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CH2MHILL

September 10, 2007

351572

Mary Dyas
Project Manager
California Energy Commission
1516 Ninth Street, MS-15
Sacramento, CA 95814-5512

RE: Data Response, Set 1A
Chevron Power Plant Replacement Project (07-SPPE-1)

Dear Ms. Dyas:

On behalf of Chevron, please find attached 12 copies and one original of the Data Responses, Set 1A, in response to Staff's Data Requests dated August 8, 2007. We are also filing copies of this Data Response electronically.

Please call me if you have any questions.

Sincerely,

CH2M HILL

SMadams

for David A. Stein, PE
Project Manager

c: Project File
Proof of Service List

CHEVRON POWER PLANT REPLACEMENT PROJECT (07-SPPE-01)

DATA RESPONSE, SET 1A

Submitted by

Chevron

September 10, 2007

CH2MHILL

2485 Natomas Park Drive, Suite 600
Sacramento, California 95833-2937

Chevron Richmond Power Plant Replacement Project
07-SPPE-1
DATA REQUEST RESPONSE SET 1A

Technical Area: Air Quality
Authors: Brewster Birdsall

BACKGROUND: PROJECT DESCRIPTION AND CONTROL TECHNOLOGIES

The project description (Figure 2.1-3) shows the stack of the “Cogen 3000” combustion turbine generator (CTG) and heat recovery steam generator (HRSG) to be 138.5 feet (42.2 meters), but a height of 50.6 m is used in the air quality analysis (p. 8.1-27

DATA REQUEST

1. Please identify the correct CTG/HRSG stack height, and ensure that the dispersion modeling analysis, including analyses for fumigation and for health risks, use the correct height

   Response: The correct stack height is 166 feet (50.6 meters). The dispersion modeling analysis included in the Application, including analyses for fumigation and for health risks, use a stack height of 166 feet.

BACKGROUND

The control efficiency of the cooling tower drift eliminators is presented as 0.002 percent in Section 2.1.11.3, and 0.005 percent in Appendix Table 8.1B-3. Cooling towers at other facilities recently permitted in the Bay Area (e.g., Tesla Power Plant) achieve a drift rate of 0.0005 percent.

DATA REQUEST

2. Please identify the correct drift rate and explain if a drift rate of 0.0005 percent is not achievable.

   Response: The drift rate specified in the SPPE for the cooling tower is 0.002 percent. However, after discussions between Chevron and Praxair (the Hydrogen Plant developer), the cooling tower drift rate has been revised to 0.0005 percent. This lower drift rate will reduce the cooling tower emissions by a factor of 4. Table AQ-2 presents the revised cooling tower PM_{10} emission on an hourly, daily, and annual basis.

Table AQ-2 Revised STG Cooling Tower Emissions

	Lb/Hour	**Lb/Day**	**Lb/Year**	**TPY**
PM_{10}	1.1	27	9865	4.9

BACKGROUND

The proposed CTG would fire natural gas or liquid petroleum gas, and the proposed HRSG would fire refinery fuel gas. The chemical and thermal properties of these fuels are not provided in the application.

DATA REQUEST

3. Please identify the heating value and chemical characteristics of the proposed fuels.

Response: Table AQ-3 presents representative fuel gas characteristics for the three proposed fuels. It should be noted that some variation in the relative concentration of these constituents will occur.

Table AQ-3 Representative Fuel Gas Characteristics

Constituents (Percent Volume)			
Compound	**Natural Gas**	**Medium Btu**	**LPG**
Hydrogen	0.10	ND	ND
Methane	94.10	75.00	ND
Ethane	2.40	1.00	ND
Propane	0.70	ND	ND
Butane	0.10	ND	92.90
Pentane	ND	ND	7.10
Carbon Dioxide	0.80	ND	ND
Nitrogen	1.20	24.00	ND
Oxygen	0.60	ND	ND
Hydrogen Sulfide	neg	neg	neg
Total %	100	100	100
Total Mol. Wgt.	17.0662	19.0554	59.1159
HHV , Btu / scf	1016.68	777.17	3325.07
SG	0.5891	0.6578	2.0406
LHV , Btu / scf	917.18	700.57	3,071.17
LHV , Btu / lb	20342.5	13916.3	19664.8
HHV , Btu / lb	22546.7	15435.6	21287.9
Wobbe	51.584	37.289	78.003
Compressibility	0.997915	0.997221	0.983255

ND= None detected; Neg = negligible, PUC-regulated natural gas is limited to less than 1 gr/100 scf.

BACKGROUND

The Bay Area Air Quality Management District has determined that nitrogen oxides (NOx) from combined cycle combustion turbine generators over 40 MW can feasibly achieve 2.0 parts per million by volume dry basis (ppmvd) after implementation of Best Available Control Technology, but the application for the proposed CTG requests a limit of 2.5 ppmvd NOx.

DATA REQUEST

4. Please explain the basis for selecting a CTG with a combustion system using steam injection for control of NOx because the General Electric Frame 6B is also offered with a dry low-NOx combustion system that could achieve lower NOx levels (15 ppmvd at the CTG exhaust instead of the proposed 25 ppmvd).

   Response: The selection of the GE Frame 6B was in part due to its ability to combust the fuels proposed for the project. The turbine will be capable of firing natural gas, medium-Btu gas, or LPG (predominately Butane). With this wide range of fuel Wobbe indices, the use of dry low NOx (DLN) combustors is not feasible. In addition, the refinery requires the ability to substantially turn down the turbine power output at times, and DLN combustors are not suited for large turn-down operations due to the relatively narrow range of allowable air flows to the combustor. Therefore, the use of standard combustors with steam injection for NOx control is required. The lowest guaranteed NOx output for the Frame 6B CTG using standard combustors with steam injection is 25 ppm NOx when burning Natural gas or Medium-BTU gas, and 42 ppm when burning LPG.

5. Please describe whether the CTG/HRSG would be likely to comply with a 2.0 ppmvd NOx limit at the stack.

   Response: No. As noted in the response to Data Request #4, a turbine that meets the Refinery's operating requirements for firing the range of specified fuels and provides the required ability to turn down output cannot achieve a 2.0 ppm NOx concentration at the stack.

BACKGROUND

The South Coast Air Quality Management District has determined that ammonia slip from a similarly-sized combined cycle combustion turbine generator (at the City of Vernon, Light & Power) can feasibly be controlled to a level of 5 ppmvd, but the application for the proposed CTG requests a limit of 10 ppmvd for ammonia.

DATA REQUEST

6. Please describe whether an ammonia slip limit of 5 ppmvd would be achievable from the engineering perspective for the proposed CTG, considering possible use of a dry low-NOx combustion system and/or an expanded catalyst system.

Response: No. Due to the need to fire multiple fuels, which results in CTG exhaust NOx levels as high as 42 ppmvd, a lower ammonia slip level is not feasible. In order to achieve a 2.5 ppmvd NOx stack concentration when firing LPG (which produces a guaranteed NOx concentration of 42 ppmvd at the CTG outlet) an approximate 94 percent SCR control efficiency will be required. In order to achieve this high efficiency, a larger ammonia injection rate margin is needed and a 10 ppm ammonia slip level is the lowest slip that is feasible.

BACKGROUND

Project Emissions

Emissions during commissioning (Table 8.1-14) and various modes of operation including startups (Table 8.1-15) are not explained. Background information on some emission calculations is not provided. Maximum annual, daily, and hourly emissions (Table 8.1-19) should include emissions from startups/shutdowns under the worst-case, reasonably foreseeable operating schedule. Section 2.1.16 shows that “Base Load” and “Load Following” modes are possible. These emissions including startups/shutdowns should be quantified and modeled for ambient air quality impacts.

DATA REQUEST

7. Please describe the steps of commissioning and provide the basis for the commissioning emission rates, including supporting documentation from vendors, emission calculations, or information prepared for the local air district permitting process but not included in the Energy Commission application.

   Response: Please see Attachment AQ-7.

8. Please provide the basis for the startup emission rates, including supporting documentation from vendors, emission calculations, or information prepared for the local air district permitting process but not included in the Energy Commission application.

   Response: Please see Attachment AQ-8.

9. Please provide the basis for the 6.3 pound per hour particulate matter emission rate from “Cogen 3000” because it is higher than what would be expected with exclusive use of pipeline natural gas.

   Response: Using the AP-42 natural gas fired combustion turbine PM_{10} emission factor of 0.0066 lb/MMBtu and the maximum heat input of 840 MMBtu/Hr (HHV) yields a PM_{10} emission rate of 5.54 Lb/Hr. Given the uncertainty in applying an emission factor for natural gas to a turbine firing medium-Btu and LPG fuels, Chevron applied a safety factor to the AP-42 emission factor, resulting in the 6.3 Lb/Hr PM_{10} emission rate.

10. Please develop the worst-case, foreseeable operating schedule and quantify the proposed project emissions (with startups) on an hourly, daily, and annual basis.

Response: The Power Plant Replacement Project combustion turbine is expected to have a very high annual capacity factor. This unit is integral to the operation of the refinery, providing both electricity and steam for refinery operations. As such, the turbine is expected to be shutdown only for scheduled/unscheduled maintenance or refinery turnarounds where steam and electrical demand drops to levels that can be served by the other cogeneration units. The only way daily emissions could be higher than those presented in the SPPE is if the turbine were started up at the start of a new day after a maintenance period. This is highly unlikely as maintenance operations are typically performed during daylight hours. Therefore, the emissions presented in SPPE Table 8.1-19 represent the maximum hourly, daily, and annual emissions.

11. Please provide an air dispersion modeling analysis of the worst-case, foreseeable operating schedule that includes startups.

Response: As noted in the response to Data Request #10, the emissions modeled reflect the worst-case, foreseeable operating schedule that includes start ups on an annual basis.

BACKGROUND

Net Emission Increases

The application shows conflicting emissions totals. According to Table 8.1-19, the CTG, HRSG, and cooling tower would emit 47.3 tons per year (tpy) PM10. However, Table 8.1-27 shows that the Power Plant Replacement would cause 14.8 tpy PM10, and text following that table states that the proposal would offset an 11 tpy PM10 increase. Table 8.1-27 (Section 8.1.8.2) does not provide sufficient detail to determine which sources create the reductions or what quantity of emission reduction credits (ERCs) would be surrendered.

DATA REQUEST

12. Please itemize the existing emission sources within the refinery that would be shutdown as a result of the Hydrogen Plant Replacement and Power Plant Replacement and quantify the baseline annual emissions.

Response: The existing boilers in the No. 1 power plant will be shutdown once Cogen 3000 becomes fully operational. With the reduction in the STG cooling tower drift rate (see response to Data Request #2), the total annual PM10 emissions for the project are 32.53 tons per year (27.6 tons from the CTG from SPPE Table 8.1-19 and 4.9 tons from the cooling tower from Table AQ-2). As of April 27, 2007, Chevron holds sufficient PM_{10} ERCs, as shown in Table AQ-12, to fully mitigate the PPRP's PM10 (and other pollutant's) emissions without of the need to obtain emission reductions from the shutdown of existing units.

TABLE AQ-12
BAAQMD ERCs Held by Chevron

No.	Certificate Owner	POC	NOX	SO2	CO	PM10
223	Chevron Products Company	60.1	20.7	1.0	9.1	5.4

TABLE AQ-12
BAAQMD ERCs Held by Chevron

No.	Certificate Owner	POC	NOX	SO2	CO	PM10
617	Chevron Products Company	68.9	8.8	0.5	7.4	1.5
900	Chevron Products Company	0	1.0	0.06	0.5	0.3
1008	Chevron Products Company	20.1	30.5	133	488	31.8
1026	Chevron Products Company	1.1	1.3	0	0	0.4
1042	Chevron Products Company	0	31.8	0	2.0	0
	Total ERCs Held	150	94	135	508	39.4

13. Please show the proposed project's annual emission increases (including startups/shutdowns) for comparison with the baseline annual emissions.

Response: The BAAQMD is in the process of approving the final emission inventory for the entire Renewal project, including baseline emissions and all contemporaneous changes in air emissions. This approved inventory is expected to be available sometime in the middle of September and will be forwarded to the CEC.

14. Please identify the quantities of ERCs for each criteria pollutant that would be surrendered as part of the proposed project. The list of potential ERCs for surrender (Table 8.1-28) should be updated because some of the certificate numbers are no longer applicable.

Response: The ERC table will be revised following finalization of the BAAQMD emission inventory. Chevron anticipates submitting the requested information sometime in the middle of September.

15. Please describe the plan for shutting down existing sources as part of the Hydrogen Plant or the Power Plant Replacement Projects and how the proposed reductions would be made enforceable, real, and permanent.

Response:: Once the BAAQMD inventory is finalized, Chevron will address whether any existing source shutdowns are needed to fully offset the PPRP. Chevron anticipates submitting the requested information sometime in the middle of September

BACKGROUND

Cumulative Impacts

Cumulative impacts are addressed (p. 8.1-37) by referring to the Chevron Energy and Hydrogen Renewal Project Draft EIR. Numerous new nearby stationary emission sources would occur in the area as a result of the Renewal Project and the numerous other pending projects listed in Section 8.1.9, including the Praxair project at the

Chevron refinery and the ConocoPhillips projects at its refinery in Rodeo, Contra Costa County. These sources should be addressed in a quantitative ambient air quality analysis of cumulative impacts. Additionally, Energy Commission staff seeks analysis of the proposed Power Plant Replacement Project in conjunction with the existing electrical generation emission sources at the refinery including "Cogen 1000" and "Cogen 2000."

DATA REQUEST

16. a. Please identify the new stationary sources that would occur in the cumulative scenario.

Response: The cumulative air quality impacts associated with the entire Renewal project are being addressed by the City of Richmond through the Renewal Project Environmental Impact Report. Chevron does not believe that a separate duplicative cumulative impact analysis is necessary. Chevron will provide the cumulative analysis to the Commission as a courtesy when the analysis becomes available.

b. Please prepare an ambient air quality impact assessment of the cumulative sources including those related to the Renewal Project and other emission sources associated with "reasonably foreseeable projects" within six miles of the proposed project.

Response: See the response to Data Request #16a.

17. a. Please identify the emissions, locations, and stack characteristics of existing generating facilities at the refinery including "Cogen 1000" and "Cogen 2000."

Response: Cogen 1000 and 2000 are existing units that have been in operation for over 15 years and are not being modified or altered as part of the proposed project. Air emissions from these units (and all existing refinery units) are reflected in the ambient background data used to assess the PPRP's air quality impacts (see SPPE Table 8.1-**22)**. In addition, the BAAQMD is conducting an independent air dispersion modeling assessment for the entire Renewal project to determine conformity with their regulations. Without waiving the above objection, the information requested is presented below for Cogen 1000 and 2000.

The average annual emissions from Cogen 1000 and 2000 are:

SOx – 4.8 TPY

NOx – 123.2 TPY

PM – 13.98 TPY

VOC – 4.13 TPY

CO – 44.97 TPY

The stack locations are as follows (refinery coordinates):

Cogen 1000 – E889′-5″, N1620′-0″

Cogen 2000 – E889′-5″, N1729′-0″

Monument 2630 shown on drawing 2.1-2 is at coordinates E1000′-0″, N2000′-0″. These coordinates relate to the Calif. Coordinate System as follows:

Refinery E1000′-0″ = Ca. E6,016,684.96′

Refinery N2000′-0″ = Ca. N2,170,683.78′

Stack Diameter is 11 ft – 4-1/4 in

Stack Gas average exit temperature at max steam flow is 360 °F

Stack gas average exit velocity is 64.5 fps

Stack flow – 1,461 kpph

b. Please prepare an ambient air quality impact assessment of these sources with the proposed project.

Response: Please see the response to Data Request #17a.

ATTACHMENT AQ-7

ATTACHMENT DR-7

Cogen Commissioning Emissions Estimate

Constants

Power, MW	50	
Overall Heat, MMBTU/hr	840	
Turbine Heat Rate, BTU/KWH (Frame 6)	10642	(Frame 6 is conservative vs. LM-6000 at 8451 BTU/KWH)
MMBTU/hr-MW	10.64	
Normal NOx conc, ppm	2.5	
Normal CO conc, ppm	4	
Normal VOC conc, ppm	2	

Emission Factors	NOx	CO	PM	VOC	NOx w/LPG
Oxygen content of flue gas, vol %	15	15		15	
MW	46	28		16	
lb/MMBTU/ppmvd	0.00369	0.00224		0.00128	
lb/MMBTU			0.00745		0.01115

Commissioning Start-up

1. Minimum Output Testing

Start Time (days)	End Time (days)	Stream Factor	Activity	NH3?	CO ox?	Days	Avg Firing MW	Avg Firing MMBTU/hr	NOx (ppm)	Use NOx (ppm)	NOx EF lb/MMBTU	Start-up NOx lb/hr	Start-up NOx lb	Start-up NOx tons	Normal NOx w/LPG lb/hr	Normal NOx lb	Excess NOx lb	Excess NOx tons	CO (ppm)	Use CO (ppm)	CO EF lb/MMBTU	Start-up CO lb/hr	Start-up CO lb	Start-up CO tons	Normal CO lb/hr	Normal CO lb	Excess CO lb	Excess CO tons	VOC (ppm)	VOC EF lb/MMBTU	Start-up VOC lb/hr	Start-up VOC lb	Normal VOC lb/hr	Normal VOC lb	Excess VOC lb	Excess VOC tons
0	7	50%	First firing, minimum output testing	No	No	7	10	106.42	200-300	300	1.10594	117.7	9886	4.94	9.4	1573.7	8313	4.16	<40	40	0.08976	9.6	802	0.40	7.5	633.3	169.0	0.08	4	0.00513	0.5	3.8	2.2	15.1	-11.3	-0.01
7	14	50%	Minimum output testing, synch, trips	No	No	7	10	106.42	200-300	300	1.10594	117.7	9886	4.94	9.4	1573.7	8313	4.16	<40	40	0.08976	9.6	802	0.40	7.5	633.3	169.0	0.08	4	0.00513	0.5	3.8	2.2	15.1	-11.3	-0.01
14	21	50%	Minimum output testing, trips	No	No	7	50	532.10	200-300	300	1.10594	588.5	49431	24.72	9.4	1573.7	47858	23.93	<40	40	0.08976	47.8	4012	2.01	7.5	633.3	3378.5	1.69	4	0.00513	2.7	19.1	2.2	15.1	4.0	0.00
21	28	100%	GE validation, etc. (all at full load)	Yes	Yes		50	532.10	tion, no excess emissions					34.60				32.24						2.81				1.86								-0.01
		Total				21	23.3	248.31		300	1.10594	274.6	69204		9.4	1573.7	21494					22.3	5617		7.5	633.3	3716.6				1.3	26.7	2.2	45.2	-18.5	

2. Come up to 50 MW following minimum output testing

Start Time (min)	End Time (min)	Activity	Hours	Avg Firing MW	Avg Firing MMBTU/hr	NOx (ppm)	Use NOx (ppm)	NOx EF lb/MMBTU	Start-up NOx lb/hr	Start-up NOx lb	Start-up NOx tons	Normal NOx w/LPG lb/hr	Normal NOx lb	Excess NOx lb	Excess NOx tons	CO (ppm)	Use CO (ppm)	CO EF lb/MMBTU	Start-up CO lb/hr	Start-up CO lb	Start-up CO tons	Normal CO lb/hr	Normal CO lb	Excess CO lb	Excess CO tons	VOC (ppm)	VOC EF lb/MMBTU	Start-up VOC lb/hr	Start-up VOC lb	Normal VOC lb/hr	Normal VOC lb	Excess VOC lb	Excess VOC tons
20	30	Come up to 20 MW	0.17	10	106.42	200-300	300	1.10594	117.7	19.6	0.01	9.4	1.6	18.1	0.01	<40	40	0.08976	9.6	1.6	0.00	7.5	1.3	0.3	0.00	4	0.00513	0.5	0.1	2.2	0.4	-0.3	0.00
30	60	Come up to 50 MW	0.50	35	372.47	200-300	300	1.10594	411.9	206.0	0.10	9.4	4.7	201.3	0.10	<40	40	0.08976	33.4	16.7	0.01	7.5	3.8	12.9	0.01	4	0.00513	1.9	1.0	2.2	1.1	-0.1	0.00
60	120	Cut in steam, increase SCR temp	1.00	50	532.10	25	25	0.09216	49.0	49.0	0.02	9.4	9.4	39.7	0.02	40	40	0.08976	47.8	47.8	0.02	7.5	7.5	40.2	0.02	4	0.00513	2.7	2.7	2.2	2.2	0.6	0.00
		Total	1.67	41.5	441.64		135	0.49767	164.8	274.62	0.14	9.4	15.6	259.0	0.13				39.6	66.1	0.03	7.5	12.6	53.5	0.03			2.3	3.8	2.2	3.6	0.2	0.00

		Start-up NOx tons	Excess NOx tons	Start-up CO tons	Excess CO tons	Excess VOC tons
3. 15-20 additional normal start-ups	20	2.86	2.68	0.67	0.52	0.00
Grand total commissioning emissions, T		37.60	35.05	3.51	2.40	-0.01
Period of commissioning emissions, weeks		3	3	3	3	3
Commissioning emission rate, T/week		12.53	11.68	1.17	0.80	0.00
Annualized commissioning emission rate during period, T/Y		651.79	607.49	60.87	41.68	-0.24

ATTACHMENT AQ-8

ATTACHMENT DR-8

Cogen Start-up Emissions Estimate

Constants

Power, MW	50	
Overall Heat, MMBTU/hr	840	
Turbine Heat Rate, BTU/KWH (Frame 6)	10642	(Frame 6 is conservative vs. LM-6000 at 8451 BTU/KWH)
MMBTU/hr-MW	10.64	
Normal NOx conc, ppm	2.5	
Normal CO conc, ppm	4	
Normal VOC conc, ppm	2	

Emission Factors	NOx	CO	PM	VOC	NOx w/LPG
Oxygen content of flue gas, vol %	15	15		15	
MW	46	28		16	
lb/MMBTU/ppmvd	0.00369	0.00224		0.00128	
lb/MMBTU			0.00745		0.01115

Normal Start-up

Start Time (min)	End Time (min)	Activity	Hours	Avg Firing MW	Avg Firing MMBTU/hr	NOx (ppm)	Use NOx (ppm)	NOx EF lb/MMBTU	Start-up NOx lb/hr	Start-up NOx lb	Start-up NOx tons	Normal NOx w/LPG lb/hr	Normal NOx lb	Excess NOx lb	Excess NOx tons
0	20	Fire ignitors, come up to full speed, synch and be on grid (~5000 rpm)	0.33	3	31.93	200-300	300	1.10594	35.3	11.8	0.01	9.4	3.1	8.6	0.00
20	30	Come up to 20 MW	0.17	10	106.42	200-300	300	1.10594	117.7	19.6	0.01	9.4	1.6	18.1	0.01
30	60	Come up to 50 MW	0.50	35	372.47	200-300	300	1.10594	411.9	206.0	0.10	9.4	4.7	201.3	0.10
60	120	Cut in steam, increase SCR temp	1.00	50	532.10	25	25	0.09216	49.0	49.0	0.02	9.4	9.4	39.7	0.02
		Total	2.00	35.1	373.36		162.5	0.59905	143.2	286.4	0.14	9.4	18.7	267.7	0.13

Activity	CO (ppm)	Use CO (ppm)	CO EF lb/MMBTU	Start-up CO lb/hr	Start-up CO lb	Start-up CO tons	Normal CO lb/hr	Normal CO lb	Excess CO lb	Excess CO tons
Fire ignitors, come up to full speed, synch and be on grid (~5000 rpm)	<40	40	0.08976	2.9	1.0	0.00	7.5	2.5	-1.6	0.00
Come up to 20 MW	<40	40	0.08976	9.6	1.6	0.00	7.5	1.3	0.3	0.00
Come up to 50 MW	<40	40	0.08976	33.4	16.7	0.01	7.5	3.8	12.9	0.01
Cut in steam, increase SCR temp	40	40	0.08976	47.8	47.8	0.02	7.5	7.5	40.2	0.02
Total				33.5	67.0	0.03	7.5	15.1	51.9	0.03

Activity	VOC (ppm)	VOC EF lb/MMBTU	Start-up VOC lb/hr	Start-up VOC lb	Normal VOC lb/hr	Normal VOC lb	Excess VOC lb	Excess VOC tons
Fire ignitors, come up to full speed, synch and be on grid (~5000 rpm)	4	0.00513	0.2	0.1	2.2	0.7	-0.7	0.00
Come up to 20 MW	4	0.00513	0.5	0.1	2.2	0.4	-0.3	0.00
Come up to 50 MW	4	0.00513	1.9	1.0	2.2	1.1	-0.1	0.00
Cut in steam, increase SCR temp	4	0.00513	2.7	2.7	2.2	2.2	0.6	0.00
Total			1.9	3.8	2.2	4.3	-0.5	0.00

VOC based on doubling normal VOC concentration when CO is high.
Negative since more than offset by lower firing rates during commissioning. Not used since negative.

Technical Area: Biological Resources
Author: Heather Blair

BACKGROUND

The SPPE application provides a thorough description of the regional biological resources, including the Chevron Energy and Hydrogen Renewal Project area (i.e., refinery boundary) and vicinity. Although the proposed Chevron Power Plant Replacement Project (PPRP) area was included in this general description, the biological setting and impact analysis did not distinguish between the Chevron PPRP components. Therefore, staff is unable to complete an analysis specific to the PPRP components.

DATA REQUEST

18. Please describe the current environmental condition of areas proposed for each Chevron PPRP component (i.e., Cogen 3000, H2-STG, 115 kV transmission line reconductoring, and temporary construction laydown areas) and adjacent areas, including but not limited to the Chevron water treatment marsh. The characterization should include, but is not limited to:

    a. a description of the habitat type(s);

    b. a listing of the common and special-status species that occur or have the potential to occur within this relatively limited area; and

    c. separate characterizations of nearby marshes (i.e., Chevron water treatment marsh, San Pablo Creek marsh, and Wildcat Creek marsh).

Response: The proposed Cogen 3000, H2-STG, and equipment staging and laydown areas are located within the previously disturbed and long operating 2900 acre Richmond Refinery. The 0.5-acre Cogen 3000 would be located within an existing 5.2-acre Cogen facility and the STG and associated equipment would occupy 0.5 acres within a new 8.3 acre hydrogen plant that is being built as part of the Richmond Refinery Renewal Project. Laydown for both portions of the project will be provided in various existing laydown areas within the refinery that are used for on-going maintenance and project laydown.

These three project components would be located in vegetation-free areas currently covered by gravel, hard pack soil, and/or pavement and fall under the Wildlife Habitat Relationships (WHR) classification system as “barren”. The barren areas occupied by Refinery structures, roadways, and paved surfaces provide little to no habitat for plants or animals. While in theory some urban-adapted birds, such as rock dove (Columba livia), mourning dove (Zenaida macroura), house sparrow (Passer domesticus) and European starling (Sturnus vulgaris), and other animals could make use of structures for roosts or other purposes, the high and constant amount of disturbance involved with operations, in addition to the large continuous areas lacking in vegetation and associated food resources, and the numerous barriers to movement are likely to dissuade even occasional use by wildlife. Special-status plant or animal species are not expected to occur in this barren habitat on and immediately adjacent to the proposed Cogen 3000, H2-STG, and equipment staging and laydown areas.

The 115 kV transmission line associated with the project will be reconductored on existing transmission line structures within the Refinery. The existing transmission line and structures span barren habitat occupied by refinery structures and operations, bio reactor ponds, and capped landscaped remediation areas. The bio reactor ponds are not considered an attractant to resting or foraging birds and other wildlife due to their caustic nature. Even so, waterfowl common to the Bay may occasionally frequent the margins of the ponds. It would likely be harmful for birds or other wildlife to enter the ponds. The capped landfill areas under the transmission line have been planted with a variety of tree species. The landfill is landscaped much like an orchard, has no understory shrubs, and the non-native grass ground cover is maintained by mowing. These trees provide roost, forage, and nesting habitat for a variety of common small to medium passerine bird species such as purple finch (Carpodacus purpureus), house sparrow (Passer domesticus) , American robin (Turdus migratorius), and western scrub jay (Aphelocoma californica). Although they may roost and forage in the landfill area, the trees are likely too small to provide nesting opportunities for raptor, heron, or egret species. The landscaped landfill cap is also likely visited by common small to medium sized mammal species such as various rodents, rabbits, raccoon (Procyon lotor), and gray fox (Urocyon cinereoargenteus).

The tank farms within the Refinery and north of the project components, is characterized by less disturbance and more vegetation relative to the project area. Although disturbed and occupied by a large number of storage tanks and other infrastructure, the tank farm area on the northeast hillsides of the Refinery includes Eucalyptus and Monterey pine (Pinus radiate) as well as an understory of coastal scrub including coyote brush (Baccharis pilularis), chamise (Adenostoma fasciculatum), and California sage (Artemisia californica). The tank farm also includes non-native grassland areas with wild oats (Avena sp.), ripgut brome (Bromus diandrus ssp. rigidus), and Italian ryegrass (Lolium multiflorum) as well as a variety of other invasives such as mustard (Brassica spp.), wild radish (Raphanus raphanistrum), and fennel (Foeniculum vulgare). A mosaic of eucaplytus, pine trees, scrub, and grassland provides habitat for a variety of animal species. The trees provide roost and nesting opportunities for raptors and other bird species. The understory may provide habitat for mule deer (Odocoileus hemionus), raccoon, gray fox, Botta's pocket gopher (Thomomys bottae), California ground squirrel (Spermophilus beecheyi), black-tailed jackrabbit (Lepus californicus), western fence lizard (Sceloporus occidentalis), California quail (Callipepla californica), Anna's hummingbird (Calypte anna), western scrub jay (Aphelocoma californica), Bewick's wren (Thryomanes bewickii), and California towhee (Pipilo crissalis).

San Pablo Creek and Wildcat Creek marshes north of the Refinery are adjacent to one another and have connectivity. Therefore they are classified together as one Significant Ecological Areas in the Contra Costa General Plan. These marshes are created by the deltas of their namesake creek and are characterized as saltwater marshes that have been subjected to an extensive history of disturbance due to pollution and modification to their tidal influence. The salt marshes are dominated by cordgrass (Spartina sp.) and pickleweed (Salicornia virginica) which transitions to sedge (Scirpus sp) as the influence of freshwater increases inland. Species observed in this Significant Ecological Area include the Federal and State endangered salt-marsh harvest mouse and California clapper rail, the State endangered and federal species of concern California black rail (Laterallus jamaicensis coturniculus), the federal species of concern San Pablo song sparrow (Melospiza melodia samuelis), white-tailed kite (Elanus leucurus), the State species of concern northern harrier (Circus cyaneus), snowy egret (Egretta thula), great blue heron (Ardea herodias), San Pablo vole (Microtus californicus sanpabloensis), and short-eared owl (Asio flammeus). Likely fish species include Pacific staghorn sculpin (Leptocottus armatus) Pacific herring (Clupea harengus pallasi), northern anchovy (Engraulis mordax), Sacramento splittail (Pogonichthys macrolepidotus), striped bass (Morone saxitalis), and inland silversides (Menidia beryllina). The marshes also provide potential habitat for other special-status species such as soft-haired bird's beak (Cordylanthus mollis ssp. Mollis), delta smelt (Hypomesus transpacificus) and anadromous fishes species.

In contrast, the Chevron Treatment Wetlands located between the Refinery and the San Pablo Creek and Wildcat Creek Marshes Significant Ecological Area is an artificial freshwater treatment marsh dominated by cattail (Typha sp.). The treatment wetlands have the potential to be occasionally used by some of the species, such as the clapper rail, that are more closely associated with saltwater marsh habitat and pickleweed, however none were observed during relatively intensive bird surveys in the treatment marsh areas between 1994-2004. This may be partially due to the treatment wetlands being non-tidal and freshwater, which is different than the estuaries associated with Bay wetland habitats. The treatment wetlands are frequented by common waterfowl such as ruddy duck (Oxyura jamaicensis), mallard (Anas platyrhynchos), northern shovelor (Anas clypeata), and pied-bill grebe (Podilymbus podiceps). Fish in the treatment wetlands are limited to those introduced for mosquito control.

BACKGROUND

Section 8.2.5.2, Discussion of Impacts, refers to Section 8.1, Air Quality, for a discussion of impacts to soils and vegetation from cooling tower drift and combustion turbine emissions. However, this information is not presented in the Air Quality section and is needed for a complete analysis.

DATA REQUEST

19. Please provide the aforementioned discussion of impacts to soils and vegetation from cooling tower drift and combustion turbine emissions.

Response: Cooling tower drift is the fine mist of water droplets that escape the cooling tower's mist eliminators and emitted into the atmosphere. Cooling towers concentrate the particulates (total dissolved solids) during the cooling process and produce a mist that contains higher total dissolved solids or salt than potable water typically contains. These salts can physically damage a leaf cell, which affects the photosynthetic ability of plants. Other effects include blocking the stomata (leaf pores) so that normal gas exchange is impaired, as well as affecting leaf adsorption and solar radiation reflectance. These effects can reduce productivity in crops, trees, and sensitive special-status plant species in a deposition area.

Studies performed by Lerman and Darley (1975) concluded that particulate deposition rates of 365 grams per square meter per year (g/m2/year) caused damage to fir trees, but rates of 274 g/m2/year and 400 to 600 g/m2/year did not cause damage to vegetation at other sites. Pahwa and Shipley (1979) exposed vegetation (corn, tobacco, and soybeans) to varying salt deposition rates to simulate drift from cooling towers that use saltwater (20 to 25 parts per thousand) in the circulation water. Salt stress symptoms on the most sensitive crop plants (soybeans) were barely perceptible effects at a deposition rate of 2.98 g/m2/year (Pawha and Shipley, 1979).

The expected deposition rate for the cooling tower is 0.88 g/m2/year. This rate assumes a conservative particulate deposition rate of 2 centimeters per second (consistent with ARB and air quality agency practice) and a maximum salt concentration of 92 microgram per cubic meter. These assumptions are based on ….[(the maximum annual particulate matter deposition rate for both the cooling tower and combustion turbine)]. This expected deposition rate is significantly less than levels expected to cause barely perceptible effects to the most sensitive crop plants based on the literature cited above.

Combustion turbine emissions of gaseous pollutants from a natural gas fired combustion turbine have been extensively evaluated in many other CEC siting cases with larger emissions and demonstrated to not significantly impact soils or vegetation. In addition, the emissions from the PPRP together with the Renewal Project will be fully offset. As a result there will be no significant impact to soils or vegetation, either individually or cumulatively.

Chevron Richmond Power Plant Replacement Project
07-SPPE-1
DATA REQUEST RESPONSE SET 1A

Technical Area: Cultural Resources
Author: Beverly E. Bastian

BACKGROUND

The Chevron PPRP application does not discuss any current standing structures on the two parcels for which new construction is proposed. Satellite imagery (date unknown) on Google Maps indicates that the site proposed for the new Cogen 3000 facility has no standing structures, but the site proposed for the expansion of Substation 5 appears to have structures on it. Additionally, the site proposed for the steam generator at the hydrogen plant appears to have standing structures in the locations proposed for the generator and for the switchgear enclosures. Staff needs to know what these structures are, and what their ages are, to fully assess the proposed project's potential impacts to possibly significant cultural resources.

DATA REQUESTS

20. Please identify any structures that are currently occupying the proposed locations of the Substation 5 expansion (if applicable – see Project Description data request) and of the generator and switchgear enclosures for the hydrogen plant.

    Response: There are no structures occupying the expansion area of Substation 5. The photograph used in the application was a few years old and showed temporary trailers in this area. Substation 5 was expanded three years ago into this area.

21. Please provide the ages of any structures that will be demolished to accommodate the construction of any of the proposed components of the PPRP.

    Response: No structures are expected to be demolished to accommodate expansion of Substation 5 or other components of the Power Plant Replacement Project. The only planned construction for Substation 5 expansion is the placement of new circuit breakers on an existing unoccupied foundation. Substation 5 was installed in the early 1990's. The Standard Oil Switching Station (SOSS) was installed in the early 1980's.

22. If any structure 45 years of age or older would be demolished to accommodate the construction of any of the proposed components of the PPRP, please provide a brief report, prepared by an architectural historian who meets the Secretary of the Interior's Professional Qualifications Standards for Architectural History, on the structures which will be demolished. The report must include recommendations regarding the potential eligibility for the California Register of Historical Resources (CRHR) of all structures 45 years of age or older that would be demolished as part of the PPRP project.

    Response: No structures 45 years of age or older are expected to be demolished. Please see Data Response 21.

23. Please provide the resume of the architectural historian making the eligibility recommendations for all structures 45 years of age or older that would be demolished as part of the PPRP project.

Response: Since no structures are to be demolished no architectural history is necessary.

BACKGROUND

The PPRP application states on p. 1-3 that the power output from the new steam turbine at the hydrogen plant will be conveyed to on-site Substation 4 via 800 feet of new 12.47-kV cables in a new piperack within the new plant before connecting to 2,000 feet of existing cables on poles, but on p. 5-4, the applicant says the new 12.47-kV cables will run 1,500 feet before connecting to the existing cables.

Additionally, the application does not describe the installation of the new piperack, in particular, whether it would involve any ground disturbance. To fully assess the potential impacts of the proposed project to unknown buried archaeological resources, staff needs the correct figures for the length of the new transmission cables and of the existing cables, and details on the installation of the new piperack.

DATA REQUESTS

24. Please provide the correct measurement of the length of the new cable construction needed for the proposed project, and, in addition, the correct measurement of the length of the existing cables between the new cables and Substation 4.

    Response: The routing of the new cables between the hydrogen plant switchgear and the tie-in to the existing cables that are routed overhead on poles has been revised since the application was prepared. The cables will no longer be routed on the piperack. Instead, the new routing will be in an underground duct bank that will be placed in a trench approximately 4 ft wide and 4 ft deep. The new cable run will be approximately 350 ft long. It will run for approximately 300 feet from the switchgear in underground duct bank, and will then be routed overhead on poles to tie-in to existing cable. Please see Figure CUL-24 depicting the revised interconnection.

25. Please describe the installation of the new piperack, focusing on any necessary ground disturbance, such as excavations for footings, if such will be needed.

    Response: There will be no necessary ground disturbance beyond the minor trenching described in Data Response 24.

BACKGROUND

The applicant proposes to reconductor two parallel on-site transmission lines, Cogen Line 1 and Cogen Line 2, to increase their ampacity to accommodate the output from the proposed Cogen 3000 replacement power plant. These reconductored lines would connect to on-site Substation 5 and then loop through PG&E's Standard Oil Substation (SOSS). The PPRP application does not discuss any changes which would be required at Substation 5 or at the SOSS to accommodate the greater ampacity of Cogen Lines 1 and 2. Nor does the application provide information on the ages of these substations. Staff needs the ages of the substations to consider whether or not they could be potential historic resources. Staff also needs information on any planned modifications at the two substations in order to assess potential impacts to potential cultural resources.

DATA REQUESTS

26. Please provide the age of Substation 5 and the age of the SOSS.

Response: Substation 5 was installed in the early 1990's. The Standard Oil Switching Station (SOSS) was installed in the early 1980's.

27. If either or both are 45 years of age or older:

 a. Please provide a discussion of any modifications to these structures that the reconductoring of Cogen Lines 1 and 2 would require.

Response: No structures 45 years of age or older are expected to be demolished or modified. Please see Data Response 21.

 b. Please provide a brief report, prepared by an architectural historian who meets the Secretary of the Interior's Professional Qualifications Standards for Architectural History, on Substation 5 and/or the SOSS. The report must include recommendations regarding the potential eligibility of these resources for the CRHR, and an evaluation of the significance of the impacts of any proposed modifications on Substation 5 and/or the SOSS.

Response: No structures 45 years of age or older are expected to be demolished or modified. Please see Data Response 21.

 c. Please provide the resume of the architectural historian making the eligibility recommendations for Substation 5 and/or the SOSS.

Response: No structures 45 years of age or older are expected to be demolished or modified. Please see Data Response 21.

BACKGROUND

In the Cultural Resources section, the application states that the local ordinances, plans, and policies of the city of Richmond do not apply to this project (p. 8.3-4), and then says that this jurisdictional issue is discussed in the section 8.4, Land Use. Staff did not find such a discussion in the Land Use section. To complete its analysis of the proposed project's compliance with laws, ordinances, regulations, and standards, staff needs to understand why the applicant believes that the local ordinances, plans, and policies of the city of Richmond do not apply to this project.

DATA REQUEST

28. Please explain why the local ordinances, plans, and policies of the city of Richmond, with respect to cultural resources, do not apply to this project.

Response: This text was inadvertently left in from a previous application. The local ordinances, plans and policies of the city of Richmond do apply to this project. The entire Renewal Project, including the PPRP, is currently under review by the City of Richmond. Based on the Draft EIR, compliance is expected with local ordinances, plans and policies applicable to the project.

BACKGROUND

For Native American consultation regarding the proposed project, the applicant is relying on the previous outreach to Native Americans made for the Chevron Renewal Project in October, 2005 (p. 8.3-14). In addition to providing contact information for concerned Native Americans, the Native American Heritage Commission (NAHC) cautions that a given list is only current for the date on which the list is sent to the person requesting it, so the applicant is citing the results of an outreach effort addressed to a list of Native Americans that is nearly two years old. Staff requires that an up-to-date list of Native Americans be obtained from the NAHC and new information specific to this proposed PPRP be sent to any Native American individuals or groups not included on the Chevron Renewal Project's October, 2005, list, with a request for information on any known cultural resources.

DATA REQUESTS

29. Please obtain an up-to-date list of potentially concerned Native Americans from the NAHC and send out letters informing those not on the previous list about the proposed PPRP project. Please include with the letters a map of the project area showing the two project sites, the Cogen 3000 site and the hydrogen plant site.

    Response: A letter has been prepared and submitted to NAHC and is provided as Attachment CUL-29. Once a response has been provided by NAHC, letters will be mailed to the list potentially interested tribes. Copies of these letters, and any responses, will be filed separately at a later date.

30. Please provide copies of any letter or email responses received from Native Americans and summaries of any responses received by telephone. If responses include locations of cultural resources of concern to Native Americans, please provide those responses under confidential cover.

    Response: Correspondence received from any tribes will be provided if received.

BACKGROUND

The DEIR for the Chevron Renewal Project states that the project area is underlain by fill deposits related to excavations for construction of the refinery in 1901 and cites as a source of the information the 1899 USGS "San Francisco" quadrangle map (p. 4.5-5). This map is described as showing the area where the refinery now stands as underwater prior to development. Staff needs to review this map to assess the potential of the project sites to contain buried or submerged cultural resources.

DATA REQUEST

31. Please provide a copy of the portion of the 1899 USGS "San Francisco" quadrangle map that shows the PPRP project area. Reduction in size is acceptable as long as the map is legible and the map scale is provided at the same reduction.

    Response: An electronic version of the 1899 USGS San Francisco quadrangle map can be viewed at http://sunsite2.berkeley.edu:8088/xdlib//maps/brk00010.00000004.xml. In addition, a hard copy of the map is provided as Attachment CUL-31. Due to the size of this document, five copies have been provided. Additional copies will be provided upon request.

BACKGROUND

The application states that the project area is sensitive for archaeological resources on p. 8.3-9, but on p. 8.3-13 it states that the potential for cultural resources is considered extremely low. Staff understands that the location of the refinery on a peninsula between two bays and adjacent to large estuaries makes the project area very likely to have been utilized by Native Americans in prehistory, and, indeed, in the early twentieth century archaeologists identified numerous large and rich shellmound sites near the shorelines of San Francisco and San Pablo Bays—including on or near the refinery property. Staff also understands that the applicant's cultural resources consultant assessed the two project sites as doubly disturbed, from previous construction and from historic-era filling to create new developable land out of marshes, and thus the consultant considered the project sites' potential for archaeological resources to be extremely low. Staff needs to consider the potential for significant cultural resources to be buried under recent fill, as proved to be the case at CA-CCo-295, discussed in the Draft Environmental Impact Report (DEIR) for the Chevron Renewal Project (2007: p. 4.5-3).

DATA REQUEST

32. Please discuss the potential for prehistoric cultural resources to be buried under fill at one or both of the proposed project sites. Include in your discussion the depth of the fill in the two project areas and the greatest depth that will be reached by project-related excavations at each of the proposed project sites.

    Response: The area proposed for construction of the PPRP is located entirely on artificial fill, as is the route of the cogeneration unit's transmission line[1]. Artificial fill possesses no cultural resources sensitivity. The thickness of artificial fill beneath and near the Cogeneration plant site, as determined from geotechnical borings, generally ranges from

---

[1] URS Corporation. 2006. *Report: Geotechnical Investigation, Hydrogen Replacement Plant Project, Chevron Products Company Richmond, California*. San Francisco, CA. September 15, 2006. Figure 5

10 to 14 feet[2]. The thickness of fill in the vicinity of the Hydrogen plant site is more variable, ranging from approximately 3.5 feet to as much as 13 feet in depth[1].

Because excavations are expected to disturb only the top six feet or less of sediment in the Project area, and because the sediment to be disturbed at this shallow depth is chiefly artificial fill with no cultural resources sensitivity, no impacts to cultural resources are anticipated from Project construction. Nor are impacts anticipated from Project operation, which will not involve ground disturbance.

In addition, the 1899 USGS "San Francisco" quadrangle map appears to depict the PPRP project area as in an area formerly covered entirely by water.

BACKGROUND

Appendix 8.11 of the application includes an SAIC soils evaluation report for the proposed hydrogen production plant, dated April 28, 2006. Figure 1 of that report has a trench feature depicted in three sections, labeled "Former Majka Ditch," Sections I, II, and III, with a note explaining that a Majka Ditch investigation was performed by Dames & Moore in 1989-1990. (No further information on this investigation was provided.) Staff could find no discussion of this ditch anywhere in the SAIC soils report or in the soils section. Staff needs to know what the Majka Ditch is/was to fully understand the nature and extent of previous disturbance at the proposed hydrogen plant site.

DATA REQUESTS

33. Please explain what the Majka Ditch is/was.

    Response: The Majka Ditch was an open ditch that was constructed in the pre-WW2 era of the refinery and used to provide surface drainage for process areas of the plant. The ditch was eventually abandoned and was filled with incidental fill from other refinery construction activities. The drainage function of the ditch was replaced with a subsurface drainage system.

34. Please provide a copy of the Dames & Moore report referenced in Figure 1 of the SAIC soils evaluation report dated April 28, 2006.

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[2] URS Corporation. 2006. *Report: Geotechnical Investigation, Cogen 3000 Project, Chevron Products Company Richmond, California*. San Francisco, CA. September 12, 2006.

Response: Excerpts from the Dames & Moore report, Results of Soils Investigation for RRMP Project, dated April 28, 2006 that are relevant to the Majka Ditch are provided as Attachment CUL-34.

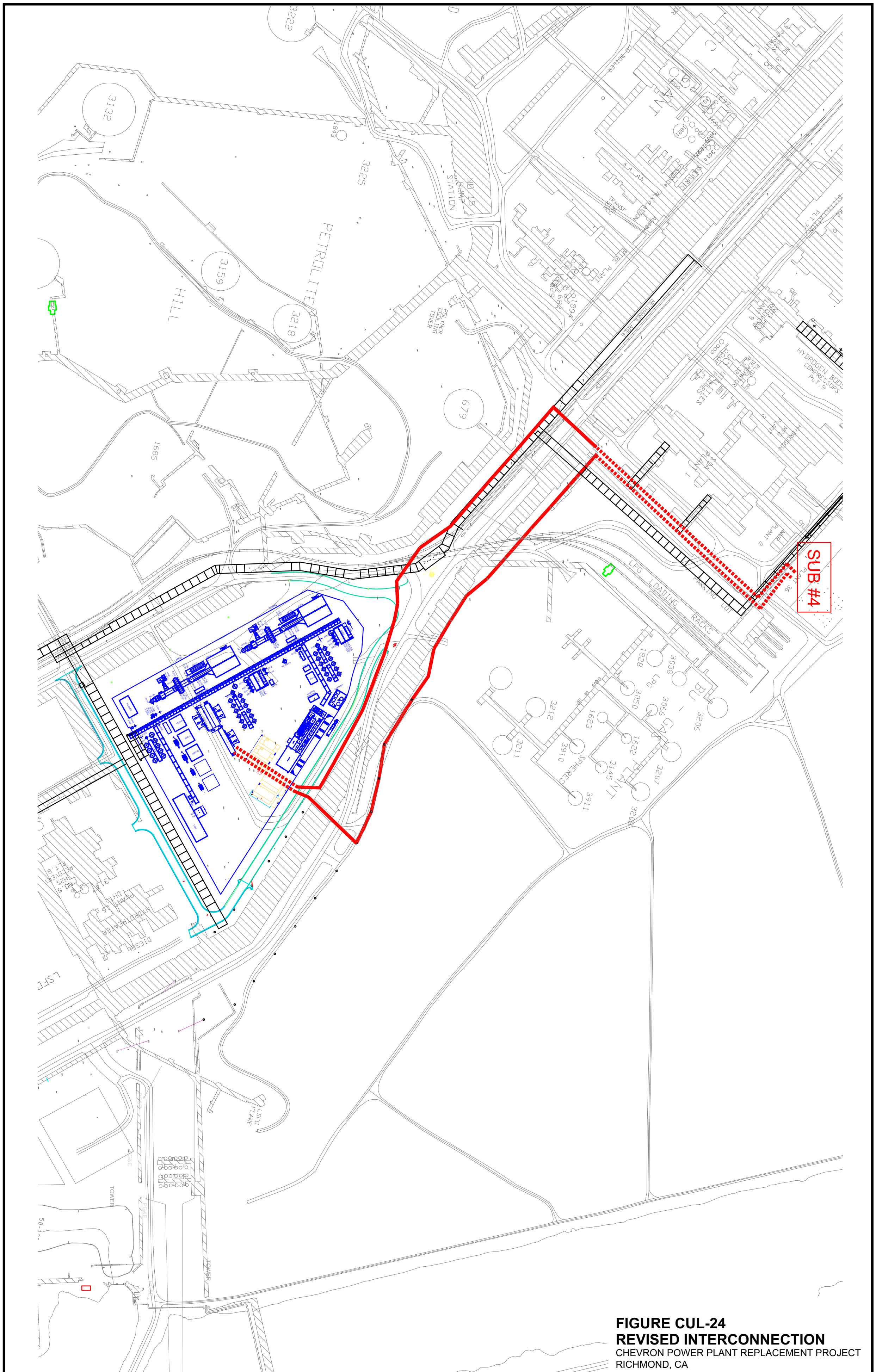


FIGURE CUL-24
REVISED INTERCONNECTION
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

ATTACHMENT CUL-29

CH2M HILL
3 Hutton Centre Drive
Suite 200
Santa Ana, CA 92707
Tel 714.429.2000
Fax 714.429.2050

September 6, 2007

Mr. Dave Singleton
Native American Heritage Commission
915 Capitol Mall, Room 364
Sacramento, CA 95814

Subject: Chevron Refinery Power Plant Replacement Project

Dear Mr. Singleton,

CH2M HILL is assisting Chevron with the preparation of a Small Power Plant Exemption (SPPE) before the California Energy Commission (CEC) for the Chevron Refinery Power Plant Replacement Project (PPRP) located in Richmond, California. The project area is indicated on the enclosed map (Pt. Richmond and San Quentin 7.5 Minute USGS quadrangles).

We would appreciate your checking the Sacred Lands Files to see if there are any culturally sensitive areas within the immediate project vicinity. We would also like to receive a list of Native American individuals or organizations interested in consulting on the project since we will attempt to contact local Indian groups to solicit their written input/concerns about the project.

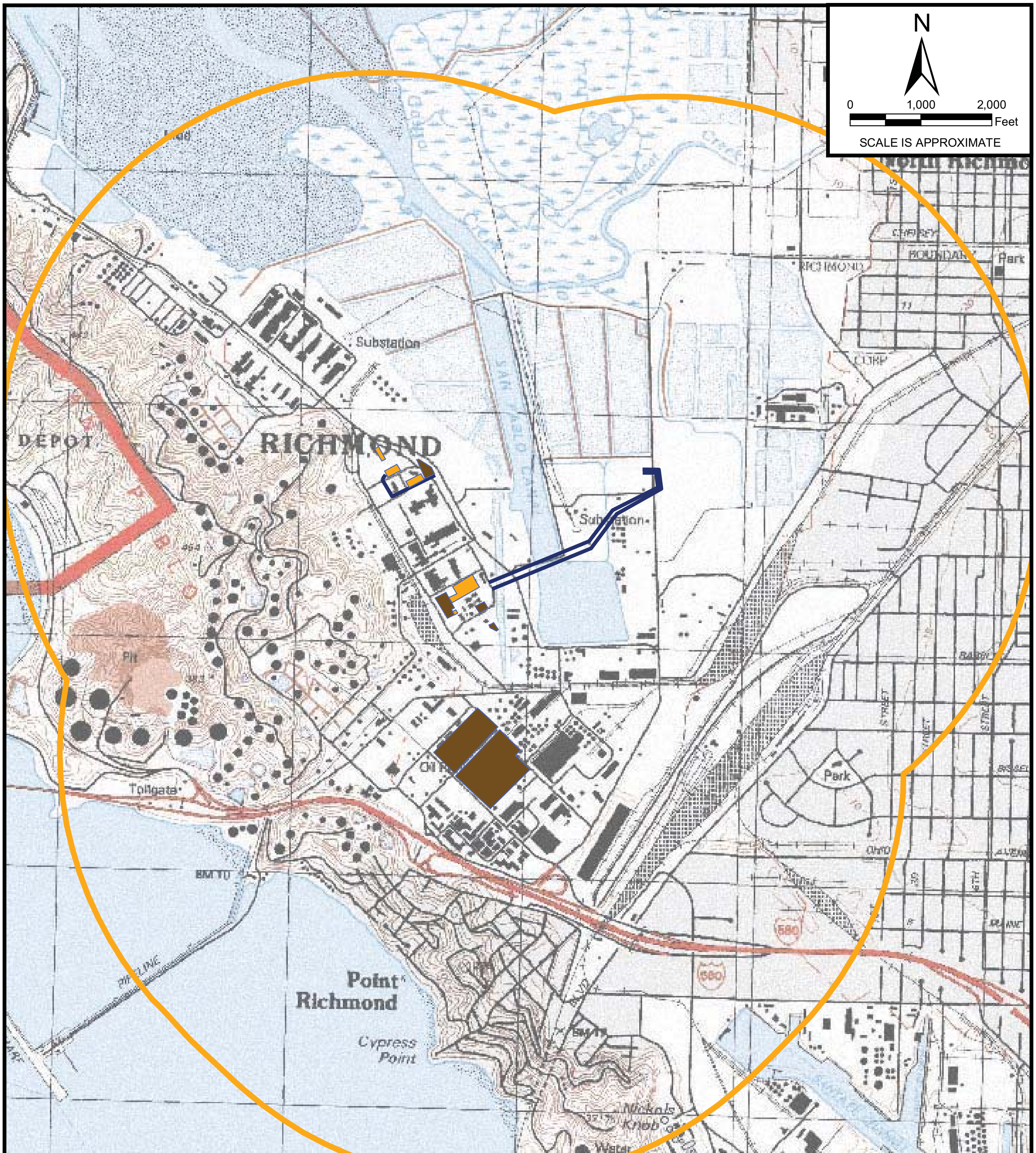
Thanks again for your cooperation and assistance. We look forward to your earliest possible reply. If you have any questions, please call me at 714-435-6140.

Sincerely,

CH2M HILL

Clint J. Helton, M.A., RPA
Project Scientist

Enclosures: Project Location Map



LEGEND

- Plant Area
- Laydown Area
- Transmission Line
- 1 Mile Buffer

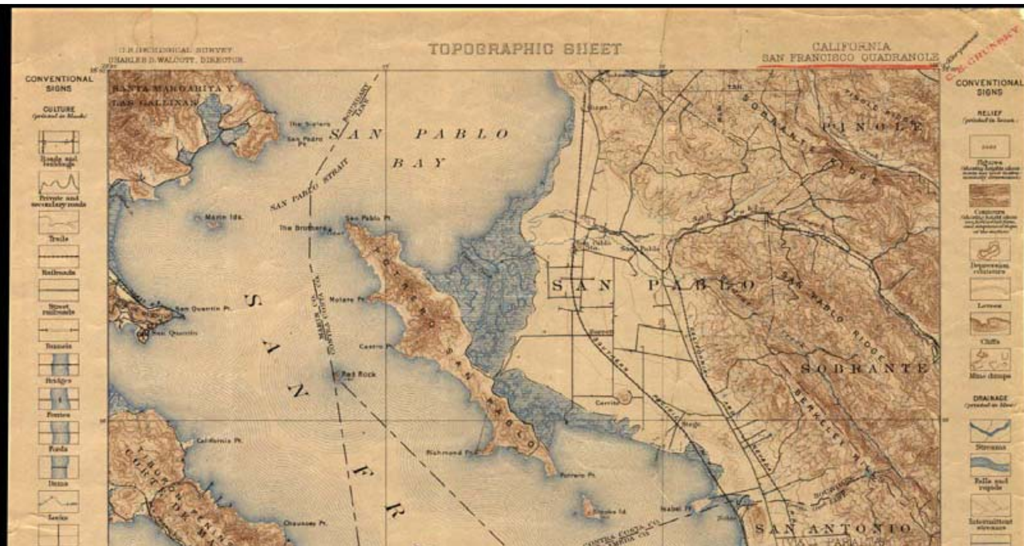
FIGURE 1.

CHEVRON POWER PLANT
REPLACEMENT PROJECT
RICHMOND, CA

ATTACHMENT CUL-31

1899 USGS San Francisco quadrangle map

Due to the size of this attachment, five hard copies are being provided to the CEC staff. Additional copies will be provided to others upon request.


U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR.
TOPOGRAPHIC SHEET
CALIFORNIA
SAN FRANCISCO QUADRANGLE
CONVENTIONAL SIGNS
CULTURE
RELIEF
DRAINAGE
SAN PABLO BAY
SAN PABLO STRAIT
SAN PABLO
PINOLE
SOBRANTE
SAN ANTONIO
SAN FRANCISCO BAY
RICHARDSON BAY
RACCOON STRAIT
GOLDEN GATE
SAUSALITO PENINSULA
PUEBLO LANDS OF SAN FRANCISCO
Angel Id.
Goat Id.
Alcatraz Id.
Red Rock
Marin Ids.
The Brothers
The Sisters
Mission Rock
G3700
svar
.U6
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T6

ATTACHMENT CUL-34

B E D M

BECHTEL ENVIRONMENTAL/DAMES & MOORE

RESULTS OF SOIL INVESTIGATION FOR THE RRMP PROJECT: MAJKA DITCH, ASPHALT PLANT/TANK FIELD AND POLEYARD TANK FIELD

Prepared For:

CHEVRON U.S.A. INC.
RICHMOND REFINERY

SEPTEMBER 14, 1990

BECHTEL ENVIRONMENTAL, INC.
P.O. Box 3965, San Francisco, CA 94119, (415) 768-1234

DAMES & MOORE, A Professional Limited Partnership
221 Main St., #600, San Francisco, CA 94105, (415) 896-5858

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CONCLUSIONS

Based on the results of our investigation, BEDM concludes:

RRMP Plant Site

Sitewide

- A layer of black sand fill containing elevated levels of Total Petroleum Hydrocarbons (TPH) (830 to 160,000 mg/kg) appears to be laterally extensive at the proposed RRMP Plant Site (see Plate 9). The black sand layer typically occurs directly over Bay Mud and ranges in thickness from one to seven feet. The thickest layer of sand is located beneath the Asphalt Loading Racks. This layer also typically contains limited detections of 1-methylnaphthalene to 300 mg/kg. The source of the black sand is unknown.

- Contamination present in Bay Mud at the site appears to be primarily related to the black sand fill. No evidence of contaminants migrating into the Bay Mud was found in 6 borings (B-1M, B-3M, B-4M, B-8M, and B-9M). Penetration of contaminants into the Bay Mud is generally less than a few feet for most borings. However, the depth of penetration is undetermined at 8 borings (B-2M, B-5M, B-12M, B-13M, B-15M, B-1A, B-2A, and B-5A)and may locally exceed 6 feet in borings B-5M and B-5A. Contaminants which suggest migration into the Bay Mud include TPH volatile organic compounds (VOCs), and some semi-volatile organic compounds.

Majka Ditch

- Majka Ditch is divided into three sections as shown in Plate 3. All Sections of the Majka Ditch fill contain high TPH levels.

- Hazardous levels of lead and arsenic are present in the fill at Section I of Majka Ditch. One sample from Section II of Majka Ditch contained hazardous levels of lead-contaminated soil. Section III does not appear to contain metals-contaminated soil.

- Hazardous levels of lead are present in two fill samples in borings B-5M and B-12M north of Majka Ditch. Both soil samples exceeded STLC criteria for lead while boring B-12M exceeded the TTLC criteria.

Asphalt Plant/Tank Field

- Contamination in fill soils at the Asphalt Loading Racks and Tanks 1609 and 3011 appears to occur predominantly in the black sand which underlies most of the RRMP Plant Site and is thickest in the vicinity of the loading racks. However, data from boring logs at the above areas do suggest that some leakage or spillage from these facilities has occurred.

- One fill sample from boring B-6A exceeded the TTLC and the STLC for lead in the Deck Tank Area. In addition, several isolated soil samples in the Deck Tank Area contained elevated TPH levels. These data suggest there may be small, localized pockets of contaminated material at the Deck Tank and Railcar Loading Area of the proposed RRMP Plant Site due to leakage from storage tanks or railcars.

1.0 INTRODUCTION

Bechtel Environmental Inc. and Dames & Moore (BEDM) prepared this report for Chevron U.S.A. Inc. which presents the results of our chemical soil characterization for the proposed Richmond Refinery Modernization Project (RRMP) Plant Site and Tank Site. BEDM understands that Chevron will submit this report to the Regional Water Quality Control Board (RWQCB). The locations of the Refinery and the RRMP sites are shown on the Vicinity Map, in Plate 1.

The purpose of this investigation was to evaluate the existence and extent of chemical contamination within the soils at the portions of the Waste Discharge Order (WDO) sites which overlap the proposed RRMP sites. As shown in Plate 2, two WDO sites overlap the proposed RRMP Plant Site. Majka Ditch is a WDO site that is completely within the RRMP Plant Site; the Asphalt Plant/Tank Field is a WDO site of which the northern portion is within the proposed RRMP Plant Site. Several RRMP above-ground tanks are scheduled for construction in the Poleyard Tank Field (See Plate 4) which is also a WDO site.

The field investigation extended from November 20, 1989 to December 15, 1989. The scope of work consisted of 15 borings at the Majka Ditch site, 10 borings in the Asphalt Plant Tank Field, and 6 borings at the Poleyard Tank Field. In addition, 11 test pits were excavated between November 30, 1989 and December 1, 1989, at Majka Ditch and the Poleyard Tank Field, to aid in the placement of borings. In addition, BEDM completed five additional soil borings (non-WDO) outside the WDO boundaries to provide additional data at the RRMP Plant Site. This Non-WDO Soil Investigation is presented in Appendix F.

This report presents the results of the soil characterization and analytical program for the three WDO sites in the RRMP area. Section 2.0 describes the individual sites and summarizes the historical data used to develop the workplans for the soil investigation. Section 3.0 outlines investigation objectives and BEDM's scope of work. The results of the soil investigation are presented in Section 4.0, while Section 5.0 presents BEDM's conclusions. The Appendices include the results of previous investigations, logs of test pits, boring logs, analytical results, reporting limits, chain-of-custody records, and results of the Non-WDO Soil Investigation completed within the RRMP Plant Site Area.

2.0 BACKGROUND

As shown on Plate 2, the proposed RRMP Plant Site Area is a triangular area approximately 18 acres in size bounded by Channel Street, Hydro Street and Petrolite Street to the north, south and west, respectively. The proposed RRMP Tank Site Area is shown on Plate 4. This area is approximately 5 acres and is located between the Lake Schramm and the Potrero-San Pablo Ridge, (approximately one-half mile west of the RRMP Plant Site Area). The RRMP overlaps three WDO sites, Majka Ditch, portions of both the Asphalt Plant/Tank Field, and Poleyard Tank Field; which are discussed in the following sections.

2.1 Majka Ditch

Majka Ditch is a WDO site, approximately 650 feet long, located within the proposed RRMP construction site. In addition, there is a 300-foot tributary ditch which intersects Majka Ditch near its midpoint. Presently, Majka Ditch is approximately 8 feet wide and approximately 2 feet in depth and empties into No. 2A Separator on a limited basis. Currently, Majka Ditch receives only stormwater runoff from the adjacent parking lots and the Asphalt Loading Racks. Runoff from the hillsides and Lake Rushing bypasses Majka Ditch and is discharged into a new 36-inch storm sewer that flows to the No. 2A Separator Diverter Box. In the past, Majka Ditch carried stormwater runoff from Lake Rushing, the Asphalt Plant, and adjacent hills to the No. 2 Separator. In addition, Chevron used water to flush the above-ground storage tanks located on the hillside and discharged the water into drainage channels that eventually fed into Majka Ditch. The Majka Ditch area did receive liquid asphalt from previous spills from Asphalt Plant operations.

In 1987, Chevron investigated Majka Ditch for compliance with Toxic Pit Cleanup Act (TPCA). Under the Majka Ditch Upgrade Project performed by Chevron, the ditch was sampled and found to contain hazardous levels of arsenic and lead. As a result, Chevron removed approximately 300 cubic yards of contaminated soil from Section I of Majka Ditch.

2.2 Asphalt Plant/Tank Field

As shown on Plate 2, the portion of the Asphalt Plant/Tank Field within the boundary of the RRMP Plant Site is approximately four acres in size and centered near the intersection of Petrolite Street and Marsh Street. The portion of the Asphalt Plant Tank Field within the RRMP Plant site is divided by Petrolite Street and is bounded to the west by Petrolite Hill, on the north by Majka Ditch and on the east by the No. 1 and No. 2 Hydrofiner. Operational areas of the Asphalt Plant Tank Field lying within the proposed RRMP Plant Site include the Asphalt Loading Racks, the Petrolite Street Pipeway east of Petrolite Street, and the Asphalt Plant Deck Tank Area which includes the Railcar Loading Area, all shown in Plate 2.

Chevron constructed the Asphalt Plant in 1916 and 1917. The rock excavated during construction was used to fill the adjacent marshlands. Other fill may also have been placed. Chevron filled the area recently occupied by the old Asphalt Loading Racks by 1939 and constructed the old Asphalt Loading Racks and the Deck Tanks in the early 1940s according to a 1945 plot plan. By 1988, the asphalt operations were being scaled down and dismantling of operating structures had begun.

2.2.1 Asphalt Loading Area

The Asphalt Loading Racks were located approximately 100 feet south of Majka Ditch and loaded tank trucks with paving asphalt and liquid asphalt. During operation (1945 to 1989), the loading racks were covered and surrounded by asphalt pavement. Two storage Tanks, 3011 and 1609, were located

3.0 OBJECTIVES AND SCOPE OF WORK

3.1 Majka Ditch

3.1.1 Objectives

- Evaluate the chemical quality of the soils within Majka Ditch and the underlying Bay Mud.
- Assess the analytical results from Chevron's 1987 Majka Ditch Upgrade Project that reported hazardous levels of lead and arsenic in Section I of the ditch.
- Evaluate the vertical extent of contaminated soils within the ditch and estimate lateral extent of contamination where possible.
- Investigate the reported location of the Cooper Pits and previously reported sand blasting area for contaminated soils.
- Investigate the gunited tributary to the north of Majka Ditch for contaminated soil.

3.1.2 Scope of Work

- Drill 15 geochemical borings and submit approximately 62 soil samples for chemical analyses for the analytes presented in Table 1 including zinc.
- Excavate 7 test pits north of Majka Ditch, prior to drilling, to help locate borings B-5M and B-12M for the Cooper Pits and the sand blasting area, respectively.
- Evaluate analytical data and prepare a written report that summarizes findings.

3.2 Asphalt Plant/Tank Field

3.2.1 Objectives

- Evaluate the chemical quality of the soils in the five areas in the Asphalt Plant/Tank Field where Chevron's previous operations may have impacted the soils:
  - Asphalt Loading Racks #17 and #18
  - Tanks 3011 and 1609
  - Petrolite Street Pipeway
  - Railcar Loading Area
  - Deck Tank Area

3.2.2 Scope of Work

- Drill and sample 9 geochemical borings.
- Submit 35 soil samples for chemical analyses for the analytes presented in Table 1.
- Evaluate analytical data and prepare a written report summarizing BEDM's findings.

(excluding the high and low values) is 1,000 mg/kg. No soil contamination was detected in the Bay Mud in borings B-1M, B-3M, B-4M, B-8M, and B-9M.

In addition to TPH, volatile and semi-volatile organic compounds were detected in the Bay Mud. BTX&E compounds were found in the Bay Mud with xylenes being the primary contaminant detected in nine of the 30 Bay Mud samples. The VOCs found in the Bay Mud are concentrated in borings B-1A through B-5A and summarized in Table 7. The BTX&E compounds detected 1.5 feet into the Bay Mud in boring B-1A ranging from 86 mg/kg benzene (detected only once in the Bay Mud) to 630 mg/kg xylenes (see Table 7). The Bay Mud in boring B-1A (depth 5.0 feet) was reported as non-detect for benzene and ethylbenzene, however low concentrations of toluene (0.85 mg/kg) and xylenes (1.4 mg/kg) were detected in this sample. The average concentration of xylenes in the Bay Mud for positive detections (excluding the maximum concentration of 630 mg/kg xylenes in boring B-1A) is 4.3 mg/kg. In summary, low levels of VOCs have migrated to a known depth of 6 feet into the Bay Mud at borings B-5M and B-5A.

Semi-volatile organic compounds (SVOCs) were detected in seven of 30 Bay Mud samples collected (borings B-6M, B-12M, B-15M, B-1A, B-4A and B-5A). The SVOCs detected in the Bay Mud and their maximum concentrations are: butylbenzylphthalate (1.3 mg/kg), naphthalene (31 mg/kg), phenanthrene (0.87 mg/kg), and 1-methylnaphthalene (44 mg/kg). The primary SVOC detected in the Bay Mud was 1-methylnaphthalene occurring in all seven positive detections. Table 9 lists all SVOCs detected in the Bay Mud for the Majka Ditch and Asphalt Plant Tank Field soil investigation. The bottom limit of contamination of SVOC is unknown in borings B-12M and B-15M where detections were reported at 3.5 feet and 2.5 feet, respectively, into the Bay Mud.

4.3 Majka Ditch Analytical Results

4.3.1 Majka Ditch Borings

BEDM completed 15 borings (B-1M through B-15M) for Majka Ditch and are shown on Plate 3. Seven borings were drilled in the ditch bottom and four borings were completed along the sides of the ditch to evaluate the lateral extent of potential contamination. Borings B-10M and B-11M were drilled in the tributary ditch north of Majka Ditch to confirm previous observations by Chevron that soil contamination is absent in this areas.

BEDM concentrated borings near the west end of Majka Ditch where Chevron detected hazardous concentrations of arsenic and lead in their 1987 Majka Ditch Upgrade Project (see Appendix A). For borings placed in the ditch, sampling began at the base of the gravel backfill placed in the Upgrade Project (approximately 2 feet below the bottom of the ditch).

BEDM submitted soil samples for analyses for the Skinner List analytes plus zinc as indicated on Table 1. The analytical summary results are divided into fill and Bay Mud materials and presented in Tables 4a and 4b, respectively. BEDM collected 34 fill samples and 28 Bay Mud samples for the Majka Ditch investigation. (Note that Sections 4.3.2 through 4.3.6 contain detailed discussions of the analytical results for Majka Ditch. For a summary of the highlights of the analytical results the reader is referred to Section 4.3.7.)

4.3.2 Metals

The metal concentrations of metals in the fill near Majka Ditch exceeded the Total Threshold Limit Concentration (TTLC) criteria in 3 of the total 34 samples collected and are therefore considered hazardous. The soil from borings B-1M (depth 8.0 feet), B-3M (depth 9.3 feet), and B-12M (depth

5.5 feet) contained lead concentrations of 2,460 mg/kg, 2,960 mg/kg, and 2,370 mg/kg, respectively. The TTLC for lead is 1,000 mg/kg. Arsenic concentrations in borings B-1M (depth 8.0 feet) and B-3M (depth 4.2 feet) exceeded the TTLC (500 mg/kg) and reported at 1,810 mg/kg and 999 mg/kg, respectively. Concentrations of metals in thirty-three samples were reported as exceeding ten times the STLC for: arsenic, cadmium, lead, mercury, and/or nickel; however, only 6 soil samples exceeded the STLC limit. Lead and arsenic were the only constituents that were reported at concentrations which exceeded STLC hazardous criteria of 5 mg/l. Samples from borings B-3M (depth 4.2 feet), B-5M (depth 7.0 feet), B-9M (depth 4.5 feet) and B-12M (depth 5.5 feet) had soluble lead concentrations of 8.5 mg/l, 6.6 mg/l, 61.0 mg/l and 116.0 mg/l, respectively. Borings B-1M (depth 8.0 feet) and B-3M (depth 9.3 feet) were reported as having soluble arsenic concentrations of 22.6 mg/l and 13.3 mg/l, respectively (these concentrations are considered hazardous). It is important to note that borings B-5M and B-12M are located approximately 120 and 60 feet, respectively, north of Majka Ditch.

All 28 Bay Mud samples collected at Majka Ditch contain metals at concentrations below TTLC limits (see Table 4b) and are considered hazardous. Three Bay Mud samples (one sample from boring B-1M, B-2M and B-15M) did contain metals at concentrations which exceeded ten times the STLC limit for arsenic, lead, mercury and/or selenium. Boring B-1M at a depth of 10.5 feet reported having a total arsenic concentration of 102 mg/kg as compared to ten times the STLC of 50 mg/l. Boring B-2M at a depth of 14.5 feet also reported having a total arsenic concentration of 145 mg/kg and a total selenium concentration of 10.7 mg/kg. The total lead concentrations for borings B-1M, B-2M and B-15M at depths of 10.5 feet, 14.5 feet and 12.5 feet were reported as 199 mg/kg, 70.9 mg/kg and 85.6 mg/kg, respectively. The WET test was performed on these samples, and the soluble concentrations of metals in these samples did not exceed the STLC. Boring B-2M at a depth of 14.5 feet reported as having a total mercury concentration of 2.2 mg/kg which slightly exceeds ten times the STLC value of 2.0 mg/l. The STLC analysis was inadvertently not performed for mercury in sample B-2M, depth 14.5 feet (see QA/QC Section 4.6), however the reported concentration barely exceeds ten times the STLC. Based on the data collected in other borings, it is highly unlikely that the mercury concentration would exceed the STLC criteria.

4.3.3 Volatile Organic Compounds

The volatile organic compounds (VOCs) benzene, toluene, xylenes and ethylbenzene (BTX&E) were detected in 9 of the 34 samples collected in the fill material from 15 borings at Majka Ditch. and are summarized in Table 7. Benzene was detected in one sample in boring B-5M (depth 7.0 feet) with a reported concentration of 2.9 mg/kg. Toluene was only detected in boring B-15M at depths of 7.0 feet and 7.5 feet with reported concentrations of 0.66 mg/kg and 0.88 mg/kg, respectively. Ethylbenzene was detected in 5 of the 34 fill samples collected with a concentrations ranging from 0.60 mg/kg for boring B-15M (depth 7.0 feet) to 3.6 mg/kg for boring B-5M (depth 7.0 feet). Xylenes were detected in 8 of the 34 soil samples and ranged from 0.77 mg/kg for boring B-13M (depth 3.0 feet) to 9.5 mg/kg for boring B-15M (depth 7.5 feet).

Volatile organic compounds were not detected in the Bay Mud in the immediate vicinity of Majka Ditch. However, ethylbenzene (3.0 mg/kg) and xylenes (7.9 mg/kg) were detected at boring B-5M, located 120 feet north of Majka Ditch, at a depth of 19.0 feet. The Bay Mud at 14.5 feet is absent of VOCs in boring B-5M. The vertical extent of the VOCs in the Bay Mud for boring B-5M is unknown.

4.3.4 Semi-Volatile Organic Compounds

Semi-volatile organic compounds (SVOCs) were reported in 14 of the 34 fill samples analyzed from Majka Ditch. (Table 8). Nine SVOCs were detected in Majka Ditch; all compounds are polynuclear aromatics (PNAs). The compounds benzo(a)anthracene, chrysene, methylchrysene, 1-methyl naphthalene, and phenanthrene comprise approximately 80 percent of the detections. Other compounds detected include benzo(a)pyrene, pyrene, naphthalene, and 7,12-dimethyl benzene(a)anthracene. Semi-volatile organic compounds were reported at concentrations up to 300 mg/kg. Semi-volatile organic compounds were detected in all Majka Ditch borings with the exception of borings B-5M, B-7M, B-10M, B-11M, and B-12M. It should be noted that the reporting limits are elevated for these samples with a maximum value of 200 mg/kg.

Semi-volatile organic compounds were reported in the Bay Mud in only 3 samples, two from B-6M and B-15M in Majka Ditch and one sample from B-12M, north of Majka Ditch.

4.3.5 Total Petroleum Hydrocarbons (TPH)

TPH was detected in all 34 fill samples taken for Majka Ditch. The maximum TPH was reported in boring B-15M in a concentration of 160,000 mg/kg at a depth of 7.0 feet, in a fine black sand. The minimum TPH concentration was reported as 440 mg/kg at boring B-6M (depth of 4.5 feet) in a brown sandy gravel. The average TPH value for all borings associated with the main section of Majka Ditch (excluding borings B-5M and B-12M) is approximately 28,000 mg/kg. High TPH concentrations were typically associated with the black sand which is discussed in Section 4.2.1.

TPH was detected in 11 of the 28 soil samples taken in the Bay Mud. The maximum TPH concentration detected was 7,900 mg/kg in boring B-7M at a depth of 15.0 feet. TPH in the Bay Mud in boring B-7M (depth 18.0 feet) was reported as non-detect. The average TPH value for positive detections in the Bay Mud for Majka Ditch was approximately 1,400 mg/kg.

4.3.6 pH

The pH of the fill material at Majka Ditch ranged from a maximum pH of 8.9 at boring B-13M (depth 5.0 feet) to a minimum pH of 3.7 at boring B-15M (depth 7.5 feet). The soil sample with the minimum pH of 3.7 also exhibited a TPH concentration of 160,000 mg/kg and 130 mg/kg of 1-methylnaphthalene.

The pH of the Bay Mud at Majka Ditch ranged from a maximum pH value of 8.8 at borings B-12M through B-14M (depth 11.0 feet) to a minimum value of 7.6 at boring B-1M (depth 10.5 feet).

4.3.7 Summary of Results for the Majka Ditch Investigation

4.3.7.1 Section I

Section I of Majka Ditch (borings B-1M and B-3M) contains hazardous levels of lead- and arsenic-contaminated fill to a known depth of 9.3 feet (approximately 1.5 feet above the Bay Mud). SVOCs were detected in all fill samples taken, except one sample at 5.5 feet in boring B-1M. The primary SVOC detected in Section I of Majka Ditch was 1-methylnaphthalene at concentrations ranging from 5.0 mg/kg to 300 mg/kg. The SVOCs were typically highest in the black sand. Two VOCs were detected in two samples from boring B-1M. All the fill samples from Section I contained elevated TPH concentrations (greater than 1,000 mg/kg) with the exception of 400 mg/kg TPH reported in boring B-2M. In particular, the black sand unit had TPH levels ranging from 22,000 mg/kg to 150,000 mg/kg for borings B-3M (depth 4.2 feet) and B-2M (depth 7.5 feet), respectively.

All metals analyses for the Bay Mud in Section I of Majka Ditch were below hazardous levels. Three of 8 Bay Mud samples had total concentrations of lead, arsenic and/or selenium greater than ten times the STLC; however, all soluble concentrations tested were less than the STLC. TPH concentrations were reported in Bay Mud in boring B-2M of 120 mg/kg (depth 11.7 feet) and 360 mg/kg (depth 14.5 feet).

4.3.7.2 *Section II*

A hazardous lead concentration was found in the fill at Majka Ditch, Section II (boring B-9M, depth 4.5 feet) with a soluble lead concentration of 61 mg/l, which exceeds the STLC criterion of 5.0 mg/l for lead. The sample location is in the top of the black sand. All other metals results were below hazardous levels in Section II of Majka Ditch. No VOCs were reported in Section II fill samples. Chrysene was reported in one fill sample from boring B-8M (depth 3.0 feet). The TPH in Section II of the fill ranged from 440 mg/kg (B-6M, depth 4.5 feet) to 41,000 mg/kg (B-7M, depth 7.0 feet); TPH contamination is typically concentrated in the black sand.

Samples of Bay Mud from Section II of Majka Ditch contained metals at concentrations below TTLC and STLC criteria. No VOCs were reported in the Bay Mud. One semi-volatile organic compound, 1-methylnaphthalene, was reported in the Bay Mud (boring B-6M, depth 9.0 feet) at a concentration of 0.43 mg/kg. TPH was reported in one Bay Mud sample (boring B-7M, depth 15.0 feet) at a concentration of 7,900 mg/kg. The TPH concentration at a depth of 18.0 feet is reported as non-detect.

4.3.7.3 *Section III*

Metals concentrations in the fill in Majka Ditch Section III were all below TTLC and STLC levels. No VOCs were reported. SVOCs were detected in samples selected from all borings in Section III of Majka Ditch. The predominant semi-volatile organic contaminant was 1-methylnaphthalene at concentrations to 280 mg/kg. The contamination is commonly associated with the black sand. TPH concentrations in the fill at Section III of Majka Ditch ranged from 830 mg/kg (boring B-14M, 5.5 feet) to 160,000 mg/kg (boring B-15M, 7.0 feet). High TPH levels are also typically associated with the black sand.

Metals concentrations in Bay Mud samples from Section III of Majka Ditch are below TTLC and STLC criteria. No VOCs were reported in the Bay Mud. The semi-volatile organic compound 1-methylnaphthalene was detected in one Bay Mud sample at a depth of 12.5 feet in boring B-15M. TPH was reported in the two Bay Mud samples from boring B-15M (depth 10.0 and 12.5 feet) at 76 and 2,700 mg/kg, respectively.

4.3.7.4 *Soil North of Majka Ditch*

BEDM completed boring B-5M where the Cooper Asphalt Pits are thought to have existed north of Majka Ditch. Concentrations of metals in fill material were all below the TTLC and STLC criteria except the soluble lead concentration at 7.0 feet of 6.6 mg/l, which slightly exceeds the STLC of 5 mg/l. Volatile organic compounds (BTX&E) were also present in this sample at concentrations less than 4 mg/kg (see Table 7). High TPH readings (26,000 mg/kg and 110,000 mg/kg) were reported in the fill at boring B-5M; the highest concentration was in the black sand. Ethylbenzene (3.0 mg/kg), xylenes (7.9 mg/kg), and TPH (2,100 mg/kg) were reported in the Bay Mud sample at a depth of 19.0 feet. No other organic contaminants were reported.

Boring B-12M was completed in an area where a sand blasting operation reportedly operated. Metal analyses on the fill indicated hazardous total and soluble lead concentrations of 2,370 mg/kg and 116 mg/l, respectively (boring B-12M, depth 5.5 feet). Volatile and semi-volatile organic compounds were not detected in the fill materials. TPH concentrations of 1,300 and 10,000 mg/kg were reported in the fill at boring B-12M.

5.0 CONCLUSIONS

Based on the results of our investigation BEDM concludes:

RRMP Plant Site

Sitewide

- A layer of black sand fill containing elevated levels of TPH (830 to 160,000 mg/kg) appears to be laterally extensive at the proposed RRMP Plant Site. The black sand layer typically occurs directly over Bay Mud and ranges in thickness from one to seven feet. The thickest layer of sand is located beneath the Asphalt Loading Racks. This layer also typically contains limited detections of 1-methylnaphthalene to 300 mg/kg. The source of the black sand is unknown and the lateral extent north of Majka Ditch is not well defined.

- Contamination present in Bay Mud at the site appears to be primarily related to the black sand fill. No evidence of contaminants migrating into the Bay Mud was found in 6 borings (B-1M, B-3M, B-4M, B-8M, and B-9M). Penetration of contaminants into the Bay Mud is generally less than a few feet for most borings. However, the depth of penetration is undetermined at 8 borings (B-2M, B-5M, B-12M, B-13M, B-15M, B-1A, B-2A and B-5A) and may locally exceed 6 feet in borings B-5M and B-5A. Contaminants which suggest migration into the Bay Mud include TPH, VOCs, and some semi-volatile organic compounds.

Majka Ditch

- All three Sections of the Majka Ditch fill contain high TPH levels.

- Hazardous levels of lead and arsenic are present in the fill at Section I of Majka Ditch. One sample from Section II of Majka Ditch contained hazardous levels of lead-contaminated soil. Section III does not appear to contain metals-contaminated soil.

- Hazardous levels of lead are present in two fill samples in borings B-5M and B-12M, north of Majka Ditch.

Asphalt Plant/Tank Field

- Contamination in fill soils at the Asphalt Loading Racks and Tanks 1609 and 3011 appears to occur predominantly in the black sand which underlies most of the RRMP Plant Site and is thickest in the vicinity of the loading racks. However, data from boring logs at the loading racks and Tanks 1609 and 3011 do suggest that some leakage or spillage from these facilities has occurred.

- One fill sample from boring B-6A exceeded the TTLC and the STLC for lead in the Deck Tank Area. In addition, several isolated soil samples in the Deck Tank Area contained elevated TPH levels. These data suggest there may be small, localized pockets of contaminated material at the Deck Tank and Railcar Loading Area of the proposed RRMP Plant Site due to leakage from storage tanks or railcars.

Technical Area: Geological Resources
Author: Patrick Pilling, Ph.D., P.E., G.E.

BACKGROUND

Existing subsurface information is essential to completely evaluate a site with respect to potential geologic hazards and how the existing materials may impact design, construction, and operation of the facility. No site-specific subsurface information has been included with the application; however, site-specific geotechnical reports are referenced in the application. Both Geological and Cultural Resources staff will review these reports prior to completing their analyses.

DATA REQUEST

35. Please provide a copy of available site-specific geotechnical reports for the project, in particular the *Geotechnical Investigation, Hydrogen Replacement Plant Project* (URS 2006a) and the *Geotechnical Investigation, GOGEN 3000 Project* (URS 2006b) as referenced in Section 8.13 of the application.

    Response: A copy of the site-specific geotechnical reports for the project including "Geotechnical Investigation, Hydrogen Replacement Plant Project" and the "Geotechnical Investigation, GOGEN 3000 Project "can be found as Attachment GEO-35. Due to the size of these documents five copies have been provided to Staff. Additional copies are available upon request.

ATTACHMENT GEO-35

Geotechnical Investigation, Hydrogen Replacement Plant Project and the Geotechnical Investigation, GOGEN 3000 Project

Due to the size of this attachment, five hard copies of each document are being provided to the CEC staff. Additional copies will be provided to others upon request.

REPORT
GEOTECHNICAL INVESTIGATION
COGEN 3000 PROJECT
CHEVRON PRODUCTS COMPANY
RICHMOND, CALIFORNIA

Job No. 28067039
September 12, 2006

URS

September 12, 2006
Job No. 28067039

Chevron Products Company
841 Chevron Way
Richmond, CA 94802

Capitol Projects
214 Main Street

Attention: Mr. John J. MacDonald
Project Manager

c/o Mr. James Jacques, P.E.
Project Civil Engineer

Dear Mr. MacDonald:

Report
Geotechnical Investigation
COGEN 3000 Project
Chevron Products Company
Richmond, California

We are pleased to present this geotechnical investigation report for the proposed COGEN 3000 Project at the Chevron Richmond Refinery in Richmond, California.

The COGEN 3000 Project site is underlain by heterogeneous fill, Recent Bay Mud, a thick layer of Alluvial Deposits, and Franciscan Bedrock. We recommend supporting the new heavily loaded COGEN facilities on friction piles gaining support from the Alluvial Deposits.

The recommendations contained in this report are based on both the recent exploration test borings completed in June 2006 as well as the eight previous borings drilled since 1941.

This report is based on our proposal submitted on March 30, 2006 for geotechnical investigation for the COGEN 3000 Project.

URS Corporation
221 Main Street, Suite 600
San Francisco, CA 94105-1917
Tel: 415.896.5858
Fax: 415.882.9261

URS

We provided our professional service under the terms and conditions of URS' Chevron Standing Contract 99014509 and Richmond Service Contract 4635799.

If you have any questions regarding this report, we would be pleased to discuss them with you.

Very truly yours,

URS CORPORATION

William G. Paratore, P.E., G.E.
Geotechnical Group Manager

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GEOTECHNICAL INVESTIGATION
COGEN 3000 PROJECT
CHEVRON PRODUCTS COMPANY
RICHMOND, CALIFORNIA

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed COGEN 3000 Project at the Chevron Richmond Refinery in Richmond, California. URS Corporation performed the work for this project at the request of Mr. James Jacques of the Chevron Products Company in accordance with an authorization to proceed dated May 15, 2006 from Mr. David Isherwood of Chevron. We provided our professional services under URS' existing standing Chevron Contract Number 99014509 and Richmond Service Contract 4635799.

The COGEN 3000 Project is located in the Chevron Richmond Refinery, as shown on the Site Vicinity Map, Figure 1. The site is west of the 100-Foot Channel in a block bounded by Catalyst Street on the south and west, Petrolite Street on the east, and Cracking Street on the north. Figure 6 shows the Site Location Plan. The COGEN 3000 site consists of two subsites, A and B.

The purpose of this investigation was to obtain geotechnical information necessary to develop general foundation recommendations for the proposed COGEN 3000 Project plant installation. Our investigation included a geotechnical field exploration to obtain subsurface stratigraphy information and to obtain soil samples for testing, geotechnical laboratory testing, geotechnical engineering analyses, and development of recommendations for foundation design and construction.

This report presents factual data regarding the subsurface soils and groundwater conditions encountered during our field exploration at specific boring locations. It provides interpretation of the subsurface conditions and the characteristics of the major strata, and it includes recommendations for design and construction. Following this Introductory section is a brief description of the Proposed Construction, Section 2.0. This is followed by a definition of the Purpose and Scope of the investigation in Section 3.0. The Geologic and Seismic Setting are presented in Section 4.0. Section 5.0 discusses the Site Conditions. Section 6.0 presents our Discussion, Conclusions, and Recommendations for design and construction of proposed facilities. Appendix A presents details of the field exploration program including the boring logs and logs of borings from previous investigations, an Appendix B presents the results of the laboratory testing program.

2.0 PROPOSED CONSTRUCTION

We understand that the proposed COGEN 3000 Project will include the construction of a new cogeneration plant at either Subsite A or Subsite B. The actual dimensions and location of the plant will be determined at a later date by Chevron.

URS has not been provided loading criteria for the new COGEN 3000 Project. Based on conversations with Chevron, we understand that the loads will be moderately heavy.

The project site is relatively flat with the existing ground surface ranging from elevation +10.6 feet to +13.0 feet for Subsite A and from elevation +10.7 feet to +14.5 feet for Subsite B, Richmond Refinery Datum (RRD). We understand that excavations at the project site may be up to 3 feet below the current ground surface. The existing site grade will not be raised.

URS does not have information regarding the exact final location of the new foundations nor information regarding the presence of any existing piles within the immediate area of the project site. Therefore, URS cannot provide recommendations regarding the re-use of existing piles. The report herein presents recommendations for new pile foundations only.

3.0 PURPOSE AND SCOPE OF WORK

The purpose of the geotechnical investigation was to obtain geotechnical information necessary to develop general foundation recommendations for the proposed COGEN 3000 Project. The scope of services for this project included the following tasks: geotechnical field exploration, geotechnical laboratory testing, geotechnical analyses and report, and project management.

3.1 GEOTECHNICAL FIELD EXPLORATION

Under this task, URS and its drilling subcontractor, Pitcher Drilling Company, drilled and sampled two borings, one boring at Subsite A and one boring at Subsite B. Both borings were drilled to bedrock. Prior to drilling, we obtained the necessary permits for soil borings from the Contra Costa County Environmental Health Department. Chevron "metro-teched" the boring locations to identify underground utilities and prepared the required "yellow-book" field operation files. URS site personnel and Pitcher Drilling crewmembers attended "Gate 91" safety training and site-specific safety training. Pitcher Drilling Company drilled the borings using mud rotary wash equipment and collected samples using the Standard Penetration Test (SPT) sampler, the Dames & Moore U-sampler, the Modified California sampler, and the Dames & Moore piston sampler. During drilling, Chevron personnel monitored the environment surrounding the drilling operations to detect the presence of possible hydrocarbon or other chemical contaminants. Pitcher backfilled the borings with cement grout and stored all drilling spoils in 55-gallon drums. The drums were left on site for pickup by Chevron personnel. Appendix A describes the geotechnical field exploration.

3.2 GEOTECHNICAL LABORATORY TESTING

We performed the following laboratory tests to evaluate the physical and engineering characteristics of the major strata:

1. Index tests including moisture content, density, particle size gradation, and Atterberg limits.
2. Consolidation tests
3. Unconfined compression strength tests
4. Resistivity tests
5. R-value test

A URS geotechnical engineer developed the testing program, and Signet Laboratories, a URS subsidiary, performed the tests in accordance with ASTM standards. Appendix B presents the geotechnical laboratory testing program and test results.

3.3 GEOTECHNICAL ANALYSES AND REPORT

We conducted the appropriate engineering analyses to evaluate different foundation alternatives including pile foundations, spread and mat foundations, and slabs-on-grade. We also performed analyses to develop preliminary design criteria including seismic design, lateral earth pressures, temporary shoring, cut slopes, permanent walls, friction coefficients and subgrade reaction moduli, soil swelling, backfill, and compaction. We prepared this report, which summarizes the data review, field explorations, subsurface stratigraphy, analyses, foundation recommendations, and design criteria. The report includes boring logs and laboratory test results.

3.4 PROJECT MANAGEMENT

We coordinated our work with Chevron and our drilling subcontractor. We attended two meetings with Chevron to discuss the results of our investigation. We also performed routine project management activities such as cost control, document control, and invoice preparation.

4.0 GEOLOGIC AND SEISMIC SETTINGS

4.1 REGIONAL GEOLOGY

San Francisco Bay is a drowned river valley, which developed within a northwest-trending structural trough formed in Franciscan Bedrock. In the late Pliocene, approximately 2 million years ago, the San Francisco-Marin block tilted towards the east along the Hayward Fault. The uplifted western edge of the block formed the hills of Marin while the downdropped eastern edge created an elongated depression, now occupied by San Francisco Bay. Following the downdropping of the bedrock block, erosion of the Berkeley/Oakland Hills and Potrero-San Pablo Ridge deposited material in alluvial fans, which gradually coalesced to form the broad, gently sloping plain that borders the eastern shoreline of the Bay.

The Refinery is located within a localized northwest-trending graben, or trough, along the eastern margin of San Francisco Bay. Figure 2 shows the Refinery site on a Geologic Map of the Richmond Area. Franciscan Bedrock below the graben has been downdropped along the now inactive San Pablo Fault, which parallels the eastern face of the Potrero-San Pablo Ridge, and along the active Hayward Fault zone, which forms the western scarp of the Berkeley Hills. During the mid-Pleistocene, a river system eroded deep channels into these areas of downdropped bedrock, creating irregular bedrock topography and forming the Carquinez Straits and the Golden Gate. In response to Pleistocene continental glaciation melting cycles, rising sea levels flooded river valleys through the Golden Gate.

Alternating cycles of sea level rise and fall characterized the Pleistocene Epoch. Minor fluctuations in the Bay water caused episodic shallow flooding along the edges of the Bay inundation zone. This episodic flooding deposited complex interfingered alluvial and estuarine deposits at Bay margin sites, such as the Refinery site.

4.2 GENERAL REFINERY GEOLOGY

The major portion of the development at the Refinery is located in the flat bay margin zone, partially covered with fill, and, in turn, underlain by estuarine, colluvial, and alluvial soils deposited from the Pleistocene to present day. Figure 3 presents schematic subsurface cross sections of the Refinery. Starting at the ground surface, the soils generally include a 2- to 15-foot-thick layer of fill that was placed over a thin zone of former marsh deposits (peat), which in turn is underlain by a thick layer of Recent Bay Mud, a soft, clayey estuarine deposit formed within the present Bay in the past 10,000 years. The Recent Bay Mud layer varies from less than 10 feet to greater than 60 feet in thickness in the Refinery area. This layer is underlain by a thick sequence of interfingering alluvial fan and colluvial deposits that overlie Franciscan Bedrock. Bedrock under the flat bay margin zone consists of sandstones and siltstones of the Franciscan Formation and the depth to bedrock is variable. Bedrock is at the surface along the Potrero-San Pablo Ridge, and it is as deep as 370 feet, based on a probe (GW 109P) located near the intersection of Xylene Street and Gertrude Street (Dames & Moore, 1981).

4.3 REGIONAL SEISMICITY

The Refinery site is located within the Coast Ranges tectonic province, an area characterized by a moderate to high level of seismicity. The Coast Ranges are principally composed of the Franciscan Formation, which was assembled and dismembered by the subduction of oceanic plate(s) beneath the western margin of North America from Late Jurassic to Early Tertiary times (Page, 1981). During the Neogene, en-echelon compressional basins of deposition, en-echelon folds, northwest-trending strike-slip faults, and lesser east-west-trending thrust faults were formed. However, the formation and uplift of individual ranges and the subsidence of structural valleys within the Coast Ranges is not well understood in terms of transform tectonics. Other assemblages within the Coast Ranges include the forearc basins sediments of the Great Valley sequence and a magnetic arc (plutonic and metamorphic rocks of the Salinian Block) (Page, 1981).

The Coast Ranges tectonic province is bounded on the west by the northwest-trending San Andreas Fault System, the primary boundary between the Pacific and North American plates. A broad region 100 to 200 km wide and centered on the plate boundary (including much of the Coast Ranges) is tectonically dominated at present by the dextral horizontal shear caused by the relative motion of the two plates. In the San Francisco Bay region, the plate boundary is a 100-km-wide zone of deformation consisting of several major strike-slip fault zones including the San Gregorio, San Andreas, Hayward-Rodgers Creek, Calaveras, Concord-Green Valley, and Greenville faults. Figure 4 portrays the active faults in the San Francisco Bay region.

The Hayward fault (Type A Fault1 as defined by the 2001 California Building Code) is the major active fault closest to the COGEN 3000 Project site. The Hayward fault has a Maximum Moment Magnitude of 7.08 and a Mean Slip Rate of 9 millimeters/year. The Hayward fault is 5.8 kilometers northeast of the refinery site at its closest point and the fault depth is about 5 kilometers.

The continuation of Hayward Fault is the Rodgers Creek Fault. These two faults are separated by a 5 kilometer wide right step beneath San Pablo Bay. Rupture of the Rodgers Creek fault and the northern segment of the Hayward fault would generate a Maximum Moment Magnitude of 7.4.

The San Andreas Fault (Type A Fault[1] as defined by the 2001 California Building Code) is another major active fault close to the COGEN 3000 Project site. The San Andreas Fault is 20 kilometers west of the site at its closest point. The Maximum Moment Magnitude of the North Coast segment of San Andreas Fault is 7.7. The slip rate is about 24 millimeters/yr and the fault depth varies along the fault.

[1] Type A Faults are faults capable of producing large magnitude events and have a high rate of seismic activity ($M_w \geq 7.90$, Slip Rate (SR)$\geq$5 mm/year).

5.0 SITE CONDITIONS

5.1 CURRENT AND PREVIOUS GEOTECHNICAL INVESTIGATIONS

URS performed a geotechnical investigation including field explorations and laboratory tests to obtain the geotechnical and groundwater data necessary to evaluate the engineering characteristics of the subsurface soils. The field exploration consisted of two borings: one boring, CG-1, to a depth of 161 feet below ground surface at Subsite A, and one boring CG-2 to a depth of 127 feet below ground surface at Subsite B. Figure 6 shows a Site Location Plan with the boring locations, and Table 1 lists the elevations of the bottom of the Fill layer, the Recent Bay Deposits layer, and the top of Franciscan Bedrock. Appendix A discusses the field exploration in detail and provides the boring logs for CG-1 and CG-2 and includes boring logs for previous investigations. Geotechnical laboratory testing was performed on selected samples from the field exploration program to evaluate the index and engineering properties of the major subsurface soils encountered at the site. Signet Testing Labs, a URS company, performed the tests at their laboratory in Hayward, California. Appendix B provides the results of these laboratory tests.

Dames & Moore, a URS predecessor company, conducted numerous geotechnical investigations at the COGEN 3000 site over the past 64 years for a variety of Refinery facilities. These historical investigations included a number of borings that provide useful subsurface soil and groundwater data for the current geotechnical investigation. Table 1 lists the year of the investigation, Dames & Moore job number, and the boring numbers from the investigation that are relevant to the current investigation. Table 1 also lists the elevation of the bottom of the Fill layer, the Recent Bay Deposits layer, and the top of Franciscan Bedrock. Figure 6 shows the locations of the relevant historical borings. Appendix A provides the boring logs for the relevant borings from previous investigations.

5.2 HISTORICAL DEVELOPMENT

The site of the COGEN 3000 project originally was a salt marsh within the then existing San Pablo Bay. From 1917 to 1920, the site was filled with hydraulic dredge spoil during construction of the turning basin located to the east of the site, rock fill from an asphalt plant, and rock fill from Acid Hill during construction of the No. 1 Power Plant. The site grade was raised to approximately elevation +13 to +14 feet (RRD) in the early 1940s during construction of the toluene and deoctanizer plants. Figure 2 show the filling history of the site and major portions of the Refinery Area.

5.3 SURFACE CONDITIONS

Subsite A currently is the location of a relatively flat gravel-paved parking lot. The ground surface ranges from elevation +10.6 feet at the north end of the lot to elevation +13.0 feet at the south end of the lot.

Most of Subsite B is a relatively flat asphalt-paved parking lot. The ground surface ranges from elevation +10.8 feet at the east end of the lot to elevation + 13.0 feet at the northeast corner and along the west end of the lot. At the northwest corner of the lot, there is a slightly raised area up to elevation +14.5 feet.

5.4 SUBSURFACE CONDITIONS

Based on the current and previous investigations from 1940s and 2006, both sites are underlain by Fill, Recent Bay Mud, Alluvial Deposits, and Franciscan Bedrock. Figure 7 and 8 shows a subsurface cross section (A-A′) and (B-B′) of both Subsite A and Subsite B, respectively. Table 1 below lists key subsurface data from this investigation (CG-1 and CG-2) and those from previous investigations.

TABLE 1
SUMMARY TABLE OF KEY SUBSURFACE DATA

Year	Company	Job Number	Boring Number	Depth of Boring (Feet)	Elevation* (Feet)				
					Elevation of Ground Surface	Elevation of Groundwater	Elevation of Bottom of Fill	Elevation of Bottom of Recent Bay Deposit	Elevation of Top of Bedrock
1941	D&M	113-A,B	B2	44.0	+13.0	+9.0	+3.0	-15.0	-
1942	D&M	113-C	T1	51.0	+12.0	+8.0	+0.0	-6.0	-
1986	D&M	113-946	B1	91.5	+11.5	Not Recorded	-3.0	-10.5	-
1987	D&M	16000-001	B1	31.5	+10.4	+5.4	-1.6	-13.1	-
1987	D&M	16000-001	B3	31.5	+10.4	+5.4	-1.6	-11	-
1987	D&M	16000-001	B4	31.5	+10.5	+7.5	+0.0	-11	-
1987	D&M	16000-001	B5	100.0	+10.8	+7.8	-2.2	-10.7	-
1987	D&M	16000-001	B6	100.5	+12.0	+7	+3.5	-12.5	-77.5
1992	D&M	16000-419	B1	9.5	+12.0	Not Recorded	+4.5	-	-
2006	URS	28067039	CG-1	161.0	+12.8	+9.0	-1.2	-8.7	-147.2
2006	URS	28067039	CG-2	127.0	+12.0	+3.0	-1.0	-13.5	-108.5

*Elevation refer to Chevron Richmond Refinery Datum

Figure 9 presents a profile of moisture content, total unit weight, and undrained shear strength versus elevation for data for 1940s to 2006 and the range in values of key engineering properties for the major subsurface strata are summarized in Table 2 below.

TABLE 2
RANGES IN VALUES OF
KEY ENGINEERING PROPERTIES FOR THE MAJOR SUBSURFACE STRATA

Soil Type	Moisture Content (%)	Total Unit Weight (pcf)	Undrained Shear Strength (psf)
Fill	20 to 30	89 to 124	400 to 600
Recent Bay Mud	65 to 100	80 to 105	80 to 900
Alluvial Deposits	10 to 38	110 to 135	800 to 3,500

Note: Several tested sample were neglected due to their location at transition zones between major strata.

5.4.1 Subsite A

Fill – The entire Fill layer at Subsite A ranges from 11 to 14 feet thick. The upper 6 to 7 feet of Fill consists of brown to gray brown, loose to medium dense, sandy to clayey gravel (GM, GC) or poorly graded gravel with sand (GP). The lower 5 to 7 feet is hydraulic fill, which consists of heterogeneous layers of dark gray to black, very soft to stiff, clayey sand to clay with variable amounts of sand. One historic boring (B3 from Dames & Moore, 1987) at the site revealed hydrocarbon contamination.

Recent Bay Mud – Beneath the Fill is 6.5 to 10 feet of soft to medium stiff, compressible fat clay (CH), known as Recent Bay Mud. Borings have revealed occasional soft, highly compressible peat layers within this deposit. The borings indicate that this layer increases in thickness from approximately 6.5 feet at the southwest end to 10 feet at the northeast end of the site.

Alluvial Deposits – The Recent Bay Mud is underlain by a thick sequence of the Alluvial Deposits, which consist of medium stiff to stiff clay (CL, CH) with variable amounts of sand interbedded with medium dense to dense fine sand with variable amounts of clay and medium to coarse sand. The boring for this investigation, CG-1, revealed the Alluvial Deposits to have a maximum thickness of approximately 139 feet.

Franciscan Bedrock – Boring CG-1 identified the maximum depth to bedrock is approximately 161 feet (elevation -148 feet). The bedrock consists of weathered, fractured sandstone from the

Franciscan Formation. Borings from previous investigations and at Subsite B indicate that the bedrock surface slopes downward from the west end of the site to the east end.

5.4.2 Subsite B

Fill – The Fill layer at Subsite B appears to increase slightly from a thickness of approximately 13 feet along the northeastern edge of the site to about 15 feet at the south corner and about 16.5 feet at the western corner of the site. Most of the historic borings and the current boring indicated the fill consists of gray to dark gray, loose to medium dense, clayey to silty gravel with sand (GC, GM) or poorly graded gravel with variable amounts of clay, silt, and sand (GP) for the upper 6 to 7 feet. Weaker material was encountered for the lower 5 to 7 feet and overlies the Soft Recent Bay Mud. Most of the borings revealed hydrocarbon contamination of the fill including the boring for this investigation (CG-2) which encountered black, soft to medium stiff, fine to coarse sandy clay with trace fine gravel (CL).

Recent Bay Mud – The Fill is underlain by 9 to 18 feet of Recent Bay Mud, which consists of dark gray, very soft to medium stiff, compressible fat clay. Borings revealed a soft, highly compressible peat layer up to 12 inches thick at the surface of the Recent Bay Mud Deposit. The borings also indicate that this layer generally increases in thickness from south to north across the site.

Alluvial Deposits – Underlying the Recent Bay Mud is a thick deposit of medium stiff to stiff clay (CL, CH) with variable amounts of sand interbedded with medium dense to dense fine sand with variable amounts of clay and medium to coarse sand. Boring CG-2 indicated that the Alluvial Deposits are approximately 95 feet thick.

Franciscan Bedrock – As revealed by Boring CG-2, the maximum depth to bedrock is approximately 124 feet (elevation -112 feet). The bedrock consists of weathered, fractured sandstone from the Franciscan Formation. Borings from previous investigations and from Subsite A indicate that the bedrock surface slopes downward from the west end of the site to the east end.

5.4.3 Groundwater

Groundwater level may fluctuate with several reasons such as rainstorm and future change in geologic condition. Because the site is several hundred feet from the open body of water (San Pablo Bay), therefore, there is no tidal effect to the groundwater table at the COGEN 3000 site. The borings from the current investigation (CG-1, CG-2) indicate the maximum groundwater level is about elevation +9.8 feet.

The groundwater table was noted at the time of drilling and may not represent the long term groundwater table. Historic groundwater level readings indicate the groundwater table may vary between elevations +7.8 feet to +9.0 feet.

The design water table should be assumed at elevation +9 feet.

6.0 DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

6.1 CONCEPTUAL FOUNDATION DESIGN

From a geotechnical engineering standpoint, the COGEN 3000 Project can be developed provided recommendations presented in this report are incorporated into the project plans and specifications and implemented during construction.

The main geotechnical concerns in selecting an appropriate foundation system for the proposed COGEN 3000 Project facilities are:

1. New structural loads
2. Existing surficial, heterogeneous, variable density fill
3. Existing weak and compressible clay (Recent Bay Mud)
4. Highly variable bedrock surface.

Based on the anticipated loading, we understand that the new facility will impose heavy loads on the subsurface soils. Furthermore, the proposed structures are sensitive to settlement. Loads supported on possible shallow foundation systems will consolidate the variable thickness of compressible fill and soft clay (Recent Bay Mud) beneath the site. The anticipated total and differential settlement from the consolidation of the fill and Recent Bay Mud, therefore, eliminate the use of heavily loaded shallow spread-type foundations as support for the proposed construction. Therefore, we conclude that a deep foundation system consisting of driven piles is the most appropriate and economical method of foundation support. Driven piles should extend through the fill and Bay Mud and gain support through friction in the stiff to very stiff Alluvial Clays.

This section presents several important geotechnical issues that will affect the foundation design and construction. This section also presents our recommendations for specific foundation and seismic design, and site preparation, as requested by Chevron.

6.2 GEOTECHNICAL ISSUES AFFECTING FOUNDATION DESIGN AND CONSTRUCTION

6.2.1 Existing Fill and New Fill

The proposed COGEN 3000 site originally was a salt marsh located at the fringes of San Pablo Bay. From 1916 to 1920, the Refinery began reclaiming this area by placing hydraulic fill from the construction of the nearby Turning Basin, rock fill from the construction of the Asphalt Plant, and rock fill from the construction of Power Plant No. 1 near Acid Hill. The ground surface elevation after these filling in events that ended in 1920 was approximately elevation +11 feet. Between 1920 and 1942, the Refinery placed additional fill at the site to raise the grade to approximately elevation +13 to +14 feet.

Settlement would be induced when the stresses acting on the underlying compressible soil strata are increased by additional fill placement. Because the existing fill loads have been in place since 1940s, it is considered that this duration of time has essentially fully consolidated the underlying soft Recent Bay Mud. Therefore, the only anticipated long-term settlement is by secondary compression and is estimated to be less than 1 inch. Therefore, areal settlement will not impart downdrag forces to the pile foundations and the allowable design capacities of the driven piles need not take into account additional downdrag loads.

Theoretically, there should be a certain amount of strength gain of the Recent Bay Mud due to the consolidation process; however, the strength gain appears to be nominal.

The variable thickness and heterogeneous nature of the fill does not allow for uniform foundation support for proposed loads.

The fill may have isolated layers of loose soil and may be prone to some densification during driving of piles. Such conditions may reduce the available passive pressure to resist lateral loads on the pile.

6.2.2 Expansive and Compressible Soil

Based on the subsurface conditions revealed from the current and previous site investigations and laboratory testing, the predominant fill material at depths of 2 feet to 3 feet below existing grade is gravel with varying amounts of sand and some silt and clay. These materials exhibit low shrink and swell potential.

Therefore, the considerations associated with the existence of expansive soil including the edge moisture variation distance, differential soil movement, determination of plasticity indices and parameters necessary to estimate the amount of any climate controlled differential movement for the design of shallow spreads and mat foundations and slabs on grade may be neglected.

Within the fill, the more looser or compressible layer is always the material that overlies the soft Recent Bay Mud deposit and that the upper part of the fill is generally medium dense. The associated considerations including areal and differential settlement due to the proposed development of the project site are addressed Section 6.4.3.

6.2.3 Abandoned Foundations

Chevron has not provided information that confirms the presence of abandoned piles at the project site. However, based on our review of available geotechnical investigations, and the history of land use, abandoned piles, if present, would consist of timber piles, concrete-filled steel pipe piles, or precast prestressed concrete piles. Based on past experience at the Refinery, old existing piles may not provide the required resistance to seismic loads. Therefore, we would recommend abandoning existing piles, if present, and founding the new structure loads entirely on new piles.

If abandoned piles are present at the proposed location of new piles, the abandoned piles may interfere with the installation of the new piles. We recommend exposing and surveying the abandoned piles. If new piles are driven a distance of less than three (3) pile diameters from the abandoned piles, the lateral resistance and the vertical load capacity of the new pile foundation may be reduced. Consequently, the new piles may need to be driven deeper to provide the desired design vertical capacities.

6.2.4 Abandoned Utilities

Abandoned utilities within proposed foundation footprints may collect significant amounts of perched water, which must be removed in order to facilitate construction of the new pile foundations. Section 6.9.4 presents recommendations regarding treatment of abandoned utilities.

6.3 DEEP FOUNDATION DESIGN

We recommend supporting the project structures on either driven reinforced round concrete piles or driven precast prestressed reinforced concrete piles, gaining frictional support in the stiff to very stiff clayey soils present below the compressible soft Recent Bay Mud deposits. Because of the corrosivity of the Bay Mud, we recommend designing all concrete piles to resist the intrusion of corrosive elements.

6.3.1 Axial Pile Capacity and Settlement

It is recommended that the axial capacity contribution from the Fill material and soft Recent Bay Mud deposits be neglected due to the high variability of composition and thickness as well as their low shear strength characteristics. Therefore, the Alluvial Deposit present below the Recent Bay Mud is considered as the supporting stratum for driven pile foundations.

According to the recommendation of NAVFAC 7.2-196, the adhesion between the Alluvial Clay and the surface of concrete pile is 0.9ksf. For the values of unit friction have a factor of safety equal to one (1.0), the recommended frictional capacities per unit length of penetration into the Alluvial Deposit for various proposed pile foundation types are presented in Table 3 below:

TABLE 3
***ULTIMATE UNIT FRICTION VALUES FOR SELECTED PILE TYPE**

Soil Horizon	12-Inch Square Pile	14-Inch Square Pile	16-Inch Square Pile	18-Inch Square Pile	12-Inch Round Pile	14-Inch Round Pile	16-Inch Round Pile
Unit Friction (Fill)	Neglect	Neglect	Neglect	Neglect	Neglect	Neglect	Neglect
Unit Friction (Bay Mud)	Neglect	Neglect	Neglect	Neglect	Neglect	Neglect	Neglect
Unit Friction (Alluvium)	3.6 kips/ ft	4.2 kips/ ft	4.8 kips/ ft	5.4 kips/ ft	2.8 kips/ ft	3.3 kips/ ft	3.8 kips/ ft

*The unit friction value is defined as friction capacity gain of the particular size of pile per unit length of penetration into the Alluvium Deposit

For long piles, factor of safety of at least 2.0 and 3.0 are recommended for compressive and uplift capacities (neglect the weight of piles), respectively.

We understand that no site regrading to higher grades are proposed at the COGEN 3000 project site; hence, downdrag loads due to the areal settlement will not occur. However, any future changes in site stress due to site regarding, groundwater lowering, or other activities may also result in future consolidation of the fill and soft Recent Bay Mud deposits and hence, the downdrag loads on piles could be significant.

For resistance to transient wind and earthquake loads, the allowable axial capacities presented above may be increased by one-third.

The axial pile capacity analyses were performed for a single pile and a group reduction factor for pile group effects was not included. The group reduction factor for vertical loading capacity of pile group is highly depending on the pile center to center spacing and the design pile layout. In general, if the actual spacing of the piles is less than four times the least pile diameter, center-to-center, group reduction effect should be considered and URS should review the pile group capacity.

The behavior of the piles under vertical loads was analyzed with the computer program T-Z Pile (Ensoft, version 2.0). The recommended vertical spring constant values are presented in Table 4:

TABLE 4
RECOMMENDED VERTICAL SPRING CONSTANT VALUES FOR SELECTED PILE TYPE

	12-Inch Square Pile	14-Inch Square Pile	16-Inch Square Pile	18-Inch Square Pile	12-Inch Round Pile	14-Inch Round Pile	16-Inch Round Pile
Vertical Spring Constant (kips/in)	497	657	834	1028	417	541	689

For piles that terminate in the stiff Alluvial clays, we estimate settlements of pile groups of less than 1 inch.

6.3.2 Lateral Pile Resistance

Lateral seismic forces will be transmitted from the structures to the foundation by a combination of pressure against the structural slabs, mats, and walls, pile caps, and piles, and by friction or adhesion between the sides of the walls and mats and the surrounding in situ fill soils.

For design, we recommend that lateral forces due to soil, hydrostatic, and seismic sources be resisted by the lateral capacity of each individual pile plus either (1) 100 percent of the soil-structure friction and 50 percent of the passive soil resistance, or (2) 100 percent of the passive soil pressures and 50 percent of the soil-structure friction. For the soil-structure friction developed between the in situ soil and mats, slabs, and pile caps, we recommend a friction value of 0.35. The soil-structure friction and the passive soil pressures recommended in this report include a factor of safety of 1.5.

Passive pressure against pile caps to resist seismic or wind loading are estimated at displacement levels comparable to those required to mobilize frictional resistance between the foundation pile caps and the supporting soil. For design purposes, we recommend a value of 300 pounds per square foot of passive resistance (with a factor of safety of 1.5) may be developed under wind and/or seismic loading.

For seismic resistance, we evaluated the lateral load capacities of the driven reinforced round concrete and the driven square reinforced precast prestressed concrete using pseudo-static analyses for fixed and free head conditions. The behavior of the piles under lateral loads was analyzed with the computer program LPILE (Ensoft, version 3). This program models the soil resistance as nonlinear springs (P-Y curve) that vary with soil shear strength and soil type along the pile shaft and was presented in Figures 10 to 12.

6.3.2.1 Effective Point of Fixity and Maximum Lateral Deflection

In order to determine the effective point of fixity, maximum lateral deflection under certain loads, it is required that a complex differential equation which involves the pile characteristics, loading combinations and soil load-deflection curve for each soil strata to be resolved. In LPILE analyses, this governing differential equation is formulated in finite difference form and is solved through iterating process instead of closed form solution. Therefore, parameters have to given to start the iterating process.

In addition, soil stress strain behavior is fully non-linear, strain dependent. Therefore, the soil reaction is highly dependent on the pile deflection (induced soil strain) and the pile deflection is highly dependents on the soil stress (induced soil reaction). Consequently, loading conditions have to be fully defined to determine the actual behavior of the soil structure interaction.

Without specific design criteria of horizontal and vertical forces on the pile cap, we are unable to provide you with the following items you request in your RFQ:

- An Effective Point of Fixity
- Maximum Lateral Deflection in free headed condition
- Maximum Lateral Deflection in fixed headed condition

The lateral pile analyses herein are for single piles only. Where piles are located closer than 4 times the least pile diameters center-to-center, the interaction of the soil between the two piles will result in a reduction of the overall load or increase in the deflection of the ground under the same load.

6.3.3 Pile Group Effect

The group efficiency under lateral loading is a function of the pile type, soil type, pile to pile spacing, type of connection between the piles and the cap, number of piles in the group geometry of the piles in the group, and the intensity of the load on the group. Generally, the pile group effect will become significant if the pile center to center spacing is less than 4 times the diameter of piles.

For practical application, pile group reduction factor were computed based on the technical manual of the computer program GROUP Version 5.0 based on the assumed general configuration of pile group. The group efficiency under lateral loading may be estimated from Figure 13. A final design pile group reduction factor should be developed once the configurations, loads, size of foundation have been established.

6.4 SHALLOW SPREAD-TYPE FOUNDATIONS

6.4.1 Bearing Capacities

Light structures (less than 30 kips total load) that are insensitive to settlement can be supported on spread-type foundations in the fill. Spread foundations up to about 8 feet in maximum dimension and 18 inches below the lower adjacent grade, with at least 6 feet of fill below the footing, could be designed for allowable bearing pressures up to about 750 pounds per square foot for dead plus live loads. For slab-on-grade floors or larger spread foundations, we recommend an allowable bearing pressure of no more than about 500 pounds per square foot for dead plus live loads. Such structures should be rigid enough to resist differential settlements, or they should be flexible enough to allow expected settlements to occur without impairing the usefulness of the structure. Otherwise, pile foundations would be required. In computing loads, the weight of concrete below current grade may be neglected.

6.4.2 Resistance to Lateral Loads

Resistance to lateral loads can be developed in the following ways:

1. Passive pressures against the leading edge of the footings; and
2. Friction between the base of the footings or reinforced concrete floor slabs and the underlying fill.

Passive pressures available in the fill may be estimated as equal to the pressure exerted by an equivalent fluid pressure of 350 and 200 pounds per cubic foot per foot of depth in the fill above and below the water table (i.e., about Elevation +9 feet), respectively. The upper foot of material should be neglected unless the material is confined by pavements. We recommend a coefficient of friction of 0.35 between the base of shallow concrete footings or floor slabs and the underlying materials. Both of the above values include a safety factor of 1.5. If both friction and passive pressure resistance are considered in design, one of these values should be reduced by 50 percent.

6.4.3 Areal Settlements

Settlement will occur due to increased stresses acting on the underlying fill, either by additional fill or by structural loading. We understand that placement of net areal fills will not be required for this project. Because the existing fill loads have been in place long enough to have essentially fully consolidated the underlying Bay Mud, the only anticipated settlement will be caused by structural loads. If our above recommendations for allowable bearing capacities and the recommended specifications of fill placement discussed in Section 6.9.5 are followed, the modulus of subgrade reaction for the soil within the stress influence zone will be about 200 to 500 kcf and we anticipate that total settlements for the immediate time period and 10 and 20 years after construction will about 1 inch.

The potential presence of old piles beneath the site would impede settlements in localized areas. This would cause differential settlements of the same magnitude as the total estimated settlement and may occur over distances as short as 10 feet. If the design requires the placement of net areal fills, settlements will likely be greater.

6.4.4 Mat and Slab Foundation Preparation

Use of vapor barrier is recommended for office facilities found on a non-pile or earth-support system.

We recommend placing a capillary break layer and vapor barrier between the mat or slab-on-grade structure and the foundation subgrade. The capillary break layer should consist of a free draining mixture of sand and gravel 6 inches thick directly over the foundation subgrade. Detail specification of the break layer is discussed in Section 6.9.5. We recommend placing a vapor barrier consisting of a plastic membrane at least 10 mils thick directly over the capillary break layer. A 2-inch-thick layer of fine sand should cover the plastic membrane to prevent tearing by construction equipment.

However, other criteria for design of sub-base thickness and material can be evaluated by the designer.

Based on the subsurface conditions revealed from the current and previous site investigations and laboratory testing, the predominant fill material at depths of 2 feet to 3 feet below existing grade is gravel with varying amounts of sand and some silt and clay. These materials exhibit low shrink and swell potential.

Therefore, the considerations associated with the existence of expansive soil including the edge moisture variation distance, differential soil movement, determination of plasticity indices and parameters necessary to estimate the amount of any climate controlled differential movement for the design of shallow spreads and mat foundations and slabs on grade may be neglected.

6.5 BELOW GRADE PERMANENT AND TEMPORARY WALL DESIGN

For below grade wall design, we recommend the following earth and water pressure criteria.

6.5.1 Lateral Earth Pressures

The active pressure criteria are based on the assumption that the maximum groundwater table will be at approximately elevation +9 feet and the temporary surcharge load during construction is 100psf and that all walls are backfilled with compacted structured fill (90 percent ASSTM D1557). For the passive pressure, the portion of the below grade wall where passive pressure develops will be assumed to below the groundwater level. The design values of lateral earth pressure are presented in Table 5 below:

TABLE 5
SUMMARY TABLE OF LATERAL EARTH PRESSURE DESIGN VALUES

Condition	Value
Unrestrained Active Pressure Above Water Table – [1] Structural Backfill Compacted to 93% ASTM D1557	40 pcf
Unrestrained Active Pressure Below Water Table – [1] Structural Backfill Compacted to 93% ASTM D1557	80 pcf
Restrained Active Pressure Above Water table – [1,3] Structural Backfill Compacted to 93% ASTM D1557	65 pcf
Restrained Active Pressure Below Water table – [1,3] Structural Backfill Compacted to 93% ASTM D1557	90 pcf
Seismic Earth Pressure (Active Side Only)– [2,3]	18H psf
Passive Pressure Above Water Table – [1,4]	350 psf
Passive Pressure Below Water Table – [1,4]	200 psf
Surcharge from Construction Activities – [5]	100 psf

Notes:
1. Equivalent Fluid Pressure
2. Uniform, rectangular pressure distribution.
3. H (feet) – Retained soil height.
4. Ignore upper one foot of embedment. Consider passive pressure to act on leading face of retaining wall footing.

5. The magnitude of surcharge depends on the weight of construction equipment and its distance from the wall.

6.5.2 Frictional Resistance

Frictional resistance along the bottom slabs of the wall can be estimated using a friction coefficient of 0.35 and the internal friction angle about 36^{o} . This value has a factor of safety of at least 1.5.

6.5.3 Below Grade Slabs

For the design of the below grade slabs, we recommend an allowable bearing pressure of up to 500 psf, on the assumption that the below grade slabs is supported on engineered fill or on top of proof-rolled fill soils. In either case, it is recommended that a minimum 18 inch blanket of Caltrans Standard Class 2 structural fill in accordance with the Caltrans standard be placed beneath all the slabs.

6.6 SEISMIC DESIGN

6.6.1 Site Response Analyses

A site-specific seismic hazard study was performed by URS in 2003 at the Chevron Richmond Refinery. The URS 2003 report presented the major aspects of seismic hazards within the Refinery. A site-specific response analysis is performed for the COGEN 3000 site using the properties of the subsurface strata pertinent to the site.

6.6.2 Analysis Approach

The analysis method for horizontal ground motions is based on the assumption of vertically propagating shear waves (S-waves). This is a commonly used method and has been shown to provide a reasonable representation of site response at soil sites for engineering purposes.

The analysis approach can be summarized in the following steps:

- Develop idealized soil profiles for analysis, including the dynamic soil properties;
- Develop earthquake rock response spectra and acceleration time histories for the selected ground motion return periods; and
- Perform one-dimensional ground motion response analyses for the selected profiles.

6.6.3 Dynamic Soil Properties

The engineering properties relevant to the site response analysis include the total unit weight, moisture content, plasticity index, overconsolidation ratio, shear wave velocity, maximum shear modulus, and curves describing the shear modulus degradation and material damping ratio as a function of cyclic shear strain.

The total unit weight, moisture content, overconsolidation ratio, plasticity index and shear strength of the subsurface soils are obtained through the URS 2006 geotechnical investigation program. Measurements of shear wave velocities of the subsurface material were not performed in the URS 2003 or 2006 exploration programs. Therefore, shear wave velocities were estimated by correlating with shear strength and plasticity index of the various soils through published empirical relationships.

The maximum shear modulus (G_{max}) is related to the shear wave velocity (V_s) through the following equation:

$$G_{\max} = \rho (V_s)^2$$

where ρ is the mass density of the material.

For clayey soils, the maximum shear modulus can be estimated as a ratio of the undrained shear strength (S_u), with the following relationship:

$$G_{\max} / S_u = 1{,}000 \text{ (Egan and Ebeling, 1985; Weiler, 1988)}$$

Also, the maximum shear modulus can be estimated from results of the consolidation tests, using the following relationship:

$$G_{\max} = \frac{625}{e_0^{1.3}} (P_a \cdot \sigma_m')^{0.5} OCR^k \text{ (Jamiolkowski et al, 1991)}$$

where e_0 is the initial void ratio, P_a is atmospheric pressure, OCR is the overconsolidation ratio and k is the plasticity index.

To compute the maximum shear modulus for sandy soils, the following methodology proposed by Seed and Idriss (1970) was used:

$$G_{max} = 1{,}000 K_{2\,max} (\sigma_m')^{0.5}$$

where σ'_m is the mean effective confining stress in psf and K_{2max} is a factor that depends upon soil type, relative density, maximum particle size, gradation and other parameters, and can be estimated based on Seed et al (1984), as follows:

$$K_{2\,max} = 20 (N_1)_{60}{}^{1/3}$$

where $(N_1)_{60}$ is the SPT blow counts corrected for overburden pressure and hammer efficiency.

The shear modulus degradation and damping ratio curves were estimated based on published literature by Seed and Idriss (1984), Idriss (1990), Vucetic and Dobry (1988, 1991). Apart from recommendations and relationships in the literature, previous experience with soils in the Refinery and engineering judgment are important in the selection of dynamic soil properties. Table 6 presents the major dynamic soil properties and Figure 14 presents the strain dependency behavior of shear modulus degradation and damping ratio for the site response analyses.

TABLE 6
SUMMARY OF DYNAMIC SOIL PROPERTIES

Soil Type	Thickness (ft)	Total Unit Weight (pcf)	Shear Wave Velocity[1] (fps) (Best Estimate)	Maximum Shear Modulus[1] (ksf) (Best Estimate)	Shear Modulus Degradation Curve[2]	Damping Ratio Curve[2]
Fill	16	120	520 – 600	1010 – 1350	Sand[3] (top 5 feet)/ Clay[4]	Sand[3] (top 5 feet)/ Clay[4]
Recent Bay Mud	8	100	420	550	Clay[4] (PI = 50)	Clay[4] (PI = 50)
Stiff Alluvial Deposits	115	130	650 – 800	1720 – 2600	Clay[4] (PI = 30)	Clay[4] (PI = 30)
Bedrock (Half Space)	-	140	2500	27300	-	-

Notes:
1. The values presented herein are best estimates for shear wave velocities and maximum shear moduli are based on in situ and laboratory test data. A sensitivity study on the soil response was performed by varying the shear wave velocities by ±15% to obtain the upper bound and lower bound values.
2. The Shear Modulus Degradation and Damping Ratio curves are presented in Figure 14
3. Based on recommendations by Seed and Idriss (1984).
4. Based on recommendations by Vucetic and Dobry (1988), and Idriss (1990)

6.6.4 Development of Input Rock Motions

Our approach to develop the earthquake rock response spectra and acceleration time histories is summarized as follows:

- Develop rock response spectrum (target spectrum) from the selected ground motion return periods;
- Select Seed earthquake acceleration time histories for input rock motions; and
- Spectrally modify selected acceleration time histories to match the target spectrum.

6.6.5 Rock Response Spectrum (Target Spectrum)

The URS 2003 report presented the rock hazard curves for PGA, 0.3-second and 0.1-second spectral accelerations, developed based on ground motion attenuation relationships and results of a probabilistic seismic hazard analysis (PSHA). A target spectrum was developed for the ground motion return period of 475 years, which is equivalent to a 10 percent probability of exceedance in 50 years.

Due to the close proximity of the COGEN 3000 project site to the RLOP and Isomax Process Area in the URS 2003 study, the target spectrum in the URS 2003 report is adopted in the site response analysis of the COGEN 3000 site.

6.6.6 Time Histories

Three sets of horizontal acceleration time histories recorded during past earthquakes were selected for analysis. These time histories were recorded during the 1999 Kocaeli, Turkey earthquake at Gebze station, the 1999 Duzce, Turkey earthquake at Lamont 531 station and the 1987 Superstition Hills (B) earthquake at Superstition Mountain station. The two orthogonal horizontal acceleration time histories from each station were used, giving a total of 6 time histories. These recording stations are classified as rock sites.

These time histories were selected because they are consistent with the overall characteristics of earthquakes dominating the hazard at the COGEN 3000 project site. Characteristics considered included magnitude, recording distance, and faulting mechanism. The table lists these selected motions along with their recorded peak accelerations and distances.

TABLE 7
SUMMARY OF EARTHQUAKE RECORDS
USED FOR SITE RESPONSE ANALYSIS

Earthquake	M	Station Name	Distance (km)	Site Condition	Component	Recorded PGA (g)
1999 Kocaeli, Turkey	7.4	Gebze	17.0	Rock	0	0.24
					270	0.14
1987 Superstition Hills (B), Imperial Valley, CA	6.7	Superstition Mountain	4.3	Rock	45	0.68
					135	0.89
1999 Duzce, Turkey	7.1	Lamont 531	11.4	Rock	North	0.16
					East	0.12

6.6.7 Spectrally Matched Time Histories

To develop acceleration time histories with response spectra that match the target spectrum, the Seed time histories were modified using the method proposed by Lilhanand and Tseng (1988) as modified by Abrahamson (1993). In this method, the time history is adjusted in the time domain by adding wavelets in iterations until a satisfactory match to the target spectrum is obtained. The method has been shown to preserve the non-stationary characteristics of the recorded time histories. The spectrally matched time histories were used as input motions in the site response analyses.

6.6.8 Site-Specific Response Analysis

The modified time histories were used in the site response analyses performed with the computer program SHAKE (Schnabel, 1972). The soil behavior is modeled using the equivalent-linear method proposed by Seed and Idriss (1970). The analysis is performed in iterations until the shear modulus and damping values used in the analysis are compatible with the computed shear strain. The modified time histories were input as an outcrop of rock in each idealized profile.

The calculated 5 percent-damped acceleration response spectra for a return period of 475 years are presented on Figures 15 through 17. The acceleration response spectra are presented at depths where significant changes in soil response are noted.

6.6.9 Effects of Fault Rupture Directivity

Because of the close proximity of the project to the Hayward-Rodgers Creek Fault system, the fault rupture directivity effects were evaluated in the URS 2003 study. The URS 2003 report concluded that the effects of fault rupture directivity at the Refinery are small and no adjustments to the seismic hazard curves are necessary.

6.7 DESIGN PEAK GROUND ACCELERATION

The U.S.G.S.' National Seismic Hazard Mapping Project website provided the peak ground acceleration for rock (PGA rock) for the return periods of 475 and 2,475 years. The return period of 475 years is equivalent to 10 percent probability of exceedance in 50 years and the return period of 2,475 years is equivalent to 2 percent probability of exceedance in 50 years.

For the bedrock beneath the project site, the PGA is 0.59 g and 0.91 g for the return period of 475 and 2,475 years, respectively.

6.7.1 Seismic Design Criteria

This site may be characterized in accordance with the 1997 Uniform Building Code as a soil profile S_E in its current condition and the acceleration response spectrum is shown in Figure 25.

Given the proximity of active faults to the site discussed in Section 4.3 of this report, we recommend the following near source factors:

- N_a of 1.16
- N_v of 1.52

The site is located in Seismic Zone 4. The Z factor for the site is therefore 0.40.

6.7.2 Liquefaction Potential

We evaluated the liquefaction potential for the project site area based on subsurface data obtained from our field investigation. Liquefaction occurs in saturated, loose to medium dense sands and silty sands during strong to moderate earthquakes. Previous borings at the site and borings CG-1 and CG-2 performed for this investigation do not reveal the presence of liquefiable deposits at Subsite A and Subsite B. The strength loss of the soil due to liquefaction is not anticipated.

6.8 CORROSION AND RESISTIVITY TESTING

Two corrosion tests were performed for this project. The tests included Redox, pH, chlorides, sulfates, and resistivity. The samples were taken at depths of 4 feet and 7 feet below the ground surface in the fill material. Additional results from previous investigations are included to evaluate the corrosivity of the soil stratums within and below the fill. The results are summarized below.

Sample	Soil Unit	Redox (mV)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Resistivity (ohms-cm)
CG-1 at 4 feet	Fill	420	7.7	N.D.	20	400
CG-2 at 7 feet	Fill	420	7.5	120	410	760
From previous investigation	Bay Mud	-	8.2	-	18 to 40	-
	Stiff Clay	-	8.6	-	70 to 610	-

We suggest that consideration be given to using either Type II (moderately sulfate resisting) or Type V (sulfate resisting) cement to minimize the effects of sulfate attack on the concrete. This type of concrete should be used in all structural concrete cast below final grade level.

Steel corrosion is not anticipated to be severe, although some corrosion is likely to occur. The specific amount or rate of corrosion is not known due to the variable chemical constituents of fill materials. Thus, protective coating should be considered for underground utilities and any below grade buried iron, steel or reinforced concrete.

The complete results of the corrosivity and resistivity testing and a brief evaluation of the results are presented in Appendix B.

Prior to our geotechnical investigation, Science Applications International Corporation (SAIC) performed an environmental survey at the project site. We have briefly reviewed their report and during our field investigation we encountered visible soil contamination. The use of Type II or Type V cement may further help to resist the effects of the contamination on concrete cast below final grade level. Chevron should review the findings of the SAIC report and take them into consideration when designing below grade structural components.

6.9 CONSTRUCTION CONSIDERATIONS

6.9.1 Site Preparation and Old Foundation Removal

If the contractor encounters organic matter and other debris during grading, we recommend stripping and removing these materials from the structure footprints, pavement areas, and other areas to be developed. Stripped materials must not be used as engineered fill.

Portions of the site could contain old concrete foundation slabs, pile caps, and piles from previous structures. The full extent and thickness of these old foundations or other rubble fill is unknown. Special equipment and extra time may be required to excavate, break up, and remove this debris.

Prior to new pile installation, old pile caps and foundations should be removed. In addition, piles from previous foundations, which may be wooden or concrete-filled steel pipe piles, will likely extend into the stiff colluvial soils. Existing old piles should be cut off approximately 2 feet below the proposed new pile caps. Where possible, we recommend that old piles be left in place unless they interfere with any proposed piles. Wherever feasible, the designers should lay out the new piles under the facility to minimize the number of old piles to be pulled.

Some adverse effects of removing the old piles include:

- The upper portions of the fill and Recent Bay Mud will be disturbed and weakened by the removal of piles. This will reduce potential lateral support of the new piles for lateral pile capacity.

- Some of the existing piles may have a deeper tip elevation than the proposed new piles. Removal of the old piles would reduce vertical capacity of the new piles and induce pile settlement.

- The Recent Bay Mud layer is an important part of the refinery Groundwater Protection System (GPS). Any unfilled holes would constitute a preferential pathway for contaminated groundwater to flow from the surface fills to the relatively uncontaminated soils below the Recent Bay Mud.

- Vibrations will occur if vibratory equipment is used for pile removal.

If the design requires removing existing piles, then the holes left by extraction of the existing piles must be backfilled. Immediately following pile removal, the holes should be grouted using a tremie pile extending to the bottom of the portion of the pile that was removed. The contractor should backfill each pile removed with grout equal in volume to at least 100 percent of the estimated volume of the hole (to within 5 feet of the ground surface or excavation subgrade).

6.9.2 Predrilling

We recommend predrilling through the fill layer all pile locations. Predrilling will facilitate identification and removal of any underground obstacles not previously identified in the deeper fill layer, prevent surface heave due to pile displacements, and would allow greater precision for correct positioning of piles. Predrilled holes should be at least 3 inches smaller than the least dimension of the new piles to minimize the effects of predrilling on lateral capacity of the piles. Predrilling should be performed immediately prior to driving each pile. Continuous flight augers can be used for predrilling to minimize caving of the hole when the predrill auger is removed.

6.9.3 Pile Driving

Provided an adequate-sized hammer is used (at least 50,000 ft-lbs), penetration resistances will be relatively low for piles driven to design depths. Based on pile driving records from newly constructed Substation 5 which is next to the project site, 80-foot long, 14-inch-square precast prestress reinforced concrete with the designed compression capacity of 145 kips were used as the foundation system and the result average blow count for the last 5 feet of driving was about 18 blows per foot and the blow count for last foot of driving was about 16 blows per foot. Capacity will develop in the piles over several days to a week after driving after "pile setup" occurs in the stiff clays supporting soils.

We recommend that Chevron record all pile blow counts during production driving, and that Chevron forward these records to URS. Furthermore, we recommend as a minimum that a geotechnical engineer be on site during the first three days of production pile driving in order to observe any problems and to set/identify pile driving criteria. We recommend that Chevron re-tap a minimum of 3 percent of the piles during the driving in order to measure driving resistance after pile setup, to allow re-evaluation of the as-installed pile capacity.

We do not anticipate reaching driving refusal in the stiff clay layer. The piles should be driven to the required depth for allowable capacity.

6.9.4 Excavation and Foundation Preparation

We recommend that slopes for the excavations be no steeper than 1.5H:1V. Excavations less than 4 feet deep may remain temporarily stable in a near vertical condition. Chevron must follow OSHA requirements regarding excavation support.

Since large scale excavations may occur, the soil rebound will be insignificant provided that the construction period is less than 6 months. However, because of the presence of weak soils below the existing fill, the contractor must exercise care not to overstress these soils. Otherwise, pumping of the soils will occur and it may be difficult to construct the grade beams on the subgrade.

We recommend that a URS geotechnical engineer be present during the excavation for new foundations to verify the anticipated soil conditions. Where appropriate, the contractor should lightly proofroll the foundation subgrade to identify any soft seams of soil present below the foundation level. Soft seams should be removed and replaced with structural fill. The foundation subgrade should be free of any loose material and standing water prior to pouring concrete foundations or placing compacted fill.

Excavations to remove existing foundations and utilities should be filled with lean concrete or properly compacted structural fill.

6.9.5 Fill Placement and Compaction

The contractor should compact backfill up against the pile cap and grade beams. The backfill should consist of granular materials, either sand, sands and gravel, or crushed rock. The rock should be free-draining open graded crushed rock with gradation between ½ and ¾ inches. The contractor should place the crushed rock in lifts of 12 inches or less.

Excavations to remove existing foundations and utilities should be filled with lean concrete or structural fill compacted to 90 percent of the maximum dry density as determined by Modified Proctor compaction (ASTM D 1557). Where the bottom of these excavations is near or below the water table, the contractor should backfill the excavation with crushed rock to at least 6 inches above the groundwater table. The contractor should place geofabric over the open graded crushed rock.

We recommend properly moisture-conditioning and placing each fill lift 8 inches or less, any required imported fill. The structural fill should consist of non-corrosive, non-expansive granular material conforming to the following criteria:

Maximum Plasticity Index:	12
Maximum Particle Size:	3 inches
Percent Passing No. 200 Sieve:	10 to 35
Minimum R-Value:	20

Other available material can be considered provided that they are non-expansive and the maximum particle size does not exceed 3 inches.

Because of the shallow groundwater table and soft underlying fill soils, vibratory compaction equipment should only be used with the consent of the geotechnical engineer.

6.9.6 Construction of Shallow Mat Foundation and Slabs on Grade and Roadway

For the construction of mat foundation or slabs on grade, we recommend additional over-excavation to a minimum of 2 feet to replace weak to undesirable existing fill material. Prior to the placement of the structural fill material as specified in Section 6.9.5, the existing fill should be proof-rolled to detect the presence of soft spots. The top 6 inches of the existing fill should then be scraped, moisture-conditioned, and compacted to a dry density of at least 95 percent of the maximum dry density as determined from ASTM test designation D1557. The structural fill should then be placed and compacted to at least 95 percent of the maximum dry density.

For the construction of roadway, we recommend the Asphalt Concrete should be underlain by a minimum of 6-inch compacted layer of Caltrans' Class II aggregate base with minimum of R-value of 50. Prior to the placement of the aggregate base layer, minimum of 2 feet of over-excavation is recommended. The top 6 inches of the existing fill should then be scraped, moisture-conditioned, and compacted to a dry density of at least 95 percent of the maximum dry density as determined form ASTM test designation D1557. The structural fill should then be placed and compacted to at least 95 percent of the maximum dry density followed by the specified aggregate base.

Suggested ground preparation details of the construction methods for both mat foundation and slab on grade and roadway are presented in Figure 18.

Two R-value tests were performed on the fill material for a depth of 3 feet. The results are shown in Appendix B and indicate the R-values of 18 and 68. It is our opinion that the tested R-value of 68 is too high and not representative of the actual near surface subsurface soil because of known areas with high clay content within the gravelly fill material; R-value of 18 is recommended for design purposed.

6.9.7 Utility Pipe Bedding and Backfilling

Utility trenches should be backfilled with fill placed in lifts not to exceed 6 inches prior to compaction. We recommend a minimum lift thickness of 9 inches prior to compaction for those areas adjacent to vitrified clay pipes to prevent compaction damages to these pipes. The first fill lift over a pipe should receive nominal compaction and all subsequent lifts should be compacted to 90 percent maximum dry density, or the required density of adjacent soils, whichever is greater. To provide uniform support, the pipes should be placed on a minimum of 4 inches of sand or fine gravel (less than ¾ inch).

Where trenches extend below the groundwater level, it will be necessary to dewater them to keep the trench base from softening and to allow the placement of pipe utilities and backfill.

6.9.8 Dewatering

Based on the current and previous borehole logs, the highest groundwater at about elevation +9.8 feet was recorded in CG-1. Therefore, temporary dewatering may be required if excavations are deeper than elevation +10 feet. It is our judgment that the installation of strategically placed sumps and pumps can lower the groundwater table several feet, if required. If necessary, we recommend using sumps at the edges of the excavation, and 2 to 3 feet below the excavation bottom, to control seepage. We recommend minimizing the overall depth of groundwater table lowering to (1) reduce the volume of potentially contaminated groundwater requiring handling and treatment, and (2) reduce the potential for added load on the Recent Bay Mud.

7.0 CONSTRUCTION MONITORING

We recommend that a URS engineer observe the pile driving operations and approve all new footing excavations at the project site prior to placement of forms or reinforcing steel. We further suggest that URS provide density control monitoring for placement of backfill.

8.0 LIMITATIONS

URS performed this investigation to provide support for the proposed COGEN 3000 Project at the Chevron Richmond Refinery in Richmond, California. The recommendations made in this report are based on the assumption that the soil and groundwater conditions do not deviate appreciably from those encountered in previously-drilled test borings. In addition, geotechnical design considerations may arise which are not apparent at this time. If any variations are encountered during the construction phase, we should be contacted so that supplementary recommendations can be made.

The recommendations presented in this report were developed with the “Standard of Care” commonly used as the state of the practice in the profession. No other warranties are included, either express or implied, as to the professional advice included in this report.

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Source:
Google Earth, 2005

N

0 .5 1
Scale in Miles

SITE VICINITY MAP

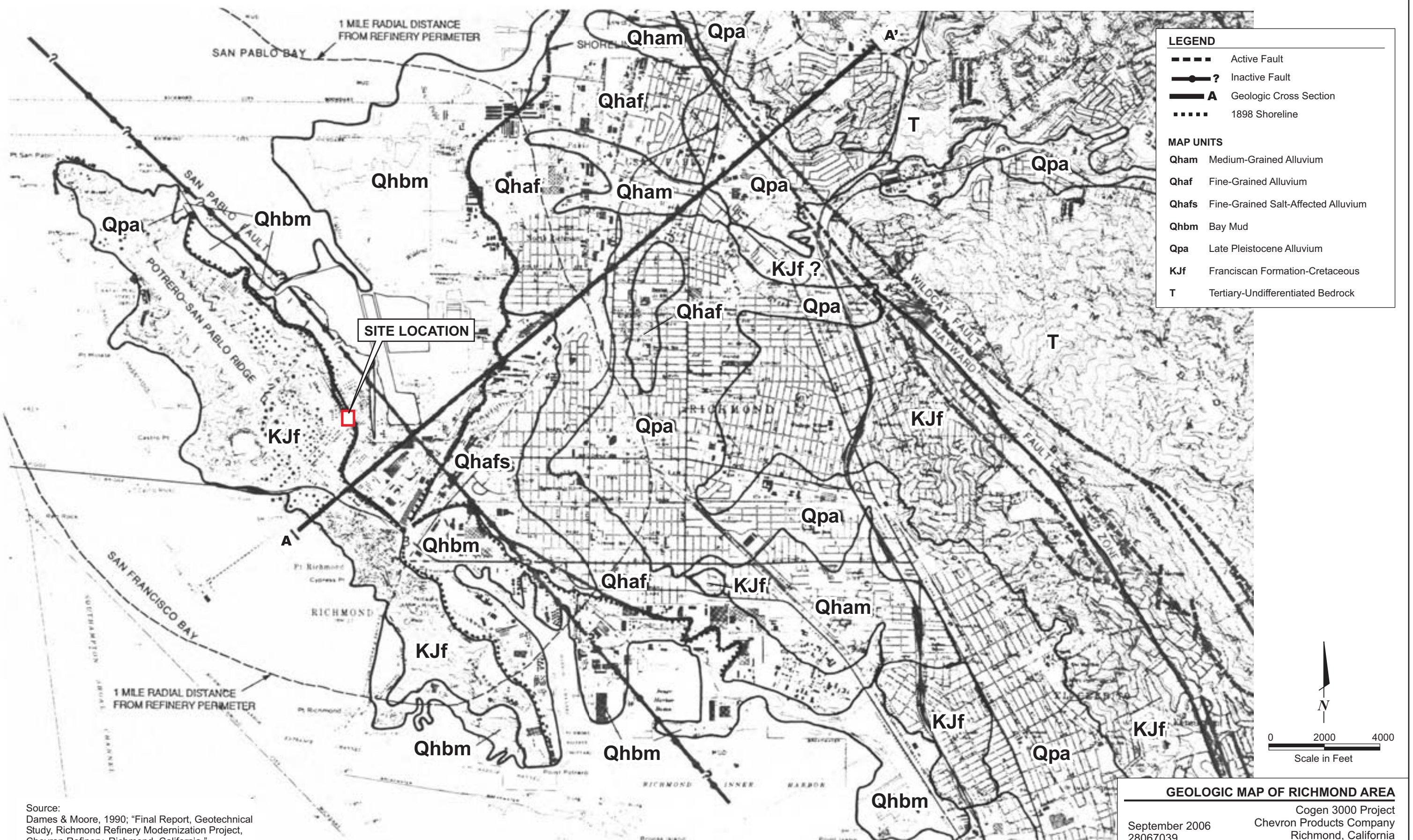
September 2006
28067039

Cogen 3000 Project
Chevron Products Company
Richmond, California

URS

FIGURE 1

9/01/06 vsa ..\Chevron Cogen\Graphics\F1_svm.cdr



Source:
Dames & Moore, 1990; "Final Report, Geotechnical Study, Richmond Refinery Modernization Project, Chevron Refinery, Richmond, California."
Job No. 16000-229, May 17.

GEOLOGIC MAP OF RICHMOND AREA

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Cogen 3000 Project
Chevron Products Company
Richmond, California

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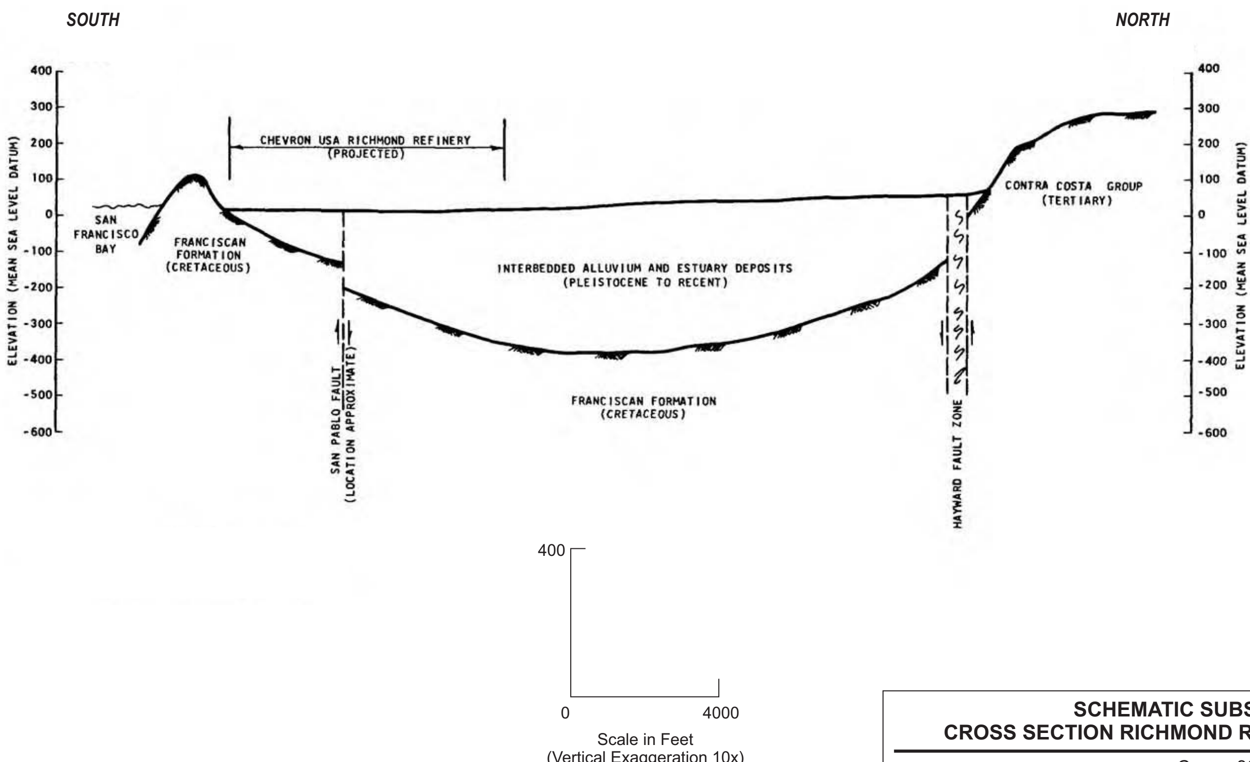
FIGURE 2

9/01/06 vsa ..\Chevron Cogen\Graphics\F2_geomap.cdr



Source:
Dames & Moore, 1981; "Report, Groundwater Investigation, Richmond Refinery, for Chevron USA, Inc."
Job No. 113-531, May 18.

SCHEMATIC SUBSURFACE CROSS SECTION RICHMOND REFINERY

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Richmond, California

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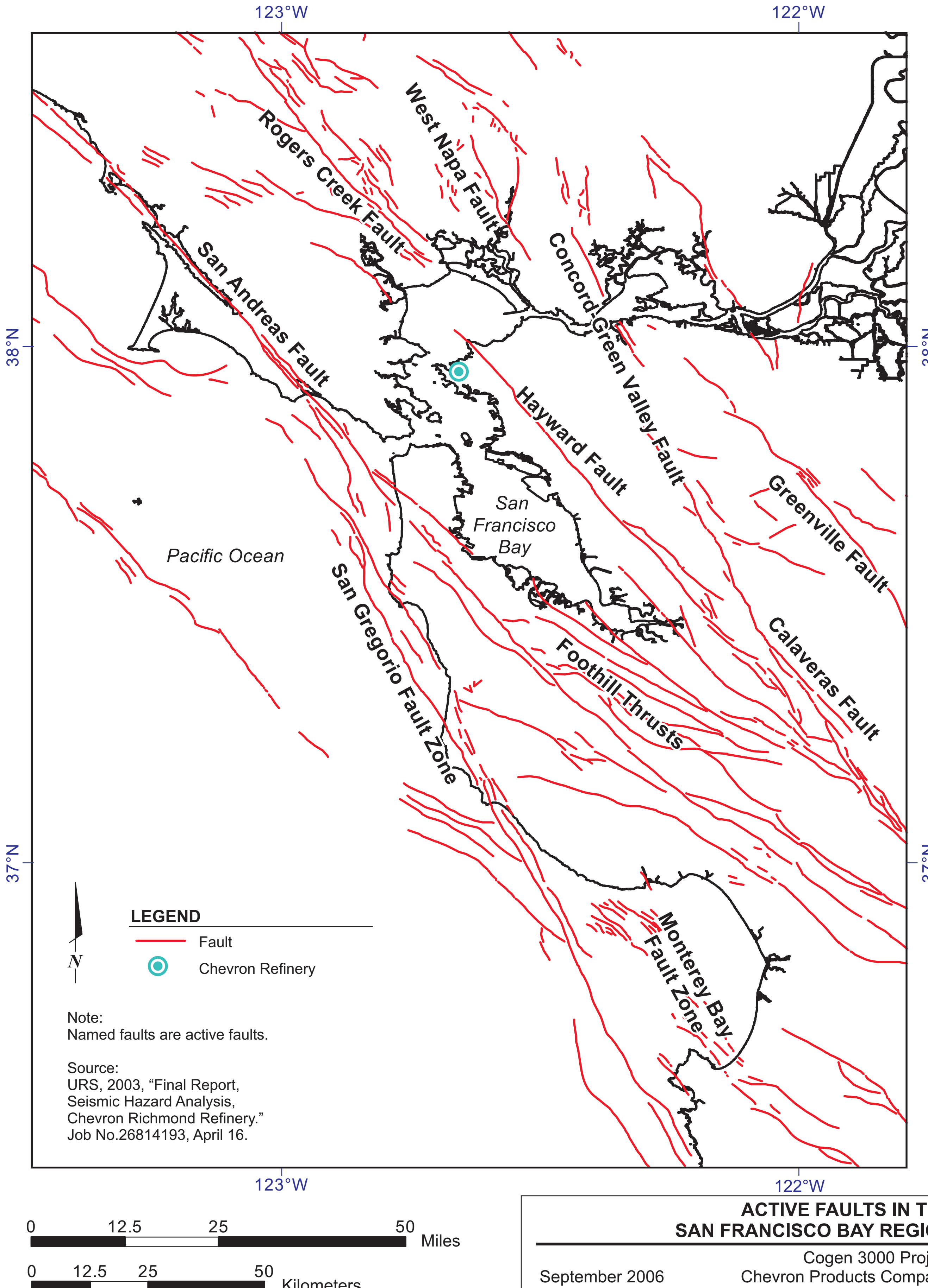
FIGURE 3

9/01/06 vsa ..\Chevron Cogen\Graphics\F3_xsec_RR..cdr



ACTIVE FAULTS IN THE SAN FRANCISCO BAY REGION

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28067039

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Chevron Products Company
Richmond, California

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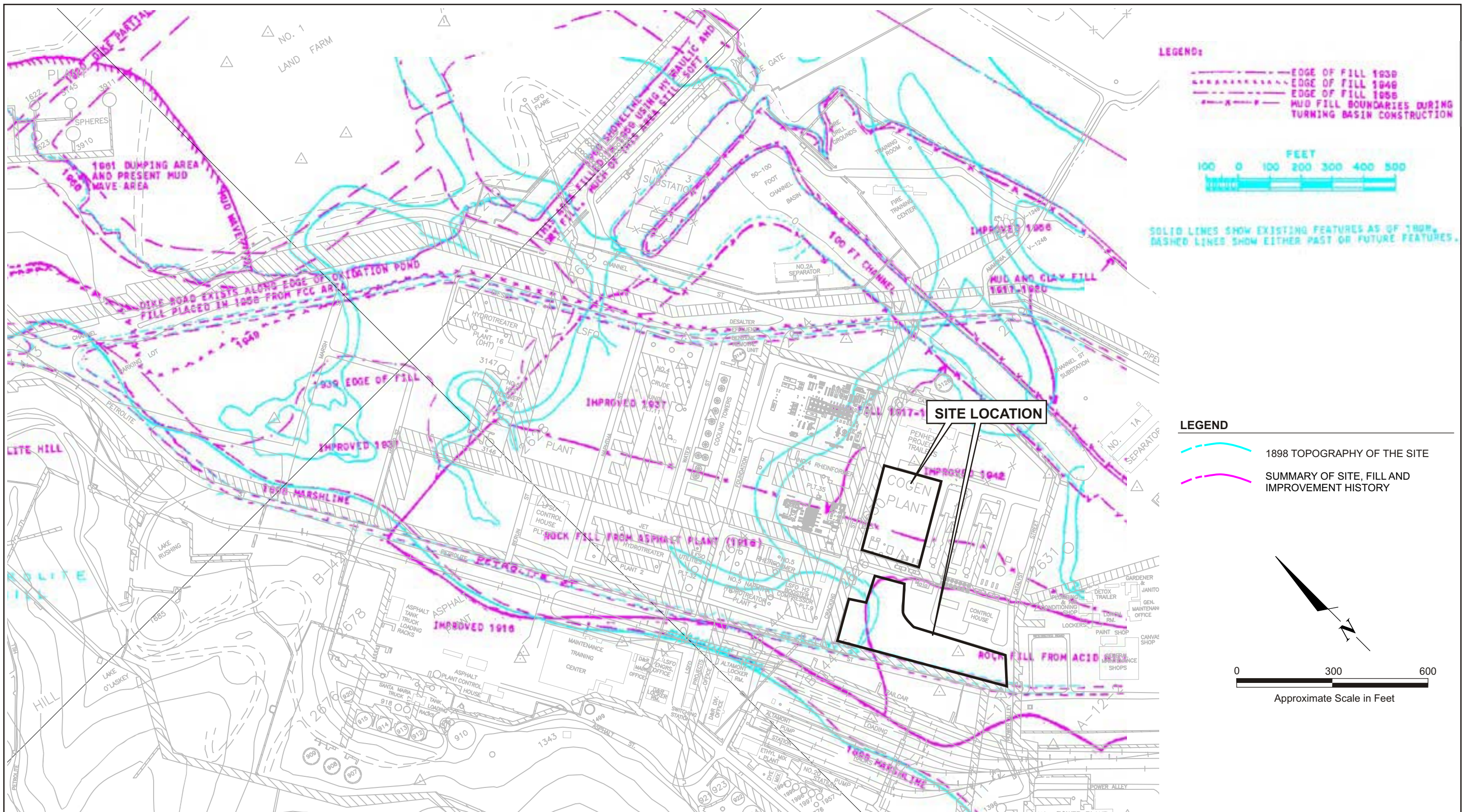
FIGURE 4

9/01/06 vsa ..\Chevron Cogen\Graphics\F4_faults.cdr



Source:
"Soil and Foundation Conditions Evaluation,
Former and Existing Marshland Areas, Richmond Refinery;"
Dames & Moore, 1969.

SITE VICINITY MAP WITH FILL HISTORY

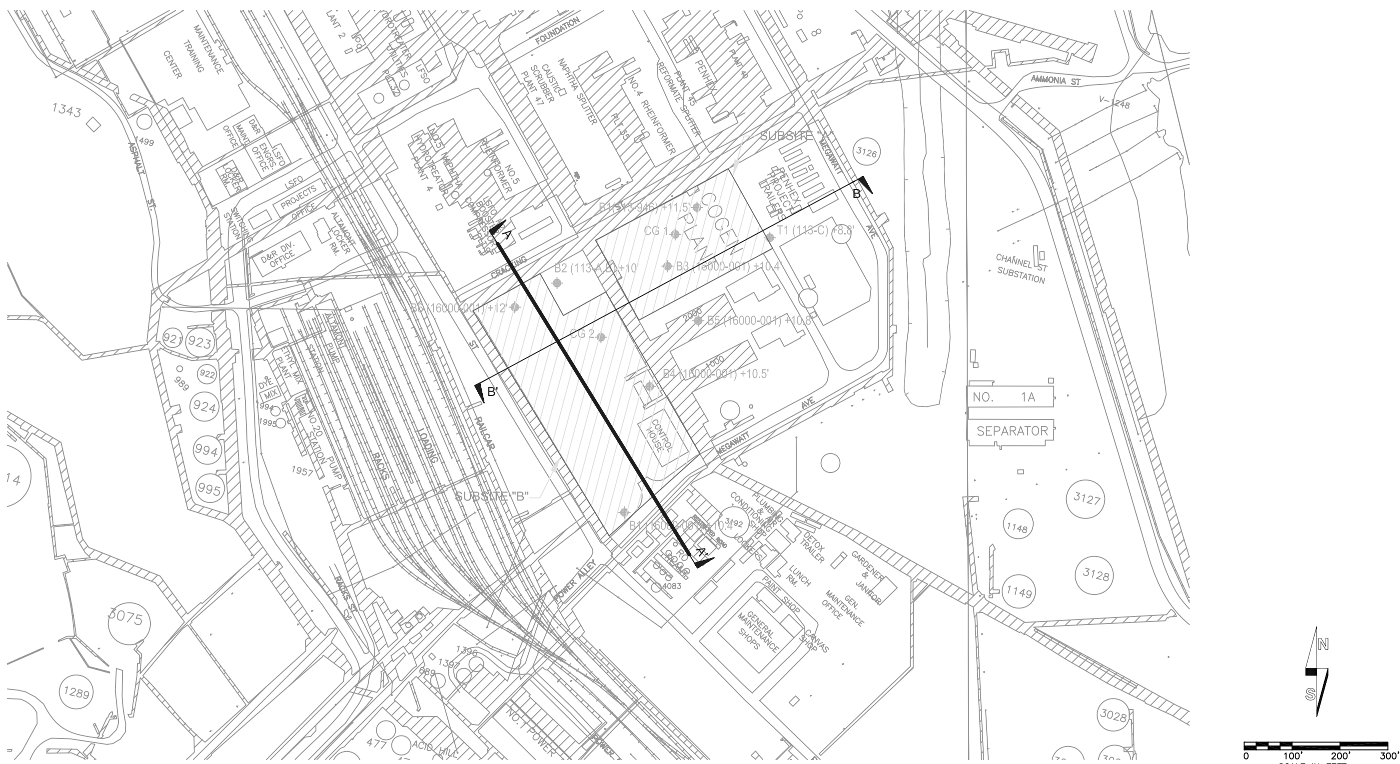
September 2006
28067039

Cogen 3000
Chevron Refinery Project
Richmond, California

URS

FIGURE 5

9/01/06 vsa ..\Chevron Cogen\Graphics\F5_svm_fill history.cdr



EXPLANATION

B6 (16000-001) +12'

- ELEVATION (FEET, RICHMOND REFINERY DATUM)
- URS (DAMES & MOORE) PROJECT NO.
- BORING DESIGNATION
- APPROXIMATE LOCATION OF TEST BORING
- PROPOSED AREA OF SITE DEVELOPMENT

REFERENCE: COGENERATION PLANT BY CHEVRON PRODUCTS COMPANY, JUNE 2004

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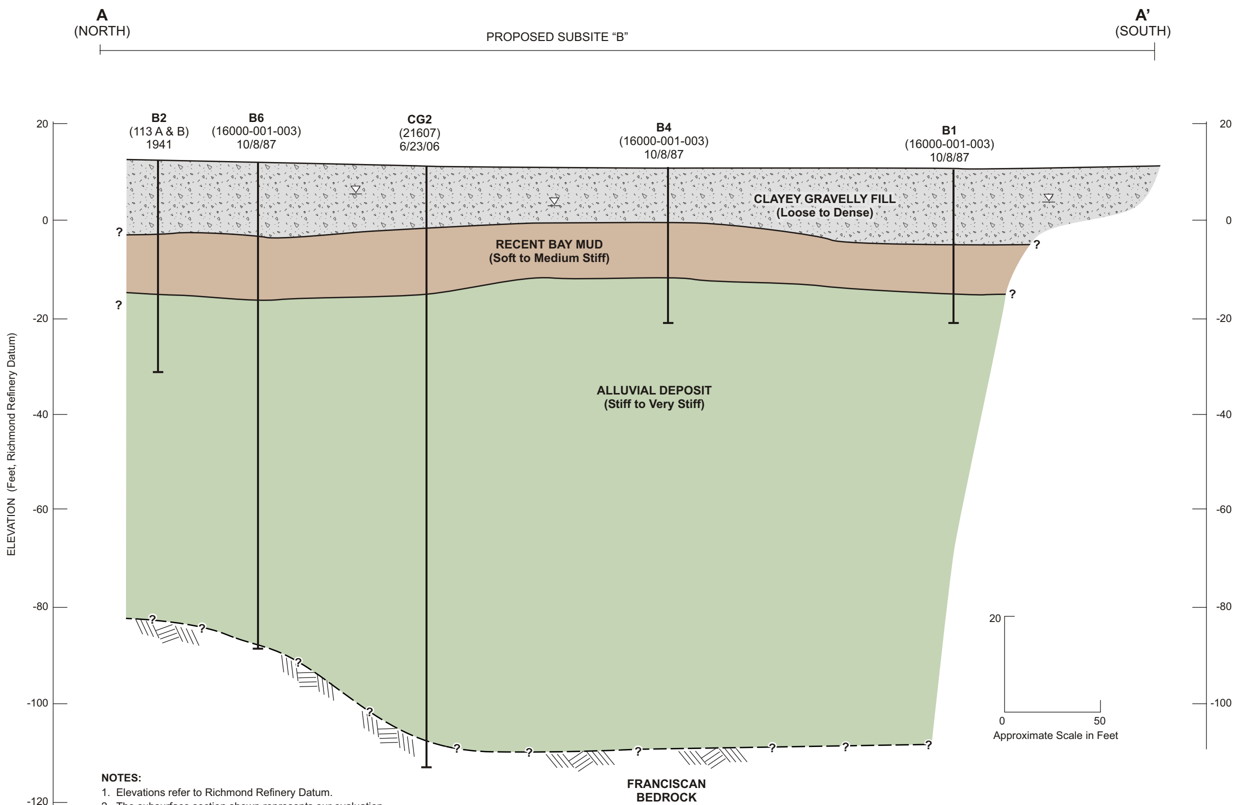
September 2006
Job No. 28067039

SITE LOCATION AND BOREHOLE LOCATION MAP

Chevron Products Company
Cogen 3000 Project
Richmond, California

FIGURE 6



NOTES:

1. Elevations refer to Richmond Refinery Datum.
2. The subsurface section shown represents our evaluation of the most probable conditions based on our interpretation of available data and local geology. The section is based on interpolation of data and involves increasing uncertainty with distance from boring locations shown in this profile.
3. The soil between points of explorations deposit may vary in type, strength and other important properties.

GENERALIZED SUBSURFACE PROFILE A-A'

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Richmond, California

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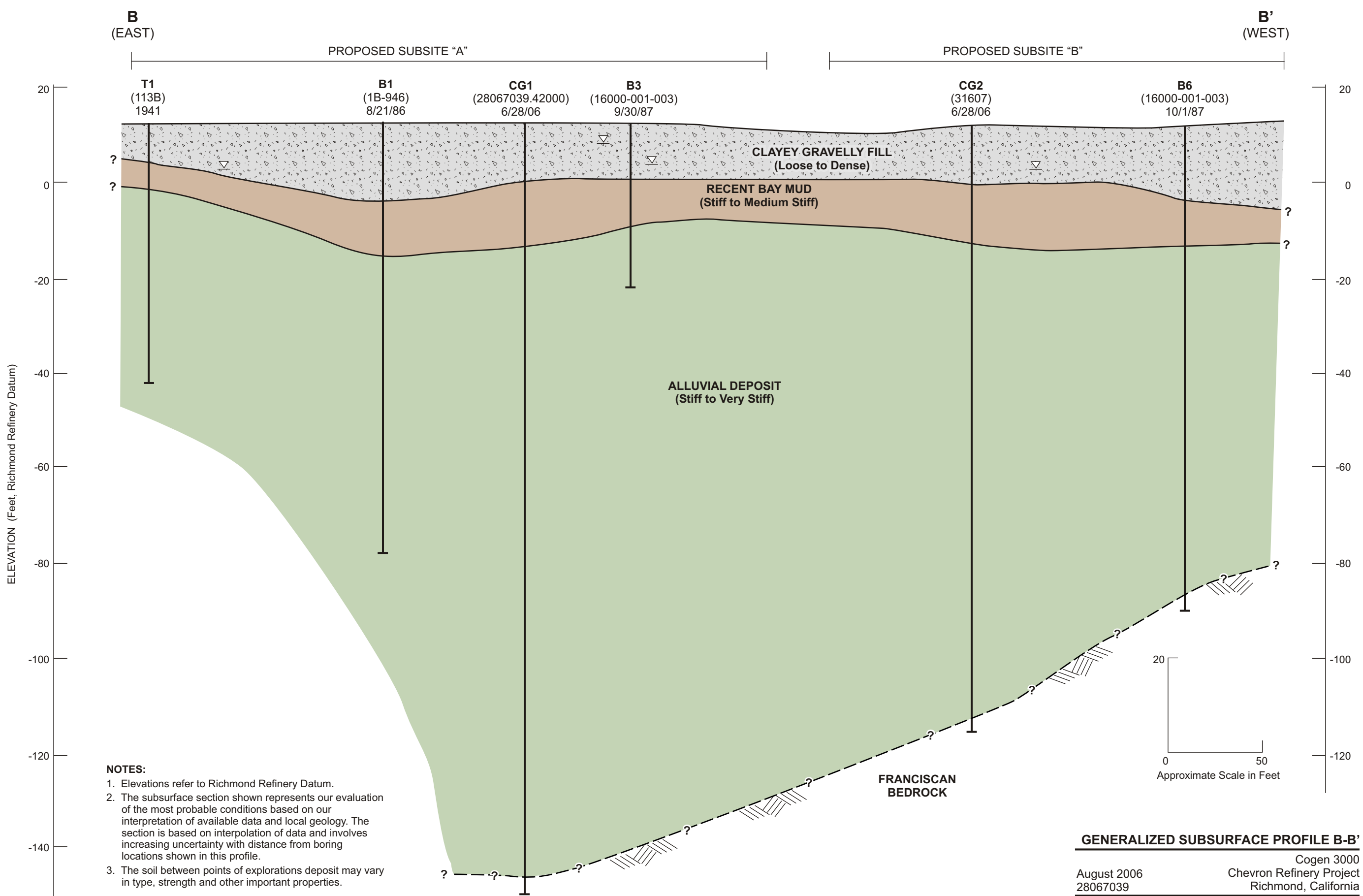
FIGURE 7

8/14/06 vsa ..\Chevron Cogen\Graphics\F7_Xsec AA_11x17.cdr



NOTES:

1. Elevations refer to Richmond Refinery Datum.
2. The subsurface section shown represents our evaluation of the most probable conditions based on our interpretation of available data and local geology. The section is based on interpolation of data and involves increasing uncertainty with distance from boring locations shown in this profile.
3. The soil between points of explorations deposit may vary in type, strength and other important properties.

GENERALIZED SUBSURFACE PROFILE B-B'

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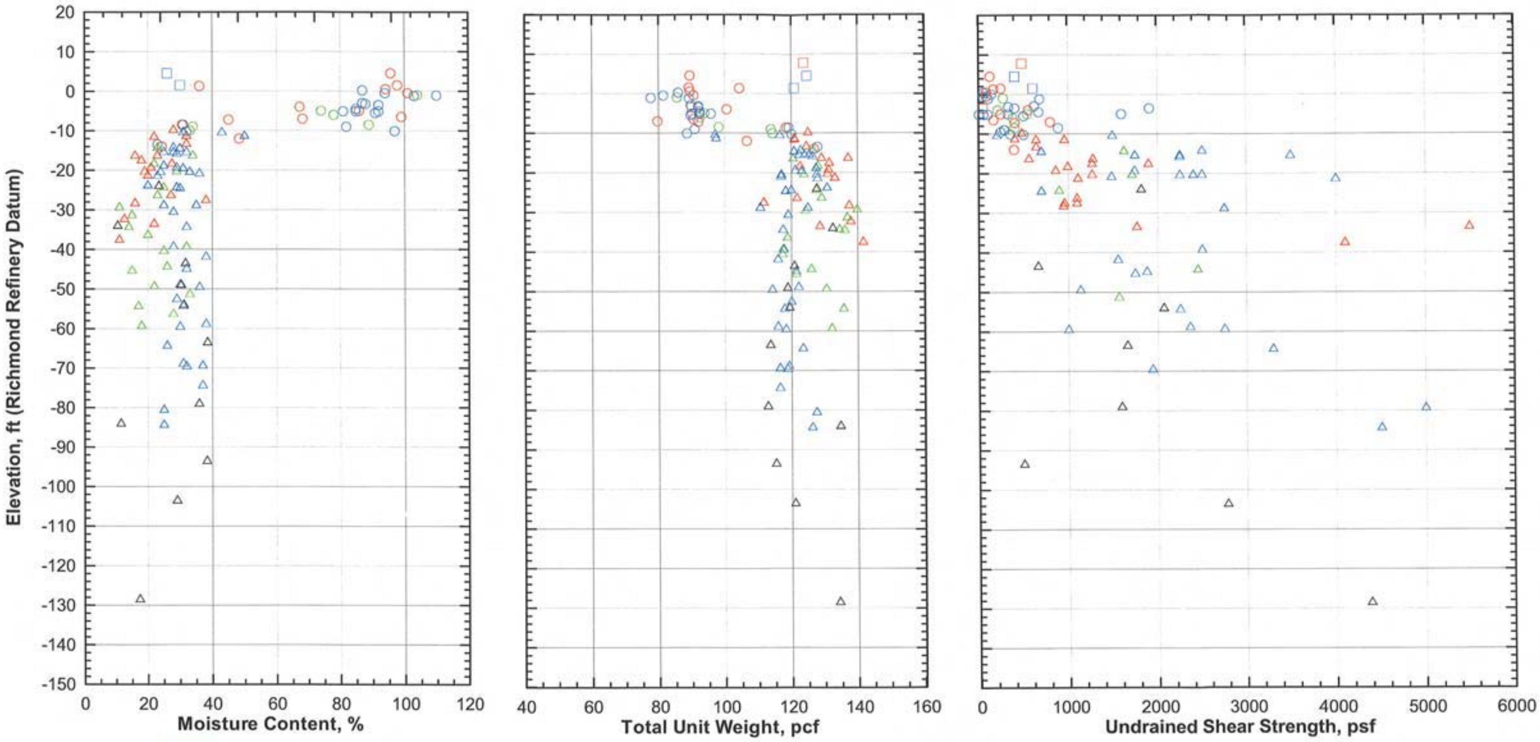
FIGURE 8

8/14/06 vsa ..\Chevron Cogen\Graphics\F8_Xsec BB_11x17.cdr



1940's
1970's
1980's
2006

Soil Layers:
□□□□ Fill
○○○○ Recent Bay Mud
△△△△ Alluvium

INDEX PROPERTIES AND STRENGTH CHARACTERISTICS VERSUS DEPTH

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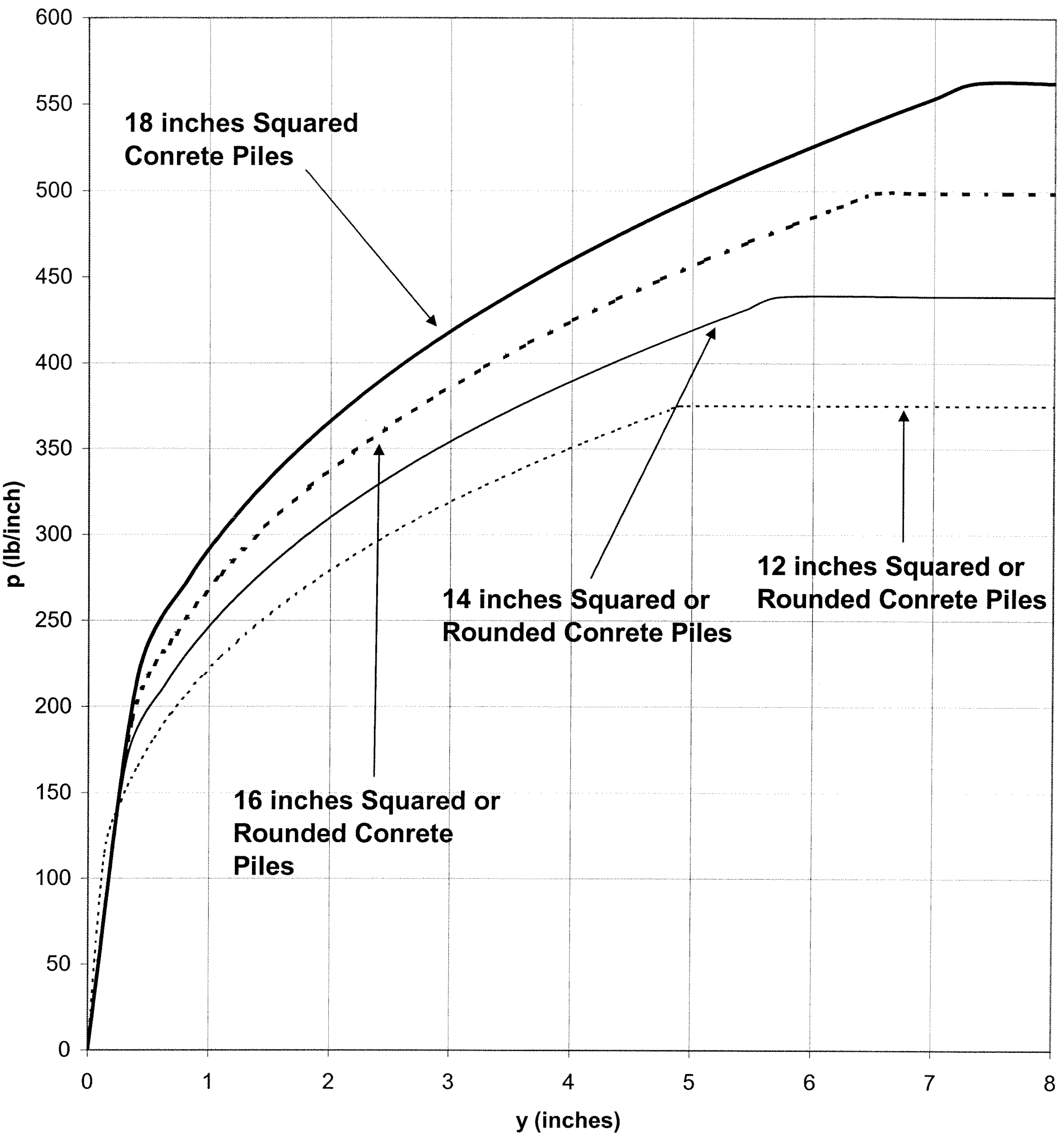
FIGURE 9

J:\Geotechnical\28067039 - Hydrogen Plants Project\COGEN\Figures and Plates\Current\COGEN 3000 final color by year.grf



P-Y Curve of Fill Material for Different Pile Types

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Richmond,California

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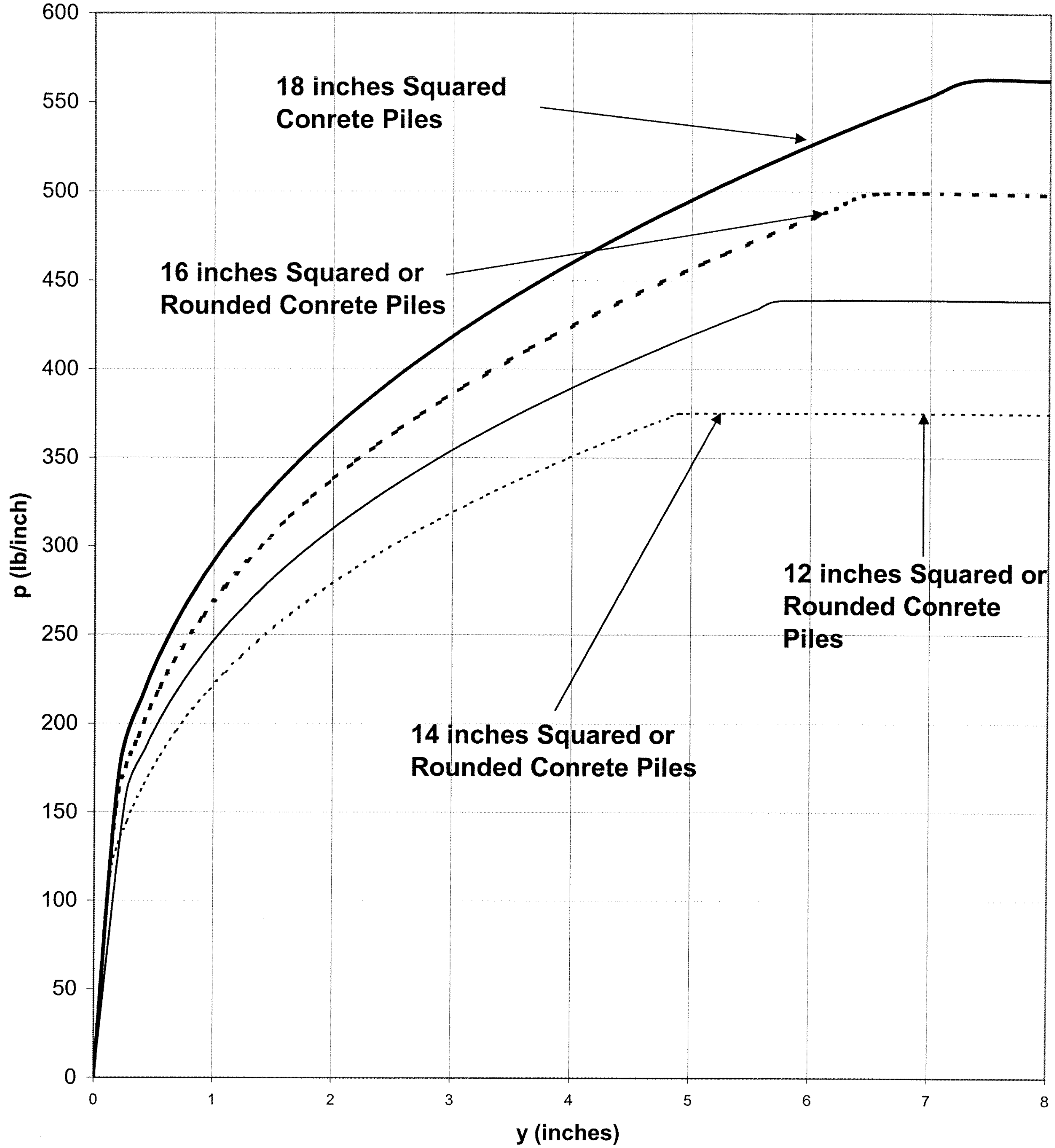
Figure 10



P-Y Curve of Fill Material for Different Pile Types

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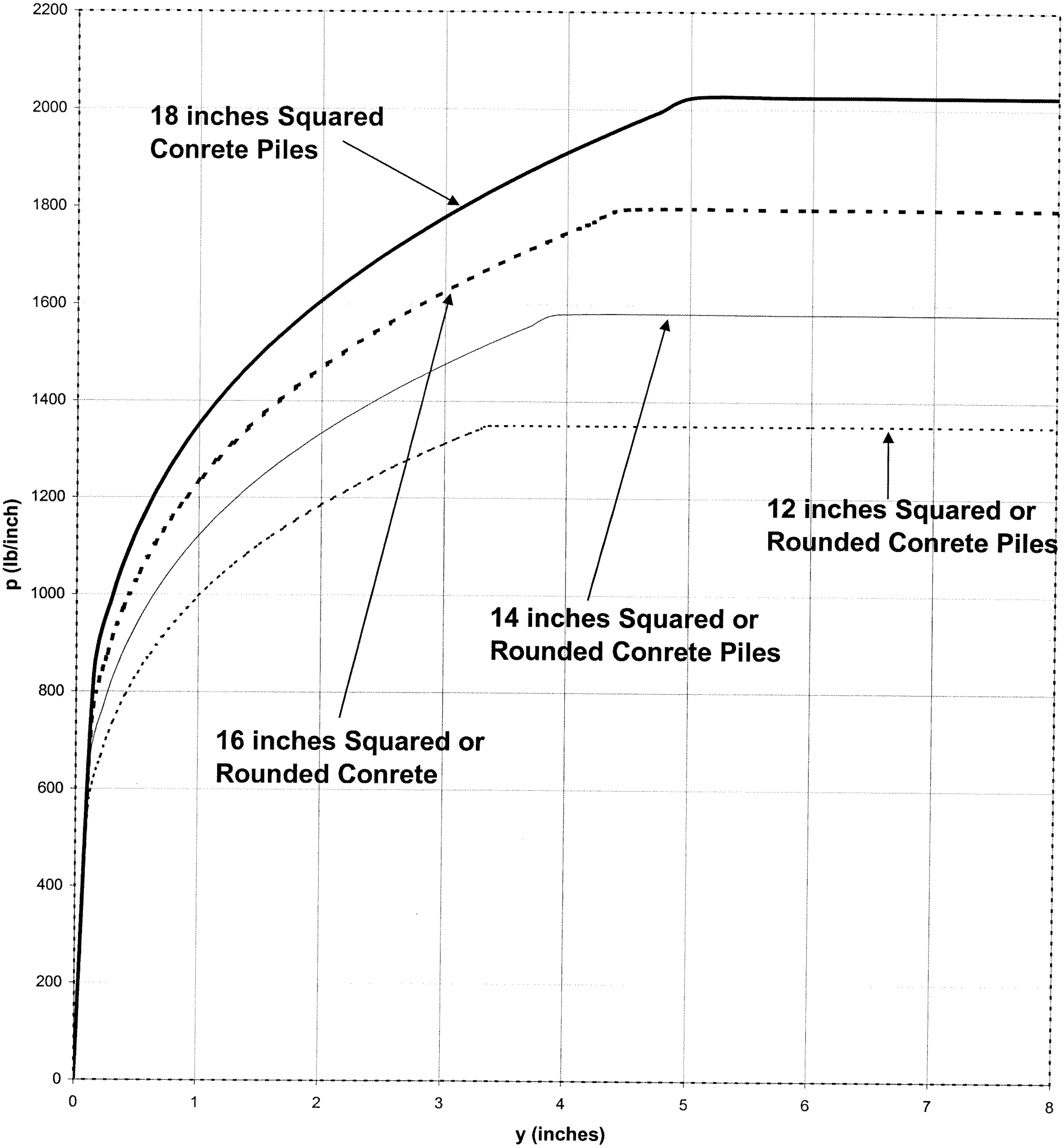
Figure 11



P-Y Curve of Alluvium for Different Pile Types

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Richmond,California

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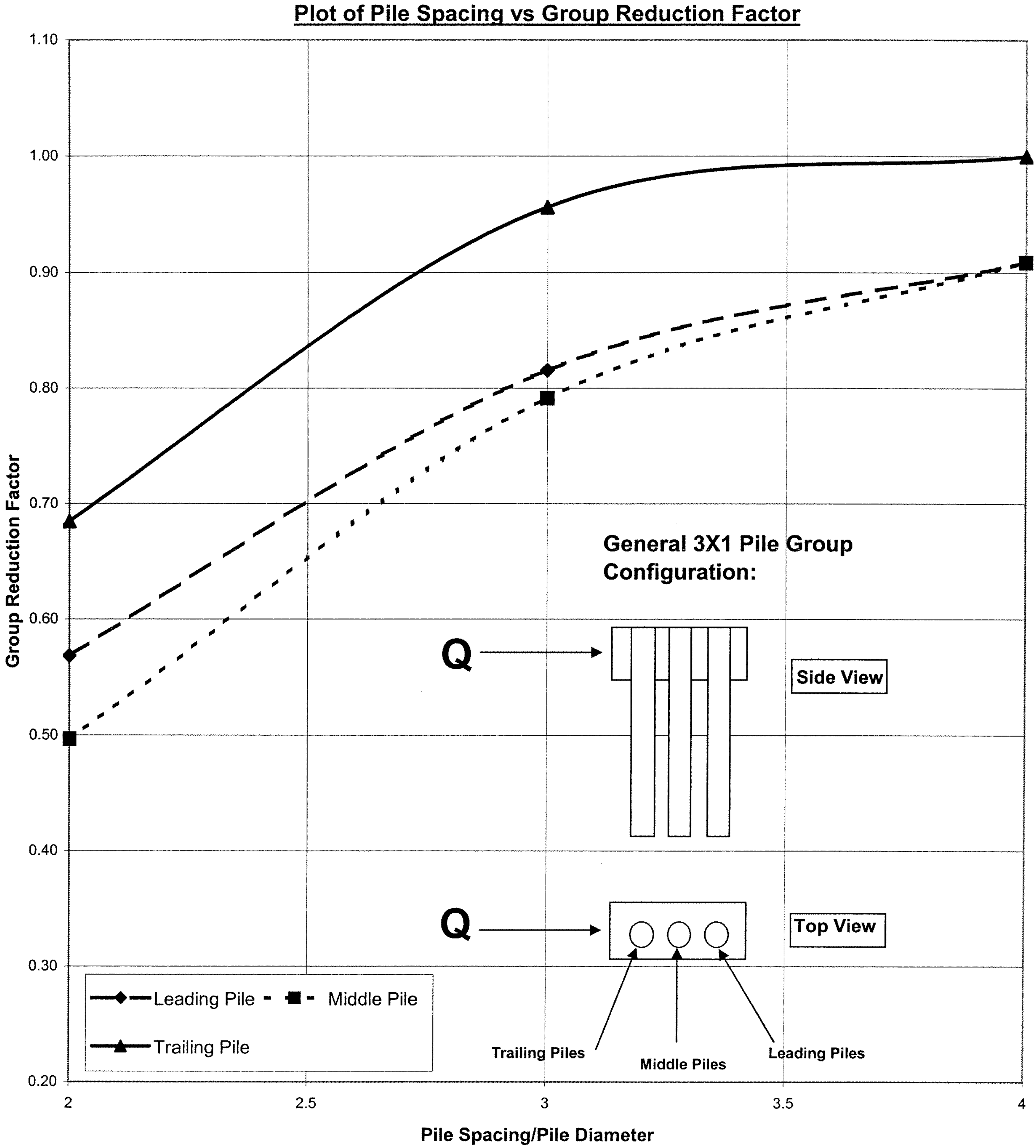
Figure 12



Note:
1. This plot shows the general trend of pile group reduction factor for the presented pile layout only.
2. A final design pile group reduction factor should be developed once the configurations, loads, size of foundation have been established.

Example of 3 Piles Group Reduction Factor

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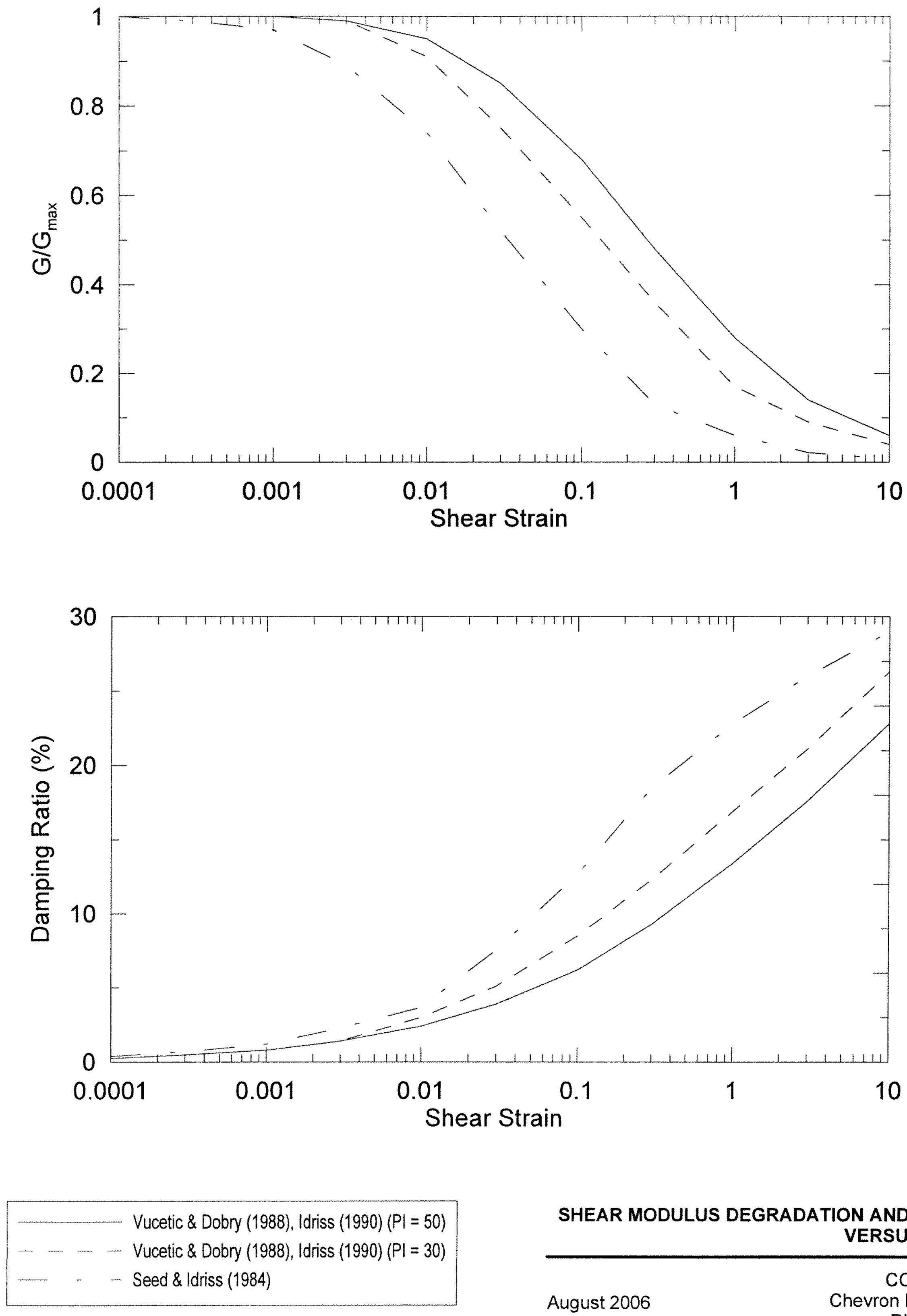
Figure 13



SHEAR MODULUS DEGRADATION AND DAMPING RATIO VERSUS SHEAR STRAIN

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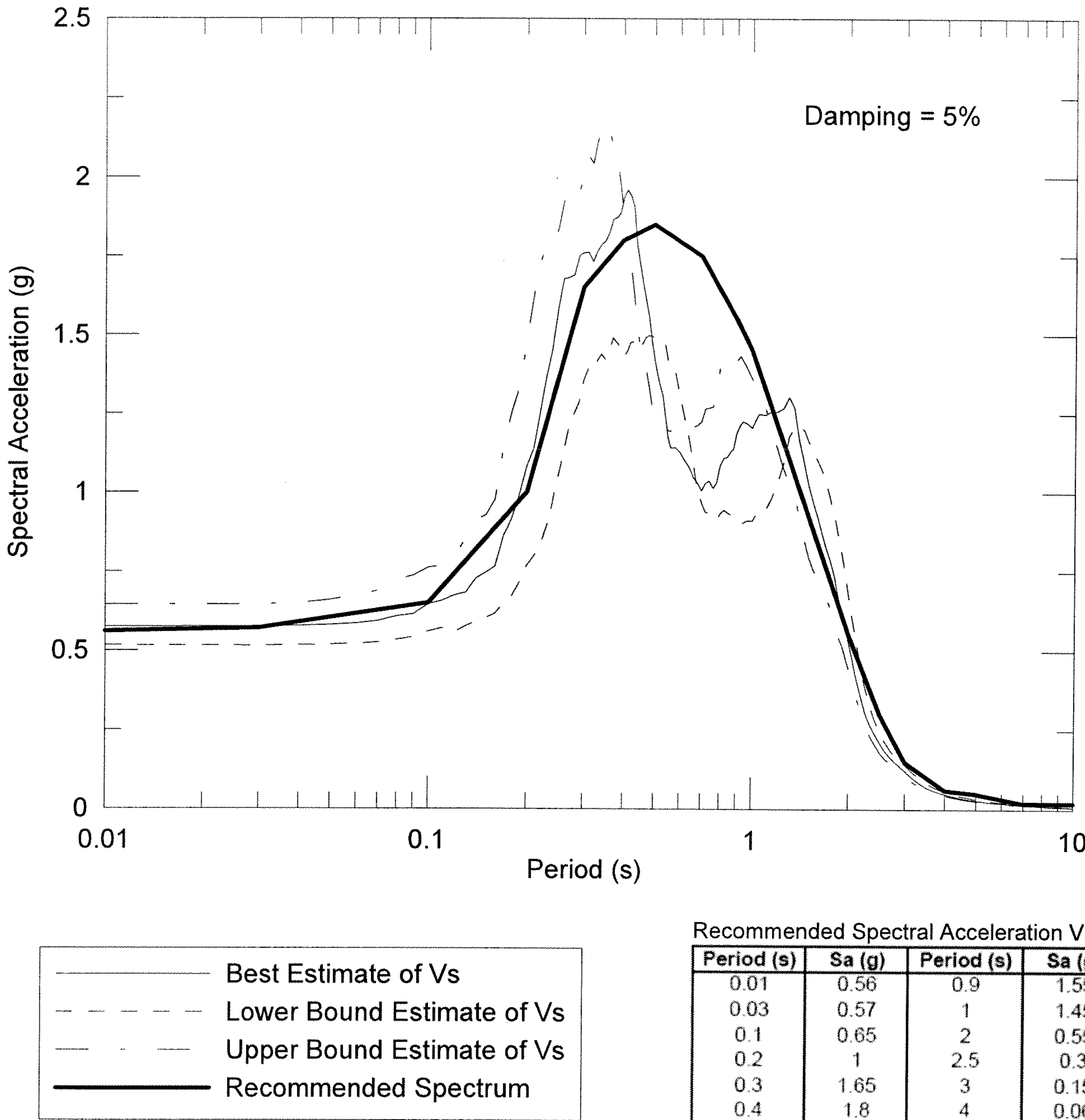
FIGURE 14



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.56	0.9	1.55
0.03	0.57	1	1.45
0.1	0.65	2	0.55
0.2	1	2.5	0.3
0.3	1.65	3	0.15
0.4	1.8	4	0.06
0.5	1.85	5	0.05
0.7	1.75		

CALCULATED AND RECOMMENDED HORIZONTAL ACCELEARTION RESPONSE SPECTRA AT THE GROUND SURFACE

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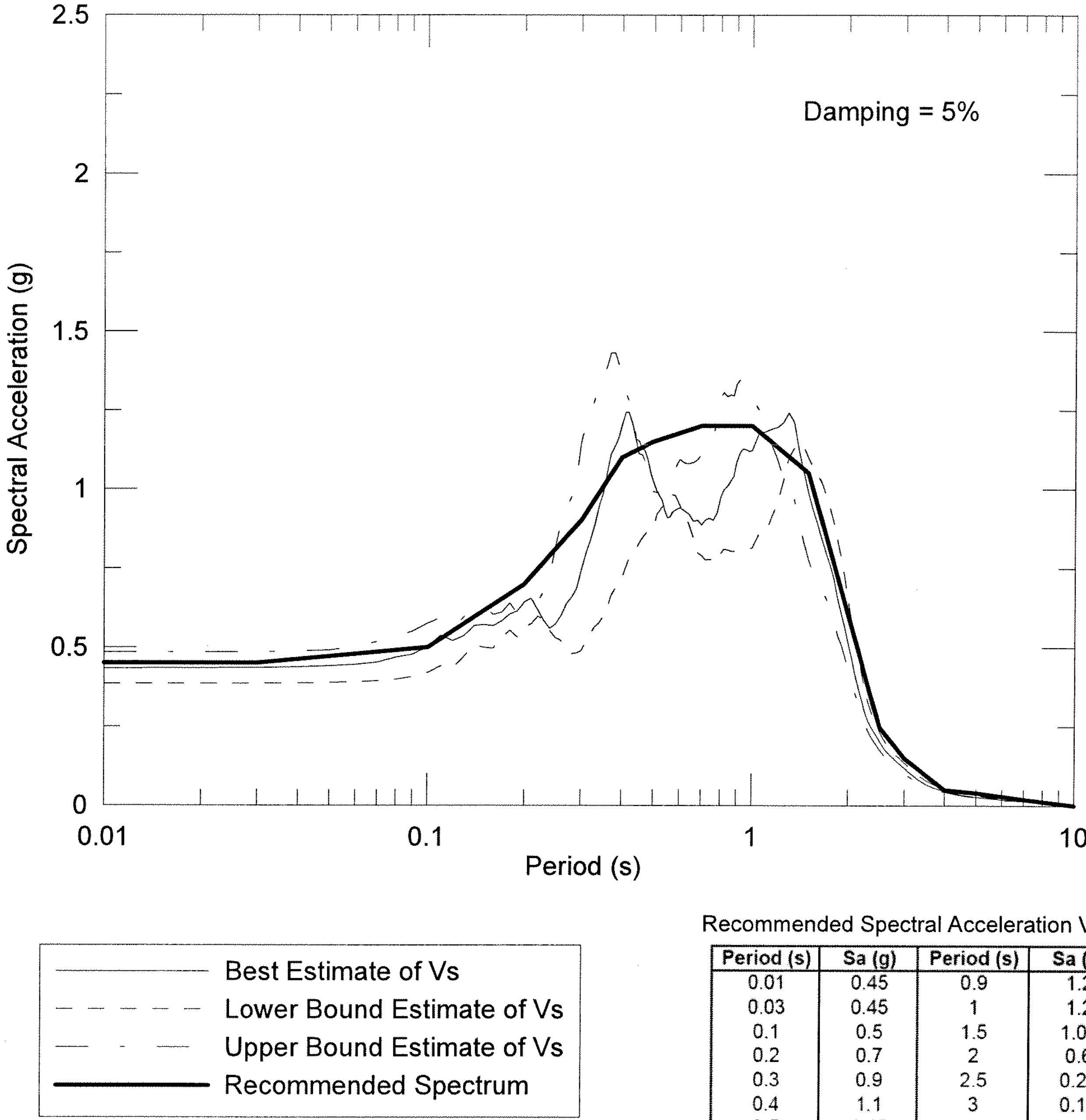
FIGURE 15



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.45	0.9	1.2
0.03	0.45	1	1.2
0.1	0.5	1.5	1.05
0.2	0.7	2	0.6
0.3	0.9	2.5	0.25
0.4	1.1	3	0.15
0.5	1.15	4	0.05
0.7	1.2	5	0.04

CALCULATED AND RECOMMENDED HORIZONTAL ACCELEARTION RESPONSE SPECTRA AT THE BOTTOM OF RECENT BAY MUD LAYER

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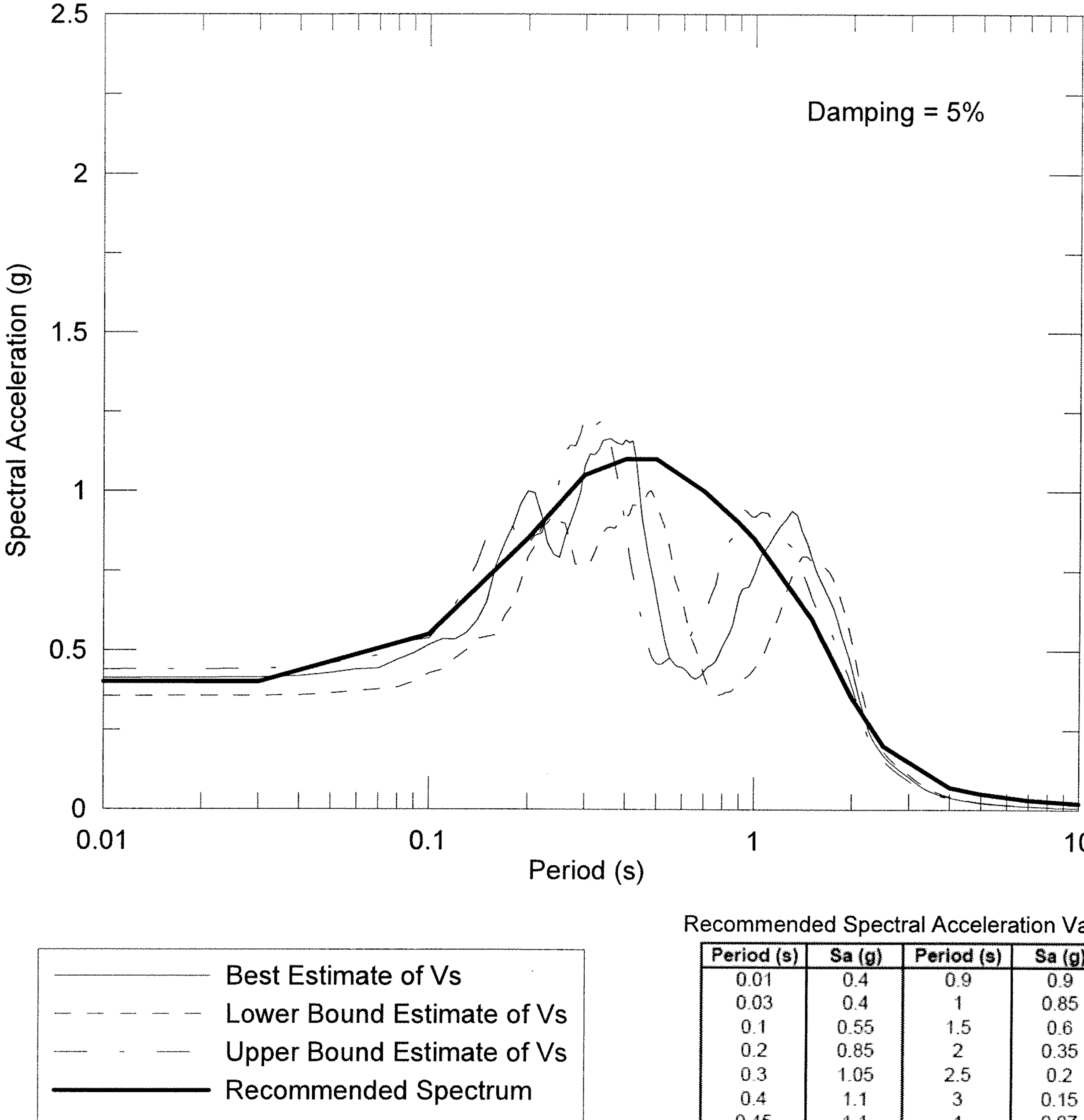
FIGURE 16



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.4	0.9	0.9
0.03	0.4	1	0.85
0.1	0.55	1.5	0.6
0.2	0.85	2	0.35
0.3	1.05	2.5	0.2
0.4	1.1	3	0.15
0.45	1.1	4	0.07
0.5	1.1	5	0.05
0.7	1		

CALCULATED AND RECOMMENDED HORIZONTAL ACCELEARTION RESPONSE SPECTRA AT THE MIDDLE OF ALLUVIUM LAYER

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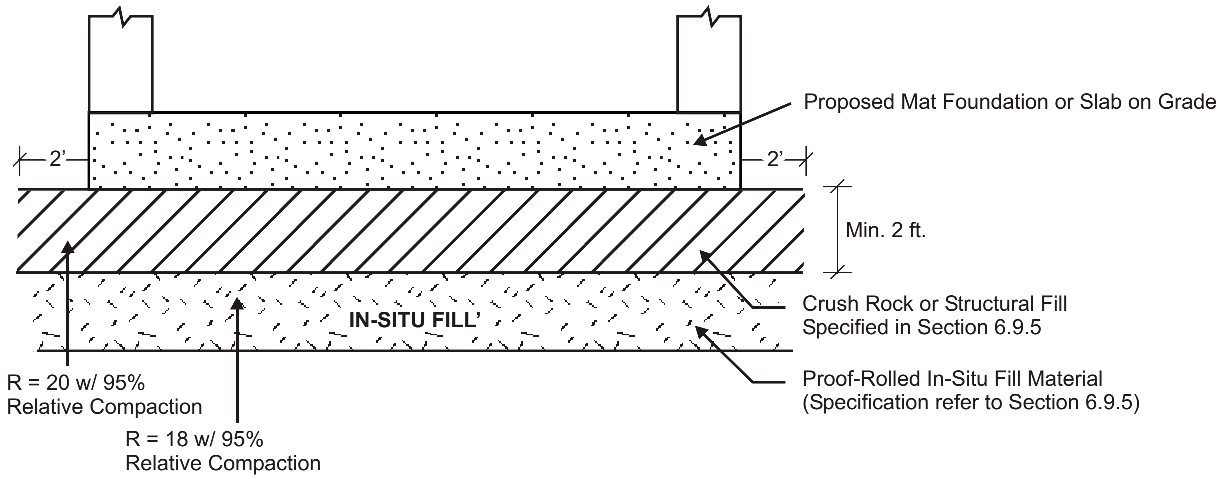
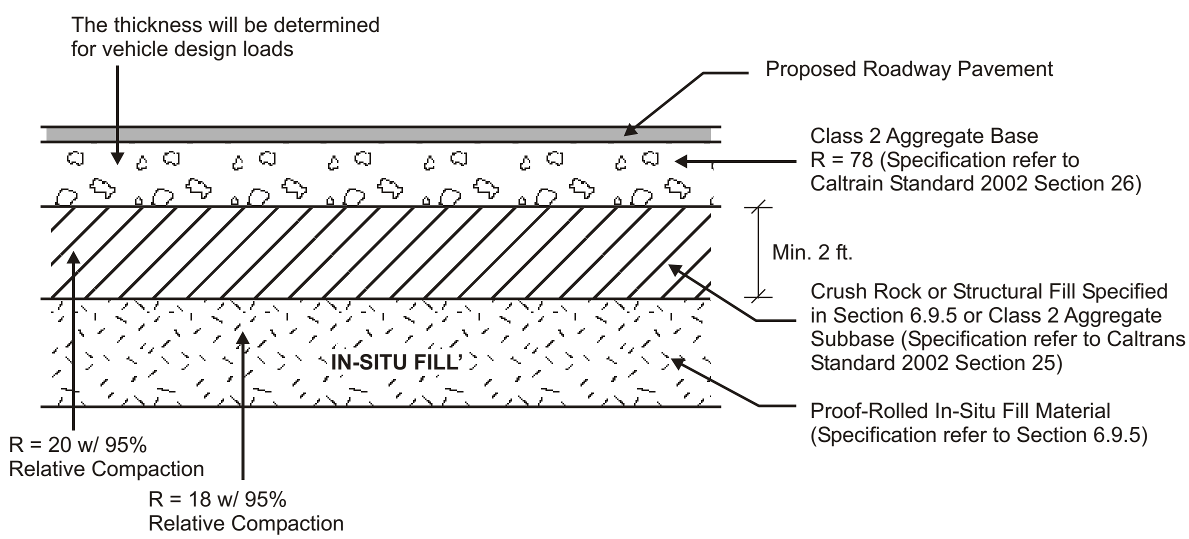
FIGURE 17



SETTLEMENT INSENSITIVE MATS



ROADWAY DESIGN

SUGGEST SITE PREPARATION FOR SHALLOW MAT FOUNDATIONS AND ROADWAY

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28067039

Cogen 3000
Chevron Refinery Project
Richmond, California

URS

FIGURE 18

9/01/06 vsa ..\Chevron Cogen\Graphics\F18_shallow mat.cdr

APPENDIX A

GEOTECHNICAL FIELD EXPLORATION AND HISTORICAL BORING LOGS

APPENDIX A

GEOTECHNICAL FIELD EXPLORATION AND HISTORICAL BORING LOGS

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APPENDIX A

GEOTECHNICAL FIELD EXPLORATION AND HISTORICAL BORING LOGS

SCOPE OF THE PROGRAM

This appendix summarizes the drilling, sampling, and testing techniques used to perform the geotechnical field exploration for the proposed COGEN 3000 Project at the Chevron Richmond Refinery in Richmond, California. The objective of this investigation was to collect geotechnical data necessary for developing recommendations regarding the foundation design and construction procedures for the proposed structures.

The geotechnical field investigation consisted of two borings. This appendix presents a detailed description of these two borings and their results.

FIELD EXPLORATION LOCATIONS

URS chose the two boring locations to investigate the subsurface conditions beneath the proposed structures. While meeting this objective, we chose the locations within the following constraints:

- Incorporate information from historical borings,
- Avoid underground utilities,
- Avoid overhead electric lines, and
- Avoid surface obstructions

Given the objectives of the program and these constraints, the two borings were drilled at the locations shown on Figure 6.

Prior to drilling, URS obtained the necessary soil boring and piezometer permits from the Environmental Health Division of Contra Costa County. Chevron "metro-teched" the boring locations to identify underground utilities and prepared the required "yellow-book" field operation files. The fieldwork began on May 22 and extended through May 25, 2006.

BORINGS

Two borings, CG-1 at Subsite A and CG-2 at Subsite B, were drilled to provide the necessary information to evaluate the subsurface stratigraphy and to collect geotechnical and groundwater data necessary for the design of the proposed structures. Figure 6 shows the locations of the borings. Each boring was drilled to bedrock. Boring CG-1 was drilled to a depth of 161 feet, and Boring CG-2 was drilled to depth of 127 feet. A short, 1-foot-long, sample of the bedrock was obtained in CG-2 for classification purposes. The following table lists the boring elevations and depths and other subsurface data.

Boring	Depth (feet)	Top Elevation (feet, RRD)	Bottom Elevation (feet, RRD)
CG-1	161	+12.8	-148.2
CG-2	127	+12.0	-115.0

All borings were drilled using rotary wash drilling equipment. Five-inch diameter casing was set through surficial materials to an approximate depth of 8.5 feet at CG-1 and 14 feet at CG-2 to support the drilling operations. Heavy mud was circulated to remove the drill cuttings and to stabilize the hole below the casing. Drilling and sampling was performed by Pitcher Drilling Company of East Palo Alto, California under subcontract to URS. All borings were drilled under the supervision of a geotechnical engineer from URS, who maintained records of all field activities, classified the soils encountered using the Unified Soil Classification System (USCS), performed field strength testing, and maintained a continuous log of the borings. Field shear strength measurements tests were performed on the ends of cohesive soil samples immediately upon retrieval using a Pocket Penetrometer or Torvane.

Disturbed and undisturbed samples were obtained for identification and laboratory testing. Soil samples were generally obtained at 5-foot intervals from ground surface to the bottom of the boring. We used three types of samplers: the standard penetration test (SPT) sampler, the Dames & Moore U-sampler, and the Dames & Moore piston sampler. The following is a brief description of the sampler types and sample handling used in this investigation.

- <u>Standard Penetration Test Sampler</u>. The standard penetration test (SPT) or split spoon sampler was used in conjunction with the Standard Penetration Test (ASTM D-1586) to obtain relatively disturbed samples for soil identification and to obtain penetration resistance data for correlation with engineering properties. The SPT sampler was driven using a standard 140-pound hammer falling 30 inches as specified in ASTM D-1586.

- <u>Dames & Moore U-Sampler</u>. The U-Sampler was used to obtain relatively undisturbed samples for laboratory testing. The U-sampler is a ring-lined, split-barrel sampler with a nominal 2½-inch inner diameter and 3¼-inch outer diameter, in substantial compliance with ASTM D-3550. The U-sampler was driven using a standard 140-pound hammer falling 30 inches. In some cohesive deposits, the U-sampler was fitted with a 6 inch long, thin-walled tube ahead of the tip, and the entire U-sampler with thin wall tube attachment was hydraulically pushed into the soil.

- Dames & Moore Piston Sampler. The piston sampler was used to obtain undisturbed samples of cohesive soils for laboratory testing. This sampler is a fixed piston sampler that hydraulically pushes a 2½-inch-diameter, 18-inch-long, brass tube into the soil.

The blow count recorded on the boring logs adjacent to the sample depth is the number of blows required to drive the sampler for the final 12 inches of an 18-inch sampling interval. These blow counts are uncorrected. The conversion factor from blow counts of Dames & Moore Samples and Modified California Sampler to blow counts of SPT is 0.5.

Soil samples were transported to Signet Testing Labs in Hayward, California.

All borings were sealed by tremie placement of lean cement grout upon completion of drilling. Drill cuttings generated during drilling were stored in drums provided by Pitcher Drilling Company. The drums were located adjacent to the borings. We understand that Chevron personnel will dispose of the drums.

LOGS OF BORINGS FOR THIS INVESTIGATION

The logs of the borings are presented in Figures A1 through A2. The logs show the interpreted subsurface conditions at the boring locations at the time the borings were drilled. The boring logs identify the types of soils encountered using the Unified Soil Classification System. They also show the depth of the samples, type of samples, and available laboratory test data. An explanation of terms used in the logs is presented in Figure A3.

LOGS OF HISTORICAL BORINGS

Since 1941, Dames & Moore has conducted numerous field investigations for various historical Refinery projects on and around the propose COGEN 3000 site. The logs of the borings for these historical investigations are a valuable source of subsurface data for the current investigation. Figures A4 through A11 present the logs of these previous borings. The logs show the interpreted subsurface conditions at the boring locations at the time the borings were drilled. The figures include explanations of the terms used in the logs.

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-1

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
	LABORATORY TEST DATA: ATTERBERG LIMITS / STRENGTH DATA								SAMPLING			
0	R Value										GP	GRAYISH BROWN FINE TO COARSE SANDY GRAVEL. Medium dense, dry. [BASEROCK]
									MC	40		
5												
									MC	8	CH	DARK GRAY AND OLIVE GRAY CLAY, trace calcium nodules (1/8" diameter). High plasticity. Stiff, moist. [BAY MUD FILL] PP: Su = 2,500 psf
10									P	100 psi	SC	DARK GRAY AND OLIVE GRAY CLAYEY FINE TO COARSE SAND. Moist to wet. [FILL]
											CH	DARK GRAY CLAY. High plasticity. Soft. Moist to wet. [RECENT BAY MUD] PP: Su = 500 psf; TV: Su = 500 psf
15	Consol	102	49				98.7	91.2	P	50 psi		
20									TW	8		Grades with trace decomposed roots, calcium nodules. Medium stiff, moist. PP: Su = 1,000 psf; TV: Su = 1,000 psf
											CL	GREENISH GRAY SILTY CLAY, with calcium nodules, trace fine sand. [COLLUVIUM]
25											SP SC	YELLOWISH BROWN FINE SAND, with clay. Medium dense, moist to wet.
									MC	12	CL	YELLOWISH BROWN CLAY, trace fine sand. Stiff, moist to wet. PP: Su = 2,250 psf
30											SP	YELLOWISH BROWN FINE SAND, trace clay. Medium dense, moist.
									MC	14	SP SC	YELLOWISH BROWN FINE SAND, with clay. Medium dense, moist. Frequent carbon nodules (1/8" diameter).
35												

Continued Next Page

Job No: 28067039 Pt. ID: CHP_COG.GPJ / CG-1	URS		Log of Boring
Date Completed: 5/25/06 Boring Depth: 161.0 ft.	Surface Elev: ft. Richmond Refinery Datum (RRD) Coordinates:		Location: Chevron Richmond Refinery

FIGURE A-1 (Cont.)

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-1

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
35									MC	34		Grades with medium to coarse sand. Grades dark greenish gray with trace coarse to medium sand.
40				UC		660	31.7	121.0	MC	24		41.0', grades light brown.
45									MC	48	SM	45.0', seam of silty sand.
											SP	GRAYISH BROWN AND YELLOWISH BROWN FINE SAND, with clay. Medium dense, moist.
											SP SM	YELLOWISH BROWN FINE SAND, with silt. Medium dense, moist. 46.5', grades with medium and coarse sand, fine gravel.
50									MC	14	CL	YELLOWISH BROWN SILTY CLAY, trace fine sand, fine gravel. Medium stiff, moist. PP: Su = 1,500 psf
55									MC	22		Grades greenish gray, stiff. PP: Su = 2,750 psf
60									MC	20		Grades with fine sand, trace medium sand. Occasional 1/8" diameter carbon nodules. PP: Su = 2,750 psf
65									MC	26		Grades light brown and yellowish brown, trace coarse sand. PP: Su = 2,750 psf
70												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-1

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
70									MC	22		Grades greenish gray. PP: Su = 3,000 psf
75				UC		1600	38.5	113.6	MC	19		Grades without medium to coarse sand. PP: Su = 2,500 psf
80									MC	23		PP: Su = 3,500 psf
85									MC	28		PP: Su = 3,000 psf
90									MC	22		Grades to fine silty clay with fine sand. PP: Su = 2,250 psf
95									MC	79	SP	DARK GREENISH GRAY FINE SAND, with small pockets of clay. Very dense, moist.
100									MC	18	CL	DARK GREENISH GRAY SILTY CLAY, with fine to medium sand, occasional 1/4" diameter green nodules. Medium stiff, moist. PP: Su = 1,750 psf 100.5', 1/2" seam of fine sand.
105												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-1

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
105				UC		493	38.3	115.3	MC	19		Grades to fine sandy silty clay, with interbedding 1/4" seams of clayey sand, medium stiff. PP: Su = 1,000 psf
110									MC	45		Grades to silty clay with fine sand, occasional green and brown mottling. PP: Su = 1,500 psf 111.5', Stopped drilling @ 2:56 pm on 5/24/06. Drilling continued at 6:20 on 5/25/06.
115				UC		2782	29.1	120.9	MC	42	CH	DARK GREENISH GRAY FAT CLAY, with brown mottling, trace fine sand. Stiff, damp. PP: Su = 4,000 psf Driller reports harder drilling/gravelly.
											SP SC	YELLOWISH BROWN AND BROWN COARSE TO FINE SAND, with some brown and yellow brown mottled clay, trace fine gravel. Dense to stiff, damp.
120	SA								MC	50/6"	CL	YELLOWISH BROWN AND BROWN CLAY, with sand, some fine gravel. Stiff, damp.
125									MC	87		
130									MC	86	SC	YELLOWISH BROWN AND BROWN CLAYEY FINE TO COARSE SAND, trace fine gravel, occasional (1/8" diameter) carbon nodules. Dense to stiff, damp.
135									MC	50/3"	SP SC	YELLOWISH BROWN AND BROWN FINE TO COARSE SAND, with some clay, trace fine gravel. Dense, damp.
140												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-1

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
140				UC		4382	17.4	134.3	MC	77	SC	BROWN AND REDDISH BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Dense to very stiff, damp. PP: Su = 4,500 psf
145									MC	76		Grades medium to fine sand, trace coarse sand, fine gravel, (1/8" diameter) carbon nodules. PP: Su = 4,500 psf
150									MC	80		PP: Su = 4,500 psf Grades with frequent gray clay mottling.
155									MC	73		PP: Su = 4,000 psf
160									MC / SPT	50/3" / 50/6"	BR	YELLOWISH BROWN AND GRAYISH BROWN SANDSTONE BEDROCK. Completely weathered. Moderately weak to weak. Very closely fractured. Very thinly bedded (3/4").
165												
170												
175												

Column groups: LABORATORY TEST DATA (ATTERBERG LIMITS: Liquid Limit, Plasticity Index; STRENGTH DATA: Type of Test, Normal or Confining Pressure, Shear Strength); SAMPLING (Type of Sampler, Sampling Resistance); SAMPLES.

Notes:

1. Boring terminated at a depth of 161 feet on May 25, 2006. Boring backfilled with grout on May 25, 2006.
2. The boring was advanced to a depth of 7.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Dames & Moore U Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler.
4. Groundwater level was measured at 3 feet on May 24, 2006..
5. Boring log indicates interpreted subsurface

Continued Next Page

	LABORATORY TEST DATA								SAMPLING				
		ATTERBERG LIMITS		STRENGTH DATA									
DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SAMPLES	SYMBOL	DESCRIPTION
175													conditions only at the location and time of the drilled boring. 6. See Figure A-3 for general log notes and explanation of symbols.
180													
185													
190													
195													
200													
205													
210													

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Richmond Refinery

BORING CG-2

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
0											GP	GRAYISH BROWN FINE TO COARSE SANDY GRAVEL. Dry. [BASEROCK]
												2.5', pieces of wood, 2-3" thick.
											CL	BLACK FINE TO COARSE SANDY CLAY, occasional fine gravel. Medium stiff, moist. Slight hydrocarbon ordor. Large gravel (2" diameter) in shoe.
5									U	35		
									U	26		6.5', 1" diameter gravel. Pieces of wood and concrete at the shoe. Wet.
												Oil visible on groundwater.
10												Visible oil on sampler. Soft.
									U	12		
											CH	DARK GRAY CLAY, trace fine sand. Soft, moist. Occasional peat seams. [RECENT BAY MUD] PP: Su = 1,000 psf
15									P	50 psi		Grades without fine sand and peat.
20									U	2		PP: Su = 500 psf; TV: Su = 600 psf
25	Consol	46	21				24.3	123.1	P	300 psi		PP: Su = 1,500 psf; TV: Su = 1,300 psf
											CL	OLIVE GRAY CLAY. High plasticity. Stiff, moist. [OLD BAY CLAY]
30									U	12		Minimal recovery at thin wall extension. PP: Su = 1,500 psf
											CL	YELLOW BROWN CLAY, with fine sand, trace red brown medium sand-sized nodules. Stiff, moist.
35												

Continued Next Page

Job No: 28067039 Pt. ID: CHP_COG.GPJ / CG-2	URS	**Log of Boring**
Date Completed: 5/23/06 Boring Depth: 127.0 ft.	Surface Elev: ft. Richmond Refinery Datum (RRD) Coordinates:	Location: Chevron Richmond Refinery

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-2

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
35				UC		1819	23.5	127.7	U	19		[COLLUVIUM] PP: Su = 2,000 psf; TV: Su = 1,400 psf
40		33	14						U	31		PP: Su = 3,000 psf
												43.0', grades with medium sand.
45							10.5	132.5	U	50/6"	SP	YELLOW BROWN FINE TO MEDIUM SAND, trace coarse sand and gravel. Very dense, moist to wet.
											CH	DARK GREENISH GRAY SILTY CLAY, trace fine to coarse sand. Soft, moist. Frequent decomposed pieces of wood.
50									U	18		PP: Su = 1,000 psf
55									U	22		Grades without decomposed wood, stiff. PP: Su = 2,750 psf
60		69	32				30.4	118.9	U	24		PP: Su = 2,500 psf; TV: Su = 1,600 psf
65				UC		2067	31.2	119.4	U	25		Grades yellowish brown and gray with frequent reddish brown medium sand-sized nodules. PP: Su = 2,500 psf; TV: Su = 1,700 psf
70												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-2

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
70	SA								U	22	ML	DARK GREENISH GRAY CLAYEY SILT, with some fine sand. Stiff, moist. PP: Su = 2,750 psf; TV: Su = 1,700 psf
75									U	30	CH	YELLOWISH BROWN CLAY, with some fine sand. Very stiff. Frequent medium sand-sized reddish brown and dark brown nodules. PP: Su = 3,500 psf; TV: Su = 1,800 psf
80									U	28		PP: Su = 3,500 psf; TV: Su > 1,000 psf
85									U	45	SC	GRAYISH BROWN AND REDDISH BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Dense to very stiff, moist to damp, stratified (1/2" to 3/4" thick). Occasional (2" diameter) calcium nodules. 89.0', driller reports "stiffer" drilling.
90				UC		1597	35.9	112.7	U	34	SP	1" SEAM GREENISH GRAY FINE SAND, trace clay.
											CL	6" VERY DARK BROWN SILTY CLAY. Soft, moist. PP: Su = 1,000 psf
											SC	YELLOWISH BROWN AND GRAYISH BROWN CLAYEY FINE SAND, trace medium to coarse sand, fine gravel. Dense to stiff, moist. Occasional pockets of green and greenish gray sand and (1/4" diameter) calcium nodules. Grades to clayey coarse to fine sand.
95							11.5	134.6	U	90		
100									U	80		
105												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING CG-2

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
105									U	81	CH	DARK YELLOWISH BROWN AND GRAYISH BROWN FINE SANDY CLAY, trace medium sand. Very stiff to hard, damp. Frequent pieces of decomposed wood. PP: Su = 4,500 psf; TV: Su > 2,000 psf
110									U	88	SC	REDDISH BROWN AND BROWN CLAYEY MEDIUM TO FINE SAND, trace coarse sand. Hard to dense, damp, calcium nodules (1/4" diameter).
115									MC	73		Grades with frequent small (1/4" diameter) pockets of carbon.
120									MC	50/2"	SC	REDDISH BROWN AND BROWN CLAYEY MEDIUM TO FINE SAND, trace coarse sand. Hard to dense, damp.
											RS	REDDISH BROWN AND YELLOWISH BROWN CLEAN FINE SAND. Very dense. Slightly cemented. [RESIDUAL SANDSTONE?]
125									MC 101	50/2" 1 500 psi	BR	REDDISH BROWN SANDSTONE. Completely weathered. Moderately weak to weak. Very closely fractured ('8"). [BEDROCK] 127.0', highly weathered.
130												
135												
140												

LABORATORY TEST DATA: ATTERBERG LIMITS; STRENGTH DATA. SAMPLING. SAMPLES.

Notes:

1. Boring terminated at a depth of 127 feet on May 23, 2006. Boring backfilled with grout on May 23, 2006.
2. The boring was advanced to a depth of 9.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Modified California and Dames & Moore U Type samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler.
4. Groundwater level was measured at 9 feet on May 22, 2006.
5. Boring log indicates interpreted subsurface conditions only at the location and time of the

Continued Next Page

LABORATORY TEST DATA									SAMPLING		
DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SAMPLES
140											
145											
150											
155											
160											
165											
170											
175											

Chevron U.S.A. Products Co.
Richmond Refinery

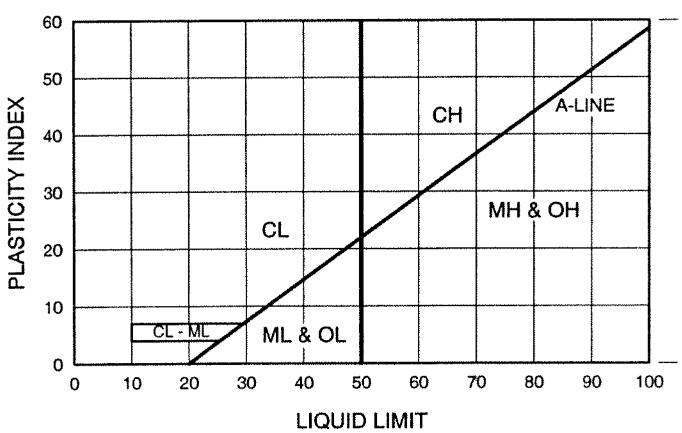
BORING CG-2

SYMBOL	DESCRIPTION
	drilled boring.
	6. See Figure A-3 for general log notes and explanation of symbols.

INDEXED SOIL AND ROCK CLASSIFICATIONS

GRAPHIC	SYMBOL	DESCRIPTION	MAJOR DIVISIONS				
	GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	CLEAN GRAVELS (LITTLE OR NO FINES)	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO.4 SIEVE SIZE	FOR VISUAL CLASSIFICATION, THE 1/4" SIZE MAY BE USED AS EQUIVALENT TO THE NO.4 SIEVE SIZE	COARSE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO.200 SIEVE SIZE	THE NO.200 U.S. STANDARD SIEVE IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE
	GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES					
	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)				
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES					
	SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES	CLEAN SANDS (LITTLE OR NO FINES)	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO.4 SIEVE SIZE			
	SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES					
	SM	SILTY SANDS, SAND-SILT MIXTURES	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)				
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES					
	ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	SILTS & CLAYS LIQUID LIMIT LESS THAN 50			FINE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO.200 SIEVE SIZE	
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS					
	OL	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF LOW PLASTICITY					
	MH	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF HIGH PLASTICITY	SILTS & CLAYS LIQUID LIMIT GREATER THAN 50				
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS					
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS					
	PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS				

PLASTICITY CHART



KEY TO TEST DATA

CONSOL = CONSOLIDATION TEST

PP: Su = POCKET PENTROMETER UNDRAINED SHEAR STRENGTH

R VALUE = R VALUE TEST

SA = SIEVE ANALYSIS

TV: Su = TORVANE UNDRAINED SHEAR STRENGTH

UC = UNCONFINED COMPRESSION TEST

KEY TO SAMPLE TYPE

. = NO RECOVERY

101 = CORE SAMPLER

MC = MODIFIED CALIFORNIA SAMPLER

P = PISTON TUBE SAMPLER

SPT = STANDARD PENETRATION TEST SAMPLER

TW = THIN WALL TUBE SAMPLER

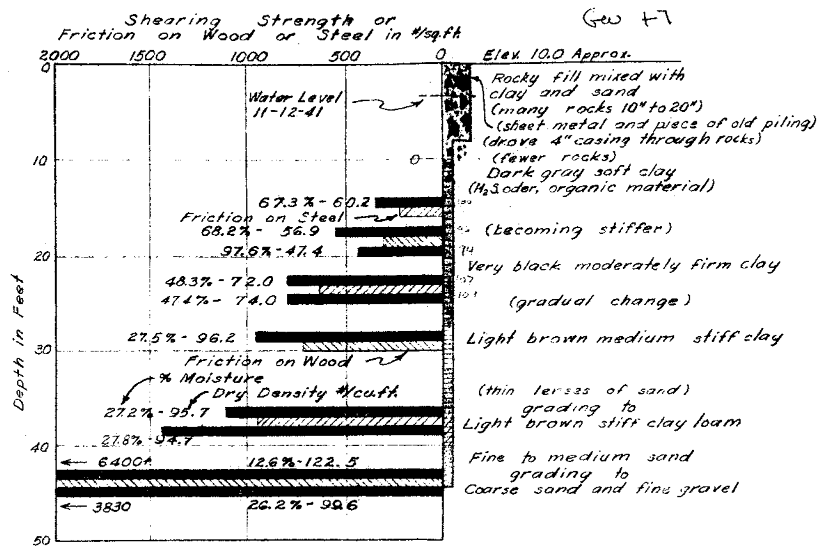
U = DAMES & MOORE TYPE U SAMPLER

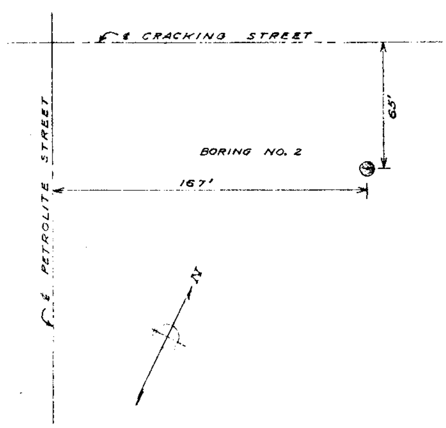
URS SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

FIGURE A-3

No. 2 24" and 4" Dia.

Gew +7





LOCATION OF BORING
SCALE: 1" = 50'

LOG OF BORING

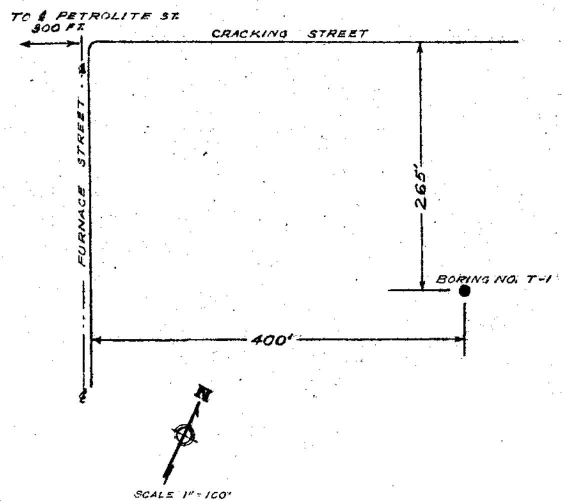
DEOCTANIZER PLANT
RICHMOND REFINERY
for the
STANDARD OIL COMPANY OF CALIFORNIA
SAN FRANCISCO, CALIFORNIA

NOVEMBER 1941

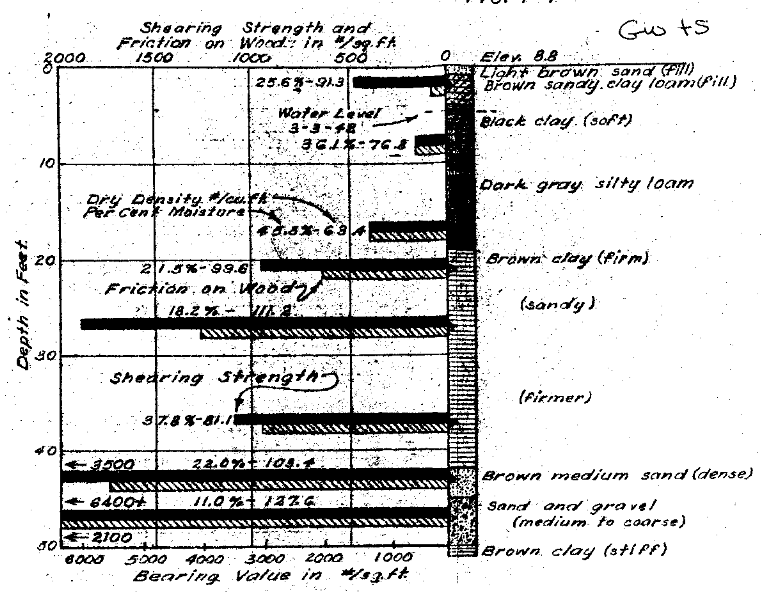
DAMES AND MOORE
Foundation Engineers
SAN FRANCISCO LOS ANGELES SAN DIEGO

No. T-1

Gw +S



LOCATION OF BORING



LOG OF BORING

TOLUENE PLANT
Richmond Refinery
for the
Standard Oil Company of California
San Francisco, Calif.
March 1942

DAMES AND MOORE
Foundation Engineers
SAN FRANCISCO LOS ANGELES SAN DIEGO

BORING B-1

DATE DRILLED 8/21/86

SURFACE ELEVATION 11.5 feet

JOB NO. 113-946

Depth in Feet (approx.)	Tests Reported Elsewhere	Liquid Limit	Plastic Limit	Type of Strength Test	Normal or Confining Pressure, PSF	Shear Strength, PSF	Moisture Content, %	Dry Density, PCF	Type of Sampler	Sampling Resistance
6									U	3
8.5							26	99	U	4
11				LV		400	30	93	P	100 psi
16	C	104	46	LV		605	92	48	P	
21				LV		890	31	91	P	
26		39	18	LV		1910	23	104	U	18
31							25	102	U	50
36							20	109	U	34
41				LV		1790	25	100	U	30
53		53	28	LV		1560	38	84	U	22
61							30	94	U	37
71				LV		2360	38	84	U	26
81							31	91	U	42
91							28	96	U	78

Symbols	Description
CL	ASPHALT PAVEMENT AND SUBBASE BROWN GRAVELY SANDY CLAY (FILL)
CL	GRAY SILTY CLAY WITH ORGANICS AND A TRACE OF SAND AND GRAVEL (SOFT) (HYDRAULIC FILL)
CH/MH	DARK GRAY SILTY CLAY TO CLAYEY SILT (SOFT) (BAY MUD) 6"-12" BROWN PEAT LAYER @18' DEPTH (GRADING WITH ORGANICS, MEDIUM STIFF)
CL	GREENISH GRAY SILTY CLAY WITH ORGANICS (STIFF)
SP/SM	BROWN MEDIUM TO FINE SAND WITH TRACE OF SILT (MEDIUM DENSE) (GRADES SILTIER AND COARSER)
CH	BLUE GRAY SILTY CLAY
CL	GRAYISH BROWN SILTY CLAY WITH TRACE SAND, GRAVEL (STIFF)
SW	COARSE GRAVELY SAND WITH TRACE
CH	MEDIUM GRAY CLAY WITH SOME SHELLS (STIFF) (OLD BAY MUD) (GRADES TO BLUE-GRAY) (GRADING SANDY)
SM	FINE GRAY SILTY SAND WITH TRACE OF (DENSE)

BORING COMPLETED TO A DEPTH OF 91.5 FEET ON 8/21/86

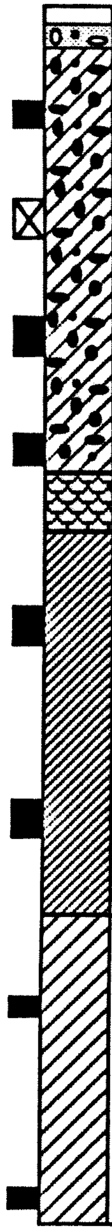
BORING B-1

DATE DRILLED: 9/30/87
SURFACE ELEVATION: 10.4 ±
Richmond Refinery Datum

GW +5.4

	LABORATORY TEST DATA						SAMPLING	
DEPTH IN FEET	TESTS REPORTED ELSEWHERE	STRENGTH TEST DATA: TYPE OF STRENGTH TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE, PSF	STRENGTH TEST DATA: SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	TYPE OF SAMPLER	SAMPLING RESISTANCE (BLOWS/FOOT)
0								
							U	16
5								
							U	6
							U	6
10								
							U	10
15								
		TV		100	81	53	U	0
20								
		TV		350	97	45	TW	2
25								
		TV		2250	32	94	U	15
30								
		TV		2250	24	103	U	15
35								
40								

SAMPLES | SYMBOLS | DESCRIPTION



SYMBOLS	DESCRIPTION
	CONCRETE
GW	GRAY FINE TO COARSE GRAVEL (BASE ROCK)
GC	DARK GRAY CLAYEY GRAVEL with silt and sand (medium dense) [FILL]
	Groundwater level 9/30/87
	Grades less dense
PT	BLACK SILTY PEAT (very soft) [PEATY BAY MUD]
CH	DARK GRAY SILTY CLAY with organics (very soft) [BAY MUD]
CL	GREEN-GRAY SILTY CLAY with fine sand partings; trace shells, trace organics (stiff)
	Grades stiffer, mottled green and brown

NOTES:
1. Boring completed at a depth of 31.5 feet on 10/1/87. Water encountered at 5 feet.
2. Elevations refer to refinery datum and are estimated from Chevron USA drawing GT-F-12428-0.
3. Dames & Moore type "U" sampler driving resistance is measured in blows per foot required to drive a "U" sampler 12 inches with a 400 pound hammer falling 18 inches after sampler has been seated 6 inches.
4. For an explanation of terms used see Soil Classification and Key to Test Data.

16000-001-03

LOG OF BORING
DAMES & MOORE

PLATE B-1A

BORING B-3

DATE DRILLED: 10/2/87
SURFACE ELEVATION: 10.4 ±
Richmond Refinery Datum

GW +5.4

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	TYPE OF STRENGTH TEST	NORMAL OR CONFINING PRESSURE, PSF	SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	TYPE OF SAMPLER	SAMPLING RESISTANCE (BLOWS/FOOT)
	LABORATORY TEST DATA	STRENGTH TEST DATA					SAMPLING	
0								
							U	14
5								
							U	2
							U	0
10		TV		50			U	1
15		TV		50	85	50	U	0
20		TV		200	43	68	TW	8
25		PP		3500	25	98	U	19
30		PP		4000	23	104	U	21
35								
40								

SYMBOLS	DESCRIPTION
	2" ASPHALT PAVEMENT
GM/GC	BROWN CLAYEY SILTY SANDY GRAVEL (medium dense) [FILL]
GM	BLACK SILTY SANDY GRAVEL with strong hydrocarbon odor; oil in sample [FILL] Groundwater level 10/2/87
PT	BLACK PEAT with strong hydrocarbon odor (soft) Grades to brown and dark gray peat
CH	DARK GRAY SILTY CLAY (very soft) [MUD]
CH	DARK GRAY SILTY CLAY (medium stiff) [OLDER BAY MUD]
CL	DARK GREENISH-GRAY SILTY CLAY (medium stiff) Grades to mottled brown and green-gray sandy silty clay (stiff) Grades sandy (very stiff)

NOTES:
1. Boring completed at a depth of 31.5 feet on 10/2/87. Water encountered at 5 feet.
SEE NOTES ON PLATE B-1A.

16000-001-03

LOG OF BORING

DAMES & MOORE

PLATE B-1C

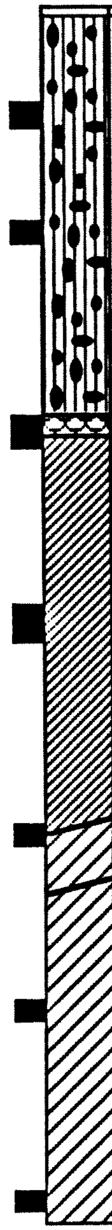
BORING B-4

DATE DRILLED: 10/2/87
SURFACE ELEVATION: 10.5 ±
Richmond Refinery Datum

GW. 7.5

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	STRENGTH TEST DATA: TYPE OF STRENGTH TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE, PSF	STRENGTH TEST DATA: SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE (BLOWS/FOOT)
0–5							U	30
5–10							U	9
10–15		TV LV		0 138	94	42	U	2
15–20		TV LV		40 323	91	47	TW	1
20–25		PP LV		500 495	50	65	TW	7
25–30		PP		2250	29	98	U	9
30–35		PP LV		2500 1490	36	86	U	6
35–40								

SAMPLES SYMBOLS DESCRIPTION



Symbol	Description
	ASPHALT PAVEMENT
GM	DARK GRAY COARSE TO FINE GRAVEL with sand, silt and clay (moist) (medium dense) Groundwater level 10/2/87 Grades looser, strong hydrocarbon odor
PT	DARK GRAY SILT with brown to black peat (very soft) [PEATY BAY MUD]
CH	DARK GRAY SILTY CLAY with moderate hydrocarbon odor (wet) (very soft) [BAY MUD]
CL	DARK BROWN CLAY (stiff)
CL	LIGHT GRAY CLAY with trace sand (medium stiff) Grading stiff Grades to mottled gray-green and brown silty clay

NOTES:
1. Boring completed at a depth of 31.5 feet on 10/2/87. Water encountered at 2.8 feet.
SEE NOTES ON PLATE B-1A.

0-001-03

LOG OF BORING
DAMES & MOORE

PLATE B-1D

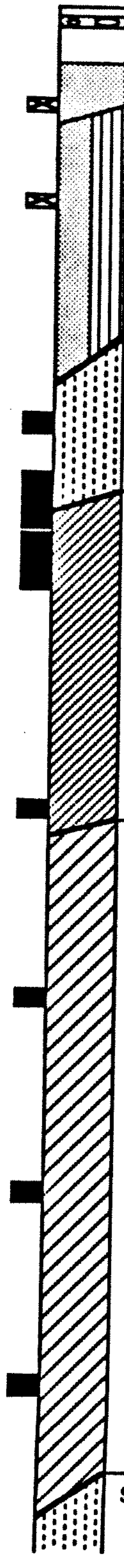
BORING B-5

DATE DRILLED: 10/8/87 to 10/13/87
SURFACE ELEVATION: 10.8 ± Feet
Richmond Refinery Datum

Gw 47.8

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	STRENGTH TEST DATA: TYPE OF STRENGTH TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE, PSF	STRENGTH TEST DATA: SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE (BLOWS/FOOT)
0								
							G	
5								
							G	
10								
					87	46	U	2
	C	LV		681	103	44	P	
	C	LV		330	88	49	P	
15								
							TW	1
20								
		TV		500	32	91	U	5
25								
		TV		700	30	93	U	9
30								
					31	94	U	8
35								
		TV		700	30	91	U	11
40								

SAMPLES



SYMBOLS	DESCRIPTION
	ASPHALT PAVEMENT
GM	BROWN SILTY GRAVEL
	CONCRETE
GM	BROWN SILTY SANDY GRAVEL (moist) [FILL]
GC/GM	▽ Groundwater level 10/9/87
	GRAY SILTY CLAYEY GRAVEL with visible hydrocarbons, strong odor [FILL]
SM	BLACK SILTY FINE SAND with hydrocarbon odor (loose)
CH	GRAY SILTY CLAY (medium stiff) [BAY MUD]
	Grades soft
	Silty clay (medium stiff) [OLDER BAY MUD]
CL	BROWN CLAY (medium stiff)
	Grades to light brown silty clay
	Grades mottled brown and light brown
SM	

16000-001-03

LOG OF BORING
DAMES & MOORE

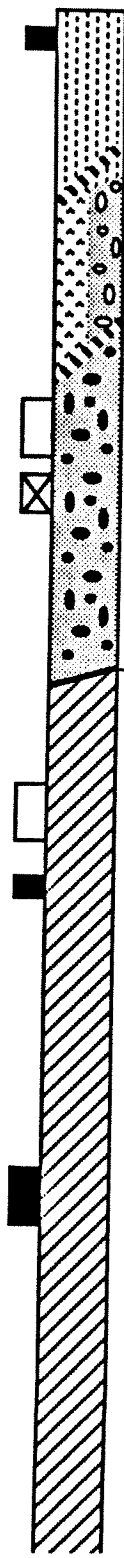
PLATE B-1E

BORING B-5 (continued)

DATE DRILLED: 10/8/87
SURFACE ELEVATION: 10.8 ± Feet
Richmond Refinery Datum

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	STRENGTH TEST DATA: TYPE OF STRENGTH TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE, PSF	STRENGTH TEST DATA: SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE (BLOWS/FOOT)	SYMBOLS	DESCRIPTION
40					28	93	U	27	SM	BROWN CLAYEY SILTY SAND (medium dense)
									SW / GW	Grading to gravelly coarse sand
45										
									GP	MEDIUM TO COARSE GRAVEL (medium dense)
50							U	24		
							U	31		
55										
									CL	LIGHT GRAY SILTY CLAY (stiff)
60							U	22		
					29	93	U	21		
65										
70		TV		1000	30	91	U	27		
75										
										Grades very stiff
80										

SAMPLES



16000-001-03

LOG OF BORING
DAMES & MOORE

PLATE B-1F

BORING B-5 (continued)

DATE DRILLED: 10/8/87 to 10/13/87
SURFACE ELEVATION: 10.8 ± Feet
Richmond Refinery Datum

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	TYPE OF STRENGTH TEST	NORMAL OR CONFINING PRESSURE, PSF	SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	TYPE OF SAMPLER	SAMPLING RESISTANCE (BLOWS/FOOT)	SYMBOLS	DESCRIPTION
80		TV		1940	32	90	U	37	CL	
									SM	GRAY SILTY MEDIUM FINE SAND (very dense)
90					25	102	U	105		
95									ML/CL	GRAY SILTY CLAY (medium stiff)
		LV		1136	36	84	U	88		
100										
105										
110										
115										
120										

NOTES:
1. Boring completed at a depth of 100.0 feet on 10/2/87. Water encountered at 3 feet.
SEE NOTES ON PLATE B-1A.

16000-001-03

LOG OF BORING
DAMES & MOORE

PLATE B-1G

BORING B-6

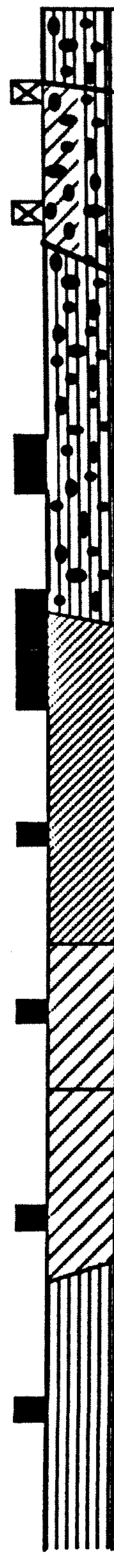
DATE DRILLED: 10/8/87
SURFACE ELEVATION: 12.0 ± Feet
Richmond Refinery Datum

Gw +7.0

LABORATORY TEST DATA / SAMPLING

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	TYPE OF STRENGTH TEST	NORMAL OR CONFINING PRESSURE, PSF	SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	TYPE OF SAMPLER	SAMPLING RESISTANCE (BLOWS/FOOT)
0–5							G	-
5–10							G	-
10–15							U	13
15–20		LV TV		621 400	87	48	P	
	C	LV PP		671 1000	85	50	P	
20–25		LV TV		282 240	82	50	U	3
25–30		PP		2500	28	96	U	9
30–35		LV		1746	29	94	U	8
35–40					29	93	U	12

SAMPLES / SYMBOLS / DESCRIPTION



SYMBOLS	DESCRIPTION
GM	BROWN AND GRAY SILTY SANDY GRAVEL with brick fragments (moist) (FILL)
GC/GM	GRAY SILTY CLAYEY FINE GRAVEL (moist) (FILL) (strong hydrocarbon odor) Ground water level 10/8/87
GM	DARK GRAY FINE GRAVEL with silt (wet) (loose) (strong hydrocarbon odor)
CH	DARK GRAY SILTY CLAY with trace organics (medium soft) (BAY MUD)
CL	DARK GRAY SILTY CLAY TRACE FINE TO COARSE SAND, trace organics (very stiff) (OLDER BAY MUD)
CL	MOTTLED BROWN AND GREENISH GRAY CLAY with trace sand (VERY STIFF)
ML	BROWN CLAYEY SILT with trace fine sand (stiff) (Occasional sandy seams)

1600-001

LOG OF BORING
DAMES & MOORE

PLATE B-1H

BORING B-6 (continued)

DATE DRILLED: 10/8/87
SURFACE ELEVATION: 12.0 ± Feet
Richmond Refinery Datum

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	TYPE OF STRENGTH TEST	NORMAL OR CONFINING PRESSURE, PSF	SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	TYPE OF SAMPLER	SAMPLING RESISTANCE (BLOWS/FOOT)	SYMBOLS	DESCRIPTION
40									ML	
		PP		2750	35	82	U	16	CL	GRAYISH BROWN SILTY CLAY, trace fine sand (stiff)
									ML	OLIVE GRAY CLAYEY SILT (soft)
45					32	89	U	16		
									CL	OLIVE GRAY SILTY CLAY (stiff)
50		PP		2500	28	92	U	14	ML	OLIVE GRAY SILT, trace clay, trace fine sand
									CL	OLIVE GRAY SILTY CLAY (medium stiff)
55		LV PP		1879 1750	32	92	U	19		
60							U	19		
65		PP		2250	31	90	U	16	ML/CL	OLIVE GRAY SILTY CLAY (stiff)
70		PP		2750			U	15		Occasional fine gravelly seams
									CL	MOTTLED BROWN AND OLIVE-GRAY SILTY CLAY (stiff)
75		PP		3300	26	98	U	34		
80										

BORING B-6 (continued)

DATE DRILLED: 10/8/87
SURFACE ELEVATION: 12.0 ± Feet
Richmond Refinery Datum

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	STRENGTH TEST DATA: TYPE OF STRENGTH TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE, PSF	STRENGTH TEST DATA: SHEAR STRENGTH, PSF	MOISTURE CONTENT %	DRY DENSITY, PCF	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE (BLOWS/FOOT)
80		LV		2899	37	85	U	27
85					37	85	U	24
90		PP		5000			U	53
95		PP		4500	25	101	U	71
100							U	50/5 1/2
105								
110								
115								
120								

SAMPLES

SYMBOLS	DESCRIPTION
CL	MOTTLED BROWN AND OLIVE GRAY SILTY CLAY (stiff)
CL	GRAY SILTY CLAY with brown silt inclusions (residual soil)
ML	SILTY CLAY (stiff) (residual soil)
GC/CL	BROWN FINE GRAVELLY CLAY TO CLAYEY FINE GRAVEL TO 1" (very stiff) (highly weathered rock)
GC/CL	BROWN AND BLACK FISSURED SHALE

NOTES:
1. Boring completed at a depth of 100.5 feet on 10/9/87.
SEE NOTES ON PLATE B-1A.

16000-001

LOG OF BORING
DAMES & MOORE

PLATE B-1J

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

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LIST OF FIGURES

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

SCOPE OF THE PROGRAM

URS performed a geotechnical testing program in the laboratory to measure the index and engineering properties of the major subsurface strata encountered at the site. The geotechnical testing program included conventional tests to confirm the existing information on the engineering characteristics of the major strata and to refine some of the engineering parameters where we deemed appropriate. Signet Testing Labs, a URS Company, of Hayward, California performed the tests.

This section briefly describes the testing program and procedures for the different types of tests and presents the test results for soils.

LABORATORY INDEX TESTS

The index tests included moisture contents, density determinations, Atterberg limits, and grain-size analyses using mechanical sieve in accordance with the applicable ASTM standards. The ASTM standards consisted of:

1. ASTM D 2216 for moisture content tests;
2. ASTM D 2937 for total and dry density tests;
3. ASTM 422 for grain size analyses; and
4. ASTM D 4318 for Atterberg Limits.

Results of the moisture content, dry density, grain size analyses and Atterberg limits are presented on the Log of Boring adjacent to the appropriate sample depth. In addition, index test data are tabulated on Table B1, particle size distributions are presented graphically in Figures B1 through B2.

TABLE B1
SUMMARY OF LABORATORY INDEX TEST RESULTS

Boring	Depth (feet)	Soil Type	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	Passing #200 Sieve (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
CG-1	120	ML	-	-	-	75.8	-	-	-
CG-1	15	MH	98.7	91.2	45.9		102	53	49
CG-2	70	ML	-	-	-	86.3	-	-	-
CG-2	25	CL	24.3	123.1	99.0	-	46	25	21
CG-2	40	CL	-	-	-	-	33	19	14
CG-2	45	SP	10.5	132.5	119.9	-	-	-	-
CG-2	60	MH	30.4	118.9	91.1	-	69	37	32
CG-2	95	SC	12.5	134.6	120.8	-	-	-	-

TRIAXIAL STRENGTH TESTS

Seven Unconfined Compression (UC) Tests were performed on selected samples of the Alluvial Clays. The tests were performed in accordance with the procedures in ASTM D 2850. Results of UC tests are presented adjacent to the appropriate sample depth on the Log of Boring. The results of the UC tests are summarized on Table B2, and plots of deviator stress versus axial strain for each test are presented on Figures B9 through B10.

TABLE B2
SUMMARY OF UNCONFINED COMPRESSION TEST RESULTS

Boring	Depth (feet)	Soil Type	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	Shear Strength (psf)	Strain at Failure (%)
CG-1	55	CL	31.7	121.0	91.8	660	11.1
CG-1	75	CL	38.5	113.6	82.0	1,600	8.7
CG-1	105	CL	38.3	115.3	83.3	493	8.1
CG-1	115	CH	29.1	120.9	93.7	2,782	5.63
CG-1	140	SC	17.4	134.3	114.4	4,382	8.2
CG-2	35	CL	23.5	127.7	103.4	1,819	11.1
CG-2	65	CH	31.2	119.4	91.0	2,067	10.7
CG-2	90	CL	35.9	112.7	83	1,597	5.7

CONSOLIDATION TESTS

Two consolidation tests were performed on samples of the Recent Bay Deposits to evaluate their compressibility characteristics and influence of past geologic history. All consolidation tests were performed in general accordance with the procedures outlined in ASTM D2435. However, small consolidation stress increments were applied until the specimen was compressed into the virgin compression zone. The purpose of this procedure was to refine the estimates of the maximum past pressure. An unload-reload cycle was applied on all samples near the transition between the initial recompression and virgin compression portions of the curve in order to better evaluate the recompression characteristics of the soils.

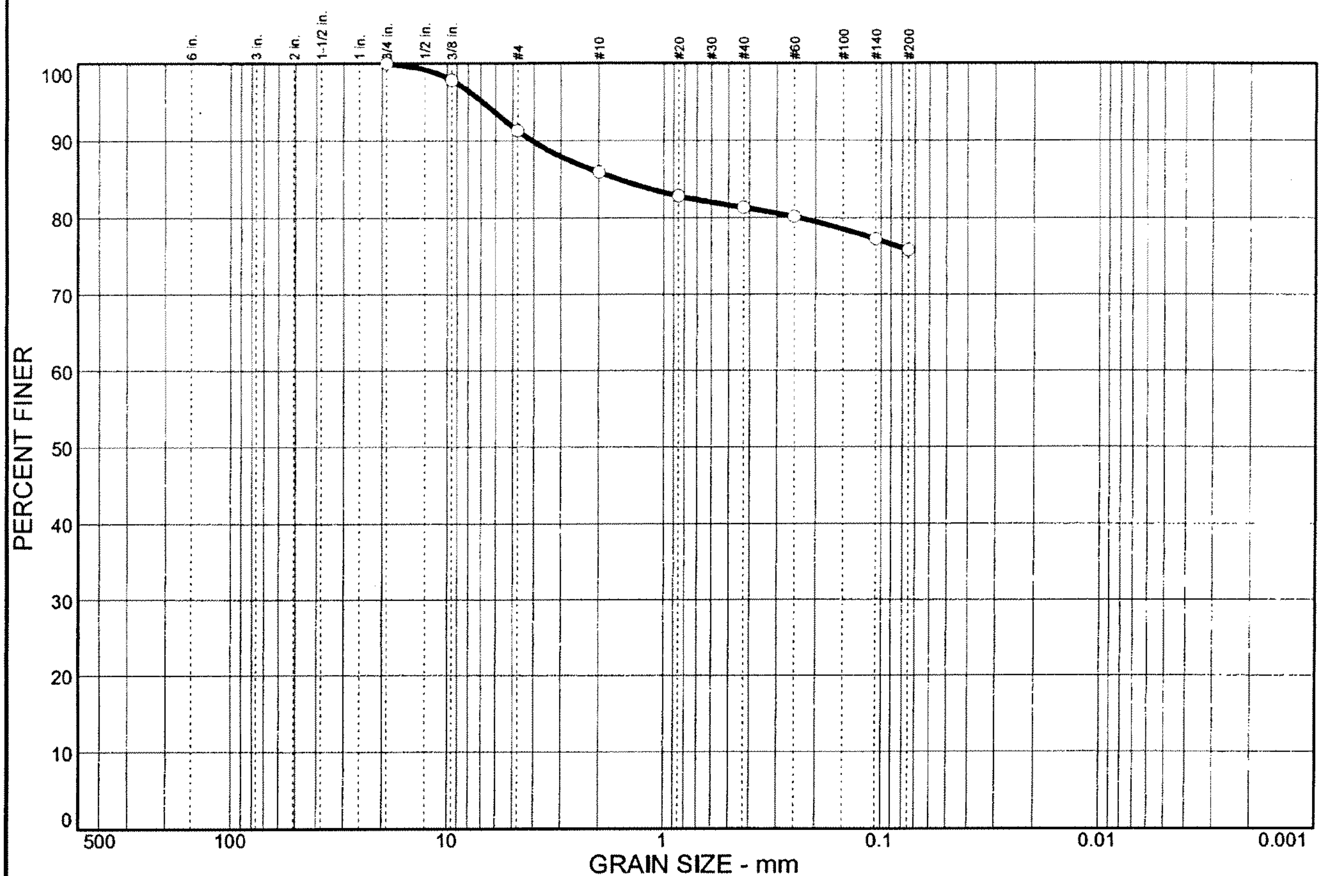
Table B3 presents the results of the consolidation tests. The compressibility parameters, Compression Ratio (Cc), Recompression Ratio (Cr) and coefficient of consolidation (Cv) are summarized on this table. The maximum past pressures were estimated using the Casagrande construction and the end-of-primary consolidation compression curve. The overconsolidation ratio (OCR) can be computed from the maximum past pressure divided by the in situ vertical effective pressure at the depth from which the sample was obtained.

The compression curves (vertical strain at the end of load increment versus the log of the effective stress and the time-rate curves for selected loading increments (dial reading versus the square root of time in minutes) are included on Figures B9 through B10.

TABLE B3
SUMMARY OF CONSOLIDATION TEST RESULTS

Boring	Depth (feet)	Soil Type	Moisture Content (%)	Total Density (pcf)	Compression Ratio (Cc/(1+e))	Recompression Ratio (Cr/(1+e))	Coefficient of consolidation(Cv)
CG-1	15	CH	98.7	91.2	0.40	0.05	0.02
CG-2	25	CL	24.3	123.1	0.22	0.15	0.01

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	8.7	5.4	4.6	5.5	75.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	97.8		
#4	91.3		
#10	85.9		
#20	82.8		
#40	81.3		
#60	80.1		
#140	77.2		
#200	75.8		

* (no specification provided)

Soil Description

Olive gray clay with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.62 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

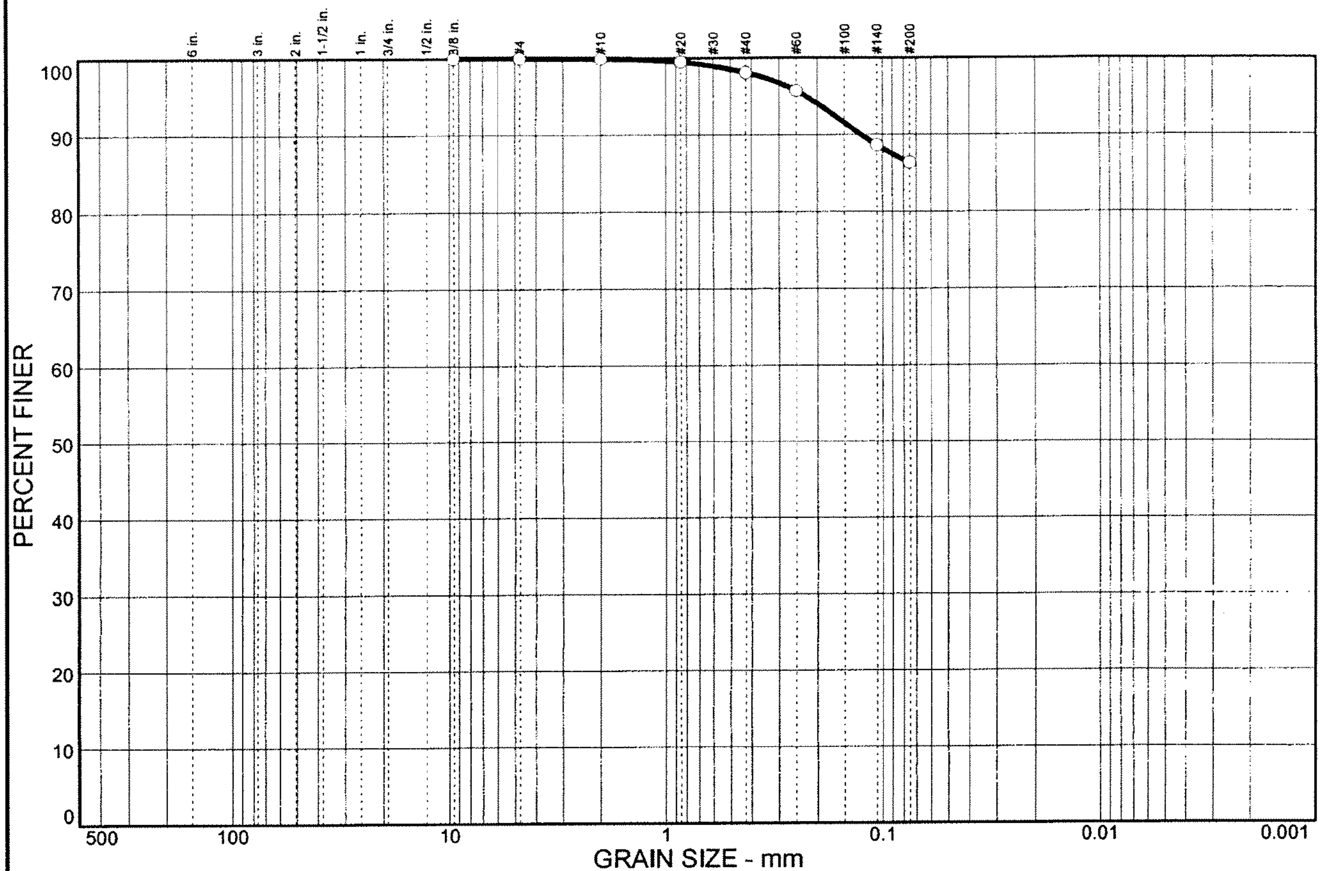
USCS= ML AASHTO=

Remarks

Sample No.: 25 **Source of Sample:** CG-1 **Date:**
Location: **Elev./Depth:** 120

Client: URS
Project: Chevron- COGEN 3000
Project No: 28067039.41000 **Plate** B-1

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	1.8	11.8	86.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.5		
#40	98.1		
#60	95.7		
#140	88.6		
#200	86.3		

* (no specification provided)

Soil Description

Olive gray clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

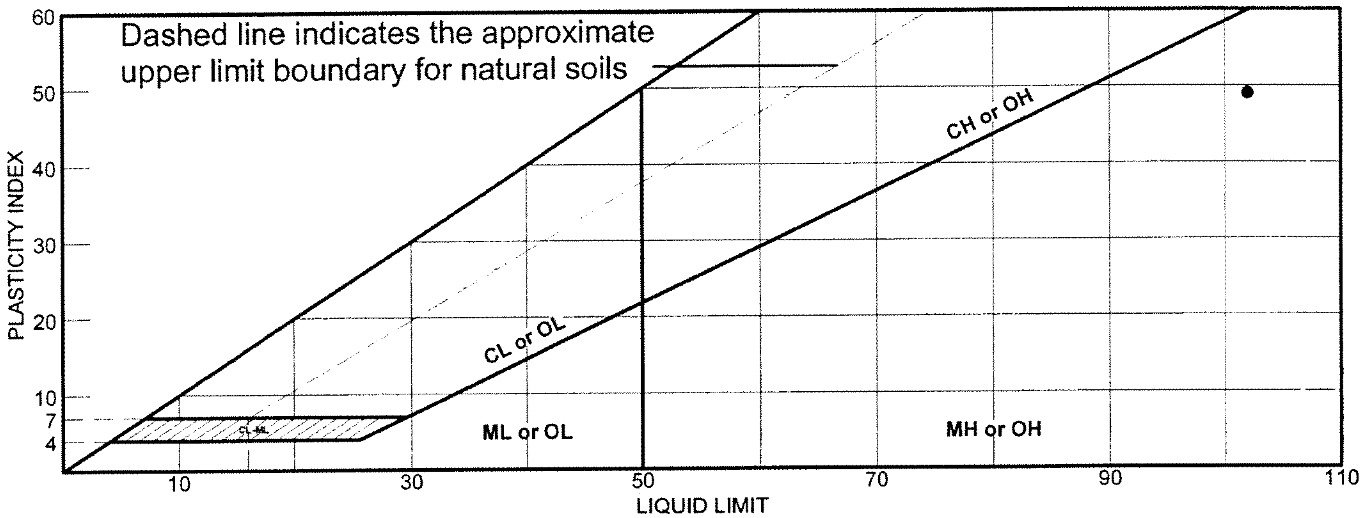
USCS= ML AASHTO=

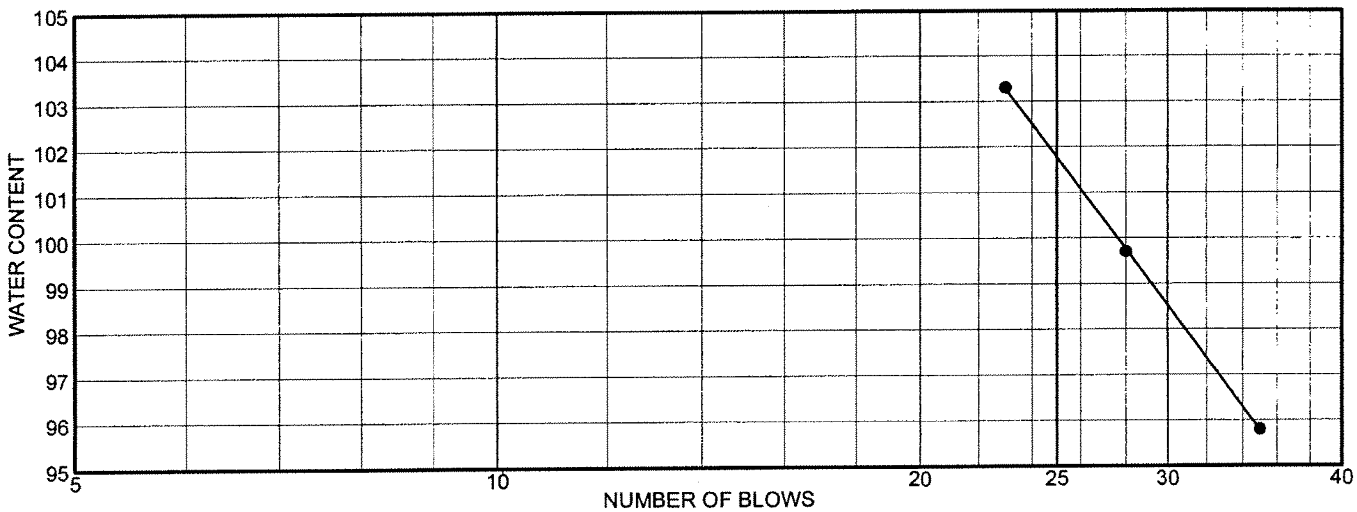
Remarks

Sample No.: 15 **Source of Sample:** CG-2 **Date:**
Location: **Elev./Depth:** 70

Client: URS
Project: Chevron- COGEN 3000
Project No: 28067039.41000 **Plate** B-2

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray silt	102	53	49			

Project No. 28067039.41000 **Client:** URS

Project: Chevron- COGEN 3000

● **Source:** CG-1 **Sample No.:** 4 **Elev./Depth:** 15-16.5

Remarks:

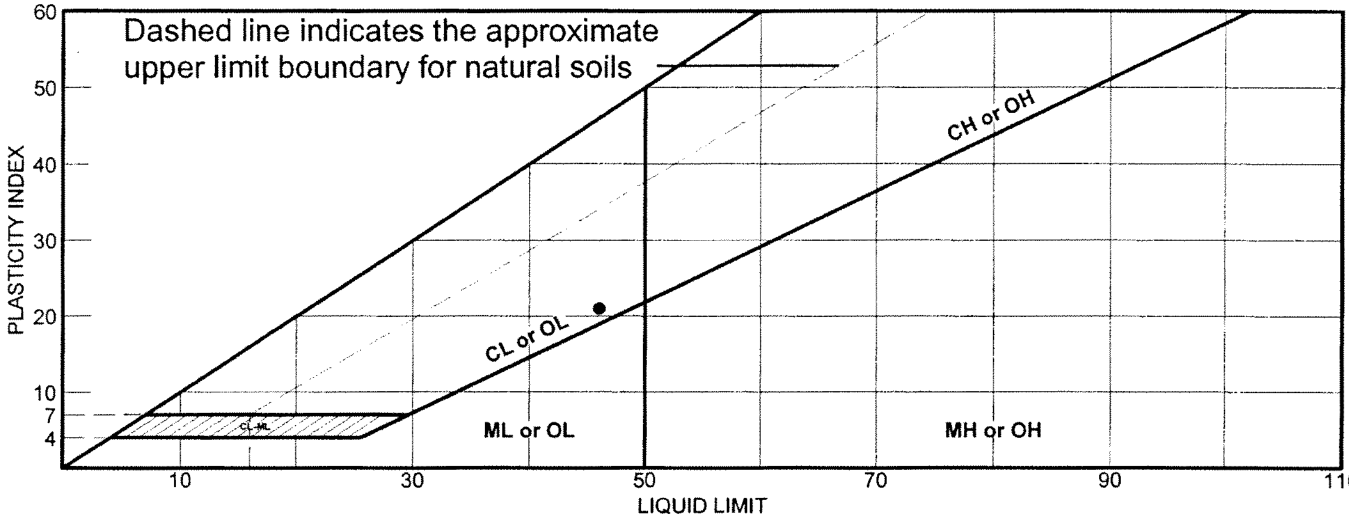
●

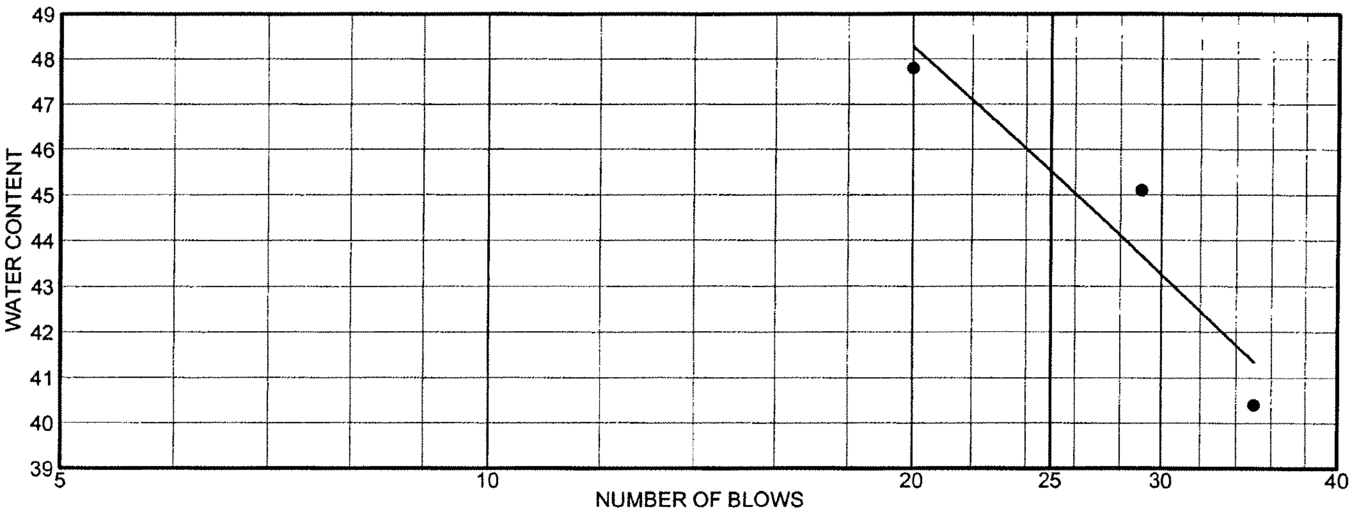
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-3

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray clay	46	25	21			

Project No. 28067039.41000 **Client:** URS

Project: Chevron- COGEN 3000

● **Source:** CG-2 **Sample No.:** 6 **Elev./Depth:** 25

Remarks:

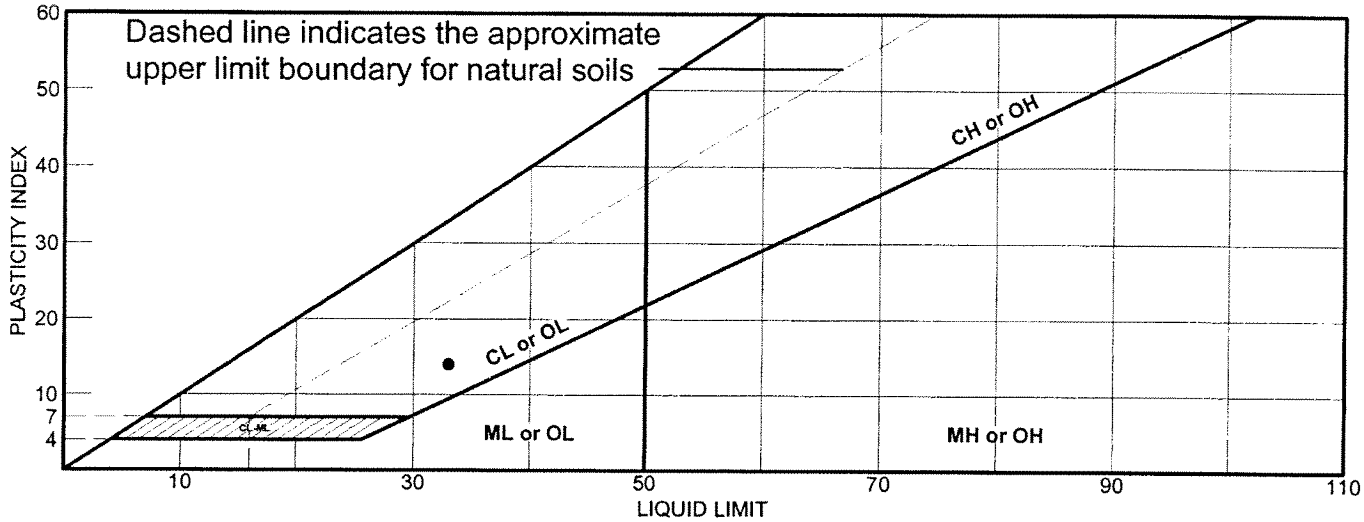
●

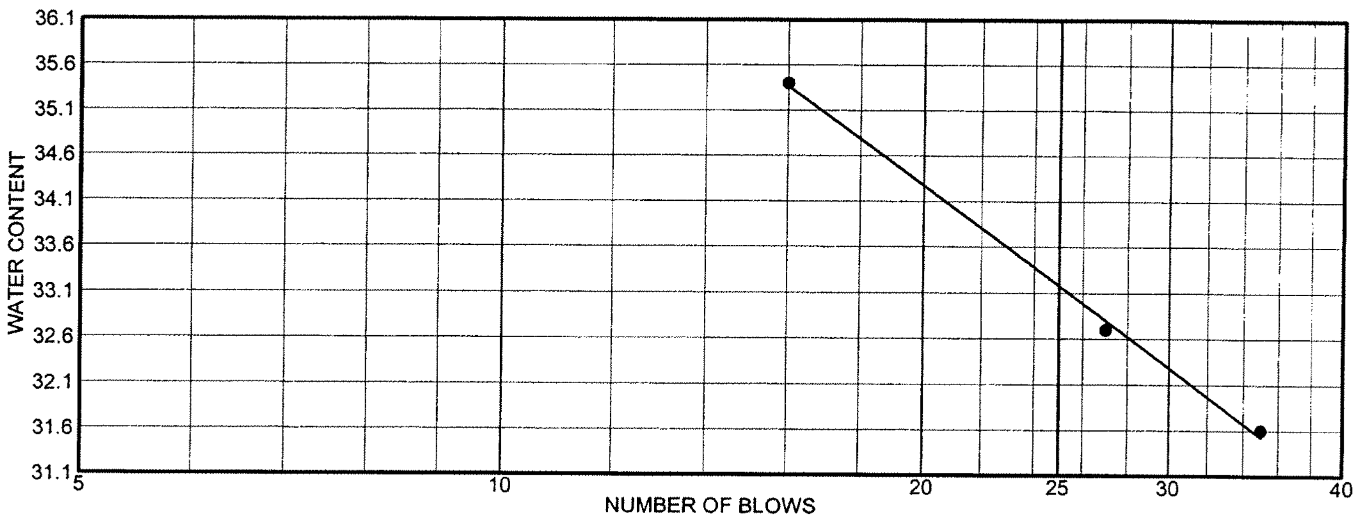
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-4

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray clay	33	19	14			

Project No. 28067039.41000 **Client:** URS

Project: Chevron- COGEN 3000

● **Source:** CG-2 **Sample No.:** 9 **Elev./Depth:** 40

Remarks:

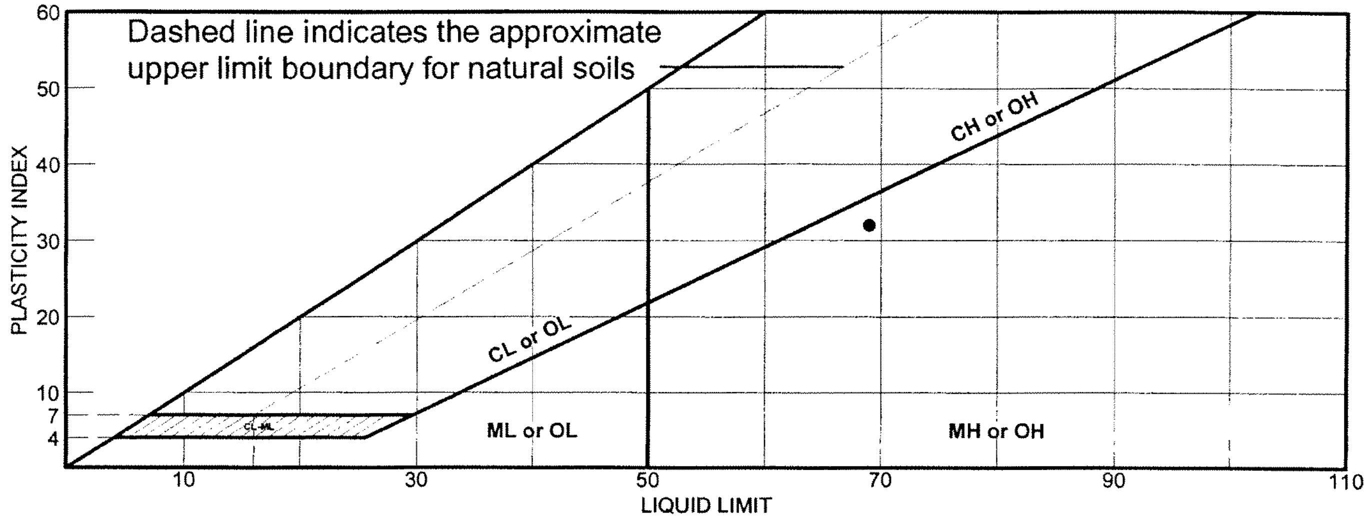
●

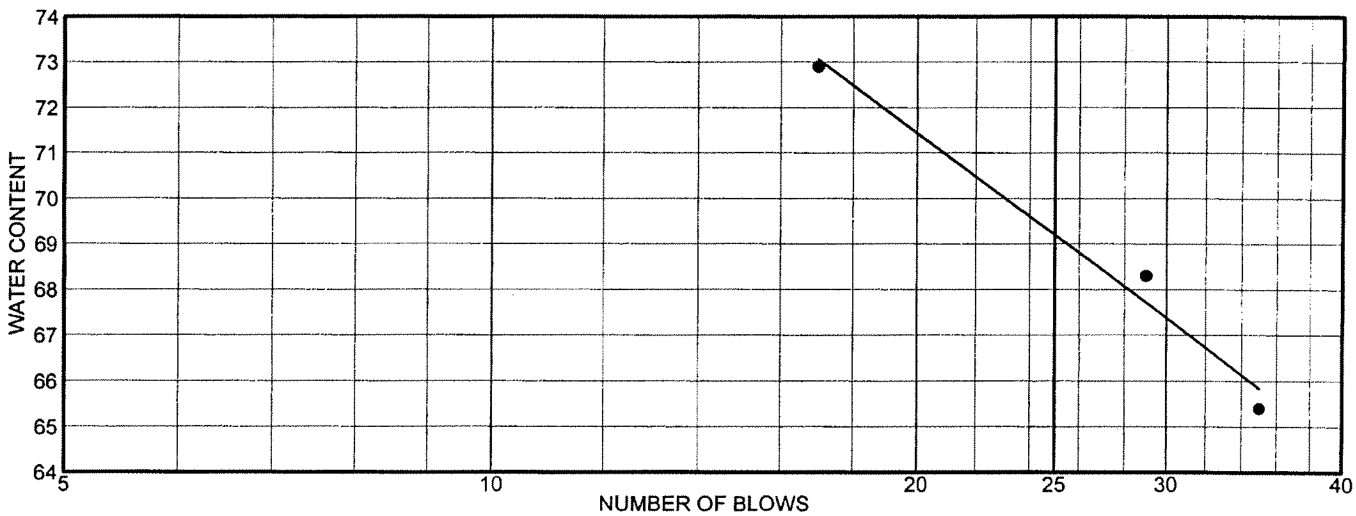
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-5

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray silt	69	37	32			

Project No. 28067039.41000 **Client:** URS

Project: Chevron- COGEN 3000

● **Source:** CG-2 **Sample No.:** 13 **Elev./Depth:** 60

Remarks:

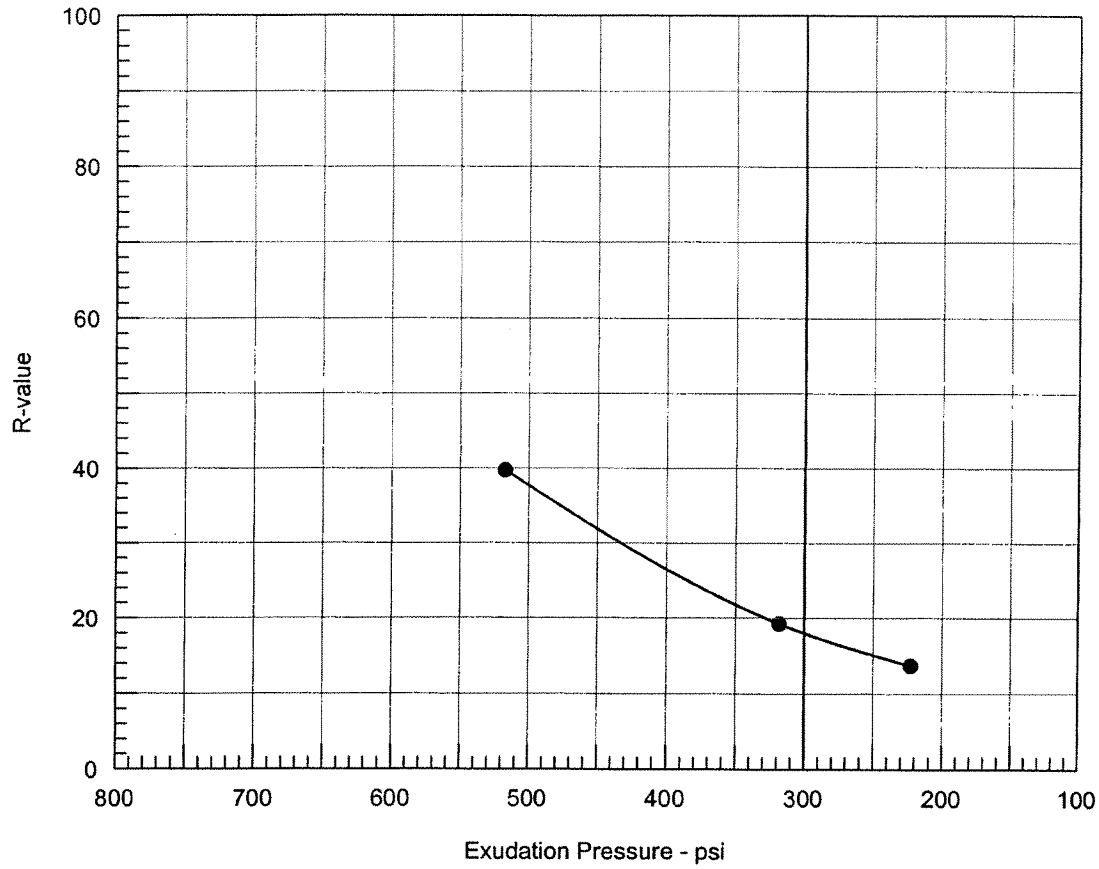
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-6

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - Cal Test 301

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	75	126.0	11.6	0.24	114	2.37	318	21	19
2	175	124.5	10.8	1.18	79	2.30	517	45	40
3	60	120.2	12.1	0.00	130	2.49	223	14	14

Test Results	Material Description
R-value at 300 psi exudation pressure = 18	Brown gravelly clayey silt

Project No.: 28067039.41000
Project: Chevron- COGEN 3000
Source of Sample: CG-1 **Depth:** 0-3
Sample Number: BS-1
Date: 7/3/2006

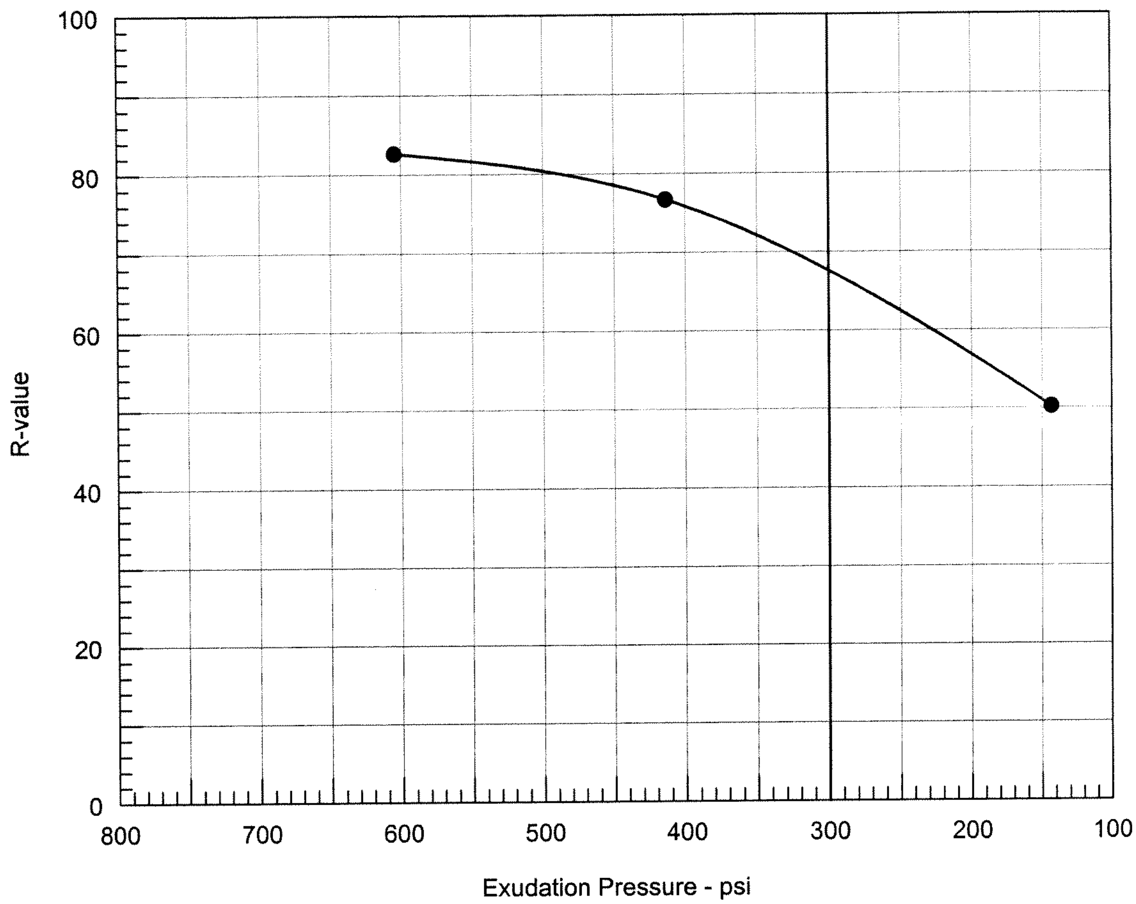
Tested by:
Checked by:
Remarks:

R-VALUE TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-7

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - Cal Test 301

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	200	119.6	11.6	0.15	24	2.40	414	78	77
2	200	115.1	12.5	0.00	60	2.60	143	48	50
3	350	117.7	10.7	0.18	20	2.46	605	83	83

Test Results	Material Description
R-value at 300 psi exudation pressure = 68	Light brown gravelly sandy silt

Project No.: 28067039.41000
Project: Chevron- COGEN 3000
Source of Sample: CG-2 **Depth:** 0-3
Sample Number: BS-1
Date: 7/3/2006

Tested by:
Checked by:
Remarks:

R-VALUE TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-7

cont.

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-1
Sample # : 12
Depth (ft) : 55
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed olive gray sandy clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

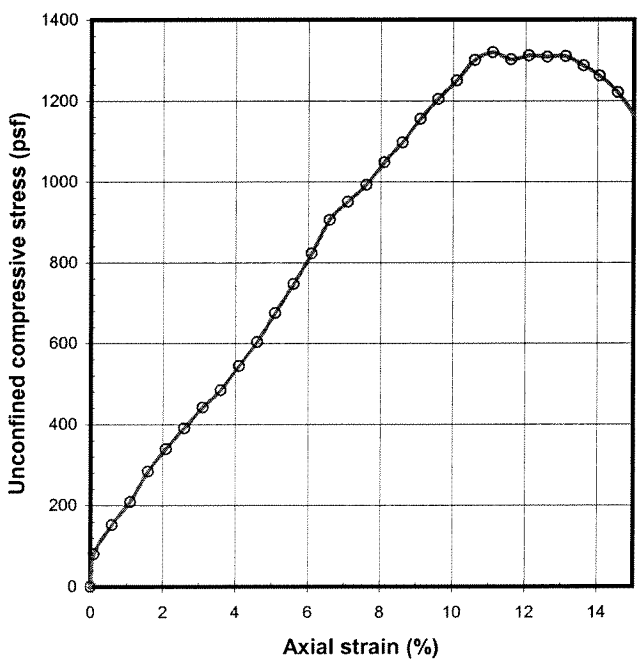
Specimen:

Total wt. =	836.0	gms
Ht. =	5.88	in
Ave dia. =	2.387	in
Area =	4.476	sq.in
Volume =	431.2	c.c.
Shearing rate =	0.08	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.835	
Ht/Dia ratio =	2.46	
Moisture =	31.7	%
Total density =	121.0	pcf
Dry density =	91.8	pcf
Saturation =	102.6	%
Unconfined compressive strength =	1319	psf
Shear strength =	660	psf
Strain @ failure =	11.10	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	2.5	0.10	80.4
0.035	4.8	0.60	152.4
0.064	6.6	1.10	209.0
0.094	9.0	1.60	284.0
0.123	10.8	2.10	339.1
0.153	12.5	2.60	390.3
0.182	14.2	3.10	442.0
0.212	15.6	3.60	484.4
0.241	17.6	4.10	543.9
0.271	19.7	4.60	603.5
0.300	22.1	5.10	674.9
0.329	24.6	5.60	746.7
0.359	27.2	6.10	822.9
0.388	30.1	6.60	905.7
0.417	31.8	7.10	950.6
0.447	33.4	7.61	992.5
0.477	35.5	8.10	1048.5
0.506	37.3	8.60	1096.9
0.535	39.5	9.10	1155.7
0.565	41.4	9.60	1204.4
0.594	43.2	10.10	1250.5
0.623	45.2	10.60	1300.6
0.653	46.1	11.10	1319.2
0.682	45.8	11.60	1302.5
0.712	46.4	12.10	1311.3
0.741	46.5	12.61	1308.9
0.771	46.8	13.11	1309.7
0.800	46.3	13.61	1286.9
0.826	45.6	14.05	1262.3
0.856	44.4	14.56	1221.0
0.883	42.4	15.02	1160.0



(see worksheet for sketch of failure)

Figure B-8

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-1
Sample # : 16
Depth (ft) : 75
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed grayish brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

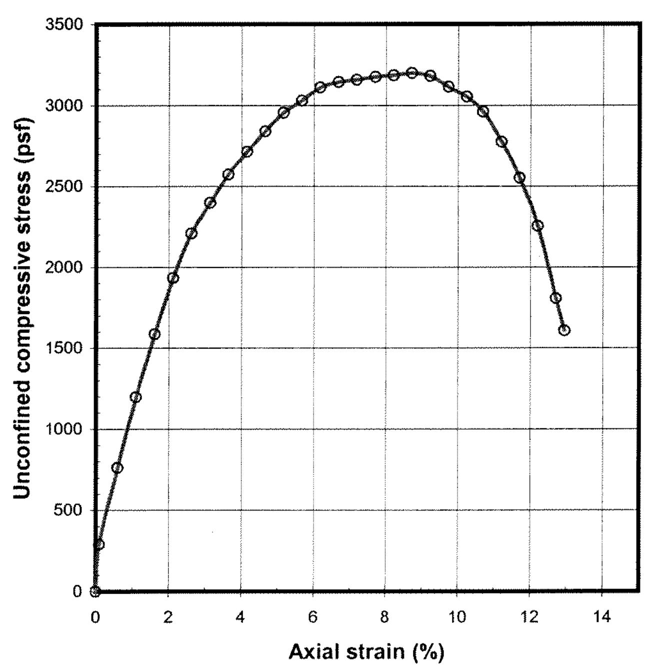
Specimen:

Total wt. =	814.9	gms
Ht. =	6.00	in
Ave dia. =	2.407	in
Area =	4.551	sq.in
Volume =	447.5	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	1.054	
Ht/Dia ratio =	2.49	
Moisture =	38.5	%
Total density =	113.6	pcf
Dry density =	82.0	pcf
Saturation =	98.7	%
Unconfined compressive strength =	3199	psf
Shear strength =	1600	psf
Strain @ failure =	8.71	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	9.2	0.10	290.3
0.036	24.2	0.61	761.5
0.067	38.3	1.11	1197.1
0.097	50.9	1.62	1585.1
0.127	62.4	2.12	1932.2
0.158	71.7	2.63	2207.8
0.189	78.2	3.14	2397.3
0.219	84.4	3.65	2572.6
0.250	89.5	4.16	2713.7
0.280	94.1	4.67	2839.0
0.310	98.5	5.17	2954.1
0.340	101.5	5.67	3028.5
0.371	104.7	6.18	3108.8
0.401	106.4	6.69	3142.5
0.432	107.5	7.19	3156.1
0.462	108.7	7.70	3175.4
0.492	109.7	8.21	3185.3
0.523	110.8	8.71	3199.1
0.553	110.7	9.22	3180.5
0.584	109.0	9.73	3113.4
0.614	107.5	10.24	3051.9
0.641	104.8	10.69	2960.6
0.672	98.7	11.20	2774.6
0.702	91.4	11.70	2552.4
0.733	81.1	12.21	2252.9
0.763	65.4	12.72	1806.8
0.778	58.3	12.96	1606.6



(see worksheet for sketch of failure)

Figure B-9

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-1
Sample # : 22
Depth (ft) : 105
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed gray sandy clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

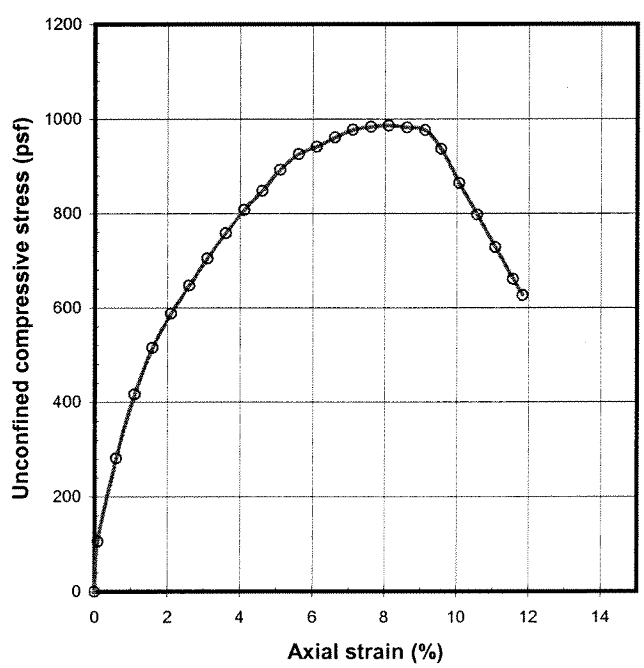
Specimen:

Total wt. =	806.6	gms
Ht. =	5.97	in
Ave dia. =	2.383	in
Area =	4.463	sq.in
Volume =	436.6	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	1.022	
Ht/Dia ratio =	2.50	
Moisture =	38.3	%
Total density =	115.3	pcf
Dry density =	83.3	pcf
Saturation =	101.3	%
Unconfined compressive strength =	986	psf
Shear strength =	493	psf
Strain @ failure =	8.12	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.3	0.09	105.4
0.036	8.8	0.60	281.3
0.066	13.1	1.10	416.6
0.095	16.2	1.60	514.9
0.126	18.6	2.10	587.6
0.156	20.6	2.61	646.9
0.185	22.5	3.10	704.4
0.215	24.4	3.61	758.0
0.246	26.1	4.11	807.2
0.275	27.5	4.61	847.6
0.305	29.2	5.11	892.5
0.335	30.4	5.61	925.9
0.365	31.1	6.11	941.4
0.395	31.9	6.62	960.9
0.425	32.6	7.11	977.2
0.455	33.0	7.62	982.9
0.484	33.3	8.12	985.9
0.515	33.3	8.62	981.7
0.544	33.3	9.12	976.0
0.571	32.1	9.57	936.1
0.601	29.8	10.07	864.1
0.631	27.6	10.57	797.1
0.661	25.4	11.07	728.4
0.691	23.1	11.57	660.5
0.707	22.0	11.84	626.0



(see worksheet for sketch of failure)

Figure B-10

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-1
Sample # : 24
Depth (ft) : 115
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

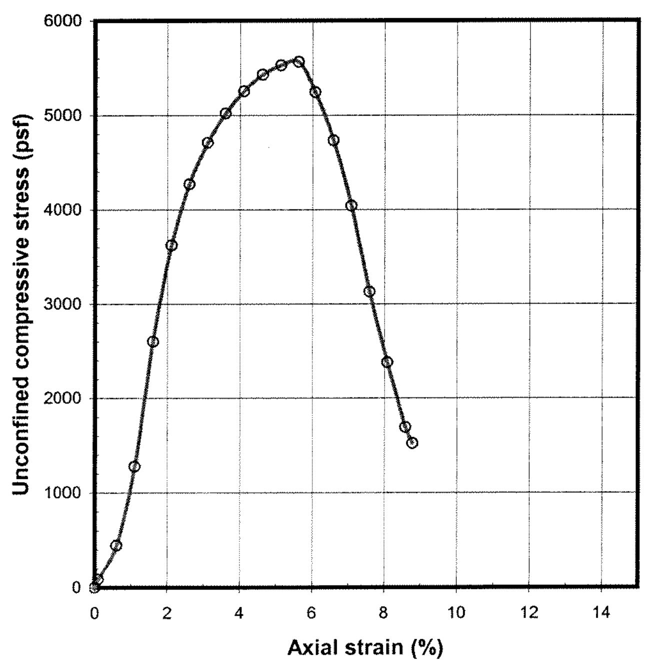
Specimen:

Total wt.	=	866.9	gms
Ht.	=	6.00	in
Ave dia.	=	2.407	in
Area	=	4.551	sq.in
Volume	=	447.5	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.799	
Ht/Dia ratio =	2.49	
Moisture =	29.1	%
Total density =	120.9	pcf
Dry density =	93.7	pcf
Saturation =	98.3	%
Unconfined compressive strength =	5564	psf
Shear strength =	2782	psf
Strain @ failure =	5.63	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	2.8	0.10	87.5
0.036	14.1	0.61	444.4
0.067	40.8	1.11	1276.5
0.097	83.5	1.61	2598.1
0.127	116.9	2.11	3620.8
0.157	138.6	2.61	4270.0
0.187	153.6	3.12	4708.7
0.217	164.6	3.62	5019.5
0.247	173.2	4.12	5254.1
0.278	179.9	4.63	5428.8
0.308	184.1	5.13	5527.5
0.338	186.3	5.63	5563.7
0.365	176.4	6.08	5242.1
0.395	160.1	6.59	4731.2
0.425	137.4	7.08	4038.3
0.455	106.9	7.59	3126.9
0.485	81.8	8.09	2378.0
0.515	58.5	8.59	1691.4
0.527	52.7	8.79	1522.0



(see worksheet for sketch of failure)

Figure B-11

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

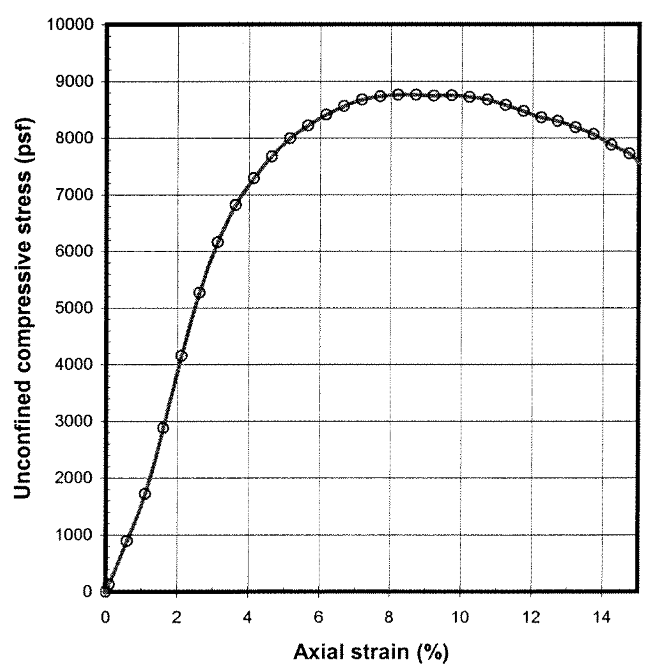
Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-1
Sample # : 29
Depth (ft) : 140
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed reddish brown clay with gravel

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 809.4 gms
Ht. = 5.17 in
Ave dia. = 2.377 in
Area = 4.438 sq.in
Volume = 376.0 c.c.
Shearing rate = 0.05 inch/min
Shearing rate = 1.00 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.473
Ht/Dia ratio = 2.18
Moisture = 17.4 %
Total density = 134.3 pcf
Dry density = 114.4 pcf
Saturation = 99.4 %
Unconfined compressive strength = 8763 psf
Shear strength = 4382 psf
Strain @ failure = 8.20 %

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.005	3.9	0.09	127.0
0.031	27.6	0.60	890.6
0.057	53.5	1.11	1716.5
0.083	90.2	1.61	2878.2
0.110	130.7	2.12	4149.8
0.136	166.8	2.62	5268.7
0.162	196.0	3.13	6160.0
0.188	218.0	3.64	6815.0
0.214	234.4	4.15	7289.1
0.241	248.0	4.65	7672.1
0.267	259.9	5.16	7997.1
0.293	268.6	5.67	8222.4
0.319	276.4	6.17	8413.1
0.345	282.7	6.68	8561.0
0.372	288.1	7.19	8674.6
0.398	291.5	7.70	8730.7
0.424	294.2	8.20	8763.3
0.450	295.7	8.71	8758.9
0.476	296.9	9.22	8744.1
0.502	298.6	9.71	8746.6
0.529	299.3	10.22	8719.0
0.555	299.5	10.73	8674.5
0.581	297.9	11.24	8578.1
0.607	296.0	11.75	8475.9
0.633	293.7	12.25	8360.7
0.657	293.1	12.71	8300.2
0.683	290.6	13.21	8184.1
0.709	288.1	13.72	8066.3
0.736	283.0	14.23	7874.7
0.762	279.1	14.73	7721.6
0.777	273.3	15.02	7536.0



(see worksheet for sketch of failure)

Figure B-12

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

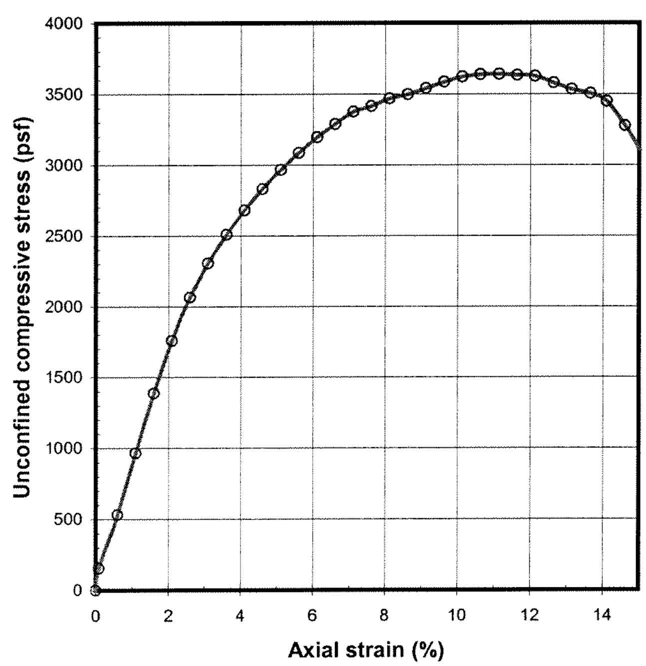
Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-2
Sample # : 8
Depth (ft) : 35
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	895.2	gms
	Ht. =	6.00	in
	Ave dia. =	2.380	in
	Area =	4.451	sq.in
	Volume =	437.6	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:			
	Void ratio =	0.630	
	Ht/Dia ratio =	2.52	
	Moisture =	23.5	%
	Total density =	127.7	pcf
	Dry density =	103.4	pcf
	Saturation =	100.7	%
	Unconfined compressive strength =	3638	psf
	Shear strength =	1819	psf
	Strain @ failure =	11.14	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	4.8	0.09	156.4
0.036	16.5	0.60	532.1
0.066	30.1	1.09	963.9
0.096	43.5	1.60	1385.4
0.126	55.5	2.10	1758.6
0.156	65.5	2.61	2065.3
0.186	73.5	3.10	2305.1
0.217	80.4	3.61	2508.1
0.246	86.3	4.11	2678.3
0.276	91.7	4.61	2829.3
0.307	96.6	5.11	2966.0
0.337	101.1	5.61	3085.9
0.367	105.2	6.12	3194.9
0.397	108.8	6.61	3287.4
0.427	112.4	7.12	3376.7
0.457	114.2	7.62	3414.0
0.487	116.6	8.12	3467.4
0.517	118.3	8.62	3497.6
0.547	120.4	9.12	3540.0
0.577	122.6	9.62	3585.3
0.608	124.5	10.13	3621.4
0.638	125.8	10.63	3637.5
0.668	126.5	11.14	3638.4
0.698	127.0	11.63	3632.3
0.728	127.5	12.13	3625.8
0.758	126.6	12.64	3577.7
0.788	125.8	13.14	3534.3
0.819	125.4	13.64	3503.5
0.846	124.0	14.10	3447.2
0.876	118.6	14.60	3277.5
0.901	112.7	15.02	3099.2



(see worksheet for sketch of failure)

Figure B-13

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

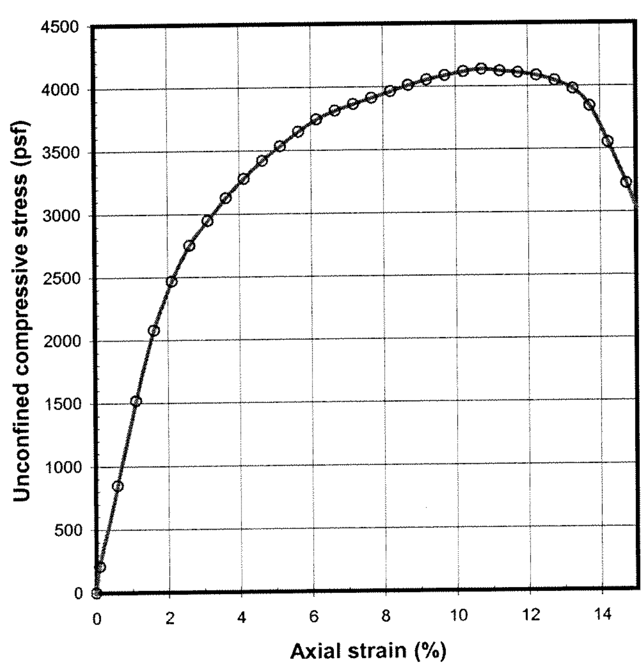
Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-2
Sample # : 14
Depth (ft) : 65
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed olive gray clay

Specimen:

Total wt. =	849.9	gms
Ht. =	5.97	in
Ave dia. =	2.403	in
Area =	4.538	sq.in
Volume =	444.0	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.851	
Ht/Dia ratio =	2.48	
Moisture =	31.2	%
Total density =	119.4	pcf
Dry density =	91.0	pcf
Saturation =	99.1	%
Unconfined compressive strength =	4134	psf
Shear strength =	2067	psf
Strain @ failure =	10.73	%



(see worksheet for sketch of failure)

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	6.5	0.10	207.1
0.036	26.8	0.61	846.0
0.066	48.4	1.11	1517.5
0.097	66.6	1.62	2079.8
0.127	79.4	2.13	2467.1
0.157	89.0	2.63	2751.3
0.187	95.8	3.13	2945.9
0.217	102.3	3.64	3127.2
0.248	107.8	4.15	3278.5
0.278	113.1	4.65	3420.3
0.308	117.5	5.16	3535.2
0.338	121.9	5.67	3648.6
0.369	125.8	6.18	3745.0
0.399	128.8	6.68	3812.7
0.429	131.2	7.19	3862.6
0.460	133.6	7.70	3911.8
0.490	136.0	8.20	3962.0
0.520	138.5	8.70	4010.9
0.550	140.7	9.21	4052.6
0.580	142.6	9.72	4085.5
0.610	144.5	10.22	4117.5
0.641	146.0	10.73	4134.0
0.671	146.3	11.24	4120.8
0.701	146.6	11.75	4105.8
0.732	146.7	12.25	4085.4
0.762	146.1	12.76	4043.4
0.792	144.5	13.27	3976.8
0.819	140.3	13.72	3841.3
0.849	130.6	14.23	3553.0
0.880	119.2	14.74	3225.5
0.897	112.2	15.02	3024.0

Figure B-14

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- COGEN 3000
Job No. : 28067039.41000
Boring # : CG-2
Sample # : 19
Depth (ft) : 90
Date tested : 06/04/06
Soil (Visual Description) : Undisturbed olive gray clay

Specimen:

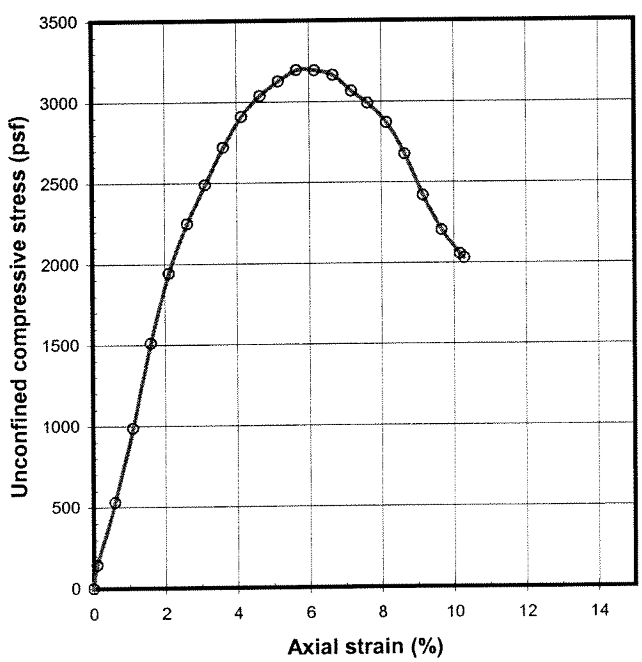
Total wt.	=	803.1	gms
Ht.	=	5.96	in
Ave dia.	=	2.407	in
Area	=	4.551	sq.in
Volume	=	444.5	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	1.030	
Ht/Dia ratio =	2.48	
Moisture =	35.9	%
Total density =	112.7	pcf
Dry density =	83.0	pcf
Saturation =	94.0	%
Unconfined compressive strength =	3195	psf
Shear strength =	1597	psf
Strain @ failure =	5.67	%

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	4.5	0.10	143.2
0.036	16.9	0.60	531.1
0.066	31.5	1.10	985.7
0.096	48.5	1.61	1510.0
0.126	62.7	2.12	1941.9
0.157	73.0	2.63	2248.2
0.187	81.2	3.13	2487.9
0.217	89.2	3.64	2719.1
0.247	95.9	4.15	2907.6
0.277	100.7	4.65	3037.0
0.308	104.1	5.16	3125.4
0.338	107.0	5.67	3194.6
0.368	107.5	6.17	3193.2
0.398	107.1	6.67	3163.6
0.428	104.3	7.18	3063.3
0.455	102.2	7.64	2988.4
0.485	98.7	8.14	2868.3
0.516	92.5	8.65	2673.3
0.546	84.1	9.16	2416.7
0.576	77.0	9.67	2202.0
0.606	72.3	10.17	2055.3
0.613	71.5	10.29	2028.2

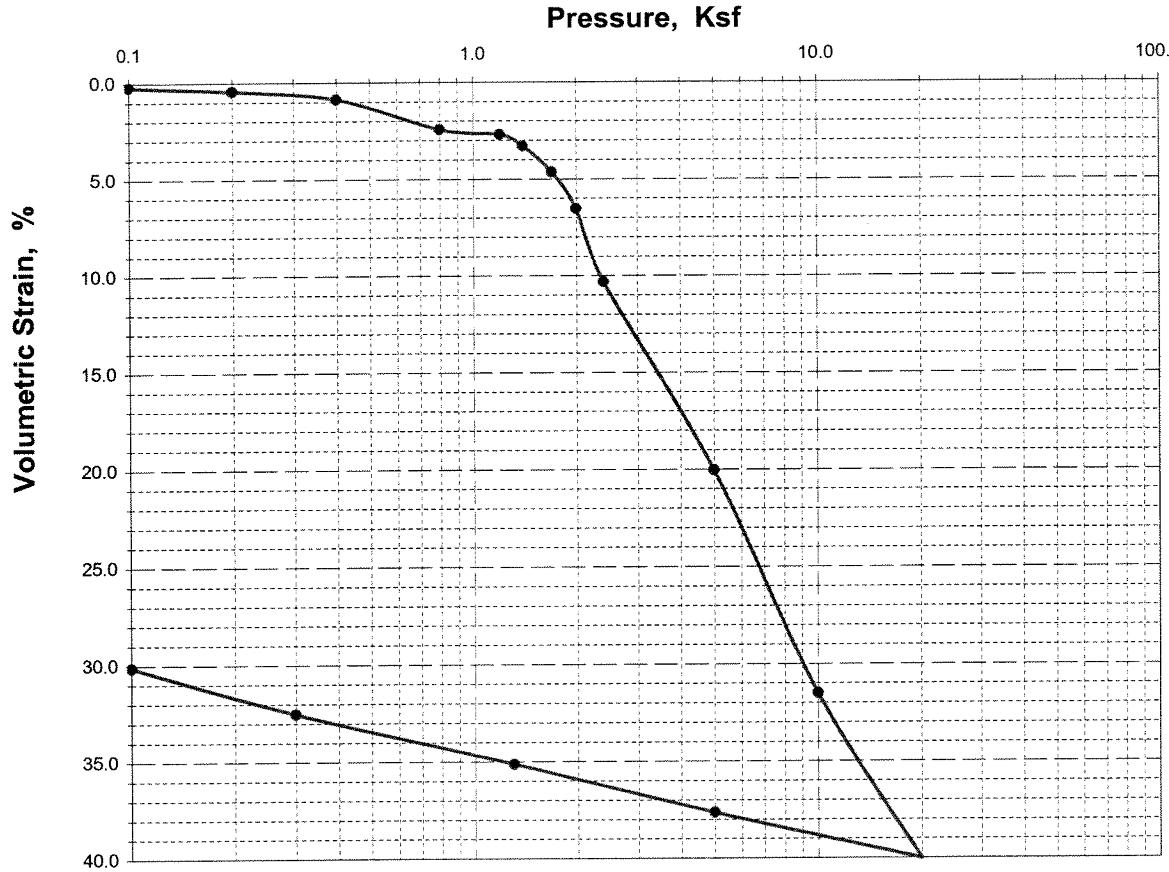


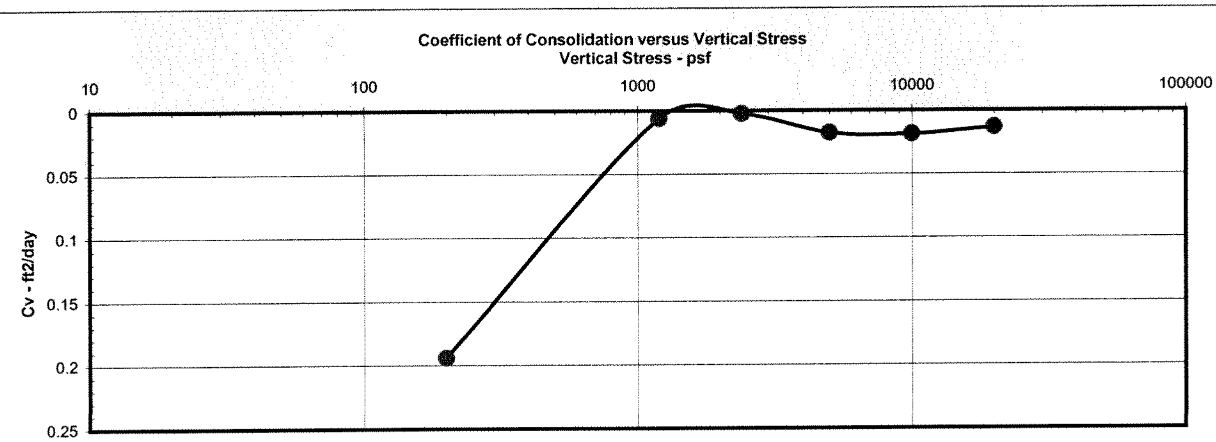
(see worksheet for sketch of failure)

Figure B-15

CONSOLIDATION TEST

Boring Number	CG-1	Sample Number	4	Depth (ft)	15-16.5			
Soil Description	Gray silt							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	98.7	91.2	2.676	99.6	1.00	2.420	(assumed) 2.70		
Final	59.2	104.5	1.568	101.9	0.699				



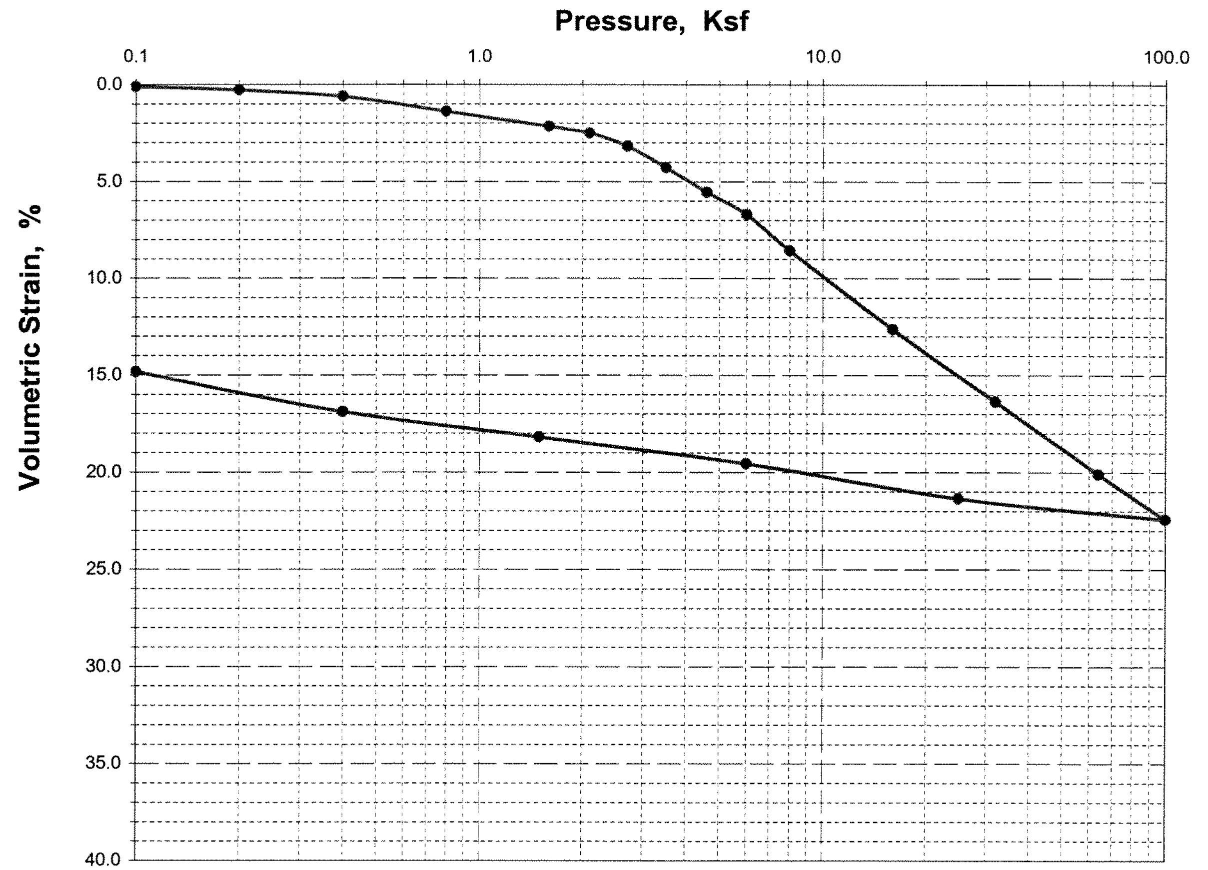


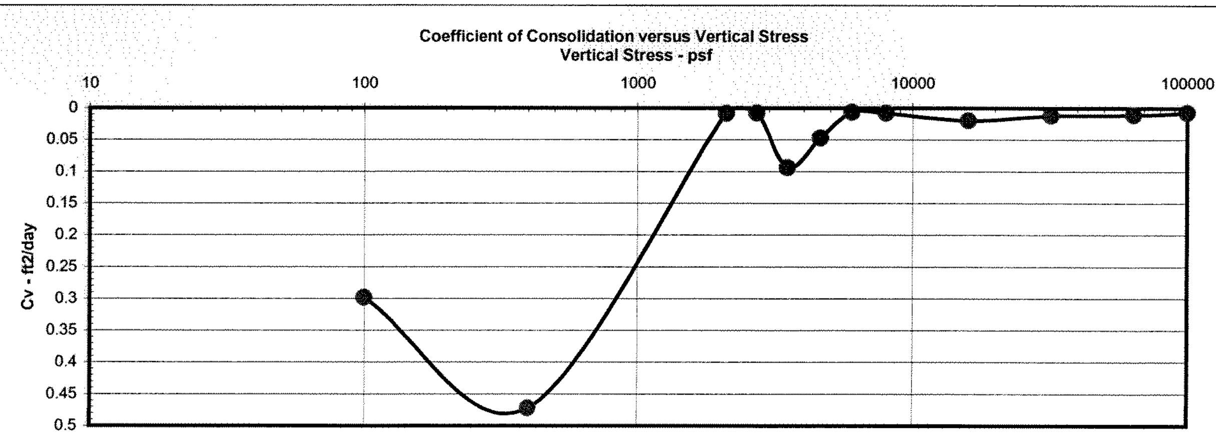
28067039.41000

Figure B-16

CONSOLIDATION TEST

Boring Number	CG-2		Sample Number	6	Depth (ft)	25			
Soil Description	Gray clay								
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	24.3	123.1	0.702	93.4	1.00		(assumed)		
Final	16.7	135.7	0.450	100.1	0.852	2.420	2.70		





28067039

Figure B-17

URS

REPORT
GEOTECHNICAL
INVESTIGATION
HYDROGEN REPLACEMENT
PLANT PROJECT
CHEVRON PRODUCTS COMPANY
RICHMOND, CALIFORNIA

Job No. 28067039
September 15, 2006

URS

Job No. 28067039
September 15, 2006

Chevron Products Company
841 Chevron Way
Richmond, CA 94802

Capitol Projects
214 Main Street

Attention: Mr. Jan F. Oosthuizen
Project Manager

c/o Mr. James Jacques, P.E.
Project Civil Engineer

Dear Mr. Oosthuizen:

Report
Geotechnical Investigation
Hydrogen Replacement Plant Project
Chevron Products Company
Richmond, California

We are pleased to present this geotechnical investigation report for the proposed Hydrogen Replacement Plant Project at the Chevron Richmond Refinery in Richmond, California.

The Hydrogen Replacement Plant Project site is underlain by heterogeneous fill, soft Recent Bay Mud, a thick layer of interbedded Collouvial/Alluvial Deposits, and Franciscan Bedrock. We recommend supporting the heavily loaded Hydrogen Replacement Plant facilities on friction piles gaining support from the Colluvial/Alluvial Deposits and end bearing piles in the shallow bedrock areas.

The recommendations contained in this report are based on both the recent exploration test borings completed in June 2006 as well as the three previous borings drilled since 1943.

URS Corporation
221 Main Street, Suite 600
San Francisco, CA 94105-1917
Tel: 415.896.5858
Fax: 415.882.9261

URS

This report is based on our proposal submitted on March 30, 2006 for geotechnical investigation for the Hydrogen Replacement Plant Project.

We provided our professional service under the terms and conditions of URS' Chevron Standing Contract 99014509 and Richmond Service Contract 4635799.

If you have any questions regarding this report, we would be pleased to discuss them with you.

Very truly yours,

URS CORPORATION

William G. Paratore, P.E., G.E.
Geotechnical Group Manager

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FIGURES

TABLES

APPENDICES

GEOTECHNICAL INVESTIGATION
HYDROGEN REPLACEMENT PLANT PROJECT
CHEVRON PRODUCTS COMPANY
RICHMOND, CALIFORNIA

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed Hydrogen Replacement Plant Project at the Chevron Richmond Refinery in Richmond, California. URS Corporation performed the work for this project at the request of Mr. James Jacques of the Chevron Products Company in accordance with an authorization to proceed dated May 15, 2006 from Mr. David Isherwood of Chevron. We provided our professional services under URS' existing standing Chevron Contract Number 99014509 and Richmond Service Contract 4635799.

The Hydrogen Replacement Plant Project is located in the Chevron Richmond Refinery, as shown on the Site Vicinity Map, Figure 1. The site is west of the 100-Foot Channel in a block bounded by Hydro Street on the south, Petrolite Street on the west, and Channel Street on the east. Figure 6 shows the Site Location Plan.

The purpose of this investigation was to obtain geotechnical information necessary to develop general foundation recommendations for the proposed Hydrogen Replacement Project plant installation. Our investigation included a geotechnical field exploration to obtain subsurface stratigraphy information and to obtain soil samples for testing, geotechnical laboratory testing, geotechnical engineering analyses, and development of recommendations for foundation design and construction.

This report presents factual data regarding the subsurface soils and groundwater conditions encountered during our field exploration at specific boring locations. It provides interpretation of the subsurface conditions and the characteristics of the major strata, and it includes recommendations for design and construction. Following this introductory section is a brief description of the Proposed Construction, Section 2.0. This is followed by a definition of the Purpose and Scope of the investigation in Section 3.0. The Geologic and Seismic Setting are presented in Section 4.0. Section 5.0 discusses the Site Conditions. Section 6.0 presents our Discussion, Conclusions, and Recommendations for design and construction of proposed facilities. Appendix A presents details of the field exploration program including the boring logs and logs of borings from previous investigations, an Appendix B presents the results of the laboratory testing program.

2.0 PROPOSED CONSTRUCTION

We understand that new equipment will be installed at the project site. The actual dimensions and location of the plant will be determined at a later date.

URS has not been provided loading criteria for the new Hydrogen Replacement Plant Project. Based on conversations with Chevron, we understand that the loads will be moderately heavy.

The project site ground surface ranges from elevation +8.7 feet to +14.7 feet, Richmond Refinery Datum (RRD). We understand that excavations at the project site may be up to 3 feet below the ground surface. Due to the consideration of site drainage, the existing site grade will be raised to about elevation +14 feet.

URS does not have information regarding the exact final location of the new foundations nor information regarding the presence of any existing piles within the immediate area of the project site.

3.0 PURPOSE AND SCOPE OF WORK

The purpose of the geotechnical investigation was to obtain geotechnical information necessary to develop general foundation recommendations for the proposed Hydrogen Replacement Plant Project. The scope of services for this project included the following tasks: geotechnical field exploration, geotechnical laboratory testing, geotechnical analyses and report, and project management.

3.1 GEOTECHNICAL FIELD EXPLORATION

Under this task, URS and its drilling subcontractor, Pitcher Drilling Company, drilled and sampled seven borings and excavated one test pit. All borings were drilled to bedrock. Prior to drilling, we obtained the necessary permits for soil borings from the Contra Costa County Environmental Health Department. Chevron “metro-teched” the boring locations to identify underground utilities and prepared the required “yellow-book” field operation files. URS site personnel and Pitcher Drilling crewmembers attended “Gate 91” safety training and site-specific safety training. Pitcher Drilling Company drilled the borings using mud rotary wash equipment and collected samples using the Standard Penetration Test (SPT) sampler, the Dames & Moore U-sampler, the Modified California sampler, and the Dames & Moore piston sampler. During drilling, Chevron personnel monitored the environment surrounding the drilling operations to detect the presence of possible hydrocarbon or other chemical contaminants. Pitcher backfilled the borings with cement grout and stored all drilling spoils in 55-gallon drums. The drums were left on site for pickup by Chevron personnel. Appendix A describes the geotechnical field exploration.

3.2 GEOTECHNICAL LABORATORY TESTING

We performed the following laboratory tests to evaluate the physical and engineering characteristics of the major strata:

1. Index tests including moisture content, density, particle size gradation, and Atterberg limits.
2. Consolidation tests
3. Unconfined compression strength tests
4. Resistivity tests
5. R-value test

A URS geotechnical engineer developed the testing program, and Signet Laboratories, a URS subsidiary, performed the tests in accordance with ASTM standards. Appendix B presents the geotechnical laboratory testing program and test results.

3.3 GEOTECHNICAL ANALYSES AND REPORT

We conducted the appropriate engineering analyses to evaluate different foundation alternatives including pile foundations, spread and mat foundations, and slabs-on-grade. We also performed analyses to develop preliminary design criteria including seismic design, lateral earth pressures, temporary shoring, cut slopes, permanent walls, friction coefficients and subgrade reaction moduli, soil swelling, backfill, and compaction. We prepared this report, which summarizes the data review, field explorations, subsurface stratigraphy, analyses, foundation recommendations, and design criteria. The report includes boring logs and laboratory test results.

3.4 PROJECT MANAGEMENT

We coordinated our work with Chevron and our drilling subcontractor. We attended meetings with Chevron during the course of our investigation. We also performed routine project management activities such as cost control, document control, and invoice preparation.

4.0 GEOLOGIC AND SEISMIC SETTINGS

4.1 REGIONAL GEOLOGY

San Francisco Bay is a drowned river valley, which developed within a northwest-trending structural trough formed in Franciscan Bedrock. In the late Pliocene, approximately 2 million years ago, the San Francisco-Marin block tilted towards the east along the Hayward Fault. The uplifted western edge of the block formed the hills of Marin while the downdropped eastern edge created an elongated depression, now occupied by San Francisco Bay. Following the downdropping of the bedrock block, erosion of the Berkeley/Oakland Hills and Potrero-San Pablo Ridge deposited material in alluvial fans, which gradually coalesced to form the broad, gently sloping plain that borders the eastern shoreline of the Bay.

The Refinery is located within a localized northwest-trending graben, or trough, along the eastern margin of San Francisco Bay. Figure 2 shows the Refinery site on a Geologic Map of the Richmond Area. Franciscan Bedrock below the graben has been downdropped along the now inactive San Pablo Fault, which parallels the eastern face of the Potrero-San Pablo Ridge, and along the active Hayward Fault zone, which forms the western scarp of the Berkeley Hills. During the mid-Pleistocene, a river system eroded deep channels into these areas of downdropped bedrock, creating an irregular bedrock topography and forming the Carquinez Straits and the Golden Gate. In response to Pleistocene continental glaciation melting cycles, rising sea levels flooded river valleys through the Golden Gate.

Alternating cycles of sea level rise and fall characterized the Pleistocene Epoch. Minor fluctuations in the Bay water caused episodic shallow flooding along the edges of the Bay inundation zone. This episodic flooding deposited complex interfingered alluvial and estuarine deposits at Bay margin sites, such as the Refinery site.

4.2 GENERAL REFINERY GEOLOGY

The major portion of the development at the Refinery is located in the flat bay margin zone, partially covered with fill, and, in turn, underlain by estuarine, colluvial, and alluvial soils deposited from the Pleistocene to present day. Figure 3 presents schematic subsurface cross sections of the Refinery. Starting at the ground surface, the soils generally include a 2- to 15-foot-thick layer of fill that was placed over thin zones of former marsh deposits (peat), which in turn are underlain by a relatively thick layer of Recent Bay Mud, a soft, clayey estuarine deposit formed within the present Bay Area in the past 10,000 years. The Recent Bay Mud layer varies from less than 10 feet to greater than 60 feet in thickness within the Refinery area. This layer is underlain by a thick sequence of interfingering alluvial fan and colluvial deposits that overlie Franciscan Bedrock. Bedrock under the flat bay margin zone consists of sandstones and siltstones of the Franciscan Formation and the depth to bedrock is variable. Bedrock is at the surface along the Potrero-San Pablo Ridge, and it is as deep as 370 feet, based on a probe (GW 109P) located near the intersection of Xylene Street and Gertrude Street (Dames & Moore, 1981).

4.3 REGIONAL SEISMICITY

The Refinery site is located within the Coast Ranges tectonic province, an area characterized by a moderate to high level of seismicity. The Coast Ranges are principally composed of the Franciscan Formation, which was assembled and dismembered by the subduction of oceanic plate(s) beneath the western margin of North America from Late Jurassic to Early Tertiary times (Page, 1981). During the Neogene, en-echelon compressional basins of deposition, en-echelon folds, northwest-trending strike-slip faults, and lesser east-west-trending thrust faults were formed. However, the formation and uplift of individual ranges and the subsidence of structural valleys within the Coast Ranges is not well understood in terms of transform tectonics. Other assemblages within the Coast Ranges include the forearc basins sediments of the Great Valley sequence and a magnetic arc (plutonic and metamorphic rocks of the Salinian Block) (Page, 1981).

The Coast Ranges tectonic province is bounded on the west by the northwest-trending San Andreas Fault System, the primary boundary between the Pacific and North American plates. A broad region 100 to 200 km wide and centered on the plate boundary (including much of the Coast Ranges) is tectonically dominated at present by the dextral horizontal shear caused by the relative motion of the two plates. In the San Francisco Bay region, the plate boundary is a 100-km-wide zone of deformation consisting of several major strike-slip fault zones including the San Gregorio, San Andreas, Hayward-Rodgers Creek, Calaveras, Concord-Green Valley, and Greenville faults. Figure 4 portrays the active faults in the San Francisco Bay region.

The Hayward fault (Type A Fault1 as defined by the 2001 California Building Code) is the major active fault closest to the Hydrogen Replacement Plant Project site. The Hayward fault has a Maximum Moment Magnitude of 7.08 and a Mean Slip Rate of 9 millimeters/year. The Hayward fault is about 6 kilometers northeast of the refinery site at its closest point and the fault depth is about 5 kilometers.

The continuation of Hayward Fault is the Rodgers Creek Fault. These two faults are separated by a 5 kilometer wide right step beneath San Pablo Bay. Rupture of the Rodgers Creek fault and

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[1] Type A Faults are faults capable of producing large magnitude events and have a high rate of seismic activity ($M_w \geq 7.90$, Slip Rate (SR)$\geq$5 mm/year).

the northern segment of the Hayward fault would generate a Maximum Moment Magnitude of 7.4.

The San Andreas Fault (Type A Fault[1] as defined by the 2001 California Building Code) is another major active fault close to the Hydrogen Replacement Plant Project site. The San Andreas Fault is about 20 kilometers west of the site at its closest point. The Maximum Moment Magnitude of the North Coast segment of San Andreas Fault is 7.7. The slip rate is about 24 millimeters/yr and the fault depth varies along the fault.

5.0 SITE CONDITIONS

5.1 CURRENT AND PREVIOUS GEOTECHNICAL INVESTIGATIONS

URS performed a geotechnical investigation including field explorations and laboratory tests to obtain the geotechnical and groundwater data necessary to evaluate the engineering characteristics of the subsurface soils. The field exploration consisted of seven borings and one test pit and their locations are shown in Figure 6. The general information of the current borings used was summarized in Table 1 below:

TABLE 1
SUMMARY TABLE OF CURRENT BORINGS

Borings	Easting[-1]	Northing[-1]	Ground Elevation[-2] (feet)	Depth of Borings (feet)
HR-1	165.6	756.3	+11.2	47.7
HR-2	71.9	484.4	+11.8	59
HR-3	231.3	340.6	+11.2	95.5
HR-4	203.1	134.4	+12.3	101.5
HR-5	87.5	9.4	+12.5	71.3
HR-6	300.0	18.8	+12.0	95.7
HR-7	458.1	262.5	+9.0	135.3

1. Measured coordinates based on the Drawing No. 06017-CL-0101 Rev. B May 2006 provided by Lurgi PSI Inc.
2. All elevations are expressed in the Richmond Refinery Datum

Table 2 lists the elevations of the bottom of the Fill layer, the Recent Bay Deposits layer, the top of Franciscan Bedrock and the recorded groundwater levels. Appendix A discusses the field exploration in detail and provides the boring logs for HR-1 through HR-7 and includes boring logs for previous investigations. Geotechnical laboratory testing was performed on selected samples from the field exploration program to evaluate the index and engineering properties of the major subsurface soils encountered at the site. Signet Testing Labs, a URS company, performed the tests at their laboratory in Hayward, California. Appendix B provides the results of these laboratory tests.

Dames & Moore, a URS predecessor company, conducted several geotechnical investigations within and near the Hydrogen Replacement Plant Project site since 1943 for a variety of Refinery facilities. These historical investigations included a number of borings that provide useful subsurface soil and groundwater data for the current geotechnical investigation. Table 1 lists the year of the investigation, Dames & Moore job number, and the boring numbers from the investigation that are relevant to the current investigation. Table 1 also lists the elevation of the bottom of the Fill layer, the Recent Bay Deposits layer, and the top of Franciscan Bedrock. Figure 6 shows the locations of the relevant historical borings. Appendix A provides the boring logs for the relevant borings from previous investigations.

5.2 HISTORICAL DEVELOPMENT

The site of the Hydrogen Replacement Plant Project originally was a salt marsh with meandering sloughs within the then existing San Pablo Bay. In 1939, the site was filled and has been reclaimed by the placement of earthfill on several occasions during the past 66 years. Figure 5 shows the filling history of the site and major portions of the Refinery Area.

5.3 SURFACE CONDITIONS

The site currently is covered by both an asphaltic pavement and in certain locations by gravel. The ground surface ranges from elevation +8.7 feet at the east end of the lot to elevation +14.7 feet along the west boundary of the site along Petrolite Street.

5.4 SUBSURFACE CONDITIONS

Based on the current and previous investigations from 1943 and 2006, the site is underlain by Fill, Recent Bay Mud, Alluvial Deposits, and Franciscan Bedrock. Figure 7 through Figure 10 present subsurface cross sections (A-A′), (B-B′), (C-C′) and (D-D′) of the site. Table 2 lists key subsurface data from this investigation (HR-1 through HR-7) and those from previous investigations.

TABLE 2
SUMMARY TABLE OF KEY SUBSURFACE DATA

Year	Company	Job Number	Boring Number	Depth of Boring (Feet)	Elevation* (Feet)				
					Ground Surface Elevation	Recorded Groundwater Elevation	Elevation of the Bottom of Fill	Elevation of the Bottom of Recent Bay Deposits	Elevation of the Top of Bedrock
1943	D & M	113-006	B-1	66.0	11.1	-	+6.1	-17.9	-47.9
1970	D & M	113-530	B-1	105.0	8.8	-	+3.8	-21.2	-84.7
1970	D & M	113-530	B-2	131.0	8.8	-	+2.8	-15.2	-111.7
2006	URS	28067039	HR-1	47.7	+11.2	+7.0	+1.3	-24.7	-31.7
2006	URS	28067039	HR-2	59.0	+11.8	-	+1.3	-7.7	-43.2
2006	URS	28067039	HR-3	95.5	+11.2	+7.2	-1.8	-20.8	-79.8
2006	URS	28067039	HR-4	101.5	+12.3	+7.3	-1.4	-20.9	-89.4
2006	URS	28067039	HR-5	71.3	+12.5	-	-0.5	-12.5	-53.5
2006	URS	28067039	HR-6	95.7	+12.0	+8.5	+0.3	-23.7	-78.7
2006	URS	28067039	HR-7	135.3	+9.0	+5.7	-1.4	-17.4	-124.4

*Elevations refer to Chevron Richmond Refinery Datum.
The recorded groundwater elevations may not represent the long-term static water table.

Figure 11 presents moisture content, total unit weight, and undrained shear strength versus elevation for data for 1943 to 2006. The range in values of key engineering properties for the major subsurface strata are summarized in Table 3.

TABLE 3
RANGES IN VALUES[-1] OF
KEY ENGINEERING PROPERTIES FOR THE MAJOR SUBSURFACE STRATA

Soil Type	Moisture Content (%)	Total Unit Weight (pcf)	Undrained Shear Strength (psf)
Fill[-2]	10 to 20	115 to 135	400 to 600
Recent Bay Mud	80 to 95	85 to 100	80 to 900
Colluvial/Alluvial Deposits	20 to 35	115 to 135	1000 to 3,000

Notes: 1. Several tested sample were neglected due to their location at transition zones between major strata.
2. Engineering properties values for Fill inferred from the CCR site which locate next to project site.

5.4.1 Geologic Stratigraphy

Fill – The Fill layer at the project site ranges from 5 to 13 feet thick. The upper 5 to 7 feet of Fill consists of grayish brown, loose to medium dense base rock or poorly graded gravel with sand (GP). The lower 6 to 8 feet is contaminated black fine sand which occasionally is underlain by heterogeneous dark gray and greenish gray, soft to medium stiff, silty clay with variable amounts of sand. All current borings (HR-1 through HR-7 from URS, 2006) at the site revealed hydrocarbon contamination.

Recent Bay Mud – Beneath the Fill is 9 to 30 feet of soft to medium stiff, compressible fat clay (CH), locally known as Recent Bay Mud. Several of the borings revealed frequent pieces of decomposed wood within this deposit.

Colluvial/Alluvial Deposits – The Recent Bay Mud is underlain by a thick sequence of the Colluvial/Alluvial Deposits, which consist of medium stiff to stiff clay (CL, CH) with variable amounts of sand interbedded with medium dense to dense fine sand with variable amounts of clay and medium to coarse sand. Boring HR-7 revealed the Colluvial/Alluvial Deposits to have a maximum thickness of approximately 107 feet.

Franciscan Bedrock – The URS 2006 and previous investigations reveal that the bedrock level dips downward to the northeast beyond the historical Marshline located near Petrolite Street. Boring HR-7 identified the maximum depth to bedrock is approximately 135 feet (elevation -124.4 feet). The bedrock consists of weathered, fractured sandstone from the Franciscan Formation.

5.4.2 Groundwater

Groundwater level may fluctuate with several reasons such as rainstorm and future change in geologic condition. Because the site is several hundred feet from the open body of water (San Pablo Bay), there is no significant tidal effect to the groundwater table at the Hydrogen Replacement Plant Project Site. The borings from the current investigation (HR-1 through HR-7) indicate the highest recorded groundwater level is, at this time, about elevation +8.5 feet.

The groundwater table was noted at the time of drilling and may not represent the long term static groundwater table. Historic groundwater level readings from refinery Wide Groundwater Monitoring Program located along Channel Street indicates the long-term average groundwater table is at about elevation +9 feet.

Based on both the current and historical groundwater monitoring records, the water table level of elevation +10 feet is recommended for design..

6.0 DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

6.1 CONCEPTUAL FOUNDATION DESIGN

From a geotechnical engineering standpoint, the Hydrogen Replacement Plant Project can be developed provided recommendations presented in this report are incorporated into the project plans and specifications and implemented during construction.

The main geotechnical concerns in selecting an appropriate foundation system for the proposed Hydrogen Replacement Plant Project facilities are:

1. New structural loads
2. Existing surficial, heterogeneous, variable density fill
3. Future additional filling
4. Existing weak and compressible clay (Recent Bay Mud)
5. Highly variable bedrock surface.

Based on the anticipated loading, we understand that the new facilities will impose relatively heavy loads to its foundation system. Furthermore, the proposed structures are sensitive to settlement. Loads supported on possible shallow foundation systems will consolidate the variable thickness of compressible fill and soft clay (Recent Bay Mud) beneath the site. The anticipated total and differential settlement from the consolidation of the fill and Recent Bay Mud, therefore, eliminate the use of heavily loaded shallow spread-type foundations as support for the proposed construction. Therefore, we conclude that a deep foundation system consisting of driven piles is the most appropriate and economical method of foundation support. Driven piles should extend through the fill and soft Recent Bay Mud and gain support through friction in the stiff to very stiff Colluvial/Alluvial Deposits or end bearing piles driven into the Franciscan bedrock.

Subsequent sections of this report present several important geotechnical issues that will affect the foundation design and construction. Also presented are recommendations for specific foundation and seismic design and site preparation.

6.2 GEOTECHNICAL ISSUES AFFECTING FOUNDATION DESIGN AND CONSTRUCTION

6.2.1 Existing Fill and New Fill

The proposed Hydrogen Replacement Plant Project Site originally was a salt marsh located at the fringes of San Pablo Bay. From 1939, the Refinery began reclaiming this area. Since then, the Refinery occasionally placed additional fill at the site to raise the grade to approximately elevation +8.7 to +14.7 feet. Figure 5 shows the filling history of the site and major portions of the Refinery Area.

Settlement will be induced when the stresses acting on the underlying compressible soil strata are increased by additional fill placement. Because the existing fill loads have been in place from 1939 to 1949 with only nominal filling in the later years, it is considered that this duration of time has essentially fully consolidated the underlying soft Recent Bay Mud. However, due to the consideration of site drainage, the Hydrogen Replacement Plant Project Site is proposed to be filled to raise the existing grades to elevation +14 feet. This additional filling will impose additional surcharge to the underlying existing fill and compressible soil strata and will lead to consolidation settlement. This areal settlement will impart downdrag forces to the pile foundations and the allowable design capacities of the driven piles need to take into account additional downdrag loads.

Theoretically, there should be a certain amount of strength gain of the Recent Bay Mud due to the consolidation process; however, the strength gain appears to be nominal.

The variable thickness, density and heterogeneous nature of the fill does not allow for uniform foundation support for proposed loads.

The fill may have isolated layers of loose soil and may be prone to some densification during driving of piles. Such conditions may reduce the available passive pressure to resist lateral loads on the pile foundations.

6.2.2 Expansive and Compressible Soil

Based on the subsurface conditions revealed from the current and previous site investigations and laboratory testing, the predominant fill material at depths of 5 feet to 7 feet below existing grade is gravel with varying amounts of sand and some silt and clay. These materials exhibit low shrink and swell potential.

Therefore, the considerations associated with the existence of expansive near surface soils including the edge moisture variation distance, differential soil movement, determination of plasticity indices and parameters necessary to estimate the amount of any climate controlled differential movement for the design of shallow spreads and mat foundations and slabs on grade may be neglected.

Within the fill, the more looser or compressible layers are always the material that immediately overlies the soft Recent Bay Mud deposit and that the upper part of the fill is generally medium dense. The associated considerations including areal and differential settlement due to the proposed development at the project site are addressed Section 6.3.

6.2.3 Abandoned Foundations

Chevron has not provided information that confirms the presence of abandoned piles at the project site. However, based on our review of available geotechnical investigations, and the history of land use, abandoned piles, if present, would consist of timber piles, concrete-filled steel pipe piles, or precast prestressed concrete piles. Based on past experience at the Refinery, old existing piles may not provide the required resistance to seismic loads. Therefore, we would recommend abandoning existing piles, if present, and founding the new structure loads entirely on new piles.

If abandoned piles are present at the proposed location of new piles, the abandoned piles may interfere with the installation of the new piles. We recommend exposing and surveying the abandoned piles. If new piles are driven a distance of less than three (3) pile diameters from the abandoned piles, the lateral resistance and the vertical load capacity of the new pile foundation may be reduced. Consequently, the new piles may need to be driven deeper to provide the desired design vertical capacities.

6.2.4 Abandoned Utilities

Abandoned utilities within proposed foundation footprints may collect significant amounts of perched water, which must be removed in order to facilitate construction of the new pile foundations. Section 6.10.4 presents recommendations regarding treatment of abandoned utilities.

6.3 ADDITIONAL FILL

Due to the consideration of site drainage, additional filling is proposed to raise the site grade to about elevation +14 feet. Since the existing ground surface elevation of the site ranges between elevation +8.7 feet to elevation +14.7 feet and the compressible Recent Bay Mud does not have a uniform thickness, the thickness of the additional fill may vary over time to eventually create a uniform final ground surface.

The amount of settlement and the rate of consolidation of the subsurface materials depend on the thickness of the additional fill, thickness and consolidation characteristics of the compressible strata and the drainage characteristics of the overlying in-situ fill material and underlying Colluvial/Alluvial Deposit. The Hydrogen Replacement Plant Project Site has been divided into 10 zones where every zone has its own site characteristics. Figure 12 shows the layout of the 10 zones. Settlement computations have been performed and the thickness of fill required to achieve a site grade elevation +14 feet were evaluated.

Table 4 estimates the total fill thickness over time that is needed to raise the existing grade such that in the long term the final site grade will be at approximately elevation +14 feet.

TABLE 4
SUMMARY TABLE OF SETTLEMENT COMPUTATION

Borings	Recent Bay Mud Thickness (feet)	Estimated Settlement (feet)	Thickness of New Fill Required
Zone 1	20	1.5	4.5
Zone 2	20	1.9	7.5
Zone 3	24	0.9	3.0
Zone 4	20	1.7	6.3
Zone 5	20	1.5	5.5
Zone 6	15	1.0	4.0
Zone 7	15	0.7	2.8
Zone 8	20-30	2.2-2.8	8.8
Zone 9	20	1.0	3.5
Zone 10	15	1.4	5.0

Further refinement of the settlement analyses should be performed during final design. The time-time rate of settlement needs further evaluation since the construction sequence of filling must be defined and when future filling operations should occur in the lower areas of the site.

6.4 DEEP FOUNDATION DESIGN

Both driven frictional and end bearing precast prestressed reinforced concrete piles are recommended for the proposed construction. The selection of friction or end bearing piles depends on the required design capacity of the piles, the elevation of bedrock surface, and the thickness of the supporting Colluvial/Alluvial Deposit. Since the present geotechnical investigation revealed that the thickness of the Colluvial/Alluvial Deposit and the bedrock surface are variable, additional geotechnical borings or a geophysical survey is recommended to more accurately define the bedrock surface in order to predetermine pile lengths.

6.4.1 Driven Frictional Precast Prestressed Reinforced Concrete Piles

In general, we recommend supporting the project structures on friction piles where the subsurface site conditions consists of a thick sequence of Colluvial/Alluvial Deposits and deep bedrock. Either driven round or square precast prestressed reinforced concrete piles should be considered for foundation support.

Because of the corrosivity of the Bay Mud, we recommend designing all concrete piles to resist the intrusion of corrosive elements.

6.4.2 Axial Pile Capacity and Settlement

6.4.2.1 Axial Pile Capacity and Settlement

It is recommended that the axial compressive capacity contribution from the Fill material and soft Recent Bay Mud deposits be neglected due to the high variability of composition and thickness as well as their low shear strength characteristics. Therefore, the Colluvial/Alluvial Deposit present below the Recent Bay Mud is considered as the supporting stratum for driven friction pile foundations.

According to the recommendations of NAVFAC 7.2-196, the adhesion between the Colluvial/Alluvial Deposit and the surface of concrete pile is 0.9 ksf. The values of unit friction have a factor of safety equal to one (1.0); the recommended frictional compressive and uplift capacity per unit length of penetration into the supporting soil for various proposed pile foundation types are presented in Table 5 and Table 6.

Since additional site filling will take place at the Hydrogen Replacement Plant Project Site and hence, consolidation settlement of the existing and new fill and soft Recent Bay Mud Deposit is anticipated, the downward movement of the surrounding soil strata relative on the piles will generate downdrag forces to the piles. In order to resist the additional loading due to the downdrag forces, we recommend that a penetration of at least 15 feet into the Alluvial Deposit is required to overcome the downdrag forces.

The pile frictional compressive capacities represent the geotechnical supporting capacity of the soil only; the structural engineer should check the structural capacity of the piles separately since an estimated range of 22 to 32 tons (12 to 18 inch pile size, respectively) of downdrag forces will be imposed on the pile at about elevation -30 feet. Since there are areas within the Hydrogen Replacement site where little or no filling is required, downdrag forces will not develop on the pile foundations in these area. Further refinement of the estimated downdrag forces should be made during final design of the foundations system.

TABLE 5
PRECAST PRESTRESSED REINFORCED CONCRETE PILES
ESTIMATED ULTIMATE UNIT FRICTION VALUES FOR COMPRESSIVE CAPACITY FOR SELECTED PILE TYPE*

Soil Horizon	12-Inch Square Pile	14-Inch Square Pile	16-Inch Square Pile	18-Inch Square Pile	12-Inch Round Pile	14-Inch Round Pile	16-Inch Round Pile
Unit Friction (Fill)	Downdrag -1.0 kips/ft	Downdrag -1.1 kips/ft	Downdrag -1.3 kips/ft	Downdrag -1.4 kips/ft	Downdrag -0.8 kips/ft	Downdrag -0.9 kips/ft	Downdrag -1.0 kips/ft
Unit Friction (Bay Mud)	Downdrag -1.0 kips/ft	Downdrag -1.1 kips/ft	Downdrag -1.3 kips/ft	Downdrag -1.4 kips/ft	Downdrag -0.8 kips/ft	Downdrag -0.9 kips/ft	Downdrag -1.0 kips/ft
Unit Friction (Alluvium)	3.6 kips/ft	4.2 kips/ft	4.8 kips/ft	5.4 kips/ft	2.8 kips/ft	3.3 kips/ft	3.8 kips/ft

*The unit friction value is defined as friction compressive capacity gain of the particular size of pile per unit length of penetration into the soil.

TABLE 6
PRECAST PRESTRESSED REINFORCED CONCRETE PILES
ESTIMATED ULTIMATE UNIT FRICTION VALUES FOR UPLIFT CAPACITY FOR SELECTED PILE TYPE*

Soil Horizon	12-Inch Square Pile	14-Inch Square Pile	16-Inch Square Pile	18-Inch Square Pile	12-Inch Round Pile	14-Inch Round Pile	16-Inch Round Pile
Unit Friction (Fill)	1.0 kips/ft	1.1 kips/ft	1.3 kips/ft	-1.4 kips/ft	0.8 kips/ft	0.9 kips/ft	1.0 kips/ft
Unit Friction (Bay Mud)	1.0 kips/ft	1.1 kips/ft	1.3 kips/ft	1.4 kips/ft	0.8 kips/ft	0.9 kips/ft	1.0 kips/ft
Unit Friction (Alluvium)	3.6 kips/ft	4.2 kips/ft	4.8 kips/ft	5.4 kips/ft	2.8 kips/ft	3.3 kips/ft	3.8 kips/ft

*The unit friction value is defined as friction uplift capacity gain of the particular size of pile per unit length of penetration into the soil.

For long piles, a factor of safety of at least 2.0 and 3.0 are recommended for compressive and uplift capacities (neglect the weight of piles), respectively. The factor of safety does not apply to the downdrag forces.

For resistance to transient wind and earthquake loads, the allowable axial capacities presented above may be increased by one-third.

The axial pile capacity analyses were performed for a single pile and a group reduction factor for pile group effects was not included. The group reduction factor for vertical loading capacity of pile group is highly depending on the pile center to center spacing and the design pile layout. In general, if the actual spacing of the piles is less than four times the least pile diameter, center-to-center, group reduction effect should be considered and URS should review the pile group capacity.

The behavior of the piles under vertical loads was analyzed with the computer program T-Z Pile (Ensoft, version 2.0). The analysis assumed that the piles and friction piles with little or no end bearing capacity. The recommended vertical spring constant values are presented in Table 7:

TABLE 7
PRECAST PRESTRESSED REINFORCED CONCRETE PILES
RECOMMENDED VERTICAL SPRING CONSTANT VALUES FOR SELECTED PILE TYPE

	12-Inch Square Pile	14-Inch Square Pile	16-Inch Square Pile	18-Inch Square Pile	12-Inch Round Pile	14-Inch Round Pile	16-Inch Round Pile
Vertical Spring Constant (kips/in)	497	657	834	1028	417	541	689

6.4.2.2 Lateral Pile Resistance

Lateral seismic forces will be transmitted from the structures to the foundation by a combination of pressure against the structural slabs, mats, and walls, pile caps, and piles, and by friction or adhesion between the sides of the walls and mats and the surrounding in situ fill soils.

For design, we recommend that lateral forces due to soil, hydrostatic, and seismic sources be resisted by the lateral capacity of each individual pile plus either (1) 100 percent of the soil-structure friction and 50 percent of the passive soil resistance, or (2) 100 percent of the passive soil pressures and 50 percent of the soil-structure friction. For the soil-structure friction developed between the in situ soil and mats, slabs, and pile caps, we recommend a friction value of 0.35. The soil-structure friction and the passive soil pressures recommended in this report include a factor of safety of 1.5.

Passive pressure against pile caps to resist seismic or wind loading are estimated at displacement levels comparable to those required to mobilize frictional resistance between the foundation pile caps and the supporting soil. For design purposes, we recommend a value of 300 pounds per square foot of passive resistance (with a factor of safety of 1.5) may be developed under wind and/or seismic loading.

For seismic resistance, we evaluated the lateral load capacities of the driven reinforced round concrete and the driven square reinforced precast prestressed concrete using pseudo-static analyses for fixed and free head conditions. The behavior of the piles under lateral loads was analyzed with the computer program LPILE (Ensoft, version 3). This program models the soil resistance as nonlinear springs (P-Y curve) that vary with soil shear strength and soil type along the pile shaft and was presented in Figures 13 to Figure 15.

6.4.2.3 Effective Point of Fixity and Maximum Lateral Deflection

In order to determine the effective point of fixity, maximum lateral deflection under certain loads, it is required that a complex differential equation which involves the pile characteristics, loading combinations and soil load-deflection curve for each soil strata to be resolved. In LPILE analyses, this governing differential equation is formulated in finite difference form and is solved through iterating process instead of closed form solution. Therefore, parameters have to given to start the iterating process.

In addition, soil stress strain behavior is fully non-linear, strain dependent. Therefore, the soil reaction is highly dependent on the pile deflection (induced soil strain) and the pile deflection is highly dependents on the soil stress (induced soil reaction). Consequently, loading conditions have to be fully defined to determine the actual behavior of the soil structure interaction.

Without specific design criteria of horizontal and vertical forces on the pile cap, we are unable to provide you with the following items you request in your RFQ:

- An Effective Point of Fixity
- Maximum Lateral Deflection in free headed condition
- Maximum Lateral Deflection in fixed headed condition

The lateral pile analyses herein are for single piles only. Where piles are located closer than 4 times the least pile diameters center-to-center, the interaction of the soil between the two piles will result in a reduction of the overall load or increase in the deflection of the ground under the same load.

6.4.2.4 Pile Group Effect

The group efficiency under lateral loading is a function of the pile type, soil type, pile to pile spacing, type of connection between the piles and the cap, number of piles in the group geometry of the piles in the group, and the intensity of the load on the group. Generally, the pile group effect will become significant if the pile center to center spacing is less than 4 times the diameter of piles.

For practical application, pile group reduction factor were computed based on the technical manual of the computer program GROUP Version 5.0 based on the assumed general configuration of pile group. The group efficiency under lateral loading may be estimated from Figure 16. A final design pile group reduction factor should be developed once the configurations, loads, size of foundation have been established.

6.4.3 Driven End Bearing Precast Prestressed Reinforced Concrete Piles

For the sites where the thickness of Colluvial/Alluvial Deposit is inadequate to generate a reasonable amount of frictional capacity to resist the compressive and uplift structural loads and the bedrock level is shallow, we recommend supporting the project structures on precast prestressed reinforced concrete pile with steel wide flange stinger driven into bedrock. In addition, since the thicknesses of the Recent Bay Mud and the Alluvial Deposit are variable at the site, driving into bedrock will provide uniform resistance and minimize the differential settlement.

A typical detail of H-pile "Stinger" is presented in Figure 17.

Because of the corrosivity of the Bay Mud, we recommend designing all concrete piles to resist the intrusion of corrosive elements.

6.4.3.1 Axial Pile Capacity and Settlement

We recommend driving the piles 1 to 3 feet into the bedrock to mobilize the end bearing capacity. The compressive and uplift capacities for the piles driven into bedrock are shown on Table 7:

TABLE 8
***MAXIMUM AND RECOMMENDED ALLOWABLE PILE CAPACITIES DRIVEN INTO BEDROCK**

Pile Type	Estimated Pile Tip Elevation[1] (feet, RRD)	Estimated Dead Load Plus Live Load[2] (kips)	Allowable Total Design Load[2] – including earthquake loads (kips)	Allowable Uplift Capacity[3] (kips)
Precast prestressed reinforced concrete piles that range from 14 to 18 inches and are either square or round	-30 to -65	200(250)	260(330)	65 (85)

Notes: (1) See Figure 7 and 8 for Idealized Soil Profile
(2) Maximum Allowable pile capacities shown in brackets ( ). These maximum values have been reduced to establish a recommended pile capacity value for the purpose of maintaining moderate driving stresses during pile driving.
(3) Uplift capacities shown require a minimum embedment of piles to a pile tip elevation of -35 feet

The major difference of axial pile capacity behavior between the frictional concrete piles and the end bearing steel pile is that the group reduction factor for end bearing pile could be ignored.

For resistance to transient wind and earthquake loads, the allowable axial capacities presented above may be increased by one-third.

The settlement of the end bearing pile is considered to be less than one-half inch.

6.4.3.2 Lateral Pile Resistance

Details and recommendations of lateral pile resistance are presented in Section 6.4.1.2 through Section 6.4.1.4.

6.5 SHALLOW SPREAD-TYPE FOUNDATIONS FOR SETTLEMENT INSENSITIVE STRUCTURE

6.5.1 Bearing Capacities

Light structures (less than 30 kips total load) that are insensitive to settlement can be supported on spread-type foundations in the fill. Spread foundations up to about 8 feet in maximum dimension and 18 inches below the lower adjacent grade, with at least 6 feet of fill below the footing, could be designed for allowable bearing pressures up to about 750 pounds per square foot for dead plus live loads. For slab-on-grade floors or larger spread foundations, we recommend an allowable bearing pressure of no more than about 500 pounds per square foot for dead plus live loads. Such structures should be rigid enough to resist differential settlements, or they should be flexible enough to allow expected settlements to occur without impairing the usefulness of the structure. Otherwise, pile foundations would be required. In computing pressures, the weight of concrete below current grade may be neglected.

6.5.2 Resistance to Lateral Loads

Resistance to lateral loads can be developed in the following ways:

1. Passive pressures against the leading edge of the footings; and
2. Friction between the base of the footings or reinforced concrete floor slabs and the underlying fill.

Passive pressures available in the fill may be estimated as equal to the pressure exerted by an equivalent fluid pressure of 350 and 200 pounds per cubic foot per foot of depth in the fill above and below the water table (i.e., about Elevation +10 feet), respectively. The upper foot of material should be neglected unless the material is confined by pavements. We recommend a coefficient of friction of 0.35 between the base of shallow concrete footings or floor slabs and the underlying materials. Both of the above values include a safety factor of 1.5. If both friction and passive pressure resistance are considered in design, one of these values should be reduced by 50 percent.

6.5.3 Areal Settlements

Settlement will occur due to increased stresses acting on the underlying fill, either by additional fill or by structural loading. We understand that the placement of new areal fills will be required for this project even through the existing fill loads have been in place long enough to have essentially fully consolidated the underlying Bay Mud, consolidation settlement caused by both additional fill and structural loads is anticipated. See further area settlement discussion in Section 6.3.

For the consolidation due to structural loads, if our above recommendations for allowable bearing capacities and the recommended specifications of fill placement discussed in Section 6.10.5 are followed, the modulus of subgrade reaction for the soil within the stress influence zone will be about 200 to 500 kcf and we anticipate that settlements due to structural loads for the immediate time period and 10 and 20 years after construction will range from less than ½ to about 2 inches depending on the actual amount of new fill placement to raise the site grade to about elevation +14.

Consolidation settlement due to the addition fill is discussed in Section 6.3.

The potential presence of old piles beneath the site would impede settlements in localized areas. This would cause differential settlements of the same magnitude as the total estimated settlement and may occur over distances as short as 10 feet. If the design requires the placement of net areal fills, settlements will likely be greater.

6.5.4 Mat and Slab Foundation Preparation

Use of vapor barrier is recommended for office facilities found on a non-pile or earth-support system.

We recommend placing a capillary break layer and vapor barrier between the mat or slab-on-grade structure and the foundation subgrade. The capillary break layer should consist of a free draining mixture of sand and gravel 6 inches thick directly over the foundation subgrade. Detail specification of the break layer is discussed in Section 6.10.5. We recommend placing a vapor barrier consisting of a plastic membrane at least 10 mils thick directly over the capillary break layer. A 2-inch-thick layer of fine sand should cover the plastic membrane to prevent tearing by construction equipment.

However, other criteria for design of sub-base thickness and material can be evaluated by the designer.

Based on the subsurface conditions revealed from the current and previous site investigations and laboratory testing, the predominant fill material at depths of 5 feet to 7 feet below existing grade is gravel with varying amounts of sand and some silt and clay. These materials exhibit low shrink and swell potential.

Therefore, the considerations associated with the existence of expansive soil including the edge moisture variation distance, differential soil movement, determination of plasticity indices and parameters necessary to estimate the amount of any climate controlled differential movement for the design of shallow spreads and mat foundations and slabs on grade may be neglected.

6.6 BELOW GRADE PERMANENT AND TEMPORARY WALL DESIGN

For below grade wall design, we recommend the following earth and water pressure criteria.

6.6.1 Lateral Earth Pressures

The earth pressure criteria are based on the assumption that the maximum groundwater table will be at approximately elevation +10 feet and the temporary surcharge load during construction is 100 psf and that all walls are backfilled with compacted structured fill (90 percent ASTM D1557). For the passive pressure, the portion of the below grade wall where passive pressure develops will be assumed to below the groundwater level. The design values of lateral earth pressure are presented in Table 9 below:

TABLE 9
SUMMARY TABLE OF LATERAL EARTH PRESSURE DESIGN VALUES

Condition	Value
Unrestrained Active Pressure Above Water Table – [1] Structural Backfill Compacted to 93% ASTM D1557	40 pcf
Unrestrained Active Pressure Below Water Table – [1] Structural Backfill Compacted to 93% ASTM D1557	80 pcf
Restrained Active Pressure Above Water table – [1,3] Structural Backfill Compacted to 93% ASTM D1557	65 pcf
Restrained Active Pressure Below Water table – [1,3] Structural Backfill Compacted to 93% ASTM D1557	90 pcf
Seismic Earth Pressure (Active Side Only)– [2,3]	18H psf
Passive Pressure Above Water Table – [1,4]	350 psf
Passive Pressure Below Water Table – [1,4]	200 psf
Surcharge from Construction Activities – [5]	100 psf

Notes:
1. Equivalent Fluid Pressure
2. Uniform, rectangular pressure distribution.
3. H (feet) – Retained soil height.
4. Ignore upper one foot of embedment. Consider passive pressure to act on leading face of retaining wall footing.
5. The magnitude of surcharge depends on the weight of construction equipment and its distance from the wall.

6.6.2 Frictional Resistance

Frictional resistance along the bottom slabs of the wall can be estimated using a friction coefficient of 0.35 and the internal friction angle is about 35°. This value has a factor of safety of at least 1.5.

6.6.3 Below Grade Slabs

For the design of the below grade slabs, we recommend an allowable bearing pressure of up to 500 psf, on the assumption that the below grade slabs is supported on engineered fill or on top of proof-rolled fill soils. In either case, it is recommended that a minimum 18 inch blanket of Caltrans Standard Class 2 structural fill in accordance with the Caltrans standard be placed beneath all the slabs.

6.7 SEISMIC DESIGN

6.7.1 Site Response Analyses

A site-specific seismic hazard study was performed by URS in 2003 at the Chevron Richmond Refinery. The URS 2003 report presented the major aspects of seismic hazards within the Refinery. A site-specific response analysis is performed for the Hydrogen Replacement Project Site using the properties of the subsurface strata pertinent to the site.

Since the bedrock level dips downward to the northeast beyond the historical marshline, two representative site geologic stratigraphy are selected (One for shallow bedrock profile and the other for deep bedrock profile) for the site specific response analyses. Figure 18 shows the distinction of shallow bedrock site and the deep bedrock site.

6.7.2 Analysis Approach

The analysis method for horizontal ground motions is based on the assumption of vertically propagating shear waves (S-waves). This is a commonly used method and has been shown to provide a reasonable representation of site response at soil sites for engineering purposes.

The analysis approach can be summarized in the following steps:

- Develop idealized soil profiles for analysis, including the dynamic soil properties;
- Develop earthquake rock response spectra and acceleration time histories for the selected ground motion return periods; and
- Perform one-dimensional ground motion response analyses for the selected profiles.

6.7.3 Dynamic Soil Properties

The engineering properties relevant to the site response analysis include the total unit weight, moisture content, plasticity index, overconsolidation ratio, shear wave velocity, maximum shear modulus, and curves describing the shear modulus degradation and material damping ratio as a function of cyclic shear strain.

The total unit weight, moisture content, overconsolidation ratio, plasticity index and shear strength of the subsurface soils are obtained through the URS 2006 geotechnical investigation program. Measurements of shear wave velocities of the subsurface material were not performed in the URS 2003 or 2006 exploration programs. Therefore, shear wave velocities were estimated by correlating with shear strength and plasticity index of the various soils through published empirical relationships.

The maximum shear modulus (G_{max}) is related to the shear wave velocity (V_s) through the following equation:

$$G_{\max} = \rho (V_s)^2$$

where ρ is the mass density of the material.

For clayey soils, the maximum shear modulus can be estimated as a ratio of the undrained shear strength (S_u), with the following relationship:

$$G_{\max} / S_u = 1{,}000 \text{ (Egan and Ebeling, 1985; Weiler, 1988)}$$

Also, the maximum shear modulus can be estimated from results of the consolidation tests, using the following relationship:

$$G_{\max} = \frac{625}{e_0^{1.3}} \left(P_a \cdot \sigma_m{}'\right)^{0.5} OCR^k \text{ (Jamiolkowski et al, 1991)}$$

where e_0 is the initial void ratio, P_a is atmospheric pressure, OCR is the overconsolidation ratio and k is the plasticity index.

To compute the maximum shear modulus for sandy soils, the following methodology proposed by Seed and Idriss (1970) was used:

$$G_{max} = 1{,}000 K_{2max} \left(\sigma_m '\right)^{0.5}$$

where σ'_m is the mean effective confining stress in psf and K_{2max} is a factor that depends upon soil type, relative density, maximum particle size, gradation and other parameters, and can be estimated based on Seed et al (1984), as follows:

$$K_{2max} = 20\left(N_1\right)_{60}{}^{1/3}$$

where $(N_1)_{60}$ is the SPT blow counts corrected for overburden pressure and hammer efficiency.

The shear modulus degradation and damping ratio curves were estimated based on published literature by Seed and Idriss (1984), Idriss (1990), Vucetic and Dobry (1988, 1991). Apart from recommendations and relationships in the literature, previous experience with soils in the Refinery and engineering judgment are important in the selection of dynamic soil properties. Table 10 presents the major dynamic soil properties and Figure 19 presents the strain dependency behavior of shear modulus degradation and damping ratio for the site response analyses.

TABLE 10
SUMMARY OF DYNAMIC SOIL PROPERTIES

Soil Type	Thickness (ft)	Total Unit Weight (pcf)	Shear Wave Velocity[1] (fps) (Best Estimate)	Maximum Shear Modulus[1] (ksf) (Best Estimate)	Shear Modulus Degradation Curve[2]	Damping Ratio Curve[2]
Fill	10-15	120	520 – 600	1010 – 1350	Sand[3] (top 5 feet)/ Clay[4]	Sand[3] (top 5 feet)/ Clay[4]
Recent Bay Mud	15-25	90	370	380	Clay[4] (PI = 50)	Clay[4] (PI = 50)
Stiff Alluvial Deposits	20-80	120	630-820	1480-2500	Clay[4] (PI = 30)	Clay[4] (PI = 30)
Bedrock (Half Space)	-	140	2500	27200	-	-

Notes:
1. The values presented herein are best estimates for shear wave velocities and maximum shear moduli are based on in situ and laboratory test data. A sensitivity study on the soil response was performed by varying the shear wave velocities by ±15% to obtain the upper bound and lower bound values.
2. The Shear Modulus Degradation and Damping Ratio curves are presented in Figure 14
3. Based on recommendations by Seed and Idriss (1984).
4. Based on recommendations by Vucetic and Dobry (1988), and Idriss (1990)

6.7.4 Development of Input Rock Motions

Our approach to develop the earthquake rock response spectra and acceleration time histories is summarized as follows:

- Develop rock response spectrum (target spectrum) from the selected ground motion return periods;
- Select Seed earthquake acceleration time histories for input rock motions; and
- Spectrally modify selected acceleration time histories to match the target spectrum.

6.7.5 Rock Response Spectrum (Target Spectrum)

The URS 2003 report presented the rock hazard curves for PGA, 0.3-second and 0.1-second spectral accelerations, developed based on ground motion attenuation relationships and results of a probabilistic seismic hazard analysis (PSHA). A target spectrum was developed for the ground motion return period of 475 years, which is equivalent to a 10 percent probability of exceedance in 50 years.

Due to the close proximity of the Hydrogen Replacement Project Site to the RLOP and Isomax Process Area in the URS 2003 study, the target spectrum in the URS 2003 report is adopted in the site response analysis of the Hydrogen Replacement Project Site.

6.7.6 Time Histories

Three sets of horizontal acceleration time histories recorded during past earthquakes were selected for analysis. These time histories were recorded during the 1999 Kocaeli, Turkey earthquake at Gebze station, the 1999 Duzce, Turkey earthquake at Lamont 531 station and the 1987 Superstition Hills (B) earthquake at Superstition Mountain station. The two orthogonal horizontal acceleration time histories from each station were used, giving a total of 6 time histories. These recording stations are classified as rock sites.

These time histories were selected because they are consistent with the overall characteristics of earthquakes dominating the hazard at the Hydrogen Replacement Project Site. Characteristics considered included magnitude, recording distance, and faulting mechanism. Table 11 lists these selected motions along with their recorded peak accelerations and distances.

TABLE 11
SUMMARY OF EARTHQUAKE RECORDS
USED FOR SITE RESPONSE ANALYSIS

Earthquake	M	Station Name	Distance (km)	Site Condition	Component	Recorded PGA (g)
1999 Kocaeli, Turkey	7.4	Gebze	17.0	Rock	0	0.24
					270	0.14
1987 Superstition Hills (B), Imperial Valley, CA	6.7	Superstition Mountain	4.3	Rock	45	0.68
					135	0.89
1999 Duzce, Turkey	7.1	Lamont 531	11.4	Rock	North	0.16
					East	0.12

6.7.7 Spectrally Matched Time Histories

To develop acceleration time histories with response spectra that match the target spectrum, the Seed time histories were modified using the method proposed by Lilhanand and Tseng (1988) as modified by Abrahamson (1993). In this method, the time history is adjusted in the time domain by adding wavelets in iterations until a satisfactory match to the target spectrum is obtained. The method has been shown to preserve the non-stationary characteristics of the recorded time histories. The spectrally matched time histories were used as input motions in the site response analyses.

6.7.8 Site-Specific Response Analysis

The modified time histories were used in the site response analyses performed with the computer program SHAKE (Schnabel, 1972). The soil behavior is modeled using the equivalent-linear method proposed by Seed and Idriss (1970). The analysis is performed in iterations until the shear modulus and damping values used in the analysis are compatible with the computed shear strain. The modified time histories were input as an outcrop of rock in each idealized profile.

The calculated 5 percent-damped acceleration response spectra for a return period of 475 years are presented on Figures 20 through 22. The acceleration response spectra are presented at depths where significant changes in soil response are noted.

6.7.9 Effects of Fault Rupture Directivity

Because of the close proximity of the project to the Hayward-Rodgers Creek Fault system, the fault rupture directivity effects were evaluated in the URS 2003 study. The URS 2003 report concluded that the effects of fault rupture directivity at the Refinery are small and no adjustments to the seismic hazard curves are necessary.

6.8 DESIGN PEAK GROUND ACCELERATION

The U.S.G.S.' National Seismic Hazard Mapping Project website provided the peak ground acceleration for rock (PGA rock) for the return periods of 475 and 2,475 years. The return period of 475 years is equivalent to 10 percent probability of exceedance in 50 years and the return period of 2,475 years is equivalent to 2 percent probability of exceedance in 50 years.

For the bedrock beneath the project site, the PGA is 0.59 g and 0.91 g for the return period of 475 and 2,475 years, respectively.

6.8.1 Seismic Design Criteria

This site may be characterized in accordance with the 1997 Uniform Building Code as a soil profile S_E in its current condition.

Given the proximity of active faults to the site discussed in Section 4.3 of this report, we recommend the following near source factors:

- N_a of 1.16
- N_v of 1.52

The site is located in Seismic Zone 4. The Z factor for the site is therefore 0.40.

6.8.2 Liquefaction Potential

We evaluated the liquefaction potential for the project site area based on subsurface data obtained from our field investigation. Liquefaction occurs in saturated, loose to medium dense sands and silty sands during strong to moderate earthquakes. Previous borings at the site and borings HR-1 through HR-7 performed for this investigation does not reveal the presence of liquefiable deposits at the site. The strength loss of the soil due to liquefaction is not anticipated.

6.9 CORROSION AND RESISTIVITY TESTING

Two corrosion tests were performed from the samples at Hydrogen Replacement Plant Project Site. The tests included Redox, pH, chlorides, sulfates, and resistivity. The samples were taken at depths of 4 feet and 7 feet below the ground surface in the fill material. Additional results from previous investigations are included to evaluate the corrosivity of the soil stratums within and below the fill. The results are summarized below.

TABLE 12
CHEMICAL AND RESISTIVITY TEST RESULTS

Sample	Soil Unit	Redox (mV)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Resistivity (ohms-cm)
HR-1 at 4 feet	Fill	420	5.6	N.D.	250	1,300
HR-2 at 7 feet	Fill	420	7.1	22.0	270	1,000
From previous investigation	Bay Mud	-	8.2	-	18 to 40	-
	Stiff Clay	-	8.6	-	70 to 610	-

We suggest that consideration be given to using either Type II (moderately sulfate resisting) or Type V (sulfate resisting) cement to minimize the effects of sulfate attack on the concrete. This type of concrete should be used in all structural concrete cast below final grade level.

Steel corrosion is not anticipated to be severe, although some corrosion is likely to occur. The specific amount or rate of corrosion is not known due to the variable chemical constituents of fill materials. Thus, protective coating should be considered for underground utilities and any below grade buried iron, steel or reinforced concrete.

Prior to our geotechnical investigation, Science Applications International Corporation (SAIC) performed an environmental survey at the project site. We have briefly reviewed their report and during our field investigation we encountered visible soil contamination. The use of Type II or Type V cement may further help to resist the effects of the contamination on concrete cast below final grade level. Chevron should review the findings of the SAIC report and take them into consideration when designing below grade structural components.

6.10 CONSTRUCTION CONSIDERATIONS

6.10.1 Site Preparation and Old Foundation Removal

If the contractor encounters organic matter and other debris during grading, we recommend stripping and removing these materials from the structure footprints, pavement areas, and other areas to be developed. Stripped materials must not be used as engineered fill.

Portions of the site could contain old concrete foundation slabs, pile caps, and piles from previous structures. The full extent and thickness of these old foundations or other rubble fill is unknown. Special equipment and extra time may be required to excavate, break up, and remove this debris.

Prior to new pile installation, old pile caps and foundations should be removed. In addition, piles from previous foundations, which may be wooden or concrete-filled steel pipe piles, will likely extend into the stiff Colluvial/Alluvial Deposit. Existing old piles should be cut off approximately 2 feet below the proposed new pile caps. Where possible, we recommend that old piles be left in place unless they interfere with any proposed piles. Wherever feasible, the designers should lay out the new piles under the facility to minimize the number of old piles to be pulled.

Some adverse effects of removing the old piles include:

- The upper portions of the fill and Recent Bay Mud will be disturbed and weakened by the removal of piles. This will reduce potential lateral support of the new piles for lateral pile capacity.

- Some of the existing piles may have a deeper tip elevation than the proposed new piles. Removal of the old piles would reduce vertical capacity of the new piles and induce pile settlement.

- The Recent Bay Mud layer is an important part of the refinery Groundwater Protection System (GPS). Any unfilled holes would constitute a preferential pathway for contaminated groundwater to flow from the surface fills to the relatively uncontaminated soils below the Recent Bay Mud.

- Vibrations will occur if vibratory equipment is used for pile removal.

If the design requires removing existing piles, then the holes left by extraction of the existing piles must be backfilled. Immediately following pile removal, the holes should be grouted using a tremie pile extending to the bottom of the portion of the pile that was removed. The contractor should backfill each pile removed with grout equal in volume to at least 100 percent of the estimated volume of the hole (to within 5 feet of the ground surface or excavation subgrade).

6.10.2 Predrilling

We recommend predrilling through the fill layer all pile locations. Predrilling will facilitate identification and removal of any underground obstacles not previously identified in the deeper fill layer, prevent surface heave due to pile displacements, and would allow greater precision for correct positioning of piles. Predrilled holes should be at least 3 inches smaller than the least dimension of the new piles to minimize the effects of predrilling on lateral capacity of the piles. Predrilling should be performed immediately prior to driving each pile. Continuous flight augers can be used for predrilling to minimize caving of the hole when the predrill auger is removed.

6.10.3 Pile Driving

Provided an adequate-sized hammer is used (at least 50,000 ft-lbs), penetration resistances will be relatively low for piles driven to design depths. Capacity will develop in the piles over several days to a week after driving after "pile setup" occurs in the stiff clays supporting soils.

We recommend that Chevron record all pile blow counts during production driving, and that Chevron forward these records to URS. Furthermore, we recommend as a minimum that a geotechnical engineer be on site during the first three days of production pile driving in order to observe any problems and to set/identify pile driving criteria. We recommend that Chevron re-tap a minimum of 3 percent of the piles during the driving in order to measure driving resistance after pile setup, to allow re-evaluation of the as-installed pile capacity.

We do not anticipate reaching driving refusal in the stiff Colluvial/Alluvial Deposit. The piles should be driven to the required depth for allowable capacity.

6.10.4 Excavation and Foundation Preparation

We recommend that slopes for the excavations be no steeper than 1.5H:1V. Excavations less than 4 feet deep may remain temporarily stable in a near vertical condition. Chevron must follow OSHA requirements regarding excavation support.

Since large scale excavations may occur, the soil rebound will be insignificant provided that the construction period is less than 6 months. However, because of the presence of weak soils below the existing fill, the contractor must exercise care not to overstress these soils. Otherwise, pumping of the soils will occur and it may be difficult to construct the grade beams on the subgrade.

We recommend that a URS geotechnical engineer be present during the excavation for new foundations to verify the anticipated soil conditions. Where appropriate, the contractor should lightly proof-roll the foundation subgrade to identify any soft seams of soil present below the foundation level. Soft seams should be removed and replaced with structural fill. The foundation subgrade should be free of any loose material and standing water prior to pouring concrete foundations or placing compacted fill.

Excavations to remove existing foundations and utilities should be filled with lean concrete or properly compacted structural fill.

6.10.5 Fill Placement and Compaction

The contractor should compact backfill up against the pile cap and grade beams. The backfill should consist of granular materials, either sand, sands and gravel, or crushed rock. The rock should be free-draining open graded crushed rock with gradation between ½ and ¾ inches. The contractor should place the crushed rock in lifts of 12 inches or less.

Excavations to remove existing foundations and utilities should be filled with lean concrete or structural fill compacted to 90 percent of the maximum dry density as determined by Modified Proctor compaction (ASTM D 1557). Where the bottom of these excavations is near or below the water table, the contractor should backfill the excavation with crushed rock to at least 6 inches above the groundwater table. The contractor should place geofabric over the open graded crushed rock.

We recommend properly moisture-conditioning and placing each fill lift 8 inches or less, any required imported fill. The structural fill should consist of non-corrosive, non-expansive granular material conforming to the following criteria:

Maximum Plasticity Index: 12
Maximum Particle Size: 3 inches
Percent Passing No. 200 Sieve: 10 to 35
Minimum R-Value: 20

Other available material can be considered provided that they are non-expansive and the maximum particle size does not exceed 3 inches.

Because of the shallow groundwater table and soft underlying fill soils, vibratory compaction equipment should only be used with the consent of the geotechnical engineer.

6.10.6 Construction of Shallow Mat Foundation and Slabs on Grade and Roadway

For the construction of mat foundation or slabs on grade, we recommend additional over-excavation to a minimum of 2 feet to replace weak to undesirable existing fill material. Prior to the placement of the structural fill material as specified in Section 6.10.5, the existing fill should be proof-rolled to detect the presence of soft spots. The top 6 inches of the existing fill should then be scraped, moisture-conditioned, and compacted to a dry density of at least 95 percent of the maximum dry density as determined from ASTM test designation D1557. The structural fill should then be placed and compacted to at least 95 percent of the maximum dry density.

For the construction of roadway, we recommend the Asphalt Concrete should be underlain by a minimum of 6-inch compacted layer of Caltrans' Class II aggregate base with minimum of R-value of 50. Prior to the placement of the aggregate base layer, minimum of 2 feet of over-excavation is recommended. The top 6 inches of the existing fill should then be scraped, moisture-conditioned, and compacted to a dry density of at least 95 percent of the maximum dry density as determined form ASTM test designation D1557. The structural fill should then be placed and compacted to at least 95 percent of the maximum dry density followed by the specified aggregate base.

Suggested ground preparation details of the construction methods for both mat foundation and slab on grade and roadway are presented in Figure 23.

Two R-value tests were performed on the fill material for a depth of 3 feet. The results are shown in Appendix B. indicate the R-values of 44 and 52. It is our opinion that the tested R-values are too high and not representative of the actual near surface subsurface soil because of known areas with high clay content within the gravelly fill material; therefore we have reduced for design purposes the R-value to 18.

6.10.7 Utility Pipe Bedding and Backfilling

Utility trenches should be backfilled with fill placed in lifts not to exceed 6 inches prior to compaction. We recommend a minimum lift thickness of 9 inches prior to compaction for those areas adjacent to vitrified clay pipes to prevent compaction damages to these pipes. The first fill lift over a pipe should receive nominal compaction and all subsequent lifts should be compacted to 90 percent maximum dry density, or the required density of adjacent soils, whichever is greater. To provide uniform support, the pipes should be placed on a minimum of 4 inches of sand or fine gravel (less than ¾ inch).

Where trenches extend below the groundwater level, it will be necessary to dewater them to keep the trench base from softening and to allow the placement of pipe utilities and backfill.

6.10.8 Dewatering

Temporary dewatering may be required if excavations are deeper than 3 to 5 feet below existing grade depending on the site location. It is our judgment that the installation of strategically placed sumps and pumps can lower the groundwater table several feet, if required. If necessary, we recommend using sumps at the edges of the excavation, and 2 to 3 feet below the excavation bottom, to control seepage. We recommend minimizing the overall depth of groundwater table lowering to (1) reduce the volume of potentially contaminated groundwater requiring handling and treatment, and (2) reduce the potential for added load on the Recent Bay Mud.

7.0 CONSTRUCTION MONITORING

We recommend that a URS engineer observe the pile driving operations and approve all new footing excavations at the project site prior to placement of forms or reinforcing steel. We further suggest that URS provide density control monitoring for placement of backfill.

8.0 LIMITATIONS

URS performed this investigation to provide support for the proposed Hydrogen Replacement Plant Project at the Chevron Richmond Refinery in Richmond, California. The recommendations made in this report are based on the assumption that the soil and groundwater conditions do not deviate appreciably from those encountered in previously-drilled test borings. In addition, geotechnical design considerations may arise which are not apparent at this time. If any variations are encountered during the construction phase, we should be contacted so that supplementary recommendations can be made.

The recommendations presented in this report were developed with the "Standard of Care" commonly used as the state of the practice in the profession. No other warranties are included, either express or implied, as to the professional advice included in this report.

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ENSOFT – LPILE Version 3.0. GROUP Version 5.0

Source:
Google Earth. 2005

N

0 .5 1
Scale in Miles

SITE VICINITY MAP

Hydrogen Replacement Plant Project
Chevron Products Company
Richmond, California

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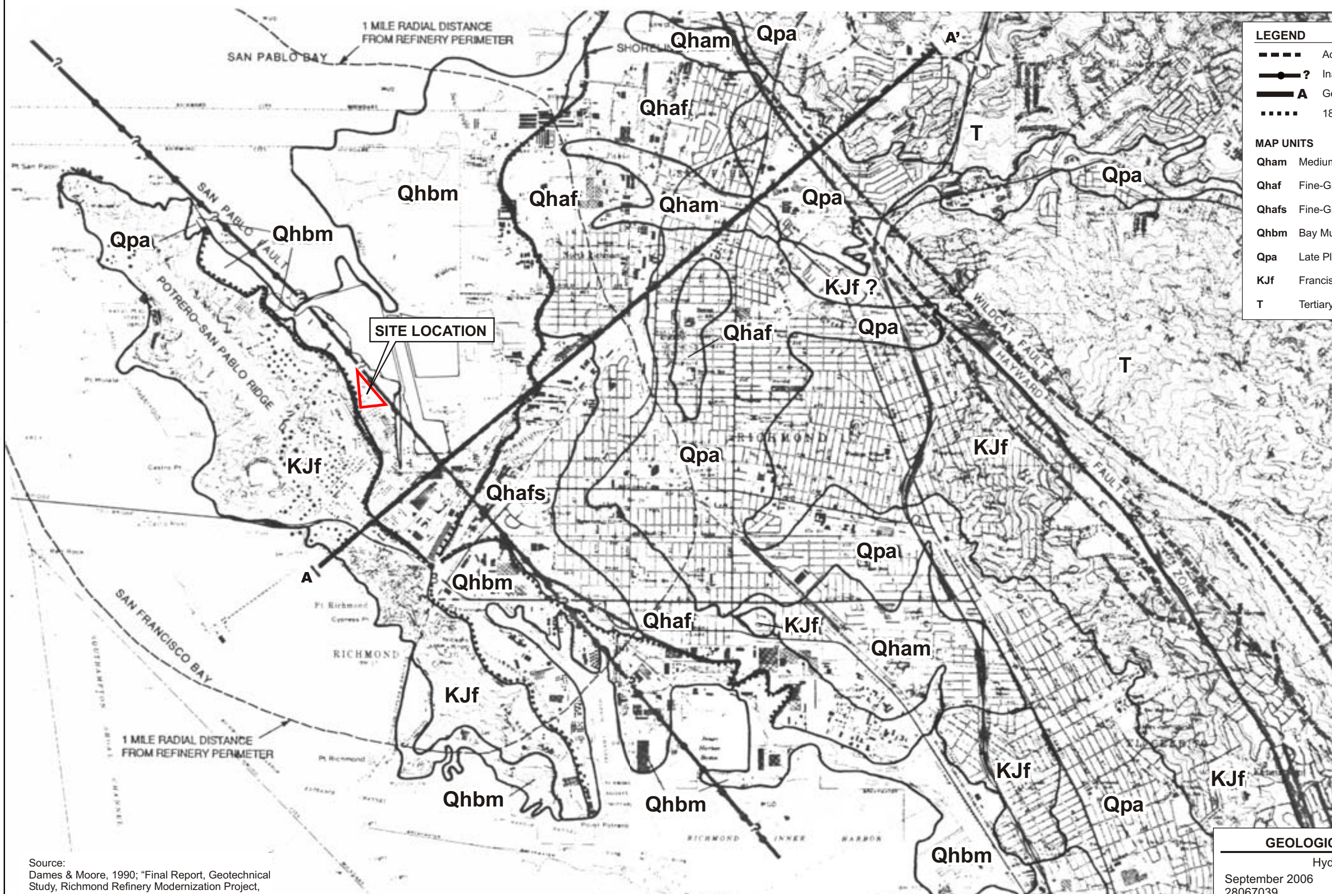
FIGURE 1

9/12/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F1_svm.cdr



Source:
Dames & Moore, 1990; "Final Report, Geotechnical Study, Richmond Refinery Modernization Project, Chevron Refinery, Richmond, California."
Job No. 16000-229, May 17.

GEOLOGIC MAP OF RICHMOND AREA

Hydrogen Replacement Plant Project
Chevron Products Company
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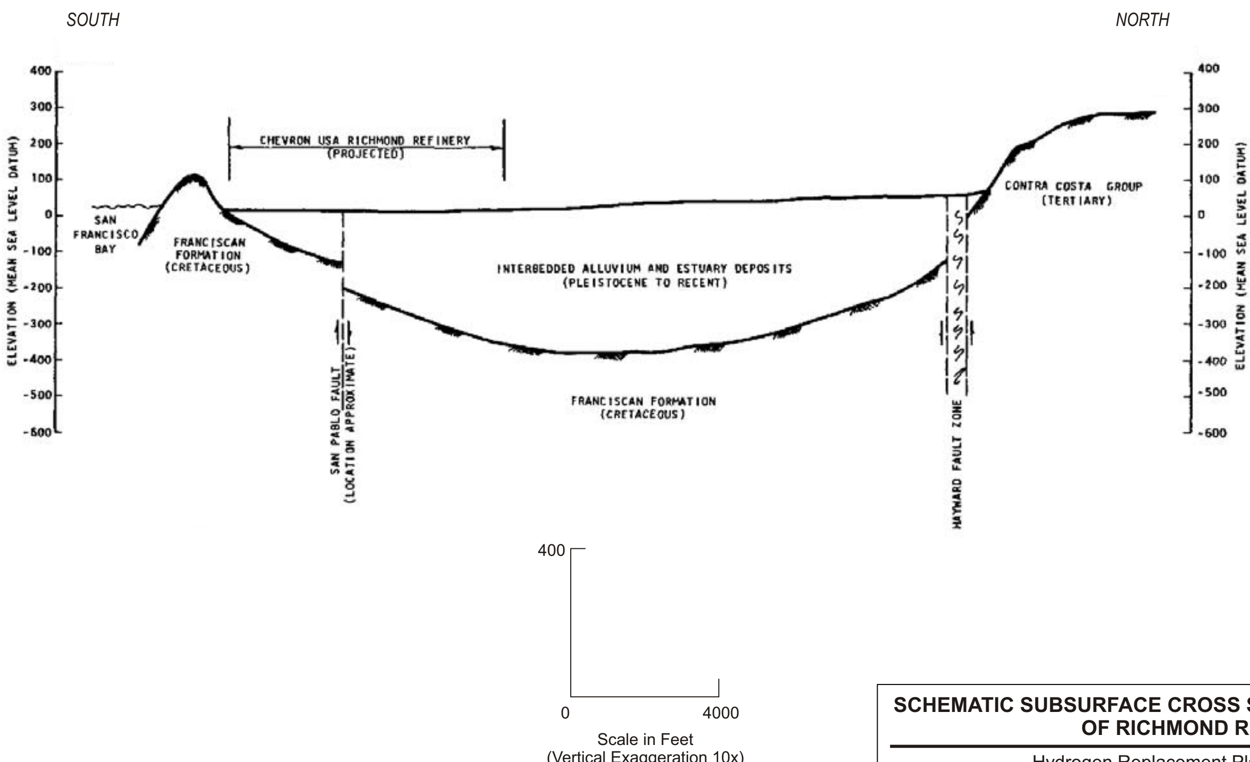
FIGURE 2

9/12/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F2_geomap.cdr



Source:
Dames & Moore, 1981; "Report, Groundwater Investigation, Richmond Refinery, for Chevron USA, Inc."
Job No. 113-531, May 18.

SCHEMATIC SUBSURFACE CROSS SECTION OF RICHMOND REFINERY

Hydrogen Replacement Plant Project
Chevron Products Company
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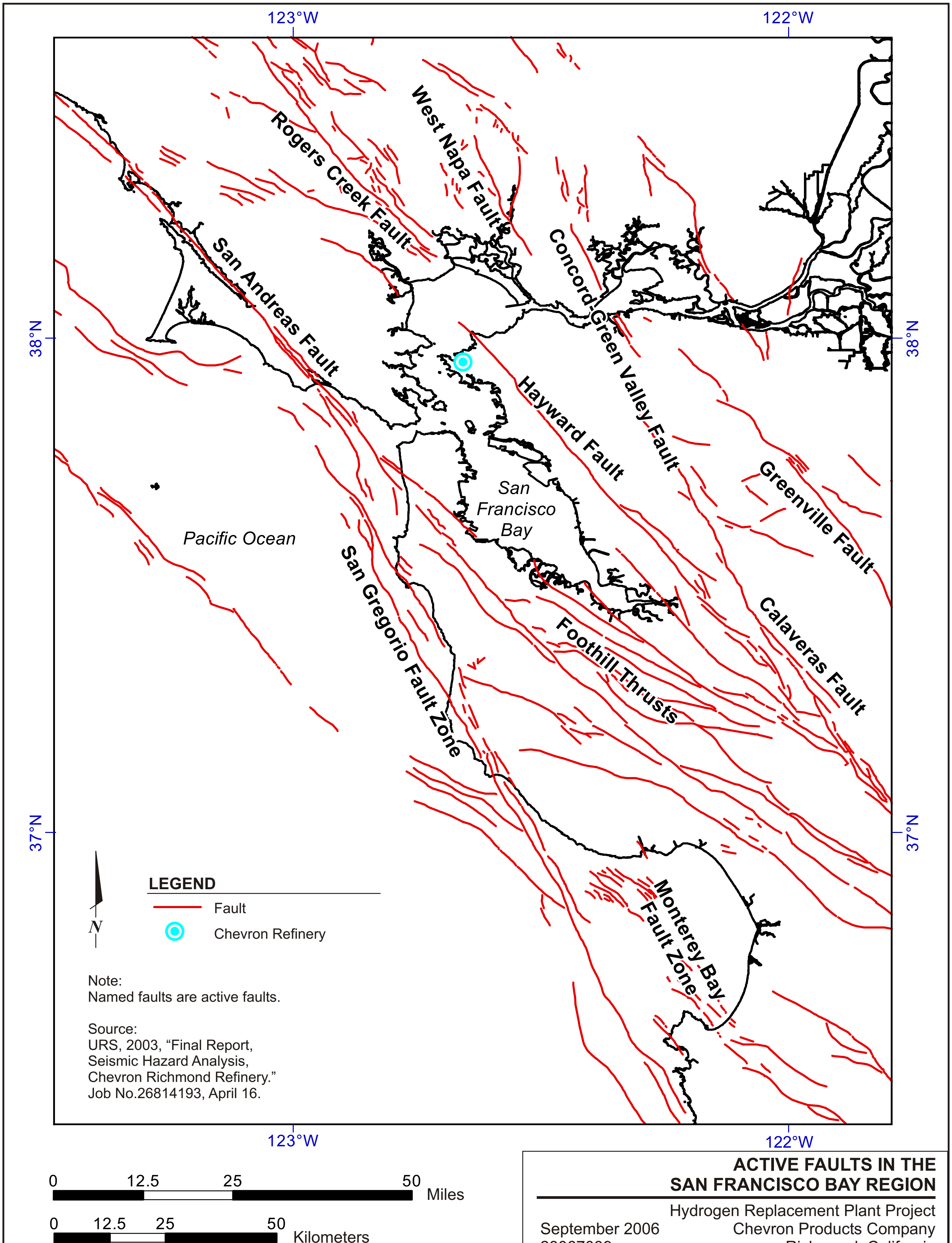
FIGURE 3



Note:
Named faults are active faults.

Source:
URS, 2003, "Final Report, Seismic Hazard Analysis, Chevron Richmond Refinery." Job No.26814193, April 16.

ACTIVE FAULTS IN THE SAN FRANCISCO BAY REGION

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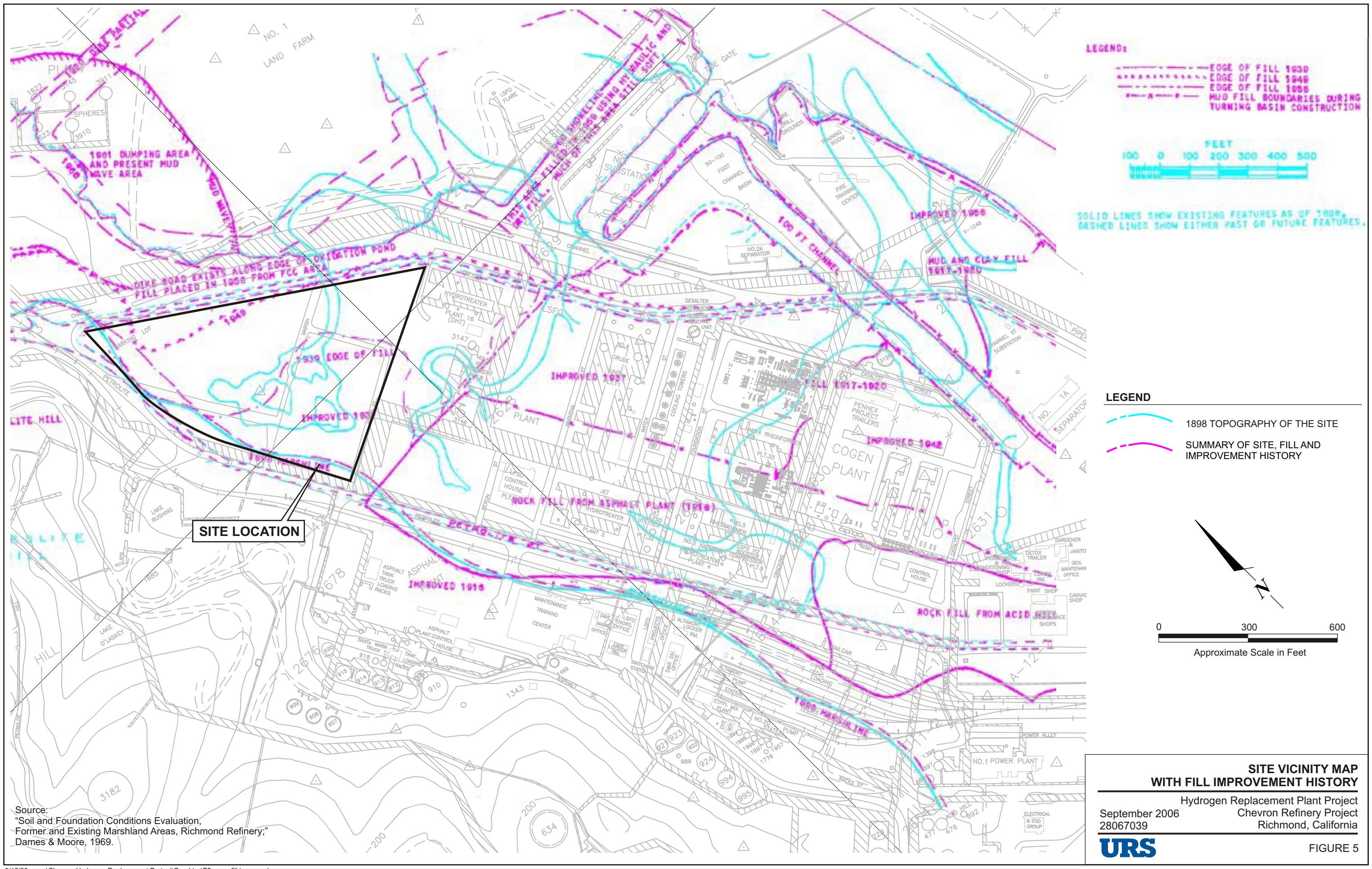
FIGURE 4

9/12/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F4_faults.cdr



SITE VICINITY MAP WITH FILL IMPROVEMENT HISTORY

Hydrogen Replacement Plant Project
Chevron Refinery Project
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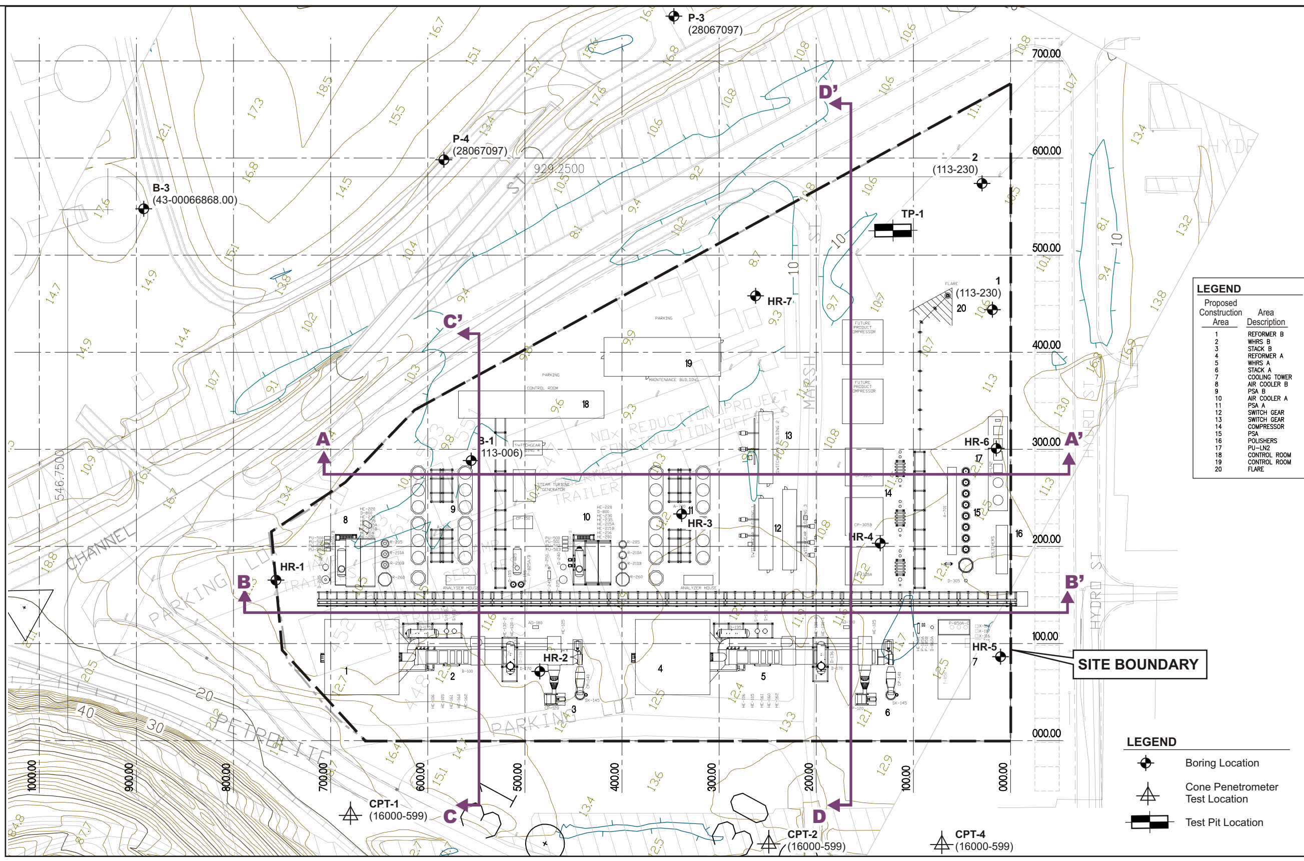
FIGURE 5

9/12/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F5_svm_fill improv.cdr



Source:
Lurgi PSI, Inc., Dwg. No. 06017-CL-0101 Rev. B May 2006

SITE LOCATION AND BOREHOLE LOCATION MAP

Hydrogen Replacement Plant Project
Chevron Refinery Project
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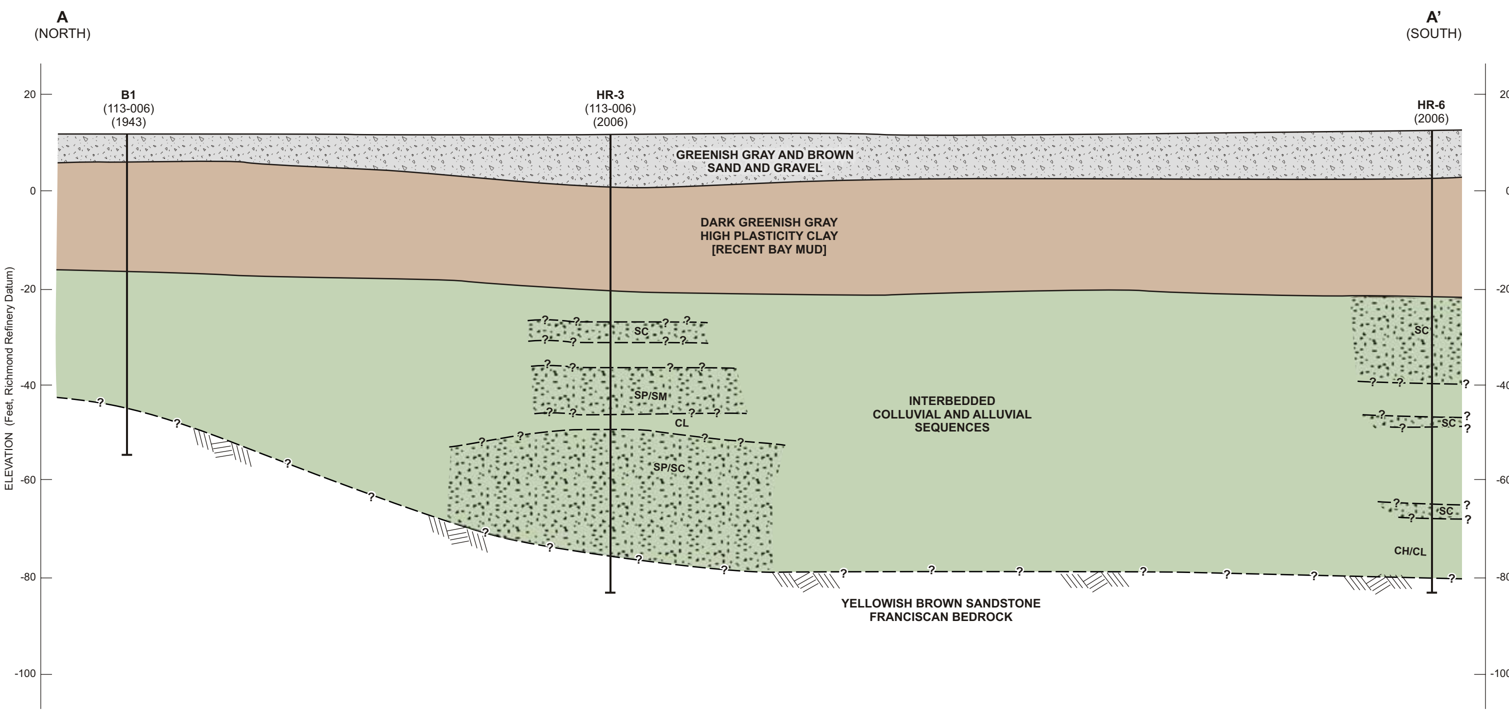
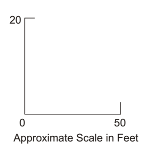
FIGURE 6

9/14/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F6_site-bore loc.cdr



NOTES:

1. Elevations refer to Richmond Refinery Datum.
2. The subsurface section shown represents our evaluation of the most probable conditions based on our interpretation of available data and local geology. The section is based on interpolation of data and involves increasing uncertainty with distance from boring locations shown in this profile.
3. The soil between points of explorations deposit may vary in type, strength and other important properties.



GENERALIZED SUBSURFACE PROFILE A-A'

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Hydrogen Replacement Plant Project
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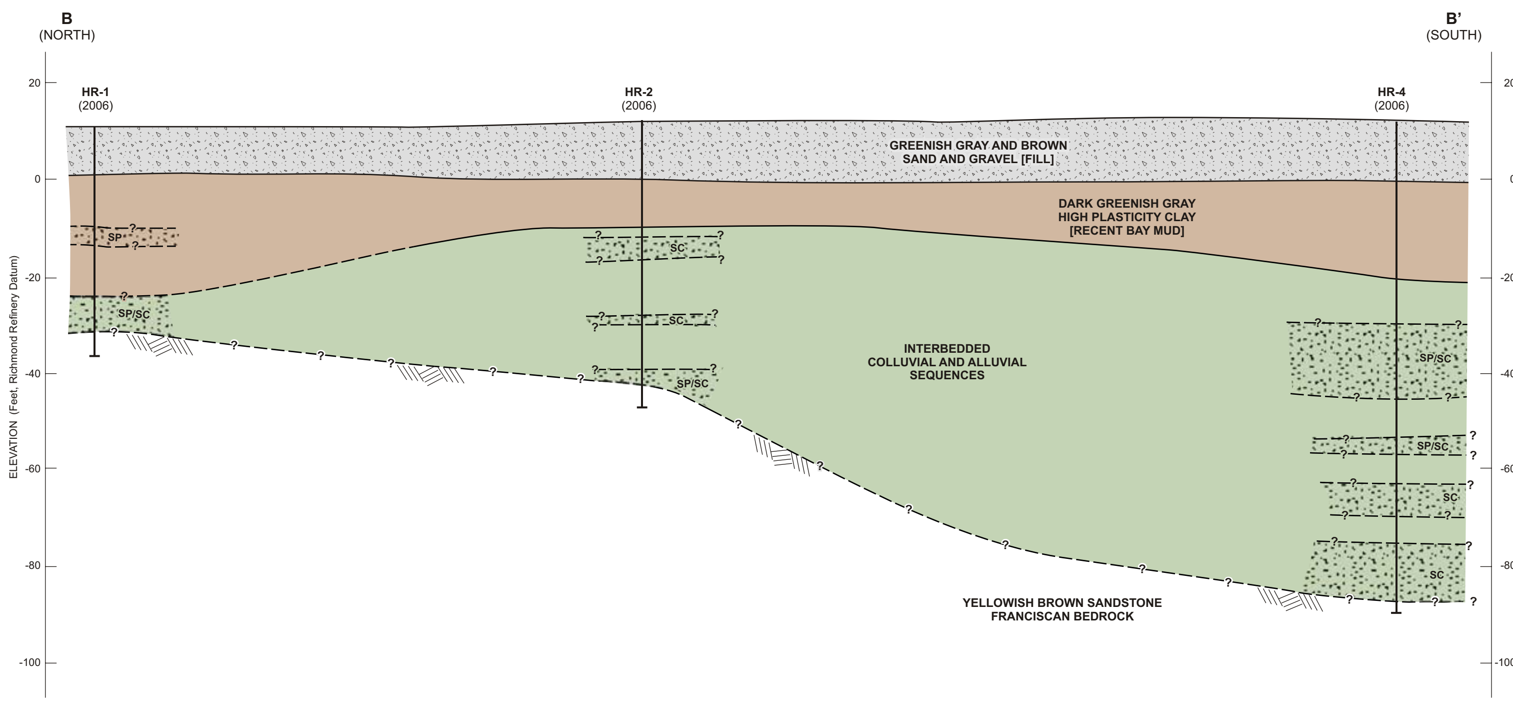
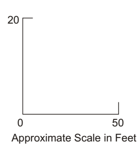
FIGURE 7

9/12/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F7_Gen xsec AA.cdr



NOTES:

1. Elevations refer to Richmond Refinery Datum.
2. The subsurface section shown represents our evaluation of the most probable conditions based on our interpretation of available data and local geology. The section is based on interpolation of data and involves increasing uncertainty with distance from boring locations shown in this profile.
3. The soil between points of explorations deposit may vary in type, strength and other important properties.



GENERALIZED SUBSURFACE PROFILE B-B'

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Chevron Refinery Project
Richmond, California

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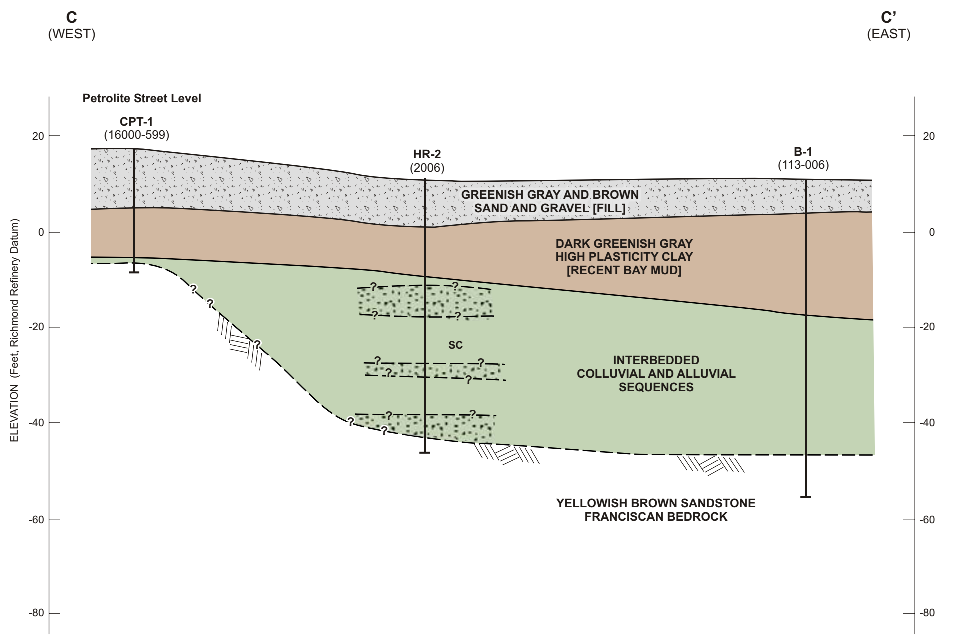
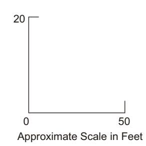
FIGURE 8

9/12/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F8_Gen xsec BB.cdr



NOTES:

1. Elevations refer to Richmond Refinery Datum.
2. The subsurface section shown represents our evaluation of the most probable conditions based on our interpretation of available data and local geology. The section is based on interpolation of data and involves increasing uncertainty with distance from boring locations shown in this profile.
3. The soil between points of explorations deposit may vary in type, strength and other important properties.



GENERALIZED SUBSURFACE PROFILE C-C'

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Hydrogen Replacement Plant Project
Chevron Refinery Project
Richmond, California

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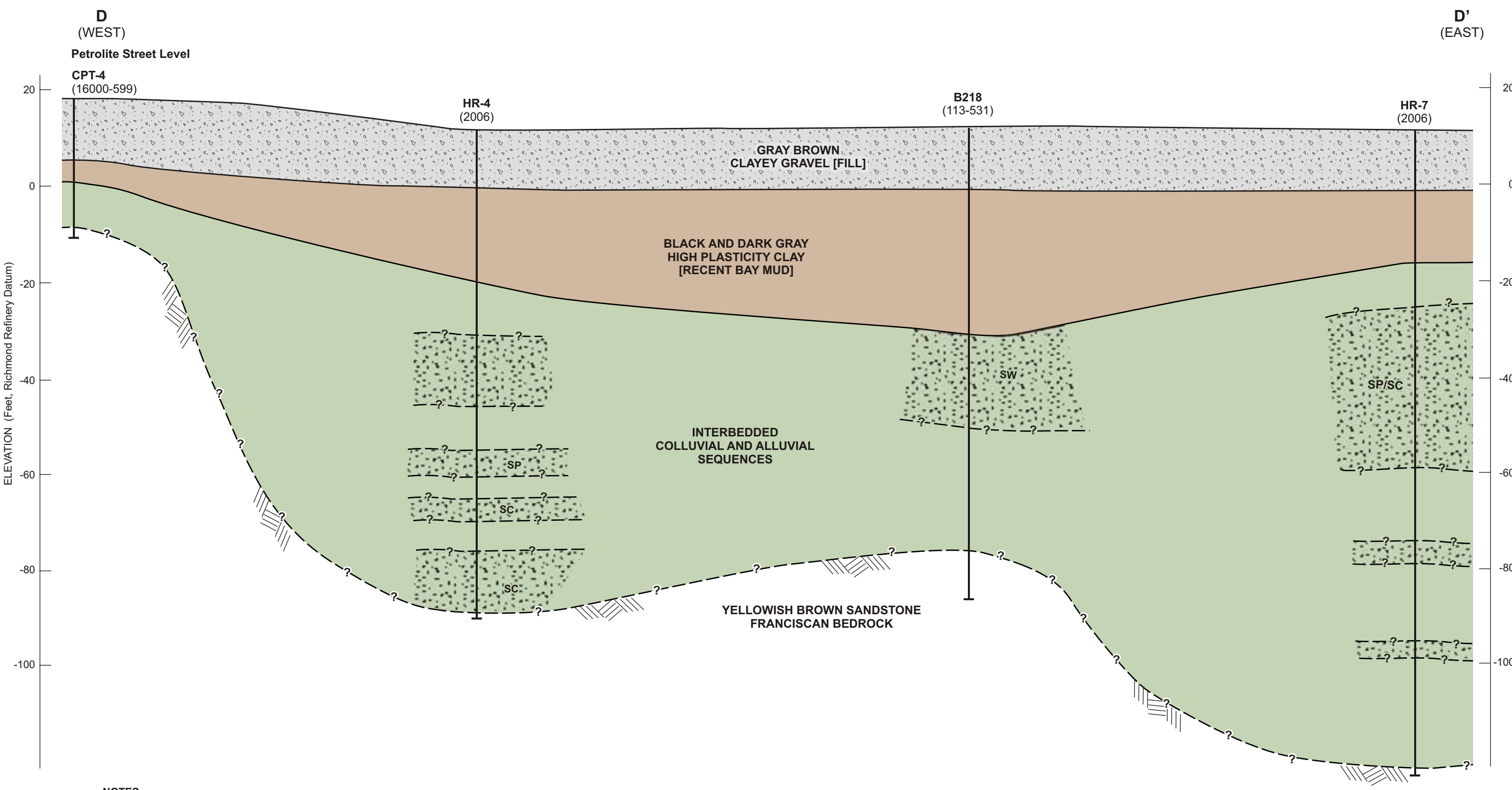
FIGURE 9



NOTES:

1. Elevations refer to Richmond Refinery Datum.
2. The subsurface section shown represents our evaluation of the most probable conditions based on our interpretation of available data and local geology. The section is based on interpolation of data and involves increasing uncertainty with distance from boring locations shown in this profile.
3. The soil between points of explorations deposit may vary in type, strength and other important properties.

GENERALIZED SUBSURFACE PROFILE D-D'

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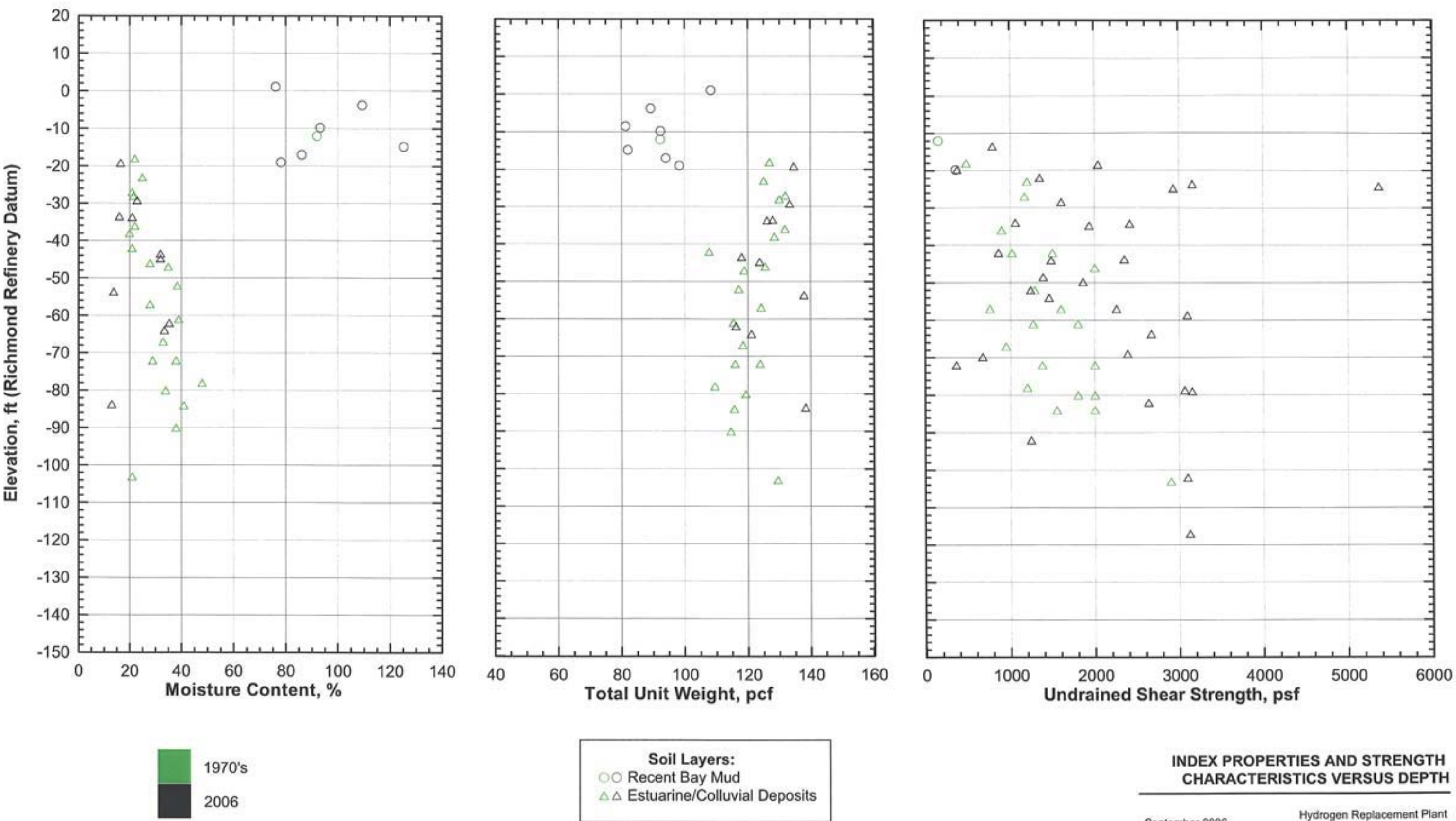
FIGURE 10

8/12/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F10_Gen xsec DD.cdr



INDEX PROPERTIES AND STRENGTH CHARACTERISTICS VERSUS DEPTH

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Chevron Products Company
Richmond, California

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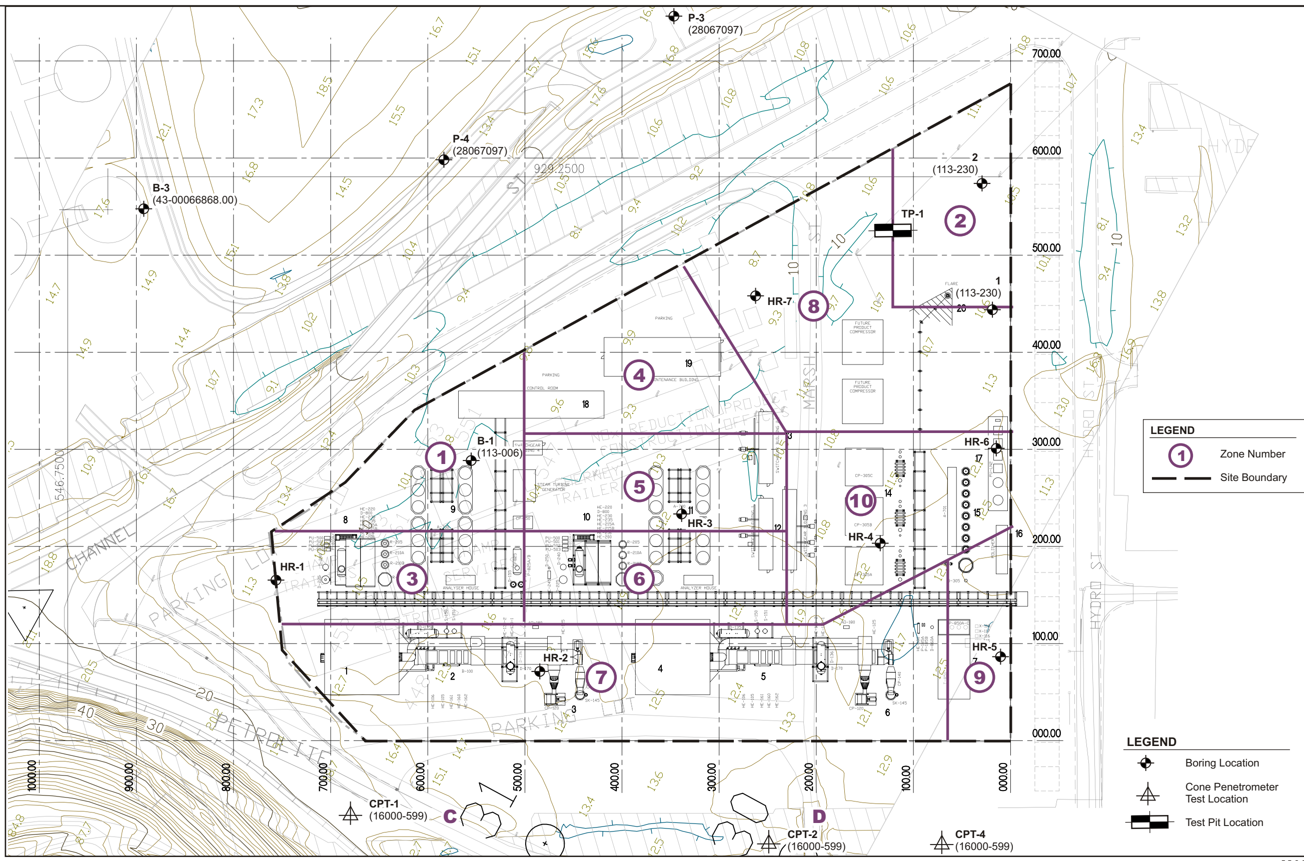
FIGURE 11

J:\Geotechnical\28067039 - Chevron Hydrogen Plants\Hydrogen Replacement\Figures and Plates\Current\Hydrogen_Replacement.grf



Source:
Lurgi PSI, Inc., Dwg. No. 06017-CL-0101 Rev. B May 2006

MAP OF 10 ZONES FOR CONSOLIDATION/COMPUTATION

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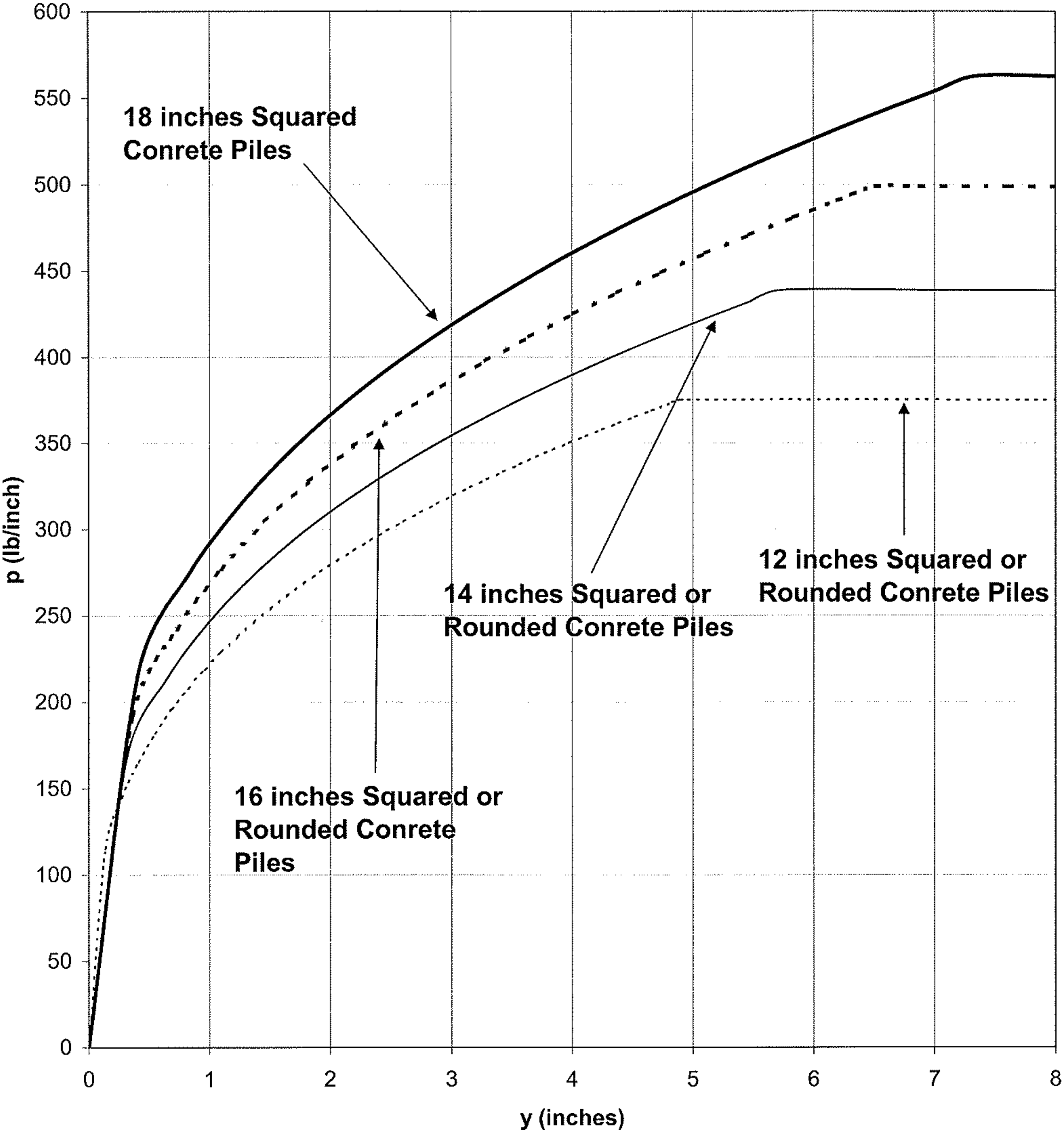
FIGURE 12

9/14/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F12_zones.cdr



P-Y Curve of Fill Material for Different Pile Types

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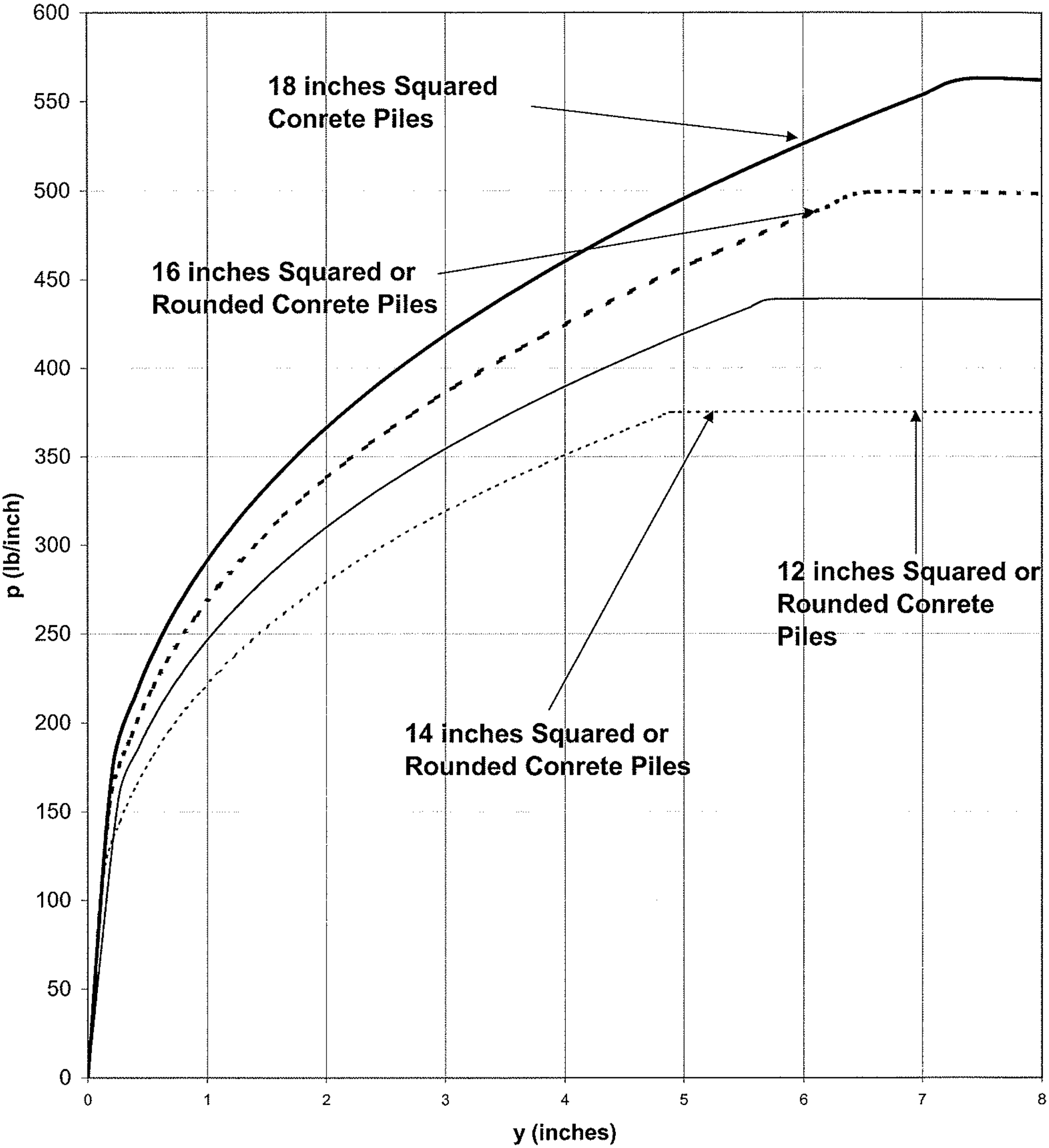
Figure 13



P-Y Curve of Recent Bay Mud for Different Pile Types

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Chevron Richmond Refinery
Richmond,California

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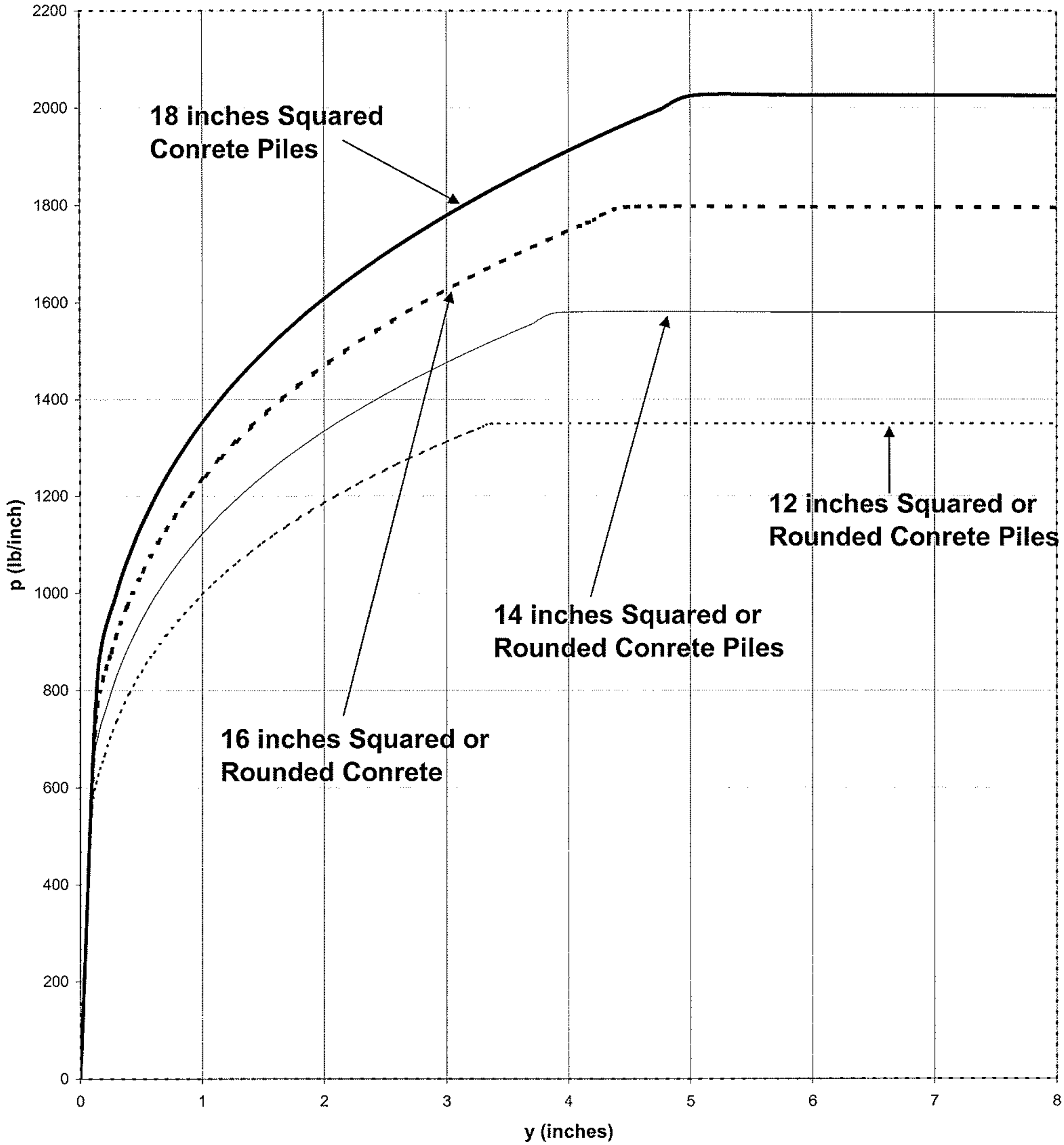
Figure 14



P-Y Curve of Alluvium for Different Pile Types

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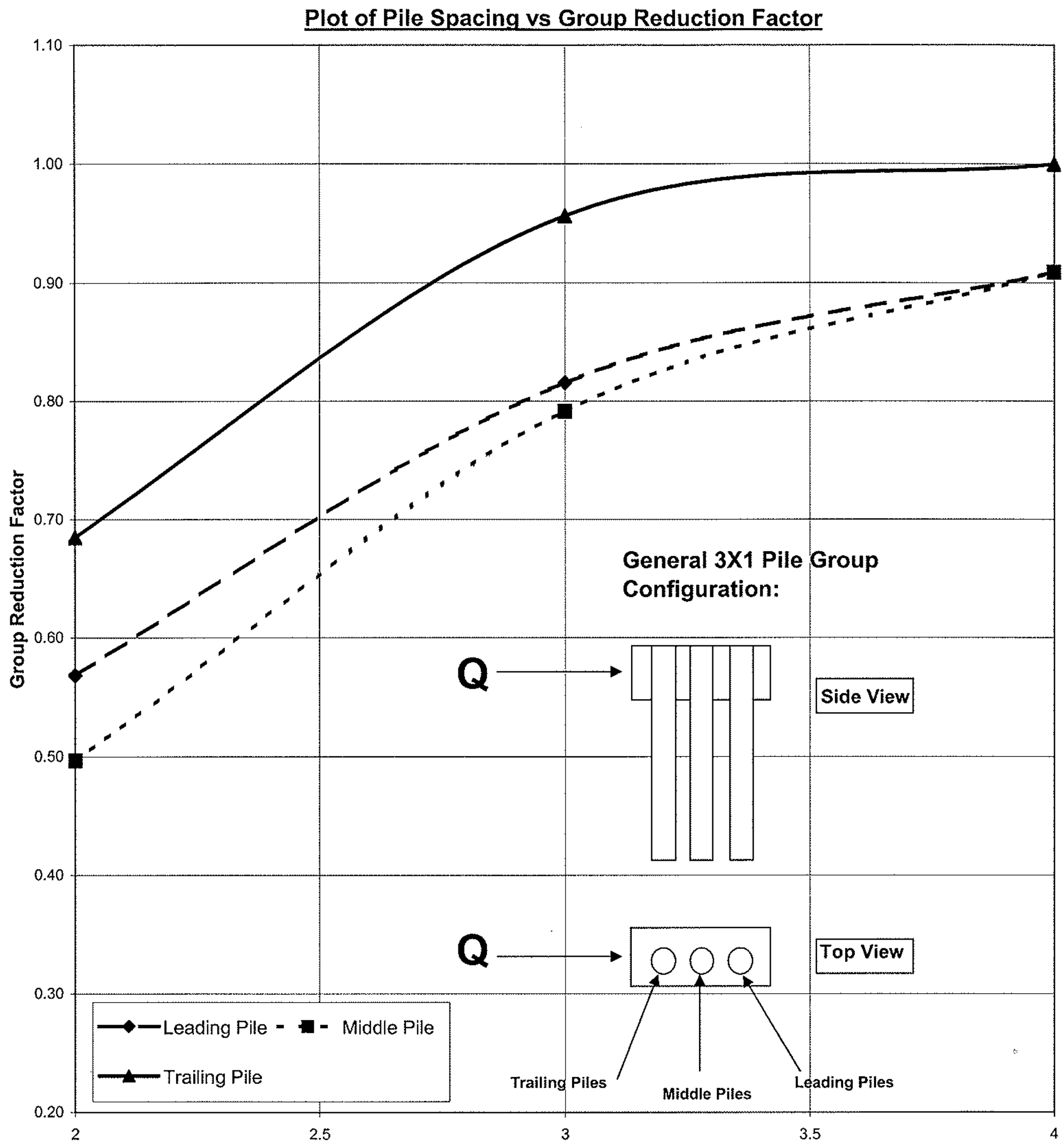
Figure 15



Note:
1. This plot shows the general trend of pile group reduction factor for the presented pile layout only.
2. A final design pile group reduction factor should be developed once the configurations, loads, size of foundation have been established.

Example of 3 Piles Group Reduction Factor

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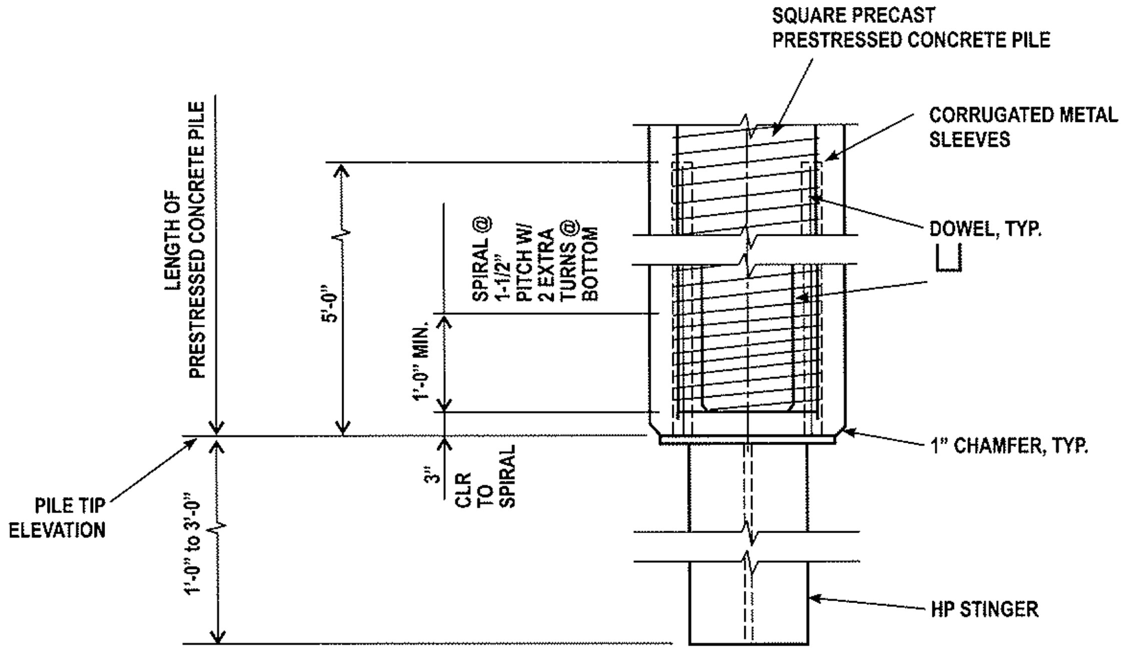
Figure 16



NOTES:

- H-pile Stinger is recommended for end-bearing piles driven to refusal into bedrock.
- Piles that derive their capacity in friction do not require a H-pile stinger.

TYPICAL DETAIL OF H-PILE "STINGER"

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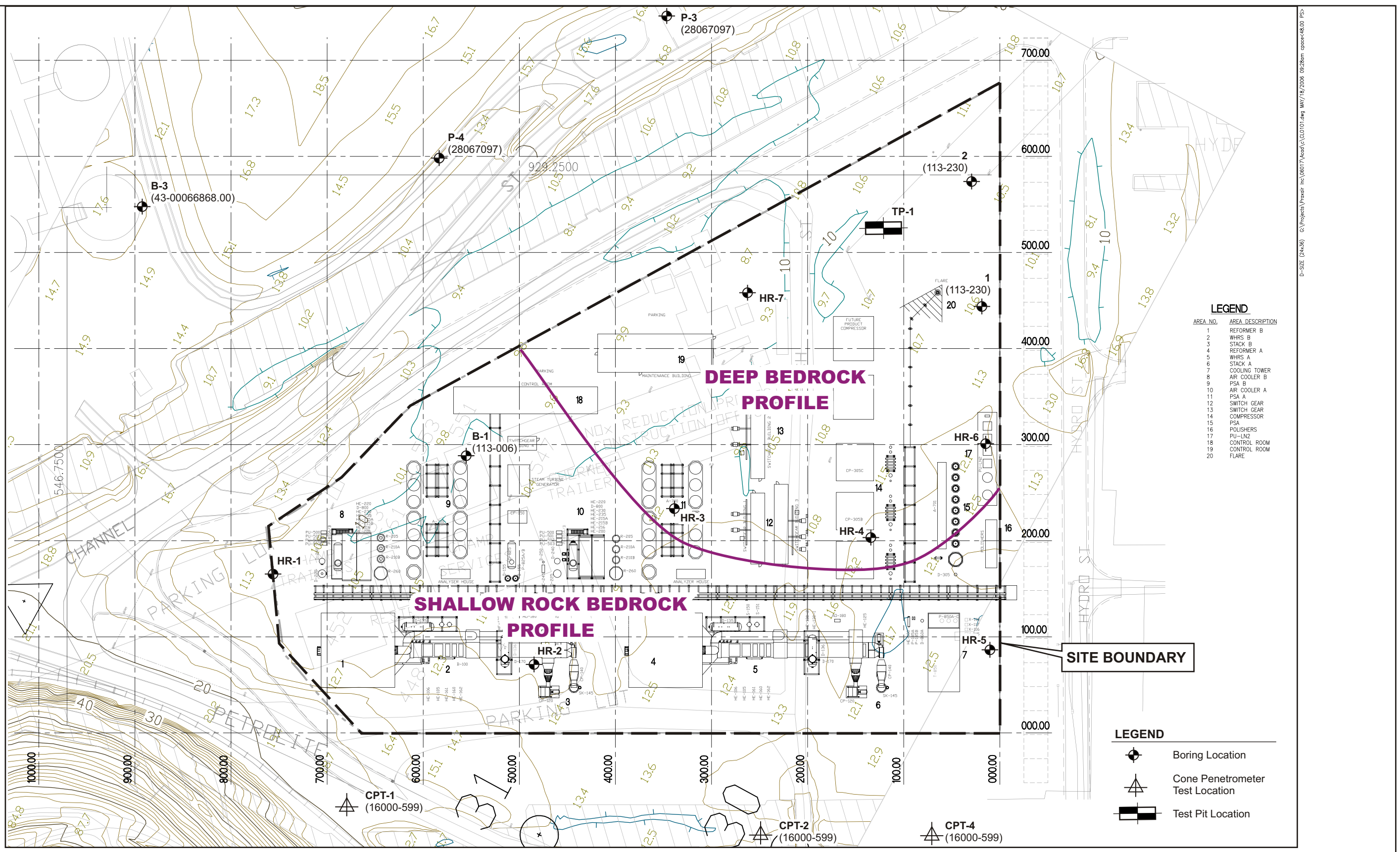
FIGURE 17

9/14/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F17_typ pile det.cdr



Source:
Lurgi PSI, Inc., Dwg. No. 06017-CL-0101 Rev. B May 2006

SITE MAP FOR SHALLOW BEDROCK PROFILE AND DEEP BEDROCK PROFILE FOR SHAKE ANALYSIS

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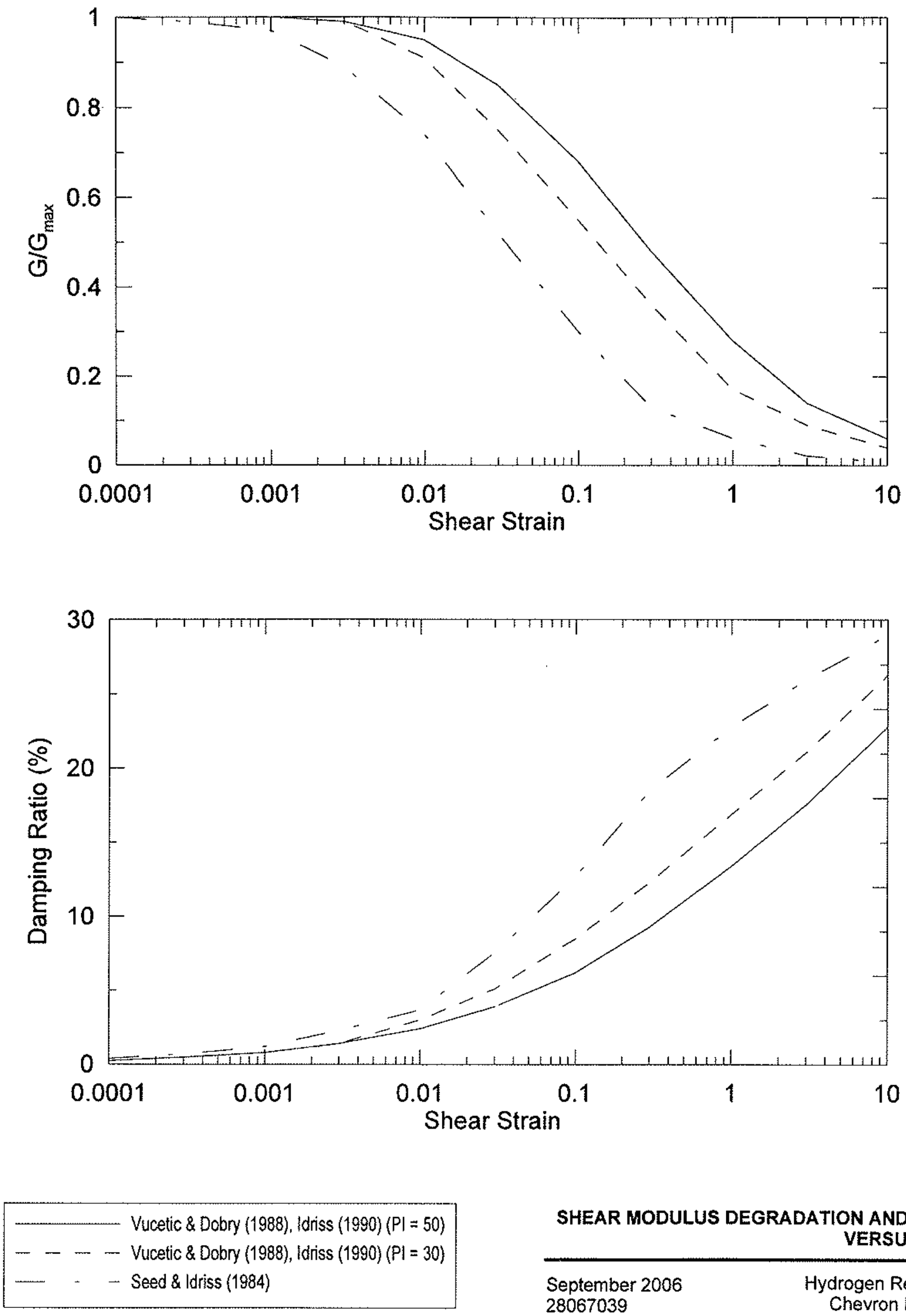
FIGURE 18

9/14/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F18_site_bedrock.cdr



SHEAR MODULUS DEGRADATION AND DAMPING RATIO VERSUS SHEAR STRAIN

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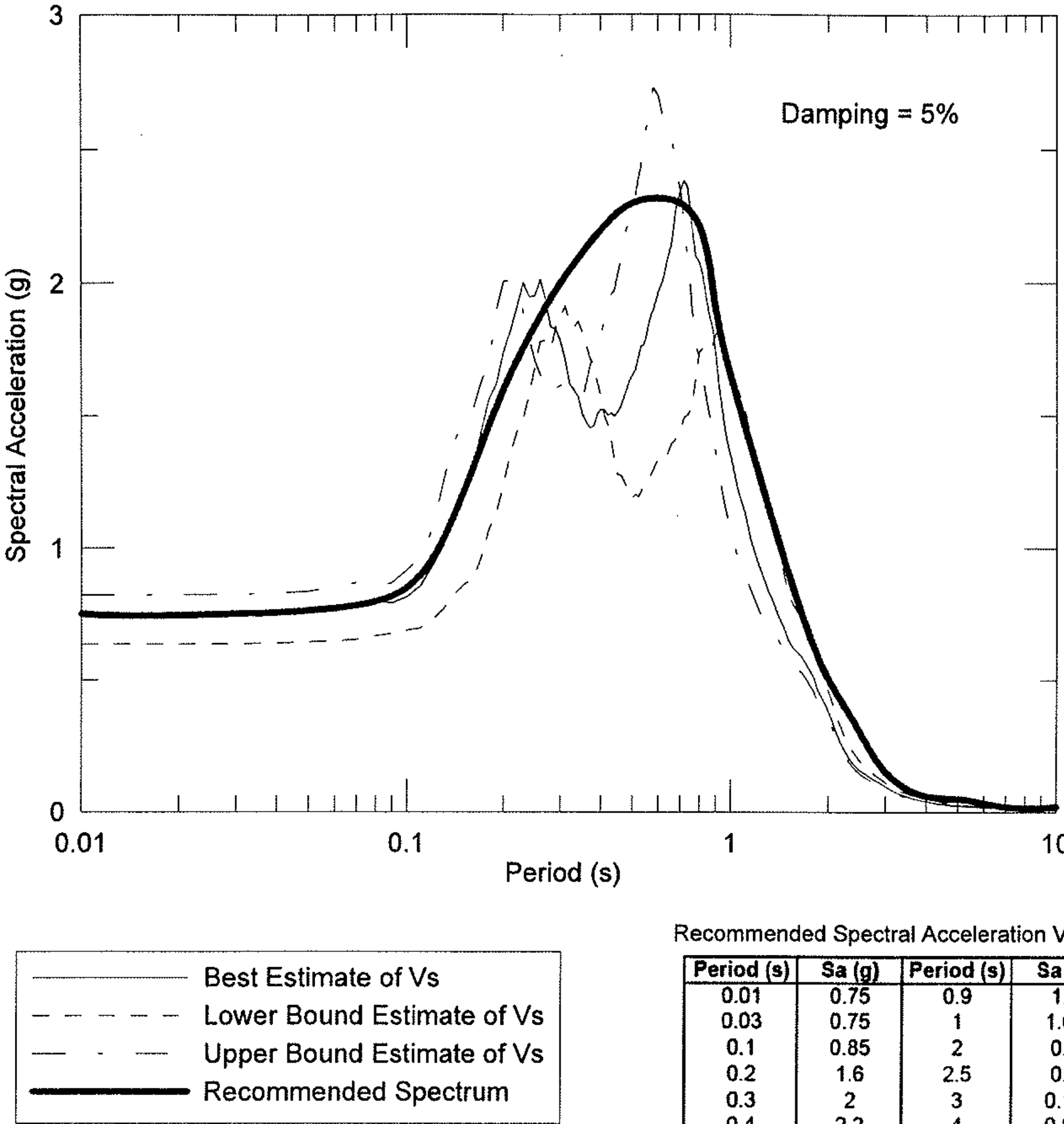
FIGURE 19



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.75	0.9	1.9
0.03	0.75	1	1.65
0.1	0.85	2	0.5
0.2	1.6	2.5	0.3
0.3	2	3	0.15
0.4	2.2	4	0.06
0.5	2.3	5	0.05
0.7	2.3		

CALCULATED AND RECOMMENDED HORIZONTAL ACCELERATION RESPONSE SPECTRA AT THE GROUND SURFACE (SHALLOW BEDROCK PROFILE)

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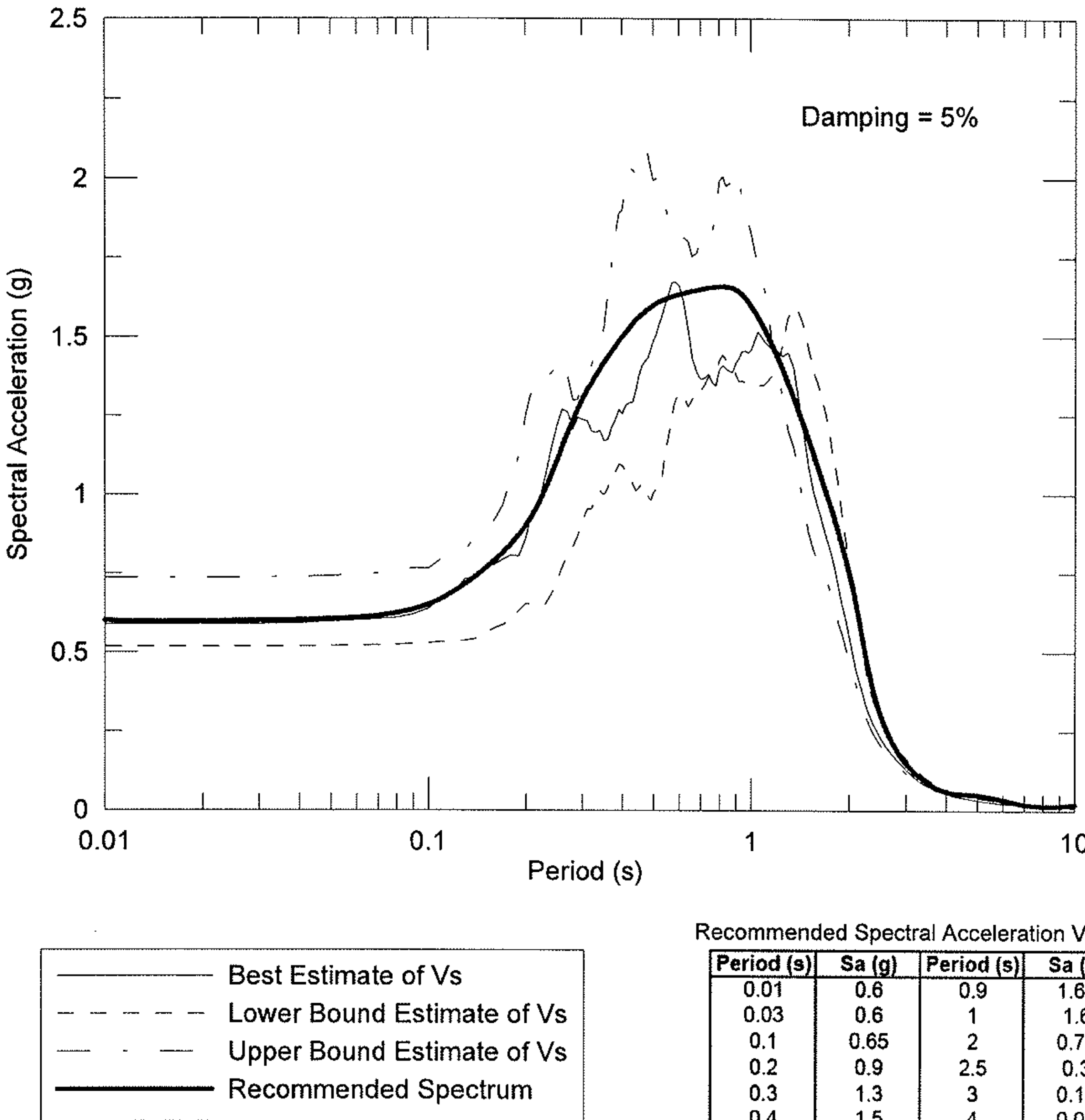
FIGURE 20a



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.6	0.9	1.65
0.03	0.6	1	1.6
0.1	0.65	2	0.75
0.2	0.9	2.5	0.3
0.3	1.3	3	0.15
0.4	1.5	4	0.06
0.5	1.6	5	0.05
0.7	1.65		

CALCULATED AND RECOMMENDED HORIZONTAL ACCELERATION RESPONSE SPECTRA AT THE GROUND SURFACE (DEEP BEDROCK PROFILE)

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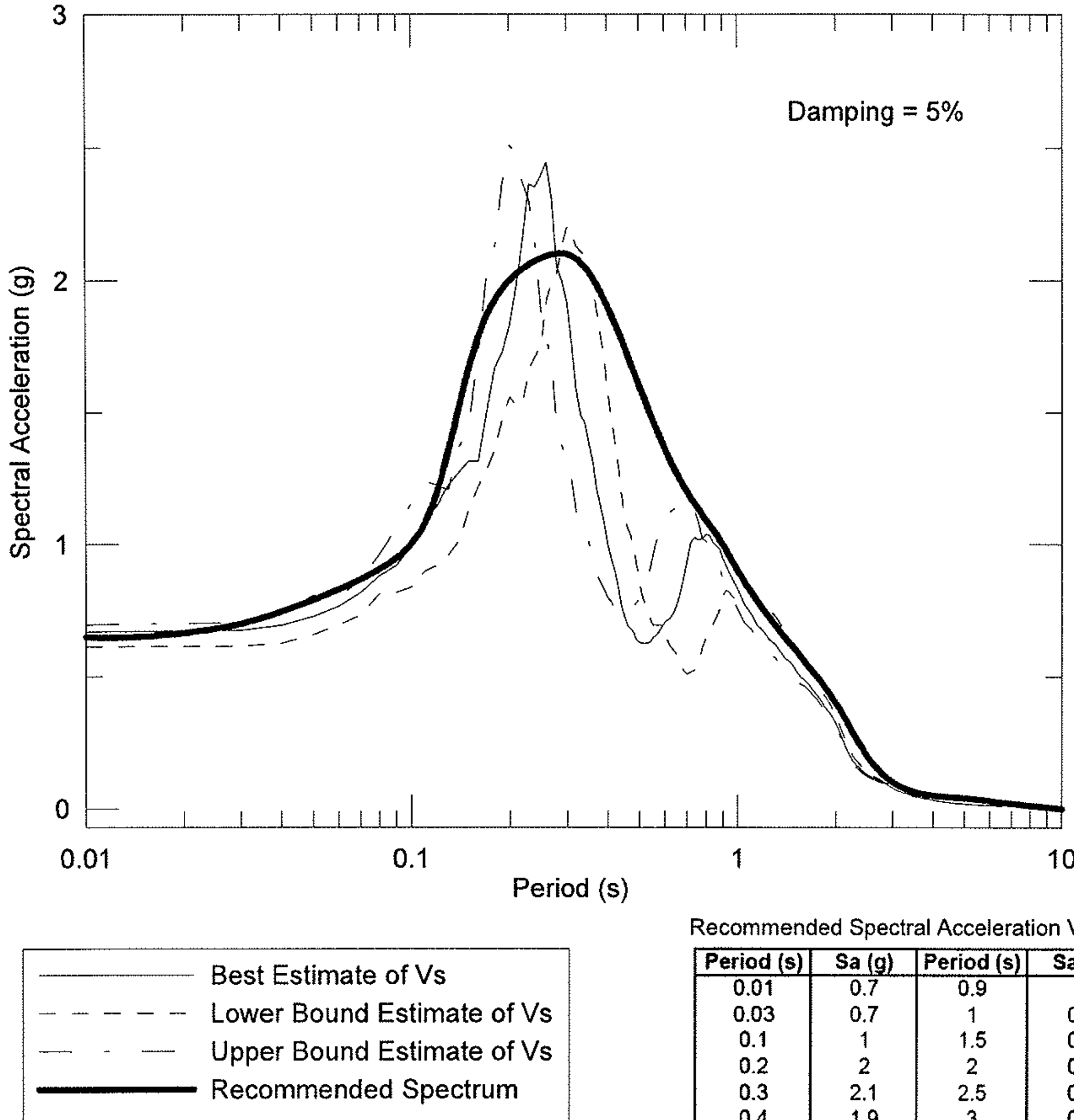
FIGURE 20b



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.7	0.9	1
0.03	0.7	1	0.9
0.1	1	1.5	0.6
0.2	2	2	0.4
0.3	2.1	2.5	0.2
0.4	1.9	3	0.1
0.5	1.6	4	0.05
0.7	1.2	5	0.04

CALCULATED AND RECOMMENDED HORIZONTAL ACCELERATION RESPONSE SPECTRA AT THE BOTTOM OF RECENT BAY MUD LAYER (SHALLOW BEDROCK PROFILE)

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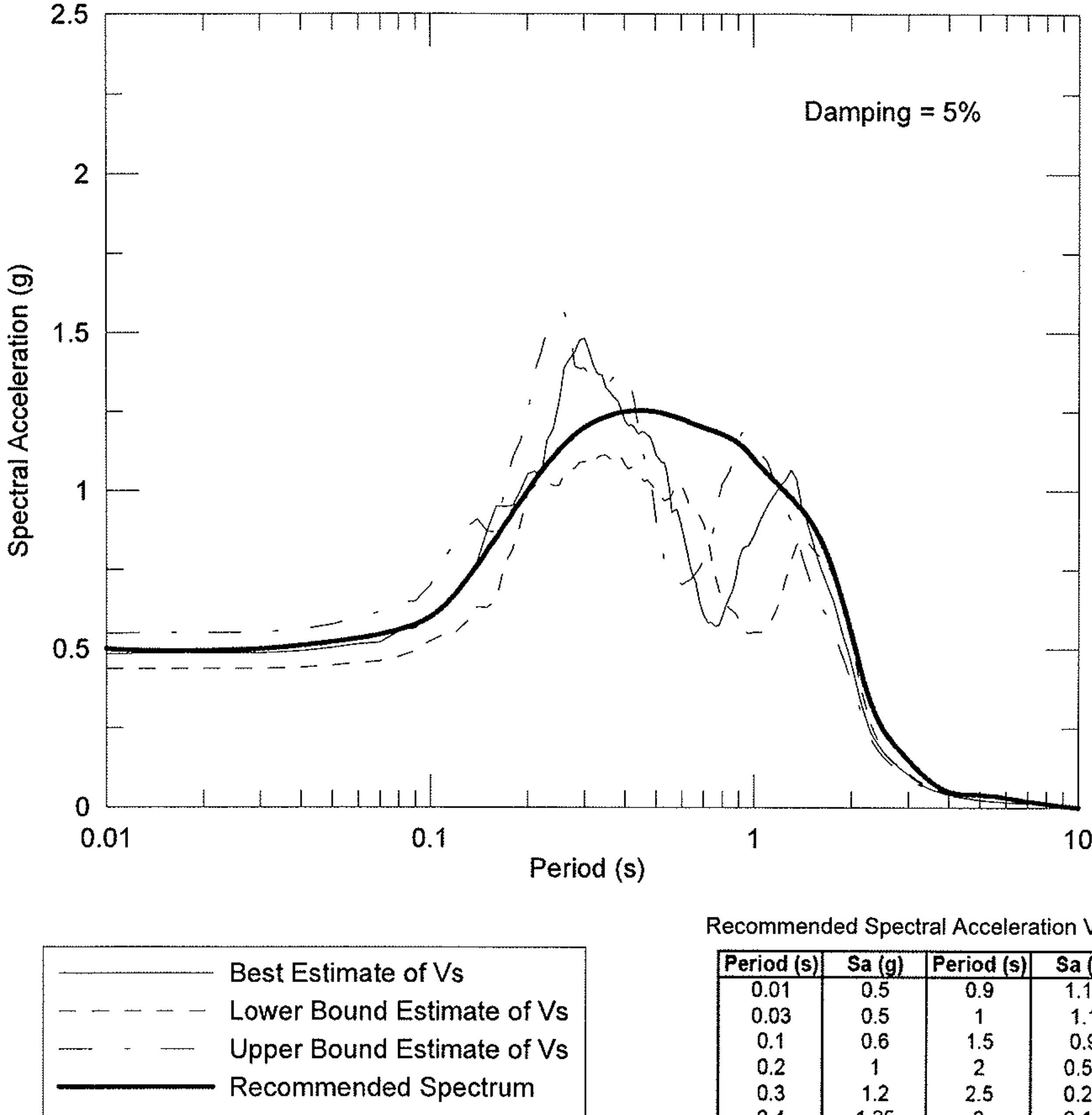
FIGURE 21a



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.5	0.9	1.15
0.03	0.5	1	1.1
0.1	0.6	1.5	0.9
0.2	1	2	0.55
0.3	1.2	2.5	0.25
0.4	1.25	3	0.15
0.5	1.25	4	0.05
0.7	1.2	5	0.04

CALCULATED AND RECOMMENDED HORIZONTAL ACCELERATION RESPONSE SPECTRA AT THE BOTTOM OF RECENT BAY MUD LAYER (DEEP BEDROCK PROFILE)

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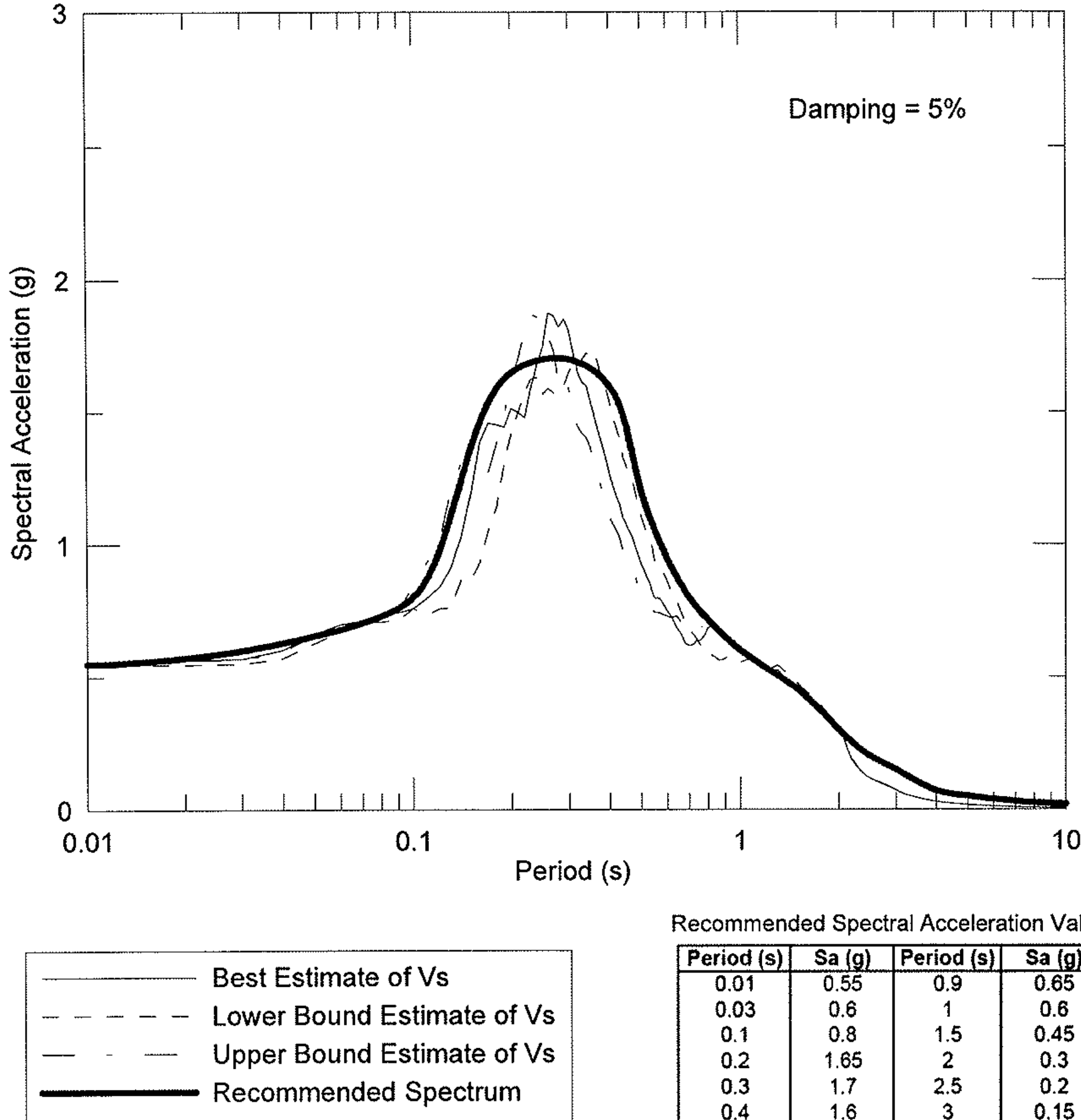
FIGURE 21b



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.55	0.9	0.65
0.03	0.6	1	0.6
0.1	0.8	1.5	0.45
0.2	1.65	2	0.3
0.3	1.7	2.5	0.2
0.4	1.6	3	0.15
0.45	1.45	4	0.07
0.5	1.2	5	0.05
0.7	0.8		

CALCULATED AND RECOMMENDED HORIZONTAL ACCELERATION RESPONSE SPECTRA AT THE MIDDLE OF ALLUVIUM LAYER (SHALLOW BEDROCK PROFILE)

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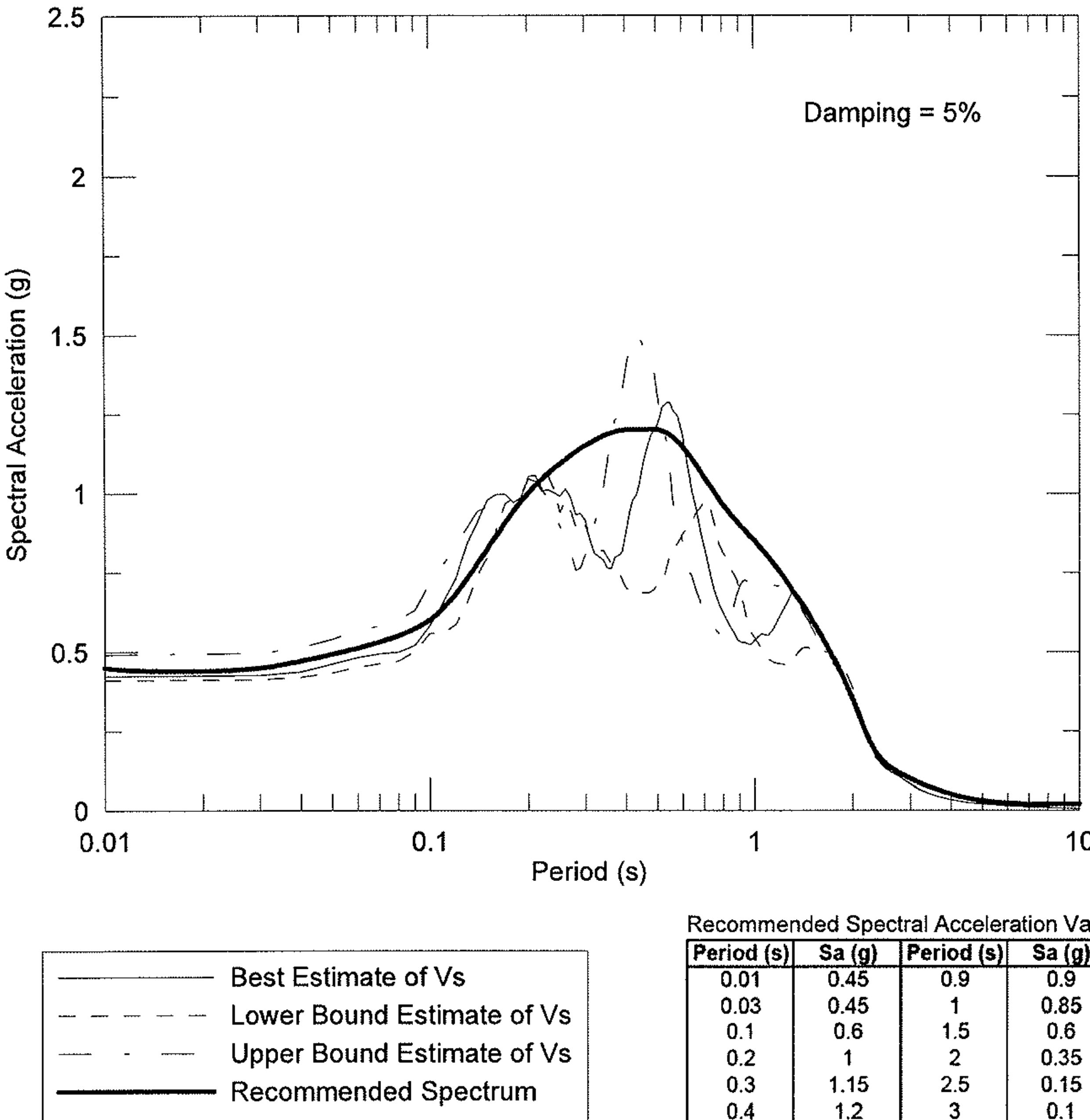
FIGURE 22a



Recommended Spectral Acceleration Values

Period (s)	Sa (g)	Period (s)	Sa (g)
0.01	0.45	0.9	0.9
0.03	0.45	1	0.85
0.1	0.6	1.5	0.6
0.2	1	2	0.35
0.3	1.15	2.5	0.15
0.4	1.2	3	0.1
0.45	1.2	4	0.05
0.5	1.2	5	0.03
0.7	1.05		

CALCULATED AND RECOMMENDED HORIZONTAL ACCELERATION RESPONSE SPECTRA AT THE MIDDLE OF ALLUVIUM LAYER (DEEP BEDROCK PROFILE)

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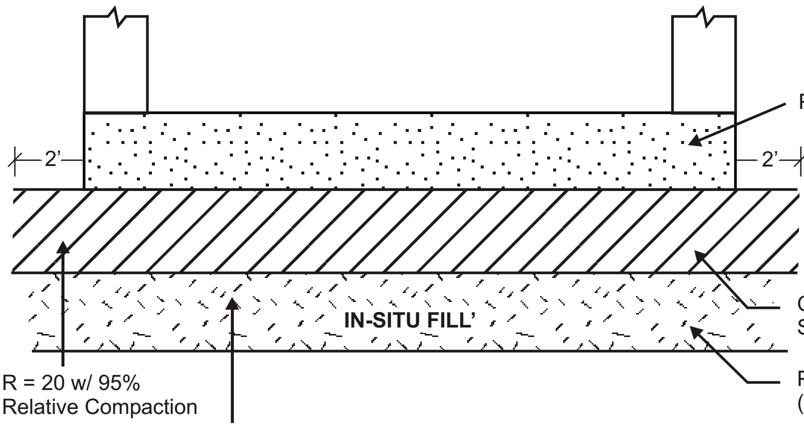
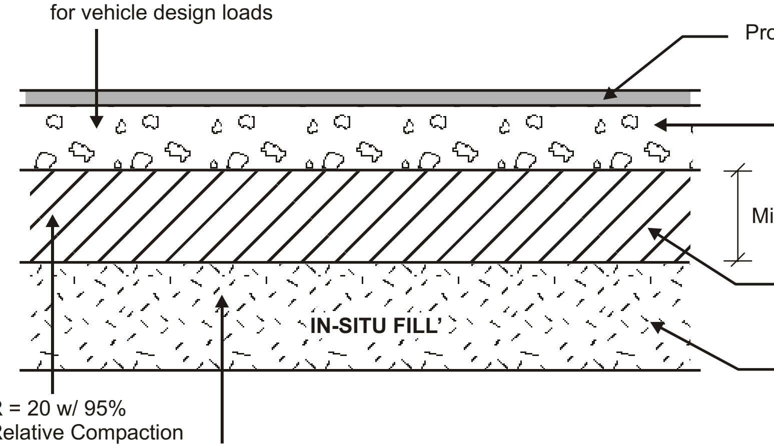
FIGURE 22b



SETTLEMENT INSENSITIVE MATS



ROADWAY DESIGN

SUGGEST SITE PREPARATION FOR SHALLOW MAT FOUNDATIONS AND ROADWAY

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Chevron Refinery Project
Richmond, California

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FIGURE 23

9/14/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\F23_shallow mat.cdr

APPENDIX A

GEOTECHNICAL FIELD EXPLORATION AND HISTORICAL BORING LOGS

APPENDIX A

GEOTECHNICAL FIELD EXPLORATION AND HISTORICAL BORING LOGS

TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX A

GEOTECHNICAL FIELD EXPLORATION AND HISTORICAL BORING LOGS

SCOPE OF THE PROGRAM

This appendix summarizes the drilling, sampling, and testing techniques used to perform the geotechnical field exploration for the proposed Hydrogen Replacement Plant Project at the Chevron Richmond Refinery in Richmond, California. The objective of this investigation was to collect geotechnical data necessary for developing recommendations regarding the foundation design and construction procedures for the proposed structures.

The geotechnical field investigation consisted of seven borings and one test pit. This appendix presents a detailed description of these seven borings and one test pit and their results.

FIELD EXPLORATION LOCATIONS

URS chose the two boring locations to investigate the subsurface conditions beneath the proposed structures. While meeting this objective, we chose the locations within the following constraints:

- Incorporate information from historical borings,
- Avoid underground utilities,
- Avoid overhead electric lines, and
- Avoid surface obstructions

Given the objectives of the program and these constraints, the seven borings and one test pit were drilled and excavated at the locations shown on Figure 6.

Prior to drilling, URS obtained the necessary soil boring and piezometer permits from the Environmental Health Division of Contra Costa County. Chevron "metro-teched" the boring locations to identify underground utilities and prepared the required "yellow-book" field operation files. The fieldwork began on May 22 and extended through May 25, 2006.

BORINGS AND TEST PIT

Seven borings, HR-1 through HR-7 and one test pit, TP-1, were drilled and excavated to provide the necessary information to evaluate the subsurface stratigraphy and to collect geotechnical and groundwater data necessary for the design of the proposed structures. Figure 6 shows the locations of the borings and test pie. Each boring was drilled to bedrock. Table A1 lists the boring elevations and casing and penetration depths.

TABLE A1
SUMMARY OF GEOTECHNICAL FIELD EXPLORATION

Boring	Casing Depth (feet)	Boring Depth (feet)	Ground Surface Elevation (feet, RRD)	Bottom Elevation of Bottom of Boring (feet, RRD)
HR-1	8.5	47.7	+11.2	-36.5
HR-2	8.5	59	+11.8	-47.2
HR-3	8.5	95.5	+11.2	-84.3
HR-4	13.5	101.5	+12.3	-89.2
HR-5	8.5	71.3	+12.5	-58.8
HR-6	8.5	95.7	+12.0	-83.7
HR-7	13.5	135.3	+9.0	-126.3

All borings were drilled using rotary wash drilling equipment. Five-inch diameter casing was set through surficial materials to the depths as presented in Table A1 to support the drilling operations. Heavy mud was circulated to remove the drill cuttings and to stabilize the hole below the casing. Drilling and sampling was performed by Pitcher Drilling Company of East Palo Alto, California under subcontract to URS. All borings were drilled under the supervision of a geotechnical engineer from URS, who maintained records of all field activities, classified the soils encountered using the Unified Soil Classification System (USCS), performed field strength testing, and maintained a continuous log of the borings. Field shear strength measurements tests were performed on the ends of cohesive soil samples immediately upon retrieval using a Pocket Penetrometer or Torvane.

Disturbed and undisturbed samples were obtained for identification and laboratory testing. Soil samples were generally obtained at 5-foot intervals from ground surface to the bottom of the boring. We used three types of samplers: the standard penetration test (SPT) sampler, the Dames & Moore U-sampler, and the Dames & Moore piston sampler. The following is a brief description of the sampler types and sample handling used in this investigation.

- Standard Penetration Test Sampler. The standard penetration test (SPT) or split spoon sampler was used in conjunction with the Standard Penetration Test (ASTM D-1586) to obtain relatively disturbed samples for soil identification and to obtain penetration resistance data for correlation with engineering properties.

The SPT sampler was driven using a standard 140-pound hammer falling 30 inches as specified in ASTM D-1586.

- Dames & Moore U-Sampler. The U-Sampler was used to obtain relatively undisturbed samples for laboratory testing. The U-sampler is a ring-lined, split-barrel sampler with a nominal 2½-inch inner diameter and 3¼-inch outer diameter, in substantial compliance with ASTM D-3550. The U-sampler was driven using a standard 140-pound hammer falling 30 inches. In some cohesive deposits, the U-sampler was fitted with a 6 inch long, thin-walled tube ahead of the tip, and the entire U-sampler with thin wall tube attachment was hydraulically pushed into the soil.

- Dames & Moore Piston Sampler. The piston sampler was used to obtain undisturbed samples of cohesive soils for laboratory testing. This sampler is a fixed piston sampler that hydraulically pushes a 2 ½-inch-diameter, 18-inch-long, brass tube into the soil.

The blow count recorded on the boring logs adjacent to the sample depth is the number of blows required to drive the sampler for the final 12 inches of an 18-inch sampling interval. These blow counts are uncorrected. The conversion factor from blow counts of Dames & Moore Samples and Modified California Sampler to blow counts of SPT is 0.5.

Soil samples were transported to Signet Testing Labs in Hayward, California.

All borings were sealed by tremie placement of lean cement grout upon completion of drilling. Drill cuttings generated during drilling were stored in drums provided by Pitcher Drilling Company. The drums were located adjacent to the borings. We understand that Chevron personnel will dispose of the drums.

LOGS OF BORINGS FOR THIS INVESTIGATION

The logs of the borings and test pit are presented in Figures A1 through A8. The logs show the interpreted subsurface conditions at the boring locations at the time the borings were drilled. The boring logs identify the types of soils encountered using the Unified Soil Classification System. They also show the depth of the samples, type of samples, and available laboratory test data. An explanation of terms used in the logs is presented in Figure A9.

LOGS OF HISTORICAL BORINGS

Dames & Moore, a URS predecessor company, conducted several geotechnical investigations near the Hydrogen Replacement Plant Project Site since 1943 for a variety of Refinery facilities. The logs of the borings for these historical investigations are a valuable source of subsurface data for the current investigation. Figures A10 through A12 present the logs of these previous borings. The logs show the interpreted subsurface conditions at the boring locations at the time the borings were drilled. The figures include explanations of the terms used in the logs.

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Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-1

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LABORATORY TEST DATA: ATTERBERG LIMITS: LIQUID LIMIT (%)	PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
0											GP	2" ASPHALT CONCRETE.
											SC	6" COARSE TO FINE SANDY GRAVEL, trace clay. [BASEROCK]
												GREENISH GRAY AND DARK GRAY CLAYEY COARSE TO FINE SAND. Medium dense to medium stiff, moist to damp. [FILL]
									MC	24	GP	DARK GRAY COARSE TO FINE GRAVEL WITH COARSE TO FINE SAND, trace clay. Medium dense, wet.
5												
										4	CL	DARK GRAY AND GREENISH GRAY COARSE TO FINE SANDY CLAY. Medium stiff to soft, moist.
											SP	DARK GRAY AND BLACK FINE TO MEDIUM SAND. Moist, loose. Hydrocarbon odor.
									TW	2		
10											CH	DARK GRAY FAT CLAY, trace fine sand. Soft, wet. Frequent pieces of decomposed wood and peat. [RECENT BAY MUD] PP: Su = 250 psf; TV: Su = 300 psf
15	Consol	96	48				109.8	89.2	P	2 500 psi		PP: Su = 250 psf; TV: Su = 300 psf
											CH	LIGHT GREENISH GRAY AND DARK GRAY CLAY, trace fine sand. Stratified with frequent pieces of decomposed wood, peat. Frequent (1/8" diameter) carbon nodules. [COLLUVIUM] PP: Su = 250 psf; TV: Su = 400 psf
20									TW	3		PP: Su = 750 psf; TV: Su = 600 psf
											SP	DARK GRAY FINE SAND, trace clay. Loose, wet.
25	-200 (91.6%)						123.0	82.0	TW	4	CL	GREENISH GRAY AND DARK GRAY CLAY, trace fine sand. Soft, wet. Stratified with frequent pieces of decomposed wood, peat. PP: Su = 750 psf; TV: Su = 800 psf
30				UC		372			TW	3		PP: Su = 750 psf; TV: Su = 700 psf
												Grades fine sandy without decomposed wood, peat.
35												

Continued Next Page

Job No: 28067039 Pt. ID: CHP_HR.GPJ / HR-1	URS		**Log of Boring**
Date Completed: 5/31/06 Boring Depth: 47.7 ft.	Surface Elev: 11.2 ft. Richmond Refinery Datum (RRD) Coordinates:		Location: Chevron Richmond Refinery

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-1

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
35									TW	4	SP SC	GREENISH GRAY MEDIUM TO FINE SAND WITH SOME CLAY, trace coarse sand, occasional fine gravel. Loose, wet.
40									MC	25	SC	DARK BROWN AND GRAY CLAYEY COARSE TO FINE SAND, trace fine gravel. Medium dense, moist. Frequent (1/8" - 1/4" diameter) reddish brown and yellowish brown fine sand nodules.
											BR	YELLOWISH BROWN AND GRAY SANDSTONE. Highly weathered. Moderately weak to weak. Very closely fractured. Moist. [BEDROCK]
45									MC	50/6"		
50												
55												
60												
65												
70												

Notes:

1. Boring terminated at a depth of 47.7 feet on May 31, 2006. Boring backfilled with grout on May 31, 2006.
2. The boring was advanced to a depth of 7.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Dames & Moore U-Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler.
4. Groundwater level was measured at 4'2" on May 31, 2006.
5. Boring log indicates interpreted subsurface conditions only at the location and time of the drilled boring.
6. See Figure A-8 for general log notes and explanation of symbols.

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-2

Depth in Feet	Tests Reported Elsewhere	Liquid Limit (%)	Plasticity Index (%)	Type of Test	Normal or Confining Pressure (PSF)	Shear Strength (PSF)	Moisture Content (%)	Total Density (PCF)	Type of Sampler	Sampling Resistance	Symbol	Description
0											GP	2" ASPHALT CONCRETE. GREENISH GRAY AND BROWN AND GRAY COARSE TO FINE SANDY GRAVEL. Medium dense, dry to damp. [BASEROCK] Grades moist.
									MC	14	SC	GREENISH GRAY AND BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Medium dense, moist. [FILL]
5									MC	4	SP	BLACK FINE SAND, trace silt. Loose, moist, oily, hydrocarbon odor.
											CL	YELLOWISH BROWN AND DARK GREENISH GRAY SILTY CLAY. Soft, moist.
10									MC	5	SP	DARK GRAY FINE SAND, trace silt. Loose, damp.
											CL	DARK GRAY CLAY, trace silt, fine sand. Soft, moist. Frequent pieces of decomposed wood, organic odor. [RECENT BAY MUD]
15									TW	2		Grades with frequent large pieces of peat. PP: Su = 500 psf
												Grades without peat, with trace fine sand.
20									TW	16	CL	GRAY SILTY CLAY, trace fine sand. Soft, wet. Frequent greenish gray nodules (1/8" diameter). [COLLUVIUM] PP: Su = 1,000 psf
											SC	YELLOWISH BROWN AND GREENISH BROWN CLAYEY MEDIUM TO FINE SAND. Stiff, damp. Frequent reddish brown nodules (1/8" diameter). [COLLUVIUM] PP: Su = 3,000 psf
25	-200 (53.7%)								MC	53		PP: Su >4,500 psf
											CL	YELLOWISH BROWN AND GRAYISH BROWN COARSE TO FINE SANDY MOTTLED CLAY, trace fine gravel. Hard, damp.
30							16.5	134.6	MC	59		Grades with frequent (1/8" diameter) carbon nodules. PP: Su > 4,500 psf
35												

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Job No: 28067039 Pt. ID: CHP_HR.GPJ / HR-2	URS	Log of Boring
Date Completed: 5/31/06 Boring Depth: 59.0 ft.	Surface Elev: 11.8 ft. Richmond Refinery Datum (RRD) Coordinates:	Location: Chevron Richmond Refinery

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-2

Depth in Feet	Tests Reported Elsewhere	Liquid Limit (%)	Plasticity Index (%)	Type of Test	Normal or Confining Pressure (PSF)	Shear Strength (PSF)	Moisture Content (%)	Total Density (PCF)	Type of Sampler	Sampling Resistance	Symbol	Description
35				UC		5367			MC	57		Grades with some medium to fine sand, no gravel. PP: Su > 4,500 psf
40							22.9	133.3	MC	39	CL	REDDISH BROWN AND BROWN COARSE TO FINE SANDY CLAY, trace fine gravel. Medium stiff, moist.
											CL	REDDISH BROWN AND GRAYISH BROWN CLAY WITH SOME MEDIUM TO FINE SAND. Very stiff, damp to moist, mottled. Frequent (1/8" diameter) carbon nodules. PP: Su = 3,000 psf
45				UC		2413			MC	28		PP: Su = 3,000 psf
50											CL	REDDISH BROWN AND GRAYISH BROWN COARSE TO FINE SANDY CLAY, trace fine gravel. Medium dense, wet. 51.5', grades more clayey.
55									MC	50/3"	SS	REDDISH BROWN SANDSTONE. Completely weathered. Moderately weak to weak. Very closely fractured (1/2"). Vertical light gray clay seam (1/2" wide). [BEDROCK]
									RC	800 psi		
60												
65												
70												

Notes:

1. Boring terminated at a depth of 59.0 feet on May 31, 2006. Boring backfilled with grout on May 31, 2006.
2. The boring was advanced to a depth of 7.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Dames & Moore U-Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler.

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Job No: 28067039
Pt. ID: CHP_HR.GPJ / HR-2

URS

Log of Boring

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SAMPLES
	LABORATORY TEST DATA	ATTERBERG LIMITS		STRENGTH DATA					SAMPLING		
70											
75											
80											
85											
90											
95											
100											
105											

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-2

SYMBOL	DESCRIPTION
	4. Groundwater level was not measured. 5. Boring log indicates interpreted subsurface conditions only at the location and time of the drilled boring. 6. See Figure A-8 for general log notes and explanation of symbols.

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-3

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
0											GP	2" ASPHALT CONCRETE.
											GC	5" GRAY BROWN COARSE TO FINE SANDY GRAVEL. [BASEROCK]
												GRAYISH BROWN CLAYEY COARSE TO FINE SANDY GRAVEL. Medium dense, damp. [FILL]
									MC	43	GP	GREENISH BROWN AND GRAYISH BROWN COARSE TO FINE SANDY GRAVEL, trace clay. Medium dense, wet. Large (2"0) piece of brick at 4.5'. Slight oily smell.
5									MC	15	SP	BLACK FINE TO MEDIUM SAND, trace silt. Medium dense, moist. Hydrocarbon odor.
10									MC	11		Grades wet.
											CH	GREENISH GRAY FAT CLAY, trace fine sand. Soft, wet. [RECENT BAY MUD]
15									P	25 psi		PP: Su = 750 psf; TV: Su = 700 psf
20		86	41				93.2	92.3	P	500 psi		Grades with occasional yellowish brown nodules. PP: Su = 750 psf; TV: Su = 700 psf
25									TW	2		PP: Su = 750 psf; TV: Su = 600 psf Grades peaty, with frequent pieces of decomposed wood, roots (1/16" diameter). Organic odor.
											OH	BROWN ORGANIC CLAY, trace fine sand. Soft, wet. Frequent pieces of decomposed wood, peat.
30				UC		355			TW	5	CH	DARK GRAY FAT CLAY, trace fine sand. Soft, wet. Frequent greenish gray nodules. 1/4" piece of white gravel at 31.2 feet. Occasional pieces of decomposed wood, peat. PP: Su = 750 psf; TV: Su = 700 psf
											CL	DARK GRAY COARSE TO FINE SANDY CLAY. Medium stiff, moist. Frequent greenish gray and yellowish brown nodules. [COLLUVIUM]
35												

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Job No: 28067039 Pt. ID: CHP_HR.GPJ / HR-3	URS	**Log of Boring**
Date Completed: 6/1/06 Boring Depth: 95.5 ft.	Surface Elev: 11.2 ft. Richmond Refinery Datum (RRD) Coordinates:	Location: Chevron Richmond Refinery

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-3

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
35				UC		2935			MC	25		Grades with reddish brown nodules also at 36.5' and yellowish brown mottling.
40									MC	38	SC	YELLOWISH BROWN AND GRAYISH BROWN INTERBEDDED CLAYEY MEDIUM TO FINE SAND, trace coarse sand, fine gravel. Medium dense to dense, moist to damp. 41.5', grades to coarse to fine sand.
45				UC		1937			MC	16	CL	DARK YELLOWISH BROWN AND GRAY CLAY, trace medium to fine sand. Stiff, damp, mottled. PP: Su = 3,000 psf; TV: Su = 1,600 psf
50									MC	22		Grades very stiff. PP: Su = 2,500 psf; TV: Su = 1,500 psf. Grades dark yellowish brown to gray.
55							32.0	123.7	MC	21		Grades gray to greenish gray.
60				UC		1863			MC	27		Grades with silt. Hard to very stiff, moist to damp. Occasional (1/8" - 1/4" diameter) calcium nodules. Piece of fine gravel at 61.5 feet. PP: Su = 3,250 psf; TV: Su = 3,500 psf
65									MC	38	SC	YELLOWISH BROWN AND GRAYISH BROWN CLAYEY FINE TO MEDIUM SAND, trace fine gravel. Medium dense to stiff, moist. 66.5', grades dark grayish brown.
70												

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Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-3

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
70									MC	64		Grades yellowish brown. 71.0', piece of calcium (1/4" diameter).
75									MC	65	CL	DARK YELLOWISH BROWN AND GRAY CLAY, with some medium to fine sand. Medium stiff, damp, mottled. PP: Su = 4,000 psf; TV: Su = 3,000 psf
											SC	YELLOWISH BROWN AND BROWN CLAYEY FINE TO MEDIUM SAND, trace fine gravel. Dense to hard, damp.
80	-200 (14.5%)			UC		673			MC	69	SC	YELLOWISH BROWN AND BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Dense to hard, damp.
											SP	DARK YELLOWISH BROWN FINE SAND, trace coarse to medium sand, fine gravel, clay. Dense, moist to wet.
85									MC	59	SC	DARK YELLOWISH BROWN AND BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Stiff to very stiff, damp. 1/2" diameter piece of gravel in shoe.
90									MC	50/6"		
											SS	YELLOWISH BROWN AND DARK BROWN SANDSTONE. Completely to moderately weathered. Moderately weak to weak. Very closely fractured. Grades moderately weathered.
95									MC	50/6"		
100												
105												

Notes:

1. Boring terminated at a depth of 95.5 feet on June 1, 2006. Boring backfilled with grout on June 1, 2006.
2. The boring was advanced to a depth of 7.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Dames & Moore U-Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the

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Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-3

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SAMPLES	SYMBOL	DESCRIPTION
105													borehole. An automatic hammer was used for driving the sampler.
													4. Groundwater level was measured at 4'0" on May 31, 2006.
													5. Boring log indicates interpreted subsurface conditions only at the location and time of the drilled boring.
110													6. See Figure A-8 for general log notes and explanation of symbols.
115													
120													
125													
130													
135													
140													

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-4

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
0												4" ASPHALT CONCRETE.
											GC	GRAYISH BROWN AND GREENISH BROWN CLAYEY COARSE TO FINE GRAVEL, with some coarse to fine sand. Moist. [FILL]
									MC	5		Grades loose.
5												
									MC	13		Grades oily, strong hydrocarbon odor.
												8.5', large brick. 9.0', large piece of metal wire.
10										14		
												Pieces of rubber, plastic, wood.
											CH	BLACK CLAY, trace fine sand. Soft, moist, oily. [RECENT BAY MUD] Grades gray, non-oily.
15									P	25 psi		PP: Su = 500 psf; TV: Su = 400 psf
												Grades with frequent pieces of wood (1/8" diameter).
20									P	55 psi		Grades gray. PP: Su = 750 psf; TV: Su = 600 psf
25									P	50 psi		Grades peaty.
											OH	LIGHT BROWN ORGANIC CLAY, trace silt and fine sand. Soft to medium stiff, moist. Frequent pieces of decomposed wood. PP: Su = 1,000 psf; TV: Su = 1,200 psf
30									TW	11	CH	GRAY CLAY WITH SOME FINE GRAVEL, trace medium to coarse sand. Soft, wet. [COLLUVIUM]
											CL	GREENISH GRAY AND YELLOWISH BROWN FINE SANDY CLAY, trace medium sand. Very stiff, damp, mottled. Occasional (1/4" diameter)
35												

Continued Next Page

Job No: 28067039 Pt. ID: CHP_HR.GPJ / HR-4	URS	Log of Boring
Date Completed: 6/1/06 Boring Depth: 101.5 ft.	Surface Elev: 12.3 ft. Richmond Refinery Datum (RRD) Coordinates:	Location: Chevron Richmond Refinery

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-4

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
	ATTERBERG LIMITS			STRENGTH DATA					SAMPLING			
35				UC		3160			MC	33		calcium nodule. PP: Su = 2,750 psf; TV: Su = 2,500 psf Grades with more fine sand. Grades to clayey fine sand.
40									MC	23		41.0', grades yellowish brown and reddish brown fine to coarse sand, trace fine gravel.
45							21.0	126.1	MC	54	SP	REDDISH BROWN AND BROWN MEDIUM TO FINE SAND, trace coarse sand, clay. Dense, wet. Occasional fine gravel. 46.5', grades to coarse to medium sand.
50									MC	82		
											SC	GREENISH GRAY FINE SAND, with some clay. [ALLUVIUM]
55				UC		2352			MC	41	CL	GREENISH GRAY FINE SANDY CLAY. Medium stiff. Occasional pieces of decomposed wood. PP: Su = 2,000 psf
60									MC	23	CH	GREENISH GRAY CLAY, trace fine sand. Very stiff, damp. Some dark gray mottling. PP: Su = 2,750 psf; TV: Su = 2,000 psf
65							13.8	137.9	MC	35	SC	REDDISH BROWN, BROWN, AND YELLOWISH BROWN CLAYEY SAND. Medium dense, wet. Occasional fine gravel. [COLLUVIUM]
70												

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Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-4

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
70				UC		3100			MC	64	CH	BROWN AND REDDISH BROWN AND YELLOWISH BROWN COARSE TO FINE SANDY CLAY, trace fine gravel. Stiff, damp. Occasional (1/8" diameter) carbon nodules. PP: Su = 3,750 psf. Grades with more coarse to fine sand, fine gravel.
75				UC		2670			MC	74	SC	BROWN AND REDDISH BROWN CLAYEY COARSE TO FINE SAND, with some fine gravel. Dense,, moist to damp. Gravel particles are subangular. Frequent small (1/4" diameter) pockets of yellowish brown sand.
80									MC	58	SC	BROWN AND REDDISH BROWN CLAYEY COARSE TO FINE SAND, with some subangular fine gravel. Dense, damp to moist. Frequent small pockets of yellowish brown fine sand.
											CL	GREENISH GRAY AND BROWN CLAY, with some fine sand. Hard, damp, mottled. Frequent small (1/8" diameter) carbon nodules. PP: Su > 4,500 psf; TV: Su = 3,500 psf. Grades with frequent reddish brown nodules.
85									MC	33		PP: Su = 3,000 psf; TV: Su = 4,000 psf
											SC	DARK GRAY AND BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Medium dense to dense, damp to moist.
90	-200 (39.2%)			UC		3066			MC	76		91.0', small pocket of light gray clay (2" diameter).
95							13.1	138.4	MC	50		Grades brown and yellowish brown.
100										95	SC	YELLOWISH BROWN CLAYEY COARSE TO FINE SAND, trace coarse to fine gravel. Dense, damp. Transitioning to bedrock.
											SS	YELLOWISH BROWN AND DARK BROWN SANDSTONE. Highly weathered. Moderately weak to weak. Very closely fractured (1/2" diameter). [BEDROCK]
105												Notes:

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Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-4

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SAMPLES	SYMBOL	DESCRIPTION
105													
110													
115													
120													
125													
130													
135													
140													

1. Boring terminated at a depth of 101.5 feet on June 1, 2006. Boring backfilled with grout on June 1, 2006.
2. The boring was advanced to a depth of 7.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Dames & Moore U-Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler.
4. Groundwater level was measured at 5'0" on June 1, 2006.
5. Boring log indicates interpreted subsurface conditions only at the location and time of the drilled boring.
6. See Figure A-8 for general log notes and explanation of symbols.

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-5

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
0											GP	2" ASPHALT CONCRETE.
											GP	5" BROWN GRAVEL WITH COARSE TO FINE SAND AND CLAY. Damp. [BASEROCK]
											GC	BROWN AND GRAY CLAYEY GRAVEL WITH COARSE TO FINE SAND. Damp to moist. [FILL]
											SP	BLACK FINE SAND, with pockets of clay, trace fine gravel. Damp. Oily. Frequent pieces of debris, cement, piece of abandoned clay pipe. Hydrocarbon odor.
									MC	24		
5												
									MC	15		Grades wet.
10												Grades gray without debris.
									MC	4		11.3', 3" pocket of gray clay with decomposed wood.
											CH	GRAY FAT CLAY, trace fine sand. Soft, moist. [RECENT BAY MUD]
15									P	25 psi		PP: Su = 500 psf; TV: Su = 500 psf
20		116	47				143.7	81.3	P	75 psi	OH	BROWN ORGANIC FAT CLAY, trace fine sand. Soft, moist to wet. Frequent pieces of decomposed wood. Organic odor. PP: Su = 1,000 psf; TV: Su = 800 psf
25				UC		791			P	400 psi	CL	GRAY AND GREENISH GRAY AND BROWN COARSE TO FINE SANDY CLAY. Medium dense, moist. [COLLUVIUM]
30				UC		2041			MC	37	SC	YELLOWISH BROWN AND GRAYISH BROWN CLAYEY FINE SAND. Medium dense, moist. to damp. 31.5', grades to coarse to fine sand with reddish brown coloring.
35												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-5

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
35									MC	23	SP-SC	GRAYISH BROWN AND REDDISH BROWN CLAYEY FINE SAND. Medium dense to loose, wet. Frequent small (1/8" diameter) carbon nodules.
											SP	GRAYISH BROWN AND REDDISH BROWN FINE SAND, trace clay. Loose, wet. Frequent small (1/8" diameter) carbon nodules.
40				UC		1606			MC	13	CH	GRAY, BROWN AND REDDISH BROWN FAT CLAY, trace medium to fine sand. Stiff, moist, mottled. PP: Su = 2,000 psf: TV: Su = 2,000 psf
												Grades sandier
45							16.0	127.9	MC	25	SP-SC	REDDISH BROWN AND BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Loose, moist. Occasional (1/2") light gray soft clay seams.
50	-200 (7.7%)								MC	69	GW-GM	REDDISH BROWN AND BROWN SILTY FINE GRAVEL, trace fine to coarse sand. Dense, moist. Grades dense, without clay seams.
											CL	GRAYISH BROWN CLAY, with some fine sand. Medium stiff, moist. Occasional small (1/8" diameter) carbon nodules.
55							32.0	118.0	MC	23		PP: Su = 2,000 psf
												Grades gray.
60				UC		1393			MC	24	CL	GRAY CLAY WITH SOME FINE SAND. Medium stiff, moist. Occasional small (1/8" diameter) carbon nodules. PP: Su = 3,250 psf
											SC	BRWON AND REDDISH BROWN CLAYEY COARSE TO FINE SAND, trace fine gravel. Medium dense, wet.
65									MC	79	SS	YELLOWISH BROWN AND DARK BROWN SANDSTONE. Completely weathered. Moderately weak to weak. Very closely fractured (1/2"). [BEDROCK]
70												

Column groups: LABORATORY TEST DATA (ATTERBERG LIMITS: Liquid Limit, Plasticity Index; STRENGTH DATA: Type of Test, Normal or Confining Pressure, Shear Strength; Moisture Content; Total Density); SAMPLING (Type of Sampler, Sampling Resistance); SAMPLES.

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-5

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SAMPLES	SYMBOL	DESCRIPTION
70									MC	50/4"			71.0', grades highly weatherd.
75													
80													
85													
90													
95													
100													
105													

Notes:

1. Boring terminated at a depth of 71.3 feet on June 7, 2006. Boring backfilled with grout on June 7, 2006.
2. The boring was advanced to a depth of 7.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Dames & Moore U-Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler.
4. Groundwater level was not measured.
5. Boring log indicates interpreted subsurface conditions only at the location and time of the drilled boring.
6. See Figure A-8 for general log notes and explanation of symbols.

Job No: 28067039
Pt. ID: CHP_HR.GPJ / HR-5

URS

Log of Boring

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-6

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
0											GP	1'2" ASPHALT CONCRETE.
											SC	6" GRAYISH BROWN COARSE TO FINE SANDY GRAVEL, with some clay. [BASEROCK]
											GP	REDDISH BROWN CLAYEY COARSE TO FINE SAND, trace gravel. Moist.
												GRAYISH BROWN AND GRAY COARSE TO FINE SANDY GRAVEL, with some clay. Loose, moist to wet.
									MC	22		Grades oily.
5												Large cobbles. Very hard. [COBBLESTONE ROADWAY?]
									MC	10	SP	BLACK FINE SAND, trace silt. Loose, wet, oily. Strong hydrocarbon odor.
												Grades gray.
10							76.1	108.3	MC	1	CH	GRAY FAT CLAY, trace fine sand. Very soft, moist to wet. [RECENT BAY MUD] PP: Su = 250 psf; TV: Su = 320 psf
15									P	50 psi		Grades with frequent small (1/16" diameter) pieces of decomposed wood. PP: Su = 500 psf; TV: Su = 600 psf
20									TW	0	CH	GRAY FAT CLAY, trace fine sand. Very soft, moist to wet. Frequent small (1/8" diameter) pieces of decomposed wood. PP: Su = 500 psf; TV: Su = 600 psf
25									P	50 psi		PP: Su = 500 psf; TV: Su = 550 psf
30							78.2	98.3	P	75 psi		Grades peaty. PP: Su = 750 psf; TV: Su = 600 psf
35												

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Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-6

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
	LABORATORY TEST DATA: ATTERBERG LIMITS (Liquid Limit, Plasticity Index); STRENGTH DATA (Type of Test, Normal or Confining Pressure, Shear Strength)								SAMPLING			
35									P	175 psi	SC	Grades dark gray. GREENISH GRAY CLAYEY FINE SAND, trace medium sand. Medium dense, moist. [ALLUVIUM] PP: Su = 1,750 psf; TV: Su = 1,600 psf
40									MC	25	SP	BROWN AND GREENISH GRAY FINE TO COARSE SAND, trace clay, fine gravel. Medium dense to loose, wet.
45				UC		1062			MC	16	SP SC	GREENISH GRAY FINE SAND, with some clay. Loose, moist. Occasional dark greenish gray medium sand.
50									MC	25	CL	Grades with some gray coloring. GREENISH GRAY AND DARK GRAY CLAY, with some fine sand, silt. Medium stiff, moist, mottled. PP: Su = 2,750 psf; TV: Su = 800 psf
55	-200 (98.7%)			UC		1486			MC	21	ML	GREENISH GRAY AND YELLOWISH BROWN CLAYEY SILT. Stiff, moist. PP: Su = 2,250 psf; TV: Su = 1,700 psf
60									MC	19	CH	GREENISH GRAY FAT CLAY, trace fine sand. Medium stiff, moist. [OLD BAY CLAY] PP: Su = 2,250 psf; TV: Su = 1,400 psf
65				UC		1462			MC	17		Grades damp, brittle. PP: Su = 3,250 psf; TV: Su = 2,000 psf Grades with small (1/8" diameter) reddish brown nodules.
70												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-6

Depth in Feet	Tests Reported Elsewhere	Liquid Limit (%)	Plasticity Index (%)	Type of Test	Normal or Confining Pressure (PSF)	Shear Strength (PSF)	Moisture Content (%)	Total Density (PCF)	Type of Sampler	Sampling Resistance	Symbol	Description
70									MC	26		Grades without reddish brown nodules, calcium nodules, less brittle, moist. PP: Su = 3,250 psf; TV: Su = 3,000 psf
75							33.5	121.1	MC	31	SC	Grades with reddish brown coloring. PP: Su = 3,000 psf; TV: Su = 2,500 psf GRAY AND REDDISH BROWN AND YELLOWISH BROWN INTERBEDDED CLAYEY FINE SAND, with frequent coarse to medium sand. Medium dense, damp. [COLLUVIUM]
80				UC		2387			MC	29	CH	PP: Su = 4,000 psf; TV: Su= 4,000 psf BROWN AND GRAY MOTTLED FAT CLAY, trace fine sand. Very stiff, damp to moist. Frequent small (1/8" diameter) carbon nodules.
85									MC	27		PP: Su = 2,250; TV: Su= 3,000 psf
90				UC		3156			MC	34	CL	GRAY AND BROWN MOTTLED SILTY CLAY, with some fine sand. Hard, damp. PP: Su > 4,500 psf; TV: Su = 4,750 psf Grades with more gray. 92.0', driller reports gravel. 93.0', harder drilling.
95									MC	50/5"	SS	YELLOWISH BROWN AND DARK BROWN SANDSTONE. Completely weathered. Weak. Very closely fractured. (1/4"). [BEDROCK]
100												
105												

Notes:

1. Boring terminated at a depth of 95.7 feet on June 6, 2006. Boring backfilled with grout on June 6, 2006.
2. The boring was advanced to a depth of 7.5 feet using dry augering technique before switching to Rotary Wash Drilling Method.
3. Sampling resistance from the Dames & Moore U-Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-6

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SAMPLES	SYMBOL	DESCRIPTION
105													hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler. 4. Groundwater level was measured at 3'2" on June 6, 2006. 5. Boring log indicates interpreted subsurface conditions only at the location and time of the drilled boring. 6. See Figure A-8 for general log notes and explanation of symbols.
110													
115													
120													
125													
130													
135													
140													

Job No: 28067039
Pt. ID: CHP_HR.GPJ / HR-6

URS

Log of Boring

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-7

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
0											GP	2" ASPHALT CONCRETE.
											GC	3" GRAY COARSE TO FINE SANDY GRAVEL. Dry. [BASEROCK]
											GC	6" ASPHALT CONCRETE.
												6" GRAY COARSE TO FINE SANDY GRAVEL, with some clay. Damp. [BASEROCK]
												BROWN CLAYEY GRAVEL WITH SOME FINE TO COARSE SAND. Medium dense, moist to damp. [FILL]
									MC	43		
5												
									MC	20		Grades greenish gray.
10												
									MC	7	CL	YELLOWISH BROWN AND GREENISH GRAY CLAY, with some coarse to fine sand, fine gravel. Soft, wet. Slight hydrocarbon odor.
											CH	BLACK CLAY, trace fine sand. Soft, moist. Slight hydrocarbon odor. [RECENT BAY MUD]
												Grades gray without odor, with frequent pieces of decomposed wood.
15									P	50 psi		PP: Su = 500 psf; TV: Su = 560 psf Sample has sulfur odor.
20									TW	2		Grades gray, without odor. PP: Su = 500 psf; TV: Su = 600 psf
25		80	30				86.1	94.0	P	75 psi		PP: Su = 750 psf; TV: Su = 600 psf
											CH	GREENISH GRAY AND DARK GRAY CLAY, trace fine sand. Stiff, moist to damp, mottled. Frequent yellowish brown fine sand nodules. [ALLUVIUM]
30		83	32	UC		1351						
									MC	19		PP: Su = 2,750 psf; TV: Su = 1,600 psf
												31.5', grades yellowish brown.
35												

Continued Next Page

Job No: 28067039 Pt. ID: CHP_HR.GPJ / HR-7	URS	**Log of Boring**
Date Completed: 6/5/06 Boring Depth: 135.3 ft.	Surface Elev: 9.0 ft. Richmond Refinery Datum (RRD) Coordinates:	Location: Chevron Richmond Refinery

FIGURE A-7 (Cont.)

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-7

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
35									MC	17	SC	YELLOWISH BROWN AND BROWN CLAYEY FINE SAND, trace medium sand. Medium dense, damp. Frequent small (1/8" diameter) carbon nodules. [COLLUVIUM]
40				UC		1242			MC	17	SC	YELLOWISH BROWN AND LIGHT GRAY CLAYEY FINE SAND, trace medium to coarse sand. Medium dense to medium stiff, moist to damp, mottled. Frequent small (1/4" diameter) pockets of reddish brown coloring. Occasional small (1/4" diameter) calcium nodules. PP: Su = 1,750 psf
45									MC	44	SP	YELLOWISH BROWN AND GRAYISH BROWN MEDIUM TO FINE SAND, trace coarse sand, clay. Medium dense to dense, wet. Grades coarse sand with fine gravel.
50				UC		863			MC	23	SC / SP / SC / SP	GREENISH GRAY CLAYEY FINE SAND, trace medium sand. Medium dense, wet. [ALLUVIUM] GREENISH GRAY COARSE TO FINE SAND, trace clay, fine gravel. Medium dense, wet. (4" layer.) GREENISH GRAY CLAYEY FINE SAND, trace medium sand. Medium dense, wet. (6" layer.) GREENISH GRAY COARSE TO FINE SAND, trace clay, fine gravel. Medium dense, wet. Grades with coarse to fine gravel.
55									MC	15	SC	GREENISH GRAY CLAYEY FINE SAND, trace medium sand. Medium dense to stiff, moist. PP: Su = 1,500 psf. Grades with coarse to fine gravel.
60									MC		CH	GREENISH GRAY AND DARK GRAY MOTTLED CLAY, trace fine sand. Stiff, damp, brittle. Occasional small (1/4" diameter) calcium nodules. PP: Su = 2,500 psf; TV: Su = 2,250 psf
65				UC		2258			MC	29		Grades very stiff. PP: Su = 3,000 psf; TV: Su = 3,250 psf
70												

Continued Next Page

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-7

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
70							35.4	116.2	MC	23		Grades stiff with reddish brown mottling. PP: Su = 2,500 psf; TV: Su = 2,500 psf
75									MC	25		75.6', large cobble (>3"0). Grades with frequent small white shells. PP: Su = 3,000 psf
80				UC		360			MC	20	CL	GREENISH GRAY CLAY, trace fine sand. Loose to medium dense, wet. Frequent white and reddish brown shells.
85									MC	48	~~CL~~ SC	YELLOWISH BROWN AND GRAYISH BROWN CLAY, with some fine sand. Stiff, damp, mottled. [COLLUVIUM] PP: Su = 3,000 psf; TV: Su = 4,000 psf REDDISH BROWN, YELLOW AND BROWN CLAYEY FINE TO MEDIUM SAND. Medium dense, damp.
90				UC		2638			MC	28	CH	YELLOWISH BROWN AND GRAYISH BROWN CLAY, trace fine sand. Stiff, damp, mottled. PP: Su = 2,750 psf; TV: Su = 2,500 psf 90.7' to 90.9', grades fine sandy.
95									MC	27	CL	GREENISH GRAY SILTY CLAY, with some fine sand. Stiff, damp. Frequent reddish brown nodules (1/4" diameter). [ALLUVIUM] PP: Su = 3,000 psf; TV: Su = 2,500 psf
100				UC		1246			MC	17	CL	GREENISH GRAY SILTY CLAY, with fine sand. Medium stiff, damp. Laminated with (1/8") vertical dark gray fine sand seams. Small layer (3/4" thick) of hard brittle dark yellowish brown clay at 100.5'.
105												

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Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-7

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	TYPE OF TEST	NORMAL OR CONFINING PRESSURE (PSF)	SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	TYPE OF SAMPLER	SAMPLING RESISTANCE	SYMBOL	DESCRIPTION
		LABORATORY TEST DATA: ATTERBERG LIMITS		STRENGTH DATA					SAMPLING			
105									MC	32	SM	10" LAYER OF DARK GRAY SILTY FINE SAND. Medium dense, moist, slightly plastic. Frequent small pieces of mica.
											CL	GREENISH GRAY SILTY CLAY, with fine sand. Laminated with dark gray silty fine sand seams.
110				UC		3100			MC	49	CH	GREENISH GRAY AND GRAY CLAY, trace fine sand. Hard, dry to damp, mottled. PP: Su > 4,500 psf; TV: Su = 4,000 psf
115									MC	37		Grades light greenish gray with frequent small (1/8" diameter) reddish brown nodules. PP: Su = 4,000 psf; TV: Su = 4,500 psf
120									MC	39	CL	YELLOWISH BROWN AND GRAYISH BROWN CLAY, with silt, fine sand. Stiff, damp, mottled. [COLLUVIUM] PP: Su = 2,500 psf; TV: Su = 2,500 psf
125				UC		3125			MC	35		Grades to greenish gray fine sandy clay with frequent reddish brown nodules (1/4" diameter). Occasional coarse to fine sand. PP: Su = 3,000 psf; TV: Su = 3,250 psf Grades with gravel.
130												
135									MC	50/3.5"	RS	GREENISH GRAY GRAVELLY COARSE TO FINE SAND, with some clay. Dense, damp. [RESIDUAL SOIL]
											BR	YELLOWISH BROWN AND DARK BROWN SANDSTONE. Completely weathered. Moderately weak. [BEDROCK]
140												

Notes:

1. Boring terminated at a depth of 135.3 feet on June 5, 2006. Boring backfilled with grout on June 5,

Continued Next Page

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH DATA: TYPE OF TEST	STRENGTH DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH DATA: SHEAR STRENGTH (PSF)	MOISTURE CONTENT (%)	TOTAL DENSITY (PCF)	SAMPLING: TYPE OF SAMPLER	SAMPLING: SAMPLING RESISTANCE	SAMPLES
140											
145											
150											
155											
160											
165											
170											
175											

Chevron U.S.A. Products Co.
Richmond Refinery

BORING HR-7

SYMBOL DESCRIPTION

2006.

2. The boring was advanced to a depth of 8 feet using dry augering technique before switching to Rotary Wash Drilling Method.

3. Sampling resistance from the Dames & Moore U-Type with thin wall extension and Modified California samplers is measured in blows required to drive the sampler 12 inches with a 140-lb hammer dropping 30 inches after the sampler has been seated 6 inches in the bottom of the borehole. An automatic hammer was used for driving the sampler.

4. Groundwater level was measured at 3'4" on June 5, 2006.

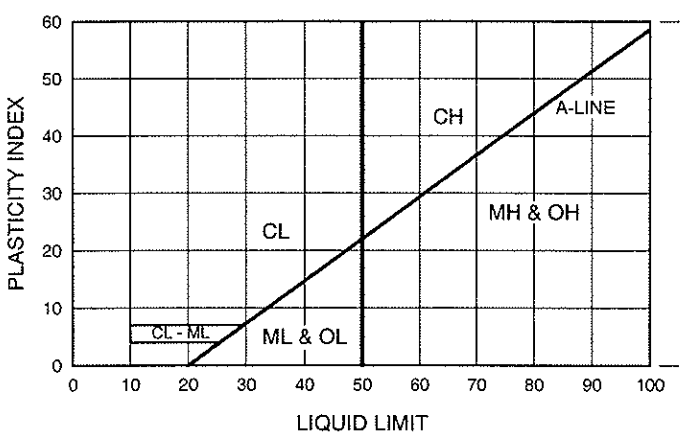
5. Boring log indicates interpreted subsurface conditions only at the location and time of the drilled boring.

6. See Figure A-8 for general log notes and explanation of symbols.

INDEXED SOIL AND ROCK CLASSIFICATIONS

GRAPHIC	SYMBOL	DESCRIPTION	MAJOR DIVISIONS				
	GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	CLEAN GRAVELS (LITTLE OR NO FINES)	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO.4 SIEVE SIZE	FOR VISUAL CLASSIFICATION, THE 1/4" SIZE MAY BE USED AS EQUIVALENT TO THE NO.4 SIEVE SIZE	COARSE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO.200 SIEVE SIZE	THE NO.200 U.S. STANDARD SIEVE IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE
	GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES					
	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)				
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES					
	SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES	CLEAN SANDS (LITTLE OR NO FINES)	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO.4 SIEVE SIZE			
	SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES					
	SM	SILTY SANDS, SAND-SILT MIXTURES	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)				
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES					
	ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	SILTS & CLAYS LIQUID LIMIT LESS THAN 50			FINE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO.200 SIEVE SIZE	
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS					
	OL	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF LOW PLASTICITY					
	MH	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF HIGH PLASTICITY	SILTS & CLAYS LIQUID LIMIT GREATER THAN 50				
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS					
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS					
	PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS				

PLASTICITY CHART



KEY TO TEST DATA

CONSOL = CONSOLIDATION TEST

PP: Su = POCKET PENTROMETER UNDRAINED SHEAR STRENGTH

TV: Su = TORVANE UNDRAINED SHEAR STRENGTH

UC = UNCONFINED COMPRESSION TEST

KEY TO SAMPLE TYPE

. = NO RECOVERY

MC = MODIFIED CALIFORNIA SAMPLER

P = PISTON TUBE SAMPLER

RC = ROCK CORE SAMPLER

TW = THIN WALL TUBE SAMPLER

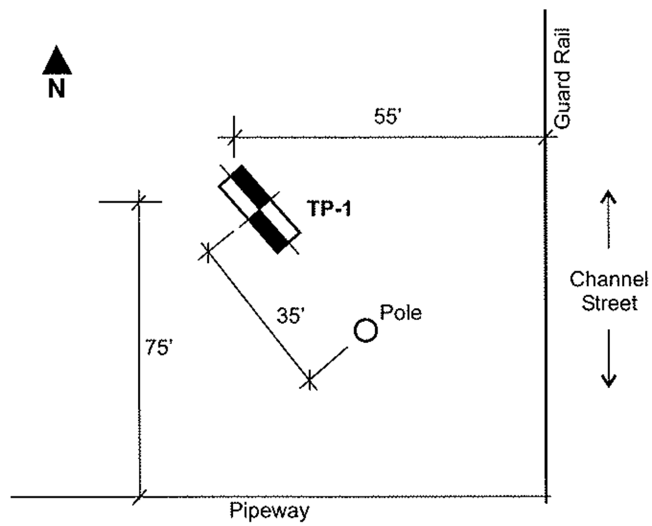
URS

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

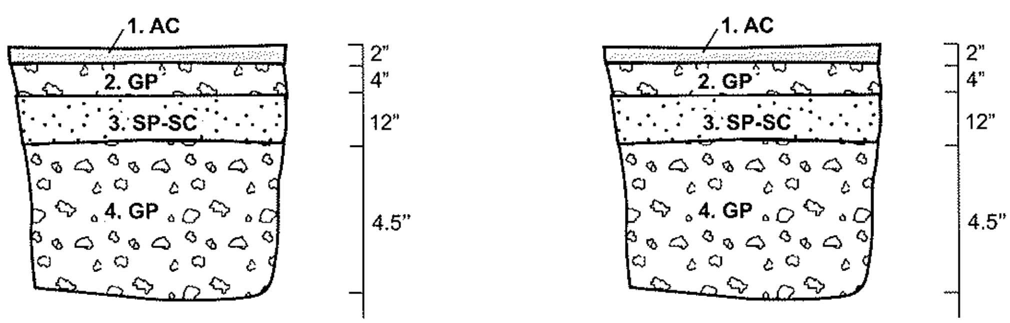
FIGURE A-8

TEST PIT TP-1

SITE LOCATION



CROSS SECTION



Not to Scale

1. 2" ASPHALT CONCRETE.
2. 4" DARK GRAY COARSE TO FINE SANDY GRAVEL with some clay (GP). Damp [BASEROCK].
3. 12" BROWN COARSE TO FINE SAND with some clay (SP-SC).
4. YELLOWISH BROWN COARSE TO FINE SANDY GRAVEL (GP). Frequent large (12" diameter) cobbles. Moist. Cobbles are angular pieces of shale and sandstone. Very dense, moist. Difficult excavating.

TEST PIT 1

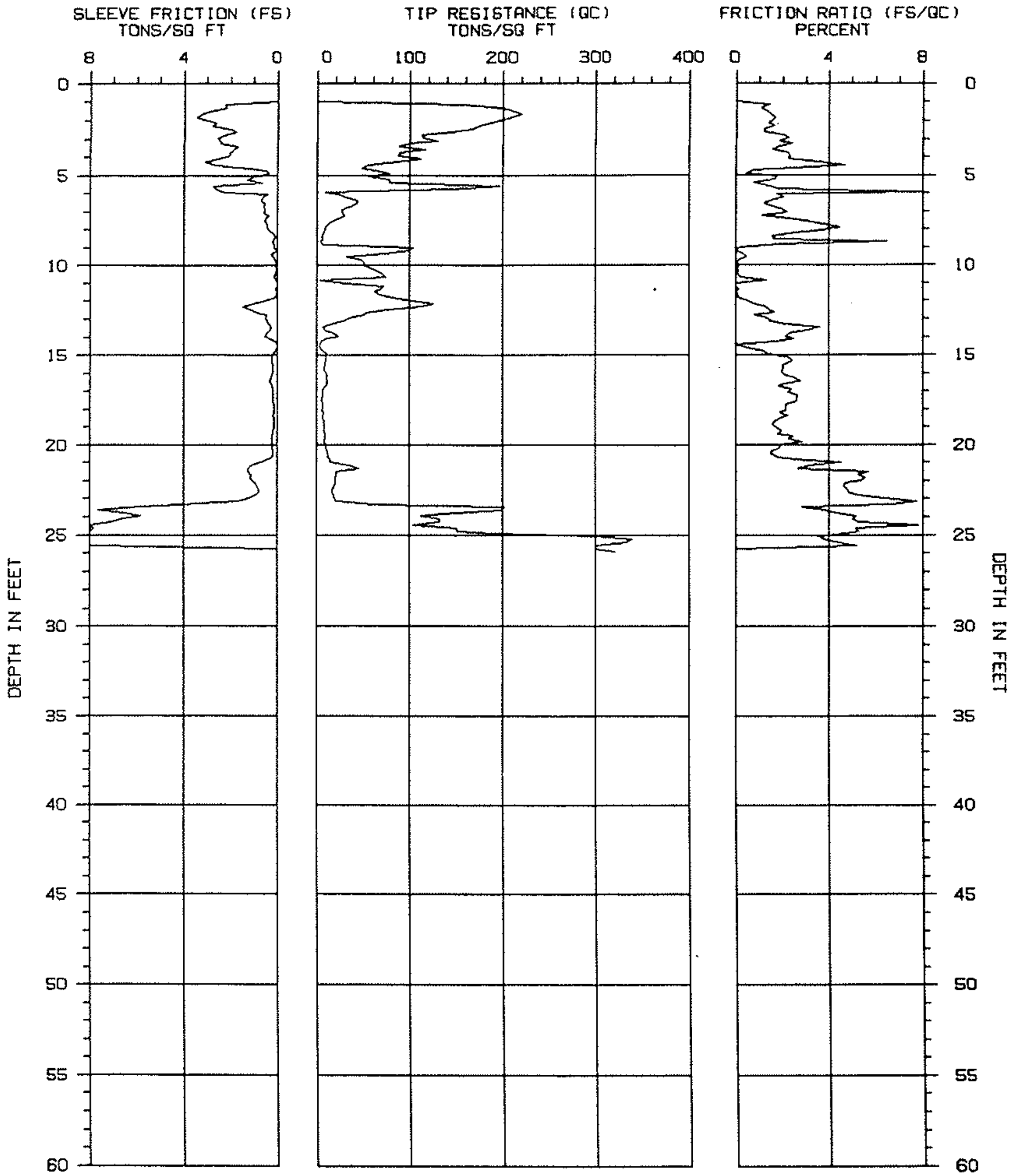
Hydrogen Replacement Plant Project
Chevron Refinery Project
Richmond, California

September 2006
28067039

URS

FIGURE A-9

9/14/06 vsa ..\Chevron Hydrogen Replacement Project\Graphics\Fig A-9_TP-1.cdr



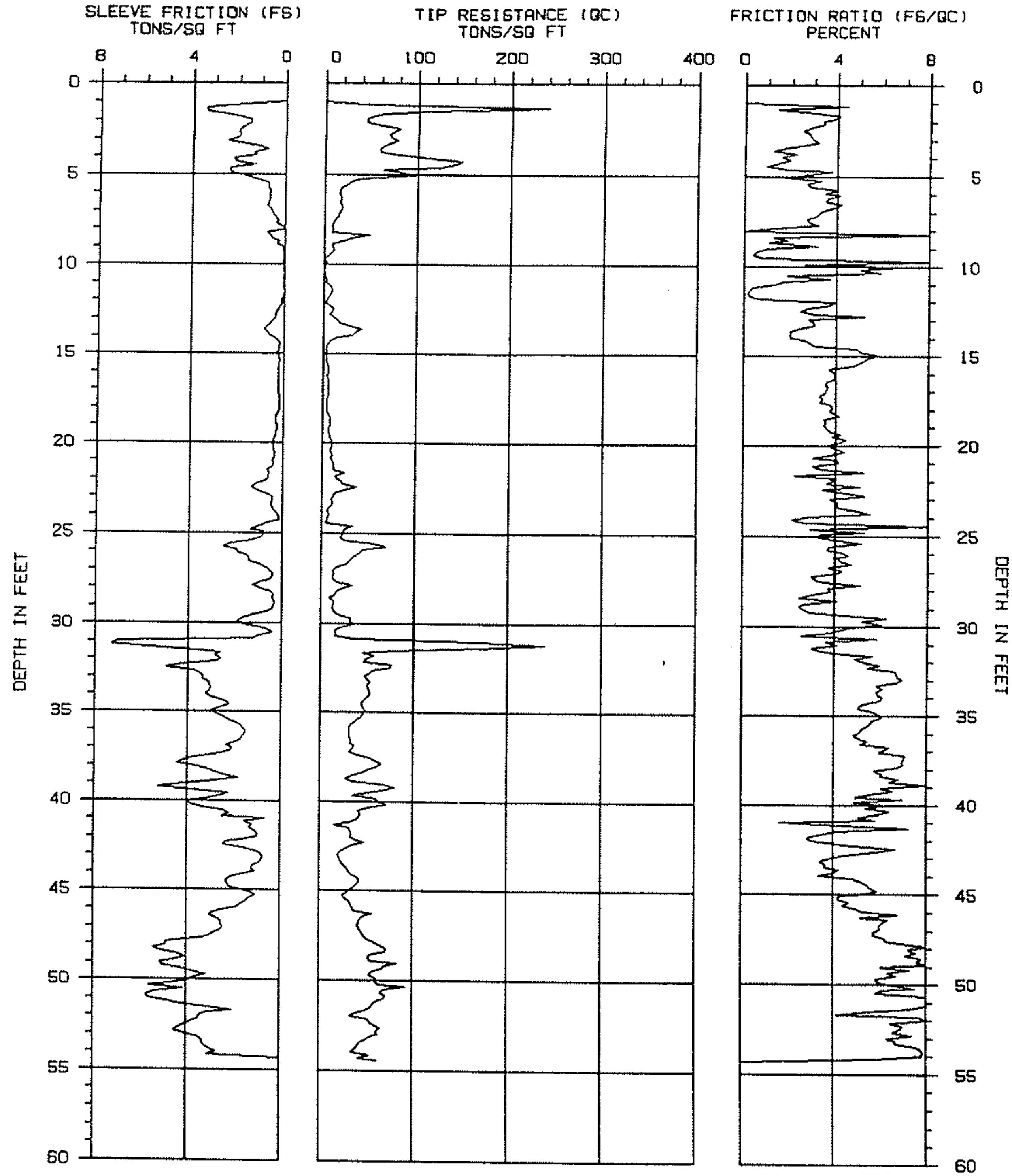
TOP 1.0 FT IS DISTURBED SOIL

TIP RESISTANCE NOT CORRECTED FOR END AREA EFFECT

CONE PENETRATION TEST — SOUNDING NUMBER: CPT-1

PROJECT NAME : D&M/PETROLITE	CONE/RIG : 473.BH.MR.R#4
PROJECT NUMBER : 99-DAAM916	DATE/TIME: 10-08-99 08:50

HFA



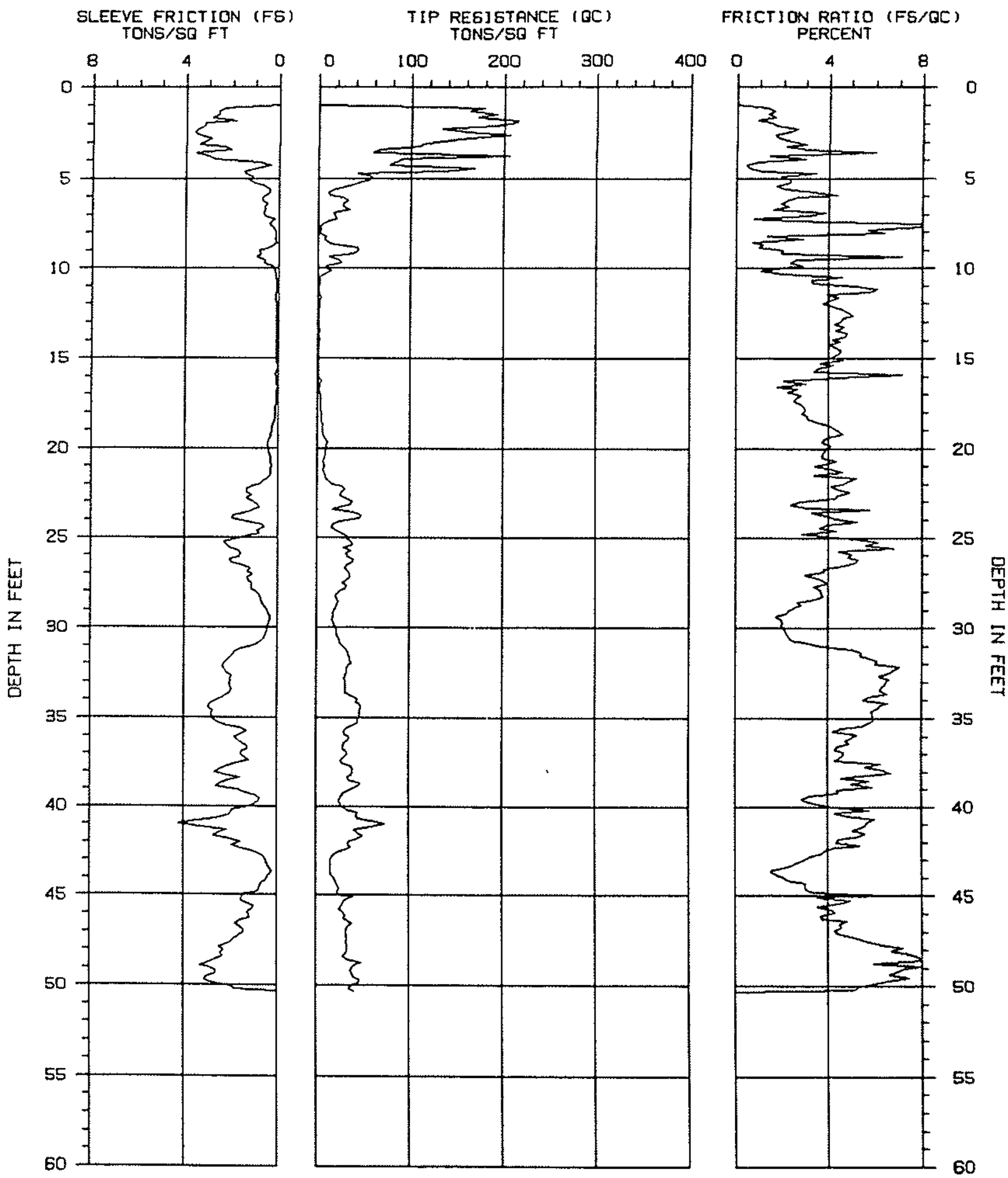
TOP 1.0 FT IS DISTURBED SOIL

TIP RESISTANCE NOT CORRECTED FOR END AREA EFFECT

CONE PENETRATION TEST

SOUNDING NUMBER: CPT-2

PROJECT NAME : D&M/PETROLITE	CONE/RIG : 473.BH.MR.R#4	HFA
PROJECT NUMBER : 99-DAAM916	DATE/TIME: 10-07-99 11:01	



TOP 1.0 FT IS DISTURBED SOIL

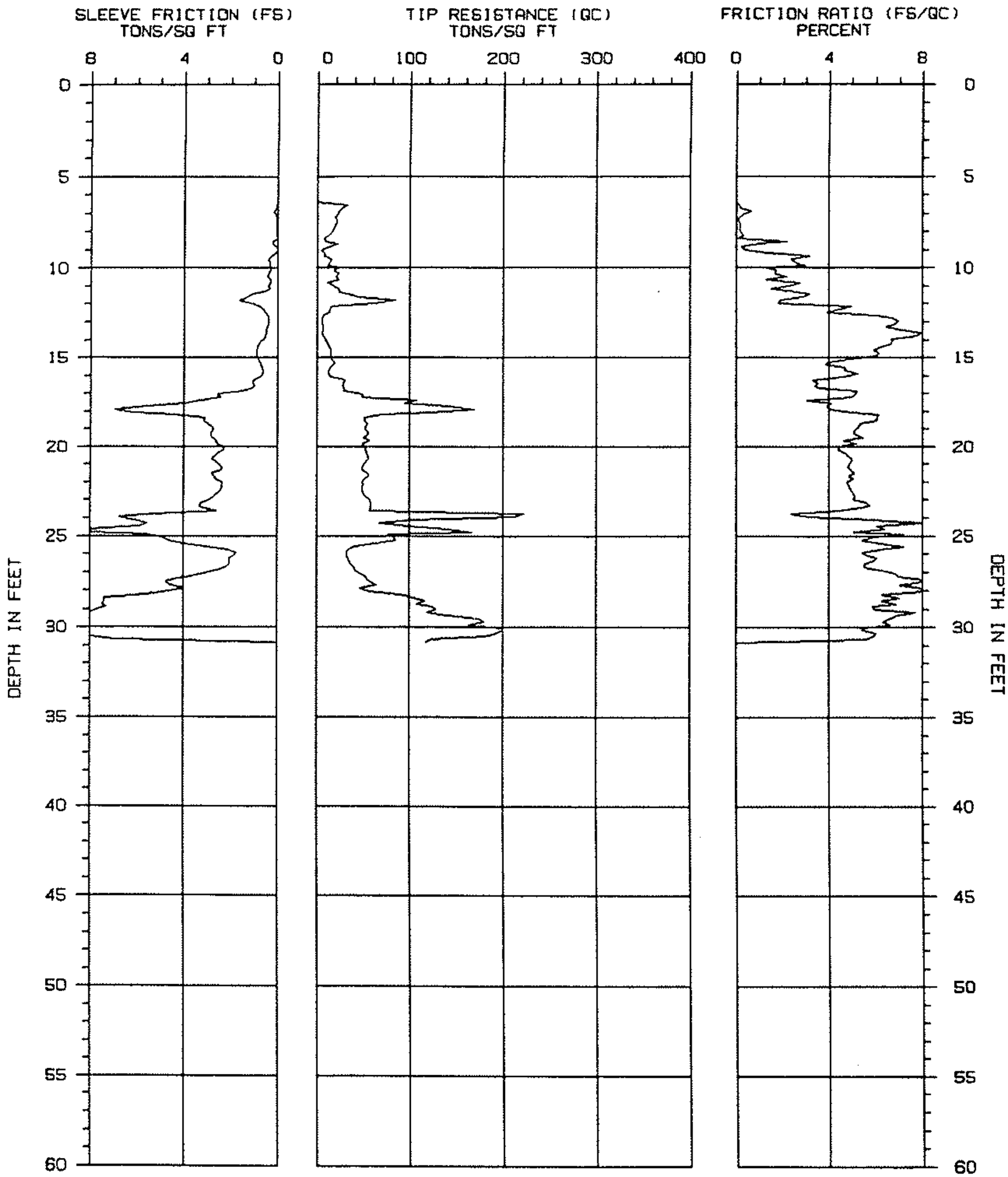
TIP RESISTANCE NOT CORRECTED FOR END AREA EFFECT

CONE PENETRATION TEST — SOUNDING NUMBER: CPT-3

PROJECT NAME : D&M/PETROLITE — CONE/RIG : 473.BH.MR.R#4

PROJECT NUMBER : 99-001 — DATE/TIME: 10-07-99 08:31

HFA

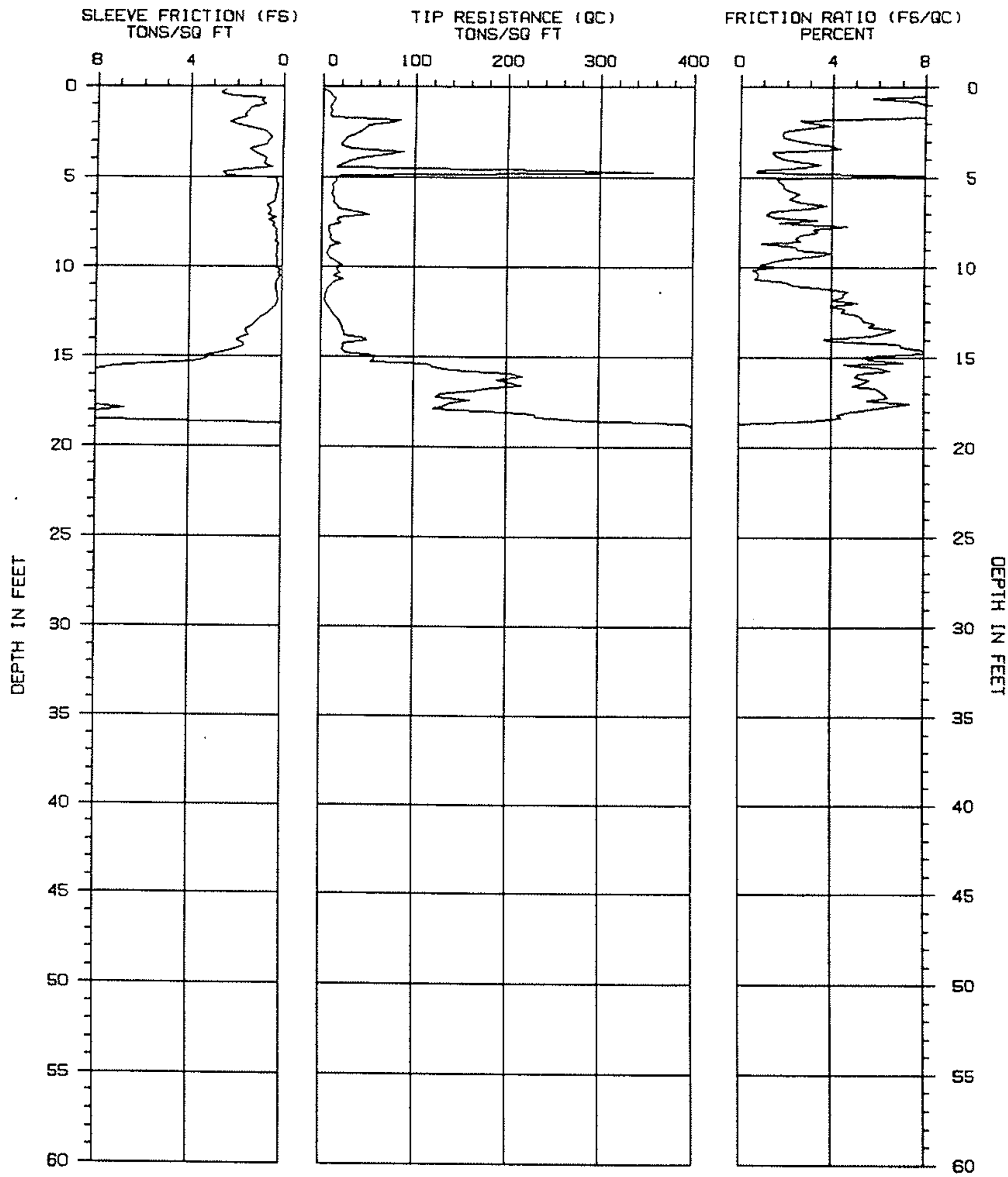


TOP 6.5 FT IS DISTURBED SOIL

TIP RESISTANCE NOT CORRECTED FOR END AREA EFFECT

CONE PENETRATION TEST	SOUNDING NUMBER: CPT-4
PROJECT NAME : D&M/PETROLITE	CONE/RIG : 473.BH.MR.R#4
PROJECT NUMBER : 99-DAAM916	DATE/TIME: 10-07-99 12:59

HFA



TIP RESISTANCE NOT CORRECTED FOR END AREA EFFECT

CONE PENETRATION TEST

SOUNDING NUMBER: CPT-5

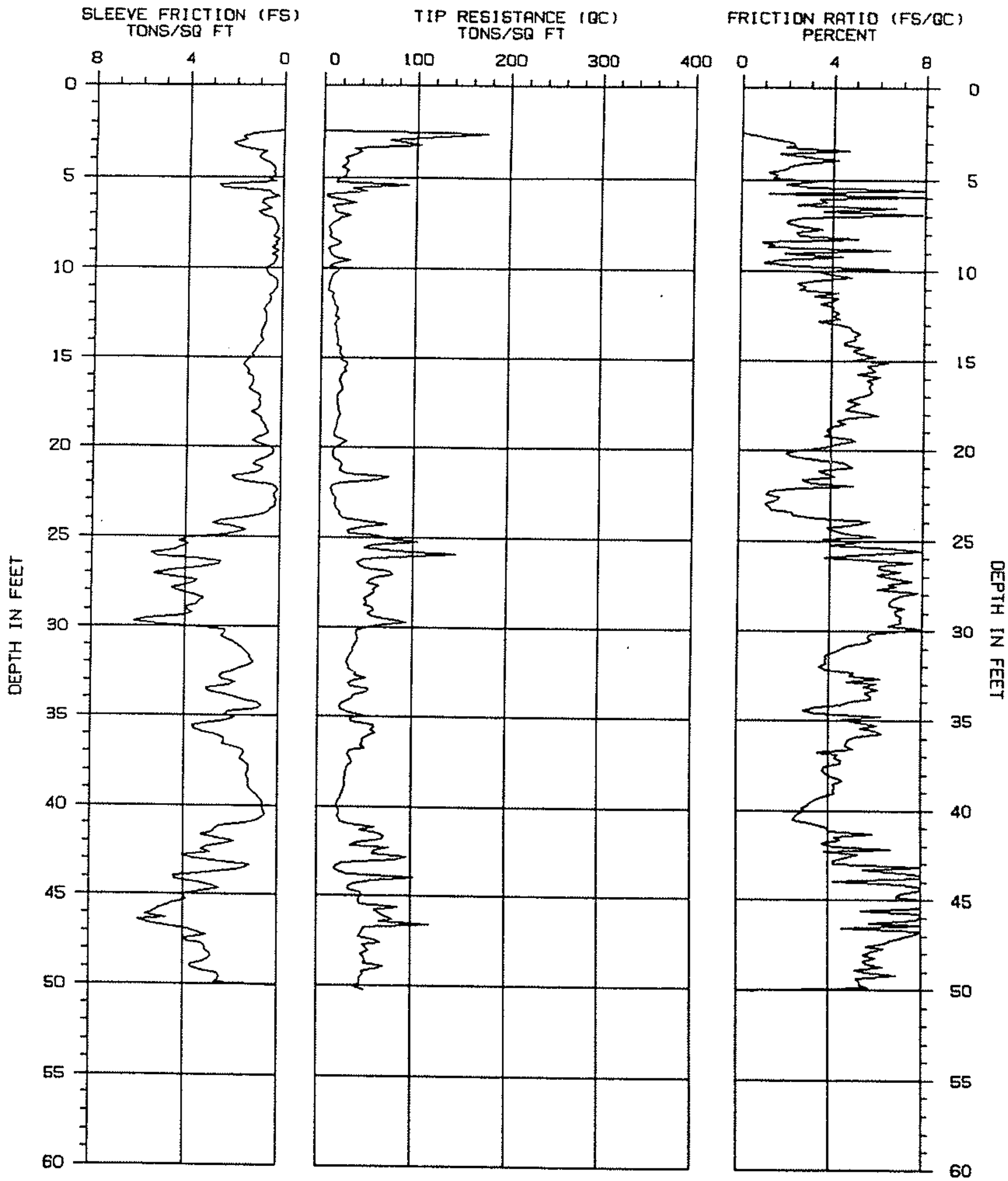
PROJECT NAME : D&M/PETROLITE

PROJECT NUMBER : 99-DAAM916

CONE/RIG : 473.BH.MR.R#4

DATE/TIME: 10-07-99 14:36

HFA

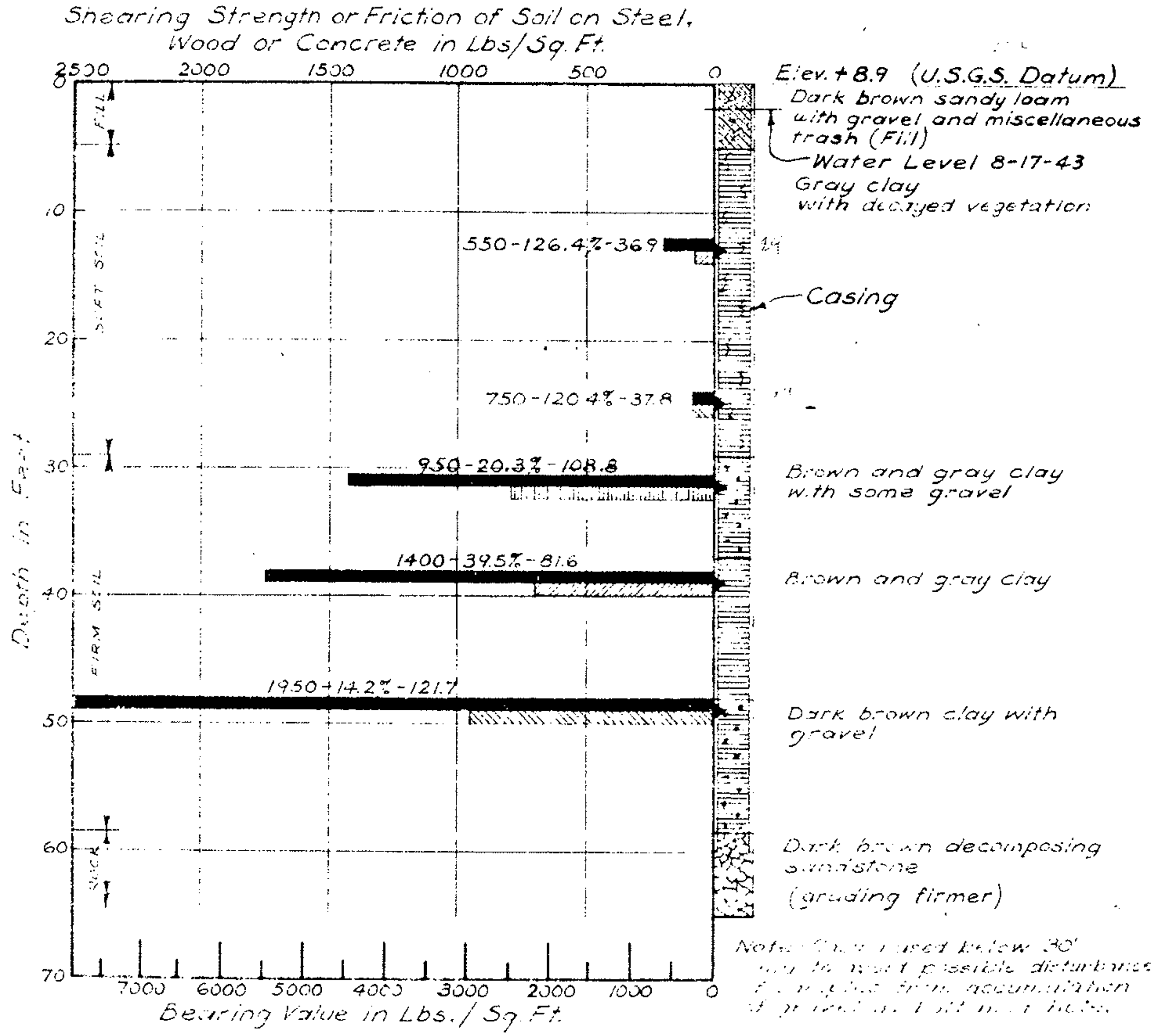


TOP 2.5 FT IS DISTURBED SOIL

TIP RESISTANCE NOT CORRECTED FOR END AREA EFFECT

CONE PENETRATION TEST		SOUNDING NUMBER: CPT-6
PROJECT NAME : D&M/PETROLITE	CONE/RIG : 473.BH.MR.R#4	HFA
PROJECT NUMBER : 99-DAAM916	DATE/TIME: 10-08-99 09:50	

BORING NO.1



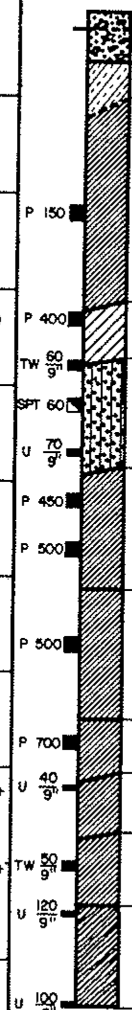
Note:
All elevations supplied by
Bechtel-McCone-Parsons Corp.

BORING 1

DRILLED 8/20/70

ELEVATION IN FEET: +10, 0, -10, -20, -30, -40, -50, -60, -70, -80, -90, -100, -110

Miscellaneous Tests	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Moisture Content (%)	Dry Density (PCF)	Shear Strength Test Data: Test Type	Triaxial Compression: $\frac{\sigma_1 - \sigma_3}{2}$	Triaxial Compression: σ_3	Field Torvane	Type of Sampler & Sampling Resistance
			92	48	UC	150	0		P 150
			25	100				1200	P 400
			27	97					TW $\frac{60}{9"}$
			16	117					
SA									SPT 60
			20	107					U $\frac{70}{9"}$
			31	89	UC	1020	0	1500	P 450
C	62	21	35	88					P 500
			28	97	UC	760	0	1600	P 500
			33	89	UC	950	0		P 700
			29	96	UC	1380	0	2000+	U $\frac{40}{9"}$
			34	89	UC	1800	0	2000+	TW $\frac{50}{9"}$
									U $\frac{120}{9"}$
									U $\frac{100}{6"}$



ELEVATION +8.8' (REFINERY DATUM)

- GW — BROWN SANDY GRAVEL (DENSE) — FILL
  - (WATER LEVEL 8/20/70)
- OH — BLACK SILTY CLAY WITH DECAYED VEGETATION (VERY SOFT)
- CH — (GRADING GRAY & SOFT)
- CL — GREENISH GRAY SANDY CLAY (MEDIUM STIFF)
- SM — GREENISH GRAY SILTY MEDIUM TO COARSE SAND WITH SOME STREAKS OF SANDY SILT (DENSE)
  - (GRADING VERY DENSE)
  - (GRADING GRAY)
- CH — GREENISH GRAY SLIGHTLY SANDY CLAY (STIFF TO VERY STIFF) — OLD BAY CLAY
- CH — GRAY SILTY CLAY (VERY STIFF) — OLD BAY CLAY
- CH — GRAY SILTY CLAY WITH BROWN SLIGHTLY SANDY SPOTS & SOME GRAVEL (VERY STIFF)
- CH — BROWN SLIGHTLY SANDY CLAY (VERY STIFF)
- CH — MOTTLED GRAY & BROWN SILTY CLAY WITH SOME VERY THIN STREAKS OF SANDY SILT (VERY STIFF)
- BROWN & GRAY HIGHLY WEATHERED ROCK (SHALE)
  - (DRILLING RATE 1 FT. PER 6 MIN. @ 100 PSI)
  - (GRADING BROWN & LESS WEATHERED)

TYPE OF SAMPLER & SAMPLING RESISTANCE

NOTES:

1. ELEVATIONS REFER TO REFINERY DATUM & ARE BASED ON STANDARD OIL DRAWING NO. FP-66975-R, DATED AUGUST 5, 1970.
2. BORINGS 1 & 2 WERE DRILLED WITH TRUCK MOUNTED ROTARY WASH EQUIPMENT (FAILING 1500).
3. TYPE OF SAMPLERS USED:
   - U - DAMES & MOORE UNDERWATER SAMPLER
   - TW - DAMES & MOORE UNDERWATER SAMPLER WITH THINWALL EXTENSION
   - P - DAMES & MOORE PISTON SAMPLER
   - SPT - STANDARD PENETRATION TEST SAMPLER
4. THE SAMPLING RESISTANCE IS FOR: A) THE PISTON SAMPLER INDICATED BY THE HYDRAULIC PRESSURE (PSI) NECESSARY TO PUSH THE PISTON TUBE 18" INTO THE SOIL.

   B) THE U, TW & SPT SAMPLERS INDICATED BY THE NUMBER OF BLOWS TO DRIVE THE SAMPLER 12" (OR LESS IF INDICATED) FOLLOWING THE INITIAL 6" OF PENETRATION. THE U & TW SAMPLERS WERE DRIVEN BY A 265-POUNDS HAMMER FALLING 18" & THE SPT SAMPLER BY A 140-POUNDS HAMMER FALLING 30".
5. THE MAXIMUM CAPACITY OF THE FIELD TORVANE USED WAS 2000 PSF.

LOG OF BORING

DAMES & MOORE

BORING 2

DRILLED 8/21-24/70

ELEVATION +8.8' (REFINERY DATUM)

Sample	Miscellaneous Tests	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Moisture Content (%)	Dry Density (PCF)	Shear Strength Test Data: Test Type	Triaxial Compression: $\frac{\sigma_1 - \sigma_3}{2}$	Triaxial Compression: σ_3	Field Torvane
P 350				22	104	UC	480	0	
TW 80									
U 75									
U 60				21	109	TX/UU	1170	1000	
U 60/9"									
U 45/9"				22	108	TX/UU	900	1000	
SPT 20									
U 40/9"				28	98				2000
P 500	C	69	27	39 38	84 85	UC	1290	0	
TW 50/8"				39	83	UC	1270	0	1800
P 700	C	68	27	38	84				
U 25/9"	C	67	28	48	74				1200
TW 50/9"				41	82	UC	1550	0	2000
TW 80/9"				38	83				
TW 60/9"				21	107	TX/UU	2900	3000	
TW 80/9"									
U 100/6"									
U 80/4"									

ELEVATION IN FEET: +10, 0, -10, -20, -30, -40, -50, -60, -70, -80, -90, -100, -110, -120, -130

- SM — BROWN SILTY & CLAYEY SAND WITH ROCK FRAGMENTS (DENSE) (WATER LEVEL 8/20/70) — FILL
- OH — BLACK SILTY CLAY WITH DECAYED VEGETATION (VERY SOFT)
- CH — (GRADING GRAY & SOFT)
- CL — GREENISH GRAY SANDY CLAY (MEDIUM STIFF TO STIFF)
- CH — BROWN SILTY CLAY (STIFF)
- SM/ML — BROWN SILTY FINE SAND WITH LENSES OF CLAYEY & SANDY SILT (DENSE)
- SM/ML — INTERBEDDED LAYERS OF GRAY SILTY FINE TO MEDIUM SAND AND SANDY & CLAYEY SILT (DENSE & STIFF)
- CH — GRAY SILTY CLAY (VERY STIFF) — OLD BAY CLAY
- CH — GRAY SILTY CLAY WITH BROWN SLIGHTLY SANDY SPOTS (VERY STIFF)
- SM — (6" LENSE OF SAND)
- CH — GRAY SILTY CLAY WITH DECAYED VEGETATION (STIFF)
- CH — GREENISH GRAY SILTY CLAY (VERY STIFF)
  - (GRADING SLIGHTLY SANDY)
  - (GRADING SILTIER)
- SC — GRAYISH BROWN CLAYEY SAND (DENSE)
- SW — BROWN GRAVELLY SAND (VERY DENSE)
- GRAY & BROWN HIGHLY WEATHERED ROCK (SHALE)
  - (DRILLING RATE 1 FT. PER 3 MIN. @ 100 PSI)
  - (GRADING GRAY & LESS WEATHERED)

LOG OF BORING

DAMES & MOORE

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

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APPENDIX B

GEOTECHNICAL LABORATORY TESTING

SCOPE OF THE PROGRAM

URS performed a geotechnical testing program in the laboratory to measure the index and engineering properties of the major subsurface strata encountered at the site. The geotechnical testing program included conventional tests to confirm the existing information on the engineering characteristics of the major strata and to refine some of the engineering parameters where we deemed appropriate. Signet Testing Labs, a URS Company, of Hayward, California performed the tests.

This section briefly describes the testing program and procedures for the different types of tests and presents the test results for soils.

LABORATORY INDEX TESTS

The index tests included moisture contents, density determinations, Atterberg limits, and grain-size analyses using mechanical sieve in accordance with the applicable ASTM standards. The ASTM standards consisted of:

1. ASTM D 2216 for moisture content tests;
2. ASTM D 2937 for total and dry density tests;
3. ASTM 422 for grain size analyses; and
4. ASTM D 4318 for Atterberg Limits.

Results of the moisture content, dry density, grain size analyses and Atterberg limits are presented on the Log of Boring adjacent to the appropriate sample depth. In addition, index test data are tabulated on Table B1, particle size distributions are presented graphically in Figures B1 through B14.

TABLE B1
SUMMARY OF LABORATORY INDEX TEST RESULTS

Boring	Depth (feet)	Soil Type	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	Passing #200 Sieve (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
HR-1	15	MH	109.7	89.2	42.5	-	96	48	48
HR-1	26	CL	125.3	82.0	36.4	91.6	-	-	-
HR-1	31	CL	156.5	78.0	30.4	-	-	-	-
HR-2	26	SC	-	-	-	53.7	-	-	-
HR-2	31	CL	16.5	134.5	115.5	-	-	-	-
HR-2	36	CL	17.0	134.1	114.7	-	-	-	-
HR-2	41	CL	22.9	133.4	108.5	-	-	-	-
HR-2	46	CL	35.2	115.0	85.0	-	-	-	-
HR-3	20	MH	93.2	92.3	48.5	-	86	45	41
HR-3	30	CH	32.6	118.4	89.3	-	-	-	-
HR-3	36	CL	18.6	1328	111.9	-	-	-	-
HR-3	46	CL	36.4	115.1	84.4	-	-	-	-
HR-3	56	CL	32.0	123.8	93.7	87	-	-	-
HR-3	61	CL	33.7	116.1	86.9	-	-	-	-
HR-3	81	SC	13.5	137.6	121.3	14.8	-	-	-
HR-4	36	CL	19.4	131.9	110.5	-	-	-	-
HR-4	46	SP	21.0	104.2	126.1	-	-	-	-
HR-4	56	SC	22.9	127.0	103.3	-	-	-	-
HR-4	66	SC	13.8	137.8	121.2	-	-	-	-
HR-4	71	CH	19.8	130.0	108.5	-	-	-	-
HR-4	76	SC	15.3	136.9	118.7	-	-	-	-
HR-4	91	SC	21.8	133.0	109.2	39.2	-	-	-
HR-4	96	SC	16.0	127.9	110.3	-	-	-	-
HR-5	20	MH	143.7	81.3	33.4	-	116	69	47
HR-5	25	CL	20.6	134.9	111.9	-	-	-	-
HR-5	31	SC	17.2	134.3	114.6	-	-	-	-
HR-5	41	CH	34.4	117.8	87.7	-	-	-	-
HR-5	51	GW-GM	-	-	-	7.7	-	-	-
HR-5	56	CL	32.0	118.1	89.4	-	-	-	-
HR-5	61	CL	28.7	121.0	94.0	-	-	-	-
HR-6	11	CH	76.1	108.3	61.5	-	-	-	-

Boring	Depth (feet)	Soil Type	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	Passing #200 Sieve (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
HR-6	26	ML	-	-	-	98.7	-	-	-
HR-6	30	MH	72.2	98.3	57.1	-	83	51	32
HR-6	46	SP-SC	19.8	130.9	109.2	-	-	-	-
HR-6	56	ML	33.4	118.4	88.8	-	-	-	-
HR-6	66	CH	32.6	119.6	90.2	-	-	-	-
HR-6	76	CH	33.5	121.2	90.7	-	-	-	-
HR-6	81	CH	29.5	121.9	94.1	-	-	-	-
HR-6	91	CL	30.6	119.1	91.2	-	-	-	-
HR-7	25	MH	86.1	94.0	50.5	-	80	50	30
HR-7	31	CH	34.0	116.2	86.7	-	-	-	-
HR-7	41	SC	18.4	132.4	111.9	-	-	-	-
HR-7	56	SC	32.2	118.5	89.7	-	-	-	-
HR-7	66	CH	26.5	123.2	97.4	-	-	-	-
HR-7	71	CH	35.4	116.2	85.8	-	-	-	-
HR-7	81	CL	24.9	122.1	97.8	-	-	-	-
HR-7	91	CH	35.7	117.0	86.2	-	-	-	-
HR-7	101	CL	37.2	115.4	84.1	-	-	-	-
HR-7	111	CH	23.0	128.9	104.8	-	-	-	-
HR-7	126	CL	25.1	124.8	99.8	-	-	-	-

TRIAXIAL STRENGTH TESTS

Thirty one Unconfined Compression (UC) Tests were performed on selected samples of the Colluvial/Alluvial Deposit. The tests were performed in accordance with the procedures in ASTM D 2850. Results of UC tests are presented adjacent to the appropriate sample depth on the Log of Boring. The results of the UC tests are summarized on Table B2, and plots of deviator stress versus axial strain for each test are presented on Figures B15 through B45.

TABLE B2
SUMMARY OF UNCONFINED COMPRESSION TEST RESULTS

Boring	Depth (feet)	Soil Type	Moisture Content (%)	Total Density (pcf)	Dry Density (pcf)	Shear Strength (psf)	Strain at Failure (%)
HR-1	31	CL	156.5	78.0	30.4	372	6.13
HR-2	36	CL	17.0	134.1	114.7	5367	15.01
HR-2	46	CL	35.2	115.0	85.0	2413	6.63
HR-3	30	CH	32.6	118.4	89.3	355	9.73
HR-3	36	CL	18.6	1328	111.9	1468	10.72
HR-3	46	CL	36.4	115.1	84.4	1937	12.76
HR-3	61	CL	33.7	116.1	86.9	1863	5.12
HR-3	81	SC	13.5	137.6	121.3	673	1.61
HR-4	36	CL	19.4	131.9	110.5	3160	14.8
HR-4	56	SC	22.9	127.0	103.3	2352	7.12
HR-4	71	CH	19.8	130.0	108.5	3100	6.17
HR-4	76	SC	15.3	136.9	118.7	2670	2.61
HR-4	91	SC	21.8	133.0	109.2	3066	5.16
HR-5	25	CL	20.6	134.9	111.9	791	4.67
HR-5	31	SC	17.2	134.3	114.6	2041	4.65
HR-5	41	CH	34.4	117.8	87.7	1606	7.13
HR-5	61	CL	28.7	121.0	94.0	1393	11.74
HR-6	46	SP-SC	19.8	130.9	109.2	1062	14.14
HR-6	56	ML	33.4	118.4	88.8	1486	8.72
HR-6	66	CH	32.6	119.6	90.2	1462	15.02
HR-6	81	CH	29.5	121.9	94.1	2387	3.64
HR-6	91	CL	30.6	119.1	91.2	6156	4.65
HR-7	31	CH	34.0	116.2	86.7	1351	8.71
HR-7	41	SC	18.4	132.4	111.9	1242	14.28
HR-7	56	SC	32.2	118.5	89.7	863	12.65
HR-7	66	CH	26.5	123.2	97.4	2258	6.17
HR-7	81	CL	24.9	122.1	97.8	360	5.12
HR-7	91	CH	35.7	117.0	86.2	2638	7.11
HR-7	101	CL	37.2	115.4	84.1	1246	14.79
HR-7	111	CH	23.0	128.9	104.8	3110	2.12
HR-7	126	CL	25.1	124.8	99.8	3125	13.26

CONSOLIDATION TESTS

Five consolidation tests were performed on samples of the Recent Bay Deposits to evaluate their compressibility characteristics and influence of past geologic history. All consolidation tests were performed in general accordance with the procedures outlined in ASTM D2435. However, small consolidation stress increments were applied until the specimen was compressed into the virgin compression zone. The purpose of this procedure was to refine the estimates of the maximum past pressure. An unload-reload cycle was applied on all samples near the transition between the initial recompression and virgin compression portions of the curve in order to better evaluate the recompression characteristics of the soils.

Table B3 presents the results of the consolidation tests. The compressibility parameters, Compression Ratio (Cc), Recompression Ratio (Cr) and coefficient of consolidation (Cv) are summarized on this table. The maximum past pressures were estimated using the Casagrande construction and the end-of-primary consolidation compression curve. The overconsolidation ratio (OCR) can be computed from the maximum past pressure divided by the in situ vertical effective pressure at the depth from which the sample was obtained.

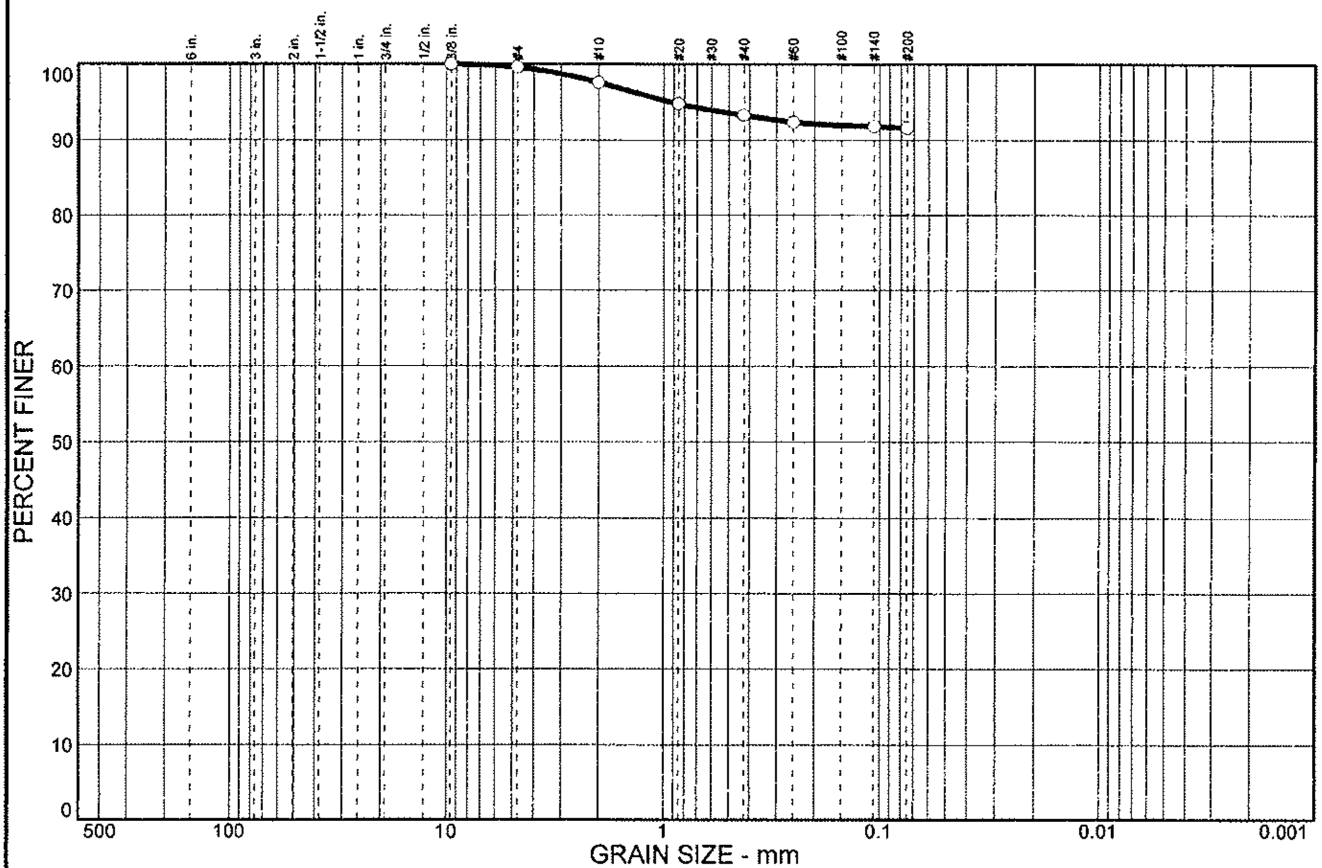
The compression curves (vertical strain at the end of load increment versus the log of the effective stress and the time-rate curves for selected loading increments (dial reading versus the square root of time in minutes) are included on Figures B46 through B50.

TABLE B3
SUMMARY OF CONSOLIDATION TEST RESULTS

Boring	Depth (feet)	Soil Type	Moisture Content (%)	Total Density (pcf)	Compression Ratio (Cc/(1+e))	Recompression Ratio (Cr/(1+e))	Coefficient of consolidation(Cv) (ft^2/day)
HR-1	15	MH	109.7	89.2	0.36	0.02	0.02
HR-3	20	MH	93.2	92.3	0.32	0.02	0.04
HR-5	20	MH	143.7	81.3	0.38	0.015	0.01
HR-6	30	MH	72.2	98.3	0.25	0.015	0.05
HR-7	25	MH	86.1	94.0	0.35	0.015	0.03

-oOo-

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	2.0	4.3	1.7	91.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	99.6		
#10	97.6		
#20	94.8		
#40	93.3		
#60	92.4		
#140	91.8		
#200	91.6		

* (no specification provided)

Soil Description

Olive gray clay with organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

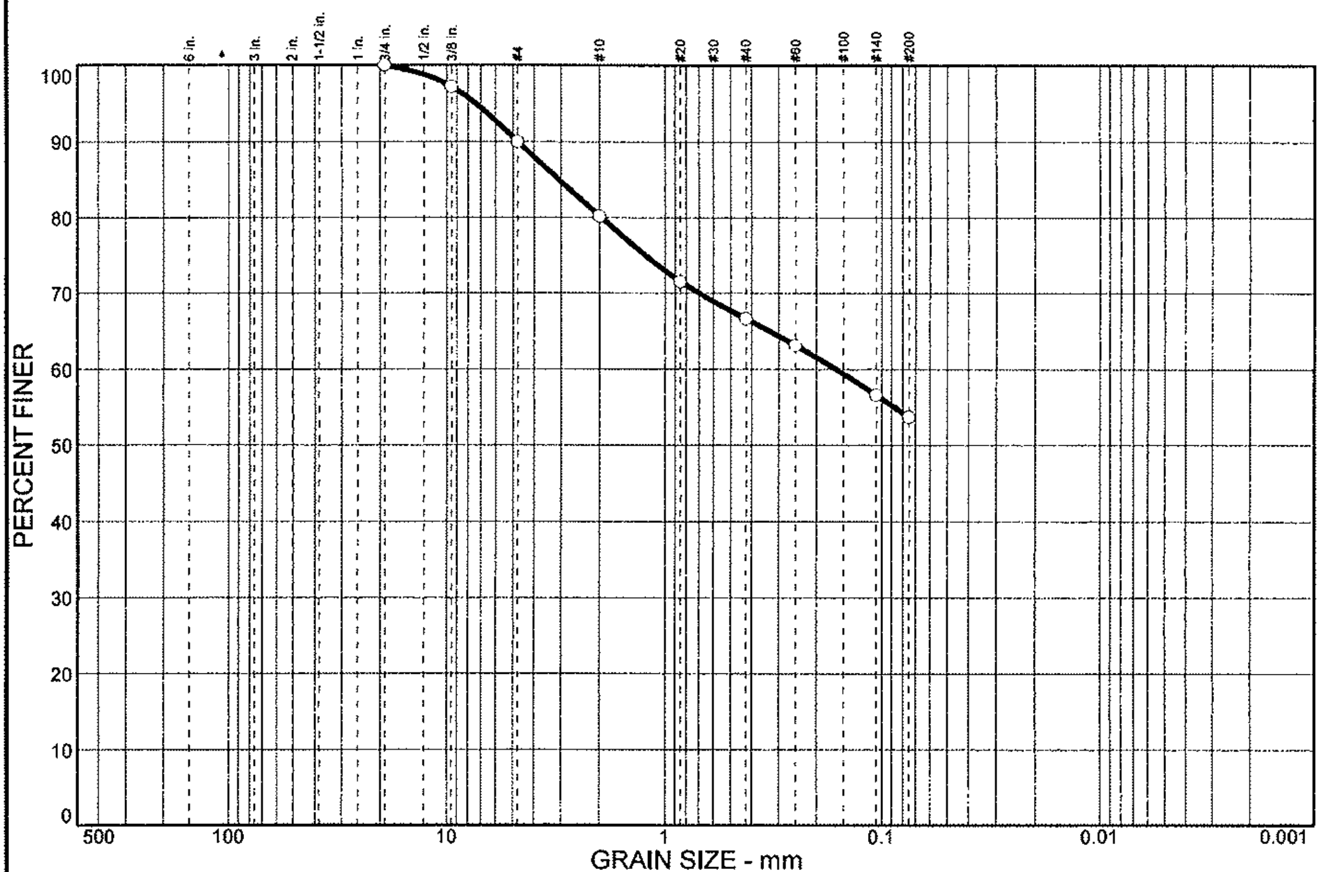
USCS= CL AASHTO=

Remarks

Sample No.: S-6 **Source of Sample:** HR-1 **Date:**
Location: **Elev./Depth:** 26-26.5

Client: URS
Project: Chevron- Hydrogen Replacement
Project No: 28067039.61000 **Plate** B-1

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	10.0	9.8	13.6	12.9	53.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	97.2		
#4	90.0		
#10	80.2		
#20	71.5		
#40	66.6		
#60	63.1		
#140	56.6		
#200	53.7		

* (no specification provided)

Soil Description

Mottled olive brown sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.07 D_{60}= 0.163 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

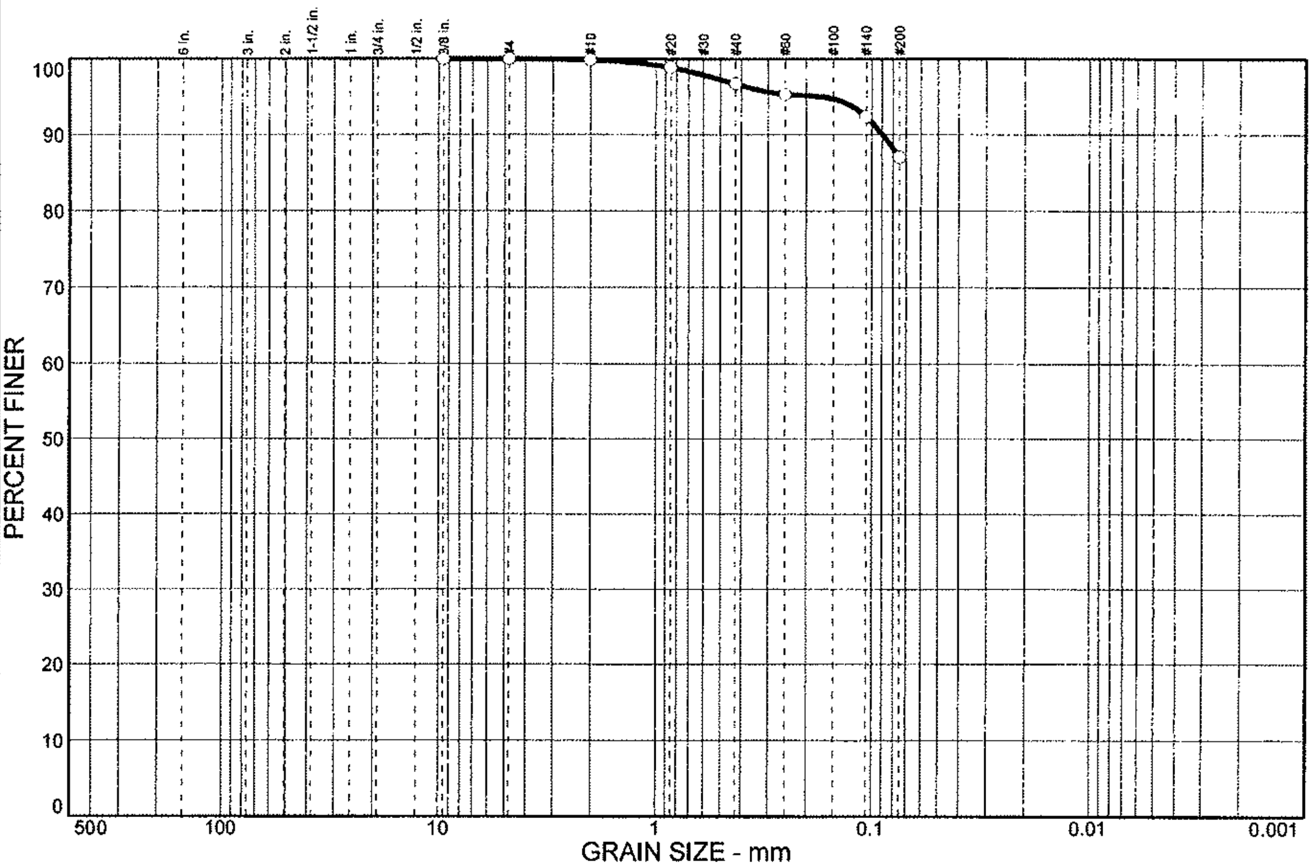
USCS= SC AASHTO=

Remarks

Sample No.: S-6 **Source of Sample:** HR-2 **Date:**
Location: **Elev./Depth:** 26-26.5

Client: URS
Project: Chevron- Hydrogen Replacement
Project No: 28067039.61000 **Plate** B-2

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	3.2	9.7	87.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	100.0		
#10	99.9		
#20	98.9		
#40	96.7		
#60	95.3		
#140	92.3		
#200	87.0		

* (no specification provided)

Soil Description

Olive gray clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

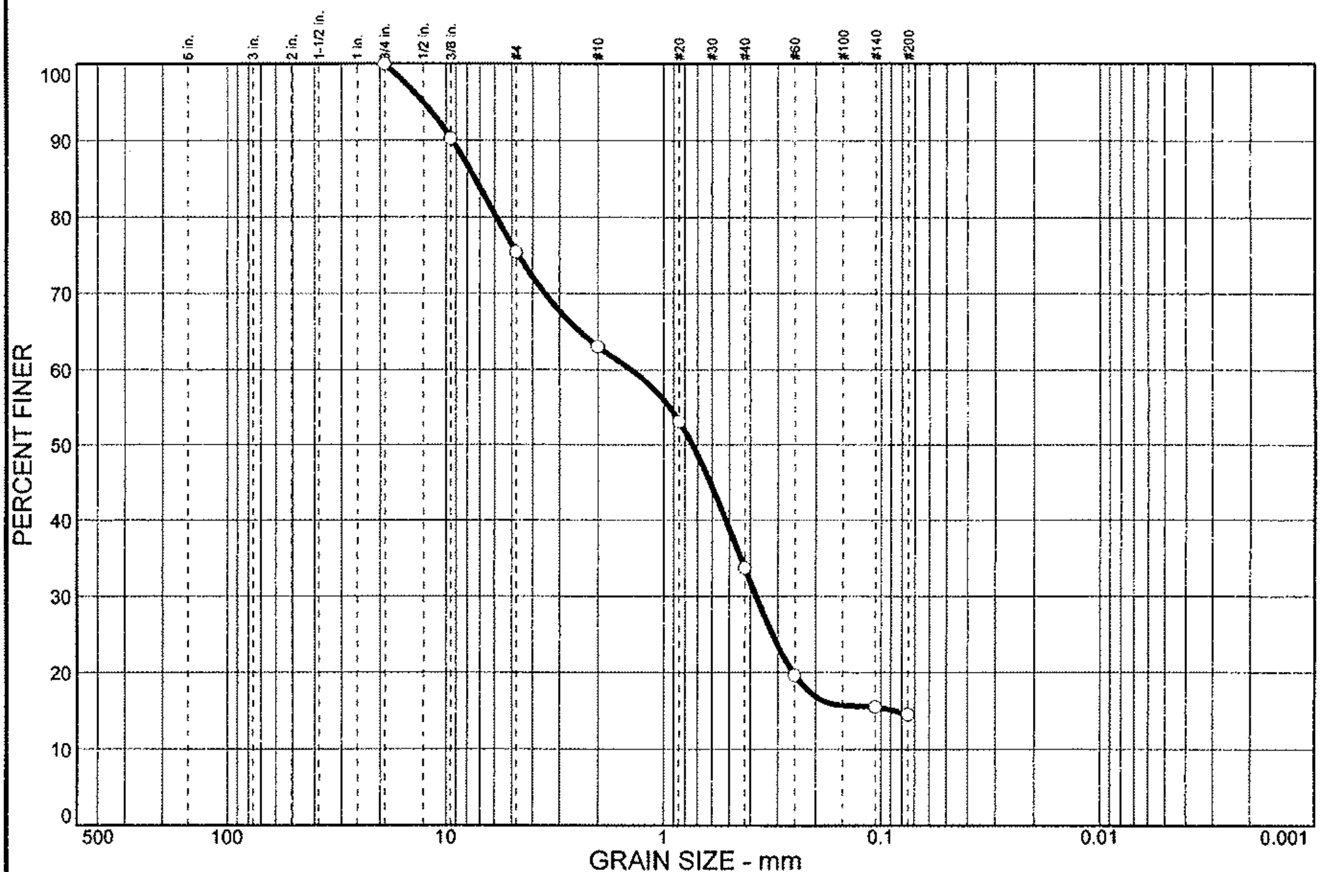
USCS= CL AASHTO=

Remarks

Sample No.: S-12 **Source of Sample:** HR-3 **Date:**
Location: **Elev./Depth:** 56-56.5

Client: URS
Project: Chevron- Hydrogen Replacement
Project No: 28067039.61000 **Plate** B-3

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	24.6	12.4	29.3	19.2	14.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	90.3		
#4	75.4		
#10	63.0		
#20	53.1		
#40	33.7		
#60	19.6		
#140	15.5		
#200	14.5		

* (no specification provided)

Soil Description

Brown sand with clay and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 7.36 D_{60}= 1.42 D_{50}= 0.740
D_{30}= 0.377 D_{15}= 0.0864 D_{10}=
C_u= C_c=

Classification

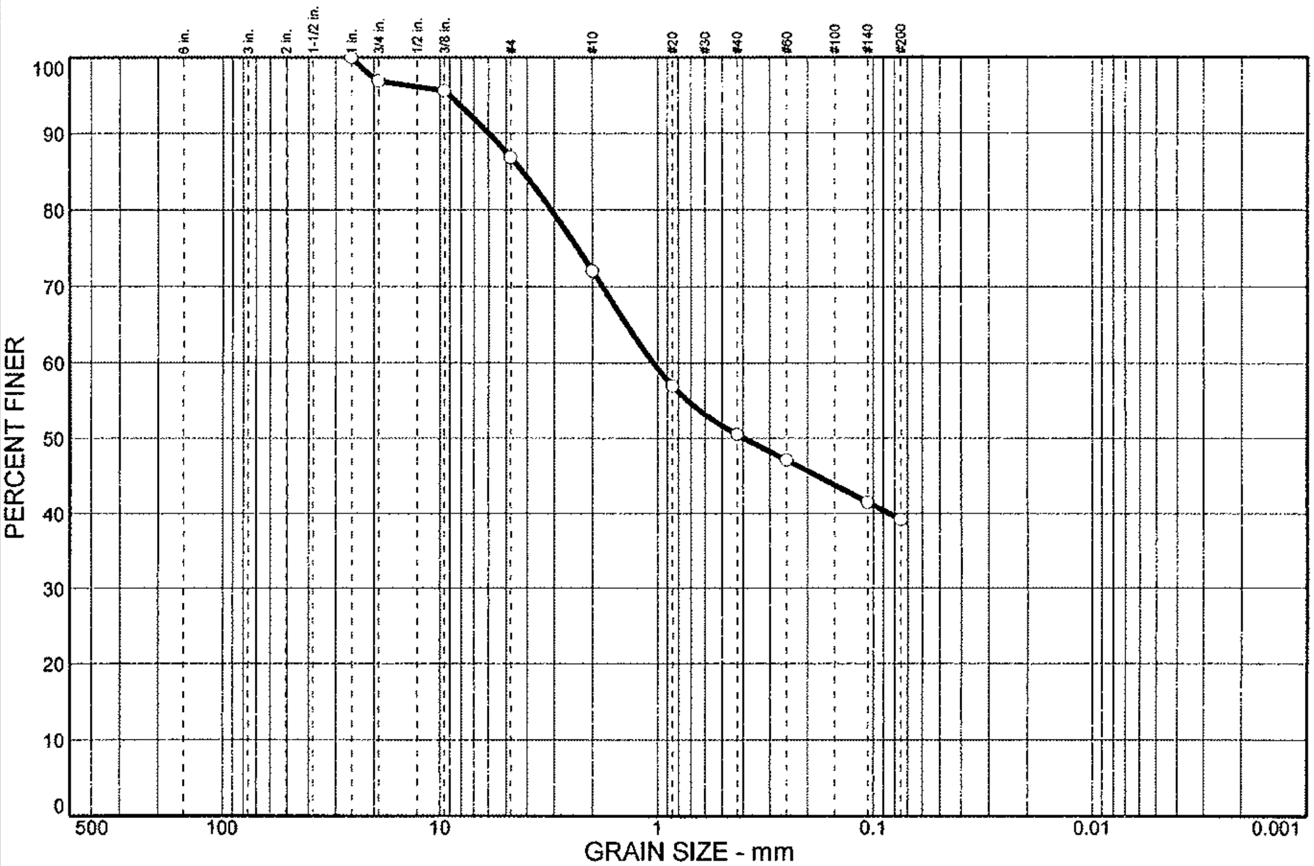
USCS= SC AASHTO=

Remarks

Sample No.: S-17 **Source of Sample:** HR-3 **Date:**
Location: **Elev./Depth:** 81-81.5

Client: URS
Project: Chevron- Hydrogen Replacement
Project No: 28067039.61000 **Plate** B-4

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	3.1	10.1	14.8	21.5	11.3	39.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
3/4 in.	96.9		
3/8 in.	95.6		
#4	86.8		
#10	72.0		
#20	56.9		
#40	50.5		
#60	47.1		
#140	41.5		
#200	39.2		

* (no specification provided)

Soil Description

Mottled brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 4.21 D_{60}= 1.05 D_{50}= 0.394
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

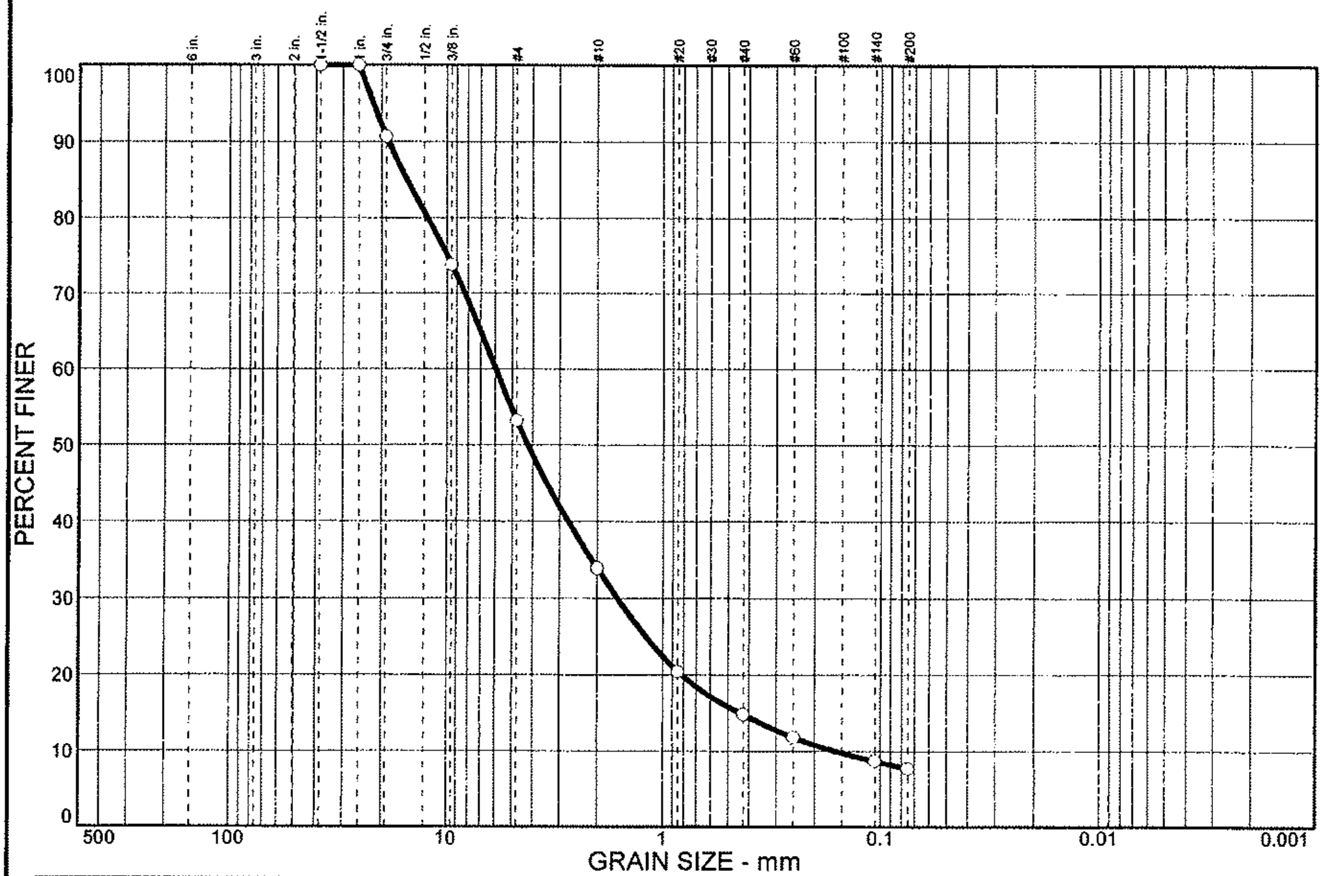
USCS= SC AASHTO=

Remarks

Sample No.: S-19 **Source of Sample:** HR-4 **Date:**
Location: **Elev./Depth:** 91-91.5

Client: URS
Project: Chevron- Hydrogen Replacement
Project No: 28067039.61000 **Plate** B-5

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	9.3	37.5	19.3	19.1	7.1	7.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
3/4 in.	90.7		
3/8 in.	73.8		
#4	53.2		
#10	33.9		
#20	20.4		
#40	14.8		
#60	11.8		
#140	8.7		
#200	7.7		

* (no specification provided)

Soil Description

Brown sandy gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 15.3 D_{60}= 5.97 D_{50}= 4.22
D_{30}= 1.61 D_{15}= 0.439 D_{10}= 0.161
C_u= 37.18 C_c= 2.72

Classification

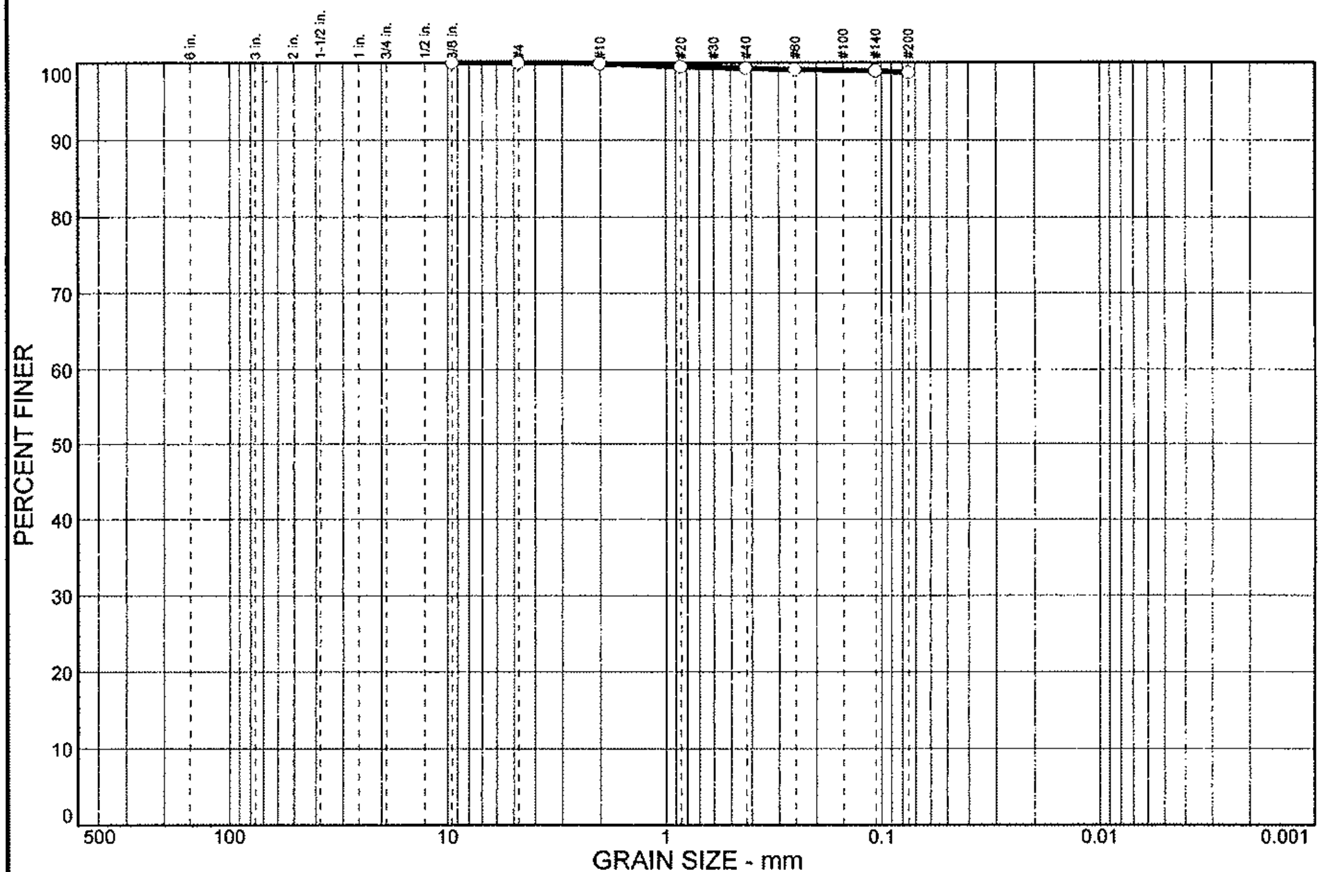
USCS= GW-GM AASHTO=

Remarks

Sample No.: S-11 **Source of Sample:** HR-5 **Date:**
Location: **Elev./Depth:** 51-51.5

Client: URS
Project: Chevron- Hydrogen Replacement
Project No: 28067039.61000 **Plate** B-6

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.6	0.6	98.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.5		
#40	99.3		
#60	99.1		
#140	98.9		
#200	98.7		

* (no specification provided)

Soil Description

Olive gray clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO=

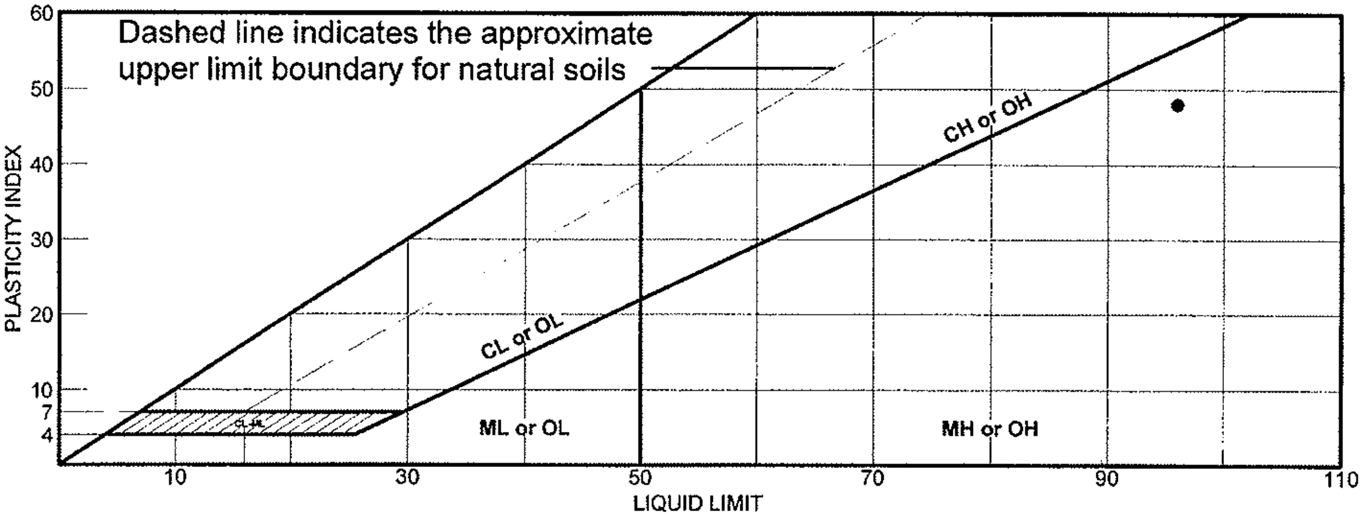
Remarks

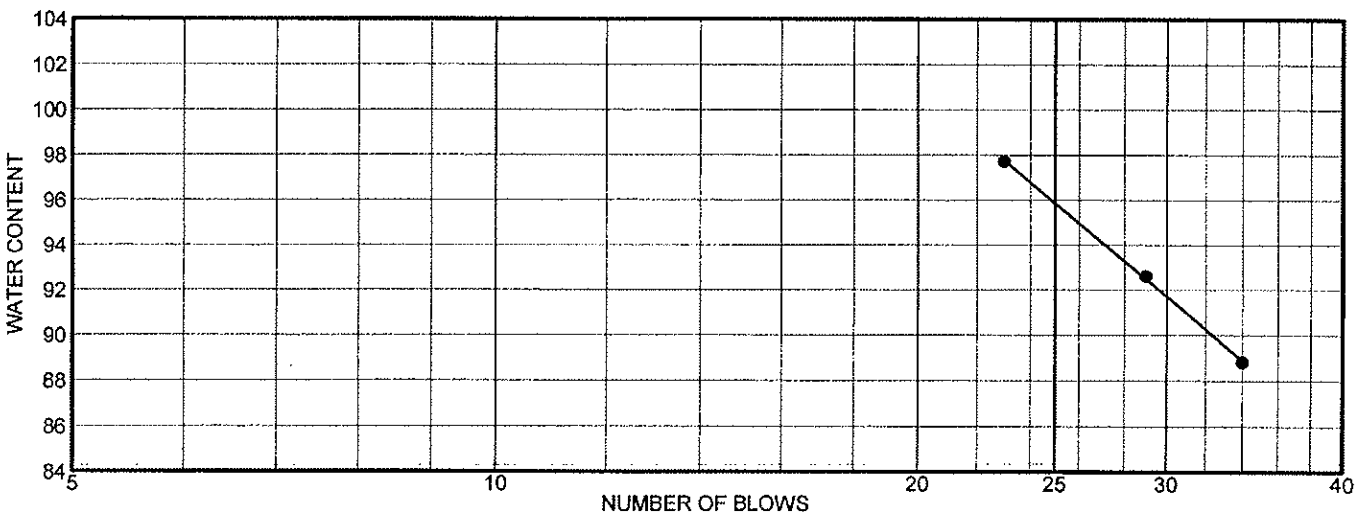
Sample No.: S-12 **Source of Sample:** HR-6 **Date:**
Location: **Elev./Depth:** 56-56.5

Client: URS
Project: Chevron- Hydrogen Replacement

Project No: 28067039.61000 **Plate** B-7

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray silt	96	48	48			

Project No. 28067039.61000**Client:** URS

Project: Chevron- Hydrogen Replacement

● **Source:** HR-1 **Sample No.:** S-4 **Elev./Depth:** 15-15.5

Remarks:

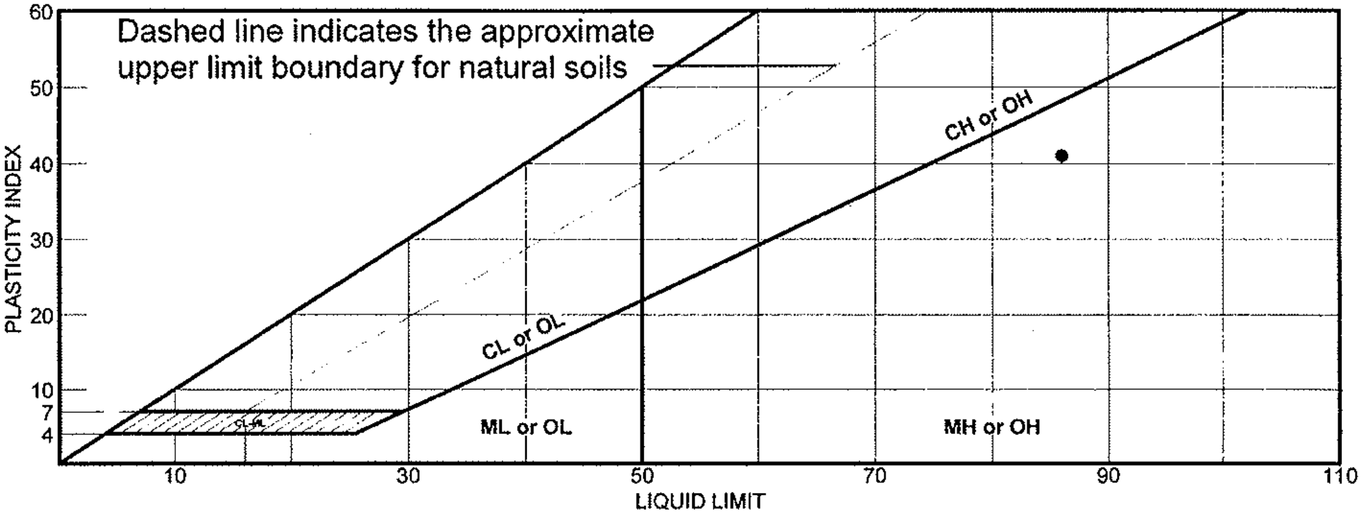
●

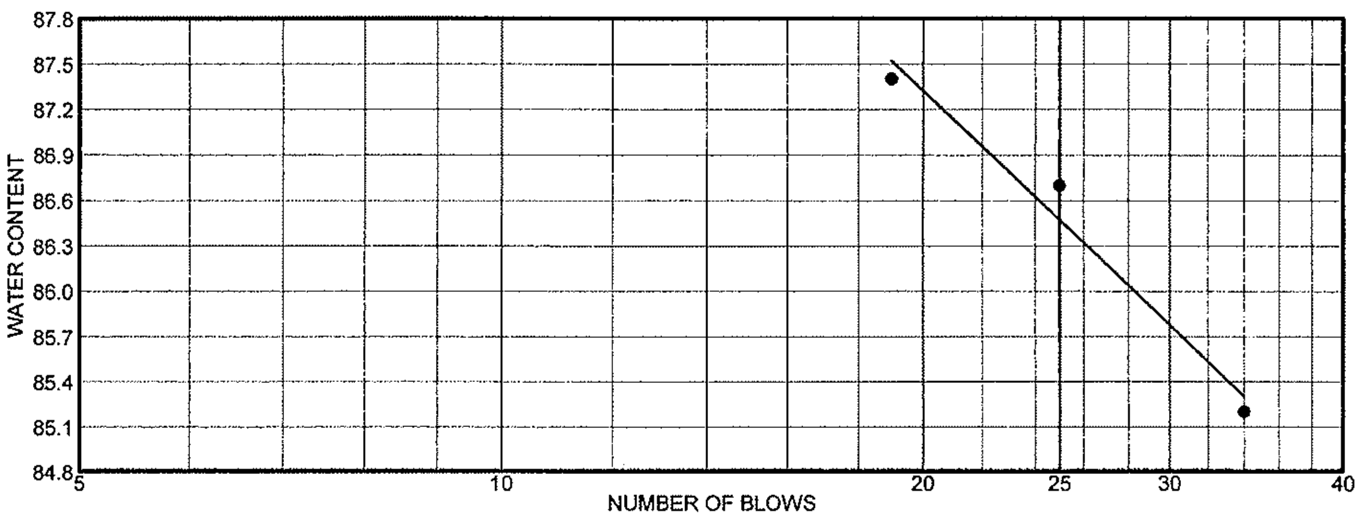
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-8

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray silt	86	45	41			

Project No. 28067039.61000**Client:** URS

Project: Chevron- Hydrogen Replacement

● **Source:** HR-3 **Sample No.:** S-5 **Elev./Depth:** 20-21.5

Remarks:

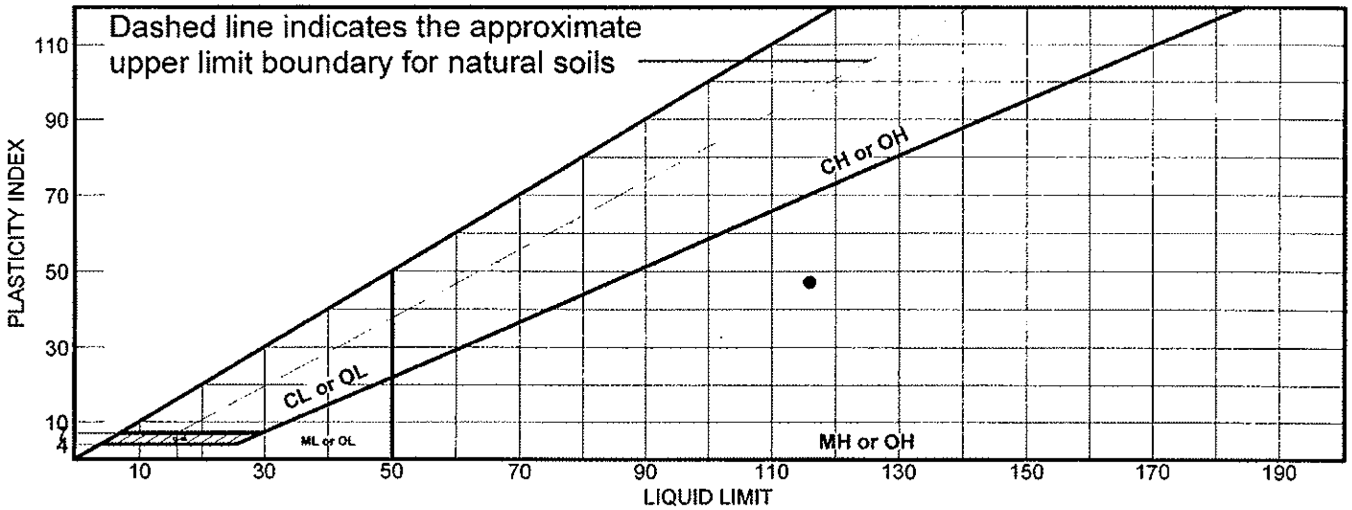
●

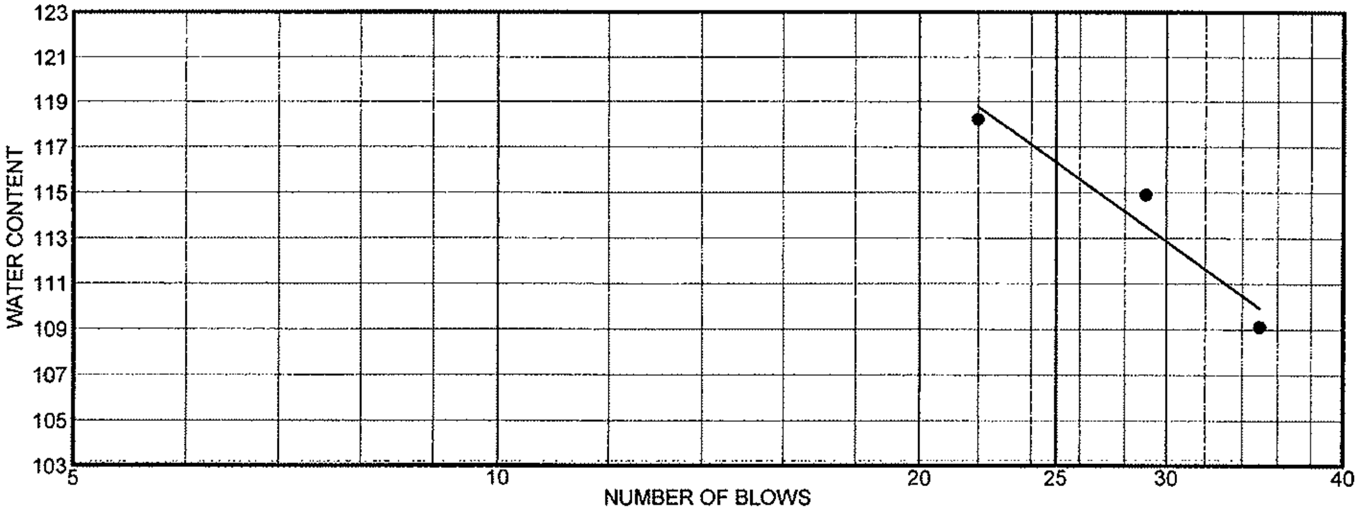
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-9

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray silt with organics	116	69	47			

Project No. 28067039.61000 **Client:** URS

Project: Chevron- Hydrogen Replacement

● **Source:** HR-5 **Sample No.:** S-5 **Elev./Depth:** 20-21.5

Remarks:

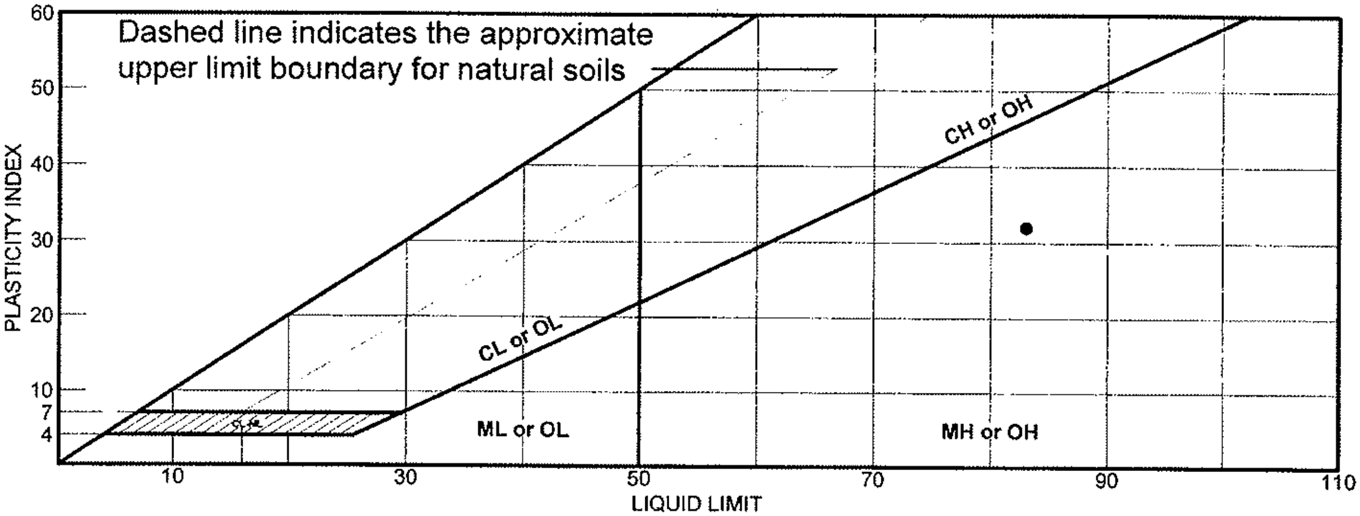
●

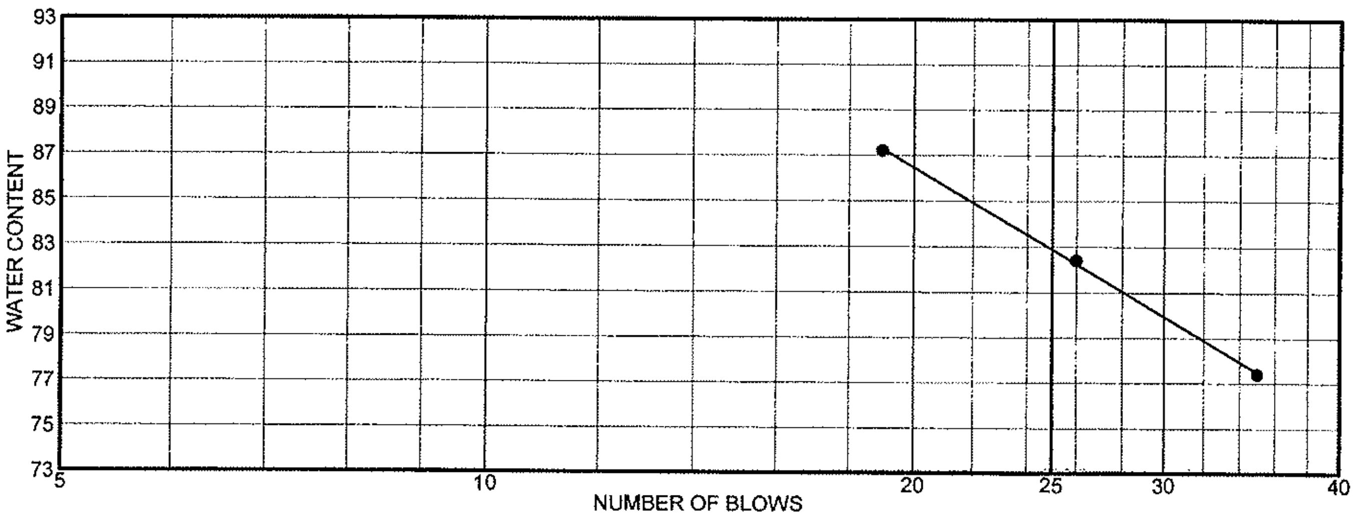
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-10

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray silt	83	51	32			

Project No. 28067039.61000 **Client:** URS

Project: Chevron- Hydrogen Replacement

● **Source:** HR-6 **Sample No.:** S-7 **Elev./Depth:** 30-31.5

Remarks:

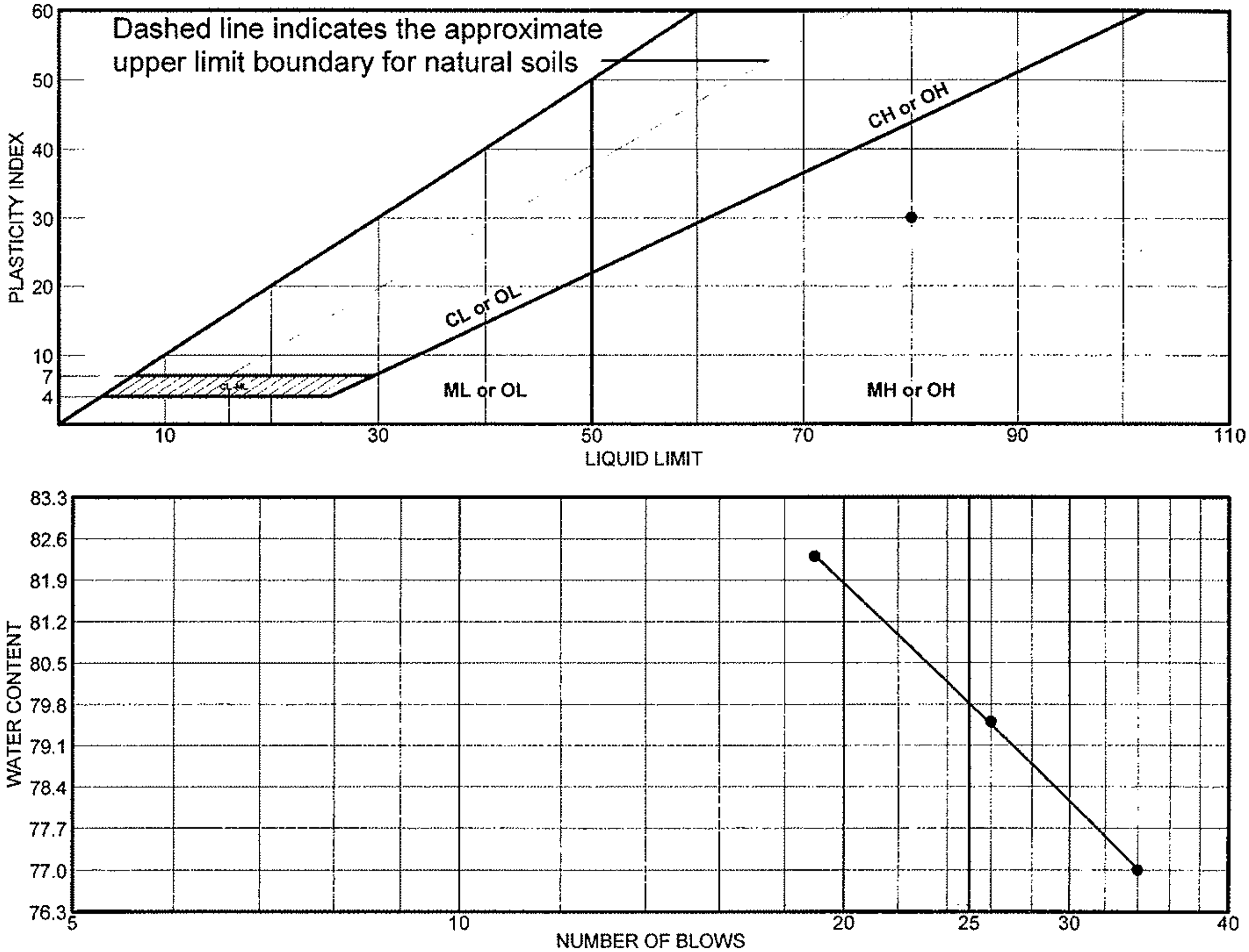
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-11

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray silt	80	50	30			

Project No. 28067039.61000 **Client:** URS

Project: Chevron- Hydrogen Replacement

● **Source:** HR-7 **Sample No.:** S-6 **Elev./Depth:** 25-26.5

Remarks:

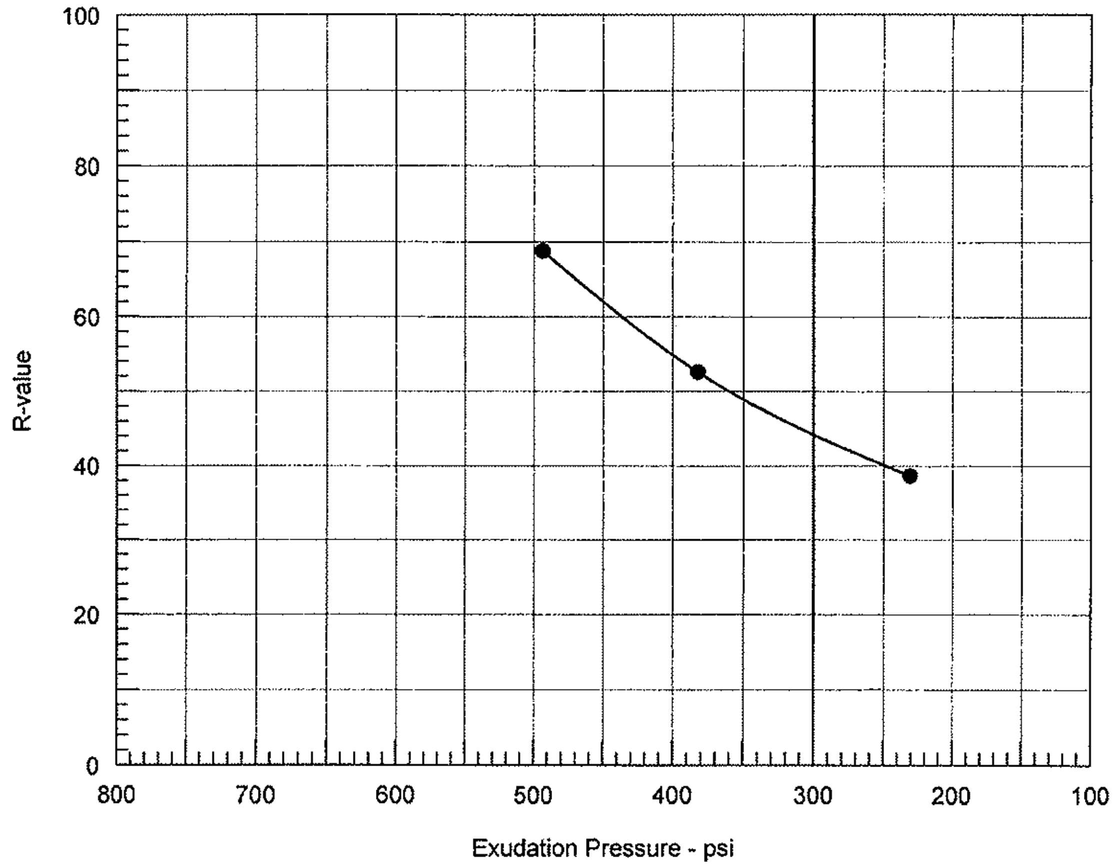
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-12

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - Cal Test 301

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	275	120.2	13.2	0.00	88	2.62	231	36	39
2	300	119.5	12.3	0.00	59	2.46	382	53	53
3	350	118.7	11.4	0.00	40	2.53	493	69	69

Test Results	Material Description
R-value at 300 psi exudation pressure = 44	Sandy silt with AC grindings

Project No.: 28067039.61000
Project: Chevron- Hydrogen Replacement
Source of Sample: HR-5 **Depth:** 0-3
Sample Number: BS-1
Date: 6/29/2006

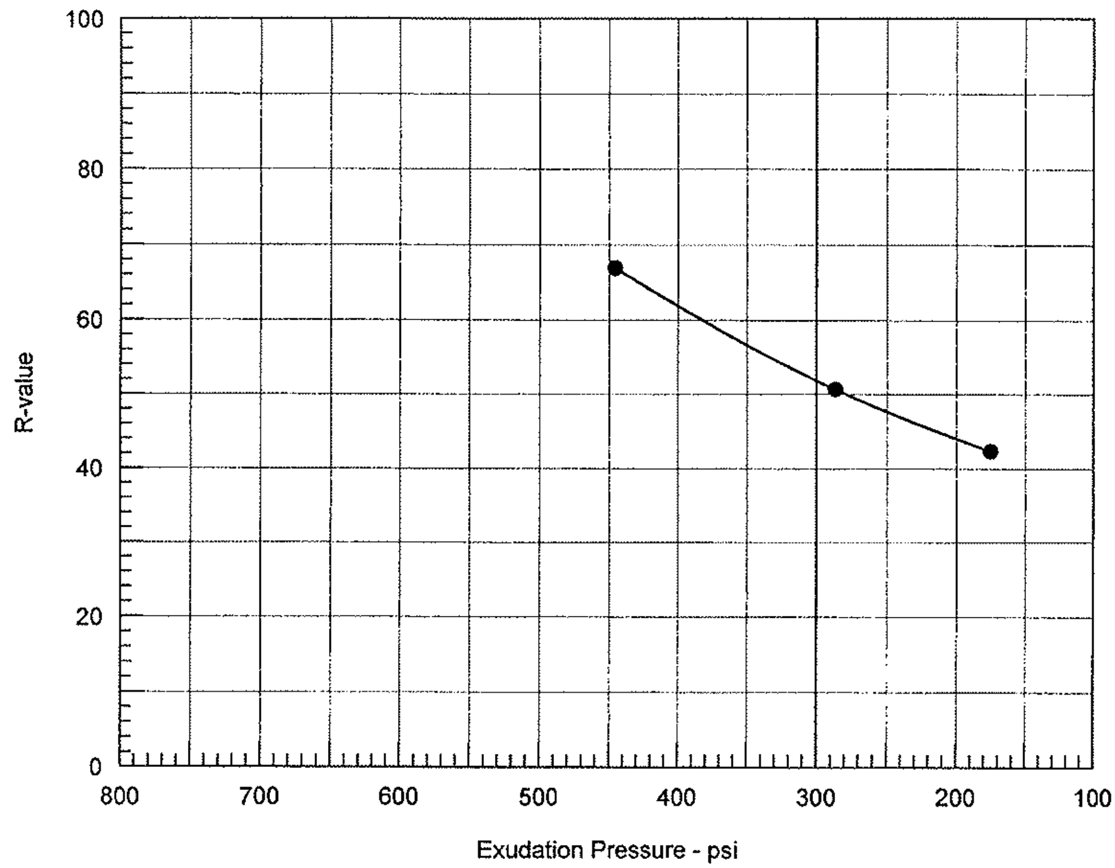
Tested by:
Checked by:
Remarks:

R-VALUE TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-13

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - Cal Test 301

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	350	134.1	7.6	0.00	65	2.46	286	51	51
2	350	133.8	6.8	0.00	44	2.51	446	67	67
3	300	134.9	8.5	0.00	72	2.44	175	44	42

Test Results	Material Description
R-value at 300 psi exudation pressure = 52	Silty sand with gravel

Project No.: 28067039.61000
Project: Chevron- Hydrogen Replacement
Source of Sample: HR-7 **Depth:** 0-3
Sample Number: BS-1
Date: 6/29/2006

Tested by:
Checked by:
Remarks:

R-VALUE TEST REPORT

SIGNET TESTING LABS, INC.

Plate B-14

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-1
Sample # : S-7
Depth (ft) : 31-31.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed olive gray silt with organics

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 528.1 gms
Ht. = 5.71 in
Ave dia. = 2.397 in
Area = 4.513 sq.in
Volume = 422.3 c.c.
Shearing rate = 0.11 inch/min
Shearing rate = 0.50 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 4.539
Ht/Dia ratio = 2.38
Moisture = 156.5 %
Total density = 78.0 pcf
Dry density = 30.4 pcf
Saturation = 93.1 %
Unconfined compressive strength = 744 psf
Shear strength = 372 psf
Strain @ failure = 6.13 %

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	2.2	0.10	71.0
0.034	5.0	0.60	159.1
0.063	8.2	1.10	260.3
0.092	11.4	1.60	357.8
0.120	13.3	2.11	414.0
0.149	14.9	2.61	461.6
0.178	16.3	3.11	504.5
0.206	17.6	3.61	542.8
0.235	19.2	4.12	588.8
0.264	21.1	4.62	643.1
0.292	22.5	5.12	680.0
0.321	23.9	5.62	718.5
0.350	24.8	6.13	743.5
0.379	24.7	6.63	736.8
0.407	24.4	7.13	722.1
0.433	23.2	7.58	684.5
0.453	22.5	7.93	662.1

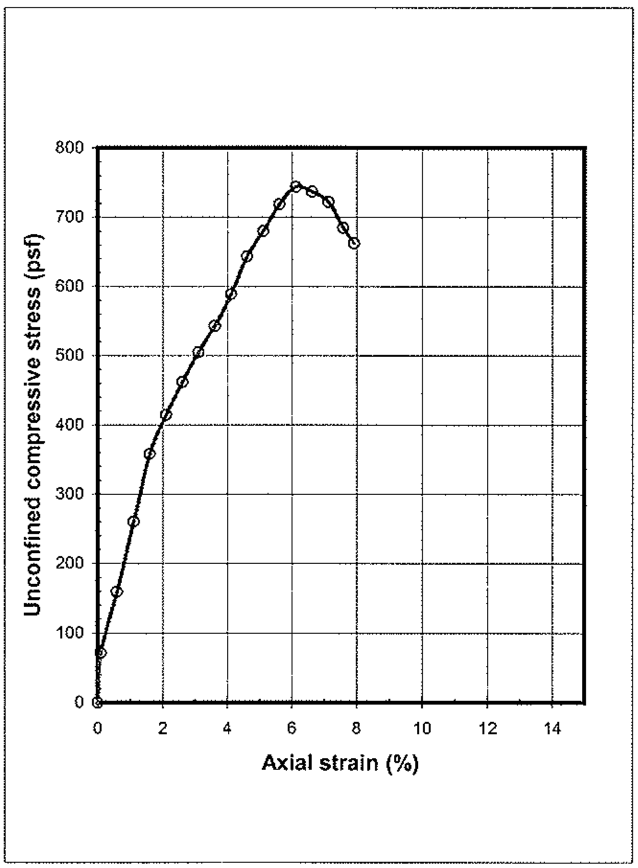


Figure B-15

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-2
Sample # : S-8
Depth (ft) : 36-36.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed olive brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt. =	961.4	gms
Ht. =	5.98	in
Ave dia. =	2.410	in
Area =	4.564	sq.in
Volume =	447.2	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.469	
Ht/Dia ratio =	2.48	
Moisture =	17.0	%
Total density =	134.1	pcf
Dry density =	114.7	pcf
Saturation =	97.7	%
Unconfined compressive strength =	10734	psf
Shear strength =	5367	psf
Strain @ failure =	15.01	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	5.4	0.10	170.3
0.036	56.2	0.61	1762.7
0.067	115.7	1.11	3610.8
0.096	173.9	1.61	5400.3
0.127	217.9	2.12	6731.0
0.157	245.5	2.62	7542.3
0.187	264.6	3.13	8086.6
0.218	280.0	3.64	8514.4
0.248	292.6	4.15	8849.9
0.278	304.2	4.65	9151.9
0.309	314.7	5.16	9417.1
0.339	324.2	5.67	9650.0
0.369	331.5	6.18	9815.2
0.400	338.8	6.68	9974.9
0.430	344.7	7.19	10094.4
0.460	349.9	7.69	10190.9
0.490	354.8	8.20	10276.8
0.520	359.5	8.70	10357.9
0.551	364.5	9.21	10441.8
0.581	369.6	9.72	10530.4
0.611	373.6	10.23	10583.9
0.642	377.8	10.73	10642.0
0.672	380.2	11.24	10647.5
0.702	382.6	11.75	10654.9
0.733	385.0	12.25	10661.2
0.763	387.2	12.76	10659.2
0.793	390.9	13.27	10699.1
0.824	394.5	13.77	10733.6
0.854	396.6	14.28	10728.5
0.884	398.9	14.79	10725.0
0.898	400.3	15.01	10734.2

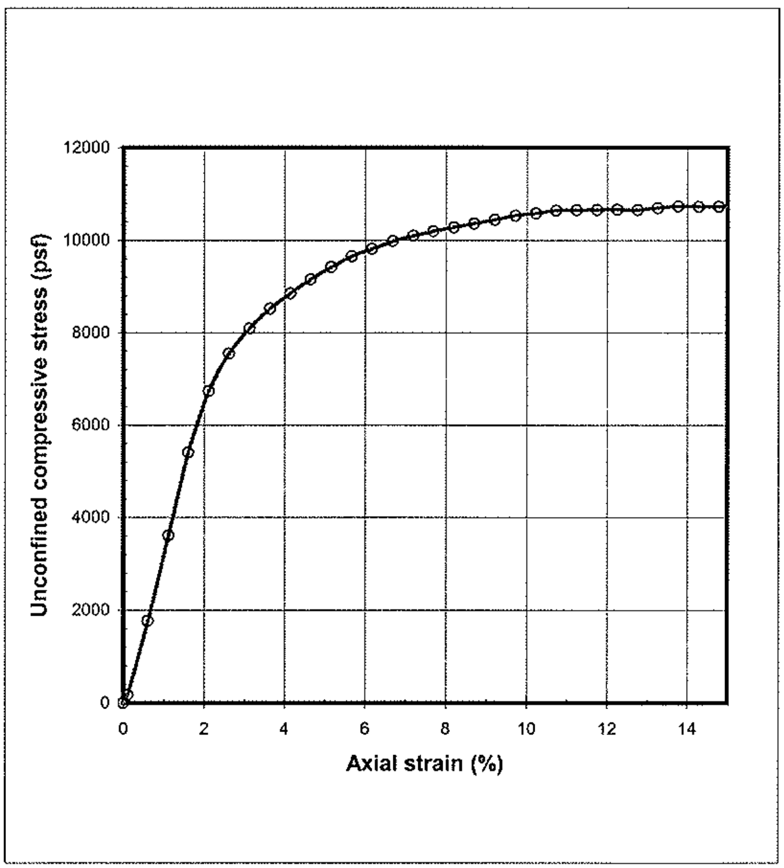


Figure B-16

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-2
Sample # : S-10
Depth (ft) : 46-46.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed olive brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt.	=	781.0	gms
Ht.	=	5.62	in
Ave dia.	=	2.420	in
Area	=	4.601	sq.in
Volume	=	423.8	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.981	
Ht/Dia ratio =	2.32	
Moisture =	35.2	%
Total density =	115.0	pcf
Dry density =	85.0	pcf
Saturation =	96.9	%
Unconfined compressive strength =	4827	psf
Shear strength =	2413	psf
Strain @ failure =	6.63	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.005	5.8	0.09	182.6
0.034	20.9	0.60	651.5
0.062	55.5	1.10	1718.3
0.090	92.4	1.60	2845.1
0.118	113.3	2.10	3470.9
0.146	126.8	2.60	3863.8
0.174	135.8	3.10	4118.3
0.203	142.4	3.61	4295.2
0.231	149.6	4.11	4489.8
0.259	155.3	4.61	4634.4
0.288	159.1	5.12	4724.1
0.316	161.9	5.62	4781.4
0.344	163.6	6.12	4805.5
0.372	165.2	6.63	4826.7
0.400	166.0	7.12	4826.3
0.429	166.1	7.63	4801.2
0.457	166.2	8.12	4777.3
0.485	163.6	8.63	4678.7
0.510	156.8	9.08	4461.4
0.538	125.4	9.58	3548.0
0.567	107.1	10.09	3014.8
0.586	103.8	10.43	2910.4

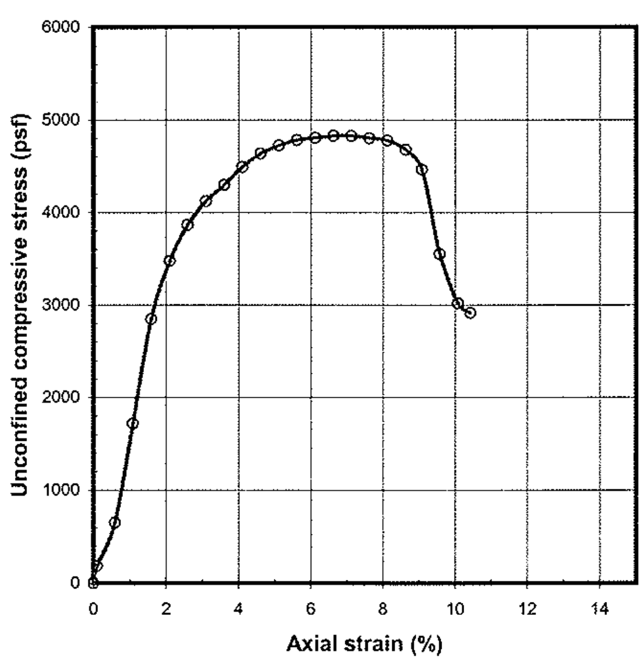


Figure B-17

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-3
Sample # : S-7
Depth (ft) : 30-30.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed dark gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	831.0	gms
	Ht. =	5.94	in
	Ave dia. =	2.393	in
	Area =	4.501	sq.in
	Volume =	438.1	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:			
	Void ratio =	0.887	
	Ht/Dia ratio =	2.48	
	Moisture =	32.6	%
	Total density =	118.4	pcf
	Dry density =	89.3	pcf
	Saturation =	99.2	%
	Unconfined compressive strength =	710	psf
	Shear strength =	355	psf
	Strain @ failure =	9.73	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	2.6	0.11	82.2
0.036	5.3	0.61	168.3
0.066	8.1	1.12	254.7
0.096	10.1	1.62	316.8
0.127	11.9	2.13	371.9
0.157	13.3	2.64	412.9
0.186	14.6	3.14	452.3
0.216	16.0	3.64	491.8
0.247	17.4	4.15	534.5
0.277	18.5	4.66	564.7
0.307	19.9	5.17	604.7
0.337	20.7	5.67	624.2
0.367	21.2	6.18	637.7
0.397	21.7	6.69	647.4
0.427	21.9	7.19	649.3
0.457	22.4	7.70	661.9
0.488	23.0	8.21	676.5
0.517	23.7	8.71	692.5
0.548	24.2	9.22	702.9
0.578	24.6	9.73	709.7
0.608	24.7	10.23	708.4
0.638	24.7	10.74	704.1
0.668	24.4	11.24	693.6
0.698	24.5	11.75	691.4
0.728	24.6	12.26	689.3
0.758	25.0	12.76	698.8
0.788	25.2	13.27	700.1
0.818	25.2	13.78	696.1
0.848	25.1	14.28	689.6
0.875	24.9	14.74	678.2
0.892	24.7	15.02	672.6

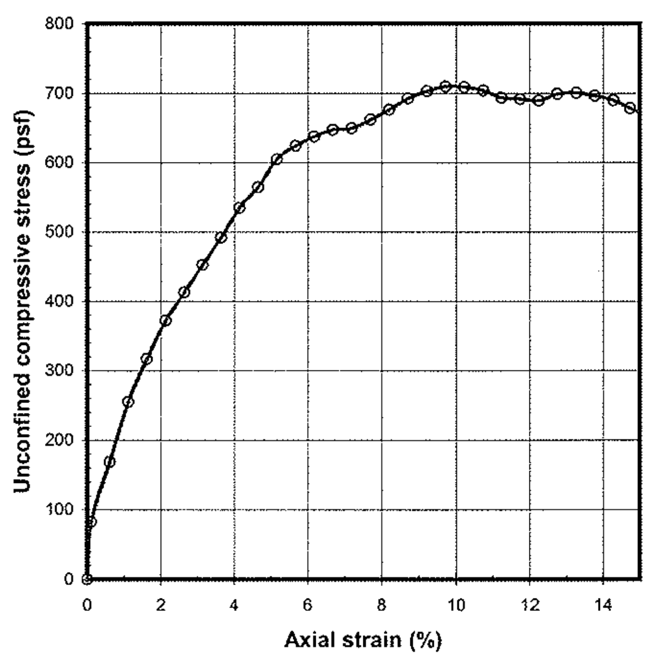


Figure B-18

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-3
Sample # : S-8
Depth (ft) : 36-36.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed dark olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt.	=	957.3	gms
Ht.	=	6.00	in
Ave dia.	=	2.413	in
Area	=	4.576	sq.in
Volume	=	449.9	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.506	
Ht/Dia ratio =	2.49	
Moisture =	18.6	%
Total density =	132.8	pcf
Dry density =	111.9	pcf
Saturation =	99.6	%
Unconfined compressive strength =	2935	psf
Shear strength =	1468	psf
Strain @ failure =	10.72	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	4.3	0.09	134.3
0.036	20.4	0.60	636.7
0.066	34.5	1.11	1072.6
0.097	45.4	1.61	1405.5
0.127	52.9	2.12	1629.4
0.158	58.5	2.63	1792.5
0.188	63.1	3.13	1923.0
0.218	67.9	3.63	2057.9
0.248	72.0	4.14	2173.1
0.279	76.6	4.65	2298.8
0.309	80.5	5.15	2403.9
0.340	84.4	5.66	2505.4
0.370	87.6	6.17	2586.0
0.401	90.1	6.68	2646.6
0.431	91.7	7.18	2678.5
0.461	93.9	7.69	2728.6
0.492	95.6	8.20	2761.5
0.522	98.0	8.70	2816.6
0.553	100.6	9.21	2872.8
0.583	102.3	9.71	2906.7
0.613	103.4	10.22	2921.9
0.643	104.5	10.72	2935.2
0.674	104.4	11.23	2915.9
0.704	104.9	11.74	2913.7
0.735	105.6	12.25	2916.0
0.765	106.7	12.75	2928.2
0.795	107.3	13.26	2928.3
0.826	108.0	13.77	2929.3
0.857	108.8	14.28	2933.7
0.887	108.7	14.78	2914.4
0.901	108.4	15.02	2899.3

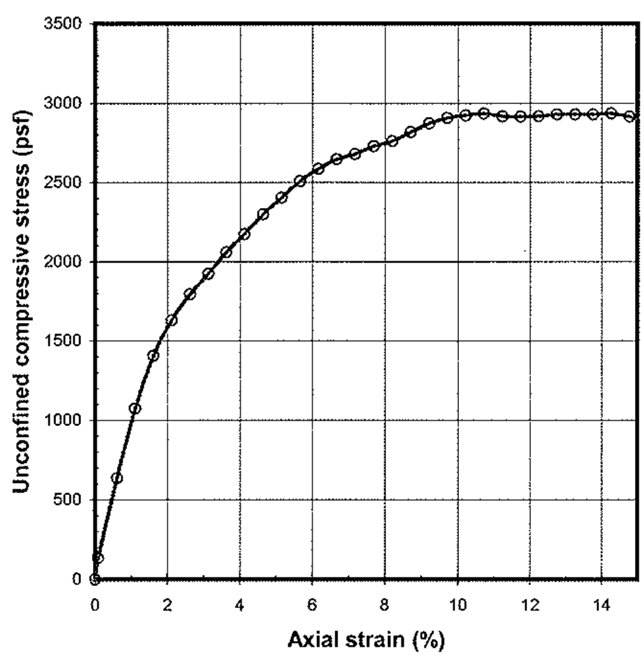


Figure B-19

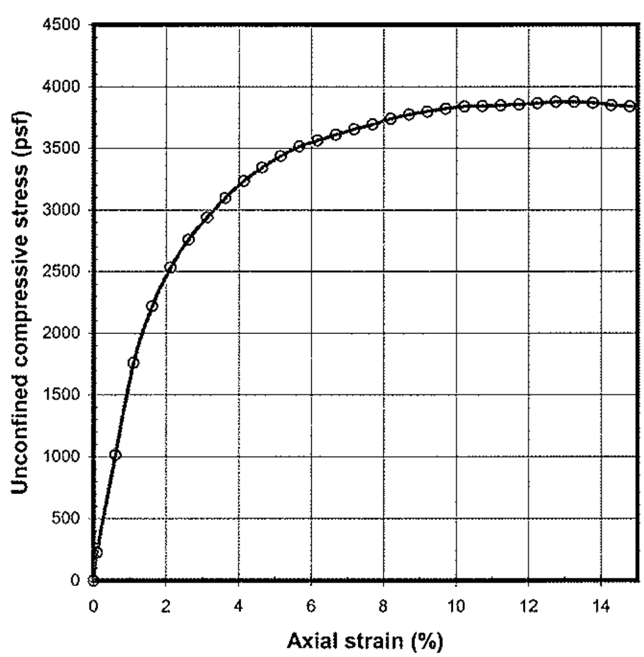
UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-3
Sample # : S-10
Depth (ft) : 46-46.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed grayish brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	813.1	gms
	Ht. =	5.91	in
	Ave dia. =	2.407	in
	Area =	4.551	sq.in
	Volume =	440.7	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:			
	Void ratio =	0.997	
	Ht/Dia ratio =	2.46	
	Moisture =	36.4	%
	Total density =	115.1	pcf
	Dry density =	84.4	pcf
	Saturation =	98.7	%
	Unconfined compressive strength =	3874	psf
	Shear strength =	1937	psf
	Strain @ failure =	12.76	%



Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	7.2	0.10	226.5
0.035	32.2	0.60	1013.5
0.065	56.2	1.11	1757.4
0.096	71.2	1.62	2216.3
0.126	81.7	2.13	2530.9
0.155	89.5	2.63	2758.5
0.185	95.8	3.13	2936.1
0.215	101.5	3.64	3095.8
0.245	106.6	4.15	3233.2
0.275	110.8	4.65	3342.8
0.305	114.4	5.16	3434.2
0.335	117.7	5.67	3514.4
0.365	120.0	6.17	3563.3
0.395	122.3	6.68	3610.3
0.425	124.4	7.19	3652.7
0.455	126.4	7.69	3691.8
0.485	128.7	8.20	3739.0
0.515	130.6	8.71	3773.6
0.545	132.2	9.21	3797.5
0.575	133.7	9.72	3820.6
0.605	135.1	10.23	3838.5
0.634	135.9	10.73	3839.6
0.664	136.9	11.23	3845.7
0.694	137.9	11.74	3852.3
0.724	139.1	12.25	3863.0
0.754	140.3	12.76	3873.5
0.784	141.1	13.26	3873.2
0.814	141.7	13.77	3865.9
0.844	141.9	14.28	3847.6
0.874	142.3	14.79	3837.1
0.887	142.4	15.01	3829.2

Figure B-20

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-3
Sample # : S-13
Depth (ft) : 61-61.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt.	=	842.1	gms
Ht.	=	6.00	in
Ave dia.	=	2.420	in
Area	=	4.601	sq.in
Volume	=	452.4	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.939	
Ht/Dia ratio =	2.48	
Moisture =	33.7	%
Total density =	116.1	pcf
Dry density =	86.9	pcf
Saturation =	96.8	%
Unconfined compressive strength =	3726	psf
Shear strength =	1863	psf
Strain @ failure =	5.12	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	5.7	0.09	176.8
0.036	21.7	0.60	674.1
0.066	42.0	1.10	1299.6
0.096	68.2	1.60	2100.1
0.126	88.0	2.10	2695.7
0.156	100.7	2.61	3068.4
0.186	109.3	3.10	3313.0
0.217	115.1	3.61	3472.6
0.246	119.2	4.10	3576.6
0.277	122.4	4.61	3653.1
0.307	125.5	5.12	3725.6
0.337	124.5	5.61	3677.5
0.364	120.3	6.07	3537.4
0.394	114.0	6.57	3333.2
0.424	104.3	7.07	3032.9
0.454	95.1	7.57	2751.2
0.480	83.5	8.01	2405.2

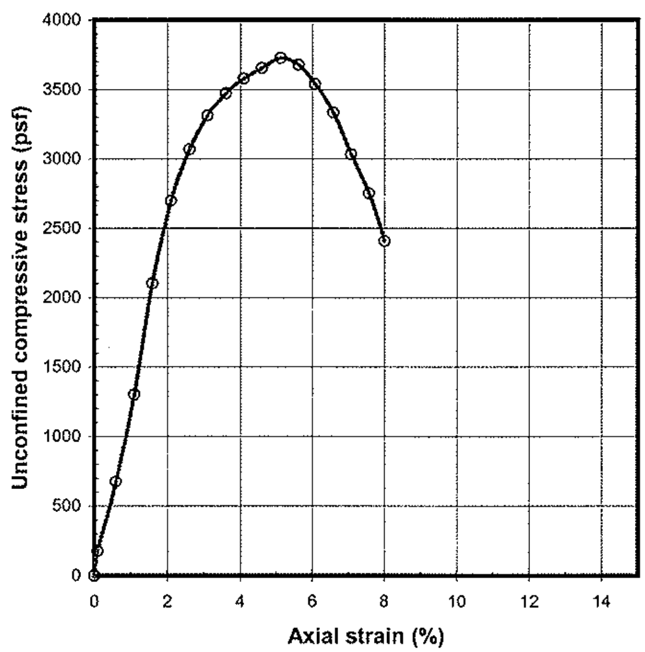


Figure B-21

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-3
Sample # : S-17
Depth (ft) : 81-81.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed brown sand with clay and gravel

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt. =	985.7	gms
Ht. =	5.96	in
Ave dia. =	2.413	in
Area =	4.576	sq.in
Volume =	446.9	c.c.
Shearing rate =	0.12	inch/min
Shearing rate =	0.50	%/min
Gs (assumed) =	2.70	

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.8	0.11	120.0
0.036	18.2	0.61	568.0
0.066	34.0	1.11	1057.8
0.096	43.5	1.61	1346.3
0.123	42.3	2.06	1303.3
0.153	31.3	2.57	959.8
0.163	28.5	2.74	872.5

Test Report:

Void ratio =	0.389	
Ht/Dia ratio =	2.47	
Moisture =	13.5	%
Total density =	137.6	pcf
Dry density =	121.3	pcf
Saturation =	93.4	%
Unconfined compressive strength =	1346	psf
Shear strength =	673	psf
Strain @ failure =	1.61	%

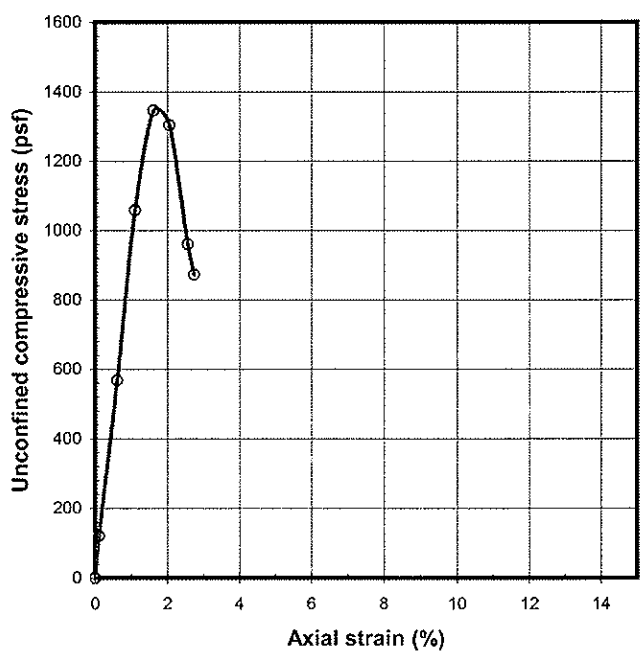


Figure B-22

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-4
Sample # : S-8
Depth (ft) : 36-36.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed olive brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	953.5	gms
Ht. =	6.00	in
Ave dia. =	2.417	in
Area =	4.589	sq.in
Volume =	451.2	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.525	
Ht/Dia ratio =	2.48	
Moisture =	19.4	%
Total density =	131.9	pcf
Dry density =	110.5	pcf
Saturation =	99.6	%
Unconfined compressive strength =	6319	psf
Shear strength =	3160	psf
Strain @ failure =	14.80	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	11.2	0.10	352.6
0.036	66.3	0.60	2067.0
0.066	102.0	1.10	3164.9
0.097	120.8	1.61	3731.1
0.128	134.5	2.13	4130.4
0.158	144.7	2.63	4420.7
0.188	152.2	3.14	4627.4
0.219	159.4	3.65	4818.4
0.250	165.8	4.16	4986.4
0.280	173.0	4.67	5176.1
0.310	179.0	5.17	5327.4
0.340	184.3	5.67	5456.2
0.371	189.5	6.18	5578.3
0.401	193.3	6.69	5660.4
0.432	196.7	7.19	5728.4
0.462	200.4	7.70	5803.0
0.493	203.5	8.21	5860.1
0.523	207.0	8.72	5929.5
0.554	211.1	9.23	6013.8
0.584	214.3	9.73	6070.8
0.614	217.8	10.24	6134.7
0.645	220.2	10.75	6168.7
0.675	222.5	11.25	6196.9
0.706	224.8	11.76	6224.2
0.736	226.7	12.27	6240.4
0.767	228.6	12.78	6257.7
0.797	230.9	13.28	6283.6
0.827	232.8	13.79	6297.7
0.858	234.5	14.30	6307.2
0.888	236.4	14.80	6319.0
0.901	236.8	15.01	6314.6

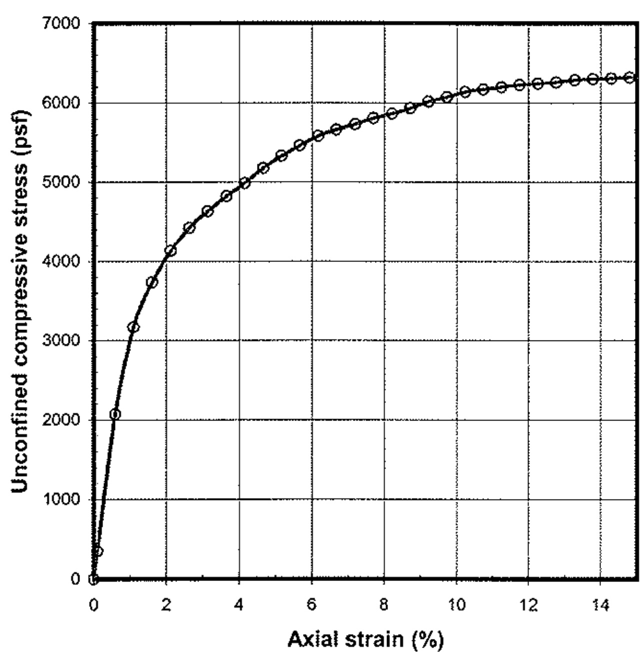


Figure B-23

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-4
Sample # : S-12
Depth (ft) : 56-56.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	913.2	gms
	Ht. =	6.00	in
	Ave dia. =	2.410	in
	Area =	4.564	sq.in
	Volume =	448.7	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:			
	Void ratio =	0.630	
	Ht/Dia ratio =	2.49	
	Moisture =	22.9	%
	Total density =	127.0	pcf
	Dry density =	103.3	pcf
	Saturation =	98.1	%
	Unconfined compressive strength =	4705	psf
	Shear strength =	2352	psf
	Strain @ failure =	7.12	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	5.9	0.09	186.2
0.036	23.7	0.60	744.5
0.066	44.2	1.10	1379.9
0.096	62.1	1.60	1929.6
0.126	77.8	2.10	2402.0
0.156	91.0	2.61	2798.0
0.187	102.9	3.11	3145.6
0.217	113.2	3.61	3441.9
0.247	122.5	4.11	3706.1
0.277	131.7	4.62	3962.5
0.307	140.2	5.11	4197.3
0.337	147.4	5.61	4391.0
0.367	153.8	6.12	4554.9
0.397	158.8	6.62	4679.6
0.427	160.5	7.12	4704.7
0.454	153.3	7.57	4470.8
0.484	141.3	8.07	4097.6
0.514	94.7	8.57	2731.5
0.524	79.1	8.73	2278.8

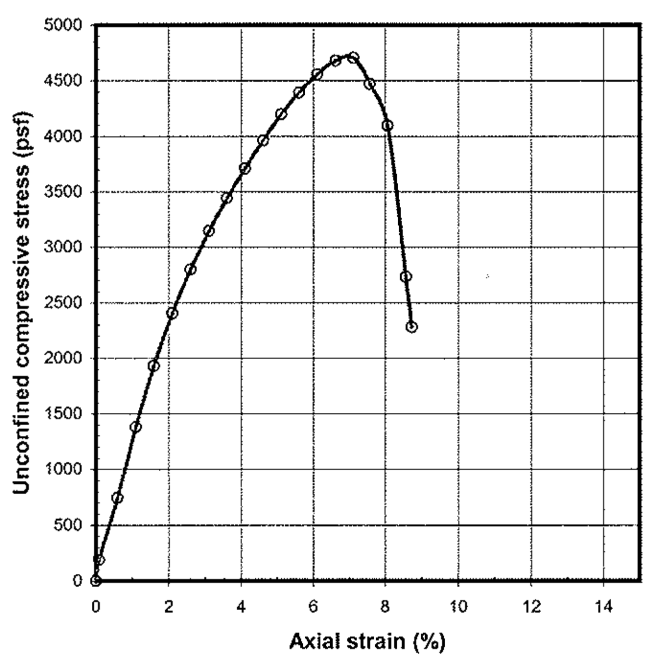


Figure B-24

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-4
Sample # : S-15
Depth (ft) : 71-71.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed mottled brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt.	=	940.0	gms
Ht.	=	6.00	in
Ave dia.	=	2.417	in
Area	=	4.589	sq.in
Volume	=	451.2	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	0.552	
Ht/Dia ratio	=	2.48	
Moisture	=	19.8	%
Total density	=	130.0	pcf
Dry density	=	108.5	pcf
Saturation	=	96.7	%
Unconfined compressive strength	=	6199	psf
Shear strength	=	3100	psf
Strain @ failure	=	6.17	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	7.8	0.10	246.0
0.037	43.0	0.61	1340.9
0.067	88.4	1.12	2743.4
0.097	126.4	1.62	3901.7
0.128	152.5	2.13	4682.5
0.158	169.4	2.63	5177.2
0.189	181.2	3.14	5506.5
0.219	189.0	3.65	5714.0
0.249	195.2	4.15	5871.0
0.280	199.5	4.66	5967.5
0.310	204.1	5.16	6073.0
0.340	207.9	5.67	6154.1
0.370	210.5	6.17	6199.0
0.401	211.6	6.68	6196.1
0.431	212.6	7.19	6191.2
0.462	211.2	7.70	6117.5
0.492	209.0	8.20	6021.7
0.523	206.8	8.71	5923.8
0.550	203.4	9.17	5796.7
0.580	202.4	9.67	5736.8
0.611	201.2	10.18	5671.9
0.641	199.2	10.69	5581.8
0.672	196.6	11.19	5478.0
0.702	192.3	11.70	5327.8
0.732	188.5	12.20	5193.6
0.762	183.9	12.71	5037.2
0.793	182.1	13.22	4959.0
0.816	179.5	13.60	4866.3

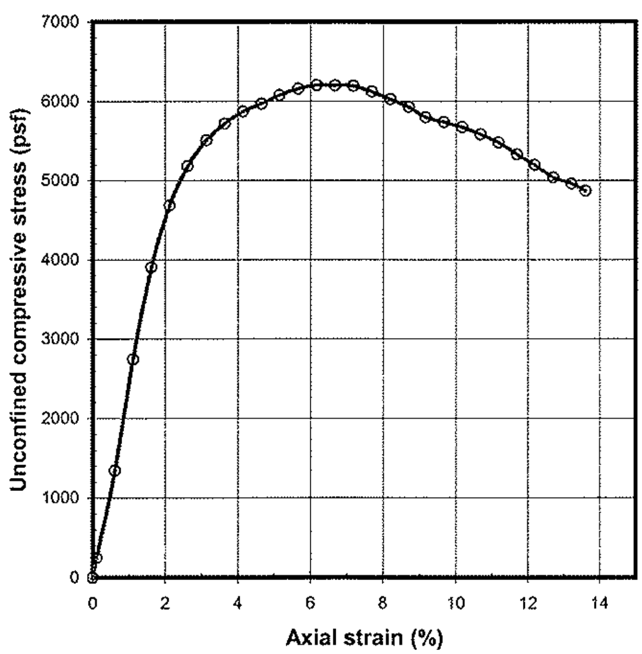


Figure B-25

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-4
Sample # : S-16
Depth (ft) : 76-76.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed mottled brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt.	=	987.2	gms
Ht.	=	6.00	in
Ave dia.	=	2.413	in
Area	=	4.576	sq.in
Volume	=	449.9	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	0.419	
Ht/Dia ratio	=	2.49	
Moisture	=	15.3	%
Total density	=	136.9	pcf
Dry density	=	118.7	pcf
Saturation	=	98.7	%
Unconfined compressive strength	=	5340	psf
Shear strength	=	2670	psf
Strain @ failure	=	2.61	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	7.5	0.10	234.2
0.036	36.5	0.60	1140.4
0.066	79.9	1.10	2487.5
0.096	121.1	1.61	3748.1
0.127	152.4	2.11	4693.5
0.157	174.2	2.61	5340.1
0.184	165.5	3.06	5047.8
0.213	156.5	3.56	4750.9
0.244	142.1	4.07	4288.5
0.274	124.1	4.56	3727.6
0.304	103.9	5.07	3102.5
0.334	81.5	5.56	2420.9
0.346	74.5	5.76	2208.4

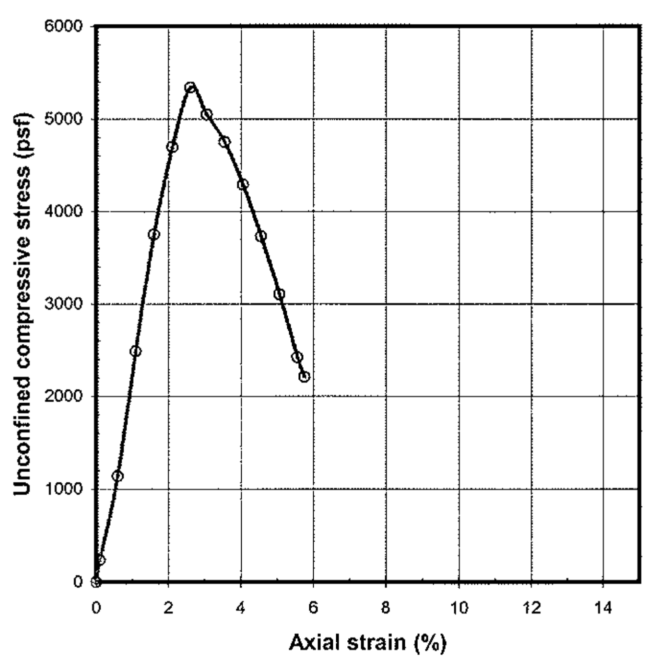


Figure B-26

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron- Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-4
Sample # : S-19
Depth (ft) : 91-91.5
Date tested : 07/06/06
Soil (Visual Description) : Undisturbed mottled brown clayey sand

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	959.2	gms
	Ht. =	6.00	in
	Ave dia. =	2.413	in
	Area =	4.576	sq.in
	Volume =	449.9	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.542	
Ht/Dia ratio =	2.49	
Moisture =	21.8	%
Total density =	133.0	pcf
Dry density =	109.2	pcf
Saturation =	108.4	%
Unconfined compressive strength =	6132	psf
Shear strength =	3066	psf
Strain @ failure =	5.16	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.005	10.1	0.09	317.7
0.036	79.1	0.61	2474.7
0.067	123.8	1.11	3852.7
0.097	148.4	1.62	4594.9
0.127	165.1	2.12	5085.1
0.158	177.5	2.64	5437.9
0.189	186.4	3.15	5680.4
0.219	192.5	3.65	5836.8
0.250	197.1	4.16	5944.5
0.279	201.7	4.66	6052.7
0.310	205.5	5.16	6131.9
0.340	206.3	5.67	6122.9
0.371	203.0	6.18	5994.2
0.398	196.6	6.63	5774.8
0.428	188.7	7.14	5513.5
0.459	179.7	7.65	5222.0
0.489	172.1	8.15	4973.4
0.520	166.3	8.66	4779.5
0.550	160.0	9.17	4574.4
0.581	154.5	9.68	4390.0
0.586	153.6	9.77	4361.8

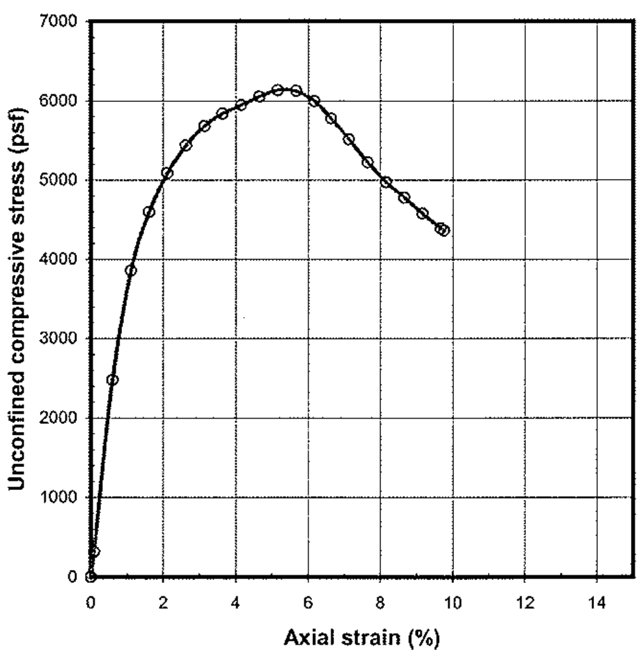


Figure B-27

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-5
Sample # : S-6
Depth (ft) : 25
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed mottled olive gray clay with gravel

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

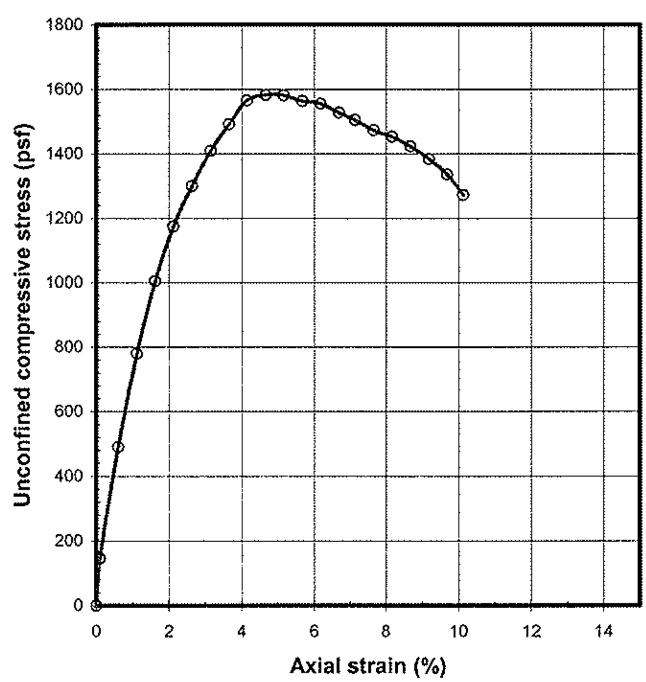
Specimen:

Total wt. =	970.3	gms
Ht. =	6.00	in
Ave dia. =	2.410	in
Area =	4.564	sq.in
Volume =	448.7	c.c.
Shearing rate =	0.08	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.506	
Ht/Dia ratio =	2.49	
Moisture =	20.6	%
Total density =	134.9	pcf
Dry density =	111.9	pcf
Saturation =	110.0	%
Unconfined compressive strength =	1582	psf
Shear strength =	791	psf
Strain @ failure =	4.67	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	4.6	0.10	145.0
0.036	15.6	0.61	489.8
0.067	25.0	1.12	779.4
0.098	32.4	1.63	1004.4
0.128	38.0	2.13	1174.7
0.158	42.3	2.64	1300.5
0.189	46.1	3.15	1409.0
0.219	49.1	3.65	1492.2
0.249	51.7	4.16	1565.0
0.280	52.6	4.67	1582.0
0.310	52.8	5.17	1581.4
0.341	52.5	5.68	1563.1
0.371	52.5	6.19	1555.5
0.401	51.9	6.69	1527.8
0.429	51.4	7.15	1505.3
0.460	50.5	7.66	1472.5
0.490	50.2	8.17	1453.4
0.521	49.4	8.68	1422.8
0.551	48.3	9.18	1383.1
0.582	46.9	9.69	1336.3
0.608	44.9	10.14	1272.5



(see worksheet for sketch of failure)

Figure B-28

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-5
Sample # : S-7
Depth (ft) : 31
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed mottled brown clay

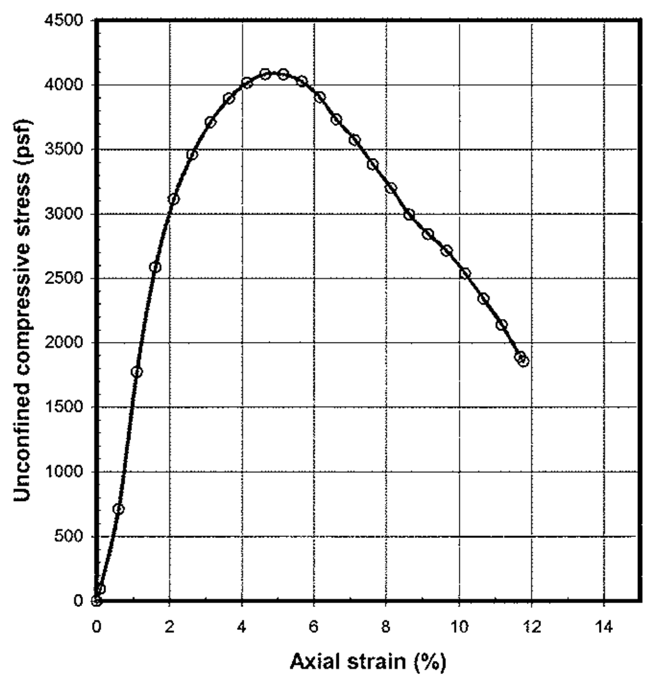
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	968.5	gms
Ht. =	6.00	in
Ave dia. =	2.413	in
Area =	4.576	sq.in
Volume =	449.9	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.470	
Ht/Dia ratio =	2.49	
Moisture =	17.2	%
Total density =	134.3	pcf
Dry density =	114.6	pcf
Saturation =	98.7	%
Unconfined compressive strength =	4082	psf
Shear strength =	2041	psf
Strain @ failure =	4.65	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.0	0.09	94.8
0.036	22.6	0.60	707.2
0.066	56.9	1.11	1772.0
0.097	83.5	1.62	2583.9
0.127	101.1	2.12	3113.5
0.158	112.8	2.63	3457.7
0.188	121.7	3.14	3709.5
0.219	128.4	3.64	3892.8
0.249	133.1	4.15	4015.9
0.279	136.1	4.65	4082.1
0.310	136.7	5.16	4080.1
0.340	135.6	5.67	4025.5
0.370	132.2	6.17	3904.3
0.398	127.0	6.63	3731.9
0.428	122.2	7.14	3572.3
0.458	116.5	7.64	3385.2
0.489	110.7	8.14	3200.2
0.519	104.2	8.65	2995.3
0.549	99.4	9.16	2842.2
0.580	95.4	9.67	2712.7
0.610	89.8	10.17	2537.9
0.641	83.3	10.68	2340.8
0.671	76.5	11.19	2137.2
0.702	68.0	11.69	1889.2
0.707	66.8	11.78	1853.3



(see worksheet for sketch of failure)

Figure B-29

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-5
Sample # : S-9
Depth (ft) : 41
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

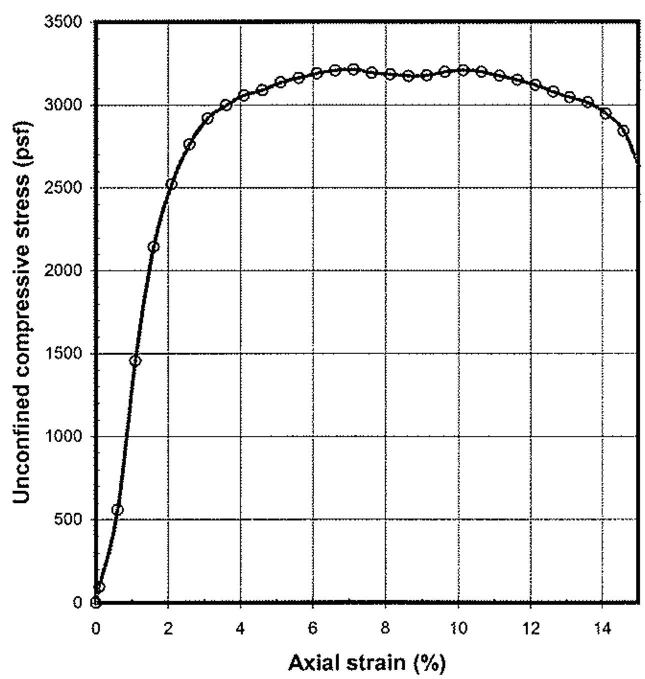
Specimen:

Total wt. =	847.2	gms
Ht. =	6.00	in
Ave dia. =	2.410	in
Area =	4.564	sq.in
Volume =	448.7	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.921	
Ht/Dia ratio =	2.49	
Moisture =	34.4	%
Total density =	117.8	pcf
Dry density =	87.7	pcf
Saturation =	100.7	%
Unconfined compressive strength =	3212	psf
Shear strength =	1606	psf
Strain @ failure =	7.13	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.0	0.09	94.7
0.036	17.8	0.60	558.8
0.066	46.7	1.10	1456.1
0.096	69.0	1.60	2142.9
0.126	81.6	2.10	2519.9
0.156	89.9	2.60	2761.4
0.187	95.5	3.11	2919.1
0.217	98.6	3.61	2998.0
0.247	101.1	4.11	3057.9
0.277	102.6	4.62	3089.3
0.307	104.7	5.12	3134.3
0.337	106.1	5.62	3161.2
0.367	107.6	6.12	3188.8
0.397	108.8	6.62	3205.9
0.428	109.6	7.13	3211.8
0.458	109.5	7.63	3191.9
0.488	109.8	8.13	3183.4
0.518	110.1	8.63	3174.1
0.548	110.8	9.13	3177.7
0.578	112.2	9.63	3198.5
0.608	113.1	10.13	3207.6
0.638	113.4	10.64	3198.4
0.668	113.2	11.14	3174.4
0.698	113.0	11.63	3149.9
0.728	112.5	12.14	3119.0
0.759	111.7	12.64	3078.6
0.785	111.0	13.09	3045.4
0.816	110.6	13.59	3014.4
0.845	108.7	14.09	2946.7
0.876	105.5	14.60	2842.8
0.901	98.0	15.02	2629.1



(see worksheet for sketch of failure)

Figure B-30

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

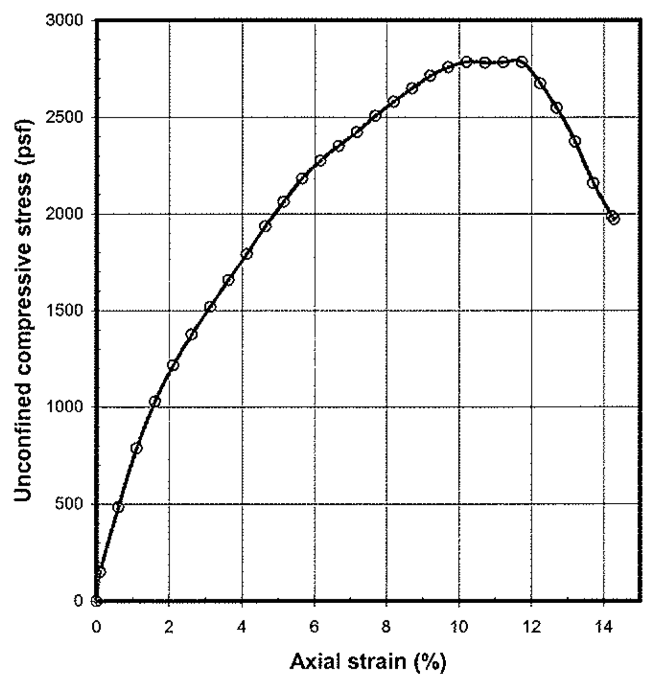
Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-5
Sample # : S-13
Depth (ft) : 61
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	862.5	gms
	Ht. =	5.93	in
	Ave dia. =	2.413	in
	Area =	4.576	sq.in
	Volume =	444.7	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:			
	Void ratio =	0.792	
	Ht/Dia ratio =	2.46	
	Moisture =	28.7	%
	Total density =	121.0	pcf
	Dry density =	94.0	pcf
	Saturation =	97.9	%
	Unconfined compressive strength =	2785	psf
	Shear strength =	1393	psf
	Strain @ failure =	11.74	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	4.8	0.10	150.7
0.036	15.5	0.60	483.8
0.066	25.3	1.11	787.5
0.096	33.2	1.61	1029.0
0.126	39.5	2.12	1215.2
0.156	44.9	2.63	1374.6
0.186	49.8	3.14	1517.9
0.215	54.6	3.63	1656.9
0.246	59.4	4.14	1790.6
0.276	64.5	4.65	1934.6
0.306	69.1	5.15	2061.6
0.336	73.5	5.66	2181.1
0.366	77.0	6.17	2274.9
0.396	80.1	6.68	2351.5
0.426	82.9	7.18	2421.9
0.456	86.3	7.69	2506.1
0.486	89.3	8.20	2580.0
0.516	92.2	8.70	2648.2
0.546	95.0	9.21	2712.9
0.576	97.1	9.71	2757.8
0.606	98.6	10.22	2784.3
0.636	99.0	10.72	2781.0
0.666	99.6	11.23	2783.4
0.696	100.3	11.74	2785.3
0.726	96.8	12.25	2674.0
0.753	92.7	12.70	2547.8
0.783	86.9	13.21	2374.2
0.813	79.5	13.72	2157.8
0.843	73.6	14.22	1987.1
0.848	73.1	14.29	1971.0



(see worksheet for sketch of failure)

Figure B-31

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-6
Sample # : S-10
Depth (ft) : 46
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay with sand

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

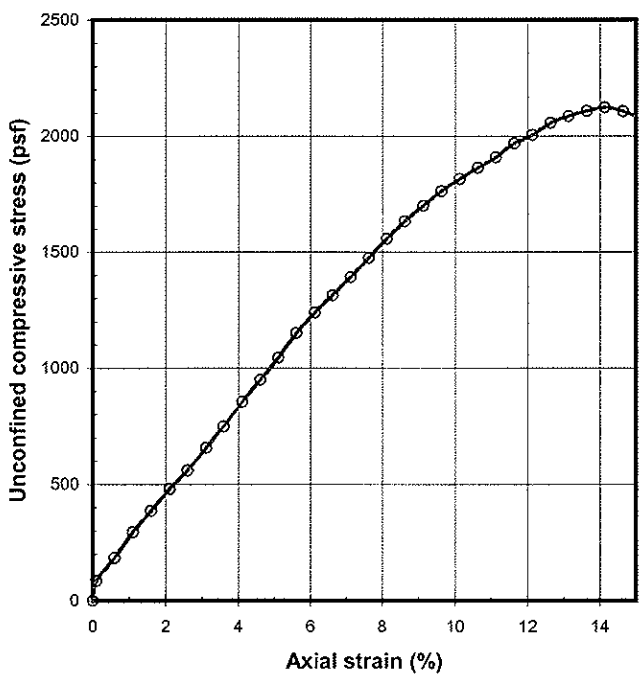
Specimen:

Total wt. =	930.8	gms
Ht. =	5.95	in
Ave dia. =	2.407	in
Area =	4.551	sq.in
Volume =	443.7	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.542	
Ht/Dia ratio =	2.47	
Moisture =	19.8	%
Total density =	130.9	pcf
Dry density =	109.2	pcf
Saturation =	98.7	%
Unconfined compressive strength =	2123	psf
Shear strength =	1062	psf
Strain @ failure =	14.14	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	2.7	0.10	85.3
0.036	5.9	0.60	184.2
0.066	9.4	1.11	294.2
0.095	12.4	1.60	385.4
0.125	15.5	2.11	478.7
0.155	18.1	2.61	558.7
0.185	21.4	3.11	655.2
0.215	24.5	3.61	747.8
0.245	28.1	4.11	852.8
0.275	31.4	4.62	948.0
0.304	34.7	5.11	1043.2
0.334	38.5	5.62	1149.6
0.364	41.7	6.12	1238.0
0.394	44.4	6.62	1312.9
0.424	47.4	7.13	1391.7
0.454	50.4	7.63	1474.4
0.484	53.6	8.13	1557.2
0.513	56.5	8.63	1632.9
0.543	59.1	9.13	1699.8
0.573	61.6	9.63	1762.5
0.603	63.8	10.13	1815.0
0.633	65.9	10.63	1863.0
0.662	67.9	11.13	1909.2
0.692	70.4	11.63	1968.8
0.722	72.1	12.14	2004.6
0.752	74.4	12.64	2056.7
0.782	75.9	13.14	2086.2
0.812	77.2	13.64	2108.4
0.841	78.2	14.14	2123.2
0.871	78.0	14.65	2107.1
0.894	77.5	15.02	2083.7



(see worksheet for sketch of failure)

Figure B-32

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-6
Sample # : S-12
Depth (ft) : 56
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay

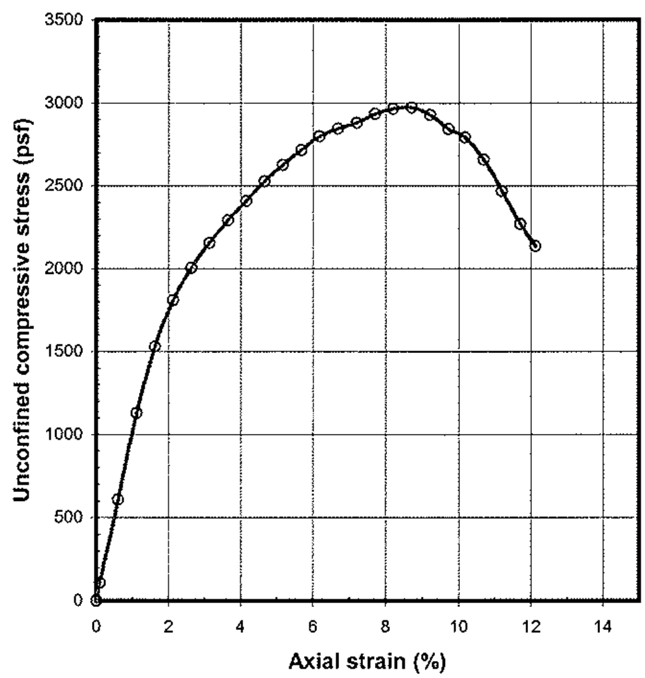
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	846.7	gms
	Ht. =	5.95	in
	Ave dia. =	2.413	in
	Area =	4.576	sq.in
	Volume =	446.2	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.898	
Ht/Dia ratio =	2.47	
Moisture =	33.4	%
Total density =	118.4	pcf
Dry density =	88.8	pcf
Saturation =	100.4	%
Unconfined compressive strength =	2972	psf
Shear strength =	1486	psf
Strain @ failure =	8.72	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.5	0.10	108.7
0.036	19.4	0.61	606.3
0.067	36.3	1.12	1129.2
0.097	49.4	1.62	1528.3
0.127	58.7	2.13	1809.2
0.157	65.4	2.64	2003.3
0.187	70.7	3.15	2154.9
0.217	75.6	3.65	2291.8
0.248	79.8	4.16	2407.6
0.278	84.3	4.67	2528.6
0.308	88.0	5.17	2625.6
0.338	91.5	5.68	2716.1
0.368	94.8	6.19	2798.8
0.398	96.9	6.70	2844.7
0.429	98.6	7.20	2878.9
0.459	101.0	7.71	2932.8
0.488	102.6	8.21	2964.7
0.519	103.5	8.72	2971.7
0.549	102.5	9.22	2928.5
0.579	100.1	9.73	2843.6
0.606	98.8	10.18	2792.2
0.636	94.6	10.69	2658.5
0.666	88.3	11.20	2468.3
0.697	81.7	11.71	2268.9
0.721	77.3	12.12	2136.4



(see worksheet for sketch of failure)

Figure B-33

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-6
Sample # : S-14
Depth (ft) : 66
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

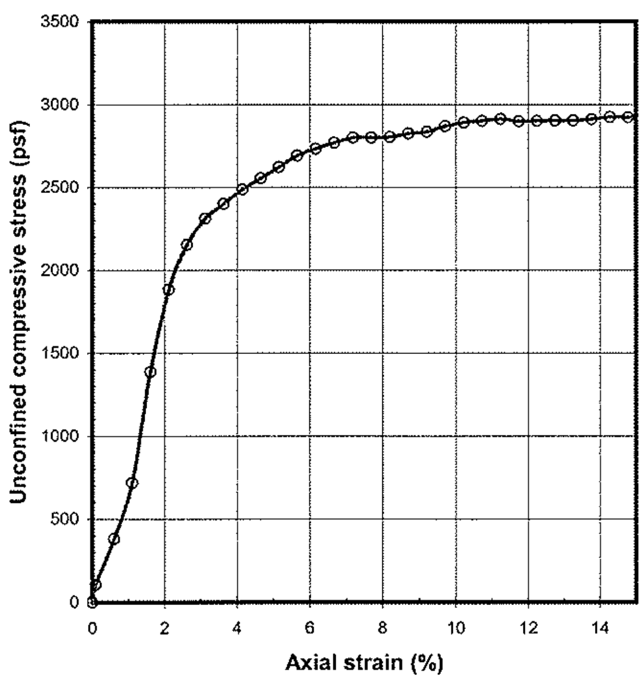
Specimen:

Total wt. =	854.9	gms
Ht. =	5.98	in
Ave dia. =	2.407	in
Area =	4.551	sq.in
Volume =	446.0	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.867	
Ht/Dia ratio =	2.48	
Moisture =	32.6	%
Total density =	119.6	pcf
Dry density =	90.2	pcf
Saturation =	101.4	%
Unconfined compressive strength =	2924	psf
Shear strength =	1462	psf
Strain @ failure =	15.02	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.4	0.09	108.2
0.036	12.1	0.60	379.9
0.066	22.9	1.11	716.1
0.096	44.5	1.61	1386.4
0.127	60.8	2.12	1882.1
0.157	69.9	2.63	2153.2
0.188	75.4	3.14	2312.4
0.218	78.7	3.64	2401.0
0.248	82.0	4.15	2487.0
0.279	84.7	4.66	2554.2
0.308	87.4	5.16	2623.1
0.339	90.2	5.66	2691.9
0.369	92.0	6.17	2732.2
0.399	93.8	6.68	2769.1
0.430	95.3	7.19	2799.6
0.460	95.9	7.69	2801.2
0.490	96.6	8.20	2804.9
0.521	97.8	8.71	2825.3
0.551	98.7	9.21	2835.3
0.581	100.5	9.72	2870.3
0.612	101.8	10.23	2891.9
0.642	102.7	10.73	2900.7
0.672	103.7	11.23	2913.0
0.702	103.8	11.74	2899.5
0.733	104.5	12.25	2900.4
0.763	105.2	12.76	2903.4
0.793	105.8	13.26	2903.6
0.823	106.7	13.77	2910.1
0.854	107.8	14.28	2923.8
0.884	108.4	14.79	2922.4
0.898	108.7	15.02	2923.8



(see worksheet for sketch of failure)

Figure B-34

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-6
Sample # : S-17
Depth (ft) : 81
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive brown clay

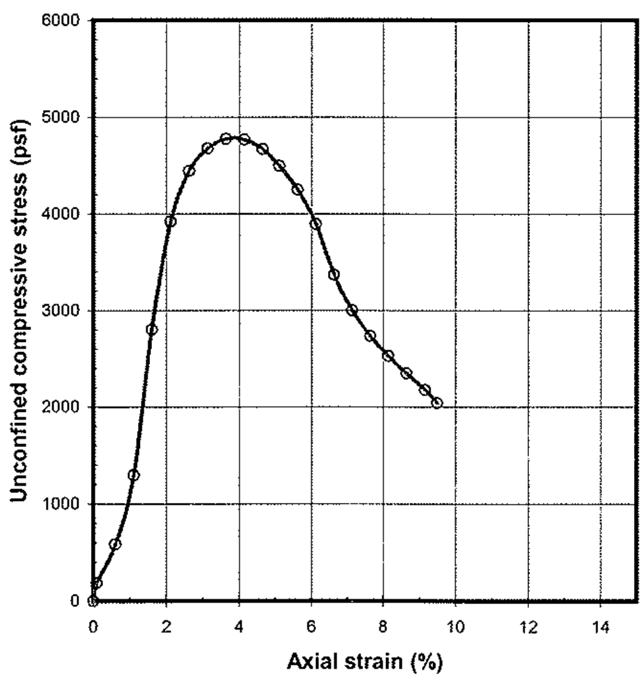
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt.	=	878.8	gms
Ht.	=	6.00	in
Ave dia.	=	2.413	in
Area	=	4.576	sq.in
Volume	=	449.9	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.790	
Ht/Dia ratio =	2.49	
Moisture =	29.5	%
Total density =	121.9	pcf
Dry density =	94.1	pcf
Saturation =	100.8	%
Unconfined compressive strength =	4775	psf
Shear strength =	2387	psf
Strain @ failure =	3.64	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	5.9	0.10	184.0
0.036	18.6	0.60	582.4
0.066	41.6	1.11	1293.8
0.097	90.5	1.61	2801.0
0.127	127.2	2.12	3918.3
0.158	145.0	2.63	4442.3
0.188	153.4	3.13	4675.0
0.218	157.5	3.64	4774.8
0.249	158.1	4.15	4767.5
0.279	155.6	4.65	4667.7
0.307	150.6	5.11	4495.8
0.337	143.0	5.61	4248.3
0.367	131.8	6.12	3893.4
0.398	114.5	6.63	3365.1
0.428	102.6	7.14	2997.5
0.459	94.0	7.64	2731.8
0.489	87.4	8.14	2526.3
0.519	81.7	8.65	2349.3
0.549	76.1	9.16	2176.2
0.570	71.7	9.50	2041.6



(see worksheet for sketch of failure)

Figure B-35

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-6
Sample # : S-19
Depth (ft) : 91
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay

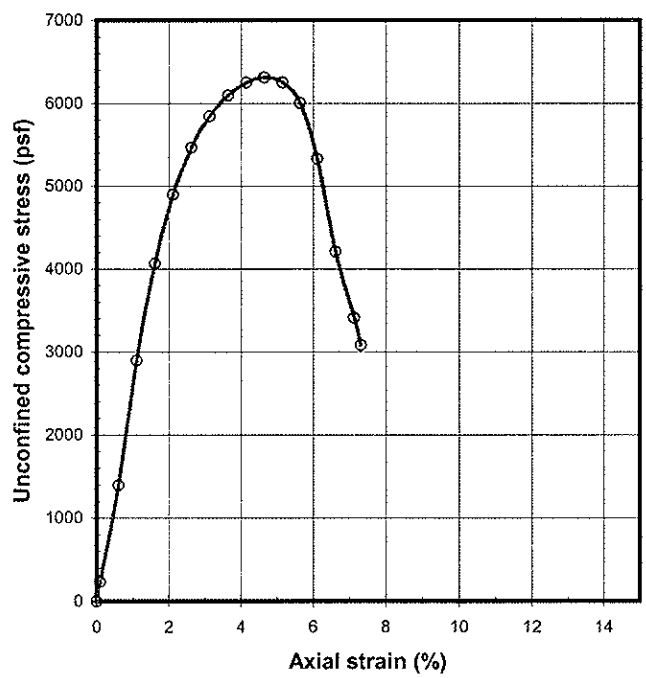
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt.	=	868.6	gms
Ht.	=	6.00	in
Ave dia.	=	2.427	in
Area	=	4.627	sq.in
Volume	=	454.9	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	0.846	
Ht/Dia ratio	=	2.47	
Moisture	=	30.6	%
Total density	=	119.1	pcf
Dry density	=	91.2	pcf
Saturation	=	97.5	%
Unconfined compressive strength	=	6312	psf
Shear strength	=	3156	psf
Strain @ failure	=	4.65	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	7.4	0.10	231.1
0.036	44.9	0.61	1389.7
0.067	94.1	1.11	2894.9
0.097	132.8	1.62	4066.8
0.127	160.7	2.12	4895.7
0.158	180.4	2.63	5465.4
0.188	193.9	3.14	5843.9
0.219	203.3	3.64	6096.8
0.249	209.5	4.15	6249.2
0.279	212.7	4.65	6312.0
0.309	211.7	5.16	6250.3
0.338	204.5	5.64	6004.3
0.367	182.4	6.12	5329.6
0.398	144.9	6.63	4209.9
0.428	117.9	7.13	3407.5
0.439	106.8	7.32	3080.3



(see worksheet for sketch of failure)

Figure B-36

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

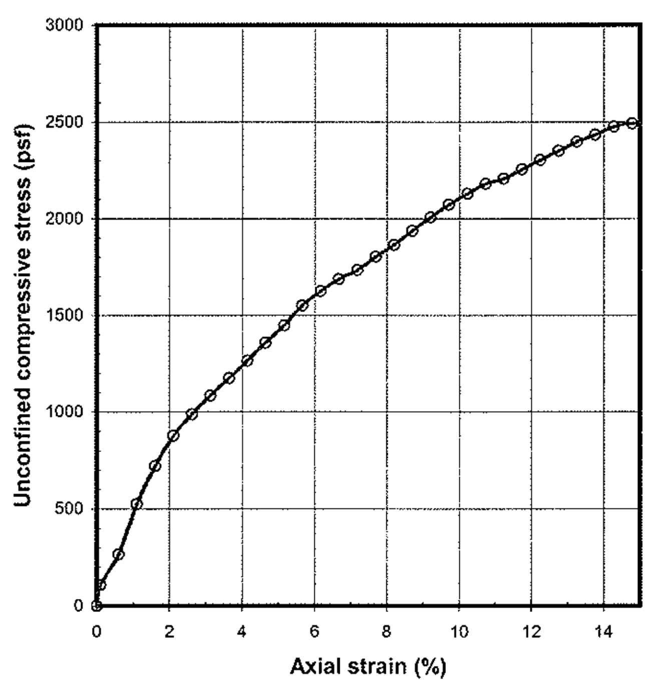
Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-21
Depth (ft) : 101
Date tested : 06/29/06
Soil (Visual Description) : Undisturbed olive gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
	Total wt. =	818.5	gms
	Ht. =	5.92	in
	Ave dia. =	2.410	in
	Area =	4.564	sq.in
	Volume =	442.7	c.c.
	Shearing rate =	0.06	inch/min
	Shearing rate =	1.00	%/min
	Gs (assumed) =	2.70	

Test Report:			
	Void ratio =	1.004	
	Ht/Dia ratio =	2.46	
	Moisture =	37.2	%
	Total density =	115.4	pcf
	Dry density =	84.1	pcf
	Saturation =	100.1	%
	Unconfined compressive strength =	2492	psf
	Shear strength =	1246	psf
	Strain @ failure =	14.79	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.4	0.10	107.8
0.035	8.5	0.60	265.2
0.065	16.8	1.11	522.8
0.095	23.2	1.61	720.7
0.126	28.4	2.12	876.8
0.156	32.1	2.63	986.6
0.186	35.4	3.14	1083.3
0.216	38.6	3.64	1174.9
0.246	41.8	4.15	1263.6
0.275	45.1	4.65	1356.2
0.306	48.3	5.17	1446.7
0.335	52.0	5.66	1548.5
0.365	54.8	6.17	1624.0
0.395	57.3	6.68	1686.5
0.425	59.2	7.19	1732.7
0.455	61.9	7.69	1802.3
0.485	64.3	8.20	1863.5
0.516	67.2	8.71	1937.1
0.546	70.0	9.21	2005.6
0.576	72.7	9.72	2071.6
0.606	75.1	10.23	2128.1
0.635	77.4	10.73	2179.3
0.665	78.8	11.23	2206.6
0.695	81.0	11.74	2254.8
0.725	83.2	12.25	2303.4
0.755	85.4	12.76	2351.0
0.785	87.6	13.26	2397.3
0.815	89.5	13.77	2434.0
0.845	91.5	14.28	2475.5
0.875	92.7	14.79	2491.6
0.889	92.8	15.02	2489.5



(see worksheet for sketch of failure)

Figure B-37

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-23
Depth (ft) : 111
Date tested : 06/29/06
Soil (Visual Description) : Undisturbed olive gray clay

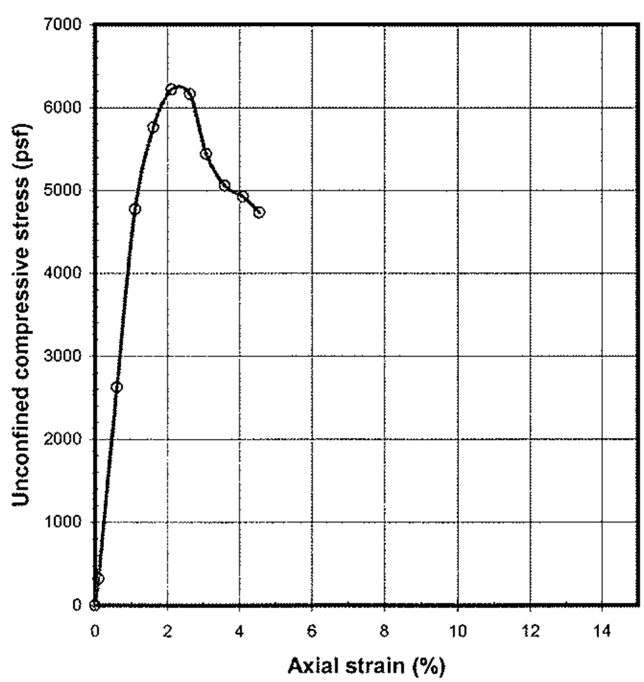
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen: Total wt. =	919.4	gms
Ht. =	6.00	in
Ave dia. =	2.400	in
Area =	4.526	sq.in
Volume =	445.0	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	10.1	0.09	322.6
0.036	83.0	0.60	2625.2
0.067	151.7	1.11	4772.2
0.097	184.1	1.61	5763.1
0.127	199.7	2.12	6219.4
0.158	199.0	2.63	6166.4
0.185	176.5	3.08	5443.2
0.215	164.9	3.59	5058.2
0.246	161.4	4.10	4925.8
0.273	155.9	4.55	4733.8

Test Report:

Void ratio =	0.607	
Ht/Dia ratio =	2.50	
Moisture =	23.0	%
Total density =	128.9	pcf
Dry density =	104.8	pcf
Saturation =	102.2	%
Unconfined compressive strength =	6219	psf
Shear strength =	3110	psf
Strain @ failure =	2.12	%



(see worksheet for sketch of failure)

Figure B-38

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-25
Depth (ft) : 126
Date tested : 06/29/06
Soil (Visual Description) : Undisturbed olive brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

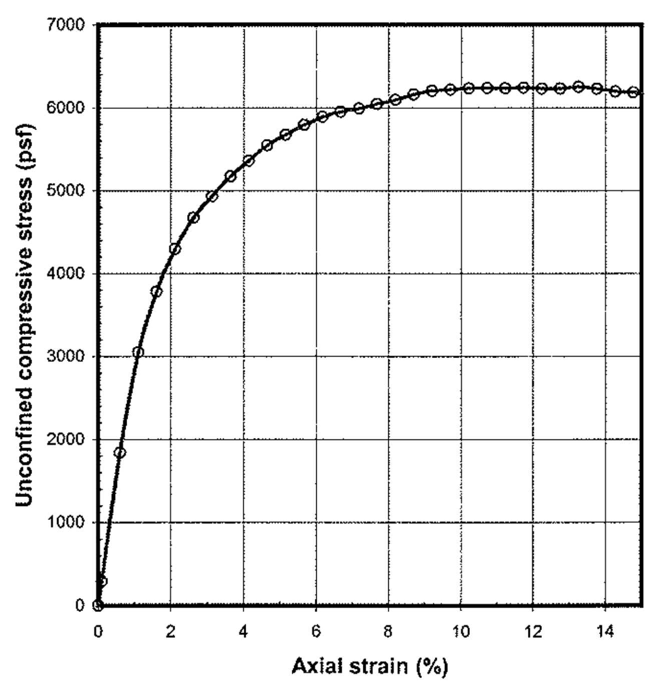
Specimen:

Total wt. =	889.1	gms
Ht. =	5.98	in
Ave dia. =	2.403	in
Area =	4.538	sq.in
Volume =	444.7	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.689	
Ht/Dia ratio =	2.49	
Moisture =	25.1	%
Total density =	124.8	pcf
Dry density =	99.8	pcf
Saturation =	98.2	%
Unconfined compressive strength =	6251	psf
Shear strength =	3125	psf
Strain @ failure =	13.26	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	9.2	0.10	290.4
0.036	58.3	0.60	1838.2
0.066	97.1	1.11	3046.3
0.097	121.1	1.61	3779.7
0.127	138.3	2.12	4295.6
0.157	151.3	2.63	4673.9
0.187	160.5	3.14	4932.5
0.218	169.1	3.64	5171.3
0.248	176.3	4.15	5360.5
0.278	183.4	4.65	5547.1
0.309	188.5	5.16	5672.7
0.339	193.6	5.67	5794.3
0.369	197.8	6.17	5889.3
0.400	201.0	6.68	5951.2
0.430	203.4	7.19	5991.1
0.460	206.3	7.69	6043.7
0.490	209.3	8.19	6097.2
0.520	212.7	8.70	6162.0
0.551	215.4	9.21	6204.9
0.581	217.2	9.72	6221.1
0.611	218.8	10.22	6233.2
0.642	220.3	10.73	6238.8
0.672	221.4	11.24	6235.5
0.702	223.0	11.75	6244.2
0.733	223.8	12.25	6231.3
0.763	225.1	12.76	6230.7
0.793	227.1	13.26	6250.8
0.824	227.6	13.77	6227.0
0.854	227.7	14.28	6194.5
0.884	228.6	14.78	6182.5
0.898	228.9	15.02	6171.4



(see worksheet for sketch of failure)

Figure B-39

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-7
Depth (ft) : 31
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay

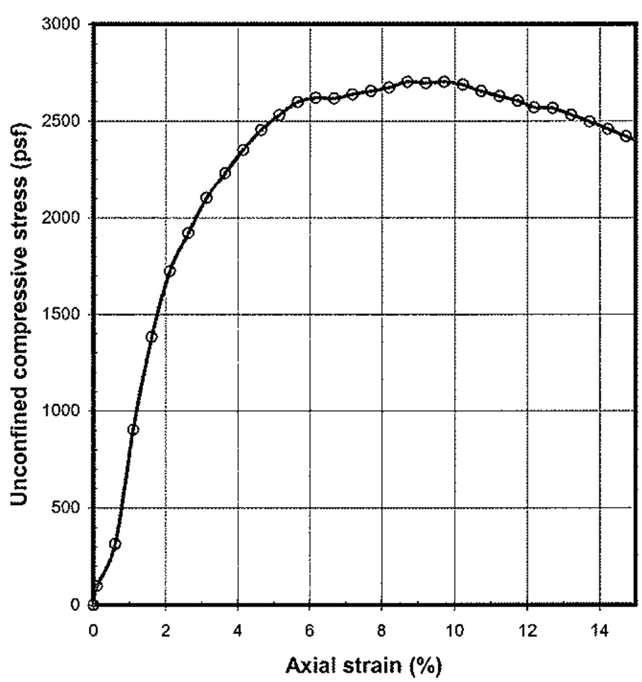
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt.	=	842.7	gms
Ht.	=	6.00	in
Ave dia.	=	2.420	in
Area	=	4.601	sq.in
Volume	=	452.4	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.943	
Ht/Dia ratio =	2.48	
Moisture =	34.0	%
Total density =	116.2	pcf
Dry density =	86.7	pcf
Saturation =	97.5	%
Unconfined compressive strength =	2703	psf
Shear strength =	1351	psf
Strain @ failure =	8.71	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.1	0.10	98.3
0.036	10.1	0.60	313.6
0.067	29.2	1.11	903.6
0.097	44.9	1.62	1381.3
0.127	56.2	2.12	1722.8
0.158	63.0	2.63	1920.7
0.188	69.4	3.14	2102.4
0.219	74.0	3.64	2230.0
0.249	78.4	4.15	2350.3
0.279	82.2	4.65	2453.9
0.309	85.3	5.16	2531.3
0.340	88.0	5.66	2598.0
0.370	89.2	6.17	2618.3
0.401	89.6	6.68	2615.3
0.431	90.8	7.19	2637.9
0.462	91.9	7.69	2654.1
0.492	93.0	8.20	2671.5
0.522	94.6	8.71	2702.6
0.553	94.9	9.22	2695.3
0.583	95.6	9.72	2702.0
0.614	95.7	10.23	2687.6
0.644	95.0	10.73	2653.0
0.674	94.6	11.23	2627.4
0.704	94.3	11.74	2603.6
0.732	93.5	12.20	2568.8
0.762	93.9	12.70	2565.9
0.793	93.2	13.21	2531.2
0.823	92.5	13.72	2497.2
0.854	91.6	14.23	2457.8
0.884	90.7	14.73	2420.5
0.901	90.0	15.02	2393.5



(see worksheet for sketch of failure)

Figure B-40

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-9
Depth (ft) : 41
Date tested : 06/30/06
Soil (Visual Description) : Undisturbed olive gray clay

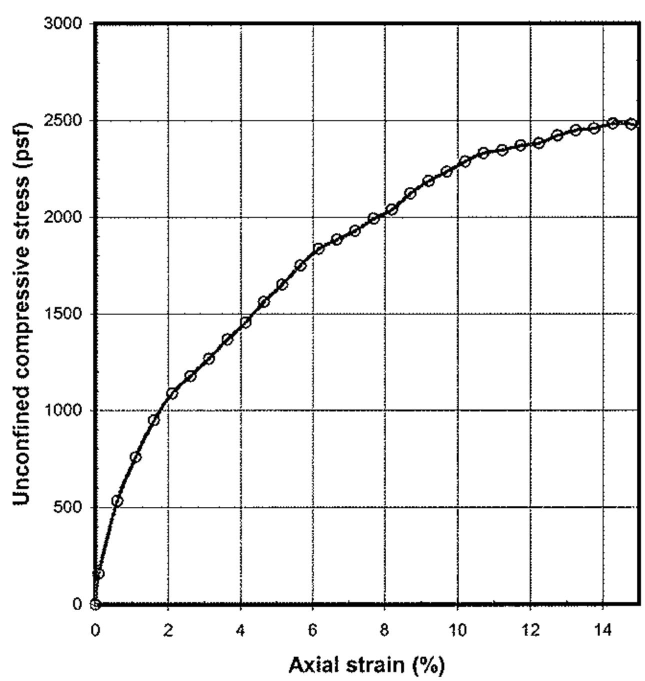
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt.	=	956.0	gms
Ht.	=	5.99	in
Ave dia.	=	2.417	in
Area	=	4.589	sq.in
Volume	=	450.4	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.506	
Ht/Dia ratio =	2.48	
Moisture =	18.4	%
Total density =	132.4	pcf
Dry density =	111.9	pcf
Saturation =	98.1	%
Unconfined compressive strength =	2484	psf
Shear strength =	1242	psf
Strain @ failure =	14.28	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	5.1	0.09	158.9
0.036	17.1	0.60	533.0
0.066	24.5	1.11	758.9
0.097	30.7	1.62	949.3
0.127	35.4	2.12	1088.2
0.157	38.5	2.63	1177.6
0.188	41.7	3.14	1268.0
0.218	45.2	3.64	1367.3
0.248	48.3	4.14	1454.2
0.278	52.2	4.65	1561.0
0.309	55.4	5.16	1649.4
0.339	59.1	5.66	1749.5
0.370	62.3	6.17	1834.8
0.400	64.3	6.68	1883.5
0.430	66.2	7.18	1928.9
0.461	68.7	7.69	1991.4
0.491	70.8	8.20	2039.7
0.522	74.1	8.71	2122.1
0.552	76.8	9.21	2187.0
0.582	78.9	9.71	2235.1
0.612	81.2	10.22	2287.2
0.642	83.2	10.73	2330.3
0.673	84.2	11.23	2345.4
0.703	85.6	11.74	2371.3
0.734	86.5	12.25	2382.1
0.764	88.4	12.76	2421.2
0.794	89.9	13.26	2447.8
0.825	90.8	13.77	2458.1
0.855	92.3	14.28	2484.0
0.886	92.7	14.78	2480.0
0.900	92.5	15.02	2465.8



(see worksheet for sketch of failure)

Figure B-41

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-12
Depth (ft) : 56
Date tested : 06/29/06
Soil (Visual Description) : Undisturbed gray clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

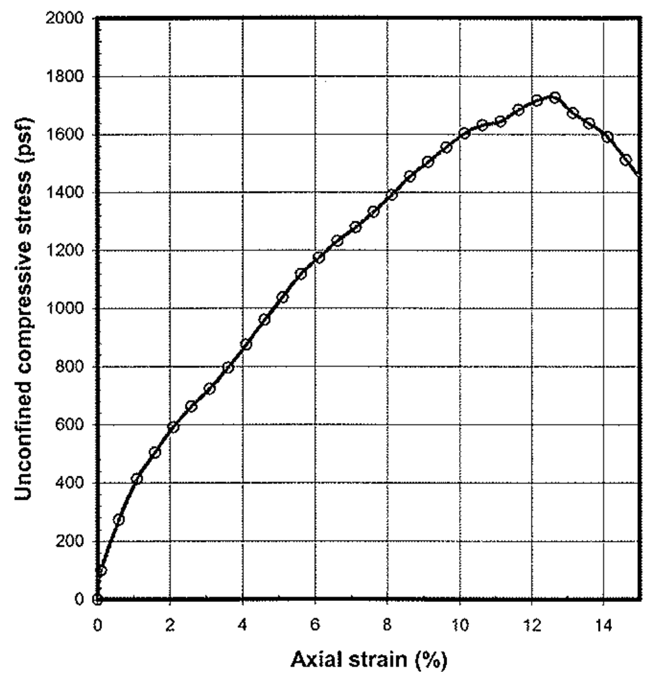
Specimen:

Total wt. =	842.9	gms
Ht. =	5.95	in
Ave dia. =	2.407	in
Area =	4.551	sq.in
Volume =	443.7	c.c.
Shearing rate =	0.06	inch/min
Shearing rate =	1.00	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.879	
Ht/Dia ratio =	2.47	
Moisture =	32.2	%
Total density =	118.5	pcf
Dry density =	89.7	pcf
Saturation =	98.9	%
Unconfined compressive strength =	1726	psf
Shear strength =	863	psf
Strain @ failure =	12.65	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.2	0.09	99.6
0.035	8.7	0.59	273.1
0.065	13.2	1.10	412.9
0.095	16.2	1.60	503.4
0.125	19.1	2.10	590.4
0.155	21.5	2.60	661.6
0.185	23.6	3.11	722.8
0.215	26.1	3.61	795.1
0.245	28.8	4.11	874.8
0.275	31.8	4.62	960.2
0.304	34.5	5.11	1036.9
0.334	37.4	5.62	1118.1
0.364	39.5	6.12	1173.6
0.394	41.7	6.62	1231.7
0.424	43.5	7.13	1278.9
0.454	45.6	7.63	1331.4
0.484	47.8	8.13	1390.6
0.514	50.3	8.63	1454.5
0.543	52.3	9.13	1503.8
0.574	54.4	9.64	1554.4
0.604	56.4	10.15	1603.2
0.633	57.7	10.64	1631.0
0.663	58.5	11.15	1644.1
0.693	60.2	11.65	1684.2
0.723	61.7	12.15	1716.1
0.753	62.4	12.65	1725.9
0.783	60.9	13.15	1673.5
0.810	59.9	13.61	1637.5
0.840	58.5	14.11	1591.1
0.870	55.9	14.62	1511.5
0.894	53.7	15.02	1444.8



(see worksheet for sketch of failure)

Figure B-42

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-14
Depth (ft) : 66
Date tested : 06/29/06
Soil (Visual Description) : Undisturbed gray clay

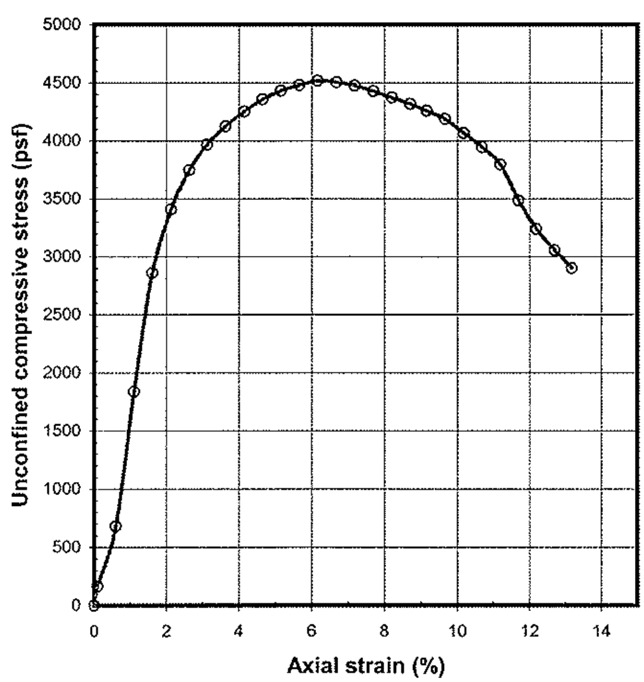
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt.	=	889.0	gms
Ht.	=	5.97	in
Ave dia.	=	2.420	in
Area	=	4.601	sq.in
Volume	=	450.2	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.729	
Ht/Dia ratio =	2.47	
Moisture =	26.5	%
Total density =	123.2	pcf
Dry density =	97.4	pcf
Saturation =	98.1	%
Unconfined compressive strength =	4516	psf
Shear strength =	2258	psf
Strain @ failure =	6.17	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	5.2	0.09	162.9
0.036	21.9	0.60	680.5
0.066	59.3	1.11	1836.3
0.097	92.9	1.62	2859.8
0.127	111.2	2.13	3406.3
0.157	123.0	2.63	3747.6
0.187	130.9	3.13	3968.4
0.217	136.8	3.64	4124.9
0.248	141.7	4.15	4250.4
0.278	146.0	4.65	4355.7
0.308	149.3	5.16	4431.6
0.338	151.7	5.66	4478.2
0.369	153.8	6.17	4516.4
0.399	154.2	6.68	4504.1
0.429	154.1	7.19	4475.6
0.459	153.3	7.69	4428.4
0.490	152.2	8.20	4372.5
0.520	151.1	8.71	4317.0
0.547	149.9	9.16	4261.3
0.577	148.2	9.67	4189.3
0.608	144.7	10.18	4066.3
0.638	141.1	10.68	3945.1
0.668	136.5	11.19	3795.1
0.698	126.1	11.70	3483.5
0.728	117.8	12.20	3237.9
0.758	111.9	12.70	3055.9
0.787	106.8	13.18	2900.5



(see worksheet for sketch of failure)

Figure B-43

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Chevron Hydrogen Replacement
Job No. : 28067039.61000
Boring # : HR-7
Sample # : S-17
Depth (ft) : 81
Date tested : 06/29/06
Soil (Visual Description) : Undisturbed olive gray sandy clay with shells

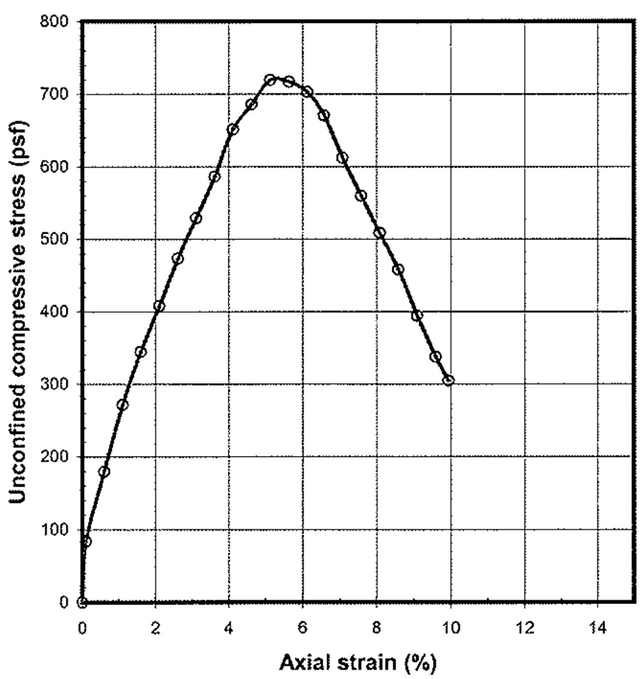
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	876.1	gms
Ht. =	5.97	in
Ave dia. =	2.413	in
Area =	4.576	sq.in
Volume =	447.7	c.c.
Shearing rate =	0.08	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.723	
Ht/Dia ratio =	2.47	
Moisture =	24.9	%
Total density =	122.1	pcf
Dry density =	97.8	pcf
Saturation =	93.0	%
Unconfined compressive strength =	719	psf
Shear strength =	360	psf
Strain @ failure =	5.12	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	2.6	0.10	83.3
0.036	5.7	0.60	179.5
0.066	8.7	1.11	271.4
0.096	11.1	1.61	344.0
0.126	13.2	2.11	407.9
0.156	15.4	2.61	473.2
0.186	17.3	3.11	528.8
0.216	19.3	3.62	586.1
0.246	21.6	4.12	651.2
0.276	22.8	4.62	685.7
0.306	24.1	5.12	719.2
0.336	24.1	5.63	717.0
0.366	23.8	6.13	703.0
0.393	22.8	6.58	670.4
0.423	20.9	7.08	612.3
0.453	19.2	7.59	559.5
0.483	17.6	8.09	508.7
0.513	15.9	8.59	457.4
0.543	13.8	9.09	394.1
0.573	11.9	9.59	337.6
0.594	10.7	9.94	304.4



(see worksheet for sketch of failure)

Figure B-44

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client :	URS
Project :	Chevron Hydrogen Replacement
Job No. :	28067039.61000
Boring # :	HR-7
Sample # :	S-19
Depth (ft) :	91
Date tested :	06/29/06
Soil (Visual Description) :	Undisturbed light grayish brown clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

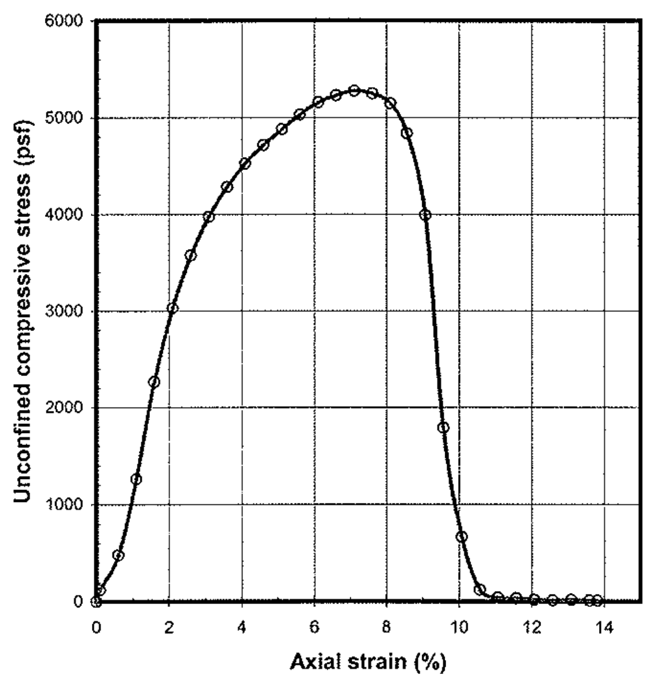
Specimen:

Total wt.	=	839.3	gms
Ht.	=	6.00	in
Ave dia.	=	2.407	in
Area	=	4.551	sq.in
Volume	=	447.5	c.c.
Shearing rate	=	0.06	inch/min
Shearing rate	=	1.00	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio =	0.954	
Ht/Dia ratio =	2.49	
Moisture =	35.7	%
Total density =	117.0	pcf
Dry density =	86.2	pcf
Saturation =	101.1	%
Unconfined compressive strength =	5276	psf
Shear strength =	2638	psf
Strain @ failure =	7.11	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.006	3.8	0.10	118.7
0.036	15.2	0.60	478.3
0.066	40.2	1.10	1257.8
0.096	72.7	1.60	2262.3
0.126	97.7	2.11	3026.0
0.156	115.9	2.60	3570.9
0.186	129.6	3.10	3973.7
0.216	140.3	3.61	4279.9
0.246	149.1	4.10	4523.7
0.276	156.2	4.61	4714.9
0.307	162.5	5.11	4877.7
0.337	168.3	5.61	5027.8
0.367	173.5	6.11	5154.6
0.397	176.9	6.61	5228.0
0.427	179.5	7.11	5275.5
0.457	179.5	7.61	5246.7
0.487	176.9	8.12	5144.1
0.514	167.2	8.57	4836.6
0.545	138.6	9.08	3987.6
0.574	62.6	9.57	1790.2
0.605	23.3	10.08	663.7
0.635	4.3	10.58	120.5
0.665	1.4	11.08	40.3
0.695	1.2	11.59	32.3
0.725	0.6	12.08	15.9
0.755	0.4	12.59	11.1
0.786	0.6	13.09	16.1
0.815	0.4	13.59	11.1
0.829	0.4	13.81	10.1

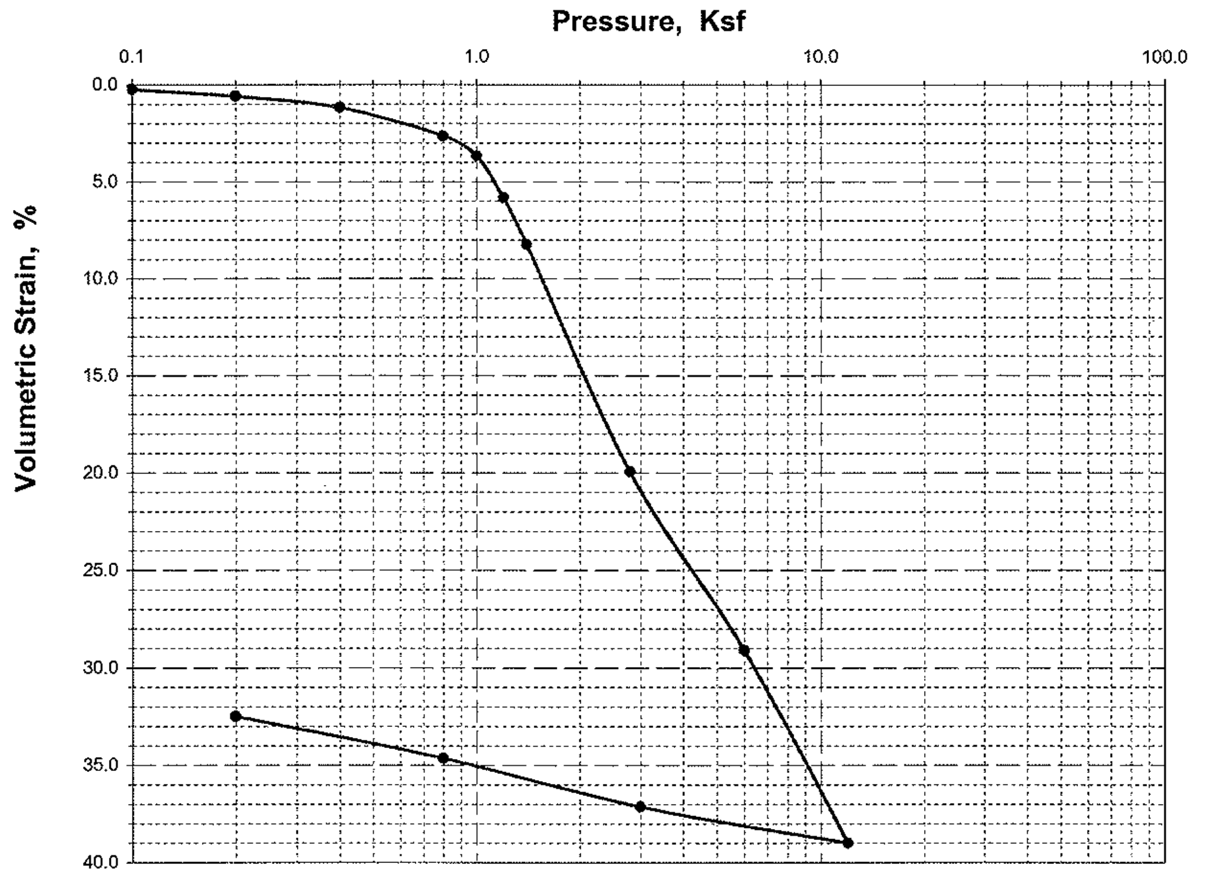


(see worksheet for sketch of failure)

Figure B-45

CONSOLIDATION TEST

Boring Number	HR-1		Sample Number	S-4	Depth (ft)	15-15.5		
Soil Description	Olive gray silt							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	109.4	89.2	2.956	99.9	1.00	2.420	(assumed) 2.70		
Final	63.9	103.5	1.670	103.4	0.675				



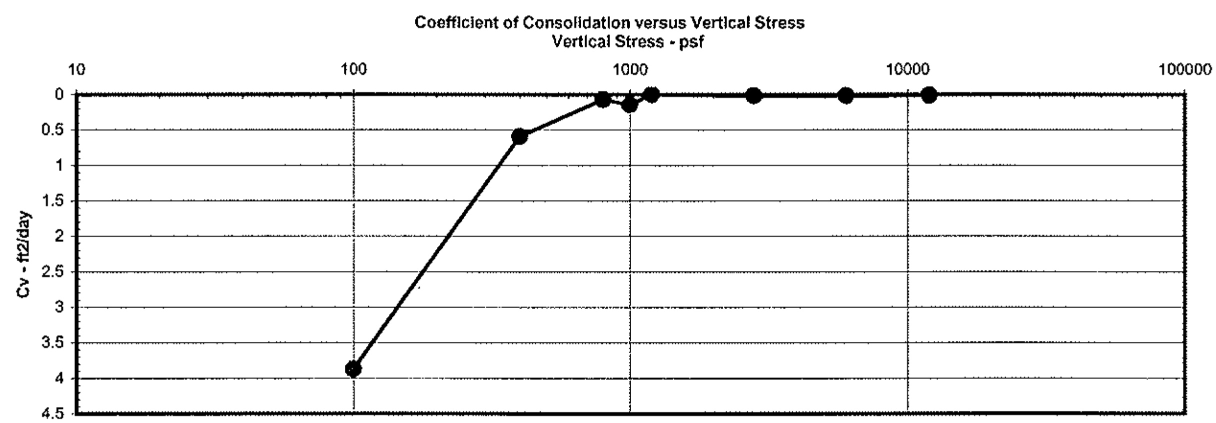


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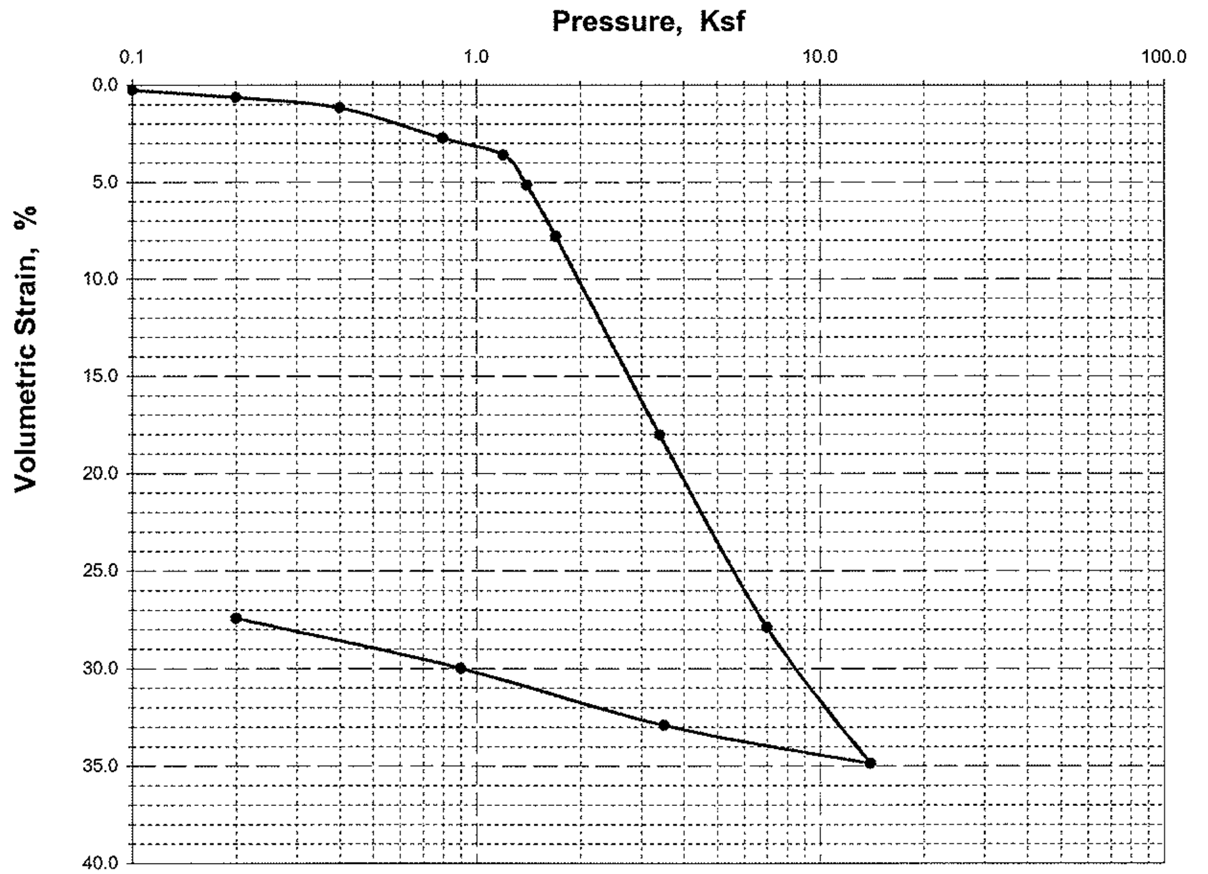
Figure B-46

CONSOLIDATION TEST

Boring Number	HR-3	Sample Number	S-5	Depth (ft)	20-21.5			
Soil Description	Olive gray silt							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	93.2	92.3	2.530	99.4	1.00		(assumed)		
Final	60.5	105.6	1.562	104.6	0.726	2.420	2.70		



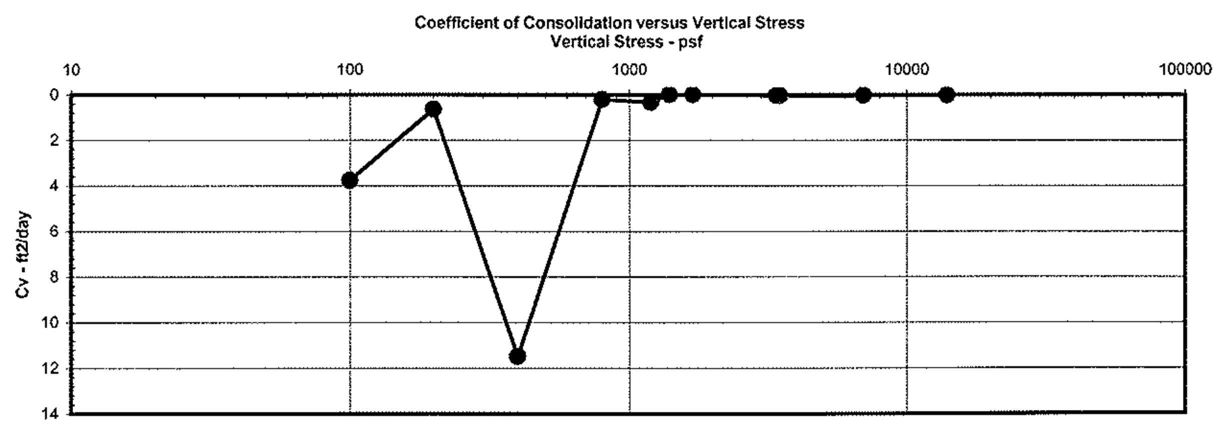


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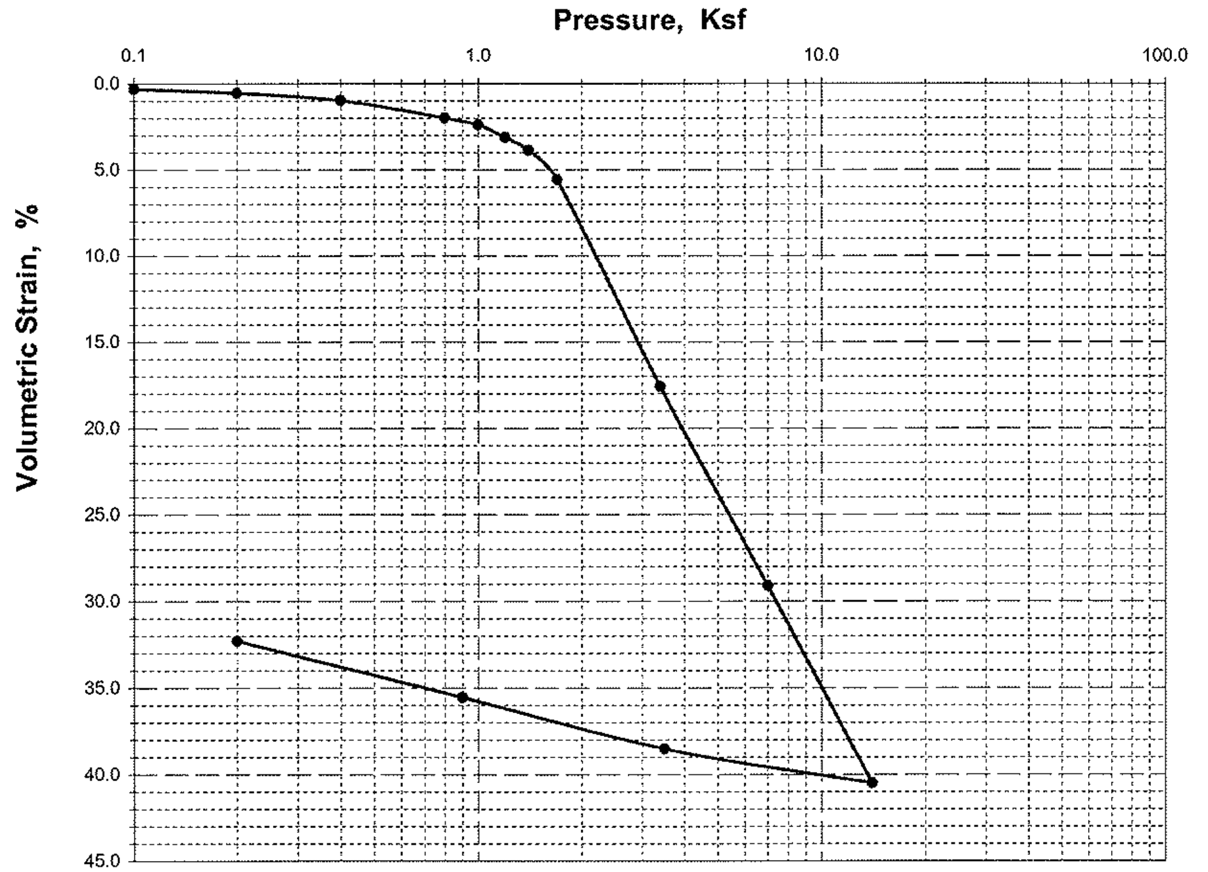
Figure B-47

CONSOLIDATION TEST

Boring Number	HR-5	Sample Number	S-5	Depth (ft)	20-21.5			
Soil Description	Olive gray silt with organics							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	143.7	81.3	4.056	95.7	1.00		(assumed)		
Final	90.0	93.6	2.423	100.3	0.677	2.420	2.70		



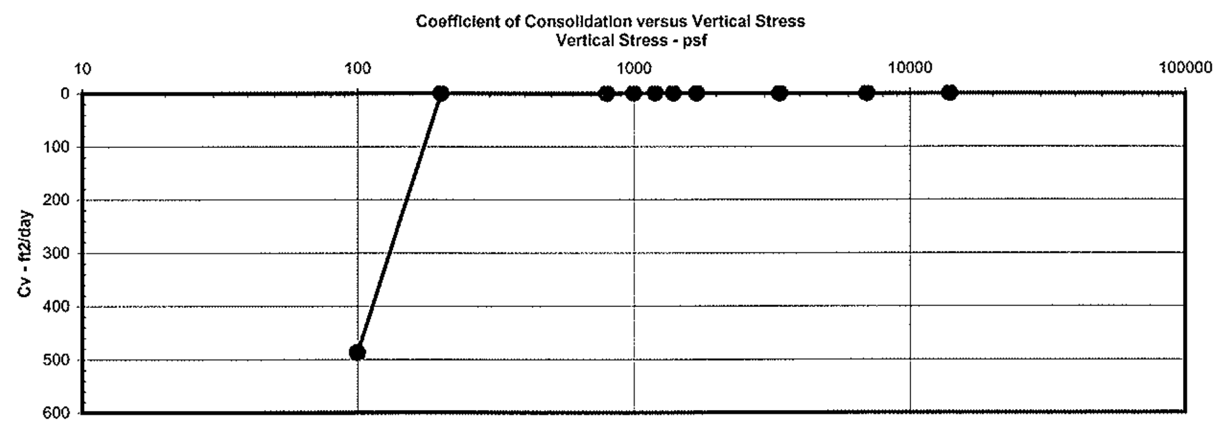


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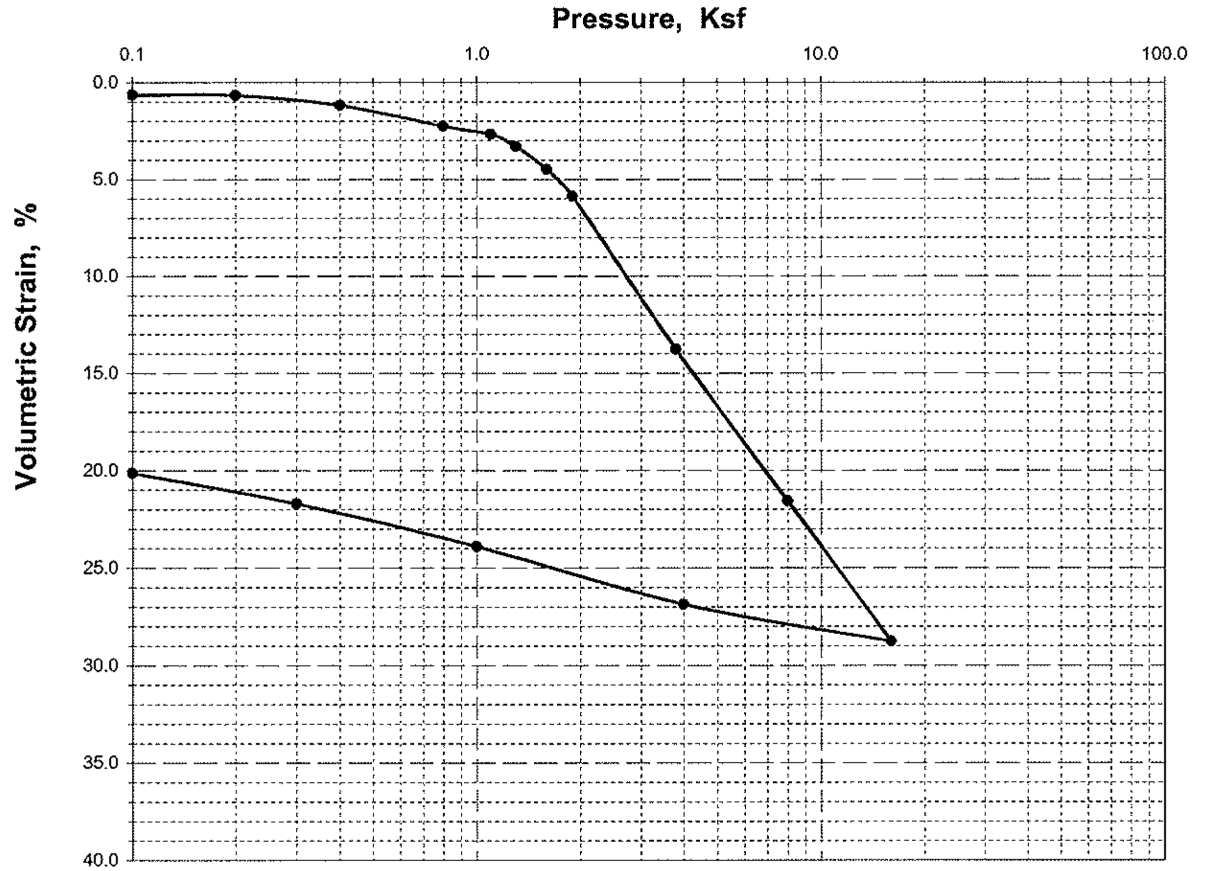
Figure B-48

CONSOLIDATION TEST

Boring Number	HR-6	Sample Number	S-7	Depth (ft)	30-31.5			
Soil Description	Olive gray silt							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	72.2	98.3	1.953	99.8	1.00		(assumed)		
Final	53.7	109.9	1.358	106.8	0.799	2.420	2.70		



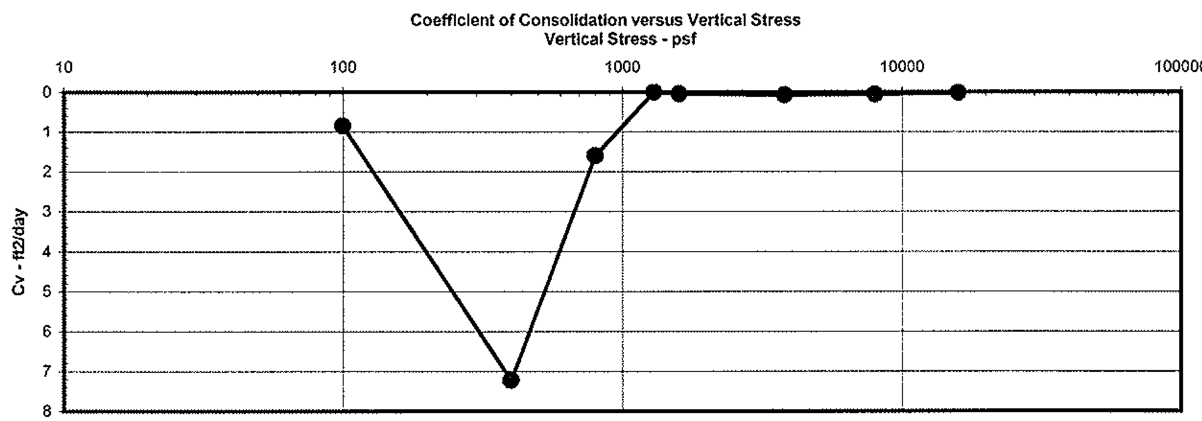


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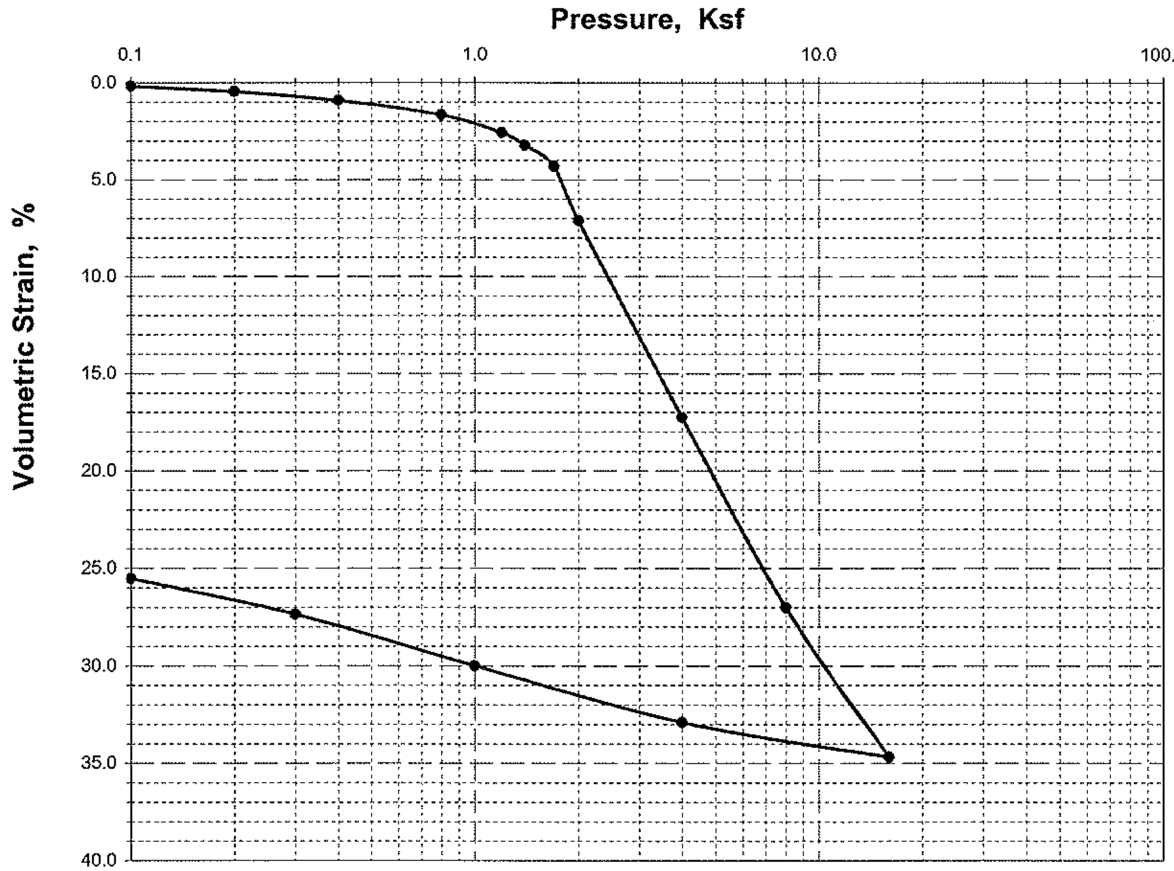
Figure B-49

CONSOLIDATION TEST

Boring Number	HR-7	Sample Number	S-6	Depth (ft)	25-26.5			
Soil Description	Gray silt							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	86.1	94.0	2.339	99.5	1.00		(assumed)		
Final	57.5	106.8	1.487	104.5	0.745	2.420	2.70		



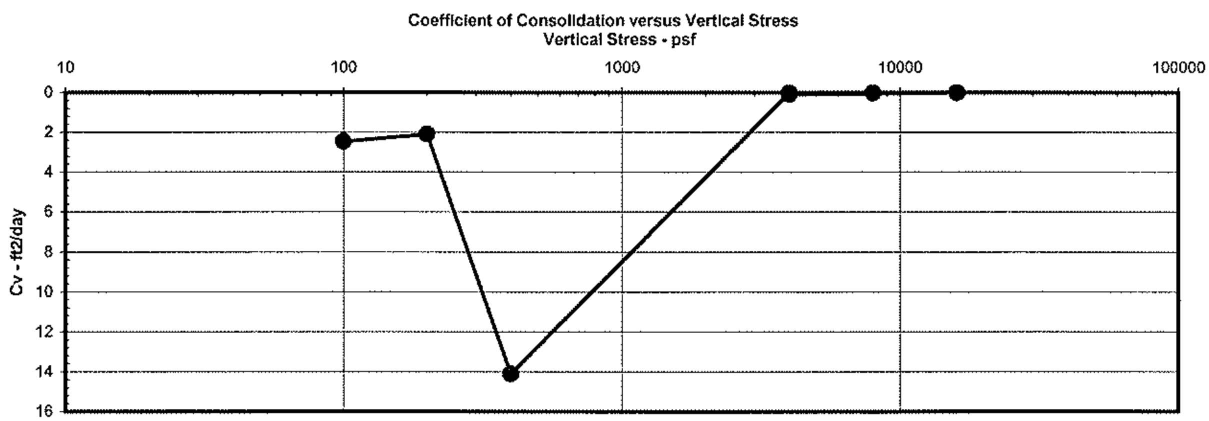


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Figure B-50

Technical Area: Hazardous Materials Management, Worker Safety, and Fire Protection
Author: Dr. Alvin Greenberg

BACKGROUND

Table 8.11-1 of the application does not list the entire hazardous materials inventory. The Table includes only anhydrous ammonia and oils, and states that small amounts of various water treatment chemicals would be stored in portable containers. Sections 8.11.5.2.1, 8.11.5.2.2, and 8.11.5.2.3 indicate that sulfuric acid (in a tank) and hydrogen gas (in cylinders) will also be stored at the project as well as water treatment chemicals in a storage tank. Amounts, concentrations, and storage locations are not provided. Staff needs this information in order to assess proper management of hazardous materials and potential risks to workers and the off-site public.

DATA REQUEST

36. Please provide a table listing the identity and CAS (Chemical Abstract Service) number of every hazardous material that will be used at the power plant project, the concentration of each liquid hazardous material, the maximum amount to be stored on-site, the location, the planned use, a summary of the hazardous characteristics, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/ Superfund Amendments and Reauthorization Act (SARA) Reportable Quantity.

    Response: Storage locations are described in Table HM-36A. Table HM-36B presents information about these materials, including trade names; chemical names; Chemical Abstract Service (CAS) numbers; maximum quantities onsite; and reportable quantities (RQs). Health hazards and flammability data are summarized in Table HM-36C. Table HM-36C also contains information on incompatible chemicals (e.g., ammonia).

Chevron Richmond Power Plant Replacement Project
07-SPPE-1
DATA REQUEST RESPONSE SET 1A

TABLE HM-36A
Use and Location of Hazardous Materials

Chemical	Use	Quantity (gallons/lbs)	Storage Location	State	Type of Storage
Anhydrous Ammonia	Control oxides of nitrogen (NO_x) emissions through selective catalytic reduction	250 lbs	Existing Storage vessels in another part of the refinery that is not part of the PPRP. There will be no storage of ammonia in either PPRP location	Stored and pumped as a liquid. Injected as a Gas	Continuously Onsite
Chevron GST Oil 68	Equipment lubrication	100 gal	Cogen Facility Lube Oil Storage Area	Liquid	Continuously Onsite
Chevron GST Oil 46	Equipment lubrication	275 gal	Cogen Facility Lube Oil Storage Area	Liquid	Continuously Onsite
Chevron EP Industrial Oil 150X	Equipment lubrication	110 gal	Cogen Facility Lube Oil Storage Area	Liquid	Continuously Onsite
Chevron GST Oil 32	Equipment lubrication	1100 gal	Cogen Facility Lube Oil Storage Area	Liquid	Continuously Onsite
BT-3881 (NALCO)	Water treatment chemical	1200 gal	Existing above ground storage tank in existing Cogen facility	Liquid	Continuously Onsite
Elim-Ox Oxygen Scavenger (NALCO)	Water treatment chemical	2400 gal	Tote bins located in Cogen Facility Chemical Storage area	Liquid	Continuously Onsite
Environmental Catalyst	CO catalyst Unit	15000 lbs	Inside HRSG	Solid	Continuously Onsite
Continuum AEC3156 (GE)	Cooling tower inhibitor & dispersant	1200 gal	H2 cooling tower chemical feed area and water treatment building	Liquid	Continuously Onsite
Sodium hypochlorite (bleach)	Cooling tower biocide treatment	2000 gal	H2 cooling tower chemical feed area and water treatment building	Liquid	Continuously Onsite
Sulfuric acid	Cooling tower water pH control	150 gal	H2 cooling tower chemical feed area and water treatment building	Liquid	Continuously Onsite
Plus-Fifty C Dry Chemical (Ansul)	Fire suppression	1000 lb	In cylinders at equipment	Solid (powder)	Continuously Onsite
SCR System Catalyst	SCR Unit	150000 lbs	Contained within the HRSG	Solid	Continuously Onsite
Sulfur hexafluoride	Switchyard/ switchgear devices	500 lbs	Contained within equipment	Gas	Continuously Onsite

TABLE HM-36A
Use and Location of Hazardous Materials

Chemical	Use	Quantity (gallons/lbs)	Storage Location	State	Type of Storage
TRI-ACT 1803 (NALCO)	Water treatment chemical	2400 gal	Cogen Facility Chemical Storage area	Liquid	Continuously Onsite

TABLE HM-36B
Chevron PPRP Chemical Inventory

Trade Name	Chemical Name	CAS Number	Maximum Quantity Onsite	CERCLA SARA RQ[a]	RQ of Material as Used Onsite[b]
Anhydrous ammonia	Anhydrous ammonia	7664-41-7 (NH3)	2,190 lbs	100 lb	100 lb
Chevron GST Oil 68 (CHEVRON)	Mixture	N/A	100 gal	c	c
Chevron GST Oil 46 (CHEVRON)	Mixture	N/A	275 gal	c	c
Chevron EP Industrial Oil 150X (CHEVRON)	Mixture	N/A	110 gal	c	c
Chevron GST Oil 32 (CHEVRON)	Mixture	N/A	1100 gal	c	c
BT-3811 (NALCO)	Sodium Hydroxide 1-5%	1310-73-2	1200 gal	1,000 lb	100,000 lb
Elimin-Ox Oxygen Scavenger (NALCO)	Carbohydrazide	497-18-7	2400 gal	c	c
Continuum AEC3156 (GE)	Alkyl Epoxy Carboxylate	N/A	1000 gal	c	c
Sodium hypochlorite	Sodium hypochlorite	7681-52-9	2000 gal	100 lb	100 lb
Sulfuric Acid	Sulfuric acid	7664-93-9	150 gal	1,000 lb	1,000 lb
Permaclean PC-11 (NALCO)	Polyethylene Glycol	25322-68-3	400 gal	c	c
Plus-Fifty C Dry Chemical (Ansul)	Mixture	N/A	1000 lb	c	c
Sulfur hexafluoride	Sulfur hexafluoride	2551-62-4	500 lbs	c	c
TRI-ACT 1803 (NALCO)	Monoethylamine 10-30%	75-04-7	2400 gal	100 lb	333 lb

[a] Reportable quantity for a pure chemical, per the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [Ref. 40 CFR 302, Table 302.4]. Release equal to or greater than RQ must be reported. Under California law, any amount that has a realistic potential to adversely affect the environment or human health or safety must be reported.

[b] Reportable quantity for materials as used onsite. Since some of the hazardous materials are mixtures that contain only a percentage of a reportable chemical, the reportable quantity of the mixture can be different than for a pure chemical. For example, if a material only contains 10% of a reportable chemical and the RQ is 100 lb., the reportable quantity for that material would be (100 lb.)/(10%) = 1,000 lb.

[c] No reporting requirement. Chemical has no listed threshold under this requirement

[d] State reportable quantity for oil spills that will reach California state waters [Ref. CA Water Code Section 13272(f)]

TABLE HM-36C
Toxicity of Hazardous Materials

Hazardous Materials	Physical Description	Health Hazard	Reactive & Incompatibles	Flammability*
Aqueous ammonia	Colorless liquid with pungent odor	*Corrosive: Irritation to permanent damage* from inhalation, ingestion, and skin contact.	Acids, halogens (e.g., chlorine), strong oxidizers, salts of silver and zinc.	Liquid is incombustible; Vapor is combustible, but difficult to burn
Chevron GST Oil 68	Yellow liquid with a petroleum odor	No immediate or delayed health effects	Strong acids or strong oxidizing agents such as chlorates, nitrates, peroxides, etc.	Not classified by OSHA as flammable or combustible
Chevron GST Oil 46	Yellow liquid with a petroleum odor	No immediate or delayed health effects	Strong acids or strong oxidizing agents such as chlorates, nitrates, peroxides, etc.	Not classified by OSHA as flammable or combustible
Chevron EP Industrial Oil 150X	Dark brown liquid	No significant hazard	May react with strong oxidizing materials	No upper or lower flammability limits
Chevron GST Oil 32	Yellow liquid with a petroleum odor	No immediate or delayed health effects	Strong acids or strong oxidizing agents such as chlorates, nitrates, peroxides, etc.	Not classified by OSHA as flammable or combustible
BT-3811 (NALCO)	Clear, light yellow liquid	Corrosive: May cause tissue damage.	Strong acids.	Non flammable
Elim-Ox Oxygen Scavenger (NALCO)	Colorless Liquid	May cause sensitization by skin contact. Do not get in eyes.	Strong oxidizers, Strong Acids, Nitrates	Not flammable
Sodium hypochlorite	Pale green; sweet, disagreeable odor	Corrosive and Toxic: Toxic by ingestion. Strong irritant to tissue.	Ammonia and organic materials.	Fire risk when in contact with organic materials
Sulfuric acid	Colorless, dense, oily liquid.	*Strongly Corrosive*: Strong irritant to all tissue. Minor burns to permanent damage to tissue.	Organic materials, chlorates, carbides, fulminates, metals in powdered form. Reacts violently with water.	Non-flammable
Plus-Fifty C Dry Chemical (Ansul)	Blue, odorless powder	Not classified as dangerous	Strong acids, NaK ally, $NH_4H_2PO_4$	Not flammable
Sulfur hexafluoride	Colorless gas with no odor.	Hazardous if inhaled.	Disilane.	Non-flammable
TRI-ACT 1803	Amber liquid, amine	Corrosive: will burn eyes and skin. Exposure to low vapor concentrations can	Strong acids, strong oxidizers, SO_2, or	Moderately flammable

TABLE HM-36C
Toxicity of Hazardous Materials

Hazardous Materials	Physical Description	Health Hazard	Reactive & Incompatibles	Flammability*
(NALCO)	odor	result in foggy of blurred vision, objects appearing in blush and appearance of a halo around lights.	acidic bisulfite products.	

Data were obtained from Material Safety Data Sheets (MSDSs) and Lewis (1991).

* Per Department of Transportation regulations, under 49 CFR 173: 'Flammable' liquids have a flash point less than or equal to 141°F; 'Combustible' liquids have a flash point greater than 141° F.

BACKGROUND

The applicant states that anhydrous ammonia will be delivered to the project through 300 feet of 2" piping from the refinery's existing storage, and that the piping will contain about 250 lbs. No further information was provided regarding pipe materials, valves, emergency shutoff mechanisms, or ammonia detectors. Furthermore, an Off-site Consequence Analysis (OCA) was not conducted by the applicant because the applicant felt that this project adds only slightly to the use of anhydrous ammonia at the refinery. Staff must have complete information about the use of this acutely hazardous material regardless of the amount the project will use.

DATA REQUEST

37. Please provide descriptions of:

a. the anhydrous ammonia storage tank;

Response: There is no dedicated anhydrous ammonia storage tank associated with PPRP, and there will be no change in the production or storage of anhydrous ammonia as a result of the PPRP. The anhydrous ammonia for the refinery is stored in three existing storage bullets (horizontal, cylindrical vessels), which are located a considerable distance from either of the facilities that make-up the PPRP. Each of the three storage vessels has a capacity of approximately 2386 barrels.

The refinery continuously produces approximately 60 TPD of anhydrous ammonia in the hydroprocessing and hydrotreating reactors and continuously consumes 13.7 TPD of this ammonia in other parts of the refinery. The excess ammonia is routed to the ammonia storage vessels where it is tested and loaded into rail cars for shipment off-site to user locations.

b. the type of pipe materials that will be used to transport anhydrous ammonia from the storage tank to the power project;

Response: The ammonia is transported in Grade A-106, seamless, standard weight carbon steel piping.

c. the number and type of control valves and emergency shut-off valves and whether they are manually and/or automatically activated;

Response: A 2-inch manually operated emergency shutoff globe valve is located at the battery limit station of Cogen 3000 to provide for isolation in the event of a leak downstream and to provide for maintenance isolation of the line. In addition, a 1-inch level control valve is provided at the vaporizer to control ammonia level in the vaporizer.

d. the number and location of ammonia sensors at the storage tank;

Response: There is no dedicated storage tank for PPRP. However there will be 5 ammonia detectors located in the vicinity of the ammonia vaporizer and ammonia injection piping.

e. the pipe route;

Response: Cogen 3000 will be the only PPRP source using ammonia. The pipe routing to Cogen 3000 is from a tie-in to the existing ammonia supply header in the main cogeneration facility north-south piperack. The new pipe will run east from the tie-in point along the new Cogen 3000 pipe rack for approximately 200 feet and down to the ammonia vaporizer adjacent to the Cogen 3000 HRSG. The vaporized ammonia is then fed via a pipe network into the ammonia injection grids inside of the HRSG. The overall length of pipe is estimated at 300 ft.

f. the total amount of anhydrous ammonia estimated to be used by the project in one year; and

Response: The plant is projected to use approximately 200 tons of ammonia per year.

g. the OCA for the use of anhydrous ammonia at the project site.

Response: An OCA was not performed for the ammonia piping being added for Cogen 3000 because the quantity of additional ammonia contained in the new supply piping, which is about 250 lbs, is negligible compared to the amount of other ammonia that exists in the refinery, all of which is covered under the Refinery Risk Management Plan (RMP). In addition, the new cogeneration unit is adjacent to the two existing Cogen units (also covered by the RMP) and an accidental release in either of the two existing units would have similar off-site consequence as a release from the new unit piping. The RMP includes an offsite consequence analysis for ammonia. The Offsite Consequence Analysis (called the Hazard Assessment in the Federal RMP rule) consists of Worst Case Scenarios (WCS), Alternative Release Scenarios (ARS), and the Five-Year Accident History for the refinery.

BACKGROUND

Section 8.11.3.2 states that transport of hazardous materials will be mostly within the plant since most chemicals are already used and stored on-site. However, section 8.11.5.3 states that hazardous materials will be “periodically” delivered to the site. In order to properly assess the risk of transporting hazardous materials for use at the power plant, staff needs additional clarification on whether any quantity of hazardous materials proposed for use on the power plant project will come from an off-site source.

DATA REQUEST

38. a. Please provide a description of the sources of any amount of hazardous materials that would be transported by vehicle from off-site sources, regardless of the distance or amount transported.

b. Please identify:

i. the material,

ii. the amount transported at any one time,

iii. the frequency of trips,

iv. the route to be taken to the Chevron Richmond Refinery, and

v. the type and specifications of the transport vehicle.

Response: The construction and operation of the PPRP will result in additional quantities of hazardous materials brought onsite. Currently water treatment chemicals for the existing onsite Cogen facilities are delivered and stored onsite at the water treatment storage area. This practice is anticipated to continue with the addition of PPRP. It is expected that approximately 460 extra gallons per month of the water treatment chemicals including Nalco BT-3811, Nalco TRI-ACT 1803, and Elim-Ox Oxygen Scavenger will be delivered to the site via 7,500 gallon tanker trucks, and flat bed tote trucks that currently deliver chemicals to the existing refinery facilities. It is expected that no increase in delivery frequency would be required over the current delivery schedule. Approximately 2275 gallons per month of water treatment chemicals, including Sodium Hypochlorite, Sulfuric Acid and Continuum AEC3156 will be delivered to the hydrogen plant via totes on flat bed truck. It is expected that deliveries would be made once per month. Access to the Chevron refinery will be via I-580 to Castro Street to Gate 31.

BACKGROUND

The only statement found in the application pertaining to the safety of workers at the proposed power project was found in section 2.2.2.2. This consisted of a 27-word statement that the project intends to comply with federal and state occupational safety and health program requirements. However, staff needs a more detailed description of the Personnel Safety Program that Chevron proposes to implement at this power project so that staff can be assured that workers will be protected and experience a safe workplace.

DATA REQUEST

39. Please provide a description of what California Occupational Safety and Health Administration (CalOSHA) regulations, industry guidelines, and local ordinances will be followed when establishing and implementing a worker safety program at the proposed power plant project.

Response: Construction and operation of PPRP will be conducted in accordance with all applicable LORS. Tables WS-39A through WS-39D summarizes the LORS relating to worker health and safety. Table WS-39A provides a summary of federal LORS; Table WS-39B summarizes the state LORS; Table WS-39C lists the local (county) LORS; and Table WS-39D provides a summary of the applicable national consensus standards.

TABLE WS-39A
Federal Laws, Ordinances, Regulations, and Standards

Law, Ordinance, Regulation, or Standard	Applicability
Title 29 Code of Federal Regulations (CFR) Part 1910*	Contains the minimum occupational safety and health standards for general industry in the United States
Title 29 CFR Part 1926*	Contains the minimum occupational safety and health standards for the construction industry in the United States

* Primary laws and regulations governing worker health and safety in California are provided in Table 5.16-2. These regulations are for reference and apply as referenced by California occupational safety and health regulations. Where a particular situation is not addressed by those regulations, the CFR will be consulted for guidance.

TABLE WS-39B
State Laws, Ordinances, Regulations, and Standards

Law, Ordinance, Regulation, or Standard	Applicability
California Occupational Safety and Health Act, 1970	Establishes minimum safety and health standards for construction and general industry operations in California
8 California Code of Regulations (CCR) 339	Requires list of hazardous chemicals relating to the Hazardous Substance Information and Training Act
8 CCR 450	Addresses hazards associated with pressurized vessels
8 CCR 750	Addresses hazards associated with high-pressure steam
8 CCR 1509	Addresses requirements for construction Injury and Illness Prevention Plans (IIPP)
8 CCR 1509, et seq., and 1684, et seq.	Addresses construction hazards, including head, hand, and foot injuries and noise and electrical shock
8 CCR 1528, et seq., and 3380, et seq.	Requirements for personal protective equipment (PPE)
8 CCR 1597, et seq., and 1590, et seq.	Requirements addressing the hazards associated with traffic accidents and earth-moving
8 CCR 1604, et seq.	Requirements for construction hoist equipment
8 CCR 1620, et seq., and 1723, et seq.	Addresses miscellaneous hazards
8 CCR 1709, et seq.	Requirements for steel reinforcing, concrete pouring, and structural steel erection operations
8 CCR 1920, et seq.	Requirements for fire protection systems
8 CCR 2300, et seq., and 2320, et seq.	Requirements for addressing low-voltage electrical hazards
8 CCR 2395, et seq.	Addresses electrical installation requirements
8 CCR 2700, et seq.	Addresses high-voltage electrical hazards
8 CCR 3200, et seq., and 5139, et seq.	Requirements for control of hazardous substances
8 CCR 3203, et seq.	Requirements for operational accident prevention programs

TABLE WS-39B
State Laws, Ordinances, Regulations, and Standards

Law, Ordinance, Regulation, or Standard	Applicability
8 CCR 3270, et seq., and 3209, et seq.	Requirements for evacuation plans and procedures
8 CCR 3301, et seq.	Requirements for addressing miscellaneous hazards, including hot pipes, hot surfaces, compressed air systems, relief valves, enclosed areas containing flammable or hazardous materials, rotation equipment, pipelines, and vehicle-loading dock operations.
8 CCR 3360, et seq.	Addresses requirements for sanitary conditions
8 CCR 3511, et seq., and 3555, et seq.	Requirements for addressing hazards associated with stationary engines, compressors, and portable, pneumatic, and electrically powered tools
8 CCR 3649, et seq., and 3700, et seq.	Requirements for addressing hazards associated with field vehicles
8 CCR 3940, et seq.	Requirements for addressing hazards associated with power transmission, compressed air, and gas equipment
8 CCR 5109, et seq.	Requirements for addressing construction accident and prevention programs
8 CCR 5110, et. seq.	Requirements for the implementation of an ergonomics program
8 CCR 5139, et seq.	Requirements for addressing hazards associated with welding, sandblasting, grinding, and spray-coating
8 CCR 5150, et seq.	Requirements for confined space entry
8 CCR 5160, et seq.	Requirements for addressing hot, flammable, poisonous, corrosive, and irritant substances
8 CCR 5192, et seq.	Requirements for conducting emergency response operations
8 CCR 5194, et seq.	Requirements for employee exposure to dusts, fumes, mists, vapors, and gases
8 CCR 5405, et seq.; 5426, et seq.; 5465, et seq.; 5500, et seq.; 5521, et seq.; 5545, et seq.; 5554, et seq.; 5565, et seq.; 5583, et seq.; and 5606, et seq.	Requirements for flammable liquids, gases, and vapors
8 CCR 5583, et seq.	Requirements for design, construction, and installation of venting, diking, valving, and supports
8 CCR 6150, et seq.; 6151, et seq.; 6165, et seq.; 6170, et seq.; and 6175, et seq.	Provides fire protection requirements
24 CCR 3 et seq.	Incorporates current addition of Uniform Building Code
8 CCR, Part 6	Provides health and safety requirements for working with tanks and boilers
Health and Safety Code Section 25500, et seq.	Requires that every new or modified facility that handles, treats, stores, or disposes of more than the threshold quantity of any of the listed acutely hazardous materials prepare and maintain a Risk Management Plan (RMP)
Health and Safety Code Sections 25500 through	Requires the preparation of a Hazardous Material Business Plan (HMBP) that details emergency response plans for a

TABLE WS-39B
State Laws, Ordinances, Regulations, and Standards

Law, Ordinance, Regulation, or Standard	Applicability
25541	hazardous materials emergency at the facility

TABLE WS-39C
Local Laws, Ordinances, Regulations, and Standards Required by San Diego County

Law, Ordinance, Regulation, or Standard	Applicability
Specific hazardous material handling requirements	Provides response agencies with necessary information to address emergencies
Emergency Response Plan	Allows response agency to integrate PPRP emergency response activities into any response actions
Business Plan	Provides response agency with overview of PPRP purpose and operations
Risk Management Plan (Certified Unified Program Agency [CUPA])	Provides response agency with detailed review of risks and hazards located at PPRP and mitigation implemented to control risks or hazards.

TABLE WS-39D
Applicable National Consensus Standards

Law, Ordinance, Regulation, or Standard	Applicability
Uniform Fire Code, Article 80	Addresses the prevention, control, and mitigation of dangerous conditions related to storage, dispensing, use, and handling of hazardous materials and information needed by emergency response personnel
National Fire Protection Association (NFPA) 10, Standard for Portable Fire Extinguishers	Requirements for selection, placement, inspection, maintenance, and employee training for portable fire extinguishers
NFPA 11, Standard for Low-Expansion Foam and Combined Agent Systems	Requirements for installation and use of low-expansion foam and combined-agent systems
NFPA 11A, Standard for Medium- and High-Expansion Foam Systems	Requirements for installation and use of medium- and high-expansion foam systems
NFPA 12, Standard on Carbon Dioxide Extinguishing Systems	Requirements for installation and use of carbon dioxide extinguishing systems
NFPA 13, Standard for Installation of Sprinkler Systems	Guidelines for selection and installation of fire sprinkler systems
NFPA 13A, Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems	Guidance for inspection, testing, and maintenance of sprinkler systems
NFPA 14, Standard for the Installation of Standpipe and Hose Systems	Guidelines for selection and installation of standpipe and hose systems

TABLE WS-39D
Applicable National Consensus Standards

Law, Ordinance, Regulation, or Standard	Applicability
NFPA 15, Standard for Water Spray Fixed Systems	Guidelines for selection and installation of water spray fixed systems
NFPA 17, Standard for Dry Chemical Extinguishing Systems	Guidance for selection and use of dry chemical extinguishing systems
NFPA 20, Standard for the Installation of Centrifugal Fire Pumps	Guidance for selection and installation of centrifugal fire pumps
NFPA 22, Standard for Water Tanks for Private Fire Protection	Requirements for water tanks for private fire protection
NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances	Requirements for private fire service mains and their appurtenances
NFPA 26, Recommended Practice for the Supervision of Valves Controlling Water Supplies	Supervision guidance for valves controlling water supplies
NFPA 30, Flammable and Combustible Liquid Code	Requirements for storage and use of flammable and combustible liquids
NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines	Fire protection requirements for installation and use of combustion engines and gas turbines
NFPA 50A, Standard for Gaseous Hydrogen Systems at Consumer Sites	Fire protection requirements for hydrogen systems
NFPA 54, National Fuel Gas Code	Fire protection requirements for use of fuel gases
NFPA 59A, Standard for the Storage and Handling of Liquefied Petroleum Gases	Requirements for storage and handling of liquefied petroleum gases
NFPA 68, Guide for Explosion Venting	Guidance in design of facilities for explosion venting
NFPA 70, National Electric Code	Guidance on safe selection and design, installation, maintenance, and construction of electrical systems
NFPA 70B, Recommended Practice for Electrical Equipment Maintenance	Guidance on electrical equipment maintenance
NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces	Employee safety requirements for working with electrical equipment
NFPA 71, Standard for the Installation, Maintenance, and Use of Central Station Signaling Systems	Requirements for installation, maintenance, and use of central station signaling systems
NFPA 72A, Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm and Supervisory Service	Requirements for installation, maintenance, and use of local protective signaling systems
NFPA 72E, Standard on Automatic Fire Detection	Requirements for automatic fire detection
NFPA 72F, Standard for the Installation, Maintenance and Use of Emergency Voice/Alarm of Communication Systems	Requirements for installation, maintenance, and use of emergency and alarm communications systems
NFPA 72H, Guide for Testing Procedures for Local, Auxiliary, Remote Station and Proprietary Protective Signaling Systems	Testing procedures for types of signaling systems anticipated for facility

TABLE WS-39D
Applicable National Consensus Standards

Law, Ordinance, Regulation, or Standard	Applicability
NFPA 75, Standard for the Protection of Electronic Computer/Data Processing Equipment	Requirements for fire protection systems used to protect computer systems
NFPA 78, Lightning Protection Code	Lightning protection requirements
NFPA 80, Standard for Fire Doors and Windows	Requirements for fire doors and windows
NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems	Requirements for installation of air conditioning and ventilating systems
NFPA 101, Code for Safety to Life from Fire in Buildings and Structures	Requirements for design of means of exiting the facility
NFPA 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants	Guidelines for testing and marking of fire hydrants
NFPA 850, Recommended Practice for Fire Protection for Fossil Fuel Steam Electric Generating Plants	Requirements for fire protection in fossil-fuel steam electric generating plants and alternative fuel electric generating plants
NFPA 1961, Standard for Fire Hose	Specifications for fire hoses
NFPA 1962, Standard for the Care, Maintenance, and Use of Fire Hose Including Connections and Nozzles	Requirements for care, maintenance, and use of fire hose
NFPA 1963, Standard for Screw Threads and Gaskets for Fire Hose Connections	Specifications for fire hose connections
American National Standards Institute/American Society for Mechanical Engineers (ANSI/ASME), Boiler and Pressure Vessel Code	Specifications and requirements for pressure vessels
ANSI, B31.2, Fuel Gas Piping	Specifications and requirements for fuel gas piping

To protect the safety and health of workers during the construction and operation of PPRP, health and safety programs designed to mitigate hazards and comply with applicable regulations will be implemented. Periodic audits will be performed by qualified individuals to determine whether proper work practices are being used to mitigate hazardous conditions and to evaluate regulatory compliance.

Construction Health and Safety Program

The following construction safety programs will be developed and implemented during construction of the PPRP, as outlined in the following lists and will be based on or extensions of existing refinery HES procedures and programs.. The construction health and safety program for PPRP will be prepared and implemented in accordance with all applicable LORS.

Injury and Illness Prevention Program

- Philosophy and safety commitment
- Safety leadership and responsibilities
- Accountability

- Specific core safety processes
- Employee communication
- Planning "job hazard analysis and pre-task"
- Compliance with work rules and safe work practices
- Measurement of compliance and effectiveness of prevention methods
- Communication of performance and implementation of necessary improvements
- Training and other communication requirements

Fire Protection and Prevention Program

- General requirements
- Housekeeping and proper material storage
- Employee alarm/communication system
- Portable fire extinguishers
- Fixed firefighting equipment
- Fire control and containment
- Flammable and combustible liquid storage
- Use of flammable and combustible liquids
- Dispensing and disposal of flammable liquids
- Service and refueling areas
- Training

Personal Protective Equipment Program

- Personal protective devices
- Head protection
- Eye/face protection
- Body protection
- Hand protection
- Foot protection
- Skin protection
- Fall protection
- High-voltage protection
- Respiratory protection
- Hearing protection
- Hazard analysis
- Training

Emergency Action Program/Plan

Emergency procedures for the protection of personnel, equipment, the environment, and materials:

- Fire and emergency reporting procedures
- Response actions for accidents involving personnel and or property
- Bomb threats
- Site assembly and emergency evacuation route procedures
- Natural disasters response

Reporting and notification procedures for emergencies; contacts, including offsite and local authorities:

- Alarm and communication systems
- Spill response, prevention, and control action plan
- Emergency response equipment
- Emergency personnel (response team) responsibilities and notification roster
- Training requirements

Construction Safety Programs

Motor Vehicle and Heavy Equipment Safety Program

- Operation and maintenance of vehicles
- Inspection
- Personal Protective Equipment (PPE)
- Training

Forklift Operation Program

- Trained and certified operators
- Fueling operations
- Safe operating parameters
- Training

Excavation/Trenching Program

- Shoring, sloping, and benching requirements
- California Occupational Safety and Health Administration (Cal-OSHA) permit requirements
- Inspection
- Air monitoring
- Access and egress

Fall Protection Program

- Evaluation of fall hazards
- Protection devices
- Training

Scaffolding/Ladder Safety Program

- Construction and inspection of equipment
- Proper use
- Training

Articulating Boom Platforms Program

- Inspection of equipment
- Load ratings
- Safe operating parameters
- Operator training

Crane and Material Handling Program

- Certified and licensed operators
- Inspection of equipment
- Load ratings

- Safe operating parameters
- Training

Hazardous Waste Program
- Evaluation of hazard
- Training
- Air monitoring
- Medical surveillance
- Health and Safety Plan (HSP) preparation

Hot Work Safety Program
- Welding and cutting procedures
- Fire watch
- Hot work permit
- PPE
- Training

Employee Exposure Monitoring Program
- Exposure evaluation
- Monitoring requirements
- Reporting of results
- Medical surveillance
- Training

Electrical Safety Program
- Grounding procedure
- Lock-out/tag-out (LO/TO) procedures
- Overhead and underground utilities
- Utility clearance
- Training

Permit-Required Confined Space Entry Program
- Air monitoring and ventilation requirements
- Rescue procedures
- LO/TO and blocking, blinding, and blanking requirements
- Permit completion
- Training

Hand and Portable Power Tool Safety Program
- Guarding and proper operation
- Training

Housekeeping and Material Handling and Storage Program
- Storage requirements
- Walkways and work surfaces
- Equipment handling requirements
- Training

Hearing Conservation Program

- Identifying high-noise environments
- Exposure monitoring
- Medical surveillance requirements
- Hearing-protective devices
- Training

Back Injury Prevention Program
- Proper lifting and material handling procedures
- Training

Hazard Communication Program
- Labeling requirements
- Storage and handling
- Material Safety Data Sheets (MSDS)
- Chemical inventory
- Training

Respiratory Protection Program
- Selection and use
- Storage
- Fit testing
- Medical requirements
- Inspection and repair
- Training

Heat and Cold Stress Monitoring and Control Program
- Monitoring requirements
- Prevention and control

Pressure Vessel and Pipeline Safety Program
- Line-breaking program
- Equipment inspection and maintenance
- Blocking, bleeding, and blanking
- Training

Operations Health and Safety Program

Upon completion of construction and commencement of operations at PPRP, the construction safety and health program will transition into an operations-oriented program reflecting the hazards and controls necessary during operation in accordance with the existing Chevron HES program. The following text outlines the topics that will be included in the Operations Health and Safety Program. The operations health and safety program for PPRP shall be prepared and implemented in accordance with all applicable LORS.

Injury and Illness Prevention Program

- Personnel with the responsibility and authority for implementing the plan
- Safety and health policy
- Work rules and safe work practices
- System for ensuring that employees comply with safe work practices

- Employee communications
- Identification and evaluation of workplace hazards

Methods and/or procedures for correcting unsafe or unhealthy conditions, work practices, and work procedures in a timely manner based on the severity of the hazards

- Specific safety procedures (see Plant Operation Safety Program)
- Training and instruction

Fire Protection and Prevention Program

- General requirements
- Fire hazard inventory, including ignition sources and mitigation
- Housekeeping and proper materials storage
- Employee alarm/communication system
- Portable fire extinguishers
- Fixed firefighting equipment
- Fire control
- Flammable and combustible liquid storage
- Use of flammable and combustible liquids
- Dispensing and disposal of liquids
- Training
- Personnel to contact for information on plan contents

Emergency Action Program/Plan (Part of the Risk Management Plan)

- Emergency escape procedures and emergency escape route assignments
- Procedures to be followed by employees who remain to operate critical plant operations before they evacuate
- Procedures to account for all employees after emergency evacuation has been completed
- Rescue and medical duties for those employees performing rescue and medical duties
- Fire and emergency reporting procedures
- Alarm and communication system
- Personnel to contact for information on plan contents
- Training requirements

Personal Protective Equipment Program

- Hazard analysis and prescription of PPE
- Personal protective devices
- Head protection
- Eye and face protection
- Body protection
- Hand protection
- Foot protection
- Skin protection
- Sanitation
- Safety belts and life lines for fall protection
- Protection for electric shock
- Medical services and first aid/bloodborne pathogens

- Respiratory protective equipment
- Hearing protection
- Training

Plant Operation Safety Program

Motor Vehicle and Heavy Equipment Safety Program
- Operation and maintenance of vehicles
- Inspection
- Personal Protective Equipment
- Training

Forklift Operation Program
- Trained and certified operators
- Fueling operations
- Safe operating parameters
- Training

Excavation/Trenching Program
- Shoring, sloping, and benching requirements
- Cal-OSHA permit requirements
- Inspection
- Air monitoring
- Access and egress

Fall Protection Program
- Evaluation of fall hazards
- Protection devices
- Training

Scaffolding/Ladder Safety Program
- Construction and inspection of equipment
- Proper use
- Training

Articulating Boom Platforms Program
- Inspection of equipment
- Load ratings
- Safe operating parameters
- Operator training

Crane and Material Handling Program
- Certified and licensed operators
- Inspection of equipment
- Load ratings
- Safe operating parameters
- Training

Hot Work Safety Program

- Welding and cutting procedures
- Fire watch
- Hot work permit
- Personal Protective Equipment
- Training

Workplace Ergonomics Program
- Identification of personnel at risk
- Evaluation of personnel
- Workplace and job activity modifications
- Training

Employee Exposure Monitoring Program
- Exposure evaluation
- Monitoring requirements
- Reporting of results
- Medical surveillance
- Training

Electrical Safety Program
- Grounding procedure
- LO/TO procedures
- Overhead and underground utilities
- Utility clearance
- Training

Permit-Required Confined Space Entry Program
- Air monitoring and ventilation requirements
- Rescue procedures
- LO/TO and blocking, blinding, and blanking requirements
- Permit completion
- Training

Hand and Portable Power Tool Safety Program
- Guarding and proper operation
- Training

Housekeeping and Material Handling and Storage Program
- Storage requirements
- Walkways and work surfaces
- Equipment handling requirements
- Training

Hearing Conservation Program
- Identifying high-noise environments
- Exposure monitoring
- Medical surveillance requirements
- Hearing protective devices

- Training

Back Injury Prevention Program
- Proper lifting and material handling procedures
- Training

Hazard Communication Program
- Labeling requirements
- Storage and handling
- MSDS
- Chemical inventory
- Training

Respiratory Protection Program
- Selection and use
- Storage
- Fit testing
- Medical requirements
- Inspection and repair
- Training

Heat and Cold Stress Monitoring and Control Program
- Monitoring requirements
- Prevention and control

Pressure Vessel and Pipeline Safety Program
- Line-breaking policy
- Equipment inspection and maintenance
- Blocking, bleeding, and blanking
- Communication
- Training

Safe Driving Program
- Inspection and maintenance
- Training

BACKGROUND

The application has understandably provided a very brief description of security measures for this project. These matters are kept confidential to ensure that information about power plant security is not available to unauthorized persons who may pose a threat to the power plant. Because it will be located within the existing refinery area, staff assumes that that power plant will be under the same security program as the refinery. However, staff needs to be informed about the security approach in order to be assured that the power plant will comply with security regulations and guidelines.

DATA REQUEST

40. Please indicate when Chevron personnel can provide staff with a confidential briefing on security measures that would cover the power plant project **or** when Chevron can make their security plan and other documents available for consideration by Commission staff.

    Response: Staff may contact Mr. Robert Liening, Chevron Facility Security Officer, at (510) 242-1878 for information regarding security measures at the project site.

Technical Area: Paleontological Resources
Author: Patrick Pilling, Ph.D., P.E., G.E.

BACKGROUND

Existing paleontologic information is essential to evaluate a site with respect to potential paleontologic resources and how construction of the project may impact potential resources. No site-specific paleontologic information has been included with the application; however, site-specific data is referenced in the application.

DATA REQUEST

41. Please provide a copy of available site-specific paleontologic information, in particular the field reconnaissance document dated November 2006 as referenced on Page 8.14-5 of the application.

    Response: The following excerpt from Sec. 8.14.4.2 (p.8.14-5) is provided:

    "The area proposed for construction of the PPRP is located entirely on artificial fill, as is the route of the cogeneration unit's transmission line[3]. Artificial fill possesses no paleontological sensitivity. The thickness of artificial fill beneath and near the Cogeneration plant site, as determined from geotechnical borings, generally ranges from 10 to 14 feet[4]. It is shallower (6 to 8 feet thick) in areas that appear to be underlain by Holocene and historic peat, sands and gravels of low paleontological sensitivity. The thickness of fill in the vicinity of the Hydrogen plant site is more variable, ranging from approximately 3.5 feet to as much as 13 feet in depth[3]."

    Therefore, because the site area is located on artificial fill, site-specific paleontological data are restricted to analyses of the potential of paleontologically sensitive sediments to occur at depth, what that depth might be, and what their paleontological sensitivity may be.

    Although no document was explicitly referenced, Attachment PAL-41 provides a copy of the summary notes prepared by the PRS following the field reconnaissance.

BACKGROUND

Information on the specific location of known paleontologic resources, locality records, and maps at a scale of 1:24,000 depicting any such resource locations, are necessary to determine the project's potential for impacts to paleontological resources. The text of the application discusses the potential for each geologic unit to contain paleontologic resources and includes a geologic map; however, a

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[3] URS Corporation. 2006. *Report: Geotechnical Investigation, Hydrogen Replacement Plant Project, Chevron Products Company Richmond, California*. San Francisco, CA. September 15, 2006. Figure 5

[4] URS Corporation. 2006. *Report: Geotechnical Investigation, Cogen 3000 Project, Chevron Products Company Richmond, California*. San Francisco, CA. September 12, 2006.

discussion and map depicting the location of known paleontologic resources in the vicinity of the project has not been included with the application.

DATA REQUEST

42. a. Please provide a discussion of documented paleontologic resources within the vicinity of the project, and

    b. Please provide, under confidential filing, a map depicting their locations, as applicable.

Response: Chevron understood that no formal site records search would be necessary for a SPPE review. Notwithstanding this assumption, Chevron undertook a brief review of relevant records. The University of California Museum of Paleontology at Berkeley, the basic records center for paleontological site records in this area, placed its database online several years ago. A brief online review of their records during the preparation of Section 8.14, and again now, reveals no sites within a mile of the project area. This is entirely consistent with local geology. Hence, such a map would be blank with respect to paleontological sites in the vicinity of the project.

BACKGROUND

Paleontologic professionals maintain substantial training in the identification and evaluation of geologic units and their potential to contain paleontologic resources, as this is necessary to properly evaluate a site with respect to potential impacts to paleontologic resources.

DATA REQUEST

43. Please provide the name and qualifications of the author of Section 8.14 of the application.

Response: Section 8.14 of the SPPE was prepared by Dr. W. Geoffrey Spaulding. Dr. Spaulding’s qualifications as a Paleontological Resources Specialist have been previously reviewed and approved by the CEC. He has prepared paleontological resources assessments, mitigation plans, and executed those plans for energy projects throughout the State. His resume is provided as Attachment PAL-43.

ATTACHMENT PAL-41

Summary notes: Field Reconnaissance of the Chevron Richmond Ref. Power Plant Replacement project area.
November 16, 2006

Geology and Topography
In lowland/filled/estuarine area to the immediate east of San Pablo Point. The coarsely bedded Franciscan sandstone comprising the east flank of the point can be seen to be dipping steeply down to the east, suggesting that this bedrock "dives" steeply, and would not be expected at depth in the project area. Assuming that there is no shelf at depth representing a remnant of some former isostatic beveling, bedrock is likely to be a substantial depth. The H2 plant site is about 200 to 300 feet from the east flank of the point/hill, while all other parts are a thousand feet or more distant.
Youngest sediment at surface to be expected would be Young Bay Mud.

Touring
By bus, with controlled walk-abouts in specific parts of the project area. Not that there would have been anything more to see if left to my own devices. The project area is completed on the flats and subsurface, as is typical of SF Bay and vicinity, is old 19th or early 20th Century fill.

General Findings
The area has been an industrial area for a *long* time, and it is underlain by fill to what is likely to be considerable depth (>10 feet). Areas seen where underlain by hydrocarbon-stained, disturbed soils or gravel, or fresh gravel except for the far eastern portion of the project area where the present slough is found. No native soils were seen of the flanks of San Pablo island, which are not involved. Should they occur at depth, hydrocarbon contamination might be a problem from the point of view of both compromising some of the scientific value of an fossils present, as well as worker safety.

No paleontological potential is evident at the surface, and there is unlikely to be any at depth unless it is below the limit of artificial fill and disturbed soils. Even then, it would likely be Holocene (yBM) and therefore not particularly sensitive.

wNeed the results of geotechnical investigations to determine depth to undisturbed sediments with paleontological potential.

ATTACHMENT PAL-43

W Geoffrey Spaulding
Paleontological Resources Specialist/Senior Scientist

Education

Ph.D., Geology (Paleobiology), University of Arizona, 1981
M. S., Geology (Palynology & Vertebrate Paleobiology), University of Arizona, 1974
B. A., Anthropology, University of Arizona, 1972

Certifications

- California State Bureau of Land Management Paleontological Resources Use Permit CA-07-17
- Approved Paleontological Resources Specialist by the California Energy Commission, State of California
- Qualifications as Paleontological Resources Expert Witness accepted by the Attorney General, State of Washington

Distinguishing Qualifications

- Specialist Paleontological Resources Management
- Expert in Paleoecology of Western North America
- Specialist in Site Formation Processes, Quaternary Paleobiology, Geoarchaeology, Paleohydrology
- Captain, Signal Corps, U. S. Army Reserve (Retired)

Relevant Experience

Dr. Spaulding is a senior scientist and paleontologist with CH2M HILL with extensive experience in paleobiology, paleontology, and paleoecology. He also is accomplished in the study of site formation processes, and the age determinations of archaeological and paleontological sites in the western United States. He has more than three decades of technical experience in the Earth and Life sciences focussing on the deserts of western North America and on California. Representative projects that he has managed in the last 12 years are listed below. Prior to joining private industry, he was on the faculty of the University of Washington, Seattle specializing in paleobiology and paleoecology.

Paleontological Resources Management

California Energy Commission Approved Paleontological Resources Specialist, Multiple Power Generation Projects, California. Conduct literature reviews, records searches, and field surveys to develop Paleontological Resources Assessments, prepare paleontological resources impacts assessment and mitigation measures, for the projects' Application for Certification before the California Energy Commission. Determine the relative levels of paleontological sensitivity of Mesozoic through Quaternary rock units in the context of the geological history of the project areas, direct field surveys, and prepare resource specific documentation for more than 16 separate projects from San Diego in the south, to the Bay Area, to Arcata in the north. Prepare Paleontological Resources Monitoring and Mitigation Plans for construction-phase compliance activities.

Paleontological Resources Specialist, Construction-Phase Mitigation Implementation, Multiple Power Generation Projects, California. Develop and manage paleontological resources monitoring and mitigation programs for the construction of power generation projects including the Walnut Energy Center south of Modesto, the Roseville Energy Park east of Sacramento, and the Gateway generation Station near Antioch. Prepare the Paleontological Resources Module of the worker education program and visual aids for worker education. Direct the recovery of discovered paleontological resources (Quaternary vertebrate and paleobotanical remains), and consult with client representatives and the California Energy Commission on the adequacy of mitigation efforts. Develop site-specific stratigraphic framework to identify paleontologically sensitive sediments, and to provide client and the CEC with guidance regarding what construction activities need and need not be monitored.

Ivanpah Valley Bright-Source Energy EIS/AFC. Conduct records review and literature search, field reconnaissance and subsequent field survey of paleontologically sensitive areas, and recordation of Paleozoic and Quaternary paleontological sites in support of a large solar powered electrical generation facility. Include modeling of pluvial lake highstands to determine maximum elevation of paleontologically sensitive sediments. Prepare appropriate paleontological resources sections for BLM EIS and California Energy Commission Application for Certification.

Salton Sea Ecosystem Restoration Project EIR. Geological and paleontological literature review, records search including consultations with California State Paleontologist, to develop large scale paleontological sensitivity assessment of the Salton Trough. Develop impact assessment and mitigation measures for Environmental Impact Report. Develop mitigation measures for eight different action alternatives, and respond to comments on the PEIR.

Paleontological Resources Assessment for Kinder Morgan's EPX Pipeline, Texas, New Mexico, and Arizona. Literature and records review, remote-sensing and map analyses to characterize the affected environment and environmental impacts for a Bureau of Land Management Environmental Assessment for the installation of an interstate petroleum products pipeline. Prepare appropriate sections of the EA, and assemble technical information from museums in three states.

Transportation-Related Paleontological Resources Management Services, southern California. Perform paleontological resources assessments, develop management and monitoring plans, prepare, review and amend subconsultant scopes of work, and provide audit services to clients for paleontological resources management work. Multiple contracts for the City of San Diego, the Regional Transportation Commission, and the Counties of Riverside, San Diego and Orange. Formations addressed included Quaternary terrestrial and lacustrine units, and Tertiary marine and estuarine sediments.

Client Task Oversight & Expert Witness Testimony On Paleontological Resources Sensitivity. Review and develop discovery and mitigation plans, and provide testimony to the Attorney General of the State of Washington. On the paleontological data potential and impacts to Middle Tertiary age fossil resources in the Columbia Basin, and on potential project-related impacts pursuant to Washington's Energy Facility Siting & Environmental Certification process, on behalf of Olympic Pipeline Corporation.

Paleontological Resources Assessment & Mitigation Plan Development, McKittrick Tar Pits, central California. Review the extensive literature; develop a resources assessment and preliminary management plan for paleontological resources in the vicinity of the renowned McKittrick Tar Pits in the Central Valley for a confidential client interested in the development of the oil-rich diatomites and sands of the area.

Duke Energy of North America, Paleontological Support Services for The Potrero and Contra Costa Applications For Certification. Conduct literature reviews, record searches, and site surveys; and prepare appropriate sections of Applications for Certification according to the format and data requirements of the California Energy Commission. Respond to CEC staff questions and requests for additional data. Provide cost-control strategies to client. In support of the relicensing efforts for two power plants in the Bay Area of California.

Owens Lake Air Quality Mitigation Program, Paleontological Resources Review and Strategy Development. Review resource assessments and draft mitigation plans on the clients behalf to assure that mitigation measures called for are consistent with the resources that may be found in the project area. Audit of consultant work to assure economy of scale in mitigation requirements.

Kern River Pipeline Cultural & Paleontological Resources Compliance, California, Nevada, and Utah. Coordination and implementation of cultural resources mitigation and monitoring efforts along a 678-mile pipeline corridor involving up to 160 personnel operating in three states. Consult with state and federal agencies (FERC, Advisory Council on Historic Preservation Bureau of Land Management), and coordinate with client representatives. Direct and participate in state-wide field compliance programs. Participate in and direct technical studies of sites ranging in age from Paleoindian to Formative Periods. Manage the preparation of reports perform the task of senior report editor.

Metropolitan Water District of Southern California, West Valley Lateral and Eastside Reservoir Projects, Cultural and Paleontological Resources Support Services. Design and conduct archaeobotanical, paleoecological, and paleoclimatic studies in support of paleontological and cultural resources testing and mitigation programs for a large reservoir development program. Manage and participate in paleobotanical and archaeobotanical research programs; direct subconsultants in palynological investigations. Develop pioneering reconstructions of inland southern California's climatic and ecological history over the last 40,000 years; consider these in the context of regional environmental changes and the archaeological record.

Los Angeles Department of Water and Power, Mead/McCullough - Victorville/Adelanto Transmission Line. Manage cultural and paleontological resources monitoring and mitigation in conjunction with the construction of a 500 kV power line extending through Nevada and California. Assess levels of significance of paleontological sites discovered during survey and monitoring, implement mitigation measures for affected sites, manage analyses, prepare reports.

City of Mesquite Cultural and Paleontological Resource Compliance. Design and manage resource surveys for linear-facilities rights of way and BLM land exchanges. Bureau of Land Management consultation on mitigation and avoidance measures, coordinate data recovery and analyses, and prepare final reports on discovered Pliocene paleontological sites.

Molycorp, Inc., Ivanpah Valley Geoarchaeological Studies. Plan for and contribute to cultural resources surveys and Phase 2 Testing and Evaluations for a large project involving over 30 Archaic to Late Prehistoric archaeological sites within and on the margins of a presently dry lake bed. Develop and implement special studies in geoarchaeology, paleohydrology, and paleoenvironmental reconstruction. Manage biological resources surveys and monitoring in support of a multiyear remediation effort; consult with land management agencies to assure compliance on behalf of the client.

Pacific Gas & Electric, Pit 3,4,5 Project, Cultural Resources Support Services. Archaeobotanical, paleoecological, and paleohydrologic studies in support of cultural resource mitigation efforts in the vicinity of Lake Britton, California. Develop a 7,000-year paleoecological record directly applicable to the study area. Contract and direct subconsultants in the development of a 1,000-year dendrohydrologic reconstruction of the flow of the Middle Pit River. Compare and contract paleoenvironmental and archaelogoical records to determine possible environmental drivers of cultural change.

U.S. Geological Survey Yucca Mountain Site Characterization Studies. . Multiple contracts for field and laboratory research, report preparation and review focusing on the timing and magnitude of past hydrologic and climatic changes in the Nevada Test Site, Yucca Mountain, and the Amargosa Desert. Assessment of millennial scale variability of groundwater levels and their potential effect on performance criteria for a high-level nuclear waste repository, as well of geomorphic process affecting paleoenvironmental data.

Yosemite National Park Cultural Resources Management Plan & Research Design. Assist in the preparation of the twenty-year update of the National Park Service's *Archaeological Research Design*. Review, evaluate, and provide a comprehensive summary of research in paleoecology, geoarchaeology, Quaternary geology, and tephrachronology. Prepare chapters on for the *Research Design* for NPS use.

National Academy of Sciences, National Research Council Panel On Coupled Hydrologic, Tectonic, and Hydrothermal Processes. Appointed by the National Academy of Sciences to a three-year tenure as an expert panel member to review research and evaluate evidence for changes in water-table elevation in the vicinity of the proposed Yucca Mountain Nuclear Waste Repository.

Yosemite National Park, Upper Tuolumne Meadows Archaeological Testing and Evaluation Program. Field and laboratory studies, and report preparation, focussed on geochronology, tephrachronology, and site formation processes in support of Yosemite National Park's visitor services expansion program. Identification and characterization of accelerated colluvial depositional processes following volcanic ash fall-out in prehistoric times, and possible effects on human occupation of the area.

Other Representative Projects

Boulder City / U.S. 93 Corridor Study Final Environmental Impact Statement (FEIS). Environmental lead in charge of preparation of an FEIS for a major highway project in southern Nevada. Manage the update of the Draft EIS, provide strategic input to client regarding NEPA, NHPA and ESA compliance strategies. Participate in agency consultations with the Environmental Protection Agency, Nevada Department of Wildlife, U.S. Army Corps of Engineers, and the Nevada Historic Preservation Office on behalf of the FHWA and Nevada DOT. Prepare, update, and gain signatures on a six-agency Programmatic Agreement for project-related cultural resources impacts mitigation.

California Desert District's Imperial Sand Dunes Recreation Area Management Plan NEPA Compliance Program. Manage a complex and fast-track NEPA compliance program, direct and participate in the preparation of a Draft Environmental Impact Statement addressing a highly visible and controversial recreational area management measures proposed by the Bureau of Land Management. Direct the final preparation of a Biological Assessment of the project. Organize and attend public meetings as a client representative, including presenting components of the project to the public on behalf of the BLM.

Reliant Energy Southern Nevada Development Program Environmental Compliance & Permitting Services. Initial services include the performance of fatal flaw analyses for multiple siting options in Clark County, consultations with client representatives and land management agencies; preparation of site-specific cost projections for NEPA, ESA, and NHPA compliance programs, as well as State and local permits and entitlements. Continuing services include coordinating Nevada Power Company/Sierra Pacific Resources and Southwest Gas efforts, scheduling tasks and activities for permitting at different sites, and tracking consultant performance on behalf of the client.

Environmental Compliance Services to Del Webb Corporation. Manage and participate in the preparation of multiple NEPA, NHPA, and ESA compliance documents, consult with agencies, and direct the compliance efforts for a complex land exchange program involving properties throughout the State of Nevada. Provide a wide range of support services including biological and cultural resources assessments, preparation of use plans, and assessments of air quality impacts, municipal budgets, and economic effects.

Apex Heavy Use Industrial Park Environmental Compliance & Permitting Assistance. Consult with agencies and facilitate client interests on critical environmental issues including air quality impacts and water resources. Prepare NEPA compliance documents for a 11,200 acre land sale, and assist subsequent infrastructure development.

Hanford Nuclear Reservation Barrier Development Program Peer Review Panel. Reviewing research strategies, team organization, and prototype designs for protective barriers intended for use on high-level and mixed waste repository sites. Reviewing studies of past and potential future environmental change.

U. S. Nuclear Regulatory Commission, Advisory Committee on Nuclear Waste. Preparation of briefing documents, participation in panel meetings, and presentation of oral evaluations of governmental studies on the characterization, data acquisition, and model evaluation of climatic and hydrologic conditions at the proposed Yucca Mountain Nuclear Waste Repository.

Professional History

Environmental Compliance Manager & Paleontological resources Specialist, CH2M HILL, Las Vegas, 2001 to present

Manager, Division of Planning & Compliance, URS Corporation, Las Vegas, 2000-2001

Manager, Environmental Services, Dames & Moore, Las Vegas, 1990-2000

Research Professor of Botany, Director of the Laboratory of Arid-lands Paleoecology, Quaternary Research Center, University of Washington, Seattle, 1983-1990

Adjunct Professor, Remote Sensing Laboratory, Department of Geosciences, University of Washington, Seattle, 1985-1990

Post-Doctoral Research Associate, College of Forest Resources, University of Washington, Seattle, 1979-1983

Graduate Research Assistant, Laboratory of Paleoenvironmental Studies, Department of Geosciences, University of Arizona, Tucson, 1974-1978

Countries Worked In

United States, Mexico, Australia

Professional Affiliations

American Association for The Advancement of Science

Selected Publications

2004 - Development of Vegetation in the Central Mojave Desert of California during the Late Quaternary. (with P. A. Koehler and R. S. Anderson). *Palaeogeography, Palaeoclimatology, Palaeoecology* 215:297-311.

2001 – Ploidy Race Distributions since the Last Glacial Maximum in the North American Desert Shrub, *Larrea tridentata* (with K.L. Hunter, J.L. Betancourt, B.R. Riddle, T.R. Van Devender, and K.L. Cole). *Global Ecology & Biogeography* 10: 521-533.

2000 – A Molecular Analysis of Ground Sloth Diet through the Last Glaciation (with M. Hofreiter, H. N. Poinar, K. Bauer, P.S. Martin, G. Possnert, and S. Paabo). *Molecular Ecology* 9: 1975-1984.

1999 - Middle to Late Quaternary Climatic Changes in Death Valley and Vicinity. In *Proceedings of Conference on Status of Geologic Research and Mapping in Death Valley National Park*. U.S. Geological Survey Open-File Report 99-153, pp. 121-124.

1999 - Environmental Imperatives Reconsidered: Demographic Crises in Western North America During The Medieval Climatic Anomaly (with T. L. Jones, G. M. Brown, L. M. Raab, J. L. McVickar, D. J. Kennett, A. L. York, and P. L. Walker). *Current Anthropology* 40(2): 137-170.
1998 - Molecular coproscopy: dung and diet of the extinct Shasta ground sloth *Nothrotheriops shastensis* (with H. Poinar, M. Hoffreiter, P. S. Martin, and S. Paabo). *Science* 281: 402-406.
1996 - Paleobiotic and isotopic analysis of mollusks, fish, and plants from Core OL-92: Indicators for an open or closed lake system (with J. R. Firby, S. E. Sharpe, J. F. Whelan, and G. R. Smith). In *An 800,000-year paleoclimatic record from Owens Lake, California*, edited by G. I. Smith and J. L. Bischoff, pp. 143-160. Geological Society of America Special Paper 317.
1995 - Environmental change, ecosystem responses, and the Late Quaternary development of the Mojave Desert. In *Quaternary Environments and Deep Time: Papers in Honor of Paul S. Martin* (D. S. Steadman and J. I. Mead, eds.), pp 225-256. Fenske Printing, Inc., Rapid City, South Dakota.
1995 - Pika (*Ochotona*) and the Late Quaternary paleoecology of the Great Basin (with J. I. Mead). In *Quaternary Environments and Deep Time: Papers in Honor of Paul S. Martin* (D. S. Steadman and J. I. Mead, eds.), pp 257-283. Fenske Printing, Inc., Rapid City, South Dakota.
1993 - Climatic changes in the western United States since 18,000 yr. B.P. (with R. S. Thompson, C. Whitlock, P. J. Bartlein, and S. P. Harrison) In *Global climates since the last glacial maximum*, edited by H. E. Wright, Jr., J. E. Kutzbach, T. Webb, III, W. F. Ruddiman, F. A. Street-Perott, and P. J. Bartlein, pp. 468-513. University of Minnesota Press, Minneapolis.
1992 - An alternative perspective on Mojave Desert prehistory (with J. H. Cleland). *Society for California Archaeology Newsletter* 26: 1-6.
1992 - *Ground water at Yucca Mountain: How high can it rise?* (with members of the NAS, NRC Panel on Coupled Hydrologic/Tectonic/Hydrothermal Processes at Yucca Mountain). National Academy Press, Washington, D.C.
1992 - Ecological characterization of fossil plants (with S. J. Mazer, T. L. Phillips, R. E. Taggert, and B. H. Tiffney). In *Terrestrial ecosystems through time: Evolutionary paleoecology of terrestrial plants and animals*, edited by A.K. Behrensmeyer *et al.*, pp. 139-180. University of Chicago Press.
1992 - Late Cenozoic terrestrial ecosystems (with R. E. Taggart, J. A. Harris, B. Van Valkenberg, L. D. Martin, J. D. Damuth, and R. Foley). In *Terrestrial ecosystems through time: Evolutionary paleoecology of terrestrial plants and animals*, edited by A. K. Behrensmeyer *et al*., pp. 419-541. University of Chicago Press.
1992 - Glacial/Interglacial 13C/12C ratios of atmospheric CO2 inferred from carbon in C4 plant cellulose (with B. D. Marino, M. B. McElroy, and R. J. Salawitch). *Nature* 357: 461-466.
1991 - A middle Holocene vegetation record from the Mojave Desert and its paleoclimatic significance. *Quaternary Research* 35: 427-437.
1991 - Pluvial climatic episodes in North America and North Africa: Types and correlation with global climate. *Palaeogeography, Palaeoclimatology, Palaeoecology* 84: 217-227.
1991 - Comparison of pollen and macrofossil based reconstructions of Late Quaternary vegetation in western North America. In *Proceedings of the 7th International Palynological Congress, Brisbane, Australia*, edited by E. M. Truswell and J. A. K. Owen, pp. 359-366. Elsevier, Amsterdam.
1990 - Packrat middens: Their composition and methods of analysis (with K. L. Cole, J. L. Betancourt and L. K. Croft. In *Packrat middens: The last 40,000 years of biotic change*, edited by J. L. Betancourt, P. S. Martin, and T. R. Van Devender, pp. 59-84. University of Arizona Press, Tucson.
1990 - Environments of the last 50,000 years in the vicinity of Yucca Mountain, central-southern Nevada. *High Level Radioactive Waste Management* 2: 1251-1258.
1990 - Vegetation dynamics during the last deglaciation, southeastern Great Basin, U.S.A. *Quaternary Research* 33: 188-203 (1990).
1990 - Vegetational and climatic development of the Mojave Desert: The last glacial maximum to the present. In *Packrat middens: The last 40,000 years of biotic change*, edited by J. L. Betancourt, P. S. Martin, and T. R. Van Devender, pp. 166-199. University of Arizona Press, Tucson.
1988 - Climatic changes of the last 18,000 years: Observations and model simulations (with COHMAP Project Members). *Science* 241: 1043-1052.
1986 - The last pluvial climatic episodes in the deserts of southwestern North America (with L. J. Graumlich). *Nature* 320:441-444.
1985 - *Vegetation and Climates of the last 45,000 years in the vicinity of the Nevada Test Site, south-central Nevada*. U. S. Geological Survey Professional Paper No. 1329.

1983 - Late Wisconsin paleoecology of the American southwest (with E. B. Leopold and T. R. Van Devender). In *The late Pleistocene of the United States*, edited by S.C. Porter, pp. 259-293. University of Minnesota Press, Minneapolis.
1983 - Late Wisconsin macrofossil records of desert vegetation in the American southwest. *Quaternary Research* 19: 256-264.
1979 - Development of vegetation and climate in the western United States (with T. R. Van Devender). *Science* 204: 701-710.

Technical Area: Project Description
Author: Mary Dyas

BACKGROUND

Figure 2.1-2 in the SPPE application, shows the existing Cogen facility plus the proposed new Cogen 3000. In the figure, in the area of Substation 5 (Sub 5), there is a label that reads “Substation No. 5 STG Addition”. The applicant states in Section 2.0 Project Description that the Cogen 3000 generator will connect via a new generator step-up transformer to the existing 115-kV Substation 5 switchyard. Within Section 2.0, there is no indication of an expansion or addition to Sub 5 other than the generation step-up transformer. It is unclear to staff if there is a new addition or expansion planned for the substation.

DATA REQUEST

44. Please clarify whether Sub 5 will be added to or expanded, and to what extent.

    Response: Sub 5 will not be expanded for the PPRP. Sub 5 was expanded a few years ago to accommodate the installation of a 30 MW steam turbine generator and provisions were made at that time for tie-in of future generation, including space, foundations, and disconnect switches to facilitate the installation of an additional 115 kV circuit breaker for bus segmenting. In addition, pilings were installed to accommodate a future generator step-up transformer. Therefore, the work that will be done at Sub 5 will only be the installation of a new 115 kV SF_6 circuit breaker on an existing foundation, installation of a new generator step-up transformer and foundation on existing pilings, revision of bus instrument transformers and relaying to accommodate the added generator, and electrical interconnection of all components.

Technical Area: Public Health
Author: Dr. Alvin Greenberg

BACKGROUND

The applicant states in section 8.6.4.2 that a construction Health Risk Assessment (HRA) is less important than control measures and therefore no HRA is performed and instead the applicant will incorporate diesel PM10 control measures that are listed in the Draft EIR (2007) prepared for the Chevron Renewal Project. The applicant stated that the justification for this approach can be found in the Bay Area Air Quality Management District (BAAQMD) CEQA Guidelines (1999) which emphasize implementation of effective control measures rather than detailed quantification of construction emissions. The applicant further states that as a result of the implementation of diesel PM10 control measures, no significant public health effects are expected during the construction phase. The applicant provides construction emission factors for NOx, SOx, CO, PM2.5 and PM10 in Appendix 8.1A but not for Toxic Air Contaminants (TACs) or diesel particulate matter.

Despite the rationale stated by the applicant, and despite the fact that staff will evaluate the diesel emissions control measures described in the DEIR, staff believes that it must have all the information available in order to fully evaluate control measures and make a conclusion regarding the adequacy of the mitigation proposed. Therefore staff needs a health risk assessment that evaluates diesel emissions from construction vehicles during the construction phase of this power plant.

DATA REQUEST

45. Please provide a health risk assessment of construction vehicle diesel emissions.

    Response: The proposed project is located in the middle of an operating petroleum refinery with the closest property boundary approximately 3,000 feet from the PPRP location. Construction of the PPRP is expected to be temporary and finite in duration (approximately 15 months in durations). The construction equipment diesel particulate emissions were estimated at 4 pounds/day (presented in SPPE Table 8.1-13). Furthermore, public health impacts associated with the entire Renewal project are being analyzed by the City of Richmond as part of the EIR and the BAAQMD. To avoid the burden of unnecessary duplication, Chevron will provide a copy to the Commission of the BAAQMD HRA associated when it becomes available.

BACKGROUND

The only sources evaluated in the Hotspots Analysis and Reporting Program (HARP) analysis in the SPPE Application are the cogeneration stacks and cooling tower. The applicant states that cumulative impacts were assessed in section 5.2.5.12 of the DEIR for the Chevron Renewal Project and that no cumulative impacts are expected. Therefore, no other on-site or off-site sources were included and no quantitative cumulative analysis was conducted. The SPPE application Section 8.1 (Air Quality) states Section 5.2 of the DEIR for the Chevron Renewal Project (ESA 2007) includes the following sources in a cumulative impacts discussion: emissions from the Power Plant Replacement Project (PPRP), the Chevron Renewal Project, and 17 pending projects (9 of which would be located at the Chevron Richmond refinery). The applicant states that the results of the analysis presented in Section 5.2.5.12 of the DEIR indicate that most of the cumulative air quality construction or operational impacts will be "insignificant, or mitigated to levels less than significant". Staff finds the DEIR's cumulative impact analysis to be "qualitative" in nature. In the absence of specific, quantitative detail, staff is unable to properly assess the cumulative impact of the PPRP plus the other planned projects.

DATA REQUEST

46. Please provide a quantitative cumulative impact assessment using the HARP model of all projects identified in section 5.2.3 of the DEIR for the Chevron Renewal Project.

    Response: The City of Richmond and the BAAQMD are performing quantitative public health impact assessments for the entire Renewal project, which includes the PPRP components. To avoid the burden of unnecessary duplication, a copy will be forwarded to the CEC for review when it becomes available.

BACKGROUND

The cooling tower will use reclaimed water; however, water quality data is not provided. The maximum Total Dissolved Solids (TDS) concentration is provided in Table 8.1-18 and some cooling tower emissions are provided in Table 8.6-4. The application also states that emission factors for the cooling water were based on information provided by Chevron as part of the BAAQMD permit application (Chevron, 2006). Staff needs to know the chemical makeup of this water in order to determine the accuracy of the emissions estimated in the health risk assessment.

DATA REQUEST

47. Please provide a table showing the water quality parameters of the water used in the cooling tower.

    Response: Table PH-47 presents a summary of the EBMUD's North Richmond Water Reclamation Plant's 2005-2006 effluent water quality summary.

TABLE PH-47
North Richmond Water Reclamation Plant 2005-2006 Effluent Water Quality Summary (micrograms/liter)

Constituent	Minimum Results	Median Results	Average Results	Number of Samples	Minimum Detection Level Range
Arsenic	ND	2	2.5	24	0.2 - 0.4
Cadmium	ND	ND	ND	24	0.02 - 0.1
Chromium	ND	0.53	0.54	24	0.2 - 0.51
Copper	5.2	7.8	7.7	24	0.2 - 0.51
Cyanide (total)	ND	ND	3.4	24	3
Lead	ND	ND	0.31	24	0.1 - 0.21
Mercury	ND	ND	0.022	24	0.02
Nickel	3.8	4.7	4.7	24	0.2 - 0.3
Selenium	ND	ND	ND	119	0.2 - 0.4
Silver	0.035	0.09	0.15	24	0.0102 - 0.2
Zinc	17.6	47	46	24	1 - 5.5
TDS	228	272	270	24	

Notes: Non-detect results at the MDL value.

48. Please also provide the Chevron 2006 report referenced above.

Response: Unlike most power plant applications reviewed by the CEC, the air permitting for the Renewal project started over a year ago. Over this period, Chevron has responded to numerous requests from the BAAQMD to revise/update emission estimates and assumptions. As a result of these requests and the project as a whole, the volume of material submitted to the BAAQMD is significant and is not in a format that allows for the submittal of a single permit application. As indicated in the response to Data Request # 13, a final BAAQMD-approved emission inventory will be forwarded to the CEC when received.

BACKGROUND

The summary of the HRA results provides Universal Transverse Mercator (UTM) coordinates for the proposed project's Point of Maximum Impact (PMI) for cancer, chronic hazard, and acute hazard. Furthermore, there are no distances from the sources to these locations or map showing the locations of maximum impact relative to the facility fenceline and structures on and off-site. Staff needs this information in order to adequately assess the impacts of the proposed project.

DATA REQUEST

49. Please provide a map showing the location of the PMI for cancer risk, chronic hazard, and acute hazard.

    Response: A map identifying the location of the PMI for cancer risk, chronic hazard and acute hazard is provided as Figure PH-49.

BACKGROUND

The air dispersion analysis was conducted using HARP with the "rural" option chosen. Given the many structures on the Chevron Refinery site and the surrounding densely populated area, staff needs to know the rationale for choosing the rural option.

DATA REQUEST

50. Please provide the rationale for choosing the "rural" option for the HARP model.

    Response: The selection of the rural dispersion coefficient was based on a land use procedure proposed by Auer (Correlation of Land Use and Cover with Meteorological Anomalies, Journal of Applied Meteorology. 1978) and outlined in the EPA's Appendix W to Part 51 - Guideline on Air Quality Models (August, 1996). Per the guidance presented in Appendix W, the rural dispersion coefficient should be used unless 50 percent or more of the area within a 3 kilometer radius is classified as heavy industrial, light moderate industrial, commercial, compact residential (less than 2 story), or compact residential (greater than 2 story). Although the area south and east of the facility is heavily developed, based on aerial photographs it appears more than 50 percent of the area within a 3 kilometer radius of the project location would be classified as metropolitan natural area (e.g. the small peninsula bordering the west and northwest boundary of the facility), is located over water, or includes industrial open spaces such as industrial size holding basins. Therefore, the use of the "rural" option in the HARP modeling is appropriate.

BACKGROUND

The SPPE Application states that the emission factors for TACs from the gas turbine used in the HRA were obtained from the Energy & Environmental Research Corporation (EERC) August 1998 publication entitled "Air Toxic Emission Factors for Combustion Sources Using Petroleum Based Fuels, Final Report, Volume II". Staff needs this information to assess the accuracy of emission factors from the three fuels proposed for use in the combustion turbine.

DATA REQUEST

51. Please provide the August 1998 report referenced above.

Response: A copy of the relevant portions of this report are presented in Attachment PH-51.

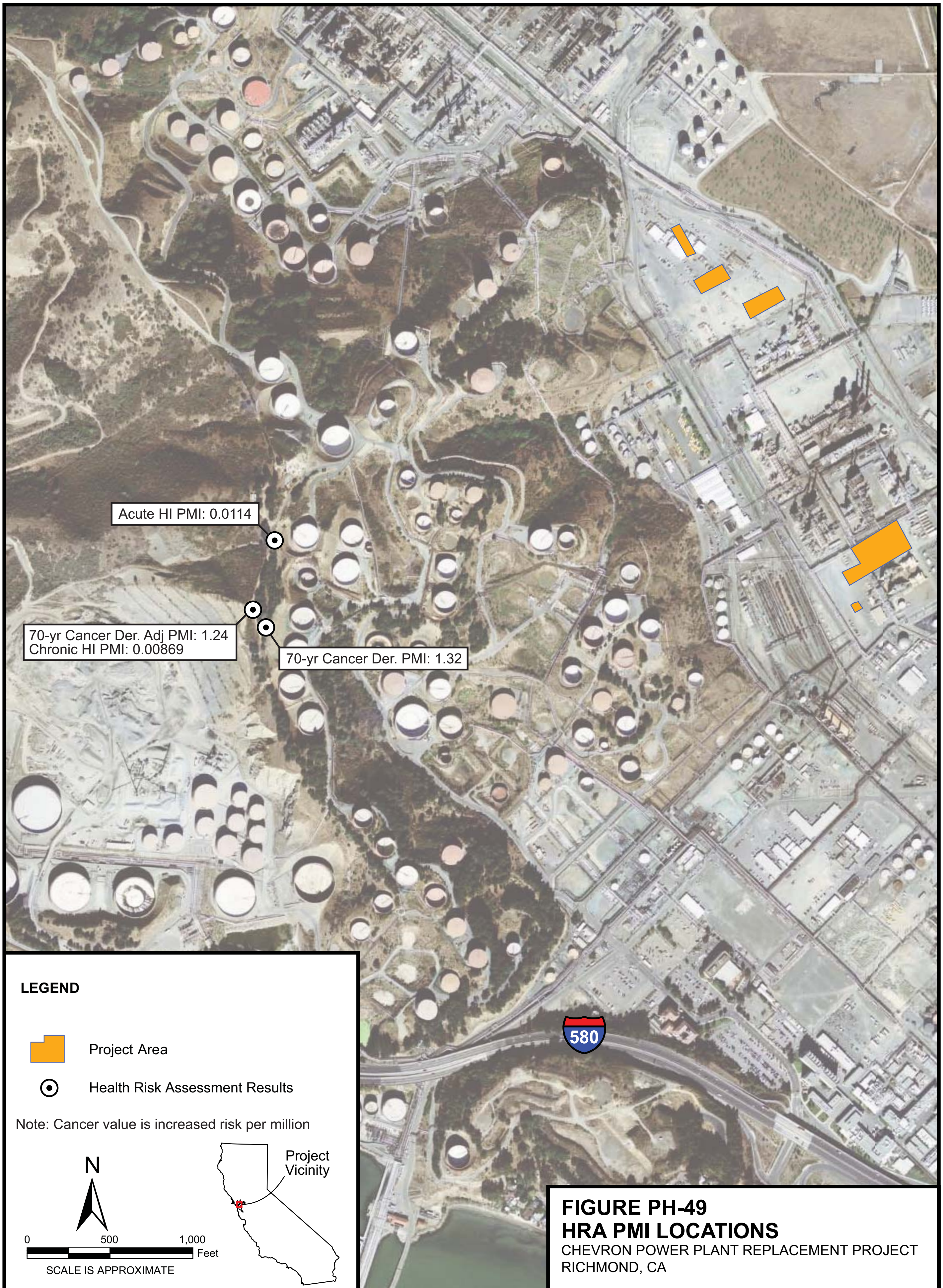

FIGURE PH-49
HRA PMI LOCATIONS
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

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ATTACHMENT PH-51

AIR TOXIC EMISSION FACTORS FOR COMBUSTION SOURCES USING PETROLEUM BASED FUELS

Final Report
Volume 2 - Development of Emission Factors Using CARB Approach

Prepared for

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August 14, 1998

ABSTRACT

The Western States Petroleum Association (WSPA) and American Petroleum Institute (API) sponsored a program to develop air toxics emission factors for petroleum industry combustion devices from source test data collected under California Assembly Bill 2588 (AB2588), entitled the Air Toxics "Hot Spots" Information and Assessment Act of 1987. The California Air Resources Board (CARB) provided WSPA and API with access to over 161 petroleum industry combustion source reports, from which data were extracted to derive emission factors. The types of devices represented include process heaters, boilers, reciprocating internal combustion engines, gas turbines, steam generators, asphalt blowers, and coke calciners. The substances quantified include: trace metals; polychlorinated dibenzo[*p*]dioxins and dibenzofurans; polycyclic aromatic hydrocarbons and other semivolatile organic compounds; benzene, toluene and other volatile organic compounds; formaldehyde and other aldehydes; and hydrochloric acid.

Procedures developed in a separate CARB-sponsored program were used to screen and validate data, eliminating those data points or sets with significant problems and/or reporting deficiencies. Through this process, the best data sets were selected for emission factor development. Emission factors were developed using two different approaches: one approach resulted in emission factors for inclusion in a CARB-sponsored database encompassing all industries in California, and a second approach for petroleum industry-specific emission factors. While the data review and validation procedures are identical for both approaches, in the latter approach emission factor derivation differs to improve the quality of emission factors for petroleum industry combustion devices. Specifically, additional pooling of source test data and elimination of low sensitivity detection limit data produced more robust emission factors for those sources.

As a result of this study, air toxics emission factors for petroleum industry combustion devices have been developed using the best available source testing information. These emission factors can be used by petroleum industry environmental health and safety engineers to develop more accurate and complete emission inventories without additional source testing.

This report consists of three volumes: Volume 1 presents emission factors derived specifically for petroleum industry combustion devices; Volume 2 presents emission factors derived for inclusion in the CARB database; and Volume 3 provides detailed results of data validation and statistical comparisons.

ACKNOWLEDGEMENTS

The success of this program was due in part to the excellent cooperation from all of the facilities which provided permission to use their source test results and process information. The procedures used to validate and calculate emission factors were provided by the California Air Resources Board (CARB). In addition, the source test reports were supplied by CARB. These reports were collected in a previous project funded by CARB. The following people are recognized for their contributions of time and expertise during this study and the preparation of this report.

<u>API Staff Contact</u>

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4D 2378	Same as 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
4D Other	Same as Tetrachlorodibenzo-p-dioxin other.
4D Total	Same as Tetrachlorodibenzo-p-dioxin total.
4F 2378	Same as 2,3,7,8-Tetrachlorodibenzofuran.
4F Other	Same as Tetrachlorodibenzofuran other.
4F Total	Same as Tetrachlorodibenzofuran total.
5D 12378	Same as 1,2,3,7,8-Pentachlorodibenzo-p-dioxin.
5D Other	Same as Pentachlorodibenzo-p-dioxin other.
5D Total	Same as Pentachlorodibenzo-p-dioxin total.
5F 12378	Same as 1,2,3,7,8-Pentachlorodibenzofuran.
5F 23478	Same as 2,3,4,7,8-Pentachlorodibenzofuran.
5F Other	Same as Pentachlorodibenzofuran other.
5F Total	Same as Pentachlorodibenzofuran total.
6D 123478	Same as 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin.
6D 123678	Same as 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin.
6D 123789	Same as 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin.
6D Other	Same as Hexachlorodibenzo-p-dioxin other.
6D Total	Same as Hexachlorodibenzo-p-dioxin.
6F 123478	Same as 1,2,3,4,7,8-Hexachlorodibenzofuran.
6F 123678	Same as 1,2,3,6,7,8-Hexachlorodibenzofuran.
6F 123789	Same as 1,2,3,7,8,9-Hexachlorodibenzofuran.
6F 234678	Same as 2,3,4,6,7,8-Hexachlorodibenzofuran.
6F Other	Same as Hexachlorodibenzofuran other.
6F Total	Same as Hexachlorodibenzofuran total.
7D 1234678	Same as 1,2,3,4,7,8-Heptachlorodibenzo-p-dioxin.
7D Other	Same as Heptachlorodibenzo-p-dioxin other.
7D Total	Same as Heptachlorodibenzo-p-dioxin total.
7F 1234678	Same as 1,2,3,4,6,7,8-Heptachlorodibenzofuran.

7F 1234789	Same as 1,2,3,4,7,8,9-Heptachlorodibenzofuran.
7F Other	Same as Heptachlorodibenzofuran other.
7F Total	Same as Heptachlorodibenzofuran total.
8D	Same as Octachlorodibenzo-p-dioxin.
8F	Same as Octachlorodibenzofuran.
AB2588	Air Toxics "Hot Spots" Information and Assessment Act of 1987
AB	Afterburner
APC	Air Pollution Control System
API	American Petroleum Institute
ARB	Air Resources Board
ATEDS	Air Toxic Emission Data System
B	Benzene
BAAQMD	Bay Area Air Quality Management District
BD	Blank Data
BF	Baffle Filter
BTX	Benzene, Toluene, and Xylene
C	Cyclone or Carbon or Substance Concentration
CARB	California Air Resources Board
CATEF	California Air Toxics Emission Factors
CB	Conventional Burner
CD	Calibration Data
CO	Carbon Monoxide
COC	CO Oxidation Catalyst
Cr	Chromium
CVAAS	Cold Vapor Atomic Absorption Spectrometry
CVR	Casing Vapor Recovery
CVRG	Casing Vapor Recovery Gas
D	Dioxins
DD	Device Description
DeNox (SNCR)	Selective Non-Catalytic NOx Reduction

DM	Demister
dscfm	Dry Standard Cubic Feet per Minute
dscf	Dry Standard Cubic Feet
EER	Energy and Environmental Research Corporation
EF	Emission Factor
EPA	Environmental Protection Agency
F	Formaldehyde or Failed Calculation Check
FF	Fuel F-factor or Fabric Filter
FIRE	Factor Information Retrieval System
GFAAS	Graphite Furnace Atomic Absorption Spectrometry
GUI	Graphical User Interface
H2S	Hydrogen Sulfide
HAP	Hazardous Air Pollutants
HC	Hexavalent Chromium
HCHO	Formaldehyde
Hcl	Hydrogen Chloride
HF	Hydrogen Fluoride
Hl	Hydrogen Chloride
HNO3	Nitric acid
HO	Halogenated Organics
Hp	Horse Power
HS	Hydrogen Sulfide
HV	Heating Value
ICAP	Inductively Coupled Argon Plasma
IC	Internal Combustion Engine
ICE	Internal Combustion Engine
IS	Internal Standards
lb/MMcf	Pounds per Million Cubic Feet
lb/Mgal	Pounds per Thousand Gallons
lb/ton	Pounds per Ton

LD	Laboratory Data or Location Data
LNB	Low-NOx Burner
LP	Liquid Petroleum
LRMS	Low Resolution Mass Spectrometry
M	Metals
MD	Method Description
MDL	Method Detection Limit
Mgal	Thousand Gallons
MMBtu	Million British Thermal Units
Mmcf	Million Cubic Feet
MMT	Multiple Metals Train
NC	No Comparison
ND	Not enough data to check calculations
Ni	Nickel
NIOSH	National Institute of Occupation Safety and Hazard
Nox	Nitrogen oxides
NR	Calculation check not required because calculations checked for another device in report or not rated in EPA system
O2	Oxygen
PERF	Petroleum Environmental Research Forum
P	Passed Calculation Check
PAH	Polycyclic Aromatic Hydrocarbons
PB	Polychlorinated Biphenyls
PCB	Polychlorinated Biphenyls
PCDD	Polychlorinated Dibenzo-p-dioxin
PCDF	Polychlorinated Dibenzofuran
PH	Polycyclic Aromatic Hydrocarbons
ppbv	Parts per Billion Volume
PQL	Practical Quantitation Limit
PR	Process Rate

QA/QC	Quality Assurance/Quality Control
QD	Quality Data
RFG	Refinery Fuel Gas
ROC	Reactive Organic Compound
RSD	Relative Standard Deviation
S	Strokes per Cycle
SCAQMD	South Coast Air Quality Management District
SCC	Source Classification Code
SCR	Selective Catalytic NOx Reduction
Scrub	Scrubber
SD	Sample Data or Spray Dryer
SG	Steam Generator
SIC	Standard Industrial Classification
SNCR (DeNOx)	Selective Non-Catalytic NOx Reduction
SO2	Sulfur Dioxide
SVOC	Semi-Volatile Organic Compounds
THC	Total Hydrocarbons
Ti	Titanium
TO	Thermal Oxidizer
VC	Vinyl Chloride
VOC	Volatile Organic Compound
WSPA	Western States Petroleum Association

EXECUTIVE SUMMARY

This project was performed with the cooperation of the California Air Resources Board (CARB) to develop updated air toxics emission factors for petroleum industry combustion sources. The emission factors developed in this project will be integrated into a larger database being developed by CARB called the California Air Toxics Emission Factor (CATEF) database. They also may be used by petroleum industry environmental health and safety engineers to develop air toxics emissions inventories to comply with state and federal requirements. In addition, these emission factors provide an improved scientific basis for technical and policy decision-making related to the development of new environmental regulations such as federal National Emission Standards for Hazardous Air Pollutants (NESHAPs) for petroleum industry sources.

California Assembly Bill 2588 (AB2588), entitled the Air Toxics "Hot Spots" Information and Assessment Act of 1987, requires facilities to provide an inventory of their air emissions for the purpose of assessing the potential health risk to communities surrounding such facilities. Source testing to characterize air toxics emissions is required when recognized emission factors or reliable engineering estimating techniques do not exist. The results of the source testing performed to comply with AB2588 were used to develop emission factors, which relate the quantity of emissions of a substance to a process-related rate.

DATA VALIDATION

To develop emission factors based on the best available source test results, the petroleum industry AB2588 source test results were screened using a data validation procedure developed by CARB for the CATEF database (Hansell, 1996). This procedure identifies data points and data sets with significant problems and/or reporting deficiencies in three steps including: initial screening, detailed validation, and outlier analysis. Initial screening identifies source tests which do not have sufficient documentation for emission factor development and assessment of data quality. The results of 93 of the 161 source tests were eliminated during the screening procedure. Most of the 93 source tests were eliminated because process rates needed for emission factor derivation were not provided. The detailed validation step was conducted on the remaining 68 source tests. Detailed validation includes checking to ensure the correct sampling and analysis procedures were used, qualifying significant problems such as high field blanks, checking calculations, and evaluating the accuracy of the test results. The impact of problems identified in the detailed validation process is quantified by conducting an outlier analysis. Outliers are identified statistically using the Dixon method. Each outlier is examined to determine if a process and/or method problem occurred as documented in the results of the detailed validation. If a documented problem occurred than the outlier is eliminated.

EMISSION FACTOR DEVELOPMENT

Emission factors included in this volume of the report were derived for inclusion in the CATEF database. The validated source test data were separated into eighteen groups:

<u>External Combustion</u>

•Boiler, Fuel Oil-Fired
•Boiler, Refinery Gas-Fired
•Heater, Natural Gas-Fired
•Heater, Natural/Refinery Gas-Fired
•Heater, Oil-Fired
•Heater, Refinery Gas-Fired
•Steam Generator, Crude Oil-Fired
•Steam Generator, Natural Gas-Fired
•Steam Generator, Natural Gas/CVR Gas-Fired

<u>Direct-Fired</u>

•Asphalt Blowing
•Coke Calcining

<u>Reciprocating ICEs</u>

•Diesel-Fired
•Field Gas-Fired
•Natural Gas-Fired

<u>Gas Turbines</u>

•Refinery Gas-Fired
•Natural/Refinery/LP Gas-Fired
•Natural Gas-Fired
•Natural/Refinery Gas-Fired

In general, the emissions data for each substance in each group were observed to vary over several orders of magnitude when multiple test conditions were present. This variability is due to a combination of measurement uncertainty and differences in the design and operation of devices tested. The variability was reduced, if possible, by identifying design and operating parameters responsible for the variation and developing subgroups. Engineering judgement and statistical analysis were used to determine whether the design or operating parameters had a significant impact on emission. Pooling of data between similar groups such as refinery gas-fired boilers and refinery gas-fired heaters was not allowed. This produced several groups in which tests of only one or two units are represented, resulting in a low EPA quality rating. Pooling data to increase the number of units represented can increase the quality of emission factors, as discussed in Volume 1.

Several subgroup parameters were investigated including: load, burner type and post combustion air pollution controls for external combustion sources; stoichiometry, capacity, and strokes per cycle for reciprocating internal combustion engines (RICE); and duct burners for gas turbines. No significant or consistent impact of the external combustion parameters on emissions was observed. Many of the subgroups did not include sufficient data to make valid statistical comparisons. Thus, emission factors were developed for each of the nine external combustion groups listed above.

Strokes per cycle and stoichiometry impacted emissions for RICE. As in the case of the external combustion sources, many of the comparisons included results from a single source test. In general, these comparisons are not considered reliable. However, when the differences are large and supported by process knowledge, subgroups can be developed. Thus, RICE were subgrouped by the number of strokes per cycle (2- or 4-stroke) and stoichiometry (rich- or lean-burn). These subgroups are the same as those used in EPA's *Compilation of Air Pollution Emission Factors* (AP-42).

Gas turbines subgroups were developed for sources with and without duct burners. Duct burners are used to provide supplemental heat for the waste heat boiler in the combined cycle. Duct burners effectively add an external combustion unit to the gas turbine, resulting in a potential difference in emissions between turbines with and without duct burners.

REPORT ORGANIZATION

Emission factors developed specifically for petroleum industry combustion sources and for CATEF are described in Volumes 1 and 2, respectively. Data collection and validation procedures are summarized in Volume 1 and a detailed description is provided in Volume 2. Volume 3 provides supporting information, including detailed procedures used for validation of source test data, validation results, and detailed statistical comparison results. Emission factors for each group are provided in Appendix A and B of this report volume. Emission factors in Appendix A are given in source classification code (SCC) units, usually pounds per million cubic feet of fuel-fired (lb/MMcf), while they are given in units of pounds per million British Thermal Units (lb/MMBtu) in Appendix B. The two appendices are otherwise identical.

Appendix B.

EMISSION FACTORS, lb/MMBtu

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Asphalt Blowing/1	30601101	TO	Blow Cycle	Halogens	HCl	C3-v-	2.08E-06	2.08E-06	2.08E-06	2.08E-06	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Arsenic	D3-v-	1.23E-05	1.23E-05	1.23E-05	1.23E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Beryllium	D3-v-	2.47E-06	2.47E-06	2.47E-06	2.47E-06	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Cadmium	D3-v-	4.94E-06	4.94E-06	4.94E-06	4.94E-06	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Chromium (Hex)	C3-v-	2.99E-06	2.99E-06	2.99E-06	2.99E-06	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Chromium (Total)	C3-v-	3.94E-05	3.94E-05	3.94E-05	3.94E-05	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Copper	D3-v-	4.47E-05	4.47E-05	4.47E-05	4.47E-05	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Lead	D3-v-	4.94E-05	4.94E-05	4.94E-05	4.94E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Manganese	D3-v-	1.16E-04	1.16E-04	1.16E-04	1.16E-04	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Mercury	A3-v-	8.53E-06	8.53E-06	8.53E-06	8.53E-06	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Nickel	D3-v-	6.26E-05	6.26E-05	6.26E-05	6.26E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Selenium	D3-v-	1.23E-05	1.23E-05	1.23E-05	1.23E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	Metals	Zinc	D3-v-	7.91E-04	7.91E-04	7.91E-04	7.91E-04	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	SVOC	Ethylbenzene	E3-v-	8.10E-04	8.10E-04	8.10E-04	8.10E-04	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	SVOC	Phenol	C3-v-	7.12E-05	7.12E-05	7.12E-05	7.12E-05	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	VOC	Acetaldehyde	C3-v-	1.67E-06	1.67E-06	1.67E-06	1.67E-06	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	VOC	Benzene	E3-v-	2.98E-04	2.98E-04	2.98E-04	2.98E-04	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	VOC	Formaldehyde	C3-v-	3.34E-06	3.34E-06	3.34E-06	3.34E-06	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	VOC	Hydrogen Sulfide	A3-v-	1.95E-03	1.95E-03	1.95E-03	1.95E-03	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/1	30601101	TO	Blow Cycle	VOC	Xylene (Total)	E3-v-	8.10E-04	8.10E-04	8.10E-04	8.10E-04	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Halogens	HCl	C3-v-	7.74E-07	7.74E-07	7.74E-07	7.74E-07	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Arsenic	D3-v-	1.09E-05	1.09E-05	1.09E-05	1.09E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Beryllium	D3-v-	2.19E-06	2.19E-06	2.19E-06	2.19E-06	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Cadmium	D3-v-	4.37E-06	4.37E-06	4.37E-06	4.37E-06	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Chromium (Hex)	C3-v-	3.09E-06	3.09E-06	3.09E-06	3.09E-06	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Chromium (Total)	C3-v-	1.34E-05	1.34E-05	1.34E-05	1.34E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Copper	D3-v-	3.56E-05	3.56E-05	3.56E-05	3.56E-05	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Lead	D3-v-	4.38E-05	4.38E-05	4.38E-05	4.38E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Manganese	D3-v-	1.95E-04	1.95E-04	1.95E-04	1.95E-04	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Mercury	A3-v-	8.03E-06	8.03E-06	8.03E-06	8.03E-06	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Nickel	D3-v-	5.65E-05	5.65E-05	5.65E-05	5.65E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Selenium	D3-v-	1.09E-05	1.09E-05	1.09E-05	1.09E-05	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	Metals	Zinc	D3-v-	5.04E-04	5.04E-04	5.04E-04	5.04E-04	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	SVOC	Ethylbenzene	E3-v-	7.17E-04	7.17E-04	7.17E-04	7.17E-04	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	SVOC	Phenol	C3-v-	4.37E-05	4.37E-05	4.37E-05	4.37E-05	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	VOC	Acetaldehyde	C3-v-	4.07E-06	4.07E-06	4.07E-06	4.07E-06	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	VOC	Benzene	E3-v-	2.64E-04	2.64E-04	2.64E-04	2.64E-04	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	VOC	Formaldehyde	C3-v-	1.22E-05	1.22E-05	1.22E-05	1.22E-05	lb/MMBtu	1	0.00	0.00	1.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	VOC	Hydrogen Sulfide	A3-v-	1.73E-03	1.73E-03	1.73E-03	1.73E-03	lb/MMBtu	1	0.00	0.00	0.00
Asphalt Blowing/2	30601101	TO	No Blow Cycle	VOC	Xylene (Total)	E3-v-	7.17E-04	7.17E-04	7.17E-04	7.17E-04	lb/MMBtu	1	0.00	0.00	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Dioxin:4D 2378	C3-v0	4.31E-12	3.88E-12	5.32E-12	3.71E-12	lb/MMBtu	1	20.50	23.20	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Dioxin:5D 12378	C3-v0	2.50E-12	1.86E-12	3.88E-12	1.77E-12	lb/MMBtu	1	47.67	53.94	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Dioxin:6D 123478	C3-v0	2.50E-12	1.86E-12	3.88E-12	1.77E-12	lb/MMBtu	1	47.67	53.94	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Dioxin:6D 123678	C3-v0	2.50E-12	1.86E-12	3.88E-12	1.77E-12	lb/MMBtu	1	47.67	53.94	0.25
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Dioxin:6D 123789	C3-v0	2.50E-12	1.86E-12	3.88E-12	1.77E-12	lb/MMBtu	1	47.67	53.94	0.25
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Dioxin:7D 1234678	C3-v0	2.12E-11	1.94E-11	3.53E-11	8.87E-12	lb/MMBtu	1	62.77	71.03	1.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Dioxin:8D	C3-v0	5.10E-10	5.63E-10	8.36E-10	1.31E-10	lb/MMBtu	1	69.66	78.83	1.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:4F 2378	C3-v0	5.54E-12	5.32E-12	7.43E-12	3.88E-12	lb/MMBtu	1	32.18	36.42	1.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:5F 12378	C3-v0	3.12E-12	3.71E-12	3.88E-12	1.77E-12	lb/MMBtu	1	37.52	42.46	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:5F 23478	C3-v0	3.12E-12	3.71E-12	3.88E-12	1.77E-12	lb/MMBtu	1	37.52	42.46	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:6F 123478	C3-v0	2.48E-12	1.94E-12	3.71E-12	1.77E-12	lb/MMBtu	1	43.44	49.15	0.50
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:6F 123678	C3-v0	1.86E-12	1.86E-12	1.94E-12	1.77E-12	lb/MMBtu	1	4.51	5.10	0.33
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:6F 123789	C3-v0	2.50E-12	1.86E-12	3.88E-12	1.77E-12	lb/MMBtu	1	47.67	53.94	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:6F 234678	C3-v0	3.74E-12	3.88E-12	5.57E-12	1.77E-12	lb/MMBtu	1	50.85	57.54	0.50
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:7F 1234678	C3-v0	9.79E-12	7.76E-12	1.42E-11	7.43E-12	lb/MMBtu	1	38.89	44.01	1.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:7F 1234789	C3-v0	3.15E-12	1.86E-12	5.82E-12	1.77E-12	lb/MMBtu	1	73.43	83.10	0.00
Boiler, Fuel Oil/1	10200403	None	None	Dioxin/Furan	Furan:8F	C3-v0	4.86E-11	4.85E-11	7.06E-11	2.66E-11	lb/MMBtu	1	45.27	51.23	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Boiler, Fuel Oil/1	10200403	None	None	Metals	Arsenic	B3-v0	9.76E-06	9.76E-06	1.14E-05	8.10E-06	lb/MMBtu	1	17.00	19.24	0.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Beryllium	B3-v0	4.28E-07	4.32E-07	4.78E-07	3.74E-07	lb/MMBtu	1	12.22	13.83	0.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Cadmium	B3-v0	5.82E-06	4.47E-06	8.58E-06	4.40E-06	lb/MMBtu	1	41.15	46.57	0.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Chromium (Hex)	A3-v0	7.82E-06	7.85E-06	8.20E-06	7.43E-06	lb/MMBtu	1	4.95	5.60	0.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Chromium (Total)	A3-v0	3.28E-05	3.52E-05	3.98E-05	2.34E-05	lb/MMBtu	1	25.70	29.08	1.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Copper	B3-v0	2.62E-05	1.37E-05	5.89E-05	6.07E-06	lb/MMBtu	1	108.86	123.19	1.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Lead	B3-v0	1.06E-05	5.84E-06	2.26E-05	3.32E-06	lb/MMBtu	1	98.91	111.92	0.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Manganese	B3-v0	3.95E-05	1.92E-05	8.29E-05	1.63E-05	lb/MMBtu	1	95.34	107.89	1.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Mercury	B3-v0	7.02E-08	6.15E-08	1.00E-07	4.89E-08	lb/MMBtu	1	38.06	43.07	0.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Nickel	B3-v0	2.27E-03	2.08E-03	2.76E-03	1.97E-03	lb/MMBtu	1	18.95	21.44	1.00
Boiler, Fuel Oil/1	10200403	None	None	Metals	Selenium	B3-v0	1.96E-05	2.44E-05	2.45E-05	9.83E-06	lb/MMBtu	1	43.13	48.81	0.17
Boiler, Fuel Oil/1	10200403	None	None	Metals	Zinc	B3-v0	1.09E-04	5.86E-05	2.10E-04	5.82E-05	lb/MMBtu	1	80.41	90.99	1.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Acenaphthene	B3-v0	6.00E-09	5.71E-09	1.06E-08	2.14E-09	lb/MMBtu	2	69.26	55.42	0.87
Boiler, Fuel Oil/1	10200403	None	None	PAH	Acenaphthylene	B3-v0	2.09E-09	2.16E-09	2.29E-09	1.59E-09	lb/MMBtu	2	12.32	9.86	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Anthracene	B3-v1	2.07E-09	1.83E-09	4.76E-09	1.29E-10	lb/MMBtu	2	98.24	78.60	0.94
Boiler, Fuel Oil/1	10200403	None	None	PAH	Benzo(a)anthracene	B3-v1	1.32E-09	1.44E-09	2.29E-09	2.03E-10	lb/MMBtu	2	77.09	61.68	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Benzo(a)pyrene	B3-v0	1.36E-09	1.46E-09	2.29E-09	3.13E-10	lb/MMBtu	2	71.84	57.48	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Benzo(b)fluoranthene	B3-v0	8.11E-09	6.77E-09	1.60E-08	2.14E-09	lb/MMBtu	2	75.81	60.66	0.40
Boiler, Fuel Oil/1	10200403	None	None	PAH	Benzo(e)pyrene	C3-v0	5.80E-09	7.00E-09	7.60E-09	2.80E-09	lb/MMBtu	1	45.15	51.09	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Benzo(g,h,i)perylene	B3-v0	6.72E-09	5.69E-09	1.50E-08	2.14E-09	lb/MMBtu	2	79.36	63.50	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Benzo(k)fluoranthene	B3-v1	1.34E-09	1.55E-09	2.29E-09	2.03E-10	lb/MMBtu	2	75.32	60.26	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Chrysene	B3-v0	2.62E-08	2.19E-08	5.83E-08	7.46E-09	lb/MMBtu	2	80.59	64.48	1.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Dibenz(a,h)anthracene	B3-v1	4.73E-09	2.20E-09	1.82E-08	1.41E-09	lb/MMBtu	2	139.45	111.58	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Fluoranthene	B3-v1	5.25E-08	4.14E-08	1.12E-07	5.97E-09	lb/MMBtu	2	89.14	71.33	1.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Fluorene	B3-v1	3.14E-08	3.10E-08	5.76E-08	5.73E-09	lb/MMBtu	2	84.62	67.71	1.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Indeno(1,2,3-cd)pyrene	B3-v0	3.05E-09	2.28E-09	5.32E-09	1.97E-09	lb/MMBtu	2	46.19	36.96	0.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Naphthalene	B3-v0	4.04E-07	4.11E-07	5.52E-07	2.73E-07	lb/MMBtu	2	28.11	22.49	1.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Phenanthrene	B3-v0	7.39E-08	7.35E-08	1.35E-07	2.11E-08	lb/MMBtu	2	60.02	48.02	1.00
Boiler, Fuel Oil/1	10200403	None	None	PAH	Pyrene	B3-v1	2.72E-08	1.58E-08	7.37E-08	2.26E-09	lb/MMBtu	2	110.83	88.68	0.97
Boiler, Fuel Oil/1	10200403	None	None	SVOC	2-Chloronaphthalene	C3-v0	1.54E-10	1.58E-10	1.94E-10	1.11E-10	lb/MMBtu	1	27.13	30.70	0.00
Boiler, Fuel Oil/1	10200403	None	None	SVOC	2-Methylnaphthalene	C3-v0	7.40E-08	7.25E-08	8.32E-08	6.63E-08	lb/MMBtu	1	11.52	13.04	1.00
Boiler, Fuel Oil/1	10200403	None	None	SVOC	Perylene	C3-v0	7.44E-10	4.05E-10	1.49E-09	3.32E-10	lb/MMBtu	1	87.56	99.09	0.00
Boiler, Fuel Oil/1	10200403	None	None	VOC	1,3-Butadiene	B3-v1	4.18E-05	4.04E-05	8.00E-05	5.74E-06	lb/MMBtu	2	94.58	75.68	0.00
Boiler, Fuel Oil/1	10200403	None	None	VOC	Acetaldehyde	A3-v1	6.99E-06	3.33E-06	2.28E-05	1.79E-06	lb/MMBtu	2	117.49	94.01	0.75
Boiler, Fuel Oil/1	10200403	None	None	VOC	Acrolein	A3-v0	1.48E-05	1.19E-05	2.28E-05	9.69E-06	lb/MMBtu	1	47.31	53.53	0.00
Boiler, Fuel Oil/1	10200403	None	None	VOC	Benzene	A3-v0	3.15E-05	3.17E-05	3.24E-05	3.04E-05	lb/MMBtu	1	3.26	3.69	0.00
Boiler, Fuel Oil/1	10200403	None	None	VOC	Chloroform	A3-v0	3.37E-05	3.40E-05	3.47E-05	3.25E-05	lb/MMBtu	1	3.26	3.69	0.00
Boiler, Fuel Oil/1	10200403	None	None	VOC	Formaldehyde	A3-v1	4.52E-05	4.72E-05	1.14E-04	1.82E-06	lb/MMBtu	2	92.14	73.72	0.18
Boiler, Fuel Oil/1	10200403	None	None	VOC	Propylene	A3-v0	1.49E-04	1.50E-04	1.53E-04	1.44E-04	lb/MMBtu	1	3.26	3.69	0.00
Boiler, Fuel Oil/1	10200403	None	None	VOC	Toluene	A3-v0	3.91E-05	3.94E-05	4.02E-05	3.77E-05	lb/MMBtu	1	3.26	3.69	0.00
Boiler, Fuel Oil/1	10200403	None	None	VOC	Xylene (Total)	A3-v0	7.51E-05	7.56E-05	7.72E-05	7.24E-05	lb/MMBtu	1	3.26	3.69	0.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Arsenic	D3-v0	5.88E-07	6.46E-07	9.40E-07	1.78E-07	lb/MMBtu	1	65.36	73.95	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Beryllium	D3-v0	1.31E-07	1.31E-07	1.32E-07	1.29E-07	lb/MMBtu	1	1.35	1.87	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Cadmium	D3-v0	2.00E-06	1.70E-06	2.64E-06	1.67E-06	lb/MMBtu	1	27.60	31.23	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Chromium (Hex)	C3-v0	6.32E-06	6.29E-06	8.78E-06	3.89E-06	lb/MMBtu	1	38.70	43.79	0.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Chromium (Total)	C3-v1	1.04E-05	4.51E-06	2.49E-05	1.80E-06	lb/MMBtu	1	121.39	137.36	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Copper	D3-v0	5.32E-06	5.32E-06	6.51E-06	4.13E-06	lb/MMBtu	1	31.59	43.78	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Lead	D3-v0	2.05E-06	2.05E-06	2.10E-06	1.99E-06	lb/MMBtu	1	3.87	5.36	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Manganese	D3-v0	2.02E-06	2.02E-06	2.65E-06	1.38E-06	lb/MMBtu	1	44.52	61.70	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Mercury	D3-v0	2.72E-07	2.69E-07	3.22E-07	2.24E-07	lb/MMBtu	1	18.19	20.58	0.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Nickel	D3-v0	4.72E-06	4.72E-06	5.94E-06	3.51E-06	lb/MMBtu	1	36.33	50.35	1.00
Boiler, Ref. Gas/1	10200701	None	None	Metals	Selenium	D3-v0	1.73E-06	1.99E-06	2.39E-06	8.11E-07	lb/MMBtu	1	47.44	53.68	0.16
Boiler, Ref. Gas/1	10200701	None	None	Metals	Zinc	D3-v2	2.83E-03	3.22E-04	8.10E-03	7.83E-05	lb/MMBtu	1	161.02	182.20	1.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Acenaphthene	A3-v0	4.90E-09	4.65E-09	5.46E-09	4.59E-09	lb/MMBtu	1	9.89	11.20	0.37
Boiler, Ref. Gas/1	10200701	None	None	PAH	Acenaphthylene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Anthracene	A3-v0	1.89E-08	2.02E-08	3.28E-08	3.71E-09	lb/MMBtu	1	77.14	87.30	1.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Benzo(a)anthracene	A3-v0	1.53E-08	1.51E-08	2.07E-08	1.01E-08	lb/MMBtu	1	34.78	39.35	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Boiler, Ref. Gas/1	10200701	None	None	PAH	Benzo(a)pyrene	A3-v0	2.86E-09	2.84E-09	3.71E-09	2.02E-09	lb/MMBtu	1	29.49	33.37	0.76
Boiler, Ref. Gas/1	10200701	None	None	PAH	Benzo(b)fluoranthene	A3-v0	5.65E-09	6.11E-09	6.99E-09	3.84E-09	lb/MMBtu	1	28.79	32.57	1.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Benzo(g,h,i)perylene	A3-v0	3.22E-09	3.28E-09	4.36E-09	2.02E-09	lb/MMBtu	1	36.33	41.11	0.78
Boiler, Ref. Gas/1	10200701	None	None	PAH	Benzo(k)fluoranthene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Chrysene	A3-v0	2.86E-09	2.19E-09	4.36E-09	2.02E-09	lb/MMBtu	1	45.70	51.71	0.50
Boiler, Ref. Gas/1	10200701	None	None	PAH	Dibenz(a,h)anthracene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Fluoranthene	A3-v0	3.56E-08	2.62E-08	6.11E-08	1.94E-08	lb/MMBtu	1	62.95	71.23	1.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Fluorene	A3-v0	8.19E-09	4.65E-09	1.53E-08	4.59E-09	lb/MMBtu	1	75.53	85.46	1.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Naphthalene	A3-v0	1.72E-07	1.63E-07	2.03E-07	1.49E-07	lb/MMBtu	1	16.13	18.25	1.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Phenanthrene	A3-v0	4.71E-08	3.63E-08	7.43E-08	3.06E-08	lb/MMBtu	1	50.50	57.15	1.00
Boiler, Ref. Gas/1	10200701	None	None	PAH	Pyrene	A3-v0	5.00E-08	4.36E-08	6.99E-08	3.63E-08	lb/MMBtu	1	35.35	40.00	1.00
Boiler, Ref. Gas/1	10200701	None	None	SVOC	Phenol	C2-v0	1.83E-06	7.04E-07	4.91E-06	5.45E-07	lb/MMBtu	4	99.84	56.49	0.85
Boiler, Ref. Gas/1	10200701	None	None	VOC	Acetaldehyde	C1-v3	3.01E-06	2.11E-06	1.01E-05	4.10E-09	lb/MMBtu	5	95.45	48.30	1.00
Boiler, Ref. Gas/1	10200701	None	None	VOC	Benzene	C1-v2	1.74E-04	5.03E-05	1.22E-03	2.86E-06	lb/MMBtu	5	186.11	91.19	0.80
Boiler, Ref. Gas/1	10200701	None	None	VOC	Formaldehyde	C1-v1	1.32E-05	1.16E-05	3.62E-05	2.81E-06	lb/MMBtu	5	66.84	33.82	1.00
Boiler, Ref. Gas/1	10200701	None	None	VOC	Hydrogen Sulfide	A1-v1	2.21E-04	1.69E-04	5.93E-04	5.01E-05	lb/MMBtu	5	92.80	45.47	0.00
Boiler, Ref. Gas/1	10200701	None	None	VOC	Toluene	E2-v2	7.23E-04	7.25E-05	4.37E-03	3.59E-05	lb/MMBtu	3	193.00	126.09	0.97
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Arsenic	D3-v0	5.88E-07	6.46E-07	9.40E-07	1.78E-07	lb/MMBtu	1	65.36	73.95	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Beryllium	D3-v0	1.31E-07	1.31E-07	1.32E-07	1.29E-07	lb/MMBtu	1	1.35	1.87	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Cadmium	D3-v0	2.00E-06	1.70E-06	2.64E-06	1.67E-06	lb/MMBtu	1	27.60	31.23	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Chromium (Hex)	C3-v0	6.32E-06	6.29E-06	8.78E-06	3.89E-06	lb/MMBtu	1	38.70	43.79	0.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Chromium (Total)	C3-v1	1.04E-05	4.51E-06	2.49E-05	1.80E-06	lb/MMBtu	1	121.39	137.36	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Copper	D3-v0	5.32E-06	5.32E-06	6.51E-06	4.13E-06	lb/MMBtu	1	31.59	43.78	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Lead	D3-v0	2.05E-06	2.05E-06	2.10E-06	1.99E-06	lb/MMBtu	1	3.87	5.36	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Manganese	D3-v0	2.02E-06	2.02E-06	2.65E-06	1.38E-06	lb/MMBtu	1	44.52	61.70	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Mercury	D3-v0	2.72E-07	2.69E-07	3.22E-07	2.24E-07	lb/MMBtu	1	18.19	20.58	0.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Nickel	D3-v0	4.72E-06	4.72E-06	5.94E-06	3.51E-06	lb/MMBtu	1	36.33	50.35	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Selenium	D3-v0	1.73E-06	1.99E-06	2.39E-06	8.11E-07	lb/MMBtu	1	47.44	53.68	0.16
Boiler, Ref. Gas/1	10200701	SCR	None	Metals	Zinc	D3-v2	2.83E-03	3.22E-04	8.10E-03	7.83E-05	lb/MMBtu	1	161.02	182.20	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Acenaphthene	A3-v0	4.90E-09	4.65E-09	5.46E-09	4.59E-09	lb/MMBtu	1	9.89	11.20	0.37
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Acenaphthylene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Anthracene	A3-v0	1.89E-08	2.02E-08	3.28E-08	3.71E-09	lb/MMBtu	1	77.14	87.30	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Benzo(a)anthracene	A3-v0	1.53E-08	1.51E-08	2.07E-08	1.01E-08	lb/MMBtu	1	34.78	39.35	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Benzo(a)pyrene	A3-v0	2.86E-09	2.84E-09	3.71E-09	2.02E-09	lb/MMBtu	1	29.49	33.37	0.76
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Benzo(b)fluoranthene	A3-v0	5.65E-09	6.11E-09	6.99E-09	3.84E-09	lb/MMBtu	1	28.79	32.57	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Benzo(g,h,i)perylene	A3-v0	3.22E-09	3.28E-09	4.36E-09	2.02E-09	lb/MMBtu	1	36.33	41.11	0.78
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Benzo(k)fluoranthene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Chrysene	A3-v0	2.86E-09	2.19E-09	4.36E-09	2.02E-09	lb/MMBtu	1	45.70	51.71	0.50
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Dibenz(a,h)anthracene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Fluoranthene	A3-v0	3.56E-08	2.62E-08	6.11E-08	1.94E-08	lb/MMBtu	1	62.95	71.23	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Fluorene	A3-v0	8.19E-09	4.65E-09	1.53E-08	4.59E-09	lb/MMBtu	1	75.53	85.46	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	2.13E-09	2.19E-09	2.19E-09	2.02E-09	lb/MMBtu	1	4.43	5.01	0.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Naphthalene	A3-v0	1.72E-07	1.63E-07	2.03E-07	1.49E-07	lb/MMBtu	1	16.13	18.25	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Phenanthrene	A3-v0	4.71E-08	3.63E-08	7.43E-08	3.06E-08	lb/MMBtu	1	50.50	57.15	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	PAH	Pyrene	A3-v0	5.00E-08	4.36E-08	6.99E-08	3.63E-08	lb/MMBtu	1	35.35	40.00	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	SVOC	Phenol	C2-v0	1.83E-06	7.04E-07	4.91E-06	5.45E-07	lb/MMBtu	4	99.84	56.49	0.85
Boiler, Ref. Gas/1	10200701	SCR	None	VOC	Acetaldehyde	C1-v3	3.01E-06	2.11E-06	1.01E-05	4.10E-09	lb/MMBtu	5	95.45	48.30	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	VOC	Benzene	C1-v2	1.74E-04	5.03E-05	1.22E-03	2.86E-06	lb/MMBtu	5	186.11	91.19	0.80
Boiler, Ref. Gas/1	10200701	SCR	None	VOC	Formaldehyde	C1-v1	1.32E-05	1.16E-05	3.62E-05	2.81E-06	lb/MMBtu	5	66.84	33.82	1.00
Boiler, Ref. Gas/1	10200701	SCR	None	VOC	Hydrogen Sulfide	A1-v1	2.21E-04	1.69E-04	5.93E-04	5.01E-05	lb/MMBtu	5	92.80	45.47	0.00
Boiler, Ref. Gas/1	10200701	SCR	None	VOC	Toluene	E2-v2	7.23E-04	7.25E-05	4.37E-03	3.59E-05	lb/MMBtu	3	193.00	126.09	0.97
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:4D 2378	A3-v0	3.68E-11	3.66E-11	4.86E-11	2.51E-11	lb/MMBtu	1	31.88	36.08	0.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:4D Other	A3-v0	4.44E-10	4.14E-10	8.31E-10	8.81E-11	lb/MMBtu	1	83.85	94.88	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:5D 12378	A3-v0	2.92E-11	2.56E-11	3.74E-11	2.47E-11	lb/MMBtu	1	24.24	27.43	0.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:5D Other	A3-v0	2.74E-10	2.83E-10	3.63E-10	1.76E-10	lb/MMBtu	1	34.15	38.64	0.40
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:6D 123478	A3-v0	3.45E-11	2.57E-11	6.45E-11	1.34E-11	lb/MMBtu	1	77.21	87.37	0.31

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:6D 123678	A3-v0	4.40E-11	5.23E-11	5.68E-11	2.30E-11	lb/MMBtu	1	41.59	47.07	0.69
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:6D 123789	A3-v0	4.22E-11	4.16E-11	5.95E-11	2.56E-11	lb/MMBtu	1	40.22	45.52	0.39
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:6D Other	A3-v0	2.06E-10	2.49E-10	2.76E-10	9.42E-11	lb/MMBtu	1	47.47	53.72	0.65
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:7D 1234678	A3-v0	4.19E-10	3.27E-10	6.05E-10	3.27E-10	lb/MMBtu	1	38.30	43.34	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:7D Other	A3-v0	4.09E-10	3.99E-10	5.27E-10	3.02E-10	lb/MMBtu	1	27.59	31.22	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Dioxin:8D	A3-v0	5.25E-09	4.98E-09	7.65E-09	3.12E-09	lb/MMBtu	1	43.40	49.11	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:4F 2378	A3-v0	4.23E-11	4.53E-11	4.85E-11	3.31E-11	lb/MMBtu	1	19.19	21.72	0.70
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:4F Other	A3-v0	4.35E-10	4.51E-10	5.97E-10	2.56E-10	lb/MMBtu	1	39.34	44.51	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:5F 12378	A3-v0	4.42E-11	4.16E-11	5.87E-11	3.23E-11	lb/MMBtu	1	30.36	34.35	0.65
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:5F 23478	A3-v0	4.09E-11	4.07E-11	5.66E-11	2.53E-11	lb/MMBtu	1	38.39	43.44	0.63
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:5F Other	A3-v0	3.76E-10	3.89E-10	4.98E-10	2.42E-10	lb/MMBtu	1	34.21	38.71	0.74
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:6F 123478	A3-v0	7.88E-11	7.53E-11	1.02E-10	5.88E-11	lb/MMBtu	1	27.77	31.43	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:6F 123678	A3-v0	7.11E-11	8.68E-11	9.00E-11	3.65E-11	lb/MMBtu	1	42.25	47.81	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:6F 123789	A3-v0	2.95E-11	3.32E-11	3.68E-11	1.84E-11	lb/MMBtu	1	33.01	37.36	0.67
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:6F 234678	A3-v0	6.50E-11	5.68E-11	8.39E-11	5.43E-11	lb/MMBtu	1	25.28	28.60	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:6F Other	A3-v0	4.81E-10	5.38E-10	6.54E-10	2.51E-10	lb/MMBtu	1	43.15	48.82	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:7F 1234678	A3-v0	4.75E-10	4.90E-10	5.42E-10	3.94E-10	lb/MMBtu	1	15.81	17.89	1.00
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:7F 1234789	A3-v0	8.04E-11	8.31E-11	8.70E-11	7.12E-11	lb/MMBtu	1	10.23	11.58	0.72
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:7F Other	A3-v0	1.77E-10	1.77E-10	2.12E-10	1.43E-10	lb/MMBtu	1	27.28	37.81	0.50
Coke Calcining/1	30601401	SD/FF	None	Dioxin/Furan	Furan:8F	A3-v1	4.13E-10	3.77E-10	7.94E-10	6.63E-11	lb/MMBtu	1	88.52	100.16	1.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Antimony	C3-v0	1.44E-04	1.42E-04	1.52E-04	1.37E-04	lb/MMBtu	1	5.19	5.87	0.34
Coke Calcining/1	30601401	SD/FF	None	Metals	Arsenic	C3-v0	1.45E-05	1.42E-05	1.56E-05	1.37E-05	lb/MMBtu	1	6.73	7.62	0.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Barium	C3-v0	6.10E-05	6.40E-05	7.79E-05	4.11E-05	lb/MMBtu	1	30.51	34.52	1.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Beryllium	C3-v0	6.03E-06	5.45E-06	7.83E-06	4.81E-06	lb/MMBtu	1	26.41	29.88	0.42
Coke Calcining/1	30601401	SD/FF	None	Metals	Cadmium	C3-v0	2.90E-05	2.85E-05	3.12E-05	2.74E-05	lb/MMBtu	1	6.71	7.59	0.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Chromium (Hex)	C3-v0	2.12E-06	1.93E-06	2.88E-06	1.54E-06	lb/MMBtu	1	32.38	36.64	1.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Chromium (Total)	C3-v0	6.90E-05	5.92E-05	9.35E-05	5.44E-05	lb/MMBtu	1	30.92	34.99	1.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Copper	C3-v0	2.90E-05	2.85E-05	3.12E-05	2.74E-05	lb/MMBtu	1	6.71	7.59	0.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Lead	C3-v0	1.91E-04	1.56E-04	2.74E-04	1.42E-04	lb/MMBtu	1	37.94	42.93	0.50
Coke Calcining/1	30601401	SD/FF	None	Metals	Manganese	C3-v0	1.44E-04	1.42E-04	2.42E-04	4.81E-05	lb/MMBtu	1	67.22	76.06	0.88
Coke Calcining/1	30601401	SD/FF	None	Metals	Mercury	C3-v1	1.48E-04	4.81E-05	3.60E-04	3.43E-05	lb/MMBtu	1	124.89	141.33	1.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Nickel	C3-v0	2.87E-04	1.56E-04	5.68E-04	1.37E-04	lb/MMBtu	1	84.93	96.10	0.65
Coke Calcining/1	30601401	SD/FF	None	Metals	Phosphorus	C3-v0	1.45E-03	1.42E-03	1.56E-03	1.37E-03	lb/MMBtu	1	6.73	7.62	0.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Selenium	C3-v0	1.45E-05	1.42E-05	1.56E-05	1.37E-05	lb/MMBtu	1	6.73	7.62	0.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Silver	C3-v0	5.07E-05	4.97E-05	5.45E-05	4.81E-05	lb/MMBtu	1	6.52	7.37	0.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Thallium	C3-v0	2.18E-04	2.14E-04	2.34E-04	2.06E-04	lb/MMBtu	1	6.65	7.53	0.00
Coke Calcining/1	30601401	SD/FF	None	Metals	Zinc	C3-v0	3.66E-04	3.08E-04	5.25E-04	2.65E-04	lb/MMBtu	1	38.08	43.10	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Acenaphthene	A3-v0	4.40E-08	4.06E-08	5.43E-08	3.70E-08	lb/MMBtu	1	20.68	23.40	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Acenaphthylene	A3-v0	5.59E-08	4.58E-08	9.29E-08	2.90E-08	lb/MMBtu	1	59.27	67.06	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Anthracene	A3-v0	5.40E-08	5.43E-08	5.79E-08	4.98E-08	lb/MMBtu	1	7.50	8.48	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Benzo(a)anthracene	A3-v0	2.60E-08	2.72E-08	2.99E-08	2.08E-08	lb/MMBtu	1	18.05	20.43	0.39
Coke Calcining/1	30601401	SD/FF	None	PAH	Benzo(a)pyrene	A3-v0	2.41E-08	2.42E-08	2.72E-08	2.08E-08	lb/MMBtu	1	13.35	15.10	0.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Benzo(b)fluoranthene	A3-v0	2.41E-08	2.42E-08	2.72E-08	2.08E-08	lb/MMBtu	1	13.35	15.10	0.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Benzo(g,h,i)perylene	A3-v0	2.41E-08	2.42E-08	2.72E-08	2.08E-08	lb/MMBtu	1	13.35	15.10	0.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Benzo(k)fluoranthene	A3-v0	2.41E-08	2.42E-08	2.72E-08	2.08E-08	lb/MMBtu	1	13.35	15.10	0.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Chrysene	A3-v0	3.73E-08	3.48E-08	4.98E-08	2.72E-08	lb/MMBtu	1	30.84	34.90	0.79
Coke Calcining/1	30601401	SD/FF	None	PAH	Dibenz(a,h)anthracene	A3-v0	2.41E-08	2.42E-08	2.72E-08	2.08E-08	lb/MMBtu	1	13.35	15.10	0.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Fluoranthene	A3-v0	1.06E-07	1.09E-07	1.16E-07	9.18E-08	lb/MMBtu	1	11.95	13.52	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Fluorene	A3-v0	1.70E-07	1.50E-07	2.18E-07	1.41E-07	lb/MMBtu	1	24.78	28.04	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	2.41E-08	2.42E-08	2.72E-08	2.08E-08	lb/MMBtu	1	13.35	15.10	0.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Naphthalene	A3-v0	7.29E-06	6.67E-06	1.04E-05	4.83E-06	lb/MMBtu	1	38.67	43.75	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Phenanthrene	A3-v0	5.66E-07	5.31E-07	7.09E-07	4.58E-07	lb/MMBtu	1	22.80	25.80	1.00
Coke Calcining/1	30601401	SD/FF	None	PAH	Pyrene	A3-v0	7.86E-08	7.75E-08	8.76E-08	7.09E-08	lb/MMBtu	1	10.68	12.09	1.00
Coke Calcining/1	30601401	SD/FF	None	VOC	Acetaldehyde	A3-v0	3.12E-03	3.14E-03	3.89E-03	2.33E-03	lb/MMBtu	1	24.96	28.25	1.00
Coke Calcining/1	30601401	SD/FF	None	VOC	Acrolein	A3-v0	1.04E-03	1.06E-03	1.14E-03	9.25E-04	lb/MMBtu	1	10.62	12.02	0.00
Coke Calcining/1	30601401	SD/FF	None	VOC	Benzene	C3-v0	1.03E-03	1.39E-03	1.45E-03	2.62E-04	lb/MMBtu	1	64.73	73.25	1.00
Coke Calcining/1	30601401	SD/FF	None	VOC	Formaldehyde	A3-v0	1.04E-03	1.06E-03	1.14E-03	9.25E-04	lb/MMBtu	1	10.62	12.02	0.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Coke Calcining/1	30601401	SD/FF	None	VOC	Toluene	C3-v0	1.63E-04	1.44E-04	2.45E-04	9.97E-05	lb/MMBtu	1	45.82	51.85	1.00
Coke Calcining/1	30601401	SD/FF	None	VOC	Xylene (m,p)	C3-v0	8.90E-05	8.62E-05	1.11E-04	6.99E-05	lb/MMBtu	1	23.14	26.18	0.22
Coke Calcining/1	30601401	SD/FF	None	VOC	Xylene (o)	C3-v0	1.32E-04	1.40E-04	1.48E-04	1.09E-04	lb/MMBtu	1	15.78	17.86	0.00
Heater, Natural Gas/1	31000404	None	None	PAH	Acenaphthene	A3-v0	1.36E-09	1.36E-09	1.58E-09	1.13E-09	lb/MMBtu	1	16.72	18.92	0.72
Heater, Natural Gas/1	31000404	None	None	PAH	Acenaphthylene	A3-v1	1.18E-08	2.77E-09	3.16E-08	1.13E-09	lb/MMBtu	1	144.82	163.88	0.97
Heater, Natural Gas/1	31000404	None	None	PAH	Anthracene	A3-v0	1.57E-09	1.79E-09	1.80E-09	1.13E-09	lb/MMBtu	1	24.62	27.86	0.76
Heater, Natural Gas/1	31000404	None	None	PAH	Benzo(a)anthracene	A3-v0	1.38E-09	1.16E-09	1.85E-09	1.13E-09	lb/MMBtu	1	29.86	33.79	0.45
Heater, Natural Gas/1	31000404	None	None	PAH	Benzo(a)pyrene	A3-v0	1.11E-09	1.13E-09	1.16E-09	1.05E-09	lb/MMBtu	1	4.76	5.39	0.00
Heater, Natural Gas/1	31000404	None	None	PAH	Benzo(b)fluoranthene	A3-v0	1.11E-09	1.13E-09	1.16E-09	1.05E-09	lb/MMBtu	1	4.76	5.39	0.00
Heater, Natural Gas/1	31000404	None	None	PAH	Benzo(g,h,i)perylene	A3-v0	1.22E-09	1.16E-09	1.39E-09	1.13E-09	lb/MMBtu	1	11.81	13.36	0.38
Heater, Natural Gas/1	31000404	None	None	PAH	Benzo(k)fluoranthene	A3-v0	1.11E-09	1.13E-09	1.16E-09	1.05E-09	lb/MMBtu	1	4.76	5.39	0.00
Heater, Natural Gas/1	31000404	None	None	PAH	Chrysene	A3-v0	1.36E-09	1.16E-09	1.79E-09	1.13E-09	lb/MMBtu	1	27.63	31.27	0.44
Heater, Natural Gas/1	31000404	None	None	PAH	Dibenz(a,h)anthracene	A3-v0	1.11E-09	1.13E-09	1.16E-09	1.05E-09	lb/MMBtu	1	4.76	5.39	0.00
Heater, Natural Gas/1	31000404	None	None	PAH	Fluoranthene	A3-v0	1.16E-08	1.04E-08	1.75E-08	6.98E-09	lb/MMBtu	1	46.07	52.14	1.00
Heater, Natural Gas/1	31000404	None	None	PAH	Fluorene	A3-v0	4.49E-09	4.39E-09	5.69E-09	3.38E-09	lb/MMBtu	1	25.79	29.19	1.00
Heater, Natural Gas/1	31000404	None	None	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	1.11E-09	1.13E-09	1.16E-09	1.05E-09	lb/MMBtu	1	4.76	5.39	0.00
Heater, Natural Gas/1	31000404	None	None	PAH	Naphthalene	A3-v0	2.31E-07	2.31E-07	2.74E-07	1.89E-07	lb/MMBtu	1	18.28	20.69	1.00
Heater, Natural Gas/1	31000404	None	None	PAH	Phenanthrene	A3-v0	3.29E-08	3.24E-08	4.63E-08	2.00E-08	lb/MMBtu	1	39.96	45.22	1.00
Heater, Natural Gas/1	31000404	None	None	PAH	Pyrene	A3-v0	5.47E-09	2.77E-09	1.14E-08	2.25E-09	lb/MMBtu	1	93.70	106.03	1.00
Heater, Natural Gas/1	31000404	None	None	SVOC	Ethylbenzene	A3-v0	2.20E-06	2.20E-06	2.20E-06	2.20E-06	lb/MMBtu	1	0.00	0.00	0.00
Heater, Natural Gas/1	31000404	None	None	VOC	Acetaldehyde	A3-v0	4.50E-06	4.50E-06	4.71E-06	4.30E-06	lb/MMBtu	1	4.47	5.06	0.32
Heater, Natural Gas/1	31000404	None	None	VOC	Acrolein	A3-v0	4.40E-06	4.46E-06	4.53E-06	4.22E-06	lb/MMBtu	1	3.66	4.14	0.00
Heater, Natural Gas/1	31000404	None	None	VOC	Benzene	A3-v0	2.28E-06	1.61E-06	3.62E-06	1.61E-06	lb/MMBtu	1	50.72	57.40	0.53
Heater, Natural Gas/1	31000404	None	None	VOC	Formaldehyde	A3-v0	4.64E-06	4.50E-06	5.19E-06	4.22E-06	lb/MMBtu	1	10.76	12.18	0.37
Heater, Natural Gas/1	31000404	None	None	VOC	Propylene	A3-v0	4.53E-04	4.47E-04	5.98E-04	3.13E-04	lb/MMBtu	1	31.59	35.74	1.00
Heater, Natural Gas/1	31000404	None	None	VOC	Toluene	A3-v0	3.15E-05	1.35E-05	7.29E-05	8.17E-06	lb/MMBtu	1	114.08	129.09	1.00
Heater, Natural Gas/1	31000404	None	None	VOC	Xylene (Total)	A3-v0	1.82E-05	2.01E-05	2.90E-05	5.58E-06	lb/MMBtu	1	64.92	73.46	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Acenaphthene	A3-v0	4.05E-09	1.38E-09	9.73E-09	1.05E-09	lb/MMBtu	1	121.25	137.21	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Acenaphthylene	A3-v1	3.16E-08	1.31E-09	9.23E-08	1.08E-09	lb/MMBtu	1	166.64	188.56	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Anthracene	A3-v0	5.59E-09	4.60E-09	7.69E-09	4.48E-09	lb/MMBtu	1	32.56	36.85	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Benzo(a)anthracene	A3-v0	5.18E-09	4.34E-09	8.97E-09	2.23E-09	lb/MMBtu	1	66.60	75.36	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Benzo(a)pyrene	A3-v1	3.24E-09	3.78E-09	5.65E-09	2.82E-10	lb/MMBtu	1	84.14	95.21	0.97
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Benzo(b)fluoranthene	A3-v0	1.44E-09	1.03E-09	2.38E-09	9.21E-10	lb/MMBtu	1	56.34	63.75	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Benzo(g,h,i)perylene	A3-v0	2.22E-10	8.16E-11	5.13E-10	7.08E-11	lb/MMBtu	1	113.71	128.67	0.77
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Benzo(k)fluoranthene	A3-v0	7.64E-10	4.49E-10	1.63E-09	2.10E-10	lb/MMBtu	1	99.78	112.91	0.92
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Chrysene	A3-v0	4.27E-10	3.62E-10	6.67E-10	2.52E-10	lb/MMBtu	1	50.33	56.95	0.52
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Dibenz(a,h)anthracene	A3-v0	7.45E-11	5.73E-11	1.12E-10	5.48E-11	lb/MMBtu	1	43.05	48.72	0.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Fluoranthene	A3-v0	9.73E-09	5.86E-09	2.05E-08	2.82E-09	lb/MMBtu	1	97.23	110.02	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Fluorene	A3-v1	3.49E-07	8.52E-08	9.09E-07	5.20E-08	lb/MMBtu	1	139.21	157.53	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	2.45E-10	2.08E-10	3.58E-10	1.68E-10	lb/MMBtu	1	41.08	46.49	0.49
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Naphthalene	A3-v1	1.24E-06	2.08E-07	3.32E-06	1.96E-07	lb/MMBtu	1	145.06	164.15	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Phenanthrene	A3-v0	1.11E-07	6.02E-08	2.31E-07	4.29E-08	lb/MMBtu	1	93.26	105.53	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	PAH	Pyrene	A3-v0	6.74E-09	4.05E-09	1.41E-08	2.08E-09	lb/MMBtu	1	95.66	108.24	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	SVOC	Phenol	A3-v0	9.22E-07	9.35E-07	1.12E-06	7.14E-07	lb/MMBtu	1	21.82	24.69	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	VOC	Acetaldehyde	C3-v0	7.02E-06	6.94E-06	7.52E-06	6.59E-06	lb/MMBtu	1	6.67	7.55	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	VOC	Acrolein	C3-v0	1.08E-06	1.10E-06	1.12E-06	1.03E-06	lb/MMBtu	1	4.51	5.11	0.00
Heater, Natural/Ref. Gas/1	30600199	None	None	VOC	Benzene	A3-v0	1.01E-05	1.02E-05	1.06E-05	9.61E-06	lb/MMBtu	1	4.81	5.44	0.00
Heater, Natural/Ref. Gas/1	30600199	None	None	VOC	Formaldehyde	C3-v0	2.19E-05	9.37E-06	4.74E-05	9.10E-06	lb/MMBtu	1	100.34	113.54	1.00
Heater, Natural/Ref. Gas/1	30600199	None	None	VOC	Propylene	A3-v0	5.75E-06	5.78E-06	6.01E-06	5.46E-06	lb/MMBtu	1	4.81	5.44	0.00
Heater, Natural/Ref. Gas/1	30600199	None	None	VOC	Toluene	A3-v0	1.26E-05	1.26E-05	1.31E-05	1.19E-05	lb/MMBtu	1	4.81	5.44	0.00
Heater, Natural/Ref. Gas/1	30600199	None	None	VOC	Xylene (Total)	A3-v0	1.45E-05	1.46E-05	1.51E-05	1.38E-05	lb/MMBtu	1	4.81	5.44	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Dioxin:4D 2378	C3-v0	3.46E-12	4.15E-12	4.17E-12	2.08E-12	lb/MMBtu	1	34.70	39.26	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Dioxin:5D 12378	C3-v1	1.74E-11	4.15E-12	4.59E-11	2.08E-12	lb/MMBtu	1	142.30	161.02	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Dioxin:6D 123478	C3-v1	1.53E-11	4.15E-12	3.96E-11	2.08E-12	lb/MMBtu	1	138.10	156.28	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Dioxin:6D 123678	C3-v1	2.08E-11	4.15E-12	5.63E-11	2.08E-12	lb/MMBtu	1	147.43	166.83	0.07
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Dioxin:6D 123789	C3-v1	3.33E-11	4.15E-12	9.38E-11	2.08E-12	lb/MMBtu	1	157.08	177.75	0.04
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Dioxin:7D 1234678	C3-v1	9.30E-11	3.11E-11	2.29E-10	1.87E-11	lb/MMBtu	1	127.05	143.76	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Dioxin:8D	C3-v0	3.26E-10	3.94E-10	4.17E-10	1.68E-10	lb/MMBtu	1	42.12	47.67	1.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:4F 2378	C3-v2	6.23E-10	1.04E-11	1.86E-09	4.15E-12	lb/MMBtu	1	171.19	193.71	1.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:5F 12378	C3-v1	5.97E-11	4.15E-12	1.73E-10	2.08E-12	lb/MMBtu	1	164.20	185.80	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:5F 23478	C3-v2	1.06E-10	4.15E-12	3.13E-10	2.08E-12	lb/MMBtu	1	168.14	190.26	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:6F 123478	C3-v2	1.34E-10	4.15E-12	3.96E-10	1.04E-12	lb/MMBtu	1	169.85	192.20	0.01
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:6F 123678	C3-v2	4.27E-11	2.07E-12	1.25E-10	1.04E-12	lb/MMBtu	1	166.91	188.87	0.02
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:6F 123789	C3-v0	3.46E-12	4.15E-12	4.17E-12	2.08E-12	lb/MMBtu	1	34.70	39.26	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:6F 234678	C3-v1	6.11E-11	6.22E-12	1.73E-10	4.15E-12	lb/MMBtu	1	158.52	179.38	0.03
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:7F 1234678	C3-v1	1.36E-10	8.29E-12	3.96E-10	4.15E-12	lb/MMBtu	1	165.30	187.05	1.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:7F 1234789	C3-v0	8.33E-12	4.15E-12	1.88E-11	2.08E-12	lb/MMBtu	1	109.22	123.59	0.00
Heater, Oil/1	31000403	None	None	Dioxin/Furan	Furan:8F	C3-v1	7.29E-11	3.32E-11	1.77E-10	8.30E-12	lb/MMBtu	1	125.10	141.57	1.00
Heater, Oil/1	31000403	None	None	Metals	Arsenic	D3-v0	5.82E-06	5.78E-06	6.02E-06	5.67E-06	lb/MMBtu	1	3.01	3.41	0.00
Heater, Oil/1	31000403	None	None	Metals	Beryllium	D3-v0	5.43E-07	5.33E-07	6.04E-07	4.92E-07	lb/MMBtu	1	10.51	11.89	0.00
Heater, Oil/1	31000403	None	None	Metals	Cadmium	D3-v1	5.73E-06	8.28E-06	8.60E-06	2.99E-07	lb/MMBtu	1	82.13	92.94	1.00
Heater, Oil/1	31000403	None	None	Metals	Chromium (Hex)	A3-v0	2.00E-06	2.14E-06	2.18E-06	1.67E-06	lb/MMBtu	1	14.20	16.07	0.00
Heater, Oil/1	31000403	None	None	Metals	Chromium (Total)	A3-v0	1.77E-05	1.85E-05	1.91E-05	1.55E-05	lb/MMBtu	1	11.14	12.60	1.00
Heater, Oil/1	31000403	None	None	Metals	Copper	D3-v0	1.83E-05	1.15E-05	3.20E-05	1.14E-05	lb/MMBtu	1	64.94	73.48	1.00
Heater, Oil/1	31000403	None	None	Metals	Lead	D3-v0	2.07E-06	1.25E-06	3.83E-06	1.13E-06	lb/MMBtu	1	73.61	83.30	0.62
Heater, Oil/1	31000403	None	None	Metals	Manganese	D3-v0	1.32E-05	1.25E-05	1.55E-05	1.17E-05	lb/MMBtu	1	15.12	17.11	0.39
Heater, Oil/1	31000403	None	None	Metals	Mercury	D3-v0	1.20E-07	8.99E-08	1.98E-07	7.28E-08	lb/MMBtu	1	56.41	63.84	0.00
Heater, Oil/1	31000403	None	None	Metals	Nickel	D3-v0	2.41E-03	2.42E-03	2.86E-03	1.96E-03	lb/MMBtu	1	18.57	21.01	1.00
Heater, Oil/1	31000403	None	None	Metals	Selenium	D3-v0	3.23E-05	2.77E-05	4.60E-05	2.33E-05	lb/MMBtu	1	37.32	42.23	0.00
Heater, Oil/1	31000403	None	None	Metals	Zinc	D3-v0	6.23E-05	5.83E-05	8.49E-05	4.38E-05	lb/MMBtu	1	33.43	37.83	1.00
Heater, Oil/1	31000403	None	None	PAH	Acenaphthene	C3-v1	1.22E-08	1.53E-08	2.09E-08	4.76E-10	lb/MMBtu	1	86.27	97.62	1.00
Heater, Oil/1	31000403	None	None	PAH	Acenaphthylene	C3-v0	5.59E-10	3.72E-10	9.55E-10	3.51E-10	lb/MMBtu	1	61.23	69.29	1.00
Heater, Oil/1	31000403	None	None	PAH	Anthracene	C3-v0	4.62E-10	4.75E-10	5.17E-10	3.94E-10	lb/MMBtu	1	13.48	15.25	1.00
Heater, Oil/1	31000403	None	None	PAH	Benzo(a)anthracene	C3-v1	2.68E-08	1.43E-09	7.79E-08	9.30E-10	lb/MMBtu	1	165.56	187.35	1.00
Heater, Oil/1	31000403	None	None	PAH	Benzo(a)pyrene	C3-v0	6.84E-10	6.02E-10	1.28E-09	1.67E-10	lb/MMBtu	1	82.16	92.97	1.00
Heater, Oil/1	31000403	None	None	PAH	Benzo(b)fluoranthene	C3-v0	5.55E-09	4.44E-09	8.02E-09	4.17E-09	lb/MMBtu	1	38.74	43.84	1.00
Heater, Oil/1	31000403	None	None	PAH	Benzo(e)pyrene	C3-v0	3.87E-09	3.70E-09	5.39E-09	2.51E-09	lb/MMBtu	1	37.44	42.36	1.00
Heater, Oil/1	31000403	None	None	PAH	Benzo(g,h,i)perylene	C3-v1	1.48E-08	3.84E-09	3.88E-08	1.78E-09	lb/MMBtu	1	140.55	159.04	1.00
Heater, Oil/1	31000403	None	None	PAH	Benzo(k)fluoranthene	C3-v0	2.35E-10	1.45E-10	4.76E-10	8.27E-11	lb/MMBtu	1	90.02	101.86	1.00
Heater, Oil/1	31000403	None	None	PAH	Chrysene	C3-v1	7.81E-08	1.95E-08	2.04E-07	1.07E-08	lb/MMBtu	1	139.73	158.12	1.00
Heater, Oil/1	31000403	None	None	PAH	Dibenz(a,h)anthracene	C3-v1	1.23E-08	8.23E-10	3.55E-08	4.57E-10	lb/MMBtu	1	164.18	185.78	1.00
Heater, Oil/1	31000403	None	None	PAH	Fluoranthene	C3-v0	1.37E-08	1.59E-08	1.73E-08	7.89E-09	lb/MMBtu	1	37.09	41.97	1.00
Heater, Oil/1	31000403	None	None	PAH	Fluorene	C3-v0	5.22E-07	2.26E-07	1.16E-06	1.76E-07	lb/MMBtu	1	106.53	120.55	1.00
Heater, Oil/1	31000403	None	None	PAH	Indeno(1,2,3-cd)pyrene	C3-v1	1.26E-08	1.08E-09	3.58E-08	1.03E-09	lb/MMBtu	1	158.71	179.59	1.00
Heater, Oil/1	31000403	None	None	PAH	Naphthalene	C3-v0	5.91E-06	7.28E-06	7.73E-06	2.71E-06	lb/MMBtu	1	47.07	53.26	1.00
Heater, Oil/1	31000403	None	None	PAH	Phenanthrene	C3-v1	1.74E-07	8.23E-08	4.20E-07	1.98E-08	lb/MMBtu	1	123.75	140.04	1.00
Heater, Oil/1	31000403	None	None	PAH	Pyrene	C3-v0	9.22E-09	8.32E-09	1.49E-08	4.38E-09	lb/MMBtu	1	57.94	65.56	1.00
Heater, Oil/1	31000403	None	None	SVOC	2-Chloronaphthalene	C3-v2	8.16E-08	3.72E-10	2.44E-07	2.49E-10	lb/MMBtu	1	172.55	195.25	1.00
Heater, Oil/1	31000403	None	None	SVOC	2-Methylnaphthalene	C3-v1	2.51E-07	7.40E-08	6.49E-07	3.17E-08	lb/MMBtu	1	137.05	155.09	1.00
Heater, Oil/1	31000403	None	None	SVOC	Perylene	C3-v0	5.17E-10	2.49E-10	1.16E-09	1.45E-10	lb/MMBtu	1	107.75	121.93	1.00
Heater, Oil/1	31000403	None	None	VOC	1,3-Butadiene	A3-v0	1.36E-04	1.37E-04	1.40E-04	1.32E-04	lb/MMBtu	1	3.14	3.55	0.00
Heater, Oil/1	31000403	None	None	VOC	Acetaldehyde	C3-v0	3.79E-06	3.80E-06	3.83E-06	3.75E-06	lb/MMBtu	1	0.98	1.11	0.00
Heater, Oil/1	31000403	None	None	VOC	Acrolein	C3-v0	4.17E-06	4.18E-06	4.21E-06	4.13E-06	lb/MMBtu	1	0.95	1.07	0.00
Heater, Oil/1	31000403	None	None	VOC	Benzene	A3-v0	5.91E-05	5.92E-05	6.10E-05	5.72E-05	lb/MMBtu	1	3.22	3.65	0.00
Heater, Oil/1	31000403	None	None	VOC	Chloroform	A3-v0	6.02E-05	6.03E-05	6.20E-05	5.83E-05	lb/MMBtu	1	3.06	3.46	0.00
Heater, Oil/1	31000403	None	None	VOC	Formaldehyde	C3-v0	2.65E-05	2.66E-05	2.68E-05	2.63E-05	lb/MMBtu	1	0.95	1.08	0.00
Heater, Oil/1	31000403	None	None	VOC	Propylene	A3-v0	1.06E-04	1.06E-04	1.09E-04	1.03E-04	lb/MMBtu	1	3.01	3.41	0.00
Heater, Oil/1	31000403	None	None	VOC	Toluene	A3-v0	6.97E-05	6.99E-05	7.18E-05	6.75E-05	lb/MMBtu	1	3.06	3.46	0.00
Heater, Oil/1	31000403	None	None	VOC	Xylene (Total)	A3-v0	1.34E-04	1.34E-04	1.38E-04	1.29E-04	lb/MMBtu	1	3.21	3.63	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Antimony	C3-v0	5.17E-07	5.84E-07	7.58E-07	2.10E-07	lb/MMBtu	1	54.13	61.25	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Arsenic	C3-v0	8.50E-07	9.90E-07	1.28E-06	2.84E-07	lb/MMBtu	1	60.10	68.00	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Barium	C3-v0	5.78E-06	5.78E-06	5.92E-06	5.63E-06	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Beryllium	C3-v0	2.57E-07	2.57E-07	2.63E-07	2.50E-07	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Cadmium	C3-v0	9.88E-07	9.65E-07	1.18E-06	8.15E-07	lb/MMBtu	1	18.76	21.23	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Chromium (Hex)	C3-v0	2.17E-06	2.21E-06	2.24E-06	2.05E-06	lb/MMBtu	1	4.62	5.23	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Chromium (Total)	C3-v0	1.07E-06	6.57E-07	1.93E-06	6.26E-07	lb/MMBtu	1	69.39	78.52	0.60
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Copper	C3-v0	4.21E-06	1.93E-06	9.39E-06	1.31E-06	lb/MMBtu	1	106.76	120.81	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Lead	C3-v0	4.89E-06	3.94E-06	7.51E-06	3.21E-06	lb/MMBtu	1	47.03	53.22	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Manganese	C3-v0	6.81E-06	6.26E-06	1.22E-05	1.97E-06	lb/MMBtu	1	75.45	85.38	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Mercury	C3-v0	1.80E-07	1.75E-07	1.93E-07	1.71E-07	lb/MMBtu	1	6.49	7.34	0.36
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Nickel	C3-v1	9.42E-06	1.31E-06	2.57E-05	1.29E-06	lb/MMBtu	1	149.30	168.95	0.95
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Phosphorus	C3-v0	6.42E-07	6.43E-07	6.57E-07	6.26E-07	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Selenium	C3-v0	1.96E-08	2.03E-08	2.54E-08	1.32E-08	lb/MMBtu	1	31.23	35.34	0.78
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Silver	C3-v1	1.61E-06	1.31E-06	3.21E-06	3.14E-07	lb/MMBtu	1	91.23	103.24	0.94
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Thallium	C3-v0	5.78E-06	5.78E-06	5.92E-06	5.63E-06	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	Metals	Zinc	C3-v0	2.08E-05	2.58E-05	2.83E-05	8.48E-06	lb/MMBtu	1	51.72	58.53	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Acenaphthene	A2-v0	2.36E-09	1.55E-09	5.61E-09	1.20E-09	lb/MMBtu	4	69.14	40.86	0.95
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Acenaphthylene	A2-v0	1.55E-09	1.25E-09	2.74E-09	1.02E-09	lb/MMBtu	4	41.70	24.64	0.51
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Anthracene	A2-v0	2.87E-09	2.30E-09	6.45E-09	1.09E-09	lb/MMBtu	4	61.24	36.19	0.92
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Benzo(a)anthracene	A1-v2	3.21E-08	5.40E-09	3.39E-07	1.05E-09	lb/MMBtu	9	265.30	101.97	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Benzo(a)pyrene	A1-v3	8.96E-08	1.73E-09	1.38E-06	1.02E-09	lb/MMBtu	9	352.36	135.44	0.98
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Benzo(b)fluoranthene	A1-v2	4.04E-08	3.31E-09	4.87E-07	1.02E-09	lb/MMBtu	9	314.58	120.92	0.99
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Benzo(g,h,i)perylene	A2-v0	1.17E-09	1.10E-09	1.40E-09	1.02E-09	lb/MMBtu	4	11.55	6.82	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Benzo(k)fluoranthene	A1-v2	2.41E-08	2.18E-09	2.96E-07	1.02E-09	lb/MMBtu	9	310.01	119.16	0.96
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Chrysene	A2-v0	1.63E-09	1.23E-09	4.79E-09	1.02E-09	lb/MMBtu	4	66.84	39.50	0.63
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Dibenz(a,h)anthracene	A1-v2	1.02E-08	1.60E-09	1.37E-07	5.93E-10	lb/MMBtu	9	279.09	107.28	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Fluoranthene	A2-v0	3.06E-09	3.14E-09	5.04E-09	1.85E-09	lb/MMBtu	4	33.80	19.97	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Fluorene	A2-v0	1.08E-08	8.77E-09	2.74E-08	2.96E-09	lb/MMBtu	4	70.62	41.74	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Indeno(1,2,3-cd)pyrene	A1-v3	1.03E-07	1.75E-09	1.42E-06	1.02E-09	lb/MMBtu	9	343.01	131.85	0.99
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Naphthalene	A2-v0	3.13E-07	2.61E-07	7.58E-07	1.19E-07	lb/MMBtu	4	66.90	39.53	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Phenanthrene	A2-v0	1.46E-08	1.50E-08	2.25E-08	6.91E-09	lb/MMBtu	4	32.60	19.27	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	PAH	Pyrene	A2-v0	2.84E-09	2.72E-09	4.53E-09	1.87E-09	lb/MMBtu	4	28.87	17.06	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	SVOC	Ethylbenzene	A2-v1	3.02E-05	1.79E-05	1.03E-04	2.72E-06	lb/MMBtu	4	104.65	59.21	0.51
Heater, Ref. Gas/1	30600106	DeNOx	None	SVOC	Phenol	C1-v1	5.63E-06	3.14E-06	2.54E-05	2.84E-07	lb/MMBtu	7	114.62	49.02	0.97
Heater, Ref. Gas/1	30600106	DeNOx	None	VOC	Acetaldehyde	B1-v3	1.53E-05	8.12E-06	8.55E-05	8.41E-08	lb/MMBtu	8	126.30	50.53	0.88
Heater, Ref. Gas/1	30600106	DeNOx	None	VOC	Benzene	B1-v1	6.47E-05	5.49E-05	1.85E-04	2.54E-06	lb/MMBtu	11	87.67	29.91	0.02
Heater, Ref. Gas/1	30600106	DeNOx	None	VOC	Formaldehyde	B1-v3	1.11E-04	1.90E-05	1.34E-03	7.67E-07	lb/MMBtu	7	262.94	112.46	1.00
Heater, Ref. Gas/1	30600106	DeNOx	None	VOC	Hydrogen Sulfide	A1-v1	2.92E-04	2.46E-04	8.04E-04	1.76E-05	lb/MMBtu	7	75.53	32.30	0.00
Heater, Ref. Gas/1	30600106	DeNOx	None	VOC	Propylene	A2-v0	2.17E-06	2.22E-06	2.98E-06	1.08E-06	lb/MMBtu	3	23.69	15.47	0.05
Heater, Ref. Gas/1	30600106	DeNOx	None	VOC	Toluene	D1-v2	1.07E-04	7.00E-05	9.19E-04	4.04E-06	lb/MMBtu	11	148.57	50.69	0.55
Heater, Ref. Gas/1	30600106	DeNOx	None	VOC	Xylene (Total)	A2-v1	3.73E-05	3.16E-05	1.08E-04	4.66E-06	lb/MMBtu	4	99.32	56.19	0.60
Heater, Ref. Gas/1	30600106	None	None	Metals	Antimony	C3-v0	5.17E-07	5.84E-07	7.58E-07	2.10E-07	lb/MMBtu	1	54.13	61.25	1.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Arsenic	C3-v0	8.50E-07	9.90E-07	1.28E-06	2.84E-07	lb/MMBtu	1	60.10	68.00	1.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Barium	C3-v0	5.78E-06	5.78E-06	5.92E-06	5.63E-06	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Beryllium	C3-v0	2.57E-07	2.57E-07	2.63E-07	2.50E-07	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Cadmium	C3-v0	9.88E-07	9.65E-07	1.18E-06	8.15E-07	lb/MMBtu	1	18.76	21.23	1.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Chromium (Hex)	C3-v0	2.17E-06	2.21E-06	2.24E-06	2.05E-06	lb/MMBtu	1	4.62	5.23	0.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Chromium (Total)	C3-v0	1.07E-06	6.57E-07	1.93E-06	6.26E-07	lb/MMBtu	1	69.39	78.52	0.60
Heater, Ref. Gas/1	30600106	None	None	Metals	Copper	C3-v0	4.21E-06	1.93E-06	9.39E-06	1.31E-06	lb/MMBtu	1	106.76	120.81	1.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Lead	C3-v0	4.89E-06	3.94E-06	7.51E-06	3.21E-06	lb/MMBtu	1	47.03	53.22	1.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Manganese	C3-v0	6.81E-06	6.26E-06	1.22E-05	1.97E-06	lb/MMBtu	1	75.45	85.38	1.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Mercury	C3-v0	1.80E-07	1.75E-07	1.93E-07	1.71E-07	lb/MMBtu	1	6.49	7.34	0.36
Heater, Ref. Gas/1	30600106	None	None	Metals	Nickel	C3-v1	9.42E-06	1.31E-06	2.57E-05	1.29E-06	lb/MMBtu	1	149.30	168.95	0.95
Heater, Ref. Gas/1	30600106	None	None	Metals	Phosphorus	C3-v0	6.42E-07	6.43E-07	6.57E-07	6.26E-07	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Selenium	C3-v0	1.96E-08	2.03E-08	2.54E-08	1.32E-08	lb/MMBtu	1	31.23	35.34	0.78
Heater, Ref. Gas/1	30600106	None	None	Metals	Silver	C3-v1	1.61E-06	1.31E-06	3.21E-06	3.14E-07	lb/MMBtu	1	91.23	103.24	0.94
Heater, Ref. Gas/1	30600106	None	None	Metals	Thallium	C3-v0	5.78E-06	5.78E-06	5.92E-06	5.63E-06	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	None	None	Metals	Zinc	C3-v0	2.08E-05	2.58E-05	2.83E-05	8.48E-06	lb/MMBtu	1	51.72	58.53	1.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Acenaphthene	A2-v0	2.36E-09	1.55E-09	5.61E-09	1.20E-09	lb/MMBtu	4	69.14	40.86	0.95
Heater, Ref. Gas/1	30600106	None	None	PAH	Acenaphthylene	A2-v0	1.55E-09	1.25E-09	2.74E-09	1.02E-09	lb/MMBtu	4	41.70	24.64	0.51
Heater, Ref. Gas/1	30600106	None	None	PAH	Anthracene	A2-v0	2.87E-09	2.30E-09	6.45E-09	1.09E-09	lb/MMBtu	4	61.24	36.19	0.92

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Heater, Ref. Gas/1	30600106	None	None	PAH	Benzo(a)anthracene	A1-v2	3.21E-08	5.40E-09	3.39E-07	1.05E-09	lb/MMBtu	9	265.30	101.97	1.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Benzo(a)pyrene	A1-v3	8.96E-08	1.73E-09	1.38E-06	1.02E-09	lb/MMBtu	9	352.36	135.44	0.98
Heater, Ref. Gas/1	30600106	None	None	PAH	Benzo(b)fluoranthene	A1-v2	4.04E-08	3.31E-09	4.87E-07	1.02E-09	lb/MMBtu	9	314.58	120.92	0.99
Heater, Ref. Gas/1	30600106	None	None	PAH	Benzo(g,h,i)perylene	A2-v0	1.17E-09	1.10E-09	1.40E-09	1.02E-09	lb/MMBtu	4	11.55	6.82	0.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Benzo(k)fluoranthene	A1-v2	2.41E-08	2.18E-09	2.96E-07	1.02E-09	lb/MMBtu	9	310.01	119.16	0.96
Heater, Ref. Gas/1	30600106	None	None	PAH	Chrysene	A2-v0	1.63E-09	1.23E-09	4.79E-09	1.02E-09	lb/MMBtu	4	66.84	39.50	0.63
Heater, Ref. Gas/1	30600106	None	None	PAH	Dibenz(a,h)anthracene	A1-v2	1.02E-08	1.60E-09	1.37E-07	5.93E-10	lb/MMBtu	9	279.09	107.28	0.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Fluoranthene	A2-v0	3.06E-09	3.14E-09	5.04E-09	1.85E-09	lb/MMBtu	4	33.80	19.97	1.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Fluorene	A2-v0	1.08E-08	8.77E-09	2.74E-08	2.96E-09	lb/MMBtu	4	70.62	41.74	1.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Indeno(1,2,3-cd)pyrene	A1-v3	1.03E-07	1.75E-09	1.42E-06	1.02E-09	lb/MMBtu	9	343.01	131.85	0.99
Heater, Ref. Gas/1	30600106	None	None	PAH	Naphthalene	A2-v0	3.13E-07	2.61E-07	7.58E-07	1.19E-07	lb/MMBtu	4	66.90	39.53	1.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Phenanthrene	A2-v0	1.46E-08	1.50E-08	2.25E-08	6.91E-09	lb/MMBtu	4	32.60	19.27	1.00
Heater, Ref. Gas/1	30600106	None	None	PAH	Pyrene	A2-v0	2.84E-09	2.72E-09	4.53E-09	1.87E-09	lb/MMBtu	4	28.87	17.06	1.00
Heater, Ref. Gas/1	30600106	None	None	SVOC	Ethylbenzene	A2-v1	3.02E-05	1.79E-05	1.03E-04	2.72E-06	lb/MMBtu	4	104.65	59.21	0.51
Heater, Ref. Gas/1	30600106	None	None	SVOC	Phenol	C1-v1	5.63E-06	3.14E-06	2.54E-05	2.84E-07	lb/MMBtu	7	114.62	49.02	0.97
Heater, Ref. Gas/1	30600106	None	None	VOC	Acetaldehyde	B1-v3	1.53E-05	8.12E-06	8.55E-05	8.41E-08	lb/MMBtu	8	126.30	50.53	0.88
Heater, Ref. Gas/1	30600106	None	None	VOC	Benzene	B1-v1	6.47E-05	5.49E-05	1.85E-04	2.54E-06	lb/MMBtu	11	87.67	29.91	0.02
Heater, Ref. Gas/1	30600106	None	None	VOC	Formaldehyde	B1-v3	1.11E-04	1.90E-05	1.34E-03	7.67E-07	lb/MMBtu	7	262.94	112.46	1.00
Heater, Ref. Gas/1	30600106	None	None	VOC	Hydrogen Sulfide	A1-v1	2.92E-04	2.46E-04	8.04E-04	1.76E-05	lb/MMBtu	7	75.53	32.30	0.00
Heater, Ref. Gas/1	30600106	None	None	VOC	Propylene	A2-v0	2.17E-06	2.22E-06	2.98E-06	1.08E-06	lb/MMBtu	3	23.69	15.47	0.05
Heater, Ref. Gas/1	30600106	None	None	VOC	Toluene	D1-v2	1.07E-04	7.00E-05	9.19E-04	4.04E-06	lb/MMBtu	11	148.57	50.69	0.55
Heater, Ref. Gas/1	30600106	None	None	VOC	Xylene (Total)	A2-v1	3.73E-05	3.16E-05	1.08E-04	4.66E-06	lb/MMBtu	4	99.32	56.19	0.60
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Antimony	C3-v0	5.17E-07	5.84E-07	7.58E-07	2.10E-07	lb/MMBtu	1	54.13	61.25	1.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Arsenic	C3-v0	8.50E-07	9.90E-07	1.28E-06	2.84E-07	lb/MMBtu	1	60.10	68.00	1.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Barium	C3-v0	5.78E-06	5.78E-06	5.92E-06	5.63E-06	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Beryllium	C3-v0	2.57E-07	2.57E-07	2.63E-07	2.50E-07	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Cadmium	C3-v0	9.88E-07	9.65E-07	1.18E-06	8.15E-07	lb/MMBtu	1	18.76	21.23	1.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Chromium (Hex)	C3-v0	2.17E-06	2.21E-06	2.24E-06	2.05E-06	lb/MMBtu	1	4.62	5.23	0.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Chromium (Total)	C3-v0	1.07E-06	6.57E-07	1.93E-06	6.26E-07	lb/MMBtu	1	69.39	78.52	0.60
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Copper	C3-v0	4.21E-06	1.93E-06	9.39E-06	1.31E-06	lb/MMBtu	1	106.76	120.81	1.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Lead	C3-v0	4.89E-06	3.94E-06	7.51E-06	3.21E-06	lb/MMBtu	1	47.03	53.22	1.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Manganese	C3-v0	6.81E-06	6.26E-06	1.22E-05	1.97E-06	lb/MMBtu	1	75.45	85.38	1.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Mercury	C3-v0	1.80E-07	1.75E-07	1.93E-07	1.71E-07	lb/MMBtu	1	6.49	7.34	0.36
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Nickel	C3-v1	9.42E-06	1.31E-06	2.57E-05	1.29E-06	lb/MMBtu	1	149.30	168.95	0.95
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Phosphorus	C3-v0	6.42E-07	6.43E-07	6.57E-07	6.26E-07	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Selenium	C3-v0	1.96E-08	2.03E-08	2.54E-08	1.32E-08	lb/MMBtu	1	31.23	35.34	0.78
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Silver	C3-v1	1.61E-06	1.31E-06	3.21E-06	3.14E-07	lb/MMBtu	1	91.23	103.24	0.94
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Thallium	C3-v0	5.78E-06	5.78E-06	5.92E-06	5.63E-06	lb/MMBtu	1	2.45	2.78	0.00
Heater, Ref. Gas/1	30600106	SCR	None	Metals	Zinc	C3-v0	2.08E-05	2.58E-05	2.83E-05	8.48E-06	lb/MMBtu	1	51.72	58.53	1.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Acenaphthene	A2-v0	2.36E-09	1.55E-09	5.61E-09	1.20E-09	lb/MMBtu	4	69.14	40.86	0.95
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Acenaphthylene	A2-v0	1.55E-09	1.25E-09	2.74E-09	1.02E-09	lb/MMBtu	4	41.70	24.64	0.51
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Anthracene	A2-v0	2.87E-09	2.30E-09	6.45E-09	1.09E-09	lb/MMBtu	4	61.24	36.19	0.92
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Benzo(a)anthracene	A1-v2	3.21E-08	5.40E-09	3.39E-07	1.05E-09	lb/MMBtu	9	265.30	101.97	1.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Benzo(a)pyrene	A1-v3	8.96E-08	1.73E-09	1.38E-06	1.02E-09	lb/MMBtu	9	352.36	135.44	0.98
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Benzo(b)fluoranthene	A1-v2	4.04E-08	3.31E-09	4.87E-07	1.02E-09	lb/MMBtu	9	314.58	120.92	0.99
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Benzo(g,h,i)perylene	A2-v0	1.17E-09	1.10E-09	1.40E-09	1.02E-09	lb/MMBtu	4	11.55	6.82	0.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Benzo(k)fluoranthene	A1-v2	2.41E-08	2.18E-09	2.96E-07	1.02E-09	lb/MMBtu	9	310.01	119.16	0.96
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Chrysene	A2-v0	1.63E-09	1.23E-09	4.79E-09	1.02E-09	lb/MMBtu	4	66.84	39.50	0.63
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Dibenz(a,h)anthracene	A1-v2	1.02E-08	1.60E-09	1.37E-07	5.93E-10	lb/MMBtu	9	279.09	107.28	0.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Fluoranthene	A2-v0	3.06E-09	3.14E-09	5.04E-09	1.85E-09	lb/MMBtu	4	33.80	19.97	1.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Fluorene	A2-v0	1.08E-08	8.77E-09	2.74E-08	2.96E-09	lb/MMBtu	4	70.62	41.74	1.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Indeno(1,2,3-cd)pyrene	A1-v3	1.03E-07	1.75E-09	1.42E-06	1.02E-09	lb/MMBtu	9	343.01	131.85	0.99
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Naphthalene	A2-v0	3.13E-07	2.61E-07	7.58E-07	1.19E-07	lb/MMBtu	4	66.90	39.53	1.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Phenanthrene	A2-v0	1.46E-08	1.50E-08	2.25E-08	6.91E-09	lb/MMBtu	4	32.60	19.27	1.00
Heater, Ref. Gas/1	30600106	SCR	None	PAH	Pyrene	A2-v0	2.84E-09	2.72E-09	4.53E-09	1.87E-09	lb/MMBtu	4	28.87	17.06	1.00
Heater, Ref. Gas/1	30600106	SCR	None	SVOC	Ethylbenzene	A2-v1	3.02E-05	1.79E-05	1.03E-04	2.72E-06	lb/MMBtu	4	104.65	59.21	0.51
Heater, Ref. Gas/1	30600106	SCR	None	SVOC	Phenol	C1-v1	5.63E-06	3.14E-06	2.54E-05	2.84E-07	lb/MMBtu	7	114.62	49.02	0.97

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Heater, Ref. Gas/1	30600106	SCR	None	VOC	Acetaldehyde	B1-v3	1.53E-05	8.12E-06	8.55E-05	8.41E-08	lb/MMBtu	8	126.30	50.53	0.88
Heater, Ref. Gas/1	30600106	SCR	None	VOC	Benzene	B1-v1	6.47E-05	5.49E-05	1.85E-04	2.54E-06	lb/MMBtu	11	87.67	29.91	0.02
Heater, Ref. Gas/1	30600106	SCR	None	VOC	Formaldehyde	B1-v3	1.11E-04	1.90E-05	1.34E-03	7.67E-07	lb/MMBtu	7	262.94	112.46	1.00
Heater, Ref. Gas/1	30600106	SCR	None	VOC	Hydrogen Sulfide	A1-v1	2.92E-04	2.46E-04	8.04E-04	1.76E-05	lb/MMBtu	7	75.53	32.30	0.00
Heater, Ref. Gas/1	30600106	SCR	None	VOC	Propylene	A2-v0	2.17E-06	2.22E-06	2.98E-06	1.08E-06	lb/MMBtu	3	23.69	15.47	0.05
Heater, Ref. Gas/1	30600106	SCR	None	VOC	Toluene	D1-v2	1.07E-04	7.00E-05	9.19E-04	4.04E-06	lb/MMBtu	11	148.57	50.69	0.55
Heater, Ref. Gas/1	30600106	SCR	None	VOC	Xylene (Total)	A2-v1	3.73E-05	3.16E-05	1.08E-04	4.66E-06	lb/MMBtu	4	99.32	56.19	0.60
ICE, Diesel/1	20200102	None	O2<13%	PAH	Acenaphthene	C3-v0	4.54E-06	4.85E-06	6.12E-06	2.67E-06	lb/MMBtu	1	38.39	43.44	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Acenaphthylene	C3-v0	8.97E-06	9.23E-06	9.34E-06	8.34E-06	lb/MMBtu	1	6.10	6.91	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Anthracene	C3-v0	1.20E-06	9.43E-07	2.04E-06	6.07E-07	lb/MMBtu	1	62.56	70.79	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Benzo(a)anthracene	C3-v0	6.14E-07	5.85E-07	6.83E-07	5.75E-07	lb/MMBtu	1	9.72	11.00	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Benzo(a)pyrene	C3-v0	2.49E-07	2.71E-07	3.36E-07	1.41E-07	lb/MMBtu	1	39.85	45.09	0.45
ICE, Diesel/1	20200102	None	O2<13%	PAH	Benzo(b)fluoranthene	C3-v0	1.08E-06	9.98E-07	1.36E-06	8.89E-07	lb/MMBtu	1	22.58	25.55	0.27
ICE, Diesel/1	20200102	None	O2<13%	PAH	Benzo(g,h,i)perylene	C3-v0	5.42E-07	5.53E-07	5.85E-07	4.88E-07	lb/MMBtu	1	9.17	10.37	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Benzo(k)fluoranthene	C3-v0	2.13E-07	8.67E-08	4.88E-07	6.51E-08	lb/MMBtu	1	111.67	126.37	0.76
ICE, Diesel/1	20200102	None	O2<13%	PAH	Chrysene	C3-v0	1.49E-06	1.56E-06	1.60E-06	1.30E-06	lb/MMBtu	1	11.03	12.48	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Dibenz(a,h)anthracene	C3-v0	3.36E-07	3.25E-07	3.58E-07	3.25E-07	lb/MMBtu	1	5.59	6.32	0.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Fluoranthene	C3-v0	3.92E-06	3.86E-06	4.12E-06	3.78E-06	lb/MMBtu	1	4.50	5.09	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Fluorene	C3-v0	1.25E-05	1.24E-05	1.28E-05	1.21E-05	lb/MMBtu	1	2.62	2.96	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Indeno(1,2,3-cd)pyrene	C3-v0	4.01E-07	4.12E-07	4.66E-07	3.25E-07	lb/MMBtu	1	17.72	20.05	0.34
ICE, Diesel/1	20200102	None	O2<13%	PAH	Naphthalene	C3-v0	1.27E-04	1.28E-04	1.31E-04	1.21E-04	lb/MMBtu	1	3.74	4.24	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Phenanthrene	C3-v0	3.97E-05	3.98E-05	4.06E-05	3.86E-05	lb/MMBtu	1	2.58	2.92	1.00
ICE, Diesel/1	20200102	None	O2<13%	PAH	Pyrene	C3-v0	3.61E-06	3.45E-06	3.95E-06	3.43E-06	lb/MMBtu	1	8.16	9.24	1.00
ICE, Diesel/1	20200102	None	O2<13%	VOC	Acetaldehyde	A3-v0	2.44E-05	1.59E-05	4.56E-05	1.19E-05	lb/MMBtu	1	75.34	85.25	1.00
ICE, Diesel/1	20200102	None	O2<13%	VOC	Acrolein	A3-v0	7.57E-06	5.04E-06	1.26E-05	5.04E-06	lb/MMBtu	1	57.74	65.33	0.56
ICE, Diesel/1	20200102	None	O2<13%	VOC	Benzene	A3-v0	7.11E-04	7.00E-04	7.33E-04	7.00E-04	lb/MMBtu	1	2.71	3.06	1.00
ICE, Diesel/1	20200102	None	O2<13%	VOC	Formaldehyde	A3-v1	7.68E-05	3.27E-05	1.85E-04	1.23E-05	lb/MMBtu	1	123.19	139.41	1.00
ICE, Diesel/1	20200102	None	O2<13%	VOC	Propylene	A3-v0	2.71E-03	2.84E-03	2.84E-03	2.46E-03	lb/MMBtu	1	8.06	9.12	1.00
ICE, Diesel/1	20200102	None	O2<13%	VOC	Toluene	A3-v0	2.63E-04	2.61E-04	2.73E-04	2.57E-04	lb/MMBtu	1	3.27	3.70	1.00
ICE, Diesel/1	20200102	None	O2<13%	VOC	Xylene (Total)	A3-v0	1.89E-04	1.91E-04	1.95E-04	1.81E-04	lb/MMBtu	1	3.85	4.36	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Acenaphthene	C3-v2	1.43E-06	8.34E-07	4.97E-06	1.00E-08	lb/MMBtu	2	136.02	108.84	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Acenaphthylene	C3-v3	5.08E-06	2.27E-06	1.35E-05	1.00E-08	lb/MMBtu	2	125.21	100.19	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Anthracene	C3-v1	1.86E-06	2.10E-06	2.65E-06	2.25E-07	lb/MMBtu	2	45.07	36.07	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Benzo(a)anthracene	C3-v1	1.67E-06	1.47E-06	4.81E-06	1.12E-07	lb/MMBtu	2	103.79	83.05	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Benzo(a)pyrene	C3-v1	1.88E-07	1.32E-07	4.21E-07	1.00E-08	lb/MMBtu	2	108.63	86.92	0.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Benzo(b)fluoranthene	C3-v0	1.87E-07	1.97E-07	2.81E-07	8.43E-08	lb/MMBtu	1	52.68	59.61	0.50
ICE, Diesel/2	20200102	None	O2>13%	PAH	Benzo(b+k)fluoranthene	C3-v0	1.03E-08	1.03E-08	1.04E-08	1.00E-08	lb/MMBtu	1	1.90	2.14	0.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Benzo(g,h,i)perylene	C3-v1	4.87E-07	4.24E-07	1.12E-06	8.43E-08	lb/MMBtu	2	72.27	57.82	0.43
ICE, Diesel/2	20200102	None	O2>13%	PAH	Benzo(k)fluoranthene	C3-v0	3.00E-07	3.09E-07	4.49E-07	1.40E-07	lb/MMBtu	1	51.63	58.43	0.50
ICE, Diesel/2	20200102	None	O2>13%	PAH	Chrysene	C3-v0	3.52E-07	3.76E-07	4.81E-07	1.97E-07	lb/MMBtu	2	33.43	26.75	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Dibenz(a,h)anthracene	C3-v0	5.84E-07	4.57E-07	1.04E-06	3.16E-07	lb/MMBtu	2	51.34	41.08	0.35
ICE, Diesel/2	20200102	None	O2>13%	PAH	Fluoranthene	C3-v1	7.59E-06	5.94E-06	1.93E-05	5.06E-07	lb/MMBtu	2	90.02	72.03	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Fluorene	C3-v1	2.90E-05	2.83E-05	5.40E-05	1.52E-06	lb/MMBtu	2	87.31	69.86	0.99
ICE, Diesel/2	20200102	None	O2>13%	PAH	Indeno(1,2,3-cd)pyrene	C3-v1	4.63E-07	2.91E-07	9.55E-07	5.62E-08	lb/MMBtu	2	84.39	67.52	0.30
ICE, Diesel/2	20200102	None	O2>13%	PAH	Naphthalene	C3-v0	8.48E-05	5.59E-05	2.20E-04	4.28E-05	lb/MMBtu	2	80.69	64.56	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Phenanthrene	C3-v1	2.93E-05	3.03E-05	5.38E-05	2.25E-06	lb/MMBtu	2	65.09	52.08	1.00
ICE, Diesel/2	20200102	None	O2>13%	PAH	Pyrene	C3-v0	4.78E-06	4.38E-06	7.62E-06	8.43E-07	lb/MMBtu	2	52.00	41.61	1.00
ICE, Diesel/2	20200102	None	O2>13%	SVOC	Benzaldehyde	A3-v0	9.01E-05	8.84E-05	9.64E-05	8.54E-05	lb/MMBtu	1	6.29	7.12	0.68
ICE, Diesel/2	20200102	None	O2>13%	VOC	1,3-Butadiene	C3-v0	3.86E-05	3.86E-05	3.86E-05	3.86E-05	lb/MMBtu	1	0.00	0.00	0.00
ICE, Diesel/2	20200102	None	O2>13%	VOC	Acetaldehyde	A3-v0	7.64E-04	7.65E-04	1.08E-03	4.21E-04	lb/MMBtu	2	42.48	33.99	1.00
ICE, Diesel/2	20200102	None	O2>13%	VOC	Acrolein	A3-v0	9.37E-05	6.05E-05	2.29E-04	4.72E-05	lb/MMBtu	2	74.63	59.71	0.82
ICE, Diesel/2	20200102	None	O2>13%	VOC	Benzene	B3-v0	8.81E-04	8.17E-04	1.38E-03	4.69E-04	lb/MMBtu	2	48.96	39.17	1.00
ICE, Diesel/2	20200102	None	O2>13%	VOC	Formaldehyde	A3-v0	1.19E-03	1.04E-03	2.39E-03	6.18E-04	lb/MMBtu	2	55.30	44.25	1.00
ICE, Diesel/2	20200102	None	O2>13%	VOC	Propylene	B3-v0	2.58E-03	2.44E-03	4.22E-03	1.04E-03	lb/MMBtu	2	57.16	45.74	1.00
ICE, Diesel/2	20200102	None	O2>13%	VOC	Toluene	B3-v0	3.96E-04	3.95E-04	5.47E-04	2.46E-04	lb/MMBtu	2	38.72	30.98	1.00
ICE, Diesel/2	20200102	None	O2>13%	VOC	Xylene (Total)	A3-v0	2.59E-04	3.21E-04	3.21E-04	1.36E-04	lb/MMBtu	1	41.24	46.67	1.00
ICE, Diesel/2	20200102	None	O2>13%	VOC	Xylene (m,p)	C3-v0	1.54E-04	1.49E-04	1.71E-04	1.42E-04	lb/MMBtu	1	10.07	11.40	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
ICE, Diesel/2	20200102	None	O2>13%	VOC	Xylene (o)	C3-v0	1.49E-04	1.49E-04	1.49E-04	1.49E-04	lb/MMBtu	1	0.00	0.00	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Acenaphthene	A3-v0	7.06E-07	7.06E-07	1.03E-06	3.81E-07	lb/MMBtu	1	65.08	90.19	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Acenaphthylene	A3-v0	1.05E-05	1.05E-05	1.49E-05	6.14E-06	lb/MMBtu	1	59.06	81.86	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Anthracene	A3-v0	4.29E-06	4.29E-06	6.35E-06	2.23E-06	lb/MMBtu	1	67.84	94.02	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Benzo(a)anthracene	A3-v0	8.54E-07	8.54E-07	8.68E-07	8.41E-07	lb/MMBtu	1	2.17	3.01	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Benzo(a)pyrene	A3-v0	8.33E-07	8.33E-07	1.46E-06	2.06E-07	lb/MMBtu	1	106.44	147.52	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Benzo(b)fluoranthene	A3-v0	1.41E-07	1.41E-07	1.63E-07	1.18E-07	lb/MMBtu	1	22.41	31.05	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Benzo(g,h,i)perylene	A3-v0	8.95E-08	8.95E-08	9.44E-08	8.46E-08	lb/MMBtu	1	7.74	10.72	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Benzo(k)fluoranthene	A3-v0	4.35E-06	4.35E-06	4.46E-06	4.23E-06	lb/MMBtu	1	3.78	5.23	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Chrysene	A3-v0	1.61E-06	1.61E-06	1.72E-06	1.50E-06	lb/MMBtu	1	9.43	13.07	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Dibenz(a,h)anthracene	A3-v0	7.33E-08	7.33E-08	7.90E-08	6.77E-08	lb/MMBtu	1	10.86	15.06	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Fluoranthene	A3-v0	1.58E-07	1.58E-07	2.06E-07	1.10E-07	lb/MMBtu	1	42.96	59.53	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Fluorene	A3-v0	2.32E-06	2.32E-06	3.43E-06	1.21E-06	lb/MMBtu	1	67.90	94.10	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	1.31E-07	1.31E-07	1.39E-07	1.23E-07	lb/MMBtu	1	8.83	12.24	0.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Naphthalene	A3-v0	2.09E-04	2.09E-04	2.12E-04	2.06E-04	lb/MMBtu	1	1.88	2.61	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Phenanthrene	A3-v0	4.68E-06	4.68E-06	6.18E-06	3.17E-06	lb/MMBtu	1	45.46	63.00	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	PAH	Pyrene	A3-v0	2.27E-07	2.27E-07	2.92E-07	1.63E-07	lb/MMBtu	1	40.10	55.57	0.64
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Acetaldehyde	A3-v0	8.36E-03	8.98E-03	1.08E-02	5.27E-03	lb/MMBtu	1	33.90	38.37	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Acrolein	A3-v1	1.90E-03	1.37E-03	4.15E-03	1.90E-04	lb/MMBtu	1	106.79	120.84	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Benzene	A3-v0	7.48E-03	4.38E-03	1.30E-02	4.03E-03	lb/MMBtu	2	60.68	53.19	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Formaldehyde	A3-v1	4.85E-02	6.46E-02	8.13E-02	4.01E-03	lb/MMBtu	2	69.80	55.85	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Propylene	A3-v0	2.37E-02	1.69E-02	3.82E-02	1.09E-02	lb/MMBtu	2	56.74	49.73	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Toluene	A3-v1	2.72E-03	2.25E-03	5.47E-03	2.12E-04	lb/MMBtu	2	72.83	63.84	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Xylene (m,p)	A3-v0	5.75E-04	3.02E-04	1.19E-03	1.80E-04	lb/MMBtu	2	80.76	70.79	1.00
ICE, Field Gas/1	20200252	None	2S/Lean	VOC	Xylene (o)	A3-v0	2.74E-04	1.30E-04	5.63E-04	6.48E-05	lb/MMBtu	2	88.41	77.49	1.00
ICE, Field Gas/2	20200202	None	4S/Lean	VOC	Benzene	A2-v0	1.64E-03	1.97E-03	2.14E-03	8.81E-04	lb/MMBtu	3	35.58	28.47	1.00
ICE, Field Gas/2	20200202	None	4S/Lean	VOC	Formaldehyde	A2-v1	3.95E-02	2.99E-02	9.32E-02	4.40E-03	lb/MMBtu	3	76.73	50.13	1.00
ICE, Field Gas/2	20200202	None	4S/Lean	VOC	Propylene	A2-v0	1.52E-02	1.75E-02	1.92E-02	9.03E-03	lb/MMBtu	3	30.49	24.40	1.00
ICE, Field Gas/2	20200202	None	4S/Lean	VOC	Toluene	A2-v0	7.31E-04	8.94E-04	1.11E-03	2.56E-04	lb/MMBtu	3	51.12	40.90	1.00
ICE, Field Gas/2	20200202	None	4S/Lean	VOC	Xylene (m,p)	A2-v1	2.87E-04	1.81E-04	8.60E-04	7.37E-05	lb/MMBtu	3	99.71	79.78	1.00
ICE, Field Gas/2	20200202	None	4S/Lean	VOC	Xylene (o)	A2-v0	8.55E-05	9.11E-05	1.16E-04	5.84E-05	lb/MMBtu	3	25.60	20.49	1.00
ICE, Field Gas/3	20200254	None	4S/Rich	VOC	Benzene	A3-v0	1.05E-02	1.05E-02	1.06E-02	1.04E-02	lb/MMBtu	1	1.15	1.59	1.00
ICE, Field Gas/3	20200254	None	4S/Rich	VOC	Formaldehyde	A3-v0	4.81E-03	4.43E-03	5.69E-03	4.31E-03	lb/MMBtu	1	15.91	18.00	1.00
ICE, Field Gas/3	20200254	None	4S/Rich	VOC	Propylene	A3-v0	2.90E-03	2.90E-03	2.90E-03	2.90E-03	lb/MMBtu	1	0.00	0.00	0.00
ICE, Field Gas/3	20200254	None	4S/Rich	VOC	Toluene	A3-v0	3.28E-03	3.28E-03	3.38E-03	3.17E-03	lb/MMBtu	1	4.56	6.32	1.00
ICE, Field Gas/3	20200254	None	4S/Rich	VOC	Xylene (m,p)	A3-v0	5.11E-04	5.11E-04	5.36E-04	4.87E-04	lb/MMBtu	1	6.73	9.33	1.00
ICE, Field Gas/3	20200254	None	4S/Rich	VOC	Xylene (o)	A3-v0	2.56E-04	2.56E-04	2.68E-04	2.43E-04	lb/MMBtu	1	6.73	9.33	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Acenaphthene	A3-v0	6.83E-07	6.06E-07	9.14E-07	5.30E-07	lb/MMBtu	1	29.79	33.71	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Acenaphthylene	A3-v0	7.23E-06	7.29E-06	1.02E-05	4.19E-06	lb/MMBtu	1	41.56	47.03	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Anthracene	A3-v0	2.44E-07	2.28E-07	3.52E-07	1.52E-07	lb/MMBtu	1	41.20	46.62	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Benzo(a)anthracene	A3-v0	7.41E-08	7.45E-08	9.14E-08	5.63E-08	lb/MMBtu	1	23.70	26.82	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Benzo(a)pyrene	A3-v0	3.38E-08	2.79E-08	4.92E-08	2.42E-08	lb/MMBtu	1	39.97	45.23	0.76
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Benzo(b)fluoranthene	A3-v2	3.11E-07	4.22E-08	8.85E-07	5.96E-09	lb/MMBtu	1	159.90	180.94	0.95
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Benzo(g,h,i)perylene	A3-v1	9.80E-08	2.79E-08	2.46E-07	1.99E-08	lb/MMBtu	1	131.00	148.24	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Benzo(k)fluoranthene	A3-v1	5.04E-07	4.64E-07	1.02E-06	2.93E-08	lb/MMBtu	1	98.44	111.40	0.98
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Chrysene	A3-v0	9.19E-08	1.05E-07	1.07E-07	6.29E-08	lb/MMBtu	1	27.27	30.86	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Dibenz(a,h)anthracene	A3-v0	1.04E-08	1.05E-08	1.40E-08	6.63E-09	lb/MMBtu	1	35.41	40.07	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Fluoranthene	A3-v0	2.38E-07	2.52E-07	3.16E-07	1.46E-07	lb/MMBtu	1	36.21	40.98	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Fluorene	A3-v0	4.38E-07	3.96E-07	5.98E-07	3.21E-07	lb/MMBtu	1	32.63	36.92	0.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Indeno(1,2,3-cd)pyrene	A3-v1	1.14E-07	3.73E-08	2.81E-07	2.32E-08	lb/MMBtu	1	127.40	144.16	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Naphthalene	A3-v0	1.16E-04	1.52E-04	1.77E-04	1.90E-05	lb/MMBtu	1	73.21	82.85	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Phenanthrene	A3-v0	8.50E-07	7.92E-07	1.20E-06	5.63E-07	lb/MMBtu	1	37.66	42.62	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	PAH	Pyrene	A3-v0	1.18E-07	1.35E-07	1.55E-07	6.29E-08	lb/MMBtu	1	41.10	46.51	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Acetaldehyde	A1-v0	3.80E-03	2.82E-03	9.47E-03	1.45E-03	lb/MMBtu	5	64.91	32.85	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Acrolein	A1-v1	1.56E-03	1.05E-03	5.22E-03	1.92E-04	lb/MMBtu	5	92.02	48.20	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Benzene	A1-v1	1.15E-03	1.17E-03	2.35E-03	2.35E-04	lb/MMBtu	7	47.28	24.77	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Formaldehyde	A1-v0	2.73E-02	2.64E-02	4.56E-02	9.22E-03	lb/MMBtu	7	38.56	16.49	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Propylene	A1-v1	1.78E-02	8.39E-03	5.57E-02	3.92E-03	lb/MMBtu	7	109.05	57.12	0.97
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Toluene	A1-v0	3.92E-04	3.77E-04	5.43E-04	1.57E-04	lb/MMBtu	7	33.98	17.80	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Xylene (m,p)	A1-v0	8.22E-05	7.74E-05	1.51E-04	3.36E-05	lb/MMBtu	7	46.27	24.24	1.00
ICE, Natural Gas/1	20200202	None	4S/Lean	VOC	Xylene (o)	A1-v0	4.71E-05	4.71E-05	8.70E-05	1.01E-05	lb/MMBtu	7	39.52	20.70	0.95
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Acetaldehyde	A3-v0	1.63E-03	1.62E-03	1.74E-03	1.53E-03	lb/MMBtu	1	6.46	7.31	1.00
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Acrolein	A3-v2	5.15E-04	3.97E-04	1.31E-03	2.50E-06	lb/MMBtu	2	105.65	84.54	1.00
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Benzene	A3-v0	9.40E-03	9.40E-03	9.73E-03	9.06E-03	lb/MMBtu	1	5.05	7.00	1.00
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Formaldehyde	A3-v1	5.07E-03	4.27E-03	1.09E-02	4.08E-04	lb/MMBtu	2	100.52	80.43	1.00
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Propylene	A3-v0	3.76E-02	3.76E-02	4.00E-02	3.52E-02	lb/MMBtu	1	8.95	12.40	1.00
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Toluene	A3-v0	2.40E-03	2.40E-03	2.50E-03	2.29E-03	lb/MMBtu	1	6.15	8.52	1.00
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Xylene (m,p)	A3-v0	4.20E-04	4.20E-04	4.32E-04	4.08E-04	lb/MMBtu	1	4.04	5.60	1.00
ICE, Natural Gas/2	20200254	None	4S/Rich	VOC	Xylene (o)	A3-v0	2.06E-04	2.06E-04	2.11E-04	2.02E-04	lb/MMBtu	1	3.29	4.56	1.00
SG, Crude Oil/1	31000413	None	None	Halogens	HCl	C3-v0	1.25E-06	1.21E-06	1.38E-06	1.17E-06	lb/MMBtu	1	8.92	10.09	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Arsenic	D2-v0	6.67E-06	4.20E-06	1.92E-05	2.37E-06	lb/MMBtu	3	84.20	55.01	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Beryllium	D3-v0	1.92E-06	2.01E-06	2.15E-06	1.58E-06	lb/MMBtu	2	13.70	10.96	0.51
SG, Crude Oil/1	31000413	None	None	Metals	Cadmium	D2-v1	1.09E-06	9.86E-07	3.61E-06	1.58E-07	lb/MMBtu	3	100.01	65.34	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Chromium (Hex)	B2-v0	1.09E-06	1.01E-06	2.22E-06	3.86E-07	lb/MMBtu	3	55.29	36.12	0.47
SG, Crude Oil/1	31000413	None	None	Metals	Chromium (Total)	B2-v1	5.75E-06	3.81E-06	1.46E-05	1.01E-06	lb/MMBtu	3	85.04	55.56	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Copper	D2-v0	6.63E-06	6.16E-06	1.24E-05	3.16E-06	lb/MMBtu	3	48.02	31.37	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Lead	D2-v0	1.88E-06	1.75E-06	3.24E-06	1.19E-06	lb/MMBtu	3	33.08	21.61	0.52
SG, Crude Oil/1	31000413	None	None	Metals	Manganese	D2-v1	2.02E-05	1.89E-05	3.79E-05	1.62E-06	lb/MMBtu	3	63.82	47.28	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Mercury	D2-v2	1.48E-05	3.43E-07	3.48E-05	5.71E-08	lb/MMBtu	3	122.84	91.00	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Nickel	D2-v0	2.40E-03	2.38E-03	2.65E-03	2.19E-03	lb/MMBtu	3	5.44	3.55	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Phosphorus	D3-v1	1.78E-04	9.57E-05	4.57E-04	1.84E-05	lb/MMBtu	2	102.06	81.66	1.00
SG, Crude Oil/1	31000413	None	None	Metals	Selenium	D2-v1	7.95E-06	2.93E-06	2.08E-05	1.19E-06	lb/MMBtu	3	108.30	70.75	0.96
SG, Crude Oil/1	31000413	None	None	Metals	Zinc	D2-v2	5.44E-04	1.90E-04	1.75E-03	1.58E-05	lb/MMBtu	3	127.81	83.50	0.94
SG, Crude Oil/1	31000413	None	None	PAH	Acenaphthene	C3-v1	2.55E-07	1.38E-07	6.21E-07	7.06E-09	lb/MMBtu	2	111.36	89.10	1.00
SG, Crude Oil/1	31000413	None	None	PAH	Acenaphthylene	C2-v1	5.00E-08	4.33E-08	1.18E-07	1.41E-09	lb/MMBtu	3	83.39	54.48	0.47
SG, Crude Oil/1	31000413	None	None	PAH	Anthracene	C2-v1	5.10E-08	2.12E-08	1.66E-07	2.12E-09	lb/MMBtu	3	133.46	92.48	1.00
SG, Crude Oil/1	31000413	None	None	PAH	Benzo(a)anthracene	C2-v1	5.18E-08	5.51E-08	9.89E-08	3.53E-09	lb/MMBtu	3	72.24	50.06	0.42
SG, Crude Oil/1	31000413	None	None	PAH	Benzo(a)pyrene	C3-v1	5.38E-08	6.35E-08	8.41E-08	3.53E-09	lb/MMBtu	2	60.91	48.74	0.24
SG, Crude Oil/1	31000413	None	None	PAH	Benzo(b)fluoranthene	C3-v1	4.71E-08	2.82E-08	1.06E-07	7.06E-09	lb/MMBtu	1	110.57	125.12	0.00
SG, Crude Oil/1	31000413	None	None	PAH	Benzo(b+k)fluoranthene	C3-v0	8.06E-08	8.01E-08	8.41E-08	7.77E-08	lb/MMBtu	1	4.07	4.61	0.00
SG, Crude Oil/1	31000413	None	None	PAH	Benzo(g,h,i)perylene	C3-v1	5.21E-08	6.00E-08	8.41E-08	7.06E-09	lb/MMBtu	2	63.92	51.15	0.21
SG, Crude Oil/1	31000413	None	None	PAH	Benzo(k)fluoranthene	C3-v0	4.00E-09	3.53E-09	7.06E-09	1.41E-09	lb/MMBtu	1	71.32	80.70	0.00
SG, Crude Oil/1	31000413	None	None	PAH	Chrysene	C2-v1	7.43E-08	7.77E-08	2.28E-07	7.06E-09	lb/MMBtu	3	92.90	60.70	0.64
SG, Crude Oil/1	31000413	None	None	PAH	Dibenz(a,h)anthracene	C3-v1	5.33E-08	6.35E-08	8.41E-08	7.06E-09	lb/MMBtu	2	61.97	49.58	0.00
SG, Crude Oil/1	31000413	None	None	PAH	Fluoranthene	C2-v1	8.72E-08	7.77E-08	3.46E-07	7.06E-09	lb/MMBtu	3	115.48	75.45	0.70
SG, Crude Oil/1	31000413	None	None	PAH	Fluorene	C2-v1	9.41E-08	4.80E-08	3.04E-07	7.06E-09	lb/MMBtu	3	116.41	76.06	1.00
SG, Crude Oil/1	31000413	None	None	PAH	Indeno(1,2,3-cd)pyrene	C3-v1	5.33E-08	6.71E-08	8.41E-08	7.06E-09	lb/MMBtu	2	64.74	51.80	0.22
SG, Crude Oil/1	31000413	None	None	PAH	Naphthalene	C2-v0	5.28E-06	3.01E-06	1.07E-05	1.43E-06	lb/MMBtu	3	80.94	56.09	1.00
SG, Crude Oil/1	31000413	None	None	PAH	Phenanthrene	C2-v1	1.65E-07	4.71E-08	1.07E-06	1.45E-08	lb/MMBtu	3	208.06	135.93	1.00
SG, Crude Oil/1	31000413	None	None	PAH	Pyrene	C2-v1	1.50E-07	8.41E-08	4.77E-07	7.06E-09	lb/MMBtu	3	95.35	62.29	0.82
SG, Crude Oil/1	31000413	None	None	SVOC	Benzaldehyde	A3-v0	4.74E-05	4.90E-05	4.95E-05	4.37E-05	lb/MMBtu	1	6.71	7.60	0.00
SG, Crude Oil/1	31000413	None	None	VOC	Acetaldehyde	A3-v0	1.78E-05	1.43E-05	3.37E-05	7.79E-06	lb/MMBtu	2	52.94	34.59	0.54
SG, Crude Oil/1	31000413	None	None	VOC	Acrolein	A3-v0	1.20E-05	3.30E-06	3.06E-05	3.30E-06	lb/MMBtu	2	108.95	71.18	0.00
SG, Crude Oil/1	31000413	None	None	VOC	Benzene	B3-v0	4.07E-06	4.37E-06	6.55E-06	2.02E-06	lb/MMBtu	2	43.66	28.53	0.36
SG, Crude Oil/1	31000413	None	None	VOC	Formaldehyde	A3-v0	6.31E-06	5.36E-06	1.11E-05	2.68E-06	lb/MMBtu	2	53.55	34.98	0.44
SG, Crude Oil/1	31000413	None	None	VOC	Propylene	B3-v1	3.91E-04	1.24E-05	1.15E-03	1.24E-05	lb/MMBtu	2	145.24	94.89	0.00
SG, Crude Oil/1	31000413	None	None	VOC	Toluene	B3-v0	2.38E-05	1.36E-05	7.80E-05	1.36E-05	lb/MMBtu	2	89.52	58.48	0.74
SG, Crude Oil/1	31000413	None	None	VOC	Xylene (Total)	B3-v1	2.18E-05	3.12E-05	3.12E-05	2.89E-06	lb/MMBtu	2	65.05	42.50	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Halogens	HCl	C3-v0	1.25E-06	1.21E-06	1.38E-06	1.17E-06	lb/MMBtu	1	8.92	10.09	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Arsenic	D2-v0	6.67E-06	4.20E-06	1.92E-05	2.37E-06	lb/MMBtu	3	84.20	55.01	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Beryllium	D3-v0	1.92E-06	2.01E-06	2.15E-06	1.58E-06	lb/MMBtu	2	13.70	10.96	0.51
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Cadmium	D2-v1	1.09E-06	9.86E-07	3.61E-06	1.58E-07	lb/MMBtu	3	100.01	65.34	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Chromium (Hex)	B2-v0	1.09E-06	1.01E-06	2.22E-06	3.86E-07	lb/MMBtu	3	55.29	36.12	0.47
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Chromium (Total)	B2-v1	5.75E-06	3.81E-06	1.46E-05	1.01E-06	lb/MMBtu	3	85.04	55.56	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Copper	D2-v0	6.63E-06	6.16E-06	1.24E-05	3.16E-06	lb/MMBtu	3	48.02	31.37	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Lead	D2-v0	1.88E-06	1.75E-06	3.24E-06	1.19E-06	lb/MMBtu	3	33.08	21.61	0.52
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Manganese	D2-v1	2.02E-05	1.89E-05	3.79E-05	1.62E-06	lb/MMBtu	3	63.82	47.28	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Mercury	D2-v2	1.48E-05	3.43E-07	3.48E-05	5.71E-08	lb/MMBtu	3	122.84	91.00	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Nickel	D2-v0	2.40E-03	2.38E-03	2.65E-03	2.19E-03	lb/MMBtu	3	5.44	3.55	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Phosphorus	D3-v1	1.78E-04	9.57E-05	4.57E-04	1.84E-05	lb/MMBtu	2	102.06	81.66	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Selenium	D2-v1	7.95E-06	2.93E-06	2.08E-05	1.19E-06	lb/MMBtu	3	108.30	70.75	0.96
SG, Crude Oil/1	31000413	SO2 Scrub	None	Metals	Zinc	D2-v2	5.44E-04	1.90E-04	1.75E-03	1.58E-05	lb/MMBtu	3	127.81	83.50	0.94
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Acenaphthene	C3-v1	2.55E-07	1.38E-07	6.21E-07	7.06E-09	lb/MMBtu	2	111.36	89.10	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Acenaphthylene	C2-v1	5.00E-08	4.33E-08	1.18E-07	1.41E-09	lb/MMBtu	3	83.39	54.48	0.47
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Anthracene	C2-v1	5.10E-08	2.12E-08	1.66E-07	2.12E-09	lb/MMBtu	3	133.46	92.48	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Benzo(a)anthracene	C2-v1	5.18E-08	5.51E-08	9.89E-08	3.53E-09	lb/MMBtu	3	72.24	50.06	0.42
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Benzo(a)pyrene	C3-v1	5.38E-08	6.35E-08	8.41E-08	3.53E-09	lb/MMBtu	2	60.91	48.74	0.24
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Benzo(b)fluoranthene	C3-v1	4.71E-08	2.82E-08	1.06E-07	7.06E-09	lb/MMBtu	1	110.57	125.12	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Benzo(b+k)fluoranthene	C3-v0	8.06E-08	8.01E-08	8.41E-08	7.77E-08	lb/MMBtu	1	4.07	4.61	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Benzo(g,h,i)perylene	C3-v1	5.21E-08	6.00E-08	8.41E-08	7.06E-09	lb/MMBtu	2	63.92	51.15	0.21
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Benzo(k)fluoranthene	C3-v0	4.00E-09	3.53E-09	7.06E-09	1.41E-09	lb/MMBtu	1	71.32	80.70	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Chrysene	C2-v1	7.43E-08	7.77E-08	2.28E-07	7.06E-09	lb/MMBtu	3	92.90	60.70	0.64
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Dibenz(a,h)anthracene	C3-v1	5.33E-08	6.35E-08	8.41E-08	7.06E-09	lb/MMBtu	2	61.97	49.58	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Fluoranthene	C2-v1	8.72E-08	7.77E-08	3.46E-07	7.06E-09	lb/MMBtu	3	115.48	75.45	0.70
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Fluorene	C2-v1	9.41E-08	4.80E-08	3.04E-07	7.06E-09	lb/MMBtu	3	116.41	76.06	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Indeno(1,2,3-cd)pyrene	C3-v1	5.33E-08	6.71E-08	8.41E-08	7.06E-09	lb/MMBtu	2	64.74	51.80	0.22
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Naphthalene	C2-v0	5.28E-06	3.01E-06	1.07E-05	1.43E-06	lb/MMBtu	3	80.94	56.09	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Phenanthrene	C2-v1	1.65E-07	4.71E-08	1.07E-06	1.45E-08	lb/MMBtu	3	208.06	135.93	1.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	PAH	Pyrene	C2-v1	1.50E-07	8.41E-08	4.77E-07	7.06E-09	lb/MMBtu	3	95.35	62.29	0.82
SG, Crude Oil/1	31000413	SO2 Scrub	None	SVOC	Benzaldehyde	A3-v0	4.74E-05	4.90E-05	4.95E-05	4.37E-05	lb/MMBtu	1	6.71	7.60	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	VOC	Acetaldehyde	A3-v0	1.78E-05	1.43E-05	3.37E-05	7.79E-06	lb/MMBtu	2	52.94	34.59	0.54
SG, Crude Oil/1	31000413	SO2 Scrub	None	VOC	Acrolein	A3-v0	1.20E-05	3.30E-06	3.06E-05	3.30E-06	lb/MMBtu	2	108.95	71.18	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	VOC	Benzene	B3-v0	4.07E-06	4.37E-06	6.55E-06	2.02E-06	lb/MMBtu	2	43.66	28.53	0.36
SG, Crude Oil/1	31000413	SO2 Scrub	None	VOC	Formaldehyde	A3-v0	6.31E-06	5.36E-06	1.11E-05	2.68E-06	lb/MMBtu	2	53.55	34.98	0.44
SG, Crude Oil/1	31000413	SO2 Scrub	None	VOC	Propylene	B3-v1	3.91E-04	1.24E-05	1.15E-03	1.24E-05	lb/MMBtu	2	145.24	94.89	0.00
SG, Crude Oil/1	31000413	SO2 Scrub	None	VOC	Toluene	B3-v0	2.38E-05	1.36E-05	7.80E-05	1.36E-05	lb/MMBtu	2	89.52	58.48	0.74
SG, Crude Oil/1	31000413	SO2 Scrub	None	VOC	Xylene (Total)	B3-v1	2.18E-05	3.12E-05	3.12E-05	2.89E-06	lb/MMBtu	2	65.05	42.50	0.00
SG, Natural Gas/1	31000414	None	None	VOC	Acetaldehyde	A3-v0	1.66E-05	1.68E-05	1.77E-05	1.53E-05	lb/MMBtu	1	7.27	8.22	1.00
SG, Natural Gas/1	31000414	None	None	VOC	Acrolein	A3-v0	1.96E-05	1.86E-05	2.37E-05	1.65E-05	lb/MMBtu	1	18.73	21.19	1.00
SG, Natural Gas/1	31000414	None	None	VOC	Benzene	B3-v0	3.94E-06	3.93E-06	4.10E-06	3.78E-06	lb/MMBtu	2	4.28	3.42	0.00
SG, Natural Gas/1	31000414	None	None	VOC	Formaldehyde	A3-v1	3.11E-05	1.87E-05	9.75E-05	3.87E-06	lb/MMBtu	2	113.45	90.78	1.00
SG, Natural Gas/1	31000414	None	None	VOC	Propylene	C3-v0	1.16E-04	1.16E-04	1.17E-04	1.16E-04	lb/MMBtu	1	0.36	0.41	0.00
SG, Natural Gas/1	31000414	None	None	VOC	Toluene	B3-v0	1.22E-05	1.22E-05	1.27E-05	1.17E-05	lb/MMBtu	2	4.28	3.42	0.00
SG, Natural Gas/1	31000414	None	None	VOC	Xylene (Total)	B3-v0	2.81E-05	2.81E-05	2.94E-05	2.70E-05	lb/MMBtu	2	4.28	3.42	0.00
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Acenaphthene	A3-v0	1.06E-09	7.84E-10	2.34E-09	4.06E-10	lb/MMBtu	2	65.71	52.57	0.72
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Acenaphthylene	A3-v1	2.69E-09	7.14E-10	1.01E-08	4.06E-10	lb/MMBtu	2	142.14	113.73	0.85
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Anthracene	A3-v1	2.18E-09	2.33E-09	4.26E-09	4.06E-10	lb/MMBtu	2	64.55	51.65	0.97
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Benzo(a)anthracene	A3-v0	1.28E-09	1.12E-09	2.42E-09	7.12E-10	lb/MMBtu	2	45.67	36.54	0.45
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Benzo(a)pyrene	A3-v0	7.08E-10	7.11E-10	1.31E-09	3.92E-10	lb/MMBtu	2	47.05	37.64	0.32
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Benzo(b)fluoranthene	A3-v0	2.01E-09	9.26E-10	4.71E-09	7.10E-10	lb/MMBtu	2	92.63	74.12	0.84
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Benzo(g,h,i)perylene	A3-v0	9.98E-10	7.14E-10	1.73E-09	4.06E-10	lb/MMBtu	2	57.41	45.93	0.59
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Benzo(k)fluoranthene	A3-v0	8.41E-10	7.14E-10	1.37E-09	4.06E-10	lb/MMBtu	2	41.36	33.09	0.52
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Chrysene	A3-v0	1.60E-09	1.80E-09	2.42E-09	7.12E-10	lb/MMBtu	2	39.17	31.35	0.33
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Dibenz(a,h)anthracene	A3-v0	5.54E-10	5.58E-10	7.15E-10	3.90E-10	lb/MMBtu	2	31.29	25.04	0.00
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Fluoranthene	A3-v0	3.67E-09	1.78E-09	8.90E-09	1.07E-09	lb/MMBtu	2	95.56	76.46	1.00
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Fluorene	A3-v0	5.66E-09	2.64E-09	1.28E-08	1.85E-09	lb/MMBtu	2	92.16	73.74	1.00
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	1.18E-09	7.14E-10	2.34E-09	4.06E-10	lb/MMBtu	2	72.24	57.80	0.66
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Naphthalene	A3-v0	2.93E-07	2.33E-07	5.46E-07	1.57E-07	lb/MMBtu	2	52.01	41.62	1.00
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Phenanthrene	A3-v0	1.68E-08	1.34E-08	3.12E-08	6.50E-09	lb/MMBtu	2	60.61	48.50	1.00
SG, Natural/CVR Gas/1	31000499	None	None	PAH	Pyrene	A3-v1	6.02E-09	2.93E-09	1.72E-08	8.55E-10	lb/MMBtu	2	106.75	85.42	1.00
SG, Natural/CVR Gas/1	31000499	None	None	SVOC	Ethylbenzene	A3-v0	9.63E-06	7.23E-06	2.02E-05	4.02E-06	lb/MMBtu	2	59.81	47.86	0.54

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Acetaldehyde	A2-v0	1.85E-05	1.68E-05	4.88E-05	5.47E-06	lb/MMBtu	4	66.12	37.41	0.84
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Acrolein	A2-v0	1.69E-05	1.92E-05	2.62E-05	5.47E-06	lb/MMBtu	4	41.86	23.68	0.88
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Benzene	B1-v0	4.45E-06	4.40E-06	6.12E-06	2.75E-06	lb/MMBtu	5	23.61	11.95	0.00
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Formaldehyde	A2-v1	2.53E-05	1.56E-05	1.01E-04	5.47E-06	lb/MMBtu	4	111.34	63.00	0.70
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Hydrogen Sulfide	C3-v0	1.59E-04	1.60E-04	2.38E-04	8.02E-05	lb/MMBtu	1	49.59	56.11	1.00
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Propylene	C2-v1	2.29E-04	1.27E-04	6.83E-04	1.23E-05	lb/MMBtu	4	94.36	53.39	0.72
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Toluene	B1-v0	1.73E-05	1.43E-05	3.04E-05	1.34E-05	lb/MMBtu	5	33.16	16.78	0.64
SG, Natural/CVR Gas/1	31000499	None	None	VOC	Xylene (Total)	B1-v0	2.66E-05	3.11E-05	4.36E-05	1.21E-05	lb/MMBtu	5	36.70	18.57	0.23
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Acenaphthene	A3-v0	3.25E-09	2.03E-09	8.46E-09	1.23E-09	lb/MMBtu	2	87.69	70.16	0.67
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Acenaphthylene	A3-v0	2.90E-09	2.74E-09	5.67E-09	1.23E-09	lb/MMBtu	2	57.20	45.77	0.54
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Anthracene	A3-v1	3.43E-08	7.19E-09	1.50E-07	3.70E-09	lb/MMBtu	2	168.94	135.17	1.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Benzo(a)anthracene	A3-v0	2.78E-09	2.31E-09	5.62E-09	1.80E-09	lb/MMBtu	2	52.46	41.98	0.34
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Benzo(a)pyrene	A3-v0	2.05E-09	2.01E-09	3.02E-09	1.23E-09	lb/MMBtu	2	41.94	33.56	0.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Benzo(b)fluoranthene	A3-v0	3.30E-09	2.74E-09	8.77E-09	1.23E-09	lb/MMBtu	2	84.51	67.62	0.44
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Benzo(g,h,i)perylene	A3-v0	2.38E-09	2.74E-09	3.25E-09	1.23E-09	lb/MMBtu	2	37.17	29.74	0.22
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Benzo(k)fluoranthene	A3-v0	2.58E-09	2.74E-09	4.46E-09	1.23E-09	lb/MMBtu	2	46.68	37.35	0.28
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Chrysene	A3-v0	4.93E-09	5.88E-09	6.05E-09	2.76E-09	lb/MMBtu	2	32.43	25.95	0.31
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Dibenz(a,h)anthracene	A3-v0	2.05E-09	2.01E-09	3.02E-09	1.23E-09	lb/MMBtu	2	41.94	33.56	0.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Fluoranthene	A3-v0	1.16E-08	1.16E-08	1.71E-08	5.51E-09	lb/MMBtu	2	36.82	29.47	1.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Fluorene	A3-v0	1.49E-08	1.40E-08	3.02E-08	7.90E-09	lb/MMBtu	2	53.86	43.09	1.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	2.29E-09	2.73E-09	3.02E-09	1.23E-09	lb/MMBtu	2	35.08	28.07	0.20
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Naphthalene	A3-v0	7.29E-07	7.77E-07	9.33E-07	4.35E-07	lb/MMBtu	2	30.01	24.02	1.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Phenanthrene	A3-v0	6.46E-08	4.86E-08	1.39E-07	2.57E-08	lb/MMBtu	2	62.98	50.39	1.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	PAH	Pyrene	A3-v0	2.25E-08	2.03E-08	4.15E-08	5.51E-09	lb/MMBtu	2	64.16	51.34	1.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	SVOC	Ethylbenzene	A3-v0	1.49E-05	1.48E-05	2.16E-05	9.05E-06	lb/MMBtu	2	42.21	33.78	0.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	VOC	Acetaldehyde	A3-v0	3.78E-05	4.55E-05	5.14E-05	1.65E-05	lb/MMBtu	1	49.40	55.90	0.85
Turbine, Natural Gas/1	20200203	None	No Duct Burners	VOC	Acrolein	A3-v0	1.72E-05	1.73E-05	1.73E-05	1.71E-05	lb/MMBtu	1	0.68	0.77	0.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	VOC	Benzene	A3-v0	1.20E-05	1.19E-05	1.82E-05	6.64E-06	lb/MMBtu	2	48.32	38.66	0.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	VOC	Formaldehyde	A3-v0	1.99E-05	1.65E-05	2.68E-05	1.65E-05	lb/MMBtu	1	29.80	33.72	0.45
Turbine, Natural Gas/1	20200203	None	No Duct Burners	VOC	Propylene	A3-v0	1.63E-03	1.61E-03	1.90E-03	1.39E-03	lb/MMBtu	1	15.66	17.72	1.00
Turbine, Natural Gas/1	20200203	None	No Duct Burners	VOC	Toluene	A3-v1	7.01E-05	5.75E-05	1.65E-04	7.85E-06	lb/MMBtu	2	89.58	71.67	0.98
Turbine, Natural Gas/1	20200203	None	No Duct Burners	VOC	Xylene (Total)	A3-v0	3.52E-05	4.04E-05	5.97E-05	9.25E-06	lb/MMBtu	2	51.95	41.57	0.38
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Acenaphthene	A3-v0	3.25E-09	2.03E-09	8.46E-09	1.23E-09	lb/MMBtu	2	87.69	70.16	0.67
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Acenaphthylene	A3-v0	2.90E-09	2.74E-09	5.67E-09	1.23E-09	lb/MMBtu	2	57.20	45.77	0.54
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Anthracene	A3-v1	3.43E-08	7.19E-09	1.50E-07	3.70E-09	lb/MMBtu	2	168.94	135.17	1.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Benzo(a)anthracene	A3-v0	2.78E-09	2.31E-09	5.62E-09	1.80E-09	lb/MMBtu	2	52.46	41.98	0.34
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Benzo(a)pyrene	A3-v0	2.05E-09	2.01E-09	3.02E-09	1.23E-09	lb/MMBtu	2	41.94	33.56	0.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Benzo(b)fluoranthene	A3-v0	3.30E-09	2.74E-09	8.77E-09	1.23E-09	lb/MMBtu	2	84.51	67.62	0.44
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Benzo(g,h,i)perylene	A3-v0	2.38E-09	2.74E-09	3.25E-09	1.23E-09	lb/MMBtu	2	37.17	29.74	0.22
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Benzo(k)fluoranthene	A3-v0	2.58E-09	2.74E-09	4.46E-09	1.23E-09	lb/MMBtu	2	46.68	37.35	0.28
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Chrysene	A3-v0	4.93E-09	5.88E-09	6.05E-09	2.76E-09	lb/MMBtu	2	32.43	25.95	0.31
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Dibenz(a,h)anthracene	A3-v0	2.05E-09	2.01E-09	3.02E-09	1.23E-09	lb/MMBtu	2	41.94	33.56	0.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Fluoranthene	A3-v0	1.16E-08	1.16E-08	1.71E-08	5.51E-09	lb/MMBtu	2	36.82	29.47	1.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Fluorene	A3-v0	1.49E-08	1.40E-08	3.02E-08	7.90E-09	lb/MMBtu	2	53.86	43.09	1.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Indeno(1,2,3-cd)pyrene	A3-v0	2.29E-09	2.73E-09	3.02E-09	1.23E-09	lb/MMBtu	2	35.08	28.07	0.20
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Naphthalene	A3-v0	7.29E-07	7.77E-07	9.33E-07	4.35E-07	lb/MMBtu	2	30.01	24.02	1.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Phenanthrene	A3-v0	6.46E-08	4.86E-08	1.39E-07	2.57E-08	lb/MMBtu	2	62.98	50.39	1.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	PAH	Pyrene	A3-v0	2.25E-08	2.03E-08	4.15E-08	5.51E-09	lb/MMBtu	2	64.16	51.34	1.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	SVOC	Ethylbenzene	A3-v0	1.49E-05	1.48E-05	2.16E-05	9.05E-06	lb/MMBtu	2	42.21	33.78	0.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	VOC	Acetaldehyde	A3-v0	3.78E-05	4.55E-05	5.14E-05	1.65E-05	lb/MMBtu	1	49.40	55.90	0.85
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	VOC	Acrolein	A3-v0	1.72E-05	1.73E-05	1.73E-05	1.71E-05	lb/MMBtu	1	0.68	0.77	0.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	VOC	Benzene	A3-v0	1.20E-05	1.19E-05	1.82E-05	6.64E-06	lb/MMBtu	2	48.32	38.66	0.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	VOC	Formaldehyde	A3-v0	1.99E-05	1.65E-05	2.68E-05	1.65E-05	lb/MMBtu	1	29.80	33.72	0.45
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	VOC	Propylene	A3-v0	1.63E-03	1.61E-03	1.90E-03	1.39E-03	lb/MMBtu	1	15.66	17.72	1.00
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	VOC	Toluene	A3-v1	7.01E-05	5.75E-05	1.65E-04	7.85E-06	lb/MMBtu	2	89.58	71.67	0.98
Turbine, Natural Gas/1	20200203	SCR/COC	No Duct Burners	VOC	Xylene (Total)	A3-v0	3.52E-05	4.04E-05	5.97E-05	9.25E-06	lb/MMBtu	2	51.95	41.57	0.38
Turbine, Natural Gas/2	20200203	SCR	Duct Burners	VOC	Formaldehyde	C3-v0	6.02E-03	5.89E-03	6.65E-03	5.52E-03	lb/MMBtu	1	9.57	10.83	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Cadmium	C3-v0	1.94E-06	9.84E-07	3.87E-06	9.55E-07	lb/MMBtu	1	86.47	97.85	0.67
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Chromium (Hex)	C3-v0	6.95E-06	6.60E-06	1.39E-05	1.45E-06	lb/MMBtu	2	83.59	66.88	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Chromium (Total)	C3-v1	4.99E-05	3.15E-05	1.71E-04	1.43E-05	lb/MMBtu	2	120.88	96.72	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Copper	A3-v0	1.75E-06	1.84E-06	2.46E-06	9.65E-07	lb/MMBtu	1	42.72	48.34	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Manganese	A3-v0	3.25E-06	2.19E-06	6.32E-06	1.23E-06	lb/MMBtu	1	83.26	94.21	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Mercury	A3-v0	4.35E-06	3.73E-06	7.82E-06	2.37E-06	lb/MMBtu	2	51.85	41.49	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Nickel	C3-v0	7.60E-06	6.32E-06	1.33E-05	3.16E-06	lb/MMBtu	1	68.51	77.52	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	Metals	Zinc	A3-v0	1.53E-05	1.45E-05	1.80E-05	1.35E-05	lb/MMBtu	1	15.37	17.39	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Acenaphthene	C3-v0	2.21E-08	2.00E-08	3.55E-08	1.07E-08	lb/MMBtu	1	56.84	64.32	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Acenaphthylene	C3-v0	1.07E-08	1.20E-08	1.23E-08	7.93E-09	lb/MMBtu	1	22.70	25.68	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Anthracene	C3-v0	2.48E-08	2.26E-08	3.41E-08	1.76E-08	lb/MMBtu	1	34.03	38.51	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Benzo(a)anthracene	C3-v1	1.49E-08	3.23E-09	3.86E-08	2.81E-09	lb/MMBtu	1	138.05	156.22	0.86
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Benzo(a)pyrene	C3-v0	9.53E-09	9.78E-09	1.26E-08	6.17E-09	lb/MMBtu	1	34.09	38.57	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Benzo(b)fluoranthene	C3-v0	2.50E-08	2.96E-08	3.20E-08	1.35E-08	lb/MMBtu	1	40.14	45.42	0.82
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Benzo(g,h,i)perylene	C3-v0	1.91E-08	1.86E-08	2.52E-08	1.35E-08	lb/MMBtu	1	30.62	34.65	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Benzo(k)fluoranthene	C3-v0	1.25E-08	1.13E-08	1.86E-08	7.49E-09	lb/MMBtu	1	45.53	51.52	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Chrysene	C3-v0	1.07E-07	6.37E-08	2.26E-07	3.23E-08	lb/MMBtu	1	96.95	109.70	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Dibenz(a,h)anthracene	C3-v0	6.60E-09	7.55E-09	7.99E-09	4.26E-09	lb/MMBtu	1	30.92	34.99	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Fluoranthene	C3-v0	9.90E-08	9.92E-08	1.46E-07	5.14E-08	lb/MMBtu	1	48.01	54.33	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Fluorene	C3-v1	1.76E-07	7.46E-08	4.15E-07	3.96E-08	lb/MMBtu	1	117.53	132.99	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Indeno(1,2,3-cd)pyrene	C3-v0	9.14E-09	9.85E-09	1.10E-08	6.61E-09	lb/MMBtu	1	24.76	28.02	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Naphthalene	C3-v0	3.74E-05	3.70E-05	3.99E-05	3.52E-05	lb/MMBtu	1	6.36	7.20	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Phenanthrene	C3-v0	6.37E-07	5.14E-07	9.03E-07	4.93E-07	lb/MMBtu	1	36.34	41.12	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	PAH	Pyrene	C3-v0	1.19E-07	9.63E-08	2.13E-07	4.84E-08	lb/MMBtu	1	71.00	80.34	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	SVOC	Phenol	C3-v0	1.43E-05	1.47E-05	1.48E-05	1.33E-05	lb/MMBtu	1	5.81	6.57	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	VOC	Acetaldehyde	A3-v0	4.11E-06	3.09E-06	6.18E-06	3.06E-06	lb/MMBtu	1	43.68	49.43	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	VOC	Benzene	C3-v0	1.52E-04	1.54E-04	1.69E-04	1.32E-04	lb/MMBtu	2	11.10	8.88	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	VOC	Formaldehyde	A3-v0	1.54E-04	8.36E-05	3.09E-04	7.03E-05	lb/MMBtu	1	86.98	98.42	1.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	VOC	Hydrogen Sulfide	A3-v0	1.50E-04	1.49E-04	1.56E-04	1.44E-04	lb/MMBtu	1	4.30	4.86	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	VOC	Toluene	E3-v0	1.62E-04	1.61E-04	1.69E-04	1.55E-04	lb/MMBtu	1	4.30	4.87	0.00
Turbine, Natural/Ref. Gas/1	20200299	SCR/COC	Duct Burners	VOC	Xylene (Total)	E3-v0	3.74E-04	3.76E-04	3.76E-04	3.72E-04	lb/MMBtu	1	0.55	0.63	0.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Arsenic	B3-v0	8.95E-06	9.00E-06	9.40E-06	8.46E-06	lb/MMBtu	1	5.25	5.94	0.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Beryllium	B3-v0	1.79E-06	1.80E-06	1.88E-06	1.69E-06	lb/MMBtu	1	5.26	5.95	0.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Cadmium	B3-v0	3.89E-06	3.60E-06	4.70E-06	3.39E-06	lb/MMBtu	1	18.07	20.45	0.40
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Copper	B3-v0	2.14E-05	9.89E-06	4.59E-05	8.46E-06	lb/MMBtu	1	99.09	112.13	0.87
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Lead	B3-v0	3.58E-05	3.60E-05	3.76E-05	3.39E-05	lb/MMBtu	1	5.23	5.92	0.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Manganese	B3-v0	9.21E-05	5.20E-05	1.95E-04	2.93E-05	lb/MMBtu	1	97.60	110.45	1.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Nickel	B3-v0	1.46E-04	5.09E-05	3.47E-04	4.09E-05	lb/MMBtu	1	118.88	134.52	1.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Selenium	B3-v0	8.95E-06	9.00E-06	9.40E-06	8.46E-06	lb/MMBtu	1	5.25	5.94	0.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	Metals	Zinc	B3-v0	2.16E-04	2.14E-04	3.58E-04	7.75E-05	lb/MMBtu	1	64.70	73.22	1.00
Turbine, Natural/Ref./LP Gas/1	20200299	SCR/COC	Duct Burners	SVOC	Phenol	C3-v1	3.05E-05	1.21E-05	7.65E-05	2.91E-06	lb/MMBtu	1	131.46	148.76	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Arsenic	B3-v0	2.92E-06	2.96E-06	2.98E-06	2.81E-06	lb/MMBtu	1	3.09	3.49	0.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Beryllium	B3-v0	1.46E-06	1.48E-06	1.49E-06	1.41E-06	lb/MMBtu	1	2.78	3.14	0.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Cadmium	B3-v0	5.28E-06	3.71E-06	9.18E-06	2.96E-06	lb/MMBtu	1	64.24	72.70	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Chromium (Hex)	C3-v0	1.45E-06	1.45E-06	1.46E-06	1.44E-06	lb/MMBtu	1	0.70	0.79	0.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Chromium (Total)	C3-v0	1.31E-05	7.19E-06	2.80E-05	4.23E-06	lb/MMBtu	1	98.65	111.63	0.82
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Copper	B3-v0	4.12E-05	3.91E-05	6.93E-05	1.51E-05	lb/MMBtu	1	65.90	74.57	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Lead	B3-v0	2.84E-05	2.96E-05	2.98E-05	2.59E-05	lb/MMBtu	1	7.62	8.62	0.30
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Manganese	B3-v0	1.29E-04	1.03E-04	2.43E-04	3.96E-05	lb/MMBtu	1	80.76	91.39	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Mercury	A3-v0	1.53E-05	1.11E-05	2.59E-05	9.05E-06	lb/MMBtu	1	59.94	67.83	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Nickel	B3-v0	1.66E-04	1.88E-04	2.04E-04	1.05E-04	lb/MMBtu	1	31.93	36.13	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Selenium	B3-v0	3.86E-06	2.98E-06	5.65E-06	2.96E-06	lb/MMBtu	1	40.11	45.39	0.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	Metals	Zinc	B3-v0	4.98E-03	5.87E-03	6.54E-03	2.54E-03	lb/MMBtu	1	42.95	48.60	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	SVOC	Phenol	C3-v0	6.71E-06	4.27E-06	1.22E-05	3.62E-06	lb/MMBtu	1	71.54	80.95	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	VOC	Acetaldehyde	C3-v0	1.56E-05	1.58E-05	1.89E-05	1.19E-05	lb/MMBtu	1	22.53	25.49	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	VOC	Benzene	C3-v0	1.06E-04	1.07E-04	1.09E-04	1.02E-04	lb/MMBtu	1	3.34	3.78	0.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	VOC	Formaldehyde	C3-v0	5.99E-04	5.96E-04	6.34E-04	5.68E-04	lb/MMBtu	1	5.57	6.31	1.00

APPENDIX B. EMISSION FACTORS LB/MMBTU

Major/Sub Group	SCC	APC System	Other Description	Substance Category	Substance	ARB Rating	Mean	Median	Maximum	Minimum	Emission Factor Unit	Tests	RSD, %	Uncertainty, %	Detect Ratio
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	VOC	Hydrogen Sulfide	A3-v0	1.16E-04	1.17E-04	1.19E-04	1.12E-04	lb/MMBtu	1	3.06	3.46	0.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	VOC	Toluene	E3-v1	7.77E-04	3.10E-04	1.84E-03	1.83E-04	lb/MMBtu	1	118.63	134.23	1.00
Turbine, Ref. Gas/1	20200701	COC	No Duct Burners	VOC	Xylene (Total)	E3-v1	2.24E-03	2.42E-04	6.31E-03	1.66E-04	lb/MMBtu	1	157.44	178.16	1.00

Det Ratio: Ratio of detected values to the sum of detected and nondetected values.
RSD: 100 times the standard deviation divided by the arithmetic average.
Uncertainty: 100 times the 95% confidence interval divided by the arithmetic average.

Technical Area: Socioeconomics
Author: Hedy Born

BACKGROUND

The applicant has stated on page 8.7-4 (Section 8.7.2.1.2) of the SPPE that the "estimated value of materials and supplies that will be purchased locally during construction is expected to be about $60 million." To gather a complete set of data and information on fiscal resources of the proposed project, please provide the following.

DATA REQUEST

52. a. Please provide the increase in estimated annual property taxes as a result of the project;

Response: A response will be submitted prior to September 26, 2007.

b. Please provide the operation cost (excluding fuel costs) within Contra Costa County; and

Response: Plant operating cost excluding fuel is approximately $1.5 million per year. This is an average over multiple years of operation as the annual cost varies depending on what overhauls occur during a year.

c. Please provide the estimated school impact fees, if applicable.

Response: A response will be submitted prior to September 26, 2007.

BACKGROUND

The applicant has stated on page 8.7-4 (Section 8.7.2.1.1) of the SPPE that an average workforce of 124 workers would be required over the 26-month construction period of the Cogen 3000 and H2-STG. In Section 8.7.2.1.2 on the same page, the construction payroll is estimated to be approximately $40 million. These numbers calculate such that the average construction worker would make approximately $322,580.65 over the 26-month construction period. This seems incongruous.

DATA REQUEST

53. Please verify the average per worker payroll during construction, including any overtime hours assumed and the terms (e.g., time-and–a-half pay rate, weekend and/or holiday pay rates).

Response: The weighted average labor rate is $36.88, with an overtime rate of $55.32. This is the base wage and does not include any benefits, burden or taxes. The hour labor rates range from $25.14 to $50.95 and includes all craft labor disciplines (laborers, electricians, welders, pipe fitters etc).

The construction schedule assumes a 50 hour work week with 10 hours of overtime each week. Standard California Labor rules regarding OT will apply. Therefore, average hourly bare salary (no benefits) labor rate (based on a 50 hour week) will be $40.57. The composite average 50-hr benefited wage rate is approximately $64.17.This hourly rate aligns with an average of approximately $347,600 in payroll and benefits over a 26 month period for the average worker. This numbers are based on rough estimates of labor hours and craft types required for the project that may change following final engineering.

BACKGROUND

Quantitative secondary economic impacts (with and without dollars) add useful additional information at the local (county)/regional/state level about the economic benefits/economic development from the project.

DATA REQUEST

54. Please provide full quantitative economic impacts (direct and secondary-indirect and induced) during the construction and operation phases of the project. Utilize an economic impact model (e.g., IMPLAN, REMI) that will estimate quantitatively at least the local (Contra Costa County) employment and income multipliers/secondary impacts. Staff recommends Type II or Type III employment and income multipliers since they show the full secondary economic impacts. Finally, provide the year for the economic impact analysis estimates.

    Response: A quantitative economic analysis is currently underway and will be provided to Staff by September 26, 2007.

BACKGROUND

Section 8.7.2.1.2 states the fiscal resources of the proposed project. In order to know the time value of money, please provide the following.

DATA REQUEST

55. Please indicate the year for all economic dollar estimates (e.g., construction costs, construction and operation payroll, sales taxes, property taxes, school impacts fees, etc.).

    Response: The year used for all economic dollar estimates is 2007.

Technical Area: Soil and Water Resources
Author: Christopher Dennis, P.G.

BACKGROUND

Construction and operation of the Chevron Richmond Refinery Power Plant Replacement Project (PPRP) may induce water and wind erosion at the COGEN 3000 area, hydrogen plant, switchgear and cooling tower areas, and construction laydown/parking sites. Both the generation and laydown/parking sites are currently developed with existing industrial buildings, paved areas, and graded areas. These facilities will be demolished and removed prior to initiating construction, exposing and disturbing the underlying soil.

To determine the potential impacts to water and soil resources from the construction of the PPRP, the Energy Commission requires a Drainage Erosion and Sediment Control Plan (DESCP). The DESCP is to be updated and revised as the project moves from the preliminary to final design phases and is to be a separate document from the Construction Storm Water Pollution Prevention Plan (SWPPP). The DESCP, submitted prior to site mobilization, must be designed and sealed by a professional engineer/erosion control specialist.

The Commission recognizes that a DESCP may be in place for the Chevron Refinery as a whole, and that all or elements of the PPRP may be covered under the existing DESCP.

DATA REQUEST

56. a. Please explain how the PPRP fits into the existing DESCP for the Chevron Refinery as a whole and provide a draft DESCP containing elements A through I listed below. These elements will outline site management activities and erosion/sediment control Best Management Practices (BMPs) to be implemented during site mobilization, excavation/demolition, construction, and post-construction activities. The level of detail in the draft DESCP should correspond to the current level of planning for site demolition and corresponding site grading and drainage.

    b. Please provide all conceptual erosion control information for those phases of construction and post-construction that have been developed or provide a statement when such information will be available.

    A. **Vicinity Map** – A map(s) at a minimum scale 1”=100’ shall be provided indicating the location of all project elements and depictions of all significant geographic features including swales, storm drains, and sensitive areas.

B. **Site Delineation** – All areas subject to soil disturbance for the PPRP (project site, lay down/demolition areas, all linear facilities, landscaping areas, and any other project elements) shall be delineated showing boundary lines of all construction/demolition areas and the location of all existing and proposed structures, pipelines, roads, and drainage facilities.

C. **Watercourses and Critical Areas** – The DESCP shall show the location of all nearby watercourses including swales, storm drains, and drainage ditches. Indicate the proximity of those features to the PPRP construction, lay down/demolition, and landscape areas and all transmission and pipeline construction corridors.

D. **Drainage Map** – The DESCP shall provide a topographic site map(s) at a minimum scale 1”=100’ showing all existing, interim, and proposed drainage systems and drainage area boundaries. On the map, spot elevations are required where relatively flat conditions exist. The spot elevations and contours shall be extended off-site for a minimum distance of 100 feet in flat terrain.

E. **Drainage of Project Site Narrative** – The DESCP shall include a narrative of the drainage measures to be taken to protect the site and downstream facilities. The narrative shall include a summary of the hydraulic analysis prepared by a professional engineer/erosion control specialist. The narrative shall state the watershed size in acres that was used in the calculation of drainage measures. The hydraulic analysis should be used to support the selection of BMPs and structural controls to divert off-site and on-site drainage around or through the PPRP construction and laydown/demolition areas.

F. **Clearing and Grading Plans** – The DESCP shall provide a delineation of all areas to be cleared of vegetation and areas to be preserved. The plan shall provide elevations, slopes, locations, and extent of all proposed grading as shown by contours, cross sections or other means. The locations of any disposal areas, fills, or other special features shall also be shown. Illustrate existing and proposed topography tying in proposed contours with existing topography.

G. **Clearing and Grading Narrative** – The DESCP shall include a table with the quantities of material excavated or filled for the site and all project elements of the PPRP (project site, lay down/demolition areas, transmission corridors, and pipeline corridors). This table shall include those materials removed from the site due to demolition, whether such excavations or fill is temporary or permanent, and the amount of such material to be imported or exported. The table shall distinguish whether such excavations or fill are temporary or permanent and the amount of material to be imported or exported.

H **Best Management Practices Plan** – The DESCP shall identify on the topographic site map(s) the location of the site specific BMPs to be employed during each phase of construction (initial grading/demolition, project element excavation and construction, and final grading/stabilization). BMPs shall include measures designed to prevent wind and water erosion in areas with existing soil contamination. Treatment control BMPs used during construction should enable testing of groundwater and/or stormwater runoff prior to discharge to San Pablo or San Francisco Bays.

I. **Best Management Practices Narrative** – The DESCP shall show the location (as identified in H above), timing, and a maintenance schedule of all erosion and sediment control BMPs to be used prior to initial grading/demolition, during project element excavation and construction, final grading/stabilization, and post-construction. Separate BMP implementation schedules shall be provided for each project element for each phase of construction. The maintenance schedule should include post-construction maintenance of structural control BMPs or a statement provided when such information will be available.

Response: A draft DESCP will be provided to Staff by –October 15, 2007.

BACKGROUND

Potentially significant impacts to soil erosion and potential stormwater runoff could be mitigated through the preparation of construction and operation plans and the use of BMPs that would mitigate these problems. Section 8.12.4.2 states that the Chevron Refinery's Regional Water Quality Control Board (RWQCB)-approved Soil Management Program would mitigate potential stormwater runoff to less-than-significant levels for soil stockpiled during construction that could possibly introduce contaminant loading into the waste stream.

DATA REQUEST

57. Please provide a copy of the procedural documentation describing in detail the Chevron Refinery's Soil Management Program as it applies to the PPRP.

Response: The SPPE incorrectly stated the status of the Chevron Refinery Soil Management Program. At the time of submittal of the SPPE, the Chevron Refinery's Soil Management Program had received a draft approval. The final approval from the Regional Water Quality Control Board (RWQCB) has not yet been obtained and is anticipated in October, 2007. When the final approval of the Soil Management Program has been received, a copy of the document will be provided to Staff.

However, in the interim, Chevron Refinery's Document No. RI-505, *Excavation Procedures* (Attachment S&W-57), defines the procedures for soil excavation work as required by federal, state, and local regulations**.**

Any construction plans at the refinery that require excavation of over 0.1 cubic yard of soil or utilize mechanical equipment to drill or bore into the soil sub-surface must be reviewed by a Chevron Health, Environment & Safety Hazardous Waste (HW) Solids Specialist. The construction contractor initiates this process by completing a Site Evaluation form, which is reviewed by the HW Solids Specialist. The HW Specialist issues a Yellowbook that provides an excavation site history, job task descriptions, potential contaminant exposure listings for site workers, Material Safety Data Sheets for potential contaminants, an example of a decontamination plan, and soil management directions. The Yellowbook is job-specific and site specific. The designated Job Field Contact is responsible for ensuring all environmental health and safety requirements have been met. A copy of the Yellowbook would be kept at the construction site at all times, until completion of construction activities.

Sampling may be required prior to the start of excavation, depending on factors such as site history, location, and volume of soil to be excavated. If the Volatile Organic Compounds (VOC) are expected to occur above the Bay Area Air Quality Management District's regulatory limit, the Yellowbook will have stricter guidelines for the management of the excavated soil. Excavated soil ≥ 50 ppm VOC must always be kept moist by water spray (or other approved vapor suppressant) or covered with continuous heavy-duty plastic sheeting (or other covering). The covering must be in good condition, joined at the seams, and securely anchored to minimize space where vapors may accumulate.

Imported soil, with the exception of gravel, rock or road base (that do not contain loose soil) and potting soil shall be tested to verify that this material does not exceed hazardous thresholds for contaminants. The HW solids Specialist would be consulted on the scope of sampling required.

If soil excavated during the job is substantially different from the soil expected, the job would be stopped immediately and the site reassessed by the HW Solids Specialist and the Field Safety Coordinator.

BACKGROUND

The SPPE application Sections 8.12.4.2 and 8.12.5, and Table 8.12-3 are inconsistent with respect to the mitigation required for stormwater runoff.

DATA REQUEST

58. Please clarify whether the stormwater runoff requires mitigation and, if so, what types of mitigation would be required.

Response: Prior to construction, a Stormwater Pollution Prevention Plan (SWPPP) would be prepared in compliance with the NPDES General Construction Activity Stormwater Permit. The SWPPP would incorporate Best Management Practices (such as covering stockpiles in the event of a rain event) to prevent construction pollutants (including contaminated soil) from contacting stormwater, with the

intention of preventing the discharge of non-stormwaters and of keeping all products of erosion from moving offsite into receiving waters.
In addition, as referenced in Data Request 57, Chevron Refinery's Document No. RI-505, Excavation Procedures (Attachment S&W-57), further defines the procedures for soil excavation work and management of stockpiles as required by federal, state, and local regulations.

The proposed project area's drainage eventually discharges to San Pablo Bay. However, if needed (such as in the event of a spill), the effluent of these locations can be first routed through the refinery process water treatment system (oil/water/solids separation, bio treatment and GAC) prior to discharge.

Regional Water Quality Control Board's Order No. R2-2006-0035/NPDES No. CA0005134 regulates the discharge of effluent from the Refinery's wastewater treatment system, and the discharges of all stormwater associated with industrial activity from the Refinery to San Pablo and San Francisco Bay. The Order establishes maximum daily, average weekly and average monthly effluent limitations for BOD, TSS, TOC, Oil & Grease, Phenolic Compounds, Chromium and other toxic substances of which if detected in excess or outside of the set limits in stormwater runoff prohibits its discharge. The Refinery maintains a regular monitoring schedule in accordance with the Order's provisions and computes the total effluent limitation on a monthly basis to demonstrate compliance with the concentration and mass limitations imposed by the Order. Waters tested outside of the Order's limits would be routed through the refinery process water treatment system prior to discharge.

BACKGROUND

The State Water Resource Control Board's (SWRCB) policy on the Use and Disposal of Inland Waters Used for Power Plant Cooling (SWRCB Resolution 75-58) states fresh inland water should only be used for power plant cooling if other sources or other methods of cooling would be environmentally undesirable or economically unsound. The SWRCB policy requires that power plant cooling water should come from, in order of priority: wastewater being discharged to the ocean; ocean water; brackish water from natural sources or irrigation return flow; inland waste waters of low total dissolved solids; and other inland waters. Additionally, Water Code Section 13550 finds the use of potable water for industrial and irrigation uses is a waste or an unreasonable use of potable water within the meaning of Section 2 of Article X of the California Constitution if recycled water is available and meets certain conditions. The Energy Commission has also expressed this policy in the 2003 Integrated Energy Policy Report.

The PPRP proposes to replace existing steam boilers that have reached the end of their life expectancy with a COGEN 3000 power plant and a H_2-STG power plant. The PPRP is expecting the East Bay Municipal Utility District (EBMUD) to supply approximately an additional 196 acre-feet per year (AFY) of potable water beyond what is currently used by the existing steam boilers (Section 8.12.4.2). The total potable water use by the COGEN 3000 will be approximately 949 AFY (Table 2.1-1). However, we recognize that only 5.3 AFY of this potable water will be used for cooling purposes. We also recognize that Chevron has an ongoing relationship with EBMUD for the supply of recycled and potable water.

DATA REQUEST

59. Please provide a limited and general discussion highlighting the primary rationale, and economic and environmental factors supporting the proposed use of potable water compared to any alternative non-potable water sources, such as degraded or recycled water. In your discussion, also please identify any barrier to providing 100% recycled water as the water source for the cogeneration evaporative cooling makeup water.

Response: The PPRP is already committed to the use available recycled water from EBMUD in the cooling tower for the steam turbine generator system. The quantity of water required for Cogen 3000 evaporative cooling system is small, approximately 6 gallons per min. Recycled water currently available does not meet the quality specifications for the combustion turbine inlet evaporative cooling system. Without substantial additional treatment, the available recycled water would cause significant damage to the turbine. Once the EBMUD RARE project is complete, Chevron is committed to using RARE water for combustion turbine inlet evaporative cooling. Because the RARE project may not be complete in time for commencement of Cogen 3000 operation, Chevron anticipates that there will be a short transition period, lasting from a few months to a year or so, during which potable water would be used for Cogen 3000. Once the RARE project is complete, Cogen 3000 evaporative cooling would be converted to RARE water. While it would be technically possible to design and install a treatment system to produce acceptable water for the turbine inlet, the system would only be needed for a few months to a year and the cost for this treatment system would be substantial. It would not be economically justifiable to install a treatment system for this short period.

60. Please provide a discussion of the reliability of the potable water supply and any potential impact to other municipal and industrial users of the potable water supply.

Response: EBMUD supplies potable water to the project site and to other water users in the parts of Alameda and Contra Costa counties on the eastern side of San Francisco Bay.

EBMUD forecasts in its Urban Water Management Plan [5](2005) an adequate supply of water to meet customer demand through the year 2030 during Normal year conditions. EBMUD efforts to ensure a reliable and adequate water supply continue to reduce the number of potential drought years when rationing is implemented. EBMUD's Water Supply Management Program (WSMP 2020), adopted in 1993, has

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[5] East Bay Municipal Utility District (EBMUD). 2005. *Urban Water Management Plan*. November 2005.

served as the basis for water conservation and recycling programs and for development of supplemental supply initiatives. WSMP 2020 ensures adequate and reliable high-quality water supplies that will meet EBMUD's customers' water needs well into the 21st century.EBMUD's Orinda Water Treatment Plant, which supplies the potable water to the Refinery, has a treatment capacity of 200 mgd and is currently operating at approximately 70 percent capacity (page 8.12-10 of the SPPE Application)[6].

Approximately 1,290 acre-feet per year (AFY) of potable water is currently used by the existing steam boilers at the Refinery. This water will become available for other use when these facilities are shut down. The proposed Project's average annual total water use is expected to be 1,351 AFY, resulting in a net increase of 61 AFY of recycled water, less than 0.001 percent of Orinda Water Treatment Plant's capacity. Potable water use will decrease as a result of the PPRP.

Considering EBMUD's long history of providing reliable water supply services, that EBMUD forecasts its water supply to be sufficient to meet customer demand during the Project's short transition period to RARE water, and that a demand of less than 0.001 percent on Orinda Water Treatment Plant's surplus capacity would be readily absorbed without leading to a condition where demand exceeds supply, any potential change to the other municipal and industrial users potable water supply would be negligible.

61. Please provide a discussion of the assurances (e.g., a will-serve letter or a letter of intent) that EBMUD has made to Chevron to supply this additional 196 AFY of potable water and the length of time of that commitment.

Response: A copy of commitment letter from EBMUD is presented in Attachment S&W-61.

BACKGROUND

Recycled water and potable water for the Chevron Refinery will be provided by EBMUD. The SPPE application proposes using recycled water for the H_2-STG cooling tower makeup (Table 2.1-1) and potable for the COGEN 3000 evaporative cooler and cycle makeup water (Section 8.12.4.2). Both Table 2.1-1 and Section 8.12.3.2 state that at some future date the use of potable water will stop and the use of recycled water, from EBMUD's Richmond Advanced Recycled Expansion (RARE), will begin.

DATA REQUEST

62. Please clarify how long the Chevron Refinery will be using potable water.

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[6] East Bay Municipal Utility District (EBMUD). *Water Supply Management Program 2040*. Accessed September 2007. http://www.ebmud.com/water_&_environment/water_supply/water_supply_management_program/default.htm

Response: Chevron will continue to use potable water for RO plant makeup until the RARE plant is on-stream and fully commissioned. EBMUD is currently targeting an on-line date for the RARE plant of the end of 2009.

63. Please provide a date when the RARE project come on-line and supply recycled water for the Chevron Refinery.

Response: Chevron has an Letter of Intent with EBMUD and the plant is scheduled to be on-line at the end of 2009. It is currently under construction.

64. Please discuss whether there is currently an adequate supply of recycled water available now from EBMUD to service the entire PPRP? Please explain.

Response: EBMUD has advised the refinery that there is an average of 1,000 GPM of additional recycled water available for use by the refinery. This amount will be more than adequate to cover all PPRP needs. However, on infrequent occasions recycle water supply is not adequate to meet the refinery demand and it is necessary to supplement with potable water.

BACKGROUND

The SPPE application states that recycled water from EBMUD's RARE project will be used when the water becomes available (Section 8.12.3.2). An Environmental Impact Report for the RARE project was approved on May 8, 2007, presumably by the city of Richmond. The RARE project is proposed to treat effluent water to recycled water standards and deliver it to the Chevron Refinery through an existing potable water supply pipeline to Chevron's reverse osmosis (RO) water treatment facility. If the RARE project is constructed, all uses currently served by potable water from the RO facility would be served by RARE recycled water, reducing potable water use at the refinery by approximately 3 to 5 million gallons per day.

DATA REQUEST

65. Please discuss the reasonable assurances Chevron can provide that all uses currently served by potable water from the RO facility would be converted over to the RARE recycled water.

Response: Chevron and EBMUD have signed a letter of intent for the RARE plant. Chevron has allocated property inside of the refinery for construction of the RARE plant since its complete output will be consumed by Chevron. The fundamental purpose of the RARE plant is to provide water to the Chevron RO facility for use as boiler feed makeup and other uses currently served from the RO plant. The PPRP will be fed from an existing header supplied by the RO plant. When the RO plant feed is switched to RARE water, the water feeding PPRP will be RARE water.

ATTACHMENT S&W-57

Approval and Communication of Refinery, Maintenance, or Engineering Instructions

Document No.: RI-505	**Title:** Excavation Procedures	**Current Date:** 05/25/05
Action: ☐ New ☒ Revision ☐ Cancellation		**Next Revision Due:** 05/2008
Responsible Organization: Health, Environment and Safety	**Position to Contact With Questions/Suggestions:** Ken Yee, Hazardous Waste Solids Specialist	

Summarize Rewritten Material:
- Updating phone numbers, equipment used, job titles and changing U&E to HES.
- Deletion of redundant explanations and instructions.
- Clarification of job roles and responsibilities.
- Clarification of requested lead time necessary for Excavations to begin.
- Clarification for HAZWOPER trained personnel for hazardous material clean-up.
- Clarification of immediate response treatment for regulatory compliance.
- Guidance added for excavating within 10 ft of electrical equipment.
- Clarification of lead time necessary for the City of Richmond permitting process.

REQUIRED COMMUNICATION/TRAINING

If Type 2 or Type 3 training is necessary – Instruction Owner is responsible for developing the training material and must work with Development Department Manager and Managers of affected personnel to coordinate training of affected personnel and documentation of training.

This document should be reviewed by:	Type 1 Simple Change	Type 2 On-The-Job Training	Type 3 Classroom Training
All Refinery Personnel	☒	☐	☐
Operations	☒	☐	☐
Maintenance & Reliability	☒	☐	☐
Technical	☒	☐	☐
HES	☒	☐	☐
Other:	☐	☐	☐

APPROVALS

Instruction Owner: Ken Yee	**Development Manager:** *(first signature before final routing)* Steve Wildman
Operations Manager: Rick Reed	**Technical/Reliability Manager:**
HES Manager: Jeff Hartwig	**Maintenance Manager:** Joe Connell
Refinery Manager: *(final signature)* Jim Whiteside	**Other Manager:**

On Completion − Instruction Owner will send file and message to IPC to post on the Refinery server.

Necessary Approval for Instructions:

• Refinery Instructions:	Development, Operations, HES, and Refinery Manager
• Safe Work Practices:	Development, Operations, Maintenance, HES, and Refinery Manager
• Emergency Plans (400 Series RIs):	Development, Operations, Maintenance, HES, and Refinery Manager
• Engineering Instructions:	Technical and HES Manager
• Maintenance Instructions:	Maintenance and HES Manager
• Reliability Instructions:	Reliability and HES Manager

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1.0 PURPOSE

This Instruction defines the procedures for soil excavation work, as required by federal, state, and local regulations. It also assigns the appropriate responsibilities for excavation work in order to prevent injury to personnel, as well as prevent unplanned shutdowns. Attached is a simplified flowchart of the process that needs to be followed for excavation work activities conducted within the Refinery (see Appendix I).

2.0 DEFINITION

Excavation shall include all ground breaking for foundations, sewers, underground process and utility lines, trenching, pile driving, electrical conduits and cables, groundwater wells, soil borings, grout holes, concrete floor cutting, guard posts, spill clean up, etc.

3.0 SCOPE

This Instruction covers all jobs conducted within the Refinery involving either excavation of soil over 0.1 cubic yard (20 gallons) or jobs that utilize mechanical equipment to drill or bore into the soil sub-surface. Jobs that meet this scope must be reviewed by the Health, Environment & Safety (HES) Hazardous Waste (HW) Solids Specialist (ext. 2-3676).

4.0 PROCEDURE

4.1 Determining the Existence of Underground Lines, Conduits, and Cable

1. It is the responsibility of the Job Originator, prior to issuing a Work Request, to review all available drawings for buried conduits, cables, and piping that may run through or within five feet of the proposed excavation and work area. Drawings can be obtained through the Design Drafting Group (ext. 2-5422). In addition, drawings can be found in the Area Business Unit (ABU) Engineering Library where the excavation activity will take place. Electronic copies can be accessed through the Richmond Refinery Information Server Home Page under "Drawings Home Page" (doc link http://www.ric841.chevrontexaco.net/drawings2/index.htm).

   If conduits, cables, or piping are found on a drawing, their field location must be positively identified through use of a metal detection line tracer by Chevron Fire Department (CFD). The centerline and depth must be marked or staked on the ground and on the appropriate drawings.

2. The Job Originator is also responsible for reviewing the excavation site in the field with the area owner (Head Operator or Maintenance Supervisor). The originator should make an effort to discuss with Operations the history of operation and maintenance in the area where the excavation will take place.

4.2 Procedures Following Determination of Underground Conduit and Cable

Power-driven excavating equipment such as power shovels, bulldozers, air-driven jack hammers, etc., should not be used within ten (10) feet on either side of an electrical warning marker. Install barriers/tape as needed to mark off the ten foot limit. This is required except under specific conditions outlined below:

1. An electrician is present while the work is in progress, ***and***

2. The location of the electrical duct bank, conduit, or cable has been precisely located by hand digging, ***and***

3. It has been positively determined that the electrical conduits or cable are safely encased in a red concrete envelope, ***and***

4. The above conditions are outlined in a written procedure and approved by the Field Safety Coordinator and the U&E ABU Electrical Distribution Coordinator (ext. 2-4615) or, if not available, the Utilities Area Supervisor.

4.3 Procedures Following Determination of Underground Piping

1. Trenches or excavations which are 5 feet or deeper and into which a person is required to descend must be shored or the sides sloped back per the Chevron Safety In Designs Manual. Excavations less than five (5) feet deep may also need to be braced, depending on the soil conditions and location. A "confined space entry" work permit (MFG-1086-1) may be required. Where oxygen deficiency (atmospheres containing less than 19.5% oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist such as excavations in landfill areas or in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet in depth. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet or more in depth so as to require no more than 25 feet of lateral travel for employees. Adequate physical protection barriers shall be provided at all excavations at all times.

2. When it is necessary to excavate within five (5) feet of an underground pipe, the location of the underground pipe shall be precisely located by hand digging the last three (3) feet. After locating the underground pipe, power-driven equipment such as listed in paragraph 4.2 (1) above may be used under these specific conditions:

   a. A trained watch person (someone knowledgeable and experienced in the workings of the equipment) is present at the site to monitor power equipment operation, ***and***

   b. The conditions are outlined in a written procedure and approved by the ABU Head Operator and Field Safety Coordinator prior to digging.

3. Check the vertical clearance from overhead electrical transmission lines and both pipelines and structures. Clearance shall not be less than 13 feet from the top point of the excavation rig, whether fully extended or not.

4.4 <u>Procedures for Obtaining and Using Soil Excavation Yellowbooks</u>

1. If the volume of excavation is greater than the 0.1 cubic yard (20 gallons), the HW Solids Specialist (ext. 2-3676) must be notified. The HW Solids Specialist should be notified as soon as possible prior to excavation. Allow at least ten (10) working days for jobs that do not require pre-excavation sampling. This will allow time to investigate the site and if required, notify the appropriate agencies. If sampling is required prior to excavation, four (4) weeks notice will be needed. Soil Excavation Yellowbooks are JOB SPECIFIC and may not be reused for nonspecified work in the same area.

   a. Prior to obtaining a Yellowbook, the Job Originator should determine if a City of Richmond Grading Permit will be required (refer to Section 5.1 of this instruction). Guidance on obtaining the City of Richmond Grading Permit can be obtained by contacting the Manager of Certified Inspection Program, at ext. 2-4568.

   b. To obtain a Yellowbook, fill out a Site Evaluation form (Appendix II). This form requests dimensions for excavation, equipment to be used, cost center for soil sampling/possible offsite disposal, site use history and map indicating location site. Submit the site map and site evaluation form to the HW Solids Specialist.

c. The site evaluation will be conducted by the HW Solids Specialist or designee. Sampling may be required prior to the start of excavation, depending on factors such as site history, location, and volume of soil to be excavated. Allow four (4) weeks for the site evaluation if sampling is necessary. Certain locations in the refinery require that the people conducting the work have California's HAZWOPER (§5192. Hazardous Waste Operations and Emergency Response) training. The HW Solids Specialist (ext. 2-3676) can verify whether HAZWOPER training will be required at specific excavation sites.

d. The HW Solids Specialist will issue a Yellowbook that provides an excavation site history, job task descriptions, potential contaminant exposure listings for site workers, Material Safety Data Sheets for potential contaminants, an example of a decontamination plan, and soil management directions. If the Volatile Organic Content (VOC) of the soil is expected to be above the Bay Area Air Quality Management District's (BAAQMD) regulatory limit (≥50ppm VOC), the Yellowbook will have stricter guidelines for the management of the excavated soil. Excavated soil ≥50ppm VOC must always be kept moist by water spray (or other approved vapor suppressant) or covered with continuous heavy-duty plastic sheeting (or other covering). The covering must be in good condition, joined at the seams, and securely anchored to minimize space where vapors may accumulate.

2. The Field Safety Coordinator (FSC) will review, modify as necessary, and approve the Health and Safety Plan. The FSC will notify the Job Originator or designated Job Field Contact when the Yellowbook is ready for pickup. The Job Originator or designated Job Field Contact will provide an evacuation plan for the work site.

3. The Job Originator or designated Job Field Contact is responsible for ensuring all jobsite requirements have been met and signatures of site workers have been obtained. The original Yellowbook containing a Health and Safety Checklist shall be kept on-site at all times and the personnel roster, if required, kept current. The original Yellowbook with signatures should be sent back to the HW Solids Specialist upon completion of the job for record keeping purposes.

4. If soil excavated during the job is substantially different from the soil expected, the job should be stopped immediately and the site reassessed.

   a. If the job was stopped due to changes in the volatile content of the soil, then air monitoring and VOC monitoring of the soil may be required. If this occurs, the HW Solids Specialist, CFD, and the Field Safety Coordinator should be contacted.

   b. If the job was stopped because the soil looks substantially different, (example: buried drums or free phase hydrocarbon discovered), then the HW Solids Specialist and Field Safety Coordinator should be contacted.

5. Environmental Management Company (EMC) site safety plans will be developed and supervised by EMC personnel. Any changes in the safety plan made during the excavation event will be indicated on the cover sheet and initialed by the HW Solids Specialist.

5.0 PERMITS

5.1 Prior to excavating or grading a City of Richmond grading permit may be required (see Appendix III for requirements). Permit request forms can be obtained from the Refinery's building permit coordinator at ext. 2-4568. Completed forms must be submitted to the building permit coordinator at least four (4) weeks prior to any excavation or grading work. The work requester will be required to gather all information needed for the City of Richmond Grading Permit.

5.2 A permit from Cal OSHA is required prior to the initiation of any work that requires a person to descend into an excavation or trench that is five feet or deeper. These permits may take up to two weeks to obtain. Cal OSHA permits are not required under the following circumstances:

1. Construction of trenches or excavations for the purpose of performing emergency repair work to underground facilities.

2. Construction or uses of excavations or trenches that do not require a person to descend into the excavation or trench.

Maintenance is responsible for obtaining trenching permits when Chevron employees will be entering excavations. Contractors are responsible for obtaining permits from Cal OSHA for the entry of their employees into excavations.

5.3 Before excavation is started, the Maintenance Supervisor or Job Field Contact shall obtain and prepare an Excavation Work Permit (MFG-44-2). **NOTE**: A GENERAL WORK PERMIT IS NOT REQUIRED WHEN USING AN EXCAVATION WORK PERMIT.

5.4 The HW Solids Specialist or designee must sign off on all Excavation Work Permits (MFG-44-2).

5.5 CFD should be contacted at least two (2) weeks in advance of any final work permit to perform a metal detection of the area. CFD must sign off on the Excavation Work Permit (MFG-44-2) after the metal detection work is done.

5.6 If CFD finds unexpected conduits, cables, or piping that conflict with the proposed excavation, the Job Originator of the work request will be contacted. The work requester must either change the excavation site or develop a plan for excavation around the known obstructions. All previous steps must be repeated again.

5.7 If the excavation is for the purpose of connecting to any utility line, a Utility Permit (MFG-632, reference RI-503) and Management of Change (MOC) documentation is required.

5.8 After all specified precautions and restrictions have been met, the Head Operator or their designee must review the jobsite and sign off that work may safely begin.

5.9 A daily Excavation Work Permit (MFG-44-2) is required unless clear drawings are attached to the MFG-44-2 permit showing where CFD has inspected, and the ABU Area Supervisor agrees to sign a longer duration permit.

5.10 The drawings and permit shall be maintained at the excavation site along with the Health and Safety Plan contained in the Yellowbook.

6.0 AREA RESPONSIBILITIES

6.1 Operations

1. In off-plot areas outside the jurisdiction of any other operating organizations, an authorized U&E ABU Representative shall be responsible for seeing that all the specified precautions and restrictions, as stated on Excavation Work Permit (MFG-44-2), are met.

2. In on-plot or plant areas, the presiding ABU shall perform their duties as noted in (1) above.

3. Each ABU Manager or delegate is responsible in their area to see that:

   a. All new additions, alterations, or dismantling of buried conduit, cable, or piping, and any existing discrepancies are to be noted in writing and reported to the Design Drafting Group (ext. 2-5422) so that drawings can be updated.

   b. Excavation near underground conduits, cables, or piping is carried on safely and in accordance with Refinery Instructions and Procedures.

   c. All buried conduit and cable markers, as well as pipeline markers are maintained in good condition.

6.2 Job Originator

1. It is the responsibility of the Job Originator to review available drawings for the excavation area. Drawing reviews should consist of the following steps:

   a. Review of Refinery contour maps, underground piping, and power line indexes available in the local operating area.

   b. Review additional drawings (refer to Section 4.0, Item 4.1 (1) for drawing locations), if available, that support the area where the excavation will take place.

   c. The excavation area shall be reviewed for the following:

      (1) Interference with traffic during excavation.

      (2) Aboveground pipeways, electrical lines, and other obstructions.

      (3) Underground piping, conduits, and duct banks.

      (4) Groundwater monitoring wells.

      (5) Any special health and safety concerns such as managing any excavated material (drilling mud, groundwater, etc.), and spill contingency and response plans.

d. Near the refinery boundary (within 1/8 mile), the following are areas which need to be checked and verified before excavation for the presence of existing pipelines, cables, or any obstructions:

(1) Neighboring facilities' drawings to determine if their lines may enter or interface on Chevron's property line.

(2) Chevron Pipe Line Co.

(3) Underground Service Alert shall be contacted for possible incoming underground services. The telephone number is (800) 642-2444. Underground Services Alert provides data on underground utilities at a specified site within 48 hours of a request.

2. Conduit Markers: Job Originator shall specify that suitable markers be installed over all underground electrical lines before these lines can be placed in service. The exact location of all markers shall be determined in the field by the Maintenance Supervisor or Field Contact overseeing the work. Only the following markers shall be used:

a. Where practicable, white 4-inch by 4-inch redwood posts, made up in accordance with Drawing GD-P87601-5, shall be installed. In general, these posts shall be placed at each end of the underground section and at every change of direction.

b. In paved areas where marker posts would restrict clearance or interfere with operations, red concrete markers with directional arrows embedded flush with the surface shall be installed. See Drawing GD-P87601-5.

3. Job Originator will have the data recorded on the proper drawing and write a memo to the Design Drafting Group (ext. 2-5422) with a copy of the data and the drawing. The originator will follow up on this information until it is incorporated on the proper drawings.

6.3 <u>Chevron Fire Department</u>

1. CFD shall use their metal detector to inspect the proposed excavation location (see Appendix IV for types of metal detection devices available). Each proposed excavation shall be inspected with the Job Field Contact at least two (2) weeks in advance of approval of the Excavation Work Permit (MFG-44-2).

2. If CFD is not able to clear a proposed excavation site that is staked or painted, CFD and the Job Field Contact or Maintenance Supervisor shall select an alternate excavation site, within the designated area, and stake/paint the new site. If an excavation site is not available, the work requester must either change the excavation site or develop a plan for excavation around the known obstructions.

3. The Maintenance Supervisor or Job Field Contact shall coordinate the metal detection inspection and advise if a second independent "locator contractor" shall perform an inspection.

4. Once the metal detection work has been completed and the site is cleared for excavating, CFD must sign off on the Excavation Work Permit (MFG-44-2).

6.4 Maintenance Supervisor or Job Field Contact

1. Identifies the excavation site with stakes or paint prior to contacting CFD for the metal detection inspection.

2. Is to be present when metal detection inspection occurs.

3. Obtains properly authorized permits before starting any excavation including the Health and Safety Plan Checklist with an assigned Yellowbook job number.

4. Ensures that the contractors doing the excavation have reviewed and signed the Yellowbook, Excavation Work Permit (MFG-44-2), and when applicable, the Ignition Source Permit. In the case of multiple excavations goverened by the same Yellowbook, each crew shall sign a separate Excavation Work Permit (MFG-44-2). Each excavation crew supervisor shall sign a permit daily (plant operator signs daily).

7.0 IMPORTING SOIL

7.1 Purpose

Imported soil may be required in the refinery. It is important to verify that this material does not exceed hazardous thresholds for contaminants that could result in future environmental costs to the Refinery. Soil that "looks like dirt and smells like dirt" may still contain unacceptable amounts of lead, arsenic, or other contaminants.

7.2 Scope

This Instruction applies to all shipments of soil into the Refinery above 0.1 cubic yard. This Instruction does not apply to "clean" gravel, rock or road base (clean: does not contain loose soil). This Instruction also does not apply to soil purchased from an approved plant nursery and imported as "potting soil."

7.3 Responsibilities

It is the responsibility of the Job Originator who is purchasing soil to assure that the soil is not contaminated. Soil excavated from the Richmond DUTRA Quarry site has been tested by U&E and may require no further testing. Contact the HW Solids Specialist (ext. 2-3676) for advice on whether further testing is required. Imported soil from any other quarry site must be tested. Contact the HW Solids Specialist for advise on the scope of sampling required. Allow four (4) weeks for test results and HW approval.

8.0 SPILL CLEAN UP

8.1 Purpose

The Refinery is required to clean up recent spills of hazardous materials including oil, catalyst, caustics and acids, chemicals, lubricants, or other hazardous materials. This Instruction describes non-emergency responsibilities for cleaning up spills of hazardous materials.

8.2 Scope

This Instruction applies to clean up efforts of all hazardous material spills inside the Refinery. These clean up efforts may be the result of an incidental release of hazardous material or a post-emergency clean up of a hazardous material spill. The Refinery is required to clean up all hazardous material spills regardless of size.

This Instruction does not cover:

1. Reporting requirements for releases of hazardous material (see RI-434).

2. Emergency response procedures for responding to and controlling releases of hazardous wastes from the Hazardous Waste Treatment and Storage Facility (see RI-422).

3. Emergency response procedures for responding to and controlling releases of hazardous waste (see RI-423).

NOTE: "Emergency Response" means a response effort by employees from outside the immediate release area or by other designated responders (i.e., mutual aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to incidental releases of hazardous substances where the substance can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area or by maintenance personnel are not considered to be emergency responses, however, they are considered immediate response treatment and containment activities which are not subject to hazardous waste permitting requirements (264.1(g)(8)(A). Site cleanup by personnel outside the immediate release area may require OSHA 1910.120 HAZWOPER Certification. Consult with the FSC. Responses to releases of hazardous substances where there is no potential safety or health hazard (i.e., fire, explosion, or chemical exposure) are not considered to be emergency responses.

8.3 <u>Responsibilities</u>

It is the responsibility of the Area Supervisor (North or South Yard Shift Supervisor off-hours) to assure that a spill of hazardous material is cleaned up. Once a spill has been identified and notifications made (per RI-434), immediate steps must be taken to safely stop the source of the spill and to minimize its impact to health, safety, and environment. Once these steps are complete, the clean up should commence. Unless extenuating circumstances dictate otherwise, spill clean up should be done diligently within daylight hours.

1. The ABU is to provide a representative to oversee the clean up effort.

2. The Refinery Shift Coordinator or designee must notify the BAAQMD prior to soil clean up, per RI-434

3. A health and safety plan may be required for the recovery of spill materials. Either the Field Safety Coordinator or CFD should develop the plan.

4. The Area Supervisor (off-hours, North or South Yard Shift Supervisor), in consultation with the Health, Environment and Safety Staff, will estimate the amount of hazardous material spilled. As soon as it is safe to do so, and **<u>prior to clean up</u>, any spill of one barrel (42 gallons) or more of petroleum (liquid @ 60^{o}F/14.7 psia) to any ground surface not protected by a non-permeable barrier, must be <u>documented with photographs</u>**. Photographs are to be arranged by the Refinery Shift Coordinator and delivered to the Environmental Field Coordinator.

5. Clean up of a small spill should be accomplished by area operator, mechanic. or contract labor under the supervision of the ABU. The Hazardous Waste Section (ext. 2-3293 or ext. 2-3676) can provide containers, labels and hazardous waste management guidance. During off-hours, contact the U&E Effluent Head Operator (ext. 2-3031) to obtain containers and labels.

6. Clean up of a large spill may require additional resources such as vacuum trucks, roll-off bins, or a "Yellowbook" for removal of contaminated soil. Contact the HW Solids Specialist (ext. 2-3676) for assistance. During off-hours, contact the U&E Effluent Head Operator (ext. 2-3031) for resources.

7. When practical, a member of the Health, Environment and Safety staff, the Area proprietor, and a member of the Hazardous Waste Section should visit the site to assess the spill and formulate a clean up plan.

8. Additional contract labor can be requested through the ABU Maintenance Supervisor (during off-hours, the Refinery Maintenance Coordinator, ext. 2-4618). When contract labor is utilized to respond to a hazardous material spill clean-up, HAZWOPER certification is a required.

9. All volumes of materials recovered or removed in the clean up process must be reported back to the Environmental Field Coordinator.

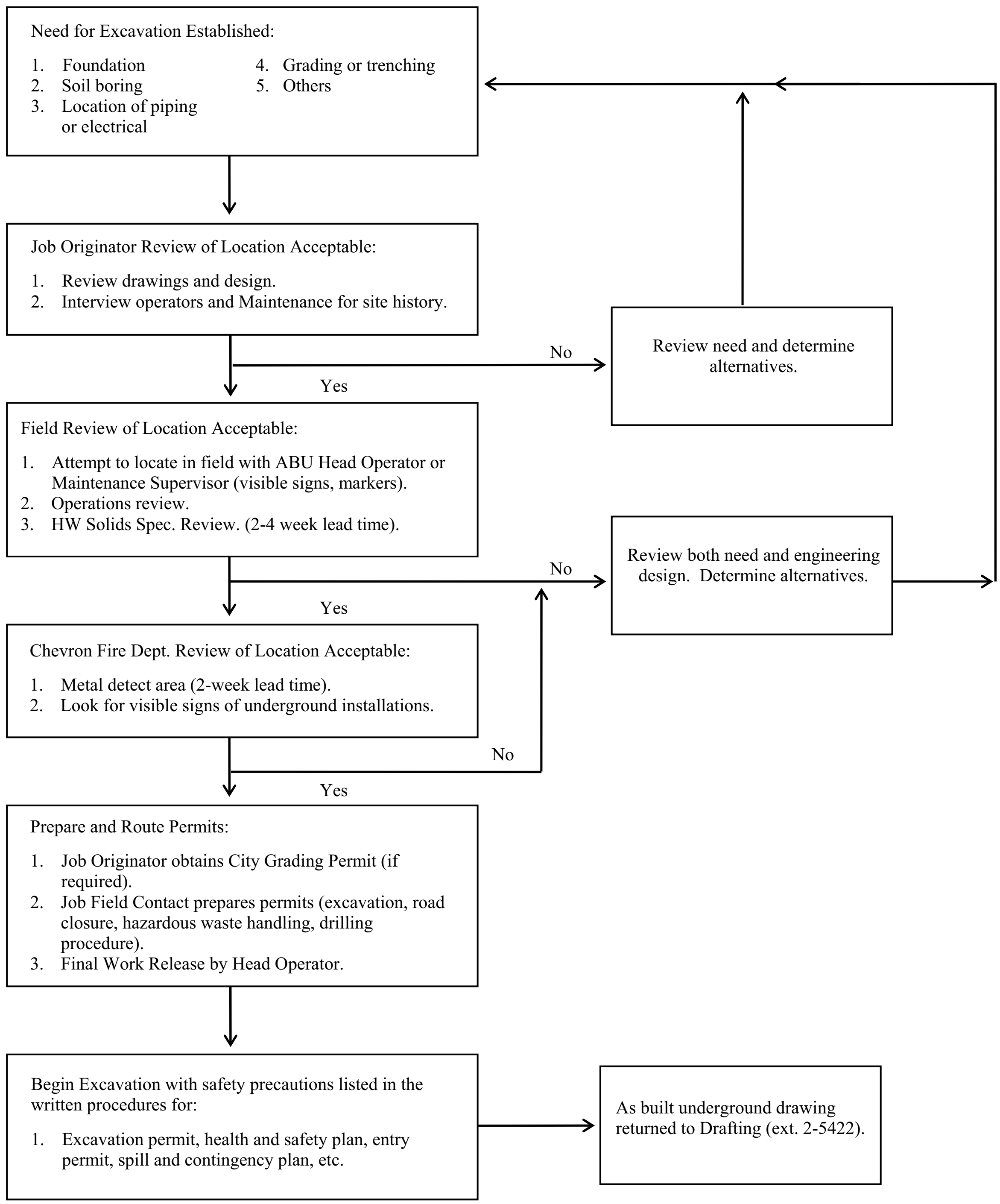
10. The Environmental Field Coordinator will determine when the clean up is complete. <u>Post-clean up</u> of a spill of one barrel or more of petroleum (liquid @ 60^0F/14.7 psia) to any ground surface not protected by a non-permeable barrier must also be <u>documented with photographs</u> when the clean up is complete. Photographs will be arranged by, and delivered to the Environmental Field Coordinator.

RICHMOND REFINERY INSTRUCTIONS

HEALTH, ENVIRONMENT & SAFETY

APPENDIX I
EXCAVATION PROCEDURES

EXCAVATION PROCEDURE FLOWCHART



HAZARDOUS WASTE SITE EVALUATION FORM

Date of Request: ____________________ **Job #** (HW completes)**:** ____________________

<u>INSTRUCTIONS</u>: Complete this form for all soil excavations > 0.1 cubic yards (20 gallons). Include any known facts about the site history, previous use or chemicals in the area, and any potential safety hazards associated with the work area. Allow at least two (2) weeks for HW review, and agency notifications. In addition, allow two (2) weeks to schedule CFD metal detection. Site sampling, if required, may delay final evaluation up to an additional four (4) weeks. **<u>PLAN ACCORDINGLY</u>.** Deliver or Fax (ext. 2-5564) a completed form, along with a detailed map, to the Hazardous Waste Solids Specialist (phone ext. 2-3676).

Job Originator: ______________________

Proposed Start Date (allow sufficient lead time for HW, CFD, FSC reviews)**:** _________________________

Does this excavation require a City of Richmond Grading Permit (see RI-505, Appendix III)**:**

Yes ______ **No** ______

Excavation Location: ____

____

Site History (include previous use, chemicals or contamination in the area and any potential safety hazards)**:** ___

____

____

Job Scope (Description)**:** ____

____

____

____

Dimensions: __________________________________ **Cu. yds:** ____________________

ABU: ____

Passport number: ___________________________ **Cost Center:** ____________________

Contact Person: ____________________________ **Phone:** _________________________

THE CITY OF RICHMOND GRADING PERMIT

A City of Richmond Grading Permit may be required prior to the start of grading or excavation. Jobs that do not meet the following exceptions are required to have a City of Richmond Grading Permit:

A grading permit is not required for the following:

1. An **excavation** which:

   a. is less than five (5) feet in depth below natural grade and adequately supported by a retaining structure designed in accordance with the Uniform Building Code, ***or***

   b. does not create a cut slope greater than seven (7) feet in height, or steeper than two (2) horizontal to one (1) vertical, ***or***

   c. does not exceed fifty (50) cubic yards.

2. A **fill** not intended to support structures and which does not obstruct a drainage course or alter existing drainage patterns if:

   a. such a fill is placed on natural grade that has a slope not steeper than five (5) horizontal to one (1) vertical, ***or***

   b. is less than three (3) feet in depth at its deepest point, measured vertically upward from natural grade to the surface of the fill, ***or***

   c. does not exceed fifty (50) cubic yards.

3. An **excavation** below finished grade for basements and footings of structures authorized by a valid building permit or trench excavations for the purpose of installing underground utilities, if to be backfilled to natural grade.

4. **Emergency work**, as authorized by the City Building Official, necessary to protect life, limb, or property, or to maintain the safety, use or stability of a public way, or drainage way.

5. **Grading** in an isolated, self-contained area if the City Building Official determines that no danger to private or public property is likely to result from the grading operation.

6. **Clearing vegetation** when all of the following conditions are met:

   a. The slope of the ground is ten percent (10%) or less.

   b. The area to be cleared is one (1) acre or less.

   c. Land disturbance is at least within one hundred (100) feet from the centerline of the watercourse or at least one hundred (100) feet from the waterline of a water body.

7. Improvement of watercourses and construction of drainage, irrigation, and domestic water supply systems and facilities performed under the supervision of the Flood Control District, an agency of the Federal or State Government, a water or sanitation district, or an irrigation or reclamation district, or the City.

UNDERGROUND PIPE AND CABLE LOCATORS USED BY PLANT PROTECTION OF THE CHEVRON RICHMOND REFINERY

MODEL NUMBER	TASKS
Metrotech 850	Tracing a pipeline in which the location is known at some point.
Metrotech 810	Trying to locate or search an area in which the presence of underground pipelines is unknown.
Metrotech 50/60	Locating energized electrical cables.

ATTACHMENT S&W-61

EAST BAY
MUNICIPAL UTILITY DISTRICT

April 24, 2007

Lamont Thompson, Senior Planner
Planning Department
City of Richmond
1401 Marina Way South
Richmond, CA 94804

Re: Water Supply Assessment – Chevron Energy and Hydrogen Renewal Project

Dear Mr. Thompson:

This letter responds to your revised request of April 17, 2007, for water agency consultation concerning the Chevron Energy and Hydrogen Renewal Project (Enclosure 1). The East Bay Municipal Utility District (EBMUD) appreciates the opportunity to provide this response.

Pursuant to Sections 10910-10915 (SB-610) of the California Water Code, the project meets the threshold requirement for an assessment of water supply availability based on the amount of water this project would require, a project that would demand an amount of water equivalent to or greater than, the amount of water required by a 500 dwelling unit project.

Please note that this assessment addresses the issue of water supply only and is not a guarantee of service, and future water service is subject to rates and regulations in effect at the time.

Project Demand

The water demands for the Chevron Energy and Hydrogen Renewal Project area are accounted for in EBMUD's water demand projections as published in EBMUD's 2005 Urban Water Management Plan (UWMP/Enclosure 2). EBMUD's water demand projections account for anticipated future water demands within EBMUD's service boundaries and for variations in demand-attributed changes in development patterns. The existing land use is industrial with a current water use averaging 12 million gallons per day (mgd), comprised of 8.0 mgd potable water and 4.0 mgd of recycled water. The estimated water demand for the proposed project is an additional 0.7 mgd as provided to EBMUD by Chevron and as described in the Draft Environmental Impact Report (EIR). This is consistent with the water consumption details provided to EBMUD as part of our recycled water feasibility studies. The information supplied in the Draft EIR is adequate for processing the Water Supply Assessment and is accounted for in EBMUD's UWMP. Approval of the assessment by the Board of Directors is required prior to its submittal to the City of Richmond (City).

375 ELEVENTH STREET • OAKLAND • CA 94607-4240 • TOLL FREE 1-866-40-EBMUD

Project Area

The Chevron Energy and Hydrogen Renewal Project is located at the existing refinery along the western edge of the City, north of Interstate 580 and west of Richmond Parkway and Garrard Boulevard. The project will modify or replace existing equipment and install new refining equipment within the existing refinery footprint. The main components of the proposed project are hydrogen plant replacement, power plant replacement, catalytic reformer replacement, and hydrogen purity improvements. This project would improve Chevron's ability to provide gasoline for local and export markets using the wide range of crude oil sources currently being processed at the refinery. While the project would not increase the refinery's consumption of crude oil beyond currently permitted levels, it would improve the refinery's ability to process a more varied proportional mix of crude oil types than it currently processes.

EBMUD Water Demand Projections

Water consumption within EBMUD's service area has remained relatively level in recent years in spite of population and account growth. Since the 1970s, water demand has ranged from 200 to 220 mgd on an annual average basis in non-drought years. The 2030 water demand forecast of 281 mgd for EBMUD's service area can be reduced to 232 mgd with the successful implementation of water recycling and conservation programs, as outlined in the UWMP. The Chevron Energy and Hydrogen Renewal Project will not change EBMUD's 2030 demand projection.

EBMUD Water Supply and Water Rights

EBMUD has water rights that allow for delivery of up to a maximum 325 mgd from the Mokelumne River, subject to the availability of Mokelumne River runoff and the senior water rights of other users. EBMUD's position in the hierarchy of Mokelumne River water users is determined by a variety of agreements between Mokelumne River water right holders, the appropriative water rights permits and licenses that have been issued by the State, pre-1914 rights and riparian rights. Conditions that restrict EBMUD's ability to use its full entitlement include:

- Upstream water use by prior right holders.
- Downstream water use by riparian and senior appropriators and other downstream obligations, including protection of public trust resources.
- Variability in rainfall and runoff.

During drought periods, the Mokelumne River can no longer meet EBMUD's projected customer demands. EBMUD studies indicate that by 2030, even with the additional dry-year water supply provided through the Freeport Regional Water Project (FRWP), deficiencies in supply of up to 37 percent could occur during multi-year drought periods.

EBMUD UWMP

The UWMP, adopted on November 22, 2005 by EBMUD's Board of Directors by Resolution No. 33508-05, is a long-range planning document that reports on EBMUD's current and projected water usage, water supply programs, and conservation and recycling programs. A summary of EBMUD's demand and supply projections, in five-year increments for a 25-year planning horizon is provided in a table (Enclosure 3) from the UWMP. The data reflects the latest actual and forecast values.

EBMUD's evaluation of water supply availability accounts for the diversions of both upstream and downstream water right holders and fishery releases on the Mokelumne River. Fishery releases are based on the requirements of a 1998 Joint Settlement Agreement (JSA) between EBMUD, U.S. Fish and Wildlife Service, and the California Department of Fish and Game. The JSA requires EBMUD to make minimum flow releases from its reservoirs to the lower Mokelumne River to protect and enhance the fishery resources and ecosystem of the river. As this water is released downriver, it is, therefore, not available for use by EBMUD's customers.

The available supply shown in the attached table (Enclosure 3) was derived from EBMUD's hydrologic model with the following assumptions:

- EBMUD Drought Planning Sequence is used for 1976, 1977 and 1978.
- Total system storage is depleted by the end of the third year of the drought.
- EBMUD will implement its Drought Management Program when necessary.
- The diversions by Amador and Calaveras Counties upstream of Pardee Reservoir increase over time.
- Releases are made to meet the requirements of senior downstream water right holders and fishery releases are made according to the JSA.
- Dry-year supply of Central Valley Project (CVP) water, through the FRWP, is available beginning in 2010.

As discussed under the Drought Management Program section in Chapter 3 of the UWMP, EBMUD's system storage generally allows it to continue serving its customers during dry-year events. EBMUD imposes rationing based on the projected storage available at the end of September. By imposing rationing in the first dry year of potential drought periods, EBMUD attempts to minimize rationing in subsequent years if a drought persists while continuing to meet its current and subsequent-year fishery flow release requirements and obligations to downstream agencies. Table 3-1 in the UWMP summarizes the Drought Management Program guidelines for consumer water reduction goals based on projected system storage.

In the table (Enclosure 3), "Single Dry Water Year" (or Year 1 of "Multiple Dry Water Years") is determined to be a year that EBMUD would implement Drought Management Program elements at the "moderate" stage with the goal of achieving a reduction between 0 to 15 percent in customer demand. Through the FRWP, the supplemental dry-year supply of CVP water will be used to reduce the rationing goal to 5 percent during the first year of a drought. Year 2 of Multiple Dry Years is determined to be a year that EBMUD would implement Drought Management Program elements at the "severe" stage with the goal of achieving between 15 to 25 percent reduction in customer demand. In Year 3 of the multiple-year drought, under current conditions (2005) and prior to the completion of the FRWP, EBMUD customers could experience deficiencies of up to 56 percent. After the completion of the FRWP, water supply deficiencies could range from about 26 percent in year 2010 to about 37 percent in year 2030. Therefore, a supplemental supply is needed, which is defined by EBMUD as the additional amount of water necessary to limit customer deficiency to 25 percent in a multiple-year drought while continuing to meet the requirements of senior downstream water right holders and the provisions of the 1998 JSA.

Supplemental Water Supply and Demand Management

The goals of meeting projected water needs and increased water reliability rely on three components: supplemental supply, water conservation and recycled water.

Chapter 2 of the UWMP describes EBMUD's supplemental water supply project alternatives to meet its long-term water demand. To address the need for a supplemental water supply during droughts, EBMUD signed a contract in 1970 with the Federal government for a supplemental supply from the CVP. In 2001, EBMUD certified the environmental documentation amending its CVP contract 14-06-200-5183A, reducing EBMUD's contract from 150,000 acre-feet (AF)/year to an entitlement not to exceed 133,000 AF in any one year or 165,000 AF over any three consecutive years. In 2001, EBMUD signed a Memorandum of Agreement with the City of Sacramento, the County of Sacramento and the U.S. Bureau of Reclamation to study a joint regional water project on the Sacramento River near Freeport. The Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS) of the FRWP identifies several regulatory permits and approvals required for the implementation of the project alternatives. These are listed in Table 2-6 of the FRWP Draft EIR/EIS, July 2003, and incorporated in the Final EIR/EIS for the project, which was certified in April 2004. EBMUD will still face water supply shortages even with the additional dry-year supply provided by the FRWP; however, the frequency and severity of customer rationing during drought periods will be reduced.

Chapter 2 of the UWMP also describes other supplemental water projects, including the development of groundwater storage within EBMUD's service area. EBMUD is studying the environmental impacts of these proposed projects. Specific capital outlay and financing information for these projects are included in EBMUD's FY06-07 Capital Improvement Program and Five-Year Plan. The FRWP would also allow for a future groundwater conjunctive use component and, along with the proposed local groundwater projects, emergency interties and planned water recycling and conservation efforts, would ensure a reliable water supply to meet projected demands for current and future EBMUD customers within the current service area. Without a supplemental water supply source, beyond the FRWP, and despite continued conservation efforts and further use of recycled water, deficiencies in supply are projected as noted above.

The Chevron Energy and Hydrogen Renewal Project presents an opportunity to incorporate water conservation measures. Conditions of approval for the implementation of the Chevron Energy and Hydrogen Renewal Project should require that those projects comply with Assembly Bill 325, Model Water Efficient Landscape Ordinance (Division 2, Title 23, California Code of Regulations, Chapter 2.7, Sections 490 through 495). EBMUD staff would appreciate the opportunity to meet with project sponsors to discuss water conservation programs and best management practices applicable to such projects. A key objective of these discussions will be to explore timely opportunities to expand water conservation via early consideration of EBMUD's conservation programs and best management practices applicable to the projects.

EBMUD currently provides approximately 4.0 mgd of tertiary treated recycled water from its North Richmond Water Reclamation Plant (NRWRP) for use in Chevron's cooling towers. EBMUD and Chevron are currently working with the West County Wastewater District (WCWD) to expand the use of recycled water at the refinery through development of the proposed Richmond Advanced Recycled Expansion (RARE) Water Project. The proposed RARE Water Project would provide up to an additional 4.0 mgd of high-purity recycled water for use in Chevron's boiler feedwater applications. Secondary effluent from the WCWD would be further treated at a new advanced recycled water treatment plant located within the Chevron Refinery. EBMUD would operate the new water treatment plant in parallel with its existing NRWRP. The increase in water usage due to the proposed Chevron project could potentially be offset by the proposed RARE Water Project.

The project sponsor should contact David J. Rehnstrom, Senior Civil Engineer, at (510) 287-1365 for further information.

Sincerely,

W. R. Kirkpatrick

William R. Kirkpatrick
Manager of Water Distribution Planning Division

WRK:TNS:sb
sb07_087a.doc

Enclosures: 1. Revised Letter of Request for Water Supply Assessment dated April 17, 2007
2. EBMUD's 2005 Urban Water Management Plan
3. EBMUD's Demand and Supply Projections Table

cc: Dean O'Hair, Manager, Public Affairs, Chevron w/o Enclosure 2
Tery Lizarraga, Manager, Health Environmental and Safety, Chevron w/o Enclosure 2
Board of Directors w/o Enclosure 2

Printed on Recycled Paper

Enclosure 1

City of Richmond

PLANNING DEPARTMENT

April 17, 2007

Mr. David Rehnstrom, Senior Civil Engineer
East Bay Municipal Utility District
Water Distribution Planning Division, Mail Stop 701
Oakland, CA 94607

Dear Mr. Rehnstrom:

This letter is a follow up to the request for a water supply assessment for the Chevron Renewal Project submitted to you by the City of Richmond on April 6, 2007. Water demand numbers in the fourth paragraph below have been revised to match updated numbers subsequently supplied by Chevron.

The City of Richmond Planning Department (the City) has received an application from the Chevron Products Company to construct and operate the Energy and Hydrogen Renewal Project (Renewal Project) at the Richmond Refinery. The Renewal Project would modify or replace existing equipment and install new refining equipment. All units would be located within the boundaries of the existing Refinery, generally placed among similar existing equipment. Construction of the initial Renewal Project components is expected to begin in the fourth quarter of 2007.

As required by the California Environmental Quality Act (CEQA), impacts are being analyzed for the Renewal Project both individually and cumulatively with other projects in the area. The City of Richmond is "lead agency" for the project as established by CEQA.

The Refinery is located along the western edge of the City of Richmond, in Contra Costa County, California, at 841 Chevron Way. The approximately 2,900-acre Refinery occupies most of the Point San Pablo Peninsula with east and south boundaries in the vicinities of the residential communities of North Richmond and Point Richmond, respectively. The Refinery is located west of Castro Street and mostly to the north of Interstate 580 (I-580).

The Refinery uses water supplied by the EBMUD, at a current rate of approximately 12.0 MGD. Refinery water demand would increase by 0.7 MGD (6%) due to the Proposed Project. The City understands that this increase in demand triggers the requirement for preparing a Water Supply Assessment (WSA), in accordance with CEQA

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Fax: (510) 620-6858

and the California Water Code, per Senate Bill 610. The City is requesting that EBMUD prepare the required WSA to verify that water supplies are sufficient for the Renewal Project over the 20-year period for normal, single dry, and multiple dry years, and to determine if the proposed increase in water consumption would require new or expanded water entitlements or would impact water supply or distribution systems. This information is needed in the CEQA review of the Renewal Project, and to document that that water will be available without adverse impact to other current users.

We are hoping to receive this information within 14 days of this request. The information you provide will be included ion the CEQA document and used to support findings by the City. Please advise me of your anticipated response date. If you need additional information or have any questions, please contact me at (510) 620-6947.

Sincerely,

Lamont Thompson

Lamont Thompson
Senior Planner

EAST BAY MUNICIPAL UTILITY DISTRICT DEMAND AND SUPPLY PROJECTIONS
(Ref: Table 4-2, UWMP 2005 – EBMUD)

	2005	2010	2015	2020	2025	2030
PROJECTED DEMAND (MGD)						
Customer Demand(1)	241	258	267	277	279	281
Adjusted for Conservation(2)	(13)	(21)	(27)	(35)	(35)	(35)
Adjusted for Recycled Water(2)	(6)	(12)	(14)	(14)	(14)	(14)
Planning Level of Demand	**222**	**225**	**226**	**228**	**230**	**232**
PROJECTED AVAILABLE SUPPLY & NEED FOR SUPPLEMENTAL SUPPLY(3) (MGD)						
Normal Water Year	>222	>224	>226	>228	>230	>232
Supplemental Supply Need	0	0	0	0	0	0
Single Dry Water Year (Multiple Dry Years – Year 1)						
Available Supply	211	213	215	217	219	220
Deficiency (Goal is 5% maximum(4))	5%(5)	5%	5%	5%	5%	5%
Supplemental Supply Need (6)	69	0	0	0	0	0
Multiple Dry Water Years – Year 2						
Available Supply	167	168	170	171	173	174
Deficiency (Goal is 25% maximum(7))	25%	25%	25%	25%	25%	25%
Supplemental Supply Need (6)	40	0	0	0	0	0
Multiple Dry Water Years – Year 3						
Available Supply	43	167	166	153	151	147
Deficiency (Goal is 25% maximum(7))	56%	26%	27%	33%	34%	37%
Supplemental Supply Need (To limit deficiency to 25%(6))	15	1	4	18	22	27
Three-Year Drought						
Total Supplemental Supply Need (To limit deficiency to 25%(6))	**124** (8)	**1**	**4**	**18**	**22**	**27**

(1) Projected Demand derived from the 2000 Demand Study, which projects water demand based on land use in EBMUD's service area.

(2) Conservation and recycled water program savings reported are based on the 1993 Updated Water Supply Management Plan (WSMP). WSMP set a conservation program savings goal of 33 MGD and a recycled water program savings goal of 14 MGD for the year 2020. Since the adoption of the WSMP the conservation savings goal has increased to 35 MGD to offset demand from anticipated annexations to EBMUD's service area. Conservation and recycled water savings goals are to be upheld through 2030. Reference Chapter 5 and Chapter 6 for details.

(3) Projected Supply data includes dry-year supply deliveries from the Freeport Regional Water Project (FRWP) beginning in 2010. Without the FRWP supply 2020 deficiencies could be as high as 67%, as discussed in the UWMP 2000.

(4) Per 2003 FRWP EIR, rationing goal is set to 5% during the first year of all droughts.

(5) In 2005 and prior to the completion of the FRWP, EBMUD's water supply system is inadequate to supply 95% of demand, and may impose customer rationing up to 15% during the first year of a drought, resulting in a need for additional water.

(6) The supplemental supply need is based on EBMUDSIM model results. It is the amount of water needed to limit customer rationing to 5% during the first year of a three-year drought and 25% during the second and third year of a three-year drought; to implement all provisions of the 1998 Joint Settlement Agreement, and to offset additional water supply system losses created by a supplemental supply. The actual need will be dependent on antecedent conditions, the severity of the actual drought, and on how much supplemental supply is obtained during the first two years of the drought and added to storage for use in subsequent years.

(7) Assumed drought conditions, per Table 3-1 (Chapter 3).

(8) An additional 15 MGD is needed in the third year if a supplemental supply is obtained in year 1 and year 2. If a supplemental supply is not available during years 1 and 2 of the drought, total system storage could be drawn down to meet 95% of demand in the first year and 75% in the second year, creating a greater storage deficit and a greater supplemental supply need in the third year.

Technical Area: Transmission System Engineering
Authors: Sudath Arachchige

BACKGROUND

Staff needs a complete interconnection study to analyze the reliability impacts and to be confident of identifying the interconnection facilities and any new and/or modified downstream facilities necessary to support the power output (60MW) increase of the PPRP to the Chevron's Richmond Refinery Distribution Electric system and to the Pacific Gas and Electric (PG&E) system. Such interconnection should comply with the Utility Reliability and Planning Criteria, North American Electric Reliability Council (NERC) Planning Standards, NERC/Western Systems Coordinating Council (WSCC) Planning Standards, and California Independent System Operator (California ISO) Planning Standards.

DATA REQUESTS

66. Please provide complete pre- and post-project electrical one-line diagrams (or resubmit Figure 2.1-6 and 2.1-7) of the PPRP switchyard showing all equipment for generator interconnections including any bus duct connectors or cables, 13.8kV and 12.47kV switchgears with refinery loads and breakers on the low side, generator step-up transformers, short overhead line or conductors with its configuration, buses and disconnect switches on the 115 kV side and their respective ratings.

    Response: The requested one-line diagrams are provided as Attachment TSE-66A through TSE-66G.

67. Please provide electricity loads for all six distribution substations at the refinery and net output of the existing power plant.

    Response: Electricity loads for all of the refinery substations are summarized in Table DR-67 below. Net generation as of 2007 is approximately 120 MW at ISO conditions.

TABLE DR-67
Refinery 115kV Substation Load Tabulation - Projection through 2011

Year	1 Sub (MVA)	2 Sub (MVA)	3 Sub (MVA)	4 Sub (MVA)	#1 PP (MVA)	6 Sub (MVA)	7 Sub (MVA)	Refinery Load (MVA)	Refinery Load (MW)
2007	30	45	33	44	11	0	0	**163**	**139**
2008	12	44	32	53	12	31	0	**184**	**156**
2009	12	45	35	53	7	36	27	**188**	**160**
2010	0	56	42	53	0	50	27	**201**	**171**
2011	0	56	42	53	0	50	27	**201**	**171**

68. Please provide a detailed description of any new downstream interconnection facilities, or any facilities that may require modifications due to interconnection of the project such as reconductoring or breaker changes.

Response: There will be no physical change required to downstream interconnection facilities. Chevron will be adding a circuit breaker to an existing foundation in Substation 5.

69. Please consult with the California ISO and PG&E prior to providing a Power Flow analysis and a Short Circuit Study report for the PPRP with and without total Cogen MW (proposed 60MW + existing Cogen MW) for 2008 Summer Peak and Summer Off peak conditions.

    a. Please provide a Load Flow analysis for N-0 (normal condition), N-1 (single contingencies) and critical N-2 (double contingencies) system conditions. Provide a list of overload criteria violations in one table showing the loadings before and after the new generation and their differences side by side.

Response: The PPRP will not be connecting to the ISO-controlled grid From an electrical standpoint, PPRP will primarily self-generate to reduce demand for PG&E electricity at the Chevron refinery. To the extent the generation facilities do not export to the grid, they are entitled to interconnection under state jurisdictional Rule 21. While Cogen 3000 may export to PG&E under certain conditions, it will export as a Qualifying Facility (QF) under the Public Utilities Regulatory Policies Act. Again, under PURPA, Rule 21 interconnection is permissible for QFs under these circumstances.Chevron submitted an application for interconnection to PG&E under Rule 21 on May 2007 which was revised on July 24, 2007 A copy of the Rule 21 application is provided as Attachment TSE-69. In accordance with Rule 21, Pacific Gas and Electric Company will conduct some or all of the following interconnection reviews to determine the interconnection requirements for a generation project.

Application Review: The application will normally be acknowledged and reviewed for completeness within 10 business days of PG&Es receipt of the application. The application must be complete before PG&E can move on to the initial review.

Initial Review: The review shall be completed, absent any extraordinary circumstances, within 10 business days of PG&Es acceptance of the completed application. This review will determine if the generation facility qualifies for a simplified interconnection or if a supplemental review is required.

Supplemental Review: The review, if required, should be completed within 20 business days of deeming the application complete. Payment of $600 by the applicant for the supplemental review must be submitted to us within 10 days of issuance of review. The review will determine if the generation facility can be interconnected or if a Detailed Interconnection Study is required first.

Detailed Interconnection Study: The applicant must enter into an agreement with Pacific Gas and Electric Company to perform additional studies, facility design/engineering, and cost estimates for required interconnection facilities. The study is at the applicant's expense.

Since PPRP will be a Qualifying Facility, Chevron will not undergo the procedures typically required of a "Transmission Owner" who would be connecting to the ISO controlled grid.

Chevron does not anticipate that PG&E will perform some of the studies that are being requested by Staff. Chevron will however provide the results of PG&E's review, including PG&E's detailed interconnection study. It is expected that the detailed interconnection study will be completed in November or December.

b. Please provide power flow diagrams (MVA, percent loading & P. U. voltage) for base cases with and without the project. Power flow diagrams must also be provided for all N-0, N-1 and N-2 studies where overload or voltage criteria violations appear.

Response: See Data Response 69a.

c. Please provide a Short Circuit Study report in one table showing fault currents at important buses with and without the new generation, and respective breaker interrupting ratings side by side.

Response: See Data Response #69a.

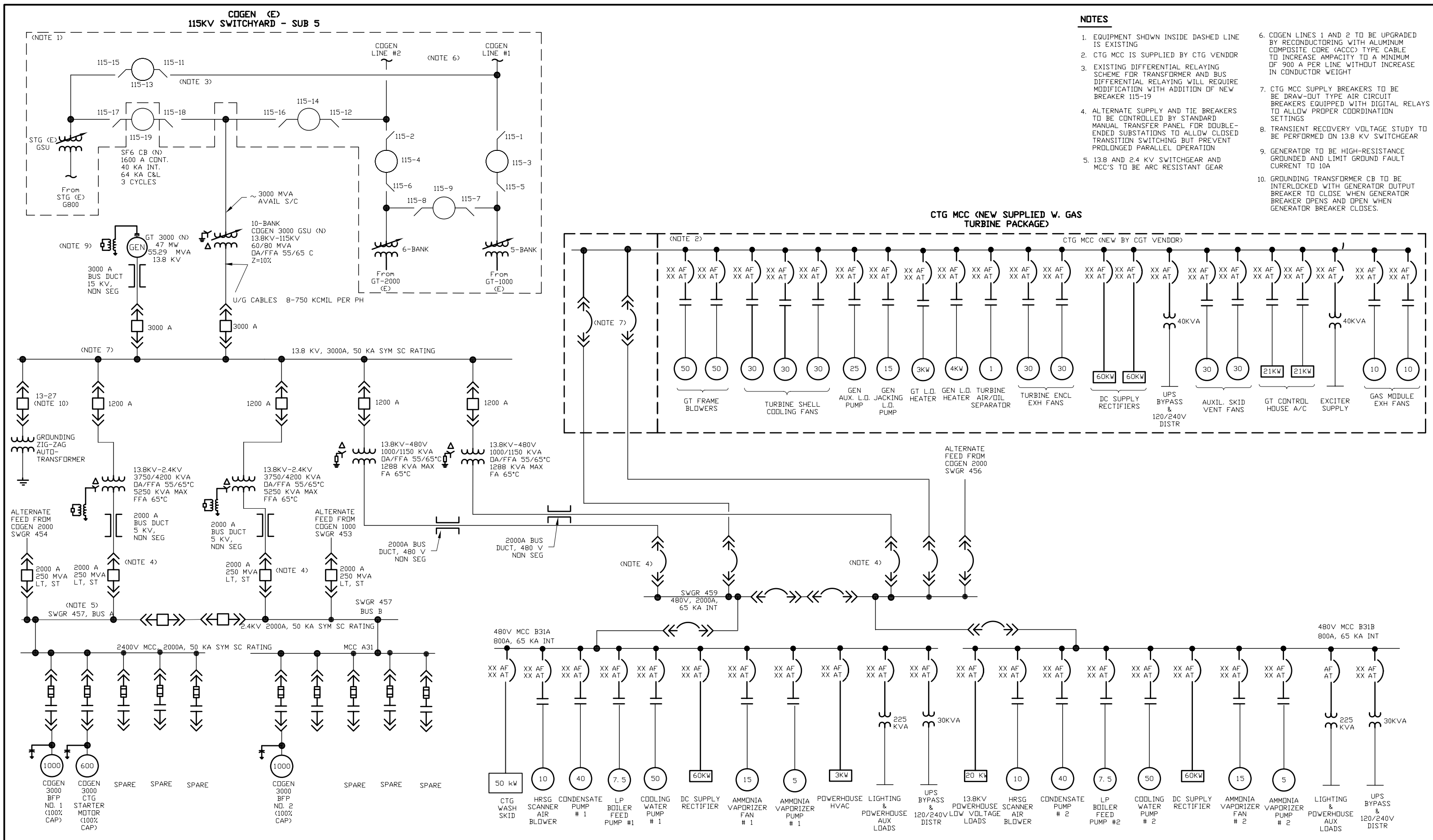
d. Please provide a list of mitigation measures considered and those selected for all criteria violations.

Response: See Data Response #69a.

ATTACHMENTS TSE-66A THROUGH TSE-66G

NOTES

1. EQUIPMENT SHOWN INSIDE DASHED LINE IS EXISTING
2. CTG MCC IS SUPPLIED BY CTG VENDOR
3. EXISTING DIFFERENTIAL RELAYING SCHEME FOR TRANSFORMER AND BUS DIFFERENTIAL RELAYING WILL REQUIRE MODIFICATION WITH ADDITION OF NEW BREAKER 115-19
4. ALTERNATE SUPPLY AND TIE BREAKERS TO BE CONTROLLED BY STANDARD MANUAL TRANSFER PANEL FOR DOUBLE-ENDED SUBSTATIONS TO ALLOW CLOSED TRANSITION SWITCHING BUT PREVENT PROLONGED PARALLEL OPERATION
5. 13.8 AND 2.4 KV SWITCHGEAR AND MCC'S TO BE ARC RESISTANT GEAR
6. COGEN LINES 1 AND 2 TO BE UPGRADED BY RECONDUCTORING WITH ALUMINUM COMPOSITE CORE (ACCC) TYPE CABLE TO INCREASE AMPACITY TO A MINIMUM OF 900 A PER LINE WITHOUT INCREASE IN CONDUCTOR WEIGHT
7. CTG MCC SUPPLY BREAKERS TO BE BE DRAW-OUT TYPE AIR CIRCUIT BREAKERS EQUIPPED WITH DIGITAL RELAYS TO ALLOW PROPER COORDINATION SETTINGS
8. TRANSIENT RECOVERY VOLTAGE STUDY TO BE PERFORMED ON 13.8 KV SWITCHGEAR
9. GENERATOR TO BE HIGH-RESISTANCE GROUNDED AND LIMIT GROUND FAULT CURRENT TO 10A
10. GROUNDING TRANSFORMER CB TO BE INTERLOCKED WITH GENERATOR OUTPUT BREAKER TO CLOSE WHEN GENERATOR BREAKER OPENS AND OPEN WHEN GENERATOR BREAKER CLOSES.



THIS IS AN AUTOCAD DRAWING. DO NOT REVISE MANUALLY.

REFERENCE DRAWINGS	REVISIONS			
	C	REVISED PER COMMENTS & CHANGED TO SPLIT BUSSES FOR DOUBLE-ENDED FEED	03-13-07	GCCH GCCH
	D	REVISED PER COMMENTS & CHANGED TO SHOW CTG LOADS FOR FRAME 6B AND TO PROVIDE ALTERNATE FEEDS	05-31-07	GCCH GCCH
	B	REVISED FOR ESTIMATION PER COMMENTS	07-19-06	GHGI GCCH
	A	FOR ESTIMATION	06-26-06	GHGI GCCH

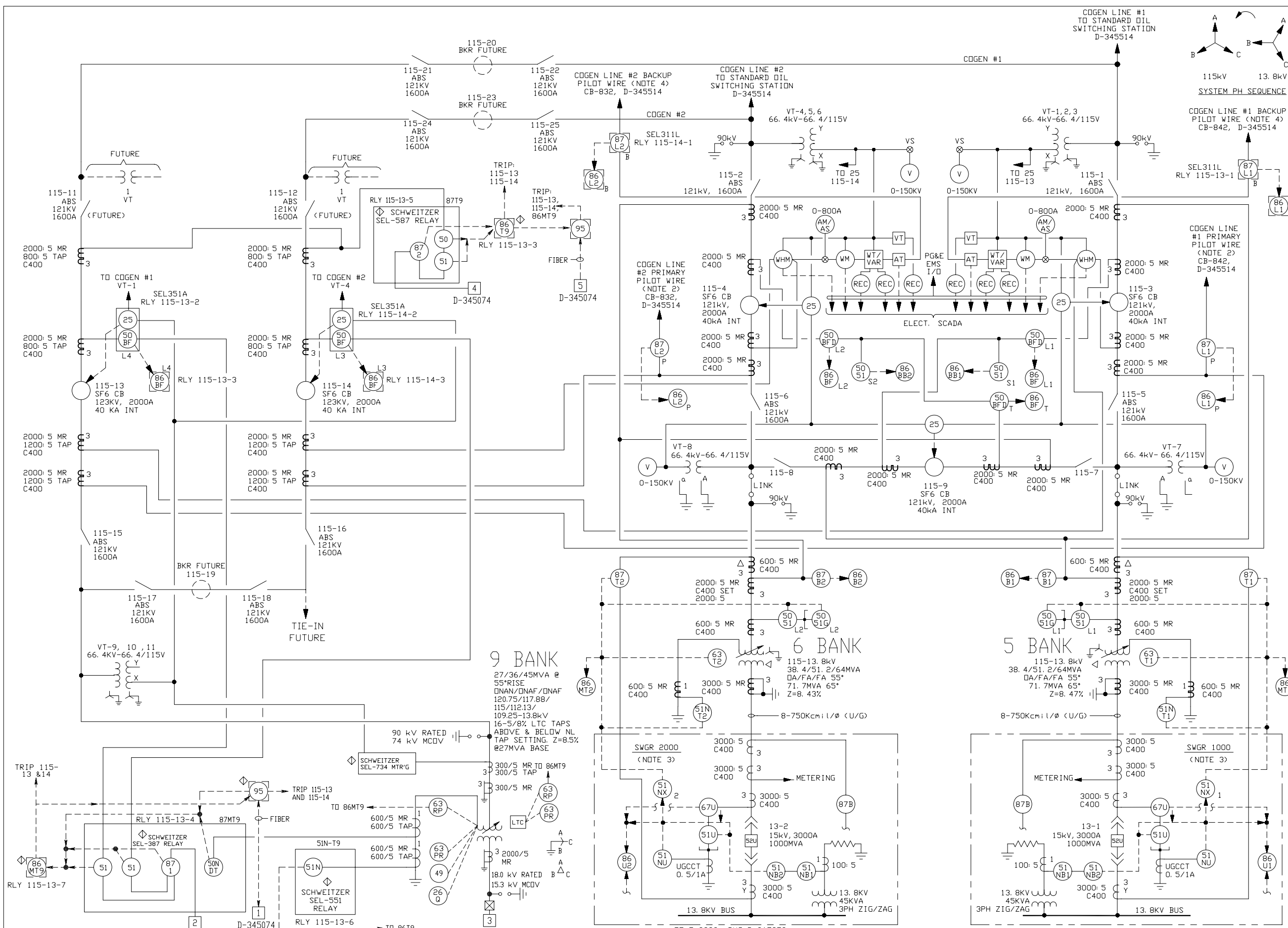
Chevron
Richmond Refinery

GHGI

ONE LINE DIAGRAM - CONCEPTUAL
EUIPMENT
COGEN PLANT TRAIN 3000
UTILITIES & ENVIRONMENTAL ABU

SCALE NONE DR. GHGI DR. APP. DATE
ENGR. GCCH ENGR. DEPT.
OPR'G. DEPT.
APPROVED

P W. O. S. O. D-SK-0001-D



	RELAY NO.	MFR & TYPE	DESCRIPTION	FUNCTION
MAIN TRANSFORMER 5-BK, 6-BK	50/51 L1, L2	GE IFC53B1A	TRANSFORMER PHASE O/C	TRIP 86MT1 (OR 86MT2)
	50/51G L1, L2	GE IFC53B1A	TRANSFORMER NEUTRAL O/C	
	63 T1, T2	---	TRANSFORMER SUDDEN PRESSURE	
	87 T1, T2	GE STD-15C5A	TRANSFORMER DIFFERENTIAL	
	51N T1, T2	GE IFC53A2A	TRANSFORMER NEUTRAL O/C	
	86 MT1/2	GE HEA	TRANSFORMER LOCKOUT RELAY	TRIP ASSO BREAKERS
115kV SYSTEM & LINE	50/BFD L1, L2, T	BASLER BE1-50BF	115kV LINE BREAKER FAILURE DETECTOR F3F-E1J-A5NOF	TRIP 86BFL1 (L2 OR BFT)
	87L1 P	ABB LCB II	115kV LINE #1 PILOT WIRE RELAY 2 TERMINAL DTT, LCB8T1B5NP	TRIP 86L1-P
	87L1 B	SEL 311L	115kV LINE #1 PILOT WIRE RELAY PART # 0311L1HDD3254K1	TRIP 86L1-B
	87L2 P	ABB LCB II	115kV LINE #2 PILOT WIRE RELAY 2 TERMINAL DTT, LCB8T1B5NP	TRIP 86L2-P
	87L2 B	SEL 311L	115kV LINE #2 PILOT WIRE RELAY PART # 0311L1HDD3254X1	TRIP 86L2-B
	25/50BF L3, L4	SEL 351	115kV BREAKER FAILURE RELAY & SYNC. CHECK	TRIP 86BFL3, L4
	87 B1, B2	GE PVD21B1A	115kV BUS DIFFERENTIAL	TRIP 86B1 (OR 86B2)
	25	BASLER BE1-25	115kV BKR SYNCH CHECK RELAY MIG-A6P-N5SOF	SUPERVISE CLOSING ASSOC BKR
	50/51 S1, S2	GE IFC51B1A	115kV PARTIAL BUS SUMMATION O/C	TRIP 86BB1 (OR 86BB2)
	86 B1, B2	GE HEA	BUS LOCKOUT RELAY	TRIP ASSO BREAKERS
	86L1/L2 P, B	GE HEA	LINE PRIMARY & BACKUP LOCKOUT RELAY	TRIP ASSO BKRS
	86 BF1, 2, T	GE HEA	115kV BKR FAILURE LOCKOUT RELAY	TRIP ASSO BKRS
	86 BB1, BB2	GE HEA	115kV BACKUP BUS LOCKOUT RELAY	TRIP ASSO BREAKERS
	86BF L3, L4	E-SW LOR	115KV BKR FAILURE LOCKOUT RELAY	TRIP ASSO BREAKERS
METERING	AT	SCIENTIFIC COLUMBUS	LINE CURRENT TRANSDUCER 4-20 mA, C1510PAN7	SCADA
	VT	SCIENTIC COLUMBUS	LINE VOLTAGE TRANSDUCER 4-20mA VT110PAN7	SCADA
	WT VAR	SCIENTIFIC COLUMBUS	LINE WATT/VAR TRANSDUCER 4-20 mA, XLWV342K5PAN7	SCADA
	WH	SCIENTIFIC COLUMBUS JEM-2	LINE WATTHOUR METER W/SOLID-STATE KYZ CONTACTS	SCADA
	AS VS	GE SBM	AMMETER/VOLTMETER SWITCH	SELECTOR SWITCH
	A V	ARGA CONTROL	DIGITAL SWITCH BOARD AMMETER/VOLTMETER	DISPLAY
	W	ARGA CONTROL	DIGITAL WATTMETER	DISPLAY
	REC	HONEYWELL STRIP CHART	3 PEN RECORDER (4-20mA) TYPE DPR 1000	FOR LINE V, W, VAR

NOTES:

1. FOR LEGEND SEE DWG D-317361, D-317362, & D-345074.
2. ALL PILOT WIRE SHALL BE FIBER OPTIC CABLE 62.5/125 MULTIMODE, TWELVE(12) WIRES. CONSTRUCTION TO PROVIDE TWO SEPARATE ROUTE FOR THE FOUR FIBER OPIC CABLES AS FOLLOWS:

   ROUTES 1: FOR COGEN #1 PRIMARY PILOT WIRE AND COGEN #2 BACKUP PILOT WIRE } 12/0

   ROUTES 2: FOR COGEN #2 PRIMARY PILOT WIRE AND COGEN #1 BACKUP PILOT WIRE } 12/0
3. FOR DETAILS OF SWGR 1000 AND SWGR 2000 PROTECTIVE RELAYING SEE SINGLE LINE DIAGRAM D-317851 & D-317852.
4. NEW FIBER INSTALLED FOR COGEN #1 & #2 BACKUP RELAYS. 36 FIBER ADSS. ABANDON OLD FIBER.

REFERENCE DRAWINGS

EOL, TX. 451-458, #5 & #6 BANKS	D-317361	ELECTRICAL TRIPPING LOGIC 115KV SYSTEM	D-317412
EOL, TX. 453-456, PROT. RELAY & METER	D-317362	3-L DIAG-115kV METER & RELAY SH. 1	D-317421
EOL, GT-1000 GENERATOR, 63MVA PR&M	D-317851	3-L DIAG-115kV MAIN TRANS M & R SH. 2	D-317422
EOL, GT-2000 GENERATOR, 63MVA PR&M	D-317852	EOL, 115kV 9-BK & 13.8KV STG-800	D-345074
3-L DIAG - 115KV METER & RELAY SH. 1	D-345480	ELECTRICAL TRIPPING LOGIC 115KV SYSTEM	D-345485
3-L DIAG - 115KV METER & RELAY SH. 2	D-345481	EOL, 115KV BUS #1 & #2 PROT RLYS, SOSS	D-345514

REVISIONS

1	CT WIRING CHANGE AFFECTING STG & STANDBY POWER CALCULATION 10-23-06	MGJF CHUB	FGKR

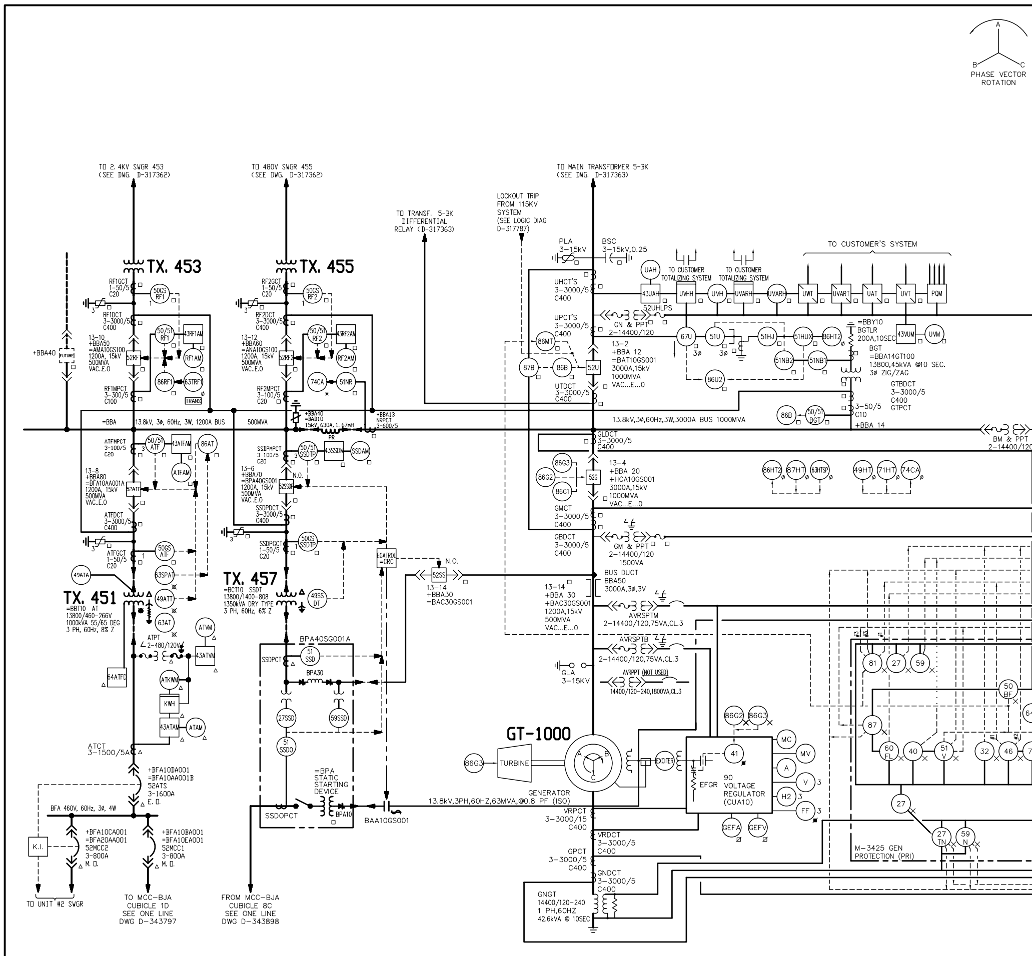
Xref CDFLOGO

11/14/2006 MGJF

SCALE NONE DR. GRIDE DR. APP. DATE APPROVED
ENGR. A. TSO ENGR. DEPT.
OPR'G. DEPT.

ELECTRICAL ONE LINE DIAGRAM
115KV & 13.8KV SYSTEMS, NO. 5 & NO. 6 BANKS
COGENERATION PLANT
UTILITIES AND ENVIRONMENTAL AREA BUSINESS UNIT

P W.O. S.O. D-317363-8A-1



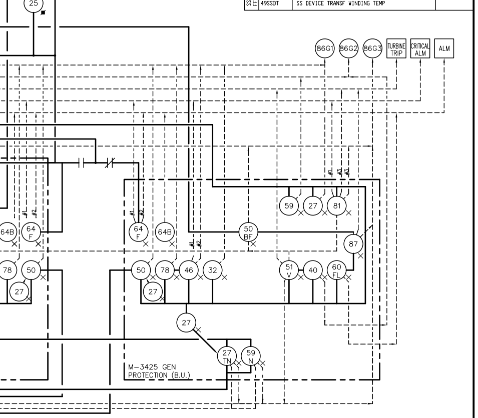
NOTES:

1. THIS DRAWING IS RE-DRAWN BY BECHTEL CORPORATION CAD SYSTEM BASED ON ASEA BROWN BOVERI (ABB) DRAWING HTDC 100639 SH. 1 OF 6 REV. J DATED 8/12/91 (BECHTEL V/P M002-E-9-1). BECHTEL ASSUMES NO RESPONSIBILITY FOR THE DESIGN OF THIS DRAWING.
2. SINBI NOT IN SERVICE.

LEGEND:

- ✳ GENERATOR PROTECTION CUBICLE (CHC 10)
- □ 13.8kV SWITCHGEAR (SWGR-1000)
- △ 460V SWITCHGEAR (BFA)
- ■ VOLTAGE REGULATOR (CUA10)
- ⊠ EGATROL (CRC10/20/30)
- ø CUST EQUIP
- ⊠ AUX TRANS (BBT10, TX-451)
- ✱ YARD
- ∽ LINE & LOADSIDE CUBICLE
- ⊠ METERING PANEL (CFQ10)

	RELAY NO.	DESCRIPTION	FUNCTION
13.8kV LINE & BUS	51U	PHASE OVERCURRENT	TRIP 86U1 & 115kV SYS 86MT1
	51NU	NEUTRAL OVERCURRENT	
	51NB2	GROUND OVERCURRENT	
	67U	DIRECTIONAL POWER RELAY	TRIP 86U1
	86U1	INCOMING LINE LOCKOUT	TRIP 52U
	87B	BUS DIFFERENTIAL	TRIP 86B
	50/51BGT	BUS GROUND OVERCURRENT	
	86B	BUS LOCKOUT	TRIP ALL 13.8kV BKRS
GENERATOR	59GN	GEN STATOR GROUND	TRIP 86E2
	32GP	GEN PRI REVERSE PPWER	
	40G	GEN LOSS OF EXCITING	
	27G	GEN UNDERVOLTAGE	
	59G	GEN OVERVOLTAGE	
	51NB1	BUS GND TRANSF NEUT OC	
	32GB	GEN BACKUP REVERSE POWER	
	87G	GEN DIFFERENTIAL	TRIP 86E1
	81G	GEN FREQUENCY (57Hz FOR 86U 54Hz FOR 86E1)	TRIP 86U1 & 86E1
	86E1	GEN PRIMARY LOCKOUT	TRIP GEN BKR 52G & EXCITER BKR 41
	86E2	GEN BACKUP LOCKOUT	
AUX TRANSFORMER FEEER	63SPAT	AUX TRANSF SUDDEN PRESSURE	TRIP 86AT
	49ATT	WINDING OVER TERM TRIP	TRIP BKR 52ATF
	50/51ATF	OVERCURRENT	
	50GSATF	GROUND FAULT	
	86AT	AUX TRANS LOCKOUT	
REFINERY FEEDER RF1	50GSRF1	GROUND FAULT	TRIP BKR 52FR1
	50/51RF1	OVERCURRENT	
	63TRF1	RF1 TRANSF SUDDEN PRESSURE	TRIP 86RF1
	86RF1	RF1 TRANSF SUDDEN PRESSURE LOCKOUT	TRIP BKR 52RF1
REFINERY FDR RF2	50/51RF2	OVERCURRENT	TRIP BKR 52RF2
	50GSRF2	GROUND FAULT	
SS TRANSF FEEDER	50/51SSDTP	SS DEVICE PRI OC	TRIP BKR 52SSDP
	50GSSDTP	SS DEVICE PRI GND FAULT	
	49SSDT	SS DEVICE TRANSF WINDING TEMP	



TRAIN-1000

THIS DATA IS ALSO SHOWN ON DWG FP-210021

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REFERENCE DRAWINGS			
ONE LINE, TX. 451-458, #5&6 BANKS	D-317361	TRICONEX PROT. RELAYS & METERING	FP-210021
RELAY DIAGRAM, TX. 453, 4, 5&6	D-317362		
RELAY DIAGRAM, #5&6 BANKS	D-317363		
RELAY DIAGRAM, GT-2000, TX. 452, 4, 6&8	F-317852		
ONE LINE, MCC-BJA FOR TRAIN-1000	D-343797		
ONE LINE, MCC-BJA FOR TRAIN-1000	D-343798		

REVISIONS								
1 ISSUED FOR CONSTRUCTION 06-01-92	AK / GR	TSD / AB	JY	3 UPDATED TITLE BLOCK. DEFINED REFERENCE DWGS. ADDED TEXT "TRAIN-1000". 10-12-98	NLN	JMU	JPS
2 ADDED "N.O." TO SW. 13-5 & 13-13 & CHGD TITLE BLOCK 04-01-96	GRD	JMU / MAC		4 UPDATED TITLE BLOCK. UPDATED PROTECTIVE RELAYS & METERING. 09-02-03	RESY / GRDE	KIDR	

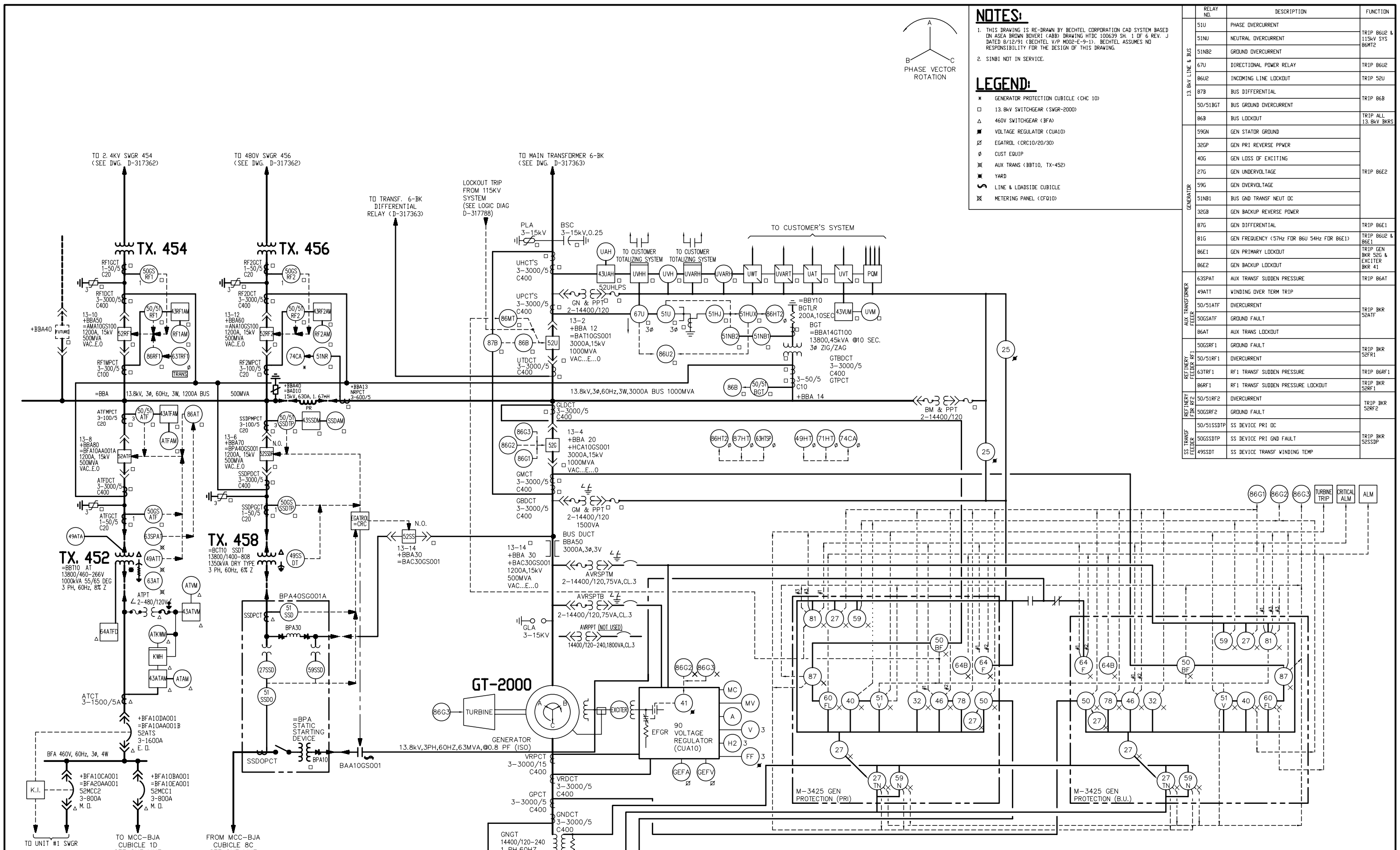
Chevron
Richmond Refinery

SCALE NONE DR. M.LEE DR. APP. ____ DATE ____ APPROVED
ENGR. ABB ENGR. DEPT. ____
OPR'G. DEPT. ____

09/10/2003 GRDE

ELECTRICAL RELAY DIAGRAM
TX. 451, TX. 453, TX. 455, TX. 457 AND GT-1000
COGENERATION PLANT
UTILITIES AND ENVIRONMENTAL AREA BUSINESS UNIT

P W.O. ____ S.O. ____ F-317851-4



NOTES:

1. THIS DRAWING IS RE-DRAWN BY BECHTEL CORPORATION CAD SYSTEM BASED ON ASEA BROWN BOVERI (ABB) DRAWING HTDC 100639 SH. 1 OF 6 REV. J DATED 8/12/91 (BECHTEL V/P M002-E-9-1). BECHTEL ASSUMES NO RESPONSIBILITY FOR THE DESIGN OF THIS DRAWING.
2. SINBI NOT IN SERVICE.

LEGEND:

*	GENERATOR PROTECTION CUBICLE (CHC 10)
□	13.8kV SWITCHGEAR (SWGR-2000)
△	460V SWITCHGEAR (BFA)
■	VOLTAGE REGULATOR (CUA10)
⊠	EGATROL (CRC10/20/30)
ϕ	CUST EQUIP
⊠	AUX TRANS (BBT10, TX-452)
■	YARD
∽	LINE & LOADSIDE CUBICLE
⊠	METERING PANEL (CFQ10)

	RELAY NO.	DESCRIPTION	FUNCTION
13.8kV LINE & BUS	51U	PHASE OVERCURRENT	TRIP 86U2 & 115kV SYS 86MT2
	51NU	NEUTRAL OVERCURRENT	
	51NB2	GROUND OVERCURRENT	
	67U	DIRECTIONAL POWER RELAY	TRIP 86U2
	86U2	INCOMING LINE LOCKOUT	TRIP 52U
	87B	BUS DIFFERENTIAL	TRIP 86B
	50/51BGT	BUS GROUND OVERCURRENT	
	86B	BUS LOCKOUT	TRIP ALL 13.8kV BKRS
GENERATOR	59GN	GEN STATOR GROUND	TRIP 86E2
	32GP	GEN PRI REVERSE PPWER	
	40G	GEN LOSS OF EXCITING	
	27G	GEN UNDERVOLTAGE	
	59G	GEN OVERVOLTAGE	
	51NB1	BUS GND TRANSF NEUT OC	
	32GB	GEN BACKUP REVERSE POWER	
	87G	GEN DIFFERENTIAL	TRIP 86E1
	81G	GEN FREQUENCY (57Hz FOR 86U 54Hz FOR 86E1)	TRIP 86U2 & 86E1
	86E1	GEN PRIMARY LOCKOUT	TRIP GEN BKR 52G & EXCITER BKR 41
	86E2	GEN BACKUP LOCKOUT	
AUX TRANSFORMER FEEER	63SPAT	AUX TRANSF SUDDEN PRESSURE	TRIP 86AT
	49ATT	WINDING OVER TERM TRIP	TRIP BKR 52ATF
	50/51ATF	OVERCURRENT	
	50GSATF	GROUND FAULT	
	86AT	AUX TRANS LOCKOUT	
REFINERY FEEDER RF1	50GSRF1	GROUND FAULT	TRIP BKR 52FR1
	50/51RF1	OVERCURRENT	
	63TRF1	RF1 TRANSF SUDDEN PRESSURE	TRIP 86RF1
	86RF1	RF1 TRANSF SUDDEN PRESSURE LOCKOUT	TRIP BKR 52RF1
REFINERY FDR RF2	50/51RF2	OVERCURRENT	TRIP BKR 52RF2
	50GSRF2	GROUND FAULT	
SS TRANSF FEEDER	50/51SSDTP	SS DEVICE PRI OC	TRIP BKR 52SSDP
	50GSSDTP	SS DEVICE PRI GND FAULT	
	49SSDT	SS DEVICE TRANSF WINDING TEMP	

TRAIN-2000

THIS DATA IS ALSO SHOWN ON DWG FP-210023

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REFERENCE DRAWINGS

ONE LINE, TX. 451-458, #5&6 BANKS	D-317361	TRICONEX PROT. RELAYS & METERING	FP-210023
RELAY DIAGRAM, TX. 453, 4, 5&6	D-317362		
RELAY DIAGRAM, #5&6 BANKS	D-317363		
RELAY DIAGRAM, GT-1000, TX. 451, 3, 5&7	F-317851		
ONE LINE, MCC-BJA FOR TRAIN-2000	D-343799		
ONE LINE, MCC-BJA FOR TRAIN-2000	D-343800		

REVISIONS

Rev.	Description	Date			
0	ISSUED FOR CONSTRUCTION	04-01-96	AK / GR	TSD / AB	JY
1	ADDED 'N.O.' TO SW. 13-6 & 13-14 & CHGD TITLE BLOCK	07-08-92	GRD	JMU / MAC	
2	UPDATED TITLE BLOCK. DEFINED REFERENCE DWGS. ADDED TEXT "TRAIN-2000".	10-12-98	NLN	JMU	JPS
3	UPDATED TITLE BLOCK. UPDATED PROTECTIVE RELAYS & METERING.	09-02-03	RESY / GRDE	KIDR	

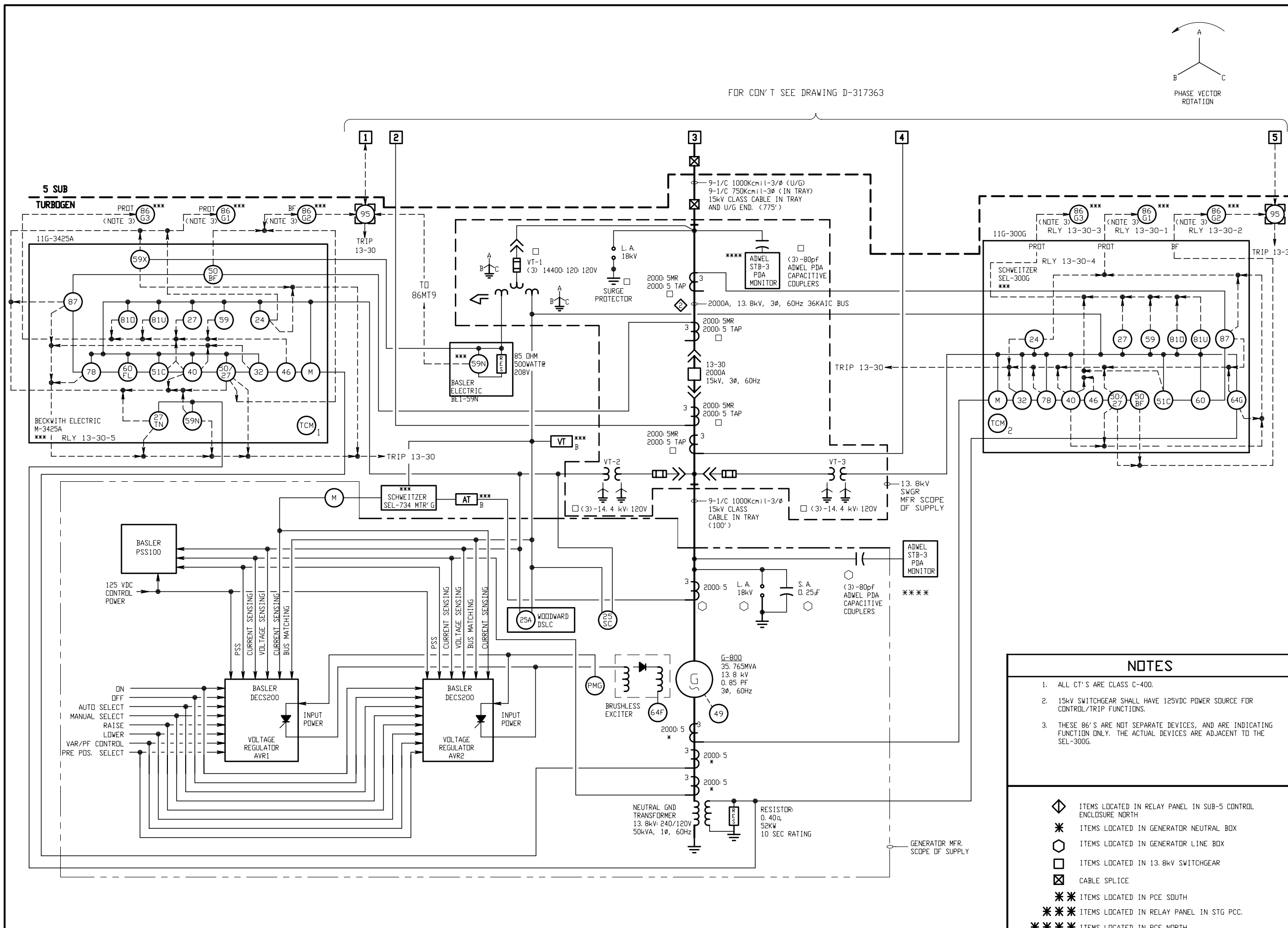
Chevron
Richmond Refinery

SCALE NONE DR. M. LEE DR. APP. DATE APPROVED
ENGR. ABB ENGR. DEPT.
OPR'G. DEPT.

09/10/2003 GRDE

ELECTRICAL RELAY DIAGRAM
TX. 452, TX. 454, TX. 456, TX. 458 AND GT-2000
COGENERATION PLANT
UTILITIES AND ENVIRONMENTAL AREA BUSINESS UNIT

P W.O. S.O. F-317852-3



NOTES

1. ALL CT'S ARE CLASS C-400.
2. 15kV SWITCHGEAR SHALL HAVE 125VDC POWER SOURCE FOR CONTROL/TRIP FUNCTIONS.
3. THESE 86'S ARE NOT SEPARATE DEVICES, AND ARE INDICATING FUNCTION ONLY. THE ACTUAL DEVICES ARE ADJACENT TO THE SEL-300G.

- ◇ ITEMS LOCATED IN RELAY PANEL IN SUB-5 CONTROL ENCLOSURE NORTH
- * ITEMS LOCATED IN GENERATOR NEUTRAL BOX
- ⬡ ITEMS LOCATED IN GENERATOR LINE BOX
- □ ITEMS LOCATED IN 13.8kV SWITCHGEAR
- ⊠ CABLE SPLICE
- ** ITEMS LOCATED IN PCE SOUTH
- *** ITEMS LOCATED IN RELAY PANEL IN STG PCC.
- **** ITEMS LOCATED IN PCE NORTH

LEGEND

24	VOLTS PER Hz RELAY
25 SC	SYNCHRONIZING/SYNCHRONISM-CHECK RELAY
25A	AUTOMATIC SYNCHRONIZER
26 Q	TRANSFORMER OIL TEMPERATURE
27	UNDERVOLTAGE RELAY
27TN	THIRD HARMONIC NEUTRAL UNDERVOLTAGE RELAY
32	DIRECTIONAL POWER RELAY
40	FIELD LOSS RELAY
46	PHASE CURRENT IMBALANCE
49	THERMAL RELAY
50	INSTANTANEOUS OVERCURRENT RELAY
50/27	INADVERTENT ENERGIZATION
50BF	BREAKER FAILURE RELAY
50N DT	RESIDUAL DEFINITE TIME OVERCURRENT
50 51	INSTANTANEOUS AND TIME OVERCURRENT RELAY
51C	VOLTAGE CONTROLLED TIME OVERCURRENT RELAY
59	OVERVOLTAGE RELAY
59N	NEUTRAL OVERVOLTAGE
59X	AUXILIARY OVERVOLTAGE (13.8KV BUS GROUND)
60FL	VT FUSE LOSS RELAY
63 PR	PRESSURE RELIEF
63 RP	RAPID PRESSURE RISE RELAY
64F	GENERATOR FIELD GROUND
64G	GENERATOR STATOR GROUND
67G	RESTRICTED EARTH FAULT
78	OUT OF STEP RELAY
81O	OVER-FREQUENCY RELAY
81U	UNDER FREQUENCY RELAY
87	PHASE DIFFERENTIAL CURRENT RELAY
95	BIDIRECTIONAL FIBER OPTIC TRIPPING RELAY
M	METERING
PMG	PERMANENT MAGNET GENERATOR
TCM	TRIP COIL MONITOR
LTC	LOAD TAP CHANGER
AT	CURRENT TRANSDUCER
VT	VOLTAGE TRANSDUCER

THIS IS AN AUTOCAD DRAWING. DO NOT REVISE MANUALLY.

REFERENCE DRAWINGS

EOL, 115kV & 13.8kV, No. 5 & No. 6 BANKS	D-317363	ELECTRIC MACHINERY COMPANY EXCITATION SYSTEM SCHEMATIC	135D807 SH 1
LOGIC DIAGRAM TURBINE TRIP LOGIC	D-345378		
LOGIC DIAGRAM PROTECTIVE RELAY TRIP LOGIC	D-345381	IDEAL - SCHEMATIC DIAGRAM - POWER CIRCUITS	14DK-6312
ELECTRICAL THREE LINE DIAGRAM	D-345382		
ELECTRICAL THREE LINE DIAGRAM	D-345383		

REVISIONS

No.	Description	Date		
2	AS BUILT PER MOC #14549	06-28-06	ETAL WWFI SAJP	CHUB MICA
1	REVISED BASLER 59N RELAY CT'S, LENGTH, VOLTAGE CLASS, PDA LOCATION, AND AT/VT NAME	06-07-05	JMD TC	TC KP
0	ISSUED FOR CONSTRUCTION	02-25-05	JMD TC	TC SWC

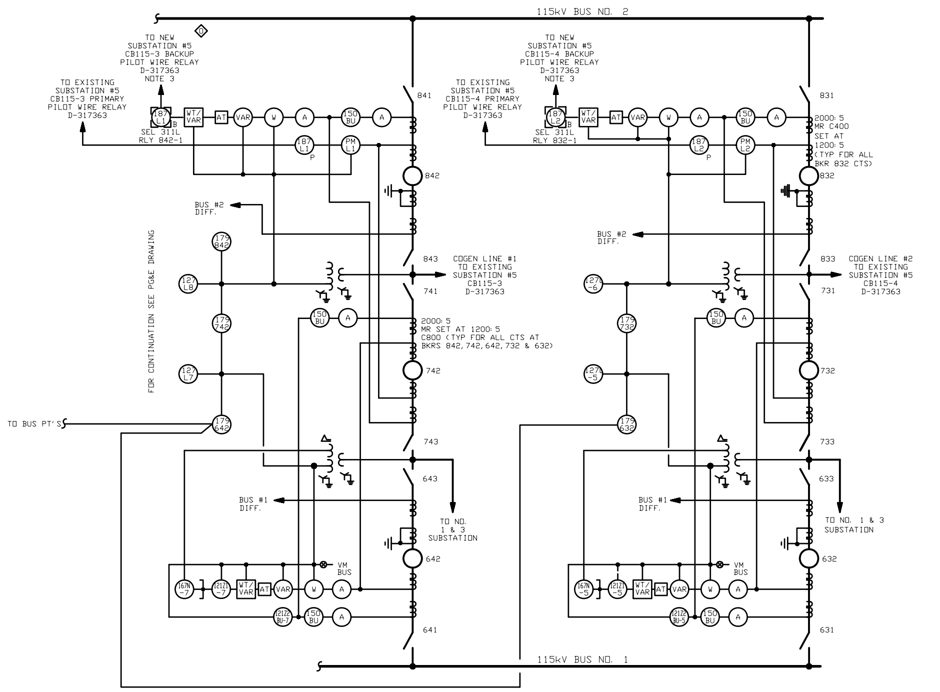
Chevron
Richmond Refinery

SCALE NONE DR. DDGR DR. APP. DATE
ENGR. JSBD, WWFI ENGR. DEPT.
OPR'G. DEPT.
APPROVED
08/01/2006 DDGR

ELECTRICAL ONE LINE DIAGRAM
STG 800 - 115kV 9-BK & 13.8kV
COGENERATION PLANT
UTILITIES AND ENVIRONMENTAL AREA BUSINESS UNIT

P W.O. S.O. D-345074-2

	RELAY NO.	MFR & TYPE	DESCRIPTION	FUNCTION
115kV SYSTEM & LINE	187L1 P	ABB LCB II	115kV LINE #1 PILOT WIRE RELAY 2 TERMINAL DTT, LCB8T1B5NP	TRIP 194L-5
	187L1 B	SEL 311L	115kV LINE #1 PILOT WIRE RELAY, PART # 0311L1HDD3254X1	TRIP 194LL-5
	187L2 P	ABB LCB II	115kV SWYD #2 PILOT WIRE RELAY 2 TERMINAL DTT, LCB8T1B5NP	TRIP 194L-6
	187L2 B	SEL 311L	115kV SWYD #2 PILOT WIRE RELAY, PART # 0311L1HDD3254X1	TRIP 194LL-6
METERING	AT	SCIENTIFIC COLUMBUS	LINE CURRENT TRANSDUCER 4-20 mA, C1S10PAN7	SCADA
	WT VAR	SCIENTIFIC COLUMBUS	LINE WATT/VAR TRANSDUCER 4-20 mA, XLWV342K5PAN7	SCADA
	A V	ARGA CONTROL	DIGITAL SWITCH BOARD AMMETER/VOLTMETER	DISPLAY
	W	ARGA CONTROL	DIGITAL WATTMETER	DISPLAY
	PM	GE PQM	POWER QUALITY METER, PQM-T20-A	TRICONEX
SWITCHING STATION	121Z1	W KD-10	ZONE 1 DISTANCE RELAY	
	167N	GE	GROUND DIRECTIONAL OC JBCG53M14	
	150 BU	ASEA	115kV BKR FAILURE DETECTOR RX1B24RK413HICE	
	121Z2 BU	GE	ZONE 2 DISTANCE RELAY CEB52A2D	



BAY 4

BAY 3

NOTES:

1. FOR LEGEND SEE DWG D-317361 AND D-317362.
2. ALL PILOT WIRE IS FIBER OPTIC CABLE 62.5/125 MULTIMODE, TWELVE(12) WIRES. TWO SEPARATE ROUTES FOR THE FOUR FIBER OPTIC CABLES AS FOLLOWS:
   - ROUTES 1: FOR COGEN #1 PRIMARY PILOT WIRE AND COGEN #2 BACKUP PILOT WIRE } 12/0
   - ROUTES 2: FOR COGEN #2 PRIMARY PILOT WIRE AND COGEN #1 BACKUP PILOT WIRE } 12/0
3. NEW FIBER INSTALLED FOR COGEN #1 AND #2 BACKUP RELAYS. 36 FIBER ADSS. ABANDONED OLD FIBER.

REDRAWN FROM DRAWING D-317363

THIS IS AN AUTOCAD DRAWING. DO NOT REVISE MANUALLY.

REFERENCE DRAWINGS			
EOL, 115KV SYSTEM SUB #5	D-317363	ELECTRICAL TRIPPING LOGIC 115KV SYSTEM	D-317412
E3L - 115KV BAY 3 - AC CIRCUITS	FP-89580, SH. 8		
E3L - 115KV BAY 4 - AC CIRCUITS	FP-89580, SH. 12		

REVISIONS							
2	AS BUILT BY DURA PER MOC 14549. 4-4-06	CHUB	DURA	SAJP			
1	TURBOGEN SYSTEM REPLACEMENT; REV. TO MATCH 3-LINE; ADDED POWER QUALITY METERS ON COGEN #1 & #2; ISSUED FOR CONSTRUCTION	CHUB	MICA		08-31-05	KBM	REM / KAP
0	TURBOGEN SYSTEM REPLACEMENT REDRAWN FROM DWG D-317363 REPLACED BACKUP LCB RELAYS ISSUED FOR CONSTRUCTION				02-18-05	PEI / KBM	REM / SWC

Chevron
Richmond Refinery

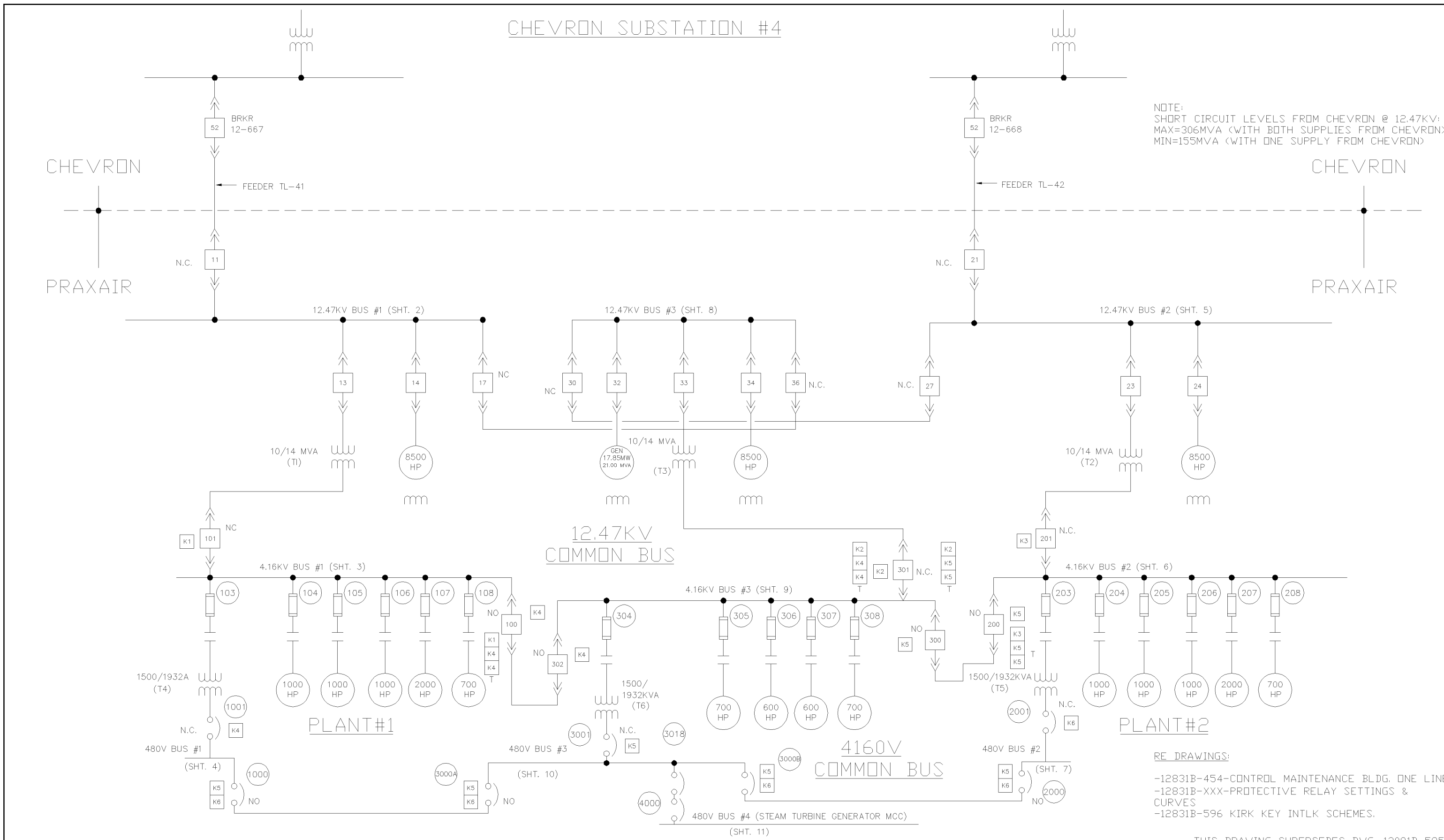
SCALE NONE DR. DOGR DR. APP. DATE
ENGR. REM ENGR. DEPT.
OPR'G. DEPT.
APPROVED

07/28/2006 DOGR

ELECTRICAL ONE LINE DIAGRAM
115KV BUS #1 & #2, PROTECTIVE RELAYING & METERING
STANDARD OIL SWITCHING STATION
UTILITIES AND ENVIRONMENTAL AREA BUSINESS UNIT

P W. O. S. O.

D-345514-2

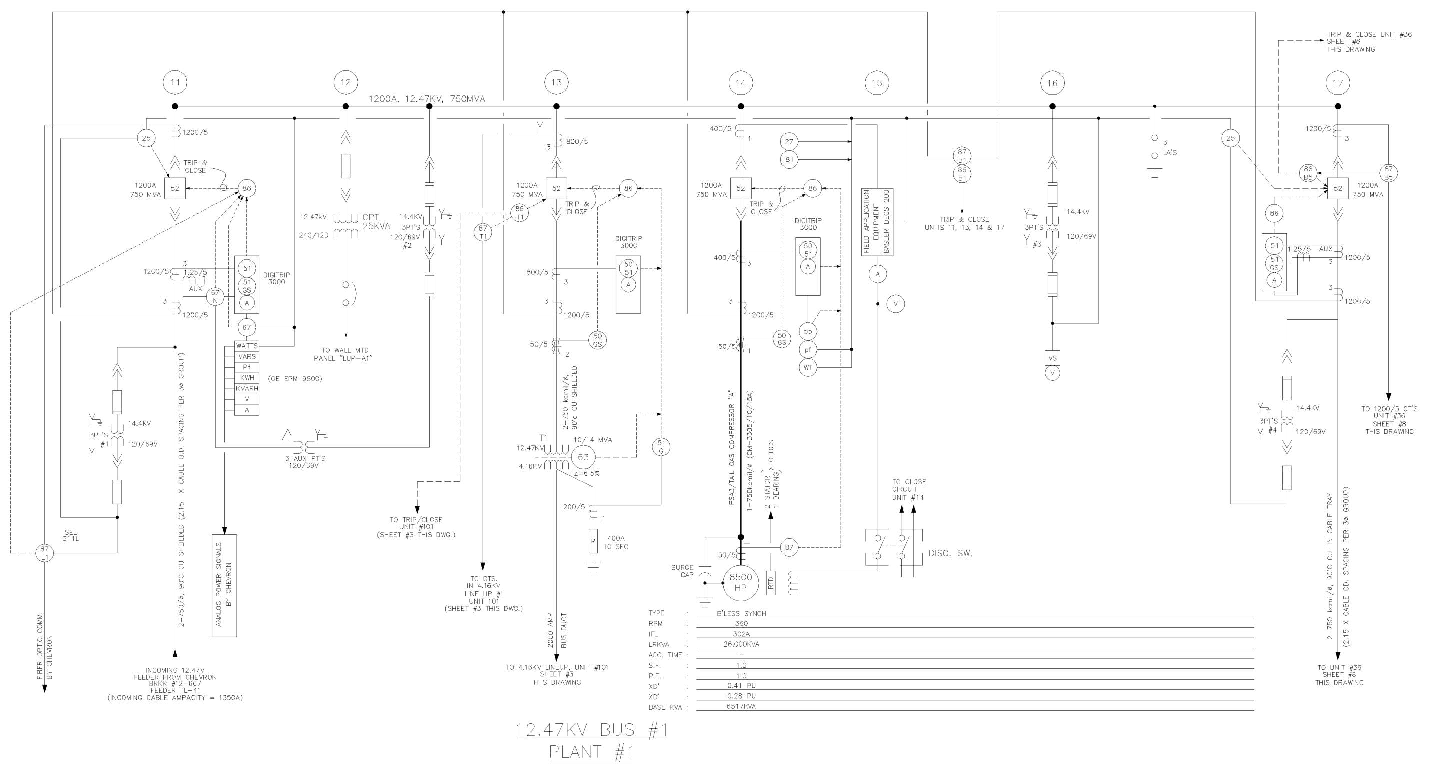


ALTRN	ALTERATION	BY	DATE	CHKD	REVD	APVD
2	REVISED 4160V LOAD UNITS 104, 105, 108, 204, 205, 208, 306, 307 & 308. REVISED 480V LOADS ADDED FUSE DATA @ 4160V REVISED KEYINTLKS					
1	REFEED 12.47KV BUS #3 - UNITS 27-30 & UNITS #17-36 REVISED GENERATOR RATING RESIZED 12.47KV INCOMING & TIE CABLES RESIZED 4.16KV TIE CABLES ADDED THIRD COOLING WATER PUMP ON 4.16KV LINEUP #3 ADDED GENERATOR AC & DC AUXILIARIES SHEET #11 UPDATED PSA/TAIL GAS COMPR. & AUXILIARY LOADS.	pwh	1/29/07	RJL	RJL	RJL

2/1/07

PRAXAIR BUSINESS CONFIDENTIAL
PRAXAIR TECHNOLOGY CENTER - TONAWANDA, NEW YORK

TYPE OF PLANT	120MMSCFD H2 PLANTS 1 & 2
TITLE	ELECTRICAL ONE LINE DIAGRAM COMPOSITE ONE LINE RICHMOND, CA
MODEL NAME	12831B-595S1
DRAWN BY	
CHECKED	RJL
SITE IDENTIFICATION	USAXXX
REVIEWED	RJL
APPROVED	RJL
PROJECT NUMBER	12831B
SCALE	NONE
DATE	9/7/06
SHEET	1
TOT. SHTS.	14
SIZE	D
DRAWING NUMBER	12831B-595
ALTERATION	2



ALTRN	ALTERATION	BY	DATE	CHKD	REVD	APVD

2/1/07

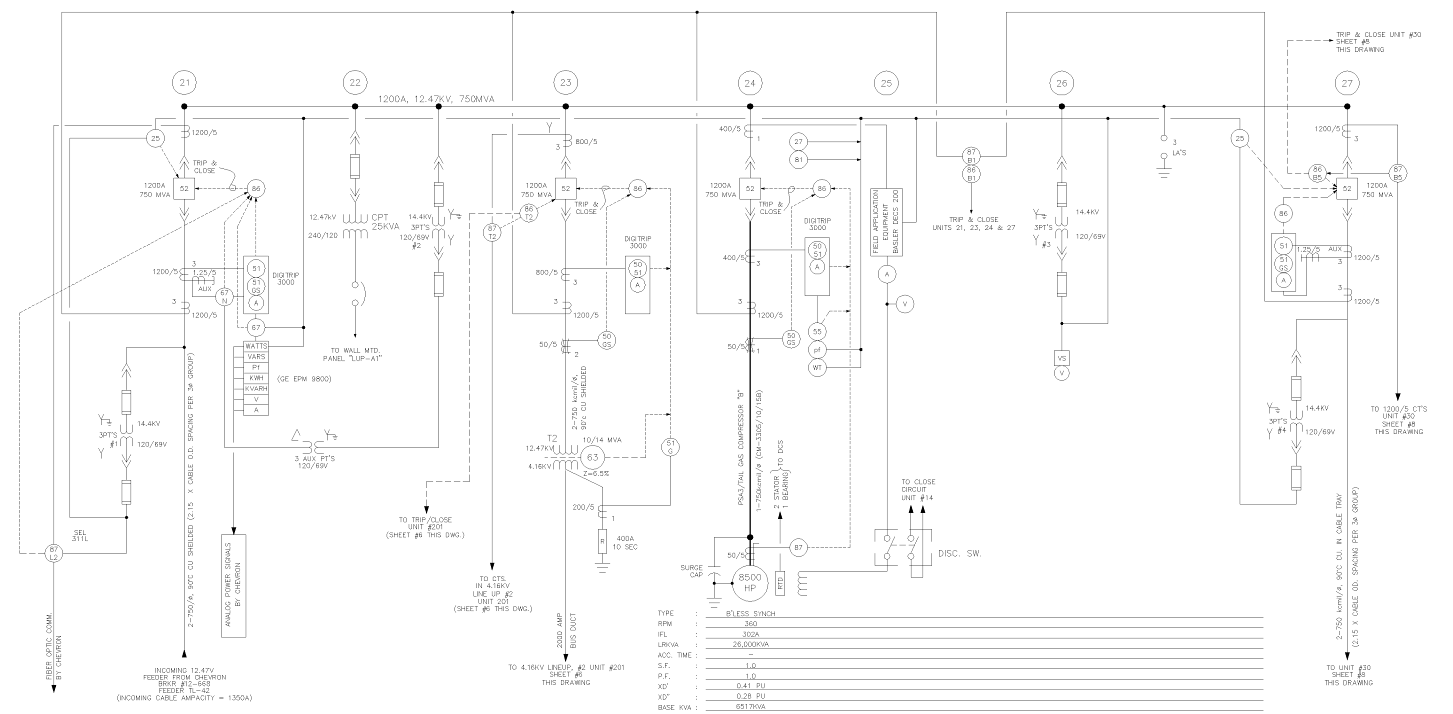
PRAXAIR BUSINESS CONFIDENTIAL
PRAXAIR TECHNOLOGY CENTER - TONAWANDA, NEW YORK

TYPE OF PLANT: 120 MMSCFD H2 PLANT #1

TITLE: ELECTRICAL ONE LINE DIAGRAM
12.47KV SWITCHGEAR #1
RICHMOND, CA

DRAWN BY	CHECKED	SITE IDENTIFICATION
	RJL	USAXXX
REVIEWED	APPROVED	PROJECT NUMBER
RJL	RJL	12831B
SCALE	DATE	SHEET	TOT. SHTS.
NONE	9/11/06	2	14
SIZE	DRAWING NUMBER	ALTERATION
D	12831B-595	2

MODEL NAME: 12831B-595S2



12.47KV BUS #2
PLANT #2

PRAXAIR BUSINESS CONFIDENTIAL
PRAXAIR TECHNOLOGY CENTER - TONAWANDA, NEW YORK

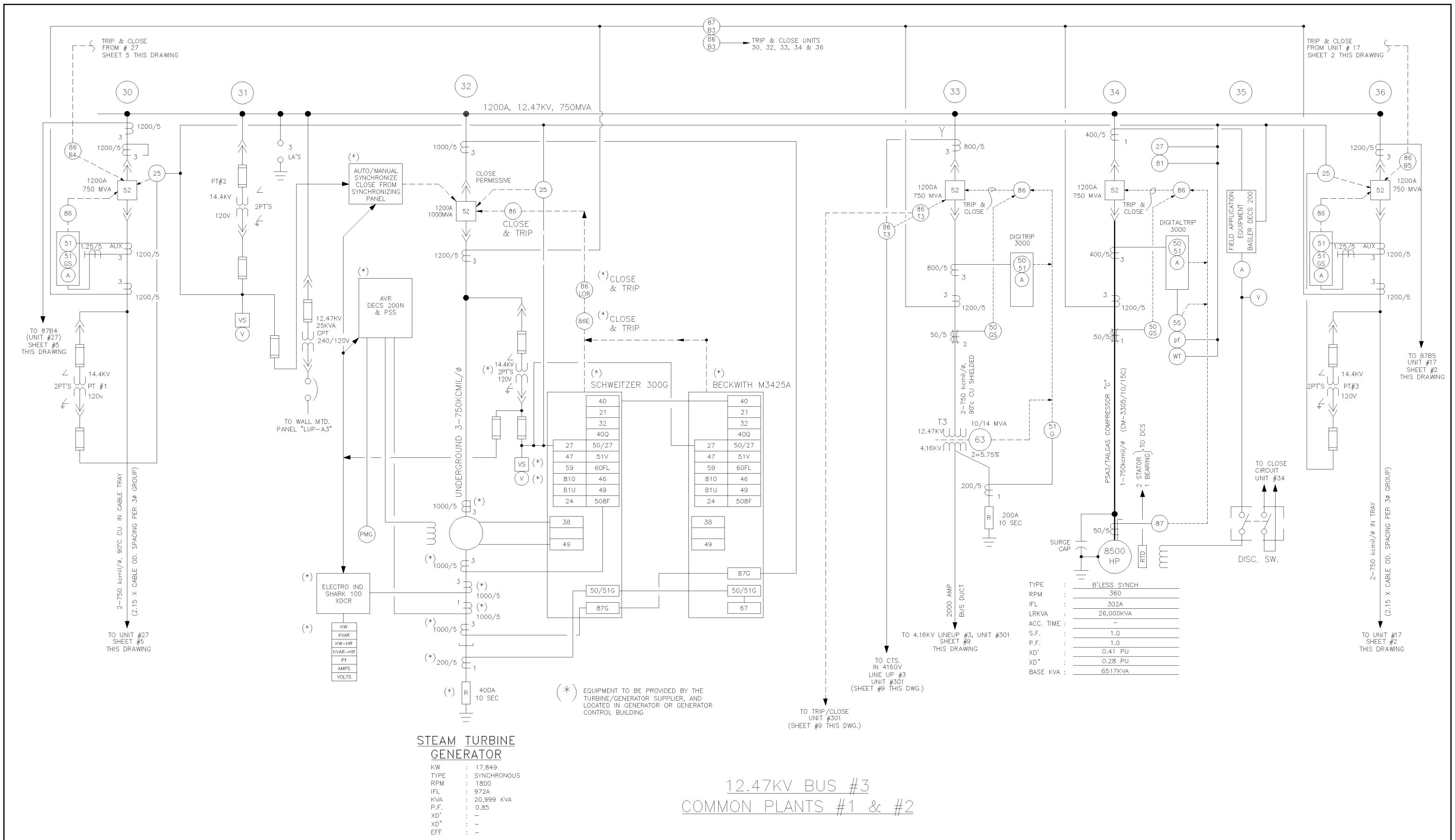
TYPE OF PLANT: 120 MMSCFD H2 PLANT #2

TITLE: ELECTRICAL ONE LINE DIAGRAM
12.47KV SWITCHGEAR
RICHMOND, CA

DRAWN BY	CHECKED	SITE IDENTIFICATION
	RJL	USAXXX
REVIEWED	APPROVED	PROJECT NUMBER
RJL	RJL	12831B
SCALE	DATE	SHEET / TOT. SHTS
NONE	9/11/06	5 / 14
SIZE	DRAWING NUMBER	ALTERATION
D	12831B-595	2

2/1/07

ALTN	ALTERATION	BY	DATE	CHKD	REVD	APVD



PRAXAIR BUSINESS CONFIDENTIAL PRAXAIR TECHNOLOGY CENTER – TONAWANDA, NEW YORK	DRAWN BY:	CHECKED: RJL
TYPE OF PLANT: 120MMSCFD H2 PLTS 1& 2	SITE IDENTIFICATION: USAXXX	REVIEWED: RJL
TITLE: ELECTRICAL ONE LINE DIAGRAM 12.47KV SWITCHGEAR #3 RICHMOND, CA	APPROVED: RJL	PROJECT NUMBER: 12831B
MODEL NAME: 12831B-59558	SCALE: NONE	DATE: 10/4/06
SHEET: 8	TOT. SHTS.: 14	SIZE: D
DRAWING NUMBER: 12831B-595	ALTERATION: 2	

ALTRN | ALTERATION | BY | DATE | CHKD | REVD | APVD

2/1/07

ATTACHMENT TSE-69

Chevron

Energy Solutions

Eduardo Alegria
Power Systems Engineer

Chevron Energy Solutions Company
A Division of Chevron U.S.A. Inc.
345 California St, 18th Floor
San Francisco, CA
Tel. 415-733-4612
Fax 415-733-4961

July 24, 2007

Pacific Gas and Electric Company
Attention: Generation Interconnection Services
Mail Code N7L
P.O. Box 770000
San Francisco, CA 94177

Subject: Generating Facility Interconnection Application for Chevron Richmond Refinery Cogen 3000 and Praxair Steam Turbine Generator

Enclosed is the Generating Facility Interconnection Application and other information for the Cogen 3000 and Praxair Steam Turbine Generation Projects at Chevron Richmond Refinery Facilities located at 100 Chevron Way, Richmond, CA 94801. This is a resubmission of the application due to a generator change from a 58MW unit to a 47MW unit; the original application was assigned to David Ore. We have completed and attached the following required documents for your review:

1. **Generating Facility Interconnection Application**
   One copy of the completed interconnection application for the 17.8 MW steam turbine generator and 47 MW cogeneration system.

2. **Engineering Drawings**
   One copy for each of the following drawings:
   - Cogen 3000 Site Plan
   - Richmond Refinery 115kV System Power Plant Replacement Project: The overall single line shows how New Cogen 3000 and New Steam Turbine Generator would be tied to the Chevron Richmond Refinery 115kV transmission system and to the Standard Oil Switching Station (SOSS), the Point of Common Coupling (PCC).
   - D-SK-0001-D: The drawing shows 5 Sub in detail where New Cogen 3000 would be connected to.
   - D-SK-0003R2: This single line diagram shows New Cogen 3000's protective relaying scheme.
   - DWG12081B-595 (1 of 14): This drawing shows the overall connection between the Chevron system and Praxair electrical system.
   - DWG12081B-595 (8 of 14): This single line shows New Steam Turbine Generator's protective relaying scheme.

3. **Relay Settings**
   One copy of the Protective Relay Settings for each generation system:
   - Steam Turbine Generator: Generator Type 1 Relay Settings
   - Cogen 3000: Generator Type 2 Relay Settings

4. **Application Fees**
   A check for $ 800.00 payable to the Pacific Gas and Electric Company for interconnection application fee was already submitted with the original application. Attached is a copy of the check.

Please let us know at your earliest convenience if there is any additional information needed. We look forward to working with you on this project.

Sincerely,

Eduardo A. Alegria

Eduardo Alegria
Power Systems Engineer
EAAE@chevron.com

Attachments

cc: Paul Millner, Business Development Manager, Chevron Products Company
John MacDonald, Project Manager, Chevron Project Resources Company
Gary Carr, Sr. Power Systems Engineer, Chevron Products Company

Part 1 – Introduction and Overview

A. **Applicability:** This Generating Facility Interconnection Application (Application) is used to request the interconnection of a Generating Facility to Pacific Gas and Electric Company's (PG&E) Distribution System (over which the California Public Utilities Commission (CPUC) has jurisdiction). Refer to PG&E's Rule 21 to determine the specific requirements for interconnecting a Generating Facility. Capitalized terms used in this Application, and not otherwise defined herein, shall have the same meanings as defined in PG&E's Rule 21 and Rule 1.

Except as noted in the next paragraph, this Application may be used for any Generating Facility to be operated by, or for, a Customer and/or Producer to supplement or serve part or all of its electric energy requirements that would otherwise be provided by PG&E, including "distributed generation", "cogeneration," emergency, backup, and standby generation, and Net Energy Metered Generating Facilities. A simpler, shorter form is also available from PG&E for Net Energy Metered Generating Facilities with a nameplate rating less than 10kW (Form 79-994). This form is available upon request by telephoning 415-972-5676 or on PG&E's website at http://www.pge.com/gen). While Customers operating Generating Facilities isolated from PG&E's Distribution System are not obligated to enter into an Interconnection Agreement with PG&E, parts of this Application will still need to be completed to satisfy PG&E's notice requirements for operating an isolated Generating Facility as specified in the California Health and Safety Code Section 119085 (b).

This Application may not be used to apply for interconnecting Generating Facilities used to participate in transactions where all, or a portion of, the electrical output of the Generating Facility is scheduled with the California Independent System Operator. Such transactions are subject to the jurisdiction of the Federal Energy Regulatory Commission (FERC) and require a different application available from PG&E.

This Application is not applicable for incentives and/or rebates offered by the Energy Resources Conservation and Development Commission ("CEC") or the CPUC. Please contact those agencies directly or on their respective websites (www.energy.state.ca.us and www.cpuc.ca.gov).

Guidelines and Steps for Interconnection: This Application must be completed and sent to PG&E along with the additional information indicated in Part 1, Section C below to initiate PG&E's interconnection review of the proposed Generating Facility. An Initial Review fee of $800 (payable by check or money order to PG&E must accompany the Applications except those Applications for isolated Generating Facilities and Net Energy Metering Generating Facilities. Supplemental Review and Interconnection Study fees may be required for large capacity and/or more complex Generating Facility Interconnections; see PG&E's Rule 21, Section C.1.b. & c. for more information regarding interconnection of a generator to PG&E's Distribution System. Please refer to the California Energy Commission's website: http://www.energy.ca.gov/distgen/interconnection/guide_book.html.

This document is only an Application. Upon acceptance of the Generating Facilities, PG&E will prepare an Interconnection Agreement for execution by the "Producer," the party that will be responsible for the Generating Facility. PG&E may also require an inspection and testing of the Generating Facility and installation of any related Interconnection Facilities prior to giving the Producer written authorization to operate in parallel. **Unauthorized Parallel Operation may be dangerous and may result in injury to persons and/or may cause damage to equipment and/or property for which a Producer/Customer may be liable!**

Please note, other approvals may need to be acquired, and/or other agreements may need to be formed with PG&E or regulatory agencies, such as the Air Quality Management Districts and local governmental building and planning commissions prior to operating a Generating Facility. PG&E's authorization to operate in parallel does not satisfy the need for an Applicant to acquire such other approvals.

C. **Required Documents:** Four (4) copies of this Application and each of the following documents **are required to be submitted** before this application will be processed. Drawings must conform to accepted engineering standards and must be legible. 11"x17" drawings are preferred.

1. A **Single-line drawing** showing the electrical relationship and descriptions of the significant electrical components such as the primary switchgear, secondary switchboard, protective relays, transformers, generators, circuit breakers, with operating voltages, capacities, and protective functions of the Generating Facility, the Customer's loads, and the interconnection with PG&E's Distribution System. Please show the location of all required net generation electric output meter(s) and the A.C. manual operated disconnect switch on the single line drawing.
2. **Site plans and diagrams** showing the physical relationship of the significant electrical components of the Generating Facility such as generators, transformers, primary switchgear/secondary switchboard, and control panels, the Customer's loads and the interconnection with PG&E's Distribution System. Please show the location of all required net generation electric output meter(s) and the A.C. manual operated disconnect switch on the site plans.
3. If **transformers** are used to interconnect the Generating Facility with PG&E's Distribution System, please provide transformer nameplate information (voltages, capacity, winding arrangements, connections, impedance, et cetera).
4. If a **transfer switch** or scheme is used to interconnect the Generating Facility with PG&E Distribution System, please provide component descriptions, capacity ratings, and a technical description of how the transfer scheme is intended to operate.
5. If **protective relays** are used to control the interconnection, provide protection diagrams or elementary drawings showing relay wiring and connections, proposed relay settings, and a description of how the protection scheme is intended to function.
6. An Initial Review fee check or money order in the amount of $800, if applicable, made out to PG&E referencing the electric account number and "Initial Interconnection Review Fee."

Part 1 Cont'd – Introduction and Overview

D. Mailing Instructions, Assistance: When this application has been completed it may be printed and mailed, along with the required attachments to:

Pacific Gas and Electric Company
Attn: Manager, Generation Interconnection Services
P.O. Box 770000
Mail Code N7L
San Francisco, California, 94177

Alternatively, you may contact PG&E at (415) 972-5676 or e-mail at gen@pge.com

Part 2 – Identifying the Generating Facility's Location and Responsible Parties

Project Name:	*Date Received:*	*Generating Facility ID:*	*Application Expiration Date (Refer to Part 2, Section E)*

(For PG&E Use Only)

A. Customer Electric Account Information (What electric service will the Generating Facility be interconnected for parallel operation with PG&E? For aggregated electric accounts (under NEMBIO, dairy operations only) provide the primary and all associated accounts/meter information)

Name shown on PG&E service account	Electric Account Number	Electric Badge (Meter) Number
CHEVRON	4293406269	3198T9

NOTE: Customer Electric account must match the customer's utility bill account information.

Meter Location Street Address	City	State	Zip
100 CHEVRON WAY	RICHMOND	CA	94801

Customer Electric Account Contact Information (Who is the customer contact for progress updates and/or additional information?)

Contact Person	Company Name
PAUL MILLNER	CHEVRON NORTH AMERICA PRODUCTS

Phone	Fax	E-mail
510-242-2164	510-217-2448	PAULMILLNER@CHEVRON.COM

Mailing Address	City	State	Zip
841 CHEVRON WAY	RICHMOND	CA	94802

B. Project Contact Information (Who is the project manager for this Generating Facility?)

Project Contact Person (Optional)	Company Name
GARY CARR	CHEVRON NORTH AMERICA PRODUCTS

Phone	Fax	E-mail
510-242-9052		GCCH@CHEVRON.COM

Mailing Address	City	State	Zip
841 CHEVRON WAY	RICHMOND	CA	94802

B.1. Will the Generating Facility be owned by a (third) party other than the name appearing on the PG&E service account in A. above (please check)? X Yes _____No

Part 2 Cont'd – Identifying the Generating Facility's Location and Responsible Parties

C.1. Customer - Generating Facility Interconnection Agreement ("GFIA") or Customer Generation Agreement ("CGA") (for 3rd Party Generator on Premises) Information (Please identify the party that will execute the applicable agreement.) This Section is not applicable to Net Energy Metering (NEM) Applicants because PG&E and the Customer, not the 3rd Party if any, must enter into the Net Energy Metering Interconnection Agreement.

CHEVRON NAP	CHEVRON NORTH AMERICA PRODUCTS
Company Name to be entered on GFIA/CGA	Legal Title of Company to be entered on GFIA/CGA
PAUL MILLNER	BUSINESS DEVELOPMENT MANAGER
Person Executing the GFIA/CGA	Title of Person Executing the GFIA/CGA

841 CHEVRON WAY, RICHMOND CA	510-242-2164	PAULMILLNER@CHEVRON.COM
Mailing Address	Phone	E-Mail

C.2. 3rd Party Owner – GFIA Information (Please identify the Party, if known, that will execute the GFIA). This Section is not applicable to Net Energy Metering (NEM) Applicants because PG&E and the Customer, not the 3rd Party if any, must enter into the Net Energy Metering Interconnection Agreement.

CHEVRON NAP	CHEVRON NORTH AMERICA PRODUCTS
Company Name to be entered on GFIA/CGA	Legal Title of Company to be entered on GFIA/CGA
PAUL MILLNER	BUSINESS DEVELOPMENT MANAGER
Person Executing the GFIA	Title of Person Executing GFIA

841 CHEVRON WAY, RICHMOND, CA	510-242-2164	PAULMILLNER@CHEVRON.COM
Mailing Address	Phone	E-Mail

D. Operating Date (What date is this Generating Facility expected to begin operation?)

4TH QUARTER 09 OR 1ST QUARTER 10

E. Expiration Date* (The date the status of this Application is changed to "withdrawn" by PG&E?)

- **The information submitted in this Application will remain active and valid for a period of 12 months from the date the Application was accepted by PG&E as a "completed" Application. If the project has not been interconnected, or that reasonable proof the project is going forward has not been submitted to PG&E by that time, the Application will be considered "withdrawn" and removed from the queue. To the extent that the Initial Review, Supplemental Review, or Detailed Interconnection Study fees have been paid to and the corresponding reviews/study completed by PG&E, Applicant will only be entitled to a return of one-half of the Initial Review fee of $400. All other fees will be forfeited.**

Part 2 Cont'd – Electing Interconnection Cost Responsibilities

F. Estimated Versus Actual Cost Responsibility

Under Rule 21 Applicants can elect estimated or actual costs for (1) detailed interconnection studies, and/or (2) Interconnection Facilities and distribution system modifications. This election must be made at the time of application submission. Under both cost options, an estimate is prepared. If the Applicant elects the actual cost option, there will be a true-up after the completion of the work. If actual costs exceed the original estimated amounts, Applicant will be responsible for costs above the estimated amounts. Conversely, if actual costs are less than the original estimated amounts, PG&E will refund the difference.

Applicants seeking interconnection under PG&E's Net Energy Metering tariffs are not responsible for Initial Review, Supplemental Review and Detailed Interconnection Study fees, nor for distribution system modifications' costs.

Selection of detailed interconnection study cost responsibility* (Non-NEM only):

____ **Estimated Cost**

____ **Actual Cost**

Selection of Interconnection Facilities and distribution system modifications' (if applicable) cost responsibility*:

____ **Estimated Cost**

____ **Actual Cost**

* **Note**: If no selections are made, estimated cost responsibility will apply.

Part 3 - Describing the Generating Facility and Host Customer's Electrical Facilities

A. (MP&I)	Indicate the operating mode of the Generating Facility	operating mode options: X 1 __2 __3 (Choose one)

Instructions and Notes

Choose from the following operating mode options:

1. **Parallel Operation:** The Generating Facility will interconnect and operate "in parallel" with PG&E's Distribution System for more than one (1) second.
2. **Momentary Parallel Operation (MP):** The Generating Facility will interconnect and operate on a "momentary parallel" basis with PG&E's Distribution System for a duration of one (1) second or less through transfer switches or operating schemes specifically designed and engineered for such operation.
3. **Isolated Operation (I):** The Generating Facility will be "isolated" and prevented from becoming interconnected with PG&E's Distribution System through a transfer switch or operating scheme specifically designed and engineered for such operation.

Part 3 – Cont'd - Describing the Generating Facility and Host Customer's Electrical Facilities

If the answer is operating mode option 1, "parallel operation," please supply all of the information requested for the Generating Facility. Be sure to supply adequate information including diagrams and written descriptions regarding the protective relays that will be used to detect faults or abnormal operating conditions on PG&E's Distribution System.

If the answer is operating mode option 2, "momentary parallel operation," only questions A, E and F of this Part 3 and questions A, B, E, F, I, L, M, N, and S of Part 4 need be answered. Be sure, however, to supply adequate information including diagrams and written descriptions regarding the switching device or scheme that will be used to limit the parallel operation period to one second or less. Please also describe the back up or protective device and controls that will trip the Generating Facility should the transfer switch or scheme not complete the transfer in one second or less.

If the answer is operating mode option 3, "Isolated Operation," ," only questions A, E, and F of this Part 3 and questions A, B, F, and S of Part 4 need be answered. Be sure, however, to supply adequate information including diagrams and written descriptions regarding the isolating switching device or scheme that will be used to prevent the Generating Facility from operating in parallel with PG&E's Distribution System.

B. *Parallel Operation Applications Only*	If the Answer to Section A above was operating mode option 1, please indicate the type of agreements that are being requested with this Application. If operating mode option 2 or 3 was selected, please skip to questions E and F. If agreement options 2, 3, 5, 7, 8, 9,or 10 to this Section B are chosen, please provide an estimate of the maximum kW the Generating Facility is expected to export to PG&E's Distribution System. If PG&E determines that the amount of power to be exported is significant in relation to the capacity available on its Distribution System, it may request additional information, including time of delivery or seasonal kW/kWh estimates.	agreement options: __1 X 2 __3 __4 __5 __6 __7 __8 __9 __10 (Choose all that apply) PER EXISTING INTERCONNECTION AGREEMENT AND POWER PURCHASE AGREEMENT Maximum kW

Instructions and Notes

Sample agreements are available from PG&E for review. Choose from the following ten (10) agreement options:

Customer Owned Generating Facility (non-NEM)

1. **A Generating Facility Interconnection Agreement (Form 79-973)** that provides for parallel operation of the Generating Facility, but does not provide for exporting power to PG&E's Distribution System. This non-export agreement, however does allow the occasional and uncompensated export of energy to PG&E's Distribution System for less than 2 seconds in duration.
2. **A "Qualifying Facility" Power Purchase Agreement** that provides for parallel operation of the Generating Facility, and exporting energy to PG&E's Distribution System for sale to PG&E. This option is available only to "Qualifying Facilities" with a total Nameplate Capacity of 100 kW or less. See Question F for the definition of a Qualifying Facility. (This type of agreement has not yet been developed by PG&E or approved by the CPUC. Check with PG&E for availability).
3. **A Generating Facility Interconnection Export Addendum (Form 79-1070)** that provides for parallel operation of the Generating Facility and the occasional, continuous, non-compensated, export of inverter-based technology solar and wind energy, 1 MW or less to PG&E's Distribution System. Continuous export is export greater than 60 seconds in duration. This addendum must be executed in concert with Agreement 1.

Third Party Owned Generating Facility (non-NEM)

4. **A Generating Facility Interconnection Agreement (Form 79-988)** that provides for parallel operation of the 3rd Party owned Generating Facility, but does not provide for exporting energy to PG&E's Distribution System. This non-export agreement, however does allow the occasional and uncompensated export of energy to PG&E's Distribution System for less than 2 seconds in duration.
5. **A "Qualifying Facility" Power Purchase Agreement** that provides for parallel operation of the 3rd Party owned Generating Facility, and exporting energy to PG&E's Distribution System for sale to PG&E. This option is available only to "Qualifying Facilities" with a total Nameplate Capacity of 100 kW or less. See Question F for the definition of a Qualifying Facility. (This type of agreement has not yet been developed by PG&E or approved by the CPUC. Check with PG&E for availability).
6. **A Customer Generation Agreement (Form 79-992)** that defines the relationship between the Customer whose name appears on PG&E's electric service account. This agreement must be executed in addition to agreements 4 and 5. This non-export agreement, however does allow the occasional and uncompensated export of energy to PG&E's Distribution System for less than 2 seconds in duration.

Part 3 Cont'd - Describing the Generating Facility and Host Customer's Electrical Facilities

Net Energy Metering Generating Facility

If you wish to have your Generating Facility participate on one of PG&E's Net Energy Metering tariffs, following your bi-directional meter installation, your meter and disconnect switch must be installed in a safe PG&E accessible location and remain unobstructed by plants, structures, locked gates or pets. Meter and disconnect switch access must be maintained at all times for your safety and PG&E's electrical system safety. Additionally, unencumbered access is required for meter reading, system maintenance, and operations. Any animals owned by the customer, for example pet dogs, should be kept clear from these areas to avoid hindering PG&E service personnel from completing their work.

Are there any meter access issues? Please check all that apply to avoid interconnection delays.

____ Dog, or other animals at Residence

____ Locked Gate

_____Shrubs or Bushes

____ Other (please explain) ________________________________

7. **A Net Energy Metering Agreement: Solar and Wind (Form 79-978),** that provides for parallel operation of the Generating Facility, and exporting energy to PG&E's Distribution System for credit under the terms of PG&E's Net Energy Metering tariffs for solar or wind Generating Facilities of 1MW or less, other than residential or small commercial Generating Facilities of 10 kW or less. This agreement also requires submittal of an expanded net energy metered supplemental application. This option is available only to eligible Generating Facilities as defined in PG&E's Net Energy Metering tariffs.

8. **A Net Energy Metering Agreement: Bio-Gas (Form 79-997),** that provides for parallel operation of the Generating Facility, and exporting energy to PG&E's Distribution System for credit under the terms of PG&E's Net Energy Metering tariffs for qualifying bio-gas digester Generating Facilities. This option is available only to eligible Generating Facilities as defined in PG&E's Net Energy Metering tariffs

9. **A Net Energy Metering Agreement: Fuel Cell (Form 79-1010),** that provides for parallel operation of the Generating Facility, and exporting energy to PG&E's Distribution System for credit under the terms of PG&E's Net Energy Metering tariffs for fuel-cell Generating Facilities. This option is available only to eligible Generating Facilities as defined in PG&E's Net Energy Metering tariffs

10. **Multiple Tariff Generating Facility Agreement (Form 79-1069),** that provides for the parallel operation of a Generating Facility that utilizes generators eligible for service under NEM or other applicable Net Energy Metering tariffs that are electrically connected behind the same Point of Common Coupling with generators not eligible to receive service under the NEM tariff.

11. **Other, please describe:** ________________________________

C. *Parallel Operation Applications Only*	If the answer to Section B above was agreement option 1 or 4, please indicate the protection option that will be used to prevent energy from being exported to PG&E's Distribution System. If protection option 3 to this Section C is selected, please provide the continuous current rating of the host Customer facility's service entrance equipment (service panel rating): If Protection Option 4 to this Section C is selected, please provide the minimum load of the host Customer facility:	Protection Option: __1 __2 __3 __4 (Choose one) __________ Amps __________ kW

Part 3 Cont'd - Describing the Generating Facility and Host Customer's Electrical Facilities

Instructions and Notes

Refer to PG&E's Rule 21, Section I.2., for additional information as to how to answer this question. If the Generating Facility will never export power to PG&E's Distribution System, a simpler, lower cost, protection scheme may be used to control the interface between the Generating Facility and PG&E's Distribution System. Choose from the following four options:

1. A reverse-power protection device will be installed to measure any export of power and trip the Generating Facility or open an intertie breaker to isolate the Generating Facility if limits are exceeded.
2. An under-power protection device will be installed to measure the inflow of power and trip or reduce the output of the Generating Facility if limits are not maintained.
3. The Generating Facility Interconnection Facility equipment has been certified as Non-Islanding and the incidental export of power will be limited by the design of the interconnection. If this option is to be used, the continuous ampere rating of the service entrance equipment (service panel rating) that is used by the host Customer facility must be stated in the space provided above.
4. The Gross Nameplate Rating of the Generating Facility will not exceed 50% of the host Customer facility's minimum electrical load. If this option is to be used, the minimum load of the host Customer facility must be stated in the space provided above.

Note: With the approval of PG&E, a Producer that wishes to retain the option to export power from a Generating Facility to PG&E's Distribution System may use a different protection scheme that provides for the detection of faults and other abnormal operating conditions.

D. *Parallel Operation Applications Only*	What is the maximum 3-phase fault current that will be contributed by the Generating Facility to a 3-phase fault at the Point of Common Coupling (PCC)? (If the Generating Facility is single phase in design, please provide the contribution for a line-to-line fault.)	6000 Amps
	Please indicate the short circuit interrupting rating of the host Customer facility's service panel:	40kA Amps

Instructions and Notes

Refer to PG&E's Rule 21 Sections D.4.a. and I.3.g. for significance and additional information. To determine this value, any transformers and/or significant lengths of interconnecting conductor used between each of the Generators (if there are more than one) that make up the Generating Facility and the PCC must be taken into account. The details, impedance, and arrangement of such transformers and interconnecting conductors should be shown on the single-line diagram that is provided. Consult an electrical engineer or the equipment supplier if assistance is needed in answering this question.

It is expected that most Applicants will want to reserve the flexibility to operate any or all of their Generators in parallel. If the design of the proposed Generating Facility limits the amount of generation that may be interconnected at any time to PG&E's Distribution System, please describe the assumptions used in calculating the maximum fault current contribution value.

E. (MP&I)	Please indicate how this Generating Facility will be operated.	X 1 __2 __3 __4 __5 __6 (Please choose all options that may apply.)

Choose from the following six operation options:

1. **Combined Heat and Power or Cogeneration** – Where the operation of the Generating Facility will produce thermal energy for a process other than generating electricity.
2. **Peak Shaving/Demand Management** – Where the Generating Facility will be operated primarily to reduce electrical demands of the host Customer facility during PG&E's "peak pricing periods".
3. **Primary Power Source** – Where the Generating Facility will be used as the primary source of electric power and power supplied by PG&E to the host Customer's loads will be required for supplemental, standby, or backup power purposes only.
4. **Standby / Emergency / Backup** – Where the Generating Facility will normally be operated only when PG&E's electric service is not available.
5. **Net Energy Metering** – Where the Generating Facility qualifies and receives service under PG&E's Net Energy Metering tariffs. For applicants for the Net Energy Metering of a solar and/or wind generating facility1000kW or less, other than residential or small commercial customers, a supplemental application (Form Number 79-998) is also required.
6. **Multiple Tariff** - Generating Facilities that have a combination of non-Net Energy Metering (non-NEM) generator(s) and a Net Energy Metering (NEM) generator(s). Check one of the following four options on the next sheet.

Pacific Gas and Electric Company

Part 3 Cont'd - Describing the Generating Facility and Host Customer's Electrical Facilities

For **Multiple Tariff** Generating Facilities, check one of the following:

☐ New facility installing non-NEM generator(s) and NEM generator(s) at the same time.

☐ Existing facility with non-NEM generator(s) and planning to add NEM generator(s). Please provide data for the table below.

☐ Existing facility with NEM generator(s) and planning to add non-NEM generator(s). Please provide data for the table below.

☐ Existing facility with NEM generator(s) and planning to add NEM generator(s) under a different NEM tariff. Please provide data for the table below.

Instructions (From Part 4)	Generator Information	Existing Generator Type	Existing Generator Type	New Generator Type	New Generator Type	Generating Facility Totals
#	Please indicate the number of each "type" of Generator being installed:	1	1	1	1	
A	Gen/Inverter Manufacturer	ABB	ABB	GENERAL ELECTRIC	BRUSH	
B	Generator/Inverter Model	GT8	GT8	EN217747 STEAM TURBINE GENERATOR	FRAME 6B BDAX7-290ERH	
C	Gen/Inverter software Version	N/A	N/A	N/A	N/A	
D	Is the Gen/Inverter certified	___ Yes X No	___ Yes X No	___ Yes X No	___ Yes X No	
E	Generator design	X Synch ___ Induct. ___ Inverter	X Synch ___ Induct. ___ Inverter	X Synch ___ Induct. ___ Inverter	X Synch ___ Induct. ___ Inverter	
F	Gross Nameplate Rating	78,300	78,300	21,000	55,294	232,894
I	Operating Voltage	13.8kV	13.8kV	12.47kV	13.8kV	
J	Power Factor rating	80%	80%	85%	85%	
K	PF Adjustment Range	MIN 80% LAG MAX 95% LEAD	MIN 80% LAG MAX 95% LEAD	MIN 80% LAG MAX 95% LEAD	MIN 80% LAG MAX 95% LEAD	
L	Wiring Configuration	THREE PHASE	THREE PHASE	THREE PHASE	THREE PHASE	

Part 3 Cont'd - Describing the Generating Facility and Host Customer's Electrical Facilities

Instructions From Part 4	Generator Information	Existing Generator Type	Existing Generator Type	New Generator Type	New Generator Type
M (Momentary Parallel)	3-Phase Winding Configuration (Choose One)	__3 Wire Delta X 3 Wire Wye __4 Wire Wye	__3 Wire Delta X 3 Wire Wye __4 Wire Wye	__3 Wire Delta X 3 Wire Wye __4 Wire Wye	__3 Wire Delta X 3 Wire Wye __4 Wire Wye
N (Momentary Parallel)	Neutral Grounding System Used (Choose One)	__ Ungrounded __ Solidly Grounded X Ground Resistor 0.44 Ohms	__ Ungrounded __ Solidly Grounded X Ground Resistor 0.44 Ohms	__ Ungrounded __ Solidly Grounded X Ground Resistor 18 Ohms	__ Ungrounded __ Solidly Grounded X Ground Resistor 0.4 Ohms
O	*For Synchronous Generators Only:* Synchronous Reactance: Transient Reactance: Subtransient Reactance:	248 (Xd %) 19.6 (X'd %) 12.6 (X"d %)	248 (Xd %) 19.6 (X'd %) 12.6 (X"d %)	197 (Xd %) 33 (X'd %) 23 (X"d %)	183 (Xd %) 15.6 (X'd %) 11.0 (X"d %)
P	*For Induction Generators Only:* Locked Rotor Current: *OR* Stator Resistance: Stator Leakage Reactance: Rotor Resistance: Rotor Leakage Reactance:	N/A (Amps) ____(%) ____(%) ____(%) ____(%)	N/A (Amps) ____(%) ____(%) ____(%) ____(%)	N/A (Amps) ____(%) ____(%) ____(%) ____(%)	N/A (Amps) ____(%) ____(%) ____(%) ____(%)
Q	Short Circuit Current Produced by Generator:	26,000 (Amps)	26,000 (Amps)	4,227 (Amps)	21,030 (Amps)
R	*For Generators that are Started as a "Motor" Only* 1. In-Rush Current: 2. Host Customer's Service Entrance Panel (Main Panel) Continuous Current Rating:	N/A (Amps) N/A (Amps)	N/A (Amps) N/A (Amps)	N/A (Amps) N/A (Amps))	N/A (Amps) N/A (Amps))
S (Momentary Parallel & Isolated)	Prime Mover Type: (Circle One)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Part 3 Cont'd - Describing the Generating Facility and Host Customer's Electrical Facilities

F. (MP&I)	Please indicate if Qualifying Facility Status will be obtained from the FERC for this Generating Facility.	__Yes __No

Instructions and Notes

Parties operating Generating Facilities complying with all of the requirements for qualification as either a small power production facility or cogeneration facility pursuant to the regulations of the FERC (18 Code of Federal Regulations Part 292, Section 292.203 et seq.) implementing the Public Utility Regulatory Policies Act of 1978 (16 U.S.C.A. Section 796, et seq.), or any successor requirements for "Qualifying Facilities," may seek certification from FERC to have the Generating Facility designated as a Qualifying Facility or "QF." In summary, QF's are Generating Facilities using renewable or alternative fuels as a primary energy source or facilities that utilize the thermal energy given off by the generation process for some other useful purpose. QF's enjoy certain rights and privileges not available to non-QF Generating Facilities.

QF status is not required to interconnect and operate in parallel with PG&E's Distribution System.

G.	Please indicate if Generating Facility will meet the annual Efficiency and Operating Standards of PUC Code 218.5(Applicable to Cogeneration Only)	X Yes __No __N/A

Part 4 – Instructions for Describing the Generators

These instructions will assist the Applicant in completing the Part 3's Generator Information.

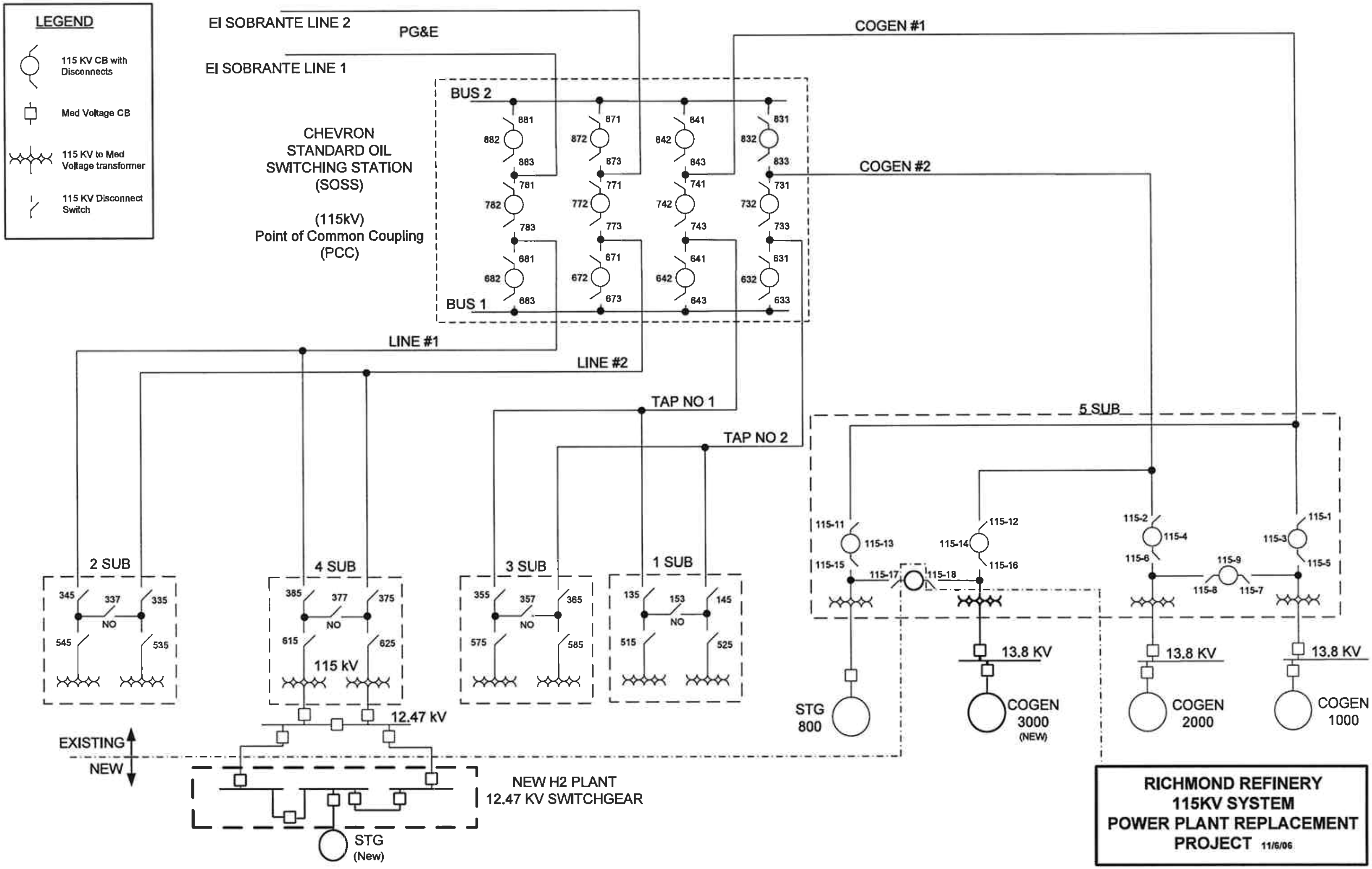
	Generator Information	Instructions and Comments
#	Please indicate the number of each "type" of Generator being installed:	Please provide the following information for each Generator "type". Be sure all Generators classified as one "type" are identical in all respects. If only one type of Generator is to be used, only one column needs to be completed. Please be sure the information in the "Totals" column is correct and reflects the total number of Generator units to be installed.
A	Generator/Inverter Manufacturer	Enter the brand name of the Generator.
B	Generator/Inverter Model	Enter the model name or number assigned by the manufacturer of the Generator.
C	Generator/Inverter Software Version	If this Generator's control and or protective functions are dependent on a "software" program supplied by the manufacturer of the equipment, please provide the version or release number for the software that will be used.
D	Is the Generator Certified by a Nationally Recognized Testing Laboratory (NRTL) according to Rule 21?	Answer "Yes" only if the Generator manufacturer can or has provided certification data. See PG&E's Rule 21, Section J for additional information regarding Generator certification.

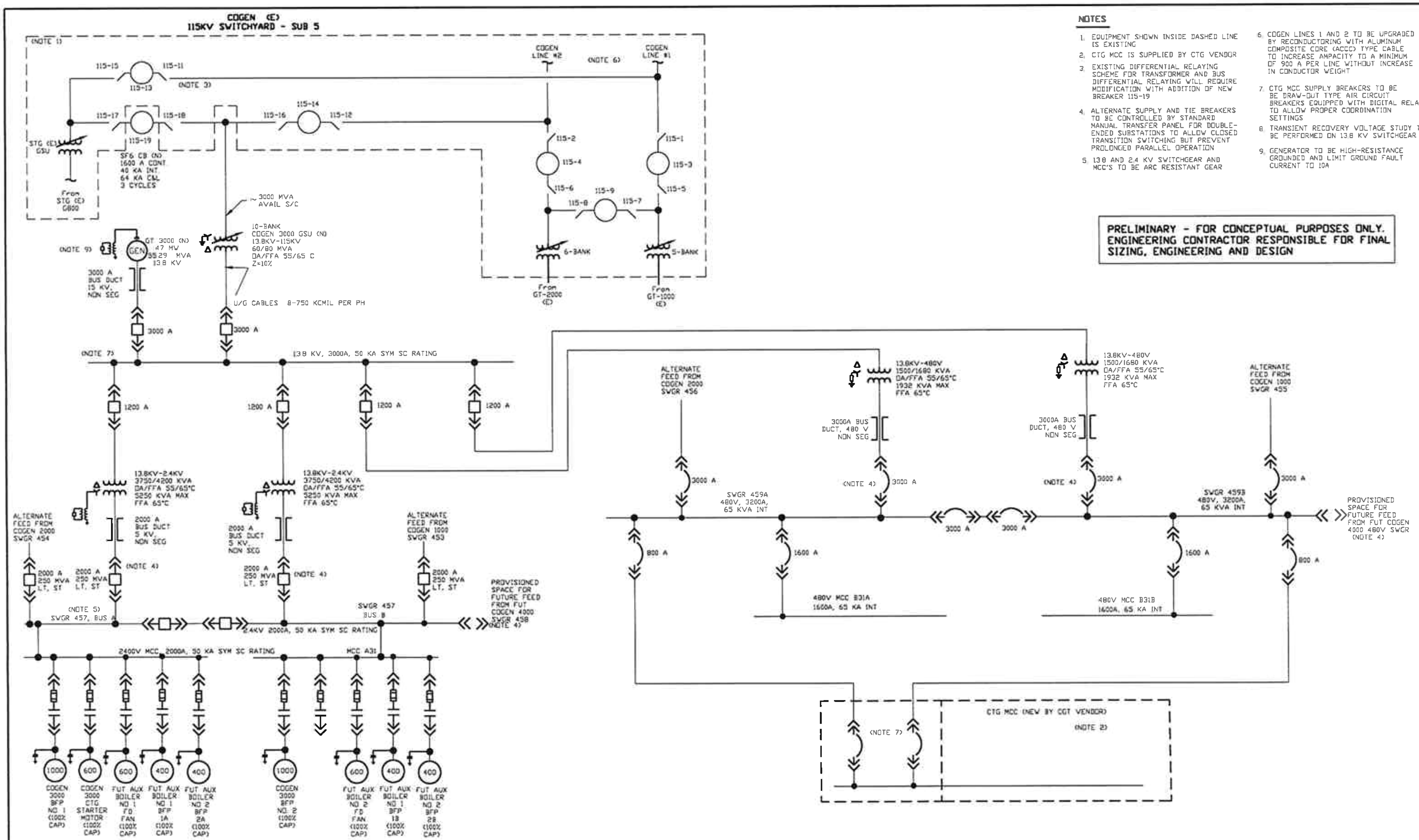
Part 4 – Instructions for Describing the Generators

	Generator Information	Instructions and Comments
E	Generator Design	Please indicate the design of each Generator. Designate "Inverter" anytime an inverter is used as the interface between the Generator and the electric system regardless of the primary power production/storage device used.
F	Gross Nameplate Rating (kVA)	This is the capacity value normally supplied by the manufacturer and stamped on the Generator's "nameplate". This value is not required where the manufacturer provides only a "kW" rating. However, where both kVA and kW values are available, please indicate both.
G	Gross Nameplate Rating (kW)	This is the capacity value normally supplied by the manufacturer and stamped on the Generator's "nameplate". This value is not required where the manufacturer provides only a "kVA" rating. However, where both kVA and kW values are available, please indicate both.
H	Net Nameplate Rating (kW)	This capacity value is determined by subtracting the "auxiliary" or "station service" loads used to operate the Generator or Generating Facility. Applicants are not required to supply this value but, if it is not supplied, applicable standby charges may be based on the higher "gross" values.
I	Operating Voltage	This value should be the voltage rating designated by the manufacturer and used in this Generating Facility. Please indicate phase-to-phase voltages for 3-phase installations. See PG&E's Rule 21, Section D.2.b. for additional information.
J	Power Factor Rating	This value should be the nominal power factor rating designated by the manufacturer for the Generator. See PG&E's Rule 21, Section D.2.i. for additional information.
K	PF Adjustment Range	Where the power factor of the Generator is adjustable, please indicate the maximum and minimum operating values. See PG&E's Rule 21, Section D.2.i.
L	Wiring Configuration	Please indicate whether the Generator is a single-phase or three-phase device. See PG&E's Rule 21, Section D.3.
M	3-Phase Winding Configuration	For three-phase generating units, please indicate the configuration of the Generator's windings or inverter systems.
N	Neutral Grounding	Wye connected generating units are often grounded – either through a resistor or directly, depending upon the nature of the electrical system to which the Generator is connected. If the grounding method used at this facility is not listed, please attach additional descriptive information.

Part 4 – Instructions for Describing the Generators

	Generator Information	Instructions and Comments
O	*For Synchronous Generators Only:*	If the Generator is of a "synchronous" design, please provide the synchronous reactance, transient reactance, and subtransient reactance values supplied by the manufacturer. This information is necessary to determine the short circuit contribution of the Generator and as data in load flow and short circuit computer models of PG&E's Distribution System. If the Generator's Gross Nameplate Capacity is 10 MW or greater, PG&E may request additional data to better model the nature and behavior of the Generator with relation to its Distribution System.
P	*For Induction Generators Only:*	If the Generator is of an "induction" design, please provide the "locked rotor current" value supplied by the manufacturer. If this value is not available, the stator resistance, stator leakage reactance, rotor resistance, rotor leakage reactance values supplied by the manufacturer may be used to determine the locked rotor current. If the Generator's Gross Nameplate Capacity is 10 MW or greater, PG&E may request additional data to better model the nature and behavior of the Generator with relation to its Distribution System.
Q	Short Circuit Current Produced by Generator	Please indicate the current each Generator can supply to a three-phase fault across its output terminals. For single phase Generators, please supply the phase-to-phase fault current.
R	*For Generators that are Started as a "Motor" Only:* 1. In-Rush Current 2. Host Customer's Service Entrance Panel (Main Panel) Continuous Current Rating	This information is needed only for Generators that are started by "motoring" the generator. See PG&E's Rule 21, Section I.3.e. for significance and additional information. If this question was answered in Part 3, question C of this Application, it need not be answered here.
S	Prime Mover Type	Please indicate the type and fuel used as the "prime mover" or source of energy for the Generator. 1 = Internal Combustion Engine – Natural Gas 2 = Internal Combustion Engine – Diesel Fueled 3 = Internal Combustion Engine - Other Fuel 4 = Microturbine– Natural Gas 5 = Microturbine – Other Fuel 6 = Combustion Turbine Natural Gas 7 = Combustion Turbine - Other Fuel 8 = Steam Turbine 9 = Photovoltaic Panels 10 = Solar-thermal engine 11 = Fuel Cell– Natural Gas 12 = Fuel Cell– Other Fuel 13 = Hydroelectric Turbine 14 = Wind Turbine 15 = Other (please describe)


LEGEND
115 KV CB with Disconnects
Med Voltage CB
115 KV to Med Voltage transformer
115 KV Disconnect Switch
El SOBRANTE LINE 2
PG&E
El SOBRANTE LINE 1
CHEVRON STANDARD OIL SWITCHING STATION (SOSS)
(115kV) Point of Common Coupling (PCC)
BUS 2
BUS 1
881 882 883 871 872 873 841 842 843 831 832 833
781 782 783 771 772 773 741 742 743 731 732 733
681 682 683 671 672 673 641 642 643 631 632 633
COGEN #1
COGEN #2
LINE #1
LINE #2
TAP NO 1
TAP NO 2
2 SUB
345 337 335 NO 545 535
4 SUB
385 377 375 NO 615 625
115 kV
12.47 kV
3 SUB
355 357 365 NO 575 585
1 SUB
135 153 145 NO 515 525
5 SUB
115-11 115-13 115-15
115-12 115-14 115-16
115-17 115-18
115-2 115-4 115-6
115-9 115-8 115-7
115-1 115-3 115-5
13.8 KV
STG 800
COGEN 3000 (NEW)
COGEN 2000
COGEN 1000
EXISTING
NEW
NEW H2 PLANT 12.47 KV SWITCHGEAR
STG (New)
RICHMOND REFINERY 115KV SYSTEM POWER PLANT REPLACEMENT PROJECT 11/6/06



NOTES

1. EQUIPMENT SHOWN INSIDE DASHED LINE IS EXISTING
2. CTG MCC IS SUPPLIED BY CTG VENDOR
3. EXISTING DIFFERENTIAL RELAYING SCHEME FOR TRANSFORMER AND BUS DIFFERENTIAL RELAYING WILL REQUIRE MODIFICATION WITH ADDITION OF NEW BREAKER 115-19
4. ALTERNATE SUPPLY AND TIE BREAKERS TO BE CONTROLLED BY STANDARD MANUAL TRANSFER PANEL FOR DOUBLE-ENDED SUBSTATIONS TO ALLOW CLOSED TRANSITION SWITCHING BUT PREVENT PROLONGED PARALLEL OPERATION
5. 13.8 AND 2.4 KV SWITCHGEAR AND MCC'S TO BE ARC RESISTANT GEAR
6. COGEN LINES 1 AND 2 TO BE UPGRADED BY RECONDUCTORING WITH ALUMINUM COMPOSITE CORE (ACCC) TYPE CABLE TO INCREASE AMPACITY TO A MINIMUM OF 900 A PER LINE WITHOUT INCREASE IN CONDUCTOR WEIGHT
7. CTG MCC SUPPLY BREAKERS TO BE BE DRAW-OUT TYPE AIR CIRCUIT BREAKERS EQUIPPED WITH DIGITAL RELAYS TO ALLOW PROPER COORDINATION SETTINGS
8. TRANSIENT RECOVERY VOLTAGE STUDY TO BE PERFORMED ON 13.8 KV SWITCHGEAR
9. GENERATOR TO BE HIGH-RESISTANCE GROUNDED AND LIMIT GROUND FAULT CURRENT TO 10A

PRELIMINARY - FOR CONCEPTUAL PURPOSES ONLY. ENGINEERING CONTRACTOR RESPONSIBLE FOR FINAL SIZING, ENGINEERING AND DESIGN

THIS IS AN AUTOCAD DRAWING. DO NOT REVISE MANUALLY.

REFERENCE DRAWINGS

REVISIONS

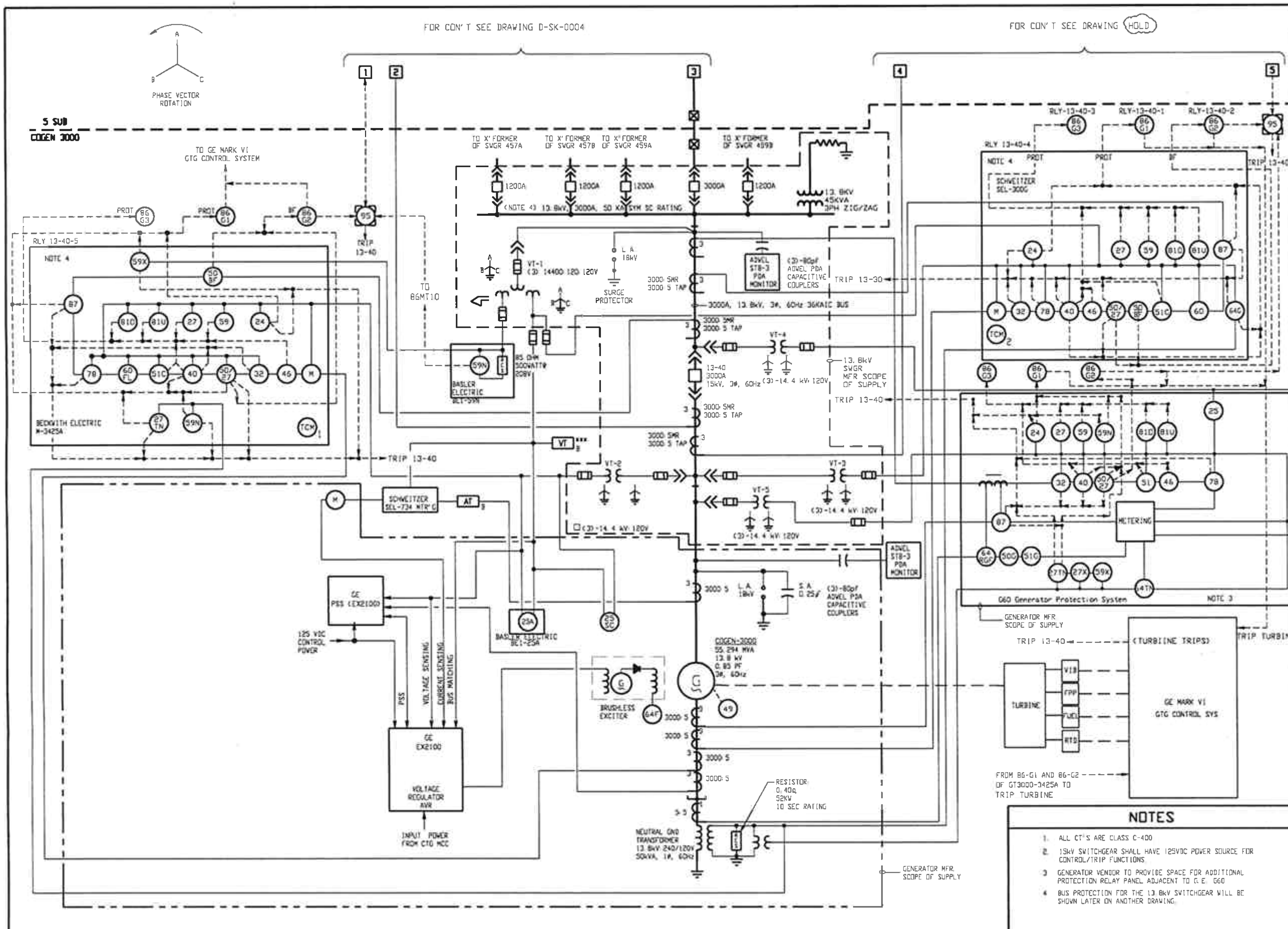
C	REVISED PER COMMENTS & CHANGED TO SPLIT BUSSES FOR DOUBLE-ENDED FEED	GCCH	03-13-07 GCCH
D	REVISED PER COMMENTS & CHANGED TO SHOW CTG LOADS FOR FRAME 6B AND TO PROVIDE ALTERNATE FEEDS	GCCH	05-31-07 GCCH
B	REVISED FOR ESTIMATION PER COMMENTS	GHGI	07-19-06 GCCH
A	FOR ESTIMATION	GHGI	06-26-06 GCCH

Chevron
Richmond Refinery

SCALE NONE DR. GHGI DR. APP. DATE
ENGR. GCCH ENGR. DEPT.
OPR'G. DEPT.
APPROVED

ONE LINE DIAGRAM - CONCEPTUAL
EUIPMENT
COGEN PLANT TRAIN 3000
UTILITIES & ENVIRONMENTAL ABU

P W.O. S.O. D-SK-0001-D



LEGEND

24	VOLTS PER Hz RELAY
25 SC	SYNCHRONIZING/SYNCHRONISM-CHECK RELAY
25A	AUTOMATIC SYNCHRONIZER
26 Q	TRANSFORMER OIL TEMPERATURE
27	UNDERVOLTAGE RELAY
27TN	THIRD HARMONIC NEUTRAL UNDERVOLTAGE RELAY
32	DIRECTIONAL POWER RELAY
40	FIELD LOSS RELAY
46	PHASE CURRENT IMBALANCE
49	THERMAL RELAY
50	INSTANTANEOUS OVERCURRENT RELAY
50/27	INADVERTENT ENERGIZATION
50BF	BREAKER FAILURE RELAY
50N DT	RESIDUAL DEFINITE TIME OVERCURRENT
50 51	INSTANTANEOUS AND TIME OVERCURRENT RELAY
51C	VOLTAGE CONTROLLED TIME OVERCURRENT RELAY
59	OVERVOLTAGE RELAY
59N	NEUTRAL OVERVOLTAGE
59X	AUXILIARY OVERVOLTAGE (13.8KV BUS GROUND)
60FL	VT FUSE LOSS RELAY
63 PR	PRESSURE RELIEF
63 RP	RAPID PRESSURE RISE RELAY
64F	GENERATOR FIELD GROUND
64G	GENERATOR STATOR GROUND
67G	RESTRICTED EARTH FAULT
78	OUT OF STEP RELAY
81O	OVER-FREQUENCY RELAY
81U	UNDER FREQUENCY RELAY
87	PHASE DIFFERENTIAL CURRENT RELAY
95	BIDIRECTIONAL FIBER OPTIC TRIPPING RELAY
M	METERING
PMG	PERMANENT MAGNET GENERATOR
TCM	TRIP COIL MONITOR
64 RGF	RESTRICTED GROUND FAULT
50G	GROUND INSTANTANEOUS OVERCURRENT
51G	GROUND TIME OVERCURRENT
LTC	LOAD TAP CHANGER
AT	CURRENT TRANSDUCER
VT	VOLTAGE TRANSDUCER

NOTES

1. ALL CT'S ARE CLASS C-400
2. 15kV SWITCHGEAR SHALL HAVE 125VDC POWER SOURCE FOR CONTROL/TRIP FUNCTIONS
3. GENERATOR VENDOR TO PROVIDE SPACE FOR ADDITIONAL PROTECTION RELAY PANEL ADJACENT TO G.E. G60
4. BUS PROTECTION FOR THE 13.8kV SWITCHGEAR WILL BE SHOWN LATER ON ANOTHER DRAWING.

THIS IS AN AUTOCAD DRAWING. DO NOT REVISE MANUALLY.

REFERENCE DRAWINGS

REVISIONS

B	ADDED MFGR & MODEL OF AUTO SYNCH RELAY.	07-26-07	CDC	CDC
A	ISSUED FOR INTECONNECTION APPL	06-18-07	JVP	JVP

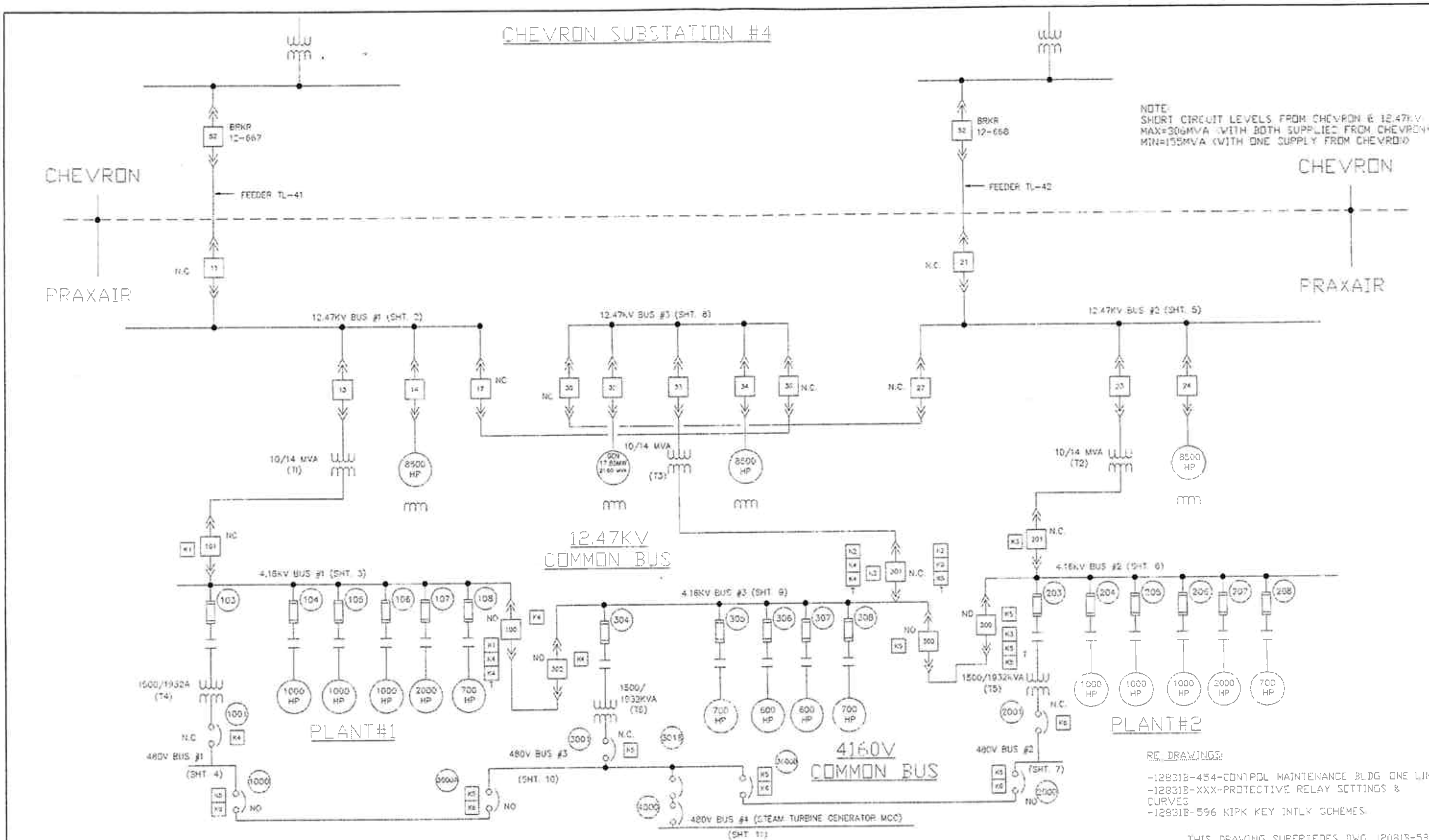
Chevron
Richmond Refinery

SCALE NONE DR. JVP DR. APP. DATE
CHKR. MS CHKR. DEPT.
ORIG. DEPT.

APPROVED

ELECTRICAL ONE LINE DIAGRAM
COGEN 3000 - 115kV 10-BK & 13.8kV
COGENERATION PLANT
UTILITIES AND ENVIRONMENTAL AREA BUSINESS UNIT

P W.O. ___ S.O. ___ D-SK-0003R2



NOTE:
SHORT CIRCUIT LEVELS FROM CHEVRON @ 12.47KV
MAX=306MVA (WITH BOTH SUPPLIED FROM CHEVRON)
MIN=155MVA (WITH ONE SUPPLY FROM CHEVRON)

RE DRAWINGS:

- 12831B-454-CONTROL MAINTENANCE BLDG ONE LINE
- 12831B-XXX-PROTECTIVE RELAY SETTINGS & CURVES
- 12831B-596 KIRK KEY INTLK SCHEMES

THIS DRAWING SUPERSEDES DWG 12083B-595

Rev	Description			
2	REVISED 4160V LOAD UNITS 104, 105, 108, 204, 205, 206, 306, 307 & 308; REVISED 480V LOADS; ADDED FUSE DATA @ 4160V; REVISED KEYINTLKS			
1	REVISED 12.47KV BUS #3 - UNITS 27-30 & UNITS #37-38; REVISED GENERATOR RATING; RESIZED 12.47KV INCOMING & TIE CABLES; RESIZED 4.16KV TIE CABLES; ADDED THIRD COOLING WATER PUMP ON 4.16KV LINEUP #3; ADDED GENERATOR AC & DC AUXILIARIES; SHEET #11 UPDATED PSA/TAIL GAS COMPR & AUXILIARY LOADS	pwh	1/29/07	RJL RJL

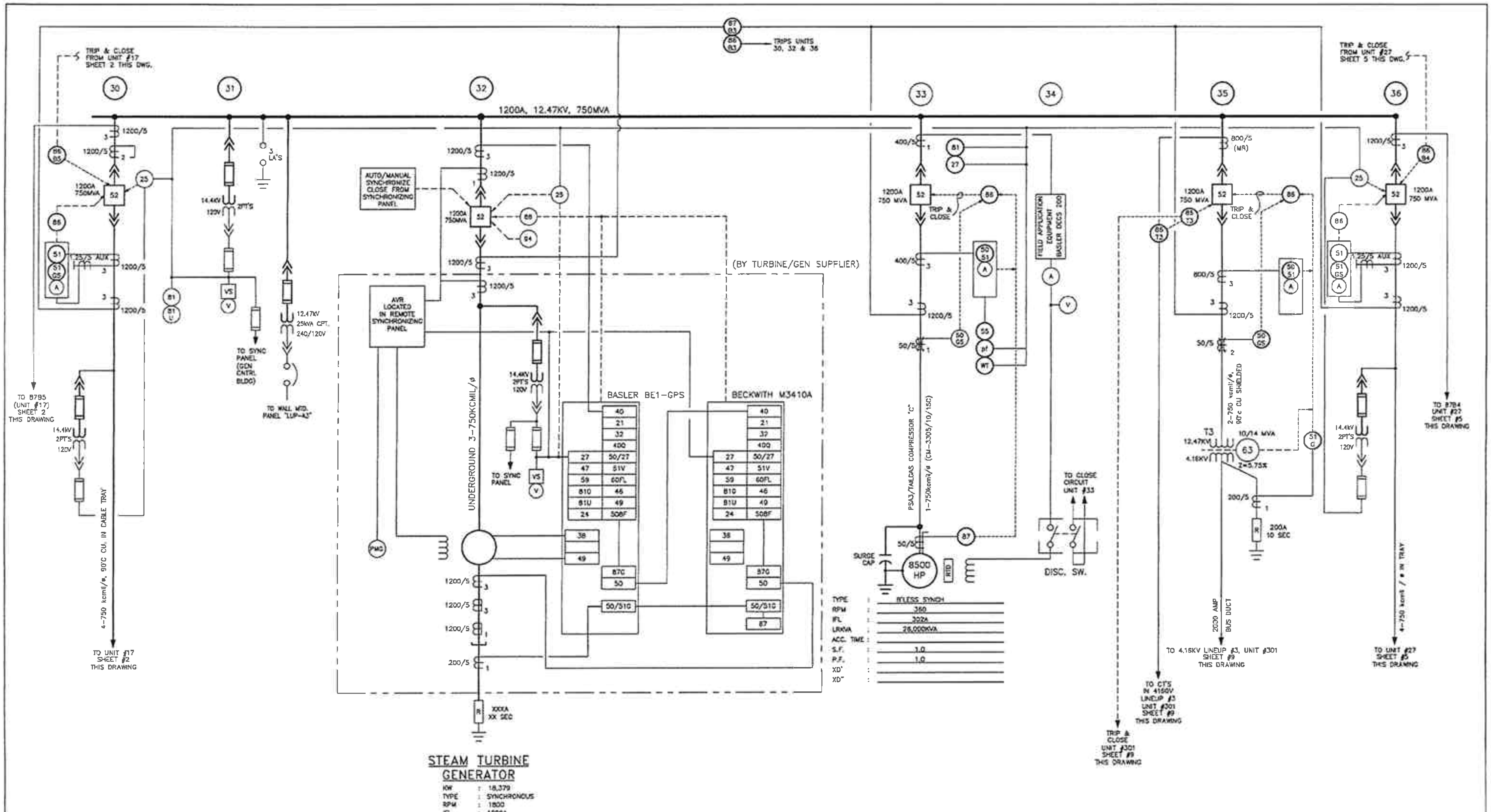
2/1/07

PRAXAIR BUSINESS CONFIDENTIAL
PRAXAIR TECHNOLOGY CENTER • TONAWANDA, NEW YORK

120MMSCFD H2 PLANTS 1 & 2

ELECTRICAL ONE LINE DIAGRAM
COMPOSITE ONE LINE
RICHMOND, CA

RJL	RJL	USAXXX
RJL	RJL	12831B
NONE	9/7/06	1 / 14
D	12831B-595	2



12.47KV BUS #3
COMMON PLANTS #1 & #2

9/22/06

PRAXAIR BUSINESS CONFIDENTIAL
PRAXAIR TECHNOLOGY CENTER - TONAWANDA, NEW YORK

120MMSCFD H2 PLTS #1 & #2

ELECTRICAL ONE LINE DIAGRAM
12.47KV SWITCHGEAR #3
RICHMOND, CA.

pwh	RJL	USAXXX
RJL	RJL	12831B
NONE	9/13/06	8 14
D	12831B-595	0

Steam Turbine Generator : Generator Type 1 Relay Settings

Voltage Trip Setting

Relay Function	IEEE Device No.	Point of Common Coupling	Maximum Trip Time
Undervoltage Relay	27	< 57.5 V with 115 V base	0.16 second
		> 57.5 V but </= 92V	3.0 second
Overvoltage Relay	59	> 138 V but </= 159V	4.0 second
		>159 V	1.0 second
	59N	< 11.1 V	5 second

Frequency Trip Setting

Relay Function	IEEE Device No.	Generating Facility Rating	Frequency Range with 60Hz Normal	Maximum Trip Time
Frequency Relay	81	17.85MW	< 58 Hz	5 second
			> 62 Hz	

Synchronization

Relay Function	IEEE Device #	Generating Facility Rating	Frequency Range with 60 Hz Normal	Voltage Range	Phase Angle Difference
Synchronizing or Synchronism check	25	17.85 MW	< 59.8 Hz > 60.2 Hz	> 103.5 V < 126.5 V	< 10 Degrees

Richmond Refinery:Praxair

Date:05/04/07

Cogen 3000 : Generator Type 2 Relay Settings

Voltage Trip Setting

Relay Function	IEEE Device No.	Point of Common Coupling	Maximum Trip Time
Undervoltage Relay	27	< 57.5 V with 115 V base	0.16 second
		> 57.5 V but </= 92V	3.0 second
Overvoltage Relay	59	> 138 V but </= 159V	4.0 second
		>159 V	1.0 second
	59N	< 11.1 V	5 second

Frequency Trip Setting

Relay Function	IEEE Device No.	Generating Facility Rating	Frequency Range with 60Hz Normal	Maximum Trip Time
Frequency Relay	81	60.5MW	< 58 Hz	5 second
			> 62 Hz	

Synchronization

Relay Function	IEEE Device #	Generating Facility Rating	Frequency Range with 60 Hz Normal	Voltage Range	Phase Angle Difference
Synchronizing or Synchronism check	25	60.5 MW	< 59.8 Hz > 60.2 Hz	> 103.5 V < 126.5 V	< 10 Degrees

Chevron Energy Solutions L.P.
P.O. Box 9034
Concord CA 94524

CHECK DATE: 05/04/2007
CHECK NO: 0024861457
PAYEE REF: 0010132251
COMPANY NO: 0825
MAIL CODE: 11EC0

Chevron

PACIFIC GAS & ELECTRIC COMPANY
ATTN GENERATION INTERCONNECTION
SERVICES
MAIL CODE N7L
PO BOX 770000
SAN FRANCISCO, CA 94177

ADDRESS INQUIRIES TO: P.O. Box 9034, Concord, CA 94524-1934
PHONE CONTACT: 925-827-7741 FAX CONTACT: 925-680-3534

INVOICE DATE	INVOICE #.	OUR REFERENCE #.	GROSS AMT.	DISC. AMT.	NET AMT.
05/03/2007	070503PAC	0019003223	$800.00		$800.00
RICHMOND REFINERY COGEN INTERCONNECTION FEE					

DETACH AND RETAIN THIS STUB FOR YOUR RECORDS

CHECK # 0024861457 ATTACHED BELOW

Chevron

Chevron Energy Solutions L.P.
P.O. Box 9034
Concord CA 94524

62-20
311

NO. 0024861457

05/04/2007

PAY TO
ORDER OF

PACIFIC GAS & ELECTRIC COMPANY
ATTN GENERATION INTERCONNECTION
SERVICES
MAIL CODE N7L
PO BOX 770000
SAN FRANCISCO, CA 94177

*******$800.00
NOT VALID AFTER 1 YEAR

Eight hundred and 00/100 Dollars

Chevron
AUTHORIZED SIGNATURE

CITIBANK DELAWARE, ONE PENN'S WAY, NEW CASTLE, DE 19720

⑈0024861457⑈ ⑆031100209⑆ 38596461⑈

Technical Area: Visual Resources
Author: James Adams

BACKGROUND

There is a brief discussion of steam plumes that would be generated by the project in the visual resources section of the SPPE application. New plumes would be created by the cooling tower associated with the condensing steam turbine generator and the combustion turbine generator. However, there is no discussion of the size and frequency of the plumes or the meteorological conditions conducive to their formation. Likewise, there is no discussion of the cumulative visual impact of project plumes in combination with existing plumes at the Chevron refinery, and new visible plumes that would be created by facilities related to the Chevron Energy and Hydrogen Renewal Project.

DATA REQUESTS

70. Please provide a discussion of the size and frequency of project-related plumes, and the meteorological conditions needed for plume formation. If a model is used to predict plumes, please provide the input and output data, and the name of the model.

    Response: The Chevron Richmond Refinery is an intensively developed industrial site with dozens of potential points of steam plume release. Existing plumes are most prominent when ambient temperatures are low (<50F) and relative humidity is above average conditions. These conditions exist during the winter and early morning/late night hours. While the conditions favorable for maximum visible steam plume formation are more limited, some visible steam is nearly always present at the refinery. The size of these existing plumes can range from tens to hundreds of feet in length and a few feet to over a hundred feet in width. Chevron expects the plumes from the PPRP to fall within this range.

    While detailed modeling of the PPRP plumes should not be necessary to reach a conclusion that the new plumes would cause an insignificant impact, the results of a SACTI modeling run for the cooling tower will be submitted by mid-September 2007. The modeling is based on the data provided in data response 73a & b.

71. Please provide a discussion of the cumulative visual impact of project plumes in combination with existing plumes at the Chevron refinery, and plumes that would be generated by the Chevron renewal project.

    Response: Since views of the existing refinery are not considered scenic and the viewsheds are dominated by the appearance of this intensively developed industrial site, which is dotted with a multitude of existing steam plumes, the addition of a new steam plume to the existing viewshed is insignificant. Steam plumes are a common feature of the Chevron refinery and the appearance of an additional steam plume would be harmonious with the existing environment and would not cause significant cumulative impacts to visual resources.

72. a. Please provide a high-quality 11" by 17" color photo-simulation, at life-size scale, of plumes that would be generated during a cold, clear winter day (no rain/no fog).

Response: Figures VIS-72A through VIS-72E have been provided. These attachments are several 11 x 17 views that were previously included in the SPPE application in a smaller format. One additional view, Figure VIS-72E depicts a view of the refinery from Wildcat Creek to the east. This photograph and the others attached to this data response were taken on December 19, 2006 between 12:00 noon and 4:00 PM. Ambient temperature during this period ranged from 46 F to 48 F. The abundance of visible steam plumes is apparent in most of these views. The largest steam plume, depicted in Figure VIS-72E, emanates from the 8-cell cooling tower on the northern portion of the refinery property. The plume from the hydrogen plant cooling tower would be no larger than this plume and is likely to be considerably smaller since the hydrogen plant cooling tower is a 3-cell tower and will be designed for a much lower heat rejection rate.

b. Provide the temperature and relative humidity that corresponds with the plumes in the simulation. The simulation should show the project plumes, existing plumes at the Chevron facility, and plumes that would be generated by the Chevron renewal project.

Response: See data response #73b for information on ambient temperature. The relative humidity measurements are not available.

c. Please provide the size (height, length, width) of the simulated project plume and the frequency of its occurrence.

Response: Available plume simulation models lack sufficient accuracy to provide a meaningful visual simulation. Since the existing plant is already dotted with multiple visual steam plumes, Chevron believes that the additional plume will not have a significant individual or cumulative impact on refinery visual resources.

FIGURE VIS-72A
VIEW FROM KOP-1
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

FIGURE VIS-72B
VIEW FROM KOP-1 WITH SIMULATION
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

ES042007007SAC figure_VIS_72b.ai 09/07/07 tdaus

FIGURE VIS-72C
VIEW FROM BARRETT AND GARRARD AVENUE
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

ES042007007SAC figure_VIS_72c.ai 09/07/07 tdaus

FIGURE VIS-72D
VIEW LOOKING WEST FROM WILDCAT CREEK - PHOTO A
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

FIGURE VIS-72E
VIEW LOOKING WEST FROM
WILDCAT CREEK - PHOTO B
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

Technical Area: Visual Resources - Plume
Author: William Walters

BACKGROUND

Cooling Tower Operating Data

Staff plans to perform a plume modeling analysis for the cooling tower. Staff requires additional cooling tower operating information to complete this analysis. Staff must obtain the design and operating parameters of the Chevron Richmond H2-STG cooling tower to confirm its visible plume frequency potential.

DATA REQUEST

73. a. Please summarize for the cooling tower the conditions that affect vapor plume formation including cooling tower heat rejection, exhaust temperature, and exhaust mass flow rate.

Response: Please see data response 73b.

b. Please provide values to complete the table, and additional data as necessary for staff to be able to determine how the heat rejection load varies with ambient conditions and also determine at what ambient conditions cooling tower cells may be shut down.

Parameter	H2-STG Cooling Tower Exhausts		
Number of Cells	4 cells		
Cell Height			
Cell Diameter			
Tower Housing Length			
Tower Housing Width			
Ambient Temperature*	43°F	60°F	85°F
Ambient Relative Humidity	77.5%	67.7%	41.1%
Number of Cells in Operation			
Heat Rejection (MW/hr)	40.2	41.1	42.5
Exhaust Temperature (°F)			
Exhaust Flow Rate (lb/hr)			

* Ambient conditions and heat rejection estimate are based on Figures 2.1-5 and 2.1-15 of the SPPE Application.

Additional combinations of temperature and relative humidity or curves showing heat rejection vs. ambient condition, if provided by the applicant, will be used to more accurately represent the cooling tower exhaust conditions. Please include appropriate design safety margins for the heat rejection, exhaust flow rate and exhaust temperature in consideration that the air flow per heat rejection ratio is often used as a condition of certification design limit.

Response: A completed table is provided below.

Parameter	H2-STG Cooling Tower Exhausts		
Number of Cells	3 cells		
Cell Height	32 ft above grade		
Cell Diameter	24 ft		
Tower Housing Length	130 ft		
Tower Housing Width	42 ft		
Ambient Temperature*	43°F	60°F	85°F
Ambient Relative Humidity	77.5%	67.7%	41.1%
Number of Cells in Operation	3	3	3
Heat Rejection (MW/hr)	40.2	41.1	42.5
Exhaust Temperature (°F)	92.41	90.85	89.8
Exhaust Flow Rate (fpm)	1374	1387	1405

74. Please provide the cooling tower manufacturer and model number information and a fogging frequency curve from the cooling tower vendor, if available.

Response: The manufacturer of the cooling tower is Midwest Cooling Towers. The tower is a custom design and there is no specific model number. The manufacturer was contacted and a fogging frequency curve is not available for the tower.

75. Please indicate under what ambient conditions cooling tower cells may be shut down while still operating the H2-STG facility at full load.

Response: The tower manufacturer estimates that a cell could be shutdown if the wet bulb temperature drops to 53°F or below.

76. Please confirm that the cooling tower fan motors will not have variable speed/flow controllers.

Response: The cooling tower motors will not be variable speed but will be 2-speed motors.

BACKGROUND

Gas Turbine/HRSG Operating Data

Staff plans to perform a plume modeling analysis for the gas turbine/HRSG. Staff requires additional gas turbine/HRSG operating information to complete this analysis. Staff must obtain the design and operating parameters of the Gas Turbine HRSG to confirm its visible plume frequency potential.

DATA REQUEST

77. Please summarize for the gas turbine/HRSG the conditions that affect vapor plume formation including exhaust temperature, exhaust mass flow rate, and exhaust water content. Please provide values to complete and correct the table.

Parameter	Gas Turbine/HRSG Tower Exhausts		
Stack Height*	50.6 meters (166 feet)		
Stack Diameter*	3.66 meters (12 feet)		
Ambient Temperature*	35°F	60°F	105°F
Ambient Relative Humidity*	90%	65%	25%
Exhaust Temperature (°F)*	161	162	159
Exhaust Flow Rate (1,000 lb/hr)*	1,194	1,221	1,148
Exhaust Water Flow Rate (lb/hr)			

* Ambient conditions and exhaust parameters are based on Figures 2.1-11 to 2.1-13 of the SPPE Application. Stack height and diameter are from the air quality modeling CD input files. The stack parameters should conform with information provided for air quality data responses.

Additional combinations of temperature and relative humidity if provided by the applicant will be used to more accurately represent the gas turbine/HRSG exhaust conditions.

Response: The following tables present the requested data.

Parameter	Gas Turbine/HRSG Exhausts		
Stack Height*	50.6 meters (166 feet)		
Stack Diameter*	3.66 meters (12 feet)		
Ambient Temperature*	35°F	60°F	105°F
Ambient Relative Humidity*	90%	65%	25%
Exhaust Temperature (°F)*	161	162	159
Exhaust Flow Rate (1,000 lb/hr)*	1,194	1,221	1,148
Exhaust Water Flow Rate (kpph)	169.4	183.7	186.8

Note the following are the stack gas constituents (mole percent) for the conditions above:

35 F Ambient Case	60 F Ambient Case	105 F Ambient Case
N2 – 71.045%	N2 – 70.354%	N2 – 69.336%
O2 – 8.903%	O2 – 8.752%	O2 – 8.643%
CO2 – 5.024%	CO2 – 5.011%	CO2 – 4.93%
SO2 – 0%	SO2 – 0%	SO2 – 0%
H20 – 14.185%	H20 – 15.048%	H20 – 16.268%
Ar – 0.842%	Ar – 0.834%	Ar – 0.822%

BACKGROUND

Visible Plume Modeling Meteorological Data

Staff will model the cooling tower plumes using previously formatted meteorological data for the years 1990 to 1995, from San Francisco International Airport (SFO) unless the applicant provides data from a more representative monitoring station(s). Please note that while this meteorological station is somewhat distant from the project site, it is also adjacent to the bay and is considered relatively representative in terms of temperature and relative humidity conditions at the project site. Staff needs this information for completing its visible plume and visual impacts analysis.

DATA REQUESTS

78. Please provide representative raw and formatted meteorological data for visible plume modeling. This meteorological data set must be reasonably determined to be from a more project representative site than SFO and include at least 5 years of 95 percent or better complete data. Additionally, this data set must have all of the normal ISCST3 meteorological data parameters, plus the following formatted parameters: relative humidity, present weather, visibility, cloud cover, and ceiling height. As appropriate, the units (such as knots for wind speed) for each of the parameters must also be provided.

    Response: A more representative meteorological data set than the SFO data that contained the requested parameters could not be found.

Technical Area: Waste Management
Author: Christopher Dennis, P.G.

BACKGROUND

A description of the expected waste stream, presumably generated during the Chevron Richmond Power Plant Replacement Project (PPRP) operation, is provided in Table 8.11.2.2. In order for staff to analyze the waste management of the PPRP, a description of the origin, type, hazardous or non-hazardous classification, estimated annual volume or weight, and estimated frequency of waste expected to be generated for each waste stream during each phase of the project is needed. In addition, the method of management of each type of waste and a description of proposed waste disposal facilities that will be used for the waste is necessary for staff to complete its waste management analysis.

DATA REQUEST

79. a. Please provide a table listing wastes associated with the demolition, construction, and operational phases of the project.

    b. Provide a description of the origin, type, hazardous or non-hazardous classification, estimated annual volume or weight, and estimated frequency of waste expected to be generated for each waste stream during each phase of the project.

Response: The wastes to be generated by the project are provided in the revised Table 8.11-2R. Additional information has been added including the hazardous classification, and the source of the waste (construction or operation). Demolition waste will not be generated as part of this project, as no demolition is anticipated during the construction of the PPRP.

TABLE 8.11-2R
Wastes Produced and Waste Management Methods

Waste	Origin	Composition	Estimated Quantity	Classification	Disposal Method
Air pollution control devices	Operation	Spent SCR and carbon monoxide (CO) catalyst	6 to 7 tons every 3 to 5 yrs	Hazardous	Recycled to equipment manufacturer
Chemical feed and sampling systems	Operation	No waste routinely generated; occasional spills only	No waste routinely generated	Potentially hazardous. Dependant on lab analysis	Spills pumped from secondary containment into container and reclaimed or disposed of offsite.
Construction waste	Construction	Wood, metal, concrete, etc.	0.5 cubic yards per month	Non-Hazardous	Transported to offsite landfill
Cooling water for H_2-STG	Operation	Blowdown	105 gpm	Non-Hazardous (Dependant on lab analysis)	Refinery wastewater treatment plant
Electrical transformers	Operation	Waste oil	No waste routinely generated	Hazardous	Pumped from transformer to 55-gallon drum. Recycle or dispose at a permitted TSDF.
Lubricating oils	Operation	Waste oil	No waste routinely generated	Hazardous	Pumped from equipment to 55-gallon drum. Recycle or dispose at a permitted TSDF.
Fuel gas system	Operation	Blowdown oils	30 gal/month	Hazardous	Blowdown from filters flows to oily/wastewater separator; oil pumped from separator into 55-gal drums. Recycle or dispose at a permitted TSDF.
Municipal Solid waste	Operation	Paper, food, plastic, etc.	2 cubic yards per month (36 tons/year)	Non-Hazardous	Transported to offsite landfill

c. Discuss the proposed method of management of that waste. Include information on Chevron's efforts to reduce and recycle waste.

Response: The handling and management of waste generated by the PPRP will follow the hierarchical approach of source reduction, recycling, treatment, and disposal. The first priority will be to reduce the quantity of waste generated through pollution prevention methods (e.g., high-efficiency cleaning methods). The next level of waste management will involve reusing or recycling wastes (e.g., used oil recycling). For wastes that cannot be recycled, treatment will be used, if possible, to make the waste nonhazardous (e.g., neutralization). Finally, offsite disposal will be used to dispose of residual wastes that cannot be reused, recycled, or treated. Procedures will be developed to reduce the quantity of hazardous waste generated. Nonhazardous materials will be used instead of hazardous materials whenever practical, and wastes will be recycled whenever practical. These wastes will be recycled where practical. Specifically, hazardous waste handling will include the following practices to minimize .the quantity of waste deposited to landfills:

- Waste lubricating oil will be recovered and recycled by a waste oil recycling contractor, such as Evergreen Oil, Inc.

- Spent SCR catalysts will be recycled by the supplier, if possible, or disposed of at a State-certified treatment and disposal facility.

d. Describe proposed disposal facilities for the waste expected to be generated during each phase of the project.

Response: Nonhazardous solid waste (often referred to as solid waste, municipal solid waste, or garbage) will be recycled or deposited in a Class III landfill. Hazardous wastes, both solid and liquid, will be delivered to a permitted offsite treatment, storage, and disposal (TSD) facility for treatment or recycling, or will be deposited in a permitted Class I landfill. The following sections describe the waste disposal sites feasible for disposal of PPRP wastes.

Nonhazardous Waste

Richmond Sanitary Service is the sole solid waste franchise to provide solid waste collection services for the Chevron Refinery. The primary disposal facility for Richmond Sanitary Service is the Potrero Landfill. The Potrero Landfill has adequate capacity to handle and dispose of solid waste generated by the facility, as shown in Table WM-80.

According to the California Integrated Waste Management Board (CIWMB),Potrero Landfill has a total capacity of 21.5 million cubic yards of refuse and the estimated remaining capacity as of August 2007 was 8.2 million cubic yards.

Because adequate landfill capacity exists, disposal of solid nonhazardous waste will not be a constraint on PPRP development.

TABLE WM-80
Solid Waste Disposal Facilities in the Vicinity of the PPRP Project

Landfill/MRF/ Transfer Station	Location	Class	Permitted Capacity* (Cubic Yards)	Remaining Capacity* (Cubic Yards)	Permitted Throughput* (Tons per Day)	Estimated Closure Date*	Violation of Minimum State Standards Noted*
Potrero Hills Landfill	Suisun City, CA	III	21,500,000 Cubic Yards	8,200,000 Cubic Yards	4,330 Tons/day	1/1/2011	None

* Solid Waste Information System Database California Integrated Waste Management Board (CIWMB). 2007.

Hazardous Waste

Hazardous waste generated at the PPRP facility will be transported to the Chevron Refinery Hazardous Waste Storage area, and stored for less than 90 days. The waste will then be transported by Sturgeon & Son (a permitted hazardous waste transporter) to the facilities listed below.

Clean Harbors Buttonwillow Landfill

This landfill is permitted at 14.3 million cubic yards and has approximately 9.2 million cubic yards of remaining capacity as of February 2006. At the current deposit rate, the landfill is permitted to accept waste until 2040. Buttonwillow has been permitted to accept all hazardous wastes except flammables, PCBs with a concentration greater than 50 parts per million, medical waste, explosives, and radioactive waste with radioactivity greater than 1,800 picocuries[7].

Waste Management Kettleman Hills Landfill

This facility accepts Class I and II waste. The B-18 Landfill is permitted for and will accept all hazardous wastes except radioactive, medical, and unexploded ordinance; this landfill has permitted capacity of 10 million cubic yards with a remaining capacity of approximately 2.6 million cubic yards as of June 2007[8]. The life expectancy remaining for Landfill B-18 is about 3 years, however expansion of the facility is anticipated. Expansion of the facility would change the closure date to 2036[9].

Additional Facilities

In addition to hazardous waste landfills, there are numerous offsite commercial liquid hazardous waste treatment and recycling facilities in California. Some of the closest facilities include Clean Harbors in San Jose, Clearwater Environmental in

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7 Buoni, Marianna. 2007. Clean Harbor's Buttonwillow Landfill. Personal communication with John Putrich/CH2M HILL. June 11.

8 Luibel, Helen. 2007. Waste Management Inc., Kettleman Hills Facility. Personal communication with John Putrich/CH2M HILL. June.

9 Yarbrough, Terri . 2005. Waste Management Kettleman Hills. Personal communication with Sarah Madams/CH2M HILL. March 8 and August 30.

Alviso, Ecology Control Industries in Richmond, Evergreen Oil Company in Newark, Onyx Environmental in Richmond, and Romic Environmental in East Palo Alto[10].

BACKGROUND

Petroleum contaminated soil and groundwater exists at the PPRP demolition and construction sites. Contaminated soil and groundwater is likely to be encountered by site workers during the demolition, construction, and operational phases of the PPRP. A plan needs to be in place for managing and properly disposing of this contaminated soil and water in addition to ensuring worker health and safety.

DATA REQUEST

80. a. Please provide a waste management plan for contaminated soil and groundwater encountered during PPRP demolition and construction.

Response: Please see Data Response 57 for discussion regarding a waste management plan for contaminated soil and groundwater.

Demolition will not occur as part of this project and therefore is not discussed.

b. Provide a waste management plan to be used on an ongoing basis during PPRP operation.

Response: The Richmond Refinery Instructions RI-506, Refinery Hazardous Waste Management is provided as Attachment WM-80B. RI-506 provides guidance on hazardous waste management, spill management, and waste disposal once the PPRP is operational.

81. a. Please provide a description of the status of the project under the jurisdiction of either the Regional Water Quality Control Board (RWQCB) and Department of Toxic Substances Control (DTSC) and a description of any requirements made by either of these State agencies regarding construction of this project.

b. If there are no agency requirements (e.g., site assessment, risk assessment, remediation) please explain why.

Response: The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) has issued several Waste Discharge Board Orders (Board Orders) for the refinery for specific sites throughout the entire facility, but there are currently no specific Board Orders for the PPRP site. Board Order #00-043 is a general order for the entire refinery facility and applies to construction at the PPRP site. Board Order

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[10] Department of Toxic Substance Control (DTSC). 2007. *California Commercial Offsite Hazardous Waste Management Facilities*. March 12.

#00-043 requires that the refinery update the existing Soil Management Program to address construction and excavation at the refinery. A copy of Board Order #00-043 is provided as Attachment WM-81.

The Department of Toxic Substances Control (DTSC) has given jurisdiction to the SFBRWQCB for remediation issues at the refinery, so no requirements are in place for the PPRP site.

BACKGROUND

The PPRP will increase the amount of waste received by local and regional waste disposal facilities.

DATA REQUEST

82. a. Please provide a list of industrial waste generating projects in the permitting and construction phases within Contra Costa County for inclusion in a cumulative impacts assessment.

Response: A total of 17 pending projects were identified in Section 5.2 of the DEIR for the Chevron Renewal Project[11]. Of these 17 projects, nine of them included projects planned by the Chevron Richmond Refinery. The remaining eight were the following non-Chevron projects:

- East Bay Municipal Utility District's Richmond Advanced Recycling Expansion (RARE) Water Project
- Valero Benicia Refinery Improvement Project
- PG&E's Richmond Fuel Oil Pipeline Divesture Project
- ConocoPhillips Clean Fuels Expansion Project
- Praxair Contra Costa Pipeline Project
- Praxair Contra Costa Hydrogen Pipeline Project
- Praxair Natural Gas Pipeline Project
- Point Molate Reuse Project

b. Describe the origin, type, hazardous or non-hazardous classification, estimated annual volume or weight, and estimated frequency of waste expected to be generated for each waste stream during each phase of these projects.

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[11] ESA Associates, Inc., *Chevron Energy and Hydrogen Renewal Project Administrative Draft EIR* – State Clearinghouse No. 2005072117. Prepared for City of Richmond, CA May 2007

Response: Information regarding the quantities of waste to be generated by these projects were not readily available, however as seen in Data Response WM-83, the amount of waste generated by the PPRP facility during both construction and operation is minimal and will not affect landfill (hazardous and nonhazardous) capacity regardless of the amount of waste generated by any of these 9 projects cumulatively. Landfill capacity in California is more than adequate.

83. Please characterize PPRP's contribution to the cumulative impact on local and regional disposal facilities.

Response: The PPRP facility will generate nonhazardous solid waste that will add to the total waste generated in Contra Costa County and in California. However, there is adequate recycling and landfill capacity in California to recycle and dispose of the waste generated by PPRP. It is estimated that PPRP will generate approximately 16 ½ tons (0.5 yd^3/month * 22 months construction x 1.5 tons/yd^3) of solid waste during construction and about 43 tons maximum a year from operations (including approximately 7 tons of solid hazardous waste). Considering that 1,185,592 tons of solid waste were landfilled in Contra Costa County in the year 2006, PPRP's contribution will likely represent less than one percent of the county's total waste generation (*2006 Landfill Summary Tonnage Report*. http://www.ciwmb.ca.gov/Landfills/Tonnages/. June 26, 2007.). Therefore, the impact of the project on solid waste recycling and disposal capacity will not be significant.

Hazardous waste generated will consist of waste oil and SCR and oxidation catalysts. The waste oil and catalysts will be recycled. Hazardous waste treatment and disposal capacity in California is more than adequate. Therefore, the effect of PPRP on hazardous waste recycling, treatment, and disposal capability will not be significant.

ATTACHMENT WM-80B

Approval and Communication of Refinery, Maintenance, or Engineering Instructions

Document No.: RI-506	**Title:** Refinery Hazardous Waste Management	**Current Date:** 11/14/05
Action: ☐ New ☒ Revision ☐ Cancellation		**Next Revision Due:** 12/2010
Responsible Organization: HES	**Position to Contact With Questions/Suggestions:** HW Liquid Specialist, ext. 2-2294	

Summarize Rewritten Material:
Updated job position responsibilities.
Updated Appendix V.
Simplified text and clarifications where appropiate.

REQUIRED COMMUNICATION/TRAINING
If Type 2 or Type 3 training is necessary – Instruction Owner is responsible for developing the training material and must work with Development Department Manager and Managers of affected personnel to coordinate training of affected personnel and documentation of training.

This document should be reviewed by:	Type 1 Simple Change	Type 2 On-The-Job Training	Type 3 Classroom Training
All Refinery Personnel	☒	☐	☐
Operations	☐	☐	☐
Maintenance & Reliability	☐	☐	☐
Technical	☐	☐	☐
HES	☐	☐	☐
Other:	☐	☐	☐

APPROVALS

Instruction Owner: Jeff Hartwig	**Development Manager:** *(first signature before final routing)* Steve Wildman
Operations Manager: Rick Reed	**Technical/Reliability Manager:**
HES Manager: Jeff Hartwig	**Maintenance Manager:** Joe Connell
Refinery Manager: *(final signature)* Jim Whiteside	**Other Manager:**

On Completion − Instruction Owner will send file and message to IPC to post on the Refinery server.

Necessary Approval for Instructions:

- Refinery Instructions: Development, Operations, HES, and Refinery Manager
- Safe Work Practices: Development, Operations, Maintenance, HES, and Refinery Manager
- Emergency Plans (400 Series RIs): Development, Operations, Maintenance, HES, and Refinery Manager
- Engineering Instructions: Technical and HES Manager
- Maintenance Instructions: Maintenance and HES Manager
- Reliability Instructions: Reliability and HES Manager

TABLE OF CONTENTS

TABLE OF CONTENTS

1.0 PURPOSE

1.1 This Instruction is a "user's guide" to the Health, Environment & Safety (HES) waste management services. It outlines the steps waste generators need to take in managing Richmond Refinery's hazardous waste. The Hazardous Waste (HW) Section of HES coordinates most waste management activities for the Refinery.

1.2 Other Applicable Instructions and Standards

The following Instructions and standards are listed as references. They either provide specific instructions or requirements that relate directly with this type of work or are, at a minimum, good to know prior to managing hazardous wastes and hazardous materials.

RI-300	Injury Illness Prevention Process
RI-314	Protective Clothing and Safety Equipment
RI-327	Handling, Installing, and Removing Refractory Ceramic Fiber Material
RI-331	Guidelines for Handling and Removing Asbestos-Containing Material
RI-350	Procedure for Cleaning Up, Storage, and Disposition of Used and Cleaned Mercury
RI-423	Hazardous Waste Generator Contingency Plan
RI-434	Reporting Hazardous Material Spills and Releases
RI-505	Soil Excavation Procedures

2.0 RESPONSIBILITIES

2.1 Generators of Waste

The generator of the waste is responsible for the following:

1. Notifying the HW Section as soon as they become aware a waste is generated.

2. Providing process knowledge to help the HW Section characterize their waste.

3. Placing waste in an appropriate, compatible container.

4. Inspecting each container in their area at least weekly.

5. Maintaining the container and labels in good condition.

2.2 Hazardous Waste Section

The Hazardous Waste Section personnel are available as a technical resource for the generators. They provide containers, advice on material compatibility, storage requirements, permit requirements, and waste minimization techniques. Additionally, once a waste material is transferred out of the generator's area, they assume total control and responsibility for storage, treatment, transportation, and disposal of the waste.

3.0 IDENTIFYING HAZARDOUS WASTE

3.1 Definition of a Waste

It is the generator's responsibility to identify when a material becomes a waste. A waste is any material which is discarded, abandoned, recycled, inherently waste-like, mislabeled, inadequately labeled, or packaged in deteriorated or damaged containers. In most cases, it is obvious when a material becomes a waste. However, the following are some examples of less obvious wastes:

1. Materials left in equipment that is shutdown for 90-days or more.

2. Excavated soils which are unable to be reused due to contamination.

3. Chemicals that are off-specification, outdated, or no longer needed.

3.2 Determining if a Waste is Hazardous

Characterization is done by the HW Section based on process knowledge or laboratory analysis. A waste may be hazardous if it is:

1. An EPA listed hazardous waste.

2. Corrosive - pH is ≤ 2 or ≥ 12.5.

3. Ignitable - Flash point < 140 F.

4. Reactive - Reacts violently with air or water.

5. Toxic - Toxic to the environment; fails federal or state toxicity criteria.

3.3 Labeling

1. Responsibilities

It is the responsibility of the area proprietor to make sure that all hazardous waste containers in their area are properly labeled. Containers should be inspected to confirm that the labels are firmly attached, in good condition, and the written information is legible. The HW section is available for guidance on proper labeling. Labels are available through the HW field Inspector, ext. 2-3293.

2. Instructions

If it is determined that the material is a waste and is hazardous, by law it must be managed as hazardous waste. Any container storing hazardous waste must have a properly filled out hazardous waste label. While the container is storing hazardous waste, the hazardous waste label must be maintained and be clearly visible. The labels must include the following information:

a. Accumulation Date

The accumulation date should be written on the label as the date waste was first put into the container. Additionally, moving waste from one container to another does not change the accumulation date. The oldest accumulation date must be transferred to any subsequent container. Containers which are emptied daily can be marked "Emptied Daily.".

b. Composition and Physical State

At least one physical state must be identified on the label. In some cases, multiple physical states may be marked i.e., sludges may be marked solid and liquid.

c. Hazardous Properties

The characteristics that make the waste hazardous must be identified on the label, i.e., Toxic, Corrosive, Ignitable, or Reactive.

d. Name and Address of the Person or Plant Generating the Waste

(1) The Refinery hazardous waste labels already have our address identified. A contact person and his/her phone number must also be identified on the label in case of any problems with the waste. The contact person will be the person responsible for the waste while it is in his/her area.

(2) Once the waste is emptied from the container, the label must be either removed from the container or, if the same waste is going to accumulate again, the accumulation date on the label updated.

4.0 HAZARDOUS WASTE MANAGEMENT

4.1 Inspection Requirements

As prescribed by law, containers storing hazardous waste must be inspected by the **area proprietor** at least **weekly**. This inspection should confirm the following items:

1. The container is securely closed and covered while unattended.
2. Waste has not leaked from or been spilled outside the container.
3. All appropriate labels are in place, in view, in good condition, and legible.
4. All required safety equipment (e.g., eyewash, safety shower, etc.) is in proper working order.

Promptly notify your supervisor/HO if any discrepancies are found and ensure they are corrected immediately.

4.2 Container Requirements

1. Compatibility

It is the generator's responsibility to make sure the container is compatible with the waste. For example, some acids may be corrosive to carbon steel and would result in a failure of the container and a resulting spill or release. If you have questions about containers and compatible wastes contact the Hazardous Waste Field Inspector at ext. 2-3293.

2. Location Limits for Ignitable and Reactive Wastes

Containers which store ignitable or reactive wastes cannot be placed within 50 feet of the Refinery's property line.

3. BAAQMD Permits

The BAAQMD may require air permits and abatement devices when storing wastes with high vapor pressures and low flash points. In addition, certain abatement devices require special monitoring. Consult the Hazardous Waste Liquid Specialist at ext. 2-2294 to determine permit requirements prior to placing the waste in a container.

4. Benzene Containing Wastes

Wastes containing any amount of benzene are subject to specific storage, abatement, and disposal requirements under benzene waste NESHAP (National Emission Standards for Hazardous Air Pollutants). Consult with the appropriate Hazardous Waste Specialist to determine specific handling requirements prior to placing benzene-containing waste in a container.

5. Subpact CC Regulated Wastes

Regulations enacted in December 1996 require air emission controls for containers that store hazardous waste if they contain >500ppm volatile organics. Consult with the appropriate Hazardous Waste Specialist to determine specific storage and abatement requirements prior to placing these types of waste in a container.

6. Safety Equipment

Storage of some wastes may require nearby safety equipment such as eyewashes or safety showers to allow emergency decontamination of personnel in case of accidental exposure. Generally, materials which are toxic or corrosive and immediately injurious to health require an in-plant or portable eyewash/safety shower located within 50 feet of the container. Consult the Hazardous Waste Field Inspector at ext. 2-3293 if unsure what safety equipment may be required. If you need to have a portable eyewash delivered or serviced, contact the Central Tool Room at ext. 2-4368.

5.0 HEALTH AND SAFETY

5.1 Health and Safety Checklist, Appendix III

1. Purpose

Federal and state regulations require that Company employees and contractors involved in hazardous waste generation receive the appropriate training and necessary safety and personal protective equipment in order to conduct their work in a manner that protects human health and the environment. The HW Section Health and Safety Checklist, commonly referred to as a "yellow book" (see Appendix III) ensures that all the applicable regulations are met.

2. Scope

The Health and Safety Checklist is applicable to all hazardous waste management operations which involve generation, accumulation, and temporary storage of hazardous waste in portable containers (bins or tanks) at points of generation.

Health and Safety Checklists can be provided by the contractor performing the work or the Health, Environment and Safety Division. The Hazardous Waste Section routinely provides Health and Safety Checklists for the following job tasks:

a. Hydroblasting

b. Process Sewer Clean Out

c. Chemical Cleaning

d. Soil Excavation

3. Instructions

a. The **generator** of hazardous waste must provide for the appropriate degree of training and necessary safety and personal protective equipment (PPE) for all Company and contract personnel handling waste in their area.

b. The **generator** is also responsible for maintaining the necessary safety equipment next to any container of hazardous waste under the generator's control even after the job has been completed and until the container is removed.

c. To determine the appropriate degree of training, necessary safety equipment, and PPE, the Company representative and, if appropriate, the contractor representative must complete the Hazardous Waste Health and Safety Checklist (Appendix III) prior to beginning a job that generates hazardous waste.

d. The HW Section and the Safety Section will provide guidance for completing the checklist.

e. The original Checklist must remain on the jobsite until the work is complete and then should be sent to the person indicated in the yellow book for proper filing. The names of all workers who could be in contact with the hazardous waste during the job must be included in the checklist.

f. A Health and Safety Checklist should include the following items:

(1) Training

(2) Safety equipment

(3) Personal protective equipment (PPE)

(4) Decontamination procedures for personnel and equipment (refer to Appendix IV for details)

(5) Emergency procedures

5.2 General Principles of Decontamination

Most jobs that generate hazardous waste require a decontamination plan. Decontamination is the process of removing contaminants that may have accumulated on personnel or equipment. This process is essential to ensure the health and safety of all personnel working with hazardous waste and ensures that the hazardous waste is not spread beyond the jobsite. The decontamination plan, when required, should be attached to the Health & Safety Checklist.

Refer to Appendix IV for an example of a decontamination procedure and plot plan.

It is the responsibility of the field supervisor/HO at the site to ensure that all personnel are wearing the required personal protection equipment and that all aspects of the decontamination procedures are strictly followed.

6.0 ORDERING PORTABLE BULK LIQUID AND SOLID CONTAINERS

6.1 Bulk Liquid Steel Tanks and Poly Tanks, Appendix I

To ensure that a portable container is scheduled for your job, submit an MFG-3131 to the HW Liquids Specialist (ext. 2-2294 or fax 2-5564). Single containers should be ordered 24 hours in advance and multiple containers should be ordered five (5) days in advance.

Detailed instructions for properly completing the MFG-3131 form are located in Section 9, "Completing the MFG-3131 Form." **An MFG-3131 is necessary even in emergencies.** During off-hours or weekends, emergency requests should be directed to the Effluent Section Head Operator (ext 2-3031) with notification made to the South Yard Shift Supervisor, ext. 2-5252.

6.2 Bulk Solid Bins

1. Ordering

   Bins and other solid waste containers are ordered through the HW Solids Specialist (ext. 2-3676 or fax 2-5564), using an MFG-3131. Single containers should be ordered 24 hours in advance and multiple containers should be ordered five (5) days in advance.

   Detailed instructions for properly completing the MFG-3131 form are located in Section 9, "Completing the MFG-3131 Form." **An MFG-3131 is necessary even in emergencies.** During off-hours or weekend, emergency requests should be directed to the Effluent Section Head Operator (ext. 2-3031) with notification made to the South Yard Shift Supervisor, ext. 2-5252.

2. Usage

   Roll top bins, sealed top bins, tarp top bins, or end dumps are used for the solid hazardous materials listed below. No liquids or 55-gallon drums are allowed in solid waste bins. **In addition, different types of waste may not be mixed in the same container without first obtaining the HW Section's approval.**

Type	Description
Sandblast Grit	Fill at 1/2 bin capacity, or bin will exceed weight allowed for disposal.
Tank Bottoms and Separator Sludge	If material is runny or has liquid, the material must be solidified before being placed in a lined bin. This work should be coordinated with the HW section prior to placing material into the bin.
Asbestos	Asbestos must be wetted and double-bagged. Also, transite must be placed in asbestos bins. Any material contaminated with asbestos must be handled accordingly. Per RI-331.
Contaminated Soil	Fill to 3/4 bin capacity, or bin will exceed weight allowed for transportation. Concrete and asphalt must be segregated from the soil. Contact HW Solids Specialist for concrete/asphalt disposition.
Contaminated Steel	Contaminated pipe or steel that cannot be reclaimed at Reclamation must be in lengths compatible for size of bin.
Ceramic Fiber	Ceramic Fiber waste should be disposed of in sealed impermeable bags and placed in an appropriate Asbestos bin. Handle material per RI-327.

3. At the Jobsite

All bins must be closed or covered when not in use. Tarp top bins will be delivered with a custom-fitted tarp installed.

Before leaving the jobsite at the end of the working day, ensure that all bins are covered completely.

Do not overload bins; 3/4 full is usually acceptable. Asbestos, which is light material, should be filled to the top.

Bins that are full or no longer required should be reported promptly to the HW Solids Specialist, ext. 2-3676. Most material in bins require sampling prior to disposal. Bins containing hazardous waste cannot be held on-site in the Refinery for over 90 days. The HW Section will remove the bin from the jobsite prior to the expiration of the 90-day time limit.

6.3 Job Planning Checklist

1. When planning to use a portable container for a cleanup operation or stock storage, the following questions should be reviewed **by the user,** as necessary, with the plant Process and/or Designs Engineer, Environmental Field Coordinator (EFC), ABU Maintenance Supervisor, or the Solid or Liquid Hazardous Waste Specialist.

   a. Is the material to be put into the container a product or a waste? Hazardous or nonhazardous?

   b. Are there alternatives to portable containers, such as available Refinery tankage, or can the material be directly reused in the process, recycled to recovered oil, or sent directly to sour water tankage?

   c. How will the solution/stock be managed when the user is finished with the container?

   d. Has this process been done before? If so, is there any information available on the material, such as contaminants?

   e. Can the volume be minimized?

   f. Has chemical cleaning been considered as an alternative to a large volume flush? For chemical cleaning jobs, the Chemical Cleaning Coordinator will order the containers.

   g. What type of container do you need (open top, tarp top, end dump, Vacbox, Poly, Frac, etc.)? Metal containers should not be requested for material under 4 pH or over 10 pH. Poly containers are suitable for 0 to 14 pH, but cannot be used if liquid temperature will exceed 140 degrees Fahrenheit.

   h. Where will the container(s) be placed? Containers require a minimum clearance of 36 inches around their perimeter.

i. Does special safety equipment need to be accessible (safety shower, eye wash, light plant, etc.)?

j. How long will the container be needed on-site?

k. Can the container reside in the location for up to 90 days after generation?

l. Can a vacuum truck or bin truck access the area? Some roads are restricted for use due to steep grades or narrow widths.

m. Will you impair access to process equipment, safety equipment, or hinder emergency access?

n. Is access to the Refinery process sewer necessary? If so, how will the material be discharged to the sewer?

o. Is secondary containment needed to prevent accidental release to the ground or surface waters?

7.0 ORDERING VACUUM TRUCKS

7.1 Ordering a Vacuum Truck, Appendix I

To ensure that a vacuum truck is scheduled and available for your job, submit an Intra-Refinery Trucking Permit, MFG-3131, to the Hazardous Waste Liquid Specialist (ext. 2-2294 or fax 2-5564) at the HW Section offices at least 24 hours in advance of the start of the job.

Detailed instructions for properly completing the MFG-3131 form are located in Section 9, "Completing the MFG-3131 Form." An MFG-3131 is necessary even in emergencies. During off-hours or weekends, emergency requests should be directed to the Effluent Section Head Operator and notification made to the South Yard Shift Supervisor, ext. 2-5252.

7.2 Ordering a Vactor

Sometimes called the "guzzler" or "super sucker," this equipment works like a transfer pump and is capable of handling liquids, sludges, and dust. This equipment works well when transferring large amounts of water or sludges with high solid-to-liquid ratios. There is no holding tank so continuous transfer of material is possible. Because vacuum trucks cannot on-load and off-load at the same time, considerable time can be saved using this system if the holding tanks are located in close proximity to the source.

The Vactor is also capable of transfer and collection of dust-laden media such as catalyst fines. When operating in this mode, an internal cyclone separation unit and a final filtering system are used to remove virtually all remaining dust particles. A hopper system is built in to provide collection of the material.

Vactors are ordered through the HW Liquids Specialist at ext. 2-2294, using an MFG-3131.

7.3 Job Planning Checklist

When planning to use a vacuum truck or Vactor for a cleanup or material transfer operation, in addition to completing the MFG-3131, the following questions should be reviewed **by the user,** as necessary, prior to placing the order for the truck.

1. Is material pumpable? Viscous stocks may require cutter preloaded into the truck before the job starts. If cutter is necessary, the generator needs to make note of cutter preloading, in Special Instruction(s) section of MFG-3131.

2. Is the truck going to travel on public roads or highways? If so, Bill of Lading forms need to be provided for the truck. These are arranged through the Scalehouse by the Hazardous Waste Liquids Specialist based on the information supplied on the MFG-3131.

3. Does the material pose a significant Health and/or Safety risk? Acids, caustics, flammables, and stock containing toxic gases (H_2S, Ammonia, etc.) require additional preplanning and coordination to be managed safely. The HW Section has specific written handling procedures for these types of hazards. Contact the Hazardous Waste Liquids or Solids Specialist for details.

8.0 HANDLING SMALL QUANTITY WASTE STREAMS

8.1 Lab and Shop Wastes

1. Scope

Plant Laboratories and Maintenance Shops often generate small quantities of hazardous waste that, because of specific hazardous properties, cannot be recycled or treated in the Refinery. To accommodate special needs, the HW Section has arranged for disposal of this type of waste on a routine basis.

2. Procedures

The disposal of small quantities of lab and shop wastes is coordinated through the Hazardous Waste Field Inspector (ext. 2-3293) by the generator submitting a Disposal Request form (see Appendix II), or MFG-3131. It typically takes a month to coordinate disposal. During this time the waste remains at the generator site. These guidelines should be followed to manage the waste on site:

a. The accumulation container cannot be larger than 55 gallons in capacity.

b. The container must be located at the container location listed on the Small Quantity Disposal Request or MFG-3131 form.

c. Each accumulation container must have a correctly filled out Hazardous Waste label attached.

d. Routine inspections of the containers are the responsibility of the contact person listed on the Small Quantity Request or MFG-3131 form. The container must be closed with the lid fastened in place when not in use, leak free, and compatible with the waste it contains.

e. Accidental spills of waste around the accumulation area must be cleaned up immediately.

f. Remember that liquids cannot be placed into containers designated for solid hazardous waste. Do not consolidate separate waste streams into a common container as incompatible materials may cause hazardous reactions. Consult the MSDS for proper handling and storage precautions.

8.2 Satellite Storage Areas

1. Scope

Under certain circumstances, hazardous waste may accumulate in small containers at individual workstations without being subject to the typical hazardous waste storage time limitations. The regulatory term for this is "satellite" storage. Satellite storage is most applicable in control room laboratories and Maintenance shops.

2. Rules for Satellite Storage

   a. Only one satellite container per waste stream and location is allowed and the container capacity cannot exceed 55 gallons.

   b. The container must have a completed hazardous waste label (call ext. 2-3293) with the additional words "Satellite Container" and "fill date" written at the top of the label.

   c. Initial date of accumulation must be noted on the container (containers which are emptied daily can be marked "Emptied Daily"). If the container has an accumulation date, it should be updated every time the container is emptied. It is the responsibility of the generator to notify the Hazardous Waste Field Inspector at ext. 2-3293 whenever labels are changed or updated. Storage time cannot exceed one year on company property.

   d. Container must be located at or near the point of generation (i.e., where the waste initially accumulates).

   e. Container must be under the control of the people generating the waste.

   f. Container must be covered, leak free, and compatible with the waste being stored.

   g. Container must remain in the particular service and location for which it was specifically authorized.

8.3 Empty Drums

1. This section covers packaging, labeling and disposal of empty drums (≤ 55 gallons, manufactured of metal, plastic, or fiber, with less than one inch of material remaining and no drainable liquid).

   The Hazardous Waste Field Inspector (ext. 2-3293) coordinates the disposal of most empty drums. Empty drums are classified into three major categories:

   a. Vendor Deposit drums

   b. Recyclable drums

   c. Disposable drums

2. Regulatory requirements are dictated by the original contents of the drum. In general, it is best to maintain empty drums in the same condition in which they arrive (i.e., all original labels are legible and drums sealed as if full).

3. Rules for Drum Storage

   a. All empty drums are considered to be potential sites of hazardous waste accumulation and must be correctly stored, labeled, inspected, handled, and disposed of.

   b. Empty drums must be properly labeled, identifying the original contents, and the words “Emptied On” with the date emptied written onto the drum Drums containing DOT-regulated material must have all labels originally placed on them when filled. This could include Flammable, Poison, Corrosive, or other types of labels depending on the original contents.

   c. Reconditioned drums used for storage must be properly labeled indicating their use.

4. Empty Vendor Deposit Drum Handling

   a. Definition

   Vendor deposit drums are defined as those drums purchased from outside vendors in which a deposit has been paid. These drums should be returned for reimbursement when empty. This also includes drums from vendors in which a contract agreement exists that requires the vendor to reclaim the drum. In most cases, vendor deposit drums are labeled as such by the vendor and are easily identified. However, a review of the current vendor contract may be required to determine if an agreement exists covering responsibilities for drum removal.

   b. Drum Condition

   Vendor deposit drums must be returned in the same condition in which they were received. They should be in good shape and free from defects or damage. Drums must be drip dry or contain one inch or less of material. Drums must be sealed with lids and bungs securely in place to prevent any leakage or contamination. **Any drums which have been refilled with a different product**

or waste stream, even though now empty, cannot be returned to the vendor and must be classified and handled as disposable.

c. Labeling

The original labels should be left in place for identification purposes. The vendor should inspect the drums prior to pick up or shipment to ensure that all required labels are in place and legible.

d. Scheduling

The generator should contact the vendor to arrange pickup of the drums. Since contract agreements differ from vendor to vendor, procedures may vary. In some cases, vendors may require a minimum number of drums be collected before they will be picked up.

e. Storage

The generator must schedule the drums for return as soon as possible to avoid unnecessary accumulation on site and reduce the possibility of unauthorized reuse.

5. Empty Recyclable Drum Handling

a. Definition

Recyclable empty drums are defined as blue 55-gallon Chevron product drums usually purchased through the Marketing Division for use in the Refinery. These drums are sent to B. C. Stocking Inc. to be cleaned and reused. Examples include lube oils, grease, and some additive drums.

b. Drum Condition

Recyclable drums must be in good condition and free from defects or damage. Drums must be completely empty and contain no drainable liquid. Drums should be sealed with lids and bungs in place to prevent any leakage. **Any drums which have been refilled with a different product or waste stream, even though now empty, cannot be recycled and must be classified and handled as disposable.** An exception to this rule is a Chevron oil product drum that has contained "recyclable oil." In this case, the drum can be recycled.

c. Labeling

Original labels should be left in place for identification purposes. No other labels are required.

6. Empty Disposable Drum Handling

a. Definition

These drums are defined as those which cannot be returned to the vendor.

b. Drum Condition

All drums must be drip dry or contain one inch or less of material. They must not leak and must be sealed with the lid, gasket, locking ring and/or bung(s) securely in place. Leaking DOT-regulated drums must be placed in over pack drums. To obtain over packs, contact the Hazardous Waste Field Inspector at ext. 2-3293.

c. Labeling

All drums scheduled for transportation must have a properly filled out hazardous waste label. After the MFG-3131 is received by the HW Section, the Hazardous Waste Field Inspector will provide DOT and hazardous waste labels to the generator.

d. Scheduling

A completed MFG-3131 must be sent to the Hazardous Waste Field Inspector to schedule drums for disposal. The MFG-3131 must be filled out completely with the number, size, type of barrel, and what the barrel last contained. An MSDS of what the barrel last contained should be attached to the MFG-3131. When the MFG-3131 is received in the HW Section office, it will be scheduled on the next drum pickup run, and you will be notified by the Hazardous Waste Field Inspector when to expect shipment. Drum shipments are usually scheduled when a sufficient quantity of request forms have been received. By scheduling transportation for a large number of drums, costs for disposal can be kept at a reasonable level. In no case will the empty drum(s) be stored for greater than 90 days.

e. Storage

Drums must be stored with the lids and bungs securely in place and all required labels affixed and legible. Drums containing hazardous waste cannot be stored for greater than 90 days and must be inspected weekly.

9.0 COMPLETING THE MFG-3131 FORM

9.1 Scope

The generator must complete an "Intra-Refinery Trucking Request" form (MFG-3131 located in Appendix I) to schedule most Hazardous Waste Section Services. It provides the detailed information necessary to manage hazardous wastes safely and within the requirements of the law.

Each form needs to be filled out accurately and completely using process knowledge, analytical data, or a combination of both. The generator can use the MSDS, Plant Process Engineer, and other resources to ensure the information presented on the form is accurate and complete.

9.2 Procedure

The generator should complete the form using the following step-by-step procedure:

1. Indicate at the top of the form the date and time the truck or container will be needed, as well as the amount of time you expect the job will take in hours or days.

2. **Job and Requisition Number:** Leave blank, this will be filled in by the HWS personnel.

3. **Date:** Indicate the date of issue on the form in the date section at the top left side of the page.

4. **ABU/Section:** Indicate the Area Business Unit requesting the services.

5. **Plant:** Process unit or location where the material will be generated.

6. **Source:** Specific location from which the material is being taken (i.e., tank number, equipment number, vessel number, or pipeline number).

7. **Cost Center:** The Standing Cost Center number to which the job costs will be charged.

8. **Item Number:** Actual description of equipment as identified by the Refinery item number system.

9. **Material:** Description of material that will be generated (e.g., 10 percent recovered oil, 90 percent DWOP water).

10. **Physical State:** Is the material a solid, liquid, or sludge?

11. **Estimated Quantity:** Barrels, gallons, tons, pounds, or cubic yards of material expected to be generated.

12. **MSDS No.:** Material Safety Data Sheet number as listed in the Hazard Communication Program binders or attach a copy of the vendor-supplied MSDS for **each** material.

13. **Material Temp.:** Indicate the temperature of the material to be placed in the container or vacuum truck. **NOTE: Vacuum trucks and Poly tanks cannot handle material over 150 degrees F.**

14. **1/2 bbl Needed?** Indicate if a 1/2 bbl will be needed, such as to collect material coming out the open end of a pipe.

15. **Laborer Needed:** Indicate if a laborer will be needed to help the driver with the job, such as when long hose lengths need to be handled.

16. **Type of Container:** Indicate type of bin, tank or vacuum truck, or drum required and the quantity needed.

17. **Type of Vacuum Truck:** Vacuum trucks are available in three sizes: 35-barrel, 60-barrel, or 120-barrel.

18. **Truck Material:** Stainless steel or mild steel vacuum trucks are available. Contact the Hazardous Waste Liquids Specialist to determine which metallurgy is compatible with your material.

19. **Hose Requirements:** Indicate how much hose will be required for the job. Standard issue hose is oil-resistant only and available in 20 ft lengths. Specialty chemical hose is available on request.

20. **Known Hazards:** List **all** the chemical hazards as identified by process knowledge or prior sampling. Accurate reporting of flash point, total benzene, pH, and toxic gases i.e., (H_2S, NH_3, etc.) are critical to ensure material is handled safely and regulatory reporting requirements are met.

21. **Components:** List all known components and their approximate percentage of the material total.

22. **Safety Equipment Required:** List all the safety equipment as required by the Refinery standards or MSDS.

23. **Contact Person:** Print name of the contact person with radio/pager and extension.

24. **Supervisor's Signature:** Signature of the Chevron supervisor/HO who is responsible for the job. **Unsigned MFG-3131's cannot be accepted or processed.**

The remaining lower portion of the form will be completed by the Hazardous Waste Section. However, when material being placed into the container is to be recycled through the process unit, the disposition should be noted in the block titled "Special Instructions." If material requires preloading the truck with cutter, it should be noted in the block titled "Special Instructions."

10.0 SPILL CLEANUP

10.1 Purpose

The Refinery is required to clean up recent spills of hazardous materials including oil, catalyst, caustics, acids, chemicals, lubricants, or other hazardous materials. This Instruction describes non-emergency procedures for cleaning up spills of hazardous materials.

10.2 Scope

This Instruction applies to **cleanup efforts** of all spills of hazardous materials inside the Refinery. These cleanup efforts may be the result of an incidental release of hazardous material, or a post-emergency cleanup of a hazardous material spill. The Refinery is required to clean up all hazardous material spills regardless of size.

This Instruction **does not** cover:

1. Reporting requirements for releases of hazardous material (see RI-434).

2. Emergency response procedures for responding to and controlling releases of hazardous wastes from the HWTS (see RI-422).

3. Emergency response procedures for responding to and controlling releases of hazardous waste (see RI-423).

4. Excavation and handling of soils (see RI-505).

10.3 Responsibilities

1. It is the responsibility of the Company area proprietor to ensure that spills of hazardous materials are cleaned up. Cleanup actions need to be initiated within 24 hours of identification of the spill.

   a. Cleanup of small spills should be accomplished by employees or contractors routinely under the proprietor's control.

   b. Spill cleanups requiring additional equipment, counsel, or disposal of contaminated material should be coordinated through the South Yard Shift Supervisor (x2-5252) and the Hazardous Waste Section.

2. Spill cleanups should comply with Section 5 of these Instructions.

11.0 SPENT CATALYST HANDLING

11.1 Disposition

1. Determination of the disposition of the spent catalyst should be agreed upon by the generator and the Hazardous Waste Solids Specialist (ext. 2-3676) prior to the reactor dump. This determination may be done based on process knowledge of potential catalyst contaminants. Confirmatory sampling may be required after the reactor has been dumped.

   Spent Refinery catalyst may be managed in one of the following ways:

   a. RAW MATERIAL SUBSTITUTE - Some catalyst may be used as a raw material substitute in the cement manufacturing process.

   b. REGENERATED OFF SITE - Catalyst that can be regenerated is sent off site in drums without on-site treatment.

   c. TREATED AS HAZARDOUS WASTE - A large percentage of spent catalyst may be required to be managed as a hazardous waste. This catalyst will normally be shipped directly to the HW Section after dumping for proper handling and management before being shipped to a disposal facility.

11.2 Container Storage Requirements

1. Most spent catalyst is stored in 20-yard sealed top bins. Bins are ordered using an MFG-3131 (see Section 6.2 "Ordering Bins"). **Since there are usually liquids present during the reactor dump and during the handling steps, specify on the MFG-3131 that the bins must be sealed and leak free.**

2. Catalyst with self-heating properties must be closely monitored while in the generator's area to ensure that a heat generating reaction is not taking place. If heating is noted, water flooding the container may be required.

12.0 WASTE MINIMIZATION

Any waste minimization or source reduction project must be reported to the Health, Environment and Safety Division Waste Minimization Coordinator (ext. 2-5610) for review. This is to ensure proper accounting and reporting of such efforts to the EPA and is required by law.

Click here to open the MS Word form

Intra Refinery Trucking Permit - MFG-3131

U/E Haz Waste Use Only
Job & Reqn #

Date ____________

Form must be completely filled out to process request.

ABU/Section	Plant	Source (Tank, line, vessel, collection point, etc.)
Cost Center	Passport Number	Item Number
Material	Physical State ☐ Liquid ☐ Sludge ☐ Solid	
Estimated Quantity	MSDS Number(s)	Material Temp. ________ °F
Special approval may be required to access restricted roads or areas of the refinery. Contact the Haz Waste Liquid Specialist x2-2294 for details.	1/2 Bbl Needed? ☐ Yes ☐ No	Labor Needed? ☐ Yes ☐ No

Type of Container

Solids Handling: ☐ Roll Top Bin ☐ Open Top Bin ☐ Sealed Top Bin ☐ Vacuum Bin

Liquids Handling: ☐ Baker Tank ☐ Frac Tank ☐ Poly Tank ☐ Vector

☐ Other ____________ # of Containers ________

Container Numbers ________ ________ ________ ________ ________ ________

☐ Drums

Type of Vacuum Truck ☐ Any ☐ 60 Bbl. ☐ Mild Steel ☐ 35 Bbl. ☐ 120 Bbl. ☐ Stainless

Hoses Needed ________ Ft. ☐ Any ☐ 2 in. ☐ 3 in. ☐ 4 in.

Known Hazards

Flash Point ______ °F H_2S ______ PPM

PH ______ Benzene ______ PPM

Components

________ ____ %
________ ____ %
________ ____ %
________ ____ %

Safety Equipment Required

☐ Acid Suits ☐ Face Shield ☐ Rubber Gloves ☐ Fresh Air (SCBA)
☐ Goggles ☐ Respirator ☐ Rubber Safety Boots ☐ Other ____________
☐ Nomex ☐ Cartridge Type ____________

Contact Person	Radio/Pager #	Extension
Supervisor's Signature	Radio/Pager #	Extension

For Utilities and Environmental Use Only

Laboratory Tag Number	Special Management Required (Circle One) Bz NESHAP Subpart CC N/A
Disposal/Offload Location	U/E Approval
Special Instruction(s)	

Material Classification

☐ Hazardous ☐ Non-Hazardous ☐ Product ☐ Recyclable

Company Used	Driver	Reg Hours	OT Hours
Truck Number	Quantity (Bbls)	Comments	

MFG-3131 (8-97)
Word Electronic Version (8-97)

HAZARDOUS WASTE SECTION
SMALL QUANTITY DISPOSAL REQUEST FORM

Date ______________________ HW Section Job Number ______________

Division ____________________ Plant ______________ Cost Center __________

Contact Person ____________________________________ Ext. __________

Material Description ____
(ATTACH MSDS FOR SPENT/ UNUSED CHEMICALS)

Material State (circle one) SOLID LIQUID GAS SLUDGE

(If solid or are there any free liquids? _______ Y _______ N

Source of Material (Vessel Name and Number) ____________________ __________

How was waste generated? (Please describe process in general terms; e.g., acid cleaning, filtering, discarding off-spec material, etc.) ______________________________

____

List known constituents by chemical name and estimate percentages of each:

____

Please estimate: Flash point _____ deg F, Boiling point _____ deg F _____ N/A

pH ______ < 3 _______ 3-12 ______ > 12 ______ N/A

Metals Content ____

Benzene, ppm _________ Other Organic Content, ppm or % ________________

List unusual hazards/ special precautions necessary for handling ____________________

____

Container Size and Description ____

Number of Containers __________________ Accumulation Date ______________

Approximate Volume of Material ____

Container Location ____

Containers must have a correctly and legibly filled out Hazardous Waste label attached if the waste is suspected or known to be a hazardous waste.

Weekly inspections of the containers are required and are the responsibility of the Contact Person listed on the Small Quantity Request Form. The container must be closed when not in use and leak free.

If there are any questions, refer to RI 506, Section 5.0, or contact the HW Field Inspector at ext. 2-3293.

HEALTH & SAFETY CHECKLIST FOR HAZARDOUS OR POTENTIALLY HAZARDOUS WASTE HANDLING JOBS

JOB TITLE: ______________________________

HW SECTION JOB #: ____________________ **DATE:** ______________

The Chevron Representative and the Contractor Supervisor will initial each item below, as completed. The completed form is to be kept at the jobsite and updated as necessary. A copy must also be filed with the Hazardous Waste Section prior to the work beginning. The original form will be delivered to the Company Representative immediately upon completion of the job.

INITIAL Company	INITIAL Contractor		
________	________	1.	All applicable work permits are at the jobsite. **NOTE**: If soil excavation (>0.1 Cu Yd) is required the BAAQMD (through ESD, ext. 2-3957) must be notified prior to beginning the excavation. Refer to Air Quality Section 3.6 in the Environmental Reference Manual for more information on notification requirements.
________		2.	The Chevron Rep. has informed the Chevron Fire Dept. (ext. 2-4200) and the RSC (ext. 2-5050) that the job will begin.
________	________	3.	The Chevron Rep. has discussed hazards on the jobsite with the Contractor and Area Supervisor, South Yard Shift Supervisor, or designate, and has reviewed the alarm procedure in case an emergency develops.
________		4.	Evacuation procedures for the work site have been reviewed and are posted at, or near, the jobsite.
________		5.	Proper personnel decontamination facilities have been supplied, tested, and are in good working condition. The Chevron Rep. has attached the decontamination plan (refer to attached guidelines for decontamination facilities) with a plot plan showing location(s) of the decontamination facilities.
________		6.	Chevron Rep. has informed the contractor's crew of the safety regulations, including smoking, beard policy, orange lined hearing areas, yellow lined acid and caustic areas, and H_2S areas.
________		7.	Contractor's crew are wearing hard hats, safety glasses and/or goggles, and any other safety equipment as specified by the Chevron Rep.
________		8.	All utilities have proper connections per RI-503 and are connected to the proper source, for example: Fresh Water (block, bleeder, double check & block)

HEALTH & SAFETY CHECKLIST FOR HAZARDOUS OR POTENTIALLY HAZARDOUS WASTE HANDLING JOBS

JOB TITLE: ______________________________

HW SECTION JOB #: ____________ **DATE:** ____________

INITIAL Company	INITIAL Contractor		
	______	9.	Contractor has roped off (or barricaded) the work area with Caution Tape, or other device to deter people from entering. Contractor has cleared the area and will keep all unauthorized personnel out of his roped-off area at all times.
	______	10.	Contractor has at least two employees on the jobsite at all times to provide a safety backup employee.
______	______	11.	The following additional Health & Safety items are required for this job if initialed by the Chevron Representative, after consultation with the Environmental & Safety Division and Hazardous Waste Section:

NOTE: IF ANY ITEM BELOW IS NOT REQUIRED, STATE WHY BELOW THE ITEM.

_____ Air monitoring for toxins.

_____ All workers are required to participate in an annual medical surveillance program

_____ Special chemical warning signs and training such as Benzene, Arsenic, etc., as required by OSHA. List type(s) required:

____
____
____

_____ Special personal protective equipment required. List type(s) required:

____
____
____

HEALTH & SAFETY CHECKLIST FOR HAZARDOUS OR POTENTIALLY HAZARDOUS WASTE HANDLING JOBS

JOB TITLE: ____

HW SECTION JOB #: __________________ **DATE:** ________________

INITIAL
Company Contractor

_____ One plant or one portable safety shower/eyewash units are located at the jobsite, have been tested, and are in good working order. Attached is a plot plan showing locations of the safety shower/eye-wash unit(s).

_____ Respirator and current respirator training and fit test and/or Fresh Air and current Fresh Air training and fit test. List type(s) required, such as Fresh Air or Organic Vapor, Acid Gas, Ammonia, etc.

____

____

NOTE: **Medical certification is required for respirator use, per OSHA 29 CFR 1910.134.**

_____ If Hot Work will occur, fire protection devices, monitoring and fire-watch training. Location of fire monitor(s), extinguishers, etc., are shown on the attached plot plan.

_____ A device, such as a telephone or a hand-held two-way radio, must be immediately available for summoning emergency assistance.

_____ Spill control equipment required. List type(s) required:

____

____

FINAL HEALTH & SAFETY CHECKLIST ACKNOWLEDGMENT

JOB TITLE: ____

HW SECTION JOB #: ______________________ **DATE:** ____________

1. Contractor personnel have been trained in the following:
   a. Operation of his equipment.
   b. Handling and hazards of all chemicals/materials on this job.
   c. OSHA Hazards Communication and Hearing Conservation.
   d. Hazardous Waste Generator training.
   e. Site Specific Training.
   f. Chevron PSM Training.
   g. BATC Training.

2. The following personnel attended a safety training meeting prior to starting the operation and are qualified to perform the work. The following items were covered during the safety training meeting:
   a. Safety and notification procedures to follow in the event of a fire or release of hazardous waste or hazardous waste constituent, per RI-423.
   b. General safety hazards that may be associated with this job. Are there tripping hazards, etc., in the area? Can they be eliminated?
   c. Hazards associated with the materials handled? Have the decontamination procedures been reviewed? Have the following MSDSs been reviewed? All chemicals used and suspected contaminants must be listed below (include approximate level, if available).

______________ ______________ ______________

______________ ______________ ______________

NOTE: The contractor supervisor authorized ONLY the contractor employees listed below to work on this job (use back of page, if required).

COMPANY CONTRACTOR

______________ ______________ ______________

(Chevron Rep) (Contractor Supervisor)

______________ ______________ ______________

______________ ______________ ______________

EXAMPLE
DECONTAMINATION PROCEDURE AND PLOT PLAN

Before leaving the hazardous materials work site, it will be necessary for all personnel and equipment to pass through the decontamination facility.

Laborers

1. Place hand-held equipment on the drop table.
2. Step in the gross wash pool and use a wire brush to remove all contaminants.
3. Step into the wash pool.
4. Step into the rinse pool.
5. Remove mud suit and place in bin.
6. Remove respirator, boot covers, gloves, and hard hats. Place on drop table.
7. Leave decon area and wash hands and face with fresh water.

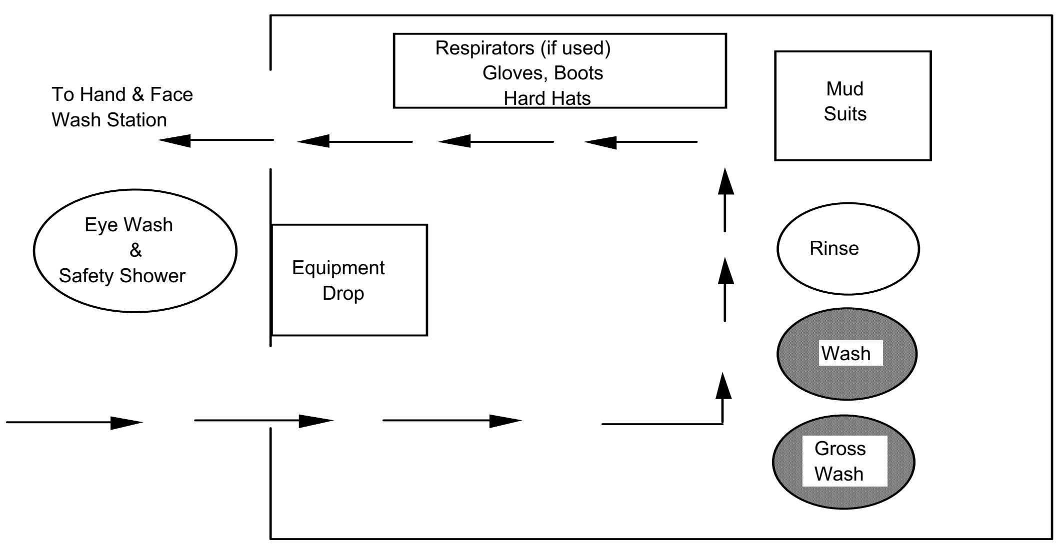
Equipment Operators

These individuals are not expected to be in contact with any hazardous material. At a minimum, they must wash face and hands before leaving the work site.

Large Equipment

Remove as much of the contaminated material at the site as possible before final decon washing to minimize the amount of waste generated.

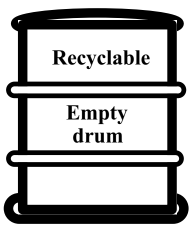
NOTE: If personnel are stopping work for water or a smoke break, they will need to wash their face and hands with fresh water.



HAZARDOUS WASTE MANAGEMENT GUIDELINES

OK	**<u>Oil soaked</u>** material (this can include rags, paper, small pieces of wood, gloves, floor sweepings, asbestos gaskets).
NOT OK	Aerosol cans, free liquids of any kind, **friable asbestos,** large amounts of dirt (> 0.1 cubic yd.), waste that emits **strong toxic odor**, welding rod (scrap metal), clean trash.

OK	All waste aerosol cans. Empty propane or Gastech cylinders.
NOT OK	Any other material.



OK	**<u>Drip dry</u>** empty, or **<u>scraped clean</u>** empty drum (otherwise the drum is a hazardous waste).
NOT OK	Drum still contains pourable liquid or unscraped material (if it once contained hazardous material, it cannot be recycled in this condition).

OK	Soil which contains hazardous contaminants (such as lead or arsenic) that exceed environmental limits.
NOT OK	Free liquids, <u>metal</u> of any kind, waste from any other job site unless approved by U&E.

OK	Soil that contains oil but does not contain hazardous levels of other contaminants (such as lead or arsenic).
NOT OK	Free liquids, <u>metal</u> of any kind, waste from any other job site unless approved by U&E.

OK	**<u>Oil stained</u>** waste (including asbestos gaskets), *scraped clean/drip dry empty* containers $\leq$ **5 gal** (dry paint cans), dry plastic paint/drop tarps.
NOT OK	**<u>Oil-soaked</u>** material, empty containers **> 5 gal** that last held hazardous material, welding rod (put rods in a small bucket, then place in a scrap metal box).

ATTACHMENT WM-81

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. 00-043
UPDATED WASTE DISCHARGE REQUIREMENTS AND RESCISSION OF ORDERS 90-146, 91-098, 92-010, 92-092, 93-016 AND 93-109 FOR:
CHEVRON PRODUCTS COMPANY, RICHMOND REFINERY
RICHMOND, CONTRA COSTA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region, hereinafter called the Board, finds that:

SITE DESCRIPTION

1. Chevron Products Company, a subsidiary of Chevron U.S.A. Inc., (hereinafter called Chevron), owns and operates the Richmond Refinery. The refinery, built in 1902, produces a broad range of fuels, lubricants, asphalt and petrochemicals. The 2,900-acre refinery is located along the southern shore of San Pablo Bay in Contra Costa County (Figure 1). The City of Richmond lies to the east of the facility. To the east and within one mile from the facility is industrial, residential, commercial and agricultural land use. Certain wastes generated from the refinery's processes have historically been deposited at various locations within the refinery.

PURPOSE OF ORDER

2. This Order updates and consolidates the requirements for continued maintenance and monitoring of inactive and closed waste management units, along with refinery-wide groundwater corrective action measures, into a single document. This Order also requires leak detection monitoring systems for above-ground petroleum storage tanks, reporting of petroleum hydrocarbon spills to permeable ground surfaces, documenting cleanup of petroleum spills, and recovering free-phase petroleum from the water table wherever practicable.

RELATED ORDERS

3. Prior to this Order, the Board regulated refinery-wide groundwater corrective action under Waste Discharge Requirements Order No. 93-109.

   Other Orders adopted for the refinery are:

   93-016 Site Cleanup Requirements for the S.P. Hill Tankfield;
   92-111 NPDES permit for the refinery's discharge of treated process water and untreated segregated stormwater;
   92-092 Site Cleanup Requirements for the Alkane Sector;

92-010 Waste Discharge Requirements for Landfill 15;
91-098 Cease and Desist Order for Pollard Pond and the Hydropits; and
90-146 Site Cleanup Requirements for Plant 1/Additives Plant.

Reference To Regulations

4. Effective July 18, 1997 many provisions of the California Code of Regulations (CCR) for non-hazardous waste were moved from Division 3, Chapter 15 into Title 27, Division 2 (Title 27). Where applicable the new regulatory citations have been incorporated in this Order.

HYDROGEOLOGIC SETTING

5. The Richmond Refinery and its appurtenant tankfields are located on the peninsula of the Potrero-San Pablo Ridge, which is composed of steeply dipping Franciscan Complex. The refining of the petroleum products generally occurs on the bay fill areas northeast of the ridge. The southwest side of the ridge consists of steep topography wherein the Franciscan Complex has been terraced for the placement of above ground petroleum storage tanks.

6. Past fluctuations in sea level created a complex sedimentary sequence of interfingered estuarine and alluvial fan deposits overlying the Franciscan Complex bedrock. The uppermost deposits are artificially placed bay fill, ranging from approximately 3 feet to approximately 30 feet in depth. The fill materials overlie bay muds which consist of silt and silty clay with abundant plant matter or peat. The bay muds overlap onto the Franciscan bedrock and thicken bayward.

7. Three hydrogeologic zones have been identified within the top 150 feet of sediments in the flat lying areas of the site, the A-Zone, C-Zone and the B-Zone, in order of increasing depth. The A-Zone is the first water bearing zone and consists of artificial fill and the naturally occurring peat rich, bay mud. The water table elevation for this zone is within two to ten feet of the ground surface and generally discharges to the Bay.

8. The C-Zone is an 80 to 90-foot-thick water bearing zone of interfingered alluvial and estuarine sediments. These sediments generally have low hydraulic conductivity, but sandy, more permeable units occur as channels and lenses. The sand units have not been shown to be contiguous across the site, but do appear to be hydraulically connected. However, based on 13 years of chemical data there is no indication that the C-Zone groundwater has been significantly impacted. Chevron has concluded that the bay mud has been an effective hydraulic barrier between the A- and C-Zones and has prevented the migration of contaminants in groundwater from the A-Zone to the C-Zone. These results and conclusions were presented to the RWQCB in two reports titled, C-Zone Investigation - Phase 1 and Phase 2, dated February 8, 1991 and December 20, 1991 respectively and continue to be supported by groundwater monitoring data collected pursuant to the refinery-wide Self-Monitoring Program.

9. The B-Zone is a relatively permeable unit at approximately 100 feet below the ground surface. It ranges from 5 to 15 feet thick and contains potable water, but has limited production capacity. The B-Zone occurs under artesian conditions and appears to be hydraulically separate from the overlying zones.

10. As shown in Figure 2, the refinery lies in four geomorphic/geologic settings referred to locally as the "Alluvial," "Flats," "Ridge," and "Transition" Zones.

    a. The **Alluvial Zone** is defined as the broad area of alluvial fan deposits, derived from the Berkeley Hills, east of the Refinery. This zone represents flatland areas in which Bay Mud was not deposited. The upper portion of the alluvial fan deposit is typically clayey with low permeability.

    b. The **Flats Zone** comprises the flatland marsh area bounded by San Pablo Bay to the north and extending south along the northeast side of Potrero-San Pablo Ridge. For the purpose of the Refinery's investigations, the inland Flats Zone/Alluvial Zone boundary has been defined to be the 5-foot Bay Mud isopach (line of equal thickness). Thus, the Flats Zone is typically underlain by at least five feet of Bay Mud except where removed by excavation or erosion, in local areas of non-deposition, or where displaced by differential settlement of overlying fill.

    c. The **Ridge Zone** consists primarily of colluvium (slope wash) overlying deformed Franciscan Complex rocks exposed along Potrero-San Pablo Ridge. The boundary of the Ridge Zone is defined as those areas of Potrero-San Pablo Ridge above the 50-foot elevation contour.

    d. The **Transition Zone** is defined as the area that separates the Flats Zone from the Ridge Zones. As described above, the Flats-Transition boundary is defined as the 5-foot Bay Mud isopach and the Ridge-Transition boundary is defined as the 50-foot elevation contour.

CORRECTIVE ACTION

11. Chevron has implemented a corrective action program described in the report "Groundwater Protection System (GPS) Engineering Report" dated December 20, 1991 for the interception of contaminated groundwater from the facility prior to entering San Pablo Bay. The GPS is intended to be a hydraulic control measure composed of a varying combination of slurry wall, extraction trench and/or extraction wells. Groundwater extraction through the trenches and/or wells establishes and maintains a contiguous capture zone which prevents migration of potentially contaminated A-Zone groundwater past the GPS alignment. The slurry wall was installed where thick and/or highly permeable intervals of A-Zone fill soils are encountered. A low permeability Bay Mud "floor" inhibits transport of A-Zone contaminants to the underlying C-Zone in the "Flats Zone" of the Refinery, (see Figure 3).

12. The Board, in Waste Discharge Requirements Order 93-109, determined that the GPS is a satisfactory corrective action measure for the containment and removal of contaminated groundwater along the perimeter of the facility adjacent to San Pablo Bay. In addition, Chevron will remediate any contamination at discrete sites within the facility according to a Free-Phase Hydrocarbon Recovery Plan and a Soils Management Plan, both of which are to be submitted pursuant to Provisions C.5 & C.7 of this Order, thereby maximizing the efficiency of the GPS as a corrective action.

13. Approximately 24,700 linear feet of extraction trench, 15,185 linear feet of barrier wall, 200 extraction locations, and one groundwater treatment plant have been installed and are operating as of the first quarter of 2000. The extracted groundwater is routed to the refinery's effluent treatment system and discharged in accordance with existing NPDES permit requirements.

WATER QUALITY PROTECTION STANDARDS

14. Title 27 of the California Code of Regulations requires the RWQCB to establish a Water Quality Protection Standard (WQPS) in a Waste Discharge Requirements order for each waste management unit covered by that order. The four components of the WQPS are as follows:

    a. Constituents of Concern
    The Constituents of Concern (COCs) for groundwater are listed in Table 2 of the attached Self-Monitoring Program. Monitoring parameters (MPs), a subset of the COCs, are typically the most mobile and commonly detected COCs in groundwater at the site and are measured on a more frequent basis than the entire list of COCs. During a corrective action period, monitoring parameters provide a means to evaluate the effectiveness of the corrective action.

    b. Concentration Limits
    Maximum Allowable Concentration Limits (MACLs) have been established for each COC listed in Table 2 of the Self-Monitoring Program. Due to the number of releases over the past 98 years of refinery operations, it may be technologically and/or economically infeasible to cleanup all petroleum refining-related constituents in the groundwater to background concentrations (non-detect for synthetic organics). The MACLs were thus developed to protect the beneficial uses of shallow groundwater beneath the refinery (see Findings 26 to 28 – Beneficial Uses). The applicable beneficial uses with the most stringent water quality objectives are related to shallow groundwater discharge to surface waters of San Francisco Bay and include uses involving the health of aquatic organism receptors in the Bay and humans who consume aquatic organisms from the Bay.

    c. Point of Compliance
    Title 27 defines the Point of Compliance as the "vertical surface located at the hydraulically downgradient limit of the Unit that extends through the uppermost

aquifer underlying the Unit." The appropriate Point of Compliance for the refinery, based on the areal extent of groundwater impacts and the large number of waste management units (WMUs) involved, is the GPS extraction trench/barrier wall system, which maintains a hydraulic capture zone to protect sensitive ecological receptors in the Bay and wetlands adjacent to the refinery. The GPS/POC boundary was established under the following guidelines: 1) at the downgradient perimeters of individual WMUs which require corrective action but are non-contiguous with other "A-Zone" areas under corrective action (e.g. Pollard Pond, Parr-Richmond site); 2) at the furthest downgradient boundary common to a group of WMUs and/or areas under corrective action (e.g. Landfarm 2-5, Plant 1/Additives Plant); or, 3) at the refinery shoreline boundary where "A-Zone" groundwater contamination not associated with specific WMUs is present.

d. Monitoring Points
Monitoring points for compliance with the refinery-wide corrective action program are shown in Table 1 of the attached Self-Monitoring Program. These monitoring points generally consist of shallow groundwater monitoring wells located downgradient of the GPS extraction well capture zone. Because refinery operations predate collection of groundwater chemistry data, background water quality monitoring locations do not exist at this site; therefore, intra-well statistical comparisons will be used for evaluating trends in concentrations of COCs detected in groundwater monitoring wells. Concentrations of petroleum hydrocarbon related COCs reported above MACLs are expected to exhibit decreasing trends over time as the GPS continues to operate and natural biodegradation processes take place.

REFINERY SECTORS

15. In order to provide phased implementation of the GPS and remediation goals, Chevron subdivided the facility into nine geographic sectors, plus the former Pollard Pond, (see Figure 4). Each sector has unique hydrogeology and varying degrees of environmental concern. The sectors are as follows:

- Landfarms/Landfills Sector
- Castro Sector
- Main Yard Sector
- North Yard Sector
- Bayside Sector - North
- Bayside Sector - South
- Alkane Sector
- Effluent Sector
- Reclamation Sector
- Former Pollard Pond

16. Sector boundaries are generally defined by a physiographic boundary separating adjacent sectors, or by the refinery property line. The upgradient sector boundaries for the Alkane, North Yard, and Main Yard Sectors correspond to an inferred groundwater drainage divide, which is generally coincident with topographic drainage divides along San Pablo Ridge. The upgradient sector boundaries for the Landfarms/Landfills, Castro, and Reclamation Sectors are generally coincident with the Refinery property line. The Bayside Sector (North and South) includes all Chevron properties on the southwestern side of San Pablo Ridge and adjacent to San Francisco Bay. With the exception of the Bayside Sector, all sites described in this Order are upgradient of the GPS.

SUMMARY OF CLOSURE ACTIVITIES COMPLETED PURSUANT TO RELATED ORDERS

The following is a summary of actions taken pursuant to RWQCB orders. All of the following orders will be rescinded and the remaining open items incorporated into this revised site-wide order.

17. Order No. 90-146: Site Cleanup Requirements for Plant 1/Additives Plant

Order No. 90-146 established a remedial action schedule for Chevron Chemical Company's former Plant 1 and Chevron USA's former Additives Plant located adjacent to each other in the southeastern corner of the refinery along Castro Street (Figure 5). Between 1930 and 1970 Plant 1 was used for pesticide formulating and packaging and the Additives Plant was used for gasoline additives manufacturing. As a result, soil is contaminated with pesticides, lead and petroleum hydrocarbons. Hazardous levels of chlordane, DDT and soluble lead have been detected in onsite soil. Corrective action completed pursuant to Order No. 90-146 included 1) installation of an extraction system for containment of contaminated shallow groundwater (GPS), and 2) covering the site with a combination of the Richmond Parkway, passing directly over a portion of the site, and placement of a geotextile and asphalt cap (or vegetated fill in some areas) over the non-roadway portions. The combined cover provides a low-permeability cap over the site and the encompassing groundwater extraction system prevents contaminated shallow groundwater from leaving the site. The Board received a report, dated December 18, 1996, documenting completion of construction, closure, and remedial operations with as-built details. Closure activities were completed in compliance with the Site Cleanup Requirements order and were consistent with approved plans. No further closure activities are necessary or required for the Plant 1/Additives Plant. Post-closure maintenance and monitoring activities are addressed in Part B of the attached Self-Monitoring Program.

18. Order No. 91-098: Revised Cease and Desist Order for Pollard Pond and the Hydrolyzing Pits

Order No. 91-098 established a compliance schedule for the closure of hazardous waste surface impoundments in two areas of the refinery under the Toxic Pits Cleanup Act (TPCA). The first impoundment, known as Pollard Pond, was a 3-acre surface impoundment located in the northwestern portion of the refinery (Figure 6) adjacent to San Pablo Bay that contained sludges with a pH less than 2 and Bay Mud dredge spoils from the refinery yacht harbor.

The second set of impoundments, known as the Hydrolyzing Pits (Hydropits), were three small unlined surface impoundments located on the shore of San Pablo Bay in the Alkane Sector (Figure 7) that historically received wastewater from the refinery's Alkane Plant until 1986. The most significant constituents of this waste stream were neutralized hydrofluoric acid, fluoride salts, and small amounts of oil containing benzene.

a. Compliance with Order 91-098 for Pollard Pond: The Board received a report, dated December 15, 1994, which documented compliance with TPCA cease discharge requirements and closure according to the Revised Closure Plan approved by the Executive Officer. Closure activities included removal of all low-pH hazardous wastes, installation of a GPS groundwater extraction trench at the downgradient boundary of the pond, dismantling of Pollard Dam, and confirmation sampling of soil from the bottom of the pond excavation. The results of the 16 confirmation samples showed diesel-range total petroleum hydrocarbons ranging from non-detectable at a reporting limit of 190 mg/kg to 3,874 mg/kg and pH ranging from 3.85 to 9.00.

   The remaining 30,000 cubic yards of non-hazardous hydrocarbon contaminated soils, originally identified for bioremediation in the closure plan, were removed from the site and placed in Landfill 15 as described in Addendum 3 to the Revised Landfill 15 Closure Report submitted to the RWQCB on May 22, 1996. Tasks remaining to be completed prior to RWQCB approval of final closure include evaluation and management of potential risks to human or ecological receptors that may result from remaining non-hazardous petroleum hydrocarbon contaminated soils and areas of low pH in the excavated portion of the pond. Provision C.3 of this Order requires Chevron to submit a Risk Analysis and Management Plan to address these concerns.

b. Compliance with Order No. 91-098 for the Hydropits: Chevron submitted a closure certification report for the closure of the Hydropits dated November 23, 1992. The Hydropits Closure Unit includes a multi-layer cap and the Alkane GPS. The key portions of the GPS with respect to the Hydropits are the groundwater extraction trench and slurry wall (hydraulic and physical barriers) along the northeastern perimeter of the Hydropits adjacent to Castro Cove. The unit no longer contains liquid hazardous waste and as such, meets the cease discharge requirements of TPCA. Closure activities were completed in compliance with the Cease and Desist Order and were consistent with approved plans. No further closure activities are necessary or required for the Hydropits. Post-closure maintenance and monitoring activities are addressed in Part B of the attached Self-Monitoring Program.

19. Order No. 92-010: Waste Discharge Requirements for Landfill 15

Landfill 15 is a 41-acre former tidal marsh area along the eastern border of the refinery that Chevron converted for waste disposal use (Figure 8). The site was used from the early 1960s to 1987 as an evaporation pond and as a landfill for a variety of wastes including sludges (separator, paint, and water treatment), oily soil and dredge spoils, resins, catalyst fines, lime, and sulfur. Approximately 13 acres of Landfill 15 were re-activated in 1992 for disposal of treated non-hazardous acidic sludge and dredged bay mud generated from the closure of Pollard Pond. Order No. 92-010 provided schedules and specifications for construction of improvements to Landfill 15 including installation of a downgradient slurry wall and groundwater extraction system (part of the refinery-wide GPS) to intercept and remove any mobile pollutants in the groundwater beneath the unit. Order No. 92-010 also required an evaluation of the monitoring program for the unit, regulated the quantity and type of waste to be discharged, and specified a closure date. The activated portion of the landfill which accepted the Pollard Pond closure waste was closed by placement of a multi-layer low-permeability cap. This activity was documented in the *Landfill 15 Active Unit Final Closure Status Report* dated June 29, 1995. The remaining 28 inactive acres that ceased receiving waste material prior to 1987 were capped in 1996 and 1997. Closure activities were completed in compliance with Waste Discharge Requirements and were consistent with approved plans. No further closure activities are necessary or required for Landfill 15. Post-closure maintenance and monitoring activities are addressed in Part B of the attached Self-Monitoring Program.

20. Order No. 92-092: Site Cleanup Requirements for the Alkane Sector

Order No. 92-092 required Chevron to submit corrective action and monitoring plans for the Alkane Tankfield area and for shallow groundwater plumes containing benzene, fluoride, and free-phase petroleum hydrocarbons originating from the Alkane Plant area (Figure 7). The contamination due to releases of benzene, hydrofluoric acid and liquid hydrocarbons necessitated source area remediation consisting of free product recovery and groundwater extraction and treatment in addition to implementation of the GPS to hydraulically contain shallow contaminated groundwater on the downgradient perimeter of the Alkane Plant area adjacent to San Pablo Bay.

As of the first quarter 2000, Chevron operates six extraction wells designed to recover floating liquid hydrocarbons and contaminated groundwater in the Alkane Plant plume source area upgradient of the Hydropits Closure Unit and the Alkane Sector GPS. These extraction wells and a groundwater treatment system make up the Alkane Plant Groundwater Recovery System (APGRS). Groundwater and liquid hydrocarbons recovered by the extraction wells are piped to the groundwater treatment system which separates the liquid hydrocarbons from the extracted groundwater and removes benzene from the groundwater by passing it through granular activated adsorption vessels. From the APGRS, the treated groundwater is routed to the refinery's effluent treatment system and is discharged in accordance with existing NPDES permit requirements. Tasks related to the corrective action and monitoring objectives of Order No. 92-092 that remain to be fulfilled before cleanup activities can be terminated are consolidated into this Order in Specification B.6, Provision C.4 and Part B of the attached refinery-wide revised Self-Monitoring Program.

21. Order No. 93-016: Site Cleanup Requirements for the S.P. Hill Tankfield

Order No. 93-106 requires cleanup of contaminated groundwater and removal of free-phase liquid petroleum hydrocarbons under the S.P. Hill Tankfield. The S.P. Hill Tankfield is located on the western flank of the Potrero-San Pablo Ridge in a southwest trending drainage basin (see Figure 9). During hydrogeologic investigations conducted between 1991 and 1993, free-phase petroleum hydrocarbons were discovered in 5 wells located in the central portion of the tankfield within a 250-foot radius of each other. Chevron has been recovering free product and some incidental groundwater from these wells since 1994. Free product recovery rates are generally less than one gallon per day. The primary cleanup objective as proposed in the *Free-Phase Hydrocarbon Removal Plan, S.P. Hill Tankfield* (June, 1993) is to recover as much free-phase hydrocarbon product as is technically feasible and cost-effective. Chevron also operates additional extraction wells to create a hydraulic depression and capture dissolved petroleum hydrocarbon constituents in groundwater several hundred feet downgradient of the free product recovery system. These additional wells are located in Basins 4 and 7, which act as aboveground storage tank secondary containment areas. Cleanup goals for dissolved constituents of concern in this part of the refinery are the Maximum Allowable Concentration Limits (MACLs) for the Bayside Sector – South (see Table 2 in Part B of attached Self-Monitoring Program). Gasoline and diesel range total petroleum hydrocarbons and benzene are the only constituents of concern which still exceeded the MACLs as of the fourth quarter, 1999. Tasks related to the corrective action and monitoring objectives of Order No. 93-016 that remain to be fulfilled before cleanup activities can be terminated are consolidated into this Order in Specification B.9, Provisions C.12 and C.13, and Part B of the attached refinery-wide revised Self-Monitoring Program.

22. **CORRECTIVE ACTION/CLOSURE STATUS FOR WMUS AND OTHER AREAS OF CONCERN NOT UNDER SEPARATE ORDERS**

The following table summarizes closure activities and/or corrective action work that has taken place since WDR 93-109 was adopted for units not addressed in separate orders as described above.

Area of Concern	Refinery Sector	Status/Corrective Actions Completed	Further Actions Necessary
Office Hill Tankfield	Bayside – South (Figure 9)	All but one of the aboveground petroleum storage tanks has been taken out of service and dismantled. Groundwater and soil sampling results from the 1991 Hydrogeologic Investigation did not detect significant concentrations of hydrocarbon in this area.	None
Point Orient Tankfield	Bayside – North (Figure 10)	In 1990 tanks in this area were taken out of service, dismantled, and contaminated soils removed. There is no evidence of accumulations of free-phase hydrocarbons on the water table along the perimeter of the tankfield. However, based on observations of hydrocarbon-contaminated soil beneath the former tanks, some of the tanks in this area may have leaked petroleum in the past. Chevron submitted a hydrogeologic investigation for this tankfield on June 23, 1992 which determined that minor soil and groundwater contamination exists at the No.10 Basin, which collects storm water runoff. Groundwater analysis from monitoring wells at this site show diesel contamination at concentrations of up to 3 mg/l.	Continue groundwater monitoring
Landfarms	Landfarms (Figure 8)	Between the 1970's and 1987, Chevron conducted landfarming operations at five locations within the site to promote biodegradation of oily soils that had been generated from various operations. The Landfarms have not received waste since 1987. Chevron entered into a Consent Agreement with the U.S. EPA and DTSC to close the Landfarm units (EPA Order RCRA 09-88-0005) and submitted the original *Landfarms Closure Plan* on March 31, 1988. The *Revised Landfarm Closure Plan* was submitted to DTSC on December 30, 1996 and revised on March 19, 1997. DTSC approved the Revised Landfarms Closure Plan on March 19, 1998. Closure of the Landfarms commenced in 1998 and was completed in 1999 and consisted of importing fill, grading, installation of a vegetative cap, installation of stormwater collection trenches, and installation of shallow groundwater extraction trenches. Chevron submitted the *Landfarm Closure Completion Certification Report* on September 30, 1999 and has since filed an application for the Post-Closure Permit.	Post-closure monitoring and maintenance per attached Self-Monitoring Program.

Area of Concern	Refinery Sector	Status/Corrective Actions Completed	Further Actions Necessary
#1 Oxidation Pond	North Yard (Figure 11)	The No. 1 Oxidation Pond, originally constructed in 1959, was separated into five compartments (passes), for the controlled sequential movement of wastewater as a component of the effluent treatment process. Pass 1 was clean closed in 1990 and permitted as a clean stormwater impound basin. Passes 2 through 5 are currently inactive but in the past received process water and stormwater. Chevron performed sampling and analysis of the pond sludges in 1985 and 1989 as part of the Report of Waste Discharge. Since December 1998, an EPA sponsored Phytoremediation Study has been underway to evaluate the efficacy of agricultural and non-crop plants for degradation of aged petroleum hydrocarbons. In 1999, Chevron completed installation of a soil-bentonite barrier wall between the First and Second Pass of the No. 1 Oxidation Pond. This wall was constructed as part of the GPS as described in *the Groundwater Protection System Engineering Report* dated December 20, 1991.	Development of site corrective action plan. (See Provision C.8)
250 Foot Channel	Effluent (Figure 11)	The 250 Foot Channel site was excavated to –40 MSL in the early 1900's and served as the original ship channel for the refinery. The channel served as the primary NPDES discharge point from 1973 – 1987. From 1987-1994 the channel received once through non-contact cooling water and stormwater; however, treated process water effluent was no longer routed through the channel as in previous years. From 1994 to the present, the channel has acted as surge capacity for stormwater and Aggressively Biologically Treated (ABT) process water effluent. In 1998, the discharge pipes in the dam were demolished, a barrier wall was installed across dam, and a pilot remediation test was conducted. A barrier wall along the east side of the channel is scheduled for construction in 2000.	Development of corrective action for sediments in channel. (See Provision C.9)

Area of Concern	**Refinery Sector**	**Status/Corrective Actions Completed**	**Further Actions Necessary**
Parr-Richmond Landfill	Reclamation Phase II (Figure 12)	Chevron acquired this site in 1954 from the Parr-Richmond Industrial Corporation. The area had been previously used for agriculture grazing, municipal landfilling and various junkyard storage activities from prior to 1930 until 1954. In 1995 GPS was installed around the perimeter of the unit as documented in accordance with the *Phase II Area GPS Implementation Plan*. In 1997, the Parr Richmond cover was constructed over the former landfill area in conformance with the *Final Corrective Action Plan, Reclamation Sector, Phase II Areas, Parr-Richmond Site.* Chevron submitted the *Parr-Richmond Former Municipal Landfill Corrective Measures Certification Report* in May 1999.	On-going monitoring and maintenance per attached Self-Monitoring Program.
Gertrude Street Site	Reclamation Phase II (Figure 12)	The Gertrude site covers approximately 3 acres on the east side of the Reclamation Phase II Area. Chevron purchased the property in 1961 and continued to lease the property to Mr. J.H. Henslee who conducted auto dismantling and drum reconditioning at the site until 1983. In 1983, approximately 200 drums were removed from the site to an appropriate waste disposal site. In 1985 the surface of the site was egarded to allow for stormwater collection as described in the *Gertrude Street Site Rainwater Containment Plan*. In 1996, Chevron submitted the *Final Corrective Action Plan, Reclamation Sector, Phase II Area, Gertrude Street Site*, which provided for final cover of the site. In 1997 the final cover for the site was completed and a groundwater extraction trench was installed to prevent groundwater migration off-site. Chevron submitted the *Closure Certification Report, Gertrude Street Site* in March 1998.	On-going monitoring and maintenance per attached Self-Monitoring Program.
Salt Water Pump Station	Bayside South (Figure 9)	In 1998, a free phase hydrocarbon sheen was observed floating on the Bay near the intake flume of the former Salt Water Pump Station. The source of this hydrocarbon is believed to be from historical pipeline leaks from the adjacent pipeway. In 1999 a soil-bentonite barrier wall was constructed adjacent to the intake flume and two monitoring wells were installed upgradient of the barrier wall.	Monitor per attached Self-Monitoring Program to evaluate need for permanent extraction system.

ABOVEGROUND PETROLEUM STORAGE TANKS

23. Aboveground petroleum storage tanks are required to comply with the requirements of Chapter 6.67 Section 25270 of the Health and Safety Code, and with Part 112, Title 40 of the Federal Code of Regulations. In part, the regulations require installation and utilization of a leak detection system for each regulated tank which has the potential to impact groundwater or surface waters. The Chevron Richmond Refinery operates approximately 197 aboveground petroleum storage tanks with a total storage capacity of 596,349,209 gallons. All but a small number of these tanks (about 40 as of the adoption date of this Order) have leak detection bottoms (LDBs). The LDB design used by Chevron, whether for a new tank or an existing tank bottom retrofit, has three basic components. From the bottom up they consist of: 1) a synthetic (usually HDPE) liner to act as a release prevention barrier, 2) a grooved concrete pad which is sloped toward a certain point, usually a sump, at the perimeter of the tank, and 3) a 0.25 inch thick welded steel bottom. The grooves in the concrete pad are intended to catch and divert any product leaking through the steel bottom to the perimeter of the tank where it can be visually observed by refinery personnel during routine inspections. It is Chevron's policy to install LDBs on all new tanks constructed at the Richmond Refinery and to retrofit old tanks with LDBs if they are kept in service after their steel bottoms need to be replaced. Chevron has been submitting an internal tank bottom integrity test schedule every two years for the tanks without LDBs. Chevron is required by Specification B.13 and Provision C.11 of this Order to continue submitting this biennial schedule and to test the tank bottoms for integrity and thickness at intervals not to exceed 10 years for tanks that have been inspected at least once under the schedule until these tanks are either retrofitted with LDBs or permanently taken out of service.

24. Aboveground petroleum storage tank facilities are required to have secondary spill containment for the capture of sudden releases from an aboveground petroleum tank. The Chevron Refinery utilizes several different types of soil berms, spill collection basins and channels located in the tank fields for containment and diversion of petroleum hydrocarbon releases. The primary regulation governing this activity is CFR 112.7 Spill Prevention Control and Countermeasure Plans (SPCC). The SPCC is designed to prevent spills at petroleum facilities to the maximum extent practicable and mitigate a spill if it occurs. The primary emphasis of the SPCC Plan is on spill prevention. Some of the spill containment areas are centrally located in the main tankfield, and because of this a large surface area may be impacted by a petroleum spill. Provision C.10 of this Order requires Chevron to submit a report that identifies tanks from which a sudden release of petroleum may impact large areas with permeable surfaces, and the steps taken to prevent a release and thus reduce the potential for groundwater degradation.

BASIN PLAN

25. The Board adopted a revised Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) on June 21, 1995. This updated and consolidated plan represents the Board's master water quality control planning document. The revised Basin Plan was approved by the State Water Resources Control Board and the Office of Administrative Law on July 20, 1995, and November 13, 1995, respectively. A summary of regulatory provisions is contained in 23CCR 3912. The Basin Plan defines beneficial uses and water quality objectives for waters of the State, including surface waters and groundwaters.

BENEFICIAL USES

26. Shallow groundwater beneath the "Flats Zone" which comprises the flatland marsh area bounded by the San Pablo Bay to the north and extending south along the northeast side of the Potrero-San Pablo Ridge has Total Dissolved Solids (TDS) that is significantly higher than the 3000 mg/l (5000 µS/cm electrical conductivity) level which the State Water Resources Control Board [State Board Resolution No. 88-63, exemption criterion 1(a)] and the Regional Water Quality Control Board (Regional Board Resolution No. 89-39) set as a maximum for a municipal or domestic water supply in the Sources of Drinking Water Policy. There is no historical, existing or planned use of groundwater as a source of drinking water in either the shallow (A- and C-Zone) or deeper (B-Zone) aquifers in this part of the refinery.

Groundwater beneath the "Ridge Zone," which is bounded on the south by San Francisco Bay and extends northwest up to the top of the Potrero-San Pablo Ridge (Bayside sectors), is primarily contained in fractured bedrock of the Franciscan Complex. Based on hydraulic conductivity data collected during hydrogeologic investigations of the tankfields in the Bayside North and Bayside South sectors, it is unlikely that a single well could produce an average sustained yield of 200 gallons per day for drinking water supply purposes [State Board Resolution No. 88-63, exemption criterion 1(c) and Regional Board Resolution No. 89-39]. There is no historical, existing or planned use of unconfined groundwater as a source of drinking water in this part of the refinery.

There is the potential, however, for groundwater on either side the Potrero-San Pablo Ridge to discharge into San Francisco and San Pablo Bays at the shoreline groundwater/surface water interface. Therefore, the surface water beneficial uses named in the Basin Plan for these bodies of water are applicable to groundwater in point-of-compliance monitoring wells near the shoreline interface.

(i) There are no existing or potential beneficial uses of groundwater underlying the site which is less than 100 feet deep or is contained in bedrock.

The existing and potential beneficial uses of groundwater underlying the site which is not contained in bedrock and is greater than 100 feet below ground surface are:

(i) Industrial process and service supply
(ii) Agricultural water supply
(iii) Municipal and domestic supply

2. 28. The existing and potential beneficial uses of San Francisco and San Pablo Bays are:

(i) Industrial service and process supply
(ii) Water contact and non-contact recreation
(iii) Wildlife habitat
(iv) Commercial and sport fishing
(v) Fish migration and spawning
(vi) Navigation
(vii) Estuarine habitat
(viii) Preservation of rare and endangered species

CEQA

29. This action is categorically exempt from the provisions of the California Environmental Quality Act pursuant to Section 15301, Title 14, of the California Code of Regulations.

NOTICE AND MEETING

30. The Board has notified Chevron and interested agencies and persons of its intent to revise waste discharge requirements for the discharge, and has provided them with an opportunity to submit their written comments.

The Board, at a public meeting, heard and considered all comments pertaining to this discharge.

IT IS HEREBY ORDERED that Chevron, its agents, successors and assigns shall meet the applicable provisions contained in 27CCR, Division 2, Subdivision 1 of the California Code of Regulations and Division 7 of the California Water Code, and shall comply with the following:

A. PROHIBITIONS

1. The treatment, discharge or storage of materials which may impact the beneficial uses of ground or surface water shall not be allowed to create a condition of pollution or nuisance as defined in Sections 13050 (l) and (m), respectively, of the California Water Code.

2. The discharge of additional hazardous waste at the facility is prohibited. For the purpose of this Order, the term hazardous waste is as defined in Title 23, Article 2 of Chapter 15.

3. The creation of any new waste management unit is prohibited without prior approval by the Regional Board.

4. Activities associated with subsurface investigations and cleanup that will cause significant adverse migration of pollutants are prohibited.

5. Chevron shall not cause the following conditions to exist in waters of the State at any place outside downgradient influence of the GPS extraction trench or well capture zone:

   a. Surface Waters

      Floating, suspended, or deposited macroscopic particulate matter or foam.

      Bottom deposits or aquatic growth.

      Turbidity, apparent color, or water levels beyond natural background levels.

      Visible, floating, suspended or deposited oil or other products of petroleum origin.

      Toxic or other deleterious substances in concentrations or quantities which may cause deleterious effects on aquatic biota, wildlife, or waterfowl, or which render any of these unfit for human consumption either at levels created in the receiving waters or as a result of biological concentrations.

   b. Groundwater

      Subsurface migration of pollutants associated with Chevron's operations to waters of the State is prohibited.

B. SPECIFICATIONS

1. Technical reports submitted pursuant to Provisions C.1, C.3, C.4, C.5, C.8, C.9, C.10, C.12, C.13, and C.15 of this Order shall be prepared under the supervision of and signed by a California registered engineer, registered geologist, or certified engineering geologist.

2. The site shall be protected from any washout or erosion of wastes or covering material and from inundation which could occur during a 100 year flood event. The final covers of all waste management units shall be graded and maintained to promote lateral runoff of precipitation and to prevent ponding.

3. Chevron shall maintain all devices or designed features, installed in accordance with this Order, such that they continue to operate as intended without interruption, except for limited periods of maintenance and repair, effluent system management during major storm events, or as a result of failures that could not have been reasonably foreseen or prevented by Chevron.

4. Chevron shall extract water from the Groundwater Protection System (GPS) at a rate which eliminates or reverses the bayward migration of contaminants. Chevron shall install, if practicable, a physical barrier downgradient of any extraction well(s) or extraction trenches that are producing Bay water at volumes deemed to be unacceptable by the Executive Officer.

<u>Hydraulic Containment</u>

5. Chevron shall monitor the "A Zone" for contaminants on the downgradient side of the GPS trench/barrier and groundwater levels on both sides of the GPS trench/barrier for the primary purpose of evaluating the effectiveness of the GPS. Chevron shall demonstrate compliance with Specification B.4 by submitting, pursuant to the Self-Monitoring and Reporting Program attached to this Order, potentiometric water elevation contour maps which graphically demonstrate maintenance of an inward hydraulic gradient into the GPS.

6. Chevron shall operate the GPS as a corrective action measure for remediation of groundwater contamination along the San Pablo Bay side of the Refinery for at least one year after compliance has been achieved with the Maximum Allowable Concentration Limits established by this Order before any reduction or termination of groundwater extraction will be considered (see attached Self-Monitoring Program).

7. If it is determined by the Executive Officer, based on groundwater monitoring information, that water quality impairment downgradient of the GPS is not improving, or continues to degrade, Chevron may be required to submit additional site- specific groundwater corrective action proposals.

<u>Alkane Plant Plume Remediation</u>

8. Chevron shall continue extracting free-phase hydrocarbons and contaminated groundwater from the central portion of the Alkane Plant plume area such that contaminants do not migrate further from the source. The contaminant extraction shall be performed until cleanup levels are achieved. Chevron shall propose cleanup levels, extraction rates, and/or other performance evaluation criteria, acceptable to the Executive Officer, for the Alkane Plant plume remediation system per Provision C.4.

9. <u>S.P. Hill Tankfield Groundwater Cleanup Requirements</u>

   a. Chevron shall continue to operate the S.P. Hill Hydrocarbon Recovery System as initially required under Site Cleanup Requirements Order No. 93-016 until it receives written approval from the Executive Officer to cease operations. To be eligible for this approval, Chevron must submit a written request that includes adequate supporting documentation demonstrating that free-phase liquid hydrocarbon recovery is no longer technically feasible and cost-effective in this part of the refinery (see Provision C.10).

   b. Chevron shall continue to operate the S.P. Hill Groundwater Extraction System as initially required under Site Cleanup Requirements Order No. 93-016 until it receives written approval from the Executive Officer to cease operations. To be eligible for this approval Chevron must submit a written request certifying that the Maximum Allowable Concentration Limits (MACLs) for the Bayside Sector – South have not been exceeded in any groundwater monitoring wells sampled per the attached Self-Monitoring Program for at least four consecutive reporting periods (see Provision C.11).

<u>Free-Phase Liquid Petroleum Hydrocarbon (FPLH) Recovery</u>

10. Chevron shall perform recovery activities, as needed, to remove FPLH from beneath the refinery. The GPS, where present, is designed to function as a groundwater containment system that captures and prevents offsite migration of dissolved constituents; it is not intended to perform FPLH source control. FPLH recovery may be necessary to reduce the source for dissolved constituents that are introduced via the free-phase. Chevron shall propose the methods to achieve this specification and the degree of cleanup but the proposal must be acceptable to the Executive Officer (see Provision C.5).

<u>Spill Reporting and Documentation of Cleanup</u>

11. Chevron shall notify this Board of any reportable quantity (42 gallons or more) of petroleum as defined in Health & Safety Code Chapter 6.67 *Above Ground Storage of Petroleum* that is either spilled or leaked to any unlined ground surface (any surface not protected by a barrier which is impermeable to petroleum products or other constituents which may cause adverse water quality impacts). Verbal notification shall be within one working day of knowledge of the spill and

shall be followed by a written description to include the nature, location and volume of the spill, and the total area and/or soil volume affected. In addition, the written report shall include a map which identifies the location of the spill and photographic documentation of the spill area before and after cleanup (see Provision C.6).

12. <u>Soil Contamination and Excavated Soil Reuse</u>
Chevron shall notify this Board of any soil contamination, not previously identified in subsurface investigations, discovered during any subsurface investigation or excavation work conducted on refinery property, which may potentially adversely impact water quality. Chevron shall store, reuse, and/or dispose of non-hazardous contaminated soil according to a plan acceptable to the Executive Officer (see Provision C.7).

<u>Aboveground Petroleum Storage Tanks</u>

13. All aboveground petroleum storage tanks, subject to Chapter 6.67, Section 25270 of the Health and Safety Code, shall comply with all provisions of that section and Part 112 of the Code of Federal Regulations. All tanks shall be adequately monitored to assure that petroleum products will not discharge to surface and subsurface waters of the State. All tanks not fitted with leak detection bottoms, or with a tank leak detection monitoring system/method approved by the Executive Officer, shall have, in the interim, their tank bottoms tested for integrity and thickness according to API Standard 653 or the most current industry or regulatory-approved standard. For tanks without leak detection bottoms, the internal tank bottom inspection interval shall be no more than 10 years for tanks that have been inspected at least once under the approved schedule. Initial tank inspections shall depend on the corrosion rates measured during previous inspections or anticipated based on experience with tanks in similar service (see Provision C.11).

14. Chevron shall conduct monitoring activities according to the Self-Monitoring and Reporting Program attached to this Order and as may be amended by the Executive Officer to verify the effectiveness of groundwater containment and/or closure systems.

15. At any time, Chevron may file a written request (including supporting documentation) with the Executive Officer, proposing modifications to the attached Self-Monitoring and Reporting Program. If the proposed modifications are acceptable, the Executive Officer may issue a letter of approval that incorporates the proposed revisions into the Self-Monitoring and Reporting Program.

16. At any time, Chevron may file a written request (including supporting documentation) with the Executive Officer, proposing modifications to standard operating plans and procedures related to compliance with this Order as required under Provisions C.5, C.7, C.9, (Free-Phase Liquid Petroleum Hydrocarbon Recovery Plan, Soils Management Plan, AGT Internal Tank Bottom Inspection

Schedule) or as necessary for implementing the attached Self-Monitoring Program (Standard Operating Procedures for Groundwater Monitoring).

17. Components of the GPS Engineering Report pertaining to operation of the system may be amended as appropriate to incorporate changes in technology that will improve operational efficiency. All proposed changes shall be submitted in writing to the Executive Officer for review and approval.

18. Chevron shall comply with all applicable provisions of 27CCR and/or 23CCR Chapter 15 that are not specifically referred to in this Order.

C. PROVISIONS

1. Chevron shall implement any Self-Monitoring and Reporting Program (SMP) issued by the Executive Officer.

2. All technical and monitoring reports required to be submitted pursuant to this Order are being requested pursuant to Section 13267 of the California Water Code. Failure to submit reports in accordance with schedules established by this Order or failure to submit a report of sufficient technical quality to be acceptable to the Executive Officer may subject Chevron to enforcement action pursuant to Section 13268 of the California Water Code.

   a. Chevron shall comply with all Prohibitions, Specifications and Provisions of this Order, immediately upon adoption of this Order or as provided below. All report submittals must be acceptable to the Executive Officer.

   b. Technical reports/plans, submitted by Chevron, in compliance with the Prohibitions, Specifications, and Provisions of this Order shall be submitted to the Board on the schedule specified herein. These reports/plans shall consist of a letter report that includes the following:

      i. Identification of any obstacles which may threaten compliance with the schedule;
      ii. In the event of non-compliance with any Prohibition, Specification or Provision of this Order, written notification which clarifies the reasons for non-compliance and which proposes specific measures and a schedule to achieve compliance. This written notification shall identify work not completed that was projected for completion, and shall identify the impact of non-compliance on achieving compliance with the remaining requirements of this Order; and,
      iii. In the self-monitoring reports (See attached SMP), an evaluation of the current groundwater monitoring system and a proposal for modifications as appropriate.

3. **POLLARD POND RISK ANALYSIS AND MANAGEMENT PLAN**

Chevron shall submit a plan, acceptable to the Executive Officer, describing its land use and management plans for Pollard Pond during postclosure and evaluating any potential risks to human or ecological receptors that may result from remaining non-hazardous petroleum hydrocarbon contaminated soils in the excavated portion of the pond. The plan shall also document pH level changes and reductions in petroleum hydrocarbon concentrations, if any, in soil in the excavated portion of Pollard Pond since 1994.

COMPLIANCE DATE: June 30, 2001

4. **ALKANE PLANT PLUME REMEDIATION GOALS PLAN**

Chevron shall submit a plan, acceptable to the Executive Officer, presenting cleanup goals and criteria for evaluating the success of the Alkane Plant Groundwater Remediation System (APGRS), including criteria for evaluating the feasibility and cost-effectiveness of operating the APGRS as a free-phase hydrocarbon and contaminated groundwater recovery system. The plan shall also present a rationale for determining when continued recovery operations are no longer necessary.

COMPLIANCE DATE: June 30, 2001

5. **FREE-PHASE LIQUID PETROLEUM HYDROCARBON RECOVERY EVALUATION PLAN**

Chevron shall submit a plan, acceptable to the Executive Officer, which provides a rationale and methodology for determining whether and to what extent free-phase liquid petroleum hydrocarbons, discovered during routine groundwater well monitoring, are recoverable. The plan shall propose a method for estimating short- and long-term hydrocarbon recovery rates that can be reasonably achieved by various recovery system alternatives, and compare these rates to the estimated subsurface migration rate of the hydrocarbons.

COMPLIANCE DATE: December 31, 2000

6. **SPILL REPORTING AND DOCUMENTATION OF CLEANUP**

Chevron shall notify this Board of any reportable quantity (42 gallons or more) of petroleum as defined in Health & Safety Code Chapter 6.67 Above Ground Storage of Petroleum that is either spilled or leaked to any unlined ground surface (any surface not protected by a barrier which is impermeable to petroleum products or other constituents which may cause adverse water quality impacts). Verbal or electronic (e-mail) notification of the spill shall be within one working day of knowledge of the spill and shall be followed by a written report to include the nature, location and volume of the spill, and the total area and/or soil volume affected. In addition, the written report shall include a map which identifies the location of the spill, photographic documentation of the spill area both before and after cleanup, and a description of the cleanup actions performed. The initial photograph shall be taken as soon as is practical considering both health and safety concerns. If the cleanup is not completed within 14 days of discovery of the spill, a summary of cleanup actions performed and an “after” photograph shall be submitted immediately upon completion.

COMPLIANCE DATE: Within 14 calendar days of discovery of spill

7. **CONTAMINATED SOIL MANAGEMENT PLAN**

Chevron shall submit a plan, acceptable to the Executive Officer, for managing non-hazardous contaminated soil discovered on refinery property during subsurface investigation or excavation work. The plan shall include, but not be limited to, descriptions of soil sampling, storage, and handling protocols and criteria for reusing non-hazardous contaminated soil within the refinery.

COMPLIANCE DATE: December 31, 2000

8. **CORRECTIVE ACTION WORK PLAN FOR #1 OXIDATION POND PASSES 2 THROUGH 5**

Chevron shall submit a work plan and schedule, acceptable to the Executive Officer, which proposes corrective action measures for petroleum hydrocarbon contaminated soil in passes 2 through 5 of #1 Oxidation Pond. The plan shall address evaluation and management of risks to potential human and ecological receptors at this site and shall include corrective action alternatives designed to minimize any identified risks.

COMPLIANCE DATE: March 31, 2001

9. **CORRECTIVE ACTION WORK PLAN FOR 250 FOOT CHANNEL**

Chevron shall submit a work plan and schedule, acceptable to the Executive Officer, which proposes corrective action measures for petroleum hydrocarbon contaminated sediment in the 250 Foot Channel site. The plan shall address evaluation and management of risks to potential human and ecological receptors at this site and shall include corrective action alternatives designed to minimize any identified risks.

COMPLIANCE DATE: March 31, 2001

10. **ABOVEGROUND PETROLEUM STORAGE TANK SECONDARY CONTAINMENT AND SPILL PREVENTION**

Chevron shall submit a technical report, which includes a detailed map identifying all tanks regulated under Chapter 6.67, Section 25270 of the Health and Safety Code, and Part 112 of the Code of Federal Regulations. Secondary containment features for all regulated storage tanks shall be identified on the map. Arrows identifying the direction of petroleum flow from a regulated tank to the containment area shall be drawn on the map unless the secondary containment consists of dikes, berms, or walls that immediately surround the tank. Chevron shall document in the report spill prevention plans to reduce the likelihood of a release of petroleum from a tank to permeable surfaces.

COMPLIANCE DATE: June 30, 2001

11. **ABOVEGROUND PETROLEUM STORAGE TANK INTERNAL TANK BOTTOM INSPECTION SCHEDULE**

Chevron shall submit a report, acceptable to the Executive Officer, every two years as indicated in the compliance date below, which updates the internal tank bottom inspection schedule for all aboveground petroleum storage tanks that do not have leak detection bottoms and are subject to Chapter 6.67, Section 25270 of the Health and Safety Code.

COMPLIANCE DATE: July 1, each even-numbered year

12. **REQUEST TO CEASE OPERATION OF THE S.P. HILL FREE-PHASE HYDROCARBON RECOVERY SYSTEM**

Chevron shall submit a report, acceptable to the Executive Officer, which demonstrates that free-phase liquid hydrocarbon recovery is no longer technically feasible or cost-effective and that termination of the program will not allow further subsurface migration of either free-phase or dissolved constituent plumes or any other adverse impacts to groundwater or surface water quality.

COMPLIANCE DATE: 60 days prior to shutting down system

13. **REQUEST TO CEASE OPERATION OF THE S.P. HILL GROUNDWATER EXTRACTION SYSTEM**

Chevron shall submit a report, acceptable to the Executive Officer, certifying that the Maximum Allowable Concentration Limits (MACLs) for the Bayside Sector – South have not been exceeded in any groundwater monitoring wells sampled per the attached Self-Monitoring Program for at least four consecutive reporting periods.

COMPLIANCE DATE: 60 days prior to shutting down system

14. **FINANCIAL ASSURANCE INSTRUMENT**

Chevron shall obtain and maintain a **Financial Assurance Instrument** acceptable to the Executive Officer until the end of the Post-Closure Maintenance Period for any classified waste management unit subject to the California Code of Regulations Title 27, Chapter 6, Subdivision 1, Division 2. Chevron shall submit a report every five years that either validates the Instrument's ongoing viability or proposes and substantiates any needed changes (e.g., a documented increase in the monitoring systems' ability to provide reliable early detection of a release can cause a decrease in the Instrument's financial coverage). For the purposes of planning the amount of the fund, Chevron shall assume a post-closure period of at least 30 years. However, the post-closure maintenance period shall extend as long as the wastes pose a threat to water quality.

COMPLIANCE DATE: July 31, 2000 and every five years thereafter.

15. **POST EARTHQUAKE INSPECTION REPORT**

Chevron shall submit a detailed **Post Earthquake Inspection Report** acceptable to the Executive Officer, in the event of any earthquake generating ground shaking of Richter Magnitude 7.0 or greater at or within 30 miles of the Facility. The report shall describe the waste management unit containment features, groundwater monitoring, and control facilities potentially impacted by the static and seismic deformations. Damage to any waste containment facility which may impact State waters must be reported to the Regional Board staff case manager for the Chevron Refinery within one working day of knowledge of the damage.

COMPLIANCE DATE: **Within 12 weeks of Earthquake**

16. **Duty to Comply**: Chevron must comply with all conditions of these waste discharge requirements. Violations may result in enforcement actions, including Regional Board orders or court orders requiring corrective action or imposing civil monetary liability, or in modification or revocation of these waste discharge requirements by the Regional Board. (CWC Section 13261, 13263, 13265, 13268, 13300, 13301, 13304, 13340, 13350).

17. **General Prohibition**: Neither the treatment nor the discharge of waste shall create a pollution, contamination or nuisance, as defined by Section 13050 of the California Water Code (CWC). (H & SC Section 5411, CWC Section 13263)

18. **Availability**: A copy of these waste discharge requirements shall be maintained at the discharge facility and be available at all times to operating personnel. (CWC Section 132631)

19. **Change In Ownership**: Chevron must notify the Executive Officer, in writing at least 30 days in advance of any proposed transfer of this Order's responsibility and coverage to a new discharger. The notice must include a written agreement between the existing and new discharger containing a specific date for the transfer of this order's responsibility and coverage between the current discharger and the new discharger. This agreement shall include an acknowledgment that the existing discharger is liable for violations up to the transfer date and that the new discharger is liable from the transfer date on. [CWC Sections 13267 and 13263]

20. **Change in Discharge**: In the event of a material change in the character, location, or volume of a discharge, Chevron shall file with this Regional Board a new Report of Waste Discharge. [CWC Section 13260(c)]. A material change includes, but is not limited to, the following:

    (a) Addition of a major industrial waste discharge to discharge of essentially domestic sewage, or the addition of a new process or product by an industrial facility resulting in a change in the character of the waste.

    (b) Significant change in disposal method, e.g., change from a land disposal to a direct discharge to water, or change in the method of treatment which would significantly alter the characteristics of the waste.

    (c) Significant change in the disposal area, e.g., moving the discharge to another drainage area, to a different water body, or to a disposal area significantly removed from the original area potentially causing different water quality or nuisance problems.

    (d) Increase in flow beyond that specified in the waste discharge requirements.

    (e) Increase in area or depth to be used for solid waste disposal beyond that specified in the waste discharge requirements. [CCR Title 23 Section 2210]

21. **Revision**: These waste discharge requirements are subject to review and revision by the Regional Board. [CCR Section 132631]

22. **Termination**: Where Chevron becomes aware that it failed to submit any relevant facts in a Report of Waste Discharge or submitted incorrect information in a Report of Waste Discharge or in any report to the Regional Board, it shall promptly submit such facts or information. [CWC Sections 13260 and 13267]

23. **Vested Rights**: This Order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to persons or property, do not protect Chevron from his liability under Federal, State or local laws, nor do they create a vested right for Chevron to continue the waste discharge. [CWC Section 13263(g)]

24. **Severability**: Provisions of these waste discharge requirements are severable. If any provisions of these requirements are found invalid, the remainder of these requirements shall not be affected. [CWC 9213]

25. **Operation and Maintenance**: Chevron shall, at all times, except during maintenance, effluent system management during major storm events, or emergency shutdowns, properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by Chevron to achieve compliance with conditions of this Order. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls including appropriate quality assurance procedures. [CWC Section 13263(f)]

26. **Reporting of Hazardous Substance Release**: If any hazardous substance is discharged in or on any waters of the State, or discharged or deposited where it is, or probably will be, discharged in or on any waters of the State, Chevron shall report such discharge to the Regional Board by calling (510) 622-2300 during regular office hours (Monday through Friday, 8:00 to 5:00).

    A written report shall be filed with the Board within five working days. The report shall describe: the nature of the hazardous substance, estimated quantity involved, duration of incident, cause of release, estimated size of affected area, nature of effect, corrective actions taken or planned, schedule of corrective actions planned, and persons/agencies notified.

27. **Entry and Inspection**: Chevron shall allow the Regional Board, or an authorized representative upon the presentation of credentials and other documents as may be required by law, to:

    (a) Enter upon the discharger's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this order;

    (b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this order;

    (c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order; and

    (d) Sample or monitor at reasonable times, for the purposes of assuring compliance with this order or as otherwise authorized by the California Water Code, any substances or parameters at any location. [CWC Section 13267]

28. **Analytical Methods**: Unless otherwise permitted by the Regional Board Executive officer, all analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health Services. All analyses shall be required to be conducted in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants" [40 CFR Part 136] promulgated by the U.S. Environmental Protection Agency. [CCR Title 23, Section 2230]

29. This Order supersedes Cease and Desist Order 91-098, Waste Discharge Requirements Orders 92-010 and 93-109, and Site Cleanup Requirements Orders 90-146, 92-092, and 93-016. Orders 90-146, 91-098, 92-010, 92-092, 93-016 and 93-109 are hereby rescinded.

I, Lawrence P. Kolb, Acting Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on June 21, 2000.

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Lawrence P. Kolb
Acting Executive Officer

Attachments:
Figure 1 - Site Location Map
Figure 2 – Refinery Geomorphic Boundaries
Figure 3 – Groundwater Protection System Basic Design
Figure 4 – Refinery Sector Boundaries
Figure 5 – Plant 1 / Additives Plant Cap
Figure 6 – Pollard Sector
Figure 7 – Alkane Sector
Figure 8 – Landfarm / Landfill Sector
Figure 9 - Bayside Sector
Figure 10 - Effluent Sector
Figure 11 – Reclamation Sector

(figures are located in separate pdf files)

Self-Monitoring and Reporting Program

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

GROUNDWATER CORRECTIVE ACTION
SELF-MONITORING AND REPORTING PROGRAM

FOR

CHEVRON PRODUCTS COMPANY
RICHMON REFINERY

CONTRA COSTA COUNTY

ORDER NO. 00-043

A. GENERAL

1. Reporting responsibilities of waste dischargers are specified in Sections 13225(a), 13267(b), 13383, and 13387(b) of the California Water Code and this Regional Board's Resolution No. 73-16. This Self-Monitoring Program is issued in accordance with Provision C.1 of Regional Board Order No. 00-043.

2. The principal purposes of a discharge monitoring program are: (1) to document compliance with waste discharge requirements and prohibitions established by the Board, (2) to facilitate self-policing by the waste discharger in the prevention and abatement of pollution arising from waste discharge, (3) to develop or assist in the development of standards of performance, pretreatment and toxicity standards, and 4) to assist the discharger in complying with the requirements of the California Code of Regulations.

B. SAMPLING AND ANALYTICAL METHODS

1. Sample collection, storage, and analyses shall be performed according to the most recent version of EPA Standard Methods and in accordance with an approved sampling and analysis plan.

2. Water and waste analysis shall be performed by a laboratory approved for these analyses by the State of California. The director of the laboratory whose name appears on the certification shall supervise all analytical work in his/her laboratory and shall sign all reports of such work submitted to the Regional Board.

3. All monitoring instruments and equipment shall be properly calibrated and maintained to ensure accuracy of measurements.

C. DEFINITION OF TERMS

1. A grab sample is a discrete sample collected at any time.

2. Receiving waters refers to any water which actually or potentially receives surface or groundwater which passes over, through, or under waste materials or contaminated soils. The receiving waters in this case are the groundwater beneath and adjacent to the waste management units and other areas of concern, the surface runoff from the site, wetlands adjacent to the refinery, San Francisco Bay, and San Pablo Bay.

3. Standard observations refer to:

   a. Receiving Waters

      i. Floating and suspended materials of waste origin: presence or absence, source, and size of affected area
      ii. Discoloration and turbidity: description of color, source, and size of affected area
      iii. Evidence of odors, presence or absence, characterization, source, and distance of travel from source

   b. Perimeters of waste management units

      i. Evidence of liquid leaving or entering the waste management units, estimated size of affected area and flow rate. (Show affected area on map)
      ii. Evidence of odors, presence or absence, characterization, source, and distance of travel from source
      iii. Evidence of erosion and/or daylighted waste

   c. The waste management units

      i. Evidence of ponded water at any point
      ii. Evidence of odors, presence or absence, characterization, source, and distance of travel from source
      iii. Evidence of erosion and/or daylighted waste

D. SAMPLING, ANALYSIS, AND OBSERVATIONS

The discharger is required to perform sampling, analyses, and observations in the following media:

1. Groundwater per Title 27, Section 20415(b)
2. Surface water per Title 27, Section 20415(c)
3. Per the general requirements specified in Title 27, Section 20415(e)

E. RECORDS TO BE MAINTAINED

Written reports shall be maintained by Chevron or its laboratory, and shall be retained for a minimum of five years. This period of retention shall be extended during the course of any unresolved litigation regarding this discharge or when requested by the Board. Such records shall show the following for each sample:

1. Identity of sample and sample station number.

2. Date and time of sampling.

3. Date and time that analyses are started and completed, and name of the personnel performing the analyses.

4. Complete procedure used, including method of preserving the sample, and the identity and volumes of reagents used.

5. Calculation of results.

6. Results of analyses, and detection limits for each analysis.

F. REPORTS TO BE FILED WITH THE BOARD

1. Chevron shall submit two Semi-annual Self-Monitoring and Reporting Program Reports (SMRs) per the due dates in the following table. For any given refinery sector as defined in Waste Discharge Requirements Order No. 00-043, samples shall be collected within a period of time not to exceed 30 days.

Report	Period Covered	Period That Samples Are to be Collected	Report Due Date
Winter/Spring	January 1 to June30	Feb 1 to April 30	August 31st
Summer/Fall	July 1 to December 31	August 1 to October 31	March 1st
Annual	January 1 To December 31	-	March 1st

Note: The annual report can be combined with the summer/fall semi-annual report.

The semi-annual reports shall include, but are not limited to the following:

a. Letter of Transmittal

A letter transmitting the essential points in each report should accompany each report. Such a letter shall include a discussion of significant findings from the last report period, and actions taken or planned for correcting the violations. If Chevron has previously submitted a detailed time schedule for correcting requirement violations, a reference to the correspondence transmitting such schedule will be satisfactory. If no violations have occurred in the last report period this shall be stated in the letter of transmittal. SMRs and the letter transmitting the SMRs shall be signed by a principal executive officer at the level of vice president or his duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge originates. The letter shall contain a statement by the official, under penalty of perjury, that to the best of the signer's knowledge the report is true, complete, and correct.

b. Each semi-annual SMR shall include a compliance evaluation summary. The summary shall contain but not be limited to:

   i. A graphic description of the elevation, velocity, and direction of groundwater flow under/around the facility, based upon the past and present water level elevations and pertinent visual observations (data to be collected semi-annually for GPS hydraulic gradient monitoring and for refinery-wide A- and C-Zone groundwater gradient monitoring).

   ii. The method and time of water level measurement, the type of pump used for purging, pump placement in the well; method of purging, pumping rate, equipment and methods used to monitor field pH, temperature, and conductivity during purging, calibration of the field equipment, results of the field pH, temperature, conductivity and turbidity observations, well recovery time or rate (as applicable), and method of disposing of the purge water.

   iii. A written discussion of the groundwater analyses indicating any change in the quality or characteristics of the groundwater.

   iv. Type of pump used, pump placement for sampling, a detailed description of the sampling procedure; number and description of equipment, field and travel blanks; number and description of duplicate samples; type of sample containers and preservatives used, the date and time of sampling, the name and qualifications of the person actually taking the samples, and any other observations.

Chevron may refer to its most current Board staff-approved Groundwater Monitoring Program Standard Operating Procedures (SOP) plan for equipment and methods listed in items ii. and iv. that it uses consistently for each monitoring event. Any deviations from the SOP should be noted and explained in the SMR.

c. A comprehensive discussion of the compliance record and status, as well as any corrective actions taken or planned which may be needed to bring Chevron into full compliance with the Waste Discharge Requirements and Title 27, Chapter 3.

d. A map or aerial photograph shall accompany each report showing observation and monitoring station locations.

e. Laboratory statements of results of analyses specified in Part B must be included in each report. The director of the laboratory whose name appears on the laboratory certification shall supervise all analytical work in his/her laboratory and shall sign all reports of such work submitted to the Board.

i. The methods of analyses and detection limits must be appropriate for the expected concentrations, considering matrix specific instrument determinations (i.e. variable instruments, method detection levels (MDLs) and practical quantitative levels (PQLs)). If the analysis performed cannot achieve the values below the MACLs, Chevron shall supply an explanation in the semi-annual report. Analysis results not meeting the MACLs shall not be used for compliance determination unless there are values reported above the practical quantification limits. If methods other than EPA approved methods or Standard Methods are used, the exact methodology must be submitted for review and approved by the Executive Officer.

ii. In addition to the results of the analyses, laboratory quality assurance/quality control (QA/QC) information must be included in the monitoring report. The laboratory QA/QC information should include the method, equipment and analytical detection limits; the recovery rates; an explanation for any recovery rate that is less than the recovery acceptance limits specified in the USEPA method procedures or the laboratory's acceptance limits, if they are more stringent than those in the USEPA method procedures; the results of equipment and method blanks; the results of spiked and surrogate samples; the frequency of quality control analysis; and the name and qualifications of the person(s) performing the analyses.

f. The Annual Monitoring Report shall be submitted to the Board covering the previous monitoring year. The Report shall include, but is not limited to, the following:

i. A graphical presentation of the laboratory analytical data for each monitoring point for all samples taken. Each graph shall plot the concentration of one or more constituents over time for a given monitoring point, at a scale appropriate to show trends or variations in water quality.

ii. A tabular summary of all the monitoring data obtained during the previous year. The report should be accompanied by a $3^1/_{2\text{-inch}}$ computer data disk tabulating the year's data in MS Excel, MS Access, or other Board staff-approved format.

iii. A comprehensive discussion of the compliance record, and the corrective actions taken or planned which may be needed to bring the dischargers into full compliance with the waste discharge requirements.

iv. A written summary of the groundwater analyses indicating any change in the quality of the groundwater.

v. An evaluation of the effectiveness of the GPS monitoring/ control system in accordance with the requirements of Part B.1.

2. Contingency Reporting

a. Chevron shall report by telephone concerning any seepage from the surface of any waste management unit immediately after it is discovered. A written report shall be filed with the Board within seven days, containing at least the following information:

i. A map showing the location(s) of seepage;

ii. An estimate of the flow rate;
iii. A description of the nature of the discharge (e.g., all pertinent observations and analyses); and
iv. Corrective measures underway or proposed.

b. Following the determination that groundwater analytical results for a compliance monitoring location exceed the Maximum Allowable Concentration Limits (MACLs) listed in Table 2, Chevron shall evaluate QA/QC samples to determine if cross-contamination may have occurred. Chevron shall follow the procedures below for any monitoring locations still exceeding the MACLs:

i. Chevron shall immediately re-sample at the compliance point where the MACL was exceeded and re-analyze if results are not consistent with historical trends.
ii. If re-sampling and analysis confirm the exceedance of a MACL, Chevron shall document this in the text of the next Semi-Annual Monitoring Report and notify the Board in writing within 21 days of re-sampling. In this letter, the discharger shall evaluate whether any re-sampling or additional corrective measures need to be implemented.

3. <u>Well Logs</u>
A boring log and a monitoring well construction log shall be submitted for each new sampling well established for this monitoring program, as well as a report of inspection or certification that each well has been constructed in accordance with the construction standards of the Department of Water Resources. These shall be submitted within 45 days after the completion of well installation activities.

PART B: MONITORING AND OBSERVATION SCHEDULE

1. GPS PERFORMANCE MONITORING

Chevron shall measure the water level in each GPS corrective action monitoring well and in a sufficient number of wells or piezometers both upgradient and downgradient of the GPS to demonstrate continuous maintenance of a hydraulic depression in the GPS trenches (inward hydraulic gradient). To demonstrate the effectiveness of the GPS, Chevron shall include the following for each refinery sector in the semi-annual SMRs:

- contour maps of 1st and 3rd quarter GPS groundwater elevation data;
- hydrographs showing water level data (measured at least once per week) at each operating extraction sump or recovery well;
- a narrative summary of the GPS performance during the reporting period; and,
- an estimate of the volume of groundwater extracted during the reporting period.

2. ON-SITE OBSERVATIONS/POST-CLOSURE MAINTENANCE AND MONITORING

Closed waste management units (Plant 1/Additives Plant, Landfill 15, Landfarms 1-5, the Hydropits, Parr-Richmond Landfill and the Gertrude Street Site) shall be inspected annually by a registered California engineer or geologist prior to the onset of the rainy season. These annual inspections shall include identification of areas of the final covers where the soil has become eroded, attacked by rodents, or otherwise damaged, or where the paved areas have become damaged. Chevron shall perform appropriate repairs for these areas prior to the rainy season. In addition, Chevron shall monitor runoff/run-on control facilities for their effectiveness and overall condition as needed according to weather conditions during the winter months (November through April) and as prescribed in the approved post-closure maintenance/monitoring plan for each individual unit. Chevron shall maintain records of all inspections and repairs and summarize in each semi-annual monitoring report any repairs made during the corresponding reporting period.

3. ALKANE PLANT PLUME REMEDIATION MONITORING

Chevron shall continue to monitor the Alkane Plant Plume remediation effort according to the *Alkane Plant Plume Remediation Plan* (December, 1992). The monitoring components of this plan include measuring potentiometric water levels, liquid hydrocarbon thickness, and benzene and fluoride concentrations. Benzene and fluoride concentrations will continue to be measured annually in samples collected from 7 wells (listed in Table 1), located around the perimeter of the plume to verify containment of the plume.

4. S.P. HILL FREE-PHASE HYDROCARBON RECOVERYAND GROUNDWATER EXTRACTION SYSTEM MONITORING

Chevron shall continue to monitor groundwater remediation activities within the S.P. Hill Tankfield according to the *S.P. Hill Tankfield Free-Phase Hydrocarbon Recovery Facilities Installation and Startup Report and Remediation Monitoring Plan* (January, 1994). Monitoring components of this plan include: 1) monthly measurements of groundwater levels and hydrocarbon thickness in the recovery wells to confirm that pumps are set at correct elevations, 2) routine inspecting of pumps and controllers, piping, and temporary storage facilities; and 3) semi-annual monitoring of all the wells in the S.P. Hill Tankfield for free-phase liquid hydrocarbon.

5. FREE-PHASE LIQUID HYDROCARBON (FPLH) RECOVERY SUMMARY

Chevron shall include a map in each semi-annual SMR that shows the locations of all wells within the refinery that contain FPLH. The measured thickness of the FPLH in each well should be indicated on the map next to the well. In addition, the SMR shall include a description of FPLH recovery method/s used, recovery volume data for the reporting period and cumulative recovery data for each active recovery well or system.

6. CHEMICAL CONSTITUENT MONITORING

The discharger shall sample the compliance monitoring points listed in Table 1 for the analytical parameters and at the frequencies listed in Table 2. All monitoring activities, including analytical and QA/QC procedures will be conducted in accordance with the most recent version of Chevron's Groundwater Monitoring Program SOP.

Table 1. List of Monitoring Wells by Sector
Refinery-Wide Groundwater Monitoring Program
Chevron Richmond Refinery

Corrective Action									
GPS									
Alkane Sector	Castro and Plant 1/Add. Sector	Landfarms/Landfill 15 Sector	North Yard Sector	Reclamation Yard Sector	Pollard Sector	Effluent Sector	Bayside North	Bayside South	Interior "C" Zone
209A	323A	232A	178A	290A	260A	108A	387AT	346F	208C
460A	642A	233A	247A	643A	262A	164A	388AT	347F	638C
595AT	554A	234A	550A	370A	803A	179A	389F	348F	378C
223C	556A	240A	GPS-9A·	560A	635C	108C	390AT	349F	379C
375C	106C	244A	377C	109C		164C	391AT	351CT	380C
670C	125C	384A	178C	238C				345AT	138C
	320C	551A		369S				340AT	382C
167A*	649A	552A		564A				337F	
170A*		610A		569C				RW619AT#	
174A*		186C						RW534AT#	
200A*		104C							
201A*		232C							
258A*		234C							
		235C							
		236C							

Notes:
* Wells associated with Alkane Plant Plume Remediation Monitoring
\# Wells associated with Remediation Monitoring Plan, S.P. Hill Tankfield.
. GPS-9A is a proposed monitoring well

Table 2: Maximum Allowable Concentration Levels (MACLs) for Constituents of Concern and Monitoring Parameters for the Chevron Refinery Corrective Action Groundwater Monitoring Program

Constituents of Concern	MACL (μg/l unless otherwise noted)		Landfarms/Landfills Sector	Castro Sector	North Yard Sector	Bayside Sector – North	Bayside Sector – South	Alkane Sector	Effluent Sector	Reclamation Sector	Pollard Pond Landfill	Interior "C"-Zone
TPH-Gas	3.7 mg/l	c	X	X	X	X	X	X	X	X	X	X
TPH-Diesel	0.64 mg/l	c	X	X	X	X	X	X	X	X		X
Benzene	71	b^2	X	X	X	X	X	X	X	X	/	X
MTBE	N/A	d	X	X	X	X	X	X	X	X	/	X
Acenaphthene	40	e	/	/	/	/	/	/	/	/	/	
Acenaphthylene	N/A	d	/	/	/	/	/	/	/	/	/	
Anthracene	110 mg/l	b^2	/	/	/	/	/	/	/	/	/	
Benzo(a)pyrene	0.049	b^2	/	/	/	/	/	/	/	/	/	
Benzo(b)fluoranthene	0.049	b^2	/	/	/	/	/	/	/	/	/	
Benzo(g,h,I)perylene	N/A	d	/	/	/	/	/	/	/	/	/	
Benzo(k)fluoranthene	0.049	b^2	/	/	/	/	/	/	/	/	/	
Chrysene	0.049	b^2	/	/	/	/	/	/	/	/	/	
Dibenz(a,h)anthracene	0.049	b^2	/	/	/	/	/	/	/	/	/	
Fluoranthene	370	b^2	/	/	/	/	/	/	/	/	/	
Fluorene	14 mg/l	b^2	/	/	/	/	/	/	/	/	/	
Indeno(1,2,3-cd)pyrene	0.049	b^2	/	/	/	/	/	/	/	/	/	
Naphthalene	N/A	d	/	/	/	/	/	/	/	/	/	
Phenanthrene	N/A	d	/	/	/	/	/	/	/	/	/	
Pyrene	11 mg/l	b^2	/	/	/	/	/	/	/	/	/	
Chlordane	0.00059	b^2		/						/		
G-BHC (Lindane)	0.063	b^2		/						/		
Dieldrin	0.14	b^2		/						/		
Selenium	5.0	b^1	/	/	/			X	/	/	/	
Arsenic	36	a	X	/					/	X		

Constituents of Concern	MACL (μg/l unless otherwise noted)		Landfarms/Landfills Sector	Castro Sector	North Yard Sector	Bayside Sector – North	Bayside Sector – South	Alkane Sector	Effluent Sector	Reclamation Sector	Pollard Pond Landfill	Interior "C"-Zone
Cadmium	9.3	a	/	/	/			/	/	/	X	/
Chromium VI	50	a	/	/	/			/	/	/	/	/
Lead	5.6	a	X	X	X	X	X	X	X	X		/
Mercury	0.025	a	/						/	/		
Nickel	8.2	b[1]	X	/	X			X	/	X	X	X
Zinc	71	b[1]	X	/	/			/	/	/	X	/
Fluoride	2.4 mg/l	f						X				
Un-ionized Ammonia-N	25	a							/	/		
pH	6.5 to 8.5	a	X	X	X	X	X	X	X	X	X	X
Turbidity (NTUs)	N/A	N/A	X	X	X	X	X	X	X	X	X	X
Temperature	N/A	N/A	X	X	X	X	X	X	X	X	X	X

X = Monitoring Parameter per Sector (analyzed semi-annually)
/ = Constituent of Concern per Sector [analyzed during summer/fall reporting period every 2 years (even-numbered years)]
a = San Francisco Bay Basin, Water Quality Control Plan (RWQCB 1995)
b = 40 CFR Part 131. *Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Proposed Rule.* August 1997.
[1] Criterion for Continuous Concentration (chronic toxicity)
[2] Human Health – consumption of aquatic organisms
c = Water quality goals used for redevelopment of San Francisco International Airport (RWQCB Order No. 99-045)
d = No state or federal numeric water quality criteria for toxicity to aquatic organisms have been promulgated
e = USEPA Ecotox Threshold, Final Chronic Value (1996)
f = Tentative value
N/A = Not applicable
(NTUs) = Nephelometric Turbidity Unit(s)

I, Lawrence P. Kolb, Acting Executive Officer, hereby certify that the foregoing Self-Monitoring and Reporting Program:

1. Has been developed in accordance with the procedures set forth in this Board's Resolution No. 73-16 in order to obtain data and document compliance with waste discharge requirements established in this Board's Order No. 00-043.

2. Is effective on the date shown below.

3. May be reviewed or modified at any time subsequent to the effective date, upon written notice from the Executive Officer.

Date Ordered: June 21, 2000

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Lawrence P. Kolb
Acting Executive Officer