DOCKETED

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5.4 Geological Hazards and Resources

This section provides an evaluation of the Advanced Compressed Air Energy Storage (A-CAES) Center at the Pecho Energy Storage Center (PESC) in terms of potential exposure to geological hazards and potential to affect geologic resources of commercial, recreational, or scientific value. The information presented in the following sections is based on readily available online information and is limited to surficial soils only. Construction of the PESC project will involve the construction of various surface facilities (i.e., buildings, air processing facility, compressors, turbines, etc.), the excavation of deep vertical shafts on the order of 2,000 feet deep below the existing ground surface, the excavation of an underground cavern, and the construction and filling of a hydrostatic compensation surface reservoir. A site-specific geotechnical exploration has not been performed at the project site to characterize the site-specific surface and subsurface conditions.

5.4.1 Affected Environment

The PESC facility is located in unincorporated territory just outside of Morro Bay in San Luis Obispo County, California. The land use surrounding the project site includes residential and open area zoning. The Cabrillo Highway (CA 1) runs adjacent to the northern edge of site and Morro Bay State Park is located approximately 0.2 miles southwest. The western edge of site is bordered by the San Bernardo Creek, and the San Luisito Creek is located along the eastern boundary of the site. Chorro Creek runs east-west through the center of the project site.

5.4.1.1 Regional Geology

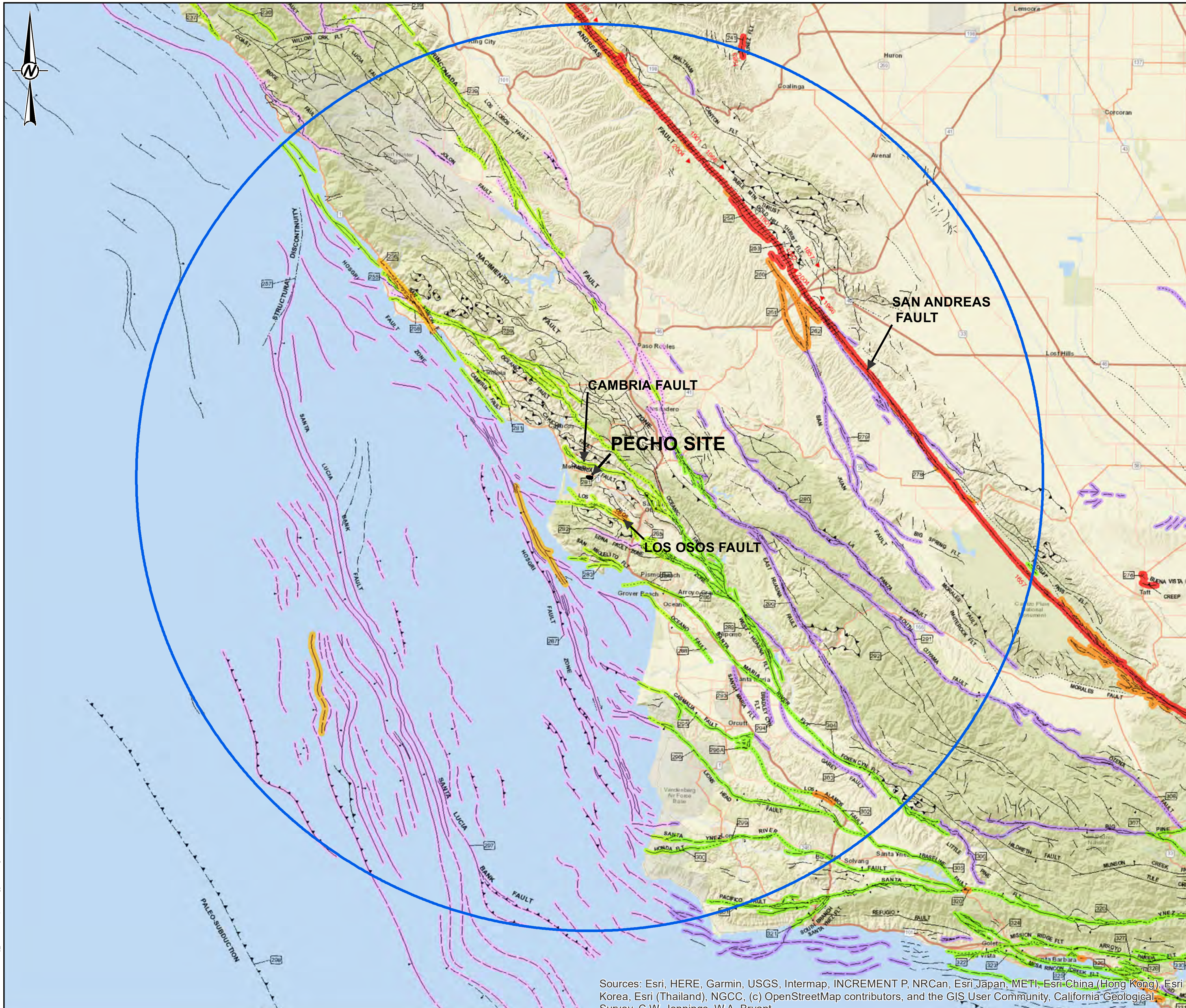
The PESC project site is located 3 miles inland from Morro Bay within the Coast Ranges geomorphic province of California (California Geological Survey (CGS) 2002). The Coast Ranges are northwest-trending mountain ranges and valleys that run along the west coast of California and subparallel to the San Andreas Fault. The project site is located within the Morro Bay South 7.5-minute Quadrangle. This quadrangle is underlain by a wide age range of deposits. Areas along the coast are mostly of Quaternary age and include both alluvial and eolian deposits of the Holocene to late Pleistocene eras. The mountainous regions located east of the bay are comprised of many different types of metamorphic and volcanic formations of Cretaceous and Tertiary origin (CGS 2009a).

5.4.1.1.1 Faulting and Seismicity

The CGS Fault Activity Map web application was used to identify major fault zones, including, but not limited to, as the Cambria, Los Osos, and San Andreas Faults, within 62 miles of the site (CGS 2016a). The State of California defines an active fault as one that has ruptured in the last 11,700 years. Potentially active faults are those with evidence of movement within the last 1.8 million years.

The potentially active Cambria Fault is approximately 1.5 miles north of the site. The potentially active Los Osos Fault is approximately 5 miles southeast of the PESC project site. The active San Andreas Fault Zone is approximately 40 miles northeast of the PESC project site. This fault is very active and has generated major earthquakes. Figure 5.4-1 shows the faults identified within a 62-mile radius of the PESC facility.

The CGS Data Viewer application was also used to determine the epicenter locations of historic earthquakes around California (CGS 2017b). The program shows known magnitude 5.0 or greater earthquakes occurring from 1769 through 2015. The closest identified earthquake to the site had a magnitude of 5.0 to 6.0 and occurred approximately 6 miles from the site. Two magnitude 7.0 or higher earthquakes have occurred within 62 miles of the project location at the Santa Lucia Bank (offshore) San Andreas fault zones.



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community, California Geological Survey, C.W. Jennings, W.A. Bryant

LEGEND

Pre-Quaternary Faults
- <all other values>
- fault, certain
- fault, approx. located
- fault, concealed
- thrust fault, certain
- thrust fault, approx. located
- thrust fault, approx. located, queried
- fault, certain (ball and bar)
- fault, approx. located (ball and bar)
- fault, concealed (ball and bar)

Quaternary Faults
- fault, certain
- fault, approx. located
- fault, approx. located, queried
- fault, inferred, queried
- fault, concealed
- fault, concealed, queried
- thrust fault, certain
- thrust fault, approx. located
- thrust fault, concealed
- dextral fault, certain
- dextral fault, approx. located
- dextral fault, concealed
- sinistral fault, certain
- sinistral fault, approx. located
- sinistral fault, concealed
- thrust fault, certain (2)
- thrust fault, approx. located (2)
- thrust fault, concealed (2)
- fault, certain (ball and bar)
- fault, approx. located (ball and bar)
- fault, concealed (ball and bar)
- dextral fault, certain (ball and bar)
- fault, concealed, queried (ball and bar)
- fault, concealed, queried (ball and bar, 2)
- fault,certain (dip)
- fault, approx. located (dip)
- fault, concealed (dip)
- reverse fault, certain
- reverse fault, approx. located
- reverse fault, concealed

- PECHO SITE
- 62 MILES RADIUS

Fault Classification (Regional)

Activity
- Historic
- Holocene
- Late Quaternary
- Quaternary

NOTES

SOURCE DATA: HTTPS://MAPS.CONSERVATION.CA.GOV/

1:850,000
0 10 20 Miles

REFERENCE

COORDINATE SYSTEM: NAD 1983 STATEPLANE CALIFORNIA V FIPS 0405 FEET

CLIENT
HYDROSTOR INC.

PROJECT
PECHO ENERGY STORAGE CENTER

TITLE
FAULT MAP

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-24
PREPARED	MR
DESIGN	MR
REVIEW	JB
APPROVED	RPCE

PROJECT No.	CONTROL	Rev.	FIGURE
21465954	---	---	5.4-1

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Path: G:\GIS\Sites\MorroBay_Rosamond\Maps\Geology\Pecho\Figure5.4-1-FaultMap.mxd

5.4.1.2 Local Geology and Stratigraphy

According to the Geologic Map of the Morro Bay North and South 7.5’ Quadrangles, shown in Figure 5.4-2, the site is underlain mostly by young alluvial flood-plain deposits of the Holocene to late Pleistocene eras (CGS 2009a, 2016b). These alluvial deposits are mostly unconsolidated and consists of sand, silt, and clay-bearing alluvium on the floodplains and along the valley floors. The southern section of site along the mountain face includes metavolcanic and mélange rocks of the Franciscan Complex. The metavolcanic rocks are commonly encountered as deeply weathered greenstone, derived from a basaltic parent rock. The Morro Rock – Islay Hill volcanic intrusive complex is also common in this area of the site, which forms as lava domes in distinctive peaks between Morro Bay and San Luis Obispo. The mélange rock unit is primarily derived from crushed metasandstone, blueschist, greenstone, graywacke and chert. The geologic map also indicates highly fragmented to largely coherent landslide deposits throughout the Franciscan Complex mélange and occurring south and east of the site.

5.4.1.3 Seismic Setting

The tectonic setting of Southern to Central California is complex and is made up of numerous fault systems, including strike-slip, oblique, thrust, and blind thrust faults. Therefore, any specific area is subject to seismic hazards of varying degree, dependent on the proximity to and length of nearby active and potentially active faults and the local geologic and topographic conditions. Seismic hazards include primary hazards such as seismic shaking and ground rupture along the fault trace, and secondary hazards resulting from strong ground shaking such as liquefaction and lateral spreading. The PESC project site area can be characterized as an active seismic area, with the potential for large-magnitude earthquakes to occur.

5.4.1.4 Potential Geological Hazards

The following subsections present the potential geological hazards that may occur within the project area.

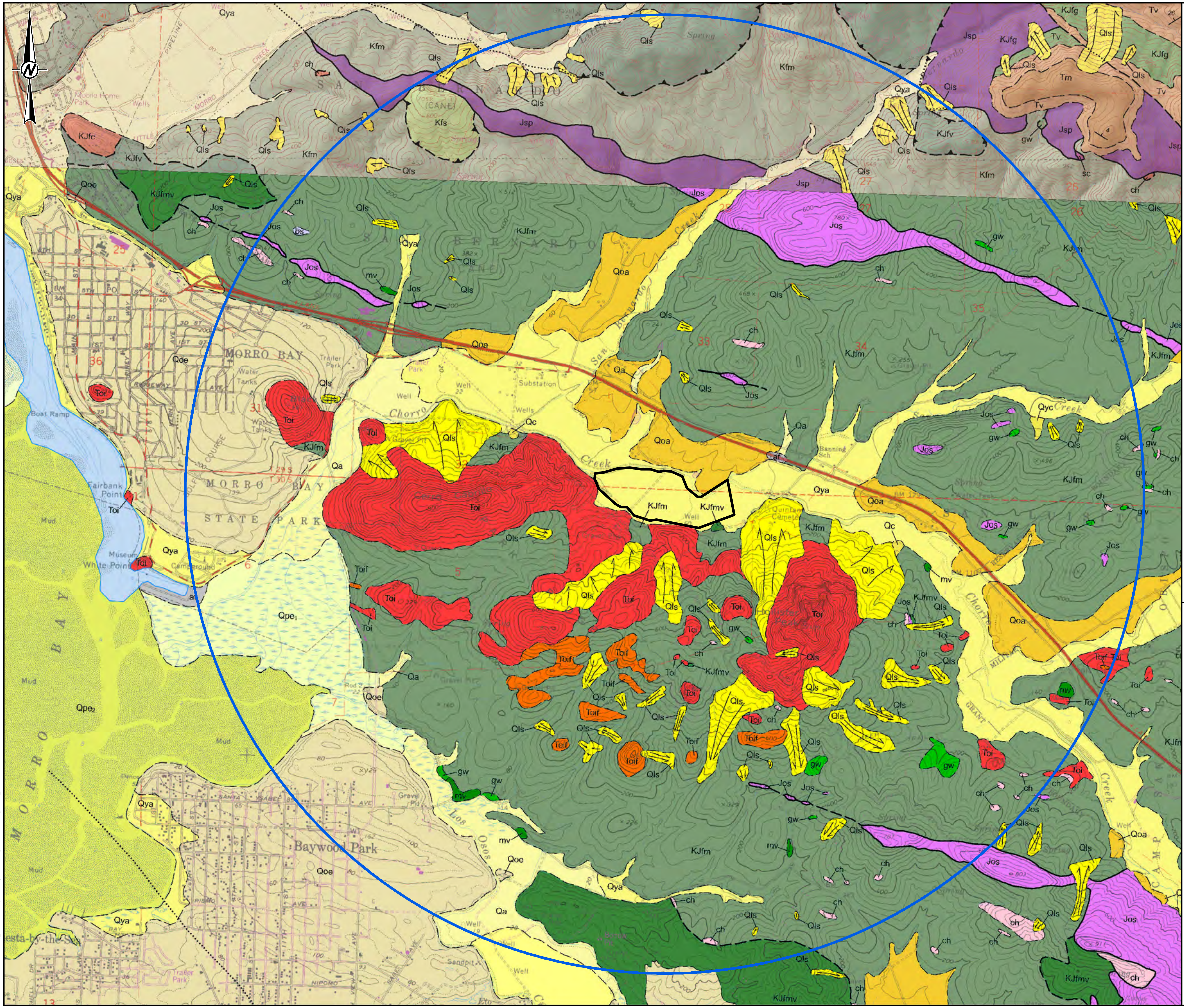
5.4.1.4.1 Ground Rupture

The CGS Seismic Hazards Program web application was used to determine the site’s proximity to any known Alquist-Priolo Earthquake Fault Zones (CGS 2017a). Alquist-Priolo fault zones are regulatory zones that encompass the minimum distance for human occupancy from active faults that have the potential for surface rupture. No structures designed for human occupancy can be placed over the fault or within 50 feet in any direction. According to the CGS Fault Activity Map, the site is not bisected by any known active or potentially active faults and the Alquist-Priolo web application shows that the site is spaced approximately 5 miles away from the nearest identified Alquist-Priolo fault zone, located at the Los Osos fault zone to the southeast.

The likelihood for a ground rupture to occur at the PESC project site is considered low and its corresponding impacts are less than significant.

5.4.1.4.2 Seismic Shaking

Due to the site’s proximity to surrounding fault zones, the site may experience strong ground motions in the event of an earthquake. The CGS Earthquake Shaking Potential Map web application categorizes areas based on their expected intermediate period ground motions with a 2 percent exceedance probability in 50 years (CGS 2017c). This application incorporates anticipated amplification of ground motions by local soil conditions and places the earthquake shaking potentials in a qualitative ranking system from highest to lowest potential. The PESC project site is ranked by the web application as having medium to low shaking potential.



LEGEND

PECHO SITE

2 MILE RADIUS

af	**Artificial fill (late Holocene)** – Deposits resulting from human construction, including engineered and non-engineered fill. Not mapped in some areas.
Qa	**Alluvial flood-plain deposits (late Holocene)** - Active and recently active flood-plain deposits. Consists of unconsolidated sandy, silty and clay-bearing alluvium.
Qpe_{1-2}	**Paralic estuarine deposits (late Holocene)** – Unconsolidated estuarine deposits composed of fine-grained sand and clay. Divided into:
Qpe_1	**Salt marsh deposits** – Unconsolidated sand and clay underlying salt marshes at mouth of Chorro Creek and Los Osos Creek.
Qpe_2	**Tidal flat deposits** – Unconsolidated sand and clay underlying tidal flats of Morro Bay
Qls	**Landslide deposits, undivided (Holocene and Pleistocene)** – Highly fragmented to largely coherent landslide deposits. Many of the landslides occur in Franciscan mélange. A large block slide in Pismo Formation siltstone is present along the axis of the Pismo syncline near the mouth of Islay Creek.
Qya	**Young alluvial flood-plain deposits, undivided (Holocene to late Pleistocene)** – Unconsolidated sand, silt, and clay-bearing alluvium deposited on flood-plains and along valley floors. Locally divided by relative age (2 = youngest, 1 = oldest):
Qyc	**Young colluvial deposits (Holocene to late Peistocene)** – Poorly sorted sandy and silty slope wash deposits.
Qoa	**Old alluvial flood-plain deposits (late to middle Pleistocene)** – Fluvial sediments preserved above active flood plains and channels. These deposits are moderately consolidated, slightly dissected and capped by moderate to well-developed pedogenic soils. Consists of gravel, sand, silt, and clay-bearing alluvium.
Qoe	**Old eolian deposits (late to middle Pleistocene)** – Old stabilized sand dune deposits consisting of moderately consolidated, well-sorted brown windblown sand. Deposits are capped by moderately well-developed pedogenic soil. Dissected by Los Osos Creek.
KJfm (bs, ch, gw, mv); Klm	**Mélange** – Chaotic mixture of fragmented rock masses embedded in a penetratively sheared matrix of argillite and crushed metasandstone. Individual rock masses contained in the matrix range from less than a meter to kilometers in scale. Blocks large enough to be shown on the map include high grade blueschist (bs), greenstone (mv), graywacke (gw) and chert (ch). Penetrative deformation of matrix postdates metamorphism of enclosed rock masses.
KJfmv; KJfv	**Metavolcanic rocks** – Primarily greenstone, metamorphosed from basalt. Includes massive to pillowed basalt flows, breccia, tuff, and diabase. Commonly deeply weathered.
Kfs	**Sandstone of Cambria (Late Cretaceous)** – Light gray, fine- to coarse-grained, medium-bedded arkose and arkosic wacke interbedded with brown to black micaceous siltstone. Unit is more coherent and less sheared and fractured than other Franciscan units. Contains Late Cretaceous foraminifera and pollen.
Jos; Jsp	**Serpentinized ultramafic rocks** – Peridotite, dunite, and harzburgite, pervasively sheared and metamorphosed to sepentinite. Occur as lenticular fault-bounded bodies in Franciscan mélange. Considered to be dismembered bodies of the Coast Range Ophiolite tectonically interleaved with mélange during subduction. Locally, hydrothermally altered to silica-carbonate rock.
Toi / Toif	**Morro Rock – Islay Hill volcanic intrusive complex (Oligocene)** – **Toi** - Porphyritic dacite. Approximately 50% of rock consists of phenocrysts with a typical composition of 65% andesine; 15% biotite and clay; 10% hornblende; 5% quartz; and 5% magnetite, apatite and zeolites. Groundmass consists of altered plagioclase, biotite, glass, quartz and hornblende (Hall, 1973). These rocks are exposed in a series of volcanic plugs and lava domes that form distinctive peaks between Morro Bay and San Luis Obispo. Flow banding is common. Radiometric ages range from 27 to 23 Ma (Stanley and others, 2000). **Toif** – Fine-grained dacite flow facies. Phenocrysts are absent or rare. Flow banding common.

NOTES

- FIGURE IS BASED ON TWO DIFFERENT GEOLOGIC QUADRANGLES. EXTENTS OF QUADRANGLES ARE APPROXIMATE
- SOURCE DATA:
https://www.conservation.ca.gov/cgs/maps-data/rgm/preliminary

0 1:30,000 1
Miles

REFERENCE

COORDINATE SYSTEM: NAD 1983 STATEPLANE CALIFORNIA V FIPS 0405 FEET

CLIENT
HYDROSTOR INC.

PROJECT
PECHO ENERGY STORAGE CENTER

TITLE
GEOLOGIC MAP OF THE MORRO BAY NORTH AND SOUTH QUADRANGLES

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-25
PREPARED	MR
DESIGN	MR
REVIEW	JB
APPROVED	RPCE

PROJECT No.	CONTROL	Rev.	FIGURE
21465954	---	---	5.4-2

Site-specific hazard analyses (SHA) have not been performed for the site. However, a cursory assessment using the USGS Unified Hazard Tool (USGS 2014), assuming a 2475 return period and Site Class B (rock) conditions, indicates a peak ground acceleration (PGA) of 0.36g (where g represents acceleration due to gravity) and mean earthquake magnitude of 6.8.

A site-specific probabilistic and deterministic seismic hazard analysis for the project site will be completed to determine the magnitude and duration of seismic shaking and related impacts. Seismic shaking impacts can be mitigated to less than significant if an appropriate SHA is conducted, and the site facilities are designed to withstand seismic ground motions in compliance with applicable seismic design codes (i.e., Section 1613 of the California Building Code (CBSC 2019), Chapter 20 of the American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures (ASCE 2016)).

Furthermore, advancement of the project is contingent on sound bedrock that is seismically stable at the depth of the underground cavern.

5.4.1.4.3 Liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of a typically loose, cohesionless (i.e., sand), saturated soil is reduced by earthquake shaking or other rapid loading. Soil maps from the Natural Resource Conservation Service (NRCS) identify three surficial soil units within the project site: Marimel sandy clay loam, Marimel silty clay loam, and Salinas silty clay loam (NRCS 2021). Section 5.11, Soils describes these in greater detail but, to summarize, these units each consist of varying amounts of sand, silt, and clay. Based on the NRCS Soil Texture Triangle, these units may consist of 35 percent to 40 percent. While liquefaction susceptibility generally decreases with increasing clay content, the NRCS data is limited and cannot be solely relied on to determine liquefaction susceptibility.

Liquefaction is also a function of the presence of groundwater. As described in Section 5.11.1.5.3, shallow groundwater is expected at the PESC project site; it is considered likely that groundwater is within the alluvium.

The California Geological Service (CGS) Seismic Hazards Program: Liquefaction Zones map (CGS 2017) was reviewed and shows that mapping has not been performed within the PESC project area. This does not preclude the possibility of liquefaction potential within the project area.

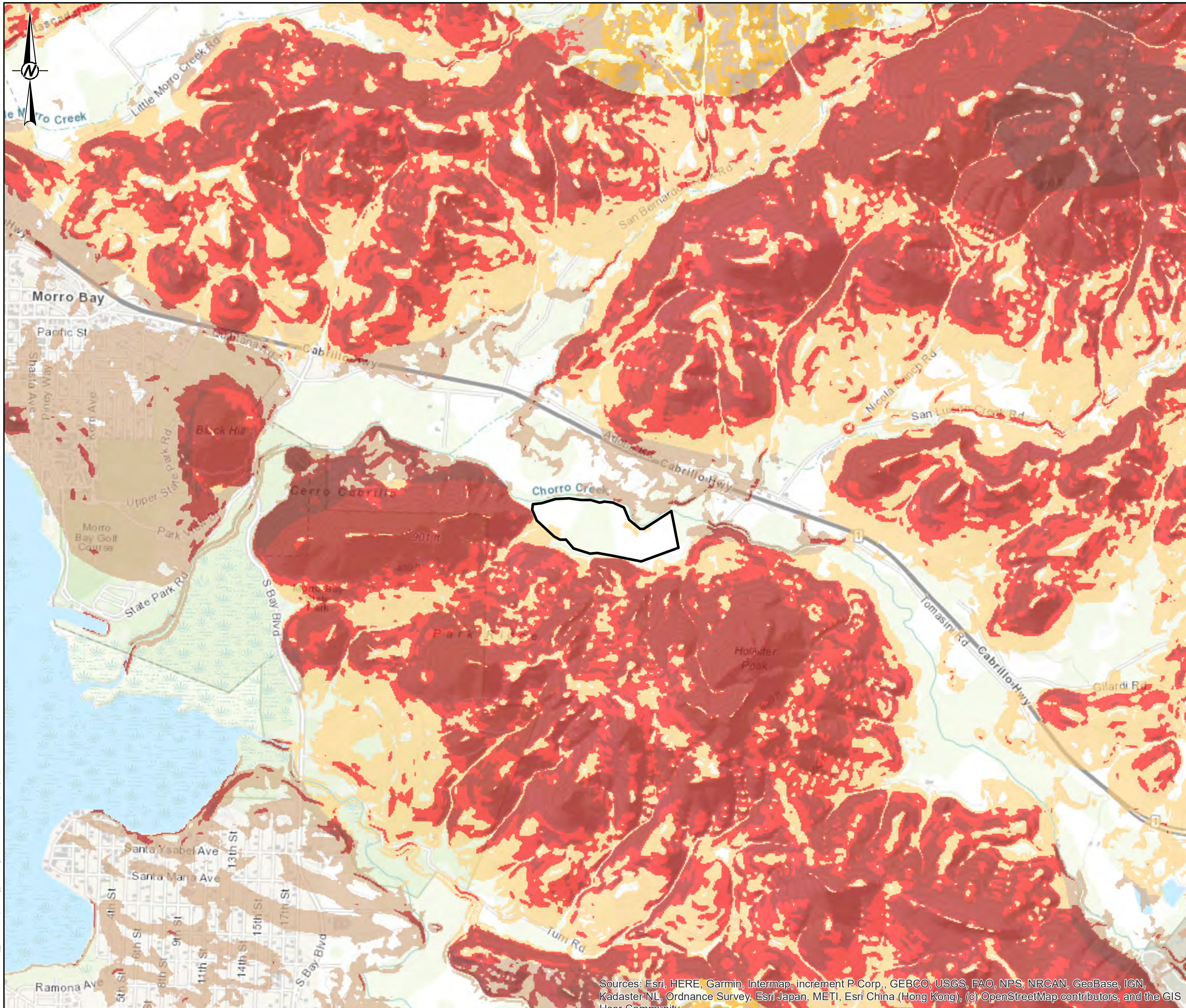
At the time this was prepared, there was not any site-specific subsurface information available to evaluate the likelihood and risk of liquefaction to occur, which may impact the construction and operation of the PESC project. However, the potential impacts and geologic hazards associated with liquefaction can be mitigated to less than significant by performing a site-specific geotechnical exploration and implementing recommendations to mitigate liquefaction, if applicable.

As stated in Section 5.4.1.4.3, advancement of the project is contingent on sound bedrock that is seismically stable at the depth of the underground cavern. Therefore, the potential impacts and geologic hazards associated with liquefaction are applicable to the surficial structures, but not applicable to the underground cavern.

5.4.1.4.4 Mass Wasting

The potential for mass wasting (landsliding) to occur depends on a variety of factors including, but not limited to, the steepness of the slope, geology, and soil moisture.

The CGS Deep-Seated Landslide Susceptibility Map web application estimates an area's susceptibility to mass wasting events based on the location of past landslides, the location and relative strength of rock units, and steepness of surrounding slopes (CGS 2018). Landslide susceptibility is characterized by the use of classes, zero (0) through ten (X), class X having the highest landslide potential. A vast majority of the site is relatively flat and defined as class 0, except for two limited areas identified as class V. This indicates a negligible to moderate susceptibility to the propagation of landslides from within the site boundary. Figure 5.4-3 shows the CGS Deep-Seated Landslide Susceptibility at the PESC project site.



LEGEND

PECHO SITE

HATCHING IS RELIC OF BASE MAP, NOT A LANDSLIDE CLASS

CLASS

- 0
- III
- V
- VI
- VII
- VIII
- IX
- X

NOTES

SOURCE DATA: HTTPS://MAPS.CONSERVATION.CA.GOV/

1:29,000

0 — 1 Miles

REFERENCE

COORDINATE SYSTEM: NAD 1983 STATEPLANE CALIFORNIA V FIPS 0405 FEET

CLIENT
HYDROSTOR INC.

PROJECT
PECHO ENERGY STORAGE CENTER

TITLE
LANDSLIDE SUSCEPTIBILITY MAP

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-24
PREPARED	MR
DESIGN	MR
REVIEW	JB
APPROVED	RPCE

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21465954	---	---	5.4-3

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As noted, Figure 5.4-2 identifies multiple areas surrounding the PESC project site boundary with surficial landslide deposits These landslide deposits were identified on the mountain slope face to the south of site and are mapped outside of the PESC project boundary.

Potential impacts related to mass wasting can be mitigated by completing a site-specific geotechnical exploration and implementing geotechnical recommendations.

5.4.1.4.5 Subsidence

Subsidence occurs as the gradual settling of the ground surface over time due to underground material movement. Subsidence is most often caused by the removal of groundwater through pumping activities, fracking activities for oil extraction, or the mining of other mineral resources. Soil compaction, sinkhole formation, and earthquakes can also cause subsidence to occur.

Construction of the PESC project will involve filling the hydrostatic compensation surface reservoir. Filling is expected to use a combination of onsite groundwater production, collected precipitation, and possible off-site water suppliers. Operation of the PESC is expected to use an onsite groundwater well to control the reservoir level. Groundwater withdrawal typically causes uniform subsidence, which is less problematic than differential subsidence. The thickness of the young alluvial deposits likely varies within the PESC project footprint and would subsequently play a role in the subsidence that is expected to occur. A site-specific geotechnical exploration will verify subsurface conditions at the PESC project site and, if necessary, control measure will be implemented to control groundwater drawdown to reduce the potential for subsidence at the project site to less than significant. Section 5.15, Water Resources, provides additional information on water sourcing.

5.4.1.4.6 Expansive Soils

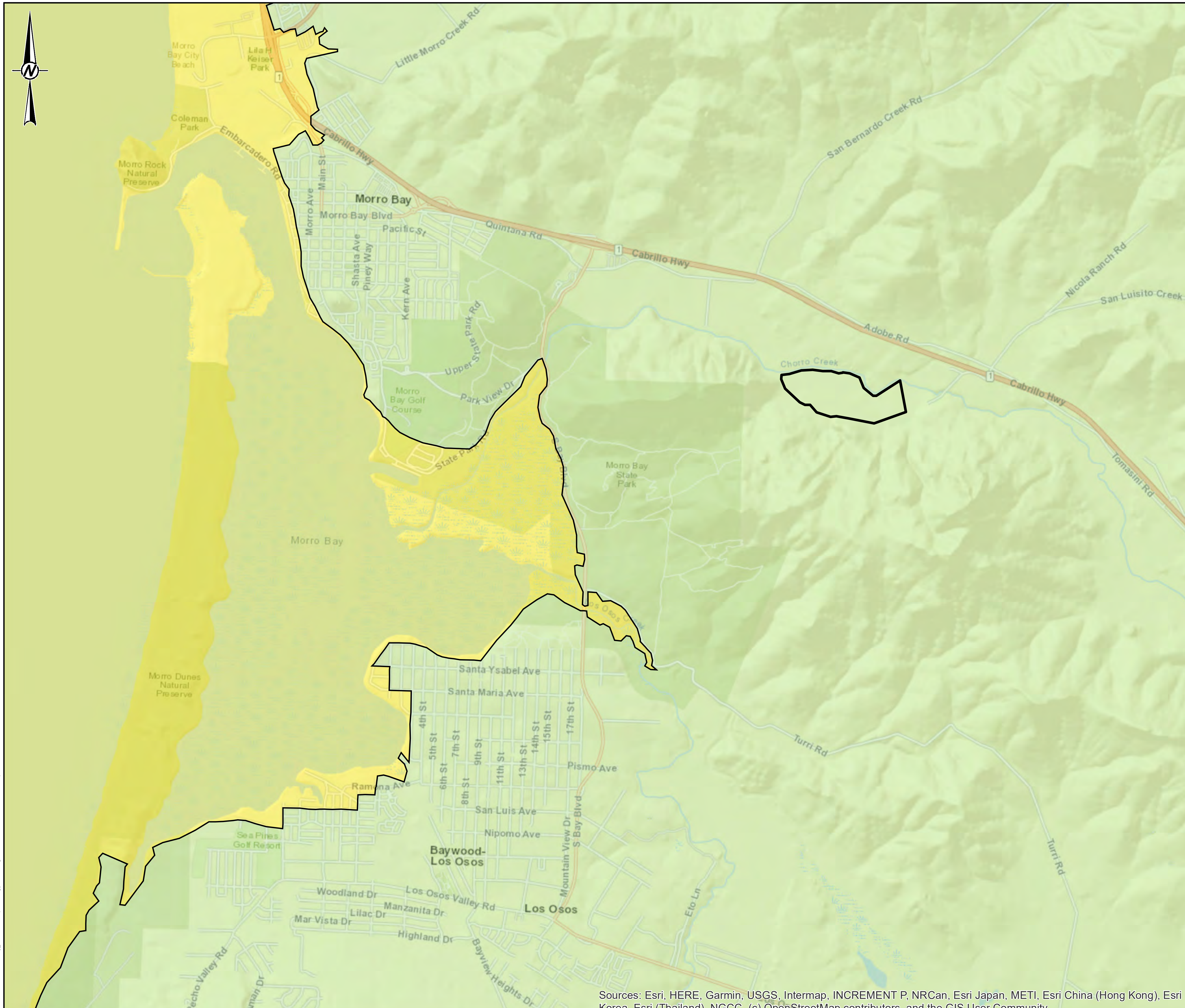
Expansive soils have the potential to shrink and swell with variations in saturation, which could cause ground instability in the form of differential settlement.

Information gathered from the NRCS Web Soil Survey, cross-referenced with the NRCS Soil Texture Triangle, suggests that the Marimel sandy clay loam possibly contains up to 35 percent clay, and the Marimel and Salinas silty clay loams possibly contain up to 40 percent clay content. These three soil units may have at least a moderate shrink-swell potential. Actual expansive soil susceptibility will depend on the actual characteristics of the materials on site. For the PESC project and its features, the presence of expansive soils would only be a possible concern to buildings and foundations. A site-specific geotechnical exploration has not been conducted to confirm the presence of expansive soils. Section 5.11, Soils, provides additional information on expansive soils. The possible presence of expansive soils can be mitigated to less than significant through the use of soil amendments or by removal and replacement with non-expansive soils, or by designing buildings and foundations to withstand the expansive soil.

5.4.1.4.7 Tsunamis and Seiches

Tsunamis are large ocean waves that are seismically induced and often the result of offshore earthquakes or landslides. According to the CGS Tsunami Hazard Area Map web application, the site is located approximately 2 miles outside the identified tsunami hazard area (CGS 2009b). This is shown in Figure 5.4-4. Therefore, the potential for the site to be affected by a tsunami is low to negligible.

Seiches are waves and oscillations within confined bodies of water that can be caused by meteorological effects (i.e., wind or variations in atmospheric pressure) or seismically induced by ground shaking. There are no large, confined bodies of water immediately adjacent to or uphill of the site, and therefore the potential for a seiche to impact the project site is negligible. The planned compensation reservoir for site operations will be designed to be



LEGEND

- PECHO SITE
- CA TSUNAMI HAZARD
- NO, OUTSIDE HAZARD AREA
- YES, TSUNAMI HAZARD AREA

NOTES

SOURCE DATA: HTTPS://MAPS.CONSERVATION.CA.GOV/

1:34,000

0 1 Miles

REFERENCE

COORDINATE SYSTEM: NAD 1983 STATEPLANE CALIFORNIA V FIPS 0405 FEET

CLIENT
HYDROSTOR INC.

PROJECT
PECHO ENERGY STORAGE CENTER

TITLE
TSUNAMI HAZARD AREA MAP

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-24
PREPARED	MR
DESIGN	MR
REVIEW	JB
APPROVED	RPCE

PROJECT No.	CONTROL	Rev.	FIGURE
21465954	---	---	5.4-4

seismically stable and with adequate freeboard to mitigate overtopping and loss of containment, including from possible seiches. Section 5.15, Water Resources, provides additional information regarding the on-site compensation reservoir.

5.4.1.4.8 Permanent Slopes and Embankments

Construction of the PESC project includes permanent embankments for the hydrostatic compensation surface reservoir. The embankment, and any other permanent slopes, will be analyzed for slope stability and designed to achieve appropriate minimum factors of safety for both static and seismic conditions. Additionally, the hydrostatic compensation surface reservoir may be considered a jurisdictional dam, which would be regulated by the Division of Safety of Dams (DSOD) during its construction and operation. Refer to Section 5.15, Water Resources, for additional information on the compensation reservoir and DSOD requirements.

5.4.1.4.9 Collapse of Below Grade Features

Construction of the proposed PESC includes the excavation of deep vertical shafts and an underground cavern. The collapse of either, or both, of these below grade features may result in surface settlement and subsidence. The potential impacts related to the possible collapse of these features may not be significant depending on their design (i.e., depths, extents, etc.) and the site-specific subsurface conditions present at the proposed project site. However, if necessary, potential impacts can be mitigated to less than significant by completing a site-specific geotechnical exploration and properly designing and constructing (i.e., rock bolts, lined shaft, etc.) as warranted based on the subsurface conditions.

Additionally, below grade features will be properly closed, as described in Section 2.0, Project Description.

5.4.1.4.10 Anthropologically Induced Seismicity

It is possible for anthropologically induced seismicity to occur when manmade activities impose additional strain on underlying rock masses below the existing ground surface, in particular along active faults. Possible triggering mechanisms of this phenomenon for the proposed PESC are reservoir induced seismicity (RIS) and compressed air at depth.

5.4.1.4.10.1 Reservoir Induced Seismicity

RIS can be triggered by rising water levels through one of the two following mechanisms (Dojchinovski 2012):

- The adaptation of the foundation rock to changes in stress due to the weight of water
- Reservoir seepage that reaches active faults located underneath or adjacent to the reservoir

Potential impacts associated with the first mechanism, if any depending on the site-specific subsurface conditions (i.e., if cavities, voids, or potentially open discontinuities are present), can be mitigated to less than significant. This mechanism tends to result in small magnitude events that would be less than the design earthquake that is selected per the outcome of the seismic hazard analysis and used for the design of the PESC.

Potential impacts associated with the second mechanism are considered less than significant because all four of the following conditions must exist for this to be a concern:

- The reservoir needs to be deep to very deep, defined as 263 to greater than 492 feet (USGS 1996)
- Seismogenic structures (i.e., faults) are present in or near the reservoir
- The seismogenic structure is active and therefore is likely close to the failure point prior to filling the reservoir

- The existence of hydrological conditions for infiltration of water from the reservoir to deep layers of the rock mass

At a minimum, the proposed reservoir is shallow (less than 50 feet deep) and there are no known active seismogenic structures near the project site.

5.4.1.4.10.2 Compressed Air Induced Seismicity

Potential impacts related to compressed air or water induced seismicity would be considered credible if the vertical shafts and/or underground cavern intersected an active fault. Because there are no known active faults near the proposed project site, the potential impacts are considered to be less than significant.

Hydraulic fracturing rock for oil and gas exploration, and deep wastewater injection wells, have occasionally caused seismic events. These types of projects differ fundamentally from the PESC project in that they intentionally fracture rock under pressures of 9,000 psi or more and/or involve the permanent disposal of significant volumes of liquids. In contrast, the successful performance of the PESC project depends on the surrounding rock remaining intact during operation (i.e., not fracturing) in order to retain air and water, which will be addressed during the design of the project. In addition, operating pressures for the GPESC project are expected to be 1,000 psi or less, which are considerably lower than that for hydraulic fracturing and most deep injection wells.

5.4.1.5 Geologic Resources of Recreational, Commercial, or Scientific Value

The geology in the project area mostly includes young alluvial deposits and metamorphic rocks with volcanic inclusions. These formations are not unique in terms of recreational or scientific value, and they occur throughout the Morro Bay area. An Economic Geology map for the San Luis quadrangle was published by the U.S. Geological Survey (USGS) in 1903 (USGS 1903). This map, included as Figure 5.4-5 recognizes the Franciscan complex metasandstones and metamorphic schists as part of the San Luis formation. This San Luis formation is shown to include jasper lentils throughout the Morro Bay region. The USGS identifies these lentils as possibly commercially valuable for road construction. However, only portions of the project site are within this jasper bearing unit, and given the extensiveness of this unit, the PESC project footprint will have less than a significant impact on its supply. Potential impacts on this commercially valuable unit are less than significant.

Additionally, the California Department of Conservation (CDOC) Division of Mines and Geology published a mineral land classification map for the Morro Bay South Quadrangle in 1989 (CDOC 1989). This mineral land classification map, included as Figure 5.4-6 evaluates areas based on presence of aggregate resources and other mineral commodities. The project location is categorized as Mineral Resource Zone (MRZ) 3, which is defined as an area possibly containing mineral deposits, but the significance of which cannot be evaluated from available data. If aggregate quality rock is within the PESC project footprint, then the excavation of the deep vertical shafts and/or underground caverns would generate aggregate rock that, otherwise, likely would not have been economically or commercially viable.

Potential impacts to geologic resources of recreational, commercial, or scientific value are considered less than significant.

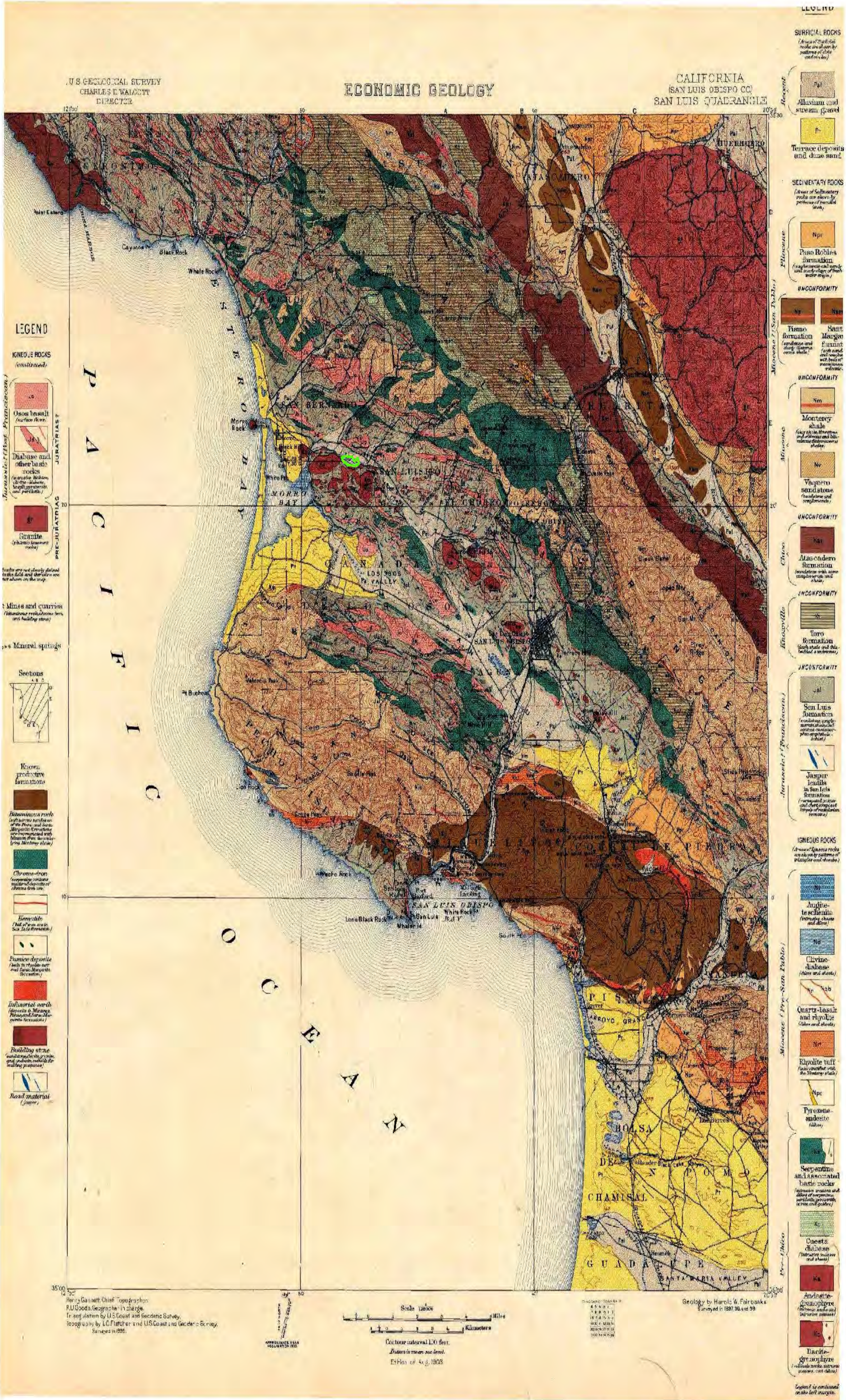


Figure 5.4-5 Economic Geology of Pecho Energy Storage Center
Pecho Energy Storage Center

CALIFORNIA DEPARTMENT OF CONSERVATION
Division of Mines and Geology
DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST
STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR
MORRO BAY SOUTH QUADRANGLE
SPECIAL REPORT 162
PLATE II
MRZ-3
MRZ-1
MRZ-1
MRZ-1
MRZ-3
MRZ-3
MRZ-1
MRZ-3
MRZ-1
MRZ-3
MRZ-1
TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000
CONTOUR INTERVAL 40 FEET
MORRO BAY SOUTH, CALIF.
EXPLANATION
DRILL HOLE
PRODUCTION-CONSUMPTION REGION BOUNDARY AND OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of Planning and Research, local government, and other sources.
MINERAL RESOURCE ZONE BOUNDARIES
All Mineral Resource Zones are for Portland Cement Concrete Grade Aggregate unless otherwise indicated by Commodity name enclosed in parentheses.
MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
MRZ-2 Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists.
MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.
MRZ-4 Areas where available information is inadequate for assignment to any other mineral resource zone.
See text for additional explanation of MRZ symbols.
SAND & GRAVEL
MRZ-2
CRUSHED AGGREGATE
B B'
GEOLOGIC CROSS SECTION LINE
Arrow at end of line indicates section continues onto adjacent plate.
N
MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES AND ACTIVE MINES OF ALL OTHER MINERAL COMMODITIES
San Luis Obispo-Santa Barbara
P-C Region
By
Russell V. Miller
1989
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761
ACTING STATE GEOLOGIST APRIL 16, 1988

5.4.2 Environmental Analysis

The following sections present the potential effects from the construction and operation of the PESC project on geologic resources and risks to life and property from geologic hazards.

5.4.2.1 Significance Criteria

According to Appendix G of the California Environmental Quality Act statutes (California Code of Regulations (CCR), 2016), a project would have a significant environmental impact in terms of geological hazards and resources if it would do the following:

- Directly or indirectly cause potential adverse effects, including the risk of loss, injury, or death involving the following:
  - 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
  - Strong seismic ground shaking
  - Seismic-related ground failure, including liquefaction
  - Landslides
- Be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on- or offsite landslide, subsidence, liquefaction, or collapse.
- Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.
- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state.
- Result in the loss of availability of a locally important mineral resource recovery site delineated on a local plan, specific plan, or other land use plan.

5.4.2.2 Geological Hazards

As described in Section 5.4.1.4, the following potential geological hazards, with corresponding impact assessment, have been identified. Mitigation measures to reduce the impact(s) to less than significant are described in Section 5.4.4.

- Ground Rupture related impacts are considered less than significant.
- Seismic Shaking related impacts can be mitigated to less than significant.
- Liquefaction related impacts can be mitigated to less than significant.
- Mass Wasting related impacts can be mitigated to less than significant.
- Subsidence related impacts can be mitigated to less than significant.
- Expansive Soils related impacts can be mitigated to less than significant.
- Tsunamis and Seiches related impacts are less than significant.

- Permanent Slopes and Embankments related impacts can be mitigated to less than significant.
- Collapse of below grade features related impacts can be mitigated to less than significant.
- Reservoir induced seismicity related impacts can be mitigated to less than significant.
- Compressed air induced seismicity related impacts are less than significant.

5.4.2.3 Geological Resources

The PESC project will not result in a loss of availability of any known valuable mineral resources. The project will not result in the loss of availability of a locally important mineral resource recover site delineated on a local plan, specific plan, or other land use plan.

5.4.3 Cumulative Effects

A cumulative impact refers to a project's incremental effect together with other closely related past, present, and reasonably foreseeable future projects whose impacts may compound or increase the incremental effect of the PESC (Public Resources Code Section 21083; CCR, Title 14, Sections 15064[h], 15065[c], 15130, and 15355).

The impacts of the PESC project are expected to be less than, or mitigated to less than, significant. However, we do not have any information on or knowledge of other projects within the vicinity of the PESC project and, therefore, do not have a basis to evaluate the cumulative effects of the project.

5.4.4 Mitigation Measures

The following mitigation measures will reduce potential impacts related to geological hazards to less than significant during construction and operation of the PESC project:

- Perform a site-specific geotechnical exploration to collect geotechnical data to:
  - Confirm surface and subsurface soil and rock types and characteristics
  - Measure the depth to groundwater
  - Determine Site Class for use in seismic hazard analyses
  - Evaluate liquefaction susceptibility and potential, and calculate corresponding liquefaction induced settlement if applicable
  - Determine if expansive soils are present
  - Support the design of the foundations and below grade features
- Verify the recommendations provided in the geotechnical report are followed during the construction and operation of the PESC project
- Perform a site-specific probabilistic and deterministic seismic hazard analysis to evaluate seismicity and provide a basis for selecting design ground motion parameters
- Potential liquefaction-derived settlement can be reduced to acceptable levels by the use of either ground improvement techniques (i.e., compaction grouting, vibro replacement, or deep soil mixing) or deep foundations (i.e., drilled piers, rock columns, or drilled piles) that account for the estimated liquefaction-derived settlement.

- Mass wasting impacts are likely limited to small portions of the project site, and these impacts, if any, can be mitigated by implementing geotechnical recommendations to stabilize the slopes or provide an adequate offset of the site facilities from existing slopes.
- Control groundwater drawdown to reduce possible subsidence to within an acceptable level
- Use soil amendments to stabilize expansive soil, or over-excavate and replace it with engineered fill
- Design structures and equipment to meet seismic requirements of the most recent version of the California Building Code (CBC) (California Building Standards Commission [CBSC] 2019)
- Ancillary features (tanks, utility towers, etc.) will be designed and constructed in accordance with their respective design standards consistent with the standard of practice
- Analyze static and seismic stability of all permanent slopes and embankments
- If applicable, comply with the DSOD requirements for the construction and operation of hydraulic retention structures that are considered a jurisdictional dam (i.e., the hydrostatic compensation surface reservoir)
- Assign a geotechnical engineer and/or engineering geologist to the project to carry out the duties required by the CBC to assess geologic conditions during construction and to approve actual mitigation measures used to protect the facility from geological hazards
- Design and construct the below grade features to prevent collapse during all phases of the project life-cycle (i.e., construction, operation, closure, and post-closure)

5.4.5 Laws, Ordinances, Regulations, and Standards

Federal, state, county, and local Laws, Ordinances, Regulations, and Standards (LORS) applicable to geological hazards and resources are discussed below and summarized in Table 5.4-1. The local LORS discussed in this section are certain ordinances, plans, or policies of the San Luis Obispo County Department of Planning and Building. There are no federal LORS that apply to geological hazards and resources.

Table 5.4-1: Laws, Ordinances, Regulations, and Standards for Geological Hazards and Resources

LORS	Requirements/Applicability	Administering Agency	Application for Certification Section Explaining Conformance
State			
California Building Code, 2019	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity	California Building Standards Commission, State of California	Section 5.4.2.2
Alquist-Priolo Earthquake Fault Zone Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 3, CCR)	Identifies areas subject to surface rupture from active faults	California Building Standards Commission, State of California	Section 5.4.2.2

LORS	Requirements/Applicability	Administering Agency	Application for Certification Section Explaining Conformance
The Seismic Hazards Mapping Act (Title 14, Division 2, Chapter 8, Subchapter 1, Article 10, CCR)	Identifies secondary seismic hazards (liquefaction and seismically induced landslides)	California Building Standards Commission, State of California	Section 5.4.2.2
California Water Code, Division 3, Dams and Reservoirs, Part 1	Jurisdictional dam oversight	DSOD	Section 5.15.5.2.5
Local			
San Luis Obispo County General Plan	San Luis Obispo County	San Luis Obispo County	Section 5.11.5.3
San Luis Obispo County Municipal Code	Standards for grading and water quality, including permit requirements	San Luis Obispo County, Department of Planning and Building	Section 5.4.7

5.4.6 Agencies and Agency Contacts

Compliance of building construction with CBC standards is covered under engineering and construction permits for the PESC. Except for possible oversight of the compensation reservoir by DSOD (described in detail in Section 5.215, Water Resources), there are no other permit requirements that specifically address geologic resources and hazards. However, excavation/grading, and inspection permits may be required before construction, and they will be included in the overall project construction permit (see Section 5.6, Land Use).

5.4.7 Permits and Permit Schedule

Except for possible oversight of the compensation reservoir by DSOD (described in detail in Section 5.15, Water Resources), no permits are required for compliance with geological LORS. However, the San Luis Obispo County Department of Planning and Building is responsible for inspections and for ensuring compliance with building standards.

5.4.8 REFERENCES

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