4.6 Geology Processes/Geologic Hazards

This section describes effects associated with geologic processes and geologic hazards that would be caused by implementation of the East Cat Canyon Oil Field Redevelopment Plan. The following discussion addresses existing environmental conditions in the affected area, identifies and analyzes environmental impacts for the proposed Project, and recommends measures to reduce or avoid significant impacts anticipated from proposed Project construction, operation, and maintenance. In addition, existing laws and regulations relevant to geology and geologic hazards are described. In some cases, compliance with these existing laws and regulations would serve to reduce or avoid certain impacts that might otherwise occur with the implementation of the proposed Project. Alternatives to the proposed Project are discussed in Section 5.0.

4.6.1 Environmental Setting

4.6.1.1 Project Studies

Three reports for the Aera East Cat Canyon Oil Field Project area prepared by Aera's consultants were reviewed. Brief summaries of these letter-reports are listed below.

- *Preliminary Geologic Hazards Evaluation, East Cat Canyon Oil Field, Sisquoc Area, Santa Barbara County, California*, by Fugro Consultants, Inc. (Fugro), dated December 19, 2013 (revised January 10, 2014). Work conducted for this study included review of published geologic maps and stereo aerial photographs, and a site reconnaissance for the Aera East Cat Canyon Oil Field site. Data from these sources were used to evaluate and characterize potential geologic hazards to aid in preliminary engineering and design of the proposed new Aera East Cat Canyon Oil Field components. Possible mitigation measures to reduce impacts from geologic hazards were outlined in a Table in the conclusions.
- *Phase I Services, Preliminary Geotechnical Engineering Study, East Cat Canyon Oil Field, Sisquoc Area, Santa Barbara County, California*, by Fugro Consultants, Inc., dated January 22, 2014. Fugro conducted a preliminary geotechnical exploration and geotechnical analysis for the Aera East Cat Canyon Oil Field site. Six exploratory borings to depths of 15 to 30 feet below ground surface (bgs) were conducted as part of this study and soil samples were submitted for geotechnical laboratory tests. The borings were located in the southeastern part of the oil field site, near to the planned locations for the central processing facility, the steam generation site, and the office multipurpose building. The report provides preliminary recommendations for grading, earthwork, and excavations, which include recommendations related to cut/fill, shoring, foundation and retaining wall design, and drainage.
- *Geohazards Study, East Cat Canyon Natural Gas Import Pipeline, Orcutt Area, Santa Barbara County, California,* by Padre Associates, Inc. (Padre), dated May 8, 2017. Padre prepared a geohazards report that outlines potential geologic and geotechnical hazards for the 14 mile long natural gas pipeline based on review of USGS and CGS reports and geologic maps, geotechnical reports by Fugro and Caltrans, historic aerial photography, groundwater data, historic seismicity, and a site reconnaissance. No geotechnical borings or soil testing were conducted as part of this study. The study was prepared in general accordance with California Geological Survey Note 48 and Special Publication 117.

4.6.1.2 Local Geology

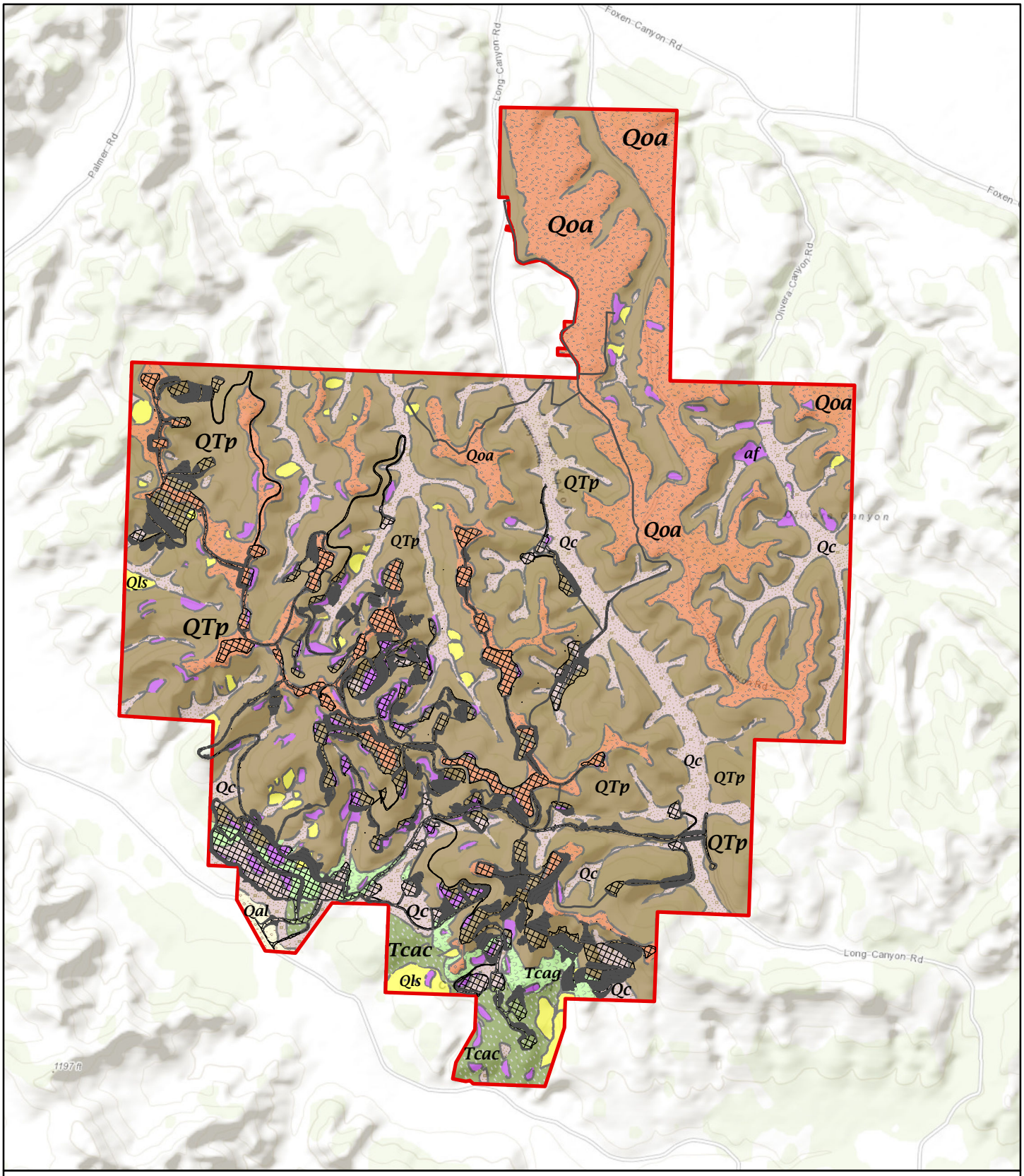
The proposed Project is located in the transition from the Transverse Ranges Geomorphic Province to the Coast Ranges Geomorphic Province. The Transverse Ranges Geomorphic Province is dominated by east-west trending mountain ranges, while the Coast Ranges Geomorphic Province is dominated by elongate

north-south trending ranges divided by narrow valleys. The proposed Project site is located in the Santa Maria Basin which is filled with a thick sequence of sedimentary rocks overlying Franciscan mélange and Coast Range ophiolite. The area has been highly folded and faulted due to the compression that resulted in the uplift of the southern Coast Ranges and associated hills.

The Aera East Cat Canyon Oil Field is developed on hillside and valley areas underlain by local artificial fill, landslide deposits, Holocene alluvium, Pleistocene older alluvium, Plio-Pleistocene Paso Robles Formation, and late Pliocene Careaga Sandstone (Dibblee, 1994). Geology underlying the proposed Project is presented in Figure 4.6-1. The proposed natural gas pipeline is underlain by Holocene alluvium, Pleistocene older dune sand deposits, Pleistocene Orcutt Formation, Plio-Pleistocene Paso Robles Formation, and late Pliocene Careaga Sandstone (Dibblee, 1989 and 1994). The proposed 115 kV power line is underlain by artificial fill and Holocene alluvium and colluvium. Geology underlying the 115 kV power line and the natural gas pipeline is presented in Figures 4.6-2a, 4.6-2b, and 4.6-2c.

The geologic units underlying the proposed Project components are summarized below:

- **Artificial Fill.** Artificial fill is located throughout the oil field, primarily beneath drilling pads and other graded work areas and access roads, and appears to be comprised of locally derived material, and may contain concrete pieces or other construction debris (Fugro, 2014). Four of Fugro's exploratory borings encountered artificial fill to depths of approximately 2 to 9 feet bgs (Fugro, 2014).
- **Alluvium/Colluvium.** Alluvium is located on alluvial fans, valleys, and flood plains. The alluvium consists of deposits of unconsolidated clay, silt, sand, and gravel (Dibblee, 1989 and Worts, 1951). The pipeline and 115kV transmission line are mapped as being primarily underlain by alluvium where they traverse Cat and Graciosa Canyons. In Fugro's mapping and exploratory borings they did not differentiate between alluvium and colluvium, and mapped all alluvial and colluvial deposits as colluvium. Colluvium is mapped by Fugro in the bottoms of the small drainages throughout the Aera East Cat Canyon Oil Field and was encountered in three of their exploratory borings (located at the central processing facility site and the office multipurpose building site) at the surface and underlying artificial fill to depths of 10 to 31 feet bgs (Fugro, 2014). The colluvium encountered and mapped by Fugro consists primarily of loose to medium dense poorly sorted mixtures of sand and gravel with some fines which ranges in thickness from a few feet on slopes and minor swales and to greater than 30 to 50 feet in significant drainage areas (Fugro, 2014).
- **Older Dune Sands**. Older dune sands are primarily inactive dunes which are anchored by vegetation and are composed of fine to coarse, well-rounded, cross-bedded quartz sand, and are slightly compacted and consolidated (Worts, 1951). Older dune sands would be encountered along the pipeline route where it crosses the southern edge of the Santa Maria Valley. The older dune sands are sometimes included in with the older alluvium deposits. This unit is only mapped underlying the natural gas pipeline as it crosses the edge of the valley just north of the Solomon Hills.
- **Older Alluvium**. Late Pleistocene older alluvium is found on the tops of ridges and hills throughout the Aera East Cat Canyon Oil Field Project site. The older alluvium is remnants of uplifted stream terraces and alluvial fan deposits, and is comprised of weakly consolidated silt, sand, and gravel (Dibblee, 1989). Fugro encountered older alluvium in their two borings located near the steam generation site, at depths of about 3 feet below the artificial fill and ranged in thickness from about 11 feet to more than 20 feet and was comprised of dense to very dense poorly graded sand, silty sand, clayey sand, and sandy silt with gravel sand, and silt (Fugro, 2014).



Sources: Geologic mapping modified from Dibblee 1994, and Fugro 2013.

0 0.25 0.5
Scale in Miles

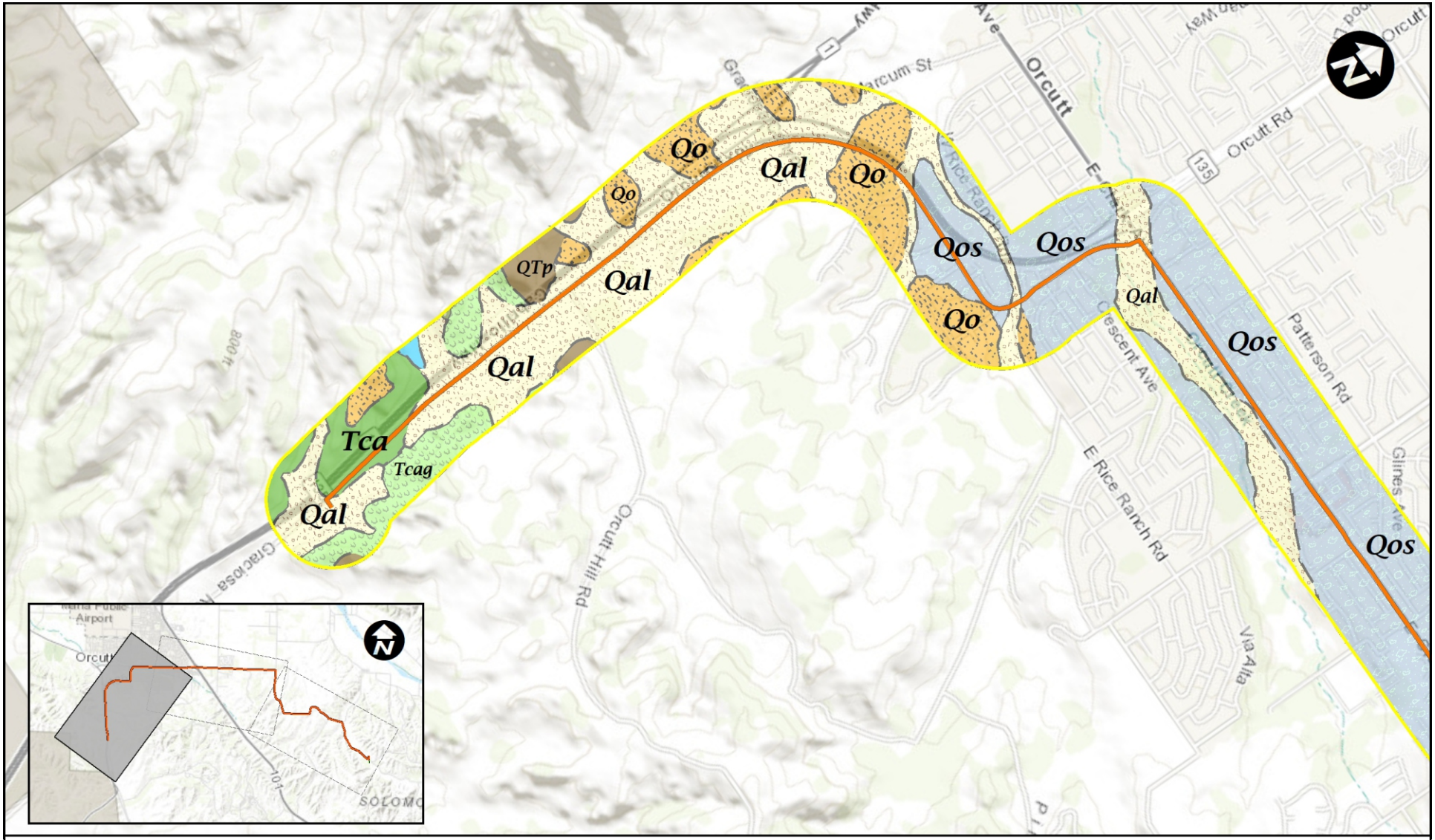
ECC Oil Field Project Area
Permanent Impact
Temporary Impact

ECC Oil Field Geology

af - Artificial Fill
Qls - Landslide Deposits
Qal - Alluvium
Qc - Colluvium
Qoa - Older Alluvium
QTp - Paso Robles Formation
Tcag - Careaga Formation (Graciosa Member)
Tcac - Careaga Formation (Cebada Member)

Figure 4.6-1

ECC Oil Field Local Geology



Sources: Geologic mapping modified from Dibblee 1989 and 1994, and Fugro 2013.

0 0.25 0.5
Scale in Miles

Proposed Natural Gas Pipeline

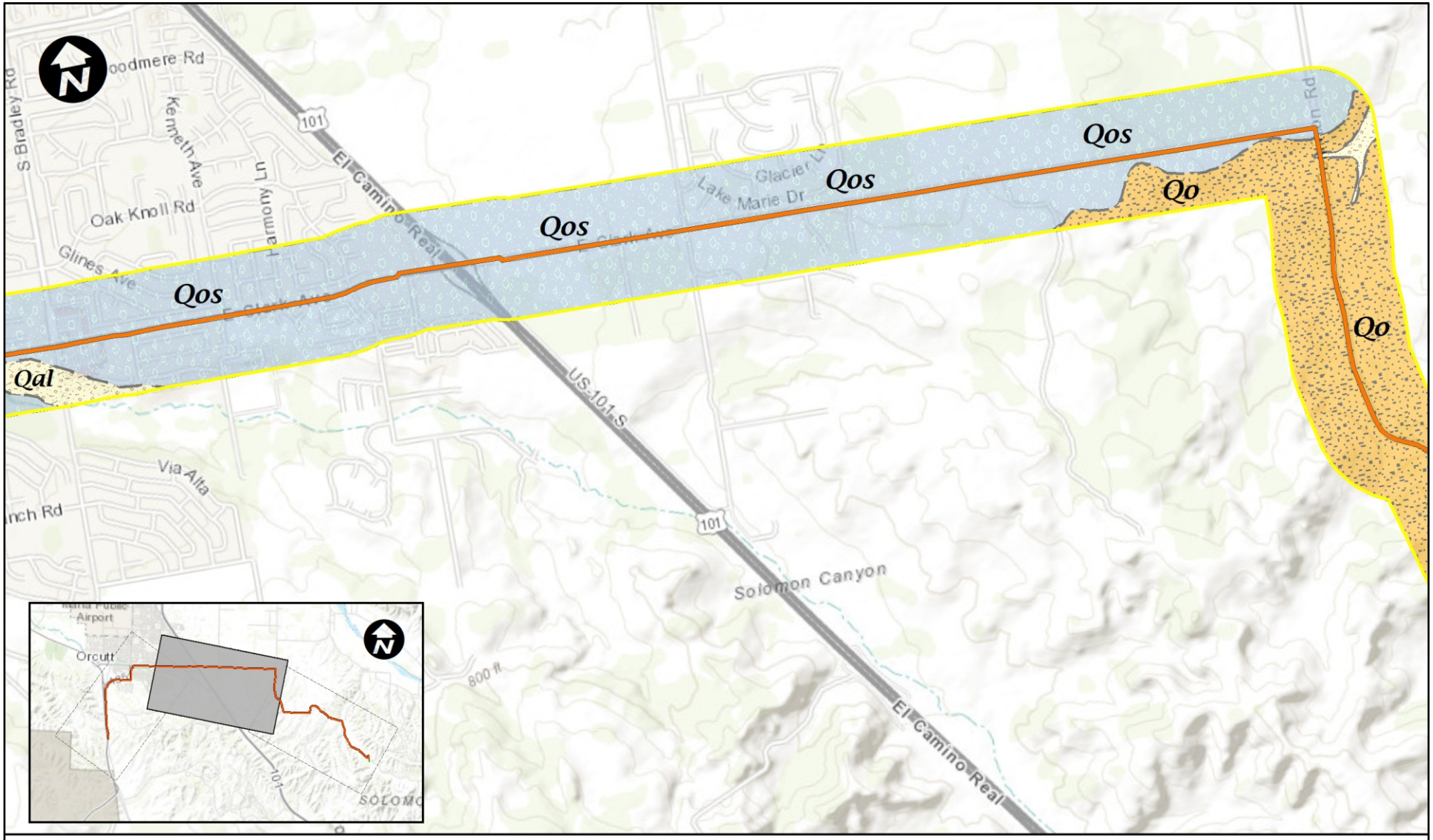
Proposed 115kV Transmission Line

1000 foot buffer

Geologic Units

af - Artificial Fill
Qls - Landslide Deposits
Qal - Alluvium
Qc - Colluvium
Qos - Older Dune Sands
Qo - Orcutt Sand
QTp - Paso Robles Formation
Tca - Careaga Formation (Undivided)
Tcag - Careaga Formation (Graciosa Member)
Tcac - Careaga Formation (Cebeda Member)
Tsq - Sisquoc Formation

Figure 4.6-2a
Proposed Natural Gas Pipeline Local Geology



Sources: Geologic mapping modified from Dibblee 1989 and 1994, and Fugro 2013.

Proposed Natural Gas Pipeline

Proposed 115kV Transmission Line

1000 foot buffer

Geologic Units

Qal - Alluvium

Qos - Older Dune Sands

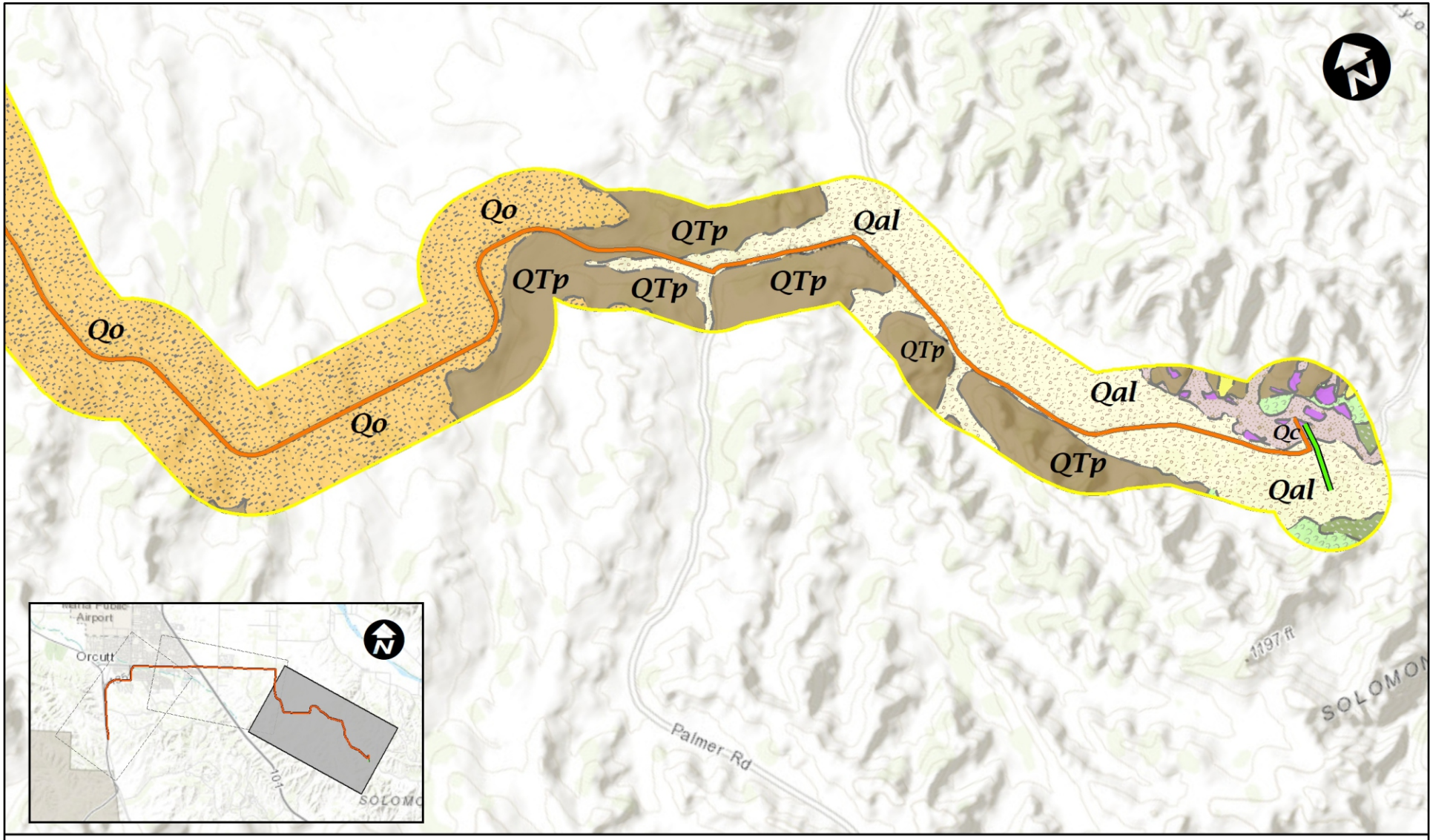
Qo - Orcutt Sand

0 0.25 0.5

Scale in Miles

Figure 4.6-2b

Proposed Natural Gas Pipeline Local Geology



Sources: Geologic mapping modified from Dibblee 1989 and 1994, and Fugro 2013.

0 0.25 0.5
Scale in Miles

Proposed Natural Gas Pipeline

Proposed 115kV Transmission Line

1000 foot buffer

Geologic Units

af - Artificial Fill

Qls - Landslide Deposits

Qal - Alluvium

Qc - Colluvium

Qo - Orcutt Sand

QTp - Paso Robles Formation

Tcag - Careaga Formation (Graciosa Member)

Tcac - Careaga Formation (Cebeda Member)

Figure 4.6-2c
Proposed Natural Gas Pipeline Local Geology

- **Orcutt Formation.** The Orcutt Formation is tan to rusty brown aeolian or dune sand and occurs as relatively thin (less than 50 feet thick) deposits capping low hills along the northern edge of the Solomon Hills (Dibblee, 1994). Orcutt Formation is mapped as underlying the pipeline route as it crosses the northern edge of the Solomon Hills.
- **Paso Robles Formation.** The Paso Robles Formation is highly variable in color and texture, generally composed of lenticular beds of conglomerate with gravel comprised of white siliceous Monterey Shale in sandy to clayey matrix; and local pebbly claystone and marly (lime-rich mudstone) limestone beds of lacustrine origin (Dibblee, 1994; Worts, 1951). The Paso Robles formation is crudely bedded, weakly consolidated and consists primarily of fluvial deposits. The Paso Robles formation is found throughout the Aera East Cat Canyon Oil Field underlying most of the slopes and is exposed is numerous road cuts, and underlies small portions of the pipeline where it traverses the southwestern edges of Cat Canyon. Paso Robles Formation was encountered in two of Fugro's exploratory borings at depths of 9.5 and 14.5 feet bgs, at the central processing facility site and the steam generation site, respectively, and consisted of soft, slightly weathered, massive sandstone and sandy claystone with gravel sized rock fragments (Fugro, 2014).
- **Careaga Sandstone.** Careaga Sandstone is locally divided into the coarse grained Graciosa Member, a gray-white to tan massive sandstone with a pebble marker at the base, and the older Cebada Member composed of tan to yellow, soft, fine-grained sandstone. The Careaga Sandstone is shallow marine to non-marine, including dune deposits (Dibblee, 1994). Careaga Sandstone is exposed in two west plunging anticlines separated by a syncline in the upper Solomon Hills, extending down into Cat Canyon at the southeast end of the West Cat Canyon Project site (Dibblee, 1994). In the Aera East Cat Canyon Oil Field the Careaga Formation is exposed as a linear band along the southern margin of the site where several new pads and access roads are planned and underlying portions of the 115kV transmission line and pipeline along the eastern margin of Cat Canyon and the western margin of Graciosa Canyon. Two of the exploratory boring by Fugro at the proposed central processing site encountered Careaga Sandstone (Graciosa Member), one at the surface and the other at a depth of approximately 9.5 feet bgs; the material encountered consisted of soft, slightly weathered, massive sandstone and sandy claystone with gravel sized rock fragments (Fugro, 2014).

4.6.1.3 Topography and Slope Stability

The proposed Project is located in the western end of the Solomon Hills and along the southern edge of the Santa Maria Valley. The Aera East Cat Canyon Oil Field project area is located on hillslopes, ridge tops, and valley floors of the Solomon Hills, primarily between Cat Canyon on the south and Long Canyon on the north. The Solomon Hills rise about 600 feet above the Santa Maria Valley and are characterized by gentle to moderately inclined slopes along narrow valleys. Cat Canyon is unique as a wide (0.25-mile), flat-floored valley. Long Canyon trends northwest between Cat Canyon and Santa Maria Valley. Elevations within the Aera East Cat Canyon Oil Field project area range from approximately 630 to 1050 feet above mean sea level (MSL). The proposed natural gas pipeline route is located along and parallel to graded roads that traverses across gentle slopes of the Solomon Hills and flat to gentle slopes along the southern edge of the Santa Maria Valley. Elevation along the pipeline ranges from approximately 325 to 835 feet above MSL.

Important factors that affect the slope stability of an area include the steepness of the slope, the relative strength of the underlying rock material, and the thickness and cohesion of the overlying colluvium. The steeper the slope and/or the less strong the rock, the more likely the area is susceptible to landslides. The steeper the slope and the thicker the colluvium, the more likely the area is susceptible to debris flows. Another indication of unstable slopes is the presence of old or recent landslides or debris flows.

Numerous small landslides in hillslopes underlain by Paso Robles and Careaga Formations, and raveling (surface movement of soil or rock particles on steep slopes), slumping, and erosion of slopes were noted and mapped throughout the Aera East Cat Canyon Oil Field Project site on steep cut slopes and near historically disturbed areas (Fugro, 2013). Colluvium identified on slopes was noted to be generally unstable and creep-prone (Fugro, 2013). No landslides are mapped along the natural gas pipeline alignment which traverses along graded roads through gently sloping to flat terrain (Dibblee, 1994), however Padre (Padre, 2017) identified areas of suspected landslide debris and moderate risk of landslides on pipeline route along Dominion and Cat Canyon Roads. The Santa Barbara Seismic Safety and Safety Element maps the entire area underlying the proposed Project as having low potential for landslides (County of Santa Barbara, 2015a).

The existing slopes in many areas of the oil field site will be modified by significant grading; approximately 305 acres of the oil field site will be graded. Approximately 3 million cubic yards each of cut and fill (3 million cubic yards of fill would be approximately equivalent to placing 10.5 inches of fill on the entire 2,112-acre oil field site) will be conducted as part of the proposed Project for access roads, pipe corridors, storm water detention basins, slope re-contouring, and to create level pads for wells and proposed Project facilities (e.g., central processing facility, steam generation site, production group station, buildings) (Aera, 2016). The finished grade of proposed Project facilities would be sloped uniformly to ensure that ponding does not occur; all cut/fill slopes would have a maximum 2:1 slope (50 percent). The faces of cut and fill slopes would be prepared to control against erosion per the proposed Project erosion control plans (Aera, 2016). The differences in existing ground surface elevation require the pad for the central processing facility to be built on three levels with processing equipment and other proposed Project infrastructure placed on all three levels. The lowest level would also include the Spill Prevention, Control, and Countermeasure Plan and Storm Water Pollution Prevention Plan containment and/or detention areas. In addition, at the steam generation site, a one-foot tall earthen berm would be located at the top of slope and would encompass approximately two-thirds of the final pad area (area of cut).

4.6.1.4 Soils

The soils underlying the proposed Project site reflect the underlying rock type, the extent of weathering of the rock, the degree of slope, and the degree of human modification. Potential hazards/impacts from soils include erosion, shrink-swell (expansive soils), and corrosion. Soil mapping by the USDA National Resource Conservation Service (NRCS), Soil Conservation Service, was reviewed for information about unsuitable characteristics of surface and near-surface subsurface soil materials. A review of the NRCS Northern Santa Barbara Area soil survey (NRCS, 2016) GIS and tabular data provides information for surface and shallow subsurface soil materials at and near proposed Project components. Numerous soils are mapped in the Aera East Cat Canyon Oil Field Project area and along the natural gas pipeline (NRCS, 2016). The majority of the soils underlying the Aera East Cat Canyon Project area include the Arnold, Chamise, Corralitos, Elder, Positas, and San Andreas-Tierra associations. The natural gas pipeline alignment is primarily underlain by seven soil units: the Arnold, Betteravia, Botella, Corralitos, Garey, Marina, and Oceano associations. The 115 kV power line is underlain entirely by the Corralitos association. Also identified in the soil survey are areas identified as rough broken land, sandy alluvial, terrace escarpments, and riverwash; these areas are classified by the NRCS as “miscellaneous areas” with little to no soil development and are not discussed further.

Potential soil erosion hazards vary depending on the use, conditions, and textures of the soils. The properties of soil which influence erosion by rainfall and runoff affect the infiltration capacity of a soil, as well as the resistance of a soil to detachment and being carried away by falling or flowing water. Soils on steeper slopes would be more susceptible to erosion due to the effects of increased surface flow (runoff)

on slopes where there is little time for water to infiltrate before runoff occurs. Soils containing high percentages of fine sands and silt and that are low in density, are generally the most erodible. As the clay and organic matter content of soils increases, the potential for erosion decreases. Clays act as a binder to soil particles, thus reducing the potential for erosion. Erosion susceptibility of soils to sheet and rill erosion by water ranges from low to moderate in the Aera East Cat Canyon OiI Field Project area, low to moderate along the power line, and low to high along the natural gas pipeline. Erosion susceptibility of disturbed soils by wind is high along the power line and in the Aera East Cat Canyon OiI Field Project area and along the natural gas pipeline it ranges from low to high.

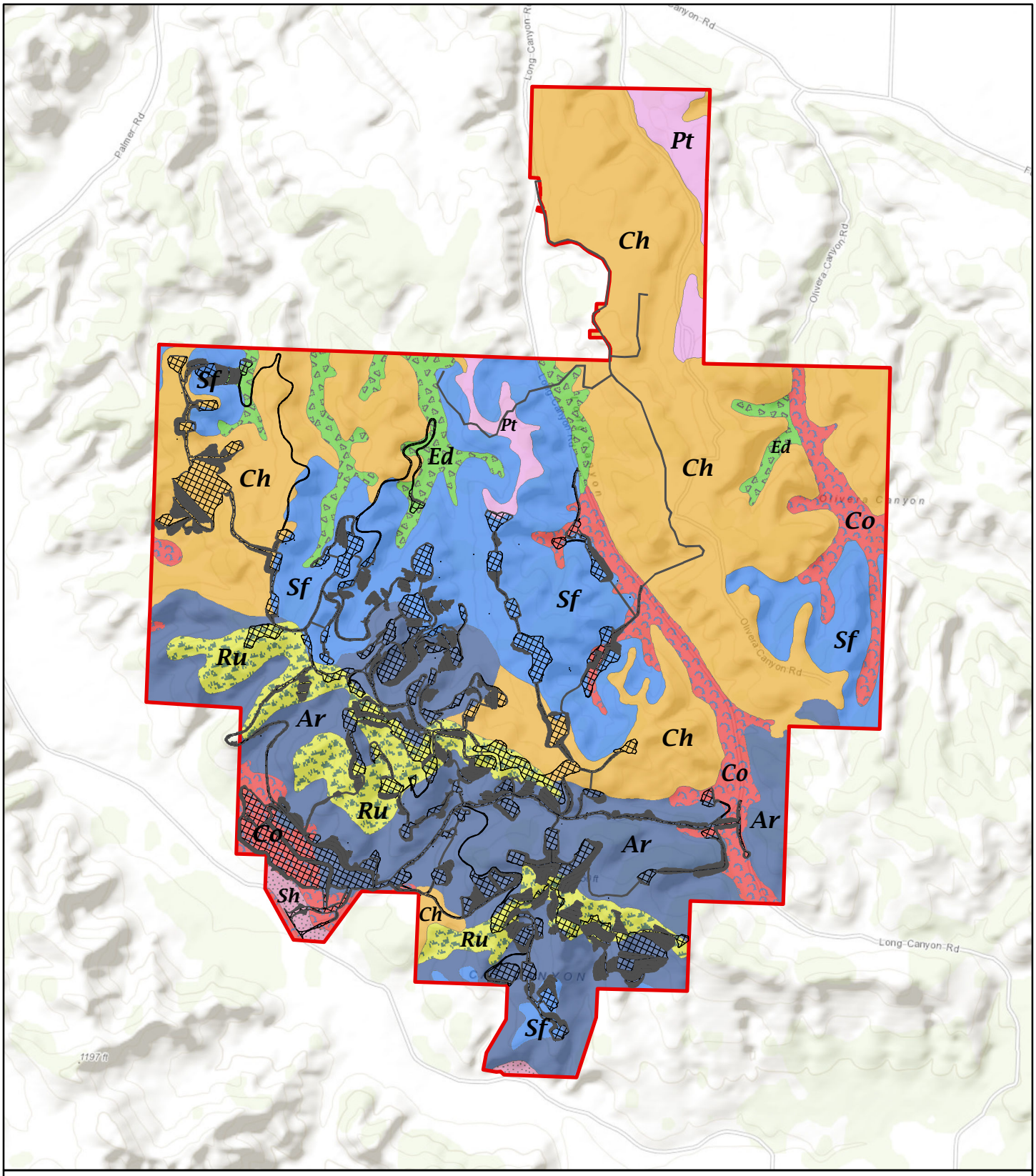
Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variation in soil moisture content. Changes in soil moisture could result from a number of factors, including rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soils are typically very fine grained with a high to very high percentage of clay. Soils with moderate to high shrink-swell potential would be classified as expansive soils. The expansive potential of the soils underlying the Aera East Cat Canyon Oil Field Project area is generally low although clayey soils with moderate to high expansion occur locally within the Positas and San Andreas-Tierra soil units. Along the natural gas pipeline route expansive potential of the soils is generally low although clayey soils with moderate to high expansion occur locally within the Botella and San Andreas-Tierra soil units. The 115 kV powerline is entirely underlain by the Corralitos soil association with low expansion potential.

Corrosivity of soils is generally related to the following key parameters: soil resistivity; presence of chlorides and sulfates; oxygen content; and pH. Typically, the most corrosive soils are those with the lowest pH and highest concentration of chlorides and sulfates. High sulfate soils are corrosive to concrete and may prevent complete curing reducing its strength considerably. Low pH and/or low resistivity soils could corrode buried or partially buried uncoated steel pipe or structures. Corrosion potential of the soils in the Aera East Cat Canyon Oil Field and underlying the pipeline and transmission line range from low to high for corrosion of uncoated steel and low to moderate for corrosion of concrete. Limited soil corrosion testing of one sample during this investigation indicates low potential for corrosion to concrete and uncoated steel (Fugro, 2014).

Summaries of the significant characteristics of the major soil associations underlying the Aera East Cat Canyon Oil Field Project area, proposed natural gas pipeline and 115kV transmission line are presented in Table 4.6-1 – Soil Characteristics. Location of these soil units underlying proposed Project components are presented in Figures 4.6-3, 4.6-4a, 4.6-4b and 4.6-4c.

4.6.1.5 Seismicity and Faulting

Santa Barbara County is located in a geologically complex and seismically active region which includes both the east west Transverse Ranges and the north-south Coast Ranges. The seismicity of the proposed Project area is dominated by the intersection of the north-northwest trending San Andreas and Coast Ranges faults, and the east-west trending Transverse Ranges fault system. Both systems are responding to strain produced by the relative motions of the Pacific and North American Tectonic Plates. This strain is relieved by right-lateral strike-slip faulting on the San Andreas and related faults, and by vertical, reverse-slip or left-lateral strike-slip displacement on faults in the Transverse Ranges. The effects of this strain and deformation includes mountain building, basin development, deformation of Quaternary marine terraces, widespread regional uplift, and generation of earthquakes. Both the Transverse Ranges and Coast Ranges areas are characterized by numerous geologically young faults. These faults can be classified as historically active, active, potentially active, or inactive, based on the following criteria (CGS, 1999):



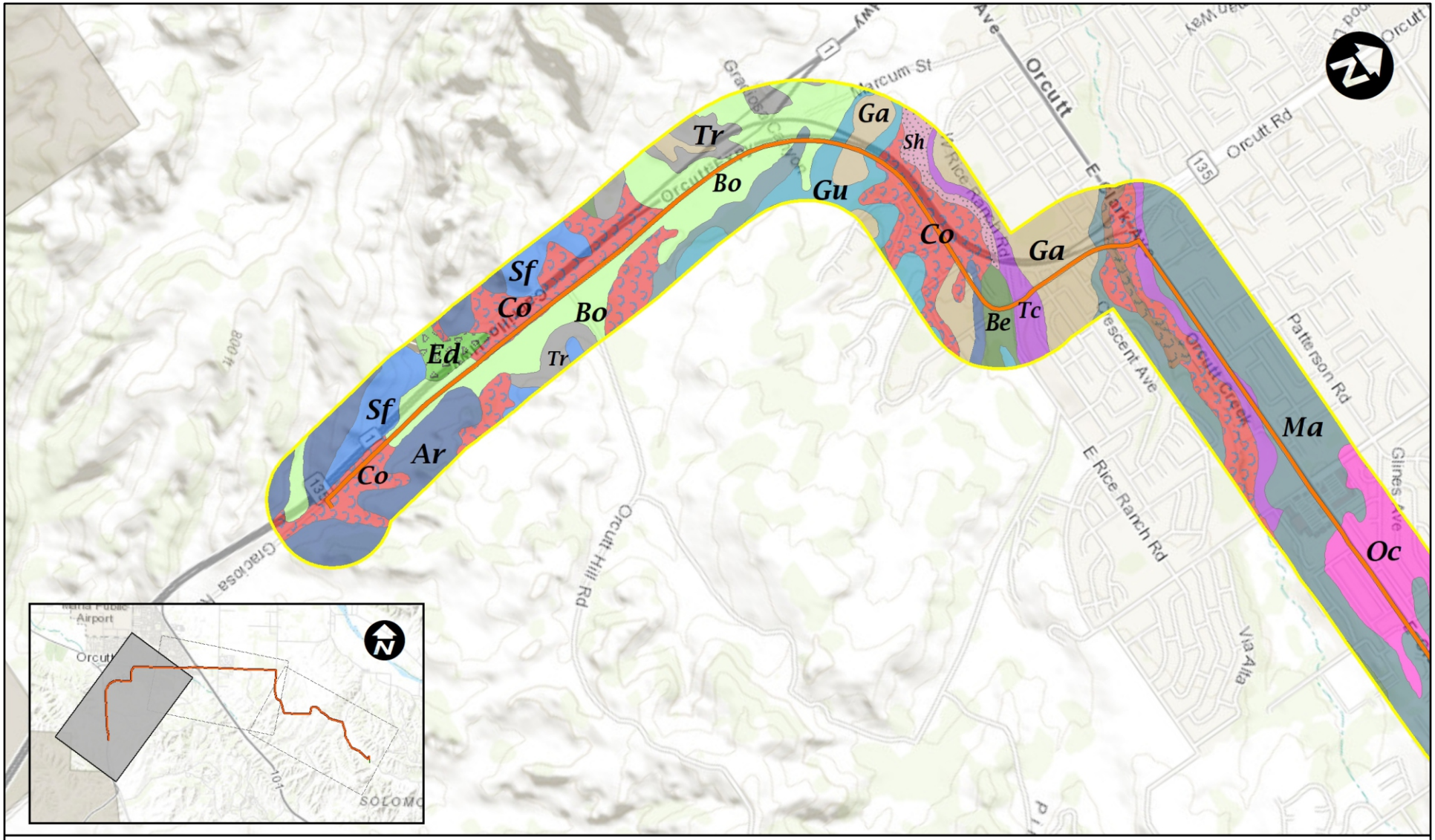
Source: NRCS, 2015

Permanent Impact
Temporary Impact
ECC Oil Field Project Area

0 0.5
Scale in Miles

ECC Oil Field Soil Units
Ar - Arnold
Ch - Chamise
Co - Corralitos
Ed - Elder
Pt - Positas
Ru - Rough broken land
Sf - San Andreas-Tierra
Sh - Sandy alluvial land

Figure 4.6-3 Oil Field Local Soils



Source: NRCS, 2015

Proposed Natural Gas Pipeline

Proposed 115kV Transmission Line

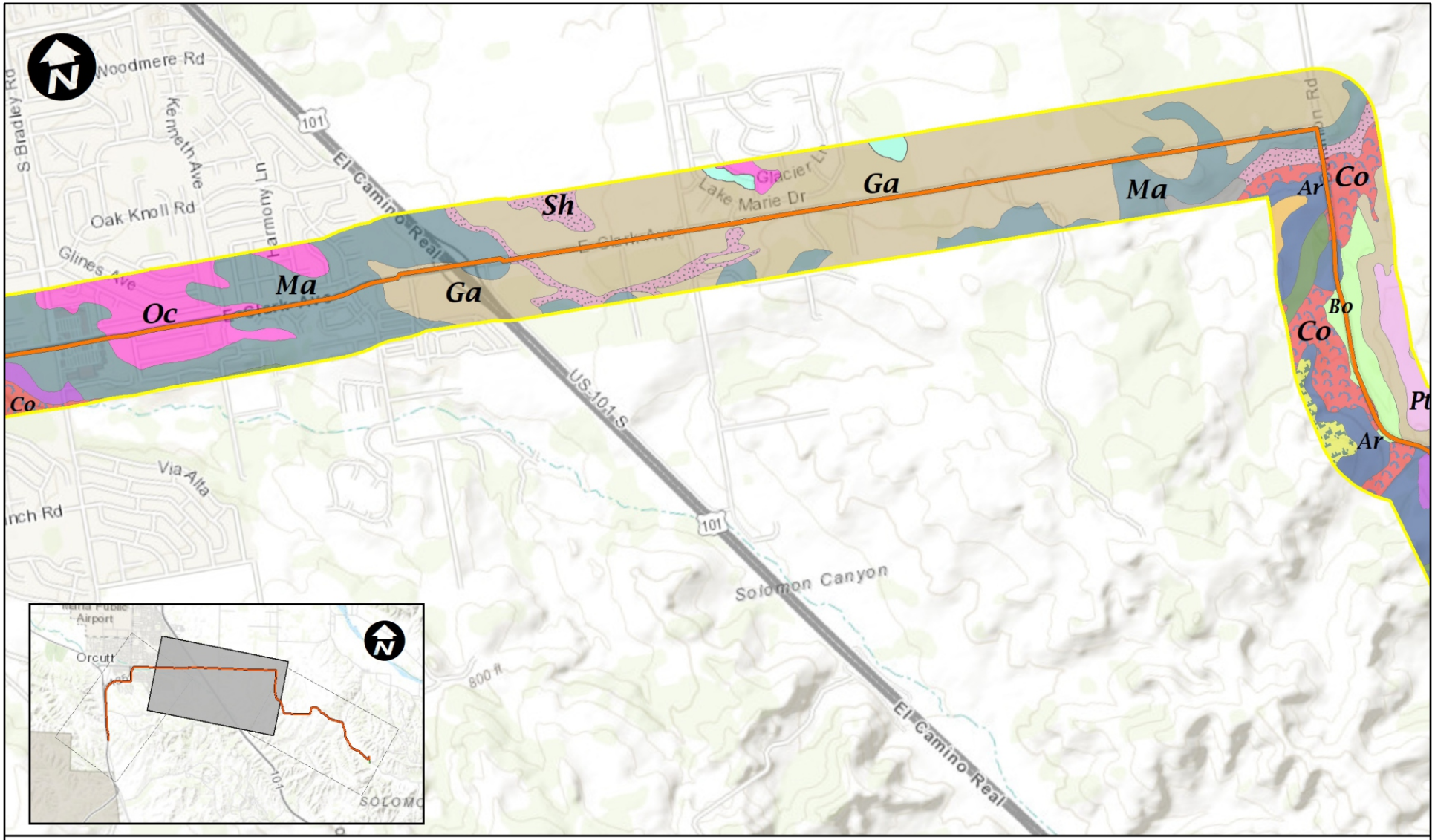
1000 foot buffer

0 0.25 0.5
Scale in Miles

Local Soil Units

- Ar - Arnold
- Be - Betteravia
- Bo - Botella
- Co - Corralitos
- Cw - Crow Hill
- Ed - Elder
- Ga - Garey
- Gu - Gullied land
- Ma - Marina
- Oc - Oceano
- Rs - Riverwash
- Sf - San Andreas-Tierra
- Sh - Sandy alluvial land
- Tc - Terrace escarpments
- Tr - Tierra

Figure 4.6-4a
Proposed Natural Gas Pipeline Local Soils



Source: NRCS, 2015

Proposed Natural Gas Pipeline

Proposed 115kV Transmission Line

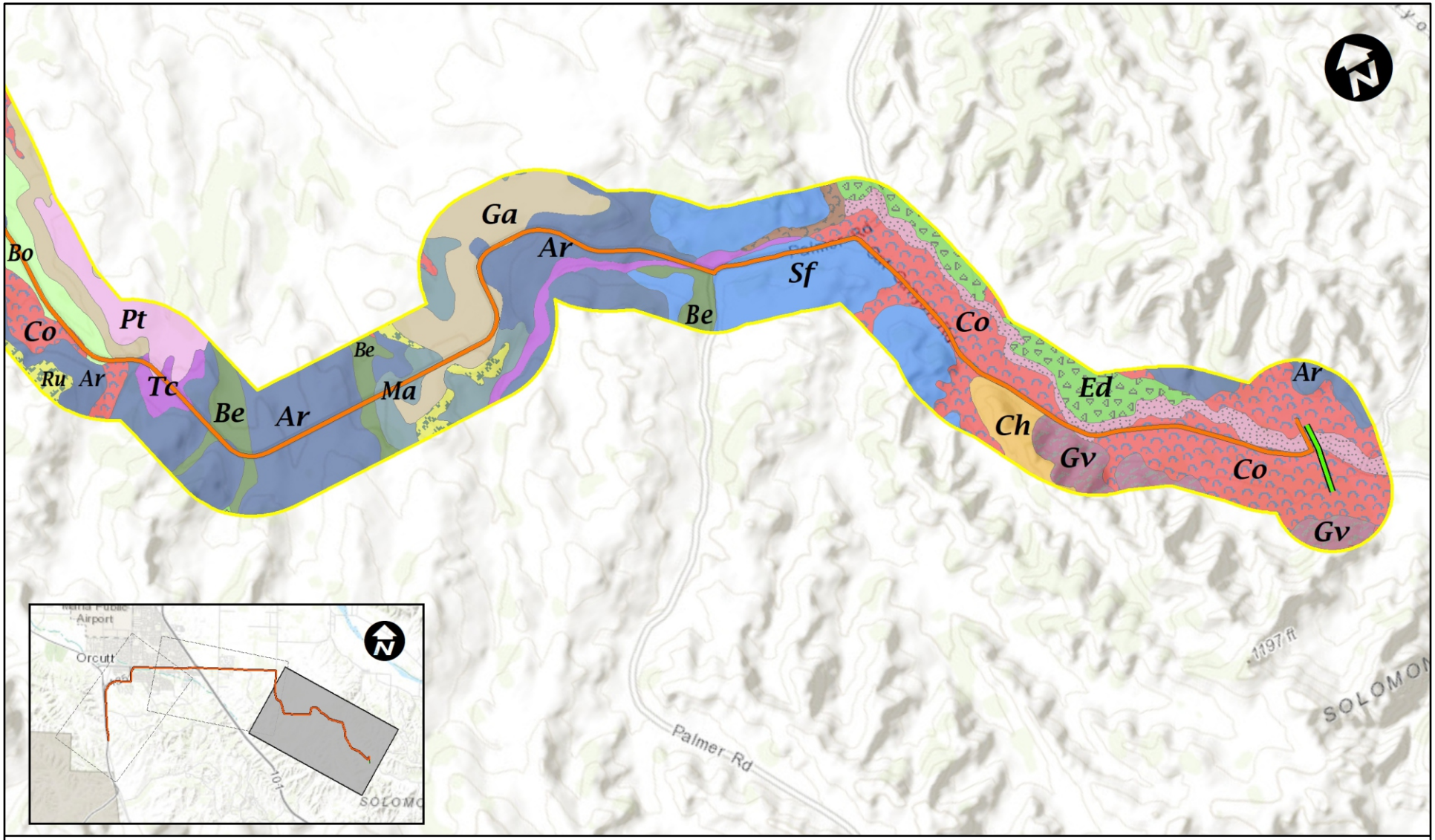
1000 foot buffer

0 0.25 0.5
Scale in Miles

Local Soil Units

- Ar - Arnold
- Be - Betteravia
- Bo - Botella
- Ch - Chamise
- Co - Corralitos
- Ga - Garey
- Ma - Marina
- Oc - Oceano
- Pn - Pleasanton
- Pt - Positas
- Ru - Rough broken land
- Sh - Sandy alluvial land
- Tc - Terrace escarpments
- Tr - Tierra

Figure 4.6-4b
Proposed Natural Gas Pipeline Local Soils



Source: NRCS, 2015

Proposed Natural Gas Pipeline

Proposed 115kV Transmission Line

1000 foot buffer

0 0.25 0.5
Scale in Miles

Local Soil Units

- Ar - Arnold
- Be - Betteravia
- Bo - Botella
- Ch - Chamise
- Co - Corralitos
- Ed - Elder
- Ga - Garey
- Gv - Gaviota
- Ma - Marina
- Pt - Positas
- Rs - Riverwash
- Ru - Rough broken land
- Sf - San Andreas-Tierra
- Sh - Sandy alluvial land
- Tc - Terrace escarpments

Figure 4.6-4c
Proposed Natural Gas Pipeline Local Soils

Table 4.6-1. Soil Characteristics

Name	Proposed Project Components	Soil Texture[1]	Description	Expansion Potential (Shrink-Swell)	Erosion Class		Corrosion Potential	
					Wind	Water	Uncoated Steel	Concrete
Arnold	Oil Field, Pipeline	Sand	Occurs on moderate to steep slopes of 5 to 45 percent underlain by sandstone. The sandy soil is formed in material weathered from the underlying sandstone and depth to parent bedrock about 40 to 60 inches.	Low	High	Low	Low	Moderate
Betteravia	Pipeline	Loamy sand	Loamy sand of the Betteravia association forms on flood plains with slopes of 0 to 15 percent. It is formed in alluvium derived from diatomaceous shale and sandstone.	Low	High	Low to Moderate	Low	Moderate
Botella	Pipeline	Loam	Found in alluvial fans and narrow valleys on slopes of 0 to 15 percent. The parent material is alluvium derived from sandstone and shale.	Moderate	Low to Moderate	Moderate	Moderate	Low
Chamise	Oil Field	Sandy loam and shaly loam	Chamise sandy loam and shaly loam form on dissected high terraces in areas of gentle to steep slopes of 5 to 75 percent. The soil is formed in alluvium.	Low	Low	Low	Moderate	Moderate to High
Corralitos	Oil Field, Pipeline, Transmission Line	Sand and loamy sand.	Sand and loamy sand of the Corralitos soil unit form in alluvium and sandy alluvium on flat to gently sloping alluvial fans and flood plains. Slopes range from 0 to 15 percent.	Low	High	Low to Moderate	Low (sand) High (loamy sand)	Moderate
Elder	Oil Field	Sandy loam and loam.	These soils are found on flood plains, alluvial fans, and alluvial plains with slopes of 0 to 15 percent. The parent material is alluvium derived from sandstone and shale.	Low	Moderate to High	Moderate	Low to Moderate	Low to Moderate
Garey	Pipeline	Sandy loam and loam	This soil is formed in eolian deposits on dissected terraces and basin floors with slopes of 0 to 30 percent.	Low	Moderate to High	Moderate to High	Low (sandy loam) High (loam)	Moderate
Marina	Pipeline	Sand	Marina sand is found on dissected terraces with slopes of 2 to 30 percent. They are formed in eolian deposits.	Low	High	Low	Low	Moderate
Oceano	Pipeline	Sand	These soils are found on old coastal sand dunes with slopes of 2 to 15 percent, Parent material consists of eolian deposits.	Low	High	Low	Low	Moderate
Positas	Oil Field	Fine sandy loam	This unit is found on dissected terraces with slopes of 9 to 15 percent. The soil is formed in alluvium.	Moderate	Moderate to High	Moderate	High	Moderate
San Andreas–Tierra	Oil Field	Loam and sandy loam	This complex is comprised of interlaced San Andreas and Tierra association soils that are difficult to distinguish from each other. These soils are formed on hills with slopes ranging from 5 to 75 percent. The parent materials consist of alluvium and material weathered from underlying soft sandstone.	Low to High	Moderate to High	Moderate	Low to Moderate	Moderate

Source: NRCS, 2016. Northern Santa Barbara Area soil survey GIS and tabular data.
1 - Loam – loam is a soil that contains relatively balanced amounts of sand, silt and clay.

- Faults that have generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) and faults that exhibit aseismic fault creep are defined as Historically Active.
- Faults that show geologic evidence of movement within Holocene time (approximately the last 11,000 years) are defined as Active.
- Faults that show geologic evidence of movement during the Quaternary time (approximately the last 1.6 million years) are defined as Potentially Active.
- Faults that show direct geologic evidence of inactivity during all of Quaternary time or longer are classified as Inactive.

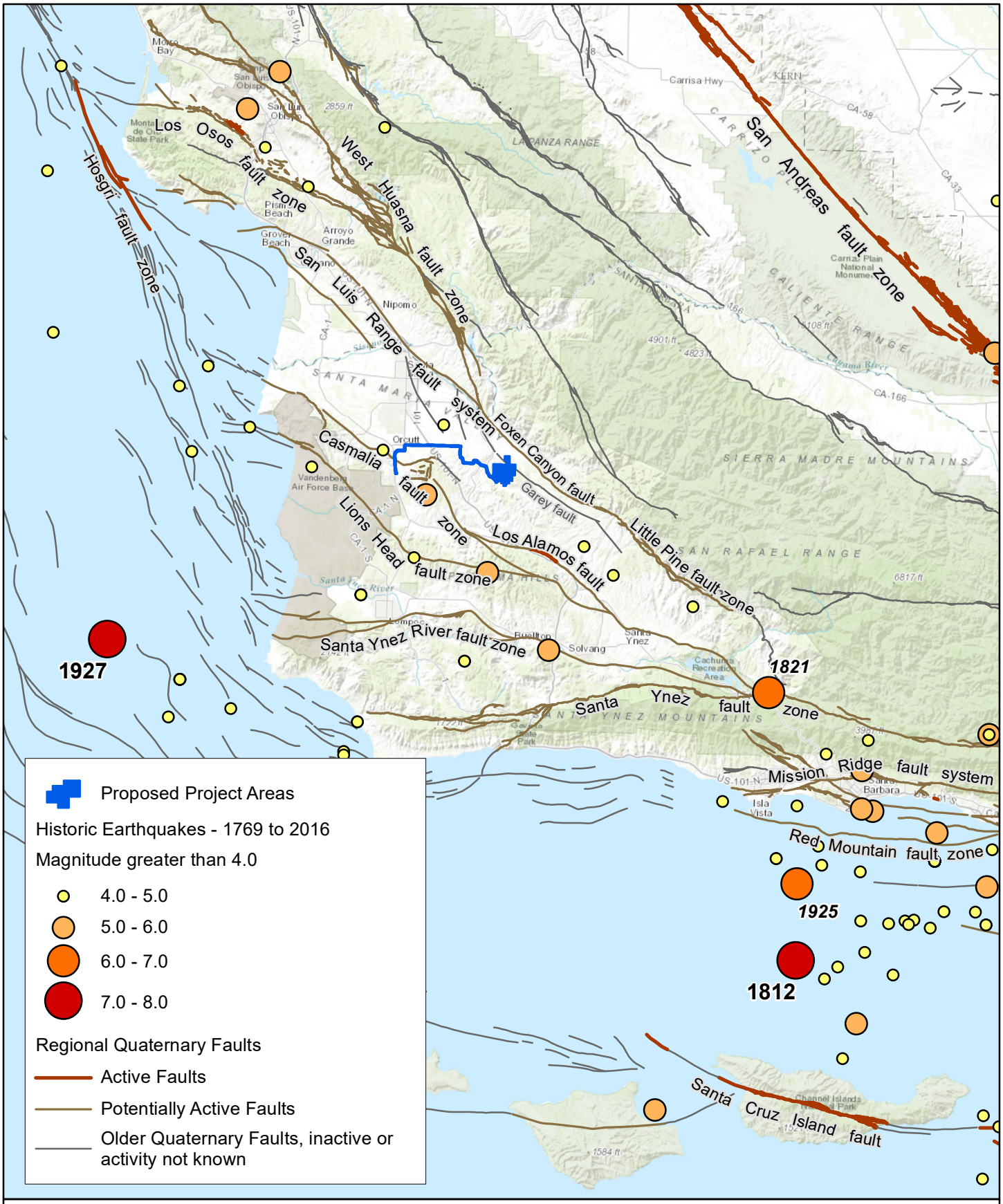
Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification is based on the assumption that if a fault has moved during the Holocene epoch, it is likely to produce earthquakes in the future. Blind thrust faults do not intersect the ground surface, and thus they are not classified as active or potentially active in the same manner as faults that are present at the earth's surface. Blind thrust faults are seismogenic structures with no surface expression and thus the activity classification of these faults is predominantly based on geologic data from deep oil wells, geophysical profiles, historic earthquakes, and microseismic activity along the fault.

Active regional faults capable of producing significant ground shaking at the proposed Project site are strike-slip faults associated with the San Andreas Fault System, offshore faults, and reverse and blind thrust faults associated with the compressional faulting and folding of the Coast and Transverse Ranges. Periodic earthquakes accompanied by surface displacement can be expected to continue in the study area through the lifetime of the proposed Project. Active faults and potentially active faults that represent a significant seismic threat to the proposed Project are listed in Table 4.6-2. Data presented in this table include estimated earthquake magnitudes, type of fault, and slip rates. Figure 4.6-5 shows locations of significant active and potentially active faults and historic earthquakes in the proposed Project area and surrounding region.

Table 4.6-2. Significant Regional Active and Potentially Active Faults

Name	Closest Distance to Project Components (miles)[1]	Estimated Maximum Earthquake Magnitude[2,3]	Fault Type and Dip Direction[1]
Casmalia	0	6.7	Reverse-Right Lateral Oblique, 75°SW
Foxen Canyon–San Luis Range	1.4	7.2	Thrust, 45°N
Lions Head	3.9	6.8	Reverse, 75°NE
Los Alamos–West Baseline	5.2	6.9	Thrust, 30°S
Los Osos	16.8	7.3	Right Lateral Strike Slip, 80°E
Santa Ynez–West segment alone or connected with East segment	19.1	7.0	Thrust, 45°SW
Red Mountain	31.7	7.0 – 7.4	Right Lateral Strike Slip, 70°S
Rinconada	32.3	7.5	Right Lateral Strike Slip, 90°
Mission Ridge–Arroyo Parida-Santa Ana	35.0	6.9	Reverse, 80°S
San Andreas–Carrizo section alone or in various rupture combinations with other sections	39.3	7.2 – 8.0	Right Lateral Strike Slip, 90°
San Andreas–Cholame section alone or in combination with the Parkfield section	40.6	7.1	Right Lateral Strike Slip, 90°
Santa Ynez–East section only	42.9	7.2	Right Lateral Strike Slip, 70°S

1 - Fault distances and parameters obtained from USGS Earthquake Hazards Program, 2008 National Seismic Hazard Maps - Source Parameters website (USGS, 2017) and USGS and CGS Quaternary Fault and Fold Database of the United States, (USGS & CGS, 2015).
2 - Maximum Earthquake Magnitude – the maximum earthquake that appears capable of occurring under the presently known tectonic framework, magnitude listed is "Ellsworth-B" magnitude from USGS OF08-1128 (Documentation for the 2008 Update of the United States National Seismic Hazard Maps) unless otherwise noted.
3 - Range of magnitudes represents varying rupture scenarios of one or more segments along a fault.



Sources: Faults - U.S.G.S. and C.G.S., 2015, Quaternary fault and fold database for the United States; Earthquakes - CGS, 2001. Updated Magnitude 4 and greater Earthquakes, Compiled from various sources (1769-2000), and USGS, 2017. ANSS Catalog Search.

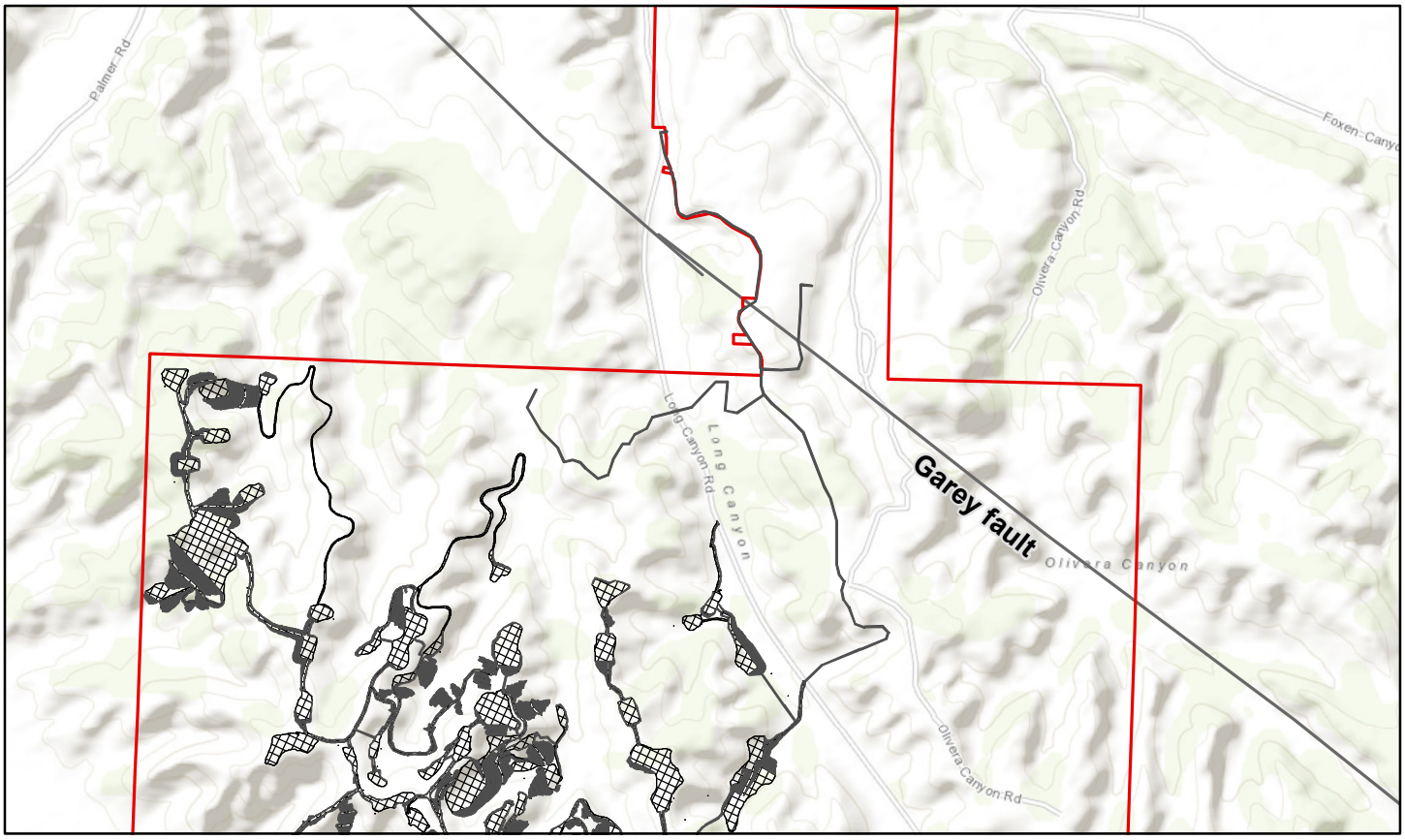
Figure 4.6-5
Regional Active Faults and Historic Earthquakes

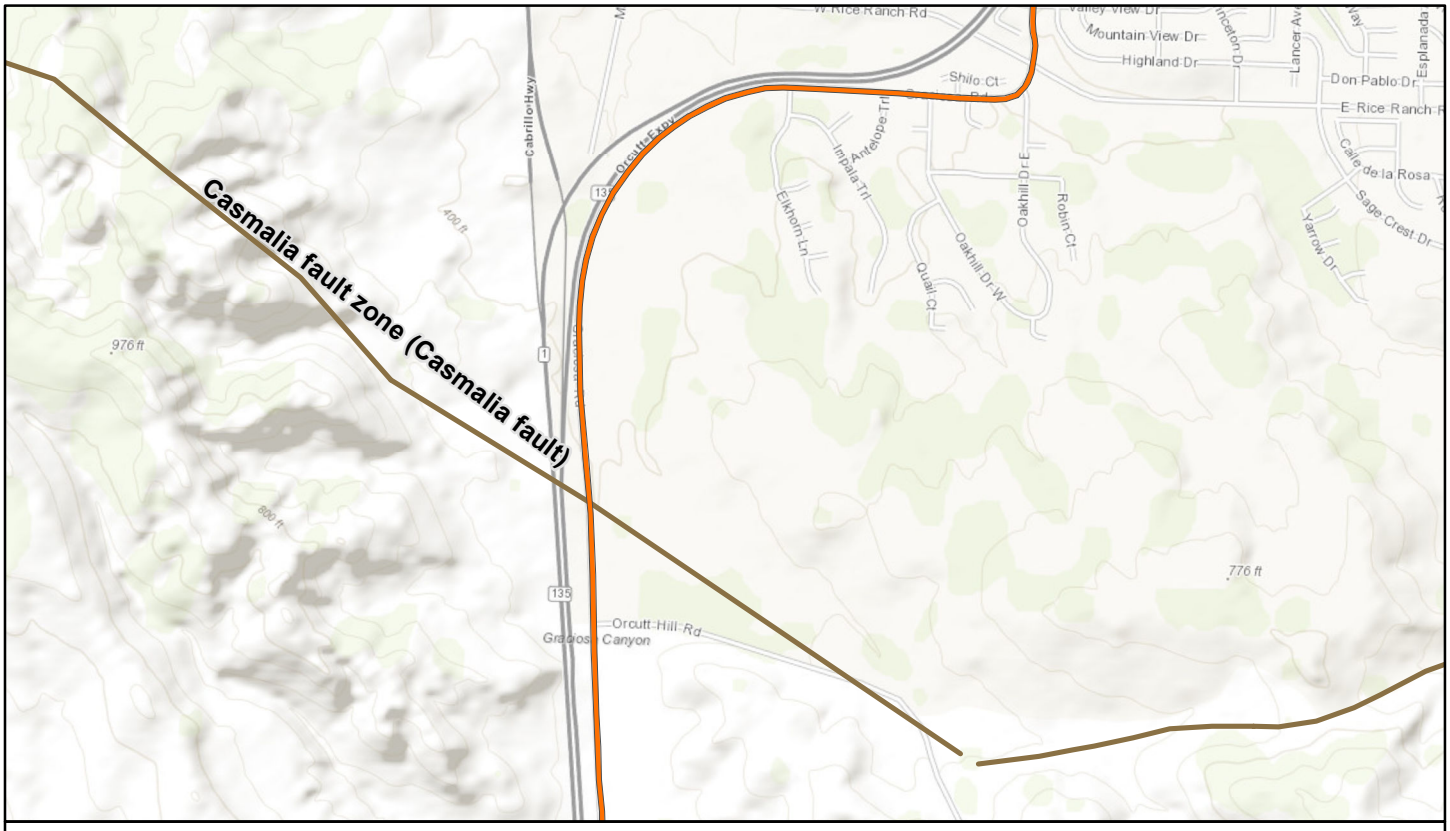
No active faults or Alquist-Priolo zoned faults cross or are in the immediate vicinity of the proposed Project. The nearest significant active fault to the Aera East Cat Canyon Oil Field Project area is the San Andreas fault zone, located approximately 39.3 miles east-northeast of the proposed Project area. The Aera East Cat Canyon Oil Field; however, is crossed by an inactive late Quaternary fault (Garey fault) and the proposed natural gas pipeline is crossed by a potentially active (less than 130,000 years old) Quaternary fault (the Casmalia fault), as shown in Figure 4.6-6 and summarized below. The Garey fault, a mapped late Quaternary aged fault, is not considered active or potentially active (USGS and CGS, 2015). The Garey fault crosses the northeastern portion of the proposed Aera East Cat Canyon Oil Field Project area where no new facilities are planned except for temporary access roads. The potentially active, less than 130,000 years old, Casmalia fault is part of the Casmalia fault zone and crosses the proposed gas pipeline alignment along Graciosa Road, approximately ½-mile south of the Highway 1 and Highway 135 interchange (USGS and CGS, 2015).

Potentially active faults in the proposed Project vicinity include: Foxen Canyon fault (San Luis Range fault system), Casmalia fault zone, Los Alamos-Baseline fault zone, and Los Osos fault zone.

- **Foxen Canyon fault (San Luis Range fault zone).** The Foxen Canyon fault, a north dipping thrust fault, is located north-northeast of the Project area and trends in a northwest direction along the Santa Maria and Sisquoc Rivers.
- **Casmalia fault zone.** Crossing the southwest portion of the natural gas pipeline and located approximately 5.2 miles southwest of the Aera East Cat Canyon Oil Field Project area is the potentially active Casmalia fault zone. The Casmalia fault zone is comprised of several reverse faults with a component of right lateral slip that generally dip steeply to the southwest and trend in northwest direction.
- **Los Alamos–Baseline fault zone.** The Los Alamos-Baseline fault is located approximately 5.2 miles south of the proposed Project area. The Los Alamos-Baseline fault zone is a south dipping thrust fault that trends in a northwest direction between the Casmalia and Santa Ynez fault zones. An approximately 5-kilometer (3.1 mile) section of the fault near Highway 101, about 6.2 miles southeast of the Aera East Cat Canyon Oil Field, is mapped as active and is Alquist-Priolo zoned. Los Osos fault zone – The Los Osos fault zone is located approximately 17 miles north of the proposed Project site. The fault zone is a very complex set of fault segments exhibiting normal, reverse, and thrust motion on varying segments within the zone. Most of the fault is mapped as potentially active, however an approximately 3 mile long segment near San Luis Obispo has been identified as having had Holocene surface rupture and is considered active.

While numerous earthquakes of up to magnitude (M) 4.0 commonly occur throughout the region, larger earthquakes are somewhat rare. The largest earthquake to occur within 50 miles of the proposed Project was the offshore 1927 M7.1 Lompoc Earthquake, which caused little damage due to its the sparse population onshore near the earthquake. The most damaging earthquake in the proposed Project area was the 1925 M6.8 Santa Barbara Earthquake, which is mapped as having occurred offshore in the Santa Barbara Basin, north of Santa Cruz Island. This earthquake caused property damage estimated at $8 million and killed 13 people. Most of the damage occurred in Santa Barbara and nearby towns along the coast. Moderate damage occurred at many points north of the Santa Ynez Mountains, in the Santa Ynez and Santa Maria River valleys. North of Santa Barbara, the earth dam of the Sheffield Reservoir was destroyed, but the water released caused little damage (SCEDC, 2017).





Source: U.S.G.S. and C.G.S., 2015, Quaternary fault and fold database for the United States

0 0.5 Miles

ECC Oil Field Project Area
Permanent Impact
Temporary Impact
Proposed Natural Gas Pipeline

Regional Quaternary Faults
Potentially Active Faults
Older Quaternary Faults, inactive or activity not known

Figure 4.6-6

Local Fault Map

Fault Rupture

Fault rupture is the surface displacement that occurs when movement on a fault deep within the earth breaks through to the surface. Fault rupture and displacement almost always follows preexisting faults, which are zones of weakness; however, not all earthquakes result in surface rupture (i.e., earthquakes that occur on blind thrusts do not result in surface fault rupture). Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. In addition to damage caused by ground shaking from an earthquake, fault rupture is damaging to buildings and other structures due to the differential displacement and deformation of the ground surface that occurs from the fault offset leading to damage or collapse of structures across this zone. In California, Alquist-Priolo Earthquake Fault Zones have been defined by the California Geological Survey along active faults with the potential for surface rupture. However, not all active faults have been zoned, as the criteria specifies that a fault must be shown to be "sufficiently active" and "well defined" by detailed site-specific geologic explorations in order to determine whether an Alquist-Priolo Earthquake Hazard Zone can be established with associated building setbacks. Many known active faults are not sufficiently "well defined" at the surface to qualify to be Alquist-Priolo zoned, but could still cause significant surface fault rupturing.

No known active or potentially active faults cross the proposed Aera East Cat Canyon Oil Field Project site; however, the potentially active Casmalia fault, part of the Casmalia fault zone, crosses the proposed gas pipeline alignment along Graciosa Road, approximately ½-mile south of the Highway 1 and Highway 135 interchange (Figure 4.6-6). The closest Alquist-Priolo zoned fault to the proposed Project is a section of the Los Alamos Fault, also considered the western extension of the Big Pine Fault. Only a portion of this fault is zoned, located along Highway 101 approximately 6.3 miles southeast of the Aera East Cat Canyon Oil Field Project area (USGS and CGS, 2015).

Strong Ground Shaking

An earthquake is classified by the amount of energy released, which traditionally has been quantified using the Richter scale. Recently, seismologists have begun using a Moment Magnitude (M) scale because it provides a more accurate measurement of the size of major and great earthquakes. For earthquakes of less than M 7.0, the Moment and Richter Magnitude scales are nearly identical. For earthquake magnitudes greater than M 7.0, readings on the Moment Magnitude scale are slightly greater than a corresponding Richter Magnitude.

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between the proposed Project area and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the proposed Project area. Earthquakes occurring on faults closest to the proposed Project area would most likely generate the largest ground motion.

The intensity of earthquake-induced ground motions can be described using peak site accelerations (PGAs), represented as a fraction of the acceleration of gravity (g). Peak ground acceleration is the maximum acceleration experienced by a particle on the Earth's surface during the course of an earthquake, and the units of acceleration are most commonly measured in terms of fractions of g, the acceleration due to gravity (980 cm/sec2). The CGS Probabilistic Seismic Hazards Ground Motion Interpolator website was used to estimate PGAs at the proposed Project site. The interpolator uses data from the 2008 Probabilistic Seismic Hazard Assessment Maps (PSHA) to interpolate peak ground accelerations with a 2 percent probability of exceedance in 50 years (return interval of 2,475 years for a maximum considered earthquake) and with a 10 percent probability of exceedance in 50 years (a return interval of 475 years for the maximum considered earthquake) (CGS, 2017). PGAs at the proposed Project site for 2 percent

probability of exceedance in 50 years is approximately 0.5 g and approximately 0.3 g for a 10 percent probability of exceedance in 50 years, which correspond to moderate ground shaking.

Liquefaction

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced strong ground shaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude and frequency of earthquakes in the surrounding region. Saturated, unconsolidated silts, sands, and silty sands within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects (Youd and Perkins, 1978). In addition, densification of the soil resulting in vertical settlement of the ground can also occur.

In order to determine liquefaction susceptibility of a region, three major factors must be analyzed. These include: (a) the density and textural characteristics of the alluvial sediments; (b) the intensity and duration of ground shaking; and (c) the depth to groundwater.

Liquefaction GIS data from the County of Santa Barbara, based on the County's Seismic Safety and Safety Element, maps most of the proposed Project area as having low liquefaction hazard; however, areas along the pipeline and within the Aera East Cat Canyon Oil Field area underlain by unconsolidated young alluvium and old dune sand that are mapped as having a moderate potential for liquefaction (County of Santa Barbara, 2015a). As discussed in the Section 4.9.1, groundwater depth in the vicinity of the proposed Project area is generally greater than 150 to 250 feet bgs, with shallower levels along major alluvial drainages, such as the Sisquoc River. Based on the depth to groundwater of greater than 50 feet in the proposed Project area and the low liquefaction hazard rating by the County for the proposed Project area, it is unlikely that liquefaction would occur in this area.

Induced Seismicity

Although the vast majority of earthquakes are due to natural tectonic stresses, induced seismic activity (seismic events caused by human activity) has been documented in the United States since at least the 1920's and attributed to a variety of causes including underground injection, oil and gas extraction, geothermal projects, impoundment of large reservoirs behind dams, mining extraction, construction, and underground nuclear tests (GWPC, 2017). There has been public concern regarding induced seismicity from well stimulation treatments and the injection of oilfield produced water. Disposal of large volumes of produced water from oil and gas production in deep injection wells has caused felt seismic events in eastern and central United States that generally have originated in buried faults in the deep Precambrian basement and not the overlying sedimentary rock (CCST, 2014; CPWG, 2017)). The 2015 DOGGR *Analyses of Oil and Gas Stimulation Treatments In California* (DOGGR, 2015), concludes that the potential for felt induced seismicity from currently practiced well stimulation treatments and wastewater injection in California is low. Although the potential for felt earthquakes is low, microseimic events not felt at the surface may occur with fluid injection (DOGGR, 2015).

There have been two known instances of oil field operation (injection) induced seismicity in California, in 2005 in the Kern County Tejon Oil Field and in 1991 in the Santa Barbara County Orcutt oil field. In 2005 there were several M4.3 to M4.7 earthquakes in the Tejon field related to very large fluid injection volumes in the vicinity of the active White Wolf fault (Goebel, et al, 2016). A 1991 induced seismic event in the Orcutt field consisted of an anomalous M3.5 event related to high pressure hydro-fracturing at relatively shallow depth (100 to 300 meters) (Kanamori and Hauksson, 1992). Although not related to oil field operations,

continuous induced seismicity has been occurring in the California-Geysers Geothermal Field since the 1960s due to deep, large volume geothermal injection in an area bounded by 2 faults and with extensive small faults; the largest induced earthquake was a M4.6 and annually induced seismicity in the area generally consists of 2-3 M4, 30-40 M3, and 300-400M2 earthquakes (Wong 2017). The potential for human felt induced seismicity attributable to secondary and enhanced oil recovery is considered to be low due to the generally smaller magnitude of induced earthquakes (less than M5.0) (NRC 2013, Wong 2017). Additionally, there is less potential for induced seismicity associated with injection wells used for enhanced recovery purposes due to the associated pressure increases being offset by pressure decreases resulting from production wells located nearby (EPA 2015). Induced seismicity related to oil and gas production in California has occurred only in oil fields where extraction of large volumes of oil and produced water occurred without replacement of fluids into the same oil-producing formations (Goebel 2016).

Well stimulation by cyclic steam injection and accompanying disposal of produced water have occurred in the Aera East Cat Canyon Oil Field since 1965 (DOGGR, 2010). A survey of earthquakes of M2.0 or greater from 1932 through 2015 for a 5-mile radius from the center of WCC reveals only 26 earthquakes of magnitudes 2.0 to 3.6 have occurred in this area between the span of 1948 to 2010 (SCEDC, 2015). No distinct trend is apparent in the number of earthquakes per year following the beginning of injection; earthquakes have occurred sporadically, ranging from zero to a maximum of 4 per year. Additionally, no active faults are in the immediate proposed Project vicinity and the closest potentially active fault is located more than 5 miles from the closest injection well for the Aera East Cat Canyon Oil Field.

4.6.1.6 Subsidence

Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials due to removal of subsurface support. It is found worldwide in a variety of environments on land and the seafloor and can result from either natural geologic and/or man-made causes (City of Long Beach, 2018). The causes of subsidence are aquifer-system compaction due to fluid withdrawal (groundwater, petroleum, geothermal), drainage and decomposition of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost (USGS, 2018). The effects of land subsidence can include damage to buildings and infrastructure such as roads, pipelines, and canals, increased flood risk in low-lying areas, and lasting damage to groundwater aquifers and aquatic ecosystems. A subsided area can vary in size from a few acres to thousands of square miles. Elevation losses can be from a fraction of an inch to tens of feet.

Most subsidence is a result of excessive groundwater pumping which has occurred throughout California, including the San Joaquin Valley, the single largest example of subsidence. Completion of California's State and federal water projects that bring water from the California's wet north to its dry south allowed some groundwater aquifers to recover. Fresh groundwater pumping for the purposes of municipal water supplies or agricultural irrigation results in a one-way net loss of fluid in groundwater aquifers, generally only replaced by percolation of subsequent winter storms or regional watershed drainage.

Alternatively, if subsidence occurs within an oil field it is due to the decrease in pore pressure in the reservoir that the oil is being extracted from. As a result of the pore pressure decrease, the effective stress from the overburden increases causing compaction of the reservoir. This compaction is translated to the surface as subsidence (Ketelarr, 2009). The compressibility of a reservoir is generally determined by the vertical interval, the amount of pressure drop, how compressible the formation is, and the depth of burial of the reservoir formation. Several well-known examples of oil field subsidence include the Long Beach Wilmington field, the Goose Creek field in Houston, and the Groningen field in the Netherland; subsidence in these fields was significant and required remediation that generally consisted of injection into the reservoirs to balance or increase reservoir pressure (deWaal, 1986). Remediation into the affected

reservoir has allowed these oil fields to continue operating without continued significant subsidence. Common oil field practices in California, include removal of an oil and water emulsion, and once separated, the produced water is reinjected back into the oil bearing formations via steam or produced water injection wells. Thus, oil field practices generally ensure that subsidence does not occur because reservoir pressure depletion occurs in a slow, controlled manner stretching out over many decades.

4.6.1.7 Oil Seeps

There is no evidence of oil seeps resulting from the historic or recent (1980s) steam injection in the Aera East Cat Canyon Oil Field (SCS, 2015; County of Santa Barbara Petroleum Office, 2016; DOGGR, 2016). Steam injection occurs in the Sisquoc Sand at depths of 2,300 to 2,900 feet which is overlain by 500 to 1,200 feet of confining shale, mudstone and siltstone of the Sisquoc Shale which is in turn overlain by mudstone, siltstone, and sandstone of the Foxen formation. These low permeability soils provide a barrier that have shown during decades of previous steaming activities to prevent oil from rising to the ground surface (see Sections 4.3.4 and 4.9.4 for seep potential resulting from the proposed Project for potential impacts to biological and hydrological resources, respectively).

4.6.2 Regulatory Setting

4.6.2.1 Federal Regulations

Federal Earthquake Hazards Reduction Act

In 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes through the establishment and maintenance of an effective earthquake hazards and reduction program. To accomplish this, the act established the National Earthquake Hazards Reduction Program (NEHRP). The agencies responsible for coordinating NEHRP are the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF); and the United States Geological Survey (USGS). In 1990, NEHRP was amended by the National Earthquake Hazards Reduction Program Act (NEHRPA), which refined the description of the agency responsibilities, program goals, and objectives. The four goals of the NEHRP are: 1) develop effective practices and policies for earthquake loss-reduction and accelerate their implementation; 2) improve techniques to reduce seismic vulnerability of facilities and systems; 3) improve seismic hazards identification and risk-assessment methods and their use; and 4) improve the understanding of earthquakes and their effects.

Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the Waters of the United States. The Act authorized the Public Health Service to prepare comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries and improving the sanitary condition of surface and underground waters with the goal of improvements to and conservation of waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural and industrial uses. The proposed Project construction would disturb a surface area greater than one acre; therefore, the applicant would be required to obtain under CWA regulations a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity. Compliance with the NPDES would require that the applicant submit a Storm Water Pollution Prevention Plan (SWPPP).

International Building Code

The International Building Code (IBC) is published by the International Code Council (ICC). The scope of this code covers major aspects of construction and design of structures and buildings, except for three-story one- and two-family dwellings and town homes. The IBC has replaced the Uniform Building Code (UBC) as the basis for the California Building Code (CBC) and contains provisions for structural engineering design. The 2015 IBC addresses the design and installation of structures and building systems through requirements that emphasize performance. The IBC includes codes governing structural as well as fire- and life-safety provisions covering seismic, wind, accessibility, egress, occupancy, and roofs.

4.6.2.2 California State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act of 1972, Public Resources Code (PRC) Sections 2621–2630 (formerly the Special Studies Zoning Act) regulates development and construction of buildings intended for human occupancy to avoid the hazard of surface fault rupture. While this Act does not specifically regulate oil field components not intended for human occupancy; it does help define areas where fault rupture, and thus related damage, is most likely to occur. This Act groups faults into categories of active, potentially active, and inactive. Historic and Holocene age faults are considered active, Late Quaternary and Quaternary age faults are considered potentially active, and pre-Quaternary age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be “sufficiently active” and “well defined” by detailed site-specific geologic explorations in order to determine whether building setbacks should be established. Cities and counties affected by the zones must regulate certain development 'projects' within the zones. They must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting.

California Uniform Building Code

The California Code of Regulations (CCR), also known as Title 24, California Building Standards Codes, provides a minimum standard for building design through the (CBC), which is based on the (IBC), but has been modified for California conditions. Chapter 16 of the CBC contains specific requirements for seismic safety. Chapter 18 of the CBC regulates excavation, foundations, and retaining walls. Chapter 33 of the CBC contains specific requirements pertaining to site demolition, excavation, and construction to protect people and property from hazards associated with excavation cave-ins and falling debris or construction materials. Chapter 70 of the CBC regulates grading activities, including drainage and erosion. Construction activities are subject to occupational safety standards for excavation, shoring, and trenching, as specified in the State of California Division of Occupational Safety and Health (commonly called Cal/OSHA) regulations (Title 8 of the CCR) and in Section A33 of the CBC.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (the Act) of 1990 (PRC, Chapter7.8, Division 2, Sections 2690–2699.) is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. The Act directs the California Department of Conservation, Division of Mines and Geology [now called California Geological Survey (CGS)] to delineate Seismic Hazard Zones or Zones of Required Investigation. Zones of Required Investigation referred to as "Seismic Hazard Zones" in CCR Section 3722, are areas shown on Seismic Hazard Zone Maps where site investigations are required to determine the need for mitigation of potential liquefaction and/or earthquake-induced landslide

ground displacements. A geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design before development permits may be granted. Cities, counties, and State agencies are directed to use seismic hazard zone maps developed by CGS in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones. However, to date, seismic hazard mapping has not been completed by the State Geologist for Santa Barbara County. Therefore, this act does not apply to the proposed Project.

California Division of Oil, Gas, and Geothermal Resources (DOGGR)

DOGGR regulates production of oil and gas, as well as geothermal resources, within the State of California. DOGGR requirements in preparation of environmental documents under CEQA are defined in CCR, Title 14, Division 2, Chapter 2. The CEQA unit coordinates with DOGGR programs, local jurisdictions, state and federal agencies, and the public. Staff also assists operators in avoiding or reducing environmental impacts from the development of oil, gas, and geothermal resources in California.

DOGGR regulations, which are defined in CCR, Title 14, Division 2, Chapter 4, include well design and construction standards, surface production equipment and pipeline requirements, and well abandonment procedures and guidelines to ensure effectiveness in preventing migration of oil and gas from a producing zone to shallower zones, including potable groundwater zones. DOGGR oversees well operations. DOGGR also has regulatory authority over Class II injection wells for enhanced recovery and disposal.

California Public Utilities General Orders

CPUC General Order 95. California Public Utilities Commission (CPUC) General Order (GO) 95 contains State of California rules formulated to provide uniform requirements for overhead electrical line construction to insure adequate service and secure safety to persons engaged in the construction, maintenance, operation or use of overhead electrical lines and to the public. GO95 is not intended as complete construction specifications, but to embody requirements which are most important from the standpoint of safety and service. Construction shall be according to accepted good practice for the given local conditions in all particulars not specified in the rules. GO95 applies to all overhead electrical supply and communication facilities which come within the jurisdiction of the California Public Utilities Commission, located outside of buildings, including facilities that belong to non-electric utilities, as follows: Construction and Reconstruction of Lines, Maintenance of Lines, Lines Constructed Prior to This Order, Reconstruction or Alteration, Emergency Installation, and Third-Party Nonconformance.

CPUC General Order 112-F. GO112-F, adopted in June 2015, establishes minimum requirements for the design, construction, quality of materials, locations, testing, operations and maintenance of gas gathering and transmission and distribution piping systems in the State. The purpose of GO112-F is to safeguard life or limb, health, property and public welfare and to provide that adequate service will be maintained by gas utilities operating under the jurisdiction of the CPUC**.** GO112-F is incorporated in addition to the Federal Pipeline Safety Regulations, specifically, Title 49 of the Code of Federal Regulations (49 CFR), Parts 191, 192, 193, and 199, which also govern the Design, Construction, Testing, Operation, and Maintenance of Gas Piping Systems in the State of California. General Order **No.** 112-F does not supersede the Federal Pipeline Safety Regulations, but rather supplements them.

4.6.2.3 Local Regulations

The County's Systems Safety and Reliability Review Committee (SSRRC) is the delegated authority in the County to undertake review of the technical design and construction drawings for hazards identification,

risk assessment and mitigation of design and operational hazards prior to construction and startup of oil and gas projects within the County. The SSRRC also reviews and oversees the Safety, Maintenance, and Quality Assurance Programs (SIMQAP) for energy facilities.

The proposed Project may be subject to policies and regulations contained within the Santa Barbara County Building Code and the Santa Barbara County Comprehensive Plan. The Santa Barbara County Code includes grading requirements in Chapter 14 – Grading Code. The Grading Code sets forth regulations, conditions and provisions to protect and preserve property and public welfare by regulating and controlling the design, construction, quality of materials, location and maintenance of grading, drainage, erosion and sediment control, where required within the County of Santa Barbara.

The Santa Barbara County Seismic Safety and Safety Element (County of Santa Barbara, 2015a), part of the Santa Barbara Comprehensive Plan, divides geologic hazards in the County into three general levels of impact, critical, sometimes critical, and less critical.

- *Critical - ground rupture from fault movement, tsunamis and seiches, and liquefaction*
- *Sometimes Critical – ground shaking, high groundwater, subsidence (normally correctable with engineering), slope stability and landslides, and soil creep*
- *Less Critical - expansive soils and compressible - collapsible soils*

The Santa Barbara Seismic Safety and Safety Element also presents the following Geologic and Seismic Policy Goal:

- *Protect the community to the extent feasible from risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche and dam failure; slope instability leading to mudslides and landslides; subsidence, liquefaction and other seismic hazards pursuant to Government Code §65302(g)(1), Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body.*

This policy goal includes six Geologic and Seismic Protection Policies and associated Implementation Measures. These Protection Policies direct the County to minimize geologic, soil and seismic hazards by implementing State and County Building Codes, enforcing development, grading, and land use codes, and enforcing the State Alquist-Priolo Earthquake Fault Zoning and Seismic Hazard Mapping Acts.

The County's Systems Safety and Reliability Review Committee (SSRRC) is the delegated authority in the County to undertake review of the technical design and construction drawings for hazards identification, risk assessment and mitigation of design and operational hazards prior to construction and startup of oil and gas projects within the County. The SSRRC also reviews and oversees the Safety, Maintenance, and Quality Assurance Programs (SIMQAP) for energy facilities.

4.6.3 Environmental Thresholds

California Environmental Quality Act

Based on the CEQA Appendix G Environmental Checklist, the proposed development activity would be considered to have potentially significant impact if it would:

- *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.*

- *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking.*
- *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction.*
- *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides.*
- *Result in substantial soil erosion or the loss of topsoil.*
- *Would the Project 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 off-site landslide, lateral spreading, subsidence, liquefaction or collapse?*
- *Would the Project 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 wastewater.*

Santa Barbara County Environmental Thresholds

The County's Thresholds and Guidelines Manual (County of Santa Barbara, 2008), includes the following guidelines for determining the potential for significance of geologic impacts:

- *The project site or any part of the project is located on land having substantial geologic constraints, as determined by the Planning and Development or Public Works department. Areas constrained by geology include parcels located near active or potentially active faults and property underlain by rock types associated with compressible/collapsible soils or susceptible to landslides or severe erosion. "Special Problems" areas designated by the Board of Supervisors have been established based on geologic constraints, flood hazards and other physical limitations to development.*
- *The project results in potentially hazardous geologic conditions such as the construction of cut slopes exceeding a grade of 1.5 horizontal to 1 vertical.*
- *The project proposes construction of a cut slope over 15 feet in height as measured from the lowest finished grade.*
- *The project is located on slopes exceeding 20 percent grade.*

4.6.4 Environmental Impacts and Mitigation Measures

This section describes effects on and from geologic and soils resources and conditions that would be caused by the implementation of the proposed Project. Geologic, soil, and seismic conditions were evaluated with respect to the adverse effects that implementation of the proposed Project may have on local geology and soils, as well as the impact that specific geologic hazards may have upon components of the proposed Project. A wide range of potential impacts, including unsuitable soils, slope instability, and seismic hazards of surface fault rupture, strong ground shaking, liquefaction, and seismically induced landslides, were considered in this analysis. Geologic formations, slope conditions, and soil types have been characterized by their potential to contribute to hazardous conditions. Areas prone to risk for potential adverse impacts due to existing geologic, topographic, or soils conditions were identified and their relationship to proposed Project components analyzed. Where existing conditions suggest a potentially significant risk or impact, mitigation measures were identified to reduce the risk or impact.

Applicant proposed Avoidance and Minimization Measure (AMM) are listed in Appendix C and include the following AMM specific to geology processes/geologic hazards (see Table 4.6-3).

With implementation of AMM GEO-1 and when analyzed against the aforementioned Environmental Thresholds, the proposed Project was found to have no impact to the following. Project impacts and the following two thresholds are not discussed in further detail beyond the summaries provided below:

- **Expose people or structures to substantial adverse effects where there is high potential for earthquake-related ground rupture in the vicinity of major fault crossings project.** No known active or potentially active faults cross or are in immediate vicinity of the proposed Project oil field redevelopment area and 115 kV power line. Therefore, there is no potential for surface fault rupture at or across the proposed Project oil field redevelopment site or 115 kV power line, resulting in no impact for these proposed Project components. Impacts related to earthquake related ground rupture along the natural gas pipeline are discussed in Section 4.6.4.3.
- **Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismically induced liquefaction.** Since the depth of groundwater is greater than 50 feet below ground surface within the proposed Project area and the low liquefaction hazard rating according to the County for the proposed Project area, it is unlikely that liquefaction would occur in the Aera East Cat Canyon Oil Field (see Section 4.6.1.5). There would therefore be no impact related to liquefaction.

Table 4.6-3. Applicant Proposed Avoidance and Minimization Measures Related to Geology Processes/ Geologic Hazards

AMM No.	Measure
GEO-1	**Geologic Hazards Recommendations**. Aera Energy LLC will implement the following during Project construction and operations: a. If structures are proposed in areas of possible landsliding, subsurface exploration will be performed to confirm the presence and geometry of the landslide deposits, to evaluate the stability of the materials; b. If landslide deposits are confirmed and their natural stability is found to be inadequate, Aera will either avoid those areas or implement measures recommended by a geotechnical engineer, such as removal and replacement with compacted fill, providing structural support, or compacted-fill buttressing; c. Areas of colluvium on slopes above proposed developments will be removed or supported; d. The overexcavation and remedial grading will be planned to remove existing artificial fill and colluvial soils beneath proposed structures and areas of development; e. Proposed cut slopes will be graded at inclinations of 2 horizontal to 1 vertical (2H:1V) or flatter; unless steeper inclinations are approved in the Grading Plan review. f. Site-specific geotechnical exploration and analyses will be conducted as needed to determine the potential for liquefaction, seismic settlement, and hydroconsolidation; g. A Project-specific grading and erosion control plan will be designed to minimize erosion and sedimentation; h. Geotechnical sampling and testing will be performed as necessary to confirm the presence or absence of expansive soil materials at the Project site; and i. Aera Energy LLC will adhere to recommendations detailed in both Fugro Consultants, Inc.'s December 2013 Phase I Services, Preliminary Geotechnical Engineering Study, East Cat Canyon Oil Field, Sisquoc Area, Santa Barbara County, California and Fugro Consultants, Inc.'s January 2014 Preliminary Geologic Hazards Evaluation, East Cat Canyon Oil Field, Sisquoc Area, Santa Barbara County, California (Appendix S).

4.6.4.1 Oil Field Development and Operation

Impact GEO-1: Seismically induced ground shaking or seismically induced slope failure could cause damage to Project structures or result in injury or death to people.

Seismically Induced Ground Shaking. Moderate to strong ground shaking is expected to occur in the event of a large earthquake on any of the major faults in the region or on the faults near the proposed Project, with an estimated PGA of 0.5 g (acceleration of gravity) for a two percent probability of exceedance in 50 years. While the shaking would be less from an earthquake that originates farther from the proposed Project site, the effects from nearby or regional earthquakes could be damaging to proposed Project structures. It is likely that Project components would be subjected to at least one moderate or larger earthquake occurring close enough to produce ground shaking at the Project site. Strong ground shaking could cause shearing, differential settlement, or heave of structures at the ground surface resulting in the weakening or collapse of these structures.

While the potential for seismically induced ground shaking in the proposed Project area during Project operation is unavoidable, many of the proposed Project components are not habitable structures that would expose people to significant hazards due to seismic shaking. While proposed Project components such as wells or pipelines could be damaged by strong seismic ground shaking, potential damage to the components from seismic events could easily be repaired and would not pose a significant hazard of loss, injury, or death (see Section 4.7.4 for discussion of risk of hazards associated with facility failures such as pipeline ruptures). Other proposed Project structures such as buildings and maintenance shops that would be occupied by onsite workers, would be required to be designed and constructed in accordance with local and State building codes.

Slope Failure. The proposed Project is located on gentle to steeply sloping hillsides, steep cut slopes, ridge tops, and gently sloping alluvial valley floors. Numerous landslides and raveling slopes are mapped within the oil field proposed Project area (Fugro, 2013 and 2014) and visible small slumps on aerial photographs, and it is possible that large regional or local earthquakes could trigger slope failures such as landslides or debris slides. Santa Barbara Seismic Safety and Safety Element maps the hillside areas in the proposed Project area as having a low potential for landslides (County of Santa Barbara, 2015a). Although significant grading will occur on the site and all slopes within the graded areas will be engineered for stability and to prevent slope failure, portions of the proposed Project will still be located above or below existing natural or graded slopes. Slope failures at or adjacent to proposed Project components could cause damage to these structures or death or injury to oil field workers. No impact to the general public traveling near to the proposed Project oil field on public roads is anticipated since Cat Canyon Road is not bordered by steep slopes at the proposed Project site. AMM GEO-1 (Geologic Hazard Recommendations) (see Appendix C and introduction to Section 4.6.4) would partially reduce this impact by identifying areas of existing landslides and unstable slopes, and avoiding or implementing mitigation as recommended by a geotechnical engineer.

Impact GEO-1 is considered less than significant (Class III) given that the proposed oil development infrastructure must be designed and constructed to withstand anticipated horizontal and vertical ground acceleration in the Project area, based on the California Building Code. In addition, the proposed Project grading plan must conform to the requirements set forth in Chapter 70 of the California Building Code and the County Grading and Building Codes. Compliance with applicable regulatory standards and codes would be verified through County Building and Safety review and approval of building and grading plans required for the Project.

Impact GEO-2: Project induced seismicity or subsidence could cause damage to structures or result in injury or death to people.

As presented in Section 2.5.2 and illustrated on Figure 2-16, steam injection and oil/steam water production wells would be drilled and completed in the Brooks reservoir at a depth of approximately 3,000 feet. Additional steam water production and recycled water/brine injection wells would be drilled and completed in the Upper Sisquoc Formation Sands reservoir at a depth of approximately 2,000 feet. The majority of the steam would be generated using produced water from the Brooks reservoir, which is anticipated to peak at an average rate of 35,000 to 40,000 barrels of water per day. To supplement the expected produced water volumes reused to generate steam, additional brackish (high salinity content) water would be produced from the Upper Sisquoc Formation sands at an anticipated peak rate of 15,500 barrels of water per day. Produced water from both the Brooks reservoir and Upper Sisquoc Formation sands would be treated, heated, and injected into the Brooks reservoir as steam. Excess produced water not used for steam injection, including the brine from softener re-generation, would be combined and re-injected into the Upper Sisquoc Formation sands at the same depth. Under the proposed Project injection/production plan, with the exception of produced oil, all produced water would be reinjected back into the Brooks reservoir and Sisquoc Formation sands as either steam or excess recycled water/brine. As shown on Figure 2-16, no low permeability zone separates the Brook Sands and Sisquoc Sand formations, so reservoir pressure is continuous. Because slightly more fluid will be extracted than injected into the reservoir, reservoir pressure will decrease slightly over time. As required by DOGGR regulation, injection rates, production rates, and pressures will be closely monitored. As discussed in Section 4.6.1.5 and 4.6.1.6, both induced seismicity and subsidence can potentially occur when there is extraction of large volumes of oil and produced water occurred without replacement of fluids into the oil-producing formations which result in drastic changes in reservoir pressure. **Because the Aera production plan includes reinjection of all produced water either as steam or excess recycled water/brine (only oil would be permanently extracted), the change in reservoir pressure would be gradual over time; therefore, the potential for induced seismicity and subsidence is considered to be less than significant (Class III).**

Impact GEO-3: Slope failures, such as landslides, could be triggered by proposed Project construction.

As noted above, the proposed Project is located on gentle to moderately sloping hillsides, ridge tops, and gently sloping alluvial valley floors; portions of the proposed Project areas have been previously graded with steep raveling slopes of 1H:1V (Fugro, 2014). The proposed Project area is mapped by the Santa Barbara Seismic Safety and Safety Element as having low potential for landslides (County of Santa Barbara, 2015a); however, numerous landslides and raveling slopes have been mapped and noted (Fugro, 2013 and 2014). Where the proposed Project is located on, crosses, or is adjacent to moderately steep slopes, mapped and unmapped landslides or areas of localized slope instability may be encountered. Ground disturbance in proposed Project work areas consisting of excavation and grading for well pads, access roads, operational facilities, and buildings could destabilize slopes and trigger slope failures. Slope failures could include landslides, earthflows, soil creep, or debris flows. Slope instability has the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy Project components or other nearby structures. AMM GEO-1 (Geologic Hazard Recommendations) would partially reduce this impact by identifying areas of existing landslides and unstable slopes and avoiding or implementing mitigation as recommended by a geotechnical engineer. **Impact GEO-3 is less than significant (Class III) given that the proposed Project grading plan must conform to the requirements set forth in Chapter 70 of the California Building Code and the County Grading and Building Codes**. Adherence to these regulatory requirements would be verified by the County through the building and grading plan review process.

Impact GEO-4: Construction and operation of the proposed Project could trigger or accelerate soil erosion.

Excavation and grading for well pads, foundations for new equipment and buildings, pipelines, and access roads could loosen soil and accelerate erosion. The Aera East Cat Canyon Oil Field site is underlain by numerous soil associations, as shown in Figure 4.6-3, and many of the soils within the oil field site have high percentages of sand and are particularly susceptible to wind erosion. Soils containing high percentages of fine sands and silt, and that are low in density, are generally the most erodible. As the clay and organic matter content of soils increases, the potential for erosion decreases. Clays act as a binder to soil particles, thus reducing the potential for erosion. Erosion susceptibility of soils in the Aera East Cat Canyon Oil Field site to sheet and rill erosion by water and erosion of disturbed soils by wind both range from low to high, as presented in Table 4.6-1 (NRCS, 2015). However, current regulations would require that the proposed Project obtain, under Clean Water Act regulations, a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity as construction at the oil field redevelopment site would disturb a surface area greater than one acre. This would require that the Applicant prepare and implement a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP would require development and implementation of BMPs to identify and control erosion, which would reduce the potential for construction triggered erosion. Additionally, erosion and the loss of topsoil at areas of ground disturbance within the proposed Project would be further minimized by implementation of AMM GEO-1 which indicates the Applicant will prepare a project specific grading and erosion plan and by provisions which would be included in the grading permit required by Santa Barbara County. **Compliance with these regulatory requirements would reduce Impact GEO-4 to a less than significant impact with mitigation (Class III)** and would be verified through the County's building and grading plan review process and subsequent site inspections**.**

Impact GEO-5: Expose people or structures to potential risk of loss or injury where expansive or other unsuitable soils are present.

Although most of the soils underlying the proposed Project have a low expansion potential, the Positas soils have moderate expansion potential and the San Andreas-Tierra soils range from moderate to high expansion potential. Expansive soils may cause differential and cyclical movements of foundations that can cause damage and/or distress to structures and equipment. Additionally, as shown in Table 4.6-1, some of the soils underlying Aera East Cat Canyon Oil Field site have potential for corrosion of uncoated steel of moderate to high (Chamise, Corralitos, and Positas) and most of the soils have potential for corrosion of concrete of moderate to high (Arnold, Chamise, Corralitos, Positas, and San Andreas-Tierra). In areas where corrosive subsurface soils underlie the proposed Project site, the corrosive soils could have a detrimental effect on concrete and metals. Depending on the degree of corrosivity of subsurface soils, concrete and reinforcing steel in concrete structures and bare-metal structures exposed to these soils could deteriorate, eventually leading to structural failures. **Implementation of MM GEO-1 would reduce the potential that unsuitable soils would cause damage to proposed Project structures to less than significant with mitigation. (Class II).**

MM GEO-1 **Soils Engineering Study.** The Applicant shall submit a soils engineering study addressing structure sites and access roads to determine necessary structural design criteria to address expansive and/or unsuitable soils. The study shall demonstrate that the submitted Project plans conform to the structural design criteria.

PLAN REQUIREMENTS and TIMING: The Applicant shall submit the study for P&D review and approval prior to issuance of the Zoning Clearance.

MONITORING: P&D permit compliance staff and grading and building inspectors shall ensure compliance in the field through periodic site inspections.

Impact GEO-6: Soils incapable of supporting septic system.

The proposed Project would include an onsite septic system. A permit is required by Santa Barbara County Environmental Health Services (EHS) for the construction of new septic system as well as the repair, modification or abandonment of existing systems. Inspection and approval of all work by EHS is required prior to backfilling any components or putting the system into service. Aera indicates that the septic system would be designed by a qualified environmental professional and would satisfy all County requirements for soils analysis, percolation testing, groundwater testing, design, and construction/installation (Aera, 2016). **Impact GEO-6 is considered less than significant (Class III).**

Impact GEO-7: Encountering contaminated soils during construction.

Currently there are no known oil seeps on the proposed Project site. However, various areas throughout the proposed Project site are known to contain pre-existing petroleum hydrocarbon-containing soils. These "legacy fill areas" are remnants from historical oil and gas operations within the Aera East Cat Canyon Oil Field prior to acquisition of the property by Shell and Aera (see Figure 2-17, Legacy Fill Areas). Project construction activities would encroach upon some legacy fill areas. Aera would excavate approximately 255,673 cubic yards of known petroleum hydrocarbon-containing soils within the proposed Project disturbance areas for beneficial reuse either onsite as road material, at other Aera locations, or at the Santa Maria Regional Landfill, in accordance with the Soil Beneficial Reuse Plan developed for the proposed Project (Aera, 2016)[1].

Contaminated soils encountered during construction activities in areas outside of the known "legacy fill areas" would be analyzed for indications of hazardous concentrations of chemicals of potential concern. If hazardous concentrations are not found, the petroleum-hydrocarbon containing soils may qualify for use under the beneficial reuse program as road sub-base, road base, and/or final road surfaces associated with proposed Project activities. To ensure the identification of any other unknown contaminated soils prior to construction, **MM GEO-2 is required to reduce the potential impact of contaminated soil to less than significant with mitigation (Class II).**

MM GEO-2 **Unknown Contaminated Soils.** During grading or excavation work, the construction contractor shall observe the exposed soil for visual or odors as evidence of contamination. If visual contamination indicators are observed during construction, the contractor shall segregate any suspect soil already excavated, stop work until sampling and testing is done to determine appropriate treatment and disposal, and appropriate measures are taken to protect human health and the environment. Contaminated soils shall be completely excavated and the contaminated areas cleaned to Regional Water Quality Control Board and local CUPA specifications before moving forward with construction of the Project components.

[1] The California Regional Water Quality Control Board (RWQCB) beneficial reuse program (expired) allows for the use of non-hazardous hydrocarbon impacted soils on ERG's leases for beneficial uses such as roads and berms. The beneficial reuse program was issued an extension by the Executive Officer of the RWQCB and operators that have coverage under the old program have been directed to continue to comply with the expired permits until the RWQCB adopts new regulations.

PLAN REQUIREMENTS and TIMING: P&D and the local CUPA shall be notified immediately when contaminated soil is found. A Remediation Plan shall be completed and submitted to the required agencies upon the discovery of any previously unknown contaminated soil.

MONITORING: P&D shall monitor implementation of remedial measures to ensure compliance with the Remediation Plan.

4.6.4.2 Power Line Construction and Operation

Impact GEO-1: Seismically induced ground shaking, Project induced ground shaking, or seismically induced slope failure could cause damage to Project structures or result in injury or death to people.

The East Cat Canyon power line is located in an area where moderate to strong ground shaking is expected to occur in the event of a large earthquake on any of the major faults in the region or on the faults near the proposed Project, with an estimated PGA of about 0.5 g for a two percent probability of exceedance in 50 years. Strong ground shaking could cause shearing, differential settlement, or heave of pole foundations at the ground surface causing weakening or collapse of these structures. The power line traverses gently sloping hills that have a low potential of seismically induced landslides. **Impact GEO-1 is less than significant (Class III) given required compliance with California Public Utilities General Order 95 (GO95) requirements for construction of overhead power lines to reduce the impact from ground shaking.**

Impact GEO-2: Project induced seismicity or subsidence could cause damage to structures or result in injury or death to people.

Power line construction and operation would not require extensive withdrawals or injection of groundwater or oil/water emulsion; therefore, Impact GEO-2 is not applicable.

Impact GEO-3: Slope failures, such as landslides, could be triggered by Project construction.

As noted in Impact GEO-1, the power line crosses gently sloping hills that have low potential for landslides. Compliance with GO95 would reduce this impact by identifying areas of existing landslides and unstable slopes and avoiding or implementing mitigation as recommended by a geotechnical engineer would ensure that **the impact of triggering landslides during power line construction is less than significant (Class III).**

Impact GEO-4: Construction and operation of the Project could trigger or accelerate soil erosion.

The minor grading for power line access road and tubular steel pole pads that would occur as part of the construction for the power line would loosen soils and make them susceptible to erosion. The powerline is underlain by the Corralitos soil association with susceptibility to sheet and rill erosion by water ranging from low to moderate and a susceptibility of wind erosion of disturbed soils of high. Implementation of regulatory requirements such as **a project specific Storm Water Pollution Prevention Plan (SWPPP) would result in a less than significant impact (Class III).**

Impact GEO-5: Expose people or structures to potential risk of loss or injury where expansive or other unsuitable soils are present.

The soil unit (Corralitos association) underlying the power line route has low potential for expansion. Corrosion potential of this soil unit ranges from low to high for uncoated steel and is moderate for concrete. Corrosive soils could cause damage to transmission pole foundations. **Implementation of MM**

GEO-1 (soils engineering study) would reduce the potential that unsuitable soils would cause damage to project structures to less than significant with mitigation. (Class II).

Impact GEO-6: Soils incapable of supporting septic system.

The power line portion of the proposed Project does not include any restrooms or other wastewater disposal facilities; therefore, there would be no impact related to soils incapable of supporting a septic system.

Impact GEO-7: Encountering contaminated soils during construction.

The power line route would cross in or near known "legacy fill area"; therefore, unknown contamination or contaminated soil could exist along the power line route. However, there would be some flexibility in siting transmission structures to avoid areas of contamination. Furthermore, **implementation of MM GEO-2, unknown contaminated soils, would reduce the potential impact of discovering unknown contaminated soil to less than significant with mitigation (Class II).**

4.6.4.3 Natural Gas Pipeline Construction and Operation

Impact GEO-1: Seismically induced ground shaking, Project induced ground shaking, or seismically induced slope failure could cause damage to Project structures or result in injury or death to people.

The East Cat Canyon natural gas pipeline route is located in an area where strong ground shaking should be expected in the event of a large earthquake on any of the major faults in the region or on the faults near the proposed Project, with and estimated PGA ranging from 0.5 g to 0.6 g for a two percent probability of exceedance in 50 years. Strong ground shaking could cause shearing, differential settlement, or heave of gas line connections at the ground surface causing cracking, weakening, or collapse of these connections. The natural gas pipeline route traverses along and parallel to graded roads that traverses across gentle slopes of the Solomon Hills and flat to gentle slopes along the southern edge of the Santa Maria Valley. There would be a less than significant impact related to seismically induced landslides for the natural gas pipeline due to the gentle topography crossed by the pipeline and the placement of the natural gas pipeline underground in and along graded roads. **Impact GEO-1 would be less than significant (Class III) given implementation of regulatory requirements during design and construction.**

Impact GEO-2: Project induced seismicity or subsidence could cause damage to structures or result in injury or death to people.

Natural gas pipeline construction and operation would not require extensive withdrawals or injection of groundwater or oil/water emulsion; therefore, Impact GEO-2 is not applicable.

Impact GEO-3: Slope failures, such as landslides, could be triggered by Project construction.

As noted in Impact GEO-1, the natural gas line crosses gently sloping hills that have low potential for landslides. The natural gas pipeline would be placed underground in and along graded roads that traverse gently sloping to flat topography. However, Padre (Padre, 2017) identified areas of suspected landslide debris and a moderate risk of landslides on the pipeline route along Dominion and Cat Canyon Roads. However, **Impact GEO-3 would be less than significant (Class III) given implementation of regulatory requirements during design and construction.**

Impact GEO-4: Construction and operation of the Project could trigger or accelerate soil erosion.

Excavation for the natural gas pipeline would loosen soils, making them more susceptible to erosion. Numerous soil associations are mapped along the natural gas pipeline route (Figures 4.6-4a/b/c). Erosion susceptibility of soils along the natural gas pipeline route to sheet and rill erosion by water ranges from low to moderate and erosion susceptibility by wind ranges from low to high. As the proposed Project will disturb more than one acre it would be required to obtain a NPDES permit and prepare a project specific Storm Water Pollution Prevention Plan (SWPPP). **Impact GEO-4 would be less than significant (Class III) given implementation of regulatory requirements during construction and operations.**

Impact GEO-5: Expose people or structures to potential risk of loss or injury where expansive or other unsuitable soils are present.

Although most of the soils underlying the proposed Project have low expansive potential, the Botella soils have moderate expansion potential (Table 4.6-1). Corrosion potential of this soil units ranges from low to high for uncoated steel and is low to moderate for corrosion of concrete. Soils excavated from the natural gas pipeline trench would either be reused as backfill, or if deemed to be unsuitable to use as backfill, the excavated material would be disposed offsite at an approved facility, and clean, engineered fill would be imported for backfill. **Implementation of MM GEO-1 and regulatory requirements would reduce the potential that unsuitable soils would cause damage to the natural gas pipeline to less than significant with mitigation. (Class II).**

Impact GEO-6: Soils incapable of supporting septic system.

The natural gas pipeline Project component does not include any restrooms or other wastewater disposal facilities, therefore there would be no impact related to soils incapable of supporting a septic system.

Impact GEO-7: Encountering contaminated soils during construction.

The natural gas pipeline is located within graded roads that pass through undeveloped hills with oil wells dotted throughout, residential areas with scattered commercial businesses, and agricultural land. A review of the SWRCB GeoTracker website reveals no active environmentally contaminated sites or large quantity hazardous material or hazardous waste sites along the alignment; only three case closed leaking underground storage tank sites were noted. Although it is unlikely that contamination exists where the alignment crosses the residential areas, unknown contamination may have occurred in the commercial, agricultural area, and in the areas adjacent to active and abandoned oil fields. However, **implementation of MM GEO-2 (unknown contaminated soils) and regulatory requirements would reduce the potential impact of discovering unknown contaminated soil to less than significant with mitigation (Class II).**

Impact GEO-8: Surface fault rupture could cause damage to Project structures or result in injury or death to people.

The proposed natural gas pipeline does not cross a mapped active or Alquist-Priolo fault; however, the alignment does cross the potentially active Casmalia fault where the pipeline runs along Graciosa Road, approximately ½-mile south of the Highway 1 and Highway 135 interchange. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Fault rupture is damaging to buildings and other structures due to the differential displacement and deformation of the ground surface that occurs from the fault offset. Surface rupture of this fault could damage the natural gas pipeline, causing leaks which would present a hazard to the public. **Implementation of MM GEO-3 would reduce the potential of dam-**

age to the pipe line and injury to the public, resulting in a less than significant impact with mitigation (Class II).

MM GEO-3 **Fault Evaluation Study and Design.** Prior to final Project design, the Applicant shall perform a fault evaluation study to confirm the location of the mapped trace of the potentially active Casmalia fault across the Project route, as shown in Figure 4.6-6, and determine potential fault offsets. Based on the results of the fault evaluation study, appropriate design features shall be incorporated in the pipeline design to mitigate damage due to fault rupture.

PLAN REQUIREMENTS and TIMING: Study results and proposed design solutions to mitigate fault rupture hazards shall be provided to CPUC for review and approval at least 60 days before final County approval of the Project design.

MONITORING: CPUC permit compliance staff and grading and building inspectors shall check plans and conduct periodic site inspections to ensure compliance in the field.

4.6.5 Cumulative Effects

Geologic and soils impacts (such as slope instability and soil erosion) are typically site-specific. The impacts of each past, present, and reasonably foreseeable project would be specific to the respective site and its users and would not be in common with or contribute to (or shared with, in an additive sense) the impacts on other sites. In addition, development of each site would be subject to site development and construction guidelines and standards (local, State, and federal) that are designed to protect public safety. In order to be cumulatively considerable, adverse geologic conditions would have to occur at the same time and in the same location as the same or similar conditions of the proposed Project.

Seismic impacts (such as ground shaking) from the numerous local and regional faults comprise an impact of the geologic environment on individual projects and would not introduce cumulatively considerable impacts. Impacts from unsuitable soils (expansive or corrosive soils) would also represent an impact of the environment on individual projects and would not be cumulatively considerable.

The development of 760 new wells within the Cat Canyon oilfield as a result of the proposed Project, and the ERG and PetroRock projects could contribute to induced seismicity and subsidence. As noted in Sections 4.6.1.5 and 4.6.1.6, research indicates that with balanced well stimulation injection and extraction that the potential for induced seismicity and subsidence is low. As discussed under Impact GEO-2, Aera's proposed production and injection plan would result in a slow decrease in reservoir pressure over time and therefore, Aera's contribution to this cumulative impact is less than significant. However, ERG indicates that their target for stimulation and extraction is the Sisquoc Oil Sands (90,000 barrel per day withdrawal of oil and produced water and injection of 30,00 barrels per day of steam) located 2500 feet below the surface. However, injection of the non-potable produced water (50,000 barrels of produced water per day) is planned for the Monterey Formation at depths of several thousand feet deeper (SCS, 2018). As these two units are separated by 500 or more feet of the Lower Sisquoc confining layer, this does not create balanced well stimulation. However, the compressibility of a reservoir is generally determined by the vertical interval, the amount of pressure drop, how compressible the formation is, and the depth of burial of the reservoir formation. Microscopic analysis of the Sisquoc Oil Sands from which ERG produces, suggest that these rocks are primarily grain supported and more component (i.e., when the fluid is removed, the sand grains will support the formation from collapsing (ERG, 2018). In addition, the Sisquoc Oil Sands are 2,500 to 3,000 feet below the surface, capped with the impermeable geologic seal of rock approximately 1,500 feet thick formed by the Foxen and Upper Sisquoc formations. Further, there is no evidence in the record

to suggest that after approximately 30 years, these practices have led to either induced seismicity or subsidence in the Cat Canyon field. **Impacts related to cumulative cyclic well stimulation and waste water injection to trigger induced seismicity and subsidence would be less than significant (Class III).**

4.6.6 Mitigation Monitoring Program

Table 4.6-4. Mitigation Monitoring and Reporting Plan

MM #	MM Title	Monitoring/ Reporting Action	Timing & Method of Verification	Agency or County Responsibilities	Applicant Responsibilities
Geology Processes/Geologic Hazards					
GEO-1	Soils Engineering Study	Submit a soils engineering study addressing structure sites and access roads to determine structural design criteria.	Study review and approval prior to County Zoning Clearance. Monitor implementation during construction.	County reviews and approves the Soils Engineering Study, and implementation of required design requirements.	Prepare Soils Engineering Study to identify expansive and corrosive soils that would be in contact with Project features. Implement any required design requirements for expansive or corrosive soils in the final project design.
GEO-2	Unknown Contaminated Soils	Observe soils in Project disturbance areas excavated materials for soil contamination. Sample and test suspected contaminated soil. Submit Remediation Plan if contaminated soils are encountered.	P&D and local CUPA to be notified immediately of contaminated soils. Review of Remediation Plan and its implementation.	County shall review and approve Remediation Plan and monitor its implementation.	Conduct visual assessment of Project disturbance areas soils and excavated materials for unknown contamination. If contaminated soils are encountered, stop work and prepare Remediation Plan for County review and approval. Implement Remediation Plan requirements.
GEO-3	Fault Evaluation Study and Design.	Perform fault evaluation study for natural gas pipeline and submit study results and design modifications to withstand fault rupture, as necessary.	Submit Study results and proposed design solutions to County for review and approval at least 60 days before final Project design	County shall review and approve Fault Study and design modifications, and monitor its implementation	Conduct fault evaluation study and provide fault rupture design solutions for the natural gas pipeline final design plan. Implement any required design requirements for fault rupture across the natural gas pipeline in the final Project design