1. INTRODUCTION

This section addresses the potential impacts of the Project relative to geologic and seismic hazards. The following analysis describes the regulatory setting, regional and local earthquake faults, existing physical features of the Project site, and the context of the Project in relation to soil stability and geologic risk. The evaluation of soils and geologic conditions on the Project site is based on the following reports:

- Western Laboratories, Geotechnical Engineering Report for Proposed Commercial Development and Northeast Corner of Main Street and Del Amo Boulevard, December 24, 1996;
- Brown & Root Environmental – Geotechnical Investigation, September 5, 1996;
- Law/Crandall, Report of Geotechnical Investigation and Pile Loading Testing for L.A. Metromall, September 5, 1996;
- Converse Environmental West, Preliminary Environmental Site Assessment for 10-acre Parcel at Main and Del Amo, Carson, California, February 26, 1990; and
- NorCal Engineering, Soils Investigation for Proposed Industrial Development at Main Street and Del Amo, 1986.

These documents are on file at the City of Carson Community Development Department, located in the Carson City Hall, 701 East Carson Street.

2. ENVIRONMENTAL SETTING

a. Regulatory Environment

(1) State of California Alquist-Priolo Earthquake Fault Zones

The primary purpose of the Alquist-Priolo Earthquake Fault Zoning Act (1972) is to prevent construction of buildings used for human occupancy on the surface trace of active faults.

The Alquist-Priolo Act requires the State Geologist to establish regulatory zones, known as Earthquake Fault Zones, around the surface traces of active faults and to issue appropriate maps to assist cities and counties in planning, zoning, and building regulation functions. Local agencies must enforce the Alquist-Priolo Act in the development permit process, where applicable, and may be more restrictive than state law requires. According to the Alquist-Priolo Act, before a project can be permitted, cities and counties shall require a geologic investigation, prepared by a licensed geologist, to demonstrate buildings would not be constructed across active faults. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back, a minimum 50-feet from the fault trace.

(2) State of California Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (1990) addresses the effects of strong ground shaking, liquefaction, landslides, and other ground failures due to seismic events. Under the Seismic Hazards Mapping Act, the State Geologist is required to delineate “seismic hazard zones.” Cities and counties must regulate certain development projects within the zones until the geologic and soil conditions of the development site are investigated and appropriate mitigation measures, if any, are incorporated into development plans. State publications supporting the requirements of the Seismic Hazards Mapping Act include the CDMG SP 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California* and CDMG SP 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California*. The objectives of SP 117 are to assist in the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations and to promote uniform and effective statewide implementation of the evaluation and mitigation elements of the Seismic Hazards Mapping Act. SP 118 implements the requirements of the Seismic Hazards Mapping Act in the production of Probabilistic Seismic Hazard Maps for the state. SP 118 also establishes criteria for the determination of landslide hazard zones and liquefaction hazard zones. Seismic evaluation and Hazard Maps have been prepared for the Newport-Inglewood fault system, Oak Ridge system, Palos Verdes Fault, Raymond Fault, Santa Monica fault system, Sierra Madre fault system (San Fernando Fault), and the Los Angeles Blind Thrust Faults, including the Compton, Elysian Park, Northridge, and Puente Hills faults. State Seismic Hazards Maps identify portions of the City of Carson, including the Project site as an area of high liquefaction potential, based on soil type, ground water tables, and the high seismicity of the area.

(3) State of California Department of Toxic Substances Control Remedial Action Plan

The State of California Department of Toxic Substances Control (DTSC) prepared a Final Remedial Action Plan (RAP) (October 1995) to address contamination in soils and groundwater on the former landfill site in Development Districts 1 and 2. Pertinent to soil stability, the RAP outlines a procedure for the capping of the waste layers and the overlaying and compaction of fill soils. Due to the presence of the capped waste and need to maintain the integrity of the proposed cap, the RAP establishes specific criteria for site development. Criteria for the approved RAP soil cover depths are addressed in Section IV.D, Hazards. The RAP anticipates that building foundations would use a pile system, with individual piles driven to the bearing soil beneath the waste and that this design would support buildings over the landfill refuse. The 1995 RAP also specifies that the piles would incorporate a sealable sleeve between the piles and the refuse liner and provide controlled slacks to allow for settlement.

(4) City of Carson General Plan Seismic Safety and Safety Element (2004)

The City's General Plan Safety Element identifies a range of hazards, including geologic hazards that may affect the City of Carson. According to the Safety Element, the geologic and seismic hazards appearing to pose the greatest threat to the City include differential settlement[45]soil instability due to shallow or perched groundwater, shrink/swell potential in native clay soils, and ground shaking due to active and potentially active fault zones throughout the region. The Safety Element identifies the Newport-Inglewood Fault Zone, the Avalon-Compton Fault Zone, the Palos Verdes Fault Zone, the Whittier Fault Zone, and the Santa Monica Fault Zone as the active faults most capable of producing earthquakes that could affect the City. The Safety Element also addresses seismically induced ground failure, including liquefaction, ground lurching, and ground cracking and presents an exhibit of the areas in the City which have shown a historical occurrence of liquefaction, or local geological, geotechnical and groundwater conditions having the potential for permanent ground displacement.

The objective of the Safety Element is the reduction of death, injury, property damage, economic suffering, and social dislocation that would result from ground failure or earthquake damage. Applicable policies include the following:

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

<u>SAF. 1.2</u>. Work with the City's Public Information Office and Public Safety Division to:

- Educate residents in earthquake safety at home,
- Educate public in self-sufficiency practices necessary after a major earthquake (e.g., alternative water sources, food storage, first aid, family disaster plans), and

[45] *As used in the context of a geotechnical evaluation, differential settlement is the irregular sinking of the ground surface under any single structure. Such settlement has the potential to result in foundation damage.*

- Identify locations where information is available to the public for planning self-sufficiency.

(5) City of Carson Municipal Code

The City of Carson Municipal Code incorporates by reference the building requirements of the Los Angeles County Code in relation to grading, soils, and geologic issues. Building Code (Title 26) Section 110.2, addresses geotechnical hazards and states that a building or grading permit shall be issued when the City's Building Official finds that a hazardous geological condition, such as potential settlement, is not present or would not be accelerated by development. An engineering geology and/or soils engineering report(s) must be prepared that indicates to the satisfaction of the City's Building Official that the hazard would be eliminated prior to the use or occupancy of the land or structures by modification of topography, reduction of subsurface water, buttressing, a combination of these methods, or by other means.

Section 110.3 of the City's Building Code prohibits the construction of buildings or structures within 1,000 feet of fills containing rubbish or other decomposable material unless the fill is isolated by approved natural or artificial protective systems or unless designed according to the recommendations contained in a report prepared by a licensed civil engineer. In addition to concerns regarding decomposition gases, this Code section requires that buildings or structures shall not be constructed on fills containing rubbish or other decomposable material unless provision is made to prevent damage to structures, floors, underground piping and utilities due to uneven settlement of the fill. Engineering geology or soils engineering reports required under Section 111 of the City's Building Code, shall contain a finding regarding the safety of the building site for the proposed structure against hazard from landslide, settlement or slippage and a finding regarding the effect that the proposed building or grading would have on the geotechnical stability of property outside of the building site. Any engineering geology report shall be prepared by a certified engineering geologist licensed by the State of California. Any soils engineering report shall be prepared by a civil engineer, registered in the State of California, experienced in the field of soil mechanics, such as a soils engineer.

Sections 112 and 113 of the City's Building Code incorporates earthquake fault zone maps and regulates the construction of structures in the proximity of earthquake zones. Chapter 16 of the Building Code establishes foundation and building structural standards that are designed to protect development in hazardous areas, including fault precaution zones and liquefaction susceptibility zones established by the State of California.

Under Chapter 33 of the Building Code, a project's soils engineering report shall include data regarding the nature, distribution and strength of existing soils, conclusions and recommendations for grading procedures and design criteria for corrective measures, including buttress fills, when necessary, and an opinion on the adequacy of the site for its proposed use based on soils engineering factors, including the stability of slopes. Recommendations included in the reports and approved by the City's Building Official shall be incorporated into the Project's grading plan or specifications. The engineering geology report is required to include an adequate description of the geology of the site, conclusions and recommendations regarding the effect of geologic conditions on the proposed development, and opinion on the appropriateness of the development based on geologic factors.

b. Physical Environment

(1) Soils and Geology Profile

The Project site is located in the Torrance Plain within the West Coast Basin, a southern portion of the greater Los Angeles Basin. The Torrance Plain is an older marine plain consisting mainly of recent alluvium and the upper Pleistocene Lakewood Formation, which overlies the lower Pleistocene-era San Pedro Formation. The recent alluvium consists primarily of stream deposits inter-bedded with fine-grained estuary/bay deposits. Deposition has been controlled by tectonic activity, geomorphic processes, changes in climate, and worldwide changes in sea level. In the general area of the Project site, the early Pleistocene age San Pedro Formation underlies the upper Pleistocene deposits. The San Pedro Formation is approximately 550 feet thick beneath the Project site and consists of interlayered sand, silt, and clay.[46]

(a) Development Districts 1 and 2

Development Districts 1 and 2 previously served as a Class II landfill, in which waste was placed in trenched cells. The thickness of the waste increases rapidly from very shallow (approximately 1.75 feet) feet adjacent to the haul roads to more than 60 feet in the interior of the waste cells. The estimated volume of solid waste in the landfill is 6,260,000 cubic yards.[47] There is no waste beneath the haul roads. Little or no waste underlies the existing dirt road bordering the site immediately north of the Torrance Lateral Channel. Borings conducted during prior geotechnical evaluations of the site determined that the refuse ranges from between 29.5 and 54.25 feet thick (borings 5, 6, 12, and 16). The average thickness of the waste is approximately 40 feet in depth.[48] A soil cover, consisting predominantly of fine-grained silt and

[46] *Brown & Root Environmental Geotechnical Report for LA Metromall (September 5, 1996), reference based on prior California Department of Public Works geology report (1960).*

[47] *The Los Angeles County Engineer had calculated that the landfill had a capacity of less than 7 million cubic yards.*

[48] *Brown & Root Environmental, Geotechnical Report for LA Metromall (September 5, 1996).*

clay, with varying minor amounts of sand, currently overlies the compacted waste area.[49] The soil cover ranges from three to 30 feet in thickness across the site.

The native soils underlying the existing cover soils consist of alluvial deposits of the Lakewood Formation. The site is underlain by late Pleistocene age deposits that are divided litohologically into an upper portion, consisting of a semiperched zone and layers of impermeable silt and clay and a lower portion consisting of coarser grained materials that form an aquifer designated as the “200-foot sand.” In the vicinity of the Development Districts 1 and 2, the top of the “200-foot sand” is found at an elevation of approximately 90 feet below mean sea level (MSL).[50] Deposits encountered in borings consist of sand, silty sand, sandy silt, with interlayering of clayey silt and silty clay between 57 feet and 70 feet below MSL. At greater than 70 feet below MSL, predominantly fine grained deposits of silt, clayey silt, and sandy silt were encountered.[51]

(b) Development District 3

Development District 3 is underlain by the Lakewood Formation, which contains soils with adequate strength to support building foundations. This formation is concealed by overlying alluvium and fill. This parcel also contains a variety of imported fill soils that have been randomly placed over the central portion of the site. A portion of the stockpiled material contains large amounts of broken concrete and asphalt pavement, with evidence of minor deleterious debris. Geotechnical excavations conducted in 1986, ranged from 4.0 to 21.0 feet in depth. Excavations found disturbed top soil and fill soils to depths ranging from 0.5 to 15.0 feet. The depth of the fill soils is exclusive of stockpiled areas, which were inaccessible. Encountered fill soils contained minor debris and gravel. Although the majority of the Development District 3 is relatively level, the deeper portion of fill soils appeared to be in the central portion of the site, which was previously a low area. This area was filled in the past to gain access to the easterly portion of the property.[52]

In 1996 field studies, fill soils were found to be shallower, with the majority of the excavations containing fill soils ranging in depth from 1.0 to 6.5 feet below ground surface. The fill soils are classified as clays with concrete and asphalt fragments; sands, with concrete and asphalt fragments; and sandy clays with gravel. The native soils, underlying the fill soils are

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[49] *Ibid.*

[50] *Brown & Root, Op. Cit., reference is based on prior California Department of Water Resources report (1957).*

[51] *Brown & Root, Op. Cit., reference is based on California Department of Public Works report (1960).*

[52] *NorCal Engineering, Soils Investigation for Northeast Corner of Main Street and Del Amo Boulevard, page 3 (1986).*

classified as medium dense to very dense sand and silts.[53] Expansion Index Tests, performed on undisturbed native soils, determined the upper soils to have low to medium expansion potential. However, due to the unconsolidated nature and debris content of overlying fill soils, geotechnical investigators have concluded that the fill and low density natural soils are not suitable to provide support for slabs on grade, pavement, and building foundations, and must be removed and re-compacted prior to development.[54]

(2) Geological Hazards

(a) Earthquake Faults

A notable amount of seismic activity, associated with the Pacific and North American plates contact zone, is produced in Southern California. In the Los Angeles Basin numerous faults accommodate the complex tectonic stresses caused by the convergence of these plates. Active faults are of the greatest concern for earthquake generation and fault rupture potential since they represent documented Holocene age fault movement and are clearly associated with historic seismicity. As shown in Figure 31 on page 318, five major faults or zones present a seismic hazard within the region. These include the Newport-Inglewood fault zone, the San Andreas fault zone; Palos Verdes fault zone; Whittier fault zone (Elysian Park structure), and the Santa Monica fault zone.

The Newport-Inglewood fault zone can be traced at the surface by geomorphically young hills and mesas, including Baldwin Hills, Dominguez Hills, Signal Hill, Huntington Beach Mesa, and Newport Mesa. An evaluation of 39 small earthquakes (1977 to 1985) indicates faulting along the north segment (north of Dominguez Hills) and along the south segment (south of Dominguez Hills to Newport Beach). Based on historic earthquakes, the fault zone is considered active. The Newport-Inglewood fault zone, which is located approximately 2.2 miles northeast of the Project site is considered capable of generating a maximum earthquake with a magnitude 7.0 on the Richter scale. Fault segments associated with the Newport-Inglewood fault zone include the Charnock Fault, located approximately 10.5 miles to the northwest of the Project site; the Overland Avenue Fault, located approximately 11.2 miles to the northwest of the Project site; and the Norwalk fault, located approximately 12 miles to the northeast of the Project site. The Cherry Hill Fault is located on the eastern edge of the City in the Dominguez Gap, to the north of Del Amo Boulevard. The Avalon-Compton fault has been identified by the California Department of Mines and Geology (CDMG) as the only active fault located in the City of

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53 *Western Laboratories Geotechnical Engineering, page 5 (December 24, 1996).*

54 *NorCal Engineering, Soils Investigation for Northeast Corner of Main Street and Del Amo Boulevard, page 5 (1986) and [54] Western Laboratories Geotechnical Engineering, page 8 (December 24, 1996).*

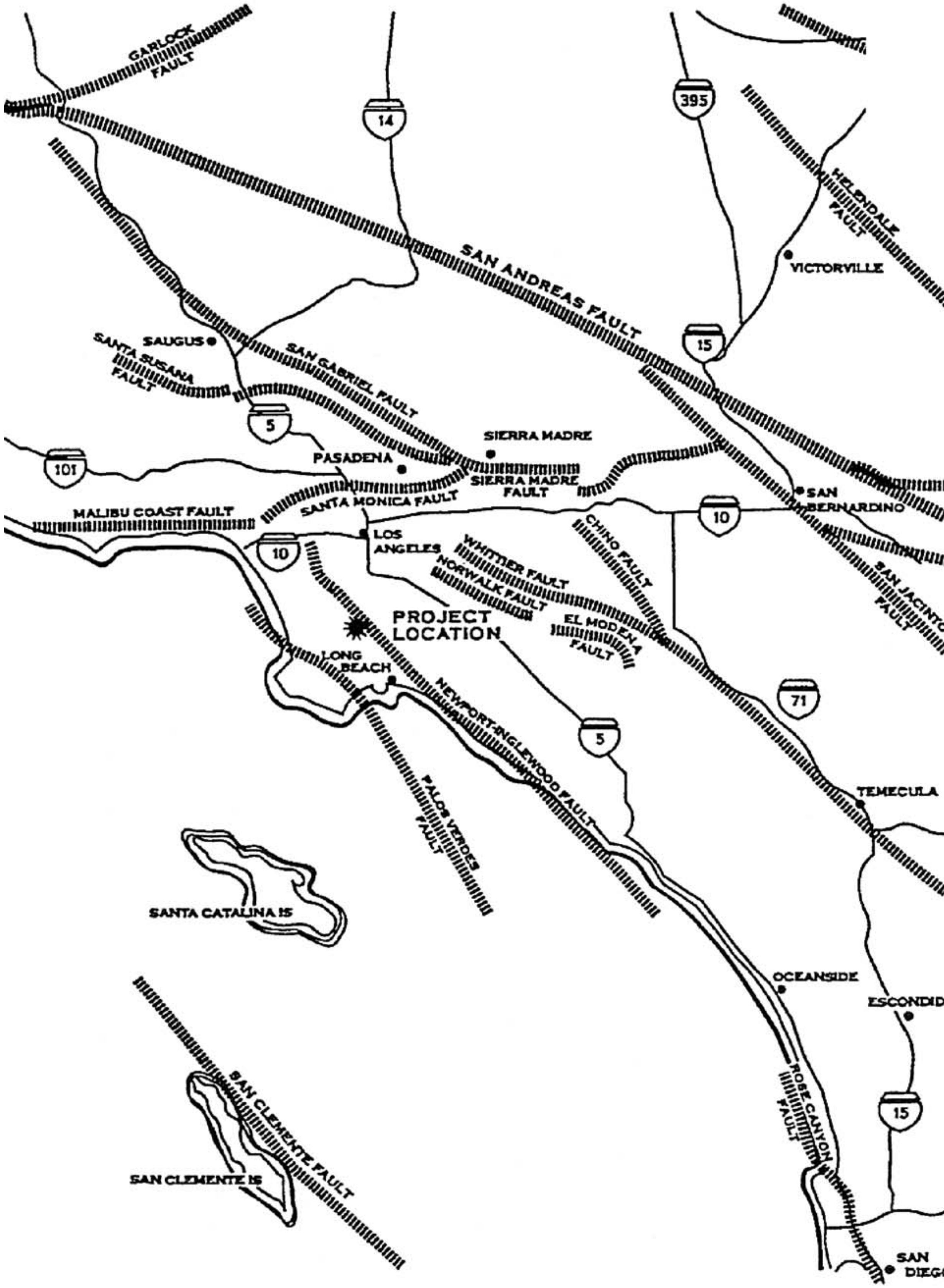

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Figure 31
Regional Fault Map

Source: City of Carson

Carson. The Avalon-Compton Fault is approximately four miles long and is located in the northeast sector of the city, immediately east of Avalon Boulevard and north of the Artesia Freeway. Historically, the Avalon-Compton fault/regional shear zone has moderate to high seismic activity with numerous earthquakes greater than Richter scale magnitude 4.0.[55]

Other regional fault zones include the San Andreas, the Palos Verdes, and the Whittier (Elysian Park Structure). The San Andreas fault zone, located approximately 48 miles to the north of the Project site, is California's most prominent structural feature, trending in a general northwest direction for over 600 miles and is considered capable of generating a maximum credible earthquake of magnitude 8.25 on the Richter scale.[56] The Palos Verdes Fault Zone, located approximately 5.3 miles to the southwest of the Project site, is traceable along the northern front of the Palos Verdes Hills. Offshore data shows an offset of Holocene material, suggesting very recent movement along the Palos Verdes Fault. The fault is considered capable of generating a maximum credible earthquake of magnitude 6.6 on the Richter scale.[57]

The 1987 Whittier Narrows earthquake (Richter Scale 5.9) occurred on the Elysian Park Structure of the Whittier fault zone. The Whittier Fault zone is located approximately 17.5 miles to the northeast and is considered capable of generating a maximum credible earthquake of magnitude 6.75 on the Richter scale.[58] The Santa Monica fault zone, located approximately 17.2 miles to the north-northwest extends approximately 15 miles through West Los Angeles and is considered capable of generating a maximum credible earthquake of magnitude 6.0 to 7.0.[59] Other nearby active fault zones in the area are the Raymond Fault zone, 19 miles to the north, and the Malibu Coast fault zone, approximately 20 miles to the northwest. The Avalon-Compton structural zone, located approximately 2 miles northeast of the Project site, is the only active fault zone in the City of Carson. Distance to active and potentially active earthquake faults is the same for all three Development Districts.

[55] *Bein, Frost, and Associates, Dominguez Hills Specific Plan EIR, pages 5.1-4 (September 1995), cited in the City of Carson General Plan Environmental Impact Report, page 4.6-5 (October 10, 2002).*

[56] *Lacopi (1977) and Greensfelder (1974) cited in the City of Carson General Plan Environmental Impact Report, page 4.6-5 (October 10, 2002).*

[57] *Darrow and Fisher (1983) cited in the City of Carson General Plan Environmental Impact Report, page 4.6-5 (October 10, 2002).*

[58] *Lamar (1970) cited in the City of Carson General Plan Environmental Impact Report, page 4.6-5 (October 10, 2002).*

[59] *City of Carson General Plan Environmental Impact Report, page 4.6-6 (October 10, 2002).*

(b) Potential Ground Shaking

The South Bay area and the City of Carson are regarded as one of the most severe shock areas of the Los Angeles Basin due to the unstable sub-base of sandy soil. The sandy sub-base is capable of producing a rolling motion that causes damage over widespread areas and may hinder the detection of faults.[60] Potential ground shaking at the Project site varies depending on the distance of the seismic source to the site 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 may cause foundation damage to large structures including commercial buildings. Short-period waves, however, are generally very distinct near the epicenter of moderate and high-magnitude events and may cause damage to any structures within close proximity. Detectable ground shaking at the Project site could be caused by any of the active or potentially active faults shown in Figure 31 on page 318. The Newport-Inglewood, Whittier, Santa Monica, and Palos Verdes faults are the active faults most likely to cause high ground acceleration in the City, although the San Andreas Fault has the highest probability of generating a maximum credible earthquake in the next 30 years. The Modified Mercalli (MM) Scale, shown in Table 30 on page 321, describes the empirical effects of ground shaking at increasing earthquake intensities. An earthquake with a projected magnitude of 7.0 to 7.9 is thought to be capable of seismic intensity values of about VIII to XI, in which damage to structures and underground pipes would occur. The bracketed duration of strong ground shaking, shown in Table 31 on page 323, is defined as the time interval between the first and last peaks of strong ground motion, when the acceleration of the ground due to seismic waves exceeds 0.50 Average Peak Acceleration. For example, strong ground shaking on a 6.5 magnitude earthquake within 10 kilometers (6.2 miles) from the Project site would last for 19 seconds. The duration and intensity of ground shaking would be similar in all three Development Districts.

(c) Surface Rupture

Surface rupture along a causative fault trace is associated with the primary movement that produced the seismic event. Offset on a fault intersecting the ground can create a discrete step or fault scarp if the fault slip occurs on a single plane or within a narrow fault zone. All development spanning an escarpment or fracture would be subject to foundation and other structural damage. As indicated previously, the Alquist-Priolo Earthquake Fault Zoning Act, which enforces a 50-foot setback zone, regulates development near active faults to mitigate the likelihood of surface rupture on a given fault. The Alquist-Priolo Act also requires additional geological study within an active fault zone to determine the location and extent of faults. The

[60] *Finding is based on California Institute of Technology Seismological Laboratory testing, cited in the 1981 City of Carson General Plan, Seismic Safety Element, page 25.*

Table 30

Modified Mercalli Intensity Scale

MMI	Effects	Average Peak Acceleration[a]	
I	Not felt except by a very few, and only under special circumstances.	Less than 0.03	Below 3.0 magnitude on Richter Scale
II	Felt by persons at rest and on upper floors	Less than 0.03	3.0-3.9 magnitude on Richter Scale
III	Felt indoors. Hanging objects swing slightly. Vibration feels like passing of light trucks. May not be recognized as an earthquake.	Less than 0.03	4.0-4.9 magnitude on Richter Scale
IV	Hanging objects swing noticeably. Vibration like passing of heavy trucks. Standing automobiles rock. Windows, dishes, doors rattle. Glasses clink, Wooden walls and frames creak	0.03 and below	4.0-4.9 magnitude on Richter Scale
V	Felt outdoors by most people. Sleepers awakened. Liquids may spill. Small unstable objects displaced. Doors swing, close, open. Pictures move. Some breakage of plaster.	0.03-0.08	4.0-5.0 magnitude on Richter Scale
VI	Felt by all. Persons walk unsteadily. Windows, dishes, glassware broken. Objects, books, etc. fall off shelves; pictures fall off walls. Furniture moved or overturned. Weak plaster and masonry cracked. Small bells ring (church, school). Trees, bushes shaken visibly	0.08-0.15	5.0-5.9 magnitude on Richter Scale
VII	Difficult to stand. Noticed by drivers of automobiles. Hanging objects shake. Furniture broken. Weak chimneys broken at roofline. Fall of plaster, loose bricks, stones, tiles, cornices, unbraced parapets and architectural ornaments. Waves on ponds; water turbid with mud. Small slides and caving in along sand and gravel banks. Large bells ring. Concrete irrigation ditches damaged.	0.15-0.25	6.0-6.9 magnitude on Richter Scale
VIII	Steering of automobiles affected. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls through out. Branches broken from trees. Cracks in wet ground and on steep slopes.	0.25-0.45	6.0-6.9 magnitude on Richter Scale
IX	General panic. Masonry destroyed or heavily damaged. General damage to foundations. Frames cracked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground	0.45-0.60	7.0-7.9 magnitude on Richter Scale
X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.	0.6-0.8	7.0-7.9 magnitude on Richter Scale

Table 30 (Continued)

Modified Mercalli Intensity Scale

MMI	Effects	Average Peak Acceleration[a]	
XI	Rails bent greatly. Underground pipelines completely out of service. Damage severs wood-frame structures, especially near shock centers. Few, if any, masonry structures remain standing. Large, well-built bridges destroyed by the wrecking of supporting piers or pillars.	0.8-0.9	8.0-8.9 magnitude on Richter Scale
XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.	0.9 and above	8.0-8.9 magnitude on Richter Scale

[a] *1.0 Average Peak Acceleration is 9.8 meters/second squared.*

Source: USGS Earthquake Hazards Program

Project site is not within a currently established Alquist-Priolo Earthquake Fault Zone for fault rupture hazards. No active or potentially active faults are known to pass directly under the Project site. Since no active earthquake faults intersect any of the three Development Districts, the potential for ground rupture within the three Development Districts is considered low.

(d) Liquefaction

The Project site is largely located within an area designated by the City of Carson General Plan Safety Element and the State of California Seismic Hazard Maps as a CDMG Liquefaction Hazard Zone,[61] as shown in Figure 32 on page 324. This classification is based on the general alluvial soil type, depth of groundwater tables, and the high seismicity of the area. The Newport-Inglewood fault zone is a potential source of ground stress that could result in liquefaction, a process by which water-saturated, loose sands lose strength during moderate or strong seismic shaking, if the ground water table were high enough during an earthquake. Liquefaction potential is greatest where the groundwater level is shallow, and loose, fine sand occur within a depth of about 50 feet or less. Liquefaction potential decreases as grain size and clay and gravel content increase. Further analysis and reporting of liquefaction potential on the Project site would be performed prior to further construction, in accordance with CDMG requirements for any properties located within a designated Liquefaction Hazard Zone.

[61] *City of Carson General Plan EIR, Exhibit 4.6-2 (October 22, 2002), based on State of California Seismic Hazard Zone Maps: Inglewood Quadrangle, Long Beach Quadrangle, Southgate Quadrangle, and Torrance Quadrangle (March 26, 1999); Special Studies Zones, Torrance Quadrangle (July 1, 1986)*

Table 31

Bracketed Duration of Strong Shaking as a Function of Magnitude

Distance to Source	Bracketed Duration (seconds) Magnitude						
	5.5	6.0	6.5	7.0	7.5	8.0	8.5
10 kilometers (6.2 miles)	8	12	19	26	31	34	35
25 kilometers (5.5 miles)	4	9	15	24	28	30	32
50 kilometers (31.0 miles)	2	3	10	22	26	28	29
75 kilometers (46.5 miles)	1	1	5	10	14	16	17
100 kilometers (62.0 miles)	0	0	1	5	5	6	7
125 kilometers (77.5 miles)	0	0	1	1	2	3	3

Source: Brown & Root EIR (September 5, 1996), based on Law/Crandall Geotechnical Investigation (after Bolt, 1973).

However, prior geotechnical evaluations determined that the potential for liquefaction at the Project site would be low within all three Development Districts.[62]

The prior geologic investigation of Development Districts 1 and 2 concluded that native soils consist of dense sand, silty sand, sandy silt, with interlayering of clayey silt and silty clay.[63] Due to the density of the native soils, granular size, and clay mix, the native soils are not considered subject to liquefaction. In addition, geotechnical analysis of soils in Development District 3 concluded that based on consolidation test results and the moisture content of native soils, the potential for liquefaction is estimated to be low in that portion of the Project site.[64]

In Development Districts 1 and 2, however, settlement, caused by densification in the underlying refuse layers, may occur during ground shaking. Uniform settlement beneath a given structure would cause minimal damage; however, because of variations in distribution, density, and confining conditions of the soils, seismic settlement would be generally non-uniform and could cause serious structural damage. Dry and partially saturated soils as well as saturated granular soils are subject to seismically-induced settlement. Generally differential settlement induced by ground failure such as liquefaction, flow slides, and surface ruptures would be much more severe than those caused by densification alone.

62 *Western Laboratories, Geotechnical Engineering Report for Proposed Commercial Development and Northeast Corner of Main Street and Del Amo Boulevard, December 24, 1996; and Law/Crandall, Report of Geotechnical Investigation and Pile Loading Testing for L.A. Metromall, September 5, 1996*

63 *Law/Crandall, op. cit. l*

64 *Western Laboratories, op. cit.*

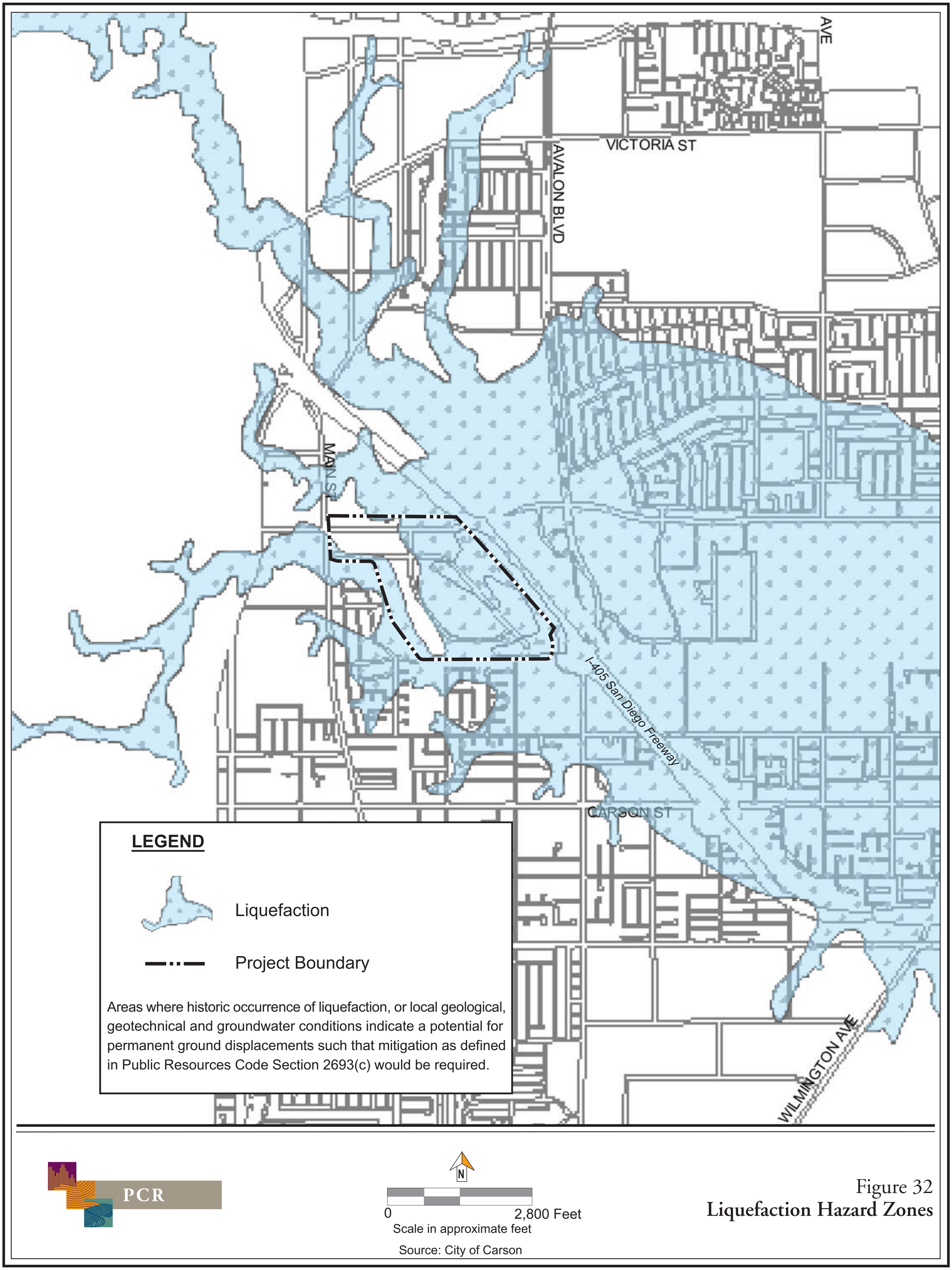

Figure 32
Liquefaction Hazard Zones

(e) Subsidence

Historical withdrawal of oil has been known to cause subsidence in portions of the Wilmington Oil field, extending along the Newport-Inglewood structural zone between Signal Hill/Port of San Pedro on the south and Redondo Beach on the north. Total subsidence reached a maximum of 29 feet over the crest of the Wilmington anticline, where most of the oil has been withdrawn. The City of Carson 1981 Seismic Safety Element states that subsidence caused by fluid withdrawal has not been a problem in the City, since subsidence in this area would be normally spread over a large area and would not be differential in nature.[65] Water injection to halt the subsidence was started in the late 1950s in the areas of maximum subsidence.[66]

Under existing conditions, local subsidence associated with the former landfill site (Development Districts 1 and 2) could occur, since refuse layers would continue to settle, due to the consistency of the refuse and the decomposition of organic matter. Decomposing refuse would cause substantial down-drag loads on foundations and slabs and, as such, existing fill soils are not suitable for the support of slab foundations. In Development District 3, due to the unconsolidated nature and debris content of overlying fills soils, prior geotechnical investigators have concluded that the upper 0.5 to 8.0 feet of the fill and low density natural soils would be subject to settling and are not suitable to provide support for slabs on grade, pavement, and building foundations.[67]

(f) Slope Stability/Landslides

Landslides tend to occur in loosely consolidated, wet soil and rock on sloping terrain or are associated with bedrock slopes exhibiting unfavorably oriented bedding planes in relation to the slope or other weaknesses. Although stockpiles of fill soils exist in Development Districts 1 and 2,[68] due to the relative absence of steep slopes on the Project site and in the surrounding area, landslide or slope instability is limited to any unprotected slopes among the variety of flood control channels that intersect the area. The Torrance Lateral Flood Control Channel, adjacent to the west and south boundary of the Project site, is concrete-lined and, thus, would not be subject to erosion or slope instability.

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[65] *City of Carson 1981 General Plan, Seismic Safety Element, page 29; based on California Division of Mines and Geology Special Report 114 (1974) .*

[66] *City of Carson General Plan EIR, page 4.6-10.*

[67] *NorCal Engineering, Soils Investigation for Northeast Corner of Main Street and Del Amo Boulevard, page 5 (1986).*

[68] *Brown & Root, Op. Cit.*

3. ENVIRONMENTAL IMPACTS

a. Methodology

In order to determine the potential significance of grading and geologic hazards associated with the development of the proposed Project, existing geological and geotechnical materials describing ground shaking, liquefaction, soil stability, and settlement are reviewed and summarized. The determination of significance is based on the findings of the summarized geological references. The determination of significance is also based on a comparison of site preparation and structural design with existing City and State regulations.

b. Thresholds of Significance

The proposed Project would be considered to have a significant geological impact if:

- The proposed Project would be susceptible to ground shaking, liquefaction, or settlement, which would result in substantial damage to structures or infrastructure and an exposure of people to risk of loss, injury, or death.

- The proposed Project would be in non-compliance with the requirements of the Carson Municipal Code and State regulations set forth in this section.

c. Project Impacts

(1) Project Design Features

The Project's structural design would comply with the design standards set forth in the Carson Municipal Code, which incorporates, by reference, Los Angeles County Code, Title 26, including Chapter 16, Seismic Design Standards. The Project would also comply with Titles 21 and 26 in meeting all applicable building regulations and required evaluation of current soils, project-specific geotechnical, and site-specific geologic conditions for the development of the proposed Project.

(a) Development Districts 1 and 2

Development in Districts 1 and 2 would include approximately 1.94 million square feet of commercial floor area, with a 300-room hotel and 1,300 residential units. Site preparation activities would be integrated with remediation and subsurface construction standards required by the 1995 RAP. Pertinent to soil stability, the 1995 RAP outlines a procedure for the capping of the waste layers and the overlaying and compaction of fill soils. Due to the presence of the capped waste and need to maintain the integrity of the proposed cap, the RAP establishes specific criteria for site development. According to the RAP, an impervious clay layer would be covered by an 18-inch protective soil layer of suitable imported materials. Notwithstanding, the Applicant is exploring the potential with DTSC to implement a refined cap design wherein the protective cap would be constructed of prepared soil foundation, LLDPE geomembrane, geotextile, composite drainage materials, and select over soils. Under this proposed cap design no importation of clays and soils would be required. While the Applicant is proposing a refined cap design, any alternations in RAP specifications would need to be reviewed and approved by the DTSC.

Project design features include the implementation of driven piles, in lieu of slabs on grade. Piles would be driven through existing fill/refuse soils to approximately 20 feet into underlying native soils. Floor slabs, including parking structures, and residences would be supported by these piles. Proposed on-site structures are anticipated to require over 5,000 piles, with approximately 4,000 pile caps. Pile caps are the connector between the piling and the overlying impermeable cap. Depending on building requirements, 1 to 4 piles per pile cap attachment would be installed. Piles would be concrete and 14 to 16 inches in diameter. Piles would range from 40 to 90 feet in length, with an average length of 55 to 60 feet. Existing roadways are not underlain by fill/refuse soils and, as such, roadway construction in existing alignments would not require the use of foundation pilings.

To further avoid differential settlement at points of entry and the pile-supported structures, a densification program using deep dynamic compaction (DDC) is planned on approximately 60 to 75 acres. DDC areas would be completed in parking lots and non-pile supported areas. Depressions caused by DDC would be filled to create a smooth surface. Localized stockpiles of fill and the approximately 20-foot-high fill slope adjacent to Lenardo Drive, along the eastern property line, would be removed during grading. The grading would result in a nearly level site, with sloping to allow for drainage.

(b) Development District 3

Development in District 3 would include the construction of 250 residential units and 50,000 square feet of commercial floor area. Approximately 11 acres would be graded. Utility easements occupying the graded area would be protected during construction. The development of the parcel would involve grubbing and removal of existing vegetation and other unsuitable materials, the compaction of undocumented and disturbed topsoil, and preparation of concrete slab-on-grade foundations. Alternative foundations could include conventional spread footings, or mat foundations. Partially below-grade (less than 15 feet) parking structures may be considered for select buildings. Grading would be approximately "balanced" and no soil import or export is anticipated. Construction techniques, including compaction, and foundation criteria would be carried out in accordance with the recommendations of an updated soils and geotechnical evaluation.

(2) Construction

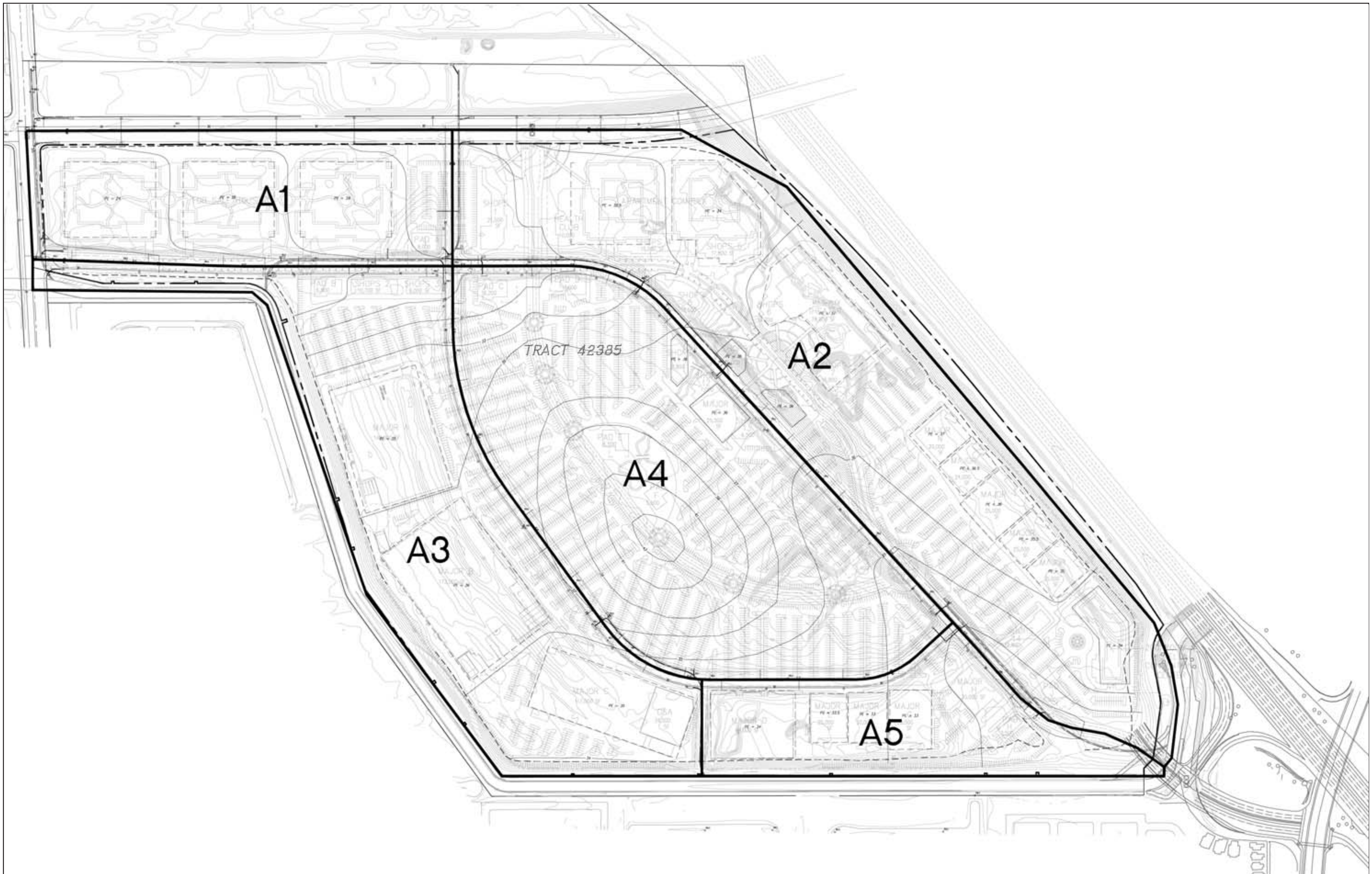
(a) Development Districts 1 and 2

Generalized site preparation would require mass grading, DDC, backfill, capping and pile driving, rough grading and pad construction. Remediation, including construction of the groundwater extraction system and building protection systems would also occur during the site preparation stage. Construction would require the excavation, movement, and on-site storage of approximately 1.5 million cubic yards of soil. Approximately 125 acres would be grubbed (vegetation and debris removal) and would be used for stockpiling of soils during mass grading. Mass grading would be staged and soils would be stockpiled to allow backfill after DDC. The need to fill after DDC would require moving stockpiled soil at least twice. With the grading of approximately 20,000 cubic yards per day, grading activities would require approximately 75 days for completion. The entire site would be compacted to create a landfill cap foundation.

Site preparation would be coordinated with remediation procedures approved by the DTSC. The preliminary sequence for building construction and construction of the remediation system is that building construction would follow earth moving and the installation of the requisite remediation systems. For the purpose of grading, Development Districts 1 and 2 would be divided into 5 areas or cells (A1 to A5) that are generally separated by existing roads. Cells A1 through A5 are illustrated in Figure 33 on page 329. It is anticipated that grading would result in an excess of approximately 420,000 cubic yards of soil. This excess soil would be used to backfill the parking and open areas of the site, an estimated 60 to 75 acres, left by the DDC activities. Cells A2 and A4 would have the majority of the DDC impacted areas. Cell A4, the primary parking area for the site, would be surrounded by retail and residential facilities and would be at the highest elevation at the Project site. This area would slope down at approximately 2 percent to the perimeter buildings and access roads.

The preliminary construction sequence is based on reducing the amount of soil movement and is as follows:

- Phase 1 - Regrade and fill Cell A3 using soil from Cells A1 and A5;
- Phase 2 - Install piling for buildings in Cell A1;
- Phase 3- Install piling for buildings in Cell A5;



Not to scale

Source: RBF Consulting, 2005

Figure 33
Cell Areas for Grading

- Phase 4 - During the grading of Cell A3-5, prepare western half of Cell A4 for DDC; and

- Phase 5 - Prepare southern half of Cell A2 for DDC.

Building construction would occur cell-by-cell, beginning with Cell A3 and completing with Cell A4. Cell A4 would be used to store and process soils for the Project and would be the last cell to be graded to finished grade. All work would be sequenced so that work would be done in parallel in each cell through the coordination of the mass grading and construction of the remedial systems.

Installation of the landfill cap under the approved 1995 RAP design would require 450,000 cubic yards of imported clay, and 330,000 cubic yards of drainage layer soils, for a total import of 780,000 cubic yards of material. Approximately 2,000 cubic yards would be imported per day, requiring approximately 1.5 years for import activities. Import would require approximately 150 trucks per day, 10 hours per day.[69] With the proposed cap design, a geomembrane system would be used in lieu of an impermeable clay cap for the sealing of underlying waste materials. Thus, the clay and drainage layer soils that would otherwise make up the impermeable clay cap would not need to be imported to the Project site.[70] Since no importation would be required, all graded soils would be balanced on site. Under the proposed RAP design, total grading would be reduced by 780,000 cubic yards and haul traffic associated with the importation of clay and drainage layer soils would be eliminated.

Construction would be conducted according to the requirements of the Municipal Code. The Applicant would submit updated soils engineering and engineering geology report(s), prior to any grading activities or modification of topography. With the enforcement of code requirements, including geotechnical and geological analyses of the site and code-established procedures associated with grading and construction, the Project would be in compliance with the previously described regulatory threshold, listed under Subsection 3.b, Thresholds of Significance. Therefore, the exposure of people or other structures to settlement or other geologic hazards caused by grading and other construction activities would be less than significant.

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[69] *Carson Marketplace Draft Preliminary Development Schedule, Major Schedule Assumptions, Proposed Project (Approved RAP),Remediation Construction, page 2 (June 13, 2005).*

[70] *Carson Marketplace Draft Preliminary Development Schedule, Major Schedule Assumptions, Proposed Project (Proposed RAP),Remediation Construction, page 2 (June 13, 2005).*

(b) Development District 3

Construction of the proposed residential and commercial buildings would require the excavation and re-compaction of the existing 1 to 8 feet of disturbed and undocumented topsoil. The average depth of re-compaction would be approximately 5 feet below the existing ground level. Grading would be approximately "balanced" on site and would require no importation or export of soils. As with Development Districts 1 and 2, construction would be conducted according to the requirements of the Carson Municipal Code. The Applicant would submit a soils engineering and engineering geology report or reports, to the satisfaction of the City Building Official, prior to any grading activities or modification of topography. With the enforcement of code requirements, including updated geotechnical and geological analyses of the site and code-established procedures associated with grading and construction, the Project would be in compliance with the previously described regulatory threshold. Therefore, the exposure of people or other structures to settlement or other geologic hazards caused by grading and other construction activities would be less than significant.

(3) Operation

Development of the Project would expose occupants and visitors to potential ground shaking that would be similar to other locations throughout the Los Angeles Basin and the City of Carson, as a result of an earthquake event at any of several earthquake fault zones in the surrounding area. Geologic hazards in Development Districts 1 and 2 include potential differential settlement due to the densification of refuse in the underlying refuse layers. Total differential settlement over 30 years is anticipated to be 2.75 feet.[71] Exposure to settlement would be reduced to less than significant levels through the implementation of driven pile foundations, in which concrete building pads and floors would be supported by piles driven directly into underlying soils. No building pads or pilings would be supported by the underlying refuse. Exposure to ground shaking would be reduced through the implementation of seismic construction standards set forth in the Carson Municipal Code, Chapter 16, which include design provisions for structures within 15 km (9.3 miles) of an active fault. The Carson Municipal Code would also require the preparation of updated soils, geotechnical, or geology reports and the compliance of the Project with any recommendations developed as part of any such report.

Seismic and geologic hazards in Development District 3 would also be reduced to a less than significant level through the implementation of existing Carson Municipal Code requirements, including preparation and compliance with the recommendation of updated soils, geotechnical, or geology reports. It is anticipated that the removal of debris and the compaction

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[71] *Brown & Root, Op. Cit., pages 13 and 14.*

of fill soils, currently stockpiled on the site, would reduce any recognized hazards associated with unstable soils.

With compliance with the most recent State and City Building Code seismic design standards and site evaluation requirements, the risk of exposure of the Project's occupants and structures to ground shaking, liquefaction, differential settlement or other geologic hazards would be less than significant. Although prior geotechnical evaluations concluded that liquefaction potential over the Project site is low, since the Project site is partially located within the CDMG Liquefaction Hazard Zone, the Project would comply with CDMG requirements for analysis and reporting of liquefaction potential.

4. MITIGATION MEASURES

The proposed Project would not result in a significant geology and soils impact. However, the following mitigation measures are recommended to assure compliance with City and State regulations.

Mitigation Measure E-1 In accordance with City of Carson Municipal Code, the Applicant shall comply with site-specific recommendations set forth in engineering geology and geotechnical reports prepared to the satisfaction of the City of Carson Building Official, as follows:

– The engineering geology report shall be prepared and signed by a California Certified Engineering Geologist and the geotechnical report shall be prepared and signed by a California Registered Civil Engineer experienced in the area of geotechnical engineering. Geology and geotechnical reports shall include site-specific studies and analyses for all potential geologic and/or geotechnical hazards. Geotechnical reports shall address the design of pilings, foundations, walls below grade, retaining walls, shoring, subgrade preparation for floor slab support, paving, earthwork methodologies, and dewatering, where applicable.

– Geology and geotechnical reports may be prepared separately or together.

– Where the studies indicate, compensating siting and design features shall be required.

– Laboratory testing of soils shall demonstrate the suitability of underlying native soils to support driven piles to the satisfaction of the City of Carson Building Official.

Mitigation Measure E-2 Due to the classification of portions of the Project site as a liquefaction zone, the Applicant shall demonstrate that liquefaction either poses a sufficiently low hazard to satisfy the defined acceptable risk criteria, in accordance with CDMG Special Bulletin 117, or (b) implement suitable mitigation measures to effectively reduce the hazard to acceptable levels (CCR Title 14, Section 3721). The analysis of liquefaction risk shall be prepared by a registered civil engineer and shall be submitted to the satisfaction of the City Building Official.

Mitigation Measure E-3 Any roads realigned from the existing configuration, or otherwise, located in areas underlain by waste soils shall comply with site-specific recommendations as set forth in engineering, geology and geotechnical reports prepared to the satisfaction of City of Carson building officials.

5. CUMULATIVE IMPACTS

Due to the high seismic activity common to the region, the potential for ground shaking and other geological hazards would be similar throughout the related project study area. Each of the 36 related projects would require case-by-case approvals, including plan check and issuance of building permits. Building permits for the related projects would involve a site-specific evaluation of slope stability, ground rupture, liquefaction, and ground movement for each of the related projects. As required by the City Code and State regulations, appropriate structural design and site preparation requirements would be enforced for each of the related projects. Although the related projects, in combination with the proposed Project, would expose more people and structures to seismic risk or other potentially hazardous geologic conditions, with the implementation of City Code regulations, cumulative impacts related to geologic risk would be less than significant.

6. LEVEL OF SIGNIFICANCE AFTER MITIGATION

The proposed Project would be in compliance with City and State regulations and is not expected to expose people or structures to any unstable geologic conditions or seismically related geologic hazards that would result in substantial damage to structures or infrastructure or exposure of people to risk of loss, injury, or death. Since the Project would not exceed the thresholds of significance relative to City and State regulations, or expose persons to geologic hazards, no unavoidable significant impacts would occur.