5.4 Geological Hazards and Resources

This section presents an evaluation of the Contra Costa Generating Station (CCGS) in terms of potential exposure to geological hazards and potential to affect geologic resources of commercial, recreational, or scientific value. Section 5.4.1 describes the existing environment that could be affected, including regional and local geology and geological hazards. Section 5.4.2 identifies potential environmental effects from project development. Section 5.4.3 discusses potential cumulative effects. Section 5.4.4 discusses possible mitigation measures. Section 5.4.5 presents the laws, ordinances, regulations, and standards (LORS) applicable to geological hazards and resources. Section 5.4.6 identifies regulatory agencies and agency contacts. Section 5.4.7 describes the required permits. Section 5.4.8 provides the references used to develop this section.

5.4.1 Affected Environment

The CCGS site is located in an industrial area within the City of Oakley near the junction of State Routes (SR) 4 and 160. The property lies approximately 2.3 miles west of Oakley proper, and approximately 3.7 miles northeast of the town of Antioch in Contra Costa County, California. It is adjacent to industrial facilities to the north and east, the SR 160 corridor and industrial facilities to the west, and vineyards and the Burlington Northern Santa Fe railroad tracks to the south. The site is located on the northern end of the Diablo Range within the Coast Ranges geomorphic province (U.S. Geological Survey [USGS], 1994 and 1997). The proposed CCGS site and proposed transmission and utility lines would run across relatively flat terrain. The CCGS site is located within the greater San Francisco Bay area, which is known to be seismically active.

5.4.1.1 Regional Geology

The Oakley area is located near the boundary of the Coast Ranges Geomorphic Province and the Great Valley Geomorphic Province. The Coast Ranges Geomorphic Province contains nearly parallel mountain ranges and valleys that trend northwest, parallel to the San Andreas Fault, and is underlain at depth by Franciscan Assemblage rocks. The Great Valley Geomorphic Province consists of an elongated structural trough that has been filled with a sequence of sedimentary deposits ranging from Jurassic to recent in age. The Great Valley is thought to be underlain a depths with granitic rocks of the Sierra Nevada Province (San Francisco Bay Area Rapid Transit [BART], 2008).

The San Joaquin-Sacramento Delta lies at the junction of the Sacramento and San Joaquin rivers, the two main waterways that drain the Central Valley. In the San Joaquin-Sacramento Delta, sedimentary bedrock is up to 6 miles thick. This area consists of a braided pattern of brackish to freshwater tidally influenced channels and sloughs encircling a series of low-lying islands (City of Oakley, 2008).

5.4.1.2 Local Geology and Stratigraphy

The vicinity of the project site is relatively flat, with an overall slope of approximately 0.25-percent grade to the east. Local drainage is directed toward the east. The elevation of the site varies from approximately 58 to 65 feet above mean sea level (California Division of Mines and Geology [CDMG], 1987).
The surficial geology in the vicinity of the CCGS site is composed entirely of late Quaternary to Holocene alluvial deposits and recent artificial fill, and late Tertiary sedimentary deposits in the southernmost portion of the 2-mile radius (Figure 5.4-1). These sediments were deposited by streams coming from mountain canyons into alluvial valley floors or alluvial plains, including debris flow, hyperconcentrated mud flow, and braided stream deposits (BART, 2008). The preliminary geotechnical report and database review have shown that the subsurface at the site consists of predominantly dune sands. The dune sands are of Holocene or Pleistocene age. Based on the site elevation, nearby projects, and nearby San Joaquin River, groundwater depths are estimated to be 14 to 15 feet below the existing site grades, with a likely flow direction to the north (TRC, 2008).

The geology of Contra Costa County is dominated by several northwest trending fault systems, with strike-slip and reverse motions, trending north-northwest. Most of the principal faults in the area have recent Holocene activity.

A preliminary geotechnical report has been completed on the project site (report included as Appendix 2G to this Application for Certification [AFC]). A second, more extensive geotechnical investigation will be completed prior to commencement of detailed design activities.

### 5.4.1.3 Seismic Setting

The modern tectonic setting of the San Francisco Bay area is dominated largely by the transform plate boundary contact between the Pacific and North American plates south of the Mendocino triple junction. The Pacific plate is slipping in a north-northwest direction (N35°W to N38°W) at a rate of about 1.81 to 1.95 inches per year (46 to 47 millimeters per year) with respect to the North American plate. Right-lateral strike-slip displacement along the major branches of the San Andreas Fault system accommodates most of this plate motion, with the remainder generating Holocene tectonism and seismicity at the western continental margin and to the east in the Sierra Nevada and Basin and Range Provinces. The site lies within the broad San Andreas Fault system that accommodates most of the plate motion between the Pacific and North American plates, although the most active faults within the system lie west of the site.

The seismicity of the CCGS site area can be characterized as an area of moderate seismic activity, with potentially large-magnitude earthquakes. Principal faults within 25 miles of the CCGS are shown on Figure 5.4-2. These faults include the Great Valley Fault Segment 5 (4.3 miles east), Greenville Fault Segment North (9.9 miles southwest), Mount Diablo Fault (10.9 miles southwest), Concord/Green Valley Fault (15.2 miles west), Calaveras Fault (19.5 miles southwest), Great Valley Fault Segment 4 (21.3 miles east), Great Valley Fault Segment 7 (22.6 miles east), and the Greenville Fault Segment South (22.8 miles south). Other faults located between 25 and 50 miles farther to the west, north, and south include the Concord, Hayward, West Napa, Calaveras, Huntington Creek–Berryessa, San Andreas, and Great Valley Segment 3 faults. Some of these faults are capable of generating maximum earthquake magnitudes of 6.3 to 7.7 (Blake, 2004). These fault zones represent a significant potential seismic hazard to the project site. No faults have been mapped crossing the CCGS site, and the site is not within an Alquist-Priolo Special Studies Zone (California Geological Survey [CGS], 2007).
This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

Notes:

FIGURE 5.4-1
GEOLOGY WITHIN TWO MILES OF SITE
CONTRA COSTA GENERATING STATION
OAKLEY, CALIFORNIA
This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

Source: Unruh & Krug, 2007; USGS 1996a

FIGURE 5.4-2
MAJOR FAULTS
CONTRA COSTA GENERATING STATION
OAKLEY, CALIFORNIA
5.4.1.4 Potential Geological Hazards

The following subsections discuss the potential geological hazards that might occur in the project area.

5.4.1.4.1 Ground Rupture

Ground rupture is caused when an earthquake event along a fault creates rupture at the surface. Since no known active faults cross the project site, the likelihood of ground rupture to occur is considered low.

5.4.1.4.2 Seismic Shaking

The project area has experienced seismic activity with strong ground motion during past earthquakes, and it is likely that strong earthquakes causing seismic shaking will occur in the future. The significant geological hazard at the CCGS site is strong ground-shaking due to an earthquake. Ground shaking from a magnitude 7.7 earthquake could occur within an approximately 50-mile radius of the site (Blake, 2004).

The controlling fault affecting the CCGS site is Segment 5 of the Great Valley Fault, located approximately 4.3 miles east of the site. This is a reverse-type fault dipping approximately 15 degrees west with a slip rate of approximately 1.5 millimeters per year (USGS, 2009) and is capable of generating a peak bedrock acceleration (g) of 0.28 (Blake, 2004) based on the maximum credible earthquake (MCE) event. Other faults that are located within a 23-mile radius of the CCGS site are capable of generating a PBA range of 0.10g to 0.28g (Blake, 2004).

5.4.1.4.3 Liquefaction

During strong ground shaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength and act as a fluid. This phenomenon is known as liquefaction. Liquefaction depends on the depth to water, grain size distribution, relative soil density, degree of saturation, and intensity and duration of the earthquake. The potential hazard associated with liquefaction is seismically induced settlement. Soil conditions at the CCGS site predominantly consist of dune sands. Nearby explorations have indicated that the sands are generally medium dense to dense with moderately low liquefaction potential. However, published liquefaction maps (City of Oakley, 2002) of the area indicate that there is a moderate potential for seismically induced liquefaction at the site. The preliminary geotechnical investigation performed liquefaction analysis on the upper silty sand layers, between elevations of 7 feet above and 7 feet below mean sea level. Based on the liquefaction analysis, both of the upper silty sand layers are potentially liquefiable. The deeper sand layers have a higher relative density and generally are not considered to be liquefiable (Black & Veatch, 2009). Further analysis will be performed in a more extensive geotechnical investigation.

5.4.1.4.4 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 project site is relatively flat and no significant excavation is planned, the potential for direct impact from mass wasting at the site is considered low to negligible.
5.4 GEOLOGICAL HAZARDS AND RESOURCES

5.4.1.4.5 Subsidence
Subsidence can be caused by natural phenomena during tectonic movement, consolidation, hydrocompaction, or rapid sedimentation. Subsidence also can occur from human activities, such as withdrawal of water or hydrocarbons in the subsurface soils. No known subsidence problems exist in the project area. The City of Oakley General Plan (Health and Safety Element chapter) does not indicate that the project area is within an area prone to subsidence (City of Oakley, 2002).

5.4.1.4.6 Expansive Soils
The soil profile at the project site predominantly consists of dune sands that may be of Holocene or Pleistocene geologic age. Expansive soils shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations. Expansive or highly compressible clays are not anticipated in the upper portions of the soil profile of the site (TRC, 2008). The preliminary subsurface geotechnical investigation did encounter clayey soils above the water table and near the design finished grade elevation of 18 feet above mean sea level. However, Atterberg Limits tests performed on clay samples collected above the water table indicate the swelling potential is “low.” Based on the subsurface investigation, the potential for soil collapse at the site is expected to be remote (Black & Veatch, 2009).

5.4.1.4.7 Seiches and Tsunamis
Tsunamis are seismically induced ocean waves with very long periods. Tsunamis may be manifested in the form of wave bores or a gradual upwelling of sea level and can be caused by landslides or earthquakes. The offshore area of the San Francisco Bay area contains many faults and fault scarps capable of producing tsunamis; however, seismically induced sea waves are uncommon or rare. The site area is not known to have experienced tsunamis in the historic past, and the USGS estimates, based on records from 1960 and 1964 events, that attenuation results in a reduction of a wave height measured at the Golden Gate by 90 percent by the time it reaches the vicinity of the Carquinez Strait. Because the project site is located approximately 20 to 25 miles up the San Joaquin River from the San Francisco Bay, the potential for a significant tsunami event that would affect the CCGS site is low.

Seiches are defined as oscillations in confined or semi-confined bodies of water due to earthquake shaking. Because there are no large bodies of water near the project site, the potential impact of a seiche on the CCGS site is negligible.

5.4.1.5 Geologic Resources of Recreational, Commercial, or Scientific Value
At the project site, the geologic units at the surface and in the subsurface are widespread alluvial deposits that occur throughout the San Francisco Bay area; these units are not unique in terms of recreational, commercial, or scientific value. The potential for rare mineral or fossil deposits is very low, given the geologic environment in the area. Additionally, the site has been and currently is used for agricultural production. Significant mineral deposits are not present in the project area as identified in the Contra Costa County General Plan (Conservation Element) (Contra Costa County, 2005).

There are no known geologic resources that provide a significant scientific or recreational value near the site. There are no wells located near the project site. According to online maps of the California Division of Oil, Gas and Geothermal Resources (CDOGGR) (2009), oil
and natural gas deposits in the wider project area appear to be several miles southeast of the project site. There is an active well approximately 2.5 miles southeast of the project site. Two active oil and gas fields are located within a 5-mile radius of the site. The River Break gas field is located approximately 2.5 miles southeast of the project site, and the Oakley gas field is located approximately 5 miles southeast of the project site.

In 1987, the CDMG published a comprehensive mineral land classification for aggregate materials in the San Francisco-Monterey Bay area. Based on this investigation, the CCGS site is mapped as MRZ-3. MRZ-3 is defined as areas containing mineral deposits, the significance of which cannot be evaluated from available data. Based on the Contra Costa County General Plan (Contra Costa, 2005) and the City of Oakley General Plan (City of Oakley, 2002) there are no known active areas of mining for mineral resources near the CCGS site.

Thus, CCGS would have no effect on oil and gas production or on other geologic resources of commercial value or on the availability of such resources.

5.4.2 Environmental Analysis

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

5.4.2.1 Significance Criteria

According to Appendix G of the California Environmental Quality Act statutes, a 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 geologic unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on- or offsite 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

5.4.2.2 Geological Hazards

There is significant potential for seismic groundshaking to affect the project site and linears in the event of a large-magnitude earthquake occurring on fault segments near the project. The proposed CCGS, however, is not located within an Alquist-Priolo Special Studies Zone or within the trace of any known active fault. The project would, therefore, not be likely to cause direct human exposure to ground rupture. Seismic hazards will be minimized by
conformance with the recommended seismic design criteria of the 2007 California Building Code (CBC) (California Building Standards Commission, 2007). Liquefaction potential present at the site will need to be considered during project design.

The probability of mass wasting, subsidence, or flooding at the project site is low to negligible.

In summary, compliance with the 2007 CBC requirements will reduce the exposure of people to the risks associated with large seismic events, liquefaction potential, and expansive soils to less-than-significant levels. Additionally, major structures will be designed to withstand the strong ground motion of a Design Basis Earthquake (DBE), as defined by the 2007 CBC. Through compliance with CBC standards, impacts associated with geological hazards will be less than significant.

5.4.2.3 Geological Resources

The proposed CCGS would not result in a loss of availability of a known mineral resource that would be of value to the region and the residents of the state. Additionally, CCGS would not 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. There are no such resources that have been identified on or near the site, and so there will be no adverse impacts on geological resources.

5.4.3 Cumulative Effects

A cumulative impact refers to a proposed project’s incremental effect together with other closely related past, present, and reasonably foreseeable future projects whose impacts may compound or increase the incremental effect of the proposed project (Public Resources Code § 21083; California Code of Regulations, Title 14, § 15064(h), 15065(c), 15130, and 15355).

The proposed CCGS will not cause adverse impacts on geological resources and will not cause an exposure of people or property to geological hazards. Additionally, there are no minor impacts that could combine cumulatively with those of other projects. Thus, the project will not result in a cumulatively considerable impact.

5.4.4 Mitigation Measures

To address potential impacts related to geological hazards, the following mitigation measures are proposed for the project:

- Structures will be designed to meet seismic requirements of the 2007 CBC. Moreover, the design of plant structures and equipment will be in accordance with 2007 CBC earthquake design requirements to withstand the ground motion of a DBE.

- 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 geological hazards.

With the implementation of these mitigation measures, CCGS will not result in significant direct, indirect, or cumulative geology-related impacts.
5.4.5 Laws, Ordinances, Regulations, and Standards

The LORS that may apply to geologic resources and hazards are summarized in Table 5.4-1. The local LORS discussed in this section are certain ordinances, plans, or policies of Contra Costa County. There are no federal LORS that apply to geological hazards and resources.

### Table 5.4-1

<table>
<thead>
<tr>
<th>LORS</th>
<th>Requirements/Applicability</th>
<th>Administering Agency</th>
<th>AFC Section Explaining Conformance</th>
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</thead>
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<td>State</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBC, 2007 as amended by Contra Costa County</td>
<td>Acceptable design criteria for structures with respect to seismic design and load-bearing capacity</td>
<td>California Building Standards Commission, State of California, and Contra Costa County</td>
<td>Section 5.4.2.2</td>
</tr>
<tr>
<td>Alquist-Priolo Earthquake Fault Zoning Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 3, California Code of Regulations)</td>
<td>Identifies areas subject to surface rupture from active faults</td>
<td>California Building Standards Commission, State of California, and Contra Costa County</td>
<td>Section 5.4.2.2</td>
</tr>
<tr>
<td>The Seismic Hazards Mapping Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 10, California Code of Regulations.)</td>
<td>Identifies non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides</td>
<td>California Building Standards Commission, State of California, and Contra Costa County</td>
<td>Section 5.4.2.2</td>
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<tr>
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<td></td>
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<tr>
<td>Contra Costa County General Plan (Contra Costa County, 2005)</td>
<td>Contra Costa County</td>
<td>Contra Costa County</td>
<td>Section 5.4.2.2</td>
</tr>
</tbody>
</table>

5.4.6 Agencies and Agency Contacts

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 (see Section 5.6, Land Use).

5.4.7 Permits and Permit Schedule

No permits are required for compliance with geological LORS. However, Contra Costa County Code Enforcement is responsible for inspections and ensuring compliance with building standards.
5.4.8 References


