4.6 GEOLOGIC AND SEISMIC HAZARDS

This section describes the current conditions relating to the geologic and seismic characteristics within the City of Carson. This section concludes with an assessment of geologic impacts and identifies corresponding mitigation measures associated with implementation of the proposed General Plan.

4.6.1 ENVIRONMENTAL SETTING

GEOLOGY

The City of Carson is located within the northerly end of the Peninsular Ranges geomorphic province. The Peninsular Ranges province extends from the Los Angeles Basin south of the Santa Monica Mountains to the tip of Baja California. It includes the San Jacinto and Santa Ana Mountain Ranges and Santa Catalina Island. This geomorphic province is characterized by elongated northwest trending mountain ranges separated by straight-sided sediment floored valleys (Yerkes et al. 1965). The northwest trend is further reflected in the direction of the dominant geologic structural features of the province, which are northwest trending faults and folds. These include the Newport-Inglewood fault zone, the Paramount syncline[1], the Dominguez anticline[2], the Gardena syncline, the Wilmington anticline and the Wilmington syncline. Geologic units of the northern Peninsula Ranges province consist of Jurassic and Cretaceous age basement rocks overlain by as much as 32,000 feet of marine and non-marine sedimentary strata ranging in age from the late Cretaceous to Holocene epochs.

PHYSIOGRAPHIC FEATURES

The City of Carson is situated in the northern part of the physiographic basin known as the Los Angeles Basin (Yerkes et al. 1965), or the Coastal Plain of Los Angeles (Mendenhall 1905). The most prominent landform within the City is Dominguez Hills, which represents the central portion of the Newport-Inglewood fault zone (or uplift). Dominguez Gap is another important landform feature within the City.

Dominguez Hills. The Dominguez Hills lie immediately west of the Alameda Street corridor, between the Redondo Beach/Artesia Freeway (SR-91) on the north and Del Amo Boulevard on the south. Dominguez Hills are a feature consisting of an elliptical, northwest trending anticlinal dome that ranges in elevation from approximately 20 feet above mean sea level (msl) to 195 feet msl.

Dominguez Gap. The Dominguez Gap constitutes a portion of the Downy Plain lying between the Dominguez Hills and the northwestern extension of Signal Hill. The gap is approximately 1.6 miles wide at its narrowest point and approximately seven miles long.

[1] Syncline: A fold that is convex downwards.

[2] Anticline: A fold that is convex upwards.

It was entrenched mainly by the ancestral San Gabriel River, which has a southward flowing ancestral Los Angeles River as a tributary. An estimated 150 feet of Holocene materials has been deposited within the Dominguez Gap.

SOILS

Soils in the City of Carson range from sand to clay loam soil types. Information obtained from the Los Angeles Soils Survey (United States Soil Conservation Service, 1969) general soils map is displayed in Table 4.6-1, *General Physical Properties of Soils in the Carson Area*. A soil association has a distinctive proportional composition of soils. Normally, a soil association consists of one or more major soil types and at least one minor soil type. The table demonstrates the general properties of soil associations that underlay the City. According to the Soil Conservation Service of the U.S. Department of Agriculture (USSCS), no prime agricultural soils exist within the City of Carson.

Table 4.6-1
General Physical Properties of Soils in the Carson Area

Association	Soil Association	Soil Type	Depth (inches)	Slope (%)	Erosion Potential	Shrink-Swell Potential
10	Oceano	Sand	60"	2-5	Mod-High	Low
13	Netz-Cortina	Fine sand and fine sandy loam	60"	0-5	Low-Mod	Low
14	Hanford	Sandy loam	60"	2-5	Low	Low
15	Yolo	Silty loam	60"	0	Low-Mod	Mod
20	Chino (with inclusions of the Foster and Grangeville Associations)	Clay loam	60"	0	Low	Mod
21	Ramona-Placentia	Sandy loam	18-60"	2-5	Low-Mod	High

Source: U.S. Soil Conservation Service, 1969.

MINERAL RESOURCES

OIL WELL PRODUCTION

The Los Angeles Basin is a major oil-producing district in Southern California. Oil, first discovered in the basin in 1889, occurs chiefly in Pliocene and Miocene strata, with lesser amounts in Pleistocene strata and in fractured schist[3] (cretaceous or older) of the basement complex. The City of Carson is located within the Dominguez and Wilmington oil fields.

[3] Schist is a medium grade metamorphic rock.

SEISMIC HAZARDS

The following section describes the presence and characteristics of seismic hazards in Carson, including earthquake faults, surface rupture, ground shaking, liquefaction, hazardous buildings and seismic response.

EARTHQUAKE FAULTS

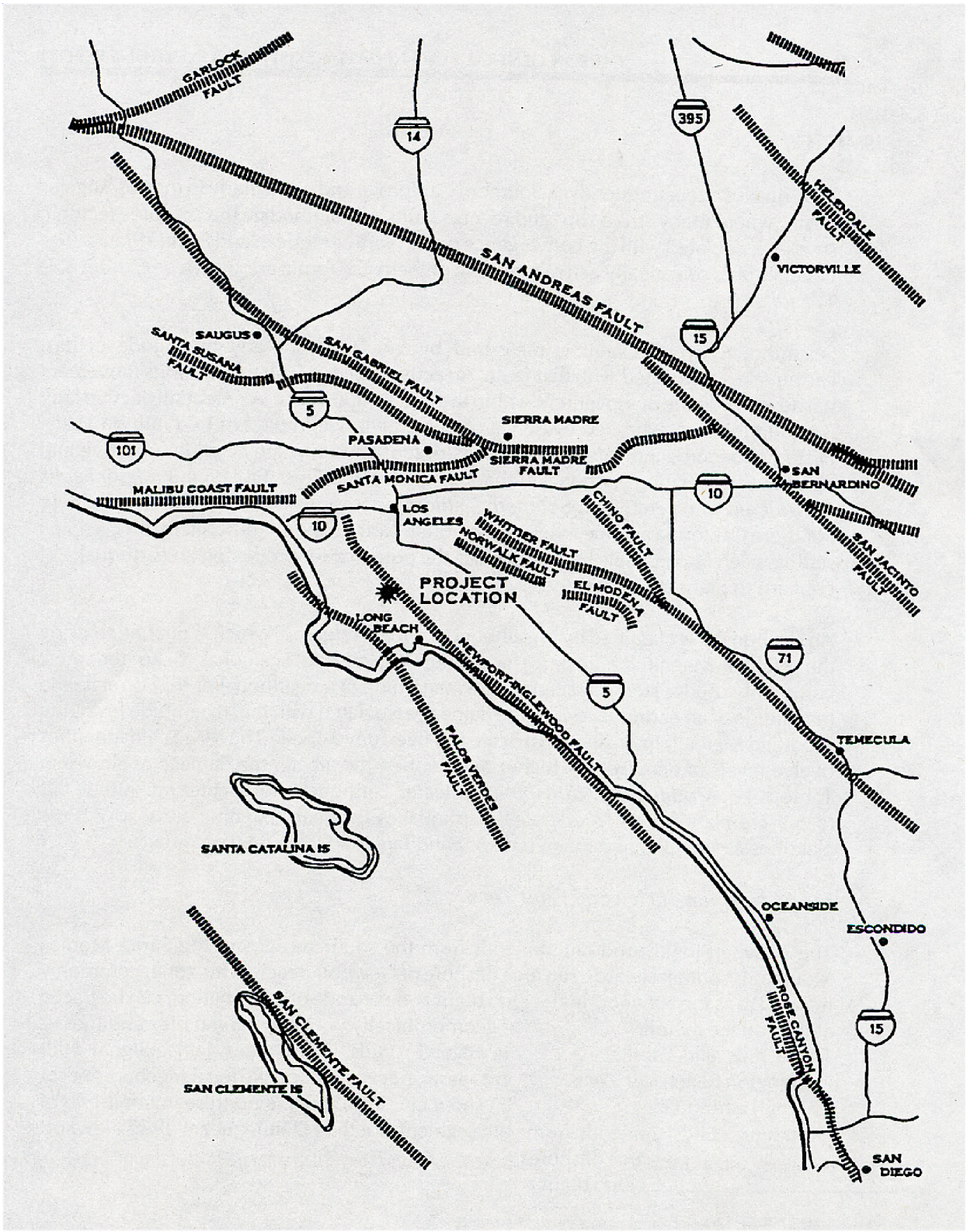
The Southern California region is considered to be seismically active. Earthquakes occur frequently, particularly in the Los Angeles Basin, where numerous faults accommodate the complex tectonic stresses caused by the convergence of the North American and Pacific Plates. Five major faults or zones present a seismic hazard for Carson: Newport-Inglewood Fault zone; San Andreas Fault zone; Palos Verdes Fault zone; Whittier Fault zone (Elysian Park structure); and Santa Monica Fault zone. Exhibit 4.6-1, *Regional Fault Map*, depicts these faults.

The intensity of earthquakes is measured, or expressed in terms of two scales. The Richter Scale measures the strength of an earthquake, or the strain energy released, as determined by seismographic observations. The Mercalli Intensity Scale (MM), describes the intensity in terms of observable impacts. Both measurement systems are referenced in the following discussions.

Newport-Inglewood Fault Zone. The Newport-Inglewood fault extends from the southern edge of the Santa Monica Mountains southeastward to an area offshore of Newport Beach. From north to south, the fault segments are:

- Charnock Fault;
- Overland Avenue Fault;
- Inglewood Fault;
- Portrero Fault;
- Avalon-Compton Fault;
- Cherry Hill Fault; and
- Seal Beach Fault.

This zone, commonly referred to as the Newport-Inglewood uplift zone or zone of deformation, can be traced at the surface by following a line of geomorphically young anticline hills and mesas. These hills and mesas include the Baldwin Hills, Dominguez Hills, Signal Hill, Huntington Beach Mesa and Newport Mesa. Recent earthquake focal mechanisms for 39 small earthquakes (1977 to 1985) show faulting along the north segment (north of Dominguez Hills) and along the south segment (south of Dominguez Hills to Newport Beach). The 1933 Long Beach earthquake has been attributed to movement on the Newport-Inglewood fault zone. Based on historic earthquakes, the fault zone is considered active. The Newport-Inglewood fault zone is considered capable of generating a maximum credible earthquake or a magnitude 7.0. The Cherry Hill branch of the Newport-Inglewood fault zone traverses Carson in the area of Dominguez Gap just to the north of Del Amo Boulevard. Movement along the fault is northeast side up, resulting in vertical displacement of waterbearing sediments extending for several miles.



N
W CARSON GEOGRAPHIC SERVICES E
S

Source: GIS Data, City of Carson, October 2002
OCTOBER 22, 2002

REGIONAL FAULT MAP

EXHIBIT 4.6-1

Avalon-Compton Fault/Regional Shear Zone. The Avalon-Compton Fault zone, which is part of the Newport-Inglewood Fault zone, has been identified by the California Department of Mines and Geology (CDMG) as the only active fault located in the City of Carson.[4] The Avalon-Compton fault is approximately four miles long and lies immediately east of Avalon Boulevard and north of the Redondo Beach/Artesia Freeway. Refer to Exhibit 4.6-1, *Regional Fault Map*. Historically, the Avalon-Compton fault/Regional Shear zone has moderate to high seismic activity with numerous earthquakes greater than Richter scale magnitude four. A geological study conducted on this fault concluded that the Avalon-Compton fault and associated Regional Shear zone is seismically active and may exist a depth within this area, but that no Holocene (or even late Pleistocene) ground rupture resultant from the two features exists in the areas studied.[5]

San Andreas Fault Zone. The San Andreas Fault zone is California's most prominent structural feature, trending in a general northwest direction for over 600 miles, encompassing virtually the entire length of California. The fault is divided into segments that have somewhat distinctive behavior patterns. The southern segment is approximately 280 miles long. It extends from the Mexican border into the transverse ranges west of Tejon Pass. Along this segment, there is no single traceable fault line (Lacopi, 1977); rather, the fault is composed of several branches. The fault is considered capable of generating a maximum credible earthquake of magnitude 8.25 (Greensfelder, 1974).

Palos Verdes Fault Zone. The Palos Verdes fault zone is located southwest of Carson and is traceable in the subsurface along the northern front of the Palos Verdes Hills. Zielbauer et al. (1962) report that early Pleistocene age San Pedro Formation beds are sharply unwarped along the fault trace, but that the fault does not cut materials younger than middle Pleistocene at the surface. Offshore data, consisting of acoustic and reflection profiles, show offset in the base of the Holocene material, suggesting very recent movement along the Palos Verdes Fault (Darrow and Fisher, 1983). The fault is considered capable of generating a maximum credible earthquake of magnitude 6.6.

Whittier Fault Zone (Elysian Park Structure). The 1987 Whittier Narrows earthquake (Richter magnitude 5.9) has been attributed to subsurface thrust faults (a low angle reverse fault) that are reflected at the earth's surface by a west-northwest trending anticline known as the Elysian Park Anticline (Lamar, 1970), or the Elysian Park structure. The axial trace of this structure extends approximately 12 miles through the Elysian Park-Repetto Hills from the Silver Lake area on the west to the Whittier Narrows on the east. The subsurface faults that create the structure are not exposed at the surface, and do not present a potential surface rupture hazard; however, as demonstrated by the 1987 earthquake and two smaller earthquakes on June 12, 1989, the faults are sources of future seismic activity. As such, the structure should be

[4] Effective January 1, 1994, the name "Special Studies Zones" has been changed to "Earthquake Fault Zones" and Chapter 7.5, Div. 2 of the Public Resources code has been renamed the "Alquist-Priolo Earthquake Fault Zoning Act".

[5] Source: *Dominguez Hills Village Specific Plan EIR*, prepared by Robert Bein, William Frost and Associates. September 1995. Page 5.1-4.

considered an active feature capable of generating future earthquakes. The fault is considered capable of generating a maximum credible earthquake of magnitude 6.75.

Santa Monica Fault Zone. The Santa Monica Fault is an east-west trending left reverse fault that extends approximately 24 kilometers within the immediate vicinity of Pacific Palisades, Westwood, Beverly Hills and Santa Monica. The annual slip rate is estimated between 0.27 millimeters (mm) and 0.39 mm per year along the fault. The Santa Monica Fault has the capability to generate between a 6.0 to 7.0-magnitude earthquake. The most recent surface rupture along this fault occurred during the Late Quaternary period (between 700,000 years ago and the present day).

GROUND SHAKING

The effects of ground shaking in Carson will vary considerably depending on the distance of the seismic source to the City and the duration of strong vibratory motion. In general, long-period seismic waves, characteristic of earthquakes that occur approximately nine miles or more from the area of concern, interact with and damage structures such as high-rise buildings, bridges, and freeway overpasses. Short-period waves, however, are generally very distinctive near the epicenter of moderate- and large-magnitude seismic events, causing severe damage predominately to low-rise rigid structures (less than three stories) not specifically designed to resist them.

Detectable ground shaking within the City of Carson could be caused by any of the active or potential active faults shown on Exhibit 4.6-1, *Regional Fault Map*. The Newport-Inglewood, Whittier, Santa Monica, and Palos Verdes Faults are the active faults most likely to cause high ground accelerations in the City.[6] The San Andreas Fault has the highest probability of generating a maximum credible earthquake in California within the next 30 years. The anticipated earthquake with a projected magnitude of 7.5 to 8.0 is thought to be capable of seismic intensity values of about IV to V on the Modified Mercalli (MM) Scale. Such an event would have an expected shaking duration of 35 to 50 seconds.

Alluvial deposits underlie the central and southeastern portions of the City, while Quaternary non-marine terrace deposits underlie the northern, western and southern portions of the City. Because of the area's unstable sub-base of sandy soil, Carson (as well as the entire South Bay area) is regarded as one of the most severe shock areas in the Los Angeles area.[7]

SURFACE RUPTURE

Surface faulting, rupture of the ground surface along a causative fault trace, is associated with the primary movement that produced the seismic event. Surface faulting is defined as slip on a fault plane that has propagated upwards to, and offsetting or disturbing, the earth's surface. Offset on a fault intersecting the ground surface can

[6] *1996 Sixth Amendment to Project Area No. 1 EIR*, Rincon, page 5.3-1, July 2, 1996.

[7] Ibid.

create a discrete step or fault scarp if fault slip occurs on a single fault plane or within a narrow fault zone. If fault slip is accommodated over a broader area, then the deformation may be manifest as a zone of fracturing and ground cracking with minor amounts of offset on individual fractures.

Principally studying the seismic history of the fault and reviewing geologic evidence, which suggest historic or prehistoric surface rupture, can determine the likelihood of surface rupture on a given fault. Past studies have shown that future surface faulting is most likely to occur where the trace ruptured last, especially if there is evidence repeated and significant displacement on the trace.

The Alquist-Priolo Earthquake Fault Zoning Act, (Public Resources Code 2621, Division 2, Chapter 7.5) regulates development near active faults so as to mitigate the hazard of surface fault-rupture. Under the Alquist-Priolo Earthquake Fault Zoning Act, designated fault zones (from inferred or trace fault information), require special studies to determine the on-site extent of the faults prior to development in the Earthquake Fault Zone (previously referred to as Special Studies Zone). The Act also requires that, prior to approval of a project, a geologic study be conducted to define and delineate any hazards from surface rupture. A geologist registered by the State of California, within or retained by the lead agency for the project must prepare this geologic report. A 50-foot setback from any known trace of an active fault is required. Additionally, a site-specific geological report is required for construction within 1/8 mile on either side of a fault zone.

The northernmost portion of the City is within an Alquist-Priolo Earthquake Fault Zone. The Avalon-Compton structural zone, which is part of the Newport-Inglewood Fault zone, is the only active fault within the City of Carson.

GROUND FAILURE

Seismically induced ground failure as discussed in this section includes liquefaction, differential compaction, ground lurching, ground cracking and earthquake induced slope failures.

LIQUEFACTION

Liquefaction of surface or subsurface materials is the result of strong ground shaking of water-saturated, loose to moderately dense sand and silty sand. It is defined as the transformation of a granular material from a solid state into a liquefied state as consequence of increased pore water pressure that occurs during an earthquake. Liquefaction can result in shifting of foundations, settling of roadways and rupture of underground pipelines and cables. Buildings and other objects on the ground surface can settle, tilt and collapse as the foundations beneath them lose support, and lightweight buried structures may float to the surface.

The Newport-Inglewood fault zone is a potential source of ground stress, and liquefaction could occur in the area if the ground water table were high enough during an earthquake. Due to existing conditions in the City, particularly in the alluvial and former slough areas, there is the possibility that liquefaction could impact buildings and/or other structures in the event of an earthquake. Exhibit 4.6-2, *Potential Liquefaction Areas*, shows the areas in the City that have shown historical occurrence of liquefaction, or local geological, geotechnical and groundwater conditions, indicating a potential for permanent ground displacements.

Differential Compaction or Settlement. Differential compaction resulting from earthquake ground shaking is potentially damaging to structures, buried utilities and services. Differential settlement may occur in cohesionless sediments where differences in densities in adjacent materials lead to different degrees of compaction during ground shaking. In the case of saturated cohesionless sediments, post earthquake settlement may occur when excess pore-water pressures generated by the earthquake dissipate.

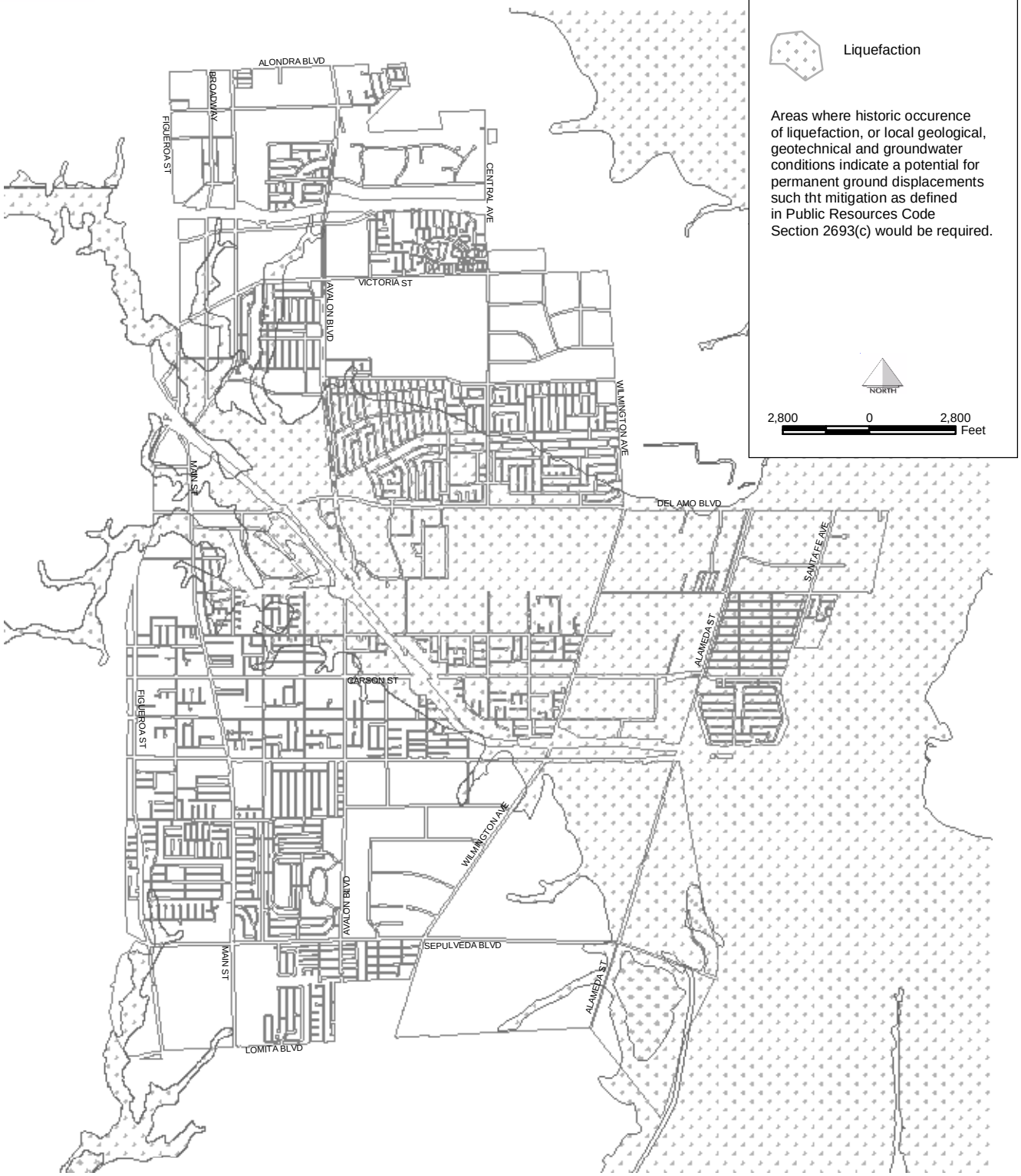
Differential settlement poses a major geotechnical constraint to development in Carson. Given the lateral and vertical variation of the alluvial soils underlying Carson, differential settlement could occur in areas thought to have a low susceptibility to settlement. There are 14 former landfills in the City. Areas where such activities have occurred may be subject to the generation of organic gases associated with decomposition, and possibly experience differential settlement as portions of the ground surface collapse inward.

Ground Cracking, Ground Lurching and Lateral Spreading. Both ground cracking and lurching are secondary features resulting from strong to moderately strong ground shaking and may be associated with liquefaction. Ground cracking usually occurs in near-surface materials, reflecting differential compaction or liquefaction of underlying materials. The potential for ground cracking exists especially in those areas of the City that have a moderate to high potential for liquefaction.

Ground lurching results when soft, water saturated surface soils are thrown into undulatory motion. Ground lurching usually occurs in those regions where a high potential for liquefaction occurs.

Lateral spreading (a form of landsliding) is referred to as limited displacement ground failure, often associated with liquefaction. Compact surface materials may slide on liquefied, or low shear strength layers at shallow depth, moving laterally several feet down slopes of less than two degrees. Such circumstances may be present where conditions conducive to shallow liquefaction exist.

Subsidence. The City of Carson is located within the Dominguez and Wilmington Oil Fields. There is no documented ground subsidence associated with the Dominguez Oil Field. However, the historic withdrawal of oil has been known to cause subsidence in portions of the Wilmington Oil Field. Total subsidence reached a maximum of 29 feet over the crest of the Wilmington anticline, where most of the oil has been withdrawn. Water injection to halt the subsidence was started in the late 1950s in the areas of



CARSON GEOGRAPHIC SERVICES

Source: State of California Seismic Hazard Zones Maps: Inglewood Quadrangle, Long Beach Quadrangle, Southgate Quadrangle and Torrance Quadrangle, March 25, 1999; Special Studies Zones, Torrance Quadrangle, July 1, 1986.
OCTOBER 22, 2002

POTENTIAL LIQUEFACTION AREAS

EXHIBIT 4.6-2

maximum subsidence, but did not become a significant factor until 1971-72.[8] According to the 1981 Carson Safety Element historical subsidence within the City is now under control.

Shallow or Perched Groundwater. Shallow or perched groundwater can cause problems when designing multi-story buildings or underground facilities, such as parking lots or storage tanks. Construction of underground facilities usually requires excavating near vertical walls of earth. Shallow groundwater conditions combined with loose unconsolidated sediments tend to make these types of excavations unstable, requiring special construction techniques to insure the safety of workers. Also of concern is the additional pressure that the groundwater adds against subterranean walls. Special drainage systems have to be designed to help reduce the additional pressure and to prevent flooding. In addition, leaking of underground storage tanks can cause contamination of the underlying regional water table. Groundwater within the City of Carson occurs at a depth of approximately 30 feet below ground surface (bgs) to 70 feet bgs.[9]

Slope Stability. Seismically related slope stability problems include landslides, rockfalls, mudslides and avalanches. Due to the relative absence of significant elevation changes in the City, slope instability in Carson is limited to the slopes adjacent to the flood control channels that intersect the City. The loose unconsolidated nature of the sediments, exposed in those slopes not faced with concrete may cause the slopes to be surficially unstable.

Shrink/Swell Potential. Shrink/swell characteristics with the City of Carson present a geotechnical constraint within the City. Soils with high clay content typically have high shrink/swell characteristics. Shrinking and swelling of soil can cause overlying concrete to crack and settle. Table 4.6-1, *General Physical Properties of Soils in the Carson Area*, identify the shrink-swell potential of soils within Carson.

LANDSLIDES

Earthquake-induced landslides of steep slopes occur in either bedrock or soils and can result in undermining of buildings, severe foundation damage and collapse. Although earthquake activity does induce some landsliding, most slides result from the weight of water-saturated soil and rock exceeding shear strength of the underlying material.

No landslide areas exist within the City of Carson. According to the California Department of Mines and Geology, no areas are known to exist within the City where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground

[8] *Alameda Corridor Environmental Impact Report,* prepared by Myra L. Frank & Associates, Inc., page 4-10, January 1993.

[9] *Annual Survey and Report of Groundwater Replenishment,* Water Replenishment District of California, Plate 2, 1998.

displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.[10]

4.6.2 STANDARDS OF SIGNIFICANCE

SIGNIFICANCE CRITERIA

In accordance with CEQA, the effects of a project are evaluated to determine if they will result in a significant adverse impact on the environment. An EIR is required to focus on these effects and offer mitigation measures to reduce or avoid any significant impacts which are identified. The criteria, or standards, used to determine the significance of impacts may vary depending on the nature of the project. Geology and Soils impacts resulting from the implementation of the proposed General Plan may be considered significant if they cause any of the following results:

- 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;
    - Strong seismic ground shaking;
    - Seismic-related ground failure, including liquefaction;
    - Landslides;
- Result in substantial soil erosion or the loss of topsoil;
- 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 landslides, lateral spreading, subsidence, liquefaction or collapse;
- Be located on expansive soil, as defined in Table 18- 1-B of the Uniform Building Code (1994), creating substantial risk to life or property; and/or
- 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 (refer to Section 7.0, *Effects Found Not to Be Significant*).

Based on these standards, the effects of the proposed project have been categorized as either a "less than significant impact" or a "potentially significant impact." Mitigation measures are recommended for a potentially significant impact. If a potentially

[10] California Department of Mines and Geology, Official Map of Seismic Hazard Zones. August 15, 2001. http://www.consrv.ca.gov/dmg/shezp/maps.

significant impact cannot be reduced to a less than significant level through the application of mitigation, it is categorized as a significant and unavoidable impact.

4.6.3 IMPACTS AND MITIGATION MEASURES

FAULT RUPTURE

❍ **IMPLEMENTATION OF THE PROPOSED GENERAL PLAN MAY RESULT IN GEOLOGIC OR SEISMIC HAZARDS WITH RESPECT TO RUPTURE OF A KNOWN EARTHQUAKE FAULT.**

Level of Significance Before Policies/Mitigation: Potentially Significant Impact.

Impact Analysis: The California Department of Mines and Geology has identified that the Avalon-Compton fault, which is part of the Newport-Inglewood Fault Zone, is an area designated as an Alquist Priolo Earthquake Fault Zone. Land use designations within this fault zone include: High Density Residential, Low Density Residential, Light Industrial, Public Facilities and General Commercial. Although the Newport-Inglewood Fault Zone is seismically active, surface faulting does not appear to be a significant potential hazard.

A site-specific geologic report is required for construction within 1/8 mile on either side of an Earthquake Fault Zone established by the CDMG. Any development would require compliance with seismic safety design requirements as stated in the current Uniform Building Code (UBC), or City Building Code.

According to Alquist Priolo criteria, if a site investigation precisely locates or demonstrates a lack of active fault rupture within the Alquist Priolo Earthquake Fault Zone, setbacks or "non-structural" zones can be reduced or eliminated. A geological study was conducted on this fault as part of an EIR prepared for the Dominguez Hills Village Specific Plan.[11] The report recommended no setbacks in compliance with Alquist Priolo criteria.

The City of Carson has identified minimizing the risk of injury, loss of life and property damage caused by earthquake hazards as one of its primary goals in the Safety Element of the proposed General Plan (SAF-1). Policies such as requiring development to comply with seismic design standards and educating residents regarding earthquake safety are included to achieve the City's goals. Implementation of the proposed General Plan with its goals and policies and compliance with Alquist Priolo Earthquake criteria would reduce any impacts as a result of fault rupture within the City to a less than significant.

Policies in the Proposed General Plan: The Safety Element includes the following policies:

[11] Source: *Dominguez Hills Village Specific Plan EIR*, prepared by Robert Bein, William Frost and Associates. September 1995. Page 5.1-4.

SAF-1.1 Continue to require all new development to comply with the most recent City Building Code seismic design standards.

SAF-1.2 Work with the City's Public Information Office and Public Safety Division to:

- Educate residents in earthquake safety at home,
- Educate the public in self-sufficiency practices necessary after a major earthquake (e.g., alternative water sources, food storage, first aid, family disaster plans, and the like), and
- Identify locations where information is available to the public for planning self-sufficiency.

SAF-1.3 Examine the potential to create a commercial loan program to subsidize the cost of retro-fitting buildings to meet seismic safety regulations. To this end, pursue all sources of State and federal funding in order to retro-fit buildings to meet seismic requirements.

Mitigation Measures: No mitigation measures beyond the policies identified in the proposed General Plan are required.

Level of Significance After Policies/Mitigation: Less Than Significant Impact.

SEISMIC GROUND SHAKING

❍ **SEISMIC GROUND SHAKING AND SECONDARY SEISMIC EFFECTS IN THE CITY DURING AN EARTHQUAKE ON THE NEARBY REGIONAL FAULTS MAY CAUSE DAMAGE TO DEVELOPMENT RESULTING FROM IMPLEMENTATION OF THE PROPOSED GENERAL PLAN.**

Level of Significance Before Policies/Mitigation: Potentially Significant Impact.

Impact Analysis: Earthquakes are a common occurrence in Southern California. Four faults are located within close proximity to the City of Carson: Newport-Inglewood, Whittier, Santa Monica and Palos Verdes Faults. The San Andreas Fault, located further from the City, is considered capable of delivering much larger magnitude earthquakes to Carson.

Development under the proposed General Plan may result in the addition of up to 1,839 residential units and approximately 15 million square feet of non-residential uses, thereby exposing more people (residents and employees) to the effects of ground shaking from regionally generated earthquakes. Strong seismic ground shaking could result in substantial damage to some buildings within the City of Carson.

The effects of seismically induced ground shaking are probably the most critical potential seismic hazards to the City of Carson. Seismic hazards include secondary effects of seismically induced ground failure including liquefaction and landslides. Property damage, personal injury, and loss of life may result from such events.

The City of Carson has identified natural disasters, such as earthquakes as an issue to be addressed in the proposed General Plan. One of the goals identified in the Safety Element is to minimize the risk of injury, loss of life and property damage caused by earthquake hazards (SAF-1). The policies include ensuring compliance with the UBC and creating loan programs to subsidize the costs of retrofitting buildings to meet seismic safety regulations. In addition to the policies proposed, the mitigation measures found below would reduce seismic impacts to less than significant levels.

Policies in the Proposed General Plan: The Safety Element includes the following policies:

SAF-1.1 Continue to require all new development to comply with the most recent City Building Code seismic design standards.

SAF-1.2 Work with the City's Public Information Office and Public Safety Division to:

- Educate residents in earthquake safety at home,
- Educate the public in self-sufficiency practices necessary after a major earthquake (e.g., alternative water sources, food storage, first aid, family disaster plans, and the like), and
- Identify locations where information is available to the public for planning self-sufficiency.

SAF-1.3 Examine the potential to create a commercial loan program to subsidize the cost of retro-fitting buildings to meet seismic safety regulations. To this end, pursue all sources of State and federal funding in order to retro-fit buildings to meet seismic requirements.

SAF-3.1 Continue to ensure that each development or neighborhood in the City has adequate emergency ingress and egress.

SAF-3.2 Maintain and update, as necessary, the SEMS Multihazard Functional Plan which identifies emergency response and recovery actions in the event of an incident.

Mitigation Measures: In addition to the policies listed above, the following mitigation measures are recommended to further reduce any impacts.

MM-SAF-1 Due to the potential for ground shaking in a seismic event, individual development projects shall comply with the standards set forth in the Uniform Building Code (most recent edition) to assure seismic safety to the satisfactions of the Department of Building and Safety prior to issuance of a building permit, including compliance with California Division of Mines and Geology Special Publication 117 (Guidelines for Evaluation and Mitigating Seismic Hazards in California, adopted March 13, 1997). Given the proximity of the Avalon-Compton fault within the City of Carson, more stringent measures may be warranted.

MM-SAF-2 Individual development projects shall comply with non-structural seismic mitigation measures, e.g. overhead glass treatments shall use safety glass or film; vending machines, ice machines (if used) and other types of machines and equipment shall be bolted or braced. Pictures and decorative items within common areas shall be secured for earthquake safety.

MM-SAF-3 Ensure individual development projects compliance with current seismic mitigation codes.

Level of Significance After Policies/Mitigation: Less Than Significant Impact.

LIQUEFACTION

❍ **IMPLEMENTATION OF THE PROPOSED GENERAL PLAN MAY RESULT IN IMPACTS RELATED TO LIQUEFACTION.**

Level of Significance Before Policies/Mitigation: Less Than Significant Impact.

Impact Analysis: Historically, the City of Carson has demonstrated occurrences of liquefaction throughout significant portions of the central and southeast sections of the City. Liquefaction occurs in areas underlain by water-saturated granular soils, particularly in the alluvial and former slough areas. Historical occurrences of liquefaction have occurred primarily in the center of the City, adjacent to and northeast of the San Diego Freeway (I-405) and in the southeast portion of the City.

It is impossible to eliminate or avoid seismic hazards within Southern California. However, the City of Carson acknowledges the necessity to address these hazards and to minimize the damage that liquefaction resulting from seismic activity can cause within the City. As a result, Carson has identified the reduction of seismic hazards as one of its goals (SAF-1). Implementation of the policies in the proposed General Plan and the mitigation measure would ensure that impacts resulting from liquefaction remain at less than significant levels.

Policies in the Proposed General Plan: The Safety Element includes the following policies:

SAF-1.1 Continue to require all new development to comply with the most recent City Building Code seismic design standards.

SAF-1.3 Examine the potential to create a commercial loan program to subsidize the cost of retro-fitting buildings to meet seismic safety regulations. To this end, pursue all sources of State and federal funding in order to retro-fit buildings to meet seismic requirements.

Mitigation Measures: In addition to the policies listed above, the following mitigation measure is recommended to further reduce any impacts.

MM-SAF-4 Individual development projects shall comply with the standards set forth in the UBC (most recent edition) for structures on-site to assure safety of the occupants to the satisfaction of the Department of Building and Safety prior to issuance of a building permit. These standards included compliance with California Division of Mines and Geology Special Publication 117 (Guidelines for Evaluating and Mitigating Seismic Hazards in California, adopted march 13, 1997) and "Recommended Procedures for Implementation of CDMG Special Publication 117- Guidelines for analyzing and Mitigating Liquefaction in California" (Dr. Geoffrey R. Martin et al, May 1999).

Level of Significance After Policies/Mitigation: Less Than Significant Impact.

LANDSLIDES

- **IMPLEMENTATION OF THE PROPOSED GENERAL PLAN MAY RESULT IN IMPACTS RELATED TO LANDSLIDES.**

Level of Significance Before Policies/Mitigation: Less Than Significant Impact.

Impact Analysis: The Seismic Hazards Mapping Program of the California Geological Survey identifies Seismic Hazard Zones within the State of California. Official maps, released March 25, 1999 verify that there are no areas known to exist with in the City of Carson where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements.[12] As a result, no mitigation in compliance with Public Resources Code 2693 (c) would be required. In addition, policies proposed in the General Plan would ensure that any impacts resulting from seismic induced landslides remain at less than significant levels.

Policies in the Proposed General Plan: The Safety Element includes the following policy:

SAF-1.1 Continue to require all new development to comply with the most recent City Building Code seismic design standards.

Mitigation Measures: No mitigation measures beyond the policies identified in the proposed General Plan are required.

Level of Significance After Policies/Mitigation: Less Than Significant Impact.

SOIL EROSION

- **IMPLEMENTATION OF THE PROPOSED GENERAL PLAN MAY RESULT IN IMPACTS RELATED TO SOIL EROSION OR THE LOSS OF TOPSOIL.**

[12] California Department of Conservation, Division of Mines and Geology, State of California Seismic Hazard Zone, Torrance and Long Beach Quadrangle, Official Map, Released March 25, 1999.

Level of Significance Before Policies/Mitigation: Less Than Significant Impact.

Impact Analysis: The City of Carson is relatively flat resulting in a low potential for soil erosion. The Dominguez Hill area does provide the opportunity for soil erosion during rain.

Implementation of the proposed General Plan would result in development of vacant and underutilized parcels. The City has established several requirements for development to minimize soil erosion, including grading requirements for all hillside developments and temporary erosion control measures during severe weather conditions. The Geology Division of the County Engineers office reviews all subdivision maps to assess impacts of development within the City. In addition, the City has identified specific policies to further reduce impacts from soil erosion. Implementation of the proposed General Plan, City established requirements and the following mitigation measure would ensure that soil erosion impacts remain at less than significant levels.

Also, refer to impact discussion related to storm water runoff in Section 4.7, *Hydrology and Drainage.*

Policies in the Proposed General Plan: The Open Space/Conservation Element includes the following policy:

OSC-2.3 Minimize soil erosion and siltation from construction activities through monitoring and regulation.

Mitigation Measures: In addition to the policy listed above, the following mitigation measure is recommended to further reduce any impacts.

MM-SAF-5 Grading plans for development projects shall include an approved drainage and erosion control plan to minimize the impacts from erosion and sedimentation during grading. Plans should conform to all standards adopted by the City and meet the requirements of Storm Water Pollution Prevention Plans (SWPPS) required by California State Water Resources Control Board.

Level of Significance After Policies/Mitigation: Less Than Significant Impact.

UNSTABLE OR EXPANSIVE SOILS

- **IMPLEMENTATION OF THE PROPOSED GENERAL PLAN MAY RESULT IN IMPACTS RELATED TO EXPANSIVE SOILS OR SOIL STRENGTH.**

Level of Significance Before Policies/Mitigation: Potentially Significant Impact.

Impact Analysis:

Differential Settlement. Variations in the alluvia soils underlying the City of Carson may allow for differential settlement within the City. Sites historically used as landfills may possibly experience differential settlement as portions of the ground surface collapse inward. The City of Carson requires preparation, approval and compliance with a geotechnical report prepared by a California-registered engineering geologist prior to any development within these areas. Additionally, compliance with design requirements as stated in the current Uniform Building Code (UBC) would reduce impacts to a less than significant level. Refer to Section 4-10, *Public Health and Safety*, for further information regarding landfills.

Subsidence. Subsidence has occurred within the City as a result of previous withdrawal of oil within the Wilmington Oil Field. However, Carson has maintained control of any further subsidence within the City. Therefore, less than significant impacts are anticipated in this regard.

Shallow or Perched Groundwater. The City of Carson requires special construction measures during excavation, such as dewatering and use of temporary shoring. In addition, drainage systems are required to be designed to help reduce the additional pressure of groundwater and to prevent flooding. Any dewatering would require appropriate permitting from the County of Los Angeles and Regional Water Quality Control.

Slope Instability. Slope instability in Carson is limited to the slopes adjacent to the flood control channels that within the City. Instability may occur due to the unconsolidated nature of the sediments, exposed in those slopes. Impacts in this regard are anticipated to be less than significant.

Shrink and Swell Potential. Unstable soils, such as the Ramona-Placentia sandy loam in the City of Carson provide an unsound base for construction and should be evaluated on a site-specific basis. The following mitigation measure would reduce impacts resulting from unstable geologic units or expansive soils to less than significant.

Policies in the Proposed General Plan: No policies within the proposed General Plan apply to potential impacts resulting from unstable geologic units or expansive soils.

Mitigation Measures: The following mitigation measure is recommended to further reduce any impacts.

MM-SAF-6 Future development shall comply with all recommendations contained in site-specific geologic, geotechnical, and structural design studies prepared for land development projects. These geotechnical reports shall address soil conditions, including low soil strength, shrink swell potential and other unstable soil conditions. Recommendations contained in these site-specific studies shall be reviewed and approved by the Building Official and incorporated in to final grading and structural design plans, as deemed appropriate by the Building Official.

Level of Significance After Policies/Mitigation: Less Than Significant Impact.

4.6.4 UNAVOIDABLE SIGNIFICANT IMPACTS

All geologic and seismic impacts associated with implementation of the proposed General Plan would be less than significant by adherence to/compliance with the policies proposed and with the imposition of mitigation measures. No unavoidable significant geologic or seismic impacts would occur as a result of implementation of the proposed General Plan.