Geology and Soils Technical Study

East Harbor Island Redevelopment/Topgolf Project

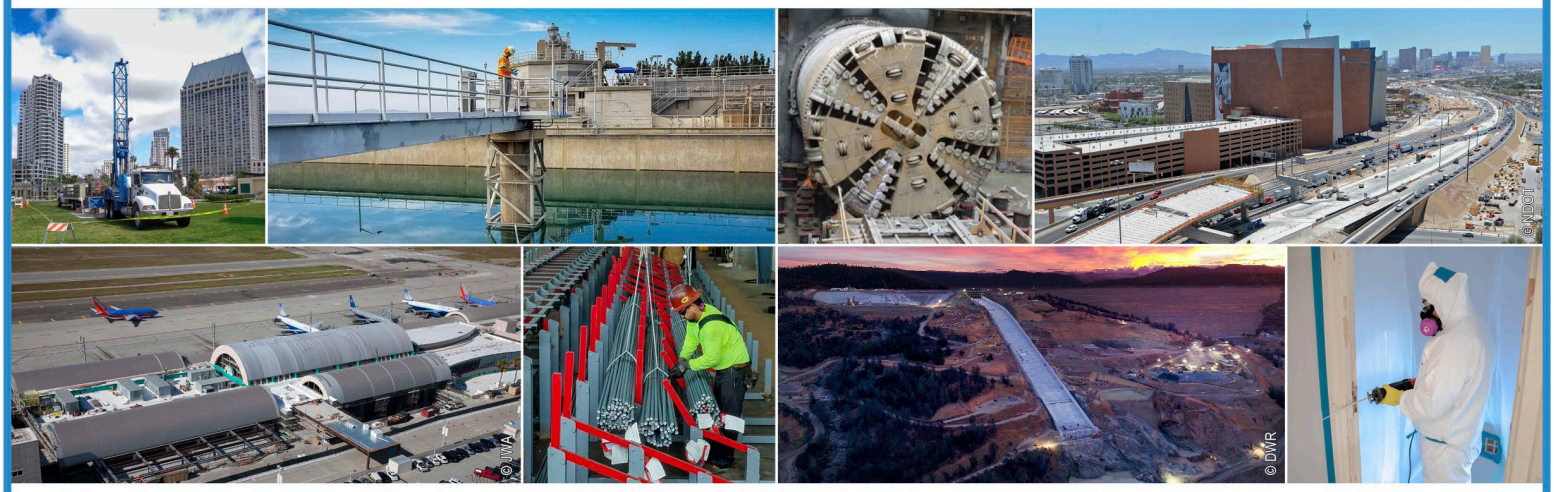
San Diego Unified Port District

San Diego, California

Harris & Associates

600 B Street, Suite 200 | San Diego, California 92101

May 10, 2024 | Project No. 109812001



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EXECUTIVE SUMMARY

Ninyo & Moore has performed a Geology and Soils Technical Study for an approximately 45-acre site located adjacent to San Diego Bay, south of North Harbor Drive, and east of Harbor Island Drive in the City of San Diego, California, within the jurisdiction of the San Diego Unified Port District (site). The site includes a relatively level area that supports the existing improvements. Liberator Way runs east-west along the much of the southerly portion of the site and a greenway and bicycle path runs east-west along the northerly portion of the site. Existing improvements include several one- and two-story buildings associated with the San Diego Harbor Police and car rental companies. Additional improvements include various shade structures, fueling stations, parking lots, fencing, boat ramps, and pavements. Much of the adjacent shoreline of the site is covered with riprap. Topographically, the site is relatively level with a gently gradient down towards to the south to San Diego Bay. Elevations across much of the site range from approximately 10 feet to 15 feet North American Vertical Datum of 1988 (NAVD), with the shoreline areas extending down to 0 NAVD and below.

The East Harbor Island Redevelopment/Topgolf project involves demolition of the existing rental car facilities, realignment of Liberator Way, and construction of a public park area and promenade, and the Topgolf entertainment complex.

In general, the following geologic and geotechnical constraints for the project include:

- The site is underlain by fill material and bay deposits that are further underlain at depth by old paralic deposits. The fill includes material that was dredged and hydraulically placed in the 1940's through the 1960's. Geotechnical constraints related to soils at the project site are:
  - *Soft Ground* – Areas with soft ground or loose soils may be located within the fill materials throughout the site.
  - *Compressible Soils* – The existing fill and bay deposits underlying the site are anticipated to consist of silty sand, silt, and sandy clay, which are considered compressible under loading.
  - *Expansive Soils* – The clayey fill soils, bay deposits, or old paralic deposits may be moderately to highly expansive.
  - *Corrosive Soils* – Due to the proximity of the marine environment and the anticipated variability of the onsite soils, it is anticipated that the site soils will be classified as corrosive.
  - *Fill Soils* – Man-made fill soils placed without engineering supervision may be loosely or inadequately compacted, may contain oversize materials unsuitable for reuse in engineered fills, and may contain unsuitable organic or expansive materials and debris that may preclude their use in engineered fills.

- Central and eastern portions of the site are located within State of California Earthquake Fault Zones (formerly known as an Alquist-Priolo Special Studies Zone) associated with the strands of the Rose Canyon fault zone. These faults include the Spanish Bight fault and the East Bay fault. Geotechnical constraints related to faulting and seismic events at the site are:
    - *Ground Surface Rupture* – Ground surface rupture due to active faulting is possible at the site due to the presence of the Spanish Bight fault in the central portion of the site and the East Bay fault in the eastern portion of the site. Additionally, lurching or cracking of the ground surface as a result of nearby seismic events is possible.
    - *Ground Shaking* – The site has a high potential for strong ground motions due to earthquakes on nearby active faults.
    - *Liquefaction* – The soils underlying the site may be subject to liquefaction or dynamic settlement during a nearby seismic event.
    - *Lateral Spread* – The soils underlying the site are considered to be potentially susceptible to seismically-induced lateral spread.
- Due to the proximity of the site to the San Diego Bay and Pacific Ocean, groundwater should be anticipated within the upper 10 feet of the site and should be anticipated at shallower depths as ground surface elevation decreases.
- The potential for landsliding at the project site is considered low.
- The site is mapped within a tsunami inundation hazard zone.
- The site is generally located in Zone X Area of Minimal Flood Hazard. However, the adjacent portions of San Diego Bay are mapped as being within a special flood hazard area subject to inundation by the 1% annual chance flood.

The conditions related to soils and geology, identified in this technical study report, would increase the cost and duration of grading and construction of the project, but would not preclude the feasibility of development of the project.

1. INTRODUCTION

Ninyo & Moore has completed a Geology and Soils Technical Study for the proposed East Harbor Island Redevelopment/Topgolf Project located south of North Harbor Drive and east of Harbor Island Drive in San Diego, California, within the jurisdiction of the San Diego Unified Port District (Figure 1). Our evaluation is based our review of published and non-published reports, aerial photographs, in-house data, a site reconnaissance, and the assessment of the potential geologic hazards in the project area. The purpose of this study was to evaluate the potential for existing environmental impacts related to geological or soils conditions that can affect the project site and adjoining areas, and to discuss measures that can be implemented to reduce or mitigate the potential impacts with respect to the design and construction of the proposed project.

2. SCOPE OF SERVICES

Ninyo & Moore's scope of services for this geologic study have included the activities listed below:

- Review of readily available regional, local, and site-specific geologic, geotechnical, fault hazard, and environmental reports.
- Review of readily available background information including topographic, soils, mineral resources, geologic, and seismic and geologic hazard maps, and stereoscopic aerial photographs.
- Performance of a site reconnaissance by a professional from our office.
- Compilation and analysis of the data obtained from our background review and site reconnaissance.
- Preparation of this report presenting our findings, conclusions, and preliminary recommendations regarding potential geologic and soil impacts at the site.

3. SITE DESCRIPTION AND PROJECT DESCRIPTION

The site consists of approximately 45-acres of land located south of North Harbor Drive and east of Harbor Island Drive in the city of San Diego, California (Figure 1). The southern boundary of the site is generally the East Basin and Convair Lagoon (also known as Venezuela Cove) portions of San Diego Bay, as well as the facility for the United States Coast Guard Sector San Diego (Figure 2). The eastern boundary of the site is near the Laurel Street dock. The site is located within the East Harbor Island Subdistrict of Planning District 2 of the Port Master Plan. Liberator Way runs east-west along much of the southerly portion of the site and a greenway and bicycle path runs east-west along the northerly portion of the site. Existing improvements include several one- and two-story buildings associated with the San Diego Harbor Police and car rental companies. Additional improvements include various shade structures, fueling stations, parking lots, fencing, and pavements. Much of the

adjacent shoreline of the subject site is covered with riprap. Near Convair Lagoon, portions of the shoreline are comprised of sandy beach and a concrete ramp. Topographically, the site is relatively level with a gently gradient down towards to the south to San Diego Bay. Elevations across much of the site range from approximately 10 feet to 15 feet North American Vertical Datum of 1988 (NAVD), with the shoreline areas extending down to 0 feet NAVD and below.

Prior to development, the site occupied a shallow area of San Diego Bay. In the 1920's and 1930's, dredging and hydraulic filling operations began to change the shoreline of San Diego Bay and expand land areas into the bay. By the early 1940's, much of the site and adjacent area to the north (encompassing North Harbor Drive and the San Diego Airport) were filled with material dredged from the bay (Port of San Diego, 1971). The western portion of the site as well as Harbor Island were built up with hydraulic fill by 1961.

Based on our review of site plans and project documents, the proposed project is anticipated to consist of demolition of the existing rental car facilities (including underground fuel storage tanks and related piping), realignment of Liberator Way, and construction of a public park area and promenade, and the Topgolf entertainment complex.

4. GEOLOGIC AND SUBSURFACE CONDITIONS

Our findings regarding regional and site geology (Figure 3) and groundwater are provided in the following sections.

4.1. Regional Geologic Setting

The project area is situated in the San Diego County coastal section of the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California (Norris and Webb, 1990; Harden 2004). The province varies in width from approximately 30 to 100 miles. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks, and Cretaceous igneous rocks of the southern California batholith. In the coastal plain portion of the province where the project is located, Quaternary-age sedimentary deposits overlie Tertiary- and Cretaceous-age sedimentary units.

The Peninsular Ranges Province is traversed by a group of sub-parallel faults and fault zones trending roughly northwest (Jennings, 2010). Several of these faults are considered active faults. The Elsinore, San Jacinto, and San Andreas faults are active fault systems located northeast of the project area. The Coronado Bank, San Diego Trough, and San Clemente faults are active

faults located west of the project area. Strands of the Rose Canyon fault zone, the nearest active fault system, are mapped across the central and eastern portions of the site. Major tectonic activity associated with these faults within this regional tectonic framework consists primarily of right-lateral, strike-slip movement. Further discussion of faulting relative to the site is provided in the Faulting and Seismicity section of this report.

4.2. Site Geology

Based on our review of published geologic maps (Figure 3) and onsite and nearby geotechnical reports (Woodward-Clyde, 1983; Ninyo & Moore, 2010), and our site reconnaissance, soils underlying the subject site are generally anticipated to consist of fill materials, bay deposits (also referred to as offshore marine deposits), and old paralic deposits. A brief description of these units, as described in the cited literature or as observed on the site, is presented below.

4.2.1. Fill

The site is mapped as being underlain by fill materials. As previously described, these materials were generally sourced from dredging operations in the bay and placed at the site from the 1920's to 1960's as hydraulic fills. As encountered in borings performed at the site, the fill materials were described as brown, tan, and gray, loose to medium dense, sand and silty clay (Woodward-Clyde, 1983). Nearby borings also encountered dark gray, loose to medium dense, sandy silt (Ninyo & Moore, 2010). A rip-rap berm lines the shoreline along the southern and eastern margins of the site. The depth of fill material across the site is anticipated to be on the order of approximately 10 to 20 feet.

4.2.2. Bay Deposits

Quaternary-age bay deposits (also referred to as offshore marine deposits) are mapped adjacent to the site and are anticipated to underlie the fill materials at the site. As described by Kennedy and Tan (2008), these materials generally consist of unconsolidated marine sediments composed mostly of very fine- to medium-grained sand and silt. The bay deposits encountered in borings previously performed onsite were described as brown, gray, and black, medium dense, silt and sand, and soft to stiff clay (Woodward-Clyde, 1983).

4.2.3. Old Paralic Deposits

Materials correlating to old paralic deposits are anticipated to underlie the fill soils and bay deposits at the site. Old paralic deposits have also been referred to as the Bay Point

Formation (Kennedy, 1975), terrace deposits, and Pleistocene deposits. As described by Kennedy and Tan (2008), old paralic deposits generally consist of mostly poorly sorted, moderately permeable, reddish-brown, interfingered strandline, beach, estuarine, and colluvial deposits composed of silt, sand, gravel, and cobbles. As encountered in borings performed at the site, old paralic deposits were encountered at depths ranging from approximately 45 to 50 feet and were described as brown, dense to very dense sand and stiff to hard clay (Woodward-Clyde, 1983).

4.3. Groundwater

Sources provided by the California Water Data Library Resources (DWR) and the California State Water Resources Control Board (SWRCB) were reviewed for information pertaining to groundwater quality and occurrence in the vicinity of the project. Data from boring logs and groundwater monitoring wells within the project area indicate that groundwater is present at depths ranging from approximately 8½ to 15 feet below existing grades (AECOM, 2016; Haley & Aldrich, 2008). Groundwater is expected to follow the topographic gradient and flow generally towards the south. Groundwater depths and flow directions can vary due to tidal influence, seasonal variations, construction dewatering, and other factors.

According to the SWRCB Water Quality Control Plan for the San Diego Basin, the site is located within the Lindbergh Hydrologic Subarea within the San Diego Mesa Hydrologic Area within the Pueblo San Diego Hydrologic Unit. This hydrologic area has been exempted by the Regional Board from the municipal drinking water use designation (SWRCB, revised 2021).

5. GEOLOGIC HAZARDS

In general, potential geologic hazards at the site include faulting and seismicity as they relate to seismic design of structures. These considerations and other geologic hazards such as liquefaction, landsliding, slope failure, and tsunamis, are discussed in the following sections.

5.1. Faulting and Seismicity

The site is located in a seismically active area, as is the majority of southern California, and the potential for strong ground motion at the site is considered significant. The Rose Canyon fault zone, the nearest active fault zone, consists of predominantly right-lateral strike-slip faults that extend south-southeast through the San Diego metropolitan area. In the northern portion of San Diego Bay, these splays include the generally north-south trending Spanish Bight and East Bay fault strands (Treiman, 2002; DeFrisco, 2021). These fault splays are designated active by the State of California (i.e., exhibit evidence of ground displacement during Holocene time which includes the

last 11,000 years) and therefore constitute a State of California Earthquake Fault Zone (EFZ) (formerly known as an Alquist-Priolo Special Studies Zone) (Hart and Bryant, 2007; CGS, 2021). As shown on Figure 4, both the Spanish Bight and East Bay faults traverse the central and eastern portions of the site, respectively. Evidence of these faults has been identified offshore in San Diego Bay by Moore and Kennedy (1975) and Singleton et al. (2021), as well as onshore by Geocon (2006, 2011, and 2012), and Kleinfelder (2012, 2013, and 2017). The results of these studies were incorporated into the most recent EFZ mapping by the California Geological Survey (CGS, 2021). To our knowledge, there have been no site-specific fault hazard studies performed at the site (Ninyo & Moore, 2022).

5.2. Ground Rupture

Based on our review of the referenced literature and our site reconnaissance, active splays of the Rose Canyon fault zone, designated as the Spanish Bight and East Bay faults, are mapped as traversing the central and eastern portions of the site (Figure 4). Therefore, the probability of damage from surface ground rupture is considered to be high. Lurching or cracking of the ground surface as a result of nearby seismic events is also possible.

5.3. Ground Motion

Considering the proximity of the site to the Rose Canyon fault which is capable of producing a maximum moment magnitude of 6.9, the project area has a high potential for experiencing strong ground motion. The 2022 California Building Code (CBC) specifies that the risk-targeted maximum considered earthquake (MCE_R) ground motion response accelerations be used to evaluate seismic loads for design of buildings and other structures. Based on our review of CGS's shear wave velocity map, the average shear wave velocity in the upper 30 meters (100 feet) of the subsurface profile (V_{s30}) is estimated to be 225 meters per second (738 feet per second) (CGS, 2015). In accordance with Chapter 20 of the American Society of Civil Engineers (ASCE) Publication 7-16 (2017) for the Minimum Design Loads and Associated Criteria for Building and Other Structures, the site classification is Site Class D. However, further evaluation of the Site Class should be performed as part of a comprehensive geotechnical study with a subsurface exploration and laboratory testing program.

In accordance with ASCE 7-16, the mapped MCE_R ground motion response accelerations were determined using the 2024 Applied Technology Council (ATC) seismic design tool (web-based). The MCE_R ground motion response accelerations are based on the spectral response accelerations for 5 percent damping in the direction of maximum horizontal response and incorporate a target risk for structural collapse equivalent to 1 percent in 50 years with deterministic limits. ASCE 7-16 specifies that the potential for liquefaction and soil strength loss be evaluated, where applicable, for the maximum

considered earthquake geometric mean (MCE_G) peak ground acceleration adjusted for site effects (PGA_M). The MCE_G peak ground acceleration with adjustment for site class effects (PGA_M) was calculated as 0.73g for Site Class D. Proposed structures should be designed to mitigate strong ground motion.

5.4. Liquefaction and Seismically Induced Settlement

Liquefaction is the phenomenon in which loosely deposited, saturated granular soils (located below the water table) with clay contents (particles less than 0.005 mm) of less than 15 percent, liquid limit of less than 35 percent, and natural moisture content greater than 90 percent of the liquid limit undergo rapid loss of shear strength due to development of excess pore pressure during strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to rapid rise in pore water pressure, and it eventually causes the soil to behave as a fluid for a short period of time. Liquefaction is known generally to occur in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below grade. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

Per the City of San Diego Seismic Safety Study (City of San Diego, 2008; Figure 5), the project area is within hazard category 31, mapped as having a high potential for liquefaction. Based on this designation, as well as the granular nature of the subsurface materials and the shallow depth to groundwater, the site has a high potential for liquefaction and seismically induced settlement. The potential for liquefaction should be further evaluated through site-specific subsurface and laboratory evaluation during the design phase of the project. Liquefaction may be mitigated by selective grading, densification of the subsurface soils, cement deep soil mixing, and/or deep foundations.

5.5. Lateral Spreading

Lateral spread of the ground surface during an earthquake usually takes place along weak shear zones that have formed within a liquefiable soil layer. Lateral spread has generally been observed to take place in the direction of a free-face (i.e., retaining wall, slope, channel, etc.) but has also been observed to a lesser extent on ground surfaces with very gentle slopes. An empirical model developed by Youd et al. (2002) is typically used to predict the amount of horizontal ground displacement within a site. For sites located in proximity to a free-face, the amount of lateral ground displacement is correlated with the distance of the site from the free-face. Other factors such as earthquake magnitude, distance from the causative fault, thickness of the liquefiable layers, and the fines content and particle sizes of the liquefiable layers also influence the amount of lateral ground displacement. The potential for lateral spreading should be further evaluated

through site-specific subsurface and laboratory evaluation during the design phase of the project. Lateral spreading may be mitigated by structural means, or ground improvement methods such as cement deep soil mixing, stone columns, rammed aggregate piers, and compaction grouting. Further discussion on mitigation of settlements and displacements can be found in Special Publication 117A (CGS, 2008).

5.6. City of San Diego Seismic Safety Study

Per the City of San Diego Safety Study, Geologic Hazards and Faults (2008), the entirety of the site is mapped within hazard category 31 (Figure 5), which is defined as having a high potential for liquefaction, with shallow groundwater, major drainages, and hydraulic fills. Hazard category 11, which is defined as an active, Alquist-Priolo fault zone, is mapped in the central portion of the site. Areas of hazard category 12, which is defined as potentially active, inactive, presumed inactive, or activity unknown fault zones, are mapped adjacent to the south-central and eastern margins of the site. However, as described previously, more recent mapping indicates the areas of mapped hazard categories 11 and 12 in the vicinity of East Harbor Island constitute a State of California EFZ classification (Figure 4).

5.7. Landsliding and Slope Failure

Landslides have not been mapped on or adjacent to the site and evidence of landsliding was not observed in our review of aerial photographs or during our site reconnaissance. The site is located within an area mapped as being least susceptible to landslides. Additionally, based on the relatively flat topography of the site, the potential for landsliding or slope instability to impact the project development is considered low.

5.8. Tsunamis

Tsunamis are long wavelength seismic sea waves (long compared to the ocean depth) generated by sudden movements of the ocean bottom during submarine earthquakes, landslides, or volcanic activity. According to our review of the most recent available tsunami map (Graehl, and Wilson, 2022), the site is located within a mapped tsunami hazard area (Figure 6).

5.9. Flood Hazards

Based on review of Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (2019), the site is generally located in Zone X Area of Minimal Flood Hazard. However, the adjacent portions of San Diego Bay, including the East Basin and Convair Lagoon, are mapped as being within a special flood hazard area subject to inundation by the 1% annual chance flood. These areas are designated as having base flood elevations ranging from 8 to 11 feet NAVD, as shown in Figure 7.

Based on review of the flood maps, the potential for significant flooding to impact the site is not a design consideration for improvements above the base flood elevations.

5.10. Expansive Soils

Expansive soils generally result from specific clay minerals that have the capacity to shrink or swell in response to changes in moisture content. Shrinking or swelling of foundation soils can lead to damage to slabs, foundations, and other engineered structures, including tilting and cracking. Clayey fill soils and bay deposits at the site may be moderately to highly expansive. The nature and extent of expansive soils at the project should be further evaluated by subsurface investigation and laboratory testing.

5.11. Corrosive Soils

Caltrans corrosion (2021) criteria define corrosive soils as soil with an electrical resistivity less than 1,500 ohm-cm, a chloride content more than 500 parts per million (ppm), more than 0.15 percent sulfates (1,500 ppm), and/or a pH less than 5.5. Due to the proximity of the marine environment and the anticipated variability of the onsite soils, it is anticipated that the site soils will be classified as corrosive. If future improvements are planned, the nature and extent of corrosive soils should be further evaluated by subsurface investigation and laboratory testing. If corrosive soils exist on the site, a corrosion engineer should be retained to assist in the design of improvements in contact with the soil.

5.12. Soils

Based on the interactive map using the Web Soil Survey website (USDA, 2024), the soil units mapped on the project site include Urban Land and Made Land (Figure 8). Both Urban Land and Made Land are considered to have no agricultural use and have low to moderate erosion potential. As noted previously, the site is located on land built up by hydraulic fills. The potential loss of agricultural or native soils due to the project is considered low.

5.13. Mineral Resources

According to the City of San Diego General Plan (2008) the project site is located Mineral Resource Zone (MZR)1. MRZ-1 is described as areas where available geologic information indicates that little likelihood exists for the presence of significant mineral resources (CGS, 1996).

6. CONCLUSIONS

Based on our review of the referenced background data and our geologic field reconnaissance it is our opinion that the following geological characteristics of the project site will require specific considerations when designing the project. These considerations include the following:

- The site is underlain by fill material and bay deposits, and underlain at depth by old paralic deposits. The fill includes material that was dredged and hydraulically placed in the 1940's though the 1960's. Geotechnical constraints related to soils at the project site are:
    - *Soft Ground* – Areas with soft ground or loose soils may be located within the fill materials throughout the site.
    - *Compressible Soils* – The existing fill and bay deposits underlying the site are anticipated to consist of silty sand, silt, and sandy clay, and are considered compressible under loading.
    - *Expansive Soils* – The clayey fill soils, bay deposits, or old paralic deposits may be moderately to highly expansive. The nature and extent of expansive soils and recommended mitigation measures should be evaluated by subsurface investigation and laboratory testing.
    - *Fill Soils* – Fill soils placed without engineering supervision may be loosely or inadequately compacted, may contain oversize materials unsuitable for reuse in engineered fills, and may contain unsuitable organic or expansive materials and debris that may preclude their re-use in engineered fills.
- Central and eastern portions of the site are located within State of California Earthquake Fault Zones (formerly known as an Alquist-Priolo Special Studies Zone) associated with the strands of the Rose Canyon fault zone. These faults include the Spanish Bight fault and the East Bay fault. Geotechnical constraints related to faulting and seismic events at the site are:
    - *Ground Surface Rupture* – Ground surface rupture due to active faulting is possible at the site due to the presence of the Spanish Bight fault in the central portion of the site and the East Bay fault in the eastern portion of the site. Additionally, lurching or cracking of the ground surface as a result of nearby seismic events is possible.
    - *Ground Shaking* – The site has a high potential for strong ground motions due to earthquakes on nearby active faults.
    - *Liquefaction* – The soils underlying the site may be subject to liquefaction or dynamic settlement during a nearby seismic event.
    - *Lateral Spread* – The soils underlying the site are considered to be potentially susceptible to seismically-induced lateral spread.
- Due to the proximity of the site to the San Diego Bay and Pacific Ocean, groundwater should be anticipated within the upper 10 feet of the site and should be anticipated at shallower depths as ground surface elevation decreases. Dewatering may be needed for excavations that extend into groundwater. Materials excavated from below the groundwater table will be in a wet condition and will need to be moisture-conditioned and/or mixed before reuse for structural backfill.
- The potential for landsliding at the project site is considered low.

- The site is mapped within a tsunami inundation hazard zone.
- The site is generally located in Zone X Area of Minimal Flood Hazard. However, the adjacent portions of San Diego Bay are mapped as being within a special flood hazard area subject to inundation by the 1% annual chance flood.

The conditions related to soils and geology, identified in in thus technical study report, would increase the cost and duration of grading and construction of the project, but would not preclude the feasibility of development of the project.

7. RECOMMENDATIONS

Based on the geologic and geotechnical considerations at the project site presented in the previous sections, we recommend further geotechnical evaluation of the project site, including the performance of a subsurface evaluation and laboratory testing program. Specific recommendations to be addressed prior to issuance of grading and building permits would include:

Soft Ground – Soils in areas with soft ground or loose soils in the area of the site may be subject to settlement and provide weak bearing conditions for support of structures and other improvements. Recommendations to mitigate this condition can typically include removal and/or replacement of soils as engineered compacted fill. The extent of soft soils and recommended removals may be evaluated by subsurface exploration and laboratory testing.

Compressible Soil – Compressible soils may lead to settlement of the proposed improvements. The following recommendations may be implemented during construction to address this condition: the soils could be excavated and removed from the site; they could be treated to mitigate their potential for compression, or the materials could be surcharged through the benefit of proposed fills.

Expansive Soils – Expansive soils may lead to damage to foundations and engineered structures. If expansive soils exist on site, the following recommendations may be implemented during construction: the soils may be removed from sensitive areas and placed in deeper fill areas; the soils may be excavated and removed from the site; or the expansive soils may be treated (i.e., lime treatment) to mitigate their potential for expansion. Special foundation designs to mitigate expansive soils may also be incorporated in the final design of the project. The extent of expansive soils and recommended mitigation measures may be evaluated by subsurface exploration and laboratory testing.

Ground Surface Rupture – In accordance with the Alquist-Priolo Act, proposed building structures for human occupancy should be offset 50 feet from the closest suspected fault location as the area within

50 feet of active faults are presumed to be underlain by active branches of that fault unless proven otherwise. A 'structure for human occupancy' is defined in California Geological Survey (CGS) Special Publication 42 (2018) as any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year. Recommended structural offsets, or setbacks, from active faults should be established based on subsurface exploration performed as part of a site-specific fault hazard evaluation conducted in accordance with CGS (2008) guidelines.

Ground Shaking – Proposed structures should be designed appropriately to mitigate strong ground shaking in the event of an earthquake on a nearby fault.

Liquefaction – Due to the presence of loose granular soils and shallow groundwater at the site, hazards associated with liquefaction and dynamic settlement should be evaluated. If liquefaction hazards are indicated, structural design and/or earthwork mitigation techniques may be implemented. Specifically, in-situ ground modification, removal of liquefiable layers and replacement with compacted fill, or support of project improvements with piles to sufficient depths can mitigate damage as a result of liquefaction and make the site safe for development

Shallow groundwater – Shoring and dewatering may be needed where construction is proposed in areas of shallow groundwater.

Corrosive Soils – If corrosive soils exist on the site, a corrosion engineer may be retained to assist in the design of improvements in contact with the soil. The extent of corrosive soils and recommended mitigation measures may be further evaluated by subsurface exploration and laboratory testing.

The conditions related to soils and geology, identified in conjunction with the Geology and Soils Technical Study, would increase the cost and duration of grading and construction of the project, but would not preclude the feasibility of development of the project.

8. IMPACT ANALYSIS

Based upon the results of our geologic desktop assessments, our findings, conclusions, and recommendations regarding potential geological impacts to the project are summarized in the following sections.

8.1. Significance Thresholds

In evaluating the significance of potential environmental concerns in a particular study area, the criteria to consider, as they relate to geologic and soil conditions, are presented in the California Environmental Quality Act (CEQA) Guidelines (2023). In accordance with the scope of work, the

findings of this study were evaluated with respect to Geology and Soils thresholds of significance within Appendix G of the CEQA Guidelines (2023).

8.2. Project Impacts and Significance

Based on the above criteria and the results of the evaluation, the potential impact by geologic and soil conditions at the project have been identified, and are discussed below.

VII. GEOLOGY AND SOILS

A. Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of known fault?

Ground surface rupture due to active faulting is possible at the site due to the presence of splays of the Rose Canyon fault zone. As noted, the Spanish Bight fault traverses the central portion of the site and the East Bay fault strand traverses the eastern portion of the site. Additionally, lurching or cracking of the ground surface as a result of nearby seismic events is possible. The risk should be assessed as part of a comprehensive geotechnical and fault hazard evaluation performed prior to project development, per CGS guidelines (CGS, 2018) and the California Building Code (CBC) Appendix J, Grading.

ii. Strong seismic ground shaking?

The project has a high potential for strong ground motions due to earthquakes on nearby and onsite active faults. The risk due to ground shaking should be evaluated as part of a design level geotechnical evaluation. Such an evaluation would include an assessment of site-specific ground motions and seismic design parameters such that structural design and mitigation techniques can be implemented during design, as appropriate. Structural elements can then be designed to resist or accommodate anticipated ground motions and to conform to the current seismic design standards. Seismic analysis and project design performed in accordance with the requirements of Chapter 16 of the 2022 California Building Code and the American Society of Civil Engineers (ASCE) 7-16 Standard can be expected to mitigate risks due to ground shaking. This impact is less than significant when industry standards for design and construction are incorporated into the project.

iii. Seismic related ground failure, including liquefaction?

Based on the presence of relatively loose fill material and bay deposits and shallow

groundwater at the site, soils underlying the site could be susceptible to liquefaction and seismic settlement hazards. Liquefaction potential should be evaluated as part of a comprehensive geotechnical evaluation performed prior to project development. Such an evaluation would be performed so an opinion can be made regarding the hazard for liquefaction and seismic settlement and that structural design and mitigation techniques can be implemented during design, as appropriate. Mitigation for construction in liquefaction hazard areas may include in-situ ground modification, removal of liquefiable layers and replacement with compacted fill, or support of project improvements with piles to sufficient depths to mitigate damage as a result of liquefaction and make the site safe for development. This impact is considered less than significant with mitigation incorporated.

iv. Landslides?

Our review of geologic literature, aerial photos and topographic maps, does not indicate the presence of mapped landslides on the project site. Additionally, landslides were not mapped by others adjacent to the site. Therefore, the potential impact of existing landslides is considered low (less than significant impact).

B. Would the project result in substantial soil erosion or the loss of topsoil?

If the site is developed in accordance with current building codes, industry standards, and the recommendations of the geotechnical evaluation, the potential for substantial soil erosion is considered to be low (less than significant impact). The potential for substantial loss of topsoil due to the proposed development is considered low due the site being previously developed.

C. Would the project be located on geologic unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

The soils underlying the site may be subject to liquefaction, lateral spreading, and settlement due to subsidence or consolidation of soft soils. The degree of these hazards should be evaluated by a design-level geotechnical evaluation performed for the project. Where soil settlements are identified, appropriate engineering measures should be employed as recommended in a design-level geotechnical evaluation or by the project structural engineer (less than significant with appropriate design and construction methods incorporated).

D. Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?

Soils with a moderate to high potential for expansion may be present at the site. Soil

conditions should be further evaluated by geotechnical laboratory testing as part of a design level geotechnical evaluation. However, we consider this impact to be less than significant with appropriate construction methods and specifications incorporated.

E. Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

The project would rely on the existing sanitary sewer system and would not use septic tanks or alternative wastewater disposal systems. We consider this impact to be less than significant.

9. LIMITATIONS

The field evaluation and geotechnical analyses presented in this report have been conducted in accordance with current engineering practice and the standard of care exercised by reputable geotechnical consultants performing similar tasks in this area. No warranty, implied or expressed, is made regarding the conclusions, recommendations, and professional opinions expressed in this report. Variations may exist and conditions not observed or described in this report may be encountered. Our preliminary conclusions and recommendations area based on an analysis of the observed conditions and the referenced background information.

The purpose of this study was to evaluate geologic and geotechnical conditions within the project site and to provide a preliminary geological report to assist in the preparation of environmental impact documents for the project. A comprehensive geotechnical evaluation, including subsurface exploration and laboratory testing, should be performed prior to design and construction of structural improvements.

10. REFERENCES

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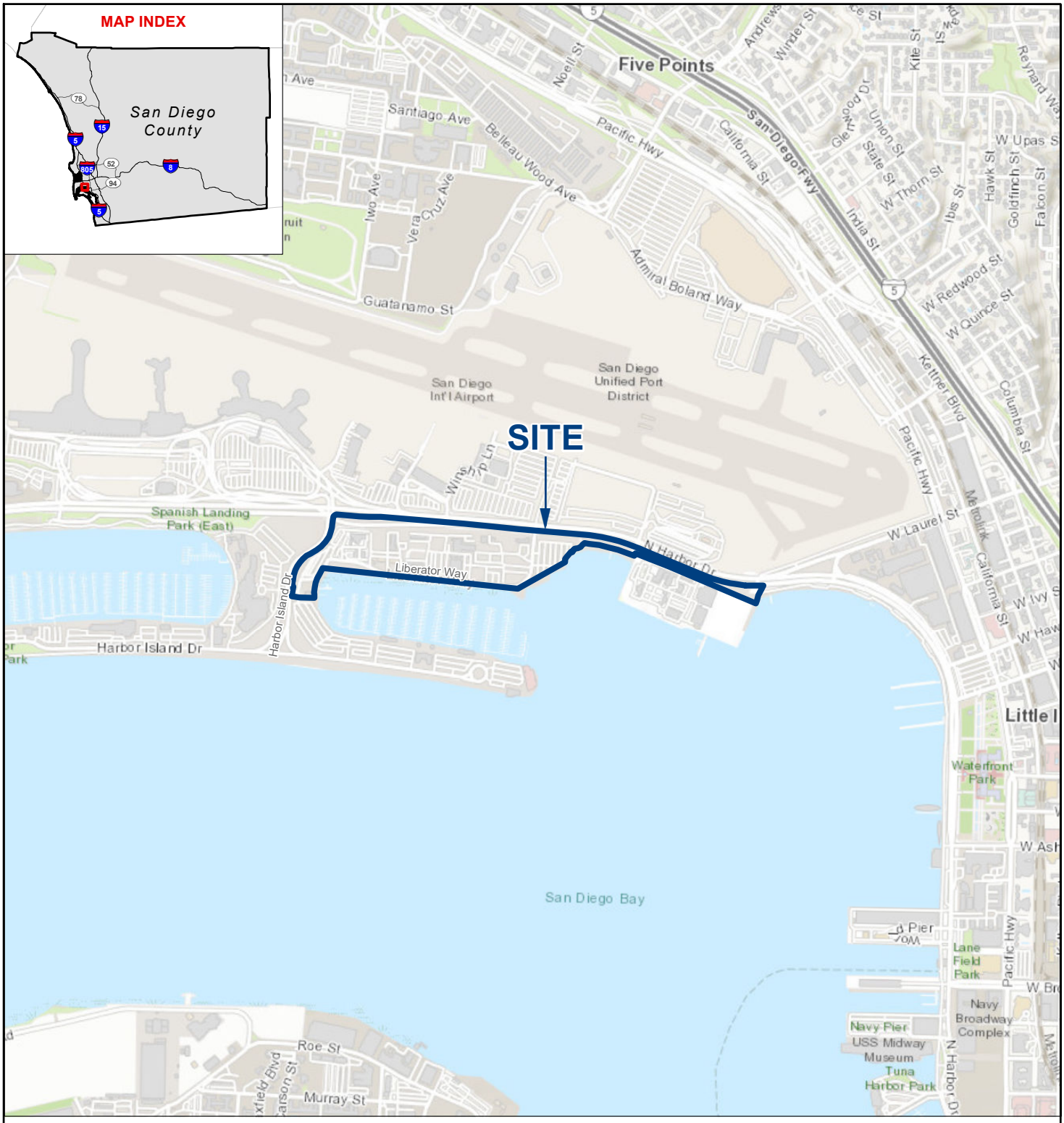
FIGURES



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NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: ESRI WORLD TOPO, 2022

FIGURE 1

SITE LOCATION

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

109812001 | 5/24

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Geotechnical & Environmental Sciences Consultants



LEGEND

SITE BOUNDARY

N

FEET

0 600 1,200

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: GOOGLE EARTH, 2024

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FIGURE 2

AERIAL SITE PLAN

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

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REFERENCE: KENNEDY, M.P., TAN, S.S., 2008, GEOLOGIC MAP OF THE SAN DIEGO 30 X 60-MINUTE QUADRANGLE, CALIFORNIA

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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FIGURE 3

GEOLOGY

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

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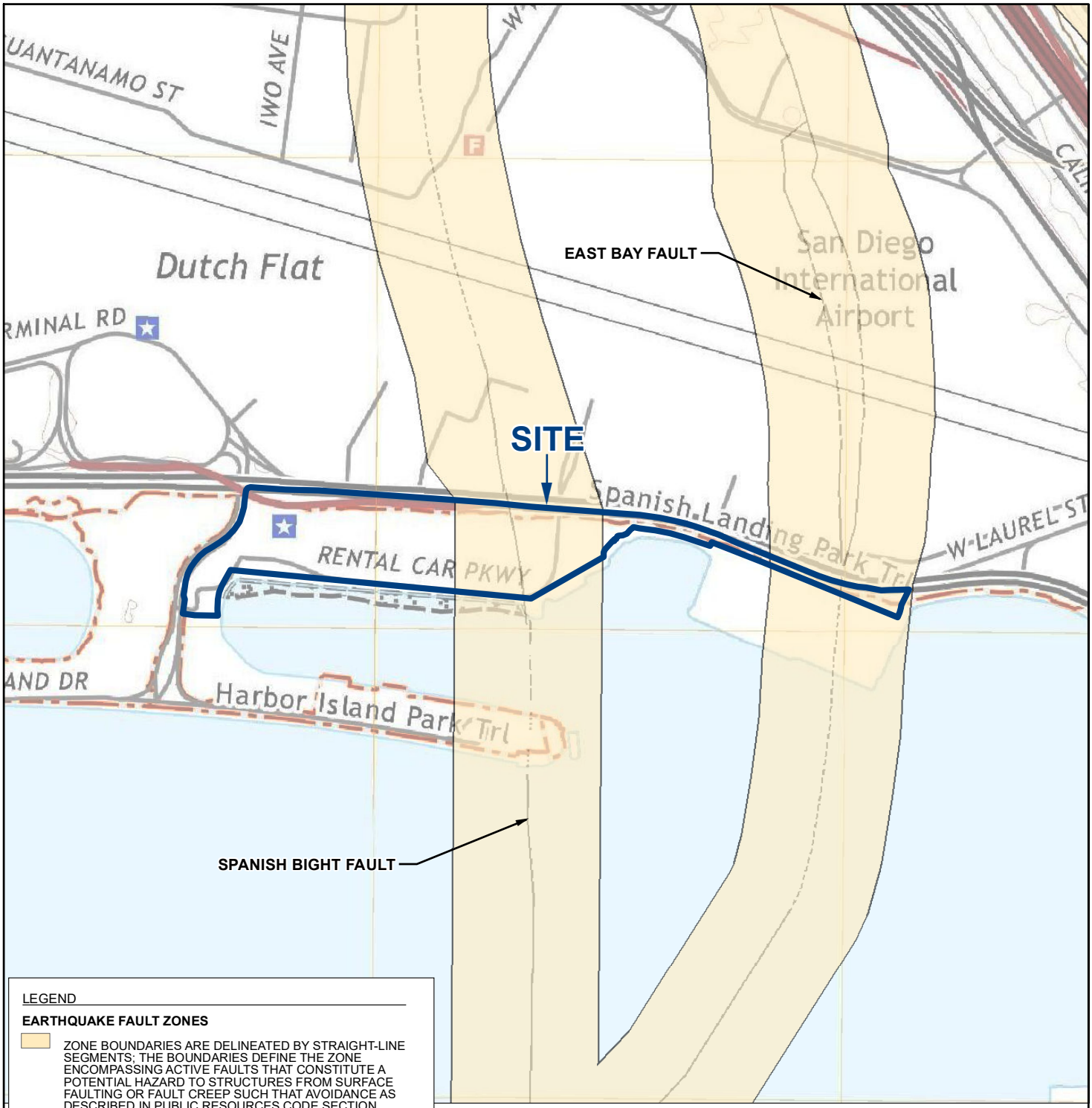

LEGEND

EARTHQUAKE FAULT ZONES

ZONE BOUNDARIES ARE DELINEATED BY STRAIGHT-LINE SEGMENTS; THE BOUNDARIES DEFINE THE ZONE ENCOMPASSING ACTIVE FAULTS THAT CONSTITUTE A POTENTIAL HAZARD TO STRUCTURES FROM SURFACE FAULTING OR FAULT CREEP SUCH THAT AVOIDANCE AS DESCRIBED IN PUBLIC RESOURCES CODE SECTION 2621.5(A) WOULD BE REQUIRED.

ACTIVE FAULT TRACES

FAULTS CONSIDERED TO HAVE BEEN ACTIVE DURING HOLOCENE TIME AND TO HAVE POTENTIAL FOR SURFACE RUPTURE: SOLID LINE WHERE ACCURATELY LOCATED; LONG DASH WHERE APPROXIMATELY LOCATED; SHORT DASH WHERE INFERRED; DOTTED LINE WHERE CONCEALED; QUERY (?) INDICATES ADDITIONAL UNCERTAINTY. EVIDENCE OF HISTORIC OFFSET INDICATED BY YEAR OF EARTHQUAKE-ASSOCIATED EVENT OR C FOR DISPLACEMENT CAUSED BY FAULT CREEP.

SOURCE: POINT LOMA QUADRANGLE, EARTHQUAKE FAULT ZONES, CGS, 2021.
USGS TOPO, 2021

N

FEET
0 1,000 2,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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FIGURE 4

EARTHQUAKE FAULT ZONES

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

109812001 | 5/24

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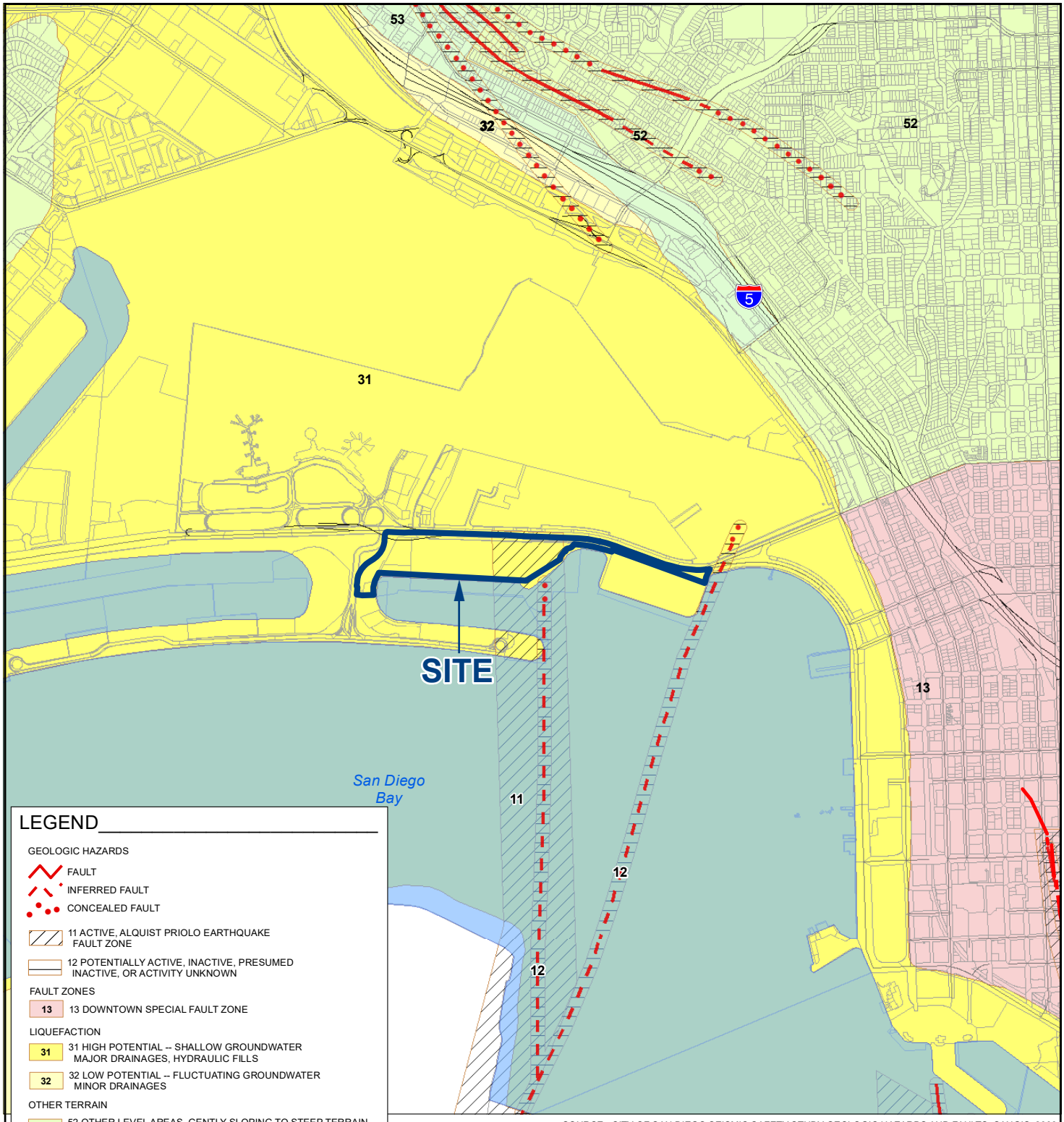

SOURCE: CITY OF SAN DIEGO SEISMIC SAFETY STUDY GEOLOGIC HAZARDS AND FAULTS, SANGIS, 2008

N

FEET

0 2,000 4,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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FIGURE 5

GEOLOGIC HAZARDS

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

109812001 | 5/24

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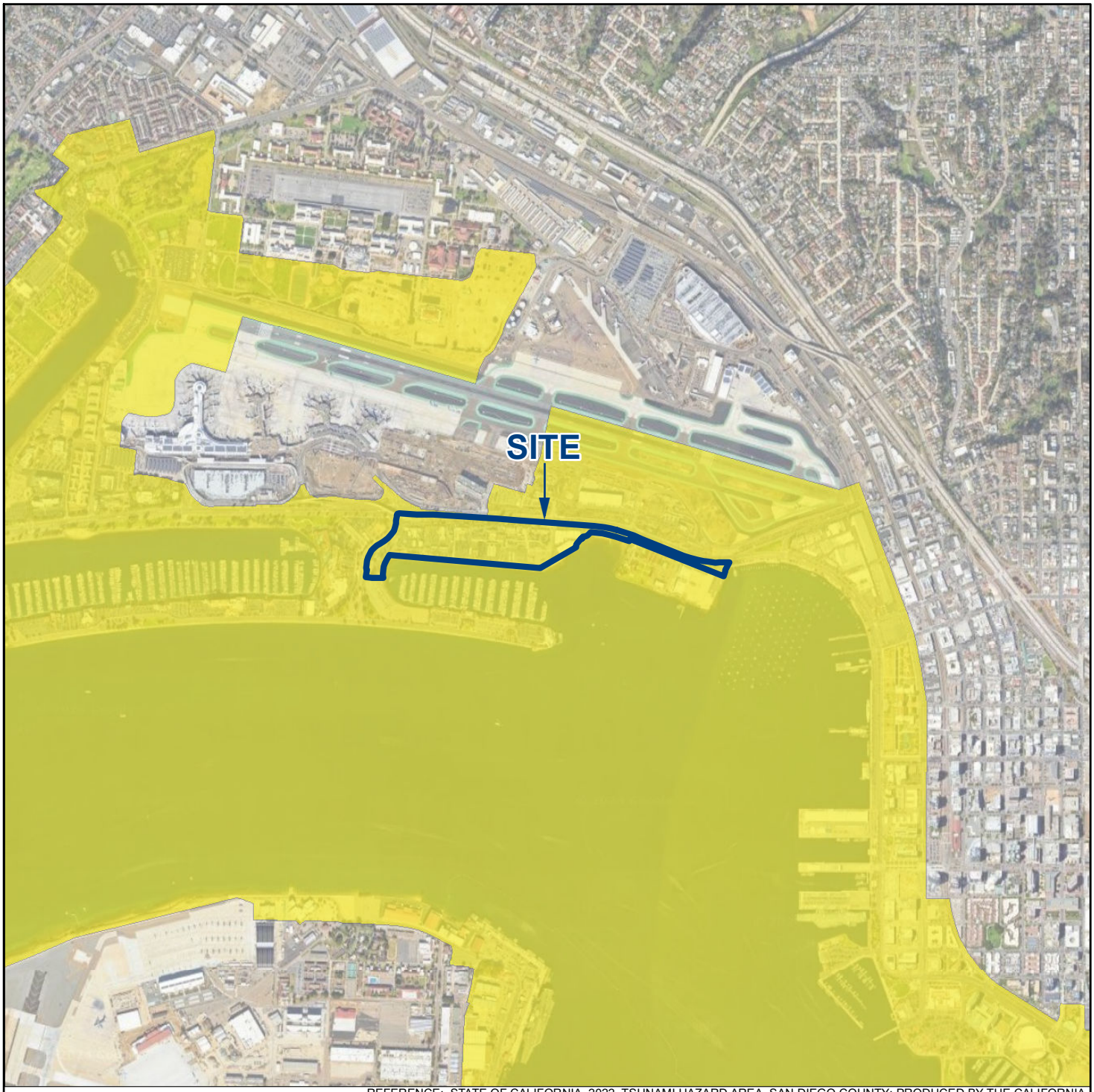

REFERENCE: STATE OF CALIFORNIA, 2022. TSUNAMI HAZARD AREA, SAN DIEGO COUNTY; PRODUCED BY THE CALIFORNIA GEOLOGICAL SURVEY AND THE CALIFORNIA GOVERNOR'S OFFICE OF EMERGENCY SERVICES; DATED 2022. GOOGLE EARTH, 2023.

LEGEND

TSUNAMI HAZARD AREA

N

FEET

0 2,000 4,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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FIGURE 6

TSUNAMI INUNDATION

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

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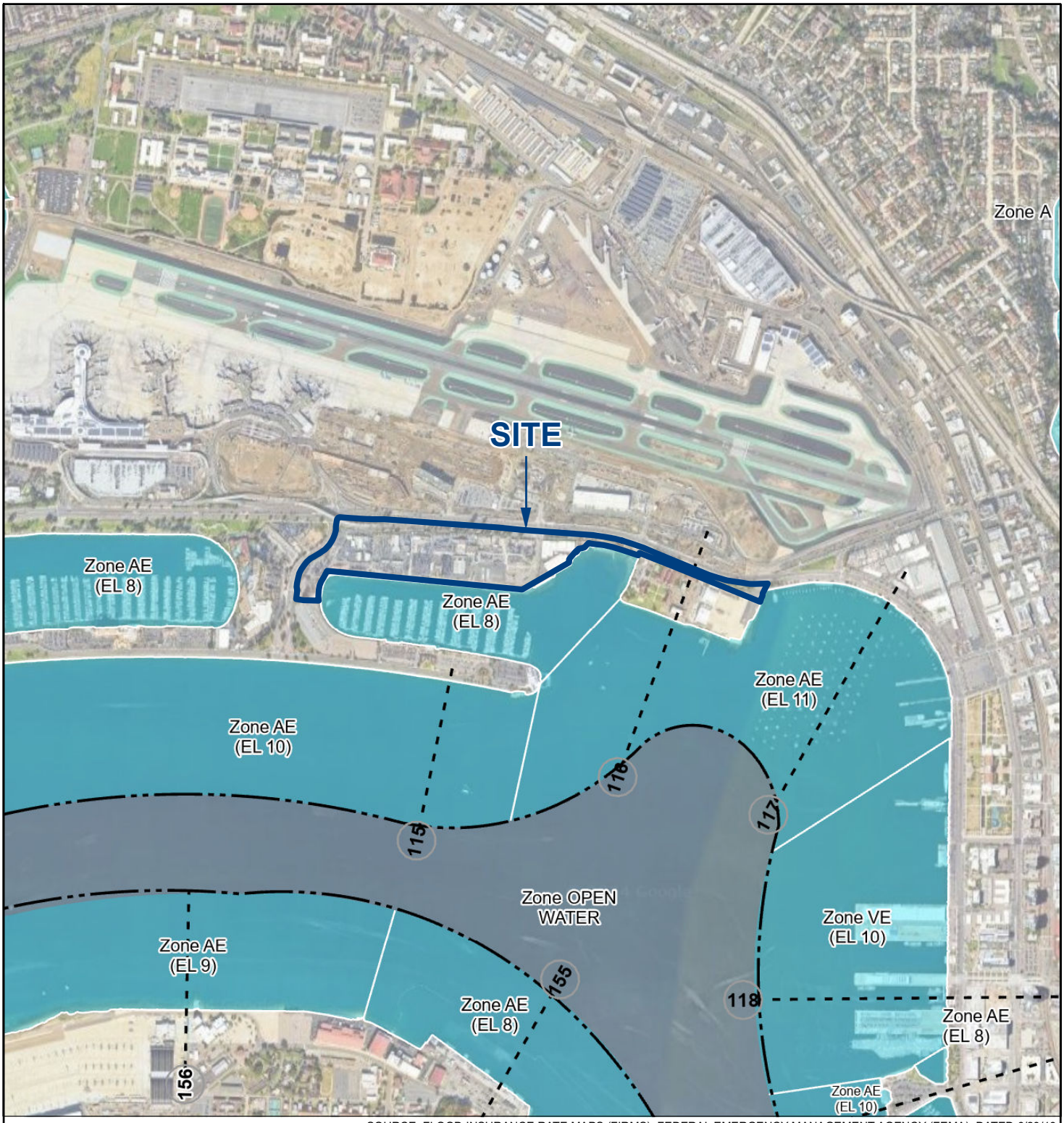

SOURCE: FLOOD INSURANCE RATE MAPS (FIRMS), FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA), DATED 6/23/13.

LEGEND

FLOOD HAZARD ZONES
ZONE TYPE

1% ANNUAL CHANCE FLOOD HAZARD

N

FEET

0 1,500 3,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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FIGURE 7

FLOOD HAZARDS

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

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SOIL DESCRIPTIONS

GaE	GAVIOTA FINE SANDY LOAM 30 TO 50 PERCENT SLOPES
GaF	GAVIOTA FINE SANDY LOAM 9 TO 30 PERCENT SLOPES
Md	MADE LAND
MIC	MARINA LOAMY COARSE SAND 2 TO 9 PERCENT SLOPES
Ur	URBAN LAND
W	WATER

LEGEND

SOIL BOUNDARY AND SOIL UNIT TYPE

N

FEET

0 1,500 3,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: GOOGLE EARTH, 2023

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FIGURE 8

USDA (SSURGO) SOIL SURVEY

EAST HARBOR ISLAND REDEVELOPMENT/TOPGOLF PROJECT
SAN DIEGO, CALIFORNIA

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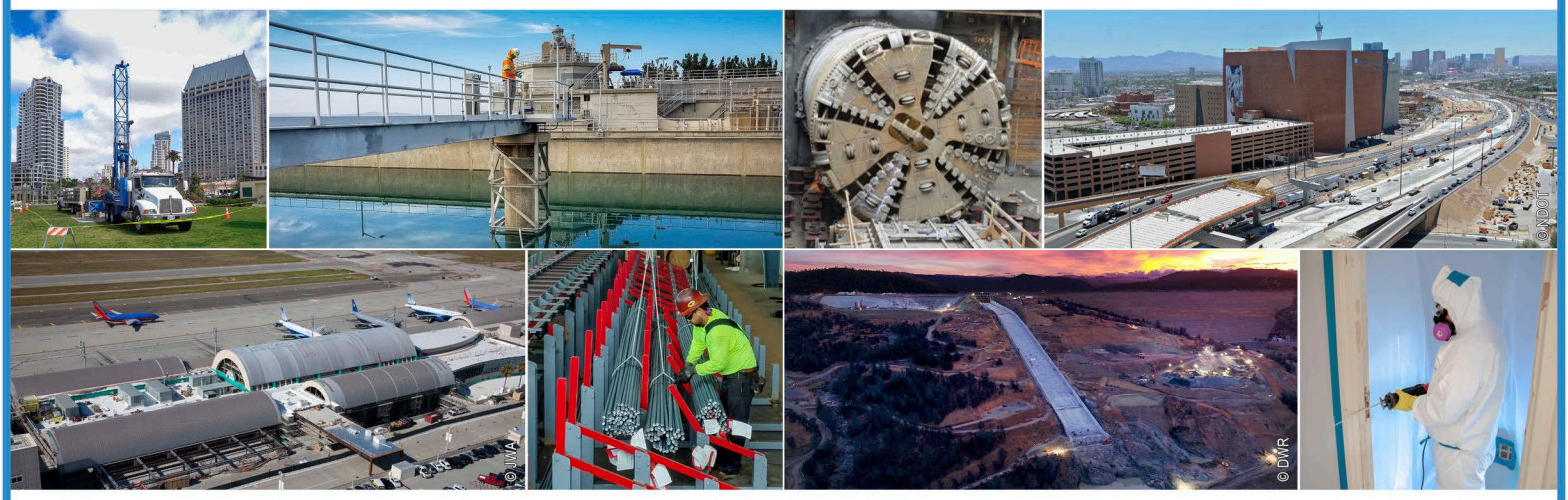

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