5.4 Geologic Hazards and Resources

5.4.1 Introduction

This section evaluates the geologic hazards and resources at the Almond 2 Power Plant (A2PP) project site and linears. Section 5.4.2 describes the existing environment that could be affected, including regional and local geology and geologic hazards. Section 5.4.3 identifies potential environmental effects from project development. Section 5.4.4 discusses potential cumulative effects. Section 5.4.5 discusses possible mitigation measures. Section 5.4.6 presents the laws, ordinances, regulations, and standards (LORS) applicable to geologic hazards and resources. Section 5.4.7 provides agency contacts. Section 5.4.8 describes the required permits. Section 5.4.9 provides the references used to develop this section.

5.4.2 Affected Environment

The A2PP is located off of Crows Landing Road, in Ceres, California, Stanislaus County. The site is adjacent to the existing Almond Power Plant to the south, a WinCo distribution warehouse to the west, industrial businesses to the north and east, and the Ceres Wastewater Treatment Plant farther east. The site parcel is approximately 4.6 acres and is relatively flat and rectangular. The proposed A2PP site and proposed transmission and utility lines would run across flat plains.

5.4.2.1 Regional Geology

The project area is situated in the Great Valley geomorphic province. The Great Valley physiographic province separates the Coast Ranges to the west from the Sierra Nevada to the east. These mountain ranges were formed by uplifts that occurred during the late Tertiary (2 to 25 million years ago) and Quaternary periods (up to 1 million years ago). The structural trough between the ranges has been filled with alluvial, lacustrine, and some marine sediments that attain a maximum thickness of about 30,000 feet near the western margin. The bedrock is composed of metamorphosed marine sediments similar to those found in the core of the Coast Ranges and the foothills of the Sierra Nevada (Kleinfelder, 1993).

5.4.2.2 Local Geology

The project site and linears are in an area of relatively flat topography typical of the Central Valley. The surficial geology within a 2-mile radius of the site is shown on Figures 5.4-1a through 5.4-1d. The project site and surrounding area, including the area surrounding the proposed linear facilities, are composed of Quaternary Modesto Formation geology. Near-surface sediments in the site area have been deposited primarily during flood stages of the Tuolumne and San Joaquin River systems, prior to the present-day flood-control systems (Kleinfelder, 1993).

5.4.2.3 Project Site Stratigraphy

The A2PP site is underlain by a fairly complete stratigraphic section of Cretaceous, Tertiary, and Quaternary deposits. The sediments deposited prior to mid-Tertiary time were in a marine environment. Changes in sea level, valley filling, and uplift resulted in the

deposition of continental sediments after Mid-Tertiary time (Kleinfelder, 1993). The site has been previously excavated to a depth of approximately 6.5 feet below ground surface for use as a soil borrow area for the WinCo distribution warehouse. The site was filled to its current elevation in 2008 with fill derived from construction of a wastewater pond in Turlock, California. Appendix 5.4A provides a copy of the grading plan used during the fill activities. According to the grading plan, the site was filled in 1 foot lifts, and compacted to 95 percent relative compaction with a TID geotechnical engineer inspecting the compaction activities.

5.4.2.4 Seismic Setting

The project site and linears are in the Central Valley of California, which is characterized by relatively low seismicity in a state that is considered to have moderate to high seismic activity. There are no active or potentially active faults known to extend through the valley alluvium in the Ceres area. Numerous faults and shear zones developed during the formation of the Sierra Nevada and Coast Ranges. The site and linears are not located in any special study zones that have been delineated as critical earthquake or fault areas, as indicated by the *Alquist-Priolo Special Studies Zone Act of* 1972, Special Publication 42 published by the California Division of Mines and Geology (Condor, 1994).

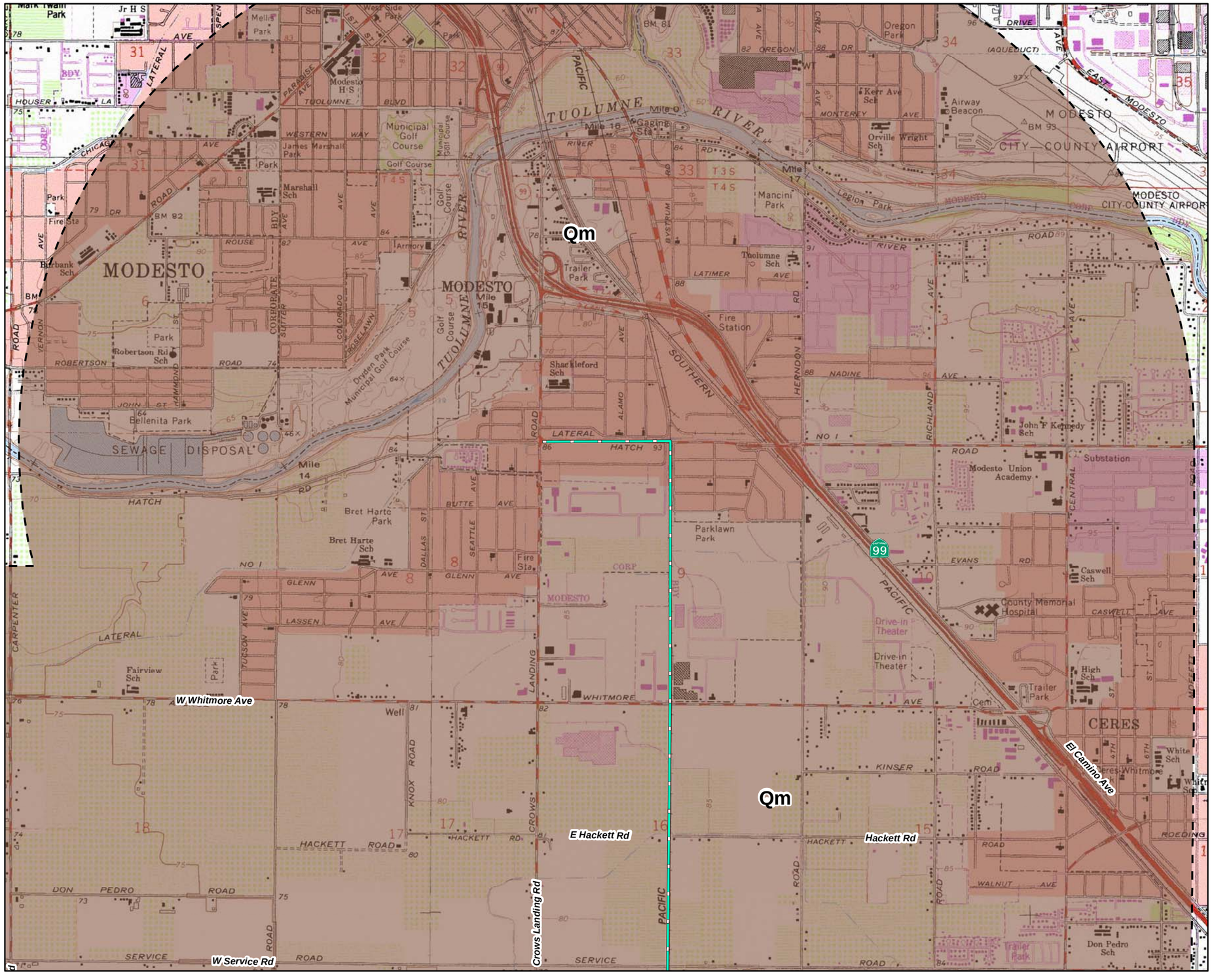
The Foothills fault system is the closest fault system to the A2PP, approximately 36 miles east of the site. The Tesla-Ortigalita fault zone is the closest to the site, approximately 34 miles to the southwest. The nearest controlling fault impacting the A2PP is Segment 7 of the Great Valley Fault System, which is approximately 12.8 miles west of the site (Blake, 2004).

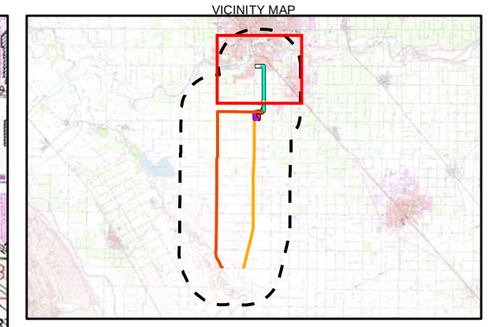
Earthquake activity without surface fracturing or faulting is common, although the most recent movement along the Tesla-Ortigalita fault zone was approximately five million years ago. A Richter magnitude 3.7 earthquake occurred with an epicenter several miles west of Crows Landing on June 27, 1986. Earthquakes of a similar or greater magnitude can be expected in the future (Condor, 1994).

No faults have been mapped crossing the project site or linears, and the site is not within an Alquist-Priolo Special Studies Zone (CGS, 2007). The locations of principal faults relative to the project site are shown on Figure 5.4-2.

5.4.2.5 Potential Geologic Hazards

Geotechnical investigations were previously conducted for the area south of the A2PP, at the existing Almond Power Plant, by Kleinfelder, Inc. in February 1993, and by Condor Earth Technologies in February 1994 (copies of these reports are provided in Appendix 5.4B). The scope of these investigations was to assess soil conditions, depth to groundwater, and anticipated foundation loads for the existing Almond Power Plant, located just south of the proposed A2PP. The data contained in the previous geotechnical investigations are sufficient to support environmental permitting for the A2PP. However, a site-specific geotechnical investigation should be conducted at the A2PP site prior to construction.





LEGEND

- Natural Gas Pipeline (Alternate A)
- Natural Gas Pipeline (Alternate B)
- 115-kV Circuit 1 Line (Corridor 1)
- 115-kV Circuit 2 Line (Corridor 2)
- Reconductored 69kV Sub-Transmission Line
- Two Mile Buffer
- Proposed Grayson Substation
- Laydown Area
- Project Site

Geology Type

- Qm - Modesto Formation

Note:
1. California Geological Survey (CGS). 1990. Geologic Map of the San Francisco-San Jose Quadrangle, California, Map No. 5A (Geology). California Department of Conservation. Prepared by D.L. Wagner, E.J. Bortugno, and R.D. McJunkin.
2. The Grayson Substation is being developed as a separate Project

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

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Feet

FIGURE 5.4-1A
GEOLOGY WITHIN TWO MILES OF SITE
ALMOND 2 POWER PLANT
CERES, CALIFORNIA

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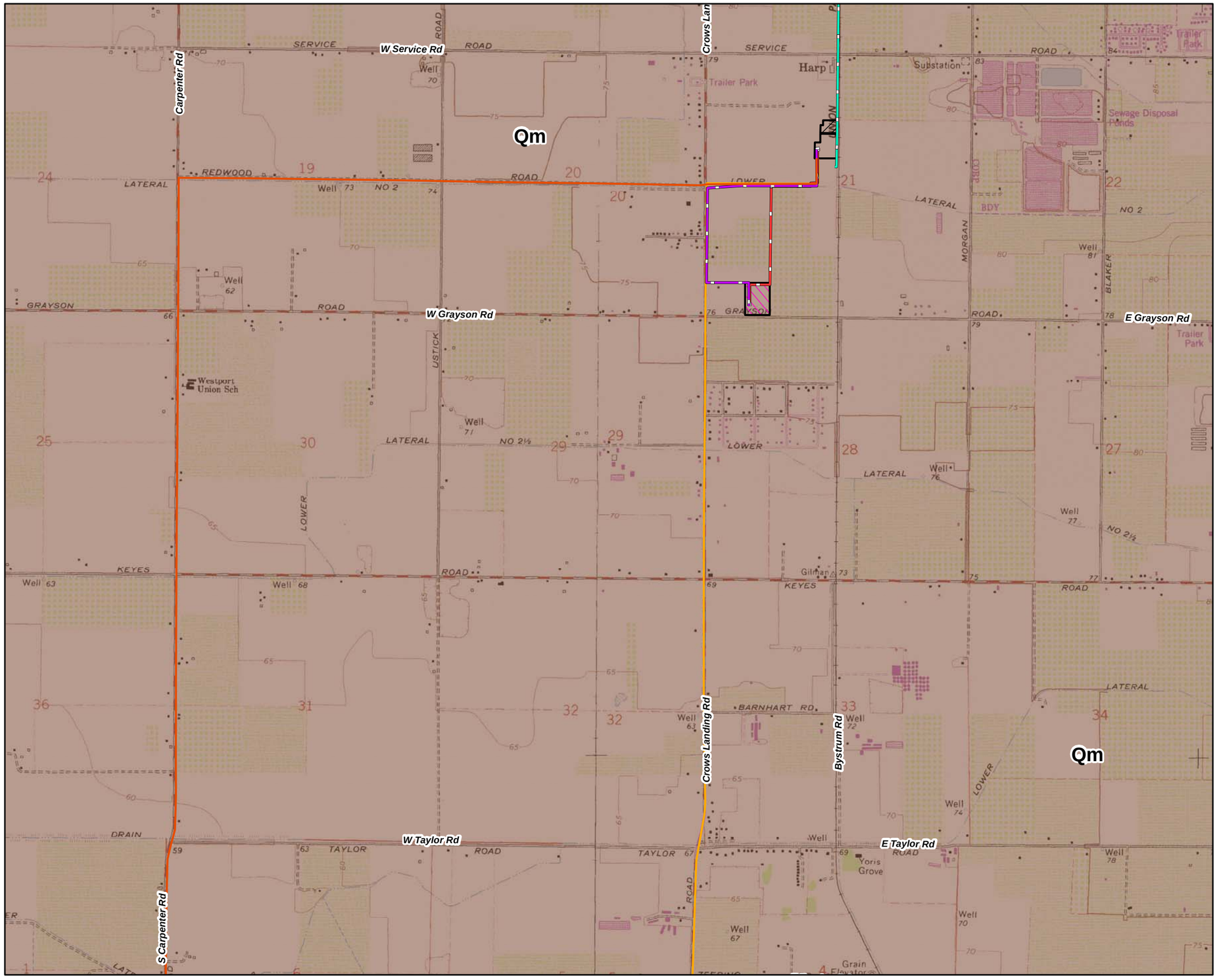
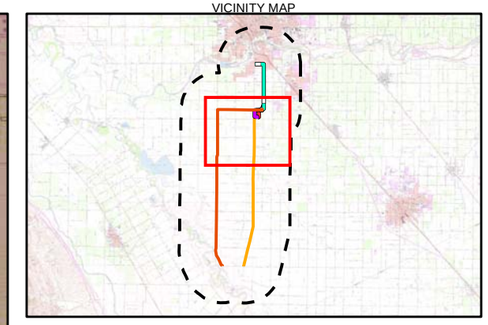


VICINITY MAP



LEGEND

- Natural Gas Pipeline (Alternate A)
- Natural Gas Pipeline (Alternate B)
- 115-kV Circuit 1 Line (Corridor 1)
- 115-kV Circuit 2 Line (Corridor 2)
- Reconductored 69kV Sub-Transmission Line
- Two Mile Buffer
- Proposed Grayson Substation
- Laydown Area
- Project Site

Geology Type

- Qm - Modesto Formation

Note:
1. California Geological Survey (CGS). 1990. Geologic Map of the San Francisco-San Jose Quadrangle, California, Map No. 5A (Geology). California Department of Conservation. Prepared by D.L. Wagner, E.J. Bortugno, and R.D. McJunkin.
2. The Grayson Substation is being developed as a separate Project

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

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FIGURE 5.4-1B
GEOLOGY WITHIN TWO MILES OF SITE
ALMOND 2 POWER PLANT
CERES, CALIFORNIA

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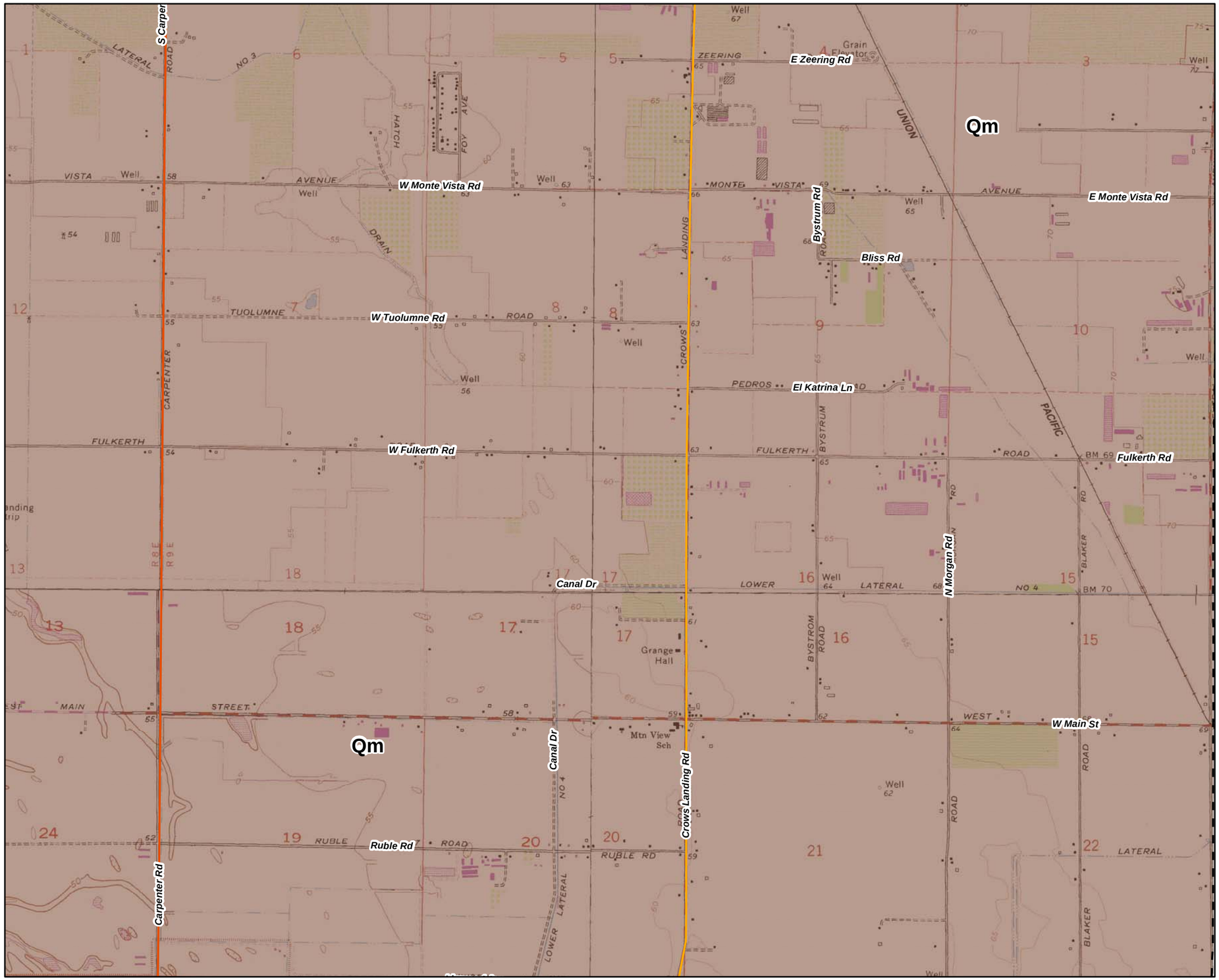

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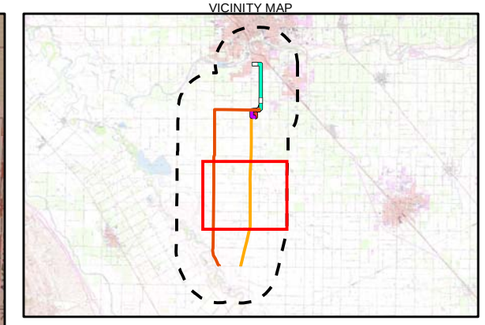

LEGEND

- Natural Gas Pipeline (Alternate A)
- Natural Gas Pipeline (Alternate B)
- 115-kV Circuit 1 Line (Corridor 1)
- 115-kV Circuit 2 Line (Corridor 2)
- Reconductored 69kV Sub-Transmission Line
- Two Mile Buffer
- Proposed Grayson Substation
- Laydown Area
- Project Site

Geology Type

- Qm - Modesto Formation

Note:
1. California Geological Survey (CGS). 1990. Geologic Map of the San Francisco-San Jose Quadrangle, California, Map No. 5A (Geology). California Department of Conservation. Prepared by D.L. Wagner, E.J. Bortugno, and R.D. McJunkin.
2. The Grayson Substation is being developed as a separate Project

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

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FIGURE 5.4-1C
GEOLOGY WITHIN TWO MILES OF SITE
ALMOND 2 POWER PLANT
CERES, CALIFORNIA

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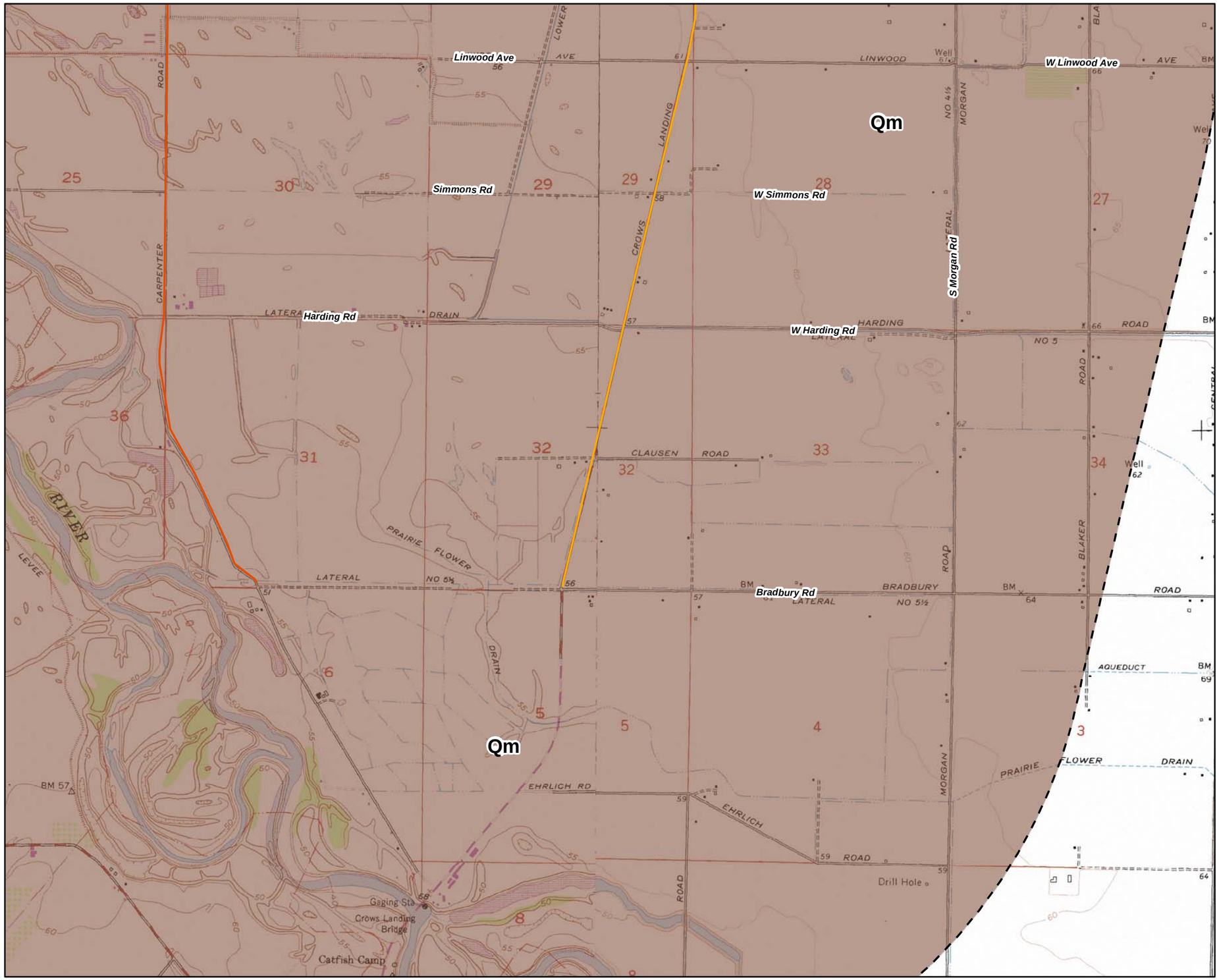
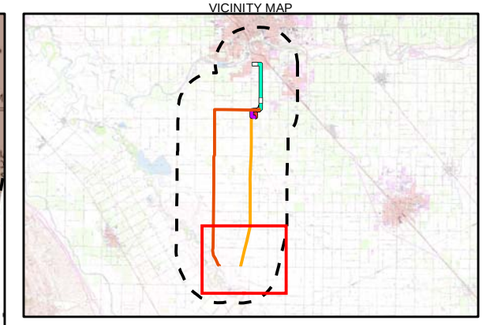


VICINITY MAP



LEGEND

- Natural Gas Pipeline (Alternate A)
- Natural Gas Pipeline (Alternate B)
- 115-kV Circuit 1 Line (Corridor 1)
- 115-kV Circuit 2 Line (Corridor 2)
- Reconductored 69kV Sub-Transmission Line
- Two Mile Buffer
- Proposed Grayson Substation
- Laydown Area
- Project Site

Geology Type

- Qm - Modesto Formation

Note:
1. California Geological Survey (CGS). 1990. Geologic Map of the San Francisco-San Jose Quadrangle, California, Map No. 5A (Geology). California Department of Conservation. Prepared by D.L. Wagner, E.J. Bortugno, and R.D. McJunkin.
2. The Grayson Substation is being developed as a separate Project

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

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FIGURE 5.4-1D
GEOLOGY WITHIN TWO MILES OF SITE
ALMOND 2 POWER PLANT
CERES, CALIFORNIA

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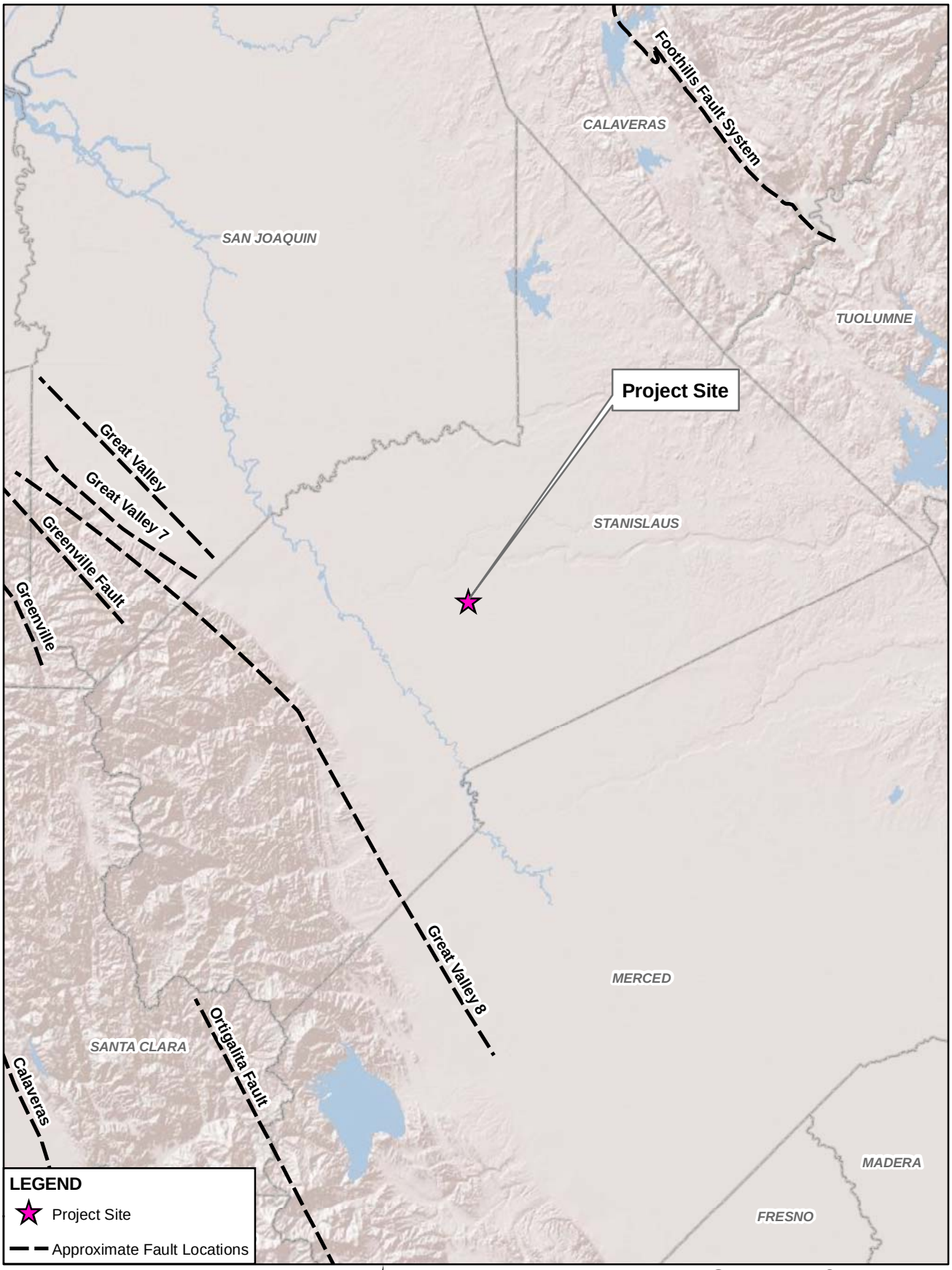

Notes:
1. Source: Blake, 2004.

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

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FIGURE 5.4-2
A2PP IN RELATION TO PRINCIPAL FAULTS
ALMOND 2 POWER PLANT
CERES, CALIFORNIA

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

5.4.2.5.1 Ground Rupture

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

5.4.2.5.2 Seismic Shaking

The project area has experienced seismic activity with moderate ground motion during past earthquakes, and it is likely that strong earthquakes causing seismic shaking will occur in the future. The significant geologic hazard at the A2PP site and linears is moderate ground-shaking due to an earthquake. Ground shaking from a magnitude 7.9 earthquake could occur within a 60-mile radius of the site (Blake, 2004).

The controlling fault impacting the A2PP site and linears is Segment 7 of the Great Valley Fault System, located approximately 12.8 miles west of the site. This is a blind reverse-type fault dipping approximately 15 degrees to the west with a slip rate of approximately 1.5±1 millimeters per year (CGS, 2002) and is capable of generating a peak bedrock acceleration (PBA) of 0.16g (Blake, 2004) based on the maximum credible earthquake (MCE) event. The Foothills Fault System, Segments 7 and 8 of the Great Valley Fault System, the Greeneville Fault, the Ortigalita Fault, and the Calaveras Fault, which are located within a 60-mile radius of the A2PP site, are capable of generating a PBA range of 0.03g to 0.16g.

5.4.2.5.3 Liquefaction

During a strong earthquake, loose, saturated, cohesionless soils can experience a temporary loss of shear strength and act as a fluid. This phenomenon is known as liquefaction. Liquefaction is dependent on the depth to groundwater, 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. The depth to groundwater at the project site is approximately 18 to 21 feet below ground surface. Data provided in the geotechnical investigation conducted at the adjacent Almond Power Plant showed that loose sands were found to be generally confined to a depth of four to six feet. Alternating layers of very stiff to hard sandy silts and clayey silts, as well as medium dense to dense silty and relatively clean sands were found below these depths (Condor, 1994).

As noted above, the project site had previously been excavated to a depth of approximately 6.5 feet. In 2008, the site was backfilled to its current elevation with commercial fill. According to the grading plan, the site was backfilled in 1 foot lifts, and compacted to 95 percent relative compaction. The liquefaction susceptibility of this material cannot be fully evaluated at this time. It is possible that loose sands may be present at the project site, but the project site is not known to be within an area of liquefaction and Stanislaus County is not included in U.S. Geological Survey Liquefaction Hazard Maps for Northern California or Susceptibility Map. Therefore, the likelihood that liquefaction will occur is considered moderate.

5.4.2.5.4 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 and linears. Because the site is relatively flat and no significant excavation is planned during site and linears construction, the potential for direct impact from mass wasting at the site is considered low to negligible.

5.4.2.5.5 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. Subsidence has not been identified as a geologic hazard at the site or linears according to the seismic and geological hazards section of the City of Ceres General Plan (Ceres, 1997). Stanislaus County has experienced some regional subsidence, primarily on the western side of the county. This subsidence is due to long-term withdrawal of groundwater causing compaction of fine-grained sediments in the aquifer system. The potential for subsidence as a hazard that could affect the A2PP is low to moderate.

5.4.2.5.6 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. According to the City of Ceres General Plan, because of the topography and water table, soils in Ceres do not typically exhibit any unusual qualities that require special foundations or engineering due to shrink-swell behavior (Ceres, 1997).

5.4.2.5.7 Flooding

The Federal Emergency Management Agency (FEMA) maintains a collection of flood insurance rate maps, which cover the entire United States. These maps identify those areas that may be subjected to 100-year floods. Based on review of the map for the A2PP site and linears (map ID 06099C0555E), the project does not lie within the mapped 100-year flood plain. The project site and linears are located in an area determined to be outside the 0.2 percent annual chance floodplain (FEMA, 2009).

5.4.2.6 Geologic Resources of Recreational, Commercial, or Scientific Value

There are no known geologic resources that provide a significant scientific or recreational value near the site. According to online maps of the State of California Division of Oil, Gas and Geothermal Resources (CDOGGR, 2009), the A2PP and linears are in an area where oil and gas exploration has occurred. No wells have been drilled within 2 miles of the A2PP, and no gas fields of potential value are present within 5 miles of the project site. Although several wells have been drilled within 5 miles of the A2PP, they were labeled as “plugged and abandoned – dry hole” according to the CDOGGR maps. There are no active gas fields within a 5-mile radius of the A2PP.

5.4.3 Environmental Analysis

The potential environmental effects from construction and operation of the A2PP on geologic resources and risks to life and property from geologic hazards are presented in the following sections.

5.4.3.1 Significance Criteria

According to Appendix G of the California Environmental Quality Act statues, the project would have a significant environmental impact in terms of geologic 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
  - Landslides
- Result in substantial erosion or the loss of topsoil
- 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
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of waste water

5.4.3.2 Geologic Hazards

There is potential for seismic ground shaking to affect the project site and linears in the event of a large-magnitude earthquake occurring on fault segments near the project. The project site and linears, however, are not located within an Alquist-Priolo Earthquake Fault Zone or within the trace of any known active fault. The project would thus not be likely to cause direct human exposure to ground rupture. Seismic and expansive soils risks will be minimized by conformance with the recommended seismic design and building criteria of the 2007 California Building Code (CBC). In addition, as stated previously, the probability of mass wasting or subsidence occurring at the project site is low.

The project structures, equipment, and linear facilities will be designed in accordance with CBC, County of Stanislaus, and City of Ceres requirements. Compliance with the CBC seismic requirements will minimize the exposure of people to the risks associated with large seismic events. In addition, major structures will be designed to withstand the strong ground motion of an MCE event that is used for evaluating the earthquake resistance of a particular structure.

5.4.3.3 Geologic Resources

There are no known geologic resources of recreational or scientific value at the project site or in the project vicinity. Aggregate production is a major resource of Stanislaus County, and may potentially be affected by the project. Construction and operation of the A2PP site and linears would not significantly affect this resource.

5.4.4 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).

For 2008–2009, the City of Ceres has 19 public works projects, five commercial/industrial projects, 10 city-related plans or programs either planned or currently under way. Of these projects, three are within a 1-mile radius of the project site and/or transmission routes, and include:

- **Crows Landing (Flea Market) and Ceres Lions Park Wells –** Addition of a 650 to 725-gallon per minute (gpm) well at the Crows Landing Flea Market and second 650-gpm well at Ceres Lions Park. Design of the pumps is under way.
- **Lagoon Cleaning Project –** As part of the City of Ceres' effort to improve the treatment system, percolation ponds east of Morgan Avenue and south of E. Service Road are being dredged, with completion expected in early 2009.
- **Larger Stand-by Power at Blaker Reservoir –** The City of Ceres plans to either replace the existing stand-by power unit currently capable of powering two of the six booster pumps, with a power unit capable of running four booster pumps, or add a second unit to power the two additional pumps. This project is currently in the planning phase.

In addition to these capital projects, the City of Ceres has an additional 30 project applications approved and five pending within the Planning Department. Of the 30 approved projects, three are industrial and are within the Service Road Industrial Master Plan area, two are residential within the Brown Annexation Master Plan area, and one residential project is within the Westpoint Master Plan area; these projects are within approximately 1 mile of the project site. The pending applications include one residential project (34 units) and three commercial projects (a total of 410,000 square feet). These projects range between 2.5 to 3 miles away from the A2PP.

In December 2008, 29 projects applications were under review with the Stanislaus County Planning Division, including general plan amendments and rezonings, and applications to develop residential, office, commercial, and industrial uses as well as religious, educational, and health institutions; agricultural-related uses; and natural resource extraction (Stanislaus County, 2008b and 2009). These projects were located elsewhere in the County in the areas of Salida, Waterford, Oakdale, Patterson, Keyes, Knights Ferry, Denaire, Turlock, Empire, Hughson, Newman, and Modesto.

Additionally, TID is preparing an Environmental Impact Report (EIR) for the TID Hughson-Grayson 115-kV Transmission Line and Substation Project, which includes the proposed Grayson Substation (State Clearinghouse Number 2009012075). In addition to the substation, the Hughson-Grayson project consists of an approximately 10-mile-long, 115-kV transmission line; a 0.5-mile-long, 69-kV transmission line from the existing TID Almond Power Plant; a new bus and breaker within the existing TID Almond Power Plant switchyard; and a second 69-kV transmission line that extends 0.8 mile east from the proposed substation. The Notice of Preparation was issued on January 26, 2009, and

reissued on February 10, 2009. The Draft EIR is anticipated to be issued in July 2009. As described previously, the A2PP will not cause any adverse impacts to geological resources and will not cause an exposure of people or property to geological hazards. There are no minor impacts that could combine cumulatively with those of other projects.

5.4.5 Mitigation Measures

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 CBC Seismic requirements to withstand the ground motion of an MCE event.
- A geotechnical engineer will be assigned to the project to carry out the duties required by the California Energy Commission (CEC) to assess geologic conditions during construction and approve actual mitigation measures used to protect the facility from geologic hazards.
- If expansive soils are identified at the site, they can be mitigated by either removal or replacement with non-expansive soil or by blending with non-expansive soil under the supervision and direction of a geotechnical engineer.

With the implementation of these mitigation measures, the A2PP will not result in significant direct, indirect, or cumulative geology-related impacts.

5.4.6 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 the Stanislaus County and the City of Ceres.

TABLE 5.4-1
Laws, Ordinances, Regulations, and Standards

LORS	Requirements/ Applicability	Administering Agency	AFC Section Explaining Conformance
State			
CBC, 2007 as amended by Stanislaus County and the City of Ceres	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity	California Building Standards Commission, State of California, County of Stanislaus, and the City of Ceres	Section 5.4.3.2
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	California Building Standards Commission, State of California, County of Stanislaus, and the City of Ceres	Section 5.4.3.2

TABLE 5.4-1
Laws, Ordinances, Regulations, and Standards

LORS	Requirements/ Applicability	Administering Agency	AFC Section Explaining Conformance
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	California Building Standards Commission, and the State of California	Section 5.4.3.2
Local			
County of Stanislaus (2008a)	Compliance of the Safety Element of the General Plan, County of Stanislaus General Plan	County of Stanislaus	Section 5.4.3.2
City of Ceres (1997)	Compliance of the Safety Element of the General Plan, City of Ceres General Plan	City of Ceres	Section 5.4.3.2

5.4.7 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 drainage permits will be required prior to construction. The grading and drainage plans will be prepared as discussed in Section 5.15, Water Resources.

5.4.8 Permits and Permit Schedule

Compliance of building construction to CBC standards is covered under engineering and construction permits for the project that are within the exclusive jurisdiction of the CEC. There are no other permit requirements that specifically address geologic resources and hazards for compliance with geologic LORS.

5.4.9 References

Blake, T.F. 2004. EQSEARCH, A Computer Program for the Estimation of Peak Acceleration from California Earthquake Catalogs.

California Building Standards Commission. 2007 California Building Code, California Code of Regulations, Based on 2006 International Building Code.

California Division of Oil, Gas, and Geothermal Resources (CDOGGR). 2009. Oil and Gas Field Maps. http://www.consrv.ca.gov/dog/. Online search for oil and gas fields.

California Geological Survey (CGS). 1990. *Geologic Map of the San Francisco-San Jose Quadrangle, California, Map No. 5A (Geology).* California Department of Conservation. Prepared by D.L. Wagner, E.J. Bortugno, and R.D. McJunkin.

California Geological Survey (CGS). 2002. *California Fault Model. Modified for use with FRISKSP and EQFAULT).* California Department of Conservation.

California Geological Survey (CGS). 2007. *Special Publication 42 (Interim Revision 2007). Fault-Rupture Hazard Zones in California. Alquist-Priolo Earthquake Fault Zoning Act*. California Department of Conservation.

City of Ceres (Ceres). 1997. *City of Ceres General Plan*. February.

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