Appendix E4. Landslide Evaluation

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MORAGA-OAKLAND X

Landslide Hazard Evaluation

InfraTerra, Inc

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EXECUTIVE SUMMARY

This report summarizes results of mapping of landslide and associated erosion hazards for existing and proposed replacement structures along existing electrical power lines that connect Moraga Substation with Oakland X Substation. The corridor evaluated for this study extends northeast approximately 5 miles from Oakland to Moraga, Alameda and Contra Costa Counties.

Results of this desktop study include a digital inventory of landslides and potentially related surface erosion features for evaluation of proposed alignments and related structures for the underground and aboveground portions. Desktop interpretation of lidar and aerial imagery for this project, validated by field reconnaissance, confirms the presence of numerous landslides along the central and eastern sections of the project corridor. Field reconnaissance documented the absence of active slope failure extending beneath existing and proposed aboveground structure locations.

No active or potentially landslides are identified extending beneath the existing or proposed towers. The towers are located on intact ground with no evidence of recent undercutting or encroachment from slides lower on the slope. However, several proposed tower locations are located uphill of active or pre-historic/older slides. These locations are not considered to be exposed to significant long-term hazard from uphill migration of these slides towards the towers but additional characterization may be warranted.

The proposed underground portion along Park Boulevard southwest of Leimert Boulevard does not cross any mapped slides. A landslide inferred by CGS at the intersection of Park Boulevard with Estates Drive, near proposed transition structure for Circuit 1 and crossed by the underground portion of the northern line, appears to either not be expressed in the current topography or have been repaired as part of construction of the Park Boulevard roadway. Additional site-specific evaluation may be necessary to confirm the absence of a long-term hazard.

Thirty-six (36) erosion sites in the vicinity of the towers and along the proposed underground portion were identified and mapped based on interpretation of available lidar and aerial imagery, confirmed where accessible during the field reconnaissance. These potential erosion sites generally consist of hillside gullies, incised slope erosion, and creek or drainage crossings. These generally have minimal potential for immediate impact to the existing or proposed towers.

EXECUTIVE SUMMARY ..... **I**

1.0 INTRODUCTION **1**

1.1. Purpose 1

1.2. Scope of Work 1

1.3. Data Sources 1

2.0 CORRIDOR GEOLOGY **3**

2.1. Geologic Units 3

3.0 LANDSLIDE HAZARDS **7**

3.1. Mapping Procedures 7

3.2. Landslide Hazards to Above Ground Structures 9

3.3. Landslide Hazards to Underground Routes 10

4.0 EROSION HAZARDS **10**

4.1. Mapping Procedure 10

4.2. Erosion Hazards 11

5.0 SUMMARY AND RECOMMENDATIONS **12**

5.1. Limitations 13

6.0 REFERENCES **14**

Tables

Table 1-1: Data Sources Used in Landslide Mapping....2

Table 1-2: Aerial Photographs Interpreted for This Study....2

Table 2-1: Description of geologic units and vulnerability to slope instability (from west to east)....4

Photos:

Photo 1: View southwest of recent shallow soil slip along overhead corridor on south side of Trestle Glen Road....13

Figures:

Figure 1: Bedrock Geologic Map....

Figure 2: Index Map of Detailed Slope Hazards Maps Along Project Route....

Figure 3: Landslide Area 1....

Figure 4: Landslide Area 2....

Figure 5: Landslide Area 3....

Figure 6: Landslide Area 4....

Figure 7: Landslide Area 5....

Figure 8: Landslide Area 6....

Figure 9: Landslide Area 7....

Figure 10: Landslide Area 8....

Figure 11: Landslide Area 9....

Figure 12: Landslide Area 10....

1.0 INTRODUCTION

This report presents maps of landslide and erosion hazards for existing and proposed structures along existing electrical power lines and proposed replacement that connect Moraga Substation with Oakland X Substation (Figure 1). The corridor evaluated for this study extends northeast approximately 5 miles from Oakland to Moraga in Alameda and Contra Costa Counties. The proposed project traverses complex bedrock geology within rugged terrain of the Oakland hills including faulted bedrock along the Hayward fault located adjacent to Highway 13 (Figure 1).

1.1 *Purpose*

The purpose of this desktop study is to evaluate landslide hazards along existing electrical power lines and proposed replacement connecting Moraga Substation with Oakland X Substation. Results of this desktop study identify landslide and potentially surface erosion features to help in the evaluation the hazards for both the underground and aboveground replacement portions.

1.2 *Scope of Work*

This evaluation performed by Christopher Hitchcock, Certified Engineering Geologist (C.E.G. 2017), supported by Brian Kessler (InfraTerra Staff Geologist), is based on a review of pertinent geologic and seismologic literature, soil survey maps, and aerial imagery. Our reconnaissance-level assessment included driving or walking each existing and proposed project to verify mapped landslide and erosion features and document recent slope failures not captured on available aerial and lidar imagery. Specifically, this study included the following tasks:

- Compilation of available geologic information;
- Preparation of GIS-based derivative slope, hillshade, and contour maps from lidar datasets;
- Desktop mapping of landslide and erosion features;
- Field reconnaissance; and,
- Preparation of this report.

1.3 *Data Sources*

Documented below are the data sources used to evaluate landslide hazards for the power line corridor. Geographic information systems (GIS) technology enables numerical- based mapping of natural hazards, including landslide susceptibility. Available digital geologic and soils data have been evaluated using ESRI ArcGIS® software (version 10.8.2) with the 3D Analyst™ and ArcGIS® Spatial Analyst™ extensions. We have incorporated various geologic and geohazards layers through the integration of existing regional geologic mapping (50,000 scale) combined with available digital hazard data and performing analysis of available satellite imagery (Table 1-1).

Lidar data downloaded, processed, and reviewed for this study was obtained from the online USGS National Map and consisted of lidar point cloud data collected and processed in 2006, 2007 and 2018 (Table 1-1). The 'Hillshade' tool within ArcGIS® Spatial Analyst was used for different illumination source angles to create shaded relief maps from the lidar-derived bare-earth surface raster. Slope generally is the dominant factor controlling whether a slope failure can occur regardless of the susceptibility to failure (e.g. consolidation, saturation or direction of bedding planes) of the geologic unit. The 'Slope' tool within ArcGIS® 3D Analyst™ was used to calculate and depict slope

(gradient, or rate of maximum change in z-value) from each cell of the lidar rasters.

Assessment of conditions and potential geologic hazards included desktop compilation and analyses of available geologic and soil data, and satellite imagery in Google Earth. For this study, initial screening of slope stability was based on landslide inventories developed by the California Geological Survey (2003a, 2003b) and statewide landslide susceptibility hazard maps (Wills et al., 2011).

Compiled bedrock geologic mapping by Graymer (2000) of the corridor was incorporated in the landslide mapping (Figure 1). Non-digital geologic mapping by Radbruch (1957; 1969) also provide useful information on engineering properties of bedrock along the project extent. Soils reviewed for this study, published by the Natural Resources Conservation Service of the U.S. Department of Agriculture (USDA), were obtained digitally from the Soil Survey Geographic (SSURGO) database. The landslide hazard maps accompanying this report incorporate mapped landslides and erosion features within GIS layers (ESRI shapefile format) in UTM Zone 10 North on the North American Datum of 1983 (NAD83) coordinate system.

Table 1-1: Data Sources Used in Landslide Mapping

Digital and Non-Digital Data	Data Source
Lidar-derived Digital Elevation Models from point cloud datasets	USGS Seamless: USGS Lidar Point Cloud CA_ALAMEDACO_2006 USGS Lidar Point Cloud CA_CONTRACOSTACO_2007 USGS Lidar Point Cloud CA_NoCAL_3DEP_Supp_Funding_2018_D18 Various PG&E lidar datasets (2007 through 2022)
50,000 scale geologic mapping	Compilation by USGS (Graymer, 2000): Radbruch (1957; 1969)
Landslide inventory	Statewide California Geological Survey database compiled from CGS (2003a, 2003b)
Landslide susceptibility hazard (Map Sheet 58)	California Geological Survey (Wills et al., 2011)
Digital aerial imagery	USGS National Agriculture Imagery Program (NAIP) M_3712215_ne/nw/sw (10-25-2017)
Surficial soil data	Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database

Satellite imagery of the area from Google Earth was compared against historic aerial photographs to detect areas of slope change over time. Digital scans of historic aerial photographs were obtained from the University of California Santa Barbara (UCSB) aerial photography library. Available relevant imagery ranging from 1939 through 1965 was interpreted for this study (Table 1-2). More recent digital NAIP Plus imagery (2016) overlain within GIS provided more recent information on slope conditions (Table 1-1).

Table 1-2: Aerial Photographs Interpreted for This Study

Flight	Date	Scale	Photo Numbers	Type
C-5750	8-2-1939	1:20,000	289-44, -45, -46	Black and White, vertical angle
BUU-1950	6-10-1940	1:20,000	344-63, -64	Black and White, vertical angle
GS-CP	10-28-1946	1:23,600	6-38, -39	Black and White, vertical angle
CAS-65-130	5-12-1965	1:12,000	7-27, -28, -29	Black and White, vertical angle

As part of geologic data compilation for seismic hazard zonation of the western project area, CGS (2003a; 2003b) prepared an inventory of existing landslides in Oakland based on review of previously published landslide mapping, analysis of stereo-paired aerial photographs, and limited field reconnaissance. Landslides were mapped at a scale of 1:24,000 with the completed mapping scanned, digitized, and attributes compiled in the statewide CGS landslide database. The CGS landslide inventory has been incorporated as part of this study and updated with more detailed (1:2,400-scale) landslide mapping using more recent aerial and lidar imagery.

For preparation of the CGS landslide inventory, previously published geologic mapping that included delineation of landslides was compiled and reviewed including mapping by Lawson (1914), Louderback (1951), Radbruch (1957, 1969), Taylor and Brabb (1972), Nilsen (1973a, 1973b, 1975), Blake and others (1974), Nilsen and others (1976), and Graymer and others (1996). Landslide features identified from these sources were reevaluated during the aerial photograph interpretation and limited field reconnaissance conducted by CGS (2003a; 2003b). The landslide inventory also included review of records of historical landslide occurrences that were in the files of the City of Oakland. For this study, the source geologic references cited above, and within the reference section of this report, were re-evaluated and incorporated along with the CGS landslide mapping. Landslides originally mapped by CGS (2003a, 2003b) are shown on detailed landslide maps prepared for this study (Figures 3 through 12).

2.0 CORRIDOR GEOLOGY

Bedrock and surficial deposits along the electrical corridor and proposed underground portion have been mapped by Case (1968), CGS (2003a), Dibblee and Minch (2005), Radbruch (1969), Graymer (2000), Graymer et al. (1994, 1997a/b, 1998), Helley et al. (1972), Helley and Graymer (1997a and b), Knudsen, et al. (1997 and 2000), Witter, et al. (2006), Wagner et al. (1991), and Ellen and Wentworth (1995). The bedrock geologic map prepared by Graymer (2000) provides the most comprehensive digital mapping covering the project area and is included as Figure 1.

2.1 *Geologic Units*

The susceptibility to slope failure along the corridor is controlled largely by the nature of the underlying bedrock and alluvial deposits, shown on Figure 1. Table 2-1 provides a general overview of the relative potential for landsliding (low to high) for bedrock and alluvial units along the project

corridor based on the density of existing mapped landslides within each unit and inferred shear strength from laboratory test data compiled by CGS (2003a, 2003b). CGS (2003a, 2003b) have classified bedrock formations along the corridor based on shear strength differences between coarse-grained (higher strength) and fine-grained (lower strength) lithologies. Formations which contain interbedded sandstone and shale were further subdivided based on the stratigraphic and material strength characteristics related to favorable and adverse bedding orientation, as determined from structural and terrain data. Generally coarse-grained material strength dominates where bedding dips into a slope (favorable bedding) while fine-grained material strength dominates where bedding dips out of a slope (adverse bedding).

Table 2-1: Description of geologic units and vulnerability to slope instability (from west to east)

Geologic Unit	Map Symbol	Description	Landslide Potential	Corridor Sections
Alluvial fan and fluvial deposits (Pleistocene)	Qpaf/Qpof	Brown, dense, gravely and clayey sand or clayey gravel that fines upward to sandy clay.	Low	Oakland X Substation; Western part of underground portion and western aboveground
Sandstone of the Novato Quarry terrane (Late Cretaceous)	Kfn	Distinctly bedded to massive, fine- to coarse-grained, mica-bearing, lithic wacke.	High	Eastern part of the underground portion and western aboveground
Franciscan complex mélange (Cretaceous and/or Late Jurassic)	KJfm/fs	Sheared argillite and graywacke with minor tuff, Includes blocks of meta-graywacke (unit fs), chert (fc), greenstone (fg) and serpentinite (sp)	High	Highway 13 corridor crossing
Undivided Franciscan complex rocks (Cretaceous and Jurassic)	Kjfm	Sheared and metamorphosed graywacke, shale, mafic volcanic rock, chert, ultramafic rock, limestone, and conglomerate.	High	Highway 13 corridor crossing
Coast Range ophiolite (Jurassic)	Jb	Massive basalt and diabase.	Moderate	East of Highway 13
Keratophyre and quartz keratophyre (Late Jurassic)	Jsv	Highly altered intermediate and silicic volcanic and hypabyssal rocks.	Moderate	East of Highway 13
Joaquin Miller Formation (Late Cretaceous)	Kjm	Thinly bedded shale with minor sandstone.	High	East of Highway 13

Geologic Unit	Map Symbol	Description	Landslide Potential	Corridor Sections
Oakland Conglomerate (Late Cretaceous)	Ko	Massive, medium- to coarse-grained, biotite and quartz-rich wacke and prominent interbedded lenses of pebble to cobble conglomerate.	Low	East of Highway 13
Shephard Creek Formation (Late Cretaceous)	Ksc	Distinctly bedded mudstone and shale, mica- rich siltstone, and thin beds of fine-grained, mica-rich wacke.	High	East of Highway 13
Redwood Canyon Formation (Late Cretaceous)	Kr	Distinctly bedded, cross-bedded to massive, thick beds of fine- to coarse-grained, biotite- and quartz-rich wacke and thin interbeds of mica-rich siltstone.	Moderate	Shepherd Canyon
Unnamed glauconitic sandstone (Paleocene)	Ta	Coarse-grained, green, glauconite-rich, lithic sandstone interbedded with mudstone.	Moderate	Shepherd Canyon
Unnamed mudstone (Eocene)	Tes	Green and maroon, foraminifer-rich mudstone, locally interbedded with hard, distinctly bedded, mica-bearing, quartz sandstone.	High	Shepherd Canyon
Unnamed glauconitic mudstone (Miocene and Oligocene(?))	Tsm	Brown mudstone interbedded with sandy mudstone containing prominent glauconite grains	Moderate	Shepherd Canyon
Claremont chert (late to middle Miocene)	Tcc	Laminated and bedded chert, minor brown shale, and white sandstone.	Low	San Leandro Creek crossing
Orinda Formation (late Miocene)	Tor	Distinctly to indistinctly bedded, nonmarine, pebble to boulder conglomerate, conglomeratic sandstone, coarse- to medium-grained lithic sandstone, and green and red siltstone and mudstone	High	Moraga Hills
Moraga Formation (late Miocene)	Tms	Interflow sedimentary rocks	High	Uphill of Moraga Substation
Siesta Formation (late Miocene)	Tst	Nonmarine siltstone, claystone, sandstone, and minor limestone	High	Moraga Substation

The western section of the Moraga-Oakland X power line corridor, starting at Oakland X Substation, is located on older alluvial fan deposits (geologic units Qpaf and Qpoaf; Figure 1). These deposits typically consist of clayey sand near the surface with clayey to sandy gravel at depth. Landslides are present on steeper slopes, but failures typically are infrequent and shallow consisting of debris flows and slumps (Figures 11 through 12). Hazards are greatest in areas of shallow groundwater or sources of uncontrolled surface drainage.

In the section of the corridor along Sausal Creek, west of Highway 13, bedrock of the Franciscan Complex (geologic units Kfh, KJf, KJfm, and fs) underlies the corridor. Both aboveground and underground portions cross bedded to massive fine- to coarse-grained sandstone (unit Kfh) that locally is prone to deep-seated slides. The steep banks of Sausal Creek are mantled by numerous older, potentially active slides that locally have been remobilized as shallower debris and earth flows (Figures 9 and 10).

Complex slivers of sheared and faulted bedrock (units Jb, fs, sp, Kjm and Ko) are present along the Hayward fault at the Highway 13 corridor crossing. These bedrock materials of the Oakland Conglomerate, Redwood Canyon, and Joaquin Miller Formations can have highly variable physical properties and susceptibility to landsliding (Table 2-1). Along Shepherd Canyon and east to San Leandro Creek, unnamed sandstone and mudstone units are highly prone to landslides with the exception of the more resistant Claremont Chert (unit Tcc; Figure 1). The eastern section of the corridor, including Moraga Substation, is underlain by sedimentary rocks of the Siesta, Moraga, and Orinda formations (Units Tst, Tms, and Tor; Figure 1), all of which are highly susceptible to slope failure.

3.0 LANDSLIDE HAZARDS

Geologic hazards with potential impact to the above and below-ground portions of the project, including along the corridor and underground replacement portion, consist primarily of slope failures which often are associated with areas of active slope erosion. Slope failures occur most frequently during and following the rainy season when high groundwater (elevated pore pressure) conditions persist. Landslides can also occur during or following during earthquakes, triggered by the strain induced in soil and rock by the ground shaking vibrations, or following significant rainfall events.

Earthquakes with magnitudes greater than about M_w4 can trigger landslides on susceptible slopes, and earthquakes greater than about M_w6 can generate widespread and large landslides (Jibson, 1993). The types of slope failure that are most commonly triggered by strong ground shaking include rock falls and topples in jointed hard rock, debris and rockslides in weathered bedrock, and translational/rotational slumping and sliding of hillslopes and stream banks.

The susceptibility of hillslopes to landslides is based on the field-verified observation that slope failures are rare on flat-lying areas, even in weak materials, and that landslide susceptibility increases with steeper slope and in weaker rocks. Landslide inventory mapping performed for this study provides a basis for determining the most likely locations for future shallow and deep-seated slope failure based on identification of past and current slope movement.

3.1 *Mapping Procedures*

Available lidar data and aerial imagery along the corridor were interpreted for this study with detailed landslide mapping conducted at 1:2,400-scale. Processing of available corridor lidar was first completed to create Digital Elevation Model (DEM) datasets. Mapping included assessment of the current conditions and evaluation of existing landslides centered along the existing power line corridor, as well as the underground portion. Figure 2 provides an index map of the detailed maps sheets along the project corridor. Maps of identified potentially active landslides identified on lidar for this study include Figures 3 through 12.

For this project, landslide features were mapped based on morphologic expression in lidar-derived topographic maps (e.g., crown scarps, evacuated drainages); tonal contrasts and appearance observed in aerial imagery; and review of available maps and publications of historic landslides. Mapping of landslides included identification of associated topographic features, such as concave slope (closed) depressions, steep or vertical scarps, shear zones located along the flanks of a landslide, and transverse ridges, snouts, and toes (Turner and Schuster, 1996). Recognizing these topographic features allows identification of landslides with a high level of certainty.

Mapped slope failures within the geodatabase include evaluation of:

(1) Slide activity (active, historic to pre-historic, older (potentially active));

(2) Interpretation certainty (definite, probable, questionable);

(3) Slope movement process (e.g., slump, earthflow, translational slide, rock fall); and,

(4) Estimated slide thickness.

The landslide inventory mapping performed for this study includes development of tabular GIS data that records the location, type, inferred activity, confidence in identification, and inferred depth of

each slope failure identified along the electrical power line corridors. This information is provided in numerical form for individual slope failure polygons, as shown on the inventory map legend for each map sheet (e.g., Figures 3 through 12).

The first number in the landslide inventory database provides the state of activity for the slope failure. Activity of the landslide is classified as active, historic to pre-historic, or older and potentially active (likely Quaternary age) based on the freshness of landslide features and amount of erosion. Recency of failure typically is estimated based on erosion of the headscarp and failure margins and the degree of vegetation within the failure. Potentially active describes landslides with no obvious historic movement but evidence of a landslide mass that could be reactivated under the right conditions.

The second landslide inventory number provides the certainty of identification (e.g., definite, probable, or questionable). The third number refers to the inferred thickness of landslide deposits. These estimated thicknesses are based on evaluation of the type of landslide, height of the slide headscarp, and field observations. For example, soil slumps and earth flows along the power line corridor and underground portion are typically shallow (less than five feet thick), while slumps and translational slides typically are more than ten feet thick, and deeper-seated slides over 15 feet thick.

The fourth number denotes the dominant type of movement of the slope failure. Classification of the types of slope failures mapped along the power line corridor is based on the scheme developed by Varnes (1978), which encompass a range of mass movements including rock falls, debris flows, earth slides, and other mass movements. The dominant type of movement for each slide is assigned to the following:

(1) Soil slip/earth flow

(2) Debris slide, including rock and talus fall

(3) Debris flow

(4) Slump/rotational slide

(5) Translational slide

Desktop interpretation of lidar and aerial imagery for this project, validated by field reconnaissance conducted in September and October of 2023, confirms the presence of numerous landslides along the central and eastern sections of the project corridor (Figures 3 through 10). Recent slope failures identified in the field, but not captured on available aerial photography and lidar imagery, were added to the landslide inventory database developed for this project. For example, a recent soil slip along Trestle Glen Road located along the overhead corridor was identified and mapped (Photo 1).

Relatively few slides are mapped in the vicinity of the underground portion and existing towers that connect Oakland X Substation to the proposed transition structure for Circuit 1 at the intersection of Park Boulevard and Estates Drive.



Photo 1: View southwest of recent shallow soil slip along overhead corridor on south side of Trestle Glen Road (See Figure 10 for location).

3.2 *Landslide Hazards to Above Ground Structures*

No landslides are identified extending beneath proposed aboveground structures. Several proposed locations are located near active or pre-historic/older slides, with the structures typically located uphill from mapped landslides. Locations with nearby slides that could potentially extend uphill toward structures include existing northern (EN) line structure EN8 and proposed replacement northern (RN) line structure RN8 (Figure 4), ES10 and proposed RS9 (Figure 5), ES19 and RS16 (Figure 7), and ES22 (Figure 8). Although considered low risk, additional site-specific evaluation may be prudent to confirm the absence of a long-term hazard. However the locations mentioned above are on intact ground with no evidence of recent undercutting or active encroachment from the slides lower on the slope.

CGS (2003a) mapped a large landslide extending beneath Park Boulevard just east of the intersection with Estates Drive (see Figure 10). This slide appears to have been identified based on interpretation of historic aerial imagery and was not confirmed as part of our review of lidar and aerial imagery. The mapped eastern margin of the slide mapped by CGS is located adjacent to, but not extending under, RN26 and RS26. The existing and proposed structures are located east of the slide margin and therefore not considered at risk from the slide, if present.

3.3 *Landslide Hazards to Underground Portion*

Relatively few, generally shallow slides are mapped in the vicinity of the underground portion. Along Park Boulevard southwest of Leimert Boulevard do not cross any mapped slides (Figures 10 through 12). A landslide inferred by CGS at the intersection of Park Boulevard with Estates Drive, near proposed transition northern line structure TN27A for Circuit 1 (Figure 10), crossed by the northern underground line appears to either not be expressed in the current topography or repaired as part of construction of the Park Boulevard roadway. Additional site-specific evaluation may be necessary to confirm the absence of a long-term hazard.

4.0 EROSION HAZARDS

Potential erosion hazards typically exist where undergrounds lines are located beneath ephemeral or perennial stream channels or topographic swales that may flood during rainstorms or near active gullies on hillslopes. Damage to tower foundations may occur from vertical channel incision (downcutting) from concentrated erosion or from lateral erosion, either during individual storms or as the result of gradual long-term channel scour or widening. Other less common erosion-related features include sinkholes or collapse features that can occur from subsurface piping or soil compaction/dissolution.

4.1 *Mapping Procedure*

The susceptibility of a channel bed or hillside gully to erosion depends on the frequency and magnitude of storm runoff, stream channel or hillside gradient and dimensions, watershed area, geologic materials, and presence of features that may focus concentrated channel or overland flow with high velocities, and land-use practices. Hazards from erosion typically are a function of both hillslope and fluvial processes, and therefore slope stability (landslide) and stream scour hazards may overlap and be interrelated.

The first number in the erosion database provides the state of activity for the slope failure. Activity of each erosion site is classified as ongoing (active), during major rainfall/flood events only, or dormant or repaired based on the freshness of erosion features. The second erosion inventory number provides the certainty of identification (e.g., definite, probable, or questionable).

The third number refers to the inferred hazard to the alignment including high (potential for immediate impact), moderate (no immediate impact), or low (minimal potential for impact).

The fourth number denotes the type of erosion hazard. The dominant types of erosion include:

(1) Fluvial erosion

(2) Scour

(3) Undercutting

(4) Hillslope erosion

(5) Gullying/headward erosion

4.2 *Erosion Hazards*

Thirty-six (36) erosion sites were identified and mapped based on interpretation of available lidar and aerial imagery, confirmed where accessible via field reconnaissance (Figures 3 to 12). These potential erosion sites generally consist of hillside gullies, incised slope erosion, and creek or drainage crossings with generally minimal potential for immediate impact to aboveground structures. The main concern is headward erosion within gullies located downslope of towers and erosion or undercutting, with associated slope failure, of roadways proposed for underground portion.

Several locations along the proposed aboveground and underground portions have an elevated level of impact of moderate erosion hazard. Of these locations, none significantly impact proposed aboveground structure locations. Location #4 located downslope of ES3 and RS3 consists of gullying and is related to incipient slope instability (Location #3; Figure 3). Location #31 consists of gullying extending uphill near EN23 and RN21, west of Mountain Blvd and may be related to incipient slope instability (Location #31; Figure 8).

Slope erosion (Erosion Site #28) identified downhill of the intersection of Park Boulevard with Estates Drive, near proposed TN27A for Circuit 1 (Figure 10), is a potential minor hazard to northern underground line if the inferred slide mapped by CGS is present.

5.0 SUMMARY AND RECOMMENDATIONS

Desktop interpretation of lidar and aerial imagery for this project, validated by field reconnaissance, confirms the presence of numerous landslides along the central and eastern sections of the project corridor. Field reconnaissance conducted in September and October, 2023, confirmed the absence of active slope failure extending beneath existing and proposed surface tower locations.

Overhead Replacement Portion

No landslides are identified extending beneath proposed aboveground replacement towers with the structures located on intact ground with no evidence of recent undercutting or encroachment from the slides lower on the slope. Several proposed aboveground tower locations are located uphill of active or pre-historic/older slides. These locations with nearby slides that could potentially extend uphill toward towers include EN8 and RN8 (Figure 4), RN9 and RS9 (Figure 5), ES19 and RS16 (Figure 7), and ES22 (Figure 8). Additional site-specific evaluation may be necessary to confirm the absence of a long- term hazard.

CGS (2003a) mapped two large landslides extending beneath Park Boulevard just east of the intersection with Estates Drive (Figure 10). Although the presence of these features was not confirmed as part of our review of lidar and aerial imagery the existing and proposed aboveground replacement towers are relocated east of the inferred slides and therefore not considered at risk.

Several locations along the proposed aboveground and underground portions have an elevated level of impact of moderate erosion hazard, including Location #3 near structure ES3 and RS3 (Figure 3) and location #31 (Figure 8) near structure EN23 and RN21, east of Mountain Blvd.

Underground Replacement Portion

The northern underground alignment crosses a landslide inferred by CGS at the intersection of Park Boulevard with Estates Drive, near proposed TN27A for Circuit 1. This slide does not appear to be expressed in the current topography and may have been repaired as part of construction of the Park Boulevard roadway. Slope erosion was identified downhill of the intersection (Erosion Site #28). Additional site-specific evaluation may be necessary to confirm the absence of a long-term slope hazard. Evidence of ongoing localized slope instability includes road cracking and patches along Park Boulevard. No major erosion features or associated incipient landsliding are mapped along the underground portion.

5.1 *Limitations*

The information provided in this report is based on desktop interpretation of publicly available data largely derived from regional mapping studies. Although inferred conditions at each structure location have been evaluated based on review of recent topographic and aerial imagery, only limited field reconnaissance of the structures has been performed with no subsurface data collection. Site conditions and associated slope hazards may vary from that inferred from regional datasets and desktop evaluation alone.

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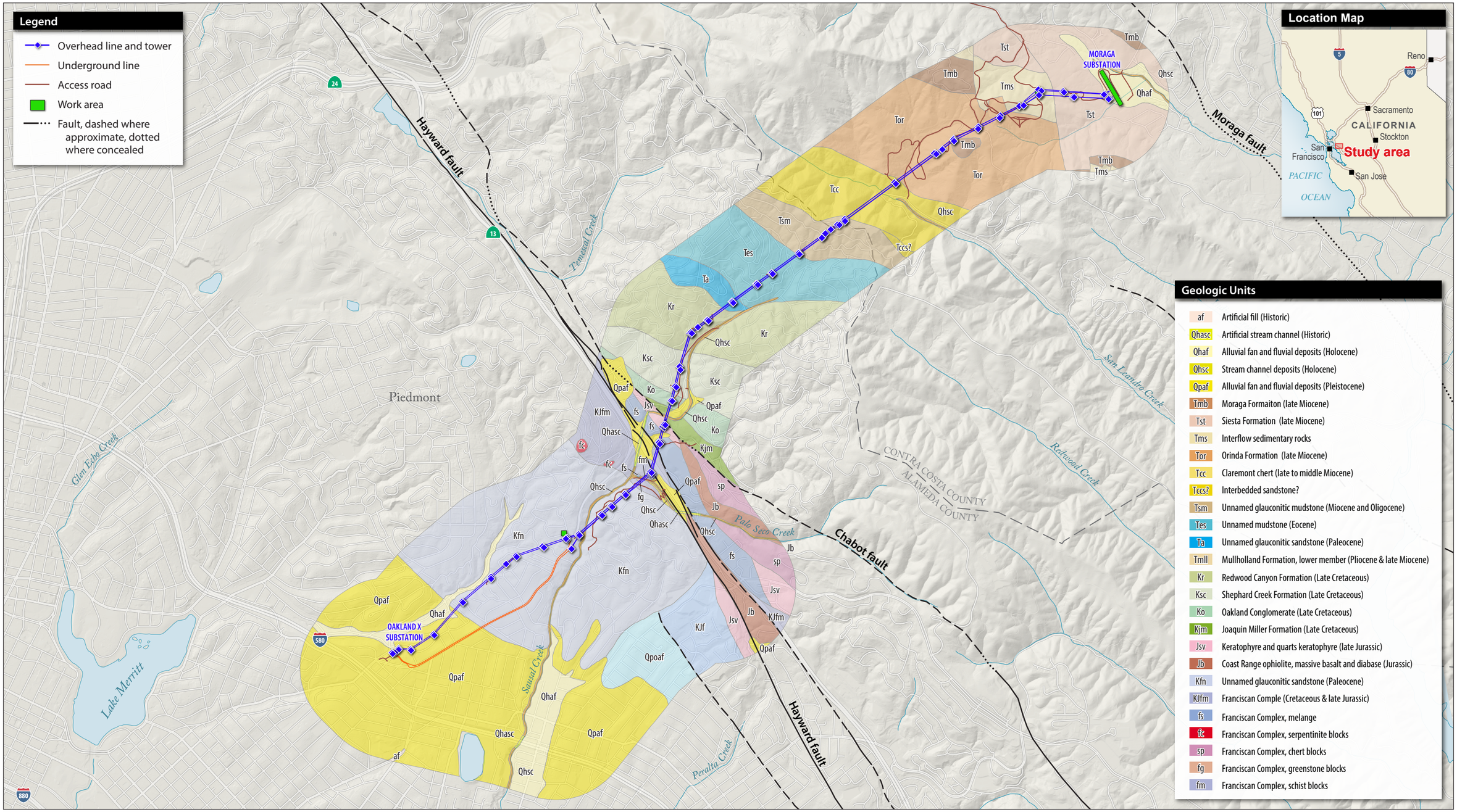


Map Projection: NAD 1983 UTM Zone 10N

Geology: Graymer, 2000. Faults: PG&E Geosciences Fault Database v16

N

0 0.5 1 mile

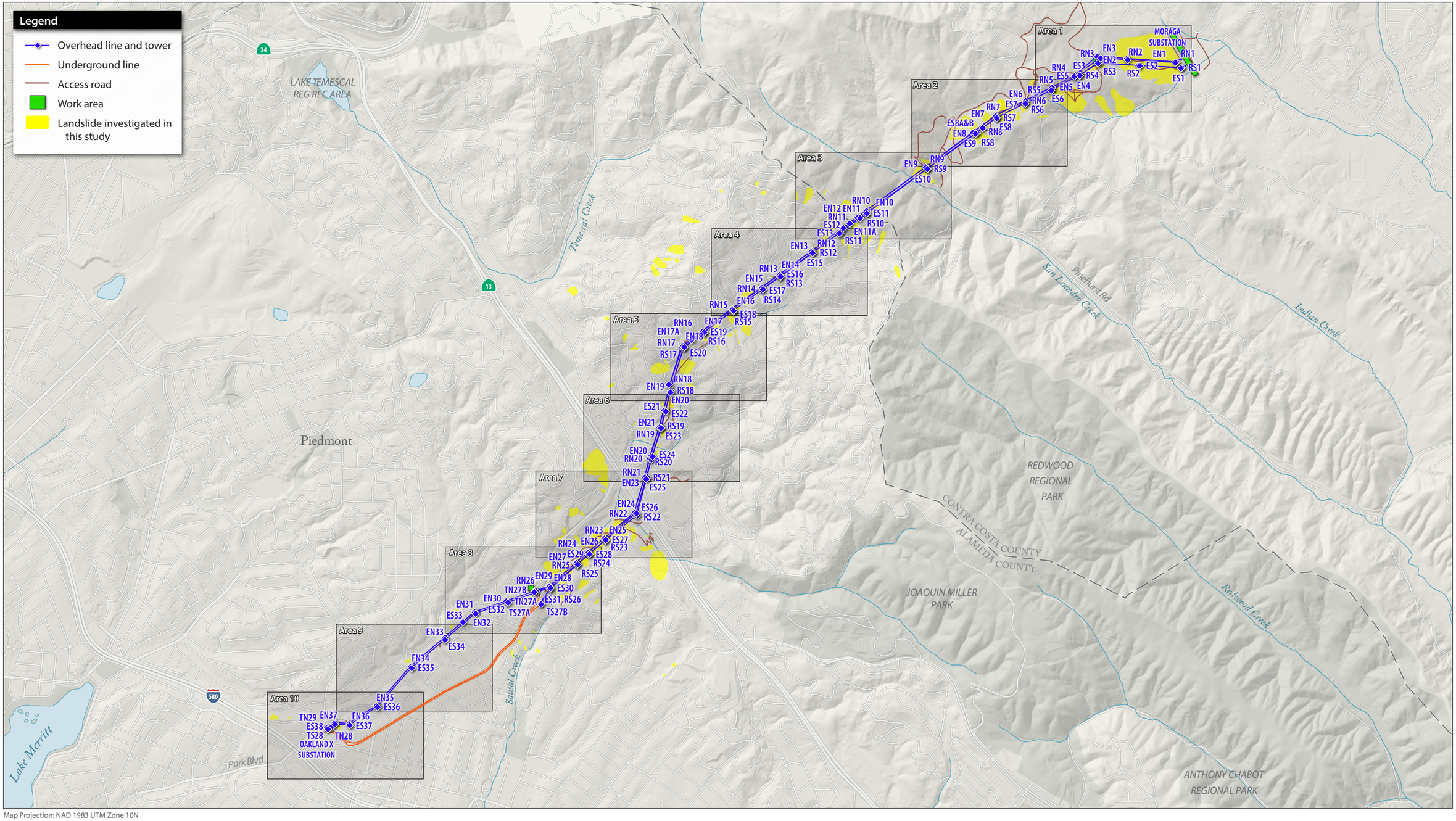
1:31,000

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 1. Bedrock Geologic Map

JUL 2024



Map Projection: NAD 1983 UTM Zone 10N

N

0 0.4 0.8 miles

1:26,000

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 2. Index Map of Detailed Slope Hazard Maps Along Project Route

JUL 2024

122°10'15"W

122°10'0"W

122°9'45"W

37°50'45"N

Legend

Overhead line and tower

Landslides

- Landslide headscarp
- Previously mapped landslide boundary (CGS)
- Active landslide
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

1233
- 1 = State of activity
- 2 = Certainty of identification
- 3 = Dominant type of movement
- 3 = Thickness of deposit

State of Activity
- 1 = Active
- 2 = Historic to pre-historic
- 3 = Older, potentially active

Dominant Type of Movement
- 1 = Soil slip/earth flow
- 2 = Debris slide, including talus fall
- 3 = Debris flow
- 4 = Slump/rotational
- 5 = Translational

Certainty of Identification
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Thickness of Deposit
- 1 = Less than 5 feet
- 2 = 5 to 15 feet
- 3 = Greater than 15 feet

Erosion Hazard

Active erosion channel

Erosion location

Location number #2 3213
- 3 = State of activity
- 2 = Certainty of identification
- 1 = Dominant erosion hazard
- 3 = Hazard to alignment

State of Activity
- 1 = Ongoing
- 2 = During major rainfall/flood events only
- 3 = Dormant or repaired

Certainty of ID
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Erosion Hazard
- 1 = Fluvial erosion
- 2 = Scour
- 3 = Undercutting
- 4 = Hillslope erosion
- 5 = Gullying/headward erosion

Hazard to Alignment
- 1 = High (potential for immediate impact)
- 2 = Moderate (no immediate impact)
- 3 = Low (minimal potential for impact)

Area of emplaced road fill

San Pablo Creek

Lost Valley Dr

Dolores Way

West Branch Creek

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 3. Landslide Area 1

JUL 2024

122°11'0"W

122°10'45"W

122°10'30"W

37°50'45"N

37°50'30"N

Legend

Overhead line and tower

Landslides

Landslide headscarp

Previously mapped landslide boundary (CGS)

Active landslide

Historic to pre-historic landslide

Landslide Designations

1233
- State of activity
- Certainty of identification
- Dominant type of movement
- Thickness of deposit

State of Activity
- 1 = Active
- 2 = Historic to pre-historic
- 3 = Older, potentially active

Certainty of Identification
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Type of Movement
- 1 = Soil slip/earth flow
- 2 = Debris slide, including talus fall
- 3 = Debris flow
- 4 = Slump/rotational
- 5 = Translational

Thickness of Deposit
- 1 = Less than 5 feet
- 2 = 5 to 15 feet
- 3 = Greater than 15 feet

Erosion Hazard

Active erosion channel

Erosion location

Location number #2 3213
- State of activity
- Certainty of identification
- Dominant erosion hazard
- Hazard to alignment

State of Activity
- 1 = Ongoing
- 2 = During major rainfall/flood events only
- 3 = Dormant or repaired

Certainty of ID
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Erosion Hazard
- 1 =Fluvial erosion
- 2 = Scour
- 3 = Undercutting
- 4 = Hillslope erosion
- 5 = Gullying/headward erosion

Hazard to Alignment
- 1 = High (potential for immediate impact)
- 2 = Moderate (no immediate impact)
- 3 = Low (minimal potential for impact)

N

0 200 400 feet

1:2,800

2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N

Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 4. Landslide Area 2

JUL 2024

122°11'30"W 122°11'15"W 122°11'0"W 37°50'30"N 37°50'15"N

Legend

Overhead line and tower

Erosion Hazard

Active erosion channel

Erosion location

Location number — #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 =Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

Landslides

Landslide headscarp
Previously mapped landslide boundary (CGS)
Active landslide
Historic to pre-historic landslide
Older, potentially active landslide

Landslide Designations

1233 — State of activity; Certainty of identification; Dominant type of movement; Thickness of deposit

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

San Leandro Creek
CONTRA COSTA COUNTY
ALAMEDA COUNTY
Manzanita Dr
Arrowhead Dr

1331 3312 1232 3342 1232 2323 1242 1242 2313 2343 2242 2343 2343 2343 1242 2232 2212 2243 1242 1232 EN10 RN10 ES11 RS10 EN11 ES12 EN11A 1231 EN12 RN11 RS11 ES13 1131 1231 2331 1231 2331 #22 1122 #7 1222 EN9 RN9 RS9 ES10

N

0 200 400 feet
1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 5. Landslide Area 3

JUL 2024

122°11'45"W 122°11'30"W 122°11'15"W

37°50'0"N

Legend

Overhead line and tower

Erosion Hazard

Active erosion channel

Erosion location

Location number — #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
- 1 = Ongoing
- 2 = During major rainfall/flood events only
- 3 = Dormant or repaired

Certainty of ID
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Erosion Hazard
- 1 =Fluvial erosion
- 2 = Scour
- 3 = Undercutting
- 4 = Hillslope erosion
- 5 = Gullying/headward erosion

Hazard to Alignment
- 1 = High (potential for immediate impact)
- 2 = Moderate (no immediate impact)
- 3 = Low (minimal potential for impact)

Landslides

Landslide headscarp

Previously mapped landslide boundary (CGS)

Active landslide

Historic to pre-historic landslide

Landslide Designations

1233 — State of activity; Certainty of identification; Dominant type of movement; Thickness of deposit

State of Activity
- 1 = Active
- 2 = Historic to pre-historic
- 3 = Older, potentially active

Certainty of Identification
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Type of Movement
- 1 = Soil slip/earth flow
- 2 = Debris slide, including talus fall
- 3 = Debris flow
- 4 = Slump/rotational
- 5 = Translational

Thickness of Deposit
- 1 = Less than 5 feet
- 2 = 5 to 15 feet
- 3 = Greater than 15 feet

ES13 RS11 #7 1222 Arrowhead Dr Frost Cir 1131 2331 1231 1231 1143 EN13 RN12 RS12 ES15 Saroni Dr Shepherd Canyon Rd Azalea Ln RN13 EN14 ES16 RS13 RN14 EN15 ES17 RS14 1243 Sayre Dr 2252 1243 Las Flores Ct RN15 EN16 ES18 RS15 1242 2242 2312 Balboa Dr Woodrow Dr Shepherd Creek

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 6. Landslide Area 4

JUL 2024

122°12'15"W

122°12'0"W

122°11'45"W

37°49'45"N

Balboa Dr

Cortez Ct

West Cir

Paso Robles Dr

Montclair Railroad Trail

Stephard Creek

Drake Dr

Zinn Dr

Rincon Dr

Shepherd Canyon Rd

#8 2235

#9 1135

#162335

#142323

#10 1132

#11 1233

RN16 EN17 ES19 RS16

EN17A

EN18 RN17 ES20 RS17

RN18 EN19 RS18 ES21

1332 1142 2312 2253 3343 1131 2242 2332 2231 1243 2342 2341 3342 1132 1242

Legend

Overhead line and tower

Erosion Hazard

Active erosion channel

Erosion location

Location number — #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 =Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

Landslides

Landslide headscarp

Previously mapped landslide boundary (CGS)

Active landslide

Historic to pre-historic landslide

Older, potentially active landslide

Landslide Designations

1233 — State of activity; Certainty of identification; Dominant type of movement; Thickness of deposit

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 7. Landslide Area 5

JUL 2024

122°12'30"W 122°12'15"W 122°12'0"W 37°49'30"N

Legend

Overhead line and tower

Landslides

- Landslide headscarp
- Previously mapped landslide boundary (CGS)
- Active landslide
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

State of activity
Certainty of identification
1233 — Dominant type of movement
Thickness of deposit

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Erosion Hazard

Active erosion channel

Erosion location

Location number — #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 = Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

#14 2323 · #13 1221 · #12 1122 · #14 2225 · #36 1135 · #31 1225 · #32 2333

1243 · 2242 · 2353 · 2252 · 1212 · 1231 · 2342 · 1231 · 2242 · 2243 · 1241 · 1242 · 1232 · 1232 · 2342 · 1332 · 2342 · 3343 · 1143 · 2243 · 1142 · 1242 · 1242 · 1242 · 2343

Previously mitigated landslide

EN20 · ES22 · EN21 · RN19 · ES23 · RS19 · EN20 · ES24 · RN20 · RS20 · RN21 · EN23 · RS21 · ES25

Drake Dr · Shepherd Creek · Shepherd Canyon Rd · Scout Rd · Mountain Blvd

13

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 8. Landslide Area 6

JUL 2024

122°12'45"W 122°12'30"W 122°12'15"W

37°49'15"N

Legend

Overhead line and tower
Access road

Landslides

Previously mapped landslide boundary (CGS)
Active landslide
Historic to pre-historic landslide
Older, potentially active landslide

Landslide Designations

1233 — State of activity / Certainty of identification / Dominant type of movement / Thickness of deposit

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Erosion Hazard

Active erosion channel

Erosion location — #2 3213 — State of activity / Certainty of identification / Dominant erosion hazard / Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 =Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

37°49'N

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 9. Landslide Area 7

JUL 2024

122°13'15"W 122°13'W 122°12'45"W

37°49'N

37°48'45"N

Legend

- Overhead line and tower
- Underground line
- Access road

Landslides

- Previously mapped landslide boundary (CGS)
- Active landslide
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

1233
- 1 = State of activity
- 2 = Certainty of identification
- 3 = Dominant type of movement
- 3 = Thickness of deposit

State of Activity
- 1 = Active
- 2 = Historic to pre-historic
- 3 = Older, potentially active

Certainty of Identification
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Type of Movement
- 1 = Soil slip/earth flow
- 2 = Debris slide, including talus fall
- 3 = Debris flow
- 4 = Slump/rotational
- 5 = Translational

Thickness of Deposit
- 1 = Less than 5 feet
- 2 = 5 to 15 feet
- 3 = Greater than 15 feet

Erosion Hazard

- Active erosion channel

Erosion location
Location number #2 3213
- State of activity
- Certainty of identification
- Dominant erosion hazard
- Hazard to alignment

State of Activity
- 1 = Ongoing
- 2 = During major rainfall/flood events only
- 3 = Dormant or repaired

Certainty of ID
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Erosion Hazard
- 1 =Fluvial erosion
- 2 = Scour
- 3 = Undercutting
- 4 = Hillslope erosion
- 5 = Gullying/headward erosion

Hazard to Alignment
- 1 = High (potential for immediate impact)
- 2 = Moderate (no immediate impact)
- 3 = Low (minimal potential for impact)

Selborne Dr
Estates Dr
Sandringham Rd
Wyngaard Ave
Saint James Dr
Trestle Glen Rd
Glendome Cir
Hollywood Ave
El Centro Ave
Elsinore Ave
San Sebastian Ave
Cavendish Ln
Park Blvd
Mitchell Creek
Leimert Blvd
Clemens Rd
Arden Pl
Bridgeview Dr
Oakview Dr

1142 1232 2232 1232 EN26 RN24 ES28 2342 RS24 1142 1231 1141 EN27 RN25 ES29 2353 RS25 1231 2343 2243 1342 1142 1242 EN28 RN26 ES30 RS26 2342 2212 1232 1241 TN27A EN29 TN27B ES31 1212 1231 1252 #28 1235 TS27A TS27B 2252 EN30 ES32 1111 (2023 slide located during field verification) 2342 2242 EN31 ES33 EN32 3342 #29 2235 1232

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 10. Landslide Area 8

JUL 2024

122°13'45"W 122°13'30"W 122°13'15"W

37°48'30"N

Legend

- Overhead line and tower
- Underground line
- Access road

Landslides

- Previously mapped landslide boundary (CGS)
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

1 2 3 3
- 1 — State of activity
- 2 — Certainty of identification
- 3 — Dominant type of movement
- 3 — Thickness of deposit

State of Activity
- 1 = Active
- 2 = Historic to pre-historic
- 3 = Older, potentially active

Certainty of Identification
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Type of Movement
- 1 = Soil slip/earth flow
- 2 = Debris slide, including talus fall
- 3 = Debris flow
- 4 = Slump/rotational
- 5 = Translational

Thickness of Deposit
- 1 = Less than 5 feet
- 2 = 5 to 15 feet
- 3 = Greater than 15 feet

Erosion Hazard

- Active erosion channel

Erosion location

Location number #2 — 3 2 1 3
- 3 — State of activity
- 2 — Certainty of identification
- 1 — Dominant erosion hazard
- 3 — Hazard to alignment

State of Activity
- 1 = Ongoing
- 2 = During major rainfall/flood events only
- 3 = Dormant or repaired

Certainty of ID
- 1 = Definite
- 2 = Probable
- 3 = Questionable

Dominant Erosion Hazard
- 1 =Fluvial erosion
- 2 = Scour
- 3 = Undercutting
- 4 = Hillslope erosion
- 5 = Gullying/headward erosion

Hazard to Alignment
- 1 = High (potential for immediate impact)
- 2 = Moderate (no immediate impact)
- 3 = Low (minimal potential for impact)

3342
#30 2331
EN33
ES34
2311
2332
3343
EN34
ES35
EN35
ES36

Clarendon Cres
Van Sic Jen Pl
Midcrest Rd
Sunnyhills Rd
Trestle Glen Rd
Creed Rd
Barrows Rd
Holman Rd
Hampel St
Fleet Rd
Norwood Ave
Greenwood Ave
Leach Ave
Galvin St
Elbert St
Glendora Ave
El Centro Ave
Elsmore Ave
San Sebastian Ave
Everett Ave
Edgewood Ave
Wellington St
Park Blvd
Evans Ave
Glenfield Ave
Townsend Ave
Via Cresta Ave

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 11. Landslide Area 9

JUL 2024

122°14'W

122°13'45"W

122°13'30"W

37°48'15"N

EN35
ES36
EN37
ES38
EN36
ES37
TN29
TN28
TS28
OAKLAND X SUBSTATION
2342
2342
2331
3343
Barrows Rd
Trestle Glen Rd
Sunnyhills Rd
Brookwood Rd
Holman Rd
Grosvenor Pl
Alma Pl
Chatham Rd
Bates Rd
Greenwood Ave
Brighton Ave
Hampel St
Hampel St
Hampel St
Randolph Ave
Glen Park Rd
Park Boulevard Way
Park Blvd
Kingsley St
Emerson St
Chatham Rd
13th Ave
Macarthur Blvd
E 34th St
Elliot St
Beaumont Ave
Brighton Ave
E 38th St
Allman St
Excelsior Ave
Bruce St
E 36th St
580

Legend

- Overhead line and tower
- Underground line
- Access road

Landslides

- Previously mapped landslide boundary (CGS)
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

1233
- State of activity
- Certainty of identification
- Dominant type of movement
- Thickness of deposit

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

N

0 200 400 feet

1:2,800

2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

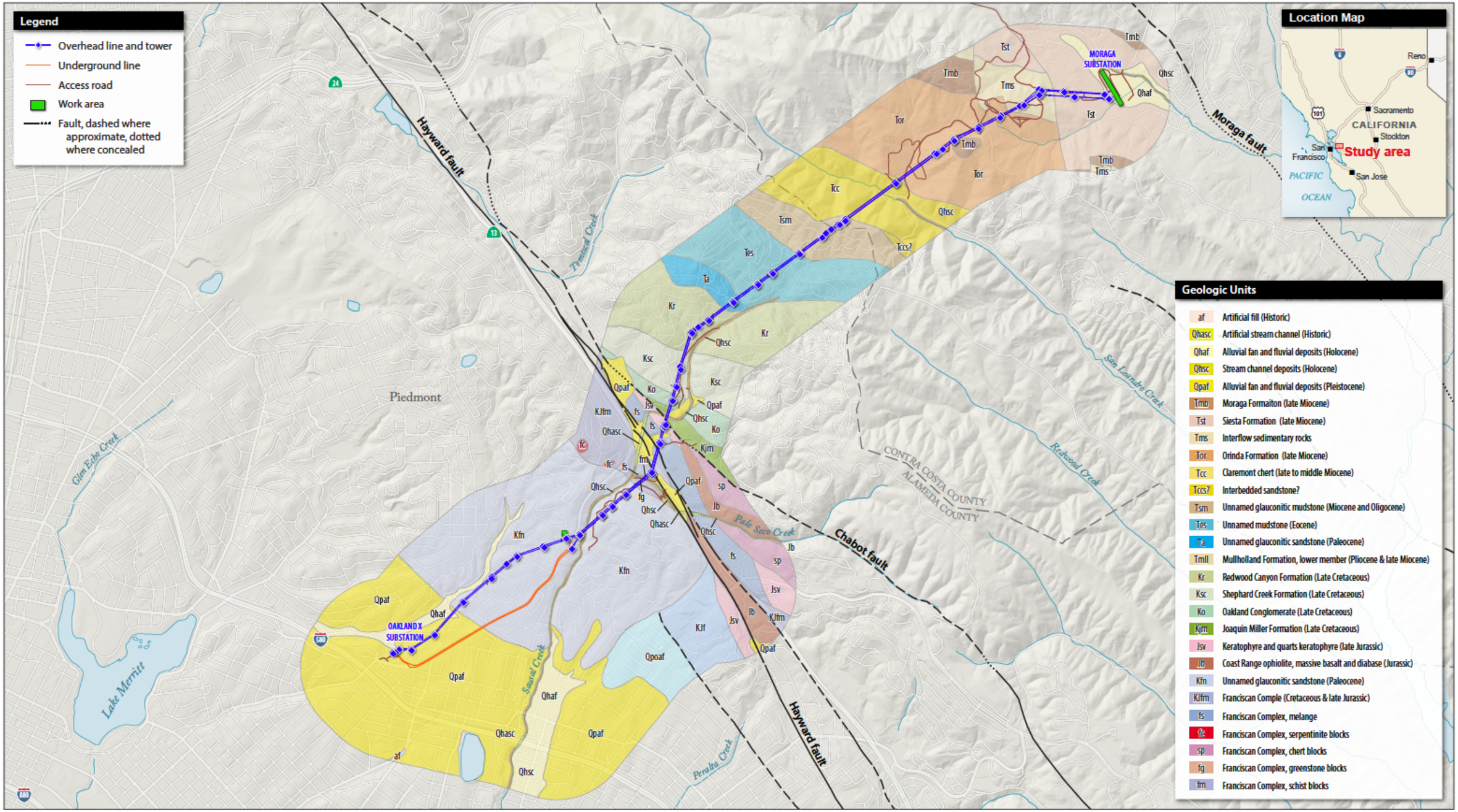
MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 12. Landslide Area 10

JUL 2024

Figure Set Revised on March 31, 2025

Figure legends revised to clarify the Landslide Designations numbering.



Map Projection: NAD 1983 UTM Zone 10N

Geology: Graymer, 2000. Faults: PG&E Geosciences Fault Database v16

N

0 0.5 1 mile

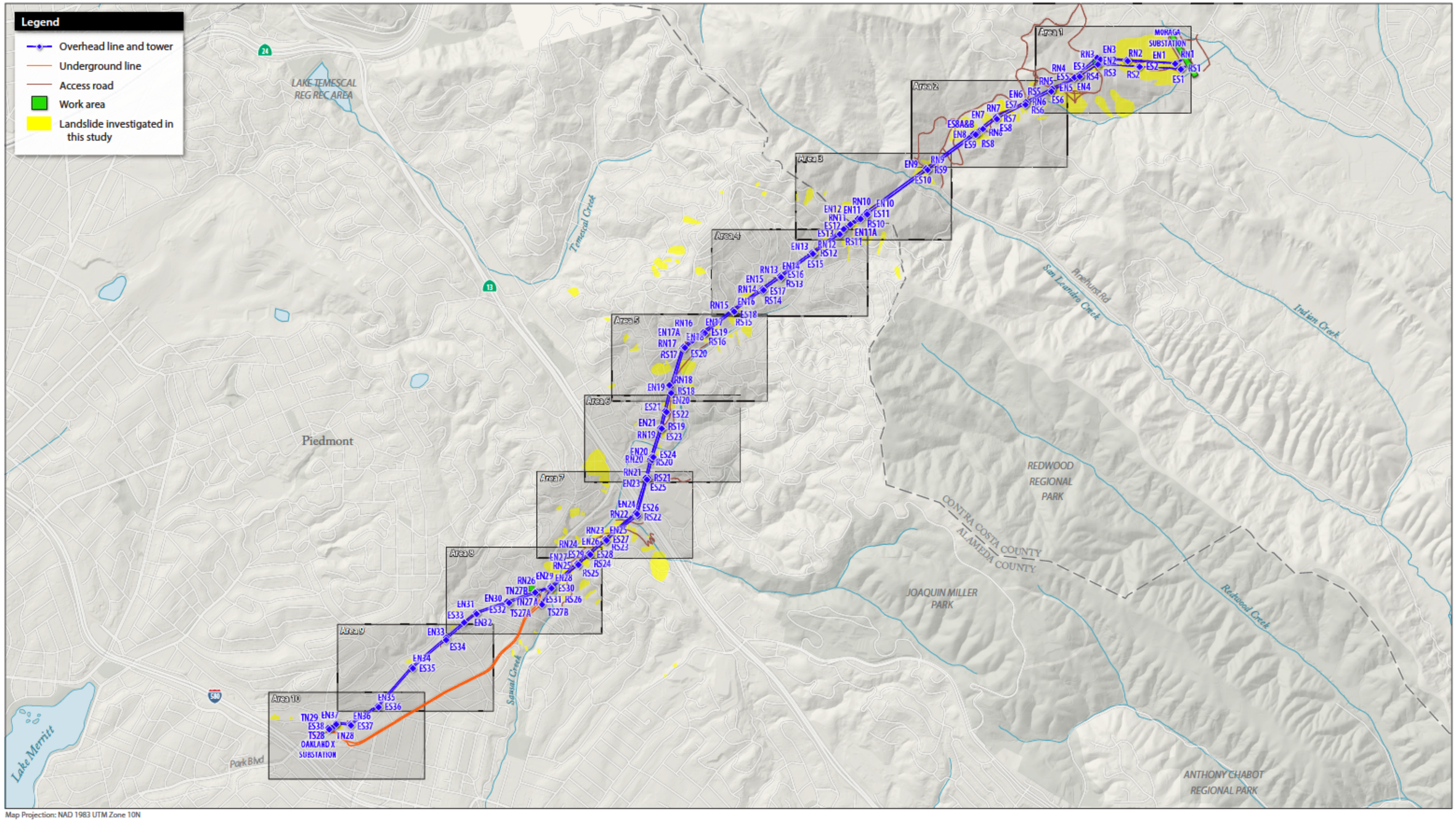
1:31,000

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 1. Bedrock Geologic Map

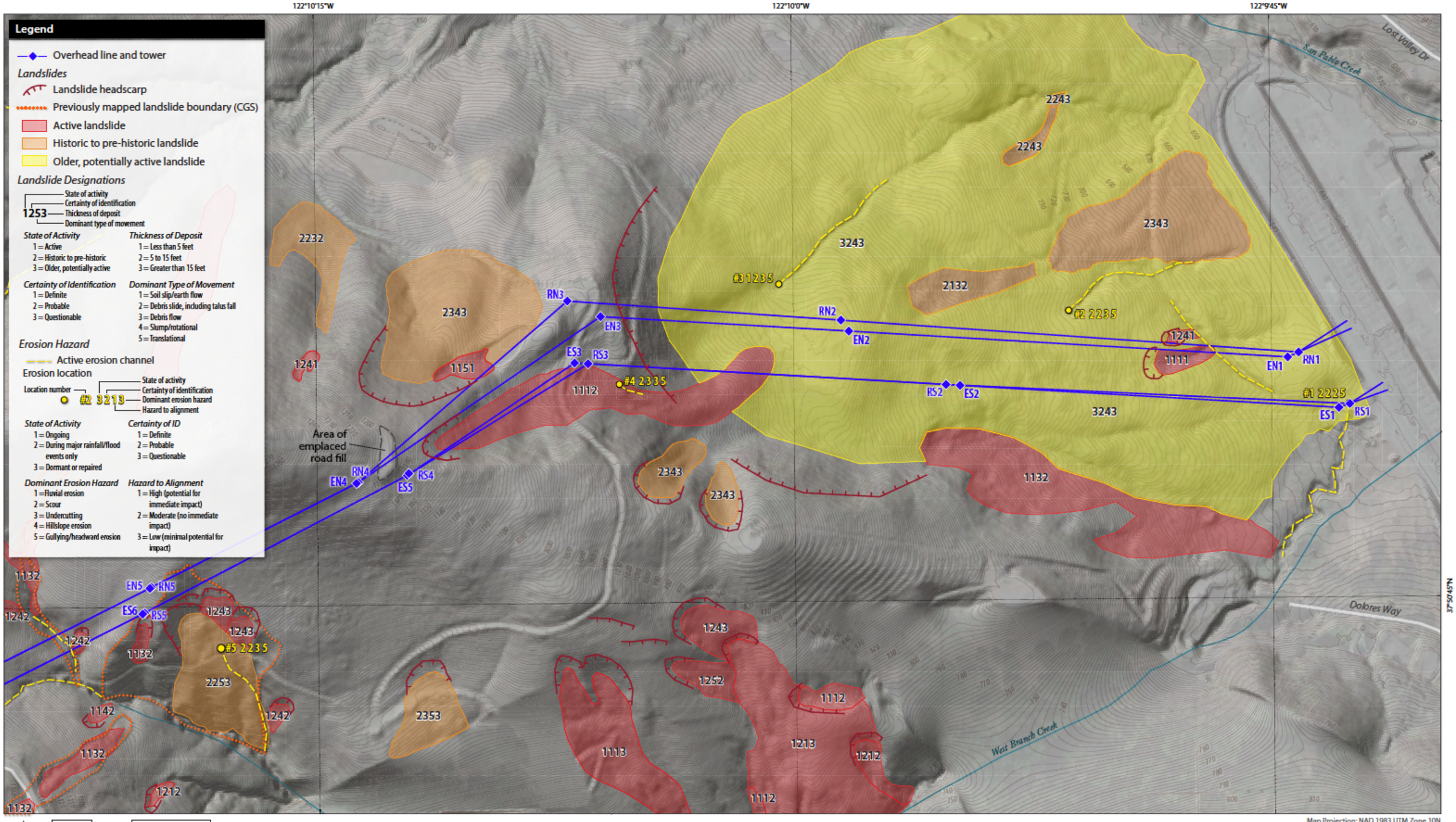
MAR 2025



MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 2. Index Map of Detailed Slope Hazard Maps Along Project Route

MAR 2025



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MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 3. Landslide Area 1

MAR 2025

122°11'0"W 122°10'45"W 122°10'30"W 37°50'45"N

Legend

- Overhead line and tower

Landslides

- Landslide headscarp
- Previously mapped landslide boundary (CGS)
- Active landslide
- Historic to pre-historic landslide

Landslide Designations

1253 — State of activity; Certainty of identification; Thickness of deposit; Dominant type of movement

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Erosion Hazard

- Active erosion channel

Erosion location

Location number #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 = Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

EN5 RN5 RS5 ES6 EN6 RN6 ES7 RS6 EN7 RN7 RS7 ES8 ES8A&B EN8 RN8 RS8 ES9

#5 2235 #6 2135

N

0 200 400 feet
1:2,800 2-foot elevation contour interval

NAD 83-4E

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 4. Landslide Area 2

MAR 2025

122°11'30"W

122°11'15"W

122°11'0"W

37°50'45"N

37°50'15"N

Legend

Overhead line and tower

Erosion Hazard

Active erosion channel

Erosion location

Location number — #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 = Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

Landslides

Landslide headscarp

Previously mapped landslide boundary (CGS)

Active landslide

Historic to pre-historic landslide

Older, potentially active landslide

Landslide Designations

1253 — State of activity; Certainty of identification; Thickness of deposit; Dominant type of movement

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

San Leandro Creek

CONTRA COSTA COUNTY
ALAMEDA COUNTY

Manzanita Dr

Arrowhead Dr

1331 3312 1232 3342 2232 2212 2243 1232 2323 1242 1242 2313 2343 2242 2343 2343 1242 2343 1242 EN9 RN9 RS9 ES10 EN10 RN10 ES11 RS10 EN11 ES12 EN11A EN12 RN11 RS11 ES13 #22 1122 #7 1222 1231 1131 1231 2331 1231 2331

N 0 200 400 feet
1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

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MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 5. Landslide Area 3

MAR 2025

122°11'45"W 122°11'30"W 122°11'15"W

37°5'0"N

Legend

Overhead line and tower

Erosion Hazard

Active erosion channel

Erosion location

Location number — #2 3 2 1 3 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 = Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

Landslides

Landslide headscarp

Previously mapped landslide boundary (CGS)

Active landslide

Historic to pre-historic landslide

Landslide Designations

1253 — State of activity; Certainty of identification; Thickness of deposit; Dominant type of movement

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

ES13 RS11 #7 1222 1131 2331 1231 1231 Arrowhead Dr East Cir Sequoia Dr 1143 EN13 RN12 RS12 ES15 Shepherd Canyon Rd Azalea Ln RN13 EN14 ES16 RS13 RN14 EN15 ES17 RS14 1243 Sayre Dr 2252 1243 Los Flores Ct RN15 EN16 ES18 RS15 1242 2242 2312 Balboa Dr Woodrow Dr Shephard Creek

N

0 200 400 feet

1:2,800 2-foot elevation contour interval

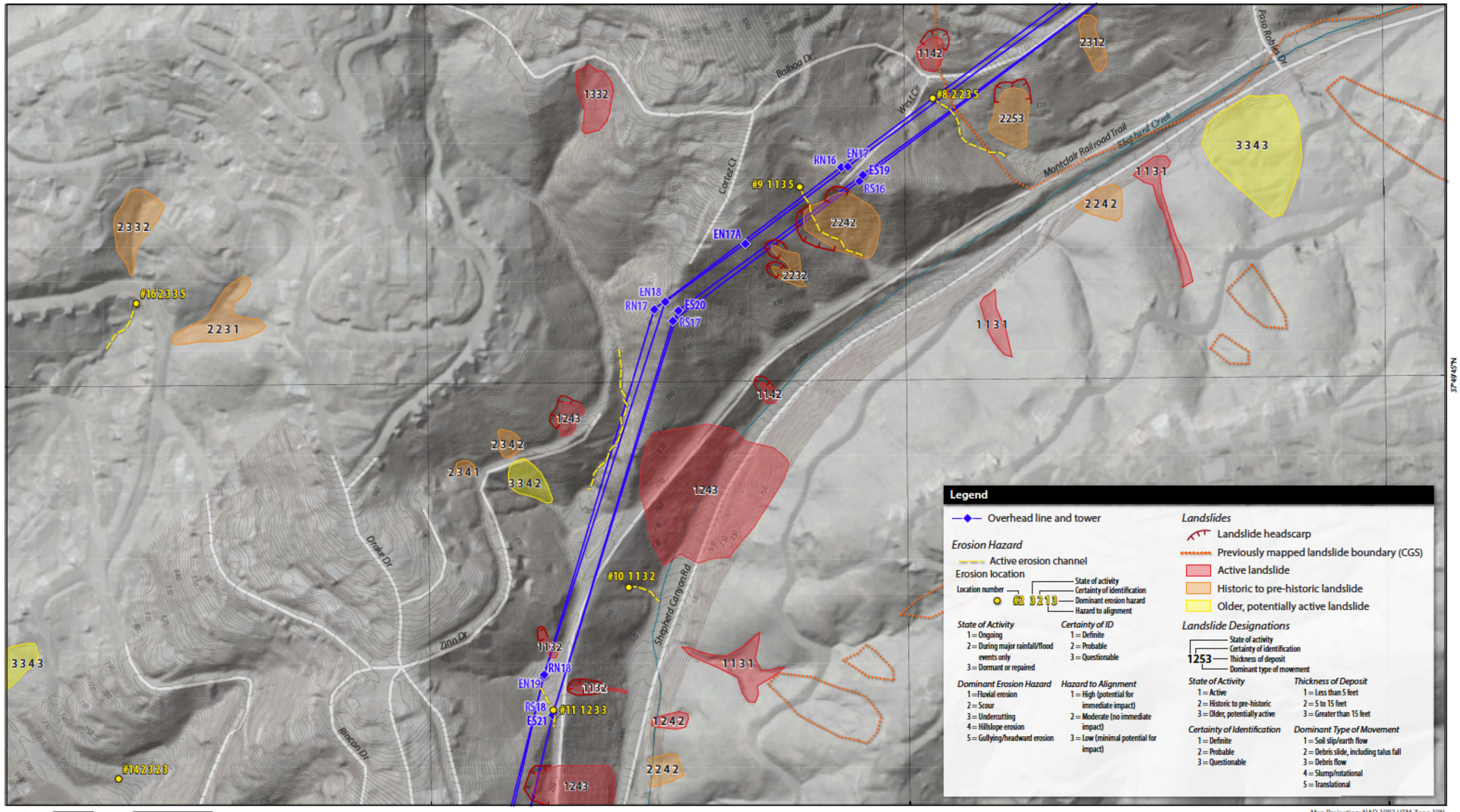
Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 6. Landslide Area 4

MAR 2025



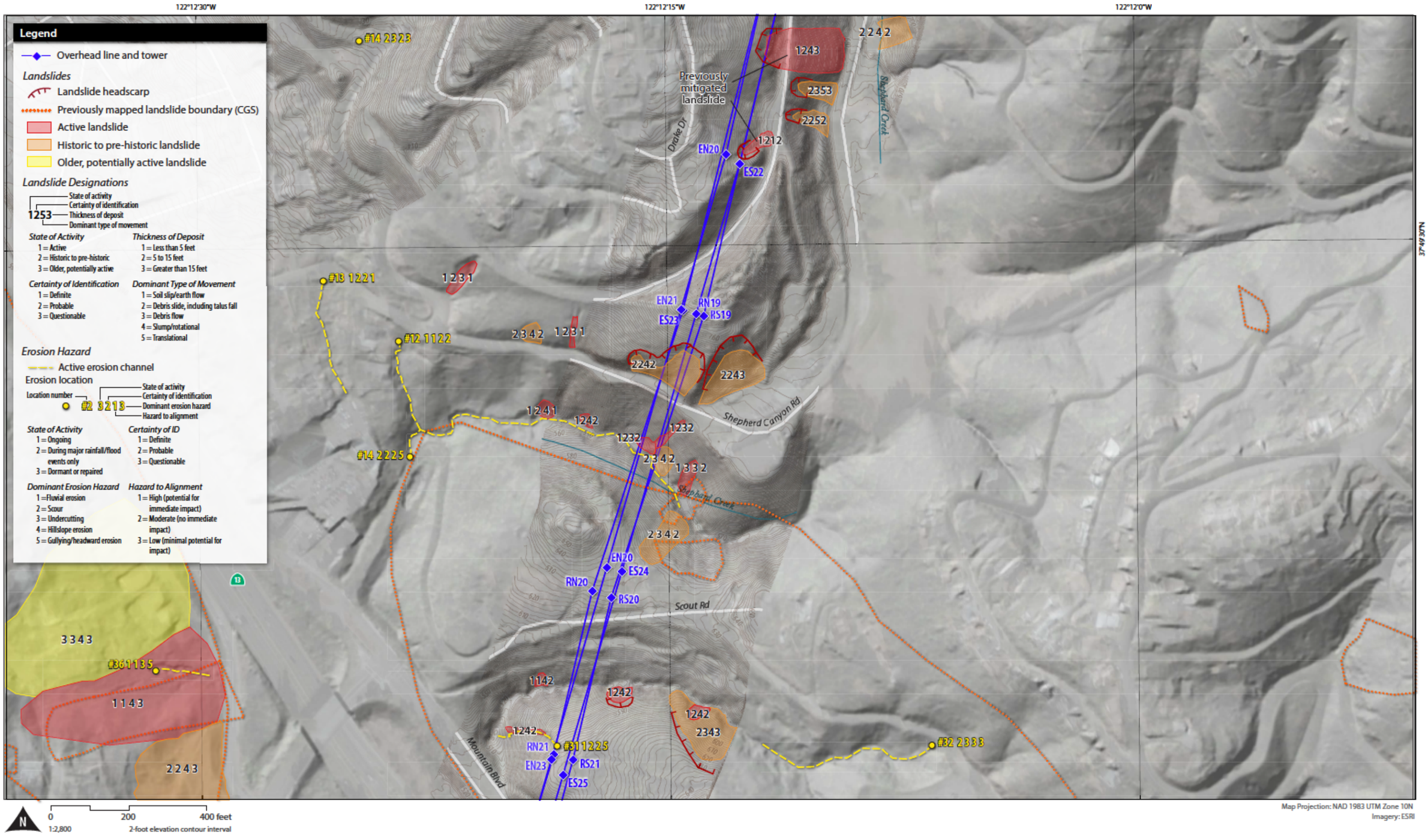
Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 7. Landslide Area 5

MAR 2025



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MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 8. Landslide Area 6

MAR 2025

122°12'45"W

122°12'30"W

122°12'15"W

37°49'15"N

37°49'N

1143
2243
#35 2225
2342
3342
2242
1232
1142
1232
1242
1242
1242
1232
1142
1231
2353
2342
2342
1242
2343
1242
2343
1242
2243
1342
2242
1232
2242
1131
1242
2342
2242
1142
2342
3353
3353
1242
2343
#32 2333
#31 1225
#23 2132
#26 1225
#25 1235
#24 1135
RN21
EN23
RS21
ES25
EN24
RN22
ES26
RS22
EN25
RN23
ES27
RS23
EN26
RN24
ES28
RS24
Trafalgar Pl
Liggett Dr
Pershing Dr
Sims Dr
Somerset Dr
Somerset Rd
Estates Dr
Park Blvd
Hampton Rd
Sunset Creek
Shepherd Creek
Monterey Blvd
Moraga Ave
Scout Rd
Palo Seco Creek
Leimert Blvd
Mountain Blvd

Legend

- Overhead line and tower
- Access road

Landslides

- Previously mapped landslide boundary (CGS)
- Active landslide
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

1253 — State of activity; Certainty of identification; Thickness of deposit; Dominant type of movement

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

- Active erosion channel

Erosion location — Location number — #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 = Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

N

0 200 400 feet

1:2,800

2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N

Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 9. Landslide Area 7

MAR 2025

122°13'15"W 122°13'W 122°12'45"W 37°49'W 37°48'45"N

Legend

- Overhead line and tower
- Underground line
- Access road

Landslides

- Previously mapped landslide boundary (CGS)
- Active landslide
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

1253 — State of activity; Certainty of identification; Thickness of deposit; Dominant type of movement

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Erosion Hazard

- Active erosion channel

Erosion location — Location number #2 3213 — State of activity; Certainty of identification; Dominant erosion hazard; Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
1 = Definite
2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 = Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

Selborne Dr
Estates Dr
Sandringham Rd
Wyngaard Ave
Saint James Dr
Trestle Glen Rd
Glendome Cir
El Centro Ave
Elsinore Ave
San Sebastian Ave
Hollywood Ave
Cavendish Ln
Park Blvd
Mistral Creek
Leimert Blvd
Airden Pl
Bridgeview Dr
Clemens Rd
Oakview Dr

EN26 RN24 ES28 RS24
EN27 RN25 ES29 RS25
EN28 RN26 ES30 RS26
TN27A TN27B EN29 ES31
EN30 ES32
EN31 ES33
EN32
TS27A TS27B

1142 1232 2232 2342 1231 1141 2353 2243 1342 1242 2212 2342 1241 1252 1212 2252 2342 2242 3342 1232

#28 1235
#29 2235

1111 (2023 slide located during field verification)

N 0 200 400 feet
1:2,800 2-foot elevation contour interval

Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 10. Landslide Area 8

MAR 2025

122°13'45"W 122°13'30"W 122°13'15"W

37°48'30"N

Legend

- Overhead line and tower
- Underground line
- Access road

Landslides

- Previously mapped landslide boundary (CGS)
- Historic to pre-historic landslide
- Older, potentially active landslide

Landslide Designations

1253 — State of activity / Certainty of identification / Thickness of deposit / Dominant type of movement

State of Activity
1 = Active
2 = Historic to pre-historic
3 = Older, potentially active

Thickness of Deposit
1 = Less than 5 feet
2 = 5 to 15 feet
3 = Greater than 15 feet

Certainty of Identification
1 = Definite
2 = Probable
3 = Questionable

Dominant Type of Movement
1 = Soil slip/earth flow
2 = Debris slide, including talus fall
3 = Debris flow
4 = Slump/rotational
5 = Translational

Erosion Hazard

- Active erosion channel

Erosion location — Location number #2 3213 — State of activity / Certainty of identification / Dominant erosion hazard / Hazard to alignment

State of Activity
1 = Ongoing
2 = During major rainfall/flood events only
3 = Dormant or repaired

Certainty of ID
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2 = Probable
3 = Questionable

Dominant Erosion Hazard
1 = Fluvial erosion
2 = Scour
3 = Undercutting
4 = Hillslope erosion
5 = Gullying/headward erosion

Hazard to Alignment
1 = High (potential for immediate impact)
2 = Moderate (no immediate impact)
3 = Low (minimal potential for impact)

3342
#30 2331
EN33
ES34
2311
2332
3343
EN34
ES35
EN35
ES36
Clarendon Cres
Van Sicklen Pl
Midcrest Rd
Sunnyhills Rd
Trestle Glen Rd
Creed Rd
Barrows Rd
Holman Rd
Hampel St
Greenwood Ave
Fleet Rd
Norwood Ave
Galvin St
Elbert St
Glendora Ave
El Centro Ave
San Sebastian Ave
Elmore Ave
Everett Ave
Edgewood Ave
Leach Ave
Wellington St
Park Blvd
Evans Ave
Glenfield Ave
Townsend Ave
La Cresta Ave

N

0 200 400 feet
1:2,800 2-foot elevation contour interval

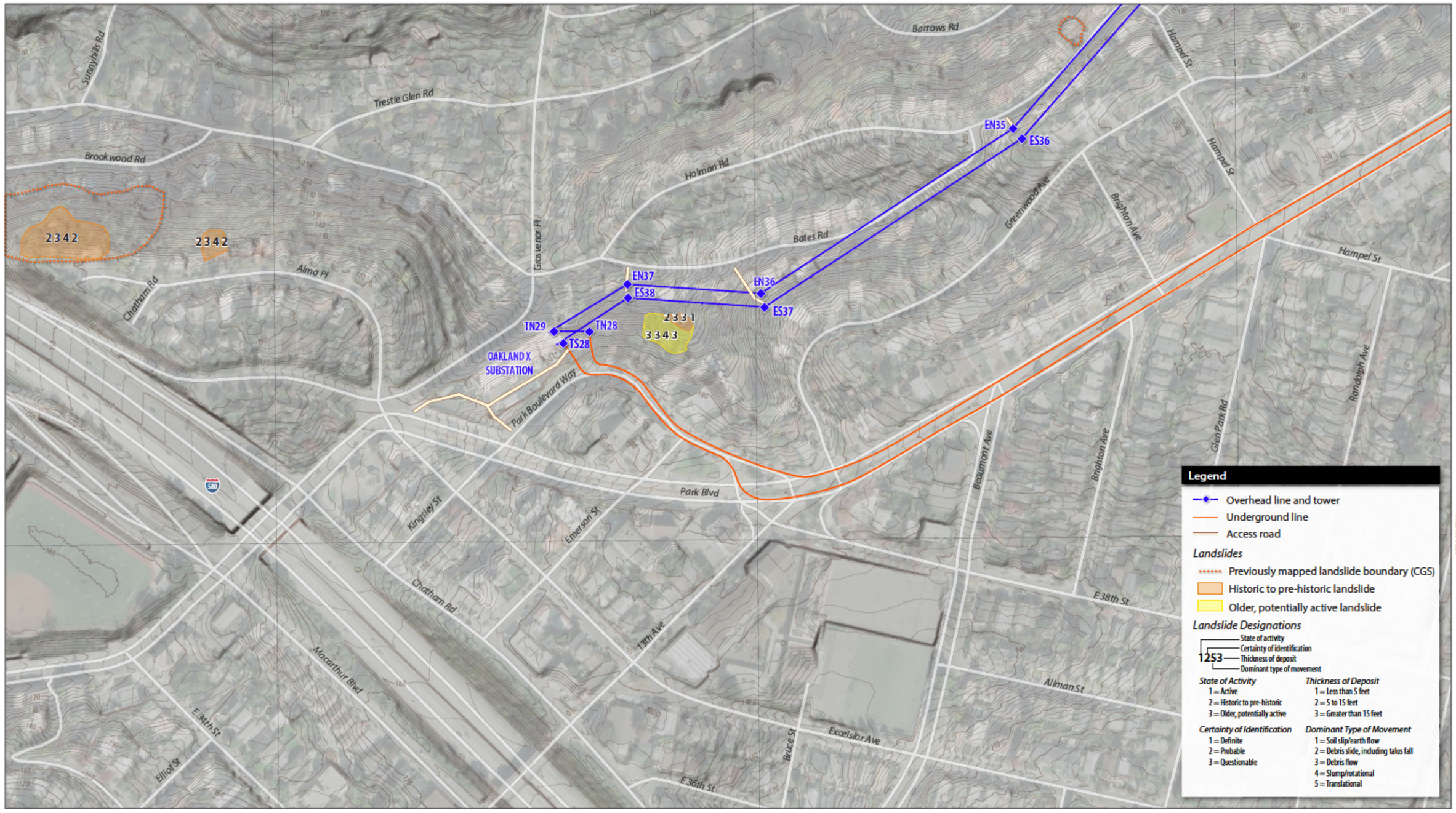
Map Projection: NAD 1983 UTM Zone 10N
Imagery: ESRI

InfraTerra

MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 11. Landslide Area 9

MAR 2025



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MOX-E MORAGA ORINDA LANDSLIDE MAPPING

Figure 12. Landslide Area 10

MAR 2025