4.5 GEOLOGY AND SOILS

This EIR section analyzes the potential for adverse impacts on existing geologic and soil conditions resulting from implementation of the proposed project. The Initial Study/Notice of Preparation (IS/NOP) identified the potential for impacts associated with hazards that would result from strong seismic groundshaking; seismic-related ground failure, including liquefaction; slope instability; landslides; potential soil erosion; development on an unstable geologic unit; and development on expansive soil (Appendix A). Issues scoped out from detailed analysis in the EIR include rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map; and development on soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems. All potential impacts related to geology and soils would be reduced to less-than-significant levels through compliance with *Huntington Beach Municipal Code* requirements.

Data used to prepare this section were taken primarily from the geotechnical investigation prepared for the conceptual plans by Geotechnical Professionals, Inc.[1] (GPI) and The Environmental Hazards Element of the City of Huntington Beach (General Plan 1996). The GPI report can be found in Appendix E. The use of geotechnical investigation reports in the preparation of *California Environmental Quality Act* (CEQA) documents provide part of the technical basis for assessing geologic impacts of, and on, proposed development. Rarely are they the sole documentation on which the geologic impact analysis rests. More commonly, as is the case for The Village at Bella Terra EIR, they are used in context with other published and unpublished material, personal interviews, and site inspections to provide sufficient information to allow informed decisions regarding the probable geologic consequences of approving a project. For example, based on the results of the investigation, the design parameters of the foundations would need to be updated prior to construction, but the observations and test results remain valid. Other sources of information include the Geotechnical Technical Memorandum prepared for the EIR by PBS&J (Appendix E); maps and reports published by the California Geological Survey (CGS) and the United States Geological Survey (USGS); and other geotechnical or environmental investigations pertinent to the conditions at the Village at Bella Terra project site.

All comments received in response to the Initial Study/Notice of Preparation (IS/NOP) circulated for the proposed project were taken into consideration during preparation of this EIR and have been addressed in this section.

Because of the technical nature of this section, a glossary is provided in Section 4.5.5 to define geologic terms that may not be familiar to the reader. Additionally, bibliographic entries for selected reference materials are provided in Section 4.5.6 of this section. Some reference materials are included in the appendices to this EIR.

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[1] Geotechnical Professionals Inc. *Updated Geotechnical Investigation Proposed The Center at Beach Edinger Avenue West of Beach Boulevard, Huntington Beach, California*. March 19, 2002.

4.5.1 Environmental Setting

The proposed project site is a developed 15.85-acre site, bounded by Center Avenue to the north, Edinger Avenue to the south, Beach Boulevard to the east, and railroad tracks to the west. The project site is currently developed for retail and auto service use. A vacant 190,100-square foot (sf) retail building, formerly occupied by a Montgomery Wards Department store, occupies the central portion of the project site. A vacant 18,600 sf auto repair facility associated with the Montgomery Wards store is located on the southwestern portion of the project site. Both developments were vacated in 2001. The project site is relatively flat, with localized variations in surface grade.

Geologic Setting

The City of Huntington Beach is on a coastal plain underlain by relatively recent sediments ranging in age from Quaternary deposits of the Pleistocene epoch (11,000 to 1,600,000 years) through the Holocene epoch (fewer than 11,000 years). The older sediments typically are shallow marine terrace deposits that have been uplifted by ongoing seismic movement and eroded to form the Bolsa Chica and Huntington Beach mesas. The mesas are bordered by younger (unconsolidated) alluvial soils that fill the gaps near Seal Beach, Bolsa Chica, and the Santa Ana River. Older alluvial and/or terrace deposits are present at this site. These sediments are estimated to be in excess of 50 feet thick. The project site is several miles inland from the coastal bluffs and the surface geology varies from the majority of Huntington Beach. Within the specific project area the soils consists of younger alluvial materials. The major active fault of most concern to the City is the Newport-Inglewood fault, located 3.1 miles southwest of the project site. 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.

Soil and Groundwater Conditions

A field investigation of the project site by GPI revealed a subsurface profile consisting of fill soils overlying native materials. The soils within the upper 30 to 40 feet are weak and very compressible. The underlying soils become more dense and stiff with depth, and exhibit moderate to high strength and moderate to low compressibility characteristics.

The fills identified at the project site consist predominantly of silty sands, clays, and their mixtures. The consistency of these materials was loose to dense (sands) and soft to stiff (clays). There is no documentation revealing when the placement of the fill soils occurred but compaction standards in place during the time the fill was introduced to the project site is below the standards currently used (assumed 1960's).[2]

The natural soils found at the project site consist of interbedded layers of organic silts and clays, clays, peat, silty sands, and sands. The peat deposits generally occur in layers up to 4 feet thick within the upper 20 feet of the soil profile, and occur in thinner layers interbedded within the organic silts and clays to

[2] Geotechnical Professionals Inc. *Updated Geotechnical Investigation Proposed The Center at Beach Edinger Avenue West of Beach Boulevard, Huntington Beach, California.* March 19, 2002. p. 4.

depths of about 45 feet. The peat deposits are highly compressible. The organic silts and clays and peat are very soft to stiff, becoming stiffer with depth. The upper silty sand and sand layers are generally loose to medium, dense and become dense to very dense at variable depths of 43 to +60 feet across the site. Locally, deeper zones of loose to medium dense sands were encountered.

All soils (native and imported) at the proposed project site are required to be in compliance with the City of Huntington Beach's Specification No. 431-92 Soil Clean-Up Standards prior to grading or building plan approval. Additionally, if contaminated soils are encountered on-site, as part of the HBFD project approval process, approval or final closure from the OCHCA and the RWQCB is required to be on file with the HBFD. As indicated in Section 4.7 Hazards and Hazardous Materials of this EIR, prior to project implementation, the Applicant will be required to submit for approval a soil testing work plan to the HBFD. Development of the proposed project would follow the requirements of the City's Public Works Department.

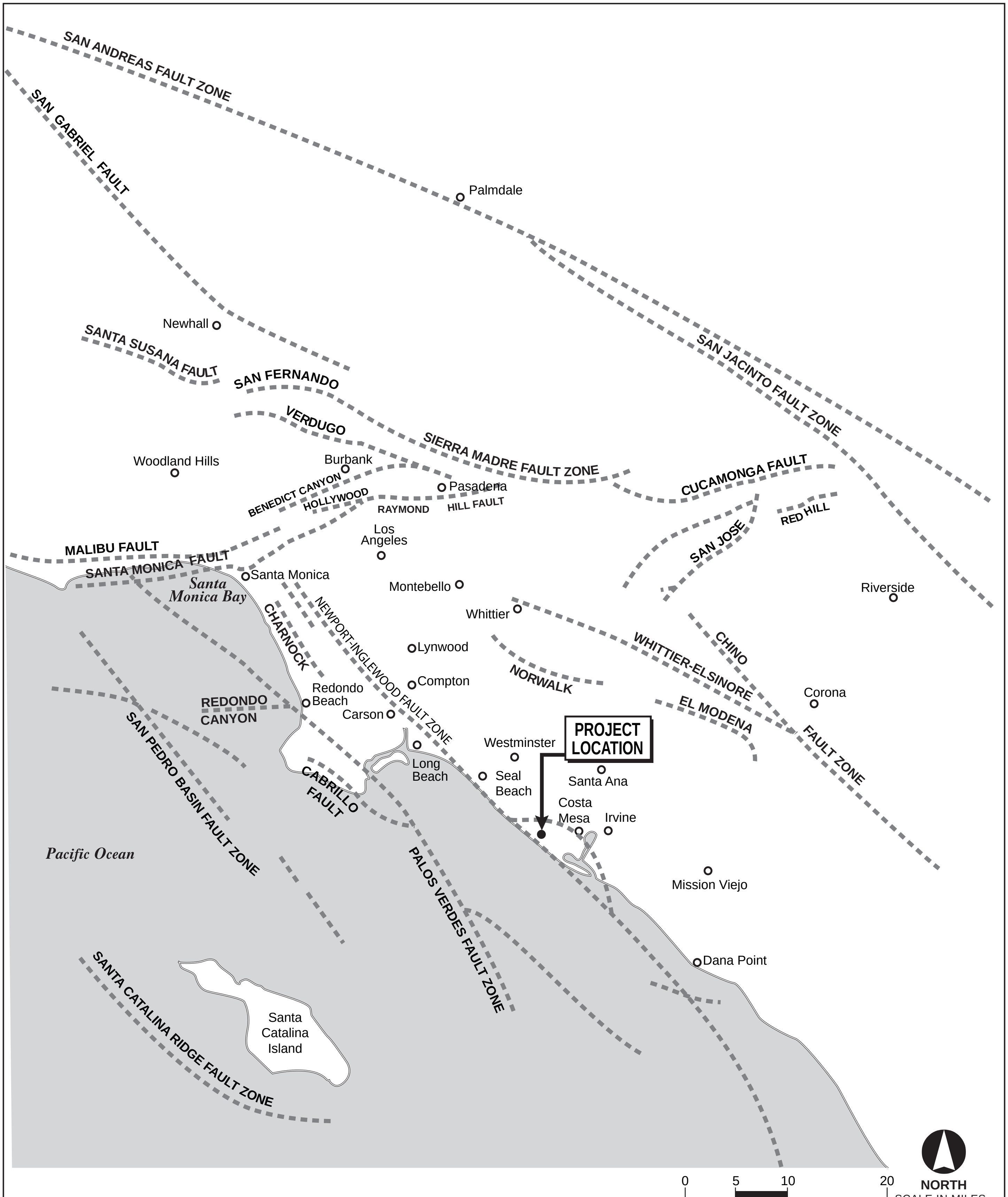
Groundwater was encountered at depths of approximately 5 to 13 feet below existing grades, corresponding to about elevations +10 to +19 feet above mean sea level. The depth to groundwater is anticipated to fluctuate across the site and seasonally.

Regional and Local Faults

All of southern California is seismically active. The region is crossed by a network of major regional faults and minor local faults. This faulting and seismicity is dominated by the San Andreas Fault System, which separates two of the major tectonic plates that represent part of Earth's continental and oceanic crust. The Pacific Plate is west of the San Andreas Fault System; the North American plate is to the east. Please refer to Figure 4.5-1 (Major Regional Faults) and Figure 4.5-2 (Local Faults) for regional and local faults, respectively.

There are numerous faults in southern California that are categorized as active, potentially active, and inactive by the California Geological Survey (CGS). A fault is classified as active if it has either moved during the Holocene epoch (during the last 11,000 years) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by CGS). A fault is classified as potentially active if it has experienced movement within the Quaternary period (during the last 1.6 million years). Faults that have not moved in the last 1.6 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

The site is not in an Alquist-Priolo Earthquake Fault Zone for surface fault rupture hazards. No active or potentially active faults with the potential for surface fault rupture are known to pass directly beneath the site.



Source: PBS&J, 2008.

PBS&J

FIGURE **4.5-1**

Major Regional Faults

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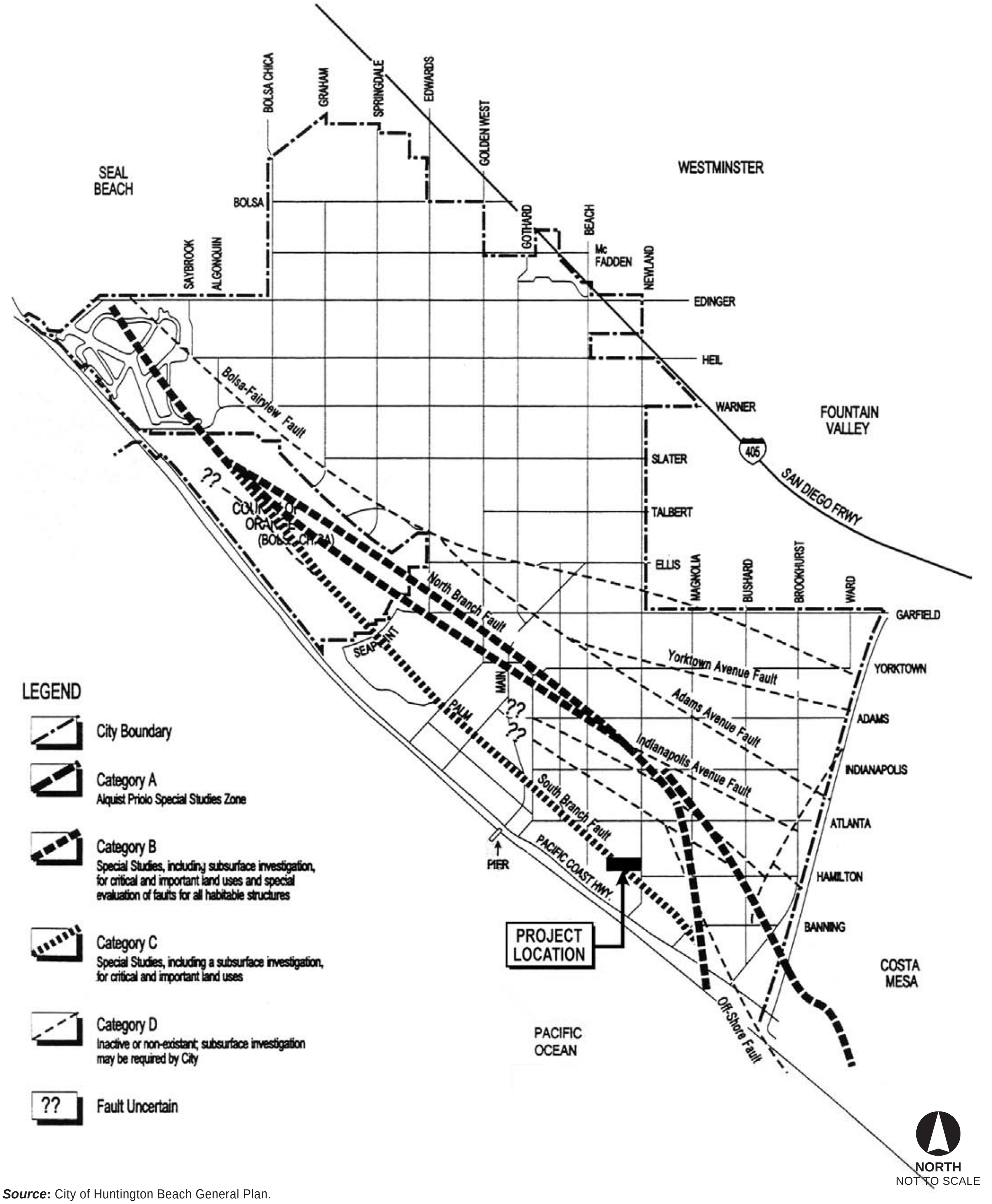
The Village at Bella Terra

03001 | JCS | 08



Source: City of Huntington Beach General Plan.

03001 | JCS | 08

PBS&J

FIGURE **4.5-2**

Local Faults

As stated above, the nearest known active fault is the Newport-Inglewood Fault Zone, which is approximately 3.1 miles southwest of the project site. The closest surface projection of the Newport-Inglewood Fault Zone is the Seal Beach segment, 3.5 miles southwest of the site. Other nearby active faults include the Palos Verdes fault, 12.5 miles southwest; the Whittier Fault Zone, 15.5 miles north-northeast; and the Elsinore Fault Zone, 21 miles northeast of the site.

There are several potentially active faults in the vicinity of the project site. These include the Los Alamitos fault, approximately 5.6 miles to the northwest; the Pelican Hill fault, 8.5 miles southeast; the El Moderno fault, 8.9 miles southeast; and the Norwalk fault, 10 miles north of the site. Table 4.5-1 (Summary of Fault Data for the City of Huntington Beach) provides a summary of information about known faults in the project area.

Historic and Future Seismicity

According to the City's General Plan Environmental Hazards Element, the estimated maximum earthquake assigned to the Newport-Inglewood fault zone is Richter magnitude (M) 7.0. The expected (average) amount of surface fault rupture on any given fault trace would range from zero to about one foot for earthquakes with magnitudes under M6.0, and from one foot to about 10 feet for earthquakes with magnitudes between M6.0–7.5. Large earthquakes occurred in the area of the City in 1769 (fault unknown), 1812 (possible the Newport-Inglewood fault), 1855 (Newport-Inglewood fault or an unnamed concealed fault), and in 1920, 1933, and 1941 (all Newport-Inglewood fault).

Table 4.5-1 Summary of Fault Data for the City of Huntington Beach

Fault Name	*Distance from City Center (miles)*	*Orientation (Compass Direction)*	*Maximum Probable Magnitude (Richter [M]/Moment [M_W])*	*Peak Acceleration (expressed as a portion of the force of gravity [g])*
Faults with Mapped Surface Traces				
Elsinore	28	NW-SE	6.75/6.7	0.11–0.18
Newport-Inglewood	Less than 2	NW-SE	5.75/7.1	0.55–1.0
Palos Verdes Coronado Bank	10	NW-SE	6.75/7.3	0.34–0.53
Raymond	30	E-W	4.0/6.5	0.02–0.21
San Andreas	51	NW-SE	8.0/7.5	0.11–0.14 (long period motions important)
Sierra Madre–San Fernando	32	E-W	6.0/7.2	0.07–0.20
Whittier-North Elsinore	19	NW-SE.	6.0/6.8	0.11–0.30
Blind of Buried Thrust Faults				
Elysian Park	25	EW-WNW-ESE	5.75/6.4	Whittier = M 5.9
Compton-Los Alamitos	Less than 10	NW-SE	5-6?/7.8	Little known; possible association with NIFZ
Torrance Wilmington	Less than 10	NW-SE	5-6?/?	Little known; apparent association with PVFZ

SOURCES: City of Huntington Beach General Plan, Environmental Hazards Element. May 13, 1996.
Southern California Earthquake Center, Uniform California Earthquake Rupture Forecast 2. 2007

Earthquakes greater than Moment Magnitude (M_W) 7.0 (see Glossary in Section 4.5.5) may occur on the Newport-Inglewood Fault once in 200 to 2,000 years. According to the Uniform California Earthquake Rupture Forecast, the probability of a M_W 7.0 earthquake occurring in the Los Angeles area (although more probably on the San Andreas Fault than on the Newport-Inglewood Fault) during the next 30 years is 82 percent.[3]

Geologic Hazards

The potential seismic hazards at the site include groundshaking, liquefaction, and settlement. Potential soil hazards include subsidence and expansion.

Groundshaking

The major cause of structural damage from earthquakes is groundshaking. The intensity of ground motion expected at a particular site depends on the magnitude of the earthquake, the distance and direction to the epicenter, and the geology of the area between the epicenter and the property. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an earthquake of great magnitude.

The major active fault in closest proximity of the project site is the Newport-Inglewood Fault, approximately 3.1 miles to the southwest. The California Geological Survey (CGS) Probabilistic Seismic Hazards Assessment Program estimates peak ground accelerations in the alluvium at the site would be 0.389g. The 2007 *California Building Code* (CBC—see Applicable Plans and Regulations, below) incorporates attenuation relationships developed by the CGS's Probabilistic Seismic Hazard Program, which consider vibration contributions from multiple seismic sources, including those generated by the nearby Newport-Inglewood fault and those of the more distant, but potentially more damaging, San Andreas fault. The resultant map (Figure 1613.5(3) of the 2007 CBC) of short term (0.2 second) ground response indicates the site could be subjected to average peak ground accelerations as high as 1.5g for the largest earthquakes in the Los Angeles area. The 2007 CBC requires the design earthquake (i.e., the maximum considered earthquake acceleration response for a given site) to be calculated using 2/3 of the mapped acceleration value—in this case, 1.0g, which accords reasonably well with the CGS calculated probabilistic short term ground response of 0.935 g for alluvium at this site.

Liquefaction

Liquefaction is the phenomenon in which uniformly sized, loosely deposited, saturated, granular soils with low clay contents undergo rapid loss of shear strength through the development of excess pore pressure during strong earthquake-induced groundshaking of sufficient duration to cause the soil to behave as a fluid for a short period of time. Liquefaction generally occurs in saturated or near-saturated

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[3] 2007 Working Group on California Earthquake Probabilities, Southern California Earthquake Center. *Uniform California Earthquake Rupture Forecast 2*. December 31, 2007. http://www.scec.org/ucerf/. Last modified April 13, 2008. Accessed by PBS&J geologist on April 14, 2008.

cohesionless soils at depths shallower than 50 feet below the ground surface. If the liquefying layer were near the surface, the effect for any structure supported on it would be much like that of quicksand, resulting in sinking or tilting. If the layer were deeper in the subsurface, it could provide a sliding surface for materials above it, resulting in lateral motion (spreading or lurching) toward any nearby 'free face' (shore bluff, river embankment, excavation wall).

The project site is in a high to very high liquefaction potential area identified by the City's Environmental Hazard Element, as well as being in a Liquefaction Investigation Zone on the State of California Seismic Hazard Zone Map for the Newport Beach Quadrangle (CDMG 1997). The geotechnical investigation completed for The Ripcurl Project adjacent to the project site by Geocon Inland Empire, Inc. concluded the historically highest groundwater in the area is approximately 5 feet beneath the ground surface.[4] The potential for soil liquefaction under groundshaking at The Village at Bella Terra site was evaluated by GPI using the direct Cone Penetration Testing (CPT) method. The majority of soils beneath the site is cohesive; however, thin silty sand and sand layers between depths of 10 to 50 feet exhibit potential for liquefaction. Assuming a magnitude-weighted peak ground acceleration of 0.37 g, an earthquake magnitude of 7.5, and a design groundwater depth of 5 feet, GPI calculated that if liquefaction were to occur, induced settlement could be as much as 1 inch. Differential settlement could be on the order of ½ inch to 1 inch per 40 linear feet across the site. Furthermore, GPI concluded that the depths and thicknesses of the liquefiable soils layers made foundation bearing failure unlikely in the event of liquefaction.

Seismically Induced Settlement

Settlement can occur in areas that are prone to rates of ground surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas often are underlain by sediments that differ laterally in composition or degree of compaction. Differential settlement refers to adjacent areas that have more than one rate of settlement. Settlement can damage structures, pipelines, and other subsurface entities.

Because the upper soft soils at the project contain organic material, GPI estimated settlement of about one to two inches within the soft peats and clays would be expected to occur over a long period of time. Settlement would occur as a result of the placement of new fill or structural loads above the existing grade. Differential settlement across 40 linear feet of ground could be on the order of ½ to 1 inch.[5]

Shrinkage and Subsidence

Shrinkage is the loss of soil volume caused by compaction of fills to a higher density than before grading. Subsidence is the settlement of in-place subgrade soils caused by loads generated by the weight of large earthmoving equipment or overlying fill or structures. For earthwork volume estimating purposes, GPI assumed an average shrinkage value of about 10 percent and subsidence of 0.1 foot for surface soils

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[4] Geocon Inland Empire, Inc. *Geotechnical Investigation, Proposed College County Mixed-Use Development, 7302-7400 Center Avenue, Huntington Beach, California*. December 12, 2006. p. 2.
[5] Geotechnical Professionals Inc. *Updated Geotechnical Investigation Proposed The Center at Beach Edinger Avenue West of Beach Boulevard, Huntington Beach, California*. March 19, 2002. p. 7.

excluding loss caused by removal of vegetation or debris. Actual shrinkage and subsidence would depend on the types of earthmoving equipment used and the final fill and structural loads.

According to the Subsidence Areas Map in the Environmental Hazards Element of the General Plan, the project site is not in an area identified to be susceptible to subsidence. Consequently, risk of subsidence occurring can be considered low.

Landslides

Landslides are the downhill movement of masses of earth and rock caused by gravity acting on over-steepened slopes; vibrations from earthquakes, machinery, blasting, etc., or other lateral or horizontal loading. The project site and the surrounding area are relatively flat with no pronounced slopes. There are no known landslides near the site, nor is the site in the path of any known or potential landslides. According to the Potentially Unstable Slope Areas of the General Plan, the project site is in an area that has no potential for unstable slopes. Potential landslide areas in Huntington Beach are limited to those areas near the mesa bluffs, although no historical problems associated with landslides have occurred in that area. Consequently, there is no potential for a landslide to be a hazard to the project site.

Expansive and Collapsible Soils

Expansive soils contain types of clays (principally montmorillonite, illite, and kaolinite) that give up water (shrink) or take on water (swell) during changes in soil moisture content. The change in volume exerts stress on building foundations and other loads placed on these soils. The occurrence of these clays often is associated with geologic units of marginal stability. Expansive soils can be widely dispersed and are found in hillside areas as well as low-lying areas in alluvial basins. Soils testing to identify expansive characteristics and appropriate remediation measures are required routinely by grading and building codes. According to the Expansive Soil Distribution Map in the Environmental Hazards Element of the General Plan, the project site is in an area of “very high” potential for expansive soils. Soils in these area are required by Section 1802.2.2 Expansive Soils, of the 2007 CBC to be tested for expansive characteristics and, if unacceptable, treated to reduce the hazards they pose. Specific treatments to eliminate expansion of soils include, but are not limited to, grouting (cementing the soil particles together), recompaction (watering and compressing the soils), and replacement with a non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are commonly used in the City. The *Huntington Beach Building Code* requires that each construction location be evaluated to determine the particular treatment, if any, that would be most appropriate.

The majority of upper soils encountered at the project site consisted of silty sands; however, some clays were encountered. The on-site clayey soils are expansive and will shrink and swell with changes in moisture content.

The upper clays and peats encountered at the project site are highly compressible. Collapsible soils undergo a rearrangement of their grains, and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Soils prone to collapse are commonly associated with high organic-content deposits, man-made fill, wind-lain sands and silts, and alluvial fan and mudflow sediments deposited during flash floods. Soils of this type are required by Section 1802.2.1 Questionable Soils, of the 2007 CBC to be tested for load-bearing value and, if unacceptable, treated to reduce the hazards they pose. Examples of common problems associated with collapsible soils include tilting floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. The *Huntington Beach Building Code* requires construction sites containing organic and other collapsible soils to be investigated and treated. Because collapsible soils are unsuitable for foundation support, the simplest approach for light structures with shallow foundations usually is to remove the soils and replace them with suitable material: for heavier structures, deep foundation support (piles, piers) often is recommended.

4.5.2 Regulatory Framework

Federal

There are no federal regulations directly applicable to the geotechnical conditions at the project site. Nonetheless, installation of any underground utility lines are required to comply with industry standards specific to the type of utility (e.g., National Clay Pipe Institute for sewers; American Water Works Association for water lines, etc.) and the discharge of contaminants is required to be controlled through the National Pollutant Discharge Elimination System (NPDES) permitting program for management of construction and municipal stormwater runoff, as described in Section 4.7 (Hydrology and Water Quality) of this EIR. These standards contain specifications for installation, design, and maintenance to reflect site-specific geotechnical conditions.

State

Alquist-Priolo Earthquake Fault Zoning Act

The state legislation protecting the population of California from the effects of fault line ground-surface rupture is the *Alquist-Priolo Earthquake Fault Zoning Act*. This state law was passed in response to the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. At the directive of the Act, in 1972 the State Geologist began delineating Earthquake Fault Zones (called Special Studies Zones prior to 1994) around active and potentially active faults to reduce fault-rupture risks to structures for human occupancy.[6] This Act has resulted in the preparation of maps delineating Earthquake Fault Zones to include, among others, recently active segments of the Newport-Inglewood and San Andreas faults. The Act provides for special seismic design considerations if developments are planned in areas adjacent to active or potentially active faults.[7] The project site is not in a State of California Earthquake Fault Zone. As described in greater detail in Section 4.5.3 (Project Impacts and Mitigation) below, the active Newport-Inglewood fault zone is approximately ¾ mile southwest of the site.

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[6] Alquist-Priolo Earthquake Fault Zoning Act, California Public Resources Code, Division 2, "Geology, Mines, and Mining," Chapter 7.5 "Earthquake Fault Zones," Sections 2621 through 2630; signed into law December 22, 1972, most recently amended October 07, 1997.

[7] California Geological Survey. 2003. CGS Special Publication 42, *Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps*. Revised 1997, Supplements 1 and 2, 1999, Supplement 3, 2003. Authors, E.W. Hart and W.A. Bryant.

California Building Code

The state regulations protecting the public from geo-seismic hazards, other than surface faulting, are contained in 2007 California *Code of Regulations*, Title 24, Part 2 (the *California Building Code* [CBC]) and California *Public Resources Code*, Division 2, Chapter 7.8 (the *Seismic Hazards Mapping Act*). Both of these regulations apply to public buildings (and a large percentage of private buildings) intended for human occupancy.

Until January 1, 2008, the *California Building Code* (CBC) was based on the then-current *Uniform Building Code* and contained Additions, Amendments and Repeals specific to building conditions and structural requirements in the state of California. The 2007 CBC, effective January 1, 2008, is based on the current (2006) *International Building Code* and contains prominent enhancement of the sections dealing with fire safety, equal access for disabled persons, and environmentally friendly construction.[8] Each jurisdiction in the state may adopt its own building code based on the 2007 CBC. Local codes are permitted to be more stringent than Title 24, but, at a minimum, are required to meet all state standards and enforce the regulations of the 2007 CBC beginning January 1, 2008. The City has adopted the 2007 CBC as the basis for its *Building Code* (*Municipal Code* Title 17, Chapter 17.04) through Ordinance No. 3789, adopted December 3, 2007.

Chapters 16 and 16A of the 2007 CBC deal with Structural Design requirements governing seismically resistant construction, including (but not limited to) factors and coefficients used to establish seismic site class and seismic occupancy category for the soil/rock at the building location and the proposed building design. Chapters 18 and 18A of the 2007 CBC include (but are not limited to) the requirements for foundation and soil investigations (Sections 1802 & 1802A); excavation, grading, and fill (Sections 1803 & 1803A); allowable load-bearing values of soils (Sections 1804 & 1804A); and the design of footings, foundations, and slope clearances (Sections 1805 & 1805A), retaining walls (Sections 1806 & 1806A), and pier, pile, driven, and cast-in-place foundation support systems (Sections 1808, 1808A, 1809, 1809A, 1810 & 1810A). Chapter 33 of the 2007 CBC includes (but is not limited to) requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes (Section 3304). Appendix J of the 2007 CBC includes (but is not limited to) grading requirements for the design of excavations and fills (Sections J106 & J107) and for erosion control (Section J110).

Seismic Hazards Mapping Act

The *Seismic Hazards Mapping Act* became effective in 1991 to identify and map seismic hazard zones for the purpose of assisting cities and counties in preparing the safety elements of their general plans and to encourage land use management policies and regulations that reduce seismic hazards. The recognized hazards include strong groundshaking, liquefaction, landslides, and other ground failure. These effects account for approximately 95 percent of economic losses caused by earthquakes. The Act has resulted in the preparation of maps delineating Liquefaction and Earthquake-Induced Landslide Zones of Required Investigation. Mapping has been completed for the Newport Beach quadrangle, which contains the project site, and the official map was issued in April, 1997. The project site is in a zone of potential

[8] California Building Standards Commission, *2007 California Building Code*, California Code of Regulations, Title 24, Part 2, Volumes 1 and 2, effective January 1, 2008.

liquefaction. This information is reflected in the City's General Plan Environmental Hazards Element goals and policies (see below). The City's enforcement of its *Building Code* (see below) ensures the project would be consistent with those goals and policies and would comply with the requirements that derive from the *Seismic Hazards Mapping Act*.

Local

The City of Huntington Beach advances public safety and welfare in the City through its General Plan and compliance with applicable local regulations in the *Huntington Beach Municipal Code*. General Plan policies specific to geologic, soil, and seismic hazards are listed in the Environmental Hazards Element. Site development work in the City is required to comply with the *Huntington Beach Building Code* and all State requirements pertaining to geologic, soil, and seismic hazards.

General Plan Environmental Hazards Element

The Environmental Hazards Element identifies various policies addressing natural and human-related hazards and the potential methods to reduce risks associated with those hazards. With the adoption of this Element, the City has established its basis of authority for requiring investigation and, if necessary, remediation of geotechnical hazards that could threaten proposed developments. The information presented below identifies goals and objectives in the Environmental Hazards Element of the General Plan related to geologic resources. These goals and objectives are considered by the City when reviewing proposed development applications. It is the Applicant's responsibility to provide the City with appropriate geological and/or geotechnical information for the City to determine whether the proposed project meets the General Plan goals and objectives.

Goals, Objectives, and Policies

Goal EH 1 Ensure that the number of deaths and injuries, levels of property damage, levels of economic and social disruption, and interruption of vital services resulting from seismic activity and geologic hazards shall be within acceptable levels of risk.

Objective EH 1.1 Ensure that land use planning in the City accounts for seismic and geologic risk, including groundshaking, liquefaction, subsidence, soil and slope stability, and water table levels.

Policy EH 1.1.4 Evaluate the levels of risk based on the nature of the hazards and assess acceptable risk based on the human, property, and social structure damage compared to the cost of corrective measures to mitigate or prevent damage.

Objective EH 1.2 Ensure that new structures are designed to minimize damage resulting from seismic hazards, ensure that existing unsafe structures are retrofitted to reduce hazards and mitigate other existing unsafe conditions.

Policy EH 1.2.1 Require appropriate engineering and building practices for all new structures to withstand groundshaking and liquefaction such as stated in the Uniform Building Code.

Goal EH 6 Ensure the safety of the City's businesses and residents from peat hazards.

Objective EH 6.2 Minimize peat hazards through the regulation of construction

Policy EH 6.2.1 Establish standards of construction within identified peat zones.

Consistency Analysis

The proposed project is required to be constructed in accordance with *Huntington Beach Municipal Code* design requirements for structures for human occupancy. Minimum requirements for protection from seismic hazards, including foundation support and structural design, are specified in the *Building Code* (see below). Minimum grading requirements, including erosion control, excavation stability, and fill material acceptability are specified in the *Grading and Excavation Code* (see below). The project would incorporate the required site preparation and structural design recommendations included in the geotechnical report prepared for the project site. The incorporated measures would ensure that earthquake survivability is a primary concern in the design and construction of the proposed project. Implementation of the proposed project would not conflict with these policies.

Although peat layers were encountered during the geotechnical investigation, hazards associated with the subsidence or collapse of these organic soils would be avoided through the use of a pile foundation that would not depend on the peat for its support (see below). Implementation of the proposed project would not conflict with this policy.

City of Huntington Beach Municipal Code

Site development in the City of Huntington Beach is required to comply with the *Huntington Beach Building Code*, *Grading and Excavation Code*, and all state requirements pertaining to geologic, soil, and seismic hazards. The City adopted the 2007 CBC as the basis for its *Building Code* (*Municipal Code* Title 17, Chapter 17.04) through Ordinance No. 3789 on December 3, 2007. The *Building Code*, as adopted, includes acceptable variations to the CBC related to minimum slab thickness, fire-extinguishing systems, building security, and methane district regulations. The *Grading and Excavation Code* (adopted by the City November 3, 2003 through Ordinance No. 3621 as *Municipal Code* Title 17, Chapter 17.05) sets forth rules and regulations to control excavation, grading, earthwork and site improvement construction, and establishes administrative requirements for issuance of permits and approvals of plans and inspection of grading construction. Specifically, the *Grading and Excavation Code* identifies, defines, and regulates hazardous conditions, plans and specifications, soils and geology reports, fills, setbacks, drainage and terracing, asphalt concrete pavement, and erosion control systems. These two code chapters stipulate the requirements for proposed new development in the City to address geotechnical issues, including all aspects of geologic and engineering site investigation, seismic-resistance foundation and building design, and slope and soil stability. With this regulatory framework in place, the City has the authority to enforce the General Plan policies protecting the public from geotechnical hazards associated with proposed development.

4.5.3 Project Impacts and Mitigation

Analytic Method

Information regarding regional geology and seismically induced hazards was researched in various sources of the CGS and the USGS. Project-specific geologic information, soil characteristics, and liquefaction potential were obtained from the 2002 Geotechnical Investigation *Updated Geotechnical Investigation, Proposed the Center at Beach Edinger Avenue West of Beach Boulevard Huntington Beach, California.* Estimated earthquake magnitudes resulting from potential seismic activity on various active faults in the area were obtained from various analyses included with the Geotechnical Investigation and the General Plan Environmental Hazards Element. Where potential geological hazards are identified, such hazards would be expected to affect any proposed development in the hazard area.

The following analysis considers the potential effects of the proposed project described in Chapter 3, Project Description, of this EIR. Construction-related impacts are considered for the project as a whole. Operational-related impacts of the project site are considered in the context of seismic and/or other geological hazards to residents, employees, and visitors.

Both GPA/ZTA options would result in an increase in allowable uses compared to the existing General Plan and Zoning designations for the project site; however, the ratios of the type of land uses would differ. Implementation of the proposed project would result in the development of a mixed-use scenario in which *either* more residential uses would be permitted (Option 1) *or* more commercial uses would be permitted (Option 2).

For the purposes of this analysis, full buildout under either scenario would result in similar impacts regardless of the type of land use proposed because the same overall building footprint would result under either option. Additionally, all future development, regardless of which Option is implemented, would adhere to similar building standards and be constructed on the same geologic conditions. Since Option 1 and Option 2 propose the same land uses, with the difference lying in the ratio of commercial and residential uses, implementation of one GPA/ZTA Option would not be inherently different from the other in terms of potential impacts to geology and soils. Therefore, the following impact analysis applies to both Option 1 and Option 2, as impacts would be the same for either GPA/ZTA.

Thresholds of Significance

The following thresholds of significance are based on Appendix G of the 2008 CEQA Guidelines and have been updated to meet the State requirement that the 2007 *California Building Code* be enforced by each jurisdiction in California after January 1, 2008. For purposes of this EIR, implementation of the proposed project would have a significant adverse impact if it would create any of the following conditions:

- Expose people or structures to potential 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 known fault
  - Strong seismic groundshaking
  - Seismic-related ground failure, including liquefaction
  - Landslides
- Result in substantial soil erosion, loss of topsoil, or changes in topography or unstable soil conditions from excavation, grading, or fill
- Be 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
- Be located on expansive soil, as defined in Section 1802.3.2 of the *California Building Code* (2007), creating substantial risks to life or property
- 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

Adverse impacts in any of the above categories would be considered unavoidable significant effects of the proposed project, if they could not be *(a)* reduced to a level of risk consistent with the standards established by the *Huntington Beach Building Code*, *(b)* eliminated, or *(c)* avoided by using generally accepted geotechnical methods applied in California.

Adherence to design and construction standards, as required by the State and City regulations and codes described previously, would ensure maximum practicable protection for users of the buildings and associated infrastructure. All aspects of seismic-related hazards, other geotechnical hazards, and erosion and sedimentation issues are regulated by City of Huntington Beach and/or the State of California. All potential geotechnical impacts are required by these codes and regulations to be rendered less-than-significant as part of proposed project designs. No additional geotechnical mitigation measures are required for the Village at Bella Terra project.

Effects Not Found to Be Significant

Threshold	Would the project expose people or structures to potential 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?

The project site is not in an Alquist-Priolo Earthquake Fault Zone and there are no known faults (active, potentially active, or inactive) on site. The possibility of fault rupture is considered very low. Therefore, no impacts from fault rupture would result and no further analysis is required.

Threshold	Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

The project site is in a relatively flat area with no pronounced slopes. There is no potential for a landslide and the subsurface soil conditions are considered favorable for gross stability of excavated slopes. As indicated in the City's General Plan Environmental Hazards Element, there is no potential for unstable slopes at the project site. Therefore, no impacts from landslide would result and no further analysis is required.

Threshold	Would the project 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 wastewater?

The proposed project would be provided sanitary sewer service by the City of Huntington Beach. No septic tanks or alternative wastewater systems are proposed. Therefore, no impact would occur and no further analysis of this issue is required.

Impacts and Mitigation Measures

Threshold	Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: ■ strong seismic groundshaking? ■ seismic-related ground failure, including liquefaction?

Impact 4.5-1 **Development of the proposed project would not expose people and/or structures to potentially substantial adverse effects, including the risk of loss, injury, or death, involving strong seismic groundshaking and/or seismic-related ground failure, including liquefaction. Although seismic groundshaking would occur during major earthquakes, compliance with applicable state and City regulations would reduce the potential impacts of vibration and associated ground failures to *less-than-significant* levels at the project site.**

The proposed project site is in a seismically active area. During the design life of the development, strong seismic groundshaking will occur at the site. Review of regional and local geo-seismic conditions indicates the project site probably would be subjected to at least one major earthquake during the next 30 years. A characteristic earthquake (see Glossary in Section 4.5.5) on the San Andreas fault (M_W 7.5), 51 miles to the northeast, probably is the largest that would affect the site, but a characteristic earthquake of the Newport-Inglewood fault (M_W 7.1) could be more destructive because the fault is so much closer to the site (3.1 miles southwest). Section 1613 Earthquake Loads, of the 2007 CBC requires the seismic-resistant design for the project buildings to factor in a design earthquake that would create average peak ground accelerations of at least 1.0g. Damage resulting from a design earthquake could include general damage to foundations, shifting of frame structures if not bolted in place, and breaking of underground pipes. In addition, active and potentially active regional faults are capable of producing seismic shaking at the project site. It is anticipated that the project site would experience ground acceleration periodically as a result of small and moderate magnitude earthquakes occurring on active nearby and distant faults. Accordingly, the proposed structures and improvements could be adversely affected by seismic groundshaking if required design measures were not implemented.

The potential for soil liquefaction from earthquake-induced groundshaking at the site was evaluated in the 2002 geotechnical investigation taking into account the current and historic groundwater levels and the increase in potential were the groundwater to rise closer to the ground surface. Based on the analysis, most soils at the site were considered cohesive, but, thin silty sand and sand layers in the subsurface exhibited a potential for liquefaction that could induce total and differential settlement. It was determined that the depths and thickness of the liquefiable soils layers made foundation bearing failure unlikely in the event of liquefaction.

Adherence to the City's *Municipal Code* would ensure the maximum practicable protection available for structures on the project site. Project design is required to include the application of CBC seismic standards as the minimum seismic-resistant. The applicable code requirements include seismic-resistant earthwork and construction design criteria, based on the site-specific recommendations of the project's California-registered geotechnical and structural engineers; engineering analyses that demonstrate satisfactory performance of any unsupported cut or fill slopes, and of alluvium and/or fill where they form part or all of the support for structures, foundations and underground utilities; and analyses of soil expansion, collapse, and subsidence potential and appropriate remediation (compaction, removal-and-replacement, etc.) prior to using any soils for foundation support, as explained below.

Adherence to the seismic design and construction parameters of the CBC, as required by State law, would ensure protection of the project's occupants and visitors. Compliance with the CBC includes procedures to ensure protection of structures and occupants from geo-seismic hazards:

- The 2006 design criteria for protection of structures and earthworks at the project site from groundshaking and ground failure would be review and updated, as necessary, by a California Certified Engineering Geologist, or California-licensed Civil Engineer (Geotechnical) to ensure compliance with the 2007 CBC standards of performance.
- During site preparation, a registered geotechnical professional must be on the site to supervise implementation of the recommended criteria.
- A California Certified Engineering Geologist, or California-licensed Civil Engineer (Geotechnical) for the Applicant must prepare an "as built" map/report to be filed with the City showing details of the site geology, the location and type of seismic-restraint facilities, and documenting the following requirements, as appropriate.
    - Engineering analyses demonstrating satisfactory performance of compacted fill or natural unconsolidated sediments where either forms part or all of the support for any structures, especially where the possible occurrence of liquefiable, compressible, or expansive soils exists.
    - Engineering analyses demonstrating accommodation of settlement or compaction estimates by the site-specific Geotechnical Report for access roads, foundations, and underground utilities in fill or alluvium.

Additionally, **CR4.5-1** and **MM4.5-1** would be required.

CR4.5-1 *A California-licensed Civil Engineer (Geotechnical) shall prepare and submit to the City a detailed soils and geotechnical analysis with the first submittal of a grading plan. This analysis shall include Phase II Environmental soil sampling and laboratory testing of materials to provide detailed recommendations for grading, chemical and fill properties, liquefaction and landscaping.*

MM4.5-1 *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 type and corrosion measures, erosion control, shoring and internal bracing, and plan review.*

In view of the requirements to comply with the seismic safety requirements of the City's Municipal Code, including adherence to **CR4.5-1**, as well as adherence to **MM4.5-1** and the design recommendations of the Geotechnical Investigation to be included in the project design, the project's impact on exposure to seismically induced groundshaking and seismic-related ground failure would be ***less than significant***.

Threshold	Would the project result in substantial soil erosion, loss of topsoil, or changes in topography or unstable soil conditions from excavation, grading, or fill?

Impact 4.5-2 **Construction and operation of the proposed project would not result in substantial soil erosion, loss of top soil, changes in topography or unstable soil conditions. Compliance with slope stability, soil stability, and seismic-resistant design standards for structures proposed for human occupancy required by the City of Huntington Beach General Plan, Building Code, and Grading and Excavation Code would reduce these potential impacts to *less-than-significant* levels at the project site.**

For the purposes of this analysis, erosional effects consider whether project activities would accelerate natural erosional processes. Because the project site currently is developed, natural erosion processes have not occurred in the recent past.

The project would include ground-disrupting activities such as excavation and trenching for foundations and utilities; soil compaction and site grading; and the erection of new structures, all of which would temporarily disturb soils. The exposure of previously covered soils during these activities could lead to increased on-site erosion and off-site sediment transport because disturbed soils are susceptible to higher rates of erosion from wind, rain, and runoff of dewatering discharge or dust control water than undisturbed soils. The State Water Resources Control Board and the City's *Municipal Code* require erosion and sediment controls for construction projects with more than one acre of land disturbance. The City's *Grading and Excavation Code* (*Municipal Code* Title 17, Chapter 17.05), which implements the requirements of CBC Appendix Section J110, Erosion Control, for construction periods, addresses the issue of soil loss. The requirements include preparation and implementation of a Storm Water Pollution Prevention Plan, with both construction-period and permanent erosion and sediment controls; preparation and implementation of an erosion and sediment control plan, describing both construction-period and permanent erosion and sediment controls; and construction site inspection by the City. The project would be required to comply with these existing regulations. Adherence to these requirements would prevent substantial on-site erosion and would reduce impacts to a less-than-significant level from the perspective of soil loss at the construction site.

Off-site erosion and sedimentation could occur if increased stormwater runoff were conveyed over unstable off-site soil surfaces or to a susceptible creek or channel where the higher erosive forces associated with increased flow rates could contribute to off-site erosion, including stream bed and bank erosion. Because all stormwater from the site would continue to be conveyed through the City storm drainage system, stormwater runoff would not flow over unstable off-site soil surfaces, and there would be a low probability of erosion or sedimentation involving them.

Earth-disturbing activities associated with construction would be temporary. Specific erosion impacts would depend largely on the areas affected and the length of time soils are subject to conditions that would be affected by erosion processes. The proposed site is approximately 15.85 acres in size, and is subject to the provisions of the General Construction Activity Stormwater Permit adopted by the State Water Resources Control Board (SWRCB). The Applicant for the proposed project must submit a Notice of Intent (NOI) to the SWRCB for coverage under the Statewide General Construction Activity Stormwater Permit and must comply with all applicable requirements, including the preparation of a Stormwater Pollution Prevention Plan (SWPPP), applicable NPDES Regulations, and best management practices (BMP). The SWPPP must describe the site, the facility, erosion and sediment controls, runoff water quality monitoring, means of waste disposal, implementation of approved local plans, control of sediment and erosion control measures, maintenance responsibilities, and non-stormwater management controls. Inspection of construction sites before and after storms is required to identify stormwater discharge from the construction activity and to identify and implement controls where necessary. Such compliance, in addition to implementation of **CR4.5-1** and **MM4.5-1**, would ensure that erosion and other soil instability impacts resulting from project construction would be ***less than significant***.

Threshold	Would the project be 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?

Impact 4.5-3 **The proposed project would be located on subsidence-prone and potentially liquefiable soils. Compliance with slope and soil stability standards required by the City of Huntington Beach General Plan, Building Code, and Grading and Excavation Code would reduce potential impacts to *less-than-significant* levels at the project site.**

The potential for landslides are addressed under effects found not to be significant: liquefaction is addressed under Impact 4.5-1. As explained in Section 4.5.1 (Environmental Setting), subsidence could be caused by the weight of large earthmoving equipment used during the construction phase of the development. In addition, the shallow groundwater table underneath the site may affect the stability of the soils during construction and operation of the project.

Subsidence

Subsidence could result in the settlement of in-place subgrade soils caused by loads generated by large earthmoving equipment. GPI assumed 0.1 foot of subsidence for the purpose of estimating the necessary volume of earth moving at the site. Actual subsidence would depend on the types of earthmoving equipment used. Because of the organic content of the upper soft peats and clays at the project site, GPI estimated settlement of about 1 to 2 inches would occur over a long period of time. Settlement would occur as a result of the placement of new fill or structural loads above the existing grade. Differential settlement across 40 linear feet of ground could be on the order of ½ to 1 inch. Because the proposed structures would be designed, constructed and operated in conformance with Section 1802.2.1 Questionable Soils, of the City's *Municipal Code* and Title 17 *Excavation and Grading Code*, potential risks to life and property from unstable soil conditions caused by subsidence would be ***less than significant***.

Shallow Groundwater

Because of the shallow depth of groundwater, encountered at depths of 5 to 13 feet below the existing ground surface, dewatering activities at the project site could be needed during construction of any subterranean levels, such as for parking. The removal of groundwater to create a dry construction pit could cause porous soils to collapse when the support provided by the water was withdrawn. Temporary shoring, dewatering wells, storage tanks, filters, and erosion control measures would be required to comply with the City's Grading Manual (Chapter 17.05.030 of the *Huntington Beach Municipal Code*). Dewatering activities would be required to comply with the NPDES Permit for Groundwater Discharge from the Santa Ana Regional Water Quality Control Board.

Because the proposed structures would be designed, constructed and operated in conformance with Section 1802.2.1 Questionable Soils, of the City's *Municipal Code* and Title 17 *Excavation and Grading Code*, and because the project would be required to comply with **CR4.5-1**, **MM4.5-1**, and **CR4.7-3**, potential risks to life and property from unstable soils caused by groundwater saturation or withdrawal would be ***less than significant***.

Threshold	Would the project be located on expansive soil, as defined in Section 802.3.2 of the California Building Code (2007), creating substantial risks to life or property?

Impact 4.5-4 **The proposed project would be located on expansive soil. Compliance with soil stability standards required by the City of Huntington Beach General Plan, Building Code, and Grading and Excavation Code would reduce this potential impact to a *less-than-significant* level at the project site.**

The majority of upper soils encountered at the project site consist of silty sands, however, some soft clays were encountered. The on-site clayey soils are expansive and will shrink and swell with changes in moisture content. Additionally, the upper clays and peats at the project site are highly compressible. Because of the potential for volume changes with fluctuations in moisture, expansive and compressible soils create a risk of distress to pavement, foundation elements, and other structures. Such soils are undesirable for use as fill within 3 feet of slab-on-grade areas. Because the proposed project structures would be designed, constructed and operated in conformance with Section 1802.2.2 Expansive Soils, of the City's *Municipal Code* and Title 17 *Excavation and Grading Code*, and because the project would be required to comply with **CR4.5-1** and **MM4.5-1**, potential risks to life and property associated with expansive soil would be reduced to a ***less-than-significant*** level.

4.5.4 Cumulative Impacts

The geographic context for the analysis of impacts resulting from geologic hazards generally is site-specific, rather than cumulative in nature. Each project site has unique geologic considerations that would be subject to uniform site-development policies and construction standards imposed by the City of Huntington Beach. Restrictions on development would be applied in the event that geologic or soil conditions posed a risk to public safety. A regional context must be considered for the analysis of the cumulative effects of exposure of people or structures to seismic hazards other than surface rupture of a fault because the hazard generators (earthquakes) and the direct effects (groundshaking, ground failure) tend to be region-wide in nature. Additionally, a watershed-wide context must be considered for the analysis of the cumulative effects of potential erosion and siltation because the direct effects (turbidity, reduction of water quality, channel-bed sedimentation) can affect all downstream reaches of a waterway system. Nonetheless, the potential for cumulative impacts to occur is limited.

Impacts associated with potential geologic hazards related to soil or other conditions occur at individual building sites. These effects are site-specific, and impacts would not be compounded by additional development. Buildings and facilities in the City of Huntington Beach would be sited and designed in accordance with the geotechnical and seismic guidelines and recommendations of the City's *Municipal Code*. Adherence to all relevant plans, codes, and regulations with respect to project design and construction would provide adequate levels of safety, and the cumulative impact would be less than significant. Adherence by the project to all relevant plans, codes, and regulations would ensure that the proposed project would not result in a cumulatively considerable contribution to cumulative impacts regarding geologic hazards, and therefore, the cumulative impact of the project would be ***less than significant***.

Impacts from erosion and loss of topsoil from site development and operation can be cumulative in effect within a watershed. The Santa Ana River Watershed forms the geographic context of cumulative erosion impacts. Development throughout Orange County and the City of Huntington Beach is subject to state and local runoff and erosion control requirements, including applicable provisions of the general construction permit, BMPs, and Phases I and II of the NPDES permit process, as well as implementation of fugitive dust control measures in accordance with SCAQMD Rule 403 (see Section 4.2 [Air Quality] of this EIR). These measures are implemented as conditions of approval of project development and subject to continuing enforcement. As a result, it is anticipated that cumulative impacts on the Santa Ana River Watershed District caused by runoff and erosion from cumulative development activity would be less than significant. The project's contribution to cumulative impacts would not be cumulatively considerable and, therefore, also would be ***less than significant***.

Implementation of the proposed project would result in the modification of site conditions to accommodate residential and commercial development and to provide a stable and safe development. During construction, areas of soil could be exposed to erosion by wind or water. Development of other cumulative projects in the vicinity of the proposed project could expose soil surfaces, and further alter soil conditions, subjecting soils to erosional processes during construction. To minimize the potential for cumulative impacts that could cause erosion, the proposed project and cumulative projects in the adjacent area are required to be developed in conformance with the provisions of applicable federal, state, County, and City laws and ordinances. The City's *Grading and Excavation Code* (*Municipal Code* Title 17, Chapter 17.05), implements the requirements of CBC Appendix Section J110, Erosion Control, for construction periods. Adequate protection in the form of BMPs and erosion and sediment control plans must be incorporated into individual projects to address current legal requirements for control of erosion caused by stormwater discharges. Project sites of more than 1 acre in size would be required to comply with the provisions of the NPDES permitting process and local implementation strategies, which would minimize the potential for erosion during construction and operation of the facilities. Compliance with this permit process, in addition to the legal requirements related to erosion control practices, would minimize cumulative effects from erosion. Therefore, cumulative impacts on erosion would be less than significant. The project would not result in a cumulatively considerable contribution to this impact and, therefore, would be ***less than significant***.

4.5.5 Glossary

- **Alquist-Priolo Earthquake Fault Zone**—In 1972 the state of California began delineating special studies zones (called Earthquake Fault Zones since January 1994) around active and potentially active faults in the state. The zones are revised periodically, and extend 200 to 500 feet on either side of identified fault traces. No structures for human occupancy may be built across an identified active fault trace. An area of 50 feet on either side of an active fault trace is assumed to be underlain by the fault, unless proven otherwise. Proposed construction within the Earthquake Fault Zone is permitted only following the completion of a fault location report prepared by a California Registered Geologist.
- **Blind Thrust Fault**—A seismic rupture plane that is not visible at the ground surface and is at a low to moderate angle.
- **Characteristic Earthquake**—Characteristic earthquakes are repeat earthquakes that have the same faulting mechanism, magnitude, rupture length, location, and, in some cases, the same epicenter and direction of rupture propagation as earlier shocks. As used in this report, the M_W of the "characteristic earthquake" indicates the scale of the seismic event considered representative of a particular fault segment, based on seismologic observations and statistical analysis of the probability that a larger earthquake would not be generated during a given time frame (often 50 or 100 years). The term "characteristic earthquake" replaces the term "maximum credible earthquake" as a more reliable descriptor of future fault activity.
- **Design Earthquake Ground Motion**—The seismically induced acceleration that buildings and structures are specifically proportioned to resist in Section 1613 of the 2007 *California Building Code*.
- **Geomorphic Provinces**—California's geomorphic provinces are naturally defined geologic regions that display a distinct landscape or landform. Earth scientists recognize eleven provinces in California. Each region displays unique, defining features based on geology, faults, topographic relief, and climate. These geomorphic provinces are remarkably diverse. They provide spectacular vistas and unique opportunities to learn about earth's geologic processes and history.

- **Horizontal Ground Acceleration**—The speed at which soil or rock materials are displaced by seismic waves. It is measured as a percentage of the acceleration of gravity (0.5 g = 50 percent of 32 feet per second squared, expressed as a horizontal force). Peak horizontal ground acceleration is the maximum acceleration expected from the characteristic earthquake predicted to affect a given area. Repeatable acceleration refers to the acceleration resulting from multiple seismic shocks. Sustained acceleration refers to the acceleration produced by continuous seismic shaking from a single, long duration event.
- **Maximum Credible Earthquake**—The largest Richter magnitude (M) seismic event that appears to be reasonably capable of occurring under the conditions of the presently known geological framework. This term has been replaced by "characteristic earthquake," which is considered a better indicator of probable seismic activity on a given fault segment within a specific time frame.
- **Maximum Considered Earthquake Ground Motion**—The most severe seismically-induced acceleration effects considered by the 2007 *California Building Code*.
- **Moment Magnitude (M_W)**—A logarithmic scale introduced by Hiroo Kanamori in 1977 that is used by modern seismologists to measure the total amount of energy released by an earthquake. For the purposes of describing this energy release (i.e., the "size" of an earthquake on a particular fault segment for which seismic-resistant construction must be designed) the M_W of the characteristic earthquake for that segment has replaced the concept of a maximum credible earthquake of a particular Richter M. This has become necessary because the Richter scale "saturates" at the higher magnitudes; that is, the Richter scale has difficulty differentiating among the sizes of earthquakes above M 7.5. To correct for this effect, the formula used for the M_W scale incorporates parameters associated with the rock types at the seismic source and the area of the fault surface involved in the earthquake. Thus, the M_W is related to the length and width of the fault rupture. It reflects the amount of "work" (in the sense of classical physics) done by the earthquake. The relationship between M and M_W is not linear (i.e., M_W is not a set percentage of M): the two values are derived using different formulae. The four well-known earthquakes listed below exemplify this relationship.

Location	*Date*	*Richter Magnitude*	*Moment Magnitude*
New Madrid MO	1812	8.7	8.1
San Francisco CA	1906	8.3	7.7
Anchorage AK	1964	8.4	9.2
Northridge CA	1994	6.4	6.7

Although some of the values shown on the moment magnitude scale (M_W) appear lower than those of the Richter magnitude scale (M), they convey more precise (and more useable) information to geologic and structural engineers.

- **Richter Magnitude Scale (M)**—A logarithmic scale developed in 1935 and 1936 by Dr. Charles F. Richter and Dr. Beno Gutenberg to measure earthquake magnitude (M) by the amount of energy released, as opposed to earthquake intensity as determined by local effects on people, structures, and earth materials (for which, see Modified Mercalli Intensity Scale, above). Each whole number on the Richter scale represents a 10-fold increase in amplitude of the waves recorded on a seismogram and about a 32-fold increase in the amount of energy released by the earthquake. Because the Richter scale tends to saturate above about M 7.5, it is being replaced in modern seismologic investigations by the M_W scale (see above).

4.5.6 References

Alquist-Priolo Earthquake Fault Zoning Act, *California Public Resources Code*, Division 2, "Geology, Mines, and Mining," Chapter 7.5 "Earthquake Fault Zones," Sections 2621 through 2630; signed into law 22 December 1972, most recently amended 07 October 1997.

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