Appendix N

GEOLOGIC STUDY

GEOLOGIC DESKTOP STUDY
SAN YSIDRO COMMUNITY PLAN UPDATE AND SAN YSIDRO HISTORIC VILLAGE SPECIFIC PLAN CITY OF SAN DIEGO, CALIFORNIA

Submitted to:

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March 30, 2016

March 30, 2016

Mr. Bruce McIntyre
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Subject: **GEOLOGIC DESKTOP STUDY**
SAN YSIDRO COMMUNITY PLAN UPDATE AND
SAN YSIDRO HISTORIC VILLAGE SPECIFIC PLAN
CITY OF SAN DIEGO, CALIFORNIA
AGE Project No. 127GS-10

Dear Mr. McIntyre:

In accordance with your request, we are pleased to submit the accompanying report to present the findings and opinions of a geologic desktop study that we have performed for the City of San Diego Planning & Community Investment Department's Update of the San Ysidro Community Plan (SYCPU) and the San Ysidro Historic Village Specific Plan (SYHVSP).

We appreciate the opportunity to be of service on this important project for the City of San Diego. If you have any questions regarding the contents of this report or need further assistance, please feel free to give us a call

Sincerely,

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CITY OF SAN DIEGO, CALIFORNIA

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1.0 INTRODUCTION

In accordance with the request of Helix Environmental Planning, Inc. (HELIX), Allied Geotechnical Engineers, Inc. (AGE) has performed a Geologic Desktop study for the San Ysidro Community Plan Update (SYCPU) and the San Ysidro Historic Village Specific Plan (SYHVSP) located in the San Ysidro community in San Diego, California.

The objectives of the study were to evaluate the general geologic and geotechnical conditions and to identify potential geologic hazards that may impact future development within the limits of the SYCPU and SYHVSP study areas. This desktop study is based on a review of readily available information and a reconnaissance visit of the project study area. Information sources that were reviewed include published geologic literature and maps, topographic maps, aerial photographs, and AGE's in-house references which include unpublished geotechnical reports pertaining to projects that are located within or in the general vicinity of the project study area.

2.0 PROJECT DESCRIPTION

2.1 San Ysidro Community Plan Update (SYCPU)

The SYCPU is a comprehensive update to the current community plan, which was adopted in 1990. The San Ysidro Community Plan covers a total of 1,863 acres within the southern tip of the City of San Diego, adjacent to Otay Mesa-Nestor, Otay Mesa, the Tijuana River Valley, and the international border with Mexico (See Figure 1).

The SYCPU includes the following eight individual elements intended to guide development: Land Use; Mobility; Urban Design; Economic Prosperity; Public Facilities, Services & Safety; Recreation; Conservation; and Historic Preservation. Each element would be updated to bring the community plan into conformance with the City of San Diego's General Plan as well as embrace current urban planning and sustainability concepts.

The Land Use Element is designed to guide future development within the community. It establishes land use designations for each portion of the community. The majority of the plan area (41 percent) would be designated for residential uses. Commercial uses and industrial development would comprise of 18 percent and 2 percent of the community plan area, respectively. A total of 11 percent of the plan area would be designated for institutional uses. Parks and Open Space would cover 5 and 13 percent of the area, respectively. The balance would be occupied by transportation facilities.

The Mobility Element is intended to improve mobility throughout the community through the development of a balanced multi-modal transportation network. The Element recommends future improvements to specific roadway segments ranging from restriping to new roadway connections. The Element also contains a number of policies designed to encourage the use of public transit including promoting pedestrian movement in the vicinity of transit and by enhancing existing bus and trolley stops.

The Urban Design Element establishes goals and policies that enhance the urban fabric of San Ysidro while retaining the historic elements that contribute to the overall character of the community.

The Economic Prosperity Element envisions a strategic approach that is focused on increasing opportunities for densification of residential and commercial development in selected parts of the community, while protecting the existing strong neighborhoods through enhancement of neighborhood villages.

The Public Facilities, Services & Safety Element identifies existing facilities and services, and addresses the capacity and needs for future services including potential sites and desired characteristics for future facilities.

The Recreation Element is intended to assure that the recreational needs of the community are met. The Element establishes goals and policies for population-based parks and recreation facilities within the community. In addition, the Element establishes goals and policies related to open space and resource-based parks.

The Conservation Element contains policies designed to meet the City's sustainable development goals in areas that have been identified as suitable for development. The Conservation Element also addresses open space and habitat protection.

The Historic Preservation Element contains specific recommendations to address the history and cultural resources, unique to San Ysidro, in order to encourage protection and appreciation of these resources.

2.2 San Ysidro Historic Village Specific Plan (SYHVSP)

The SYHVSP, identified on Figure 1, is a comprehensive planning document that will implement the vision of the SYCPU for this Specific Plan Area. The SYHVSP covers approximately 112 acres, and is bounded by Beyer Boulevard to the north, I-5 to the south, I-805 to the east, and Smythe Avenue to the west.

The overall goal of the Specific Plan is to create an attractive, intensified urban environment with a mix of land uses surrounding the Beyer Trolley Station and along San Ysidro Boulevard, while preserving the low-scale single- and multi-family character of the residential areas.

The Land Use Component of the Specific Plan includes guidelines intended to: (1) preserve the historic character of the area, (2) attract community-oriented development, (3) promote alternate forms of transportation (e.g. walking and biking), and (4) focus increased residential density on major transportation corridors and near transit. The Specific Plan Area includes the following five land use designations, as specified by the SYCPU: Low-Medium Density Residential, Medium Density Residential, Community Commercial (Residential Permitted), Institutional, and Park.

The Mobility Component of the Specific Plan sets forth a number of polices and guidelines to promote mobility including (1) install new, and widen existing, sidewalks, (2) improve lighting and landscaping along sidewalks, (3) improve street crossings, and (4) incorporate bikeway facilities on select roadways.

The Urban Design Component of the Specific Plan identifies policies intended to enhance public spaces, including parks, public plazas, and roadways. The Specific Plan encourages the creation of pocket parks and neighborhood plazas. Enhanced streetscape is encouraged including benches, bicycle parking, and improved landscaping and lighting. Bioswales and pervious pavement are encouraged to reduce stormwater runoff and pollutants. Signage improvements are recommended to increase transit usage, and facilitate movement within the community. Lastly, the inclusion of public art is encouraged.

The Infrastructure and Public Facilities Component of the Specific Plan establishes policies and describes improvements necessary for the upgrading and expansion of public facilities, including water, wastewater, solid waste, stormwater, natural gas, police and fire protection, schools, libraries, parks, and other public services. Water conservation measures are identified to help assure a reliable water supply. Stormwater facilities are encouraged to convey runoff through the Specific Plan Area, and reduce water pollution. Adequate staffing and equipment are identified as important to assuring adequate police and fire protection. A new location for the community library in the Specific Plan Area is proposed. Mini and pocket park locations are identified in the Specific Plan area to enhance recreational opportunities within the Specific Plan Area as well as the overall Community Plan Area.

3.0 REGIONAL GEOLOGY

The SYCPU study area is underlain by Oligocene age and younger sedimentary deposits that lie unconformably over basement rocks consisting of the Jurassic age Santiago Peak Volcanics and Cretaceous age plutonic rocks of the Southern California Batholith (Walsh and Demere, 1991). The basement rocks are not exposed within the project study area. The sedimentary units consist of both marine and non-marine deposits that display a gentle regional southwest dip (Vanderhurst, Hart, and Warren, 2011). Regional uplift of the sedimentary units has created a stair-stepping series of relatively level terraces/mesa tops which comprise the majority of the San Ysidro community. The terraces have been dissected by erosion and are locally covered by Quaternary age fluvial deposits within the Tijuana River floodplain.

The major structural feature within the project study area is the La Nacion fault zone (LNFZ) , a north-south trending series of near-vertical normal faults that downdrop to the west. The La Nacion fault is classified as potentially active (City of San Diego Seismic Safety). Several strands of the LNFZ are mapped in the San Ysidro community.

The SYHVSP study area is underlain by late Pliocene age and younger sedimentary deposits consisting of both marine and non-marine deposits. These deposits form a relatively level terrace/mesa top which has been dissected by erosion. There are no known (mapped) faults in the SYHVSP.

3.1 Geologic Units

3.1.1 San Ysidro Community Plan Update (SYCPU)

Geologic units which have been mapped in the SYCPU study area include: artificial fill; young alluvial deposits; landslide deposits; Old Paralic Deposits Unit 6; Very Old Paralic Deposits, San Diego Formation; and the Otay Formation (Kennedy and Tan, 2008). The approximate geologic contacts of these units are shown on Figure 2 - Geologic Map. A brief description of these units (in order of increasing age) is presented below.

3.1.1.1 Artificial Fill Materials (not mapped)

Although not shown on the geologic map, man-made fills associated with local site development activities can be expected to occur at various locations throughout the SYCPU study area . The fill materials consist of a wide variety of materials ranging from fine-grained silts and clays to coarse-grained soils composed of sand, gravel and/or cobbles that have been derived from local or imported sources. In some areas, the fill materials may also contain buried demolition debris, including asphalt and concrete. The deepest fills are likely found in areas where they were placed in former low-lying areas and stream channels.

3.1.1.2 Young Alluvial Deposits (map symbol Qya)

Quaternary age young alluvial deposits cover much of the Tijuana River Valley, with lesser amounts of these materials also occurring within stream channels that dissect the various terraces and mesas within the study area. The fluvial deposits are described as poorly consolidated silt, sand, gravel and cobble-sized particles.

3.1.1.3 Landslide Deposits (map symbol Qls)

Several Quaternary age landslides are mapped in the eastern portion of the SYCPU study area. The slides are the result of rotational movement by gravity due to basal erosion of over-steepened slopes. The slides typically move as coherent masses along a weak bentonite seam or bed within the Otay Formation.

Recent studies (Vanderhurst, Hart, and Warren, 2011) describe a pre-late Pliocene mega-landslide in southwestern San Diego County. The western edge of the landslide is defined by the LNFZ on the east margin of the study area. This mega-landslide, named the Otay Lateral Spread (OLS), was first discovered in the late 1980's during grading of residential subdivisions in Otay Mesa. Ongoing development of Otay Mesa and adjacent areas has provided additional exposure of the landslide, allowing the landslide to be more accurately mapped and described. In general, the recent studies indicate that this slide is approximately 2.4 miles long and 8 miles wide, occurring along a single continuous bentonite clay bed within the Otay Formation. The approximate limits/extent of the OLS along the eastern boundary of the SYCPU study area are depicted on Figure 3.

Although the majority of the landsliding occurred in the Pliocene Epoch, some localized re-activation of landsliding has been documented during recent grading of residential subdivisions. The most common methods of mitigating landslide potential include removal of the slide debris and construction of buttress fills and/or the installation of shear pins for slides with shallow (50 feet or less) basal slip surfaces. For landslides with basal slip surfaces that are more than 50 feet in depth, typical mitigation measures include the removal of the unstable mass, construction of deep shear keys and buttress fills, and a system which controls and maintains the collection and disposal of groundwater within the landslide mass.

3.1.1.4 Old Paralic Deposits, Unit 6 (map symbol Qop6)

Late to middle Pleistocene age Old Paralic Deposits, Unit 6 rest on the Nestor Terrace in the SYCPU study area. These deposits were formerly referred to as the Bay Point Formation and an unnamed sandstone unit (Kennedy and Tan, 1977). The deposits generally consists of a marine, lagoonal and nonmarine sandstone that is poorly-consolidated, fine to medium grained, and pale brown. The marine portion of the formation is fossiliferous, interfingering with the non-marine portion of the formation.

3.1.1.5 Very Old Paralic Deposits (map symbol Qvop)

The Very Old Paralic Deposits are not mapped within the limits of the SYCPU study area. These deposits cap the top of Otay Mesa to the east of the project study area. The deposits were formerly referred to as the Lindavista Formation (Kennedy and Tan, 1977), and generally consist of Pleistocene age sediments composed of marine and non-marine reddish brown sandstone and conglomerate. Ferruginous cement gives the formation its characteristic color and resistant nature.

3.1.1.6 San Diego Formation (map symbol Tsdss & Tsdcg)

The Pliocene age San Diego Formation consists of an upper conglomerate and a lower sandstone unit. The conglomerate part of the formation is a pebble, cobble and boulder conglomerate in a coarse-grained sandstone matrix that is well indurated and cemented with ferruginous cement. The cement gives the conglomerate a reddish brown color. The sandstone unit of the San Diego Formation consists of a fine to medium grained marine sandstone. The sandstone is typically pale yellowish-brown in color, poorly indurated, and locally fossiliferous.

3.1.1.7 Otay Formation (map symbol To)

The Oligocene age Otay Formation is the oldest unit exposed in the SYCPU study area, occurring on slopes in the east portion of San Ysidro. The Otay Formation is fluvial, with a basal conglomerate, middle gritstone, and upper sandstone-mudstone. Bentonite claystone layers occur throughout the formation, creating weakened planes upon which landsliding and slope failures can occur. The majority of bentonite beds and associated landsliding occur within the upper sandstone/mudstone member.

3.1.2 San Ysidro Historic Village Specific Plan (SYHVSP)

Geologic formations mapped in the SYHVSP study area include man-made fills, Old Paralic Deposits, and the sandstone facies of the San Diego Formation.

3.2 Soils

3.2.1 San Ysidro Community Plan Update (SYCPU)

Surface soils in the SYCPU study area are generally described as sandy, loamy, or clayey (United States Department of Agriculture, 1973). Sandy soils of the Tujunga Series (TuB) occur within the Tijuana River Valley. These soils are described as very deep, excessively drained sands derived from granitic alluvium on slopes of 0 to 5 percent. Short periods of flooding are probable.

Soils in the remainder of the SYCPU project study area consist of Chesterson fine sandy loam (CfD2), Huerhuero loams (HrC and HrD2), Huerhuero-Urban land complex (HuC), Olivenhain cobble loam (OhE and OhF), and Diablo Clays (DaC, DaD and DaF). These soil groups have been derived from weathering of geologic units within the study area, and have been locally altered by grading activities. The Chesterson and Huerhuero loams are locally eroded where the ground surface has a slope of 9 percent or greater.

3.2.2 San Ysidro Historic Village Specific Plan (SYHVSP)

Mapped surface soils in the SYHVSP study area predominantly consist of Huerhuero-Urban land complex (HuC). Sandy soils of the Tujunga Series (TuB) occur along the southwesterly portion of the SYHVSP, and Olivenhain cobble loam (OhE) occurs along the northern portion of the SYHVSP.

3.3 Groundwater

3.3.1 San Ysidro Community Plan Update (SYCPU)

The depth to groundwater varies greatly from one location to another within the SYCPU study area as indicated by various subsurface studies which are briefly described below:

- The southwesterly portion of the study area is located within the Tijuana River Valley. Historically, large volumes of groundwater have been withdrawn from the Tijuana River aquifer and water surface elevations were as low as Elevation -15 feet MSL in the past. Periodic flooding of the Tijuana River may be assumed to recharge the aquifer relatively quickly. Groundwater in the river valley has been designated as having beneficial use for groundwater recharge.

- In 2005 AGE performed a desktop study to evaluate groundwater conditions beneath Via de San Ysidro, San Ysidro Boulevard and Center Street. The results of the study indicate that groundwater elevation along these streets remained relatively level during the 5- to 15-year period for which well records were available for review. Regional groundwater elevation within this segment ranged from +29 to +36 feet MSL (10 feet to 17 feet bgs). Both perched water between elevation +41 to +45 feet MSL (10 feet to 14 feet bgs) and confined water at approximately +38 feet MSL (17 feet bgs) were encountered in the vicinity of Center Street.

- In 2006, AGE also performed additional subsurface geotechnical investigation for a portion of the Otay Mesa Trunk Sewer which extends along Via De San Ysidro, San Ysidro Boulevard and Center Street. At the time of our field investigation, groundwater was encountered in all four borings. The groundwater level in these borings was measured at depths ranging from 11 to 21 feet bgs (approx. elevations of +34 to +38 feet MSL) following completion of the drilling and sampling operations. In boring B-1 that was performed in January of 2005 on San Ysidro Boulevard, the groundwater was measured at a depth of 19 feet bgs (approx. elevation of +29 feet MSL).

- In 2011 AGE performed a geotechnical investigation for Larsen Field Park and Athletic Facility which is located on the north side of Camino De La Plaza, across the street from the Las Americas Development. At the time of our field investigation, groundwater was encountered in the borings at a depth of 9 feet bgs following completion of the drilling and sampling operations.

- Our search of the Geotracker database revealed the presence of four monitoring wells located at a Chevron gas station located at 220 East Sycamore Road. The Geotracker database contains information regarding groundwater depth measurements that were performed during the period starting in the fourth quarter of the year 2000 through the fourth quarter of 2003. The available data indicates groundwater level fluctuations ranging from a low of 13.69 feet to a high of 11.47 feet bgs at the Chevron station site which has an approximate elevation of +49 to +51 feet MSL.

- Based on AGE's previous work performed for the City's Otay Mesa Trunk Sewer project Phasea 1A, 1B, 3A and 3B between 2002 to 2008, the depth of groundwater within the study area north of Beyer Boulevard is estimated to be in excess of 100 feet bgs. Groundwater gradient is generally in a southerly/southwesterly direction toward the Tijuana River Estuary.

3.3.2 San Ysidro Historic Village Specific Plan (SYHVSP)

Based on prior studies performed by AGE, the depth to regional groundwater in the southwest portion of the SYHVSP study area is estimated to range from 10 feet to 17 feet bgs (approximate elevations +29 to +36 msl). The depth to groundwater is anticipated to be on the order of 100 feet bgs in the northeasterly portion of the SYHVSP.

4.0 SUMMARY OF FINDINGS AND OPINIONS

4.1 Potential Geologic Hazards

4.1.1 San Ysidro Community Plan Update (SYCPU)

Based on the results of our study, several potential geologic hazards are identified within the SYCPU study area which are more fully described herein. AGE has prepared a Geologic Hazard Map for the project study area which is presented on Figure 4 - Geologic Hazards Map.

4.1.1.1 Faulting and Seismicity

The SYCPU study area is not located within a currently designated State of California, Division of Mines and Geology Earthquake Fault Special Study Zone. A review of the published geologic maps indicates that several strands of the LNFZ are mapped within the study area as shown on Figures 2, 3 and 4. The faults shown on these figures are a compilation of those from the City of San Diego Seismic Safety Study Maps as well as Kennedy & Tan's geology map(2008).

The LNFZ is comprised of several en echelon faults within a generally north-south trending broad system of faults that extends from the Otay Mesa area in the south to an area near the intersection of Collwood Boulevard and Montezuma Road on the north. The faults are generally dip-slip in nature with a down-to-the-west sense of separation. Geologic studies that have been performed on the LNFZ to date have not discovered any evidence for fault activity within Holocene time (11,000 years BP) (Dowlen, et.al, 1975; Elliott and Hart, 1977; Hart, 1974; Leighton & Associates, 2001). Based on the California Geological Survey's fault classification criteria, the LNFZ may be considered "potentially active", meaning that it has documented evidence of movement within Pleistocene time (the last 1.5 to 2 million years) but no movement in Holocene time.

The nearest mapped active faults to the project site are the faults within the Alquist- Priolo Earthquake Fault Zone in downtown San Diego . The fault zone is located approximately 3.8 miles north of the northwest corner of the study area (approximate Latitude 32.568482° and Longitude -117.064754). The RCFZ is a complex set of anastomosing and en-echelon, predominantly strike slip faults that extend from off the coast near Carlsbad to offshore south of downtown San Diego (Treiman, 1993). Investigations of the RCFZ in the Rose Creek area (Rockwell et. al., 1991) and in downtown San Diego (Patterson et. al., 1986) found evidence of multiple Holocene earthquakes. Based on these studies, several fault strands within the RCFZ have been classified as active faults, and are included in Alquist-Priolo Special Studies Zones.

Other major active faults that have produced recurring earthquakes having magnitude greater than 4 are the Elsinore fault, the San Miguel-Vallecitos fault in Baja California, and the Coronado Bank fault. Other more distant, active faults that are considered potential sources of seismic activity include the offshore San Diego Trough and San Clemente fault zones and some of the faults in Imperial Valley which include the San Jacinto and San Andreas fault zones. The location of the site in relation to the active faults in the region is shown on the Regional Fault Map (Figure 5).

4.1.1.2 Strong Ground Motion

The major seismic hazard that could impact the study area is ground shaking in response to an earthquake occurring on one of the major regional active faults. These faults include the Rose Canyon, Coronado Bank, San Diego Trough, and San Clemente faults which are located offshore, the Laguna Salada and San Miguel-Vallecitos faults in Baja California, and the more distant faults in Imperial Valley which include the Elsinore, San Jacinto, and San Andreas faults. A summary of seismic source characteristics for faults that present the most significant seismic hazard potential to the project area is presented on the next page.

Although several strands of the LNFZ traverses the project study area, it is not considered an active fault and a significant seismic source. For project design purposes, we recommend that the RCFZ be considered as the dominant seismic source.

Fault Name	Approximate Distance from Project Study Area (mile)	Maximum Magnitude	Estimated Deterministic Peak Ground Acceleration (g)
Rose Canyon	3.8	6.9	0.402
Coronado Bank	13.5	7.4	0.248
Elsinore - Julian	46.5	7.1	0.062
Newport-Inglewood (offshore)	46.7	6.9	0.054
Elsinore - Coyote Mountain	49.0	6.8	0.048
Earthquake Valley	49.9	6.5	0.038
Elsinore - Temecula	56.5	6.8	0.041
San Jacinto - Coyote Creek	66.5	6.8	0.034
San Jacinto - Borrego	66.7	6.6	0.030
Laguna Salada	69.1	7.0	0.038
San Jacinto - Anza	69.7	7.2	0.043
Palos Verdes	71.8	7.1	0.039
Superstition Mountain (San Jacinto)	72.3	6.6	0.028
Elsinore - Glen Ivy	76.7	6.8	0.03
Elmore Ranch	76.9	6.6	0.026
Superstition Hills (San Jacinto)	77.3	6.6	0.026
San Jacinto - San Jacinto Valley	81.8	6.9	0.03
Newport - Inglewood (L.A. Basin)	88.4	6.9	0.027

Fault Name	Approximate Distance from Project Study Area (mile)	Maximum Magnitude	Estimated Deterministic Peak Ground Acceleration (g)
Imperial	89.9	7.0	0.029
Chino - Central Avenue (Elsinore)	91.8	6.7	0.032
Brawley Seismic Zone	93.5	6.4	0.018
San Andreas - Southern	93.5	7.4	0.037
San Andreas - Coachella	93.5	7.1	0.03
Whittier	95.6	6.8	0.023
Compton Thrust	97.7	6.8	0.033
San Andreas - San Bernardino	99.4	7.3	0.032

4.1.1.3 Historic Seismicity

EQSEARCH is a program that performs automated searches of a catalog of historical Southern California earthquakes. As the program searches the catalog, it computes and prints the epicentral distance from a selected site to each of the earthquakes within a specified radius (100 kilometers). From the computed distance, the program also estimates (using an appropriate attenuation relation) the peak horizontal ground acceleration that may have occurred at the site due to each earthquake. Program output which is included in this appendix consists of a listing of historical earthquakes within the search area and a seismic recurrence curve plot.

We used a combined earthquake catalog for magnitude 5.0 or larger events which occur within 100 kilometers from the study area between the year 1800 and December 2008. The earthquake catalog for events prior to about 1933 is limited to the higher magnitude events.

The search results indicate that the nearest earthquake of magnitude 5.0 occurred on May 24, 1865 about 10.2 miles northwest from the study area on a mapped strand of the Coronado Bank fault near Silver Strand beach which resulted in a calculated ground acceleration of 0.104g. The highest site acceleration generated by this search is 0.147g from a magnitude 5.9 earthquake which occurred on May 27, 1862 on a strand of the Coronado Bank fault near the North Island Naval base on Coronado Island. The largest earthquake recorded within the search distance is a magnitude 6.8 earthquake which occurred on April 21, 1918 about 82 miles to the north in the town of Hemet.

4.1.1.4 Fault Ground Rupture

There are no known active faults that cross the study area. Therefore, the potential for fault ground rupture is considered low. However, the potential for seismically-induced ground rupture on any of the LNFZ strands and/or undiscovered faults that may cross the project study area can not be precluded.

Future development throughout the SYCPU area could potentially be subject to significant seismic-induced ground shaking hazards. All proposed development and development activities would be required to conform with applicable regulatory/industry and code standards related to geologic hazards including pertinent elements of the Seismic Hazards Mapping Act, Alquist-Priolo Earthquake Fault Zoning Act, CBC and related City standards. Specifically, this would include investigation of potential active faults and associated structural setbacks or other applicable measures to address surface/fault rupture hazards. Based on the noted requirements for regulatory/industry conformance, potential impacts related to surface/fault rupture hazards from implementation of the SYCPU would be less than significant.

4.1.1.5 Seismically Induced Liquefaction, Settlement and Lateral Spread

Seismically-induced soil liquefaction is a phenomenon during which loose, saturated granular materials undergo matrix rearrangement, develop high pore water pressure, and lose shear strength due to cyclic ground vibrations induced by earthquakes. Manifestations of soil liquefaction at the project site can include loss of soil bearing capacity, ground subsidence and differential settlement, ground lurching and tilting in level ground, and instabilities in areas of sloping ground. Soil liquefaction can also result in increased lateral and uplift pressures on buried structures.

A review of the City of San Diego Seismic Hazard Map (1995) indicates that the southern portion of the project study area may be underlain by liquefiable soil. The approximate limit of the area underlain by liquefiable soil is shown on Figure 4.

The area within the project study area which identified as being underlain by liquefiable material is relatively flat, therefore, the risk of lateral spread displacement during a seismic event is considered remote.

Differential seismic settlement occurs when seismic shaking causes one type of soil to settle more than another type. It may also occur within a soil deposit with largely homogeneous properties if the seismic shaking is uneven due to variable geometry or thickness of soil deposit. Based on the available data, differential seismic settlement may be encountered within the project study area which is underlain by alluvial deposits as shown on the Geologic Map (Figure 2).

4.1.1.6 Ground Lurching

Ground lurching is permanent displacement or shift of the ground in response to seismic shaking. Ground lurching occurs in areas with high topographic relief, and usually occurs near the source of an earthquake. It is our opinion that the potential for ground lurching within the project study area may be considered low.

4.1.17 Other Seismic-Induced Hazards

The study area is not located near any open bodies of water which are large enough to generate tsunamis or seiches during a seismic event. Therefore, the potential for damage to site improvements caused by seismic induced tsunamis or seiches is considered very low. Minor seiches in the Tijuana River Channel and Flood Channel may occur during seismic shaking.

A review of the pertinent flood map (FEMA National Flood Insurance Maps 06073C2154F, 06073C2156F, 06073C2162F, 06073C2166F) indicates that the portion of the project study area located south of San Ysidro Boulevard is located within the 500-year flood plain. The maps further indicate that this area is protected from the 100-year flood, but is subject to flooding in the event of failure of the protection system or overtopping. The area along the Tijuana River Channel which is located to the south of West Calle Primera is subject to 100-year flood events. The project study area is also bounded on the south by the flood channel and on the west by the Tijuana River Valley which are subject to 100-year flood events. It is our opinion, therefore, that the potential for flooding in the areas located south of San Ysidro Boulevard is considered significant.

4.1.1.8 Landslides

The eastern portions of the study area are underlain by several ancient landslides (Kennedy & Tan, 1977; Kennedy and Tan, 2008; City of San Diego, 1995). The largest of these landslides is referred to as the San Ysidro Landslide, which is located on the hillside above East Beyer Boulevard, and immediately southeast of Beyer Elementary School. The other slides form a contiguous line along the walls of Spring Canyon and further to the south towards the International Border. Based on currently known information, these landslides appear to represent portions of the OLS which were re-activated.

Ground movement caused by landsliding often results in catastrophic structural damage and economic losses. In some cases, landslides may also result in loss of life. Considering the size of the majority of the landslides in the SYCPU study area, it may not be feasible nor cost-effective to perform remedial action on a parcel by parcel basis.

AGE performed a geotechnical investigation of the landslide that is located on Otay Mesa Road in connection with the design of the City of San Diego Otay Mesa Trunk Sewer Phase 2 project (2003). Based on the information presented in a report prepared for the Remington Hills subdivision by GeoSoils (1996) and AGE's field exploration, this landslide can be described as a block glide failure which developed on a weak bentonite bed in the Otay Formation. The basal slip surface for this slide was encountered in AGE's boring B-4 at a depth of 14 feet 2 inches below ground surface. The slip plane is characterized by a 1/4-inch thick nearly horizontal, highly disturbed clay seam overlying a 2-foot thick dark brown topsoil layer.

Based on the findings of their investigation, GeoSoils (1996) performed a slope stability analysis of the landslide, and considered the landslide to be marginally stable under static conditions. The results of their analysis indicate a calculated static factor of safety (F.S.) of 1.5 and a seismic F.S. of 0.7 against reactivation under low groundwater conditions for this landslide.

The ancient landslides have been stable for a long time. The potential for future reactivation of these landslides depends primarily on future groundwater conditions in the slide area that are difficult to predict at this time. If a substantial rise in the water table occurs as a result of prolonged heavy precipitation, slide reactivation is likely to occur, particularly if a large magnitude local earthquake occurs at the same time. The future stability of the landslide also depends on grading activity associated with the (future) developments.

4.1.1.9 Soil Erosion

Implementation of future development within the study area is not anticipated to result in substantial soil erosion. The majority of the study area is developed, and any future development will need to comply with storm water management regulations, including the implementation of erosion control measures during construction.

4.1.1.10 Expansive Soils

Expansive soils in the subgrade beneath foundations, concrete slabs-on-grade, and pavements could heave when they become wet and result in structural damage to the improvements. Expansive soils primarily occur in the eastern portions of the project study area that are underlain by the Otay Formation. These soils are generally considered to possess moderate to very high expansive characteristics. Soils with low to medium expansion potential may also occur in localized areas that are underlain by the Bay Point Formation.

4.1.1.11 Soil Subsidence

Non-seismic induced soil subsidence is usually associated with karst/limestone terrain, sub-surface mining, extraction of natural gas and/or decomposition of thick peat (organic) layer. None of the conditions described above are known to exist within the project study area. Therefore, the potential for soil subsidence within the project study area is considered very low.

4.1.1.12 Collapsible Soil

Collapsible soil, or near-surface subsidence, is generally caused by failure of sediment due to rapid loss of fines when subjected to wetting and/or ground subsidence resulting from groundwater table depression due to groundwater withdrawal. The effect of the first process is generally localized and creates the most impact to most projects. The process is common in arid and semi-arid areas such as Arizona. Due to relatively low permeability, the types of sediment encountered within the project area are generally not susceptible to rapid loss of fines. Therefore, within the project study area, the potential for collapsing soil due to the first process is considered low. Ground subsidence due to the second process generally covers a wide region and may occur over a period of decades, and the effects are not noticeable without a large scale long term study.

4.1.1.13 Mineral Resources

The majority of the project study area is located within urban areas where no significant mineral deposits are present or are likely to exist. Therefore, the potential for loss of mineral deposits due to development in these portions of the project study area is considered low.

4.1.1.14 Groundwater

Groundwater elevation within the study area is anticipated to range from more than 100 feet bgs within the project study area north of Beyer Boulevard, to less than 10 feet bgs in the area along and to the south of San Ysidro Boulevard.

4.1.2 San Ysidro Historic Village Specific Plan (SYHVSP)

Unless specifically noted in this section, the potential geologic hazards in the SYHVSP study area are similar as those described in Section 4.1.1.

The SYHVSP area is underlain by competent geologic materials which generally are not considered susceptible to seismic-induced soil liquefaction or differential seismic settlement. Therefore, the risk of lateral spread displacement during a seismic event is also considered remote.

Portions of the SYHVSP (southwest of San Ysidro Boulevard) are located within the 500-year flood plain. The remainder of the SYHVSP is located outside the 100 and 500-year flood plains.

There are no known (mapped) landslides in the SYHVSP area (Kennedy & Tan, 1977; Kennedy and Tan, 2008; City of San Diego, 1995). Therefore, landsliding does not represent a potential hazard.

The majority of soils in the SYHVSP area are considered non-expansive. Soils with low to medium expansion potential may locally occur in areas that are underlain by Old Paralic Deposits.

Groundwater elevation within the SYHVSP area is anticipated to range from 100 feet bgs or greater in the northeast portion of the study area to as shallow as 10 feet bgs in the southwest portion of the study area.

4.2 Opinions and Recommendations

The primary geologic hazards and geotechnical constraints that could impact future development within the area comprising the SYCPU include: seismic ground shaking, landslide and slope stability issues, the presence of expansive soils, soil liquefaction, and shallow groundwater. Geologic hazards and geotechnical constraints associated with the SYHVSP include: seismic ground shaking, local presence of expansive soils and shallow groundwater.

In order to mitigate the potential hazards, it is recommended that a site-specific geotechnical investigation be performed for each project to evaluate the existing conditions and develop recommendations for the appropriate mitigation measures. Depending on the type of project that is proposed, the investigations should, at a minimum, address: site preparation and earthwork considerations, foundation design parameters, control of surface and subsurface drainage, slope stability, and construction-related considerations such as shoring and dewatering. The scope of the geotechnical investigation should include a subsurface field exploration program and laboratory testing to evaluate the engineering characteristics of the on-site soil/rock materials. The scope of the subsurface exploration program should be customized based on the location and type of the proposed facilities or improvements.

Development in landslide-prone areas should include the performance of a comprehensive geotechnical investigation to characterize the limits/extent of the ancient landslide, the engineering characteristics of the soil material(s) which comprises the slip surface(s), and the hydrogeologic conditions within and in the areas surrounding the slides. To assure feasibility, the geotechnical investigation should be performed prior to development of any of the vacant land located within the area shown on Figures 3 and 4 as being prone to landslide activity. The results of the investigation should be adequate to develop a 3-dimensional model of the slide and to perform applicable and reliable slope stability analyses. The investigation should also evaluate the impact of the proposed development on the stability of the adjoining properties and the need to expand the scope of the mitigation measures.

Due to the wide-spread nature of the landslide potential, any attempts at landslide mitigation will have to be performed on a large scale rather than a parcel by parcel basis to assure that the remedial actions are successful as well as cost-effective.

5.0 LIMITATIONS

This report has been prepared for the sole use of HELIX and the City of San Diego for the Program Environmental Impact Report being prepared for the SYCPU and SYHVSP. This report is intended for preliminary planning purposes only and does not provide sufficient data for design and/or construction.

The geotechnical services provided by AGE for this project have been performed in accordance with generally accepted principles and practices of the local geotechnical profession at the time of report preparation. No other warranty, either expressed or implied, is made by AGE.

6.0 REFERENCES

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Vanderhurst, W. Lee, Hart, Michael W., and Warren, C., 2011, "The Otay Mesa Lateral Spread, a Late Tertiary Mega-Landslide in Metropolitan San Diego County, CA", Environmental and Engineering Geoscience, Vol. XVII, No. 3.

Aerial Photographs

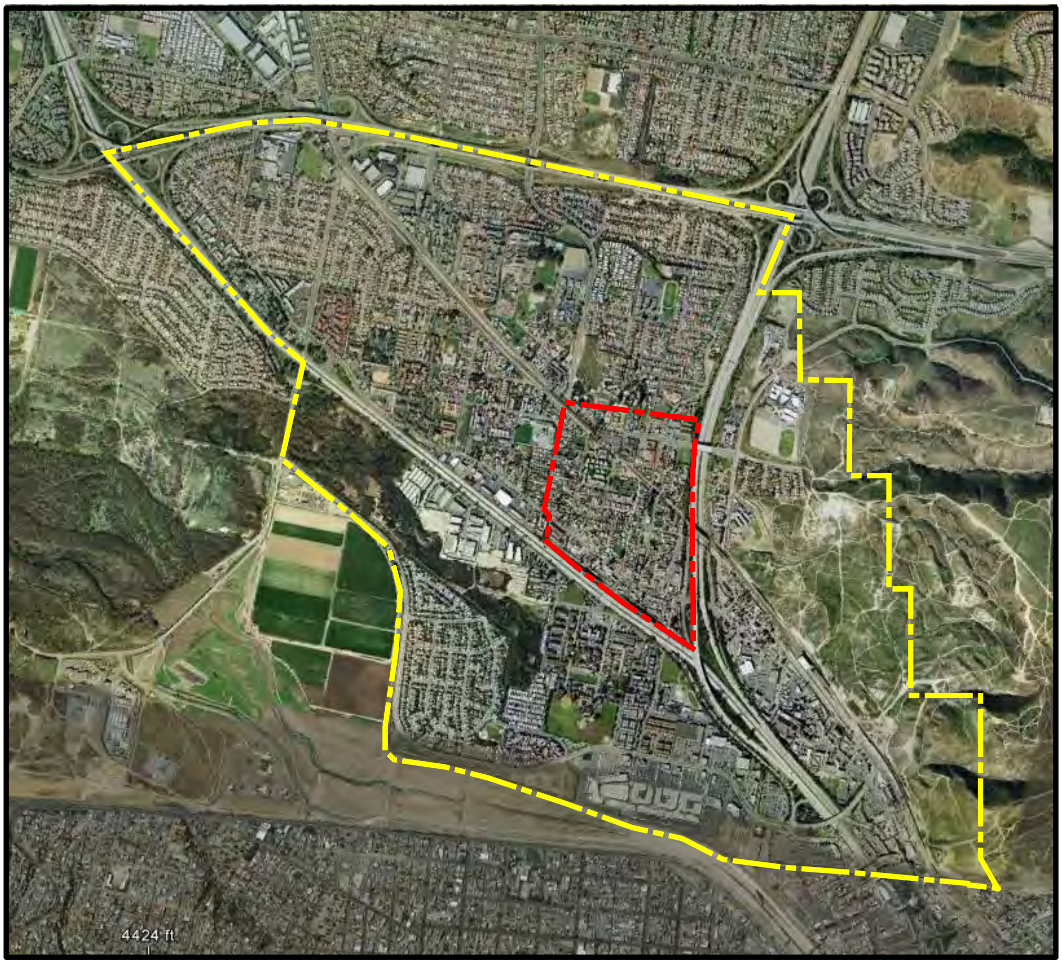
Aerial photographs dated 1953, 1963, 1974, 1989, 1994, and 2002.

Google Earth 2015.

Topographical Maps

USGS, 1904, 1930, 1943, 1953, 1967, 1975, 1991, and 1996.

FIGURES



LEGEND:

Approximate boundary of San Ysidro Community Plan Update (SYCPU)

Approximate boundary of San Ysidro Historic Village Specific Plan (SYHVSP)

N

NOT TO SCALE

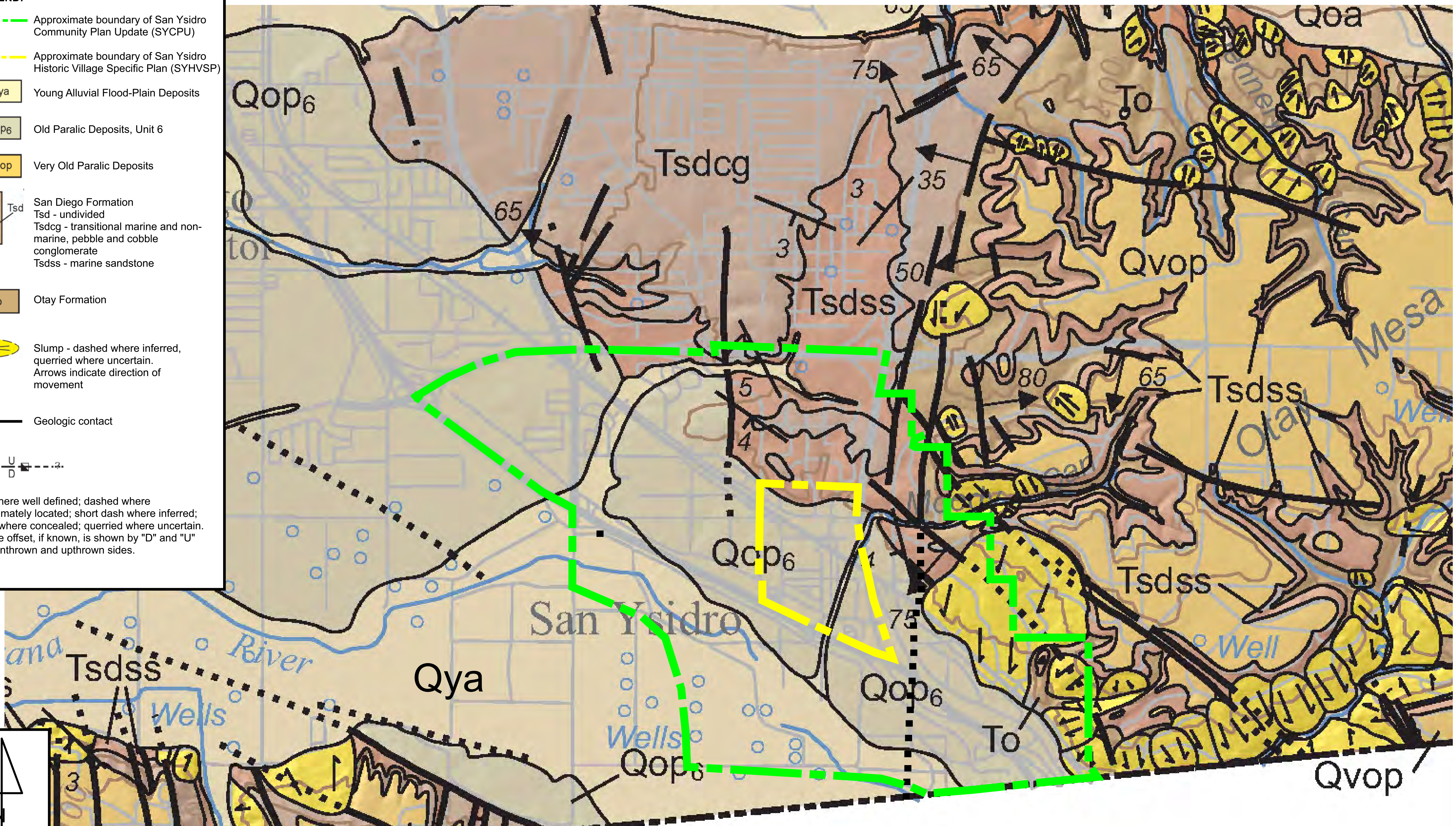
SOURCE:
GOOGLE MAP, 2012

LOCATION MAP SHOWING APPROXIMATE LIMITS OF SAN YIDRO COMMUNITY PLAN UPDATE AND SAN YSIDRO HISTORIC VILLAGE SPECIFIC PLAN

PROJECT NO. 127 GS-10	**ALLIED GEOTECHNICAL ENGINEERS, INC.**	**FIGURE 1**

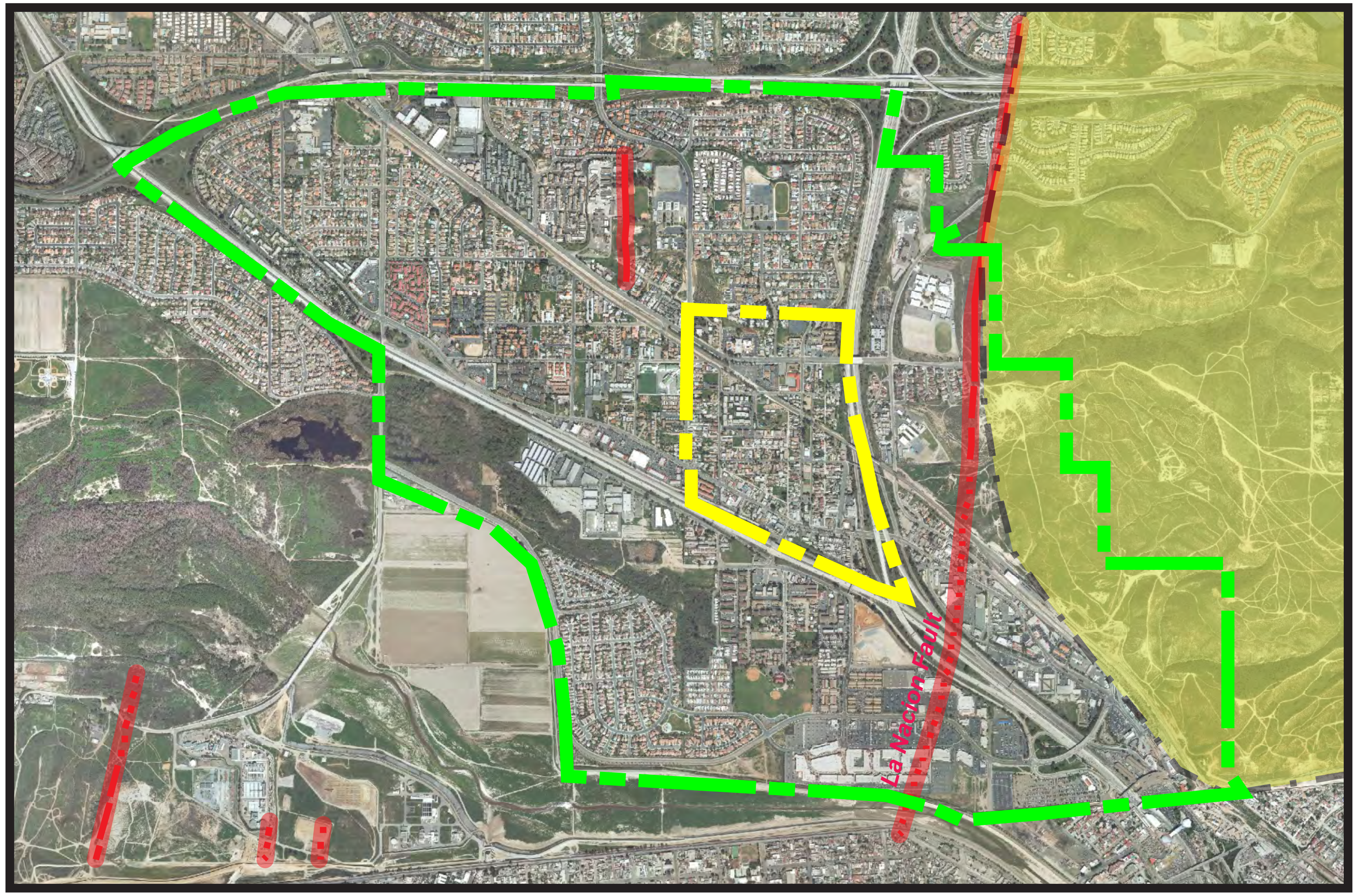
LEGEND:

- Approximate boundary of San Ysidro Community Plan Update (SYCPU)
- Approximate boundary of San Ysidro Historic Village Specific Plan (SYHVSP)
- Qya — Young Alluvial Flood-Plain Deposits
- Qop_6 — Old Paralic Deposits, Unit 6
- Qvop — Very Old Paralic Deposits
- Tsdcg / Tsd / Tsdss — San Diego Formation
  - Tsd - undivided
  - Tsdcg - transitional marine and non-marine, pebble and cobble conglomerate
  - Tsdss - marine sandstone
- To — Otay Formation
- Slump - dashed where inferred, querried where uncertain. Arrows indicate direction of movement
- Geologic contact
- Fault - solid where well defined; dashed where approximately located; short dash where inferred; dotted where concealed; querried where uncertain. Relative offset, if known, is shown by "D" and "U" on downthrown and upthrown sides.



Source: Kennedy and Tan, 2008, City of San Diego Seismic Safety Study, 2008

SAN YSIDRO COMMUNITY PLAN UPDATE AND SAN YSIDRO HISTORIC VILLAGE SPECIFIC PLAN	GEOLOGIC MAP
PROJECT NO. 127 GS-10 / ALLIED GEOTECHNICAL ENGINEERS, INC.	FIGURE 2



LEGEND

Otay Mesa Lateral Spread after Vanderhurst, W. L., Hart, M.W., and Warren, C., 2011 "The Otay Mesa Lateral Spread, a Late Tertiary Mega-Landslide in Metropolitan San Diego County, CA". Environmental & Engineering Geoscience, Vol. XVII, No. 3, August, 2011.

Fault; dashed where approximate, dotted where concealed.

Approximate boundary of San Ysidro Community Plan Update (SYCPU)

Approximate boundary of San Ysidro Historic Village Specific Plan (SYHVSP)

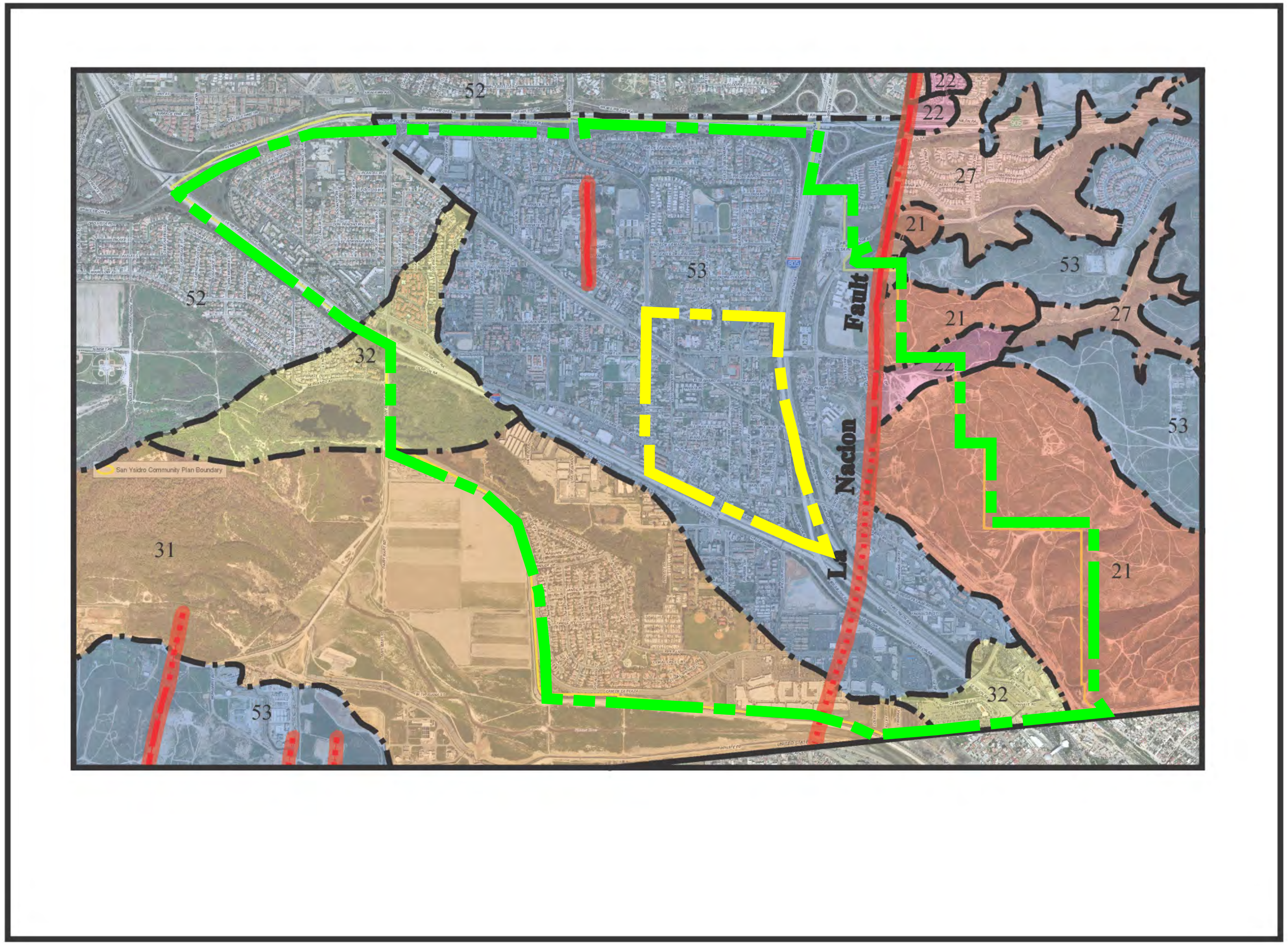
N

SCALE: 1" = 2,000'

SAN YSIDRO COMMUNITY PLAN UPDATE AND SAN YSIDRO HISTORIC VILLAGE SPECIFIC PLAN

APPROXIMATE LIMIT OF OTAY MESA LATERAL SPREAD

PROJECT NO. 127 GS-10	ALLIED GEOTECHNICAL ENGINEERS, INC.	FIGURE 3



EXPLANATION

GEOLOGIC HAZARD CATEGORIES

Fault Zones

12 Potentially Active
Inactive, presumed inactive or activity unknown

Landslides

21 Confirmed, known, or highly suspected

22 Possible or conjectured

Slide-prone Formations

27 Otay, Sweetwater and others

Liquefaction

31 High Potential- Shallow groundwater major drainages, hydraulic fills

32 Low Potential- fluctuating groundwater minor drainages

Other Terrain

52 Other level areas, gently sloping to steep terra favorable geologic structure, low risk

53 Level or sloping terrain, unfavorable geologi low to moderate risk

Fault; dashed where approximate, dotted where concealed

Contact

Approximate boundary of San Ysidro Community Plan Update (SYCPU)

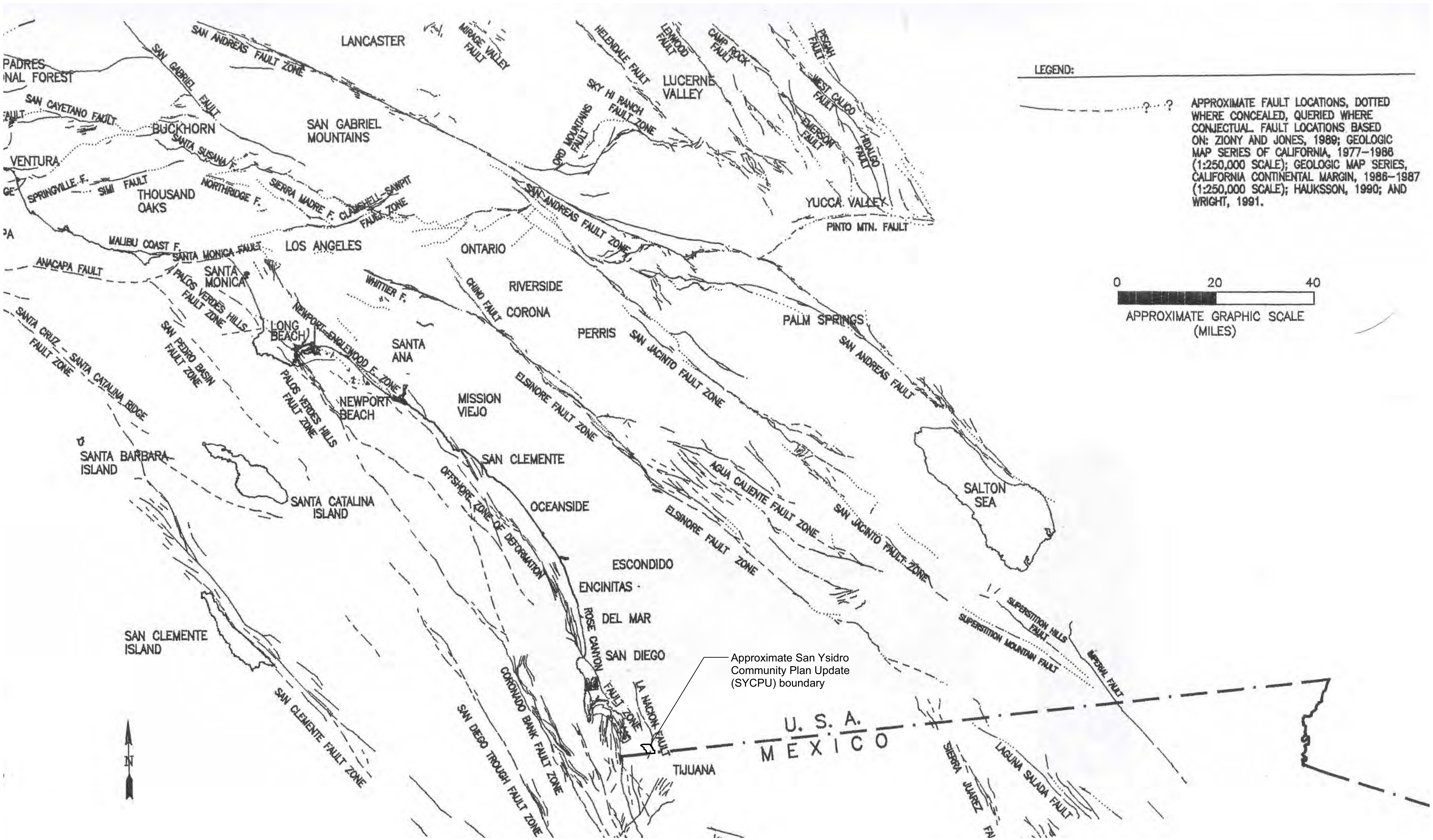
Approximate boundary of San Ysidro Historic Village Specific Plan (SYHVSP)

N

SCALE: 1" = 2,000'

Source: Kennedy and Tan, 2008, City of San Diego Seismic Safety Study, 2008

SAN YSIDRO COMMUNITY PLAN UPDATE AND SAN YSIDRO HISTORIC VILLAGE SPECIFIC PLAN	GEOLOGIC HAZARDS MAP
PROJECT NO. 127 GS-10 / ALLIED GEOTECHNICAL ENGINEERS, INC.	FIGURE 4



SAN YSIDRO COMMUNITY PLAN UPDATE AND SAN YSIDRO HISTORIC VILLAGE SPECIFIC PLAN		REGIONAL FAULT MAP
PROJECT NO. 127 GS-10	ALLIED GEOTECHNICAL ENGINEERS, INC.	FIGURE 5