8.4 Geological Hazards and Resources

This section evaluates the effect of geological hazards on the project and of the project on geological resources of commercial, recreational, or scientific value. Section 8.4.1 describes the existing environment that could be affected, including regional and local geology and geological hazards. Section 8.4.2 identifies potential environmental effects from project development. Section 8.4.3 discusses cumulative effects. Section 8.4.4 presents mitigation measures. Section 8.4.5 presents the laws, ordinances, regulations, and standards (LORS) applicable to geological hazards and resources. Section 8.4.6 describes the required permits and provides agency contacts. Section 8.4.7 provides the references used to develop this section.

The tectonics and geology in the site area is relatively well known from numerous studies completed for Humboldt Bay Power Plant Unit 3 (Earth Sciences Associates, 1975, 1977; Woodward-Clyde Consultants, 1980) and the Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) that is now under construction (PG&E, 2004). The following geologic information is abstracted from the detailed Safety Analysis Report for the ISFSI (PG&E, 2003). Numerous geotechnical investigations have been conducted at the vicinity of the Humboldt Bay Repowering Project (HBRP) site over its more than 50-year operating history; the most recent one for the ISFSI. In addition, a geotechnical investigation has been conducted for the HBRP site. The preliminary draft geotechnical report is found as an attachment to Appendix 10G.

8.4.1 Affected Environment

The proposed HBRP is located within the existing 143-acre Humboldt Bay Power Plant property near the coastal community of King Salmon on the east shore of Humboldt Bay in Humboldt County. It is about 3 miles south of Eureka. The Pacific Gas and Electric Company (PG&E) property includes Buhne Point, a small headland on the eastern shore of Humboldt Bay and part of the small isolated Buhne Hill that rises to elevation 64 feet above mean lower low water (MLLW). The property also includes the adjoining sand flats in the bay to the northwest and adjacent marsh and filled marsh to the northeast, east and south. The proposed HBRP is sited on a flat part of the property on a filled marsh on the north east side of Buhne Hill. The proposed facilities are underlain by Quaternary estuarine and marine deposits and local alluvium.

8.4.1.1 Regional Geology

The HBRP is within the Coast Ranges physiographic/tectonic province. The geology of the region around the site is very complex, reflecting geologically rapid processes driven by recent[1] tectonics and rapid erosion. The site lies within the Eel River sedimentary basin, a broad depositional basin that is underlain by a thick late Cenozoic marine sedimentary sequence consisting of the Wildcat Group and Hookton Formation (PG&E, 2003). These late Cenozoic deposits unconformably overlie basement rocks of the late Jurassic to late Tertiary Franciscan Complex. The sediments in the basin are young and generally not well cemented and have been dramatically deformed by tectonics driven by the Cascadia Subduction zone

[1] In geologic terms, 'recent' means within the last 10,000 years.

as it extends from offshore to onshore in the Eureka area. The resulting geologic structures of this zone in the Humboldt Bay region are dominated by north-northwest trending compressional structures, some of which are reactivated faults that formed during earlier phases of plate convergence that have affected the region since the Late Jurassic. The Mad River fault zone and the Little Salmon fault zone are major reverse faults that pass near the site. They are active, with multiple movements documented during the past 10,000 years.

Northwestern California, including the HBRP site, is within a highly active seismic region that has had numerous earthquakes. The site is on the western edge of the North American plate, within the southern end of the Cascadia subduction zone, and a short distance north of the Mendocino triple junction (Figure 8.4-1). These are related to the Cascadia subduction zone, the Mendocino fracture zone, faults within the Gorda tectonic plate, and faults at the surface either connected to the subduction zone or in the Coast Ranges part of the North American tectonic plate. More than 120 earthquakes greater than magnitude 5 have been recorded within 100 miles of the site, including 10 that have exceeded magnitude 7. Most of these earthquakes have occurred in the offshore region within and along the southern margin of the Gorda plate and on the Mendocino fault zone. Only one of these earthquakes occurred on the interface of the Gorda and North American plates (the M 7.2 1992 Petrolia earthquake); most of the others have occurred within the Gorda Plate or in the overriding North America plate. Figure 8.4-2 shows faulting in the Humboldt Bay region.

8.4.1.2 Local Geology

The HBRP site is underlain by a thick sequence of Pleistocene alluvial to marine sedimentary 'rocks' of the Hookton Formation that are capped by a late Pleistocene marine terrace that is estimated to be 80,000 years old (Figure 8.4-3). The Hookton Formation is about 1,100 feet thick beneath the HRBP site area. The Hookton Formation unconformably overlies the thick sequence of marine and continental rocks of the Pleistocene Scotia Bluffs Formation.

The Hookton Formation forms Buhne Hill. Surrounding Buhne Hill and overlying the Hookton rocks are Holocene estuarine deposits from Humboldt Bay and alluvial deposits from Elk Creek. These sedimentary units are complicated with rapid facies changes, and layers of organic silt, soft sand and silt, sand and lenses of gravel (Figure 8.4-4).

As discussed below, Buhne Hill lies within the Little Salmon fault zone. The hill has been uplifted and tilted slightly to the northeast by displacements on the Buhne Point fault, which is to the southwest and the Discharge Canal fault, which is to the northwest (Figure 8.4-5). The strata of the Hookton Formation between these faults have been shown to be continuous and unfaulted along the crest of Buhne Hill and a similar situation is expected beneath the HBRP site.

8.4.1.3 Faulting

The HBRP site lies near the southern end of the Cascadia Subduction zone. Two major zones of thrust faults and folds in the Humboldt Bay area are of interest to the HBRP, the Mad River fault zone and the Little Salmon fault zone. These faults trend north and northwest, dip east and northeast, and displace Franciscan Complex basement and lower Wildcat Group rocks over the upper Wildcat Group, as well as the uppermost strata of the Hookton Formation and Holocene sediments.

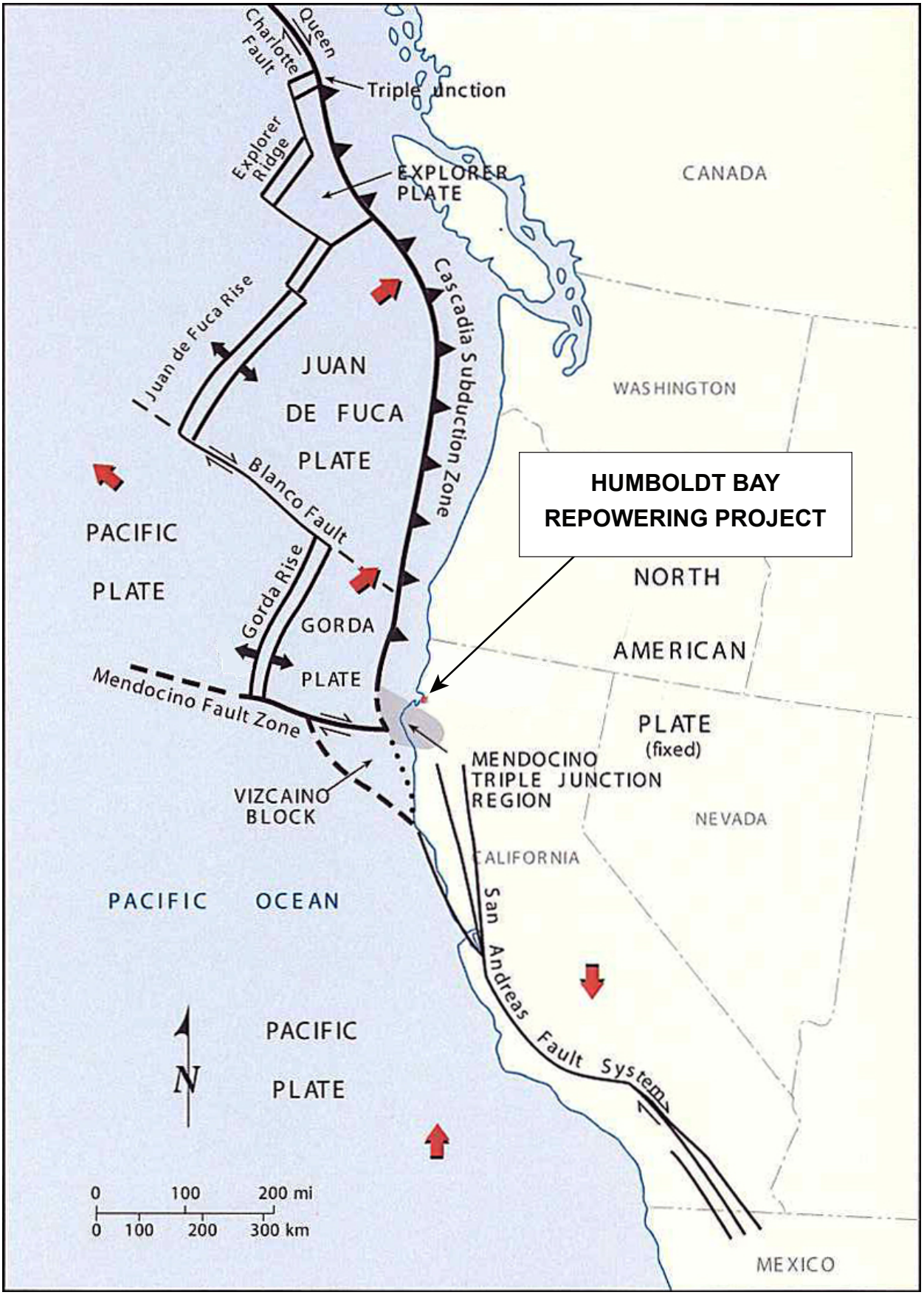

FIGURE 8.4-1
REGIONAL TECTONICS
HUMBOLDT BAY REPOWERING PROJECT

SOURCE: Humboldt Bay ISFSI Safety Analysis Report, January 2004

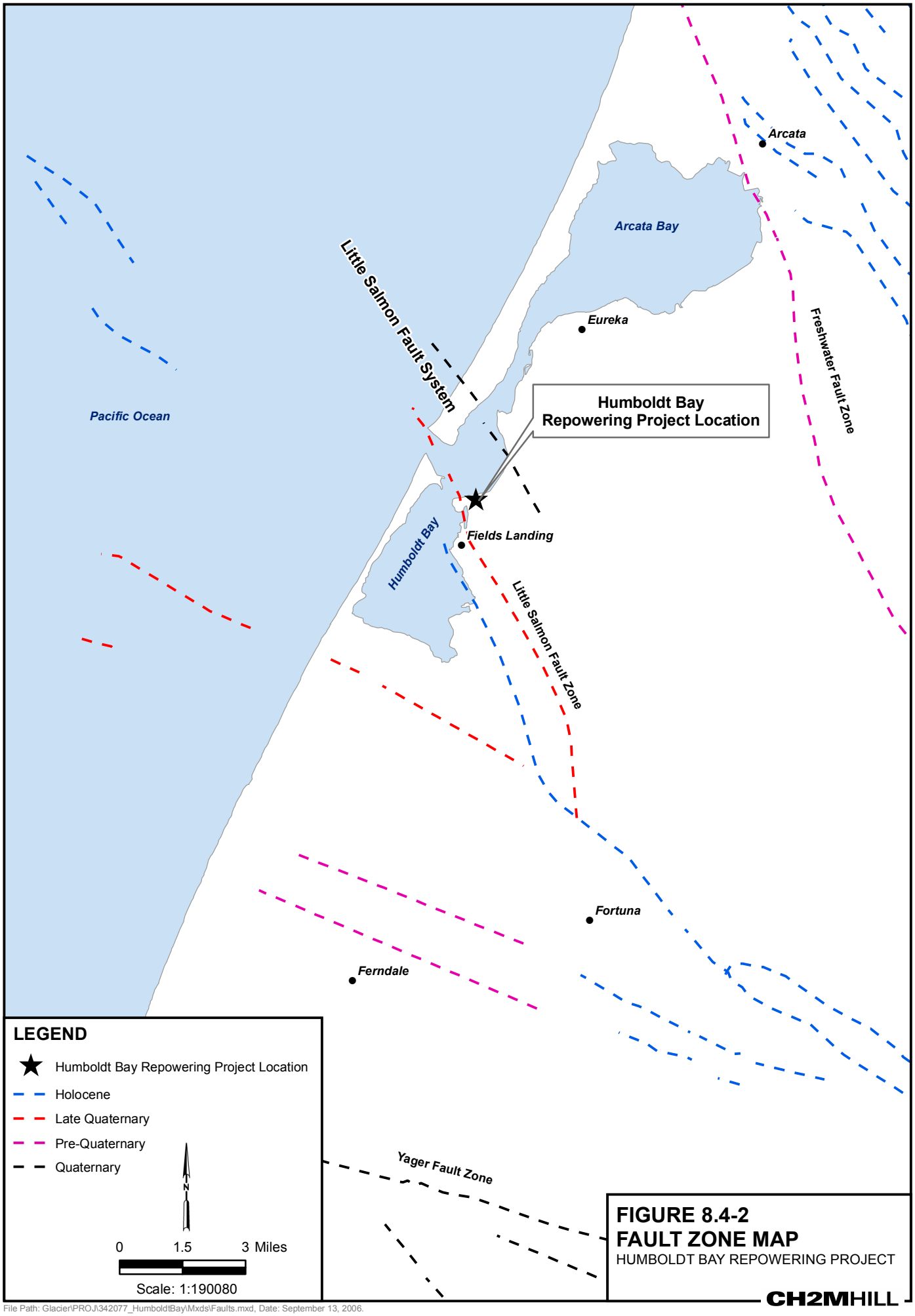

FIGURE 8.4-2
FAULT ZONE MAP
HUMBOLDT BAY REPOWERING PROJECT

CH2MHILL

File Path: Glacier\PROJ\342077_HumboldtBay\Mxds\Faults.mxd, Date: September 13, 2006.

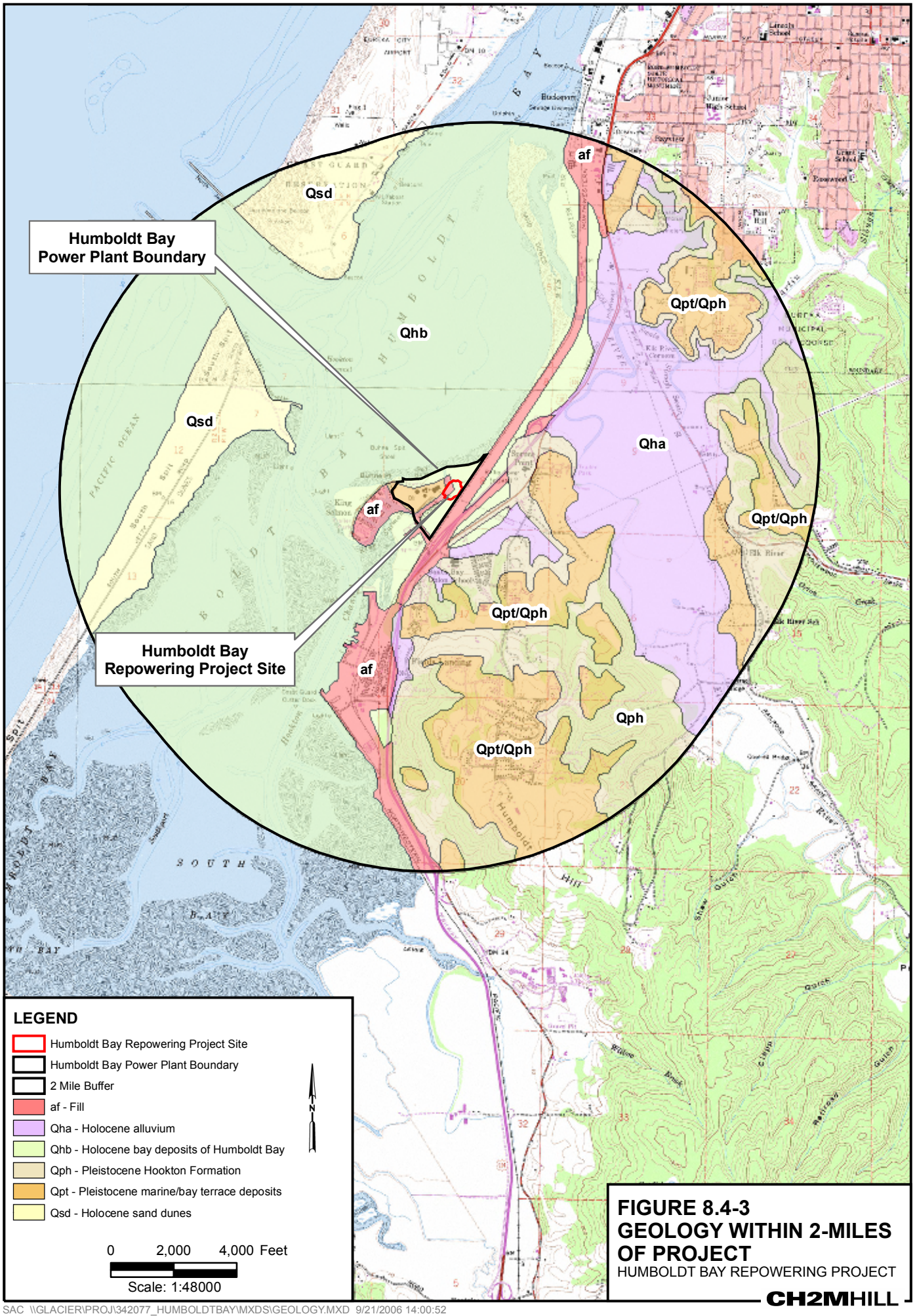

FIGURE 8.4-3
GEOLOGY WITHIN 2-MILES OF PROJECT
HUMBOLDT BAY REPOWERING PROJECT

CH2MHILL

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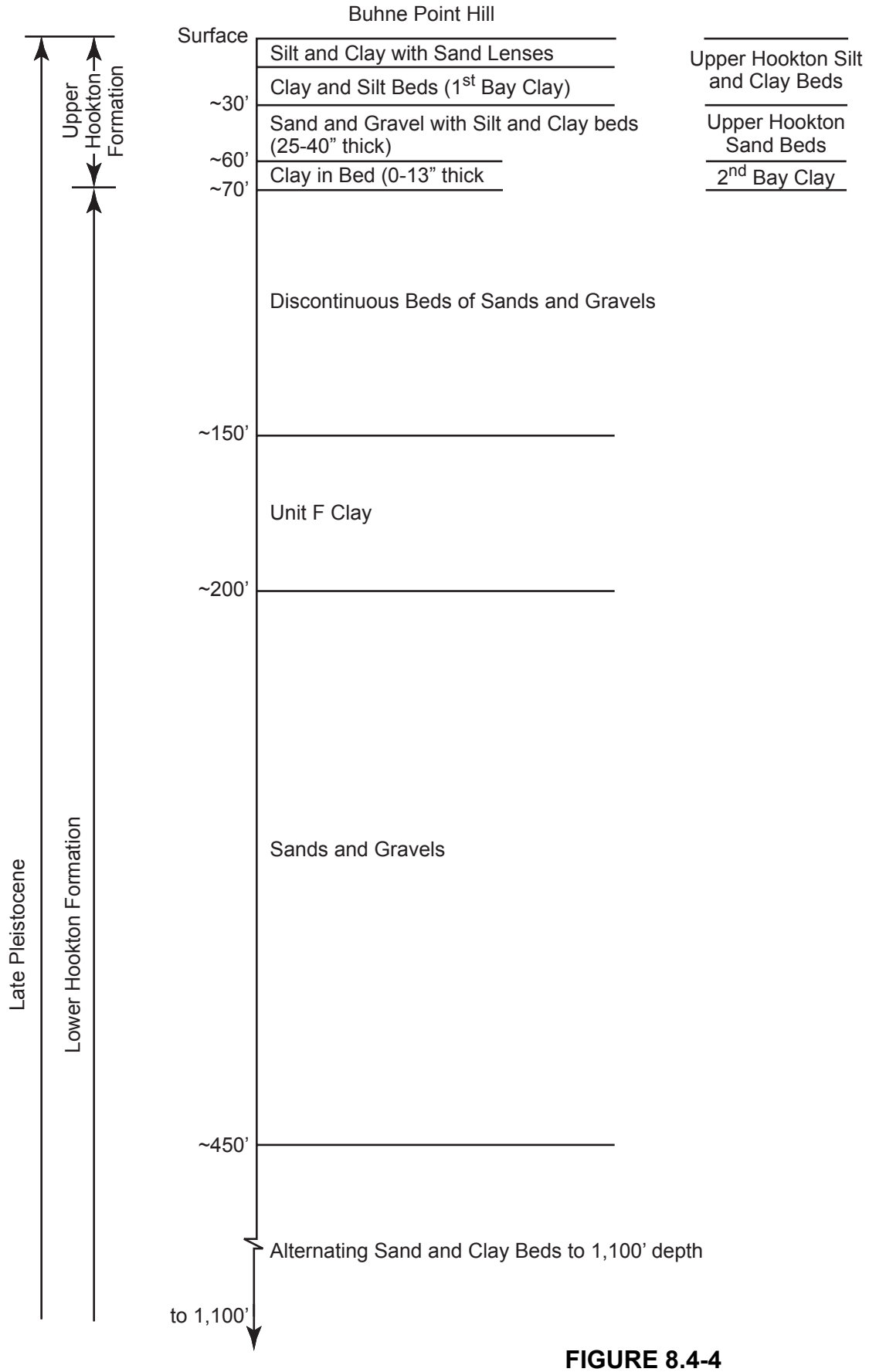

FIGURE 8.4-4
GENERALIZED STRATIGRAPHIC COLUMN IN THE HBRP SITE AREA
HUMBOLDT BAY REPOWERING PROJECT

CH2MHILL

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SOURCE: Humboldt Bay ISFSI Safety Analysis Report, January 2004

FIGURE 8.4-5
ONSITE FAULTS
HUMBOLDT BAY REPOWERING PROJECT

CH2MHILL

PO062006001SAC figure_8.4-5.ai 09/14/06 tdaus

8.4.1.3.1 Mad River Fault Zone

At its closest point, the Mad River fault zone is about 23 kilometers north of the site. The onshore part of the fault zone includes the Trinidad, Blue Lake, McKinleyville, Mad River, Fickle Hill, and Greenwood Heights faults. The surface traces of these faults are generally parallel, northwest-trending, and 2 to 5 kilometers apart. At the coast, the fault zone is about 20 kilometers wide. The total length of the fault zone, including the offshore traces is about 80 kilometers (Clarke, 1992). The fault has documented surface faulting in the Holocene (Carver et al., 1998).

8.4.1.3.2 Little Salmon Fault Zone

The HBRP lies within the Little Salmon fault zone. The zone has a total length of 95 kilometers, including offshore traces (Clarke, 1992). The Little Salmon fault zone is part of the Little Salmon fault system of active folds and reverse faults that extends from its intersection with the Freshwater fault/Coastal Belt thrust near Bridgeville, California, northwest to its intersection with the Thompson Ridge fault off the coast of southern Oregon. The fault system trends parallel to the deformation front associated with the leading edge of the Cascadia subduction zone.

Four traces of the Little Salmon fault zone are mapped in the vicinity of the HBRP site. These include two primary fault traces, the Little Salmon and Bay Entrance faults and two subsidiary faults that are in the hanging wall of the Bay Entrance fault. The subsidiary faults are the Buhne Point fault and the Discharge Canal fault.

8.4.1.3.3 Little Salmon Fault

The Little Salmon fault is within the Little Salmon fault zone. This fault is believed to rupture concurrently with the Cascadia Subduction Zone as well as independently. The Little Salmon fault projects to the surface about 1.4 miles southwest of the site. Projection of structure contours places the fault about 1,300 meters beneath the western boundary of the Humboldt Bay Power Plant site. The fault was not, however, encountered at this site area in borings, suggesting that the fault either dies out south of the site or its dip steepens at depth, placing the fault more than 1,600 meters below the site (PG&E, 2003).

8.4.1.3.4 Bay Entrance Fault

The Bay Entrance fault is the nearest of the main traces of the Little Salmon fault zone to the site. South of the site, the Bay Entrance fault corresponds to the east trace of the Little Salmon fault zone. As inferred from borings, the fault projects to the surface about 500 meters west of the site. The base of the Hookton Formation is displaced about 440 meters (dip-slip) and the upper Hookton Formation is displaced about 270 meters. Progressive separation of the older beds in the Hookton Formation indicates the fault was active during deposition of the Hookton Formation. The long-term, dip-slip displacement rate on the Bay Entrance fault southwest of the site is believed to be about one millimeter per year.

8.4.1.3.5 Buhne Point Fault

The location of the Buhne Point fault is based on analysis of borings and trenches in and around Buhne Hill (see Figure 8.4-5). The Buhne Point fault is a thrust fault that dips to the northeast and directly underlies a portion of the Humboldt Bay Power Plant property. The projected surface trace of the Buhne Point fault is southwest of the site near the south side of Buhne Hill about 800 feet from the site. The Buhne Point fault shows progressively greater

vertical separation of older horizons. Based on displacement, the long-term average slip rate on the Buhne Point fault is about 0.1 millimeters per year. This slip rate is an order of magnitude lower than the slip rate for the Little Salmon and Bay Entrance traces of the fault zone.

8.4.1.3.6 Discharge Canal Fault

A small fault, informally referred to as the Discharge Canal fault, displaces the upper Hookton Formation with a vertical separation of three meters or more (Figure 8.4-5). The fault was exposed in the trenches excavated for the investigations in the early 1980s and is partly exposed in a hand-dug pit in the sea cliff about 75 meters west of the discharge canal that was excavated for the ISFSI. It projects about 300 feet to the north of the site. The Discharge Canal Fault and the Buhne Point Fault have caused the uplift responsible for Buhne Hill.

8.4.1.4 Geological Hazards

The following sections discuss the potential geological hazards that might occur in the project area. Several geologic hazards have the potential to significantly affect the site, including seismic shaking, liquefaction, tsunami inundation, and possible surface faulting.

In keeping with the requirements of the California Energy Commission and the California Coastal Commission, the project will design the facilities to minimize the risks to life from these geologic hazards and keep damage to property within acceptable limits as discussed below. The project will not contribute to erosion, geologic instability or alter the natural landforms because the site is already a filled marsh and as such is disturbed. Hence, construction of the HBRP components will not change the geological or groundwater environment.

8.4.1.4.1 Ground Rupture

Ground rupture on a fault is caused when an earthquake produces fault displacement at the surface. The HBRP is within the Little Salmon fault zone between the Buhne Point fault and the Discharge Canal fault as discussed above. The surface projections of these faults, however, do not intercept the proposed site (see Figure 8.4-5). Displacements on these reverse faults during an earthquake on the Cascadia Subduction zone or the Little Salmon fault alone will potentially uplift the site, but would not be expected to produce surface faulting at the site. Small fractures and faults having as much as about 2 centimeters of vertical displacement are documented from past displacements between these faults and may occur in the strata that underlie the site during future earthquakes on the Little Salmon fault. These small displacements are not significant to the foundation of the proposed power plant or its components.

8.4.1.4.2 Seismic Shaking

Seismic waves passing through the earth generated by earthquakes cause the ground to shake. Severe ground shaking is the most widespread and destructive aspect of earthquakes and the degree of ground shaking is a function of the distance from earthquake epicenter, magnitude of the earthquake, site-specific soil types, among other factors.

A large earthquake significant to the HBRP may be generated by the Cascadia Subduction zone or on local faults, such as the Little Salmon and Mad River Fault zones. Six earthquakes have produced ground motions greater than 0.1g at the Humboldt Bay Power

Plant. Two moderate earthquakes, ML 5.3 in 1975 and ML 5.4 in 1994, produced relatively large ground motions of 0.30g and 0.55g, respectively, the largest ground motions recorded at the site to date. A magnitude 7.2 earthquake occurred in June 2005 in the middle of the Gorda Plate, about 60 miles offshore and about 50 miles from the HBRP. The ground shaking at the Humboldt Bay Power Plant was less than 0.1g and the resulting tsunami was measured in inches and only detected by tide gauge records.

PG&E completed a deterministic ground motion for a controlling earthquake scenario for use in evaluating the ISFSI. The hypothetical earthquake consisted of two subsources: (1) a magnitude 8.8 earthquake on the main Cascadia Interface at a distance of 8 kilometers and (2) a magnitude 7.7 reverse slip earthquake on the Little Salmon Fault at a distance of 9 kilometers. Using inputs from the site-specific geotechnical study, the estimated peak horizontal ground acceleration at the ISFSI was determined to be 2.9g (PG&E, 2003). It should be recognized that this ground motion would be considered the maximum ground motion to which the site would be susceptible and, as such, would be appropriate for the nuclear ISFSI site risk analysis and much more rigorous than would be required for facilities such as the HBRP.

Because the site is located in Seismic Zone 4, according to the California Building Code, the project has elected to use the California Building Code (CBC) for seismic design loads. The CBC refers to the Structural Engineering Design Criteria (Appendix 10B, paragraph 3.1.3). Assuming a type D soil, this results in a 10 percent probability of exceedence in 50 years (10/50).

8.4.1.4.3 Liquefaction

During strong ground-shaking, loose, saturated, cohesion-less soils can experience a temporary loss of shear strength and act as a fluid. This phenomenon is known as liquefaction. Liquefaction is dependent on depth to water, grain size distribution, relative density of the soils, degree of saturation, and intensity and duration of the earthquake. The potential hazard associated with liquefaction would be seismically induced settlement and possible surface displacement from lateral spreading.

The depth to groundwater at the HBRP in the Holocene estuarine sediments is shallow, 2 to 4 feet and the soil types in the Holocene estuarine deposits generally consist of loose, poorly consolidated sands, silts and organic silts (Figures 8.4-3 and 8.4-4). These deposits have a high potential for liquefaction but are expected to be less than about 12 feet below the site (the depth will be determined based on the site geotechnical investigation report).

The underlying Hookton Formation deposits consist of generally dense sands and stiff clays that are not considered to be susceptible to liquefaction because the Standard Penetration Tests (SPT) in borings in the Hookton Formation indicated that nearly all blow counts in the Hookton are above 30 blows per foot (bpf). The few blow counts that are below 30 bpf are typically above 20 bpf and are spatially isolated, indicating low risk of liquefaction in the Hookton Strata.

8.4.1.4.4 Tsunami

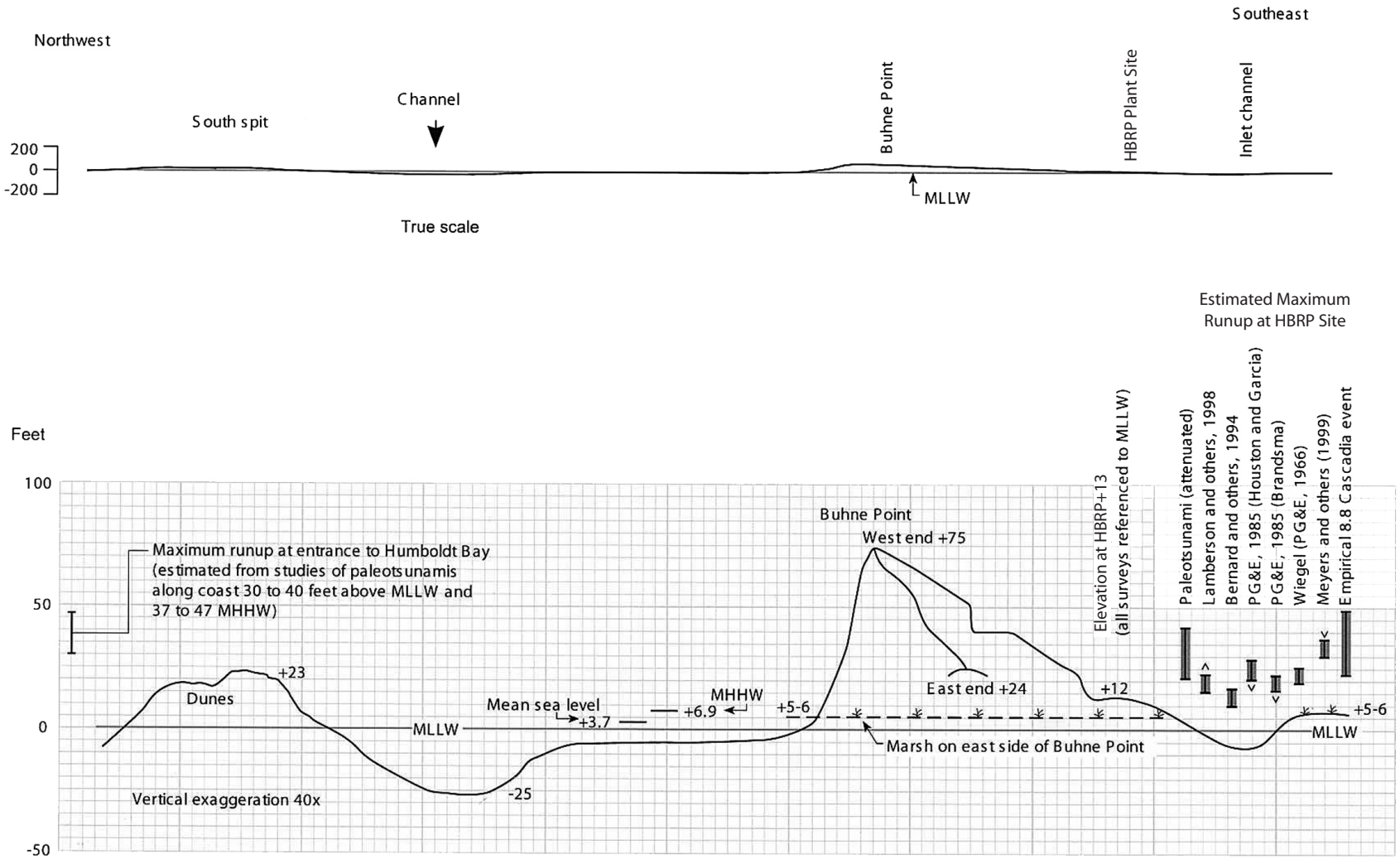
A tsunami is a gravitational sea wave or swell produced by any large-scale, short-duration disturbance of the ocean floor, most commonly from fault offset during an earthquake or a submarine landslide. The HBRP site is on the shoreline of Humboldt Bay and directly

opposite the mouth of Humboldt Bay and is subject to tsunami inundation. The tsunami associated with the 1964 Alaska earthquake was very destructive in Crescent City, but only caused minor runups within Humboldt Bay. Following this event, at the request of the Atomic Energy Commission, PG&E prepared a report that reviewed the historic occurrence of far-field tsunamis in northern California, the exposure of the Humboldt Bay Power Plant site to past tsunamis and estimated the likelihood of future tsunami flooding at the site (PG&E, 1966). During the past 15 years, tsunami hazards along the coast of northern California have received increased attention by scientists, engineers, and public safety agencies because of new findings and interpretations of the tsunamigenic potential of the Cascadia subduction zone and their implications for near-field tsunami generation (Barnard et al., 1994; Toppozada, et al. 1995; Bourgeois and Reinhart, 1989; Benson et al., 1997; Myers et al., 1999; and Priest et al., 2000).

The tsunami studies showed that the North and South spits of Humboldt Bay tend to act as barriers partially blocking tsunamis from entering the bay. Several sites whose geologic setting make them suitable for assessing past tsunamis were investigated along the northern California coast and many were documented (Carver et al., 1998; PG&E, 2003). Although tsunami sand layers were not found in the marsh sediments near the HBRP site, tsunami are recorded at the south end of Humboldt Bay, so tsunami have undoubtedly inundated the lower areas around Buhne Hill including the HBRP site, but the depth of water remains uncertain.

Tsunami runup estimates in Humboldt Bay were assessed for the ISFSI (Figure 8.4-6). These were based on several early estimates as well as recent investigations of paleotsumami along the coast. The results of the recent studies are based on the reconstructed runup heights at North Spit and Lagoon Creek, and evidence that the most recent three or more Cascadia subduction zone events overtopped the South Spit. The maximum runup height for the highest of the recent tsunamis is estimated to be about 30 to 40 feet MLLW at the mouth of Humboldt Bay. However, the runup after entering Humboldt Bay would be significantly lower on the eastern shore of the bay than on the open coast (PG&E, 2003). The runup height from a local Cascadia-generated tsunami generated by an earthquake with a magnitude between 8 and 9 is estimated to be as much as 30 to 40 feet above mean lower low water at the bay entrance. Using an attenuation factor of 0.7 to 0.9 for Buhne Hill because it is directly opposite the bay entrance, the inundation height is estimated to be 21 to 36 feet (MLLW) if the tsunami occurred at low tide or 28 to 43 feet (MLLW) if the tsunami occurred at high tide. Incorporating wave run-up for storms, the maximum value would be about 50 feet MLLW at high tide (PG&E, 2003).

The HBRP site clearly lays within the potential tsunami inundation zone and tsunami are a recognized hazard. Currently, there are no officially recognized probabilistic flood hazard maps for the region; however, previous studies estimate 10 percent probability of exceedence in 50 year (10/50) elevations at the site of between 5 and 9 feet. Tsunami flow velocities are estimated to be between 6.5 and 16.5 feet /second (Houston and Garcia, 1978).



EXPLANATION

- Range of tsunami runups between MLLW and MHHW
- Maximum runup estimate
- Minimum runup estimate

Notes:

1. MLLW is reference for bathymetry and topography at Humboldt Bay Power Plant and ISFSI sites.

SOURCE: Humboldt Bay ISFSI Safety Analysis Report, January 2004

FIGURE 8.4-6
BUHNE HILL WITH TSUNAMI LEVELS, SCHEMATIC SECTION
HUMBOLDT BAY REPOWERING PROJECT

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8.4.1.4.5 Mass Wasting

Mass wasting depends on steepness of the slope, underlying geology, surface soil strength, and moisture in the soil. Significant excavating, grading, or fill work during construction might introduce mass wasting hazards at the project site. Because the site is relatively flat and no significant excavation is planned during site construction, the potential for direct impact from mass wasting at the site is considered low to negligible.

8.4.1.4.6 Subsidence

Subsidence can be a natural or man-made phenomenon resulting from tectonic movement, consolidation, fluid removal (oil, gas, or water), or rapid sedimentation or oxidation of organic-rich soil. Organic soils with significant collapse potential were not encountered during the geotechnical investigation. The potential for subsidence, as a hazard that could affect the project site, is low (PG&E, 2003).

8.4.1.4.7 Expansive Soils

Expansive soils shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations. Soil present at the site predominately consists of silty clayey loam; however, none of the mapped soils that would be affected by the proposed HRBP are known to contain expansive clays. The geotechnical report will provide information to ensure that proper fill selection, moisture control, and compaction would prevent any identified expansive soils from causing significant damage.

8.4.1.5 Geological Resources of Recreational, Commercial, or Scientific Value

According to the maps of the State of California Division of Oil, Gas and Geothermal Resources (CDOGGR, 2005) two gas reserves are in the project vicinity. The Table Bluff and Tompkins Hill gas fields are located more than four miles south of the HRPB.

8.4.2 Environmental Consequences

The potential environmental effects from construction and operation of the HBRP on geological resources and risks to life and property from geological hazards are presented in the following sections.

8.4.2.1 Significance Criteria

According to Appendix G of CEQA, the project would have a significant environmental impact in terms of geological hazards and resources if it would do the following:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault (Alquist-Priolo fault zone)
  - Strong seismic ground shaking
  - Seismic-related ground failure, including liquefaction
- Be located on a geological unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse

- 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
- Result in the loss of availability of a locally important mineral resource recovery site delineated on a local plan, specific plan, or other land use plan

8.4.2.2 Geological Hazards

8.4.2.2.1 Earthquake Hazards

The project site is not located within an Alquist-Priolo earthquake fault zone. However, there is significant potential for strong seismic ground shaking to affect the HBRP in the event of a large magnitude earthquake occurring on fault segments at and near the project site. During such shaking without appropriate design considerations, HBRP equipment could collapse and/or be damaged during a seismic event. Therefore, without designing the structures to withstand potential horizontal ground shaking, construction of the HBRP at the site would be a potentially significant impact to property.

Similarly, construction of the HBRP at the site without appropriate design consideration may pose a significant impact to employees that could be in and among structures that collapsed during a seismic event.

In order to reduce these potential significant impacts to persons and property from seismic shaking to less than significant levels, the HBRP will be designed and constructed in accordance with CBC Seismic Zone 4 Design Standards. The seismic requirements are further defined in Appendix 10B, Structural Engineering Design Criteria. The plant structures and equipment and natural gas filtering/regulator systems will be designed in accordance with CBC, Seismic Zone 4 requirements. Compliance with the CBC, Seismic Zone 4 requirements will minimize the exposure of people to the risks associated with large seismic events. In addition, the major structures will be designed to withstand the strong ground motion of the design earthquake.

It is important to note that the HBRP will replace the existing facilities at the Humboldt Bay Power Plant. When the HBRP is operational, the existing work force will be no greater than the current work force currently at the site. In fact, after the existing Humboldt Bay Power Plant facilities are decommissioned and demolished, the work force will be less, thereby resulting in fewer people exposed to risks associated with seismic shaking. Also, the existing facilities were constructed in the 1950s and 1960s. Since the time of construction of the existing facilities, more stringent design standards have been adopted. Therefore, the HBRP will be designed to withstand seismic shaking better than the older buildings.

In order to further to protect employees at the site, PG&E will continue to implement its safety training on what to do in an seismic event as described in Section 8.16, Worker Health and Safety.

8.4.2.2.2 Liquefaction and Lateral Spreading

Because the project site is located on a Holocene soil that is potentially liquefiable and subject to lateral spreading and settlement, the foundation will be designed withstand such potential movement during a seismic event. Recommendations of a geotechnical engineer will incorporated into design to ensure that the risk of liquefaction is less than significant.

8.4.2.2.3 Landslides

The potential for on- or off-site landslide very low and, therefore, the exposure of people and property to these types of geological hazards would not constitute a significant impact.

8.4.2.2.4 Tsunami

While the HBRP does not create nor contribute to the potential for a tsunami to form and inundate the site, it will place persons and property within a known tsunami inundation zone. During a tsunami event, the risks to property can be described as the risks associated with flooding, as well as the potential for wave forces to damage or destroy structures. In order to reduce the potential loss of property to flooding, the project will be designed and constructed in a manner such that electrical components are protected to the extent possible from coming into contact with water. This may involve locating electrical components in elevated areas rather than in basements or underground vaults. With respect to protecting HBRP equipment from wave forces generated during a tsunami event, in addition to designing and constructing the facility in accordance with Seismic Zone 4 criteria, measures such as anchoring all structures, including the diesel tank(s) to prevent flotation, collapse, or lateral movement resulting from hydrodynamic and hydrostatic loads, including buoyancy, will be incorporated into the design and construction of the HBRP. With these measures, the potential risks to HBRP equipment during a tsunami event will be mitigated to the extent feasible.

With respect to exposing employees and persons on site to risk during a tsunami event, PG&E will continue to implement its safety and emergency training programs as described in Section 8.16, Worker Health and Safety.

It is important to note that the HBRP will not increase the risk of tsunami-related damage off-site. With the measures incorporated into the design and construction of particularly vulnerable facilities, such as building facing and storage tanks, with anchoring to reduce buoyancy, the risk that a tsunami would pick up material and/or equipment from the site and transport it off site is reduced to the extent feasible.

8.4.2.3 Geological Resources

Geological resources of commercial value (sand, gravel, clay mines, oil, gas or other commercial mineral resources) are not present within 2 miles of the project site. There are also no geological resources of recreational or scientific value near the project site. No significant impact to geological resources would thus occur with the project.

8.4.2.4 California Coastal Act Compliance

The Coastal Act Section 30253 states, in relevant part[2]:

> New development shall:
>
> (1) Minimize risks to life and property in areas of high geologic, flood, and fire hazard.
>
> (2) Assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area or in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs…

[2] This section is also included in the Humboldt Bay Area Plan of the Humboldt County Local Coastal Program.

As described in the above analyses of geological hazards, the HBRP will be designed to appropriate standards that would minimize the risks to life and property in case of seismic activity, tsunami, or flood. In addition, the HBRP would have no effect on natural landforms along shoreline bluffs and cliffs, nor would it contribute to erosion or geological instability (see also Section 8.11, Soils). The project would, therefore, be in compliance with this section of the Coastal Act.

8.4.2.5 Conformity with the Humboldt County Local Coastal Plan and Zoning Ordinance

The proposed project conforms to the policies of the Humboldt Bay Area Plan of the Humboldt County Local Coastal Program and the Humboldt County Zoning Ordinance. Table 8.4-1 summarizes the project's conformity with these plans. As the table shows, the project is in conformity with all of the County's policies.

8.4.3 Cumulative Impacts

The project facilities will be constructed to the requirements of the CBC Seismic Zone 4. Site-specific geotechnical investigations will be performed before final design and construction. Construction and operation of the project will not cause significant adverse impacts in terms of geological hazards and resources and would also not cause any minor or less than significant impacts that could be considered significant cumulatively with effects of other nearby developments.

8.4.4 Mitigation Measures

Mitigation measures proposed for the project are as follows:

- Structures will be designed to meet seismic requirements of the 2001 CBC. Moreover, the design of plant structures and equipment will be in accordance with CBC, Seismic Zone 4 requirements to withstand the ground motion of a design earthquake. In addition, special design considerations will be made for constructed facilities, such as that for liquefaction potential as determined by the geotechnical investigation.
- A geotechnical engineer will be assigned to the project to carry out the duties required by the CBC to assess geologic conditions during construction and approve actual mitigation measures used to protect the facility from geologic hazards. The design to mitigate potential tsunami will insure life safety and will be selected as appropriate to minimize property damage for the HBRP facilities.
- The potential that surface faulting does not occur at the facilities will be confirmed.
- Anchoring all structures, including the diesel tank(s) to prevent flotation, collapse, or lateral movement resulting from hydrodynamic and hydrostatic loads, including buoyancy, will be incorporated into the design and construction of the HBRP.
- In order to minimize the risk to employees and persons on site during a tsunami event or seismic event, PG&E will continue to implement its safety and emergency training programs as described in Section 8.16, Worker Health and Safety.

TABLE 8.4-1
Humboldt Bay Repowering Project Geologic Hazard Conformity with Applicable Plans and Policies

Element	Goal/Objectives/Policy	Conformity?
Humboldt County Zoning Regulations		
Preliminary engineering geologic report and a preliminary soil engineering report	313-121.5.1 and 313-121.5.1.2 RI Report Requirements. A preliminary engineering geologic report and a preliminary soil engineering report shall be prepared for the classes of development and hazard areas indicated by an "RI" in the Geologic Hazards Land Use Matrix. These requirements are also included in Section 3292 of the Humboldt County General Plan.	Yes. A preliminary geotechnical report has been prepared. It is included as an attachment to Appendix 10G.
Alquist-Priolo Fault Hazard report	313-121.5.6 When a report is required pursuant to the Alquist-Priolo Fault Hazard regulations of this ordinance; it should be combined with the reports required under this part where feasible.	Not applicable. The project is not within a Alquist-Priolo fault zone.
Contents of Reports	313-121.6.1 Engineering Geologic Report. The preliminary geologic report shall provide a preliminary geological reconnaissance and evaluation of the project site and surrounding terrain. The degree of analysis should be appropriate to the degree of potential risk presented by the site and the proposed project. Reports shall be prepared in accordance with the California Division of Mines and Geology Note #44. "Recommended Guidelines for Preparing Engineering Geologic Reports." CDMG Notes #37, 43, and 49 shall be utilized and applicable when seismic or fault rupture hazards are identified as concerns.	Yes. The final geotechnical report will include the information required or reference where the information is located in the AFC.
	313-121.6.2 Preliminary Soil Engineering Report. The preliminary soil engineering report shall describe the nature of the subsurface soils and any soil conditions which would affect the design and/or layout of the proposed development. The report shall include the locations and logs of any test borings and percolation test results if on-site sewage disposal is proposed. The report shall recommend areas or issues of concern which require additional engineering or geologic evaluation. These reports shall be prepared in accordance with the UBC, Appendix, Chapter 70, Excavation and Grading, and/or Chapter 29, Excavations, Foundations, and Retaining Walls.	Yes. The final geotechnical report will include the information required or reference where the information is located in the AFC.
Contents of Report for Coastal Zone Projects	Within the Coastal Zone, Supplementary Information for Reports for Development Located in the Coastal Zone. The supplemental information is contained in Sections 313-121.6.3.1 through 313-121.6.3.7 of the Zoning Ordinance.	Yes. The final geotechnical project will include the information required or reference where the information is located in the AFC.
Development Standards	313-121.7 The applicant shall either provide additional information as recommended by the preliminary geologic and/or soils report, or modify the proposed development to avoid identified areas of potential instability. The proposed development shall be sited, designed and constructed in accordance with the recommendations of the report(s) in order to minimize risk to life and property on the project site and for any other affected properties.	Yes. PG&E will comply with the requirements of this section.
	313-121.7.2 Projects shall be constructed in accordance with the currently applicable Uniform Building Code, Section 2312, Earthquake Regulations, or any successor provision, as applicable.	Yes. The project shall be constructed in accordance with the currently applicable UBC Section 2312, Earthquake Regulations, or any successor provision, as applicable.

TABLE 8.4-1
Humboldt Bay Repowering Project Geologic Hazard Conformity with Applicable Plans and Policies

Element	Goal/Objectives/Policy	Conformity?
Development Standards within the Coastal Zone	313-121.7.3 Developments shall be sited and designed to assure stability and structural integrity for their expected economic life spans while minimizing alternation to natural landforms.	Yes. The project is sited and will be designed to assure stability and structural integrity for its expected economic life span. Given that the HBRP is on an existing site, alternation to natural landforms is minimized.
Humboldt County General Plan – Volume II -Humboldt Bay Area Plan of the Humboldt County Local Coastal Program		
Hazards	30253 New Development shall: 1) Minimize risks to life and property in areas of high geologic, flood and fire hazard. 2) Assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding areas or in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs.	Yes. See Section 8.4.2.4.
Development Policies	3.17.B2a and b. This section lists the contents for a project geotechnical report.	Yes. The final geotechnical report will include the information required.
	3.172c Developments shall be sited and designed to assure stability and structural integrity for their expected economic life spans while minimizing alternation to natural landforms.	Yes. The project is sited and will be designed to assure stability and structural integrity for its expected economic life span. Given that the HBRP is on an existing site, alternation to natural landforms is minimized.
	3.173 Tsunamis – New development below the level of the 100 year tsunami run-up elevations described in Tsunami Predictions for the West Coast of the Continental United States (Technical Report H-78-26 by the Corps of Engineers) shall be limited to public access, boating, public recreation facilities, agriculture, wildlife management, habitat restoration, and ocean intakes, outfalls, and pipelines, and dredge spoils disposal.	Not Applicable. The HBRP is not a new development. It is a repowering project for the existing Humboldt Bay Power Plant. See Section 2.1.
	3.174 Flood Plains – No critical facilities should be permitted to locate within the 100 year flood plain. Utility lines may cross hazard zones if there is no reasonable alternative and provisions are made to mitigate the hazard. Non-critical facilities should be permitted in the 100 year flood plain only if adequate flood control measures, such as control works, compact fill, etc., that would result in a site being beyond or above the 100 year flood extend, are provided. Further, the County will continue to review development in light of and impose conditions consistent with National Flood Insurance Program.	The HBRP is sited within a special flood hazard area and currently located in a Zone A (100-year flood zone) area per the Federal Emergency Management Agency (FEMA) classification system. During site grading and preparation, the site will be built up to a base flood elevation (BFE) of 13 feet, therefore removing the site from Zone A. See Section 2.6.1 and 8.15.1.3.

With the implementation of these mitigation measures, the HRBP will not result in significant direct, indirect, or cumulative geology-related impacts.

8.4.5 Laws, Ordinances, Regulations, and Standards

The LORS that apply to geologic hazards and resources are summarized in Table 8.4-2.

TABLE 8.4-2
Laws, Ordinances, Regulations, and Standards

Jurisdiction	Authority	Administering Agency	Compliance
Local	CBC, 2001	County of Humboldt	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity
State	CBC, 2001	County of Humboldt	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity
State	California Coastal Act Section 30253	California Coastal Commission	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity

8.4.6 Permits Required and Permit Schedule

The Uniform Building Code (UBC, 1997) specifies the acceptable design criteria for construction of facilities with respect to seismic design and load-bearing capacity. However, the California Building Standards Code (2001), which subsumes the CBC, incorporates the UBC by reference and contains additional requirements, and is the applicable code to be followed for the project. Compliance of building construction with UBC standards is covered under engineering and construction permits for the project (see Table 8.4-3 for a summary). There are no other permit requirements that specifically address geologic resources and hazards.

TABLE 8.4-3
Permits Required and Permit Schedule

Permit/Required Information	Schedule
Building Permit including Seismic Design Criteria: • Geotechnical/Geological report • Requires structural, civil, electrical and mechanical plans • Identify geological hazards and conduct a seismic risk analysis	Submit application 30 days prior to start of construction.
Grading/Drainage/Erosion Control Permit: • Geotechnical/Geological Hazard Evaluation • Engineered Grading Plan • Topographic Plan • Drainage controls • Surface Hydrology Report • Erosion and Dust Control Plan	Submit application 30 days prior to start of construction activities.

8.4.7 Involved Agencies and Agency Contacts

No permits are required for compliance with geological LORS. However, the Humboldt County Building Division is responsible for enforcing compliance with building standards, including the CBC (Table 8.4-4).

TABLE 8.4-4
Agency Contacts

Issue	Contact/Agency	Title	Telephone
Building Permit	Heather Walker, Humboldt County Building Division	Permit Specialist	(707) 445-7245

8.4.8 References

Benson, B.E., K.A. Grimm, and J.J. Clague. 1997. Tsunami Deposits beneath Tidal Marshes on Northwestern Vancouver Island, British Columbia: Quaternary Research, v. 48, p. 192-204.

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Pacific Gas and Electric Company. 2003. Humboldt Bay Independent Spent Fuel Storage Installation Safety Analysis Report.

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Toppozada, T., G. Borchardt, W. Haydon, and M. Peterson. 1995. Planning Scenario in Humboldt and Del Norte Counties, California, for a Great Earthquake on the Cascadia Subduction Zone: California Division of Mines and Geology Special Publication 115, 151 p. plus appendices.

Woodward-Clyde Consultants. 1980. Evaluation of the Potential for Resolving the Geologic and Seismic Issues at the Humboldt Bay Power Plant Unit No. 3: Summary to Pacific Gas and Electric Company, San Francisco, 74p. plus appendix volume.