8.15 Geologic Hazards and Resources

8.15.1 Introduction

The Eastshore Energy Center (Eastshore) will be a nominal 115.5-megawatt (MW) intermediate/peaking load facility operating up to 4,000 hours per year using natural gas-fired reciprocating engine technology. The Eastshore facility will be located at 25101 Clawiter Road in the City of Hayward, Alameda County, California, on a 6.22 acre parcel owned by Eastshore Energy, LLC, the project owner. Major features of the Eastshore project include the following:

- Demolition of the existing site building, foundations and paved surface,
- Grading of site and installation of new foundations, piping and utility connections,
- Fourteen (14) nominal 8.4 MW (gross) Wartsila model 20V34SG natural gas-fired reciprocating engine – generator sets,
- Fourteen (14) state-of-the-art air pollution control systems representing Best Available Control Technology (BACT), one system per each of the 14 engines, consisting of a selective catalytic reduction (SCR) unit for oxides of nitrogen (NOx) control and an oxidation catalyst unit for carbon monoxide (CO) and precursor organic compounds (POC) control,
- Fourteen (14) approximately 70-foot tall stacks, each with a separate continuous emissions monitoring system (CEMS),
- Acoustically-engineered main building enclosing all 14 engines,
- Closed loop cooling system consisting of multiple fan-cooled radiator assemblies outside of the main engine building,
- Two 10,000 gallon (each) aqueous (19% by weight) ammonia storage tanks and handling system serving the SCR units,
- One raw water storage tank, approximately 35,000 gallons,
- One nominal 225–kW diesel-fired emergency black start generator,
- One (1) either electric or 7.15 MMBtu/hr natural gas-fired heater (BAAQMD exempt), used for heating of the natural gas fuel to the reciprocating engines,
- Miscellaneous ancillary equipment,
- Pre-existing onsite water and wastewater service interconnections,
- Onsite 115 kV switchyard including switchgear and step-up voltage transformers,
- Approximately 1.1-mile 115 kV single-circuit transmission line interconnecting to PG&E's Eastshore Substation,
- Approximately 200-foot offsite natural gas line connection to PG&E Line 153,

- Chain-link security fencing enclosing the facility with a secured entrance on Clawiter Road, and
- 4.65-acre temporary construction laydown and parking area located immediately across Clawiter Road from the Eastshore site.

This section evaluates the effect of geologic hazards and resources that might be encountered on the project site and associated linear facilities. The objective of this analysis is to evaluate potential project impacts resulting from construction or 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.

Subsection 8.15.2 describes the relevant LORS for geologic hazards. Subsection 8.15.3 describes the affected environment including the regional and local geology, seismicity, and hazards. Subsection 8.15.4 assesses the project's impacts, and Subsection 8.15.5 provides mitigation measures to reduce significant impacts from geologic hazards and to geologic resources. Subsection 8.15.6 addresses relevant agencies, Subsection 8.15.7 lists required permits, and Subsection 8.15.8 lists references used in preparing this analysis.

8.15.2 Laws, Ordinances, Regulations, and Standards

The LORS that apply to geologic resources and hazards are summarized in Table 8.15-1.

TABLE 8.15-1
Laws, Ordinances, Regulations, and Standards

Jurisdiction	Authority	Administering Agency	Compliance
State/Local	California Building Code (CBC), 2001 as amended by the City of Hayward	California Building Standards Commission, State of California, and City of Hayward	Acceptable design criteria for structures with respect to seismic design 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	City of Hayward General Plan	City of Hayward	Compliance with the conservation and environmental protection element of the General Plan

8.15.3 Affected Environment

The proposed Eastshore energy project site is an approximately 6.22-acre parcel located in the City of Hayward, Alameda County, California. The property is zoned for industrial use. The project site and linears are approximately 1.5 miles from the eastern shore of the San

Francisco Bay. The San Francisco Bay area lies in the central part of the Coast Ranges physiographic province of California. The San Francisco Bay is a northwest-trending structural depression in the northern Coast Ranges and lies roughly between the San Andreas Fault to the west and the Hayward Fault to the east. This province is characterized by a northwest-trending series of elongated ranges and narrow valleys and extends from the Oregon border to the Transverse Ranges in Southern California (Norris and Webb, 1990). The proposed power plant site is a relatively flat (approximate elevation 25 feet) and is underlain by Quaternary age sediments. The site, as well as much of the San Francisco Bay area, is within a highly active seismic region.

8.15.3.1 Regional Geology and Structure

The geology of the project vicinity is complex, largely a result of the interaction of the strike-slip tectonics of the San Andreas fault system and the compressional tectonics of the Coast Ranges. The Coast Ranges are composed of a series of parallel, northwesterly trending folded and faulted ranges and represent structural blocks comprised of a variety of lithologic types. These structural blocks are juxtaposed by major geologic structures. The San Andreas fault zone lies to the west (approximately 15 miles) and is a major boundary that separates the Franciscan Complex rocks of the North American Plate from the Salinian basement rocks of the Pacific Plate.

8.15.3.2 Local Geology

The local geology is composed of deposits of recent quaternary age underlain by bedrock deposits. Figure 8.15-1 shows the geology within a 2-mile radius of the Eastshore site. The quaternary deposits in the project site area is generalized as a transgressive sequence of alluvial fan and fan-delta facies (Halley and Graymer, 1997). A description of the deposits present is as follows:

Af – Artificial Fill. Comprised of man-made deposits of various material and age. Most are compacted and quite firm, but fills made before 1965 are typically not compacted and may consist of simply dumped materials.

Qhbm – Bay Mud. Comprised of water saturated estuarine mud (clay and silty clay) deposits underlying marchlands and tidal flats of the San Francisco Bay. May contain few lenses of well-sorted fine sand and silt, oyster shell layers, and peat. The mud interfingers with and grades into fine-grained deposits at the distal edge of Holocene fans. Estimated thickness ranges up to 40 meters.

Qhfp - Alluvial Terrace Deposits. Comprised of rounded gravel in a clayey silt matrix.

Qhb – Basin Deposits. Consists of silty clay to clay deposits at the distal edge of alluvial fans adjacent to bay mud.

Qhbs – Floodplain Deposits. Consists of clay to silty clay deposits similar to Qhb except that they contain carbonate nodules and iron-stained mottles.

Qhaf – Alluvial Fan and Fluvial Deposits. Alluvial fan deposits are brown or tan, medium dense to dense gravely sand or sandy gravel that generally grade upward to sand or silty clay. Near the distal fan edges, the fluvial deposits are typically brown, medium dense sand that fines upward to sandy or silty clay.

8.15.3.3 Seismic Setting

The project site lies within the San Andreas Fault system region that separates the North American and Pacific plate boundaries. This boundary has been the site of numerous large-scale earthquakes. The area is considered seismically active. Active faults are those that show evidence of displacement during Holocene time (within last 11,000 years). The Hayward Fault is considered to be one of the most potentially hazardous faults in the United States because of its high slip rate, its demonstrated ability to generate a large earthquake, and its location through a highly urbanized and intensely developed area (City of Hayward, 2002). The Hayward fault is the primary geologic structure in the site area. It is an active right-lateral strike-slip fault, with an estimated late Holocene slip rate of 9 millimeter (mm) per year. Associated with the main trace are numerous splays and subsidiary traces that may accommodate secondary movements or that may be older abandoned traces. Bedrock units in the vicinity of the Hayward Fault zone have been offset in a complex manner (CGS, 2003).The significant faults in the San Francisco Bay area are described below and are shown on Figure 8-15-2.

TABLE 8.15-2
Principal Faults within 25 miles of the Proposed Eastshore Energy Project

Fault Name	Approximate Distance		Maximum Credible Earthquake (MCE) Magnitude (M_w)	Estimated Peak Bedrock Acceleration (g)
	(mi)	(km)		
Hayward	3.3	5.3	7.3	0.534
San Andreas	15	24.2	7.9	0.278
Calaveras	11	17.7	6.9	0.235
Concord	20	32	6.4	0.274
Greenville	22	35	6.5	0.288

Source: Blake, 2004, Deterministic Site Parameters, Sadigh et al attenuation relationship for rock outcrop (Sadigh, et al., 1997).

g = acceleration due to gravity

8.15.3.3.1 Hayward Fault. The Hayward Fault System lies approximately 3.3 miles east of the site. The fault system is considered to include the northern and southern Hayward Fault system as well as the Rodgers Creek fault, and extends from Healdsburg south to Fremont (WGNCEP, 2003). It is approximately 87 miles long and is considered by the WGNCEP to be the most likely source of the next major earthquake in the Bay Area (WGNCEP, 1996). The 1868 local moment magnitude (M_w) 6.8 earthquake was the last major earthquake on the Hayward fault. A maximum credible earthquake (MCE) M_w 6.9 has been assigned to the simultaneous rupture of the northern and southern segments of the Hayward fault (WGNCEP, 2003). A simultaneous MCE rupture of the three segments that make up this fault system has been assigned a M_w 7.3. According to the WGNCEP (2003), the Hayward and Rodgers Creek fault system has a 27 percent probability of generating at least a Mw 6.7 earthquake within the next 30 years along this fault.

8.15.3.3.2 San Andreas Fault. The San Andreas fault is approximately 15 miles west of the site, across the San Francisco Bay. This fault is the largest active fault in California and extends from the Gulf of California to Cape Mendocino in northern California. The San Francisco Mw 7.9 earthquake of 1906 was attributed to this fault. The fault was previously divided into three segments. However the recommendation of the WGNCEP (1996) was to subdivide the fault into four segments (the section of the fault north of Point Arena is now referred to as the Offshore segment). The primary three segments are located in the San Francisco Bay Area (North Coast, Peninsular, and Southern Santa Cruz Mountains) and have recently been assigned individual MCEs of Mw 7.5, Mw 7.2 and Mw 7.0, respectively, by the WGNCEP (2003). The same working group identified the MCE for all four segments combined, as is thought to be the cause of the 1906 earthquake, to be Mw 7.9. According to the WGNCEP (2003), there is a 21 percent probability of a Mw 6.7-equal or greater earthquake within the next 30 years along this fault.

8.15.3.3.3 Calaveras Fault. The Calaveras fault lies approximately 11 miles east of the site. It is approximately 76 miles long and contains three identified segments that extend from Hollister to Danville. MCEs assigned for the three segments range from Mw 5.8 and Mw 6.2 for the southern and central segments, respectively, to Mw 6.8 for the northern segment (WGNCEP, 2003). Combined, the fault is assigned an MCE of Mw 6.9. According to the WGNCEP (2003), there is an 11 percent probability of a Mw 6.7-equal or greater earthquake within the next 30 years along this fault.

8.15.3.4 Geologic Hazards

The following subsections 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 five hazards that could be significant and include: seismic ground shaking; ground rupture; liquefaction; subsidence and settlement; and seiches/tsunamis. Additional information will be available following preparation of a site-specific geotechnical report, which will be provided to the CEC upon request.

8.15.3.4.1 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, and the type, thickness, and condition of underlying geologic materials. Areas underlain by unconsolidated, recent alluvium, or fill may amplify the strength and duration of strong ground motion.

Strong ground motion is the most significant geologic hazard at the project site. Blake (2004) estimates that peak bedrock acceleration (PBA) at the site from a Mw 7.3 earthquake could produce up to 0.0.54g (rounded up). This would affect the plant site and proposed transmission line connection to the PG&E transmission system. Peak bedrock accelerations stated above were cross referenced with the Caltrans Seismic Hazard Map (Mualchin, 1996) for general verification which estimates a PBA of approximately 0.54g and a Mw 7.5 for the Hayward fault. This acceleration is interpolated from acceleration contours shown on the map and then adjusted based on the attenuation relationship by Sadigh et al (Sadigh et al., 1997) for a rock outcrop site.

Based on the evidence described above, the City of Hayward has identified this area to be susceptible to strong ground motion (City of Hayward, 2002). The potential for strong seismic ground shaking to occur at the site is high.

8.15.3.4.2 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 (Jennings, 1994). 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.

8.15.3.4.3 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 relatively shallow estimated at less than 10 feet below ground surface (CGS, 2003). Because of the seismic potential and high ground water, the City of Hayward and the State of California have identified the project site area to have a moderate to high potential for liquefaction to occur (City of Hayward 2002, CGS, 2003).

8.15.3.4.4 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 introduce temporary slope stability hazards at either the project site or along linear facility routes. 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 at the site is considered low.

8.15.3.4.5 Subsidence. 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 withdrawal of water and/or hydrocarbons in the subsurface soils and construction of new facilities such as mass fills and new structures or buildings. Without proper and site-specific geotechnical assessment relative to the proposed facilities, subsidence potential could be high. A site-specific geotechnical investigation is being conducted and will determine the level of subsidence potential for the site and recommendations to mitigate if significant.

8.15.3.4.6 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 project site and linears are primarily underlain by sandy, granular soil intermixed with silt and clay. These silts and clays, though intermixed with granular soil, could have expansion potential. A site-specific geotechnical investigation is being conducted and will determine the level of expansion potential for the site.

8.15.3.4.7 Tsunami/Seiche. Tsunamis are waves typically generated offshore or within large bodies of water during a subaqueous fault rupture or a subaqueous landslide event. Seiches are waves generated within a large body of water caused by the 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 impacted by a tsunami or seiche resulting from the occurrence of a major earthquake along the San Andreas and/or Hayward faults. According to the City of Hayward General Plan (2002), 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 result in a run-up of less than 10 feet above sea level if it reached Hayward. Since the project site lies at an elevation of approximately 25 feet above sea level, and is located approximately 1.75 miles from the shore of the San Francisco bay, the likelihood that the site will be impacted by a tsunami/seismic seiche is low.

8.15.3.5 Geologic Resources 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 below.

8.15.3.5.1 Mineral/Aggregate Production. The production of salt by evaporation is the only mineral resource in the project vicinity. Cargill Incorporated operates several salt evaporator ponds in the City of Newark. The project would not affect this operation. No other mineral or aggregate resource was identified in the area.

8.15.4 Environmental Impacts

8.15.4.1 Generating Facility

8.15.4.1.1 Geologic Hazards. Ground-shaking presents the most significant geologic hazard to the proposed SFERP site and project linear. Based on the analysis in Section 8.15.3, Table 8.15-3 summarizes the geologic hazards associated with the Eastshore project site and linear facilities that have a moderate to high potential to occur.

TABLE 8.15-3
Summary of Potential Geologic Hazards

Project Component	Area of Potential Concern	Geologic Hazards of Potential Concern
Proposed generating facility site (up to 5 acres)	Entire site	Seismic ground-shaking, liquefaction, subsidence
Transmission linear	Entire site	Seismic ground-shaking, liquefaction, subsidence

8.15.4.1.2 Geologic Conditions and Topography. Construction will require minor grading and excavation, thereby altering the terrain of the proposed Eastshore power plant site. Impacts on the geologic conditions involve changes in drainage, cuts, and fills. Since the site is generally level, site grading is not expected to adversely impact the geologic environment.

8.15.4.2 Geologic Resources of Recreational, Commercial, and Scientific Value

No known natural resources occur in the Eastshore project site area. No significant impact to geologic resources would occur with the project.

8.15.5 Mitigation Measures

The following subsections describe mitigation measures that could be used to reduce impacts from geologic hazards.

8.15.5.1 Ground Rupture

No active faults cross the Eastshore project site or project linear (Jennings, 1994). Therefore, no mitigation measures are required to reduce the hazard from surface faulting rupture.

8.15.5.2 Ground-Shaking

The Eastshore project site and project linear will need to be designed and constructed to withstand strong earthquake-shaking as specified in the 2001 CBC for Seismic Zone 4 - in accordance with City of Hayward construction standards. A site-specific geotechnical investigation (forthcoming) will aid in the development of the seismic design criteria.

8.15.5.3 Liquefaction

The soil types present at the Eastshore project site and along the project linear may be conducive to liquefaction. A site-specific geotechnical investigation currently being conducted will aid in the assessment of liquefaction potential and lateral spreading. Mitigation for liquefaction may include grouting, deep-dynamic compaction, stone columns, geopiers, or deep foundations such as piles or drilled shafts.

8.15.5.4 Subsidence

Without proper geotechnical assessment of the site relative to the proposed facilities, subsidence potential could be high. A site-specific geotechnical investigation is being conducted and will determine the level of subsidence potential for the site and recommendations to mitigate if significant. If required, mitigation could include preloading/surcharging, deep foundations, grouting, deep-dynamic compaction or geopiers.

8.15.5.5 Expansive Soils

Expansive soils can be mitigated by removing the soil and backfilling with non-expansive soil, instituting chemical stabilization of the soil, or constructing a foundation treatment that resists uplift of the expansive soil. Soil types present in the general site vicinity may have expansion potential. A site-specific geotechnical investigation is being conducted and will determine the level of expansion potential for the site and present mitigation recommendations.

8.15.6 Involved Agencies and Agency Contacts

No permits are required for compliance with geological LORS. However, the City of Hayward Building Department is responsible for enforcing compliance with building standards.

8.15.7 Permits Required and Permit Schedule

Compliance of building construction with CBC standards is covered under engineering and construction permits for the project. There are no other permit requirements that specifically address geologic resources and hazards. However, excavation/grading and inspection permits may be required prior to construction and will be included in the overall project construction permit.

8.15.8 References

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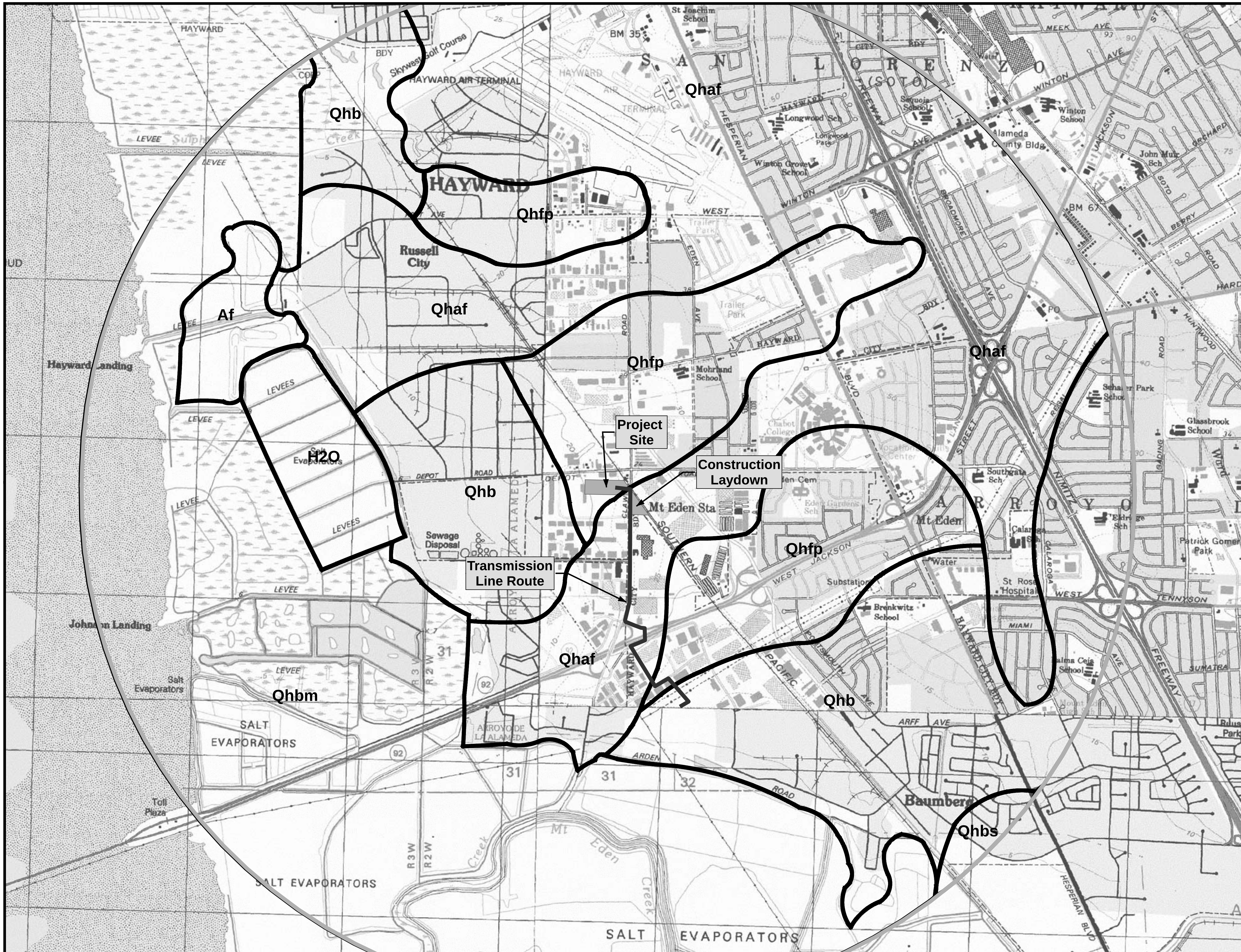

LEGEND

- Two Mile Buffer of Site Location
- Geologic unit contact (approximate)
- Site Location
- Transmission Line Option

H20 – Water
Af – Artificial Fill
Qhbm – Bay Mud
Qhfp – Alluvial Terrace Deposits
Qhb – Basin Deposits
Qhbs – Floodplain Deposits
Qhaf – Alluvial Fan Deposits

Source : Halley, et al. 1997. USGS. Quaternary Geology of Alameda County and Surrounding Areas, California.
Derived from the digital data base, Open File Report 97-97.

N

2,000 1,000 0 2,000 Feet

SCALE IS APPROXIMATE

FIGURE 8.15-1
AREA GEOLOGY WITHIN TWO MILES OF EASTSHORE ENERGY CENTER
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA

CH2MHILL

BAO \\ZINFANDEL\GIS\PROJECTS\EASTSHORE\MAPFILES\FIG_8_15_1_GEOLOGY_11_17.MXD FIG_8_15_1_GEOLOGY_11_17.PDF 8/24/2006 17:36:56

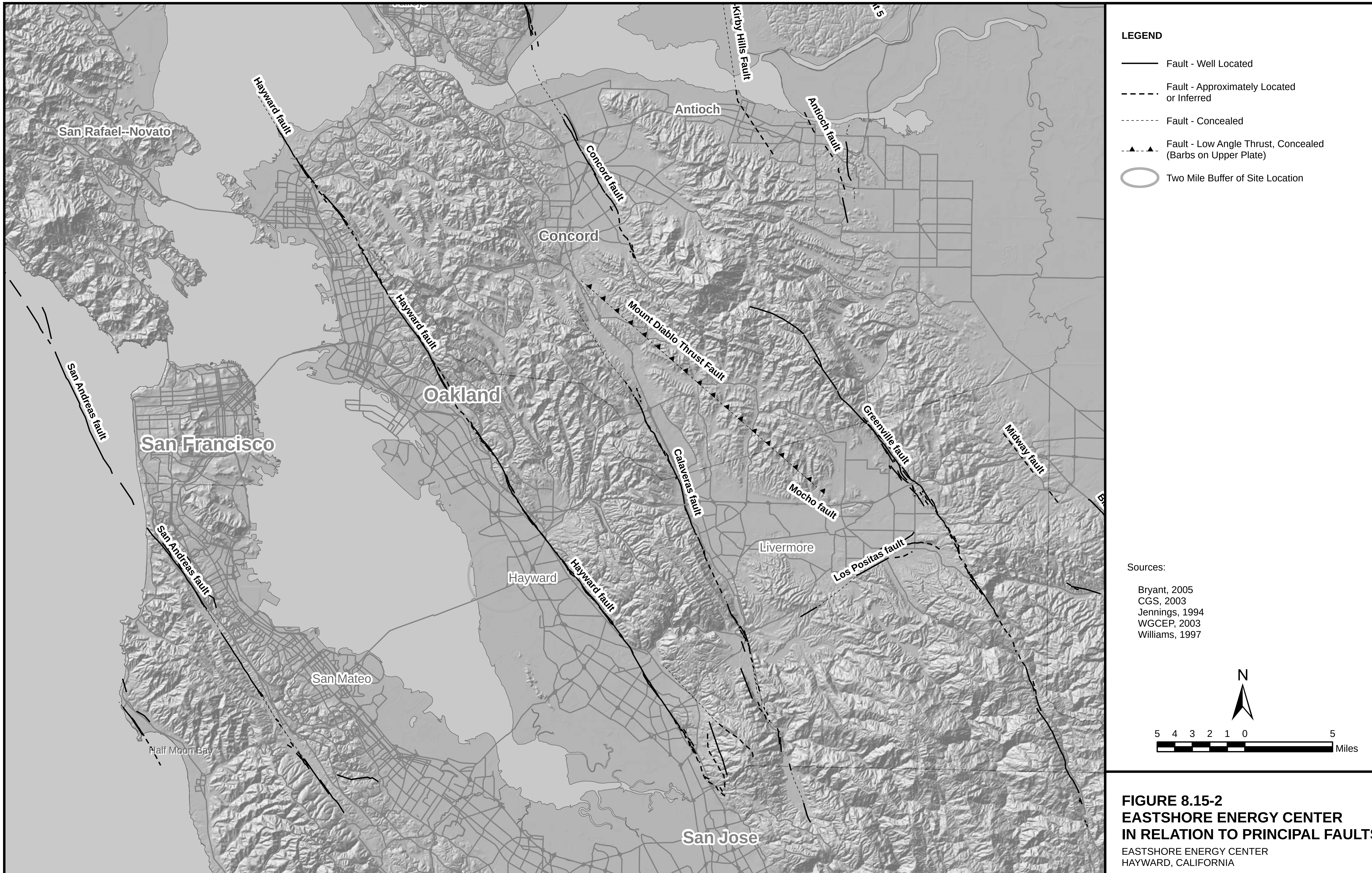

FIGURE 8.15-2
EASTSHORE ENERGY CENTER IN RELATION TO PRINCIPAL FAULTS
EASTSHORE ENERGY CENTER
HAYWARD, CALIFORNIA

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