4.2 GEOLOGY, SOILS, AND SEISMICITY

This section is based on information supplied by local planning documentation and subsurface geotechnical/environmental studies performed in the site vicinity to provide a basis for the geotechnical reports prepared for this Subsequent Environmental Impact Report (SEIR) (refer to Appendix C, Updated Preliminary Review of Geological Constraints and Geologic Hazards, Huntington Beach Desalination Report). These studies include the following:

- California Geological Survey. 1981. Geologic Map of Orange County California, Showing Mines and Mineral Deposits.
- City of Huntington Beach. 1996. *City of Huntington Beach General Plan*.
- FEMA (Federal Emergency Management Agency). 2009. Flood Insurance Rate Map. Map Number 06059C0263J. Revised December 3, 2009.
- *Geotechnical Investigation for Future Huntington Beach Maintenance Facility, East End of Edison Road, East of Newland Street, Huntington Beach, California*. Prepared by G.A. Nicoll, Inc., 2000.
- Geotechnical Investigation, Huntington Beach Channel (Flood Control Facility No. D01, City of Huntington Beach, County of Orange, California.) Prepared for the Orange County Environmental Management Agency, February 21, 1991.
- Huntington Beach Generating Station Phase II Environmental Site Assessment. Prepared by CH2M Hill, November 27, 1996.
- Magorien, D. Scott, C.E.G. 2010. *Updated Preliminary Review of Geotechnical Constraints and Geologic Hazards, Poseidon Resources Seawater Desalination Project, Huntington Beach, California,* February 2, 2010.
- *Preliminary Geotechnical Assessment, Southeast Reservoir Site Acquisition, Huntington Beach, California*. Prepared by GeoLogic Associates, May 24, 2002.
- USDA (U.S. Department of Agriculture). 1978. Soil Conservation Service and Forest Service Soil Survey. September 1978.
- USGS (U.S. Geologic Survey). 1981. Newport Beach Quadrangle. California Division of Mines and Geology.
- USGS. 1997. Special Publication 42: Fault-Rupture Hazard Zones in California. California Division of Mines and Geology. Updated in 1997.

In addition, Robert H. Sydnor of the California Geological Survey provided a comprehensive bibliography and several relevant maps that have been reviewed and incorporated into this section.

This section considers impacts of the project for both the stand-alone and co-located scenarios. Impacts on geology, soils, and seismicity would remain the same for both scenarios because the operational characteristics relative to the Huntington Beach Generating Station (HBGS) are not relevant to geotechnical considerations.

EXISTING CONDITIONS

PROPOSED DESALINATION FACILITY SITE

Site Topography

The proposed project site is unpaved and currently developed with three, large fuel oil storage tanks (Tanks 1, 2, and 3), containment berms, pipelines, pumps, and associated structures (refer to Figure 3-2, Site Vicinity Map). The subject site lies at an elevation of approximately 5 feet above mean sea level (amsl). The three storage tanks on site are surrounded on all sides by a 10- to 15-foot-high soil containment berm. Each tank is elevated approximately 2 to 3 feet above the floor of the site, which slopes gently to the east.

Surrounding Topography

Areas within the project vicinity are similar in topography to the subject site. Surrounding areas to the west, north, and east are generally flat and have an approximate elevation of 5 feet amsl. Elevations to the south gradually slope in a southwest orientation along Huntington State Beach and Huntington City Beach toward the Pacific Ocean. The Santa Ana River, located east of the project vicinity, lies in a depression with an approximate elevation of sea level at the mouth to 6 inches amsl a quarter mile upstream. In addition, the Ascon/Nesi Landfill (located approximately 300 feet northeast of the project site) is elevated several feet above grade as a result of the accumulation of oil drilling byproducts and solid waste during its operation from approximately 1938 to 1984.

The most noticeable topographic feature in the area is the Huntington Beach Channel, which is operated and maintained by the Orange County Flood Control District (OCFCD). This channel borders the eastern margin of the project site. The 60-foot-wide channel is bounded on each side by a 5- to 7-foot-high levee. The interior sides of the portion of the levee near the subject site have been improved with driven sheet-piles to increase the capacity of the channel. Each of the 33- to 36-foot-long interconnecting sheet-piles has been driven to the point where only 10 to 12 feet of each pile are exposed above the bottom of the channel. The southern limit of the sheet-pile wall terminates approximately 100 feet south of the northeast corner of the impoundment berm for fuel oil storage Tank 2 (Magorien 2010).

SITE GEOLOGY

Surficial Geology

The native soils beneath the project site consist of an upper 60-foot-thick layer of interbedded coastal estuarine/littoral sediments consisting of fine sand, silt, clay, and mixtures thereof. According to GeoLogic Associates (2002), these sediments range in age from approximately 8,600 years old to the present. Between depths of about 60 to 90 feet, the native sediments are represented by middle-to-late Holocene (8,600 to 11,000 years old) fluvial deposits. These sediments are composed largely of sand and clayey sand with layers and lenses of silt and highly plastic clay that contains varying amounts of organic detritus. Below a depth of 90 feet below ground surface (bgs) are Pleistocene (11,000 to 1.8 million years old) marine and nonmarine strata. These native soils are overlain by varying thicknesses of artificial fill soil that was placed during construction of the HBGS and associated fuel storage tanks. According to building foundation studies by G. A. Nicoll, Inc. (2000), for the construction of the Huntington Beach Maintenance Facility (situated approximately 500 feet north of the site),the uppermost 13 feet of native Holocene deposits are considered unsuitable for foundation support due to their compressible nature when placed under structural (i.e., building) loads. Limited standard penetration test (SPT) and core penetrometer test (CPT) data from previous studies by G.A. Nicoll, Inc. (2000), and GeoLogic Associates (2002) indicate that the uppermost 10 to 16 feet of the native sediments in the area are highly susceptible to liquefaction during strong ground motion from nearby seismic sources.

Soil layers susceptible to liquefaction were not continuous beneath the project site. Below a depth of about 17 feet, the native sediments have “N-values” (as derived from SPT and CPT data) that are suggestive of soils not prone to liquefaction and are not considered compressible or subject to collapse under normal structural loads. In addition, alluvial sediments below a depth of approximately 17 to 25 feet have “N-values” (as derived from SPT data) that are suggestive of soils not prone to liquefaction, nor are they considered compressible or subject to collapse under normal structural loads.

According to limited testing near the site, surface soils in the area have a relatively high pH value (8.4), low resistivity (170 ohm-centimeter [ohm-cm]), and high soluble sulfate content (4,000 parts per million [ppm]), indicating these soils are considered highly corrosive to concrete and metals in contact with these soils.

There is no current evidence to suggest the occurrence of soils containing collapsible, organic peat deposits in the vicinity of the project site.

Seismicity/Faulting

The primary seismic hazard to the subject site vicinity is the possibility of ground shaking due to the proximity of major active faults in the Southern California region. A number of concealed faults exist approximately 1.25 miles north of the proposed project site, while the South Branch Fault (a concealed fault that branches from the Newport Inglewood Fault) traverses the southern portion of the subject site (refer to Figure 4.2-1, Regional Geology and Seismicity).

Although the project area is not located within an Alquist-Priolo Earthquake Fault Zone (formerly referred to as Special Study Zones), as designated by the California Geological Survey, the site is within approximately 1.25 miles of the Newport-Inglewood Fault Zone, an Alquist-Priolo Earthquake Fault Zone (California Geological Survey 1986; USGS 1997). Additional active or potentially active faults in the vicinity include the following:

- Elsinore Fault – Located 28 miles from the City of Huntington Beach (City) center and capable of a magnitude 7.5 earthquake
- Palos Verdes-Coronado Bank Fault – Located 10 miles from the City center and capable of a magnitude 7.5 earthquake

- Raymond Fault – Located 30 miles from the City center and is capable of a magnitude 7.5 earthquake
- San Andreas Fault – Located 51 miles from the City center and capable of a magnitude 8.3 earthquake
- Sierra Madre-San Fernando Fault – Located 32 miles from the City center and capable of a 7.5 magnitude earthquake
- Whittier-North Elsinore Fault – Located 19 miles from the City center and capable of a magnitude 7.5 earthquake
- Elysian Park Fault – Located 25 miles from the City center and capable of a 7.0 magnitude earthquake
- Compton Blind Thrust Fault – Located approximately 10 miles from the City center and capable of a 7.0 magnitude earthquake
- Torrance-Wilmington Fault – Located approximately 10 miles from the City center and capable of a magnitude 7.0 earthquake.

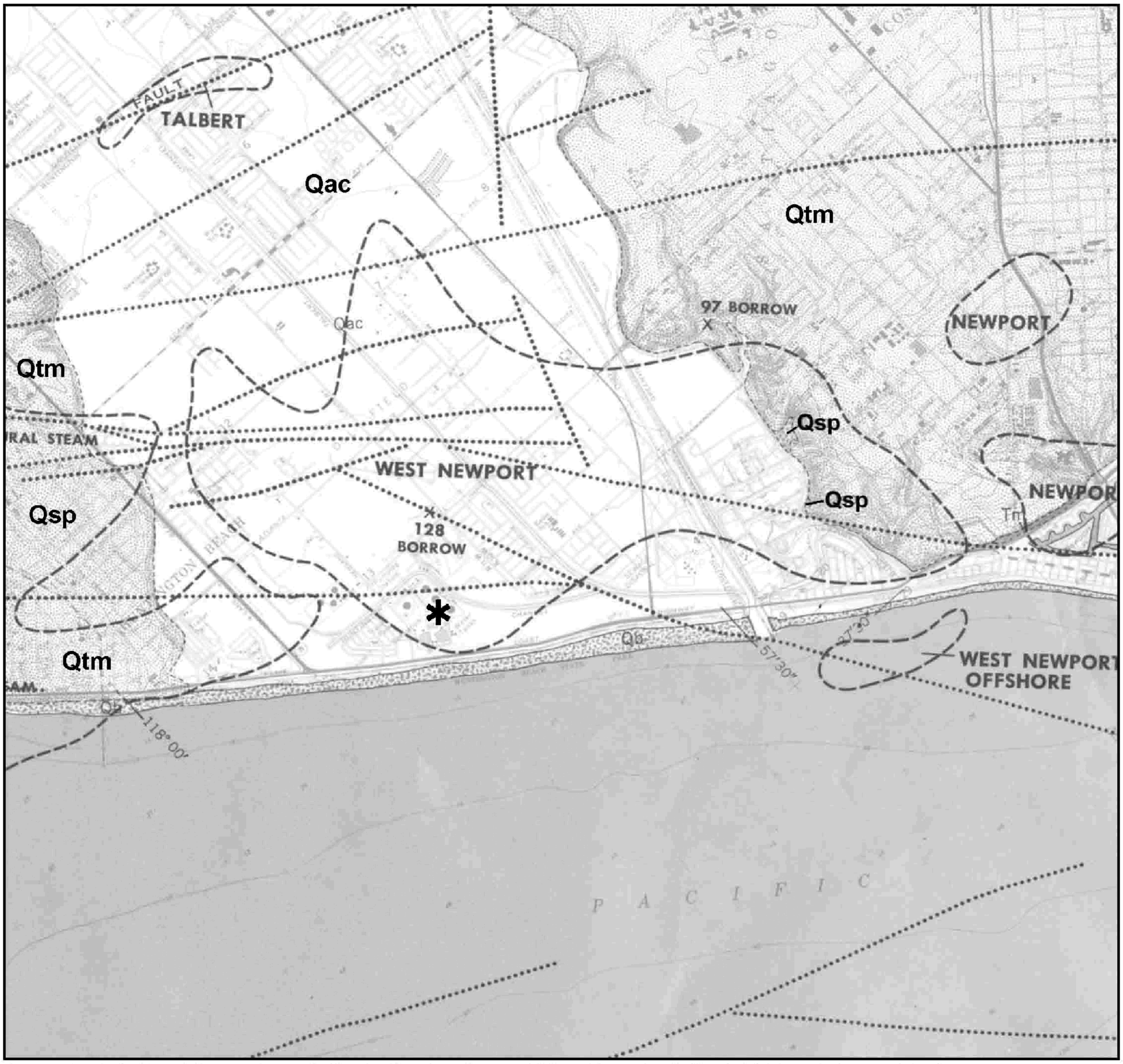
Newport-Inglewood Fault Zone. The subject site is shown as being approximately 1.25 miles south of the Newport-Inglewood Fault Zone, which is an Alquist-Priolo Earthquake Fault Zone (USGS 1998, p. N-34). Alquist-Priolo Earthquake Fault Zones are intended to prohibit the location of developments for human occupancy across the trace of active faults to minimize the loss of life and property in the event of an earthquake. The Newport-Inglewood Fault Zone is an active, right-lateral fault system consisting of a series of en echelon[1] fault segments and anticlinal folds that are believed to be the expression of a deep-seated fault within the basement rock (Bryant 1988; Barrows 1974; City of Huntington Beach 1995).[2] The fault zone is visible on the surface as a series of northwest-trending elongated hills, including Signal Hill and the Dominguez Hills, extending from Newport Beach to Beverly Hills. The total fault length is approximately 44 miles. The estimated maximum earthquake magnitude assigned to the fault zone is 6.9 momentum magnitude (Mw), based on its estimated rupture length versus magnitude relationship by Slemmons (1982) and its slip rate at 12 millimeter/year (a Type B seismic source).

The South Branch Fault, a component of the Newport Inglewood Fault, traverses the project site. A seismic study performed for the Bolsa Chica Project (located approximately 5 miles northwest of the proposed desalination facility) indicates that the South Branch Fault is classified as neither active nor potentially active under the Bolsa Chica site (City of Huntington Beach 1995). The City of Huntington Beach utilizes its 1996 General Plan and the California Division of Mines and Geology (CDMG) Alquist-Priolo Earthquake Fault Zones to develop four categories for faults within the City. The City's General Plan indicates that this fault is Category C, requiring special studies and subsurface investigation for critical and important land uses.

---

1 Faults in an overlapping or staggered arrangement.

2 Convex upward folds with cores containing the stratigraphically older rocks.



Source: Geologic Map of Orange County California, Showing Mines and Mineral Deposits, California Division of Mines and Geology, 1981.

✱ - Project Site

Qsp
San Pedro Formation

Qt | Qtm
Terrace deposits
Qt = Nonmarine terrace deposits
Qtm = Marine terrace deposits

. . . . . . *Concealed Fault Lines*

Limits of oil and gas fields (California Division of Oil and Gas, 1972).

Qac | Qb
Qac = Alluvium and colluvium
Qb = Beach sediments

FIGURE 4.2-1
Regional Geology and Seismicity

Seawater Desalination Project at Huntington Beach

6483-01
MAY 2010

INTENTIONALLY LEFT BLANK

In addition, GeoLogic Associates (2002) analyzes the potential for fault rupture beneath the proposed project site, currently occupied by the existing fuel oil tanks. A subsurface stratigraphic correlation/ fault investigation was performed to assess the potential for surface fault rupture within Holocene-age deposits below the potential water tank sites. According to the criteria established by the CDMG, a fault is considered "active" if it can be demonstrated that the fault has produced surface displacement within Holocene time (about the last 11,000 years). Due to the presence of a relatively thick layer of fill soils and shallow groundwater, conventional fault trenching and soil-stratigraphic techniques could not be employed by GeoLogic Associates to assess the presence of surface-fault-rupture potential at the project site. Instead, their investigation involved the use of CPT and exploratory borings for stratigraphic correlation purposes, as well as the use of radiocarbon dating of organic sediments and shells obtained from the exploratory borings. According to data collected, no evidence of faulting within Holocene sediments was found beneath the site. The report concludes that the risk of surface fault rupture is minimal over the lifetime of the proposed project (GeoLogic Associates 2002). However, based on subsurface data from CPT-4 and CPT-5, there remains a possibility that surface-fault-rupture potential exists in the southwestern corner of Tank 1 and the southwestern portion of Tank 3.

Liquefaction/Subsidence Potential

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to liquid when subject to intense ground shaking. Liquefaction occurs when three general conditions exist: (1) shallow groundwater, (2) low-density silty or fine sandy soils, and 3) high-intensity ground motion. Liquefaction occurs when the dynamic loading of a saturated sand or silt causes pore-water pressures to increase to the point where grain-to-grain contact is lost and the material temporarily behaves as a viscous fluid. Liquefaction can cause settlement of the ground surface, settlement and tilting of engineered structures, flotation of buoyant buried structures, and fissuring of the ground surface. A common trait of liquefaction is formation of sand boils—short-lived fountains of soil and water that emerge from fissures or vents and leave freshly deposited conical mounds of sand or silt on the ground surface. According to the State of California's Seismic Hazard Zone Map for Newport Beach Quadrangle (USGS 1981) and the City's General Plan "Liquefaction Potential" Map (City of Huntington Beach 1996), the project site lies within an area of high-liquefaction potential. This assessment is further validated by results of the subsurface geotechnical studies performed for the nearby Huntington Beach Maintenance Facility, the sheet-pile wall improvements for the channel, and GeoLogic Associate's preliminary geotechnical assessment for the City's Southeast Reservoir site acquisition project in 2002. Limited SPT and CPT data indicate that the uppermost 10 to 16 feet of the native sediments in the area are highly susceptible to liquefaction during strong ground motion from nearby seismic sources.

Soil layers susceptible to liquefaction were not continuous beneath the project site. Below a depth of about 17 feet, the native sediments have "N-values" (as derived from SPT and CPT data) suggestive of soils that are not prone to liquefaction and are not considered compressible or subject to collapse under normal structural loads. In addition, alluvial sediments below a depth of approximately 17 to 25 feet have "N-values" (as derived from SPT data) suggestive of soils that are not prone to liquefaction, nor are they considered compressible or subject to collapse under normal structural loads.

Lateral Spread

Lateral spreading involves the dislocation of the near-surface soils generally along a near-surface liquefiable layer. In many cases, this phenomenon of shallow landsliding occurs on relatively flat or gently sloping ground adjacent to a "free face," such as an unsupported channel wall along a stream or flood control channel. Given the "weak" nature of near-surface soils, fine-grained sediments, shallow groundwater, liquefaction-prone soils, and the nearby flood control channel, there is a high potential for lateral spread beneath the site during a major earthquake in the area. In addition, the sheet-piles installed along the sides of the Huntington Beach Channel by the OCFCD are not designed to resist liquefaction or lateral loads that could occur as the result of a lateral spread.

Landslides

Potential landslide areas within the City of Huntington Beach are limited primarily to the mesa bluffs region. However, the potential for seismically induced landsliding along the levee of the neighboring Huntington Beach Channel is considered moderate to high. As stated previously, the sheet-pile walls constructed along the interior walls of the levee are not designed to withstand potentially large, lateral forces associated with strong ground motion from a nearby earthquake.

OFF-SITE PIPELINE ALIGNMENT AND UNDERGROUND PUMP STATIONS

Pipeline Alignments

The proposed off-site product water delivery pipelines would be located primarily within existing roads or easements, in generally flat topography. The primary pipeline alignment would traverse a wide range of surficial soils with varying characteristics and qualities because the pipeline's length would be approximately up to 10 miles. As with the desalination facility site, the off-site facilities are subject to typical seismic hazards of Southern California. Shallow groundwater may be encountered along the pipeline alignment near the proposed desalination facility, depending on the depth of trenching for pipeline implementation.

OC-44 Booster Pump Station

The proposed underground booster pump station site and two alternative sites that are within the same geographic area would occur in the City of Newport Beach, within a Resource Preservation Easement. The pump station sites are at an approximate elevation of 200 feet amsl. The surrounding terrain can be characterized as hilly/canyon, although much of the surrounding vicinity has been graded for residential development. Bedrock beneath the subject sites belongs to the diabase intrusive volcanic formation, overlain by Calleguas clay loam soil (USDA 1978). This soil is characterized as being well drained and moderately permeable. It should be noted that the sites are within a designated Zone of Required Investigation for liquefaction hazards and have demonstrated either a historic occurrence of liquefaction or local geological, geotechnical, and groundwater conditions indicating a potential for liquefaction (California Geological Survey 2001). The sites are not situated within an Alquist-Priolo Earthquake Fault Zone or earthquake-induced landslide Zone of Required Investigation as designated by the California Geological Survey (California Geological Survey 1986; USGS 1997).

Coastal Junction Booster Pump Station

The Coastal Junction pump station location is situated at an approximate elevation of 80 feet amsl. The site is located in the parking lot of a church within a developed area. The topography of the site is flat. The subject site is not located within an Alquist-Priolo Earthquake Fault Zone or earthquake-induced Zone of Required Investigation as designated by the California Geological Survey (California Geological Survey 1986; USGS 1997). It is underlain by soils from the Sorrento-Mocho association, which is described as nearly level to moderate-sloping, well-drained sand loams, loams, or clay loams on alluvial fans and flood plains (USDA 1978). It should be noted that the site is within a designated Zone of Required Investigation for liquefaction hazards and has demonstrated either a historic occurrence of liquefaction or local geological, geotechnical, and groundwater conditions indicating a potential for liquefaction (California Geological Survey 2001).

OC-35 Pump Station

The proposed improvement to the OC-35 pump station consists of replacement of a pump and pipeline modifications that would not be affected by geologic conditions. The pump replacement would occur at the existing developed pump-station site and would not involve excavation or other modifications that would be affected by, or cause any effects on, geology or soils conditions. Therefore, no further discussion is provided for this project feature.

Magnolia and Brookhurst Pump Station

The Magnolia Pump Station is situated in a disturbed right of way (ROW). The topography of the site is flat. The subject site is not located within an Alquist-Priolo Earthquake Fault Zone or earthquake-induced Zone of Required Investigation as designated by the California Geological Survey (California Geological Survey 1986; USGS 1997). The site is not located within a designated liquefaction area (City of Garden Grove General Plan, Safety Element RBF Consulting, 2008).

The Brookhurst Pump Station is situated in a disturbed ROW. The topography of the site is flat. The subject site is not located within an Alquist-Priolo Earthquake Fault Zone or earthquake-induced Zone of Required Investigation as designated by the California Geological Survey (California Geological Survey 1986; USGS 1997). It should be noted that the site is within a designated liquefaction area where historic occurrence of liquefaction or local geological, geotechnical, and groundwater conditions indicate a potential for ground displacement (City of Garden Grove General Plan, Safety Element RBF Consulting, 2008).

Bristol Pump Station

The Bristol Pump Station is situated in a developed recreational area that contains relatively level terrain. The subject site is not located within an Alquist-Priolo Earthquake Fault Zone or earthquake-induced Zone of Required Investigation as designated by the California Geological Survey (California Geological Survey 1986; USGS 1997). The site is within a designated liquefaction area where historic occurrence of liquefaction or local geological, geotechnical, and groundwater conditions indicate a potential for ground displacement (City of Garden Grove General Plan, Safety Element RBF Consulting, 2008).

OC-44 Bypass Station

The OC-44 Bypass Station is situated in the street adjacent to a drainage ditch and a golf course. The site is underlain by alluvial and colluvial material, including older alluvium and slope wash (City of Costa Mesa, General Plan, Safety Element, Exhibit SAF-1, 2000). The soils for the proposed bypass station location are generally classified as silty sand (City of Costa Mesa, General Plan, Safety Element, Exhibit SAF-2, 2000). The site is within a designated moderate liquefaction area where there is a liquefaction potential (City of Costa Mesa, General Plan, Safety Element, Exhibit SAF-4, 2000).

IMPACTS

SIGNIFICANCE CRITERIA

Based on the criteria set forth by the California Environmental Quality Act (CEQA) (14 CCR 15000 et seq.), a project may create a significant geological environmental impact if one or more of the following occurs:

- It exposes people or structures to potentially substantial adverse effects, including the risk of loss, injury, or death involving:
    - 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 a known fault (refer to Division of Mines and Geology Special Publication 42)
    - Strong seismic ground shaking
    - Seismic-related ground failure, including liquefaction
    - Landslides
- It results in substantial soil erosion or the loss of topsoil
- It is located on a 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
- It is located on expansive soils, as defined in Table 18-1-B of the Uniform Building Code (UBC) (1994), creating substantial risks to life or property
- It contains soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

PROPOSED DESALINATION FACILITY SITE

Seismicity/Faulting

GeoLogic Associates (2002) completed a Preliminary Seismic Assessment for this project (refer to Appendix D, Preliminary Seismic Assessment). The results of this preliminary study indicate an absence of evidence that faulting has ever occurred at the facility site and that the risk of future surface faulting at the desalination facility site is minimal.

The Preliminary Seismic Assessment has determined that the maximum ground acceleration for the Maximum Considered Earthquake (MCE) for this site is 0.74 g. An earthquake of magnitude 6.9 on the Newport Inglewood Fault was considered to be the MCE for the site. The Preliminary Seismic Assessment also indicates that the return period of an earthquake with the designated MCE acceleration of 0.74 g is more than 200 years and its probability of occurrence during the next 50 years is below 10% (GeoLogic Associates 2002).

As a part of desalination operations, the operations staff would develop an earthquake mitigation and preparedness plan that would be coordinated with the local jurisdiction's preparedness activities. This plan would define coordination measures to ensure continuous facility operations and water delivery under earthquake emergency conditions.

Although a portion of the project site overlays the South Branch Fault, the site is not situated within an Alquist-Priolo Earthquake Fault Zone. The proposed project and associated improvements, including an on-site 66 kilovolt (kV) substation, would be constructed in compliance with the seismic safety requirements of the UBC and applicable CDMG publications. Given the site's proximity to the Newport-Inglewood and Compton Blind Thrust faults, more stringent design measures may be warranted or required, as determined by the site-specific geotechnical survey for the project. All structures would be designed in accordance with the seismic design requirements of the most recent edition of the UBC. The specific design provisions (e.g., wall and slab thickness, lateral bracing, structural configuration) for seismic enforcement would be developed during the design phase of this project. In addition, a detailed construction-level geotechnical study would be prepared during the design phase of the project. This report would include mitigation measures regarding grading, foundations, retaining walls, streets, utilities, remedial work, overexcavation/recompaction, dewatering, water quality, and chemical/fill properties of underground items including buried pipe and concrete and protection thereof. Impacts relating to seismic-related ground shaking are potentially significant; therefore, mitigation measures have been identified.

Liquefaction and Lateral Spread Potential

The Preliminary Seismic Assessment prepared for the proposed project concluded that seismic activity from numerous faults within the vicinity, including the Newport-Inglewood Fault Zone (the closest active fault), may result in liquefaction in soils at depths of 7 to 16 feet bgs. The liquefaction potential was revised from the original 2002 study based on current design guidelines provided in ASCE 7-05 (ASCE 2006). The current seismic design guidelines require the use of peak ground acceleration (PGA) from the MCE with a 2% probability of exceedance in 50 years as the design ground motion for the evaluation of liquefaction triggering. Using these guidelines, PGA for the project site was estimated at 0.74 g, assuming an average shear wave velocity of 350 meters per second (m/s) within the upper 100 feet bgs. Soils below that depth were not found to be susceptible to liquefaction. Soil layers susceptible to liquefaction were not determined to be continuous throughout the proposed desalination facility site. Liquefied soils may experience post-liquefaction settlements of 4 to 5 inches. Proposed on-site, aboveground structures have the potential to experience post-liquefaction distress. In addition, the presence of liquefaction-prone soils and the location of the subject site relative to the Huntington Beach Channel pose a risk of seismically induced lateral spread. Substantial distress to both aboveground and underground structures would occur in the form of seismically induced landsliding. However, as stated previously, a construction-level geotechnical study would be prepared for the proposed project site during the design phase of the project that would recommend design measures to mitigate liquefaction and lateral spread impacts such as: (1) over-excavation and recompaction of liquefaction/lateral spread-prone soils, (2) in situ soil densification, (3) injection grouting, or (4) deep soil mixing. The desalination facility project would be subject to the UBC and applicable CDMG publications in regard to liquefaction. Impacts from liquefaction and lateral spread are potentially significant; therefore, mitigation measures have been identified.

Landslides

Potential landslide areas within the City are limited primarily to the mesa bluffs region. However, the potential for seismically induced landslides along the levee of the neighboring Huntington Beach Channel is considered moderate to high. As stated previously, the sheet-pile walls constructed along the interior walls of the levee are not designed to withstand potentially large, lateral forces associated with strong ground motion from a nearby earthquake. Therefore, earthquake-induced slope instability should be considered part of the geotechnical evaluation for the project. The exterior berms that surround the site and that would remain in place should undergo slope stability analysis. With proper consideration of slope stability in the geotechnical evaluation and potential stability measures resulting, as applicable, impacts would be less than significant.

Wind/Water Erosion

It is anticipated that the entire subject site would be either landscaped or paved, thereby reducing the likelihood for long-term operational wind/water erosion impacts to less-than-significant levels. However, the project would involve construction processes possibly causing wind and water erosion to occur during grading activities. The project would be subject to standard erosion control practices as typically required by the City. Any potential temporary increase in wind/water erosion during construction would be reduced to less-than-significant levels with implementation of measures identified in the Erosion Control Plan to be submitted to the City's Department of Public Works with the grading permit (refer to Section 4.9, Construction-Related Impacts). Any potential permanent increase in wind/water erosion would be reduced to less-than-significant levels with landscaping in areas not paved (refer to Figure 3-16, Conceptual Landscape Master Plan).

Geology/Soils

As shallow groundwater exists on site (at a depth of approximately 7 to 9 feet bgs), saturated soils and caving conditions would be encountered during removal and excavation for grading/excavation below the groundwater table level. This would necessitate dewatering operations as well as lateral support for the sides of any excavation pits, if necessary. All dewatering activities would comply with National Pollution Discharge Elimination System (NPDES) regulations and State Water Resources Control Board requirements, and pumped groundwater would be sampled, tested, and treated, if necessary (refer to Section 4.9, Construction-Related Impacts, for more information about dewatering).

Because the uppermost 17 feet of native soils within project site boundaries are considered compressible upon placement of structural loads (e.g., aboveground storage tank, buildings), project implementation would require either the complete removal and recompaction of compressible soils or the use of piles and grade beams to support the structure. In addition, Type V cement would be used for concrete and special coatings or other measures for metal pipes to protect against the effects of corrosion.

It is anticipated that the product water storage tank could be supported by a conventional concrete mat type foundation, with provision to accommodate anticipated settlements due to existing saturated, soft soils and liquefaction. However, soil conditions would not preclude the use of other foundation systems, which would be evaluated when design concepts are available.

A detailed geotechnical survey would be performed during the design phase of the proposed project. This survey would further characterize on-site soil and groundwater conditions and would determine the site's soil-bearing capacity. The final detailed soils and geology analysis will be prepared by a registered engineer and will be submitted to the City of Huntington Beach Public Works Department prior to issuance of a grading permit for the project. This information would be used to develop a detailed foundation design for on-site structures. Impacts relating to expansive soils are potentially significant; therefore, mitigation measures are identified. In addition, the project would be required to adhere to the UBC requirements (see Section 4.9, Construction-Related Impacts, of this SEIR).

OFF-SITE PIPELINES AND UNDERGROUND PUMP STATION

Pipeline Alignments

The proposed product water delivery pipelines are not anticipated to result in significant impacts in regard to geology and soils, because the majority of the alignment would occur within existing street ROW and various utility lines that currently exist along the alignment. Pipeline construction would be subject to standard erosion control measures similar to those implemented for the desalination facility site to contain any potential wind and water erosion on site. Because the pipeline alignments being considered are relatively flat and have been graded, impacts to natural topography are not anticipated. A design-level geotechnical investigation would be performed for the selected pipeline alignment to examine the potential for earthquake shaking hazards, surface rupture, shallow groundwater, and unstable soils (liquefaction, subsidence, lateral spread). Should the potential for such geological hazards exist, adequate mitigation for both pipeline construction and pipeline design would be incorporated to mitigate impacts in this regard to less-than-significant levels. Also refer to Section 4.9, Construction-Related Impacts, of this SEIR for a more detailed evaluation of pipeline construction.

OC-44 Booster Pump Station

Construction of the proposed off-site underground booster pump station at either the primary site or two optional sites would also be subject to standard erosion control measures as required by local, state, and federal regulations to contain any potential wind and water erosion on site. Because the primary and optional sites are relatively flat and are approximately 0.12 to 0.55 acres in size, impacts to the natural topography of the site and surrounding vicinity are not anticipated. A design-level, site-specific geotechnical study would be prepared for the underground pump station and would incorporate adequate mitigation measures (if deemed necessary) for geologic hazards such as seismic shaking, surface rupture, shallow groundwater, liquefaction, subsidence, lateral spread, and landslides. Because the underground pump station would require excavation to a depth of approximately 40 feet, lateral bracing for the sides of the chamber may be necessary because the site is in a designated liquefaction hazard zone (California Geological Survey 2001). Upon implementation of both standard code requirements and recommended mitigation measures, impacts in regard to geology and soils are not anticipated to be significant. Also refer to Section 4.9, Construction-Related Impacts, of this SEIR for a more detailed evaluation of pump-station construction.

Coastal Junction Booster Pump Station

Because both the geologic/seismic conditions of the site and design characteristics of the pump station are similar to that of the OC-44 pump station, refer to the OC-44 pump station impact analysis.

Magnolia and Brookhurst Pump Station

Because both the geologic/seismic conditions of the site and design characteristics of the pump station are similar to that of the OC-44 pump station, refer to the OC-44 pump station impact analysis.

Bristol Pump Station

Because both the geologic/seismic conditions of the site and design characteristics of the pump station are similar to that of the OC-44 pump station, refer to the OC-44 pump station impact analysis.

OC-44 Bypass Station

Because both the geologic/seismic conditions of the site and design characteristics of the bypass station are similar to the pipeline route, refer to the pipeline alignment impact analysis.

SUMMARY OF IMPACTS

The following geology, soils and seismicity impacts have been identified: (a) seismic ground-shaking (b) expansive soils are potentially compressible in their present state, and soils on site contain corrosive materials and (c) soils within the project site have a potential for lateral spread and are prone to liquefaction.

MITIGATION MEASURES

SEISMICITY/FAULTING

GEO-1 A subsurface fault investigation shall be performed in accordance with California Geological Survey Note 49 to assess the nature and extent of possible surface-fault rupture across the southern portion of the site. If evidence for potential fault-surface rupture is found, an appropriate “setback” for structures from the zone of surface faulting will be required.

GEO-2 The potential for lateral spread shall be investigated as part of the site-specific geotechnical investigation for the project. The geotechnical report shall identify that geotechnical observation, laboratory testing, or both be completed during grading to identify areas of highly expansive soils and to determine the actual expansion potential of finish-grade soils. Compressible soils in areas that have the potential for lateral spread will require removal and recompaction in areas of proposed improvements or future fill per the specifications of a California-licensed engineer.

GEO-3 A certified engineer shall ensure that all structures associated with the proposed desalination facility have been designed to withstand the "design-level" earthquake, as set forth in the latest edition of the Uniform Building Code, prior to the issuance of grading permits. In addition, the project must follow the site specific geotechnical report and the professional engineer's recommendations.

GEO-4 A California-licensed Civil Engineer (Geotechnical) shall prepare and submit to the City a detailed soils and geotechnical analysis with the first submittal of the grading plan. This analysis shall include soil sampling and laboratory testing of materials to provide detailed recommendations for grading, chemical and fill properties, liquefaction and landscaping. The grading plan for the proposed project shall contain the recommendations of the final soils and geotechnical report. The recommendations shall be implemented in the design of the project, including but not limited to the measures associated with site preparation, fill placement, temporary shoring and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement type and corrosion measures, erosion control, shoring, and internal bracing and plan review.

WIND/WATER EROSION

Refer to Section 4.3, Hydrology, Drainage, and Stormwater Runoff, mitigation measure HWQ-1.

LIQUEFACTION/GEOLOGY/SOILS

GEO-5 The use of Type V cement shall be used for concrete and special coatings, or other measures should be used to protect metal pipes against the effects of corrosion.

GEO-6 Depending upon the construction methods dewatering may be required in order to safely excavate the sites of the proposed below groundwater facilities, and may require some form of lateral support. Groundwater pumped from the dewatering wells will need to meet National Pollutant Discharge Elimination System permit requirements before it is discharged (refer to Section 4.9, Construction-Related Impacts). In order to prevent the buried tanks (and certain pipelines) from "floating" when water levels in the tanks/pipelines are drawn down, it will be necessary to either ""anchor" them down, add additional weight to the tanks/pipelines themselves, and/or add sufficient soil surcharge across the top of the tank/pipelines.

GEO-7 Compressible soils in areas that have the potential for lateral spread will require removal and recompaction or future fill per the specifications of a California-licensed engineer. This process will require dewatering and support of walls of excavation or use of deep foundations such as stone columns or piles and grade beams to support proposed structures.

GEO-8 The proposed project shall incorporate recommended measures of the final soils and geotechnical/seismic analysis to stabilize structures from on-site soils known to be prone to liquefaction. Typical methods include, but are not limited to:

- Over-excavation and recompaction of soils
- In situ soil densification, such as vibro-flotation or vibro-replacement (i.e., stone columns)
- Injection grouting
- Deep soil mixing.

GEO-9 A California-licensed Civil Engineer (Geotechnical) shall prepare and submit to the City a detailed soils and geotechnical analysis with the first submittal of the grading plan. This analysis shall include soil sampling and laboratory testing of materials to provide detailed recommendations for grading, chemical and fill properties, liquefaction and landscaping. The grading plan prepared for the proposed project shall contain the recommendations of the final soils and geotechnical report. These recommendations shall be implemented in the design of the project including but not limited to measures associated with site preparation, fill placement, temporary shoring, and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement types and corrosion measures, erosion control, shoring and internal bracing and plan review.

OFF-SITE PIPELINES AND UNDERGROUND PUMP STATIONS

Refer to Section 4.9, Construction-Related Impacts.

UNAVOIDABLE SIGNIFICANT IMPACTS

None have been identified.