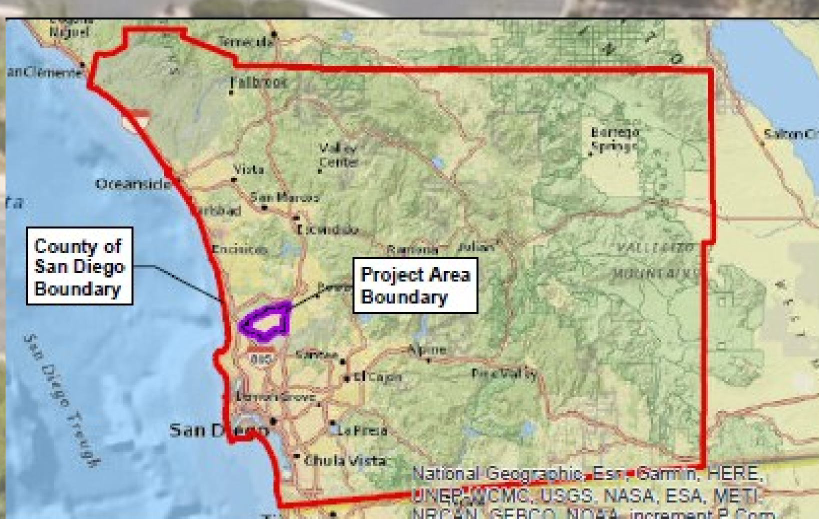
Desktop Geotechnical and Geologic Hazard Evaluation
Mira Mesa Community Plan Update
San Diego, California

Prepared For:
Dudek.
605 Third Street
Encinitas, California 92024

Prepared By:
The Bodhi Group, Inc.

December 2019
Project No. 9127007



December 24, 2019
Project No. 9127007

Ms. Asha Bleier, AICP
DUDEK
605 Third Street
Encinitas, CA 92024

Subject: Desktop Geotechnical and Geologic Hazard Evaluation
Mira Mesa Community Plan Update
San Diego, California

Dear Ms. Bleier,

We are pleased to submit our Geotechnical and Geologic Hazard Study report. The report was prepared in support of the Mira Mesa Community Plan Update and identifies geotechnical and geologic hazards within the Mira Mesa Plan area and the significance of these hazards to existing and future land uses in the Plan area.

Respectfully submitted,

THE BODHI GROUP, INC.

REGISTERED GEOLOGIST
W. LEE VANDERHURST
No. 1125
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

W. Lee Vanderhurst, C.E.G.
Senior Geologist

Sree Gopinath, P.E.
Principal Engineer

Distribution: 1) Addressee

TABLE OF CONTENTS

Tables

Figures

EXECUTIVE SUMMARY

This Geotechnical and Geologic Hazard Evaluation (Study) identifies geotechnical and geologic hazards that could have potentially adverse effects on future manmade improvements within the Mira Mesa Community Plan Update (MMCPU) area (Study Area, Figure 1). Locations within the Study Area with the highest potential for future development or redevelopment is also shown on Figure 1.

For this study, we reviewed relevant geologic maps and guidelines published by the City of San Diego, State of California, and the United States Geologic Survey. In-house resources were also reviewed.

A summary of the geology and geologic hazards is provided below.

- In increasing order of age, soils in the Study Area consist of artificial fill (both documented and undocumented), young alluvium, old estuarine deposits, landslide deposits, very old paralic deposits (Units 7, 8, and 9), and formational materials of the Stadium Conglomerate, Scripps Formation, Del Mar/Friars Formations undifferentiated, Ardath Shale, and Santiago Peak Volcanics. Undocumented fill and young alluvium may be subject to consolidation under additional fill or new geotechnical loads. Locations with new development or redevelopment resulting in new or additional geotechnical loads are shown on Figure 1. The other geologic formations in the Study Area are well consolidated to well cemented and will support most new fill and structural loads. The very old paralic deposits and formational materials contain layers of cemented sandstone, gravel and cobbles which may be difficult to excavate and may impact excavations like basements or underground utility trenches. Volcanic rock is extremely hard; however, fracture spacing in the rock will influence excavation in this material.
- The Study Area is not underlain by active faults. The closest known active fault is the Rose Canyon Fault, which is located approximately 10 miles southwest of the center of the Study Area. Potentially active faults underlie the southwest corner of the Study Area. The Study Area, like the rest of San Diego, is in a region of active faults and will be subject to strong ground motion in the event of an earthquake on these active faults.
- Liquefaction occurs in soft, saturated soil during moderate to severe ground shaking during earthquakes. According to City of San Diego maps, most of the lower elevation portions of the Study Area (areas close to the bottom of the major canyons) are defined as having a high potential for liquefaction.
- Landslide hazards are mapped both by the State of California and the City of San Diego. Both the State and City of San Diego show the slopes along the south side of Penasquitos Canyon and the large canyon between Penasquitos and Carrol Canyons to have localized landslides. The formations beneath the base of theses canyon slopes are considered to be potentially unstable. The mesa area, however, does not contain steep slopes and is not susceptible to landslide hazards according to the City of San Diego.
- Expansive soils form on very old paralic deposits, Del Mar and Friars Formation undifferentiated, and Ardath Shale. Most the Study Area consists of soils that range from medium to highly expansive in nature. Expansive soil can adversely affect structures and pavements.
- Potentially corrosive soils may be present in some localized areas on the mesa.
- Infiltration rates for at grade soil will be affected by shallow impermeable formational material and soil types. In general, the earth materials within 10 feet of the current ground surface will have poor infiltration characteristics.

The geologic hazards identified above, that are encroached by planned development in the Study Area, can be mitigated through avoidance or by engineering design in accordance with established State of California and City of San Diego requirements and codes. Locations within the Study Area with the highest potential for new development or redevelopment are identified on Figure 1.

There are no policies or recommendations of the MMCPU that will have a direct or indirect significant environmental effect with regards to geologic hazards. The proposed land uses are compatible with the known geologic hazards. Storm water infiltration into soils may be limited and alternative systems like bioswales or bioretention basins may be needed. Geotechnical investigations are recommended for any construction adding geotechnical loads to soils within 25 feet of the top of slopes exceeding 10 feet in height or on undocumented fills. This recommendation supersedes the exemptions discussed in The City of San Diego Information Bulletin 515; “Geotechnical Study Requirements” (2016).

1. INTRODUCTION

The Bodhi Group has completed a Geotechnical and Geologic Hazards Study (Study) in support of the Mira Mesa Community Plan Update (MMCPU) area (Study Area). The Study was performed at a California Environmental Quality Act (CEQA) level for the Study Area. This report presents the results of our "desktop" evaluation of the geotechnical and geologic hazards potentially affecting the Study Area. The purpose of our evaluation was to identify geotechnical and geologic conditions or hazards that might affect future development and/or redevelopment within the Study Area. The Study Area is shown on Figure 1. Locations within the Study Area with the highest potential for future development or redevelopment are identified on Figure 1. The following services were provided:

- Reviewed relevant published geologic information including State of California-issued geologic and hazard maps, the City of San Diego Seismic Safety Study Geologic Hazards and Faults maps, and the City of San Diego Guidelines for Geotechnical Reports.
- Reviewed and summarized regional and local geology and identified potential geotechnical and geologic hazards.
- Researched and identified relevant geologic hazards listed in the "Guidelines for Preparing Geologic Reports for Regional-Scale Environmental and Resource Management Planning," California Geological Survey (California Division of Mines and Geology) Note 52, as amended or updated, City of San Diego Guidelines for Geotechnical Reports, and City of San Diego Significance Determination Thresholds.
- Researched other City and County resources, and our in-house library of historical vertical aerial photographs, geotechnical and geological hazards such as faulting, seismicity, and liquefiable soils.
- Prepared this technical report that identifies geotechnical and geologic hazards. Included in this report is a location map (Figure 1), a map of the regional and Study Area geology showing distribution of surficial deposits and geologic units (Figure 2), a map of the active regional faults (Figure 3), a map showing the dam inundation zone in the Study Area (Figure 4), and a geologic hazards map identifying areas susceptible to the potential geologic hazards described in this report (Figure 5).

1.1. Significant Assumptions

Documentation and data provided by the client or from the public domain, and referred to in the preparation of this study, are assumed to be complete and correct and have been used and referenced with the understanding that the Bodhi Group assumes no responsibility or liability for their accuracy. The conclusions contained herein are based upon such information and documentation. Because Study Area conditions may change and additional data may become available, data reported and conclusions drawn in this report are limited to current conditions and may not be relied upon on a significantly later date or if changes have occurred at the Study Area.

Reasonable CEQA-level efforts were made during the Study to identify geologic hazards. "Reasonable efforts" are limited to information gained from information readily-accessible to the public. Such methods may not identify Study Area geologic or geotechnical issues that are not listed in these sources. In the preparation of this report, the Bodhi Group has used the degree of care and skill ordinarily exercised by a reasonably prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. No other warranties are made to any third party, either expressed or implied.

2. PROJECT LOCATION AND DESCRIPTION

The Mira Mesa Community Planning Area (CPA) is a major residential and employment center, with approximately 80,000 residents (City of San Diego, 2018b) and 83,000 jobs (City of San Diego, 2019). Mira Mesa CPA is the largest industrial area in the region with a concentration of biotech, high-tech, defense, craft beverage/food, and manufacturing clusters. The Study Area is a major industrial, office, and commercial center located in central San Diego (Figure 1). Topographically, most of the Study Area is situated on a gently rolling mesa top dissected by three large east-west trending canyons and a number of smaller tributary canyons.

The purpose of the MMCPU is to bring the current Community Plan (Plan) up to date by analyzing current land use, development, and environmental characteristics; evaluating changes in demographics that may affect land use needs; understanding demand for housing, public facility, and commercial development; determining key issues of concern and providing vision and objectives for the Plan update; evaluating the "fit" of current Plan policies to achieve community goals and regulatory requirements; and to ensure that all policies and recommendations remain in harmony with the General Plan, Climate Action Plan, and State mandates (City of San Diego, 2018b).

The Study Area, located in the City of San Diego, within San Diego County, encompasses approximately 10,500 acres located in the north central portion of the City of San Diego and is generally bound by Interstate 805 corridor on the west, Interstate 15 corridor on the east, by Penasquitos Canyon on the north, and by Miramar Road on the south (City of San Diego, 2018b).

The majority of the Study Area sits at an elevation between 275 and 500 feet North American Vertical Datum of 1988 in feet (NAVD 88), with some areas sloping to 100 feet NAVD 88 within finger canyons in the north and west/central portions of the Study Area. The majority of the Study Area is generally developed with the exception of the tributary canyons located throughout.

3. HISTORY

Prior to World War II, the Study Area was part of a large Mexican land grant that supported cattle grazing. The area was used as a landing field and bombing test range during World War II. Following the war, the eastern portion of Carrol Canyon was used as a sand and gravel quarry at some point prior to 1953 (UDSA, 1953). Residential development began in 1969. By the late 1970's, the south central and eastern portions of the Study Area had been developed with residential buildings. In the 1980's, the areas along Miramar Road and west of Camino Santa Fe were being developed into commercial, industrial, and research buildings. Large scale earth moving was utilized throughout the Study Area to create building pads and infrastructure.

4. GEOLOGY

San Diego is located within the western (coastal) portion of the Peninsular Ranges Geomorphic Province of California. The Peninsular Ranges encompass an area that roughly extends from the Transverse Ranges and the Los Angeles Basin, south to the Mexican border, and beyond, another approximately 800 miles to the tip of Baja California (Harden, 1998). The geomorphic province varies in width from approximately 30 to 100 miles, most of which is characterized by northwest-trending mountain ranges separated by subparallel fault zones. In general, the Peninsular Ranges are underlain by Jurassic-age metavolcanic and metasedimentary rocks and by Cretaceous-age igneous rocks of the southern California batholith. Geologic cover over the basement rocks in the westernmost portion of the province in San Diego County generally consists of Upper Cretaceous-, Tertiary-, and Quaternary-age sedimentary rocks. Figure 2, Regional Geologic Map, modified from Kennedy and Tan (2008), shows the regional geology.

Structurally, the Peninsular Ranges are traversed by several major active faults. The Elsinore, San Jacinto, and the San Andreas faults are major active fault systems located northeast of San Diego and the Rose Canyon, San Diego Trough, Coronado Bank and San Clemente faults are major active faults located within or west-southwest of San Diego. Major tectonic activity associated with these and other faults within this regional tectonic framework is generally right-lateral strike-slip movement. These faults, as well as other faults in the region, have the potential for generating strong ground motions in the Study Area. Figure 3, Regional Fault map shows the proximity of the Study Area to nearby mapped Quaternary faults.

4.1. Local Geology

In increasing order of age, soils in the Study Area consist of artificial fill (both documented and undocumented), young alluvium, landslide deposits, young canyon and estuarine terraces, Very old paralic deposits (Units 9, 8 and 7), the Stadium Conglomerate and Scripps Formation (Upper and Lower members). The distribution of the units is shown on Figure 2, Regional Geologic Map. Descriptions of the general characteristics of these units are presented below.

- *Af Artificial fill (late Holocene).* Although there are no mapped limits of artificial fill on Figure 2, manmade fill underlies large portions of the Study Area. Most areas underlain by fill are associated with construction of buildings or infrastructure. These fills are likely compacted. Uncompacted fills associated with the quarry operations are likely present in Carrol Canyon. The uncompacted fills are subject to settlement under building or additional fill loads.
- *Qya – Young alluvial deposits (Holocene and late Pleistocene).* Young alluvial deposits are characterized as poorly consolidated, poorly sorted, permeable canyon deposits of sandy, silty, or clay-bearing alluvium. These deposits occur in the bottoms of the major canyons (Carrol Canyon, Sorrento Canyon and Penasquitos Canyon and their larger tributaries. Young alluvial deposits may settle under structural or additional fill loads. Compacted fill overlying settlement prone young alluvial flood plain deposits may settle under new building or additional fill loads.
- *Qpe – Paralic estuarine deposits (early Holocene).* Early Holocene estuarine deposits are found as subtle terraces along the base of Penasquitos Canyon and consist of poorly consolidated sand and clay. These deposits may settle under new building or additional fill loads.
- *Qls – Landslide deposits (late Pleistocene to Holocene).* Landslide deposits are mapped in the slopes of Penasquitos and Sorrento Canyons. The appear related to weak, slide-prone formations (Scripps Formation Del Mar and Friars Formations undifferentiated, and Ardath Shale) in combination with steep natural slopes.

- *Qvop9 – Very old paralic deposits, Unit 9 (middle to early Pleistocene).* All of the very old paralic deposits (Units 9-7) are exposed on the top of the mesa in the Study Area (Figure 2). They are differentiated by subtle changes in elevation and topography. The units become older as they occur at higher elevations and are exposed further to the east.

  The Unit 9 deposits are located in the western portion of the Study Area and consist of poorly sorted, moderately permeable, well consolidated, reddish brown, interfingered strandline, beach, estuarine, and colluvial deposits composed of siltstone, sandstone, and conglomerate. These paralic deposits are well consolidated and are usually suitable for light structural or thin fill loads. They are locally cemented and may create difficult excavation conditions for utility trenches or basements. An expansive, highly plastic clay residual soil has formed on these deposits on the mesa tops.

- *Qvop8 – Very old paralic deposits, Unit 8 (middle to early Pleistocene).* The Unit 8 deposits are located in the central portion of the Study Area and consist of poorly sorted, moderately permeable, well consolidated, poorly to moderately cemented, reddish brown, interfingered strandline, beach, estuarine, and colluvial deposits composed of siltstone, sandstone, and conglomerate. These paralic deposits are well consolidated and are typically suitable for light structural or thin fill loads. They are locally cemented and may create difficult excavation conditions for utility trenches or basements. An expansive, highly plastic clay residual soil has formed on these deposits on the mesa tops.

- *Qvop7 – Very old paralic deposits, Unit 7 (middle to early Pleistocene).* Unit 7 of the very old paralic deposits are located in the eastern portion of the Study Area and are characterized as poorly sorted, moderately permeable, reddish-brown, interfingered standline, beach, estuarine, and colluvial deposits composed of siltstone, sandstone and conglomerate. The Unit 7 deposits are frequently moderately to very well cemented and can be very difficult to excavate. An expansive, highly plastic clay residual soil has formed on these deposits on the mesa tops.

- *Qvop6 – Very old paralic deposits, Unit 6 (middle to early Pleistocene).* The Unit 6 deposits are located in the eastern portion of the Study Area and are poorly sorted, moderately permeable, reddish-brown, interfingered standline, beach, estuarine, and colluvial deposits composed of siltstone, sandstone and conglomerate. The Unit 6 deposits are frequently moderately to very well cemented and can be very difficult to excavate. An expansive, highly plastic clay residual soil has formed on these deposits on the mesa tops.

- *Qvop5 – Very old paralic deposits, Unit 5 (middle to early Pleistocene).* The Unit 5 deposits are located in the eastern portion of the Study Area and are poorly sorted, moderately permeable, reddish-brown, interfingered standline, beach, estuarine, and colluvial deposits composed of siltstone, sandstone and conglomerate. The Unit 5 deposits are frequently moderately to very well cemented and can be very difficult to excavate. An expansive, highly plastic clay residual soil has formed on these deposits on the mesa tops.

- *Tst – Stadium Conglomerate (middle Eocene).* The Stadium Conglomerate underlies almost the entire Study Area, underlying the very old paralic deposits. It is most exposed in the slopes in the major canyons and their tributaries. It consists of massive cobble conglomerate with a dark-yellowish brown, coarse-grained sandstone matrix. The conglomerate contains slightly metamorphosed volcanic and volcaniclastic rocks and quartzite. The conglomerate is very well consolidated and locally very well cemented. The conglomerate can typically support very heavy structural and fill loads. The Stadium Conglomerate is difficult to excavate and is at least 200 feet thick in the central portion of the Study Area but pinches out to the west. (Kennedy and Tan, 2008).

- *Tsc upper and Tsc – Scripps Formation, upper member and undifferentiated (middle Eocene).* This formation consists of yellowish-gray, medium-grained, sandstone with lenses of cobble conglomerate and claystone. Within the Study Area, it is exposed in the lower portions of the major canyons and tributaries. A tongue of the Scripps formation overlies a portion of the Stadium Conglomerate in the upper Carrol Canyon. This “upper” member is difficult to differentiate from the rest of the Scripps Formation without the presence of the Stadium Conglomerate. The Scripps Formation is well consolidated and locally very well cemented (concretion beds) and can typically support high structural and fill loads. Bedding in the is highly variable and can create potential slope instability where adverse structure and local claystone beds combine as evident by landslides in Penasquitos Canyon in areas underlain by this formation.

- *Td+Tf – Del Mar/Friars Formations Undifferentiated (middle Eocene).* The Del Mar/Friars Formations undifferentiated is exposed in the eastern portion of Penasquitos Canyon at the base of the north facing slopes. The formation is composed of claystone and some lensoidal bodies of sandstone. The claystone is fractured and locally sheared. The weak claystone can create unstable conditions in slopes.
- *Ta – Ardath Shale (middle Eocene).* The Ardath shale is exposed in the lower elevations in the western portion of the Study Area, primarily at the base of slopes along the main canyons. The formation is composed of highly fractured silty claystone and intercalated fine sandstone. Where fresh, the formation is well consolidated and locally strongly cemented. Where weathered, the formation desiccates into weak, sheared and remolded clay that is expansive and is unstable in slopes. Clay seams and shears in the unweathered formation can create unstable conditions in slopes where the local structure is adverse.
- *Ju –Undifferentiated Volcanic Rocks (Mesozoic Undifferentiated).* The volcanic rocks exposed in the northeast corner of the Study Area consists of locally metamorphosed and unmetamorphosed volcanic rock ranging from dacite to andesite. The rock is very hard but locally fractured. Excavation characteristics will be dependent upon fracture spacing.

4.2. Local Structural Geology

The older geology (Stadium Conglomerate Scripps Formation and Ardath Shale) underlying the Study Area dips (tilts) gently to the south and west which forms a north-south-trending shallow-dipping syncline and anticline (Figure 2). The very old paralic deposits are flat lying or dip gently to the west. The structure is considered favorable as it dips into the north facing slopes of the major canyons. However, there appear to be as many landslides on these slopes as in slopes with adverse structure.

A number of anastomosing, mostly short and discontinuous west northwest to northeast trending faults associated with the Torrey Pines fault have offset the Eocene sediments in the southwest corner of the Study Area (Figure 2). The faults show normal separation and do not offset early Quaternary very old paralic deposits (Kennedy and Tan, 2008). The faults do not trend with the current active structural grain in San Diego County. However, the faults are considered to be potentially active (City of San Diego, 2008a).

5. TECTONICS AND SEISMICITY

San Diego is affected by the boundary between the North American and Pacific tectonic plates. The boundary, in southern California is characterized by a wide zone of predominantly northwest-striking, right-slip faults that span the Imperial Valley and Peninsular Range to the offshore California Continental Borderland Province (from the California continental slope to the coast). The San Clemente fault zone located 50 miles west of San Diego and the San Andreas fault zone 70 miles east of San Diego define the boundary for the Study Area. The most active faults based on geodetic and seismic data are the San Andreas, San Jacinto, and Imperial faults. These faults take up most of the plate motion. Smaller faults, however, are active enough to create damaging earthquakes and these include the Elsinore, Newport-Inglewood-Rose Canyon, and the offshore Coronado Banks, San Diego Trough, and San Clemente fault zones (Figure 3).

5.1. Local and Regional Faults

Table 1 summarizes the local and regional fault characteristics for the active faults that will affect the Study Area. A Quaternary fault is defined by the State of California (2007) as a fault that shows evidence of movement in the last 1.6 million years. Quaternary (Holocene and Pleistocene) faults can be classified as either active or potentially active faults. Active faults are those Quaternary Holocene faults which have been shown to have ruptured in the last 11,000 years. Potentially active faults are those Quaternary Pleistocene faults which have been shown to have ruptured during the 1.6 million years but not within the last 11,000 years. Potentially active faults have a much lower probability for future activity than active faults. The Study Area is not underlain by active or potentially active faults. Earthquakes on the faults summarized below will, however, create ground shaking that can affect the Study Area.

The nearest active fault capable of causing ground rupture and strong earthquake shaking is the Rose Canyon fault zone located 10 miles southwest of the centroid of the Study Area. The Rose Canyon fault zone is the southernmost portion of the Newport-Inglewood fault zone which extends from Long Beach to the north to the Descanso fault, offshore of Baja California. A Magnitude 6.3 earthquake occurred on the Newport-Inglewood fault in 1933 and caused serious damage in the Los Angeles area. There have been no historical damaging earthquakes documented on the Rose Canyon fault nor has there been historical fault rupture. Fault trenching on the Rose Canyon fault has shown that the fault has ruptured the ground surface several times in the last 10,000 years (Rockwell, 2010).

Table 1 - Fault Characteristics for Active Faults in the Region

Fault Name	Approximate Distance to Study Area	Slip Rate (mm/yr)	Fault Length (miles)	Estimated Magnitude (Maximum Moment Magnitude (Mw))
Newport-Inglewood-Rose Canyon Fault Zone	10	1.5	130	7.2
Coronado Bank Fault Zone (offshore)	22	3.0	115	7.6
San Diego Trough Fault Zone (offshore)	43	1.5	106	7.5
San Miguel-Vallecitos Fault Zone (Northern Baja California)	43	0.2	100	6.9
Elsinore Fault Zone	43	5.0	190	7.0
San Clemente Fault Zone (offshore)	70		129	7.7
San Jacinto Fault Zone	73	4.0	152	6.8
Southern San Andreas Fault Zone	109	25	140	7.2

Table References include; CDMG 2002, CGS 2010, Hirabayashi and others 1996, Kahle and others 1984, Ryan and others 2012.

The nearest potentially active faults to the Study Area are located in the southwest corner of the site. Due to their limited lengths and discontinuous nature, they are not likely sources of future earthquakes or ground rupture.

5.2. Historical Earthquakes

The available record of historical (dating back to the late 1700's) earthquakes larger than Magnitude 6 in the coastal San Diego area is as complete as other regions in the State of California (Anderson, et al 1989). Only a small number of earthquakes have been reported in coastal San Diego whereas other portions of southern California and Baja California, Mexico, have experienced many moderate to large earthquakes in the same historical window.

Strong shaking and minor damage has occurred in the coastal San Diego region as a result of large earthquakes on distant faults or smaller earthquakes on local faults (Agnew et al 1979; Toppozada et al 1981). Earthquakes in Imperial County and northern Baja California in 1800, 1862, and 1892 are believed to have produced the strongest intensities in the San Diego area.

In the 1930's seismographs were established in San Diego. Since that time, swarms of small to moderate magnitude earthquakes have been recorded in San Diego Bay. In 1964, a swarm of small earthquakes was reported generally in the south San Diego Bay (Simmons 1977). In 1985 a swarm of earthquakes with a maximum magnitude of M4.7 occurred just over one-half mile south of the Coronado Bay Bridge (Reichle et al 1985). A magnitude M5.3 earthquake and a series of aftershocks occurred about 44 miles west of Oceanside in 1986 (Hauksson and Jones 1988). The 1986 earthquake was widely felt but did not cause significant damage.

6. LANDSLIDES AND SLOPE STABILITY

Slopes with potentially unstable characteristics in the Study Area are associated with the three major east-west trending canyons in their tributaries. The bases of these slopes are often underlain by the Scripps Formation, Ardath Shale or Del Mar/Friars Formation undifferentiated which are susceptible to landslides and other slope instabilities due to weak claystone. The upper portions of the slopes are underlain by Stadium Conglomerate and very old paralic deposits which have high shear strengths and provide the stable cap that creates the mesa on which Mira Mesa was developed. A review of predevelopment aerial photographs (USDA, 1953) show evidence of large-scale landslides or shallow slope failures along the north-facing slopes of Penasquitos Canyon and the unnamed major canyon to the south. The combination of steep natural slopes, building and fill loads as well as infiltration of irrigation and storm water can create conditions that result in landslides in an urban development. Natural slopes in excess of 2:1 (horizontal:vertical) should be considered potentially unstable. Man-made slopes resulting from grading associated with commercial and residential development are assumed to have been engineered in accordance with City of San Diego requirements.

7. SOILS AND INFILTRATION

The USDA has mapped soil types (series) throughout the United States using a complex system of characteristics. The soil series descriptions can be used as a rough indicator of permeability. Permeability is the main factor that affects the infiltration of water. Infiltration of storm water into soil is a goal of the San Diego Regional Water Quality Control Board (RWQCB) and the City of San Diego. Table 2 summarizes the main soil series located on the mesa in areas of past and future development.

Table 2 - USDA Soil Series Descriptions

Name	Description	Thickness (Inches)	Permeability
Gaviota	Gravelly loam	10-17	Moderately rapid
Redding	Gravelly loam	22-35	Very slow
Altamont Clay	Clay	50-65	Slow
Chesterton	Fine sandy loam	34-42	Very slow to impermeable

The USDA series descriptions are based on natural soil development. Most of the soil in the mesa portion of the Study Area has been altered by grading to create level building sites or streets. As a result, the permeability estimates in Table 2 can only provide a rough indicator of the infiltration potential of the soils in the Study Area. Other factors should be considered in evaluating storm water infiltration feasibility including lateral migration of water on impermeable very old paralic deposits and groundwater mounding. A full list of criteria is enumerated in the City of San Diego Storm Water Standards, Part 1, 2017 Edition (City of San Diego, 2017).

8. HYDROGEOLOGY

According to the Regional Water Quality Control Board (RWQCB) San Diego Basin Plan (RWQCB, 1994), the Study Area lies within three separate hydrologic basins. The hydrologic basins and beneficial use information is listed below.

- The majority of the Study Area is located in the Miramar Reservoir Hydrologic Area (HA) of the Penasquitos Hydrologic Unit (HU). The Miramar Reservoir HA has existing beneficial use for municipal, agricultural, and industrial supply.
- The southernmost portion of the Study Area is located in the Miramar HA of the Penasquitos HU. The Miramar HA is excepted from beneficial use for municipal supply and has potential beneficial use for industrial supply.
- A small portion of the Study Area located in the northeast corner is located in the Poway HA of the Penasquitos HU. The Poway HA has existing beneficial uses for agricultural, and municipal supply, and potential beneficial use for industrial supply.

Based on a review of previous environmental investigation reports and monitoring well data collected from State Water Resources Control Board-managed GeoTracker website (Geotracker), groundwater levels vary across the Study Area and groundwater has been encountered as shallow as 3 feet to deeper than 100 feet below ground surface (bgs). The groundwater flow directions vary within the Study Area.

9. DRAINAGE AND FLOODING

The Study Area is situated mostly on a highly urbanized, gently rolling mesa. Drainage is mainly along streets, gutters and storm drain pipelines that empty into the canyons incising the mesas. Graded slopes use concrete swales that empty into storm drains for drainage. The relatively few natural slopes drain into adjacent canyons or tributaries. Low gradients on streets and storm drains as well as blocked storm drain inlets can create local, short duration flooding during very heavy rainfall. The Study Area is not shown to be in 100- or 500-year Federal Emergency Management Agency flood zones.

In the event of a breach of Miramar Reservoir, the Study Area east of Black Mountain Road and Carrol Canyon will be inundated (California Division of Safety of Dams, 2019). Figure 4 shows the extent of the estimate flooding in case of dam failure at the Miramar Reservoir.

10. MINERALOGIC RESOURCES

Data from the U.S. Geological Survey (USGS) Mineral Resource Data System show that there is one mineralogic resource in the Study Area (USGS 2015), HG Fenton Materials Company. The quarry at this site is located in Carrol Canyon roughly from just west of Camino Santa Fe eastward to Black Mountain Road at the eastern edge of the Study Area. The quarry has been in operation from the 1950's to the present. The quarry produces sand and crushed gravel from the Stadium Conglomerate. Portions of the quarry have been closed and have or are being reclaimed.

Conservation Element of the City of San Diego General Plan (City of San Diego 2008b) indicates the eastern portion of the Study Area is mapped in Mineral Resource Zone 2 (MRZ-2) which is described as areas underlain by mineral deposits (sand and gravel) where geologic data show that significant measured or indicated resources are present.

The MRZ-2 area is nearly fully developed and is in a highly urbanized area. Other than the current HG Fenton operation it is not considered available for future mining activities.

11. GEOLOGIC HAZARDS AND IMPACTS

This section identifies geologic hazards that may affect proposed policies and programs of the MMCPU and proposed land use. These hazards include seismicity and ground motion; liquefaction; seismically-induced settlement; slope instability; subsidence; expansive and corrosive soils; impermeable soils; shallow groundwater, and flooding. These hazards are shown on Figure 5 and have been overlain with the areas subject to geotechnical loads associated with new development or redevelopment.

The geologic hazards identified above can be mitigated through administrative controls (e.g., avoiding with building in hazard-prone areas or structure setback) and/or engineering improvements (e.g., ground improvement, ground restraints, or appropriate structure foundation). Site-specific and hazard-specific geotechnical investigations would be required to evaluate the appropriate mitigation measure or combination of measures.

The City of San Diego Seismic Safety Study Geologic Hazards and Faults maps document the known and suspected geologic hazards and faults in the region. The maps show potential hazards and rates them by relative risk, on a scale from nominal to high. The Seismic Safety Study is intended as a tool to determine the level of geotechnical review to be required by the City for planning, development, or building permits. The Study Area is shown on portions of map grid tiles 34, 35, and 39 of the City of San Diego Seismic Safety.

Figure 5, Summary of Geohazards, shows the location of hazards as defined by the City maps and are discussed below. The mesa area is underlain by "level mesa underlain by terrace deposits or bedrock with nominal risk" (51), "other level areas or gently sloping to steep terrain with favorable geologic structure." Low risk (52). Slope areas are underlain by "Friars Formation with neutral or favorable geologic structure" (23), "Friars Formation with unfavorable geologic structure" (24), "Ardath Shale with neutral or favorable geologic structure" (25). The areas at the top of slopes has been designated 53 "level or sloping terrain with unfavorable structure and "low to moderate risk".

The bottoms of drainages are designated as Category 31 or 32 which exhibit a "high potential for liquefaction due to high groundwater" or "low potential for liquefaction due to fluctuating groundwater levels". Landslide deposits are "Confirmed, known, or highly suspected" (21), "Possible or conjectured" (22).

11.1. Seismicity and Ground Motion

An active fault is defined by the State Mining and Geology Board as one that has experienced surface displacement within the Holocene epoch, i.e., during the last 11,000 years (California Geological Survey, 2007). The Study Area is subject to potential ground shaking caused by activity along faults located near the Study Area.

Ground shaking during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and the type of geologic material underlying the area. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments such as artificial fill or unconsolidated alluvial fill.

As noted, the Study Area is subject to ground shaking hazards caused by earthquakes on regional active faults. Based on a Probabilistic Seismic Hazards Ground Motion Interpolator provided by the California

Department of Conservation (2008), the Study Area is located in a zone where the horizontal peak ground acceleration having a 10 percent probability of exceedance in 50 years is 0.247g (where g represents the acceleration of gravity).

11.2. Liquefaction, Seismically Induced Settlement

Liquefaction is a phenomenon whereby unconsolidated and/or near-saturated soils lose cohesion as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in temporary, fluid-like behavior of the soil. Soil liquefaction causes ground failure that can damage roads, pipelines, underground cables, and buildings with shallow foundations. Research and historical data indicate that loose granular soils and non-plastic silts that are saturated by a relatively shallow groundwater table are susceptible to liquefaction.

Among the potential hazards related to liquefaction are seismically induced settlement. While lateral spreads are also associated with these ground failures, the liquefaction prone soil in the Study Area is not situated near or adjacent to slopes. Seismically induced settlement is caused by the reduction of shear strength due to loss of grain-to-grain contact during liquefaction and may result in dynamic settlement on the order of several inches to several feet. Other factors such as earthquake magnitude, distance from the earthquake epicenter, thickness of the liquefiable layers, and the fines content and particle sizes of the liquefiable layers will also affect the amount of settlement.

Liquefiable soil is located in the bottoms of the major canyon bottoms traversing the Study Area. These areas are currently in open space or in quarry areas either being actively mined or need to be reclaimed. A small area west of Camino Ruiz in Carrol Canyon has been developed. It is assumed that the earthwork and construction has been accordance with City of San Diego requirements and have mitigated liquefaction effects in that specific area.

11.3. Tsunamis, Seiches, and Dam Failure

A tsunami is a sea wave generated by a submarine earthquake, landslide, or volcanic action. Submarine earthquakes are common along the edge of the Pacific Ocean, thus exposing all Pacific coastal areas to the potential hazard of tsunamis. However, no portion of the Study Area lies within a mapped tsunami inundation zone. A seiche is an earthquake-induced wave in a confined body of water, such as a lake, reservoir, or bay. However, no portion of the Study Area lies near a confined body of water on which a seiche could be expected to occur.

An earthquake-induced dam failure can result in a severe flood event. When a dam fails, a large quantity of water is suddenly released with a great potential to cause human casualties, economic loss, lifeline disruption, and environmental damage. Based on the California Division of Safety of Dams (2019), the areas shown on Figures 4 and 5 are within the inundation zone of Miramar Dam.

11.4. Slope Instability

According to the City of San Diego Seismic Safety Study the slopes in the Study Area are underlain by Friars Formation and Ardath Shale with neutral to favorable structure (Geologic Hazard Category 23 and 25) and Friars Formation with adverse structure (24). The risk of landsliding is not discussed on the maps. Since there are landslides on slopes with neutral and favorable geologic structure, all slopes underlain by the Friars Formation, Ardath Shale or Del Mar/Friars Formation undifferentiated should be considered potentially unstable. The tops of the slopes are mapped as being at low to moderate risk for landsliding (Hazard Category 53).

Buildings or infrastructure older than 1985 within 50 feet of the tops of natural slopes may have been designed without consideration of slope stability (this area is in general agreement with Hazard Category 53, City of San Diego, 2008). Additions of new building loads in these locations may not meet current City of San Diego standards for slope stability.

11.5. Subsidence

Subsidence typically occurs when extraction of fluids (water or oil) cause the reservoir rock to consolidate. Water extraction is minimal in the Study Area and the geologic materials area well consolidated. Subsidence is not a hazard in the Study Area.

Settlement of unconsolidated soil (fill or alluvium) may occur locally where new loads are imposed on previously uncompacted fill, compacted fill on unconsolidated material such as weathered very old paralic deposits or alluvium, or unconsolidated alluvium.

11.6. Expansive or Corrosive Soils

Other potential geological hazards include expansive or corrosive soils. Expansion of the soil may result in unacceptable settlement or heave of structures or concrete slabs supported on grade. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors. Soils with a relatively high fines content (clays dominantly) are generally considered expansive or potentially expansive. Table 2 summarizes soils in the Study Area; the soils are predominantly clayey and are considered potentially expansive. Grading has mixed the natural soils with the granular formational materials and will affect the potential for expansive soil greatly. Parking lots subgrades may be suitable for pavements but unsuitable for building foundations.

11.7. Impermeable Soil

The permeability of soil within 10 feet of the current ground surface is important when evaluating the potential for and the design of storm water infiltration devices. The soil in the Study Area exhibits very slow infiltration (Table 2) and the well consolidated, frequently cemented old paralic deposits are typically encountered at very shallow depths. As a result, the use of typical shallow infiltration systems may be problematic in the mesa portion of the Study Area.

Cemented old paralic deposits and Stadium Conglomerate often create difficult excavation conditions which may increase grading or excavation costs for basements, foundations, or trenching for underground utilities.

11.8. Groundwater

The permanent groundwater table is expected to be too deep to impact the planned developments shown on the MMCPU. Local shallow groundwater and perched groundwater may be present locally due to leaking storm drains, water lines, and irrigation. Excavations deeper than 5 feet may encounter groundwater conditions that might affect construction (temporary slope stability, shoring, dewatering and permanent drainage behind walls).

12. IMPACT MITIGATION

The impacts summarized above may be mitigated through administrative controls (e.g., avoiding building in hazard-prone areas or structural setback areas) and/or engineering improvements (e.g., ground improvement, ground restraints, remedial grading or foundation design). Site specific geotechnical investigations are required to recommend the appropriate mitigation measure(s).

12.1. Seismicity and Ground Motion

The entire Study Area will be affected by seismicity and ground motion. Mitigation can be accomplished by geotechnical and structural engineering design. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports and State of California requirements. Most mitigation measures will involve foundation design and or ground improvement.

12.2. Liquefaction, Seismically Induced Settlement

Predicted liquefaction will occur in the major canyon bottoms. Mitigation can be accomplished by ground improvement and or foundation design. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports and State of California requirements.

12.3. Tsunamis, Seiches, and Dam Failures

No mitigation measures are necessary for Tsunami or Seiches because the Study Area is not impacted by these hazards. Dam failure inundation may be mitigated through civil design.

12.4. Slope Instability

Mitigation may be achieved by avoidance of development on slopes or stabilizing the slopes through grading or using specially designed foundations. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports with an emphasis on slope stability. Additions to existing structures or development of ancillary structures to existing development will need independent geotechnical investigations if located within 25 feet of slopes in excess of 10 feet high, and on undocumented fills. The investigations should be applied in Hazard Categories 21-25 and 53.

12.5. Subsidence

Construction of improvements in areas underlain by alluvium or fill should be designed to withstand settlement of unconsolidated soil. Geotechnical investigations for design of settlement resistant structures should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports. Mitigation measures typically include ground improvement and/or foundation design.

12.6. Expansive or Corrosive Soil

Expansive soil measures include specially reinforce foundations or removal and replacement of expansive soil with less expansive material. Roadways may need heavier pavement sections. Remedial grading conducted in the past for current parking lots may not have been suitable for buildings foundations. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports to provide appropriate recommendations. Corrosive soil should be evaluated by a Corrosion Engineer for recommendations for soil replacement or cathodic protection.

12.7. Impermeable Soil

Infiltration potential should be evaluated in accordance with City of San Diego Storm Water Standards, Part 1, 2017 Edition (City of San Diego, 2017). Cemented subgrade will require heavier than normal equipment to excavate and may be predicted with subsurface geotechnical exploration or geophysical surveys.

12.8. Groundwater

The effects of potential groundwater on construction should be evaluated by geotechnical investigations in accordance with City of San Diego Guidelines for Geotechnical Report. Recommendations for dewatering, temporary and permanent slope stabilization, and subsurface drainage should be discussed.

13. THRESHOLDS OF SIGNIFICANCE

In accordance with Appendix G of the CEQA Guidelines, the project will have significant effect on the environment if:

G-1: Expose people to potential substantial adverse effects, including the risk of loss, injury or death involving: a) fault rupture, b) seismic shaking, c) seismic ground failure, d) landsliding.

G-2: Result in substantial soil erosion or loss of top soil.

G-3 Be located in a geologic unit or soil that is unstable (landsliding, settlement, lateral spreading) or that would become unstable as a result of the project.

G-4 :Be located on expansive soil causing substantial risk to life or property.

G-5: Having soils incapable of supporting the use of septic tanks where sewers are not available.

13.1. Threshold G-1 a) Fault Rupture

No significant effect. There are no active faults in the Study Area. The potentially active faults in the Study Area are short, discontinuous and do not parallel the active structure (north-south to northwest-southeast) in San Diego area and are not likely sources of earthquakes or ground rupture. They should be evaluated on a case by case basis as required by the City of San Diego.

13.2. Threshold G-1 b) Strong Seismic Ground Shaking

Less than significant effect. Construction of buildings and other civil works will be required to use seismic resistant designs in accordance with California and City standards and codes. If not constructed to these standards, the impact could be significant.

13.3. Threshold G-1 c) Seismic Ground Failure

Less than significant effect. The liquefiable soils in the Study Area are located in open space. No construction is shown in these areas on the MMCPU.

13.4. Threshold G-1 d) Seismic Induced Landsliding

Less than significant effect. Planned development will be within areas previously developed. Slopes within developed areas have been constructed in accordance with City of San Diego standards and codes and are assumed to be stable under static and pseudostatic conditions.

13.5. Threshold G-2 Substantial Soil Erosion and Loss of Topsoil

Less than significant effect. The Study Area is almost fully developed with landscaping, buildings, and paving. Areas not developed are dedicated open space areas that are well covered with natural vegetation. Most of the Study Area is located on a mesa where gradients are very low. As a result, the potential for erosion is very low. Since construction will be required to follow City of San Diego standards and code that stipulate protection against temporary and permanent erosion, the impact of erosion and loss of topsoil is less than significant.

13.6. Threshold G-3 Unstable Soil (Landslide, Settlement, Lateral Spreading)

Landslide: Less than Significant. Landslides and landslide prone geologic formations are exposed along the southern slopes of Penasquitos Canyon and the adjacent canyon to the south. The MMCPU shows planned development only in areas previously developed. These areas have been stabilized or have utilized suitable setbacks by the previous development. Any new development in these areas should include geotechnical review of the as-built conditions and evaluation of the impact new construction will have on the stability of new and old structures.

Settlement: Less than Significant. Settlement prone soil within the MMCPU consists of undocumented fills, fills placed on settlement prone soil (in the southeast corner of the Study Area) or soils within 25 feet of the tops of slopes 10 feet high or higher. The impact of these settlement prone soils will occur when additions or new fills place new loads on settlement prone soil. Geotechnical reports performed in accordance the City of San Diego Guidelines should be required for ANY new development that would add additional loads on undocumented fills, fills placed on settlement prone soil, or soil within 25 feet of slopes in excess of 10 feet in height to evaluate the effect of the additional loads. Without changing the requirements for geotechnical investigation for minor additions or fills, the effects of Settlement Prone Soil on the planned development could be significant.

Lateral Spreading: Less than Significant. Lateral Spreading occurs in sloping liquefaction prone soil or liquefaction prone soil with an open face (slope). Liquefaction prone soil in the Study Area is overlain be fill or is confined to stream channel bottoms. The potential for lateral spreading in the Study Area is insignificant.

13.7. Threshold G-4 Expansive Soil

Less than Significant. Expansive soil is present on the mesa portions of the Study Area. This area has been heavily modified by previous development, so the distribution of the expansive soil will be site dependent. Geotechnical investigations as required by the City of San Diego will identify the effects of expansive soil on the planned development. Typical remediation measures include removal of unsuitable soil and replacement with non-expansive soil, chemical treatment of expansive clay, or specially designed and reinforced foundations.

13.8. Threshold G-5 Soil Unsuitable for Onsite Sewage Disposal Systems

Less than Significant. Soil and geologic formations with poor percolation characteristics are widespread in the Study Area. The Study Area is currently well served by existing sewer systems. The use of onsite sewage disposal systems is not anticipated.

14. CONCLUSIONS

Conclusions of this Study are listed below.

- There are no geologic hazards that cannot be avoided or mitigated
- There are no policies or recommendations of the MMCPU which will have a direct or indirect significant environmental effect with regard to geologic hazards.
- The proposed land uses are compatible with the known geologic hazards.
- There are no potential impacts related to geologic hazards from the implementation of the MMCPU that can't be avoided, reduced to an acceptable level of risk, or reduced below a level of significance through mandatory conformance with applicable regulatory requirements or the recommendations of this technical report
- The impact of unstable soil can be reduced to less than significant levels by requiring geotechnical investigations on ALL construction on ground underlain by settlement prone undocumented fills, fills on settlement prone soil, or soil within 25 feet of the tops of slopes in excess of 10 feet high.

15. LIMITATIONS

This report was prepared in general accordance with current guidelines and the standard-of-care exercised by professionals preparing similar documents near the Study Area. No warranty, expressed or implied, is made regarding the professional opinions presented in this document. As this report represents a review of existing documentation on geotechnical conditions of the planning areas rather than in-depth on-site investigation, it cannot account for variations in individual site conditions or changes to existing conditions. Please also note that this document did not include an evaluation of environmental hazards.

The conclusions, opinions, and recommendations as presented in this document, are based on a desktop analysis of data, some of which were obtained by others. It is our opinion that the data, as a whole, support the conclusions and recommendations presented in the report.

The purpose of this study was to evaluate geologic and geotechnical conditions within the planning areas to assist in the preparation of environmental impact documents for the project. Comprehensive geotechnical evaluations, including subsurface exploration and laboratory testing, should be performed prior to design and construction of structural improvements. Any future projects on individual sites in the planning areas will require site-specific geotechnical studies as required by State and City regulations.

16. REFERENCES

Agnew, D. C., Legg, M., and Strand, C., 1979, Earthquake History of San Diego, Earthquake and Other Perils, San Diego Region, Abbott, P. L., and Elliott, W. J. eds., San Diego Association of Geologists.

Allen, C. R. and St. Armand, P., 1965, Relationship between Seismicity and Geologic Structure in the Southern California Region, Seismological Society of America Bulletin, v 55, No. 4.

Anderson, J. G., Rockwell, T. K., and Agnew, D. C., 1989, Past and Possible Future Earthquakes of Significance to the San Diego Region, Earthquake Spectra, v. 5.

Brune, J. N., Simons, R. S., Rebollar, C., and Reyes, A., 1979, Seismicity and Faulting in Baja California in Earthquakes and Other Perils, San Diego Region, Abbott, P. L. and Elliott. W. J. eds., San Diego Association of Geologists.

California Department of Water Resources, 2017, Water Data Library Website: www.water.ca.gov/waterdatalibrary: accessed May.

California State Water Resources Control Board, 2019, Geotracker Website: http://geotracker.waterboards.ca.gov: accessed December.

California Department of Conservation, 2008. Ground Motion Interpolator. Online. http://www.quake.ca.gov/gmaps/PSHA/psha_interpolator.html. Accessed: May 2017.

California Division of Mines and Geology, 2002, California Department of Conservation, Division of Mines and Geology Open File Report 96-08, U.S. Department of the Interior, U.S. Geological Survey Open File Report 96-706 Probabilistic Seismic Hazard Assessment for the State of California, Appendix A: Fault Source Parameters, 1996, revised in 2002.

California Division of Mines and Geology, 2008, Guidelines for Evaluating Seismic Hazards in California, Special Publication 117A

California Division of Mines and Geology, 1963, Geology and Mineral Resources of San Diego County, California, by F. H. Weber Jr., County Report 3

California Emergency Management Agency, California Geological Survey, and the University of Southern California, 2009. Tsunami Inundation Map for Emergency Planning, San Diego Bay, Scale 1:24,000.

California Geological Survey, 2002, Special Publication 49, Guidelines for Evaluating the Hazards of Surface Fault Rupture.

California Geological Survey, 2003, State of California, Earthquake Fault Zones, Point Loma Quadrangle: Scale 1:24,000.

California Geological Survey, 2007, Special Publication 42, Fault-Rupture Hazard Zones in California.

California Geological Survey, 2010, Fault Activity Map of California, http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html#.

California Geological Survey, 2013, Note 52 Guidelines for Preparing Geological Reports for Regional-Scale Environmental and Resource Management Planning.

California Division of Safety of Dams, 2019, Dam Breach Inundation Map, Web Publication: www.fmda.water.ca.gov/webgos/?appid=damprototypevz.miramarsandiego, accessed November 2019

Cao, T., Bryant, W.A., Rowshandel, B., Branum, D., and Willis, C.J., 2003, The Revised 2002 California Probabilistic Seismic Hazards Maps: California Geological Survey.

City of San Diego Seismic Safety Study, Geologic Hazards and Faults, 2008a, Grids 26 and 31, Scale 1: 800.

City of San Diego, 2008b, City of San Diego General Plan, Adopted March 10, 2008, Resolution No. R-303473.

City of San Diego, 2011, San Diego Development Services, California Environmental Quality Act, Significance Determination Thresholds.

City of San Diego, 2016, San Diego Development Services, Geotechnical Study Requirements, Information Bulletin 515.

City of San Diego, 2017, Storm Water Standards, Part 1, BMP Design Manual, Chapters for Permanent Site Design and Storm Water Treatment and Hydromodification, November 2017 Edition.

City of San Diego, 2018a, Guidelines for Geotechnical Reports.

City of San Diego, 2018b, Existing Conditions Community Atlas, Mira Mesa Community Plan Update: dated November.

City of San Diego, 2019, Sorrento Mesa Land Use Compatibility Analysis, Mira Mesa Community Plan Updates, Working Draft, dated: August.

County of San Diego, 2004, revised 2010, http://www.sandiegocounty.gov/content/dam/sdc/oes/docs/DRAFT_COSD_DamFailure1.pdf.

Harden, D.R., 1998, California Geology: Prentice Hall, Inc.

Hauksson, E. and Jones, L .M, 1988, The July 1988 Oceanside (ML=5.3) Earthquake Sequence in the Continental Borderland, Southern California, Bulletin of the Seismological Society of America, Vol 78.

Hirabayashi, C. K., Rockwell, T. K., Wesnousky, S. G., Sterling, M. W., Surez-Vidal, F., 1996, A Neotectonic Study of the San Miguel-Vallecitos Fault, Baja California, Mexico, Bulletin of the Seismological Society of America, Vol. 86.

Kahle, J. E., Bodin, P. A. Morgan, G. J. 1984, Preliminary Geologic Map of the California-Baja California Border Region.

Kahle, J. E., 1988, A Geomorphic Analysis of the Rose Canyon, La Nacion and Related Faults in the San Diego Area, California, California Division of Mines and Geology Fault Evaluation Report FER-196.

Kennedy, M. P. 1975, Geology of the San Diego Metropolitan Area, California, California Division of Mines and Geology Bulletin 200.

Kennedy, M. P. and Tan, S. S. 1975 Character and Recency of Faulting, San Diego Metropolitan Area, California, California Division of Mines and Geology, Special Report 123.

Kennedy, M.P., and Tan, S.S. compilers, 2008, Geologic Map of the San Diego 30’X60’ Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, Scale 1:100,000.

Jennings, C.W. and Bryant, W.A., 2010, Fault Activity Map of California and Adjacent Areas: California Geological Survey, California Geological Map Series, Map No. 6): Scale 1:250,000.

Tan, S.S., 1995, Landslide Hazards in the Southern Part of the San Diego Metropolitan Area, San Diego County, California, OFR 95-03.

Reichle, M., Bodin, P., Brune, J. 1985, The June 1985 San Diego Earthquake Swarm (Abs), EOS Transactions, American Geophysical Union, Vol. 66

Rockwell, T., Hatch, M. E. and Shug. D. L., 1987, Late Quaternary Rates, Agua Blanca and Borderland Faults, U.S. Geological Survey, Final Technical Report.

Rockwell, T., 2010, The Rose Canyon Fault Zone in San Diego, Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics and Symposium in honor of Professor I. M. Idriss, San Diego California.

Ryan, H. F., Conrad, J. F., Paul, C. K., McGann, M., 2012, Slip Rate on the San Diego Trough Fault Zone, Inner California Borderland and the 1986 Oceanside Earthquake Swarm Revisited, Bulletin of the Seismological Society of America, Vol. 102.

San Diego Association of Governments (SANDAG), 2019, http://www.arcgis.com/home/webmap/viewer.html?url=https://services.arcgis.com/oxInpRhVIBxlo4pO/ArcGIS/rest/services/City_of_San_Diego_Potentially_Active_Faults/FeatureServer/0&source=sd, accessed November, 2019.

San Diego Regional Water Quality Control Board (RWQCB), 1994, Water Quality Control Plan for the San Diego Basin (9), with amendments effective on or before May 17, 2016, dated: September. https://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/.

Simmons, R. S., 1977 Seismicity of San Diego, 1934-1974, Bulletin of the Seismological Society of America, Vol. 67.

Toppozada, J. A., Real, C. R., and Parke, D. L., 1981, Preparation of Isoseismal Maps and Summaries of Reported Effects for Pre-1990 California Earthquakes, California Division of Mines and Geology Open File Report 81-11.

United States Department of Agriculture, 1953, Stereo Aerial Photographs, Flight AXN, Line 3M, Frames 182-185 and Line 4M, Frames 8-11.

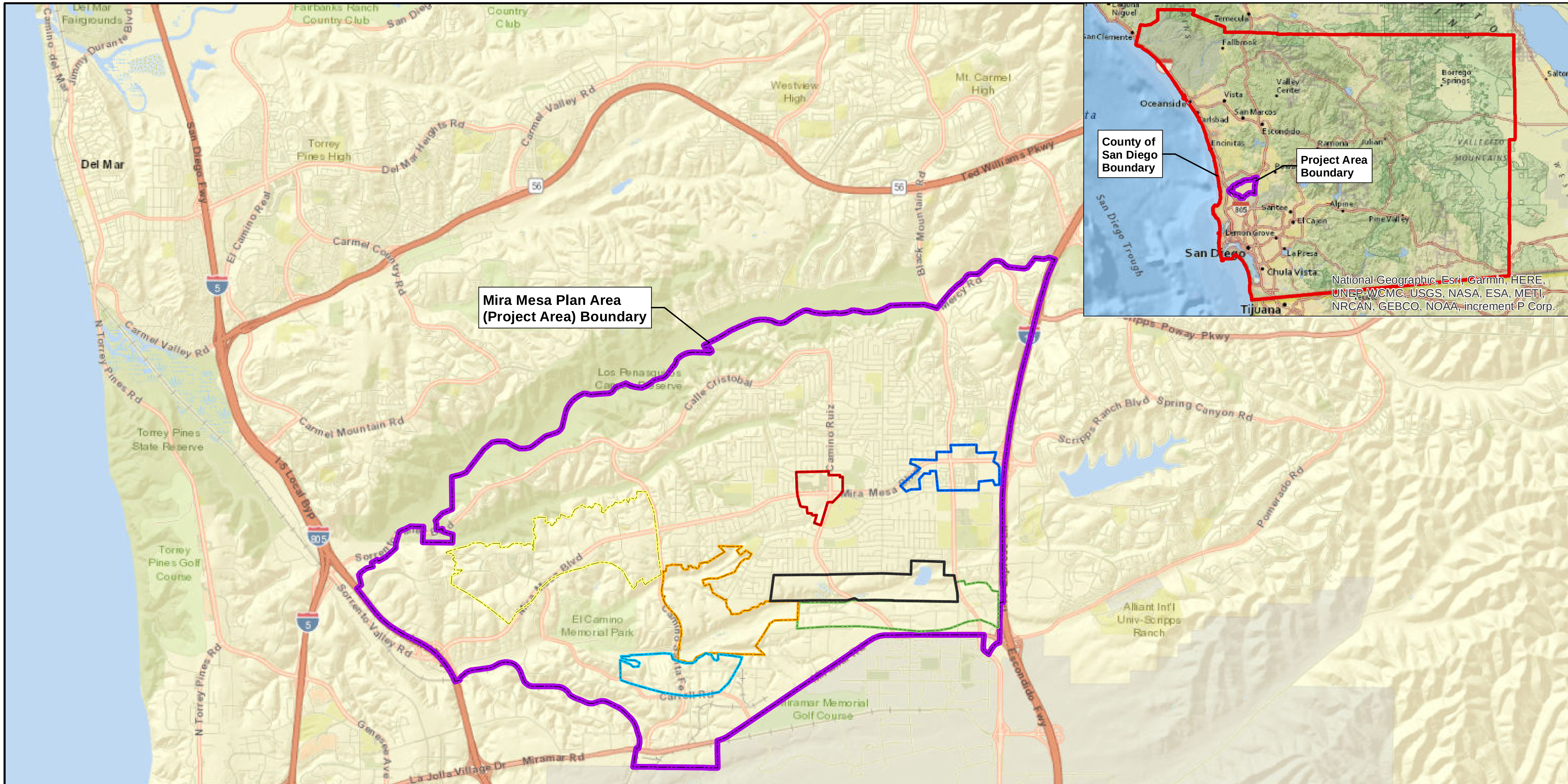
United States Department of Agriculture, 1973, Soil Survey, San Diego Area, California.

United States Geological Survey, 2015a Mineral Resources Data System, http://mrdata.usgs.gov/mrds/, accessed November 2019.

United States Geological Survey, 2015b, Hazard Curve Application, http://geohazards.usgs.gov/hazardtool/application.php, accessed November, 2019.

University of California at Davis, California Soil Resource Laboratory, 2017, https://casoilresource.lawr.ucdavis.edu/gmap/, accessed April.

FIGURES



Legend

Mira Mesa CPU Boundary	Mira Mesa Town Center (Focus Area)
3 Roots	Miramar Gateway (Focus Area)
Employment Intensification	Sorrento Mesa (Focus Area)
Mira Mesa Gateway (Focus Area)	Stonecreek Development

N / W / E / S

0 2,500 5,000 Feet

Project No. 9127007

Date: 12/2019

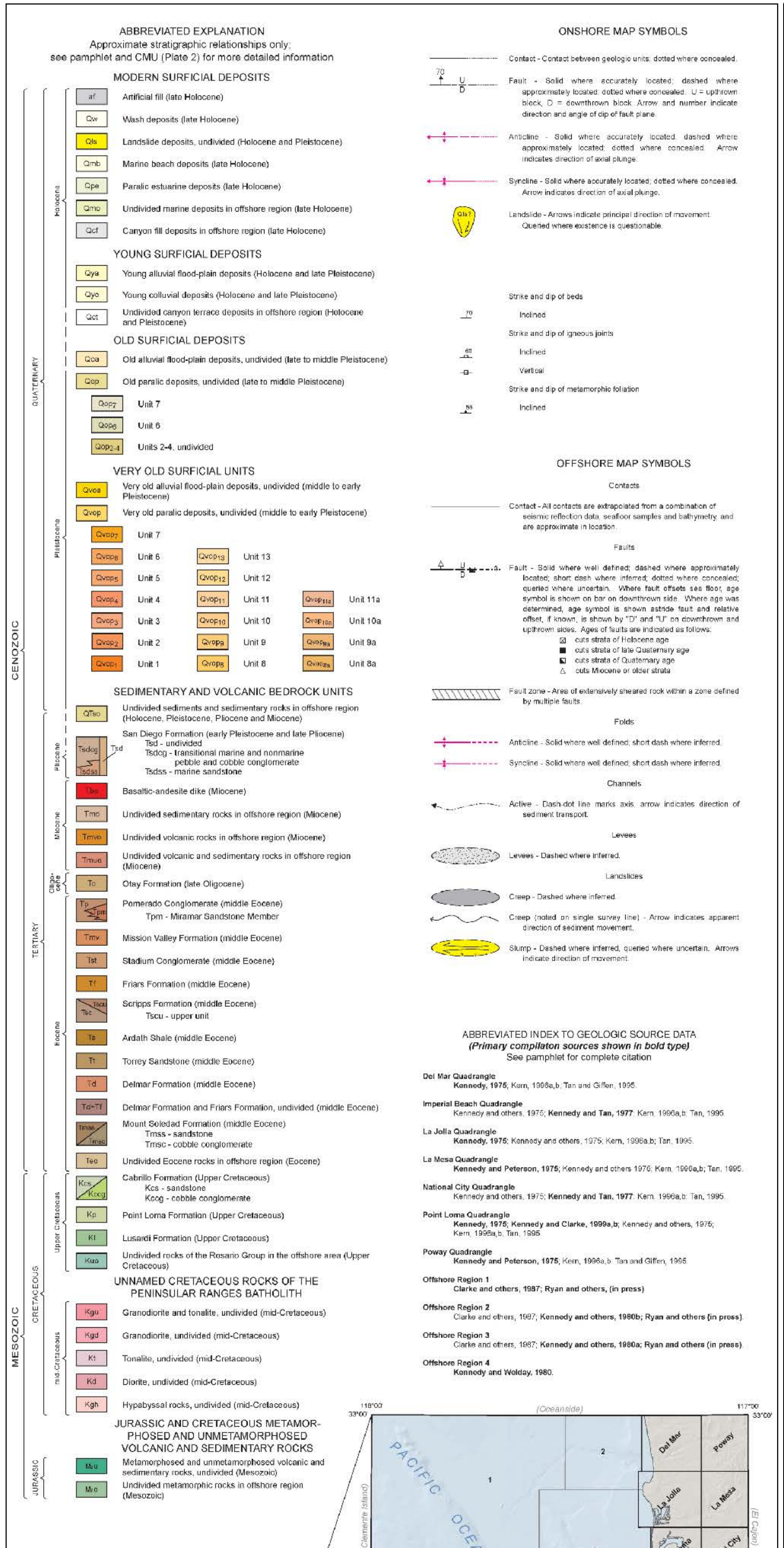
Drawn By: SG

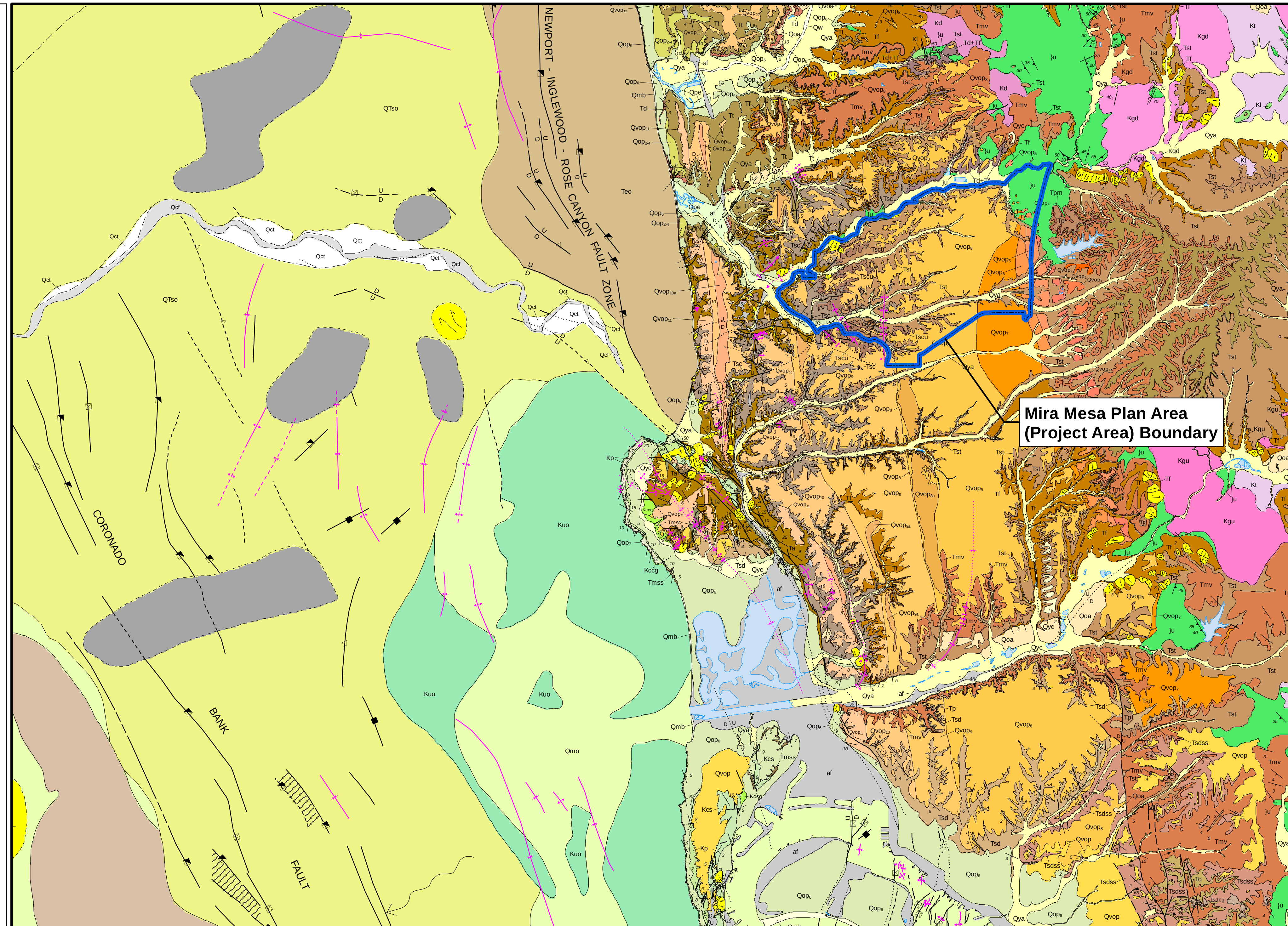
Project Area Location Map

Mira Mesa
Community Plan Update
San Diego, California

THE BODHI GROUP
INNOVATING | SUSTAINING | SOLVING

Figure 1





N
W E
S

0 7,500 15,000 Feet

Project No. 9127007

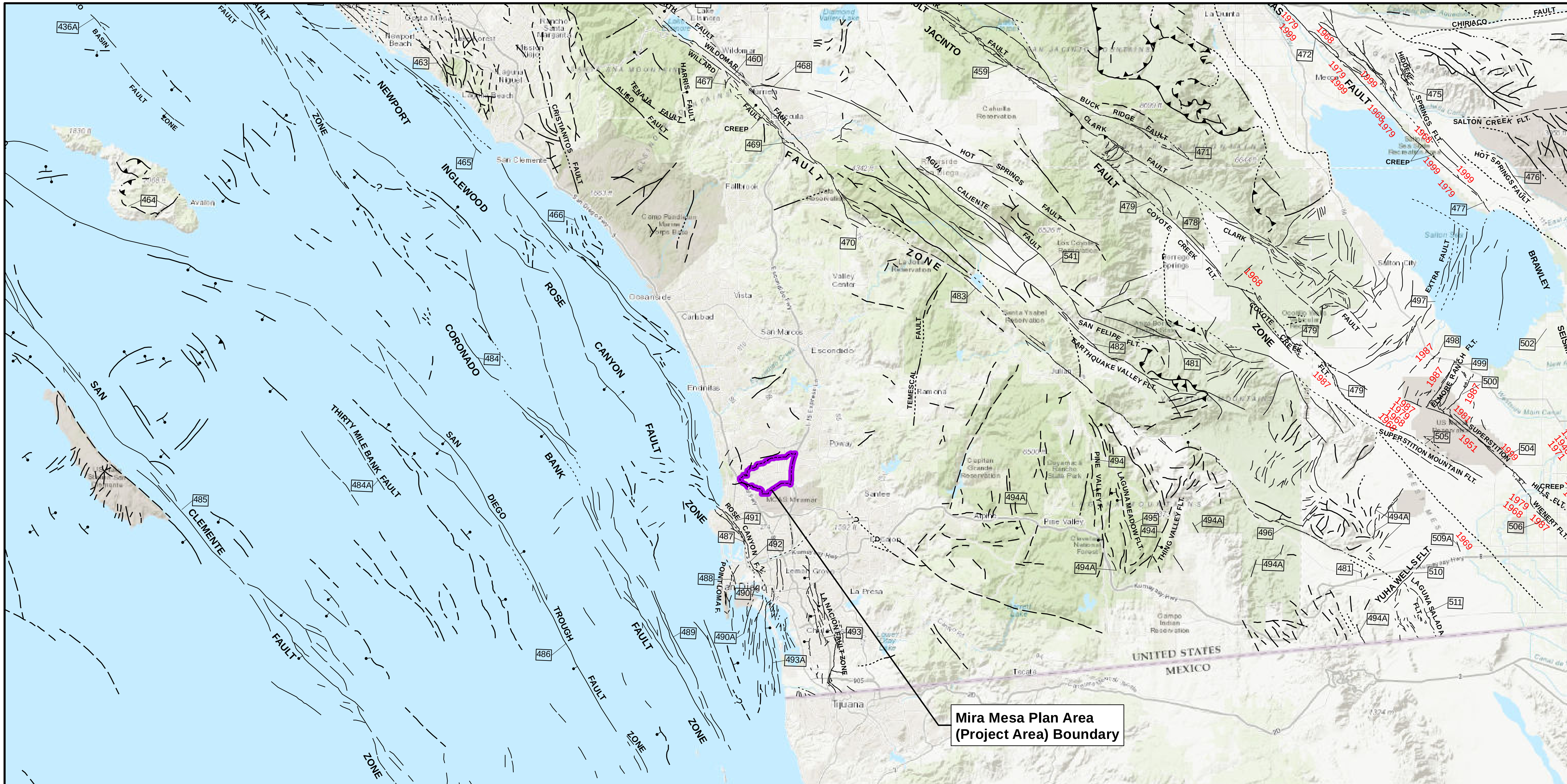
Date: 12/2019

Drawn By: SG

Regional Geology
Mira Mesa CPU
Project Area

Mira Mesa
Community Plan Update
San Diego, California

Figure 2



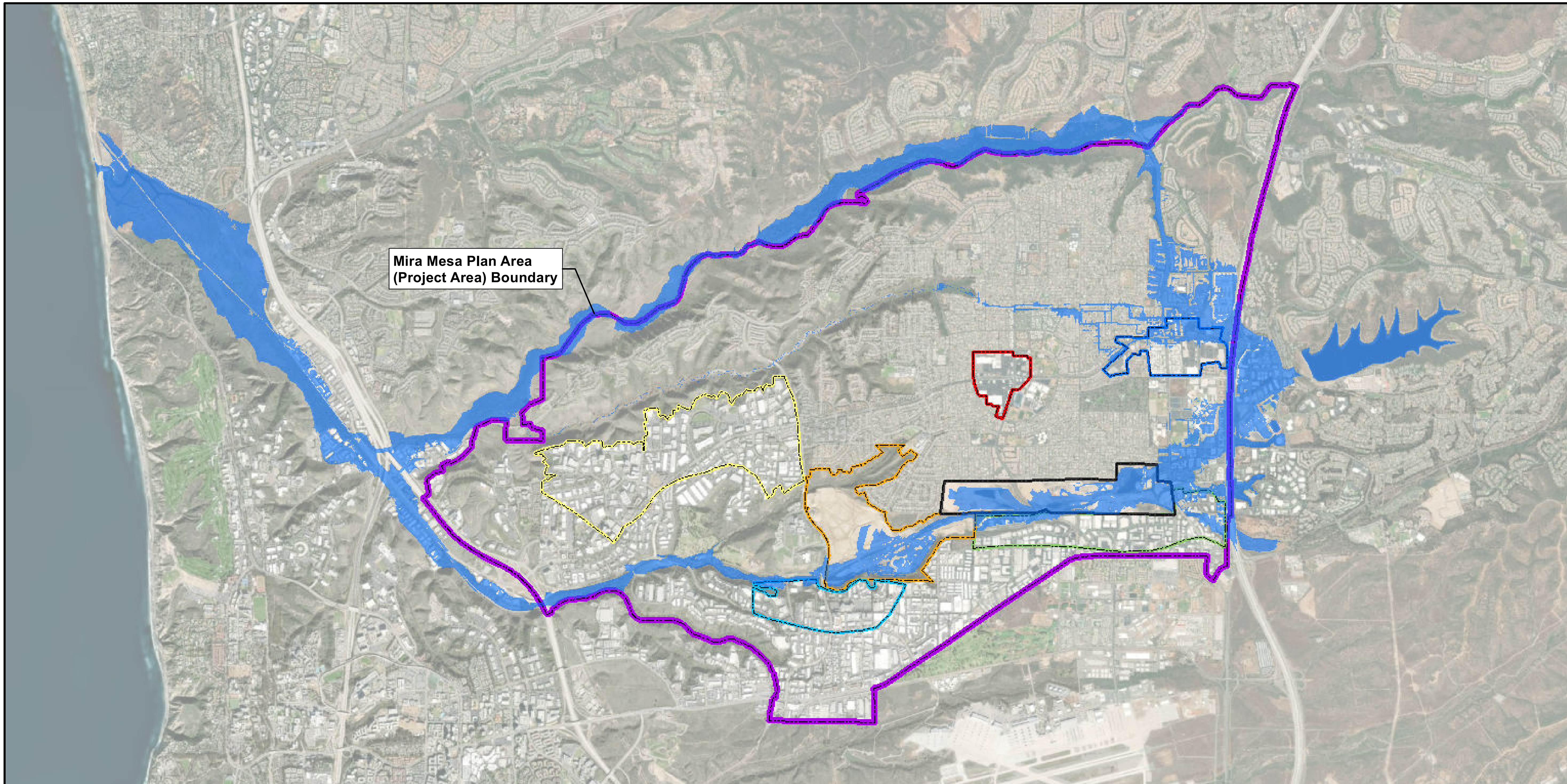
Legend

- Mira Mesa CPU Boundary
- fault, approx. located
- fault, approx. located, queried
- fault, certain
- fault, concealed
- fault, concealed, queried
- fault, inferred, queried
- thrust fault, certain
- thrust fault, approx. located
- thrust fault, concealed
- dextral fault, certain
- dextral fault, approx. located
- dextral fault, concealed
- sinistral fault, certain
- sinistral fault, approx. located
- sinistral fault, concealed
- thrust fault, certain (2)
- thrust fault, approx. located (2)
- thrust fault, concealed (2)
- fault, certain (ball and bar)
- fault, approx. located (ball and bar)
- fault, concealed (ball and bar)
- dextral fault, certain (ball and bar)
- fault, concealed, queried (ball and bar)
- fault, concealed, queried (ball and bar, 2)
- fault, certain (dip)
- fault, approx. located (dip)
- fault, concealed (dip)
- reverse fault, certain
- reverse fault, approx. located
- reverse fault, concealed

N S E W

0 6 12 Miles

Project No. 9127007	**Regional Fault Map** **Mira Mesa CPU Study Area**	THE BODHI GROUP INNOVATING | SUSTAINING | SOLVING	
Date: 12/2019			
Drawn By: SG	**Mira Mesa** **Community Plan Update** **San Diego, California**	Figure 3	



Legend

- Areas Subject to Dam Inundation Flooding
- Mira Mesa CPU Boundary
- 3 Roots
- Employment Intensification
- Mira Mesa Gateway (Focus Area)
- Mira Mesa Town Center (Focus Area)
- Miramar Gateway (Focus Area)
- Sorrento Mesa (Focus Area)
- Stonecreek Development

N W E S

0 2,000 4,000 Feet

Project No. 9127007

Date: 12/2019

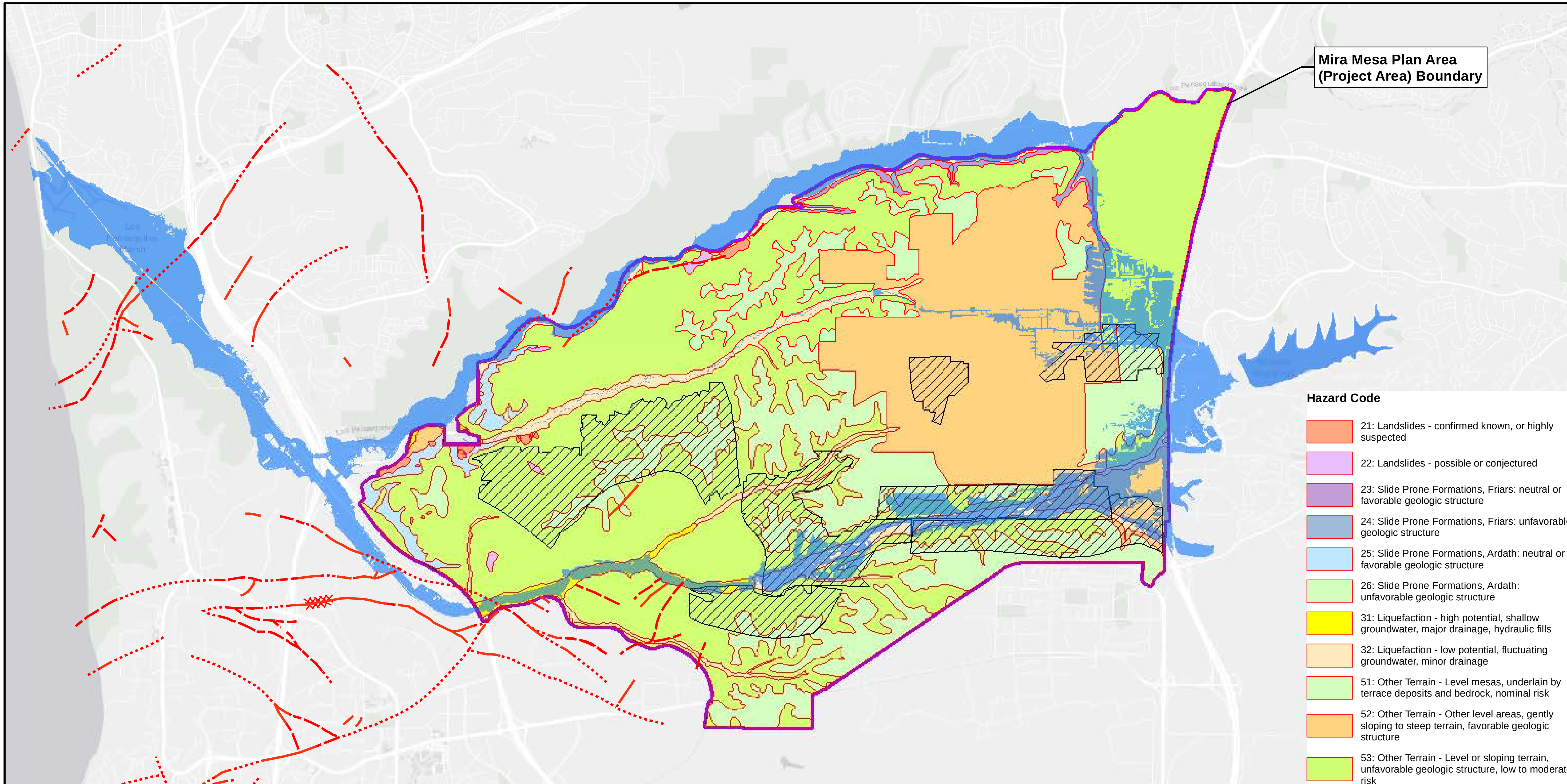
Drawn By: SG

Dam Inundation Map
Mira Mesa CPU Project Area

Mira Mesa
Community Plan Update
San Diego, California

THE BODHI GROUP
INNOVATING | SUSTAINING | SOLVING

Figure 4



Legend

- Mira Mesa CPU Boundary
- Areas with potential new geotechnical loads
- Areas Subject to Dam Inundation Flooding
- Potentially Active Fault
- Potentially Active Inferred Fault
- Potentially Active Concealed Zone
- Potentially Active Shear Zone

N / S / E / W

0 2,000 4,000 Feet

Project No. 9127007

Date: 12/2019

Drawn By: SG

Summary of Geohazards
Mira Mesa CPU Project Area

Mira Mesa
Community Plan Update
San Diego, California

THE BODHI GROUP
INNOVATING | SUSTAINING | SOLVING

Figure 5