 and 3 Project consisted of borings and CPTs. The locations of borings and CPTs performed for this study are shown on Figure 3-1. Information for each exploration including the California State Plane Zone 6 coordinates (in feet), ground surface elevations, and total exploration depth are tabulated in Table 3-1.

October 2008 Exploration. The field exploration program performed for the Black Rock Units 1, 2 and 3 project was initiated on October 7, 2008, and was completed on October 17, 2008. The subsurface exploration program consisted of 30 borings to obtain soil samples and 21 CPTs.

Of the 30 borings drilled on site, 23 were performed using a HSA and 7 were performed using rotary wash (RW) drilling equipment. RW borings were located under or near the planned locations of major features of the three generating areas. HSA borings were completed under the proposed locations of ponds, smaller equipment pads and along the access roads. The RW borings ranged in depth from approximately 50 to 85 feet below ground surface. The HSA borings ranged in depth from approximately 5 and 25 feet below ground surface. Soil samples were obtained at various depth intervals in both the RW and HSA borings. A Fugro geologist prepared a written log of the drilling and sampling conditions and the soil types observed for each boring. Further details regarding the field exploration program, including the boring logs, are presented in Appendix A.

Twenty-one CPTs were advanced at various locations across the site. The depths of the CPTs ranged from between 25 and 76 feet below ground surface. A total of about 1,330 linear feet of CPT soundings were performed for this study. A graphic log was generated in the field for each CPT performed. Further information regarding the CPT and the CPT logs are presented in Appendix A.

3.3 REFERENCE DATUM

A topographic survey map of the project site was provided by CalEnergy for Fugro's use in planning and executing the field investigation and engineering analyses. The map was based on the following data:

Horizontal Datum. California State Plane North American Datum 83 (NAD83), Zone 6 (Feet).

Vertical Datum. The vertical datum reference for this project is North American Vertical Datum 88 (NAVD88) (Feet).

3.4 SUBSURFACE OBSTRUCTIONS AND UTILITIES

Fugro notified Underground Service Alert (USA) and coordinated with CalEnergy for utility identification prior to commencement of the field exploration program. No utilities were identified at the site at any of Fugro's boring or CPT locations and no subsurface obstructions were encountered during the Fugro's field exploration program. However, it should be noted that other buried utilities and structures not located by USA or CalEnergy, or observed by Fugro, such as irrigation pipelines used for farming activities and pipes or other buried structures used by CalEnergy for their existing adjacent geothermal facilities, may be present on or adjacent to the Black Rock project site.

Table 3-1. Subsurface Explorations Summary

Boring / CPT	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (feet)	Start Date	Completion Date	Coordinates (feet) California State Zone 6, NAD 83	
					Northing	Easting
Rotary Wash Borings						
RW-01	-227.5	76.5	10/7/2008	10/8/2008	2004839	6752288
RW-02	-228.0	51.5	10/10/2008	10/10/2008	2004568	6751983
RW-03	-226.0	76.5	10/14/2008	10/14/2008	2004120	6751781
RW-04	-225.9	86.5	10/14/2008	10/14/2008	2004092	6751986
RW-05	-225.6	76.5	10/13/2008	10/13/2008	2004222	6752411
RW-06	-225.0	76.5	10/10/2008	10/10/2008	2004172	6752610
RW-07	-227.0	76.5	10/8/2008	10/8/2008	2004790	6752499
Hollow-Stem Auger Borings						
HSA-01	-228.5	6.5	10/15/2008	10/15/2008	2005752	6752870
HSA-02	-228.3	6.5	10/15/2008	10/15/2008	2005656	6752525
HSA-03	-228.9	26.5	10/15/2008	10/15/2008	2005555	6752124
HSA-04	-228.8	6.5	10/15/2008	10/15/2008	2005469	6751158
HSA-05	-224.0	6.5	10/17/2008	10/17/2008	2005837	6754161
HSA-06	-228.1	6.5	10/15/2008	10/15/2008	2005027	6752048

Boring / CPT	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (feet)	Start Date	Completion Date	Coordinates (feet) California State Zone 6, NAD 83	
					Northing	Easting
Hollow-Stem Auger Borings						
HSA-07	-228.0	6.5	10/15/2008	10/15/2008	2004934	6751075
HSA-08	-223.0	6.5	10/17/2008	10/17/2008	2005823	6755553
HSA-09	-227.5	26.5	10/15/2008	10/15/2008	2004753	6751236
HSA-10	-227.0	6.5	10/15/2008	10/15/2008	2004617	6751677
HSA-11	-227.0	11.5	10/15/2008	10/15/2008	2004291	6751165
HSA-12	-223.0	6.5	10/17/2008	10/17/2008	2004491	6752434
HSA-13	-219.0	6.5	10/17/2008	10/17/2008	2005204	6753571
HSA-14	-226.0	16.5	10/16/2008	10/16/2008	2004317	6751970
HSA-15	-226.2	11.5	10/15/2008	10/15/2008	2003996	6751182
HSA-16	-222.0	16.5	10/16/2008	10/16/2008	2004195	6750966
HSA-17	-226.0	6.5	10/16/2008	10/16/2008	2003936	6751586
HSA-18	-225.8	6.5	10/16/2008	10/16/2008	2003894	6752364
HSA-19	-221.0	16.5	10/18/2008	10/18/2008	2003583	6750967
HSA-20	-224.6	26.5	10/16/2008	10/16/2008	2003443	6752397
HSA-21	-225.8	6.5	10/16/2008	10/16/2008	2003288	6751504
HSA-22	-225.5	11.5	10/16/2008	10/16/2008	2003352	6751853
HSA-23	-225.8	6.5	10/16/2008	10/16/2008	2003270	6752135
Cone Penetration Tests (CPTs)						
C-101	-221.0	25.41	10/8/2008	10/8/2008	2005421	6750956
C-102	-228.9	50.19	10/8/2008	10/8/2008	2005697	6752117
C-103	-221.0	25.37	10/8/2008	10/8/2008	2004791	6750954
C-104	-227.9	75.24	10/7/2008	10/7/2008	2004966	6752229
C-105	-227.2	75.31	10/7/2008	10/7/2008	2004829	6752401
C-106	-227.3	50.15	10/7/2008	10/7/2008	2004673	6751827
C-107	-227.5	75.25	10/7/2008	10/7/2008	2004748	6752273
C-108	-226.6	75.36	10/7/2008	10/7/2008	2004655	6752567
C-109	-226.2	75.41	10/8/2008	10/8/2008	2004265	6751740
C-110	-225.6	75.37	10/9/2008	10/9/2008	2004312	6752361
C-111	-226.2	75.34	10/8/2008	10/8/2008	2004119	6751643
C-112	-225.7	75.37	10/8/2008	10/8/2008	2003996	6751779
C-113	-225.8	75.29	10/8/2008	10/8/2008	2004171	6751918
C-114	-225.7	75.28	10/8/2008	10/8/2008	2003947	6752088
C-115	-225.8	75.48	10/9/2008	10/9/2008	2004188	6752273
C-116	-225.2	75.43	10/8/2008	10/8/2008	2004134	6752408
C-117	-225.4	75.31	10/9/2008	10/9/2008	2004215	6752530
C-118	-224.9	75.8	10/9/2008	10/9/2008	2004045	6752706
C-119	-221.0	25.26	10/8/2008	10/8/2008	2003867	6750965
C-120	-224.9	50.33	10/8/2008	10/8/2008	2003460	6752247
C-121	-225.9	50.38	10/8/2008	10/8/2008	2004311	6752168

4.0 LABORATORY TESTING PROGRAM

The purpose of the laboratory testing program was to supplement field classification of soils and provided relevant physical indices and engineering properties of the subsurface materials. The primary objectives of the program were to:

- Classify and characterize sampled subsurface materials;
- Evaluate the existing in situ conditions; and
- Develop relevant strength and compressibility properties of selected subsurface materials.

To meet these objectives, various tests were performed on selected samples. Test types are generally grouped into six categories: classification and index tests, moisture content and density evaluations, strength tests and estimates, compressibility tests, soil chemical tests (for corrosion evaluations), and subgrade characterization tests. Classification and index, soil chemical, and subgrade characterization tests were performed on both disturbed and relatively undisturbed samples, including 3.0-inch diameter thin-wall push (i.e., Shelby) samples, 2.4-inch diameter drive (i.e., ring) samples, Standard Penetration Test (SPT), and bulk samples. Density evaluations, strength tests, and compressibility tests were typically performed only on relatively undisturbed Shelby and ring samples.

The numbers of the various tests conducted for the Black Rock units 1, 2 and 3 are listed in Table 4-1.

Table 4-1. Summary of Laboratory Tests Performed on Selected Samples

Laboratory Testing	Number of Tests	ASTM Test Designation[1]
Water Content	81	ASTM D2216
Density	79	ASTM D2937
Grain Size Distribution	3	ASTM D422
Percent Fines #200 Sieve	19	ASTM D1140
Atterberg Limits	22	ASTM D4318
Compaction	3	Cal. 216A[2]
Consolidation (Incremental Load Control)	6	ASTM D2435
Direct Shear	1	ASTM D3080
R-Value	3	ASTM D2435
Expansion Index	3	ASTM D4828
Corrosivity	5	ASTM D1498 ASTM D4972 ASTM G57 ASTM D4327

[1]ASTM International (2005)
[2]California Department of Transportation Test Designation

Laboratory test results are tabulated or presented graphically in Appendix B. A tabular summary of all laboratory tests performed for the Black Rock Units 1, 2 and 3 project is presented on Figures B-1 through B-6. Various laboratory test results also are tabulated versus depth on the individual boring logs (Figures A-2 through A-31). Test results that cannot be conveniently tabulated or plotted versus depth on logs also are provided in Appendix B. Test results in this category include: grain-size curves, plasticity charts, direct shear, consolidation, compaction test results and the corrosivity test results performed by a subconsultant laboratory.

5.0 GEOLOGIC AND SUBSURFACE CONDITIONS

5.1 REGIONAL SETTING

5.1.1 Geomorphic, Physiographic and Structural Setting

Southern California is divided into several physiographic regions, or provinces. The proposed project area is located in the Colorado Desert Geomorphic Province, which is a low-lying, barren basin dominated by the Salton Sea. The province is a depressed block that is bounded by the Mojave Desert Geomorphic Province to the east, and the Peninsular Ranges Geomorphic Province to the west (CGS, 2002).

The Salton Trough consists of the Coachella Valley to the north of the Salton Sea, the Salton Sea itself, and the Imperial Valley to the south (see Figure 5-1). The trough widens toward the southeast due to the nature of the relative plate motion as described in the following section. As shown on Figure 5-2, the Salton Trough is bounded by the San Andreas fault zone, Orocopia Mountains and Chocolate Mountains to the east; and the San Jacinto fault zone, Superstition Hills and Peninsular Ranges to the west. The east wall of the Trough at the San Andreas fault consists of Precambrian Rocks, Mesozoic plutons, and schists (Figures 5-3 and 5-4). The west wall consists of Cretaceous plutonic rocks of the Southern California (Peninsular Ranges) batholith and their metamorphic host rocks (Wallace, 1990, Jennings, 1994).

The structure of the Salton Trough itself can be generally described as a gap in the crystalline basement between the two walls of the Trough. This deep basin is underlain by a thick sequence of sediments and volcanic rocks. The volcanic rocks intrude into the sedimentary section as both silicic rocks that form volcanoes and as mafic rocks that are penetrated in geothermal wells. The volcanoes are found in areas where spreading is actively occurring in the Brawley Seismic Zone and Cerro Prieto geothermal area. Rhyolite and obsidian domes at the Salton Buttes are found in the Brawley Seismic Zone on the southeastern side of the Salton Sea near the project site, and Cerro Prieto Volcano is present in the Cerro Prieto geothermal area to the south (Wallace, 1990, Harden, 2004). Inclusions of mid-ocean ridge basalt have been found within the high-silica volcanic rocks indicating that mid-ocean ridge magma is interacting with the continental crust beneath the Salton Trough (Harden, 2004). Heat flow measurements also show that rifting is active in the trough, and the geothermal gradient is high enough to produce geothermal reservoirs. The proposed project will tap into one of these geothermal reservoirs.

The Salton Trough is being lengthened by continued right-lateral oblique transtension, and is being deepened by vertical motion on smaller faults associated with extension in the seismic zones where rifting is occurring. Thus, the trough is getting bigger and deeper as sediments accumulate in the large, subsiding basin. This process has been occurring continuously for the past 4 million years, allowing 5 to 6 kilometers (km) of Pliocene and Pleistocene sediments to accumulate (Wallace, 1990, Harden, 2004). This sediment thickness is obtained from numerous geophysical studies and wells drilled in the area (Wallace, 1990). Thus, "basement rock" or bedrock is at a depth of approximately 15,000 feet in the deepest portions of the trough. The subsidence in the trough has created a low-lying basin that is up to approximately 275 feet below sea level. Much of the Salton Trough, including the project site area, is below sea level.