8.13 Geologic Resources and Hazards

This section evaluates the effect of geologic hazards and resources that might be encountered on the Chevron Richmond Refinery Power Plant Replacement Project (PPRP, or the Project). The objective of this analysis is to evaluate the potential for Project impacts from construction or during the operation of the Project. This section presents a summary of the relevant laws, ordinances, regulations, and standards (LORS), the Project setting, environmental impacts, and proposed mitigation measures affecting geological resources. In addition, required permits and permitting agencies are identified.

8.13.1 Introduction

Chevron is proposing the PPRP to add an additional 60 megawatts (MW) net generation to its existing refinery electrical generation located within Chevron's Richmond Refinery in the City of Richmond (see Figure 1.2-1) in Contra Costa County, California. The proposed PPRP will be integrated into Chevron's plans to meet its growing refinery electrical load, and produce steam to replace an existing boiler plant that is approaching its end of life. The PPRP is a subset of the larger Richmond Refinery Renewal Project that is concurrently undergoing California Environmental Quality Act (CEQA) review by the City of Richmond. The California Energy Commission (CEC) has jurisdiction for only the PPRP portion of the Renewal Project that is the subject of this application.

The PPRP will consist of the following components:

- A nominal 43-MW net, natural gas- or liquid petroleum gas (butane)-fired cogeneration train consisting of one combustion turbine generator (CTG), a refinery fuel gas-fired heat recovery steam generator, 13.8-kV switchgear and ancillary equipment.
- Shutdown of the existing No. 1 power plant refinery steam boilers currently providing steam to the Refinery.
- A 17-MW net extraction, condensing steam turbine generator (STG), an associated cooling tower, and 12-kV switchgear installed as part of the new hydrogen production facility (the remainder of the hydrogen plant is under CEQA review as part of the Renewal Project). The new hydrogen plant will be a net generator of steam for both the STG and the Refinery steam system.
- Reconductoring of approximately 4,000 feet of existing onsite double-circuit overhead 115-kV transmission line to upgrade its ampacity. The reconductoring will reuse existing transmission line structures.
- Adjacent onsite service connections for fuel, reclaimed water, water, wastewater, steam, and electricity to existing piperacks, with the exception of the reconductoring noted above.

The Cogen 3000 portion of the PPRP will occupy approximately 0.5 acre within an existing 5.2-acre cogeneration facility, and the STG and associated equipment (H_2-STG) will occupy approximately 0.5 acre within a new 7.9-acre hydrogen plant that will be built as part of the Richmond Refinery Renewal Project. The PPRP will be located well within the heart of the existing 2,900-acre Richmond Refinery. Temporary construction laydown and parking for

the PPRP will be provided in various existing laydown areas within the Refinery that are currently used for ongoing maintenance and project laydown. A complete description of the PPRP is provided in Section 2.0.

8.13.2 Laws, Ordinances, Regulations, and Standards

The LORS applicable to geologic resources and hazards are summarized in Table 8.13-1.

TABLE 8.13-1
Laws, Ordinances, Regulations, and Standards

Jurisdiction	Authority	Administering Agency	Compliance
State/Local	California Building Code (CBC), 2001 as amended by the City of Richmond	California Building Standards Commission, State of California, and City of Richmond	Acceptable design criteria for structures with respect to operating (dead plus live and wind) loads, seismic design loads, and load-bearing capacity
State/Local	Alquist-Priolo Earthquake Fault Zoning Act	Title 14, Division 2, Chapter 8, Subchapter 1, Article 3, California Code of Regulations	Identifies areas subject to surface rupture from active faults
State /Local	The Seismic Hazards Mapping Act	Title 14, Division 2, Chapter 8, Subchapter 1, Article 10, California Code of Regulations	Identifies non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides
Local	Contra Costa County General Plan, Conservation and Safety Element	Contra Costa County	The County shall require all new buildings to be constructed in accordance with the CBC for a Seismic Zone 4
Local	City of Richmond General Plan, Public Safety Element	City of Richmond	The City shall require all new buildings to be constructed in accordance with the CBC for a Seismic Zone 4

8.13.3 Geologic Setting

The Project is located on the Chevron Richmond Refinery site in the City of Richmond, Contra Costa County, California. The power plant Project site lies near the San Pablo Peninsula. The peninsula is characterized as a northwest-trending, steep-sided ridge about 3 miles long that separates the San Francisco and San Pablo Bays. The San Francisco Bay Area lies within a fairly broad depression within the coast ranges created from an east-west expansion between the San Andreas and Hayward faults (Norris and Webb, 1990). The San Pablo Peninsula is a fairly resistant basement rock.

8.13.3.1 Local Geology

The Project site is located in an area of relatively flat topography (elevation approximately 10 feet above mean sea level) on the northeastern side of San Pablo Peninsula. Franciscan Complex Formation rocks dominate the area, and consist of sedimentary and volcanic rocks. Specifically, sandstone, serpentine, chert, greenstone, and other metamorphic rocks are present. Also present, to the northeast, is a thick sequence of estuarine and alluvial sedimentary deposits that include Bay Mud, and areas where reclamation has occurred with

artificial fill. Older alluvial and estuarine deposits underlie the Bay Mud and originate from erosion of the hills to the east (Wagner et al., 1990). Figure 8.13-1 (all figures are located at the end of this section) shows the geology within a 2-mile radius of the Project site.

8.13.3.2 Structure

The structural geology of the area is complex, and the area contains major deformations associated with historic tectonic activity, faulting, and landslides. Repeated tectonic activity in the San Francisco Bay Area has resulted in a complex geologic structure dominated by activity along major faults that comprise the San Andreas and Hayward fault systems.

8.13.3.3 Seismicity

The San Francisco Bay Area is known to be a region of high seismic activity. The U.S. Geological Survey (USGS) Working Group on Northern California Earthquake Potential (WGNCEP) has evaluated that there is a 62-percent probability of one or more earthquakes with a moment magnitude (M_W) of 6.7 or higher occurring in the San Francisco Bay Area before 2032 (WGNCEP, 2003).

Numerous active and potentially active faults are present within 30 miles of the Project site area. Approximate fault alignments are shown on Figure 8.13-2. The nearest active fault to the site is the Hayward fault, which is a northwest-southeast trending fault approximately 4 miles to the east. The West Napa fault lies approximately 17 miles to the northeast. The Concord-Green Valley fault lies approximately 18 miles to the east. The Rogers Creek fault lies approximately 15 miles to the north. The San Andreas fault lies approximately 14 miles to the west. The northern part of the Calaveras fault lies approximately 20 miles to the southeast. All of these faults are considered active. The Hayward-Rodgers Creek fault systems, according to the WGNCEP (2003), are the faults that have the highest probability of generating M_W 6.7 or greater earthquakes before 2032.

The site is not located within the special study zone, as delineated by the Alquist-Priolo Special Studies Zone Act of 1972, and no known fault, active or inactive, reaches the surface within the Project site area (Jennings, 1994).

Table 8.13-2 presents the known active faults within the vicinity of the Project site.

TABLE 8.13-2
Active Faults in the Project Site Area

Fault	Distance and Direction from Project Site	Recent Activity	Notable Activity	Maximum Moment Magnitude Earthquake (M_W)
Hayward	4 miles east	Pre-Historic Holocene	1836 and 1868 ruptures	6.9
West Napa	17 miles northeast	Holocene		6.5
Concord-Green Valley	18 miles east	Historic Holocene		6.7
Rodgers Creek	15 miles north	Historic Holocene		7.0
San Andreas	14 miles west	Historic	1906 and 1989 ruptures	7.9
Calaveras (northern)	20 miles southeast	Historic Holocene		6.8

Note:
The maximum moment magnitudes are taken from the USGS National Mapping Fault Parameters (2002). The USGS (2002) also considers a rupture scenario that involves both the Hayward-Rodgers Creek Fault with an assigned maximum moment magnitude of 7.2.

An inactive fault is present near the Project site area. The San Pablo fault runs parallel to and along the east side of the San Pablo Peninsula. This fault has shown no evidence of displacement in the last 1.6 million years (Blake, 1974).

8.13.3.4 Geologic Hazards

The following sections discuss the potential geologic hazards that might occur in the Project area based on a literature search and preliminary analysis for the site. There are seven hazards that could potentially be significant: seismic ground shaking, ground rupture, liquefaction (leading to settlement and/or lateral spreading), slope stability, subsidence (local settlement) and settlement, expansive soils, and seiches/tsunamis.

8.13.3.4.1 Seismic Ground Shaking

During an earthquake, seismic waves are produced that emanate in all directions from the fault rupture. Seismic waves can produce strong ground shaking that is typically strongest near the fault and attenuates as the waves move away from the source. The severity of ground shaking is controlled by the interaction of magnitude, distance, the type of rupture, and thickness and condition of underlying geologic material. Areas underlain by unconsolidated, recent alluvium or fill may amplify the strength of ground motion.

Strong ground motion is the most significant geologic hazard at the Project site. Peak ground bedrock and alluvium acceleration of up to approximately 0.57g (10 percent probability in 50 years) has been estimated based on a M_W 7.1 event on the Hayward fault (CGS, 2003).

The potential for strong ground motion to occur in the Project site is high.

8.13.3.4.2 Ground Rupture

The site is not located within a special study zone, as delineated by the Alquist-Priolo Special Studies Zone Act of 1972, and no known fault, active or inactive, reaches the surface within the Project area (CGS, 1999). No known faults were found to cross the Project site or linears. The potential for ground rupture to occur at the Project site or along the Project linears is low.

8.13.3.4.3 Liquefaction

During strong ground-shaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength. This phenomenon is known as liquefaction. Liquefaction is dependent on grain size distribution, relative density of the soils, degree of saturation, and intensity and duration of the earthquake. The potential hazard associated with liquefaction is seismically induced settlement and lateral spreading. The depth to groundwater at the Project site is very shallow, measured in several borings at approximately 5 feet below ground surface (approximately 9 feet mean sea level) (URS, 2006a and 2006b). Because of the seismic potential and high groundwater, Contra Costa County has identified the Project site area to have a generally high potential for liquefaction to occur (Contra Costa County, 1994). However, the site-specific geotechnical investigations conducted at the site did not identify liquefiable deposits and the loss of soil strength due to liquefaction is not anticipated (URS, 2006a and 2006b).

8.13.3.4.4 Slope Stability

Slope instability depends on steepness of the slope, underlying geology, surface soil strength, and pore pressures in the soil. Significant excavating, grading, or fill work during

construction might also introduce temporary slope stability hazards at either the Project site or along linear facility routes. Seismic-induced landslides typically occur in slide-prone geologic units that contain excessive amounts of water and which are located on steep slopes. Because the Project site and linear corridors are relatively flat, and no significant and permanent vertical excavations or fills are planned during site construction, the potential for direct impact from landslides is considered low.

8.13.3.4.5 Subsidence and Settlement

Subsidence can be caused by natural phenomena during tectonic movement, consolidation, hydrocompaction, liquefaction settlement as described above, or rapid sedimentation. Subsidence can also result from human activities, such as, on a regional scale, the withdrawal of water and/or hydrocarbons from the subsurface soils, and on a local scale, the construction of new facilities such as mass fills and new structures or buildings. Artificial fill may also be susceptible to differential settlement. The site-specific geotechnical investigations conducted at the sites did not identify subsidence as a hazard of concern.

8.13.3.4.6 Expansive Soils

Expansive soils are clay rich soils that have the ability to shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations. The site-specific geotechnical investigations conducted at the sites did not identify soil that exhibits a high shrink-swell potential.

8.13.3.4.7 Tsunami/Seiche

Tsunamis are waves typically generated offshore during a subaqueous fault rupture or a subaqueous landslide event. Seiches are waves generated within an enclosed large body of water (such as a lake) caused by horizontal movement of an earthquake. Due to the proximity of the Project site to the San Francisco Bay, there is a potential for the Project site to be exposed to a tsunami resulting from the occurrence of a major earthquake along the San Andreas and/or Hayward faults. A tsunami with a wave height of 20 feet at the Golden Gate Bridge, which is likely to occur approximately once every 200 years, would attenuate to a wave height of less than 2 feet at the Carquinez Strait (Contra Costa County, 1994). The potential for tsunami/seiche impact to the Project site is low.

8.13.3.5 Geologic Resource of Recreational, Commercial, or Scientific Value

Geologic resources of recreational, commercial, or scientific value in the Project vicinity that could be affected include mineral/aggregate production. No known scientific or recreational geologic resources were identified in the vicinity of the Project site. No known oil or gas reserves were identified to be present in the Project vicinity (CDOGGR, 2003). Commercial geologic resources of value are discussed in the next paragraph.

8.13.3.5.1 Mineral/Aggregate Production

The Richmond area has been identified as containing mineral resources that are largely limited to sand, gravel, and rock products. Within the City of Richmond's planning area, the State of California has classified several sectors as Mineral Resource Zone-2. This classification indicates the existence of a deposit that meets certain criteria for value and marketability. Sector W-1, located in the knobby bayfront hills of the San Pablo Peninsula to the west of the Project site, is a source of crushed rock, but is not mined because of the presence of the Refinery tank farm. The Project will not affect this resource. No other mineral or aggregate resources in the Project site area have been identified (City of Richmond, 1994).

8.13.4 Impacts

Presented below are the CEQA Checklist questions used to assess the significance of potential impacts.

8.13.4.1 Environmental Checklist

The checklist in Table 8.13-3 is used by the CEC to assess the significance of potential impacts.

TABLE 8.13-3
California Energy Commission Environmental Checklist

	Potentially Significant Impact	Less than Significant with Mitigation	Less than Significant	No Impact
Geology—Would the Project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving the following:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault. Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking.	X			
iii) Seismic-related ground failure, including liquefaction.			X	
iv) Landslides.				X
b) Result in substantial soil erosion?				X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in an on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse due to the loss of topsoil?			X	
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?				X
Mineral Resources—Would the Project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?				X

8.13.4.2 Discussion of Impacts

No active faults cross the Project site, and the vicinity of the site is not within the Alquist-Priolo Earthquake Fault Zone (CGS, 1999).

The most likely geologic hazard at the Project site is strong ground shaking from a seismic event.

Even though there is relatively high potential for the site to be exposed to strong ground shaking, the potential for liquefaction to occur is low since site-specific geotechnical investigations did not identify liquefiable material to be present at the sites (URS, 2006a and 2006b).

Since the Project site is relatively flat, the potential for slope instability (landslides, soil collapse) and substantial soil erosion is considered low. The site-specific geotechnical investigations did not identify these geologic hazards to be significant at the sites (URS, 2006a and 2006b).

Subsidence and expansive soils were not identified to be present at the site during the geotechnical investigations (URS, 2006a and 2006b). As a result, the potential for subsidence to occur and expansive soils to be present is low.

No mineral resources of significant commercial value were noted to be present at the Project site. No recreational or scientific resources are known to exist at the Project site.

8.13.5 Mitigation Measures

Mitigation measures are necessary for the Project site because of potential geologic hazards. Therefore, the following measure is proposed:

- Design and construct the Project to conform to the CBC requirements for Seismic Zone 4.

8.13.6 Involved Agencies and Agency Contacts

The City of Richmond Building and Engineering Departments are responsible for the compliance of construction projects with regard to geologic hazards. Table 8.13-4 presents contact information for the City of Richmond.

8.13.7 Permits Required and Permit Schedule

No permits that specifically address geologic resources and hazards were identified. Compliance of building construction to CBC standards is covered under engineering and construction permits for the Project.

TABLE 8.13-4
Agency Contacts

Agency	Contact	Title	Address	Telephone
City of Richmond – Engineering Department	Rich Davidson	City Engineer	1401 Marina Way South, Richmond, CA 94804	(510) 307-8092

8.13.8 References

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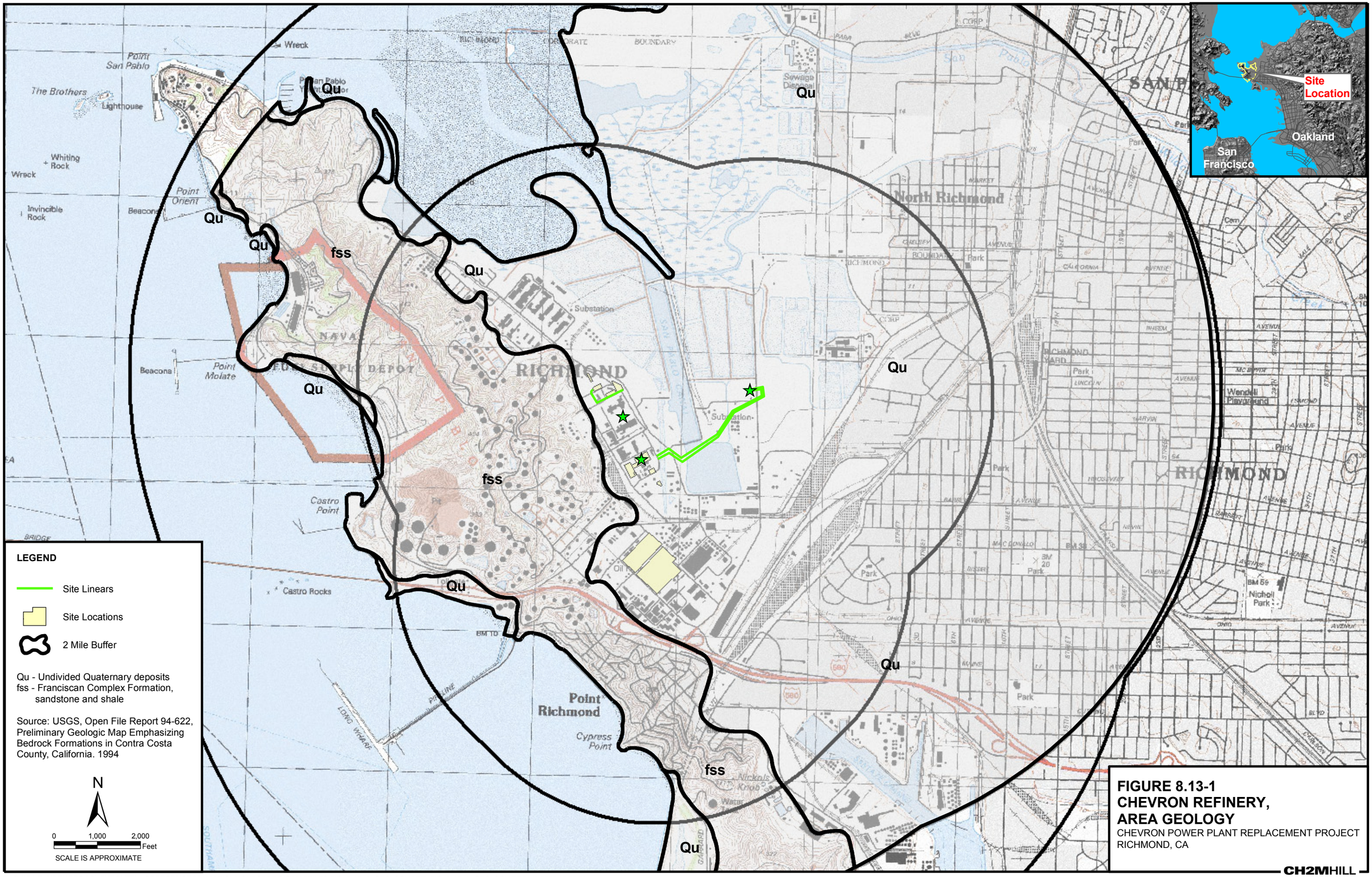

FIGURE 8.13-1
CHEVRON REFINERY, AREA GEOLOGY
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

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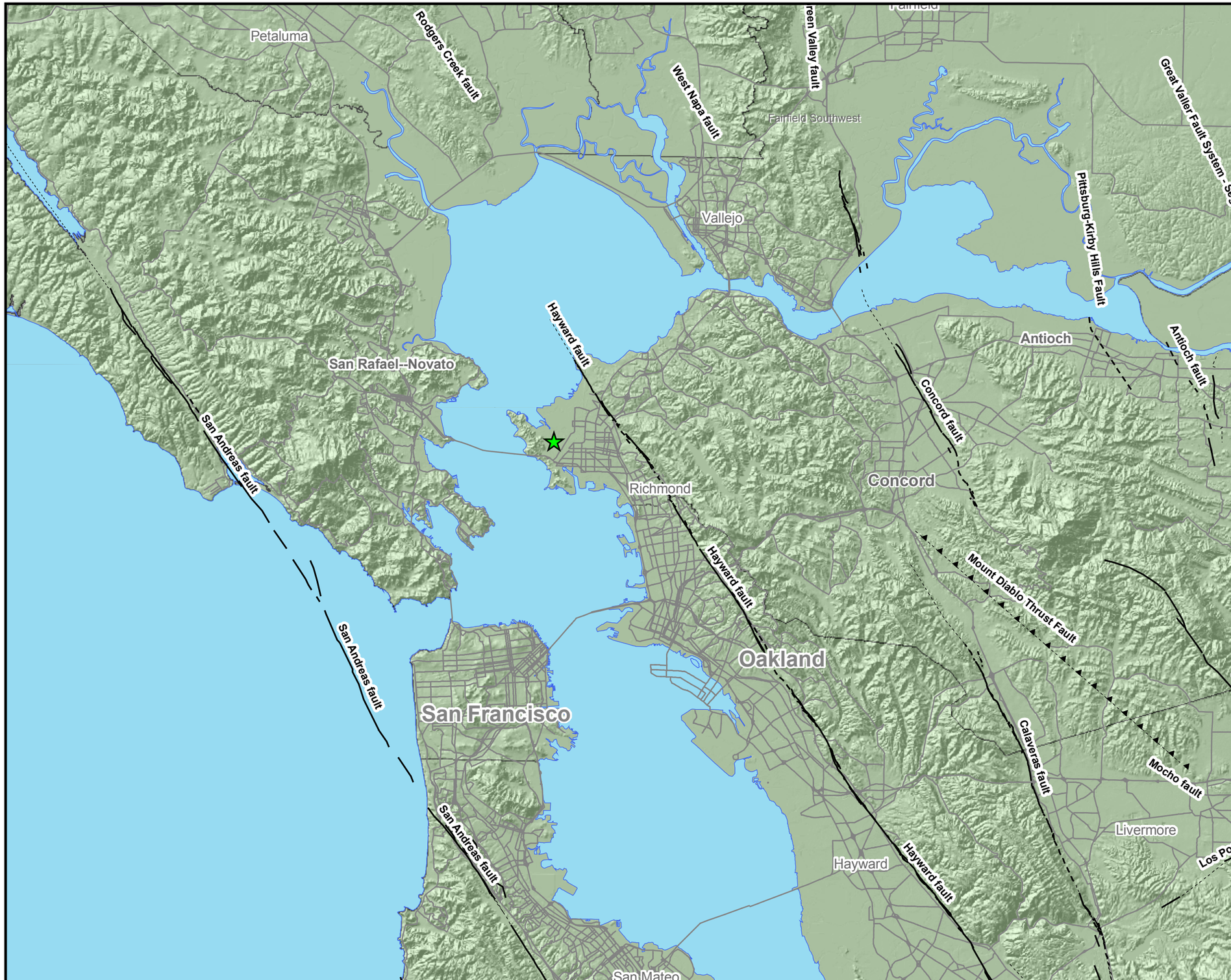

LEGEND

- Fault - Well Located
- Fault - Approximately Located or Inferred
- Fault - Concealed
- Fault - Low Angle Thrust, Concealed (Barbs on Upper Plate)
- Site Location

Sources:

Bryant, 2005
CGS, 2003
Jennings, 1994
WGCEP, 2003
Williams, 1997

N

5 4 3 2 1 0 5 Miles

FIGURE 8.13-2
CHEVRON REFINERY, PRINCIPAL REGIONAL FAULTS
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

CH2MHILL

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