Appendix E1. Paleontological Resources Impact Evaluation

Paleontological Resources Impact Evaluation

Date:	June 17, 2024
Project name:	Moraga–Oakland X 115 kV Rebuild Project
Attention:	Christophe Descantes
Client:	Pacific Gas and Electric Company
Prepared by:	MariaElena Conserva/Earthview Science
Copies to:	Colleen Taylor/Jacobs; Andrea Gardner/Jacobs

Earthview Science
Oakland, California
United States
T +1.510.859.3016
www.earthviewscience.com

1. Summary

This Paleontological Resources Impact Evaluation Report was completed to assess potential paleontological impacts associated with the Moraga–Oakland X 115 kV Rebuild Project (project) and to assist Pacific Gas and Electric Company (PG&E) in complying with laws, ordinances, regulations, and standards pertaining to paleontological resources. The proposed project will be located within the City of Orinda, in unincorporated areas of Contra Costa County, and the Cities of Oakland and Piedmont within Alameda County.

This assessment was conducted according to procedures in *PG&E Paleontological Resources Standards and Procedures* (PG&E 2015) and includes a review of geologic maps, institutional records, scientific literature, aerial imagery, and project plans.

This assessment finds that the project area has paleontological sensitivity ranging from very low to high (Bureau of Land Management Potential Fossil Yield Classification [PFYC] System Classes 1 to 4).

2. Project Description

2.1 Overview

The project will include rebuilding the four PG&E existing 115 kV circuit lines and structures, and minor modifications to Moraga and Oakland X substations. Approximately 4 miles of the existing 5 miles of overhead lines will be rebuilt overhead, and approximately 1 mile will be rebuilt in city streets. Project operation and maintenance will be conducted with existing staffing using existing access.

2.2 Ground-Disturbing Activity

Ground-disturbing work will be associated with the following project elements:

Power line structure installation. Two lines will be rebuilt as double-circuit overhead lines for approximately 3.9 miles from Moraga Substation to the intersection of Park Boulevard and Estates Drive in Oakland. Approximately 48 replacement structures (towers or poles) and four transition pole structures will be installed in new locations along the rebuilt overhead lines. In addition, three transition structures will be installed near Oakland X Substation. The excavation method for towers and poles will most likely be augering or micropile installation. The maximum augering excavation dimensions are expected to be approximately 3-8 feet in diameter and approximately 30 feet deep. Structures installed by micropile will not create spoils.

- **Guard structure installation.** Guard structures may be created with line trucks or wooden poles with cross-beams. Where wooden poles are used, an auger will excavate holes where the wood poles will be

embedded. A hole is expected to be excavated up to approximately 8 feet deep and have an approximately 20 to 24-inch diameter. The drill diameter will be less than 3 feet.

- **Power line structure removal.** Where the concrete foundation is not left in place, it will be removed to up to approximately 4 feet below ground using hand tools and jack hammers as needed.
- **Duct banks**. Two double-circuit underground duct banks will be installed for approximately 1.2 miles from the intersection of Park Avenue and Estates Drive to Oakland X Substation. Trench excavation for the duct bank will be approximately 4 feet wide by approximately 5 feet deep on average, but may occasionally be deeper (approximately 10 feet), depending on field conditions, the presence of other utilities, and depth of vaults along the route.
- **Vaults**. The line rebuilt in an underground configuration will require the installation of vaults at approximately 1,200-foot intervals. Each vault will require an approximately 42-foot-long, 18-foot-wide, and 13-foot-deep excavation.
- **Moraga Substation**. Limited modifications are planned within Moraga Substation to upgrade 115 kV components. No modifications outside or to the existing Moraga Substation fence line are planned, and no excavation will occur.
- **Oakland X Substation**. Limited modifications are planned within Oakland X Substation to upgrade 115 kV components. No modifications outside or to the existing Oakland X Substation fence line are planned, and no excavation will occur.
- **Blading**. Blading may be required in some locations for access roads and work areas. One landslide will be repaired on the existing dirt access road to EN9 and ES10.

3. Regulatory Setting

This section summarizes the state and local regulatory context and professional standards that apply to paleontological resources in the project vicinity. No federal regulations related to paleontological resources are applicable to the project.

3.1 State

3.1.1 California Environmental Quality Act

The California Environmental Quality Act (CEQA) encourages the protection of all aspects of the environment by requiring state and local agencies to prepare multidisciplinary analyses of the environmental impacts of a proposed project, and to make decisions based on the findings of those analyses.

Treatment of paleontological resources under CEQA generally is conducted according to guidance from the Society for Vertebrate Paleontology (SVP) or other agencies (Bureau of Land Management (BLM) or U.S. Forest Service (USFS)), and typically includes identification, assessment, and development of mitigation measures for potential impacts to significant or unique resources.

Appendix G of the CEQA Guidelines provides guidance relative to significant impacts on paleontological resources, which states that a project normally will result in a significant impact on the environment if it will disrupt or adversely affect a paleontological resource or site or unique geologic feature, except as part of a scientific study.

3.1.2 California Public Resources Code

The State of California Public Resources Code (Chapter 1.7), Sections 5097.5 and 30244, includes additional state-level requirements for the assessment and management of paleontological resources. These statutes require reasonable mitigation of adverse impacts to paleontological resources resulting

from development on state lands, define the removal of paleontological sites or features from state lands as a misdemeanor, and prohibit the removal of any paleontological site or feature from state land without permission of the applicable jurisdictional agency. Section 30244 requires reasonable mitigation for impacts on paleontological resources that occur as a result of development on public lands. Further, California Penal Code Section 622.5 sets the penalties for damage or removal of paleontological resources.

3.3 Local

City and county general plans may include objectives, policies, and actions for identifying and protecting paleontological resources. However, because the California Public Utilities Commission has exclusive jurisdiction over utility project siting, design, and construction, PG&E is not subject to local discretionary regulations. A description of local policies and regulations for paleontological resources is provided for informational purposes and to assist with CEQA review.

The general plans of Contra Costa County and the Cities of Orinda, Oakland, and Piedmont were reviewed for provisions relevant to paleontological resources (Contra Costa County 2005; City of Orinda 1987; City of Oakland 1996; City of Piedmont 2009).

The *Contra Costa County General Plan* calls out significant ecological resource areas in the county, including four areas with high concentrations of fossils, the closest of which is Siesta Valley, approximately 2 miles from the project area (Contra Costa County 2005, page 8-5). The plan stipulates that developers "provide information to the County on the nature and extent of the biotic resources that exist in the area. The County Planning Agency shall be responsible for determining the balance between uses of the land and the protection of resources. The cumulative impacts on the natural resources from other rural uses, such as agriculture, mining, or wind energy, must be examined and addressed as part of the review of applications. Both public and private stewardship of the resources within unique natural areas shall be considered as long as the protection is long-term and guaranteed in some manner."

The Open Space, Conservation, and Recreation Element of the *City of Oakland General Plan* stresses the importance of paleontological resources as follows: "Some of Oakland's most important natural assets are 'earth resources' including soils and minerals, archaeologic and fossil remains, and the geologic formations that define the city's topography" (City of Oakland 1996, page 3.2). However, the General Plan does not explicitly address paleontological resources in policies, goals, or objectives.

No provisions related to paleontological resources were found for Orinda or Piedmont.

3.4 Professional Standards

SVP is an organization of professional and academic paleontologists that established standard guidelines (SVP 1995, 2010) for practices regarding paleontological resource assessments, monitoring and mitigation, data and fossil recovery, sampling procedures, specimen preparation, identification, and museum curation. However, these guidelines were developed at an institutional level dedicated to scholarship and education rather than resource management or regulatory compliance.

In 2014, a white paper that includes best mitigation practices for paleontological studies was published. The mitigation practices outlined in this paper have a consensus among professional paleontologists regarding field methods, reporting standards, qualifications, and other procedures for conducting paleontological resource management activities (Murphey et al. 2014). PG&E has incorporated many of these findings into its guidance and assumes that professional paleontologists follow standards outlined by SVP, BLM, and other professional organizations except where they conflict with PG&E guidelines.

4. Methods

Existing data were analyzed according to *PG&E Paleontological Resources Standards and Procedures* (PG&E 2015). The analysis included (1) geologic map review, (2) scientific literature review, (3)

institutional paleontological records search, and (4) aerial imagery review. Several geological maps were reviewed for this analysis. The map that provided the most detailed surficial geology of the project area was chosen: Graymer (2000) at a 1:50,000 scale. Geological and paleontological literature relevant to the project area was reviewed. Databases from the University of California, Museum of Paleontology (UCMP) and Paleobiology Database (PBDB) were searched for paleontological records within 1 mile of the project area (PBDB 2023; UCMP 2023). Google Earth aerial imagery was reviewed for physiographic context and land use.

The study area for this evaluation includes the maximum project footprint plus a half-mile buffer beyond the project (Figure 1).

5. Results

5.1 Geologic Setting

The project area is within the Coast Ranges geomorphic province (California Geological Survey 2002), extending approximately 5 miles from the East Bay Hills to the sloping alluvial plain along the Bay. The complex geology of the East Bay Hills reflects the forces that have shaped the region. The East Bay Hills are a sequence of Mesozoic rocks overlain by younger strata. The Franciscan Complex, likely composed of Jurassic oceanic crust, pelagic deposits, and turbidites, underlies most of the Bay Area and crops out in a portion of the study area (Graymer 2000). Another Bay Area basement rock sequence crops out in the project area – the Great Valley Complex, representing accreted and deformed ocean crust and thick turbidite sequences. It can be divided into the Great Valley Sequence and Coast Range Ophiolite, both of which crop out in the project area. Younger, fault-bounded rock bodies are grouped into assemblages (Graymer 2000). The project area contains rock sequences from Assemblage I, which dates from the Paleocene to the Miocene, and Assemblage II, which dates to the Pliocene. These assemblages and complexes are described in greater detail in Section 5.2. Refer to Figure 2 for geological ages.

West of the East Bay Hills is the San Francisco Bay Area coast plain. The San Francisco Bay occupies a depression in the Coast Ranges between the San Andreas Fault to the west and the Hayward Fault to the east. This depression filled with sediments eroded from the hills and deposited by streams flowing into the Bay, forming a thick layer of sediment from the Pleistocene and Holocene periods. The west end of the study area is on an alluvial fan extending from the hills toward the Bay.

Major geographic features in the project area include the Hayward Fault line, Sausal Creek, and Shepherd Creek. The topography in the area consists of rolling hills, vegetated canyons, and higher elevations in the eastern and central sections of the project. A more gradual slope with less topographical variation occurs in the western portion of the project. Project elevation ranges from approximately 650 feet above sea level at Moraga Substation to approximately 1,370 feet above sea level when the lines crest the Oakland Hills and then to approximately 140 feet above sea level at Oakland X Substation.

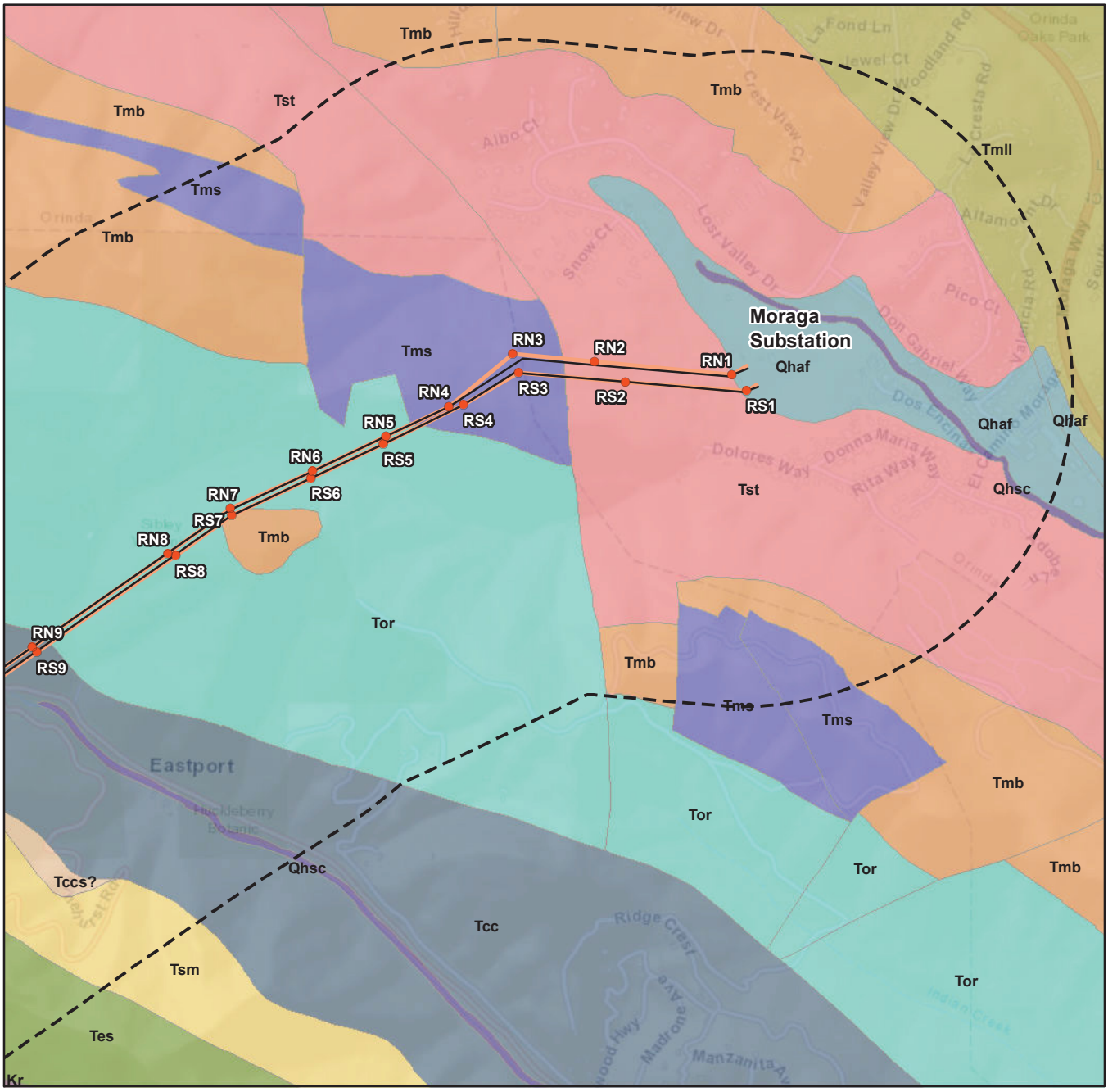
5.2 Geologic Units

Geologic units in the study area are shown on the map in Figure 1 and described in the following sections from youngest to oldest.

5.2.1 Quaternary Deposits

These deposits span recent, Holocene, and Pleistocene periods. In the study area, they are located in valley bottoms and at the west end of the project area along the coastal plain.

- **Artificial fill (af)** is material deposited by humans from various sources.



Legend

Overhead Structures
- Proposed

Overhead Routes
- Existing
- Proposed

Underground Routes
- Proposed
- 0.5-mile Project Buffer

Geologic Units

Quaternary Deposits
- Qhsc - stream channel deposits
- Qhaf - alluvial and fluvial deposits (Holocene)

Assemblage I
- Tst - Siesta Formation
- Tms - Interflow Sedimentary Rocks
- Tmb - Moraga Formation
- Tor - Orinda Formation
- Tcc - Claremont chert
- Tccs?
- Tsm - Glauconitic mudstone
- Tes - Mudstone

Assemblage II
- Tmll - Mulholland Formation

Great Valley Sequence
- Kr - Redwood Canyon Formation

Version: 3/19/2024

N

0 0.25
Miles

Figure 1. Page 1 of 4
Geologic Units
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Geology Data Source: Graymer, 2000

Jacobs

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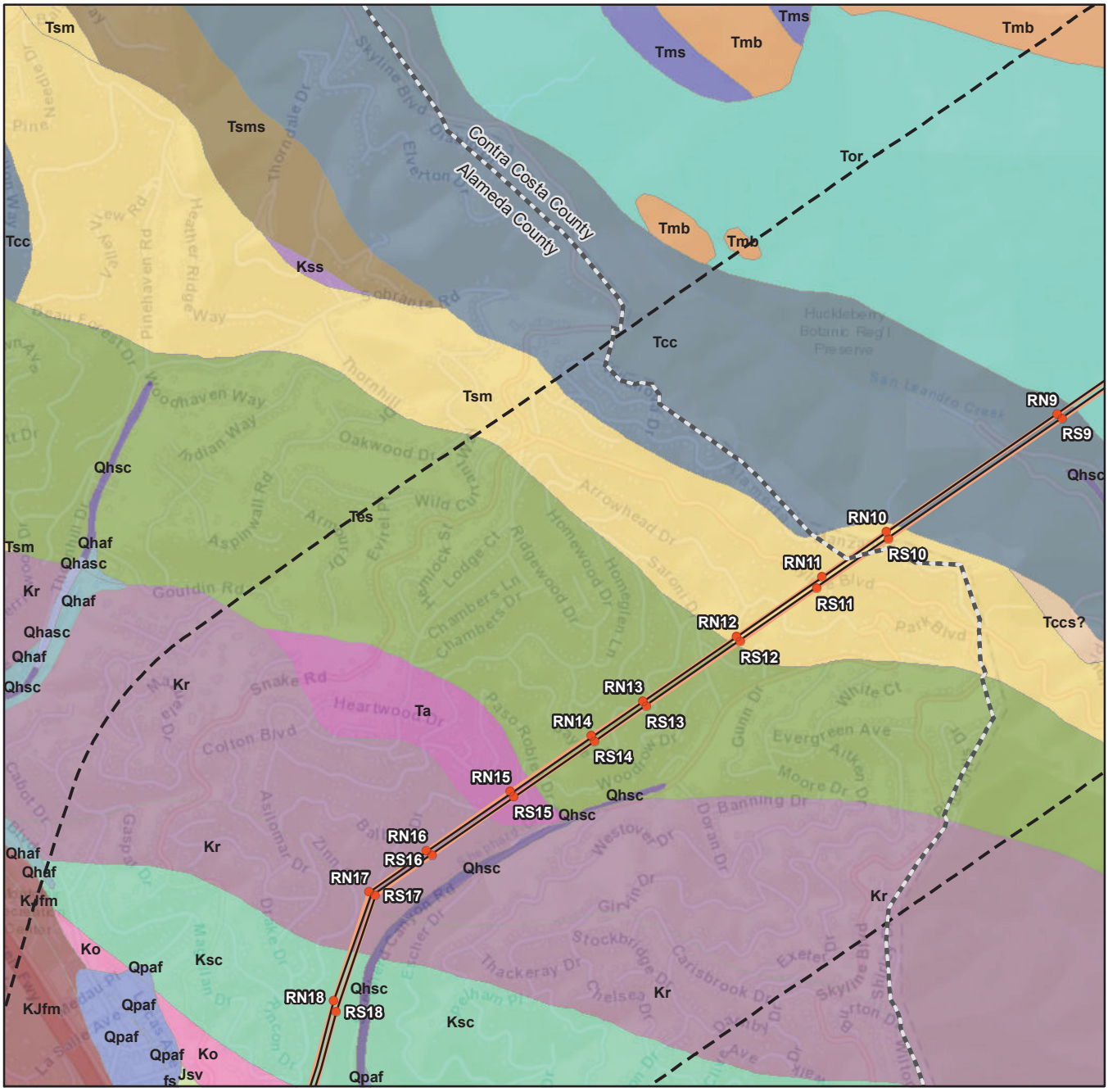


Version: 3/19/2024

Legend

Overhead Structures
- Proposed

Overhead Routes
- Existing
- Proposed

Underground Routes
- Proposed
- 0.5-mile Project Buffer

Geologic Units

Quaternary Deposits
- Qhasc - artificial stream channels
- Qhsc - stream channel deposits
- Qhaf - alluvial and fluvial deposits (Holocene)
- Qpaf - alluvial and fluvial deposits (Pleistocene)

Assemblage I
- Tsms - interbedded sandstone
- Tms - Interflow Sedimentary Rocks
- Tmb - Moraga Formation
- Tor - Orinda Formation
- Tcc - Claremont chert
- Tccs?
- Tsm - Glauconitic mudstone
- Tes - Mudstone
- Ta - Glauconitic sandstone

Great Valley Sequence
- Kss - lithic sandstone
- Kr - Redwood Canyon Formation
- Ksc - Shepard Creek Formation
- Ko - Oakland Conglomerate
- Jsv - Keratophyre

Franciscan Complex
- KJfm - Franciscan Complex
- fs - Graywacke

N

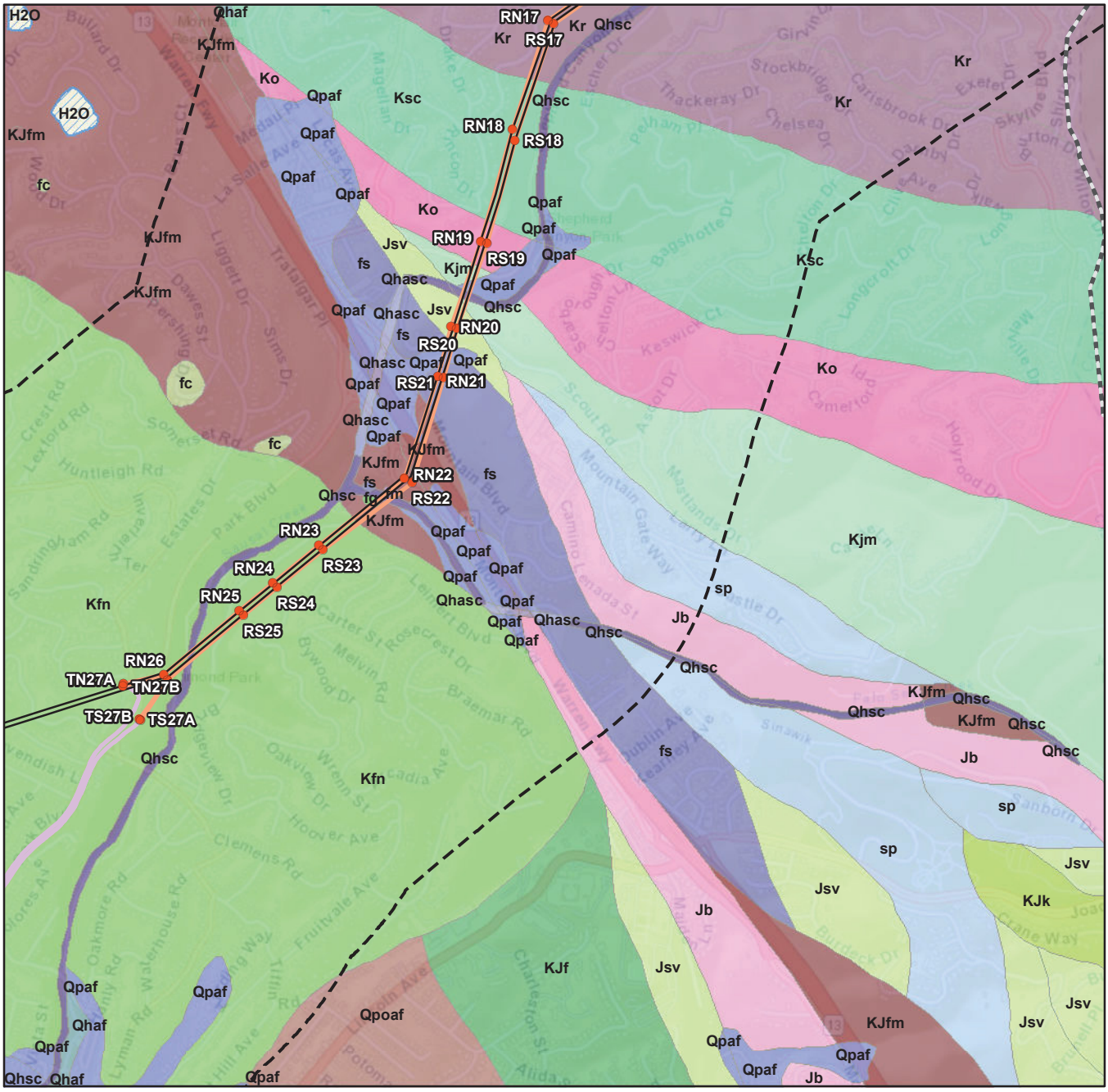
0 0.25 Miles

Figure 1. Page 2 of 4
Geologic Units
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Geology Data Source: Graymer, 2000

Jacobs



Legend

Overhead Structures
- Proposed

Overhead Routes
- Existing
- Proposed

Underground Routes
- Proposed
- 0.5-mile Project Buffer

Geologic Units

Quaternary Deposits
- Qhasc - artificial stream channels
- Qhsc - stream channel deposits
- Qhaf - alluvial and fluvial deposits (Holocene)
- Qpaf - alluvial and fluvial deposits (Pleistocene)
- Qpoaf - alluvial terrace (Pleistocene)

Great Valley Sequence
- Kr - Redwood Canyon Formation
- Ksc - Shepard Creek Formation
- Ko - Oakland Conglomerate
- Kjm - Joaquin Miller Formation
- KJk - Knoxville Formation
- Jsv - Keratophyre

Coast Range Ophiolite
- Jb - Massive basalt and diabase
- sp - Serpentinite

Franciscan Complex
- Fm - glaucophane schist
- Fg - greenstone
- Fc - chert
- KJf - undivided Franciscan Complex rocks
- Kfn - Sandstone Novato Quarry
- KJfm - Franciscan Complex
- fs - Graywacke

Other
- H20 - Water

Version: 3/19/2024

N

0 0.25 Miles

Figure 1. Page 3 of 4
Geologic Units
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Geology Data Source: Graymer, 2000

Jacobs

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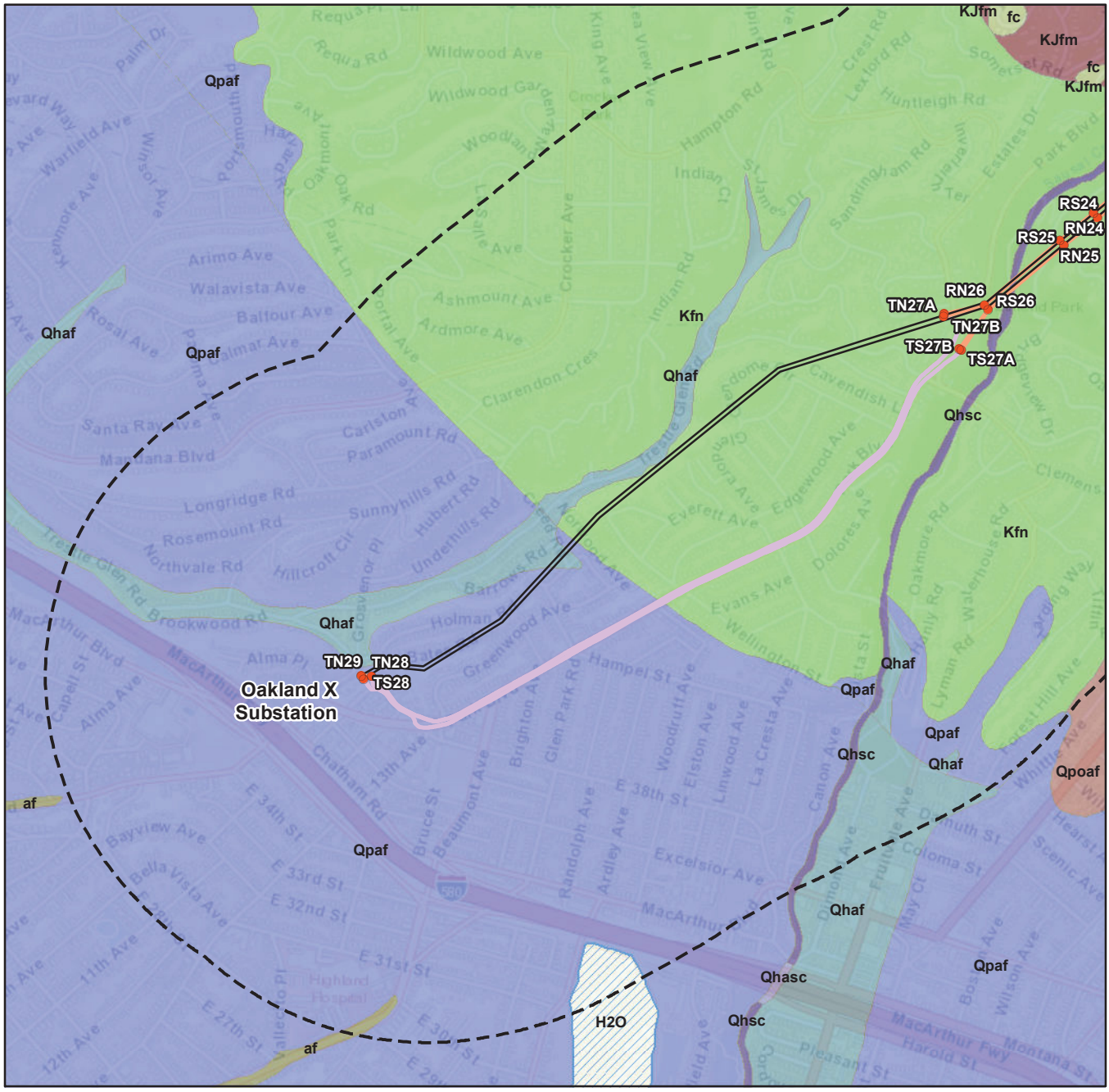

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Legend

Overhead Structures

- Proposed

Overhead Routes

- Existing
- Proposed

Underground Routes

- Proposed
- 0.5-mile Project Buffer

Geologic Units

Quaternary Deposits

- Qhasc - artificial stream channels
- Qhsc - stream channel deposits
- af - artificial fill
- Qhaf - alluvial and fluvial deposits (Holocene)
- Qpaf - alluvial and fluvial deposits (Pleistocene)
- Qpoaf - alluvial terrace (Pleistocene)

Franciscan Complex

- Fc - chert
- Kfn - Sandstone Novato Quarry
- KJfm - Franciscan Complex

Other

- H20 - Water

N

0 0.25 Miles

Figure 1. Page 4 of 4
Geologic Units
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

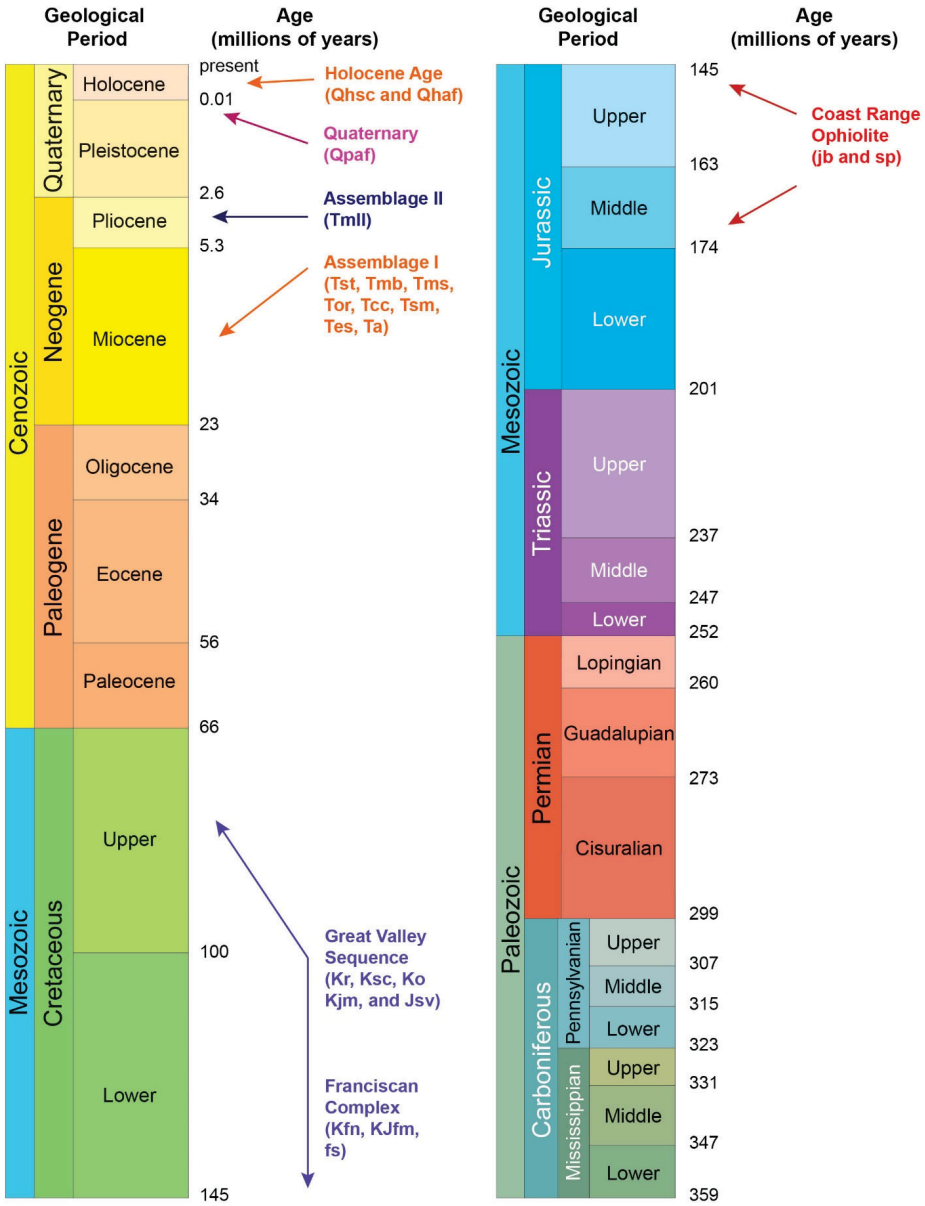
Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Geology Data Source: Graymer, 2000

Jacobs

- **Stream channel deposits (Qhsc)** are Holocene-age sand, clay, silty sand, or sandy gravel with minor cobbles of modern stream courses.
- **Holocene alluvial deposits (Qhaf)** are brown to tan, medium dense to dense, gravely sand or sandy gravel that grades upward to sandy or silty clay. The best-developed Holocene alluvial fans are on the San Francisco Bay plain. All other alluvial fans and fluvial deposits are confined to narrow valley floors.
- **Quaternary alluvial deposits (Qpaf)** are Pleistocene-age alluvial and fluvial deposits. They are brown, dense, gravelly and clayey sand or gravel that grades upward to sandy clay. These deposits are located along most modern stream channels outboard of Holocene deposits. They are distinguishable from younger deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are overlain by Holocene deposits on the lower parts of the alluvial plain and incised by channels partly filled with Holocene alluvium on higher parts of the alluvial plain.

Figure 2. Geologic Periods Relevant to this Assessment



Source: modified from International Chronostratigraphic Chart (Cohen et al., 2022)

5.2.2 Assemblage I

Assemblage I is a series of Miocene to Paleocene-age rock bodies at the eastern end of the project area, notable for containing volcanic material (Graymer 2000). The constituent rock bodies are relatively narrow and form a series of East Bay Hills ridges at the east end of the study area. Assemblage I rock bodies in the study area include:

- **Siesta Formation (Tst)** is a narrow, late Miocene-age formation that outcrops for approximately 6 miles, extending 4 miles north of the project area and 2 miles to the south. It consists of nonmarine siltstone, claystone, sandstone, and minor limestone.
- **Moraga Formation (Tmb and Tms)** is a late Miocene-age volcanic rock body with two subunits: Tmb and Tms. Tmb is basalt and andesite with minor rhyolite tuff that crops out discontinuously across approximately 9 miles. Its north end is broad, narrowing to the south. Tms is part of the Moraga Formation, consisting of interflow sedimentary rocks.
- **Orinda Formation (Tor)** is a late Miocene-age formation widespread in the East Bay Hills. It is distinctly to indistinctly bedded, pebble to boulder conglomerate, conglomeratic sandstone, coarse- to medium-grained lithic sandstone, and green and red siltstone and mudstone. Conglomerate clasts are subangular to well rounded and contain a high percentage of detritus derived from the Franciscan complex.
- **Claremont chert (Tcc)** is a late to middle Miocene-age laminated, bedded chert, minor brown shale, and white sandstone. Chert crops out as distinct, massive to laminated, gray or brown beds. Distinctive black, laminated chert crops out locally in the Berkeley Hills.
- **Glauconitic mudstone (Tsm)** is Miocene and Oligocene-age brown mudstone interbedded with sandy mudstone with prominent glauconite grains. The unit is bounded below and above by faults. It was mapped as Sobrante(?) Formation by Radbruch (1969).
- **Mudstone (Tes)** is Eocene-age green and maroon, foraminifera-rich mudstone, locally interbedded with hard, distinctly bedded, mica-bearing, quartz sandstone. This unit is bounded above and below by faults.
- **Glauconitic sandstone (Ta)** is Paleocene-age, coarse-grained, green, glauconite-rich, lithic sandstone with well-preserved coral fossils. Locally interbedded with gray mudstone and hard, fine-grained, mica-bearing quartz sandstone. Outcrop of this unit is restricted to a small, fault-bounded area in the Oakland Hills.

5.2.3 Assemblage II

- **Mulholland Formation** (**TmII)** is a Pliocene-age formation of mostly sandstone and mudstone. It forms the ridgeline at the eastern edge of the study area but does not underlie the project area.

5.2.4 Great Valley Sequence

Great Valley Sequence is a series of Jurassic and Cretaceous-age rock bodies. These units are thickly deposited accumulations of mudstone, sandstone, and conglomerate. They represent sequences of turbidites deposited on the oceanic crust. The Great Valley Sequence is west of Assemblage I and includes the following units:

- **Redwood Canyon Formation (Kr)** is distinctly bedded, cross-bedded to massive, thick beds of biotite, quartz-rich wacke, and thin interbeds of mica-rich siltstone.
- **Shepard Creek Formation (Ksc)** is distinctly bedded mudstone, shale, mica-rich siltstone, and thin fine-grained, mica-rich wacke beds.
- **Oakland conglomerate (Ko)** is massive, medium- to coarse-grained biotite, quartz-rich wacke, and prominent interbedded pebble-to-cobble conglomerate lenses. Conglomerate clasts are distinguished by a large amount of silicic volcanic detritus, including quartz porphyry rhyolite.

- **Joaquin Miller Formation (Kjm)** is thinly bedded shale with minor sandstone. The shale grades into thinly bedded, fine-grained sandstone near the top of the formation.
- **Keratophyre (Jsv)** are highly altered intermediate and silicic volcanic and hypabyssal rocks.

5.2.5 Coast Range Ophiolite

West of the Great Valley Sequence is a series of rock bodies known as Coast Range Ophiolite. It is a slab of oceanic upper mantle and crust formed from the middle to the late Jurassic. The ophiolite sequences that occur in the study area include:

- **Massive basalt and diabase (jb)** are types of igneous rock with a similar composition. Basalt is considered extrusive because it cools on or near the surface whereas diabase cools underground.
- **Serpentinite (sp)** is a metamorphic rock that forms in midocean ridges and in subduction zones.

5.2.6 Franciscan Complex

West of Coast Range Ophiolite is a series of rock bodies known as the Franciscan Complex, which consists in this area of deformed and metamorphosed sedimentary and volcanic rocks of late Jurassic to late Cretaceous age. The Franciscan Complex units in the study area are:

- **Sandstone Novato Quarry (Kfn)** is distinctly bedded to massive, mica-bearing, lithic wacke. Where distinctly bedded, sandstone beds are about 1 meter thick and siltstone interbeds are a few centimeters thick. Sedimentary structures are well preserved.
- **Franciscan Complex (KJfm)** is sheared black argillite, graywacke, and minor green tuff, containing blocks and lenses of graywacke and meta-graywacke, chert, shale, metachert, serpentinite, greenstone, amphibolite, tuff, eclogite, quartz schist, greenschist, basalt, marble, conglomerate, and glaucophane schist. Blocks range in size from pebbles to several hundred meters in length.
- **Graywacke and meta-graywacke (fs)** are sandstone rocks formed by submarine currents when sediment laden water moves rapidly down a slope forming a sort of underwater avalanche. A mass of sediment called, a turbidite, is deposited on the seafloor.

5.3 Literature and Records Search Results

Institutional records searches and scientific literature reviews were performed for the study area and surroundings. Many of the geologic units associated with the project are not known to be fossiliferous or have no fossil records associated with them in this area.

The geologic units in the study area in which vertebrate macrofossils have been found are, from youngest to oldest: Pleistocene-age sediment, Siesta Formation, Moraga Formation, Orinda Formation, Claremont Formation, and Mulholland Formation. The fossil records for these units are discussed in the following subsections.

Few records of invertebrate fossils were found for the geologic units in the project area in Contra Costa or Alameda counties. These included two invertebrate fossils recorded for the Siesta Formation (refer to Table 2). Three invertebrate fossils were recorded as part of the Orinda Formation (refer to Table 4). In addition, three invertebrate fossil localities are recorded as part of the Redwood Canyon Formation; however, no specimen type is listed for any of the localities. Well-preserved fossil corals are reported in Graymer (2000) and Alden (2023) in glauconitic sandstone on Saroni Drive within half a mile of the project area.

Microfossils are present in various units in the study area but, when present, generally are found in abundance.

5.3.1 Pleistocene-Age Fossils

Pleistocene-age fossils have been found on the East Bay Coastal Plain in sediment mapped as Holocene or Pleistocene at the surface. The west end of the project area is on Pleistocene-aged sediment (Qpaf). Table 1 lists 13 fossil locality records within 5 miles of the project area. The closest fossil locality is at Montclair Playground, less than 1 mile from the project area. The other 12 localities are more than 2 miles away.

Table 1. Pleistocene-Age Fossil Localities within 5 Miles of the Project Area

	Locality Name	Location	ID	Taxon	Other Information	Reference
1	Montclair Playground	Oakland	V3933	*Mammuthus, Camilidae*	N/A	UCMP 2023
2	Oakland 81st Ave	Oakland	V4045	*Mammuthus*	Excavation at Sunshine Bisquit Co.	Savage 1951; UCMP 2023
3	Oakland Coliseum	Oakland	V6420	*Mammuthus, Glossotherium*	Construction of sports arena	UCMP 2023
4	Alameda	Alameda Island	not listed	*Megalonyx*	Found on east end	Hay 1927
5	Alameda Canal	Alameda	V69168	*Glossotherium*	N/A	UCMP 2023
6	Harrison St Tunnel	Posey Tube	V2841	*Mammuthus*	Alameda tube construction	Savage 1951; UCMP 2023
7	Alameda Tube Excavation	Webster St Tube	V6227	26 specimens, various	Alameda tube construction	UCMP 2023
8	Webster St	Alameda County	V69170	*Proboscidea*	BART construction?	UCMP 2023
9	Aquatic Park	Berkeley	V4007	*Bison*	N/A	Savage 1951; UCMP 2023
10	University Ave	Berkeley	V6644	*Mammut*	BART construction?	UCMP 2023
11	Shattuck Ave 1	Berkeley	V67194	*Glossotherium*	BART construction?	UCMP 2023
12	Berkeley Municipal Wharf	Berkeley	V3613	*Mammuthus*	Found by WPA 1936	Savage 1951; UCMP 2023
13	Oak Knoll Hospital View	Oakland	V5834	26 specimens, various	N/A	UCMP 2023

5.3.2 Siesta Formation Fossils

The Siesta Formation (Tst) is an Assemblage I geologic unit of late Miocene age. It forms a narrow belt, oriented northwest-southwest near the east end of the Project area. Table 2 records 15 fossil localities in this unit, 11 of which are vertebrates. The closest localities are the "Curtis" locality 2 miles southwest of the project area and 5 localities in the Siesta Valley approximately 2 miles northwest. The other fossil localities are all within 4 miles of the project area.

Table 2. Siesta Formation (Tst) Fossil Localities in the East Bay

	ID	Fossil Type	Locality Name	County	Taxon	Reference
1	V6000	V	Curtis	Contra Costa	*Equidae*	UCMP 2023

	ID	Fossil Type	Locality Name	County	Taxon	Reference
2	-707	IV	Siesta Valley 1	Contra Costa	*Camelidae*	UCMP 2023
3	V3652	V	Siesta Valley 2	Contra Costa	Various	UCMP 2023
4	V4604	V	Siesta Valley 3	Contra Costa	Various	UCMP 2023
5	V68113	V	Siesta Valley 4	Contra Costa	*Camelidae*	UCMP 2023
6	V75231	V	Siesta Valley 5	Contra Costa	*Equidae*	UCMP 2023
7	V2404	V	Bald Peak	Alameda	Various	UCMP 2023
8	-1082	V	Bald Peak N	Contra Costa	Various	UCMP 2023
9	V67102	V	Bald Peak N	Contra Costa	*Equidae*	UCMP 2023
10	V75273	V	Gompho Springs	Contra Costa	Not listed	UCMP 2023
11	V6352	V	Melvin's	Contra Costa	*Camelidae*	UCMP 2023
12	V75272	V	Tom's Sites	Contra Costa	Not listed	UCMP 2023
13	P3832	P	Siesta	Alameda	Not listed	UCMP 2023
14	B7268	I	Not listed	Contra Costa	*Gastropoda*	UCMP 2023
15	IP12002	I	Not listed	Contra Costa	*Gastropoda*	UCMP 2023

V = Vertebrate, I = Invertebrate, P = Plant

5.3.3 Moraga Formation Fossils

Two fossil localities were recorded in the Moraga Formation (Tmb and Tms) (Table 3). The first is less than 2 miles from the project area. The second is approximately 2.5 miles from the project area and is recorded as having been found in volcanic tuff.

Table 3. Moraga Formation (Tmb and Tms) Fossil Localities in the East Bay

	ID	Fossil Type	Locality Name	County	Taxon	Reference
1	V85014	V	Curtis Class	Contra Costa	*Camilidae*	UCMP 2023
2	V6580	V	Roadcut Canyon	Contra Costa	*Equidae*	UCMP 2023

V = Vertebrate, I = Invertebrate, P = Plant

5.3.4 Orinda Formation Fossils

The Orinda Formation (Tor) has at least 20 records of vertebrate fossil localities in Contra Costa County (Table 4). The locality known as "Bellshire" is the closest to the project area at approximately 1.5 miles north. Several others, including the Caldecott Tunnel and Orinda localities, are approximately 2 miles away.

Table 4. Orinda Formation (Tor) Fossil Localities in the East Bay

	ID	Fossil Type	Locality Name	County	Taxon	Reference
1	V3603	V	Bellshire	Contra Costa	*Artiodactyla*	UCMP 2023; Stirton 1939
2	V3615	V	Caldecott Tunnel 1	Contra Costa	*Camelidae*	UCMP 2023

	ID	Fossil Type	Locality Name	County	Taxon	Reference
3	V3651	V	Caldecott Tunnel 2	Contra Costa	Not listed	UCMP 2023
4	V6031	V	Caldecott Tunnel 2	Contra Costa	*Camelidae*	UCMP 2023
5	V6224	V	Caldecott Tunnel 3	Contra Costa	Various	UCMP 2023
6	V6336	V	Caldecott Tunnel 3	Contra Costa	Various	UCMP 2023
7	V12012	V	Caldecott Tunnel 4th Bore Orinda General	Contra Costa	Various	UCMP 2023
8	V70135	V	Caldecott Tunnel 5	Contra Costa	Various	UCMP 2023
9	V2837	V	Claremont Tunnel 1	Contra Costa	*Equidae*	UCMP 2023
10	V2839	V	Claremont Tunnel 2	Contra Costa	*Equidae*	UCMP 2023
11	V2840	V	Claremont Tunnel 3	Contra Costa	*Mammutidae*	UCMP 2023
12	-1035	IV	Bollinger Canyon 2	Contra Costa	*Equidae*	UCMP 2023
13	-1042	IV	Bollinger Canyon 3	Contra Costa	*Equidae*	UCMP 2023
14	V3523	V	Elkington	Contra Costa	*Camelidae*	UCMP 2023
15	V83085	V	Kokinos	Contra Costa	*Equidae*	UCMP 2023
16	V1001	V	Orinda 1	Contra Costa	*Equidae*	UCMP 2023
17	V92089	V	Orinda Gomphothere	Contra Costa	*Gomphotheriidae*	UCMP 2023
18	V3641	V	Rocky Ridge 3	Contra Costa	*Desmostylidae*	UCMP 2023
19	V83070	V	Round Top	Contra Costa	*Equidae*	UCMP 2023
20	V91210	V	Round Top North	Contra Costa	Not listed	UCMP 2023
21	V74154	V	Round Top South	Contra Costa	*Equidae*	UCMP 2023
22	V69121	V	San Pablo Ridge	Contra Costa	Not listed	UCMP 2023
23	V6239	V	Whitten	Contra Costa	*Camelidae*	UCMP 2023
24	V1102	V	Wildcat Canyon District	Contra Costa	*Leporidae*	UCMP 2023; Stirton 1939
25	589	IM	Wildcat Canyon	Contra Costa	*Ostracoda*	UCMP 2023
26	140-		N/A	Contra Costa	*Gastropoda*	UCMP 2023
27	A2568	I	N/A	Contra Costa	*Bivalvia*	UCMP 2023
28	A2569	I	N/A	Contra Costa	*Bivalvia, gastropoda*	UCMP 2023

V = Vertebrate, I = Invertebrate, P = Plant, M = Microfossil

5.3.5 Claremont Formation Fossils

Four records of vertebrate fossils were found in Alameda County in the Claremont Formation but none in Contra Costa County (Table 5). They were found during the fourth bore of the tunnel, less than 2 miles from the project area.

Table 5. The Claremont Formation Fossil Localities in the East Bay

	ID	Fossil Type	Locality Name	County	Taxon	References

1	V12004	V	Caldecott 4th Bore Claremont General	Alameda	*Osteichthyes, Chondrichthyes*	UCMP 2023
2	V12009	V	Caldecott Tunnel 4th Bore Claremont Chert	Alameda	*Cetacea*	UCMP 2023
3	V12010	V	Caldecott Tunnel 4th Bore Claremont Sandstone	Alameda	Not listed	UCMP 2023
4	V12011	V	Caldecott Tunnel 4th Bore Claremont Chert and Shale	Alameda	*Osteichthyes*	UCMP 2023

V = Vertebrate, I = Invertebrate, P = Plant, M = Microfossil

5.3.6 Mulholland Formation Fossils

The Mulholland Formation (TmII) has yielded many Pliocene-age vertebrate fossils (Table 6). This formation is approximately one-half mile east of Moraga Substation.

Table 6. Mulholland Formation Fossil Localities in the East Bay

	ID	Fossil Type	Locality Name	County	Taxon	Reference
1	V5330	V	Avila	Contra Costa	Not listed	UCMP 2023
2	V4717	V	Borghesani	Contra Costa	*Aves*	UCMP 2023
3	V65129	V	Bush	Contra Costa	*Equidae*	UCMP 2023
4	V3935	V	Cull Creek	Alameda	Not listed	UCMP 2023
5	V73148	V	Darren's Bear	Contra Costa	*Agriotherium*	UCMP 2023
6	V5807	V	Donald Drive	Contra Costa	*Equidae*	UCMP 2023
7	V5055	V	Holmes	Contra Costa	*Camilidae*	UCMP 2023
8	V3607	V	Las Trampas Creek	Contra Costa	*Gomphotherium*	UCMP 2023
9	V6814	V	Mudhole	Alameda	*Camilidae*	UCMP 2023
10	V3611	V	Mulholland 2	Contra Costa	Various	UCMP 2023
11	V3862	V	Mulholland 3	Contra Costa	Various	UCMP 2023
12	V4858	V	Mulholland 4	Contra Costa	*Equidae*	UCMP 2023
13	V4955	V	Mulholland 5	Contra Costa	*Equidae*	UCMP 2023
14	V65510	V	Mulholland Fm General	Contra Costa	*Camilidae*	UCMP 2023
15	V5271	V	Mulholland Hill	Contra Costa	*Equidae*	UCMP 2023
16	V4003	V	Orinda Crossroads	Contra Costa	*Equidae*	UCMP 2023
17	V4104	V	Orinda Crossroads 2	Contra Costa	*Camilidae*	UCMP 2023
18	V5017	V	Orinda School House	Contra Costa	Various	UCMP 2023
19	V5018	V	Palos Colorados	Contra Costa	Various	UCMP 2023
20	V5505	V	Rheem	Contra Costa	*Muridae*	UCMP 2023
21	V5048	V	Sacramento Northern Railroad	Contra Costa	*Rhinocerotidae*	UCMP 2023
22	V3303	V	Saint Mary's Banks	Contra Costa	Various	UCMP 2023
23	V6815	V	Saint Mary's College 1	Alameda	*Gomphotherium*	UCMP 2023
24	V6029	V	San Pablo Dam Road	Contra Costa	*Tayassuidae*	UCMP 2023

V = Vertebrate, I = Invertebrate, P = Plant, M = Microfossil

6. Paleontological Significance and Sensitivity

PG&E uses definitions of significance and sensitivity based on the FLPMA, as well as standards developed by agencies and professional societies, including the BLM, SVP, and the California Department of Transportation (PG&E 2015).

6.1 Definition of Significance and Significance Criteria

Significance refers to the scientific importance of fossils. PG&E (2015) considers an individual fossil specimen to be significant if it is identifiable and if it meets one of the following criteria:

- A type specimen (the individual from which a species or subspecies has been described)
- A member of a rare species
- A species that is part of a diverse assemblage (for instance, a site where more than one fossil has been discovered) and from which important information regarding life histories of individuals can be drawn
- An element different from, or more complete than, those now available for its species
- A complete specimen

More specifically, PG&E uses the following research criteria to determine whether a fossil is significant:

- Taxonomy – Fossils that represent rare or unknown taxa, such as defining a new species
- Evolution – Fossils that represent important stages in evolutionary relationships, to fill gaps or enhance under-represented intervals in the stratigraphic record
- Biostratigraphy – Fossils that are important for determining relative geologic age, or for use in stratigraphic correlation
- Paleoecology – Fossils that are important for re-creating ancient community structure and ancient sedimentary environment
- Taphonomy – Fossils that are exceptionally well or uniquely preserved

6.2 Sensitivity Criteria

PG&E uses the PFYC developed by BLM to assess paleontological sensitivity (Table 7). In this system, geologic units are classified based on the relative abundance of scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts. It is important to note that although significant localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class. The relative abundance of significant localities is the primary determinant for the class assignment.

Table 7. Paleontological Sensitivity of Geologic Units Using BLM Potential Fossil Yield Classification System

Class 1 – Very Low
Geologic units not likely to contain fossil remains that include: ▪ Igneous or metamorphic units ▪ Units precambrian in age or older ▪ Artificial or imported fill material
Class 2 – Low
Geologic units not likely to contain vertebrate or scientifically significant nonvertebrate fossils that include: ▪ Vertebrate or significant invertebrate or plant fossils not present or very rare ▪ Geologic units younger than 10,000 years before present ▪ Recent aeolian deposits ▪ Sediments that exhibit significant physical and chemical changes
Class 3 – Moderate or Unknown
Fossiliferous sedimentary units in which fossil content varies in significance, abundance, and occurrence or they are of unknown fossil potential. These units have the following subclassifications: ▪ Class 3a – Moderate potential: relatively low potential to impact significant fossils but high potential to impact common fossils. They generally exhibit the following characteristics: - Marine in origin with sporadic occurrences of vertebrate fossils - Vertebrate and scientifically significant invertebrate or plant fossils occur intermittently, with low predictability ▪ Class 3b – Unknown potential: sedimentary unit is poorly studied or documented but conditions suggest significant fossils could be present.
Class 4 – High
Geologic units that have a high occurrence of significant fossils that vary in occurrence and predictability. These units have the following subclassifications: ▪ Class 4a – Unit is exposed with little soil or vegetative cover or has extensive outcrop areas with exposed bedrock ▪ Class 4b – Unit is buried by extensive soil or vegetation cover. Exposed outcrops are less than contiguous 2 acres.
Class 5 – Very High
Geologic units that consistently produce scientifically significant fossils. Fossils can be reasonably expected to occur within the impacted area.
Source: Adapted from PG&E 2015.

6.3 Determination of Sensitivity for Geologic Units within Study Area

PFYC criteria from Table 7 were applied to the geologic units in the study area as summarized in Table 8. These sensitivity ratings incorporate the geologic unit description in Section 5.2 and literature and records search in Section 5.3. The ratings also incorporate the extent of proposed earth-moving activities discussed in Section 2.

Table 8. Paleontological Sensitivity of Geologic Units in Study Area

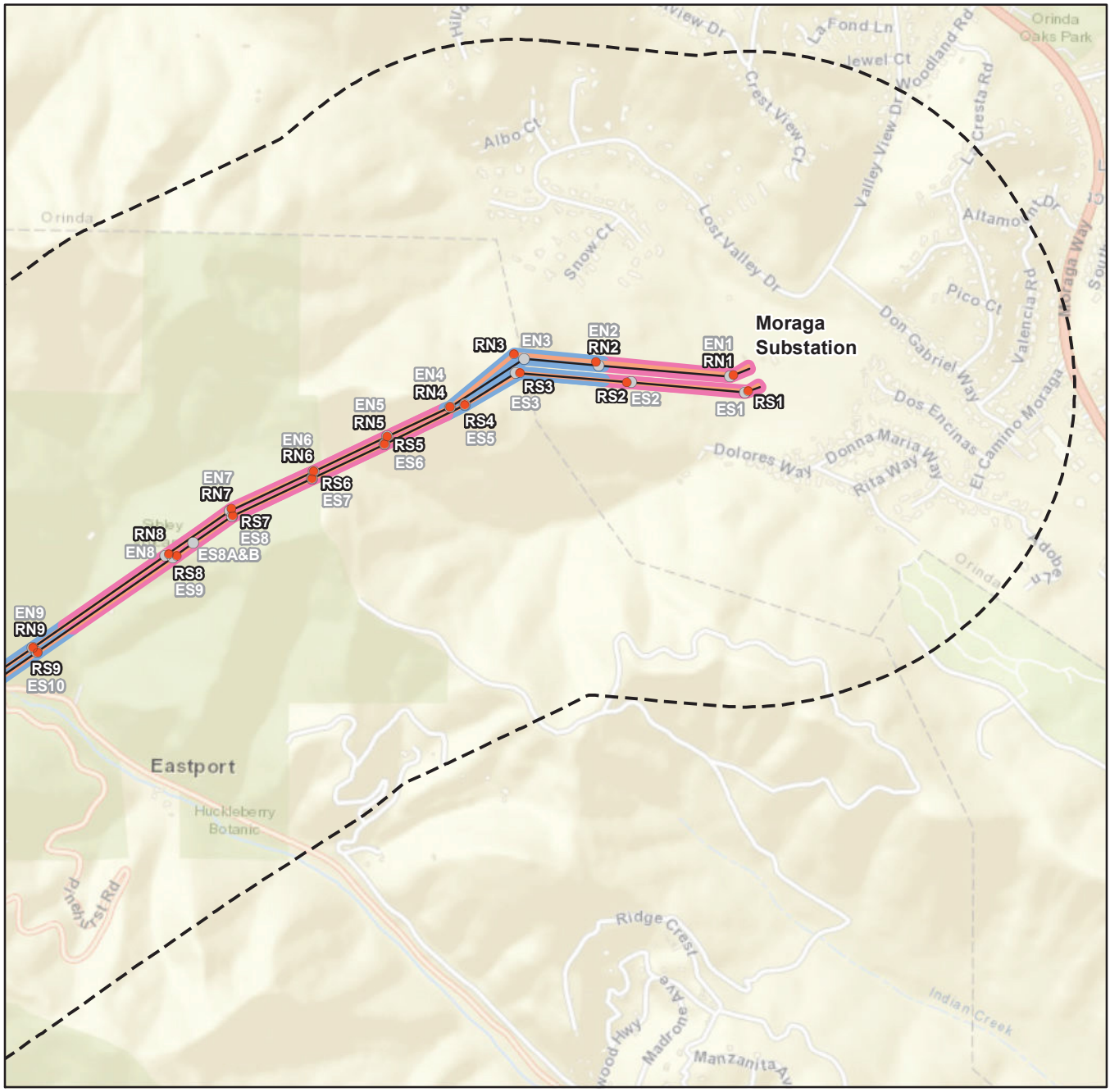
Geologic Unit	Paleontological Sensitivity – PFYC Category	Basis for Sensitivity Rating
Af – Artificial fill	1: very low	Artificial fill has lost its geological context.
Qhsc – stream channel deposits	2: low	Holocene-age sediment generally is considered too young to contain scientifically significant fossils.
Qhaf – Alluvial/fluvial deposits (Holocene)		
Qpaf – Alluvial/fluvial deposits (Pleistocene)	4: high	The project area crosses Pleistocene-age sediment at its west end. Significant vertebrate fossils are periodically found in Qpaf sediment. Because of the extent of excavation for the duct banks and vaults in this unit, there is a high probability that vertebrate fossils will be encountered.
Tst – Siesta Formation	4: high	This formation has many fossil localities relative to the small size of the outcrop. Twelve fossil localities were found within 4 miles of the project area.
Moraga Formation – Tmb and Tms	3a: moderate	Two vertebrate localities were found in these formations. Both are within 2 miles of the project area. This is considered a moderate concentration of fossils considering the extent of the outcrops.
Tor – Orinda Formation	4: high	This formation has 20 vertebrate fossil localities in the East Bay. Several of these are within 2 miles of the project area.
Tcc – Claremont chert	3a: moderate	Only four fossil localities are attributed to this formation. All four were found in the drilling of the Caldecott Tunnel.
Tsm – glauconitic mudstone	2: low	No vertebrate fossil records were found for this unit despite it being disturbed by Caldecott tunnel boring.
Tes – mudstone	2: low	This unit is known to be foraminifera-rich (Graymer 2000). But these microfossils are abundant in this unit.
Ta – glauconitic sandstone	4: high	Well-preserved fossil corals are reported in Graymer (2000). Alden (2023) describes them as being found on Saroni Drive within half a mile of the project area.
TmII – Mulholland Formation	2: low	This formation is fossiliferous but is limited to the study area's eastern margin. It crops out on a ridge east of Moraga Substation. Because the geology changes greatly over small areas, project activities will not likely disturb this formation.
Kr – Redwood Canyon Formation	3: moderate	This formation has yielded a couple marine invertebrate fossils across a large area.
Ksc – Shephard Creek Formation	2: low	No fossil records were found for this unit.
Ko – Oakland Conglomerate	2: low	No fossil records were found for this unit.

Geologic Unit	Paleontological Sensitivity – PFYC Category	Basis for Sensitivity Rating
Kjm – Joaquin Miller Formation	2: low	No fossil records were found for this unit.
Jsv – Keratophyre	1: very low	Intrusive igneous rocks are not paleontologically sensitive.
Jb – Massive basalt and diabase	1: very low	Coast Range Ophiolite are intrusive igneous rocks and other rocks not considered paleontologically sensitive.
Sp - Serpentinite		
Kfn – Sandstone Novato Quarry	2: low	Fossils have been discovered in this unit in Marin County, but none have been found in Alameda County or Contra Costa County.
KJfm – Franciscan Complex	2: low	Franciscan Complex units have undergone low-grade metamorphic processes. Macrofossils are lacking in these units with rare exceptions. Microfossils are present but are found in abundance.
Fs – Graywacke and meta-graywacke		

7. Findings

Figure 3, Paleontological Sensitivity Map, is based on Table 8 and shows the paleontological sensitivity of geologic units underlying existing and rebuilt power line alignments and substations. From Figure 3 and Table 4, the following conclusions can be made.

- Excavation activities deeper than 3 feet in the following geological units have high paleontological sensitivity and have high potential to encounter paleontological resources:
  - Tst – Siesta Formation
  - Tor – Orinda Formation
  - Ta – Glauconitic sandstone
  - Qpaf – Alluvial/fluvial deposits (Pleistocene)
- Excavation activities in other units have very low to moderate potential to encounter paleontological resources. These units include:
  - Af – Artificial fill
  - Qhsc – Stream channel deposits
  - Qhaf – Alluvial/fluvial deposits (Holocene)
  - Tmb/Tms - Moraga Formation
  - Tcc – Claremont chert
  - Tsm – Glauconitic mudstone
  - Tes – Mudstone
  - TmIl – Mulholland Formation
  - Ksc – Shepard Creek Formation
  - Ko – Oakland Conglomerate
  - Kjm – Joaquin Miller Formation
  - Jsv – Keratophyre
  - Jb – Massive basalt and diabase
  - Sp – Serpentinite
  - Kfn – Sandstone Novato Quarry
  - KJfm – Franciscan Complex
  - Fs – Graywacke and meta-graywacke



Legend

Overhead Structures
- Existing
- Proposed

Overhead Routes
- Existing
- Proposed

Underground Routes
- Proposed
- 0.5-mile Project Buffer

Paleontological Sensitivity Category (PFYC)
- 1: Very Low
- 2: Low
- 3: Moderate
- 4: High

Version: 3/19/2024

N

0 0.25
Miles

Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Figure 3. Page 1 of 4
Paleontological Sensitivity
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

Geology Data Source: Graymer, 2000

Jacobs

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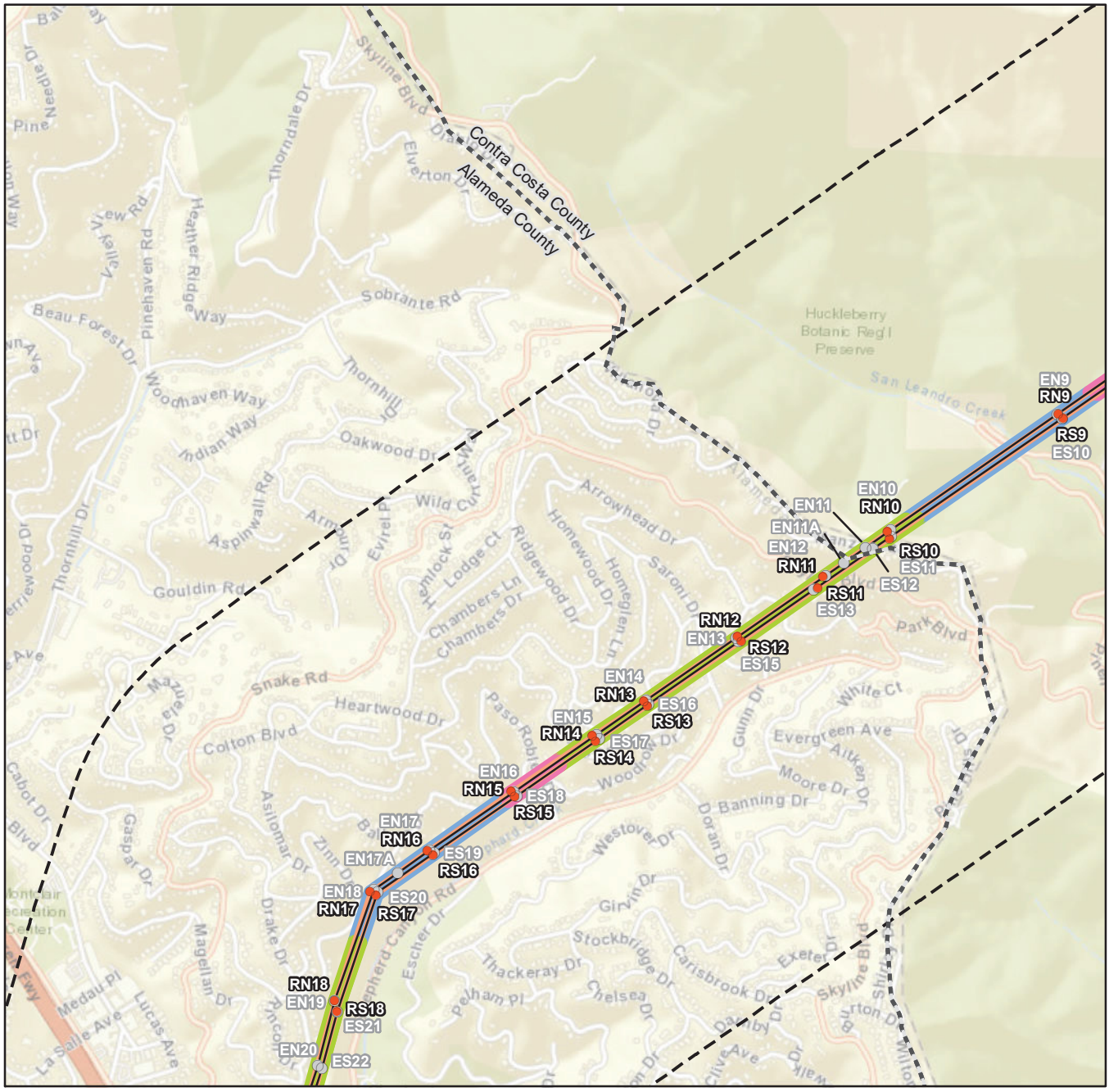

Version: 3/19/2024

Legend

Overhead Structures
- Existing
- Proposed

Overhead Routes
- Existing
- Proposed

Underground Routes
- Proposed
- 0.5-mile Project Buffer

Paleontological Sensitivity Category (PFYC)
- 1: Very Low
- 2: Low
- 3: Moderate
- 4: High

N

0 0.25
Miles

Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Figure 3. Page 2 of 4
Paleontological Sensitivity
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

Geology Data Source: Graymer, 2000

Jacobs

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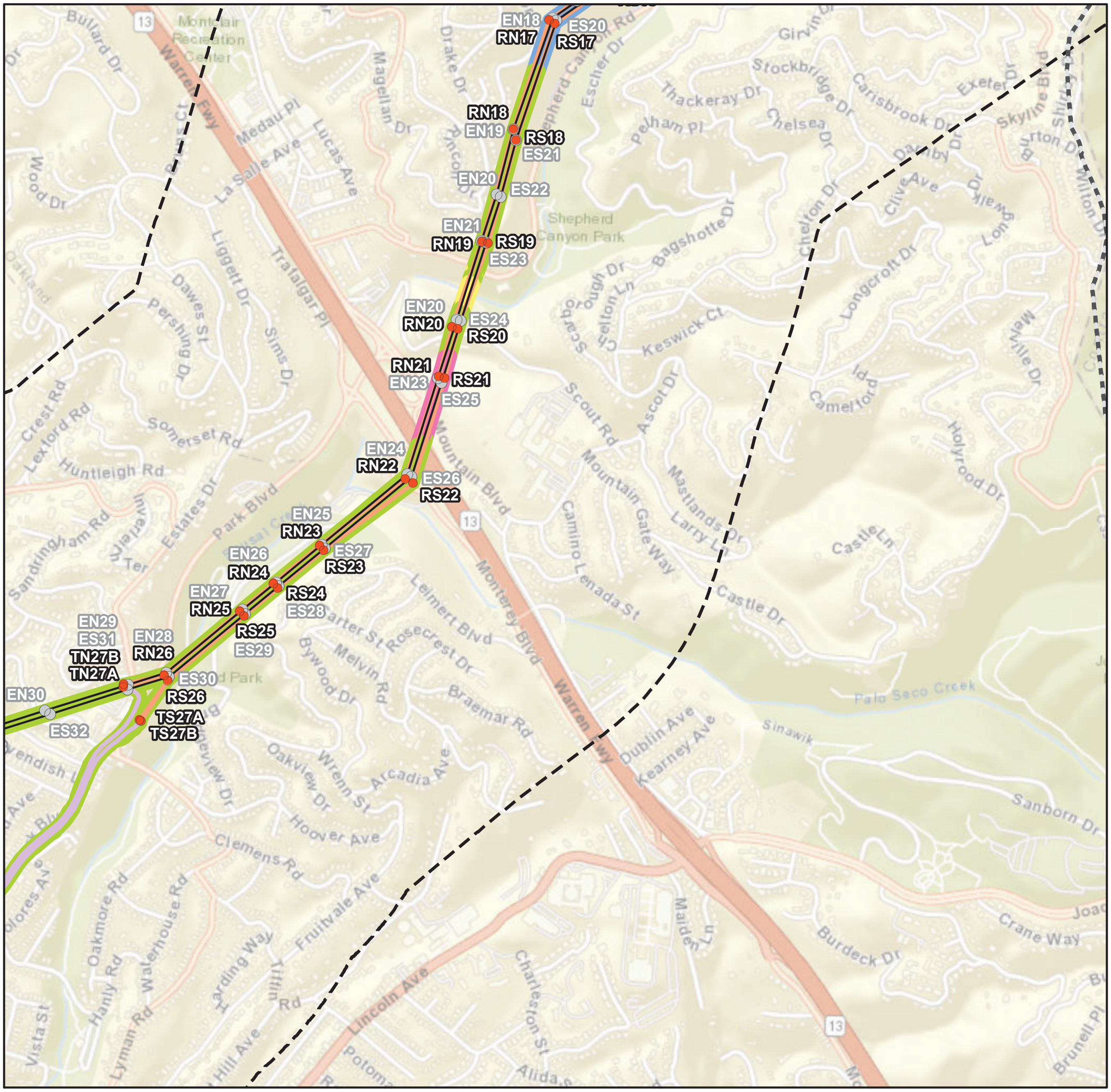

Legend

Overhead Structures
- Existing
- Proposed

Overhead Routes
- Existing
- Proposed

Underground Routes
- Proposed
- 0.5-mile Project Buffer

Paleontological Sensitivity Category (PFYC)
- 1: Very Low
- 2: Low
- 3: Moderate
- 4: High

Version: 3/19/2024

N

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Figure 3. Page 3 of 4
Paleontological Sensitivity
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Geology Data Source: Graymer, 2000

Jacobs

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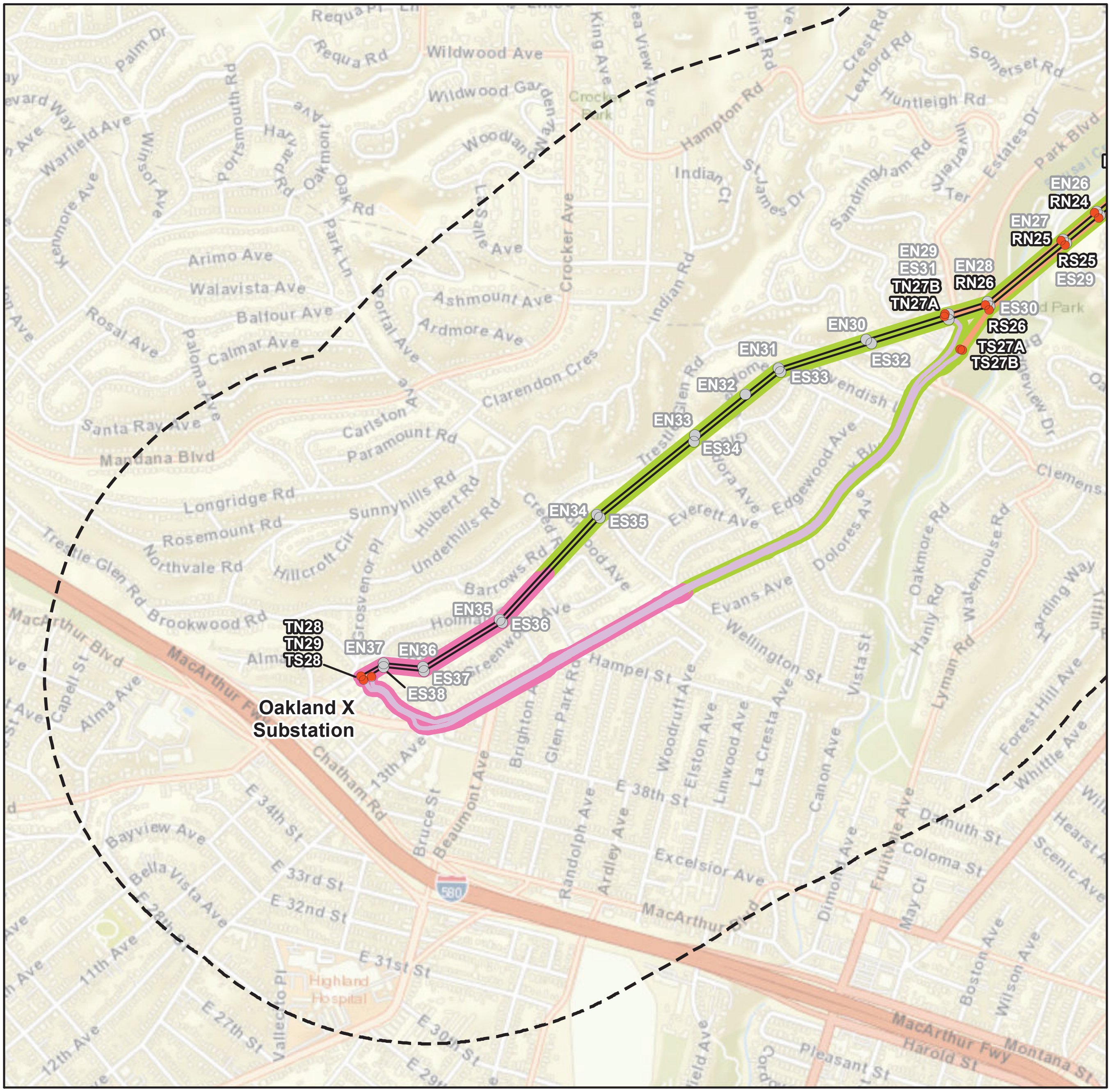

Legend

Overhead Structures

- Existing
- Proposed

Overhead Routes

- Existing
- Proposed

Underground Routes

- Proposed
- 0.5-mile Project Buffer

Paleontological Sensitivity Category (PFYC)

- 1: Very Low
- 2: Low
- 3: Moderate
- 4: High

Version: 3/19/2024

N

0 0.25
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Figure 3. Page 4 of 4
Paleontological Sensitivity
Oakland Power Reinforcement Project
Pacific Gas & Electric Company

Preliminary and Subject to Change Based on CPUC Requirements, Final Engineering, and Other Factors

Geology Data Source: Graymer, 2000

Jacobs

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There is potential to encounter geologic units of greater sensitivity at depth and also potential – although relatively low – for unanticipated fossil discovery in geologic units determined to be of low to moderate sensitivity.

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Table of Abbreviations

APM	Applicant-Proposed Measure
bgs	below ground surface
BLM	Bureau of Land Management
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CRS	Cultural Resource Specialist
FLPMA	Federal Land Policy and Management Act
kV	kilovolt(s)
OPLA-PRP	Omnibus Public Lands Act, Paleontological Resources Preservation
PBDB	Paleobiology database
PFYC	Potential Fossil Yield Classification
PG&E	Pacific Gas and Electric
SVP	Society for Vertebrate Paleontology
UCMP	University of California, Museum of Paleontology
USC	United States Code
USFS	U.S. Forest Service