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Engineers/Consultants

February 19, 2012

Mr. Craig Olson, PE
Ms. Mallika Ramanathan, PE
HDR Engineering
2365 Iron Point Road, Suite 300
Folsom, CA 95630

Subject: Geotechnical and Geologic Research
Pinole-Hercules Water Pollution Control Plant Upgrade Project
Pinole, California

DRAFT

Dear Mr. Olson and Ms. Ramanthan:

This letter report summarizes the results of our geologic and geotechnical research for the Pinole-Hercules Water Pollution Control Plant (WPCP) Upgrade project.

1 Introduction

The WPCP site is located in Pinole, California along the edge of the San Pablo Bay. Project site maps are presented on Figures 1 and Figure 2. The WCPC Upgrade Project includes the following new facilities and associated piping:

WPCP Upgrade Project will include the following new facilities and associated piping:

- Headworks Structure (Influent Pump Station, Headwords, and Grit Facility)
- Primary Clarifier #3
- New Electrical Building
- Secondary Clarifiers #1 and #2
- Secondary Clarifier Distribution Box
- Extension to Aeration Basins
- Solid Handing Building
- Sludge Storage

References to the project design elements described are based on a Pinole-Hercules WPCP Plant Site Map (Figure 4-4) provided by HDR (print date 02-11-13).

2 Geotechnical Research

2.1 Geologic Mapping

Detailed descriptions of soils in the vicinity of the project area, along with a map outlining their general distribution are presented on Figure 3. The geologic mapping shows the project is located in an area of artificial fill (placed on Young Bay Mud), and alluvial fan and fluvial deposits. The Young Bay Mud is typically soft clay with occasional loose sand layers. The alluvial fan and fluvial deposits are typically mixed clayey sands and clays.

2.2 Near-Surface Soil Mapping

Soil mapping of the upper 5 feet of native soil by Welch and others (1977) at the WPCP site is presented on Figure 4. The mapped native soil unit at the WPCP includes the Joice Muck soil unit (i.e., also known as Young Bay Mud). The parent material of the Joice Muck soil unit consists of organic material. The natural drainage class is very poorly drained. This soil is occasionally flooded and frequently ponded. Engineering and chemical properties of the Joice soil unit in the upper approximately 5 feet are summarized in Tables 1 and 2, below.

Table 1. Engineering Properties Native Soils (upper approximately 5 feet)

USDA Soil Type	Depth (Inch)	Classification		Percent Passing Sieve #				Liquid Limit	Plasticity Index
		USDA	USCS	4	10	40	200		
Joice Muck (Ja)	0-15	Muck	PT	0	0	-	-	-	-
	15-60	Muck	PT	0	0	-	-	-	-

Table 2. Chemical Properties Native Soils (upper approximately 5 feet)

USDA Soil Type	Depth (Inch)	Cation-Exchange Capacity	Effective Cation-Exchange Capacity	Soil Reaction	Calcium Carbonate	Gypsum	Salinity	Sodium Adsorption Ratio
		Meg/100g	Meg/100g	pH	Pct	Pct	Mmhos/cm	-
Joice Muck (Ja)	0-15	-	80-120	4.5-5.5	0	0	16.0-48.0	0
	15-60	-	70-120	4.5-6.0	0	0	16.0-48.0	0

2.3 Historic Topographic Maps and Historic Aerial Photographs

Historic topographic maps and historic aerial photographs of the WPCP site are presented in Figure 5 and Figure 6, respectively. The following is a summary of the WPCP site development between 1902 and present-day as documented on the historical topographic maps and aerial photographs:

- In 1902, the WPCP site was located within a wet land area along the edge of the San Pablo Bay. A possible pier structure appears to have been located at the WPCP site.

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- Between 1902 and 1942, the WPCP site was fill-in. It is not known if the possible pier structure and/or the pier piling were removed prior or during the placement of the initial WPCP site filling.
- Between 1942 and 1957, additional fill was placed on WPCP the site; Pinole Creek was realigned along the northeast side of WPCP site; and the original WPCP was constructed. The WPCP facilities appear to include Primary Clarifier #1, Digester #1, Effluent Pump Station, and drying beds.
- Between 1957 and 1969, the WPCP fill pad was expanded and Pinole Creek was realigned and widened along the northeast side of the WPCP site. Digester #2 was in construction in 1969.
- Between 1969 and 1984, a large expansion of the WPCP occurred. New structures included the original Secondary Clarifiers #1 and #2, Aeration Basins, Clarifier #2, Control Building, Blower Building, Maintenance Shop, Sludge Handling Building, Cogen Building, and Corp Yard Building. In addition, Secondary Clarifiers 3 and 4, Primary Clarifier 3, and the Chlorine Contact Basin, and were in construction in 1984.
- Between 1984 and 1990, the park southwest of the WPCP was developed and an additional warehouse-like structure was constructed northeast of Corp Yard Building.
- Between 1990 and Present, Digesters #3 and #4 were constructed.

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2.4 Previous Geotechnical Engineering Reports

Previous geotechnical investigations were performed at the WPCP by Koelzer Engineering Services (1995), Hultgren-Tillis Engineers (2001), and DCM Engineering (2005). The locations of the test borings (herein referred to as “reference borings”) are shown on Figure 1 and on Figure 2. Copies of the reference borings are included in Appendix A of this letter report.

ConCeCo/Matcor performed corrosion testing on soil samples selected and obtained by DCM Engineering during the geotechnical engineering investigation for the WPCP Anaerobic Digester Improvements Project. The results of the corrosion tests are represented on Figure B-1 in Appendix B.

2.5 Published Environmental Reports

The State of California’s Geotracker site map identifies no leaky underground storage tank (LUST) cleanup sites or any other cleanup sites at or in the near vicinity of the WPCP site.

2.6 Faults and Seismic Setting

The location of active faults and other major seismogenic sources relative to the WPCP site are shown on Figure 7. As illustrated on Figure 7, the WPCP site is not crossed by any known active fault (an active fault as defined by the State Geologist is one with clearly identified evidence of surface displacement within the last 11,000 years. The nearest active fault to the project pipeline alignment is the Hayward Fault located 2.5 kilometers to the southwest of the project area.

The nearest active faults to the WPCP and their respective seismic parameters are provided in Table 3.

Table 3. Nearby Active Fault Parameters

Fault	Maximum Moment Magnitude	Slip Rate (mm/yr)	Seismic Source Type	Closest Distance to WPCP (km)
Hayward	7.1	9	A	4.5
Rogers Creek	7.0	9	A	7
West Napa	6.5	1	B	14.5
Concord-Green Valley	6.5	6	B	16
Calaveras	6.8	6	B	28
San Andreas	7.9	24	A	33

The major earthquake faults in the project area are the San Andreas Fault, Hayward Fault, West Napa Fault, Concord-Green Valley Fault, Rodgers Creek Fault, and Calaveras Fault which are within 4.5 to 33 kilometers of the project site.

The Association of Bay Area Governments (ABAG) has reported that the Working Group on California Earthquake Probabilities (2007) has estimated that there is a 63% probability that one or more major earthquakes ($M \geq 6.7$) will occur in the San Francisco Bay Area within the next 30 years.

The WPCP site will be subject to the highest levels of ground shaking during future earthquakes on the Hayward Fault, Rodgers Creek Fault, San Andres Fault, and on other seismogenic sources in Northern California. The maximum moment magnitude for the Hayward Fault, Rodgers Creek Fault, and San Andreas Fault is M7.1, M7.0, and 7.9, respectively.

The level of ground shaking anticipated at the project site during seismic events is illustrated on Figure 8. There is a 10% probability in 50 years that earthquake ground shaking will exceed 0.70g at the project site. The actual ground shaking that will occur at the project site during an earthquake will be influenced by a variety of factors including (1) the earthquake magnitude, its distance (e.g., near source factors), mode, and direction of seismic wave propagation (directivity), and (2) topographic and soil to bedrock amplification or attenuation conditions.

Bolt (1993) indicated that when the average peak ground acceleration exceeds about 0.50g, the ground cracks conspicuously and underground pipelines are sometimes broken (i.e., damage consistent with a Modified Mercalli Intensity IX or greater); see Figure 8. It is probable that the ground surface acceleration at the project site will reach or exceed 0.5g to 0.6g during large earthquakes on faults in the San Francisco Bay Area, and that in such events, damage to WPCP structures from seismic shaking should be expected.

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2.8 Liquefaction

As illustrated on Figure 10, the WPCP is in a mapped area having high liquefaction susceptibility (Witter & others, 2006). Liquefaction develops when cyclically-induced ground stresses generated by earthquake shaking result in an increase in pore water pressure within the soil to sufficient levels that the soil loses shear strength and liquefies. Liquefied soils compact (settle) as pore pressures return to static levels and soil particles reconfigure to denser packing. This densification of confined sand layers can cause ground surface settlement. Liquefied soils can experience flow failure in the form of lateral spreading in the direction of an unconfined free face (e.g., toward a creek bank) and toward ground fissures and sand boils. Soils most susceptible to liquefaction are loose, clean, saturated, non-cohesive silts and sands within 50 feet of the ground surface.

The reference borings (see Appendix A) logged localized layers of loose silty sand in between about 11.5 feet and 15.5 feet at Boring RB-1, 8 feet to 13 feet at Boring RB-2, 9.5 feet and 11.5 feet at Boring RB-6 that are potentially susceptible to liquefaction settlement. Should liquefaction of these 2- to 5-foot thick silty sand layers occur during a strong seismic event, we estimate that the densification could result in about 1 to 2 inches of settlement to the overlying piping and ground surface.

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3 Subsurface Soil and Groundwater Conditions

A summary of the subsurface soil and groundwater conditions encountered in the reference boring logs is presented in Table 4.

Table 4. Summary of Reference Boring Data

Reference Boring	Total (Feet)	Fill (Feet)	Soft to Medium Stiff Bay Mud (Feet)	Loose to Medium Dense Sand (Feet)	Medium Stiff Clay or Silt (Feet)	Stiff to very stiff Clay or Silt (feet)	Ground-Water Seepage Depths (feet)
RB-1	46.5	0 to 5	5 to 11	11 to 15.5 44.5 to 45.5[F]	-	15.5. to 44.5 45.5 to 46.5	11, 19, & 36[£] feet
RB-2	23.5	0 to 7.5	-	-	7.5 to 14	14 to 23.5	6.1[ᵌ]
RB-3	37.5	0 to 5.5	5.5 to 7.5	7.5 to 13.5 24.5 to 30	13.5 to 21	21 to 24.5 30 to 37.5	6.4[ᵌ]
RB-4	40	0 to 7.5	NE	28.5 to 29.5	-	7.5 to 28.5 29.5 to 40	22 feet
RB-5	30	0 to 7	7 to 11.5[‡]	27 to 30[†]	-	11.5 to 27[¥]	8 feet
RB-6	30	0-12	NE	-	-	12 to 30[^]	NM

[F] Medium dense to dense clayey gravel layer.
[£] Depth of water level measured 15 minutes after drilling.
[ᵌ] Static groundwater levels levels of 6.1 and 6.4 feet below existing grade were measured by Hultgren-Tillis in 2001 within slotted pipes placed within boreholes.
[ᶳ] Silt and Sandy Silt
[‡] Includes loose silty sand to clayey sand Bay Mud between 9.5 and 11.5 feet.
[†] Dense sands
[¥] Very stiff to hard
[^] Contains fine sand interlayers

Groundwater seepage was noted during the drilling of some of the reference borings. It should be noted that the reference borings were drilled with hollow stem augers which seal off groundwater in boreholes. As such, groundwater levels within boring holes could not be accurately determined.

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4 WPCP Upgrade Structure Foundations

4.1 Structure Foundations

It is our understanding that all the existing WPCP treatment structures are supported on reinforced concrete mats.

The anticipated foundation type, approximate foundation depth, anticipated underlying foundation soils, and anticipated amount of over-excavation required below the planned WPCP Upgrade Project structure foundations is summarized in Figure 5, below.

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Table 5. Anticipated Foundation Type and Depth, Anticipated Soils Type, and Overexcavation

Planned WPCP Upgrade Project Structures	Foundation Type	Approx. Foundation Base Depth	Anticipated Underlying Foundation Soils	Anticipated Over-Excavation
Headworks: Influent Pump Station	Mat	18 feet	Stiff to Very Stiff Clay	2 to 4 feet
Headworks: Headworks and Grit Screens	Mat[¥]	2 feet	Fill Underlain by Bay Mud	12 feet*
Primary Clarifier #3	Mat	19 feet	Stiff to Very Stiff Clay	2 to 4 feet
Electrical Building	Mat	At-grade	Fill Underlain by Bay Mud	12 feet*
Secondary Clarifiers #1/#2	Mat	14 feet (edge) 18 feet (center)	Stiff to Very Stiff Clay	8 feet (edge) to 4 feet (center)
Secondary Clarifier Box	Mat	12 feet	Loose to Medium Dense Sand	4 feet
Aeration Basin Extension	Mat	18 feet	Very Stiff to Hard Clay	2 feet
Solids Handling Building	Mat[¥]	At-grade	Fill Underlain by Bay Mud	12 feet*
Sludge Storage Tank	Mat[¥]	At-grade	Fill Underlain by Bay Mud	12 feet*

* Deep over-excavation required to remove underlying Bay Mud and potential liquefiable loose/medium dense sands below the Headworks/Grit Screens, Electrical Building, Solid Handling Building and Sludge Storage Tank. Note the deeper excavation below these structure could be required is liquefiable soils are encountered below 12 feet.

Alternative options to deep over-excavation at Headworks/Grit Screens, Electrical Building, Solids Handling Building, and Sludge Storage Tank and include ground improvement (e.g., stone columns, compaction grouting) and piles.

4.2 Seismic Design

The WPCP site is located near, but not crossed by, active faults. The potential for damage to new structures due to fault offset is remote. The primary seismic hazard at the project site will be ground shaking. On the basis of historical evidence, it is reasonable to assume that during its lifetime, the WPCP Upgrade Project structures will be subject to at least one moderate to severe earthquake that will cause violent ground shaking at the project site. The effects of ground shaking on WPCP Upgrade Project structures should be mitigated by design and construction detailing in accordance with the foundation and seismic provisions in the 2010 California Building Code, as a Site Class D.

4.3 Soil Corrosivity

Reference soil corrosivity test results (see Figure B-1 in Appendix B) indicate the sulfate and chlorides concentrations in the sampled soils from Reference Boring B-4 are relatively low; however, do the close proximate to the San Pablo Bay and the remnant layers of Bay Mud in the soil profile we anticipate that all buried concrete will need to be designed for at least moderately corrosive soils as defined in ACI Building Code 318.

Additional corrosivity testing will be performed as part of the geotechnical engineering investigation for the WPCP Upgrade Project.

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5.0 Close

Based on our geotechnical and geologic research presented herein, no fatal geotechnical-related flaws in the proposed WPCP Upgrade project were found. We appreciate the opportunity to be service to the Cities of Pinole and Hercules and HDR on WPCP Upgrade Project. If you have any questions regarding this letter report, please contact us.
Sincerely yours,

JACOBS ASSOCIATES

Robert Kahl, PE, GE
Associate

Attachments: Figure 1 - Project Site and Reference Boring Location Map
Figure 2 - WPCP Photo and Reference Boring Location Map
Figure 3 - Geology Map
Figure 4 - USDA Soil Survey Map
Figure 5 - Historic Topographic Maps
Figure 6 - Historic Air Photos
Figure 7 - Bay Area Faults
Figure 8 - Seismic Shaking Map
Figure 9 - Modified Mercalli Scale
Figure 10 - Liquefaction Map

<u>Appendices</u>
Appendix A – Reference Boring Logs
Appendix B – Reference Corrosion Test Results

Reference: 5011.0

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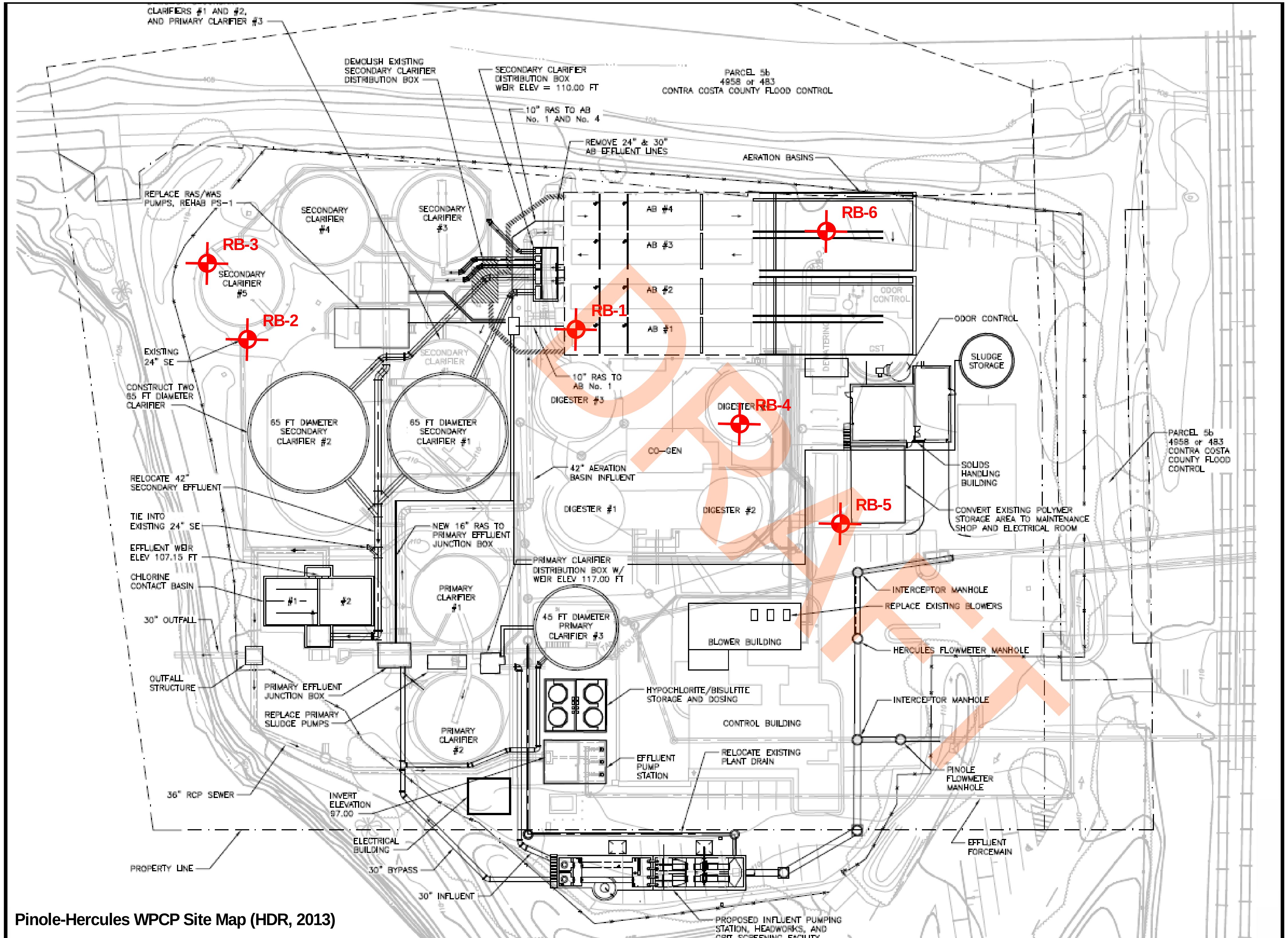

Pinole-Hercules WPCP Site Map (HDR, 2013)

0 30 60 120 ft.

1" = 60'
Approximate

LEGEND:

RB-1 Reference Borings (logs in Appendix A)

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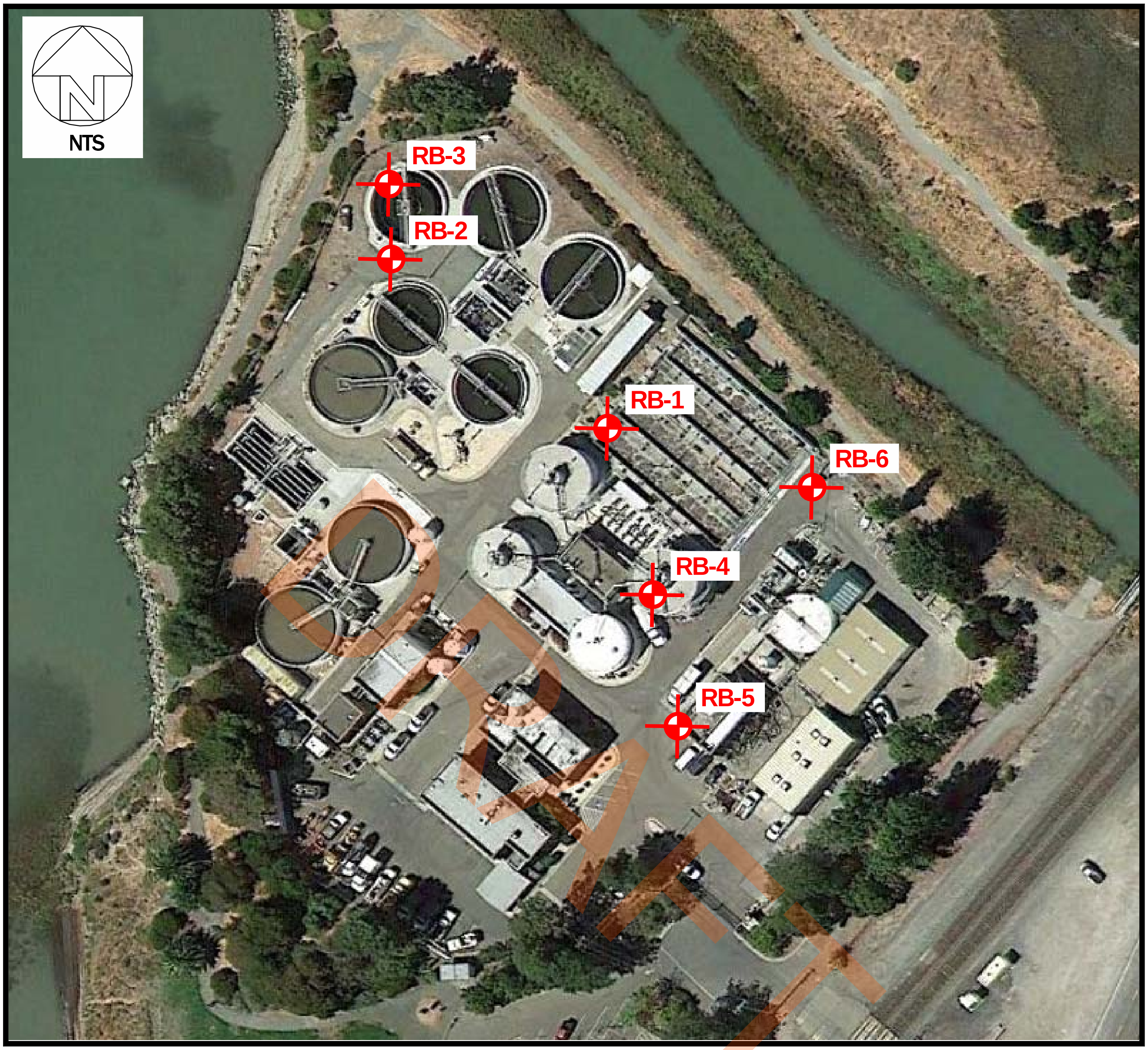
Pinole-Hercules WPCP Upgrade Project
Pinole, California

Project Site and Reference Boring Location Map

Figure **1** (Color)



LEGEND:

RB-1 Reference Borings
(logs in Appendix A)

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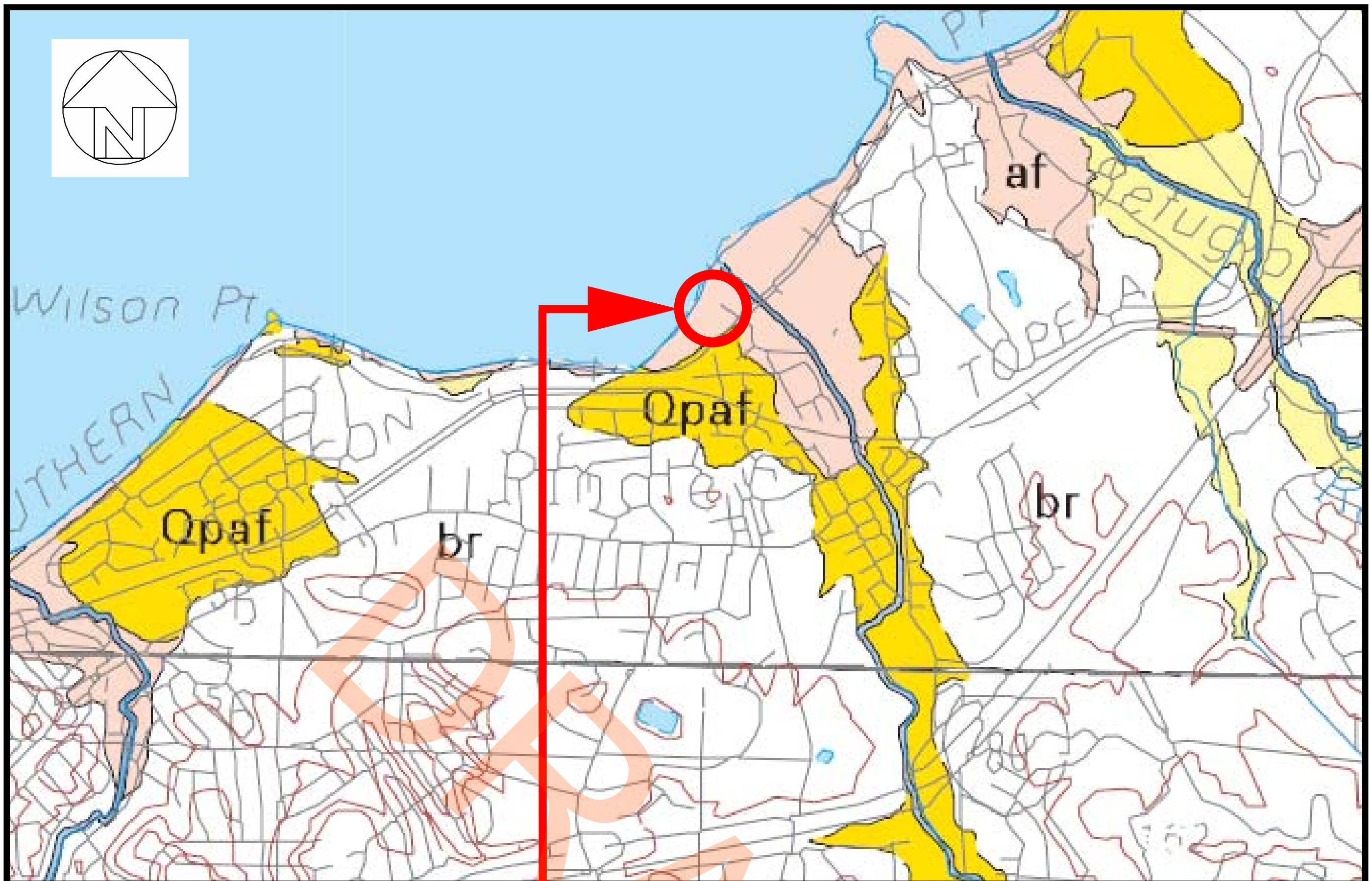
Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

WPCP Photo and
and Reference Boring Location Map

Figure
2



MAP AND DESCRIPTION SOURCE:
U.S. Geological Survey Open-File Report OF97-98.

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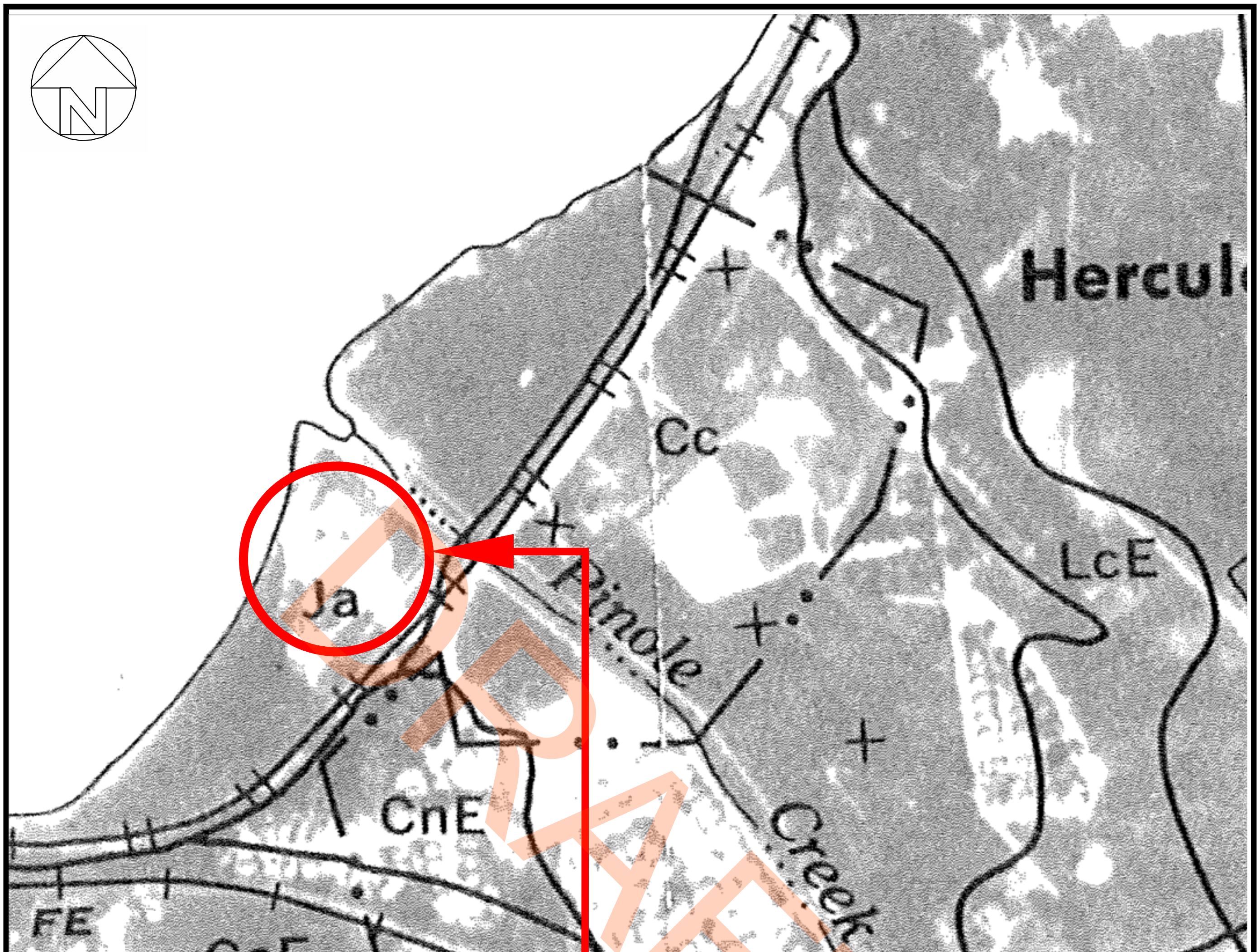
DESCRIPTIONS:

af	**ARTIFICIAL FILL (Historic)** - Man-made deposit of various materials and ages. Some are compacted and quite firm, but fills made before 1965 are nearly everywhere not compacted and consist of dumped materials.
Qpaf	**ALLUVIAL FANS AND FLUVIAL DEPOSITS (Pleistocene)** - Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located along most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. they are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50m.

JACOBS ASSOCIATES Engineers/Consultants		**HDR** Pinole-Hercules -Water Pollution Control Plant Upgrades Pinole, California **Geology Map**	**Figure** **3**
File No. 5011.0	February 2013		



MAP AND DESCRIPTION SOURCE:
Soil Survey of Contra Costa County by Welch and others (1977).

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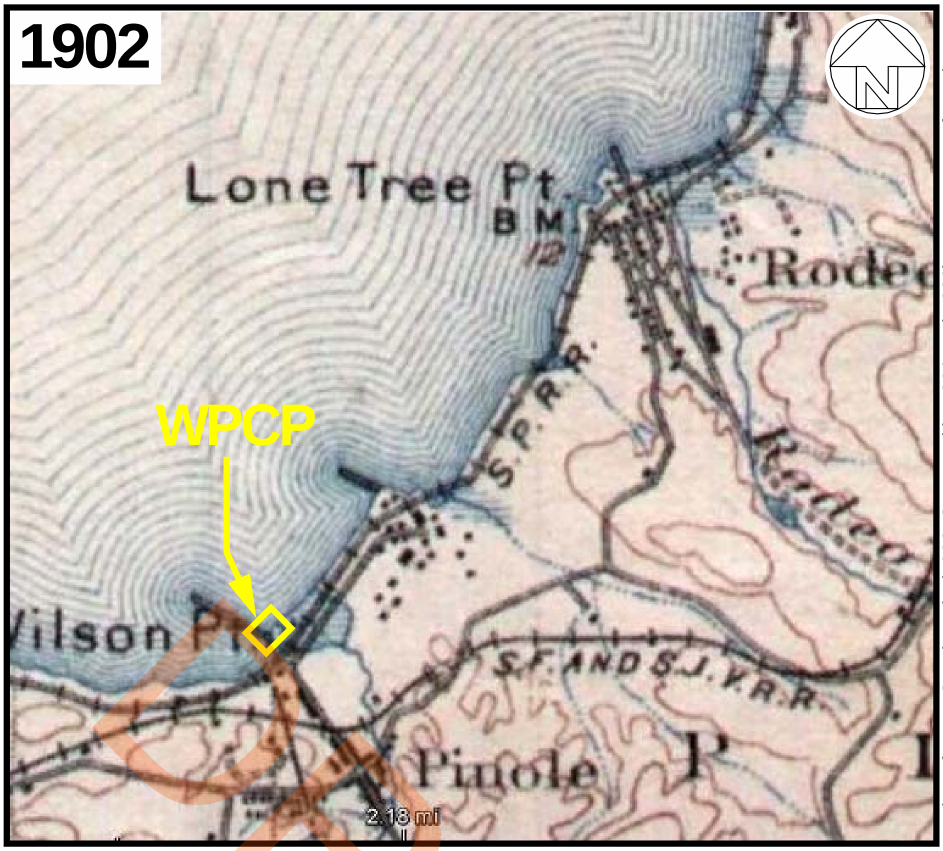
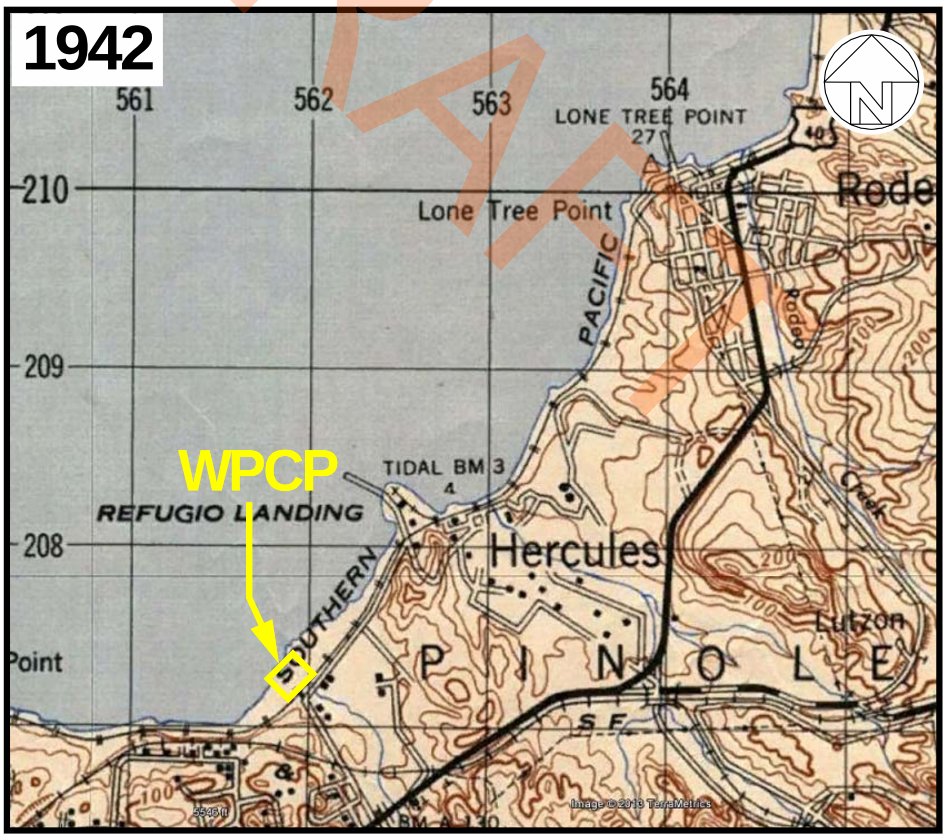
Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

USDA Soil Survey Map

Figure
4



Portion of Napa Quadrangle (1902, Surveyed in 1896 and 1899), Department of Interior, U.S.Geologic Survey.



Portion of Napa Quadrangle (1948, Aerial Photography from 1937), U.S. Corps of Engineers.

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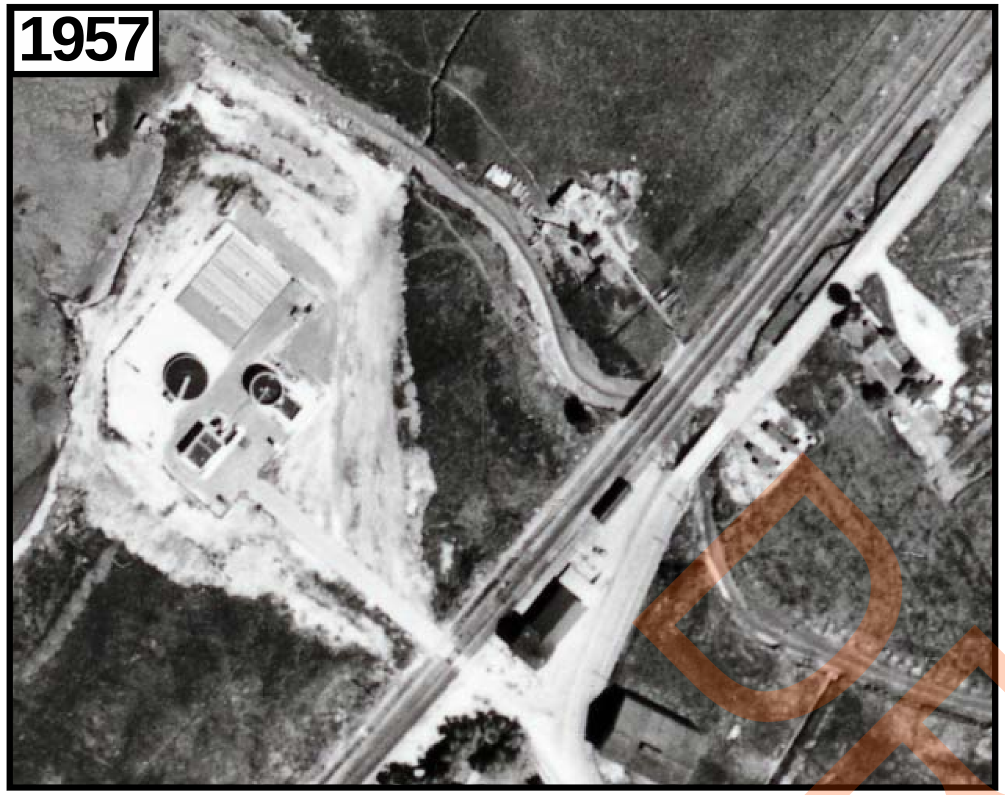
Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Historic Topo Maps

Figure

5



Portion of Pacific Aerial Surveys AV 253-07-02, dated 5-3-57

Portion of Pacific Aerial Surveys AV 2480-03-52, dated 5-17-84

Portion of Pacific Aerial Surveys AV 902-11-02, dated 5-19-69

Portion of Pacific Aerial Surveys AV 3845-06-01, dated 6-12-90

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Historic Air Photos

Figure 6

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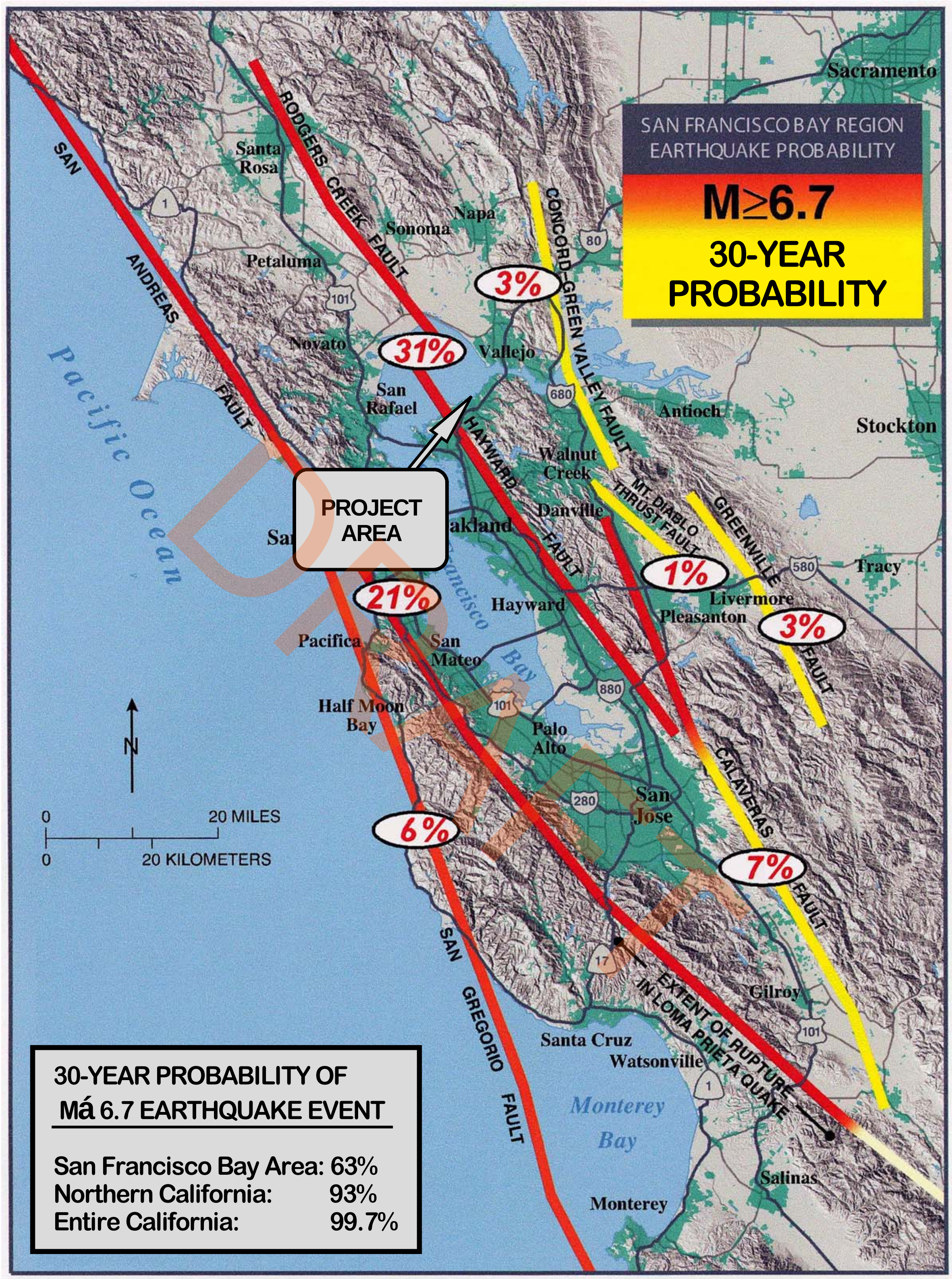

Modified from WGCEP (2003 and 2007)

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Pinole, California

Bay Area Faults

Figure 7

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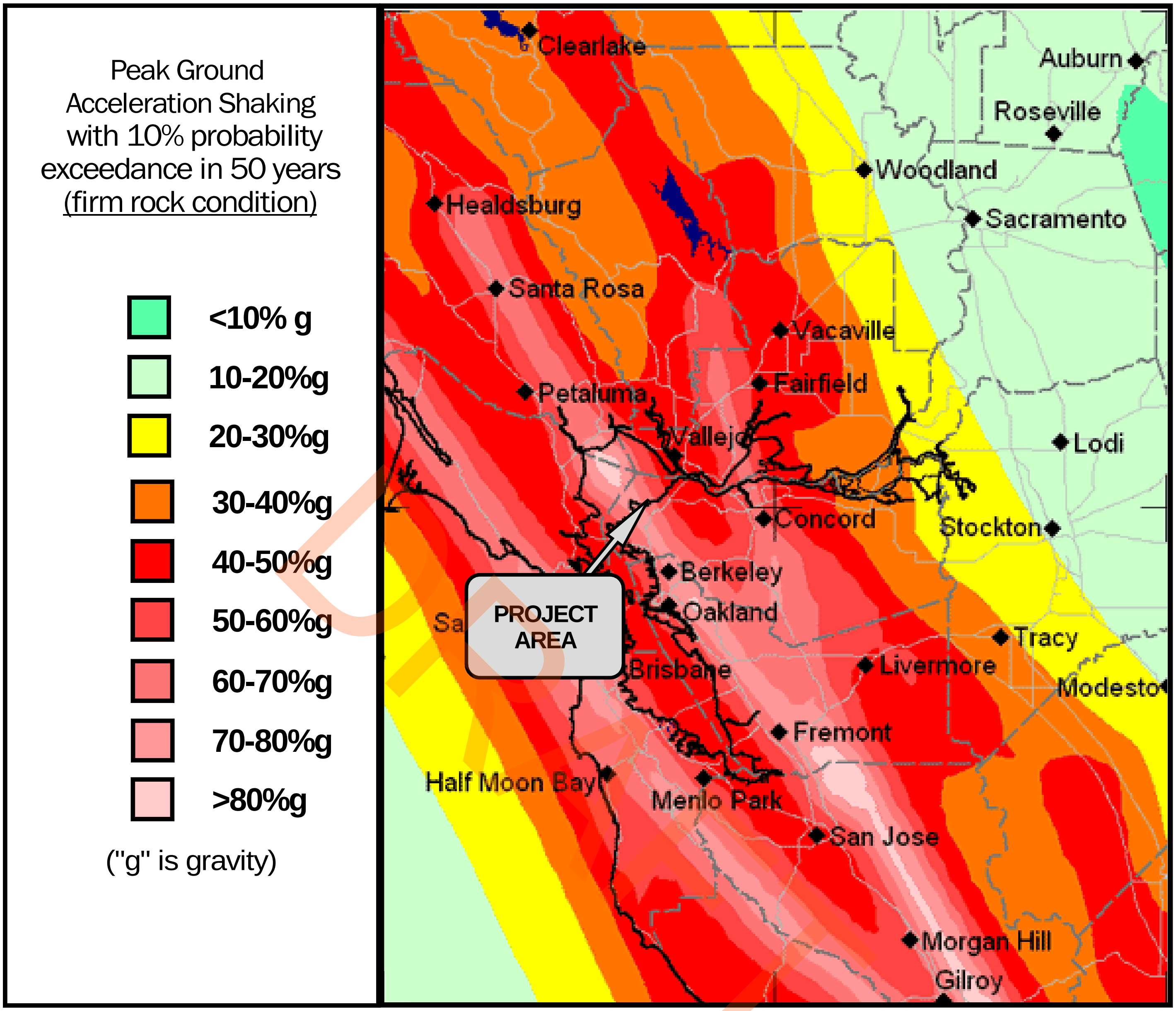

Modified from USGS/CGS 2002 Probabilistic Seismic Hazards Assessment Model (Cao and others 2003).

Latitude/Longitude	N 38.013°/W -122.297°
Peak Ground Acceleration:	0.553g

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Seismic Shaking Map

Figure **8**

AVERAGE PEAK VELOCITY (CENTIMETERS PER SECOND)	MODIFIED MERCALLI INTENSITY VALUE AND DESCRIPTION	AVERAGE PEAK ACCELERATION ("g" is gravity - 9.80 metres per second squared)
	I. Not felt except by a very few under especially favorable circumstances.	
	II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.	
	III. Felt quite noticeable indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing vehicles may rock slightly. Vibration like passing of a truck. Duration estimated.	
1-2	IV. During the day felt indoors by many, outdoors by few. At night some awakened. Rattling of dishes, windows, and doors; walls make creaking sounds. Hanging objects swing. Sensation like a heavy truck passing. Standing vehicles rocked noticeably.	0.015g-.02g
2-5	V. Felt by nearly everyone, many awakened. Some dishes, windows and so on broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles and other tall objects sometimes noticeable. Pendulum clocks may stop. Buildings trembled throughout.	0.03g-0.04g
5-8	VI. Felt by all, many frightened and run outdoors. Some moderately heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Trees, bushes, shaken slightly to moderately. Damage slight in poorly constructed buildings. Broken dishes, glassware and some windows. Moved furnishings and overturned furniture.	0.06g-0.07g
8-12	VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; chimneys cracked to considerable extent. Noticed by persons driving vehicles. Waves on ponds, lakes, running water. Broke numerous windows, heavy furniture overturned. Dislodged bricks and stones.	0.10g-0.15g
20-30	VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving vehicles disturbed.	0.25g-0.30g
45-55	IX. Damage considerable in specially designed structures; well-designed frame structures thrown out-of-plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. Reservoirs threatened.	0.50g-0.55g
More than 60	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Railroad rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks. Reservoirs greatly damaged. Open cracks in cement pavements and asphalt road surfaces.	More than 0.60g
	XI. Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly. Dams, dikes, embankments severly damaged. Destroyed large well-built bridges.	
	XII. Damage total. Practically all works of construction damaged greatly or destroyed. Landslides, falls of rock, slumping of river banks extensive. Fault slips in firm rock, with notable horizontal vertical off-set displacements. Water channels, surface and underground disturbed and modified greatly. Waves seen on ground surfaces.	

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REFERENCE ; Compiled from "Earthquakes & Volcanoes," Volume 21, Number 1, 1989, and "Earthquakes A Primer," Bruce A. Bolt, W.H. Freeman and Company, San Francisco, Copyright 1993.

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Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Modified Mercalli Scale

Figure
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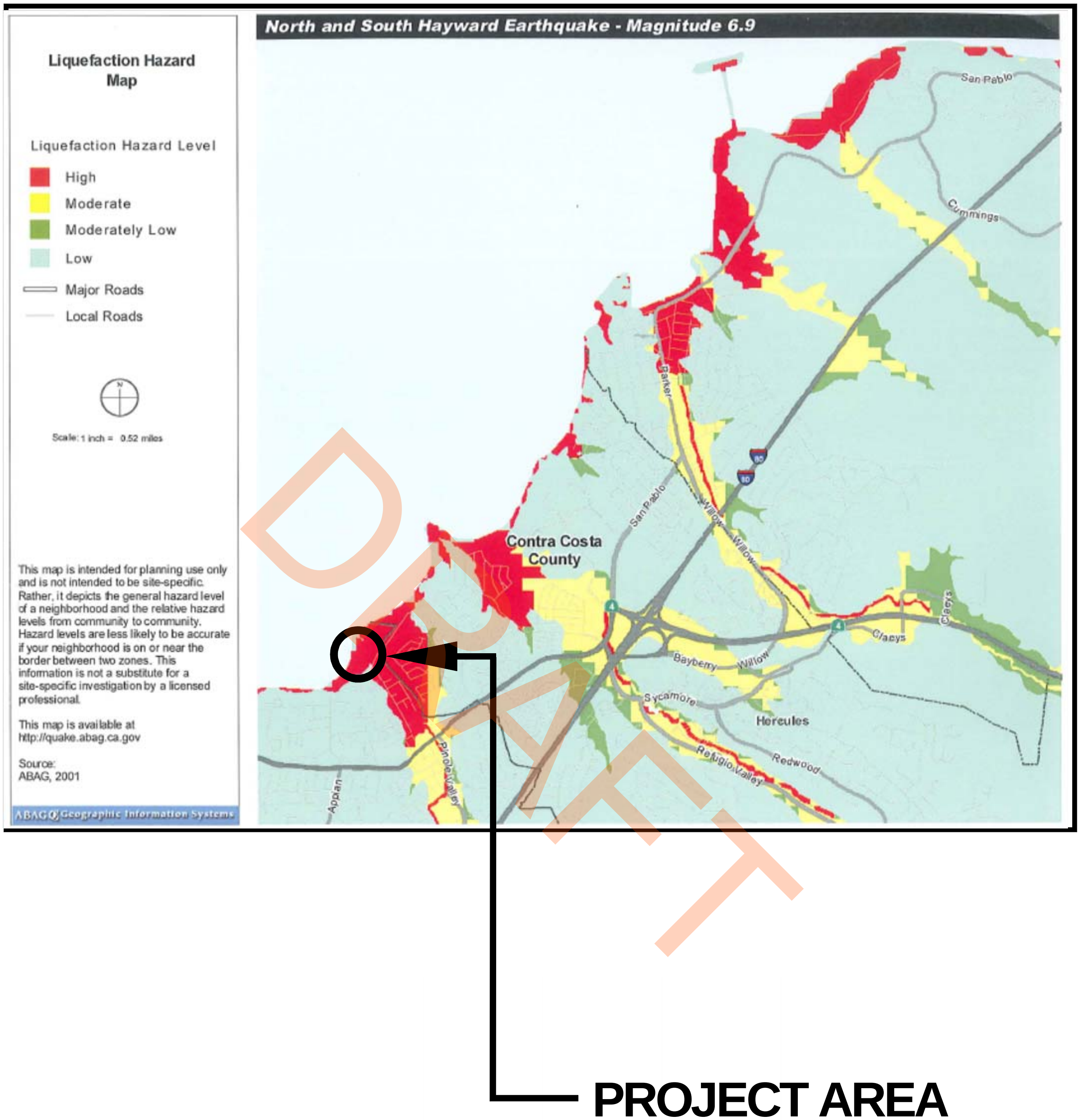

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Liquefaction Map

Figure **10**

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Appendix A

Completion Date	3-31-95	Surface Elevation	10' MSL (See Note 3)
Equipment	MOBILE B-61 with 8" Hollow Stem Auger	Ground Water	Free water observed at 11'

Depth (ft)	Dry Density (pcf)	Moisture Content (%)	Blow/ft	Sample		Description
0						
1						
2					CL	**MEDIUM BROWN SILTY CLAY** moderately stiff, moderately moist, sticky, trace sand
3	91	24.0	11	3.0–3.5		
4						trace of small gravel
5						
6						
7	82	33.2	3.5	6.5–7.0		
8					CH	**BLACK TO DARK BROWN CLAY** very moist, fat, trace fine sand, soft to very soft
9						
10						increasing trace of fine gravel
11						▽ moderate water entry encountered at 11.0 feet while drilling
12	95	27.2	6	11.5–12.0		
13					SC	**MEDIUM GREY GREEN SILTY SAND** loose, water saturated, trace clay
14						
15						
16	88	32.6	19	16.0–16.5	ML	**MEDIUM TAN GREEN SILT** moist, medium dense, sandy
17						

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KOELZER ENGINEERING SERVICES

FILE NUMBER: 1185.02 4-6-95

LOG OF BORING 1

Waste Water Treatment Plant
Pinole, California

PLATE: 4

Reference: Koelzer Engineering Services (1995).

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Reference Boring RB-4

Figure
A-1
(1 of 3)

Completion Date	3-31-95	Surface Elevation	10' MSL (See Note 3)
Equipment	MOBILE B-61B with 8" Hollow Stem Auger	Ground Water	Free water observed @ 11'

Depth (feet)	Dry Density (pcf)	Moisture Content (%)	Blow/ft	Sample		Description
17–24					ML	**MEDIUM TAN GREEN SILT (CON'T)** moist, medium dense, sandy
19						water rapidly entering borehole @ approx. 19' below ground surface
21.5–22.0	74	41.8	30	21.5–22.0		grading to medium brown clayey silt w/a slightly waxy appearance
24–28	93	26.5	31	26.5–27.0	ML	**ORANGE TAN SANDY SILT** moist, massive, medium dense
28–29.5					MH	**MEDIUM TAN CLAYEY SILT** moist, fine sand, plastic, stiff
29.5–34	87	31.3	30	31.0–31.5	CL	**MEDIUM TAN SILTY CLAY** very moist, stiff, massive, waxy

KOELZER ENGINEERING SERVICES

FILE NUMBER: 1185.02 4-6-95

LOG OF BORING 1(cont'd)

Waste Water Treatment Plant
Pinole, California

PLATE: 5

Reference: Koelzer Engineering Services (1995).

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Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-1 (cont'd)

Figure **A-1**
(2 of 3)

DRAFT

Completion Date	3-31-95	Surface Elevation	10' MSL (See Note 3)
Equipment	MOBILE B-61 with 8" Hollow Stem Auger	Ground Water	Free water observed at 11'

Depth (feet)	Dry Density (pcf)	Moisture Content (%)	Blow/ft	Sample		Description
34						
35						
36						water level at 36.0 feet, 15 minutes after drilling (not a static water level)
37	88	31.5	32	36.5-37.0		
38						
39						
40					ML	**MEDIUM TO LIGHT TAN SANDY SILT** moderately moist, medium dense trace white kaolinite & organic flakes
41						
42	101	24.3	45	41.5-42.0		
43						
44						
45					GC	**BROWN TAN CLAYEY GRAVEL**
46	85	33.6	35	45.5-46.0	ML	**MEDIUM TAN CLAYEY SILT** moist, very stiff, trace gravel
47						boring terminated at 46.5'
48						
49						
50						
51						

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KOELZER ENGINEERING SERVICES

FILE NUMBER: 1185.02 4-6-95

LOG OF BORING 1 (CON'T)
Waste Water Treatment Plant
Pinole, California

PLATE: 6

Reference: Koelzer Engineering Services (1995).

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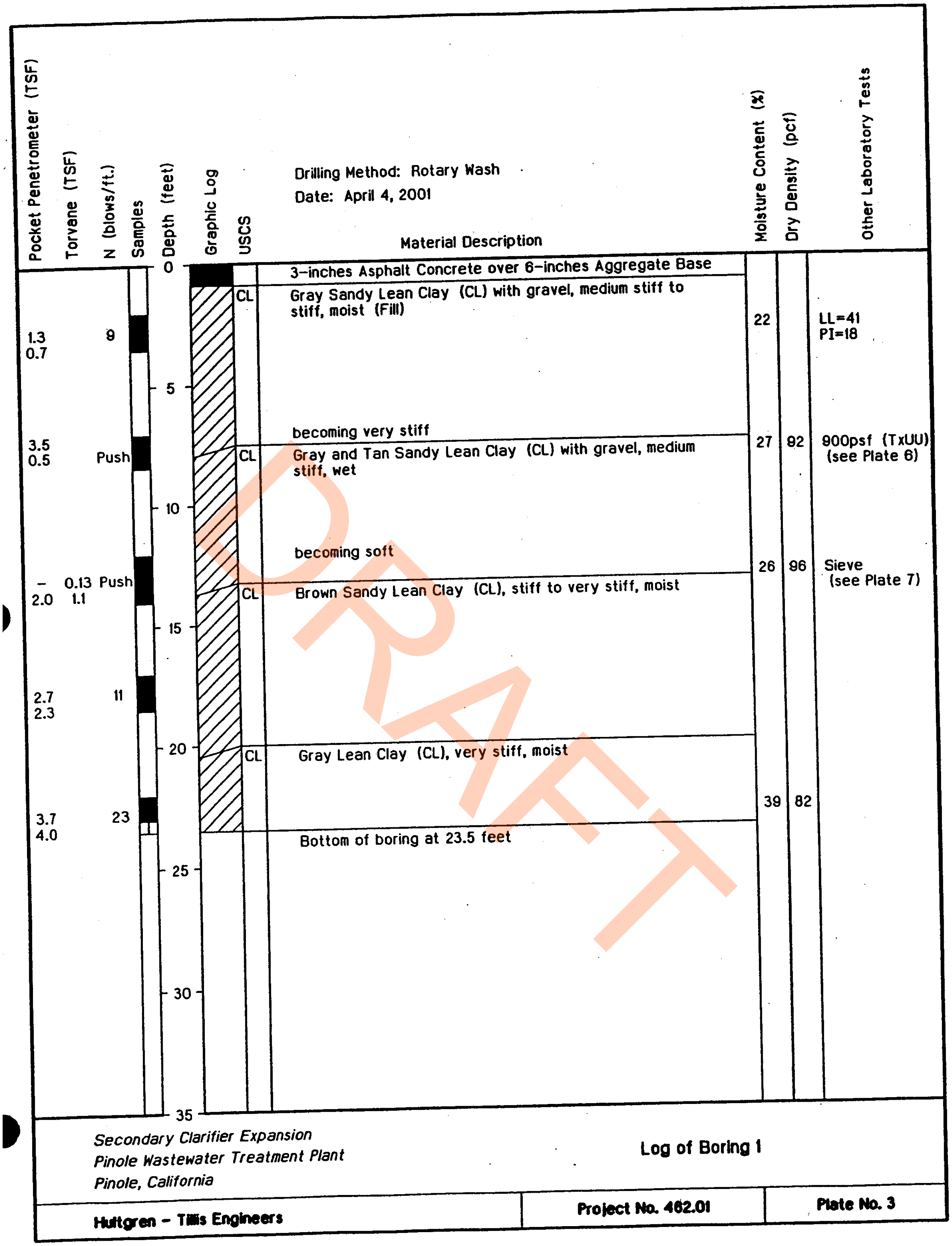
Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-1 (cont'd)

Figure **A-1**

(3 of 3)



Reference: Hultgren-Tillis Engineers (2001).

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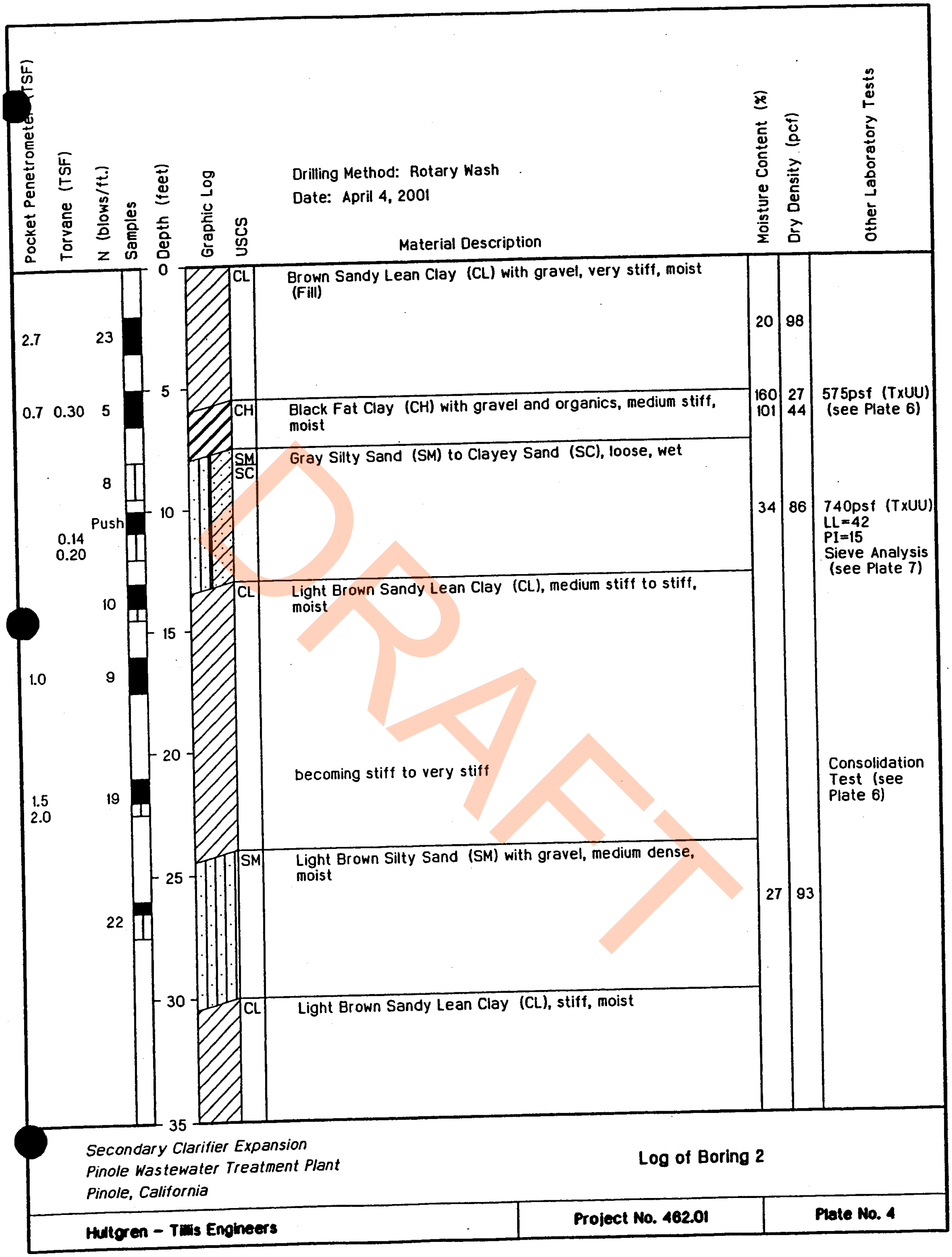
Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-2

Figure
A-2



Drilling Method: Rotary Wash
Date: April 4, 2001

Pocket Penetrometer (TSF)	Torvane (TSF)	N (blows/ft.)	Depth (feet)	USCS	Material Description	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
			0	CL	Brown Sandy Lean Clay (CL) with gravel, very stiff, moist (Fill)	20	98	
2.7		23						
0.7	0.30	5	5	CH	Black Fat Clay (CH) with gravel and organics, medium stiff, moist	160 101	27 44	575psf (TxUU) (see Plate 6)
		8		SM SC	Gray Silty Sand (SM) to Clayey Sand (SC), loose, wet			
	0.14 0.20	Push	10			34	86	740psf (TxUU) LL=42 PI=15 Sieve Analysis (see Plate 7)
		10		CL	Light Brown Sandy Lean Clay (CL), medium stiff to stiff, moist			
1.0		9	15					
			20		becoming stiff to very stiff			Consolidation Test (see Plate 6)
1.5 2.0		19						
			25	SM	Light Brown Silty Sand (SM) with gravel, medium dense, moist	27	93	
		22						
			30	CL	Light Brown Sandy Lean Clay (CL), stiff, moist			
			35					

Secondary Clarifier Expansion
Pinole Wastewater Treatment Plant
Pinole, California

Log of Boring 2

Hultgren – Tillis Engineers | **Project No. 462.01** | **Plate No. 4**

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Reference: Hultgren-Tillis Engineers (2001).

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Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-3

Figure
A-3
(1 of 2)

Pocket Penetrometer (TSF)	Torvane (TSF)	N (blows/ft.)	Samples	Depth (feet)	Graphic Log	USCS	Drilling Method: Rotary Wash Date: April 4, 2001 Material Description	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
				35		CL				
1.5		12								
							Bottom of boring at 37.5 feet			
				40						
				45						
				50						
				55						
				60						
				65						
				70						

Secondary Clarifier Expansion
Pinole Wastewater Treatment Plant
Pinole, California

Log of Boring 2

Hultgren – Tillis Engineers	**Project No. 462.01**	**Plate No. 5**

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Reference: Hultgren-Tillis Engineers (2001).

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Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-3 (cont'd)

Figure
A-3
(2 of 2)

LOG OF BORING B-1

LOCATION: See Plate 2
GROUND SURFACE: Grass lawn

DEPTH feet	SAMPLE NO.	TYPE	PENETRATION RESISTANCE blows/ft.	GROUNDWATER	DESCRIPTION ①	MOISTURE %	DRY DENSITY lbs./ft.³	LIQUID LIMIT	PLASTICITY INDEX	GRAIN SIZE: Gravel (>#4 sieve) %	GRAIN SIZE: Sand (#4 to #200 sieve) %	GRAIN SIZE: Fines (<#200 sieve) %	UNCONFINED COMPRESSIVE STRENGTH kips/ft.²	DIRECT SHEAR: Cohesion p.s.f.	DIRECT SHEAR: Internal Friction Angle
					FILL - MIXED LEAN TO FAT CLAY WITH GRAVEL - dark grayish brown - up to 2" gravel - medium to high plasticity										
5	1	■	10		**FILL - MIXED SANDY LEAN CLAY** - olive brown - trace gravel - moist - medium plasticity - medium stiff. **CORROSION TEST** See Plate C-6	29	94			5	38	57	0.6		
10	2	■	17		**LEAN CLAY (CL)** - dark greenish gray - few sand, little silt - moist to wet - medium plasticity - stiff	25	98	44	20				1.9		
	3	■	24		**CORROSION TEST** See Plate C-6										
15					**FAT CLAY (CH)** - grayish brown - thin (<12") interlayers of wet clayey sand - moist to wet - high plasticity - very stiff	57	81								
20	4	■	25			34	86			0	6	94	3.4		
				② ▼											
25	5	■	27		**CONSOLIDATION TEST** **SAMPLE 5** $C_c = 0.22$ $e_o = 0.7405$	28	97	55	31						

CONTINUED AT 25 FEET ON PAGE 2 OF 2

DRAFT

REMARKS: ① Boring drilled on April 13, 2005. See Plates in Appendix A for definitions of terms.
② Equilibrium groundwater depth unknown. Seepage at 24' during drilling. Hollow stem augers sealed off groundwater in borehole.

DCM Engineering

FILE NO. J-4922-1 | JULY 2005

BROWN AND CALDWELL
Pinole/Hercules WPCP
Anaerobic Digester Improvements
Pinole, California
LOG OF BORING B-1

PLATE NO. B-1 (1 of 2)

BORING REFERENCE: DCM Engineering, 2005

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Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-4

Figure A-4 (1 of 2)

LOG OF BORING B-1 (CONT'D)

LOCATION: See Plate 2
GROUND SURFACE: Grass lawn

DEPTH feet	SAMPLE NO.	TYPE	PENETRATION RESISTANCE blows/ft.	GROUNDWATER	DESCRIPTION ①	% MOISTURE	DRY DENSITY lbs./ft.³	LIQUID LIMIT	PLASTICITY INDEX	GRAIN SIZE Gravel (>#4 sieve) %	GRAIN SIZE Sand (#4 to #200 sieve) %	GRAIN SIZE Fines (<#200 sieve) %	UNCONFINED COMPRESSIVE STRENGTH kips/ft.²	DIRECT SHEAR Cohesion p.s.f.	DIRECT SHEAR Internal Friction Angle
				②											
25					**CONTINUED FROM 25 FEET ON PAGE 1 OF 2** **FAT CLAY (CH)** - grayish brown - thin (<12") interlayers of wet clayey sand - moist to wet - high plasticity - very stiff										
30	6		33		**CLAYEY SAND (SC)** - olive brown - fine sand - wet - medium plasticity clay - medium dense	27	97								
					LEAN CLAY (CL) - olive brown - few sand - moist to wet - medium plasticity - very stiff										
35	7		33			29	93								
40	8		37			30	92								
					BOTTOM OF BORING AT 40 FEET										
45															

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REMARKS: ① Boring drilled on April 13, 2005. See Plates in Appendix A for definitions of terms.
② Equilibrium groundwater depth unknown. Seepage at 24' during drilling. Hollow stem augers sealed off groundwater in borehole.

DCM Engineering

FILE NO. J-4922-1 | JULY 2005

BROWN AND CALDWELL
Pinole/Hercules WPCP
Anaerobic Digester Improvements
Pinole, California
LOG OF BORING B-1

PLATE NO. B-1 (2 of 2)

BORING REFERENCE: DCM Engineering, 2005

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File No. 5011.0 | January 2013

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Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-4 (cont'd)

Figure A-4

(2 of 2)

LOG OF BORING B-2

LOCATION: See Plate 2
GROUND SURFACE: Asphalt parking area
(approx. 8" asphalt concrete over 6" aggregate base)

DEPTH feet	SAMPLE NO.	TYPE	PENETRATION RESISTANCE blows/ft.	GROUNDWATER	DESCRIPTION ①	MOISTURE %	DRY DENSITY lbs./ft.³	LIQUID LIMIT	PLASTICITY INDEX	GRAIN SIZE Gravel (>#4 sieve) %	GRAIN SIZE Sand (#4 to #200 sieve) %	GRAIN SIZE Fines (<#200 sieve) %	UNCONFINED COMPRESSIVE STRENGTH kips/ft.²	DIRECT SHEAR Cohesion p.s.f.	DIRECT SHEAR Internal Friction Angle
					FILL - MIXED LEAN TO FAT CLAY WITH GRAVEL - dark grayish brown - up to 2" gravel - moist - medium to high plasticity										
5	1		18	②	**FILL - MIXED SANDY LEAN CLAY** - dark greenish gray - moist - medium plasticity - stiff	29	89						1.3		
	2		10	▼	**BAY MUD - LEAN CLAY (CL)** - dark greenish gray - moist to wet - medium plasticity - soft			39	16						
10					**BAY MUD - SILTY SAND (SM) TO CLAYEY SAND (SC)** - dark greenish gray - trace fine gravel - trace shells - wet - loose	32	87			3	70	17			
15	3		28		**FAT CLAY (CH)** - grayish brown - trace sand - moist to wet - high plasticity - very stiff to hard	28	95								
20	4		58			17	116								
25	5		35			20									

CONTINUED AT 25 FEET ON PAGE 2 OF 2

DRAFT

REMARKS:
① Boring drilled on April 13, 2005. See Plates in Appendix A for definitions of terms.
② Equilibrium groundwater depth unknown. Seepage at 8' during drilling. Hollow stem augers sealed off groundwater in borehole.

DCM Engineering	BROWN AND CALDWELL Pinole/Hercules WPCP Anaerobic Digester Improvements Pinole, California LOG OF BORING B-2	PLATE NO. B-2 (1 of 2)
FILE NO. J-4922-1 / JULY 2005		

BORING REFERENCE: DCM Engineering, 2005

JACOBS ASSOCIATES Engineers/Consultants	HDR Pinole-Hercules -Water Pollution Control Plant Upgrades Pinole, California **Reference Boring RB-5**	Figure **A-5** (1 of 2)
File No. 5011.0 / January 2013		

LOG OF BORING B-2 (CONT'D)

LOCATION: See Plate 2
GROUND SURFACE: Asphalt parking area
(approx. 8" asphalt concrete over 6" aggregate base)

DEPTH feet	SAMPLE NO.	TYPE	PENETRATION RESISTANCE blows/ft.	GROUNDWATER	DESCRIPTION ①	MOISTURE %	DRY DENSITY lbs./ft.³	LIQUID LIMIT	PLASTICITY INDEX	GRAIN SIZE Gravel (>#4 sieve) %	GRAIN SIZE Sand (#4 to #200 sieve) %	GRAIN SIZE Fines (<#200 sieve) %	UNCONFINED COMPRESSIVE STRENGTH kips/ft.²	DIRECT SHEAR Cohesion p.s.f.	DIRECT SHEAR Internal Friction Angle
				②	CONTINUED FROM 25 FEET ON PAGE 1 of 2										
25					**FAT CLAY (CH)** - grayish brown - trace sand - moist to wet - high plasticity - very stiff to hard										
	6		44		**CLAYEY SAND (SC)** - olive brown - wet - dense	19									
30					**POORLY GRADED SAND (SP)** - olive brown - with gravel - wet - dense										
					BOTTOM OF BORING AT 30 FEET										
35															
40															
45															

REMARKS: ① Boring drilled on April 13, 2005. See Plates in Appendix A for definitions of terms.
② Equilibrium groundwater depth unknown. Seepage at 8' during drilling. Hollow stem augers sealed off groundwater in borehole.

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FILE NO. J-4922-1 | JULY 2005

BROWN AND CALDWELL
Pinole/Hercules WPCP
Anaerobic Digester Improvements
Pinole, California
LOG OF BORING B-2

PLATE NO.
B-2
(2 of 2)

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BORING REFERENCE: DCM Engineering, 2005

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Pinole-Hercules -Water Pollution Control Plant Upgrades
Pinole, California

Reference Boring RB-5 (cont'd)

Figure
A-5
(2 of 2)

LOG OF BORING B-3

LOCATION: See Plate 2
GROUND SURFACE: Asphalt parking area (approximately 8" asphalt concrete)

DEPTH feet	SAMPLE NO.	TYPE	PENETRATION RESISTANCE blows/ft.	GROUNDWATER	DESCRIPTION ①	MOISTURE %	DRY DENSITY lbs./ft.³	LIQUID LIMIT	PLASTICITY INDEX	GRAIN SIZE Gravel (>#4 sieve) %	GRAIN SIZE Sand (#4 to #200 sieve) %	GRAIN SIZE Fines (<#200 sieve) %	UNCONFINED COMPRESSIVE STRENGTH kips/ft.²	DIRECT SHEAR Cohesion p.s.f.	DIRECT SHEAR Internal Friction Angle
				②	**FILL - MIXED LEAN CLAY WITH SAND AND GRAVEL** - grayish brown to greenish brown - up to 2" gravel - moist to wet										
5	1	■	26		**FILL - MIXED LEAN CLAY WITH SAND** - dark greenish gray - few ½" gravel - wet - medium plasticity - stiff to very stiff	25	93							560	28°
10	2	■	20		**FILL - MIXED CLAYEY SAND AND SANDY LEAN CLAY** - olive brown to dark greenish gray - up to 2" gravel - wet - medium plasticity clay - stiff (clay) - medium dense (sand). **CONSOLIDATION TEST** SAMPLE 2: C_c = 0.19, e_o = 1.1034	26	80			9	43	48			
15	3	■	29		**FAT CLAY (CH)** - dark grayish brown - locally contains fine sand interlayers - moist to wet - high plasticity - very stiff	42	78	87	51				5.9		
20	4	■	39			28	90			0	23	77			
25	5	■	15			29									

CONTINUED AT 25 FEET ON PAGE 2 OF 2

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REMARKS: ① Boring drilled on April 13, 2005. See Plates in Appendix A for definitions of terms.
② Equilibrium groundwater depth unknown. Hollow stem augers sealed off groundwater in borehole.

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BROWN AND CALDWELL
Pinole/Hercules WPCP
Anaerobic Digester Improvements
Pinole, California
LOG OF BORING B-3

PLATE NO. B-3 (1 of 2)

BORING REFERENCE: DCM Engineering, 2005

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Pinole-Hercules -Water Pollution Control Plant Upgrades
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Reference Boring RB-6

Figure A-6 (1 of 2)

LOG OF BORING B-3 (CONT'D)

LOCATION: See Plate 2
GROUND SURFACE: Asphalt parking area (approximately 8" asphalt concrete)

DEPTH feet	SAMPLE NO.	TYPE	PENETRATION RESISTANCE blows/ft.	GROUNDWATER	DESCRIPTION ①	MOISTURE %	DRY DENSITY lbs./ft.³	LIQUID LIMIT	PLASTICITY INDEX	GRAIN SIZE Gravel (>#4 sieve) %	GRAIN SIZE Sand (#4 to #200 sieve) %	GRAIN SIZE Fines (<#200 sieve) %	UNCONFINED COMPRESSIVE STRENGTH kips/ft.²	DIRECT SHEAR Cohesion p.s.f.	DIRECT SHEAR Internal Friction Angle
				②											
25					**CONTINUED FROM 25 FEET ON PAGE 1 of 2**										
					FAT CLAY (CH) - dark grayish brown - locally contains fine sand interlayers - moist to wet - high plasticity - very stiff										
	6		32			26									
30					**BOTTOM OF BORING AT 30 FEET**										
35															
40															
45															

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REMARKS: ① Boring drilled on April 13, 2005. See Plates in Appendix A for definitions of terms.
② Equilibrium groundwater depth unknown. Hollow stem augers sealed off groundwater in borehole.

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BROWN AND CALDWELL
Pinole/Hercules WPCP
Anaerobic Digester Improvements
Pinole, California
LOG OF BORING B-3

PLATE NO. B-3 (2 of 2)

FILE NO. J-4922-1 | JULY 2005

BORING REFERENCE: DCM Engineering, 2005

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Reference Boring RB-6 (cont'd)

Figure A-6 (2 of 2)

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Appendix B

CORROSION TESTS and RESULTS

BORING SAMPLE NO.	RESISTIVITY (ohm-cm)		REDOX (mv)	pH	SULFIDES	SULFATES (ppm)	CHLORIDES (ppm)
	as-received	saturated					
B-1-1	893	842	+311	6.85	Negative	170	54
B-1-3	653	544	+85	7.59	Negative	200	375

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Test Notes:

1. Appendix A of ANSI/AWWA C105/A215, TABLE A, provides soil test methods and evaluation for conditions corrosive to gray or ductile-cast iron pipe and fittings.

2. The above tests (excluding redox and sulfides) were performed in accordance with the following Caltrans Test Methods:

   a. California Test 643 (1993): METHOD FOR ESTIMATING THE SERVICE LIFE OF STEEL CULVERTS

   b. California Test 532 (1993): METHOD FOR ESTIMATING THE TIME TO CORROSION OF REINFORCED CONCRETE SUBSTRUCTURES

   c. California Test 422 (1978): METHOD OF TESTING SOILS AND WATERS FOR CHLORIDE CONTENT

   d. California Test 417 (1986): METHOD OF TESTING SOILS AND WATERS FOR SULFATE CONTENT

3. ASTM D4568: METHOD OF TESTING SOILS FOR SULFIDE CONTENT.

4. Testing provided by ConCeCo/Matcor Engineering, Inc.

Reference: DCM Engineering (2005)

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Reference Corrosion Test Results

Figure
B-1