4.5 Geology/Soils

This section analyzes potentially significant impacts related to geology and soils that could result from implementation of the project. This analysis relies upon the results of the Paleontological and Cultural Resources Assessment Report for the project (Appendix D).

4.5.1 Existing Conditions

The city of Irvine (City) is located within the northern extent of the California Geomorphic Province known as the Peninsular Ranges, which extends from Mount San Jacinto in the north, through the tip of Baja, Mexico in the south. Subparallel to these ranges on the east is the San Andreas Fault Zone. The northwestwards motion of the Pacific Plate has created these ranges and their corresponding valleys (see Appendix D).

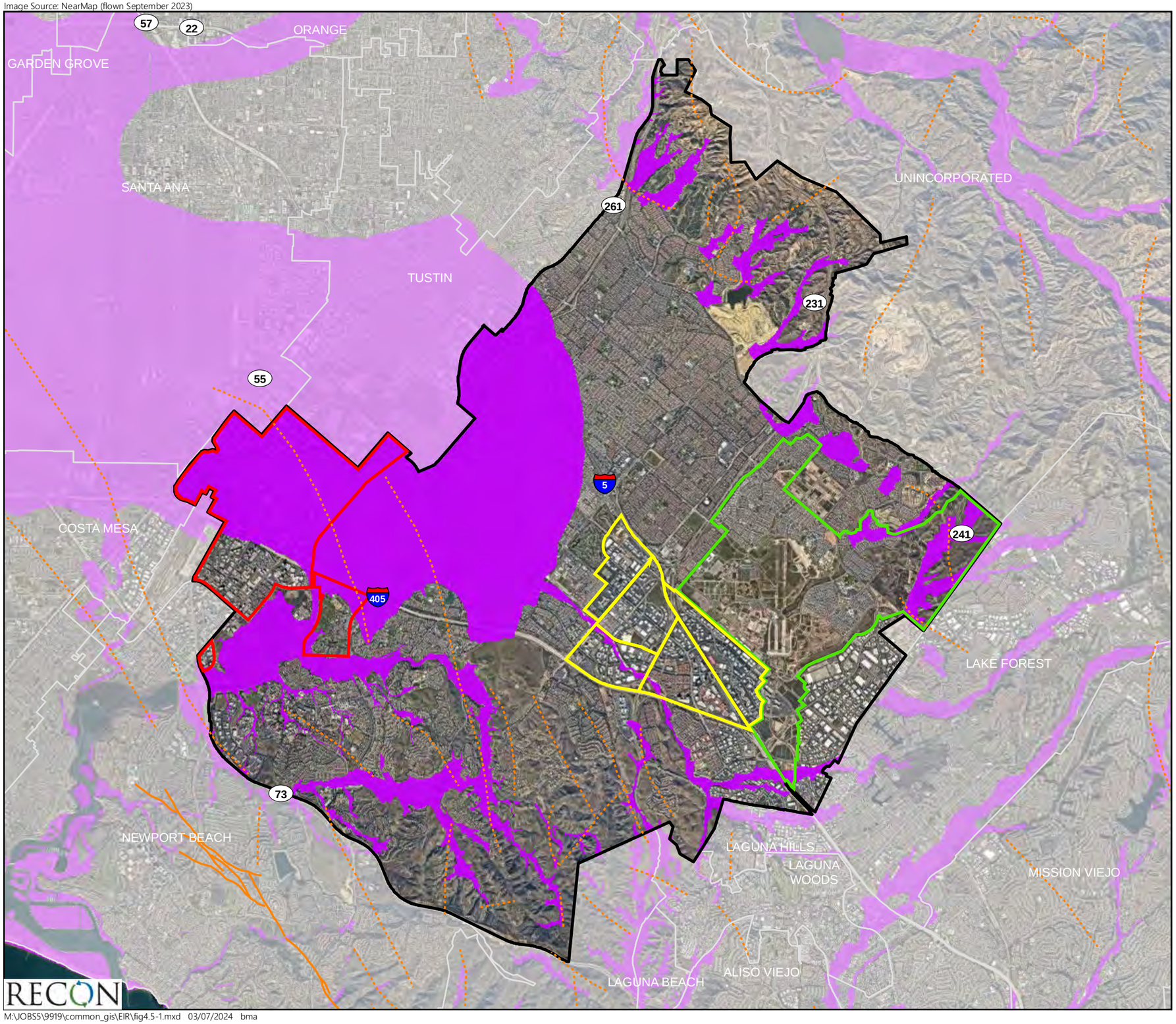
The City has a complicated paleoenvironmental history that began during the Mesozoic Era (the "Age of Dinosaurs"), about 93 million years ago. The past 93 million years ago has seen the City transition from deep water marine in the Late Cretaceous, to coastal lowlands during the Paleocene to Oligocene, to shallow marine during the early Miocene, to deep marine during the early to early-late Miocene, back to shallow marine in the latest Miocene through the Pliocene, and finally to increasingly arid terrestrial deposits from the Pleistocene to the Holocene. In addition, younger sediments have been washed into the ocean by action of streams.

4.5.1.1 Surface Rupture

A seismic event, or earthquake, is the movement of the earth's crust along a fault. The impact of a seismic event on any given location depends on two factors: geologic setting and geologic conditions. Geologic setting refers to an area's proximity to active earthquake faults, which are fractures in the earth's crust forming a boundary between rock masses that have shifted. For planning purposes, an active fault is usually defined as a fault that shows surface movement within the last 13,000 years.

The City and its sphere of influence are affected by both local and regional active faults. Figure 4.5-1 presents the City's location in relation to active faults. According to the U.S. Geological Survey and California Geological Survey, there are several regional faults within Alquist-Priolo Special Study Zones near the City that could result in seismic hazards should an earthquake occur along one of them, including Newport-Inglewood-Rose Canyon fault zone (approximately 1.5 miles west of Irvine), Pelican Hill fault (approximately 1.5 miles west of Irvine), El Modena fault (approximately 5 miles north of Irvine) and Peralta Hills fault (approximately 5 miles north of Irvine). In addition, numerous faults have been identified within the City; however, they are not considered active (shown movement at the surface in the past 13,000 years) and therefore, do not require delineation within a special study zone. Regardless, these faults should be accounted for in future development decisions.

Image Source: NearMap (flown September 2023)



Irvine City Boundary
Focus Area 1
Focus Area 2
Focus Area 3
Liquefaction Hazard Zone
Faults

0 Miles 1.5

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FIGURE 4.5-1
Seismic Hazards

The San Joaquin Hills blind thrust fault is the only known fault that runs through Irvine and travels in an east-west/southeasterly direction through the City. The location of the fault is thought to run just north of the San Joaquin Hills, with the Irvine Civic Center sitting on top of the inferred location. However, the reliability of the inferred location is considered poor. If an earthquake were to occur on this blind thrust fault, the likelihood of surface rupture would be underground, thereby reducing potential risk to structures.

4.5.1.2 Ground Shaking

Geologic conditions refer to the stability of the soil during an earthquake. For example, loose, unconsolidated soil is more prone to liquefaction during an earthquake than compacted soil or rock. The City and its sphere of influence are in Seismic Zone 4, as identified in the Uniform Building Code. This zone indicates the highest classification of the four zones in the United States, with the most stringent requirements for building design. As the City is located within proximity to faults, the City could be subject to significant ground shaking which could damage buildings or infrastructure.

Ground shaking is the effect of surface motion generated by an earthquake that results in the majority of damage during seismic events (City of Irvine 2020). Several factors control how ground motion interacts with structures, making the hazard of ground shaking difficult to predict. Seismic waves propagating through the Earth's crust are responsible for the ground vibrations normally felt during an earthquake. Structures throughout the City could be affected by ground shaking during a seismic event. The City's Local Hazard Mitigation Plan (LHMP) includes a summary of the 2015 Third Uniform California Earthquake Rupture Forecast which provides the most recent assessment of the probability of a major earthquake on various faults between 2015 to 2044. The San Joaquin Hills Fault, located within the City, has a 40 percent probability of a major earthquake occurring while the Newport-Inglewood Fault, located 8 miles from the City, has a 95 percent probability of occurring. The LHMP also includes the U.S. Geological Survey forecasts regarding the severity of seismic shaking in different locations for various plausible earthquake scenarios. The U.S. Geological Survey scenarios show that the Newport-Inglewood and San Joaquin Hills faults could cause the strongest seismic shaking in Irvine. However, the largest magnitude events are anticipated to come from the more distant San Jacinto and San Andreas faults, which could cause earthquakes that have an overall higher magnitude than the Newport-Inglewood or San Joaquin Hills faults. However, due to the distance of the San Jacinto and San Andreas faults, the shaking intensity felt in Irvine would be reduced compared to the shaking that would be felt nearer the earthquakes' epicenters. The overall magnitude of potential earthquake scenarios occurring along the Newport-Inglewood and San Joaquin Hills faults is lower than some of the more regional faults but their proximity to Irvine means that the City would be subjected to high intensity shaking from these earthquakes. However, the likelihood of a powerful earthquake occurring along these faults per the 2015 Third Uniform California Earthquake Rupture Forecast within the next 25 years is exceptionally low.

4.5.1.3 Liquefaction

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to a fluid when subject to high intensity ground shaking. Liquefaction occurs when three general conditions exist: (1) shallow groundwater; (2) low -density non-cohesive (granular) soils; and (3) high -intensity ground motion. Liquefaction is typified by a buildup of pore-water pressure in the affected

soil layer to a point where a total loss of shear strength occurs, causing the soil to behave as a liquid. Studies indicate that saturated, loose to medium dense, near surface cohesionless soils exhibit the highest liquefaction potential, while dry, dense, cohesionless soils and cohesive soils exhibit low to negligible liquefaction potential. According to the Department of Conservation, the Planning Areas encompass earthquake zones of required investigation for liquefaction as mapped by the California Geologic Survey. Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toes of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

Figure 4.5-1 presents where liquefaction zones have been identified throughout the City, and Table 4.5-1 presents the acreage of land within the City, as well as specifically in the focus areas, designated as liquefaction zones.

Table 4.5-1
Liquefaction Susceptibility Acreages

Area	Acres
Focus Area 1	2,250.27
Focus Area 2	46.15
Focus Area 3	440.28
Remainder of City	9,136.6
TOTAL	**11,873.3**

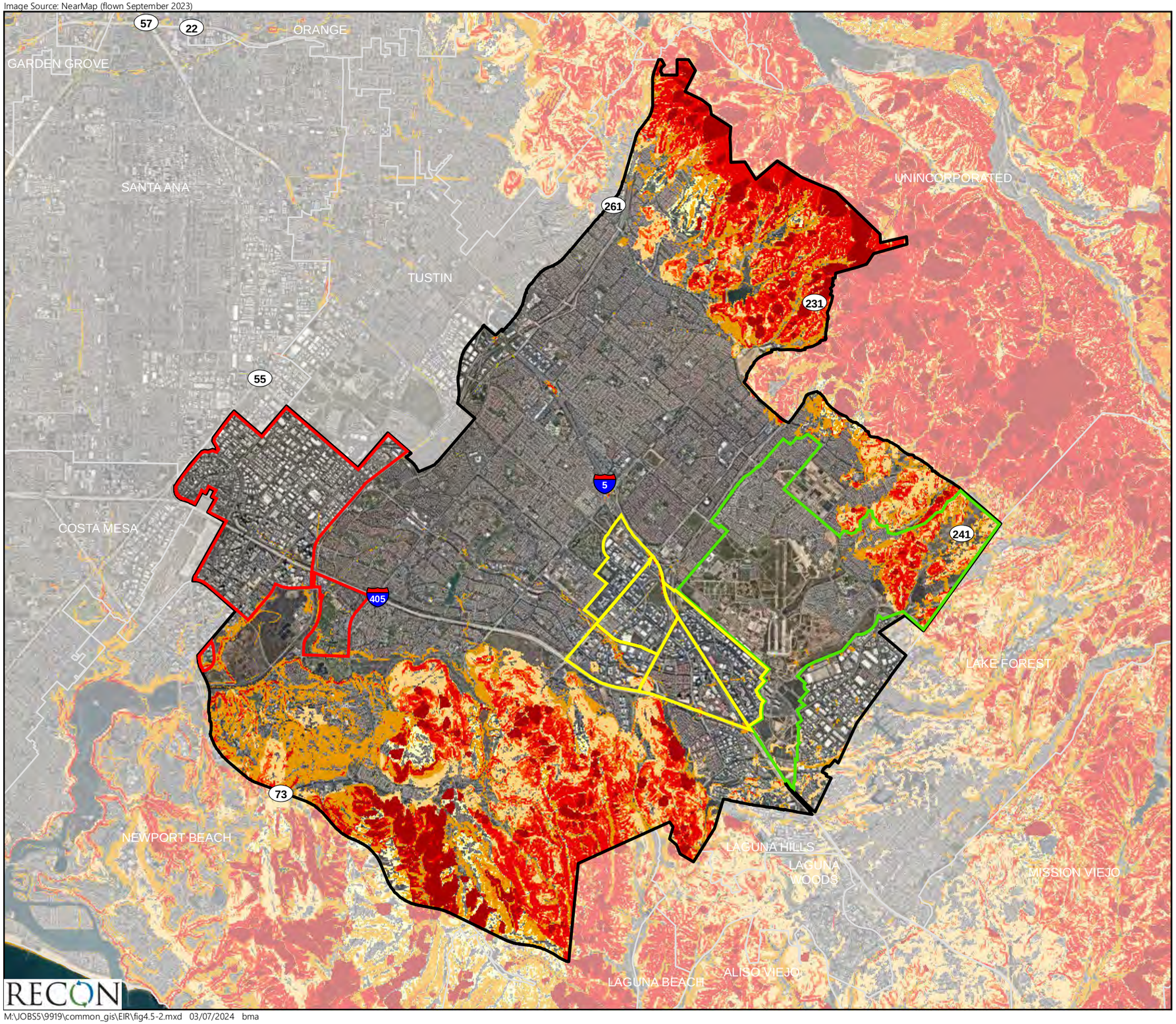
4.5.1.4 Soil Stability and Landslides

a. Landslides

Landslides occur when earth on slopes become destabilized, typically after heavy rains, when the precipitation saturates the soil and makes it less stable, or when significant erosion from rainfall destabilizes the ground. Slopes that have recently burned face a greater risk from rain-induced landslides, as the fires burn up many of the trees, brush, and other vegetation that help stabilize the earth. Earthquakes may also be a source of landslides as the shaking can destabilize already loosened soils (City of Irvine 2020).

There is the potential for landslides in the steeper portions of the foothills of the Santa Ana Mountains to the northeast of the City and the San Joaquin Hills to the southwest of the City. These areas are characterized with steep topography and geologic units that can become unstable. While no definitive scale for measuring landslides exists, landslide events are usually measured using the amount of material that is displaced (i.e., the cubic feet of earth that moved). In addition, to these landslide hazards, the California Geological Survey has mapped deep seated landslide hazards, which uses a scale of landslide susceptibility that is based on slope steepness and the strength of the underlying rock, with 0 being no susceptibility and 10 being the highest susceptibility. Figure 4.5-2 identifies the deep-seated landslide susceptibility within the City. Areas in the foothills of the Santa Ana Mountains and San Joaquin Hills show the greatest susceptibility within the City.

Image Source: NearMap (flown September 2023)



Irvine City Boundary
Focus Area 1
Focus Area 2
Focus Area 3

Landslide Susceptiblity Classes

0
III
V
VI
VII
VIII
IX
X

The landslide susceptibility matrix, based on Rock Strength (RS) and Slope Steepness (SS) in degrees, is described below. Roman numerals may also be used to indcate class assignment:

- RS(1) & SS(<3 to 10); RS(2) & SS(<3); RS(3) & SS(<3) = susceptibility 0 (0).
- RS(1) & SS(10 to15) = susceptibility class 3 (III)
- RS(2) & SS(3 to10) = susceptibility class 5 (V)
- RS(1) & SS(15 to 20) susceptibility class 6 (VI)
- RS(1) & SS(20 to 30); RS(3) & SS(3 to 10) = susceptibility class 7 (VII)
- RS(1) & SS(30 to >40); RS(2) & SS(10 to 15) = susceptibility class 8 (VIII)
- RS(2) & SS(15 to >40); RS(3) & SS(10 to 15) = susceptibility class 9 (IX)
- RS(3) & SS(15 to >40) = susceptibility class 10 (X)

0 Miles 1.5

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FIGURE 4.5-2
Deep-Seated Landslide Susceptibility

b. Subsidence

Subsidence occurs when the level of the ground decreases, as if the surface is sinking. Subsidence can either be sudden (as in a sinkhole) or happen gradually over time. It can be caused by mining, groundwater pumping, or fossil fuel extraction, creating empty underground spaces that can collapse and cause the soil above to drop. Erosion, natural cave collapses, and seismic activity can also cause subsidence (City of Irvine 2020).

The City identified the low-lying areas that sit on top of the Orange County Water District (OCWD) groundwater basin as the most likely locations for subsidence. Other sections of the City are potentially subject to subsidence in the event of a major earthquake (magnitude of 5.0 or greater), although the City does not have a history of seismically induced subsidence. In terms of extent, subsidence is typically measured by the distance that the ground has sunk from its original elevation (i.e., in feet or inches) or by using the rate of subsidence (i.e., inches or centimeters per year).

There is evidence of subsidence in most of Orange County because of excessive groundwater pumping in the first half of the 20th century, prior to the development of the California State Water Project, which siphons water from the Owens Valley. Currently it is estimated that the greater LA Basin (including Orange County) experiences approximately 20 millimeters of net subsidence seasonally due to groundwater pumping and artificial recharge (City of Irvine 2020).

4.5.1.5 Paleontological Resources

Figure 4.5-3 presents the designations of paleontological sensitivity throughout the City. The City classifies paleontological sensitivity based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts within the known extent of geologic units (see Appendix D). Although significant localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher potential. The relative abundance of localities is intended to be the major determinant for the value assignment. Thousands of fossils have been recovered within the City boundaries. The following presents a summary of geologic units within the City and their assigned paleontological sensitivity:

- The Vaqueros, Sespe-Vaqueros, Sespe, Monterey, Puente and Capistrano Formations are assigned a high sensitivity. Formations assigned a moderate sensitivity include the Williams Formation Pleasants Sandstone Member, the Santiago Formation, the Topanga Group, the undifferentiated Puente Formation, and the Pliocene Niguel Formation.
- Pleistocene sediments generally lie beneath young sediments with no fossils. Shallow excavations should not impact Pleistocene fossils. Because the presence of Pleistocene fossils has been demonstrated the sediments have been ranked as moderate.
- The Silverado Formation has a low sensitivity along with young sediments. The El Modeno Volcanics and artificial fill are assigned no sensitivity (see Appendix D).

Map Source: City of Irvine

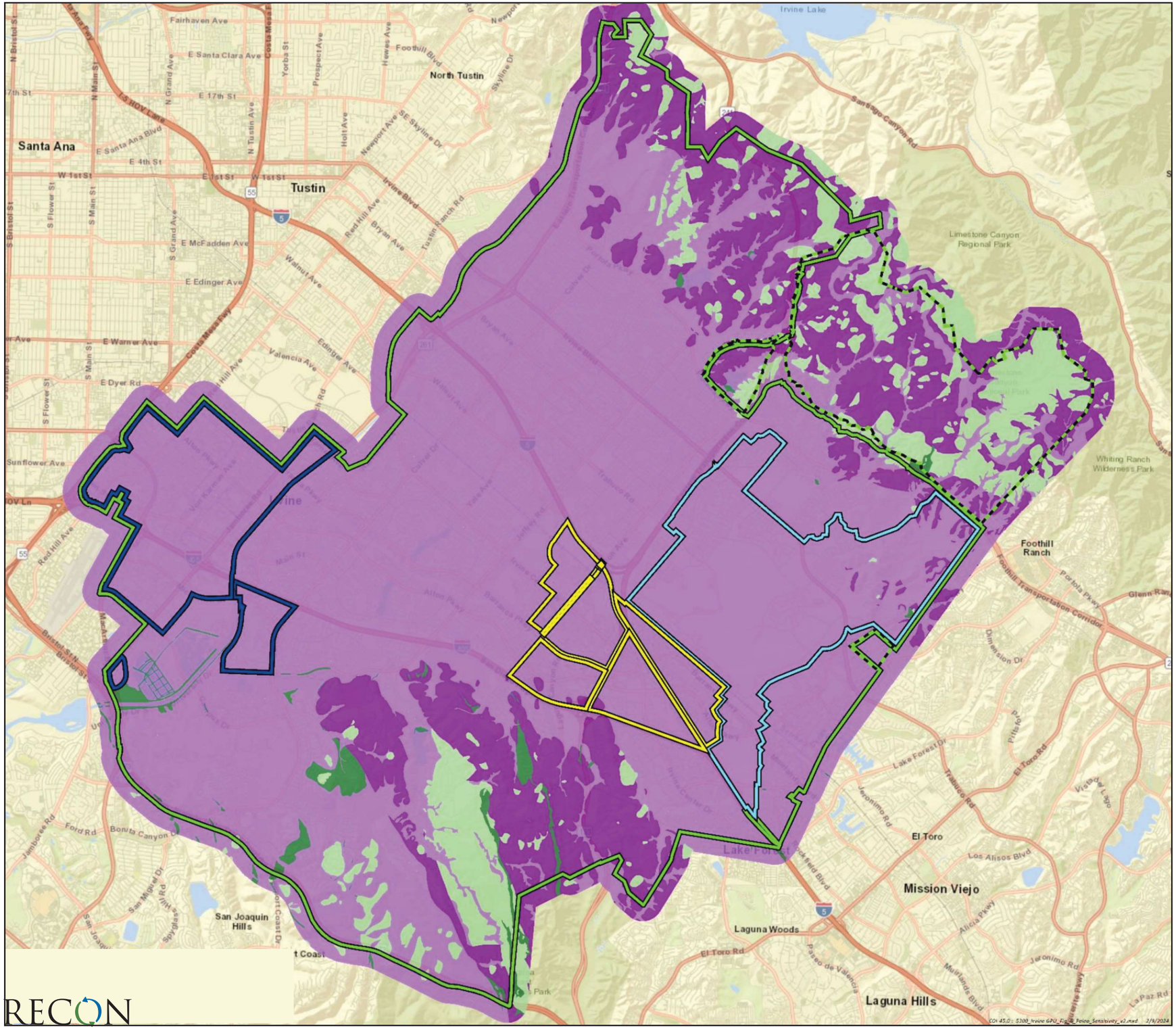

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FIGURE 4.5-3
Paleontological Sensitivity

4.5.2 Applicable Regulatory Requirements

4.5.2.1 State Regulations

a. Earthquake Fault Zoning Act (Alquist-Priolo Act)

The State of California Alquist-Priolo Earthquake Fault Zoning Act (1972) was established to mitigate the hazard of surface faulting to structures for human occupancy. Pursuant to the act, the state geologist has established regulatory zones (known as earthquake fault zones) around surface traces of active faults. Application for a development permit for any project within a delineated earthquake fault zone shall be accompanied by a geologic report, prepared by a geologist registered in the state of California, that is directed to the problem of potential surface fault displacement through a project site.

b. Seismic Hazard Mapping Act

The Seismic Hazard Mapping Act (SHMA) was adopted in 1990 to protect the public from the effects of nonsurface fault rupture earthquake hazards, including strong ground shaking, liquefaction, seismically induced landslides, ground amplification or other ground failure caused by earthquakes. The goal of the act is to minimize loss of life and property by identifying and mitigating seismic hazards. The California Geological Survey is the primary agency responsible for the implementation of the SHMA. The California Geological Survey prepares maps identifying seismic hazard zones and provides them to local governments, which include areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures. SHMA requires responsible agencies to only approve projects within these zones following a site-specific investigation to determine if the hazard is present, and if so, the inclusion of appropriate mitigation(s). In addition, the SHMA requires real estate sellers and agents at the time of sale to disclose whether a property is within one of the designated seismic hazard zones.

c. California Building Standards Code (Title 24)

Title 24 of the California Code of Regulations (CCR) provides state regulations that govern the design and construction of buildings, associated facilities, and equipment. These regulations are also known as building standards (reference California Health and Safety Code Section 18909). Cities and counties are required by state law to enforce CCR Title 24 and may adopt ordinances making more restrictive requirements than provided by CCR Title 24 due to local climatic, geological, or topographical conditions.

d. State Water Resources Control Board General Construction Permit 2022

The State Water Resources Control Board (SWRCB) adopted the 2022 Construction Stormwater General Permit, Order 2022-0057-DWQ, on September 8, 2022, and it went into effect on September 1, 2023. State and regional water quality control boards have been charged with ensuring that beneficial uses and water quality objectives are established for all waters of the state. Development in the City would be subject to the National Pollutant Discharge Elimination System to protect water

resources and control pollutants in runoff. The GCP is administered at the local level by the Santa Ana Regional Water Quality Control Board.

e. California Public Resources Code Section 5097.5(a)

A person shall not knowingly and willfully excavate upon, or remove, destroy, injure, or deface, any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site, including fossilized footprints, inscriptions made by human agency, rock art, or any other archaeological, paleontological, or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over the lands.

4.5.2.2 Regional Regulations

a. South Coast Air Quality Management District Rules 402 and 403

Rules 402 and 403 require that fugitive dust be controlled during construction activities to limit exposure of nearby sites to fugitive dust resulting from construction activities. Rule 402 requires dust suppression techniques be implemented to prevent dust and soil erosion from creating a nuisance offsite. Rule 403 requires that fugitive dust be controlled with best available control measures so that the presence of such dust does not remain visible in the atmosphere beyond the property line of the emissions source. This would reduce erosion potential during construction.

4.5.2.3 Local Regulations

a. Existing General Plan (2000)

The existing General Plan Seismic Element contains the following objectives and policies applicable to development in the project area:

Objective D-1: Potential Hazards: Take potential environmental hazards into account in the General Plan.

- Policy (a): Identify the locations of potential seismic hazards to minimize the effects of the potential hazard through special development constraints. Conduct a research program to develop more refined boundaries for seismic response areas, particularly for SRA 1.

Objective D-2: Response to Hazards: Require appropriate measures to protect public health and safety and to respond to seismic hazards in all public and private developments.

- Policy (a): Use Figure D-3 during development review to minimize the effects of environmental hazards as follows:
  - For development in Seismic Response Areas 1, 2, 3, and 4: Concurrent with submittal of applications for concept plans and zone changes, as well as the

preparation of environmental impact reports, preliminary geotechnical reports are required for the following uses:

1. All planning area level proposals.
2. Community/regional level shopping centers.
3. Major commercial/office centers.
4. Major public facilities
5. Major public utilities
6. Major transportation linkages.
7. Any facility critical to emergency response (i.e. hospitals, police and fire stations, municipal government centers, transportation linkages, and designated emergency centers).
8. Major industrial development (applies to SRA 1 only).

If a detailed geotechnical report confirms the existence of a seismic hazard, the City has the option to require special earthquake resistant design features or use limitations as appropriate to the specific case.

- For development in Seismic Response Area 5: Preliminary geotechnical reports shall be submitted with applications for concept plans and zone changes as well as with environmental impact reports for non-open space uses. Those reports should concentrate on addressing slope instability and probable changes to the environment which would occur if these areas would be developed.

  If a detailed geotechnical report confirms existence of potential seismic hazard, the City has the option to require special earthquake resistant design features or use limitations as appropriate to the specific case.

- Policy (d): Require detailed site studies to determine the potential for seismic hazards for facilities which are critical in an emergency. These facilities include but are not limited to:

  - Police and fire stations.
  - Municipal government centers.
  - Transportation infrastructure.
  - Major public utilities (electrical, gas and water facilities).
  - Designated emergency centers.
  - Buildings greater than 15 stories in height.

- Policy (g): Require a detailed geological and soils study as needed, in accordance with the requirements of the City's Subdivision Ordinance, before approving development.

b. Municipal Code

Title 5 (Planning), Division 9 (Building Regulations)

The City's Building Code Regulations are included in Division 9 of the City's Municipal Code, as adopted under Section 5-9-101 (Adoption of Building Code). Division 9 adopted by reference the most recent version of the California Building Code.

Title 5 (Planning), Division 10 (Grading Code and Encroachment Regulations), Chapter 1 (Grading Code)

The City's Grading Code establishes rules and regulations to control excavation, grading, and earthwork construction (including fills and embankments), and establishes administrative requirements for issuance of permits, approval of plans, and inspection of grading construction in accordance with the requirements for grading and excavation contained in the Uniform Building Code as adopted and modified by City ordinance. The Grading Code also contains water quality requirements.

c. Grading Manual

The City's Grading Manual is a compilation of rules, procedures, and interpretations necessary to carry out the provisions of the City's Grading Code. The purpose of the Grading Manual is to assist users of the Grading Code by supplementing it with detailed information regarding rules, interpretations, standard specifications, procedures, requirements, forms, and other information applicable to control excavation, grading and earthwork construction in the City. The Grading Manual also contains guidelines for the preparation of geotechnical and geology reports, slope stability analysis and erosion control plans. The geotechnical and geology reports, slope stability analysis and erosion control plan are required to be submitted as part of the grading plan and are reviewed and approved by the Building & Safety Division of the Community Development Department.

d. Local Hazard Mitigation Plan

The City developed the LHMP, most recently updated in 2020, to identify the hazards, estimate the probability of future occurrences, and set goals to mitigate potential risks to reduce or eliminate long-term natural or man-made hazard risks to human life and property for the City and its residents. The goals of the LHMP are to:

1. Protect against threats from natural hazards to life, injury, and property damage.
2. Increase public awareness of potential hazard events.
3. Preserve critical services and functions by protecting key facilities and infrastructure.
4. Protect natural systems from current and future hazard conditions.
5. Coordinate mitigation activities among City departments, neighboring jurisdictions, and with federal agencies.
6. Prepare for long-term change in hazard regimes.

The LHMP identifies local faults that may generate earthquakes and identifies potential vulnerabilities within the City that could be adversely affected by seismic events. The LHMP also identifies a mitigation strategy for reducing losses associated with seismic events.

The LHMP states that no active faults are located within the City; however, there are several nearby faults that could result in seismic hazards in the event of an earthquake. In addition to the hazards caused by seismic shaking, there is also a risk of liquefication in parts of the City due to the highwater table and types of soil present. THE LHMP documents historic southern California earthquakes that affected the Irvine region. The largest and most recent earthquake to occur within 100 miles of the City of Irvine was the 6.7 magnitude Northbridge Earthquake in 1994 that occurred approximately 56 miles from the City. Additional earthquakes that have occurred within the region since the beginning of the twentieth century are presented in Table 4.5-2.

Table 4.5-2
History of Major Southern California Earthquakes Since 1992

Year	Richter Scale Magnitude	Description
1933	6.4	Occurred near Long Beach, California, approximately 12 miles from Irvine
1937	6.0	Occurred near Oasis in Riverside County, approximately 92 miles from Irvine
1948	6.0	Occurred near Desert Hot Springs, California, approximately 88 miles from Irvine
1971	6.6	Occurred near San Fernando, California, approximately 61 miles from Irvine
1986	6.0	Occurred in the northern part of Palm Springs, California, approximately 72 miles from Irvine
1992	6.1	Occurred near Joshua Tree, California, approximately 87 miles from Irvine
1992	6.3	Occurred near Big Bear, California, approximately 66 miles from Irvine
1994	6.7	Northridge Earthquake occurred in a neighborhood of the city of Los Angeles and was 56 miles from Irvine
2019	7.1	Occurred roughly 11 miles northeast of Ridgecrest, California

SOURCE: City of Irvine 2020.

e. Planning Commission Resolution No. 09-2968

Standard Conditions are adopted by Planning Commission Resolution No. 09-2968. These conditions assist staff in applying standardized wording for frequently used conditions of approval for discretionary and subdivision applications. Standard conditions are applied on a case-by-case basis depending upon the specifics of the application. Companion conditions are cross-referenced and are required to be used together. The following standard conditions related to Geology and Soils apply:

Standard Condition 2.6 Site Specific Geotechnical Study

Prior to the issuance of grading permits, the applicant shall provide to the Chief Building Official a site-specific geotechnical study for each proposed structure. The geotechnical report shall be prepared by a registered civil engineer or certified engineering geologist, having competence in the field of seismic hazard evaluation and mitigation. The geotechnical report shall contain site-specific evaluations of the seismic hazard affecting the project and shall identify portions of the project site

containing seismic hazards. The report shall also identify any known off-site seismic hazards that could adversely affect the site in the event of an earthquake. The contents of the geotechnical report shall include, but shall not be limited to, the following:

a. Project description.
b. A description of the geologic and geotechnical conditions at the site, including an appropriate site location map.
c. Evaluation of site-specific seismic hazards based on geological and geotechnical conditions, in accordance with current industry standards of practice.
d. Recommendations for earthwork and construction.
e. Name of report preparer(s), and signature(s) of a certified engineering geologist and/or registered civil engineer, having competence in the field of seismic hazard evaluation and mitigation.
f. Include the official professional registration or certification number and license expiration date of each report preparer in the signature block of the report.

Standard Condition 3.3 Disclosure Statements

Prior to the issuance of building permits, the applicant shall submit to the Director of Community Development for review and approval a completed occupancy disclosure form for the project. The approved disclosure form, along with its attachments, shall be included as part of the rental/lease agreements and as part of the sales literature for the project. The disclosure statement shall include information, current as of the date of submittal, with respect to each item marked with an "x" on the list below. The items marked "n/a" need not be included.

a. Information on Noise resulting from aircraft and/or helicopter operations from John Wayne Airport.
b. Reference to Emergency Preparedness information available on the City of Irvine website at www.cityofirvine.org/office-emergency-management.
c. Map of Special Flood Hazard Area information for areas subject to inundation.
d. Notice that initial occupancy and any subsequent change in use or occupancy of any non-residential condominium space, requires the buyer or the new or existing occupant to apply to the Community Development Department and obtain approval by way of a of written zoning confirmation letter or obtain a building permit and obtain inspection approval for any necessary work to establish the use and/or occupancy consistent with that intended.
e. Notice that the property owner shall be responsible for continuous maintenance of the emergency access equipment thus ensuring these systems will be operational at all times, as required by the Chief of Police.
f. Notice that the property is located near and/or adjacent to private and/or public park(s) that may include recreational, field/court lighting, and other related improvements.
g. Notice that the property is located near and/or adjacent to public open space land that may include trails, trailheads, parking facilities, and other related improvements and operations.
h. Notice that the property is located near and/or adjacent to public trails and/or related improvements and operations.
i. Notice that residential buildings such as single-family homes, condominiums and apartments are prohibited from being used as short-term rentals (aka vacation rentals). A rental

arrangement for a term of less than 31 days is considered "short-term". For more detailed information contact the Community Development Department.

Standard Condition 2.5 Archaeologist/Paleontologist

Prior to the issuance of the first preliminary or precise grading permit for a project that is located on land that includes potentially significant archaeological and/or paleontological sites, and for any subsequent permit involving excavation to increased depth, the applicant shall provide letters from an archaeologist and a paleontologist. The letters shall state that the applicant has retained these individuals, and that the consultant(s) will be on call during all grading and other significant ground disturbing activities. Determination of the need for these consultants shall be based on the environmental analysis for the project. These consultants shall be selected from the roll of qualified archaeologists and paleontologists maintained by the County of Orange (OC Public Works / OC Planning). The archaeologist and paleontologist shall meet with Community Development staff, and shall submit written recommendations specifying procedures for cultural/scientific resource surveillance. These recommendations shall be reviewed and approved by the Director of Community Development prior to issuance of the grading permit and prior to any surface disturbance on the project site. Should any cultural/scientific resources be discovered during grading, no further grading shall occur in the area of the discovery until the Director of Community Development is satisfied that adequate provisions are in place to protect these resources. This condition and the approved recommendations shall be incorporated on the cover sheet of the grading plan under the general heading: "Conditions of Approval."

f. Existing Plans, Programs, and Policies

Compliance measures are regulations imposed uniformly by the approving agency based on the proposed action taken and are required of the project to reduce its potential environmental effects. Because these features are standard requirements, they do not constitute mitigation measures. The following measures are existing plans, programs, or policies (PPP) that apply to the project and will help to reduce and avoid potential impacts related to geology and soils:

- PPP-GEO-1 Compliance with General Construction Permit
- PPP-GEO-2 Compliance with California Public Resources Code Section 5097.5(a) regarding paleontological resources
- PPP-GEO-3 Compliance with South Coast Air Quality Management District Rules 402 (Dust Suppression) and 403 (Fugitive Dust)
- PPP GEO-4 Compliance with Municipal Code Title 5 (Planning), Division 9 (Building Regulations) California Building Code
- PPP GEO-5 Compliance with Municipal Code Title 5 (Planning), Division 10 (Grading Code and Encroachment Regulations), Chapter 1 (Grading Code)
- PPP GEO-6 Compliance with the City's Grading Manual
- PPP GEO-7 Compliance with the Local Hazard Mitigation Plan
- PPP GEO-8 Compliance with Standard Condition 2.6 Site Specific Geotechnical Study
- PPP GEO-9 Compliance with Standard Condition 3.3 Disclosure Statements
- PPP-GEO-10 Compliance with Standard Condition 2.5 Archaeologist/Paleontologist

Proposed General Plan Strategies and Policies

In addition to the above-listed PPPs, the following proposed Goals, Objectives, Policies, and Implementation Actions are applicable to the analysis of geology and soils and would replace existing goals, strategies, and policies outlined in the City's existing General Plan following project approval:

SafetyElement

Goal 3: Anticipate the risks and mitigate the effects that flood hazards pose to the community.

Objective S-3. Flood Hazards. The following policies support Goal S-3:

- **Policy (a):** Work with Orange County Flood Control District to ensure flood control facilities are adequately provided and maintained.
- **Policy (b)**: Collaborate with partner agencies and municipalities to align green infrastructure projects (i.e., projects that allow for the filtration of stormwater where it falls) and develop regulations for watersheds across jurisdictions to reduce impervious hard surfaces.
- **Policy (c):** Support efforts of other organizations and academic institutions to conduct studies of the impact combined riverine and coastal flooding, groundwater intrusion, and increased precipitation has on flood risk and vulnerability.
- **Policy (d)**: Support efforts of other organizations and academic institutions to inventory and map vegetation on hillsides with a specific focus on improving hillside stability in the case of extreme rainfall and seasonal erosion.
- **Policy (e):** Develop or update a long-term plan to address current and future flood risk to critical facilities.
- **Policy (g)**: Ensure resilience and long-term functionality of stormwater and sewer systems.
- **Policy (h):** Encourage the use of climate-smart landscaped surfaces (e.g., permeable pavement, stormwater parks, green streets) in new and existing developments to reduce runoff, minimize flood hazards, and maintain existing drainage ways.

Safety Element

Goal 2: Improve the community's resilience to seismic and geologic hazards by ensuring the integrity of the built environment.

Objective S-2. Seismic and Geologic Hazards. The following policies support Goal S-2:

- **Policy (a)**: Coordinate with Irvine Ranch Water District and Orange County Water District on emergency water storage and distribution following a liquefaction or landslide event.
- **Policy (b)**: Coordinate groundwater management with Orange County Water District to avoid subsidence impacts in Irvine.
- **Policy (c)**: Promote the strengthening of planned utilities, the retrofit and rehabilitation of existing weak structures and lifeline utilities, and the relocation or strengthening of certain critical facilities to increase public safety and minimize potential damage from seismic and geologic hazards.

- Policy (d): Encourage replanting bare or disturbed areas after landslides to reduce erosion.

4.5.3 Significance Determination Thresholds

The City has adopted Appendix G of the State California Environmental Quality Act (CEQA) Guidelines as the significance thresholds for geological resources. A significant impact would occur if the project would:

1) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:
   a. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault. Refer to Division of Mines and Geology Special Publication 42,
   b. Strong seismic ground shaking,
   c. Seismic-related ground failure, including liquefaction,
   d. Landslides;
2) Result in substantial soil erosion or the loss of topsoil;
3) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse;
4) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property;
5) 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;
6) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

4.5.4 Methodology

The potential for significant impacts associated with the project has been determined based upon review of existing secondary source information and data relative to the geology and soils resources available for the City. Additionally, a paleontological resources assessment was prepared for the project that included a records search at the Natural History Museum of Los Angeles County, as well as review of published literature, unpublished paleontological reports, and fossil databases (see Appendix D).

4.5.5 Topics 1 and 3: Seismic Hazards and Unstable Geology, and Topic 4: Expansive Soils

Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving: (i) rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault (refer to Division of Mines and Geology Special Publication

42); (ii) strong seismic ground shaking? (iii) seismic-related ground failure, including liquefaction; or (iv) landslides?

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

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

4.5.5.1 Impact Analysis

a. Earthquake Fault Rupture and Strong Seismic Ground Shaking

The City and its sphere of influence are affected by both local and regional active faults. As previously stated, the City's LHMP includes a summary of the most recent assessment of the probability of a major earthquake on various faults between 2015 to 2044. The San Joaquin Hills Fault, located within the City, has a 40 percent probability of a major earthquake occurring while the Newport-Inglewood Fault, located 8 miles from the City, has a 95 percent probability of occurring. The LHMP also includes the U.S. Geological Survey forecasts regarding the severity of seismic shaking. The scenarios show that the Newport-Inglewood and San Joaquin Hills faults could cause the strongest seismic shaking in Irvine. However, the largest magnitude events are anticipated to come from the more distant San Jacinto and San Andreas faults, which could cause earthquakes that have an overall higher magnitude than the Newport-Inglewood or San Joaquin Hills faults. However, due to distance of the distant of the San Jacinto and San Andreas faults, the shaking intensity felt in Irvine would be reduced compared to the shaking that would be felt nearer the earthquakes' epicenters. The overall magnitude of potential earthquake scenarios occurring along the Newport-Inglewood and San Joaquin Hills faults is lower than some of the more regional faults but their proximity to Irvine means that the City would be subjected to high intensity shaking from these earthquakes. However, the likelihood of a powerful earthquake occurring along these faults within the next 25 years is exceptionally low.

Future projects introducing new development in the City associated with project approval could expose people to impacts related to seismic ground shaking. These projects would be required to adhere to safety requirements in the Municipal Code requirements related to the City's Building Code, Grading Code, Grading Manual, and site-specific geotechnical studies (PPPs GEO-4, GEO-5, GEO-6, and GEO-8), which would ensure that structures would be designed with the geologic hazards in mind to reduce risks associated with strong seismic ground shaking, seismic-related ground failure, and other geologic hazards such as subsidence and landslides. Compliance with these regulations would reduce impacts related to seismic shaking to a less than significant level. Furthermore, safety requirements related to ruptures and seismic shaking include Safety Element Update Policy S-2(c), which promotes the strengthening of planned utilities, the retrofit and rehabilitation of existing weak structures and lifeline utilities, and the relocation or strengthening of certain critical facilities to increase public safety and minimize potential damage from seismic and geologic hazards. Updated Safety Element goals, objectives, and policies would further the City's goal of reducing seismic-related hazards.

b. Liquefaction, Landslides, Lateral Spreading, Subsidence, and Expansive Soils

Figure 4.5-1 presents where liquefaction zones have been identified throughout the City, and Table 4.5-1 presents the acreage of land within the City designated as a liquefaction zone. Approximately 2,250.26 acres of Focus Area 1, 46.15 acres of Focus Area 2, and 440.28 acres of Focus Area 3, and 9,136.6 acres in the remainder of the City are in the liquefaction susceptibility zone. Figure 4.5-2 identifies the areas of the City that are considered vulnerable to seismic induced landslides. As illustrated by this figure, there is the potential for landslides in the steeper portions of the foothills of the Santa Ana Mountains to the northeast of the City and the San Joaquin Hills to the southwest of the City. These areas are characterized with steep topography and geologic units that can become unstable. Even these areas; however, are designated as having a moderately low risk of landslides due to seismic conditions, and a low likelihood of a landslide under other conditions.

The City's LHMP identified that the most likely locations for subsidence in Irvine are the low-lying areas that sit on top of the OCWD groundwater basin as Irvine does not have a history of seismically induced subsidence. Since Irvine has not experienced acute subsidence events, it seems unlikely that subsidence will occur in the City's future and would be unlikely to impact new development as part of the project. The most likely cause of a future event would be linked to an extreme drought in the future that leads to intensified groundwater withdrawals from the groundwater aquifer. In addition, although the likelihood of occurrence is low, the City's proximity to seismically active faults suggest the potential for a significant earthquake exists, which could lead to seismically induced subsidence in the future. As discussed further in Section 4.8, Hydrology, future projects would be required to comply with the OCWD's groundwater management plan (PPP HYD-4), applicable Water Quality Management Plan requirements, and City Standard Condition 2.7 (PPP HYD-13) to minimize impacts related to groundwater depletion or intrusion. Safety Element Update Policy S-2(b) would further support the City's goal of coordinating with OCWD to avoid and reduce groundwater depletion.

As noted by the City's LHMP, although expansive soils exist, the City requires compliance with the California Building Code (PPP GEO-4), which is intended to mitigate hazards associated with this condition through professional consideration of foundation types and design criteria, including bearing capacity, for structures to be developed in the City to minimize the effects of expansive soils.

The project would facilitate future development consisting of residential uses required to meet the City's Regional Housing Needs Assessment (RHNA) requirement, nonresidential uses within the Great Park, nonresidential uses at the same intensities as permitted under the existing General Plan, and the extension of Ada roadway.

Future development under the project would be required to adhere to safety requirements in the City's General Plan Safety Element Update and Municipal Code requirements related to the City's Building Code (PPP GEO-4), Grading Code (PPP GEO-5), Grading Manual (PPP GEO-6), and Standard Condition 2.6 Site Specific Geotechnical Study (PPP GEO-8) which would reduce impacts related liquefaction, landslide lateral spreading, subsidence, and expansive soils to a less than significant level. Furthermore, the project's Conservation and Open Space Element and Safety Element Update include the objectives and policies related to geologic hazards. For example, Conservation and Open Space Objective COS-3 aims to minimize the danger to life and property from geophysical hazards, including, but not limited to, unstable soils, liquefaction, steep slopes, and floodways, and Safety

Element Objective S-2 aims to improve the community's resilience to seismic and geologic hazards by ensuring the integrity of the built environment. Therefore, compliance with existing City's Municipal Code (PPP GEO-4 and GEO-5), Grading Manual (PPP GEO-6), LHMP (PPP GEO-7), and applicable standard conditions (PPPs GEO-1, PPP GEO-2, GEO-8, GEO-9) would ensure that both direct and indirect impacts related to the risk of loss, injury, or death involving: rupture of a known seismic-related ground failure, including liquefaction, landslides, lateral spreading. and expansive soils would be less than significant. Compliance with these measures would also limit impacts resulting from development on geology or soil that is unstable or that could become unstable, or located on expansive soil, to a less than significant level.

4.5.5.2 Significance of Impacts Topics 1 and 3: Seismic Hazards and Unstable Geology and Topic 4: Expansive Soils

Future projects would be required to comply with existing City's Municipal Code (PPP GEO-4 and GEO-5), Grading Manual (PPP GEO-6), LHMP (PPP GEO-7), and applicable standard conditions (PPPs GEO-1, PPP GEO-2, GEO-8, GEO-9). Compliance with these regulations would ensure that the project would not result in any impacts related to seismic hazards (rupture, shaking, failure, and landslides), unstable geology, or expansive soils, and impacts would be less than significant.

4.5.5.3 Mitigation Topics 1 and 3: Seismic Hazards and Unstable Geology and Topic 4: Expansive Soils

Impacts would be less than significant. No mitigation is required.

4.5.6 Topic 2: Soil Erosion

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

4.5.6.1 Impact Analysis

The project would facilitate future development consisting of residential uses required to meet the City's RHNA requirement, nonresidential uses within the Great Park, nonresidential uses at the same intensities as permitted under the existing General Plan, and the extension of Ada roadway.

As further described in Section 4.8, Hydrology, future development under the project would have the potential to result in increased erosion both on- and off-site during construction and operation of future development.

The statewide General Construction Permit (PPP HYD-1) requires preparation and implementation of a SWPPP for projects that would disturb one or more acres and include construction or demolition activity, including, but not limited to, clearing, grading, grubbing, or excavation, or any other activity that results in a land disturbance of equal to or greater than one acre (SWRCB 2022). The SWPPP would provide construction related BMPs to reduce erosion, resulting from construction associated with future development.

Post-construction erosion resulting from increased runoff would also generally be avoided or reduced through site design and hydromodification control BMPs as required per PPP-HYD-3, PPP-HYD-5, PPP-HYD-10, PPP-HYD-12, and PPP-HYD-16. Projects would also be required to adhere to the City's Municipal Code (PPP-HYD-10, PPP-HYD-11), Standard Conditions (PPP-HYD-14, PPP-HYD-15), Grading Manual (PPP-HYD-12), to reduce operational impacts associated with erosion. Additionally, General Plan Policies S-3(b), S-3(e), S-3(f), S-3(h), S-3(i), S-3(j), S-3(k), S-5(d), S-5(f), S-5(h), and S-5(j) would further the City's goals of reducing erosion and siltation impacts resulting from operation of future development associated with the project by increasing groundwater infiltration.

Therefore, with implementation of the PPPs above, impacts related to soil erosion would be reduced to a less than significant level.

4.5.6.2 Significance of Impacts

Future projects would be required to comply with existing City regulations and applicable standard conditions (PPPs HYD-1, HYD-3, PPP-HYD-5, PPP-HYD-10, PPP-HYD-11 PPP-HYD-12, PPP-HYD-14, PPP-HYD-15, and PPP-HYD-16). Compliance with these regulations would ensure that project would not result in any impacts related to substantial soil erosion or the loss of topsoil. Impacts would be less than significant.

4.5.6.3 Mitigation

Impacts would be less than significant. No mitigation is required.

4.5.6.4 Significance of Impacts after Mitigation

Impacts would be less than significant. No mitigation is required.

4.5.7 Topic 5: Septic Tanks

Would the project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

4.5.7.1 Impact Analysis

The project does not propose the use of septic tanks or alternative wastewater disposal systems. All future development under the project would be served by wastewater utility providers.

4.5.7.2 Significance of Impacts

All future development under the project would be served by wastewater utility providers. Therefore, the project would not have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater. No impact would occur.

4.5.7.3 Mitigation

No impact would occur. No mitigation is required.

4.5.8 Topic 6: Paleontological Resources and Unique Geology

Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

4.5.8.1 Impact Analysis

The project would facilitate future development consisting of residential uses required to meet the City's RHNA requirement, nonresidential uses within the Great Park, nonresidential uses at the same intensities as permitted under the existing General Plan, and the extension of Ada roadway.

Previous City documents used a four-tiered ranking system to assess the sensitivity of sediments for fossils (City of Irvine 2015). Using the City's system, geologic units are classified according to the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts within the known extent of the geological unit described in Section 4.5.1.5.

As shown in Figure 4.5-3, the northeastern and southeastern portion of the city are interspersed with areas of high paleontological sensitivity rating, while the remaining majority of the City classified as having moderate paleontological sensitivity rating. Future development within areas with high and moderate sensitivity would have the potential to disturb native soils, and therefore may impact paleontological resources. Per Standard Condition 2.5 (PPP-GEO-10), prior to the issuance of the first preliminary or precise grading permit for a project that is located on land that includes potentially significant archaeological and/or paleontological sites, and for any subsequent permit involving excavation to increased depth, the applicant must provide letters stating that a qualified archaeologist and paleontologist would be on-site during ground disturbing activities and would provide procedures for cultural/scientific resource surveillance. Despite compliance with Standard Condition 2.5, impacts would remain potentially significant and mitigation requiring a site-specific paleontological assessment and/or monitoring for all soils below 5 feet would be required (mitigation measure GEO-1).

4.5.8.2 Significance of Impacts

At a program level of analysis, it cannot be known with certainty that impacts to paleontological resources could be fully avoided, which would be considered significant.

4.5.8.3 Mitigation

GEO-1: Prior to issuance of grading permits, applicants for future proposed ground disturbing projects in undisturbed sediments ranked moderate or above shall be required to either (1) provide a technical paleontological assessment consisting of a record search, survey, background context and project specific recommendations

performed by a qualified paleontologist (with a graduate degree and a specialization in vertebrate paleontology) to the City of Irvine Department of Community Development or (2) agree to monitoring all excavations below five feet. If resources are known or reasonably anticipated the recommendations shall provide a detailed mitigation plan requiring monitoring during grading and other earthmoving activities in undisturbed sediments. The plan will establish a fossil recovery protocol that includes data to be collected, requires professional identification, radiocarbon dates and other special studies as appropriate, requires curation at local curation facility such as such as the John D. Cooper Center operated by the County of Orange for fossils meeting significance criteria. A comprehensive final mitigation compliance report including a catalog of fossil specimens with museum numbers and an appendix containing a letter from the museum stating that they are in possession of the fossils shall be required.

4.5.8.4 Significance of Impacts after Mitigation Topic 5: Paleontological Resources

Impacts to paleontological resources would equate to a significant impact as paleontological resources are nonrenewable resources in nature. However, through implementation of GEO-1, the development of a technical paleontological assessment would reduce potential impacts to paleontological resources during ground disturbance on sites with moderate or high sensitivity sediments. In addition, GEO-1 requires that a fossil recovery protocol would be implemented in the event of unanticipated discovery during construction that would ensure that paleontological resource would not be destroyed. Projects would also be subject to compliance with PPP-GEO-10 (Standard Condition 2.5) which would ensure that ground disturbing activities during project construction are monitored by a qualified archaeologist and paleontologist. Impacts related to paleontological resources would therefore be mitigated to a less than significant level. Implementation of the mitigation measure GEO-1 described above would potentially reduce impacts on paleontological resources to a level less than significant. However, as no specific development projects have been identified at this time, it is not possible to ensure that every future project could fully mitigate potentially significant impacts. Therefore, impacts to paleontological resources would remain significant and unavoidable at this program level of review.

4.5.9 Cumulative Analysis

As defined in Section 15130 of the State CEQA Guidelines, cumulative impacts are the incremental effects of an individual project when viewed in connection with the effects of past, current, and probable future projects within the cumulative impact area for geology and soils. The study area for the assessment of cumulative impacts related to geologic resources is defined as the City. Future development could increase the number of people exposed to seismic and geologic hazards, and erosion rates could be accelerated by earthwork for new construction. Projects would be required to comply with applicable City regulations, including following the adopted Building Code, Municipal Code, and Standard Conditions to reduce the potential for seismic-related impacts and impacts related to soil erosion (PPPs GEO-1 through GEO-9). Additionally, increased development could encroach on areas with paleontological resources which could be lost if not monitored properly.

However, all future development would be required to adhere to all relevant PPP's described above (PPP-GEO-1 through PPP-GEO-10). Implementation of the mitigation measure GEO-1 described above would potentially reduce impacts on paleontological resources to a level less than significant. However, as no specific development projects have been identified at this time, it is not possible to ensure that every future project could fully mitigate potentially significant impacts. Therefore, impacts to paleontological resources would remain cumulatively considerable and significant and unavoidable.