4.7 Geology and Soils

This section describes the geology and soils geography present at the UCR campus and in the larger region and how the regulatory framework addresses these resources. This section then analyzes the potential impacts related to geology, soils, and paleontological resources that could result from implementation of the proposed 2021 LRDP. Potential effects of soil conditions on air and water quality because of construction-related activities are discussed in Section 4.3, *Air Quality* and Section 4.10, *Hydrology and Water Quality*.

4.7.1 Environmental Setting

Geologic Setting

Riverside County is geographically and topographically diverse. It encompasses mountains, hills, and riparian valleys. UCR is located in the City of Riverside (City), which is in the northwest portion of Riverside County, with the Santa Ana Mountain ranges approximately 20 miles south and southwest of the campus and the San Bernardino Mountains approximately 20 miles north and northeast of the campus. The Box Springs Mountains lie north, northeast, east, southeast, and south of East Campus. The City lies in the northern end of the Peninsular Ranges geomorphic province of California, south of its intersection with the Transverse Ranges. The Peninsular Ranges extend into Baja California and are bound on the east by the Colorado Desert (California Geology Survey [CGS] 2002). Most of the City's planning areas consist of granite, adamellite, Mesozoic granitic rock, granodiorite, Mesozoic basic intrusive rocks, and alluvium (located around the Santa Ana River). Most are dated from the Mesozoic period, except for the alluvium, which dates from the Quaternary (City of Riverside 2012). Alluvial deposits weathered and eroded from the surrounding mountain ranges comprise most of the geologic components of the project area.

Mountains and hills typically have slopes of 15 to 50 percent, and valley and basin areas usually have slopes of less than 15 percent. In the City, most natural slopes are very flat, generally less than 15 percent, with some slopes ranging from 15 to 25 percent in eastern and southern portions of the City. Many slopes in the City's planning area are steeper than the topography of the City as a whole. For example, areas around Lake Mathews and the Box Springs Mountains are much steeper than the terrain in which the campus is situated. Slopes along a substantial portion of the area west and south of Lake Mathews and along the northeastern line exceed 30 percent (City of Riverside 2012).

The City lies in the 92-square-mile Upper Santa Ana Valley Groundwater Basin, Riverside-Arlington Sub-basin (Groundwater Basin Number 8-2.03) (California Department of Water Resources 2004). The Riverside-Arlington Sub-basin encompasses both northwest Riverside County and southwest San Bernardino County, with groundwater stored primarily in clay, silt, and gravel alluvium deposited by the Santa Ana River and its tributaries. The 1969 Western-San Bernardino Judgment (*Western Municipal Water District of Riverside County et al. v. East San Bernardino County Water District et al.*, Case No. 78426) settled extraction rights throughout the Upper Santa Ana River watershed to meet flow obligations to lower reaches of the river (Riverside Public Utilities 2016). The judgment resulted in adjudication of a portion of the sub-basin (the "Riverside Sub-basin"), with the remainder of the sub-basin (the "Arlington Sub-basin") remaining non-adjudicated.

UCR Campus

The UCR campus is in the adjudicated Riverside South basin in Riverside County. Two watermasters, one appointed by the San Bernardino Valley Municipal Water District and one appointed by Western Municipal Water District, oversee groundwater extractions in the adjudicated portions of the basin and ensure compliance with the terms of the judgment.

The UCR campus is within the Perris Block in the northern portion of the Peninsular Ranges geomorphic province (CGS 2002). The Perris Block is a roughly-rectangular area of relatively low relief that has remained relatively stable and undeformed during the Neogene (Norris and Webb 1990; Morton and Miller 2006). It is bound by the Cucamonga Fault Zone to the north, the San Jacinto Mountains to the east, the Elsinore Fault Zone to the southwest, and the Chino Basin to the west. According to Morton and Miller, the Perris Block is underlain by lithologically diverse prebatholithic metasedimentary rocks, intruded by Cretaceous plutons of the Peninsular Ranges Batholith, which are subsequently overlain by thin to relatively thick, discontinuous sections of nonmarine Quaternary sediments. Quaternary deposits in the Perris Block consist of Pleistocene and Holocene alluvial fan deposits emanating from the nearby San Gabriel Mountains to the north and fluvial deposits from the Santa Ana River, which bisects the Perris Block and flows southward.

Elevations on campus range from approximately 1,000 to 1,400 feet above sea level. Most of the surface of the campus represents the valley floor as it existed during the Pleistocene epoch (greater than 11,000 years ago), which was incised by two active washes, the University Arroyo and the Box Springs Arroyo, during Holocene time (the last 11,000 years). This resulted in the current landform of the campus. The geologic materials that underlie the campus include granitic bedrock that is part of the Val Verde tonalite, older alluvium (deposited during the Pleistocene), and younger alluvium (deposited during the Holocene) (UCR 2005).

The UCR campus and the Riverside area are surrounded by the Santa Ana Mountains on the west, San Bernardino Mountains on the north and northeast, and the San Jacinto Mountains on the east. The San Jacinto and Santa Ana Mountains consist mainly of Mesozoic metamorphic and volcanic rocks, Cretaceous plutonic rocks, and Mesozoic to Cenozoic sediments. The main components of the San Bernardino Mountains are also Mesozoic and Cretaceous rock. The Box Spring Mountains, located north, northeast, east, southeast, and south of East Campus, are composed mainly of Cretaceous-age granitic rock from the southern California batholith. The Quaternary-aged alluvial fill currently beneath the Riverside area is generated by erosion of the southern California batholith.

Geologic units in Riverside County are mapped at a scale of 1:100,000 (Morton and Miller 2006). The five mapped units in UCR (i.e., Qaf, Qyf, Qya, Qof, Qvof) consist mainly of Quaternary-aged alluvial deposits, differentiated by age, with the oldest dating from early Pleistocene. The majority of the West Campus is mapped as Quaternary old (late to middle Pleistocene) alluvial fan deposits (Qof), consisting of moderately to well-consolidated silt, sand, and gravel, with a small portion of Quaternary very old (early Pleistocene) alluvial fan deposits (Qvof) along the southeastern portion of West Campus. The drainage channel that runs through West Campus is mapped as Quaternary young (Holocene to late Pleistocene) axial channel deposits (Qya), consisting of slightly to moderately consolidated silt, sand, and gravel deposits. East Campus is composed mainly of Quaternary very old (early Pleistocene) alluvial fan deposits (Qvof), consisting of moderately to well consolidated orange to reddish brown silt, sand, gravel, and conglomerate. The western portion of East Campus also is mapped as Quaternary old (late to middle Pleistocene) alluvial fan deposits (Qof). The drainage channel that runs through East Campus is mapped as Quaternary young (Holocene to late Pleistocene) axial channel deposits (Qya), consisting of slightly to moderately consolidated silt, sand, and gravel deposits. Artificial fill (Qaf) , mapped within a small portion of the southern area of West Campus, consists of sand, gravel, and bedrock from pits, quarries, and excavations related to previous construction, mining or quarrying activities (Morton and Miller 2006). Figure 4.7-1 depicts the geologic units mapped within UCR.

Young alluvial fan deposits (Qyf) were deposited in the Holocene and late Pleistocene and consist of gray-hued sand and gravel deposits derived mainly from the rocks of Peninsular Ranges batholith. Young axial channel deposits (Qya) were also deposited in the Holocene and late Pleistocene and is comprised of gray, unconsolidated alluvium consisting of medium- to fine-grained sand and silt flooring several low relief valleys and their tributaries. Old alluvial fan deposits (Qof) were deposited in the late to middle Pleistocene and consist of indurated, sandy alluvial fan deposits developed extensively in the western part of the quadrangle. Most of the old alluvial fan deposits are reddish-brown. Very old alluvial fan deposits (Qvof) were deposited in the early Pleistocene and are mostly well-dissected, well-indurated, reddish-brown sand deposits. The very old alluvial fans commonly contain duripans and locally silcretes.

Paleontological Resources

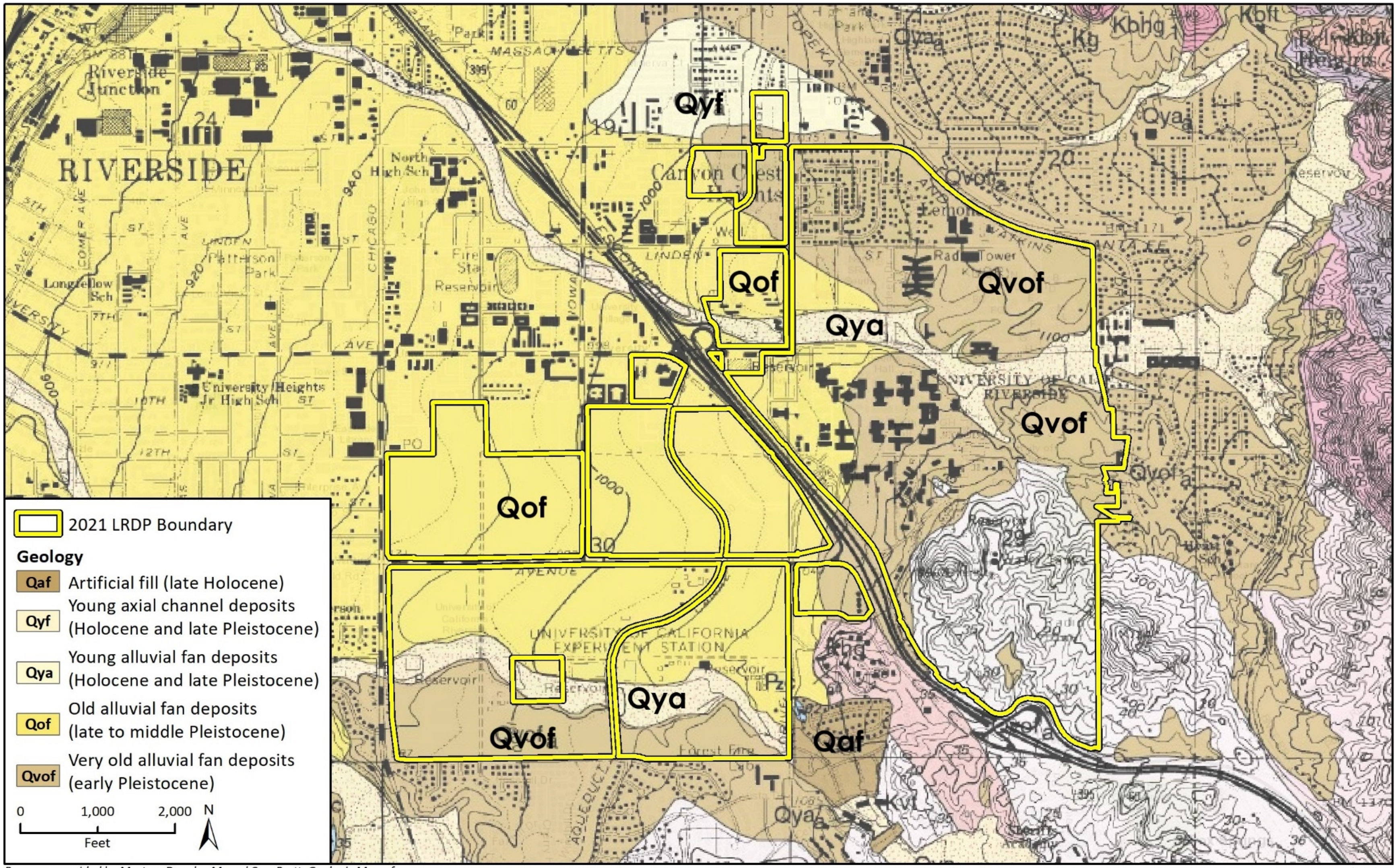
Paleontological resources (fossils) are the remains and/or traces of prehistoric life. Fossils are typically preserved in layered sedimentary rocks and the distribution of fossils is a result of the sedimentary history of the geologic units in which they occur. Fossils occur in a non-continuous and often unpredictable distribution in some sedimentary units, and the potential for fossils to occur in sedimentary units depends on several factors. Although it is not possible to determine whether a fossil will occur in any specific location, it is possible to evaluate the potential for geologic units to contain scientifically significant paleontological resources.

The paleontological sensitivity of the UCR campus has been evaluated according to the following Society of Vertebrate Paleontology (SVP) (2010) categories, which are presented below.

High Potential (Sensitivity)

Rock units from which significant vertebrate or significant invertebrate fossils or significant suites of plant fossils have been recovered are considered to have a high potential for containing significant non-renewable fossiliferous resources. These units include but are not limited to, sedimentary formations and some volcanic formations, which contain significant non-renewable paleontological resources anywhere in their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. Sensitivity comprises both: (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, or botanical and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, ecologic, or stratigraphic data. Areas which contain potentially datable organic remains older than recent, including deposits associated with nests or middens, and areas that may contain new vertebrate deposits, traces, or trackways are also classified as significant. Full-time monitoring is typically recommended during any project-related ground disturbance in geologic units with high sensitivity.

Figure 4.7-1 Geologic Units Underlying UCR Campus and Adjacent Areas



Basemap provided by Morton, Douglas M. and Cox, Brett, Geologic Map of the Riverside East 7.5' Quadrangle, Riverside County, California, 1988.

Fig 4.6-3 Local Geology

Low Potential (Sensitivity)

Sedimentary rock units that are potentially fossiliferous but have not yielded fossils in the past or contain common and/or widespread invertebrate fossils of well documented and understood taphonomic (processes affecting an organism following death, burial, and removal from the ground), phylogenetic species (evolutionary relationships among organisms), and habitat ecology. Reports in the paleontological literature or field surveys by a qualified vertebrate paleontologist may allow determination that some areas or units have low potentials for yielding significant fossils prior to the start of construction. Generally, these units will be poorly represented by specimens in institutional collections and will not require protection or salvage operations.

Undetermined Potential (Sensitivity)

Specific areas underlain by sedimentary rock units for which little information is available are considered to have undetermined fossiliferous potentials. Field surveys by a qualified vertebrate paleontologist to specifically determine the potentials of the rock units are required before programs of impact mitigation for such areas may be developed.

No Potential

Rock units of metamorphic or igneous origin are commonly classified as having no potential for containing significant paleontological resources. For geologic units with no sensitivity, a paleontological monitor is not required.

A review of the museum records maintained in the University of California Museum of Paleontology (UCMP) online collections database reports at least four vertebrate fossil localities in geologic types located within the UCR Campus, including Quaternary old (late to early Pleistocene) alluvial deposits (e.g., Qvof, Qof). Quaternary old (late to early Pleistocene) alluvial deposits (Qof, Qvof), mapped in the majority of West Campus and large portions of the East campus, have a well-documented record of abundant and diverse vertebrate fauna recorded throughout California (Paleobiology Database 2021; UCMP 2020). Numerous vertebrate fossil taxa from Riverside County including horse, tapir, bison, camelid, deer, mastodon, mammoth, ground sloth, canine, rabbit, and rodent have been noted in the region (Jefferson 2010). Therefore, Quaternary old (late to early Pleistocene) alluvial deposits (Qof, Qvof), have a high paleontological sensitivity, pursuant to SVP standards (SVP 2010). Other geologic types that occur on the UCR campus, including Quaternary young (late to middle Holocene) alluvial deposits (Qyf, Qya) mapped in the northern portion of East Campus and throughout most of West Campus, respectively, are likely too young to preserve paleontological resources. These areas are considered to have low paleontological sensitivity. The closest UCMP vertebrate locality on record is V65248, which yielded fossil specimens of a mammoth (*Mammuthus*) near the City (UCMP 2020).

While this section provides an overview of the underlying paleontological sensitivity based upon the underlying sediments, existing developed sites within the UCR Campus have been subject to grading, excavation, and artificial fill, which reduces the site-specific paleontological sensitivity to the depth of previous soil disturbance. This type of site-specific information is not captured in regional geologic unit diagrams, such as Figure 4.7-1.

Soils

Expansive soils are a geologic hazard because an increase in soil volume can exert force on structures and damage building foundations, walls, and floors. Areas underlain by compressible sediments are susceptible to differential settlement, and these include poorly engineered artificial fill or loose unconsolidated alluvial sediments. When these soils dry out and shrink, structural damage can occur.

The City's General Plan acknowledges that Riverside has the following general soil associations, or types: Cajalco-Temescal-Las Posas, Traver-Domino-Willows, Cieneba-Rock Land-Fallbrook, Monserate-Arlington-Exeter and Hanford-Tujunga-Greenfield associations. Soil associations are generally well-drained sandy loams that are moderately deep (City of Riverside 2012). The City is underlain by areas susceptible to varying degrees of erosion, ranging from slight to very high. Most soils are described as being well-drained with slow to moderate runoff and slow to moderate permeability (City of Riverside 2012).

Most of the UCR campus is underlain by older alluvium consisting of sands and silty sands, along with moderate amounts of clay in the upper 2 to 5 feet of the soil (Figure 4.7-1). In-situ weathering and the formation of an argillic soil profile associated with granitic rocks have given rise to the clay content, which in turn helped impart a reddish-brown color to the alluvial deposits. Younger alluvium and fill are found in and around the channels of the University Arroyo and Box Springs Arroyo, which have incised the elevated geomorphic surface (UCR 2005). Because portions of the UCR campus have been subject to grading operations associated with the construction activities, fill materials are at various locations on campus, particularly in areas on East Campus.

On the UCR campus, the Cieneba-Rockland-Fallbrook soils are found on the southeast portion of campus in steeper bedrock areas, while the Monserate-Arlington-Exeter soils comprise the flatter alluvial areas in most of the campus (UCR 2005). Soil types or associations can be defined further by series. The steeper bedrock areas of campus include the Cieneba and Vista series, which are characterized as being minimally developed and relatively thin soils. These soils are found at the southeastern portion of the campus, which has relatively steeper slopes than other parts of the campus. Both soils have low shrink-swell characteristics, but their erosion hazard ranges from moderate to high.

The flatter alluvial areas include Arlington, Buren, Hanford, Madera, and Monserate series, which derive from erosion of granite rocks. The Arlington and Hanford soils are primarily found on the relatively flat-sloped West Campus and have a low shrink-swell characteristic. These soils consist of silty fine to coarse sands, with deeper layers of silt and relatively clean sand. Erosion hazards for these soils range from slight to moderate. The Buren series, located on the East Campus, has a moderate to low shrink-swell potential and is relatively thick and well developed, with an argillic horizon and hardpan layer. The Monserate soils are found on most of the northeastern part of the campus and consist of sandy loams over sandy clay loams. Monserate soils are well-drained and the shrink-swell potential is low to moderate. Most soils on campus have low to moderate shrink-swell characteristics, and, thus, the potential for water uptake after rainfall that causes soils to expand and damage building foundations is considered low. Discussion of existing soil stability hazards including subsidence, liquefaction, lateral spreading, landslide, and collapse are provided below.

Subsidence

Subsidence occurs when a large portion of land is displaced vertically, usually due to the withdrawal of groundwater, oil, or natural gas. Natural subsidence occurs from shifting of tectonic plates and dissolution of limestone and can produce sinkholes. Human-induced subsidence can occur from pumping water, oil, or gas from underground reservoirs; collapse of underground mines; drainage of wetlands; and soil compaction. Subsidence can be problematic because it threatens the stability of roads, bridges, canals, and other infrastructure. Soils particularly subject to subsidence include those with high silt or clay content. Soils with high shrink-swell potential can be particularly susceptible to subsidence during a loss of soil moisture.

Most soils on the campus have low to moderate shrink-swell characteristics and would not be susceptible to subsidence during a loss of soil moisture (UCR 2005). Therefore, risks associated with natural subsidence is unlikely to occur on the UCR campus. Activities related to human-induced subsidence such as pumping, mining, and draining are not expected to occur on campus.

Liquefaction

Liquefaction describes a phenomenon in which loose, saturated, relatively cohesionless soil deposits lose shear strength during strong ground motions. Primary factors controlling liquefaction include intensity and duration of ground motion, gradation characteristics of the subsurface soils, on-site stress conditions, and the depth to groundwater. Liquefaction is typified by a loss of shear strength in the liquefied layers due to rapid increases in pore water pressure generated by earthquake accelerations. Liquefaction typically occurs in areas where the soils below the water table are composed of poorly consolidated, fine- to medium-grained, primarily sandy soil. In addition to the requisite soil conditions, the ground acceleration and duration of the earthquake must also be of a sufficient level to induce liquefaction. Liquefaction may also lead to lateral spreading.

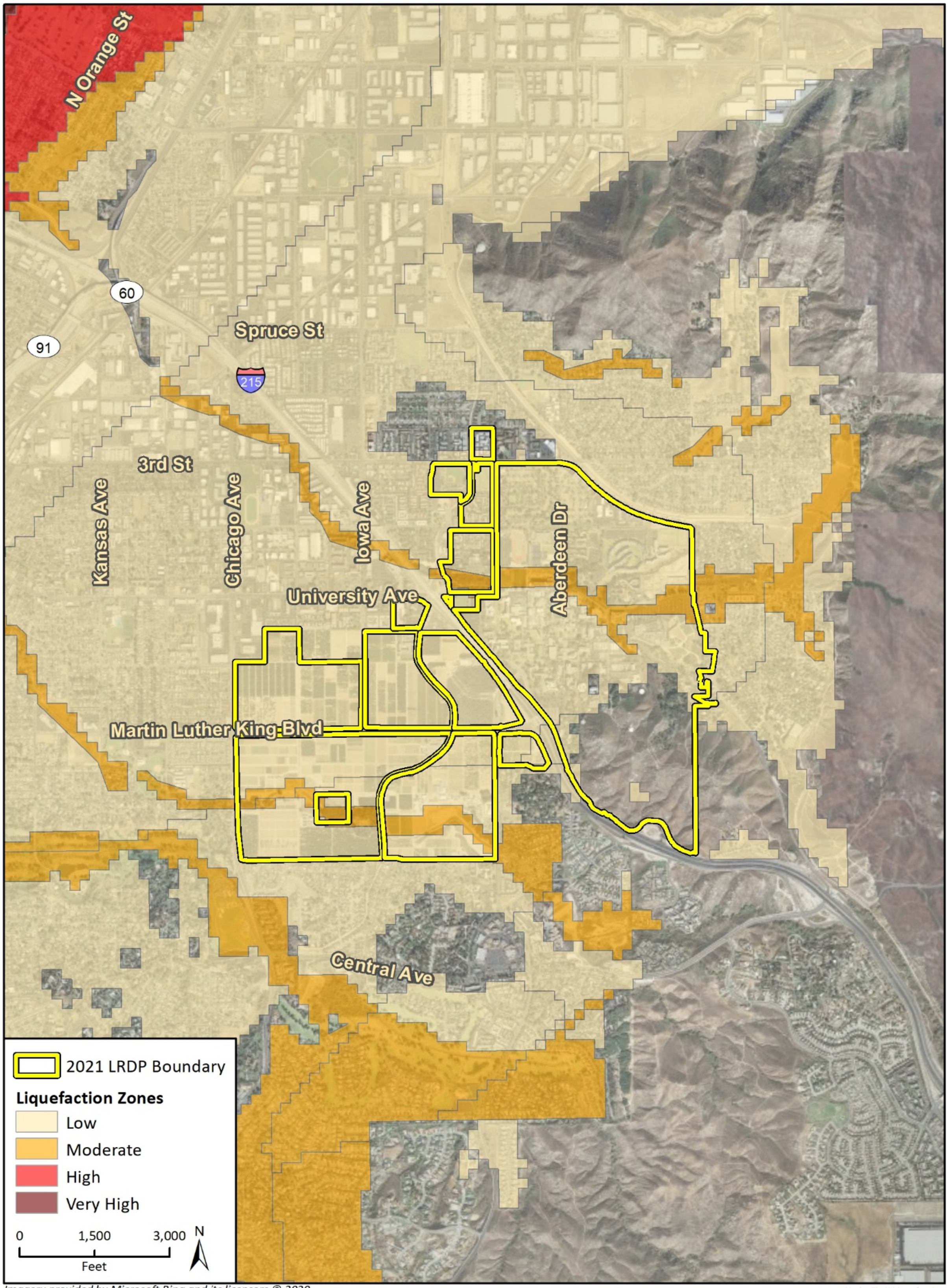
Liquefaction historically has been responsible for substantial damage to bridges, buildings, buried pipes, and underground storage tanks throughout the Country. According to Figure PS-2 of the City's General Plan Public Safety Element, the UCR main campus has mostly low potential for liquefaction, with narrow areas considered moderate risk for liquefaction along the southern portion of West Campus between Martin Luther King Boulevard and Le Conte Drive and the portion of East Campus, adjacent to the I-215/SR 60 freeway between Blaine Street and University Avenue and from University Avenue east to the Box Springs Mountains (City of Riverside 2018). Figure 4.7-2 illustrates the liquefaction zones found underlying the campus. The older alluvium and bedrock that underlies large portions of the campus are non-liquefiable regardless of groundwater depth (UCR 2005).

Lateral Spreading

Lateral spreading (also known as expansion) is the horizontal movement or spreading of soil toward an "open face," such as a streambank, the open side of fill embankments, or the sides of levees. It often occurs in response to liquefaction of soils in an adjacent area. The potential for failure from lateral spreading is highest in areas where there is a high groundwater table, where there are relatively soft and recent alluvial deposits, and where creek banks are relatively high.

Because portions of the campus are in areas with low to moderate risk of liquefaction, the potential for lateral spreading in those areas, and in areas with drainage features, should be considered low to moderate as well.

Figure 4.7-2 Liquefaction Zones Underlying the UCR Campus



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Additional data provided by FEMA, 2020.

Landslide

Landslides occur when slopes become unstable and masses of earth material move downslope. Landslides are generally considered to be rapid events, often triggered during periods of rainfall or by earthquakes. Mudslides and slumps are a shallower type of slope failure compared to landslides. Lateral spreading may occur when potentially liquefiable soils are present and exposed in conjunction with a sloping ground surface. If soils in the slope liquefy, temporary instability could result in movement of sediments and slope failure.

The UCR campus is not in an area susceptible to landslides. Elevations on campus range from approximately 1,000 to 1,400 feet above sea level. The topography at the campus is relatively flat due to previous grading and existing development. Additionally, the campus is not in the path of any known or potential landslides. West Campus and most of East Campus are relatively flat and not subject to landslides.

Collapse

Soil collapse typically occurs following the wetting and loading of unsaturated materials, but soils with higher moisture content such as quick clays may undergo collapse as well. Collapsible soils also include those sediments that contain perennial ice or permafrost that has subsequently melted. UCR does not contain soils with high-moisture content and is unlikely to undergo soil collapse.

Seismicity

The term *seismicity* describes the effects of seismic waves that are radiated from an earthquake fault in motion. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves. Seismicity can result in seismic-related hazards such as fault rupture, ground shaking, and liquefaction. Faults form in rocks when stresses overcome the internal strength of the rock, and fault rupture occurs when movement on a fault breaks through to the surface and can result in damage to infrastructure and persons. Ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking.

The numerous faults in southern California include active, potentially active, and inactive faults. The criteria for these major groups are based on measures developed by California Geological Survey (CGS) for the Alquist-Priolo Earthquake Fault Zone Program. An active fault is one that has had surface displacement within Holocene time (about the last 11,000 years). A potentially active fault has demonstrated surface displacement during Quaternary time (approximately the last 1.6 million years) but has had no known Holocene movement. Faults that have not moved in the last 1.6 million years are considered inactive. The major seismic-related hazards associated with earthquakes include ground rupture, major seismic ground shaking, seismic-related ground failure (include liquefaction), and landslides.

In the Riverside area, several faults have the potential to produce seismic impacts (City of Riverside 2018). Alquist Priolo Earthquake Fault Zones have been designated for the Elsinore, San Jacinto, and San Andreas fault zones in Riverside County. Several recent earthquakes in southern California have been of a sufficiently high magnitude to be felt in Riverside. These earthquakes include the 1971 San Fernando (6.5 magnitude [M]), the 1988 Pasadena (4.9M), the 1987 Whittier Narrows (5.9M), the

1989 Sierra Madre (5.9M), the 1992 Landers (7.3M) and Big Bear (6.2M), and the 1994 Northridge (6.7M) earthquakes. Figure 4.7-3 depicts the regional faults and fault zones in the county.

Seismic-induced Ground Rupture and Ground Shaking

Ground rupture and strong ground shaking from an earthquake can result in damage, with buildings shifted off their foundations and underground pipes being broken. The campus is not in an Alquist-Priolo Earthquake Fault Zone and has no active faults that pass directly beneath it (City of Riverside 2012). However, the campus is subject to seismic ground shaking due to the proximity and potential earthquake magnitude of nearby faults. Table 4.7-1 lists the regional faults in relation to UCR. Figure 4.7-3 shows the faults and fault zones near UCR.

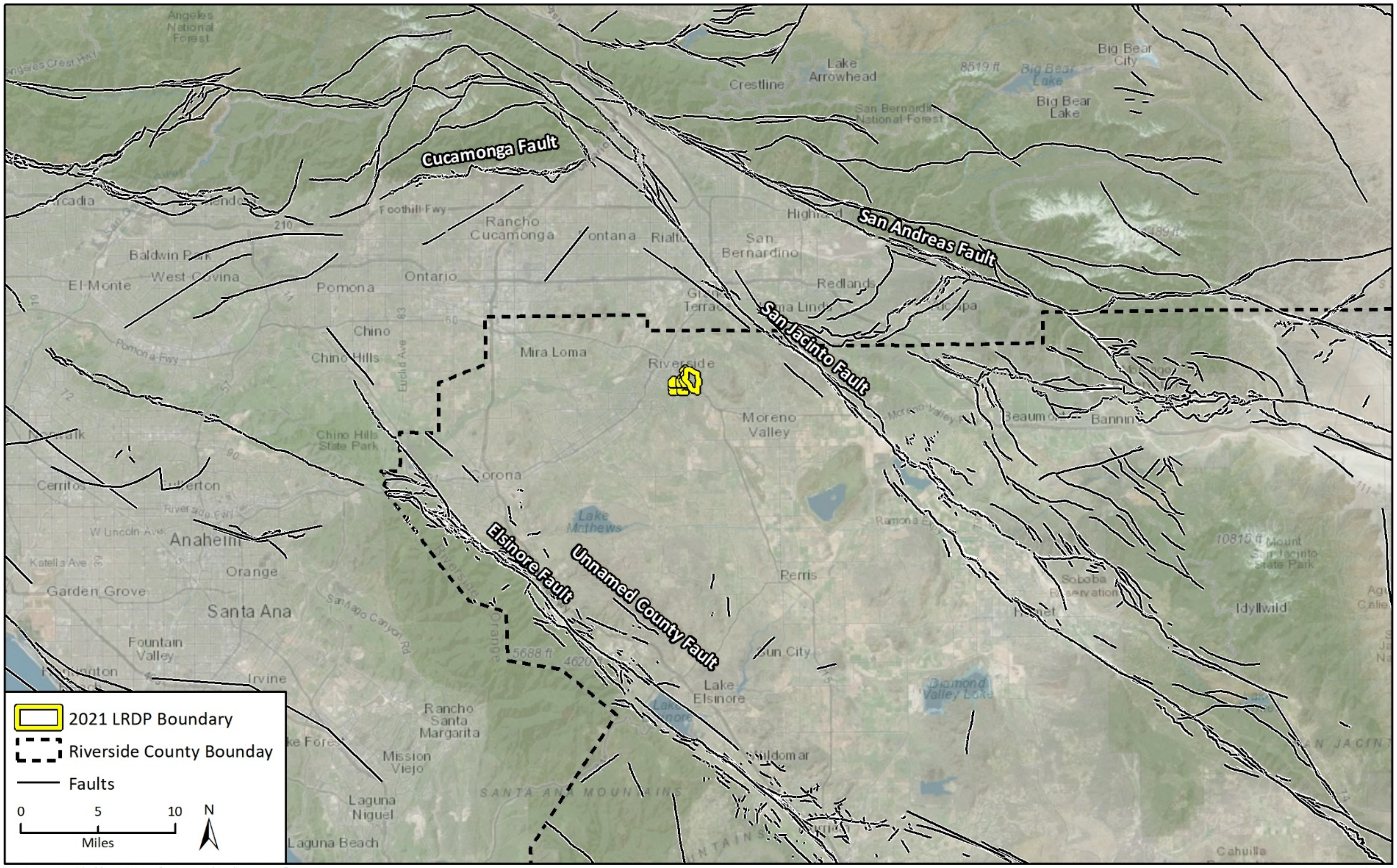
Table 4.7-1 Regional Faults in Relation to UCR Campus

Fault Name	Approximate Distance from UCR to Fault	Potential Magnitude	Approximate Length of Fault (miles)
San Jacinto Fault	5 miles	7.0	130
San Andreas Fault	13.5 miles	8.3	600
Elsinore Fault	15 miles	6.0	110
Cucamonga Fault	20 miles	7.0	19
Source: CGS 2015			

The San Jacinto Fault is northeast of UCR, approximately 5 miles from the border of the East Campus. The San Jacinto Fault traverses approximately 130 miles, from northwest of El Centro in Imperial County to northwest of San Bernardino, passing through the intersection of Interstates 10 and 215, the city of Loma Linda and the Box Springs Mountains. The fault has the capability of producing up to a 7.0M earthquake. The San Andreas Fault at its closest point is approximately 13.5 miles northeast of the border of the East Campus. The San Andreas Fault extends 600 miles, from Eureka in northern California's Humboldt County south to the U.S./Mexico border near Calexico and beyond. The San Andreas Fault is estimated to be capable of producing up to an 8.3M earthquake. The Elsinore Fault is approximately 15 miles southwest of the West Campus, extending approximately 4 miles west of Lake Mathews and Corona and south into the city of Lake Elsinore. The northwest-southwest trending fault has the capability of producing up to a 6.0M earthquake. The Cucamonga Fault is located approximately 20 miles northwest of the East Campus and West Campus. The Cucamonga Fault is approximately 19 miles long and has the capability of producing a maximum earthquake of 7.0M.

Historically, earthquakes that have occurred in the region have mostly resulted from the San Jacinto Fault, which has the greatest potential for causing the greatest extent of ground shaking at the campus. Each of the nearby major fault systems near UCR can produce a large earthquake that would result in severe earthshaking on the campus, but no surface rupture is likely.

Figure 4.7-3 Regional Earthquake Fault Lines



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Additional data provided by Riverside County, 2020 and USGS, 2020.

Fig 4.6-1 Regional Earthquake Fault Zones - Landscape

Seismic-induced Landslide and Liquefaction

Seismically induced liquefaction occurs when an earthquake causes ground shaking that results in saturated soil losing shear strength, deforming, and acting like a liquid. Specifically, liquefaction occurs when ground shaking causes water-saturated soils to become fluid and lose strength. When liquefaction occurs, it can result in ground failure that can result in damage to roads, pipelines, and buildings.

The UCR campus is not in an area subject to earthquake-induced landslide, but the campus is in an area where earthquake-induced liquefaction could occur. Elevations on campus range from approximately 1,000 feet to 1,400 feet above sea level. The topography at the campus is relatively flat due to previous grading and existing development, and the campus is not in the path of any known or potential landslide areas. UCR's main campus is characterized primarily by low potential for liquefaction and narrow areas that are considered moderate risk for liquefaction along the southern portion of West Campus between Martin Luther King Boulevard and Le Conte Drive and the portion of East Campus adjacent to the I-215/SR 60 freeway between Blaine Street and University Avenue and from University Avenue east to the Box Springs Mountains (City of Riverside 2018). Figure 4.7-2 illustrates the liquefaction zones found underlying the campus. The older alluvium and bedrock that underlies large portions of the campus are non-liquefiable regardless of groundwater depth (UCR 2005).

Existing UCR Structures

In area where seismic events are possible and expected, such as much of California, buildings are constructed to withstand ground shaking and other geological hazards associated with earthquakes. As technology developers and human understanding of engineering and earthquakes evolves, new building standards are developed to help buildings better withstand and survive earthquakes. For this reason, newer buildings incorporate more recent design and engineering standards to prevent failure during earthquakes compared to older buildings. As listed in Table 4.5-1 in Section 4.5, *Cultural Resources*, there are 38 existing buildings on the UCR campus that were constructed prior to 1975.

4.7.2 Regulatory Setting

Federal

National Earthquake Hazards Reduction Act

U.S. Congress passed the National Earthquake Hazards Reduction Act in 1977 to reduce the risks to life and property from future earthquakes through the establishment and maintenance of an effective earthquake hazards reduction program. To accomplish this goal, the act established the National Earthquake Hazards Reduction Program. This program was substantially amended in November 1990 by the National Earthquake Hazards Reduction Program Act, which refined the description of agency responsibilities, program goals, and objectives to focus on minimizing loss from earthquakes after they occur. The National Earthquake Hazards Reduction Program promotes the adoption of earthquake hazard reduction activities by all scales of government and works to develop national building standards and model codes for use by engineers, architects, and all others involved in the planning and construction of buildings and infrastructure.

Occupational Safety and Health Act

OSHA (29 CFR 1910) is intended to ensure that employers provide their workers with a work environment free from recognized hazards to safety and health, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, or unsanitary conditions. Operation of this program is delegated to the State and operated by the Division of Occupational Safety and Health, known as Cal/OSHA. Standards are created by the National Institute for Occupational Safety as the research institution for the federal Occupational Safety and Health Act (Fed/OSHA). These standards are adopted at the State and local level and are enforced on campus by Cal/OSHA and other agencies.

OSHA requires employers with specified activities to prepare and implement emergency action plans (EAPs), provides guidance for EAPs, and recommends that all employers prepare these plans. Employers can use this structure to prepare for earthquakes. OSHA also provides guidance to prepare for workplace hazards resulting from earthquakes. OSHA recommends training workers on preparing for earthquake by proactively training workers, as well as development a response plan to implement in the event of an earthquake. Employers whose workers will be involved in emergency response operations for releases of, or substantial threats of releases of, hazardous substances regardless of the location of the hazard must comply with OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120. This may include emergency response following an earthquake. Instruction CPL 02-02-073 describes OSHA enforcement procedures under the relevant provisions of the HAZWOPER standard.

State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 (Alquist-Priolo Act; Public Resources Code Sections 2621-2630) was passed into law following the destructive February 9, 1971 San Fernando earthquake that had a magnitude of 6.6. The Alquist-Priolo Act provides a mechanism for reducing losses from surface fault rupture on a statewide basis. The intent of the Alquist-Priolo Act is to ensure public safety by prohibiting the siting of most structures for human occupancy across traces of active faults that constitute a potential hazard to structures from surface faulting or fault creep. Generally, siting of structures for human occupancy must be set back from the fault by approximately 50 feet. Therefore, if a project site is in an active earthquake fault zone, the local agency must withhold development permits until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting. No portion of the campus is included in an Alquist-Priolo Earthquake Fault Zone designated by the State of California.

Seismic Safety Act

The Seismic Safety Act established the California Seismic Safety Commission in 1975 with the intent of providing oversight, review, and recommendations to the Governor and State legislature regarding seismic issues. The Commission's name was changed to Alfred E. Alquist Seismic Safety Commission in 2006. Since then, the Commission has prepared several documents[1] based on

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[1] Some of these documents are listed as follows:

- Research and Implementation Plan for Earthquake Risk Reduction in California 1995 to 2000, report dated December 1994
- Seismic Safety in California's Schools, 2004, "Findings and Recommendations on Seismic Safety Policies and Requirements for Public, Private, and Charter Schools," report dated December 1994
- Findings and Recommendations on Hospital Seismic Safety, report dated November 2001
- Commercial Property Owner's Guide to Earthquakes Safety, report dated October 2006
- California Earthquake Loss Reduction Plan 2007–2011, report dated July 2007

recorded earthquakes, such as the 1933 Long Beach earthquake, the 1971 Sylmar earthquake, and the 1994 Northridge earthquake.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 was enacted, in part, to address seismic hazards not included in the Alquist-Priolo Act, including strong ground shaking, landslides, and liquefaction. Under this Act, the State Geologist is assigned the responsibility of identifying and mapping seismic hazards. CGS Special Publication 117, adopted in 1997 by the State Mining and Geology Board, constitutes guidelines for evaluating seismic hazards other than surface faulting and for recommending mitigation measures under Public Resources Code Section 2695(a). In accordance with the mapping criteria, the CGS seismic hazard zone maps identifies areas with the potential for a ground shaking event that corresponds to 10 percent probability of exceedance in 50 years.

The purpose of the Seismic Hazards Mapping Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and State agencies are directed to use seismic hazard zone maps developed by CGS in their land-use planning and permitting processes. Cities and counties shall require a geotechnical report defining and delineating any seismic hazard pursuant to Public Resources Code Section 2697.

California Building Code

The California Building Code (CBC) Title 24, Part 2, provides building codes and standards for the design and construction of structures in California. The purpose of the CBC is to establish minimum standards to safeguard the public health, safety, and general welfare through structural strength, means of egress facilities, and general stability by controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of building and structures. The CBC contains specific requirements for seismic safety, excavation, foundations, retaining walls, and site demolition. It also regulates grading activities, including drainage and erosion control. Chapter 16 of the CBC contains definitions of seismic sources and the procedure used to calculate seismic forces on structures.

In addition, the CBC contains necessary California amendments, which are based on the American Society of Civil Engineers (ASCE) Minimum Design Standards 7-05. ASCE 7-05 provides requirements for general structural design and includes means for determining earthquake loads as well as other loads (flood, wind, etc.) for inclusion into building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California. The earthquake design requirements of the CBC take into account the occupancy category of the structure, site class, soil classifications, and various seismic coefficients, which are used to determine a Seismic Design Category (SDC) for a project. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to SDC E/F (very high seismic vulnerability and near a major fault). Design specifications are then determined according to the SDC.

Development under the LRDP would be required to comply with the CBC, including Part 2, Volume 2, Chapter 18, Soils and Foundations, which outlines the minimum standards for structural design and construction. This includes geotechnical evaluations, which among other requirements, includes a record of the soil profile, regulation of active faults, recommendations for foundation type and design criteria that address issues, as applicable, such as, but not limited to, bearing capacity of soils, provisions to address expansive soils, settlement, and varying soil strength. If a building department or other appropriate enforcement agency, determines that recommended action(s) presented in the geotechnical evaluations are likely to prevent structural damage, the approved recommended action(s) must be made a condition to the building permit (Section 1803.1.1.3 of Chapter 18).

The CBC provides standards for various aspects of construction, including, but not limited to, excavation, grading, and earthwork construction, preparation of the site prior to fill placement, specification on fill materials and fill compaction and field testing, retaining wall design and construction, foundation design and construction, and seismic requirements. It includes provisions to address issues such as, but not limited to, construction on expansive soils and soil strength loss. Pursuant to California law, project design and construction would be required to comply with provisions of the CBC.

The CBC is updated every 3 years by order of the legislature, with supplements published in intervening years. State law mandates that local government enforce the CBC. In addition, a city and/or county may establish more restrictive building standards reasonably necessary because of local climatic, geological, or topographical conditions. The 2019 CBC is based on the 2018 International Building Code and adds more extensive structural seismic provisions. Projects implemented under the proposed 2021 LRDP would adhere to the most current CBC.

Natural Hazards Disclosure Act

The Natural Hazards Disclosure Act, as codified in California Civil Code Sections 1103-1103.14, requires real estate sellers and brokers to prepare Natural Hazards Disclosure Statements upon transfer of real property if such property is located in a number of federally or State-mapped natural hazard areas. Hazard areas covered under the disclosure form include special flood hazard areas, areas of potential flooding due to dam failure inundation, fire hazard severity zones, wildland areas, earthquake fault zones, and seismic hazard zones. The natural hazard areas most relevant to geology and soils are earthquake fault zones and seismic hazard zones.

California Environmental Quality Act

Paleontological resources are protected under CEQA, which states, in part, that a project will "normally" have a significant effect on the environment if it, among other things, will disrupt or adversely affect a paleontological site except as part of a scientific study. Specifically, Appendix G of the State CEQA Guidelines, the Environmental Checklist Form, asks, "Will the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?" To determine the uniqueness of a given paleontological resource, it must first be identified or recovered (i.e., salvaged). Therefore, CEQA mandates mitigation of adverse impacts, to the extent practicable, to paleontological resources.

CEQA does not define "a unique paleontological resource or site." However, the Society of Vertebrate Paleontology does define a "significant paleontological resource" in the context of environmental review as follows:

> Fossils and fossiliferous deposits, here defined as consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontological resources are typically to be older than recorded human history and/or older than middle Holocene (i.e., older than about 5,000 radiocarbon years) (SVP 2010).

The loss of paleontological resources meeting the criteria outlined above (i.e., a significant paleontological resource) would be a significant impact under CEQA, and the CEQA lead agency is responsible for ensuring that impacts to paleontological resources are mitigated, where practicable, in compliance with CEQA and other applicable statutes.

California Public Resources Code

Section 5097.5 of the California Public Resource Code states "no person shall knowingly and willfully excavate upon, or remove, destroy, injure or deface" any "vertebrate paleontological site" on public lands without the "permission of the public agency having jurisdiction over such lands". Violation of this section is a misdemeanor.

As used in this Public Resource Code section, "public lands" means lands owned by or under the jurisdiction of the State or any city, county, district, authority, or public corporation, or any agency thereof. Consequently, public agencies are required to comply with Public Resource Code Section 5097.5 for their own activities, including construction and maintenance, as well as for permit actions (e.g., encroachment permits) undertaken by others.

University of California

UC Seismic Safety Policy

The UC Seismic Safety Policy was established to implement Seismic Policy set by the Capital Asset Strategies & Finance. The UC Seismic Policy applies to all buildings and structures in a UC campus. All facilities must be evaluated to provide "An acceptable level of earthquake safety for students, employees, and the public who occupy University Facilities and Leased Facilities." Planning for all projects included in the 2021 LRDP should address the options considered to improve seismic performance beyond minimally required code performance (UC 2017).

UC Facilities Manual Seismic Program Guidelines

The procedures and guidelines located in the UC Facilities Manual are a current and central source of information regarding guidance for UC Seismic Safety Policy compliance. The purpose of the UC Facilities Manual Seismic Program Guidelines is to highlight and clarify portions of the policy. These guidelines should not be used as a substitute for the policy. Where information in the policy and the Facilities Manual varies, campuses are to follow the most conservative approach for immediate and long-term safety and preservation of life. The UC Facilities Manual Seismic Program Guidelines will serve as a resource for development under the 2021 LRDP to maintain compliance with the UC Seismic Safety Policy.

University of California, Riverside

UCR Earthquake Plan

The Earthquake Plan is a component of UCR's Emergency Operations Plan and provides guidance and direction in response to an earthquake event that possibly affects the campus. The objectives of the Earthquake Plan are to evaluate and determine if there is damage or an impact to the campus following an earthquake, define the strategies UCR will use in response to an earthquake that affects the campus community and disrupts normal campus operations, and to provide direction to emergency response activities by identifying key response objectives and actions. To facilitate planning efforts and develop appropriate response strategies, two specific earthquake scenarios (moderate earthquake and major earthquake) are identified in the Earthquake Plan with appropriate response phases (e.g., immediate response; ongoing response) and responsible parties.

Regional and Local (Non-Binding)

As noted in Section 4, "University of California Autonomy," UCR, a constitutionally-created State entity, is not subject to municipal regulations of surrounding local governments for uses on property owned or controlled by UCR that are in furtherance of the university's educational purposes. However, UCR may consider, for coordination purposes, aspects of local plans and policies of the communities surrounding the campus when it is appropriate and feasible but not bound by those plans and policies in its planning efforts.

City of Riverside General Plan

CITY OF RIVERSIDE PUBLIC SAFETY ELEMENT

The City's General Plan Public Safety Element includes policies to minimize potential damage to existing and new structures and loss of life that may result from geologic and seismic hazards. These include ensuring that all new development in the City abides by the most recently adopted City and State seismic and geotechnical requirements.

CITY OF RIVERSIDE HISTORIC PRESERVATION ELEMENT

The City's General Plan Historic Preservation element includes the objective of using historic preservation principles as an equal component in the planning and development process. The City expressed policy commitments to protect sites of archeological and paleontological significance and ensure compliance with all applicable State and federal cultural resources protection and management laws in its planning and project review process.

4.7.3 Environmental Impacts and Mitigation Measures

Significance Criteria

UCR utilizes the following 2020 CEQA Guidelines Appendix G significance criteria questions related to Geology and Soils.

Would the proposed 2021 LRDP:

a) 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?
   iv. Landslides?

b) Result in substantial soil erosion or the loss of topsoil?

c) 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?

d) 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?

e) 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?

f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

Issues Not Evaluated Further

Soil Erosion or Topsoil Loss (Criterion b)

The Initial Study for the 2021 LRDP (Appendix A) concluded that campus construction activities would comply with the UCR Plan Review and Building Permit Program, which specifies requirements for new construction on campus, as well as inspections protocol for existing buildings. Adherence to applicable rules under the UCR Plan Review and Building Permit Program would be necessary to reduce and/or prevent erosion during construction activities. Therefore, no further evaluation is required.

Expansive Soil (Criterion d)

The Initial Study for the 2021 LRDP (Appendix A) concluded that implementation of the proposed 2021 LRDP would not be located on expansive soil. Therefore, no further evaluation is required.

Soil Adequacy to Support Alternative Wastewater Disposal Systems (Criterion e)

The Initial Study for the 2021 LRDP (Appendix A) concluded that the proposed 2021 LRDP would be served by the municipal sewer system and would not entail the construction or use of septic tanks or other alternative wastewater disposal systems. Therefore, projects implemented under the proposed 2021 LRDP would result in no impact related to soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems. No further evaluation is required.

Analysis Methodology

To evaluate the potential 2021 LRDP impacts, resource conditions that could pose a risk to development of projects under the proposed 2021 LRDP were identified through review of documents pertaining to these topics within the LRDP boundary. Sources consulted include the City's General Plan, U.S. Geological Survey and CGS technical maps and guides, the Natural Resources Conservation Service Soil Survey (available through the Soil Survey Geographic Database), previous campus project CEQA documents, background reports prepared for nearby plans and projects, and published geologic literature. The information obtained from these sources was reviewed and summarized to establish the existing conditions (provided above) and identify potential environmental hazards based on proximity of the hazards to growth and land uses envisioned in the 2021 LRDP. In determining level of significance, the analysis assumes that the 2021 LRDP would comply with relevant laws, regulations, and guidelines.

2021 LRDP Objectives and Policies

There are no objectives or policies in the proposed 2021 LRDP related to geology, soils, and paleontological resources.

Impact Analysis

IMPACT GEO-1 INCREASE THE RISK OF EXPOSURE OF PEOPLE OR BUILDINGS TO SEISMIC-RELATED HAZARDS.

THE CAMPUS IS NOT LOCATED IN AN ALQUIST-PRIOLO FAULT ZONE AND NO FAULT LINES TRAVERSE DIRECTLY UNDER THE CAMPUS. HOWEVER, THERE IS POTENTIAL FOR BOTH EARTHQUAKES AND GROUND SHAKING IN THE CAMPUS AREA, AS WELL AS ASSOCIATED GROUND FAILURE AND LANDSLIDES. PROJECTS UNDER THE PROPOSED 2021 LRDP WOULD BE REQUIRED TO COMPLY WITH CBC BUILDING REQUIREMENTS AS WELL AS THE UC SEISMIC SAFETY POLICY AND UC FACILITIES MANUAL SEISMIC PROGRAM GUIDELINES. IMPACTS WOULD BE LESS THAN SIGNIFICANT. NO MITIGATION MEASURES ARE REQUIRED.

Construction

Generally, construction workers would be within partially complete to nearly complete structures designed and constructed to comply UC Facilities Manual Seismic Program Guidelines, the UC Seismic Safety Policy, and CBC, Title 24, Part 2. Compliance with the CBC would ensure that all new and modified buildings would be capable of withstanding anticipated levels of ground shaking. Construction workers performing earthwork activity, such as grading or excavating would be subject to potential ground shifts and collapse, such a utility trench collapsing while they are within the trench. However, the CBC also establishes grading requirements that apply to excavation and fill activities and requires the implementation of erosion control measures. Additionally, applicable OSHA requirements that address earthquake hazards, such as HAZWOPER standards for cleanup of diesel fuel following an earthquake during construction, would be required. Therefore, construction workers would not be exposed to substantial hazards of strong seismic ground shaking, such as excavation or building collapse. Impacts during construction would be **less than significant**.

Operation

FAULT RUPTURE

UCR is in the seismically active region of southern California and is in the vicinity of earthquake faults and fault zones where large earthquakes may originate. However, UCR is not directly located in an Alquist-Priolo Fault Zone, and, according to the California Earthquake Hazards Zone Map, the UCR campus is located approximately 5 miles southwest of the San Jacinto Fault Zone, 13.5 miles southwest of the San Andreas Fault, 15 miles northeast of the Elsinore Fault Zone, and 20 miles southeast of the Cucamonga Fault. At this distance, it is unlikely that ground rupture would occur on the UCR campus. Thus, implementation of the proposed 2021 LRDP would not expose people or structures to substantial adverse effects associated with fault rupture. Therefore, impacts associated with fault rupture are **less than significant**.

STRONG SEISMIC GROUND SHAKING

The campus and proposed 2021 LRDP components would be subject to ground shaking generated from regional fault activities from the various fault zones located near the campus including the San Jacinto, San Andreas, Cucamonga, and Elsinore Fault Zones, which have the potential to cause moderate to large earthquakes (DOC 2020). Ground shaking has the potential to dislodge objects from walls, ceilings, and shelves, and to damage and destroy buildings and other structures. People and property located within the LRDP boundary would be exposed to these potential hazards. The campus minimizes these seismic-induced risks through several requirements as described below.

Proposed 2021 LRDP implementation would include the addition of approximately 3.7 million asf (approximately 5.5 million gsf) of academic buildings and support facilities on the UCR main campus. Renovations of existing campus buildings may also occur during implementation of the proposed 2021 LRDP. Development of new and retrofitted campus building projects would be required to conduct a site-specific geotechnical study and comply with the provided engineering design recommendations. Additionally, 2021 LRDP campus projects would be required to comply with the UC Facilities Manual Seismic Program Guidelines, the UC Seismic Safety Policy, and CBC, Title 24, Part 2. In cases of UCR retrofitted structures and redevelopment which replaces older campus structures, the proposed 2021 LRDP would improve seismic safety in comparison to baseline conditions.

Projects under the proposed 2021 LRDP would comply with the UC Seismic Safety Requirements and the latest CBC, to ensure that all new and modified buildings would be capable of withstanding anticipated levels of ground shaking. The UC Seismic Safety Policy establishes that University policy is "to the extent feasible by present earthquake engineering practice, to provide an acceptable level of earthquake safety for students, employees, and the public who occupy University Facilities and Leased Facilities" (UC 2017). The UC Seismic Safety Policy addresses interior and exterior building elements that may fall or slide during an earthquake and requires anchorage for seismic resistance of nonstructural building elements such as furnishings, fixtures, material storage facilities, and utilities that could dislodge, fall, or rupture during an earthquake.

The CBC, Title 24, Part 2 provides building codes and standards for the design and construction of structures in California. The CBC requires, among other things, seismically resistant construction, and foundation. The CBC also establishes grading requirements that apply to excavation and fill activities and requires the implementation of erosion control measures. California's building codes are published in their entirety every 3 years. Half of the 2019 CBC, California Code of Regulations, Title 24 were approved and adopted by the Commission in December 2018. The recently updated 2019 CBC are based on the International Building Code with the addition of more extensive structural seismic provisions. Chapter 16 of the CBC contains definitions of seismic sources and the procedure used to calculate seismic forces on structures.

The purpose of the CBC is to establish minimum standards to safeguard the public health, safety, and general welfare through structural strength, means of egress, and general stability by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures in its jurisdiction. In addition, the CBC contains necessary California amendments, which are based on the ASCE Minimum Design Standards 7-05. ASCE 7-05 provides requirements for general structural design and includes means for determining earthquake loads as well as other loads (flood, wind, etc.) for inclusion into building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California.

The earthquake design requirements of the CBC consider the occupancy category of the structure, site class, soil classifications, and various seismic coefficients, which are used to determine a SDC for a project. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to

SDC E/F (very high seismic vulnerability and near a major fault). Design specifications are then determined according to the SDC. Development under the proposed 2021 LRDP would be required to comply with the CBC, including Part 2, Volume 2, Chapter 18, Soils and Foundations, which outlines the minimum standards for structural design and construction. This includes geotechnical evaluations, which among other requirements, includes a record of the soil profile, regulation of active faults, recommendations for foundation type and design criteria that address issues, as applicable, such as, but not limited to, bearing capacity of soils, provisions to address expansive soils, settlement, and varying soil strength. If a building department or other appropriate enforcement agency (in this case, the Campus Building Official), determines that recommended action(s) presented in the geotechnical evaluations are likely to prevent structural damage, the approved recommended action(s) must be made a condition to the building permit (Section 1803.1.1.3 of Chapter 18).

The CBC provides standards for various aspects of construction, including, but not limited to, excavation, grading, and earthwork construction, preparation of the site prior to fill placement, specification on fill materials and fill compaction and field testing, retaining wall design and construction, foundation design and construction, and seismic requirements. It includes provisions to address issues such as, but not limited to, construction on expansive soils and soil strength loss. Pursuant to California law, project design and construction would be required to comply with provisions of the CBC.

While proposed development under the 2021 LRDP would not increase the risk of seismic hazards on campus, it would increase the UCR campus population. However, the majority of the existing residential structures in the region are substantially older than the new development proposed under buildout of the 2021 LRDP. Approximately 76 percent of the region's housing stock was built prior to 1990 (City of Riverside 2017). Therefore, the existing housing in the region does not incorporate modern Building Code safety requirements. The rest of the state's housing stock follows similar trends. Consequently, individuals moving from older residences into new structures proposed under the 2021 LRDP would likely benefit from increased seismic safety. Consistent with changes to the UC Seismic Safety Policy in 2017, UCR has an ongoing program to upgrade or replace existing buildings not adequately prepared to withstand currently assessed seismic hazards, which includes an evaluation of each structure located within the LRDP boundary and a determination as to the need for further structural improvements. Furthermore, seismically reduced risks would be minimized through compliance with the CBC, which, as discussed above, includes specific structural seismic safety provisions. The campus would also adhere to the UC Seismic Safety Policy which requires anchorage for seismic resistance of nonstructural building elements that could create a hazard if dislodged during an earthquake. Thus, compliance with the UC Seismic Safety Policy and CBC would reduce the potential operational impact related to seismic ground shaking to **less than significant**.

SEISMIC-RELATED GROUND FAILURE AND LIQUEFACTION

Ground failure can include an entire suite of affects ranging from simple ground cracking to complex lateral spreading landslides. Failures may be associated with saturated deposits (liquefaction) or unsaturated deposits (densification). Three key factors which indicate whether an area is potentially susceptible to liquefaction include severe ground shaking, shallow groundwater, and cohesionless sands.

According to Figure PS-2 of the City's General Plan Public Safety Element, the majority of the UCR campus is characterized by low potential for liquefaction, with narrow areas considered moderate risk for liquefaction along the southern portion of West Campus between Martin Luther King Boulevard and Le Conte Drive and the portion of East Campus adjacent to the I-215/SR 60 freeway between Blaine Street and University Avenue and from University Avenue east to the Box Springs Mountains. Elevations on campus range from approximately 1,000 feet to 1,400 feet above sea level. Liquefaction-induced ground failure can involve a complex interaction among seismic, geologic, soil, topographic, and groundwater factors. Failures can include ground fissures, sand boils, ground settlement, loss of bearing strength, buoyancy effects, ground oscillation, flow failure, and lateral spread (Bartlett and Youd 1992). These can influence surface and subsurface structures.

Development of new and retrofitted campus building projects would be required to conduct a site-specific geotechnical study and comply with the provided engineering design recommendations. Additionally, LRDP campus projects would be required to comply with the UC Facilities Manual Seismic Program Guidelines, the UC Seismic Safety Policy, and CBC, Title 24, Part 2.

The CBC provides standards for various aspects of construction, including, but not limited to, excavation, grading, and earthwork construction, preparation of the site prior to fill placement, specification on fill materials and fill compaction and field testing, retaining wall design and construction, foundation design and construction, and seismic requirements. It includes provisions to address issues such as, but not limited to, construction on expansive soils and soil strength loss. Pursuant to California law, project design and construction would be required to comply with provisions of the CBC.

While development under the proposed 2021 LRDP would not increase the risk of seismic hazards on campus, it would increase UCR campus population. However, the majority of the existing residential structures in the region are substantially older than the new development proposed under buildout of the 2021 LRDP. Approximately 76 percent of the region's housing stock was built prior to 1990 (City of Riverside 2017). Therefore, most the region's housing stock does not incorporate modern Building Code safety requirements. The rest of the state's housing stock follows similar trends. Consequently, individuals moving from older residences into new structures proposed under the 2021 LRDP would likely benefit from increased safety. Furthermore, these seismically reduced risks would be minimized through compliance with the CBC, which, includes specific structural seismic safety provisions as well as implementation of recommendations in a site-specific geotechnical investigation. Thus, compliance with CBC, the UC Facilities Manual Seismic Program Guidelines and the UC Seismic Safety Policy would ensure operational impacts related to seismic ground failure, including liquefaction, would be **less than significant**.

LANDSLIDES

According to the Geologic and Seismic Technical Background Report for the City's General Plan EIR, a few areas of the City could be prone to seismically induced landslides and rockfalls (City of Riverside 2007). Seismically induced landslides and rockfalls are common during large earthquakes. Structures located below this hazard area could be subject to severe damage. According to the DOC Earthquake Zones of Required investigation, there are no areas with the UCR campus that are prone to landslides (2020). The proposed 2021 LRDP would potentially provide for some development in the southeastern area of East Campus adjacent to natural hillsides, such as the UCR Botanic Gardens interpretive center, but the geologic materials on the campus render the risk for deep-seated landslides to be very low, even on natural slopes. This is due to the sturdy nature of the alluvial materials and bedrock underlying most of the campus, as these have no weak planar structures developed that could trigger a large, deep-seated landslide.

All structures to be constructed or redeveloped under the proposed 2021 LRDP would be required by the UC Seismic Safety Policy to undergo an independent review of the structural seismic design in compliance with the latest CBC requirements to ensure structural design of all new and modified buildings would not result in adverse effects such as on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse. All new campus facilities built as part of the proposed 2021 LRDP would be required to conduct a project-specific geotechnical study pursuant to the CBC prior to construction to assess potential for displacement caused by landslides or other earth movements or soil constraints. These reports would inform the type of building foundations and pre-construction stabilization necessary for proposed development under the 2021 LRDP. While development under the proposed 2021 LRDP would not increase the risk of seismic related landslides on campus, it would expose more people to potential risks associated with damage from landslides. These seismically reduced risks would be minimized through compliance with the CBC, which, as discussed above, includes specific structural seismic safety provisions. Therefore, operational impacts associated with landslides would be **less than significant**.

Mitigation Measures

No mitigation is required.

Significance After Mitigation

Impacts would be less than significant without mitigation.

IMPACT GEO-2 INCREASE THE RISK OF EXPOSURE OF PEOPLE OR BUILDINGS TO SEISMIC-RELATED GROUND FAILURE, INCLUDING LANDSLIDE, LATERAL SPREADING, SUBSIDENCE, LIQUEFACTION, OR COLLAPSE.

UCR IS UNDERLAIN BY SOILS WITH LOW POTENTIAL FOR LIQUEFACTION OR OTHER SOIL-RELATED HAZARDS. FURTHERMORE, THE OLDER ALLUVIUM AND BEDROCK THAT UNDERLIES LARGE PORTIONS OF THE CAMPUS ARE NON-LIQUEFIABLE REGARDLESS OF GROUNDWATER DEPTH. PROJECTS DEVELOPED UNDER THE PROPOSED 2021 LRDP WOULD BE REQUIRED TO COMPLY WITH CBC BUILDING REQUIREMENTS AS WELL AS THE UC SEISMIC SAFETY POLICY. IMPACTS WOULD BE LESS THAN SIGNIFICANT. NO MITIGATION MEASURES ARE REQUIRED.

Construction

Construction of new campus facilities built as part of the proposed 2021 LRDP would require connections to underground utilities, such as water and sanitary sewer. Installation of utility connections would require construction workers to excavate temporary utility trenches and stockpile materials. Construction on the UCR campus must comply with the CBC. The CBC establishes grading requirements that apply to excavation and fill activities and requires the implementation of erosion control measures. Additionally, applicable OSHA requirements that address earthquake hazards, such as HAZWOPER standards for cleanup of diesel fuel following an earthquake during construction, would be required. Compliance with the CBC and OSHA would reduce impacts of construction hazards to **less than significant**.

Operation

SUBSIDENCE

Dry to partially saturated sediments not susceptible to liquefaction may be susceptible to dynamic consolidation and local ground subsidence. This consolidation or densification occurs in loose cohesionless sediments as the void spaces are diminished due to intense seismic shaking. Hazard maps are not normally created for this condition, and there are no specific data in the City, which allow prediction of the locations or magnitudes of potential consolidation and subsidence (City of Riverside 2007). In general, Qya soils would be most susceptible to dynamic consolidation effects. Qof could also be susceptible but less so due to its higher in-place density and some cementation. Areas where artificial fill (Qaf) placed without proper engineering controls and inspections are also susceptible to dynamic consolidation and subsidence. Subsidence due to groundwater withdrawal is possible in the City due to substantial pumping. No subsidence in the City, which includes the UCR campus, was noted in the City's General Plan Public Safety Element (2018).

All new campus facilities built as part of the proposed 2021 LRDP would be required to conduct a project-specific geotechnical study prior to construction to assess potential for displacement caused by lateral spreading and subsidence, or other earth movements or soil constraints. If future development under the proposed 2021 LRDP occurs in an area susceptible to subsidence, the project-specific geotechnical study would include project specific measures to address subsidence. UCR would be required to adhere to the measures outlined in the geotechnical report and impacts would be **less than significant**.

Liquefaction

Potential liquefaction hazards of the proposed 2021 LRDP were discussed above in Impact GEO-1. As discussed therein, impacts associated with liquefaction hazards would be **less than significant**.

Lateral Spreading

Liquefaction-induced ground failure can involve a complex interaction among seismic, geologic, soil, topographic, and groundwater factors. Failures can include lateral spreading. Lateral spread is a liquefaction-induced landslide of a fairly coherent block of soil and sediment deposits that moves laterally (along the liquefied zone) by gravitational force, sometimes on the order of 10 feet, often toward a topographic low such as a depression or valley area. Considering past earthquake experience from other areas, lateral spreads caused significant damage to critical facilities during the 1971 San Fernando earthquake with a magnitude of 6.5.

As discussed under *Liquefaction*, all structures to be constructed or redeveloped under the proposed 2021 LRDP would be required to comply with the UC Seismic Safety Policy and the latest CBC requirements, to ensure structural design of all new and modified buildings would not result in adverse effects such as on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse. All new campus facilities built as part of the proposed 2021 LRDP would be required to conduct a project-specific geotechnical study in compliance with the CBC prior to construction to assess potential for displacement caused by lateral spreading or other earth movements or soil constraints. These reports would inform the type of building foundations and pre-construction stabilization necessary for proposed development under the proposed 2021 LRDP. Therefore, operational impacts associated with lateral spreading would be **less than significant**.

Landslides

According to the Geologic and Seismic Technical Background Report for the City's General Plan EIR, a few areas of the City could be prone to seismically induced landslides and rockfalls (City of Riverside 2007). Seismically induced landslides and rockfalls are common during large earthquakes. Structures located below this hazard area could be subject to severe damage. According to the DOC Earthquake Zones of Required investigation, no areas on the UCR campus are prone to landslides (DOC 2020). Slope instability under non-earthquake (static) conditions are not considered to be a significant hazard in the City. The slope stability hazard in the City is rated as negligible because the topography is very flat to moderately flat, and no bedded sedimentary bedrock is exposed. Projects implemented under the proposed 2021 LRDP could develop in the southeastern area of East Campus, adjacent to natural hillsides. The risk for deep-seated landslides is very low, even on natural slopes because of the sturdy nature of the alluvial materials and bedrock underlying most of the campus, and these have no weak planar structures developed that could trigger a large, deep-seated landslide.

All structures to be constructed or redeveloped under the proposed 2021 LRDP would be required to comply with the UC Seismic Safety Policy and the latest CBC requirements, to ensure structural design of all new and modified buildings would not result in adverse effects such as on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse. All new campus facilities built as part of the proposed 2021 LRDP would be required to conduct a project-specific geotechnical study in compliance with the CBC prior to construction to assess potential for displacement caused by landslides or other earth movements or soil constraints. These reports would inform the type of building foundations and pre-construction stabilization necessary for proposed development under the 2021 LRDP. Therefore, operational impacts associated with landslides would be **less than significant**.

COLLAPSE

Soil collapse typically occurs following the wetting and loading of unsaturated materials, but soils with higher moisture content such as quick clays may undergo collapse as well. Collapsible soils also include those sediments that contain perennial ice or permafrost that has subsequently melted. Because the campus is primarily composed of soils with low to moderate shrink-swell characteristics, it is unlikely for proposed development under the 2021 LRDP to undergo soil collapse.

Development would be subject to site-specific geotechnical evaluations to further examine the soil type and moisture content at potential planned project locations. These reports would inform the risks relating to soil collapse and provide recommendations to minimize impacts. Therefore, operational impacts related to soil collapse would be considered **less than significant**.

OVERALL

Construction of facilities and structures under the proposed 2021 LRDP would comply with the CBC and UC Seismic Safety policy. Compliance with the CBC and UC Seismic Safety policy would reduce effects to a less-than-significant level. Planned development under the proposed 2021 LRDP would be subject to site-specific geotechnical evaluations to further examine the potential risks relating to unstable geologic units or soils. These reports would inform the type of building foundations and pre-construction stabilization necessary for development under the proposed 2021 LRDP. Therefore, overall operational impacts related to unstable geologic units or soils becoming unstable because of project development under the proposed 2021 LRDP is considered **less than significant**.

Mitigation Measures

No mitigation is required.

Significance After Mitigation

Impacts would be less than significant without mitigation.

IMPACT GEO-3 DIRECTLY OR INDIRECTLY DESTROY UNIQUE PALEONTOLOGICAL RESOURCES.

REASONABLY FORESEEABLE DEVELOPMENT UNDER THE 2021 LRDP COULD CAUSE A SUBSTANTIAL ADVERSE CHANGE IN OR DISTURB KNOWN OR UNKNOWN PALEONTOLOGICAL RESOURCES AS DEFINED IN CEQA GUIDELINES SECTION 15064.5. HOWEVER, MITIGATION MEASURES MM GEO-1 AND MM GEO-2 WOULD MINIMIZE POTENTIAL IMPACTS DURING EXCAVATION ACTIVITIES. IMPACTS TO PALEONTOLOGICAL RESOURCES WOULD BE LESS THAN SIGNIFICANT WITH MITIGATION INCORPORATED.

Construction

Based on a paleontological literature review and existing fossil locality information available on the Paleobiology Database and UCMP database, the paleontological sensitivity of the geologic units underlying the UCR campus were determined in accordance with criteria established by the SVP (2010).

Quaternary old (late to early Pleistocene) alluvial deposits (Qof, Qvof), mapped in the majority of West Campus and large portions of the East campus, have a well-documented record of abundant and diverse vertebrate fauna recorded throughout California (Paleobiology Database 2021; UCMP 2021). Numerous vertebrate fossil taxa from Riverside County including horse, tapir, bison, camelid, deer, mastodon, mammoth, ground sloth, canine, rabbit, and rodent have been noted in the region (Jefferson 2010). Therefore, Quaternary old (late to early Pleistocene) alluvial deposits (Qof, Qvof), have a high paleontological sensitivity, pursuant to SVP standards (SVP 2010).

Quaternary young (late to middle Holocene) alluvial deposits (Qyf, Qya) mapped in the northern portion of East Campus and throughout most of West Campus, respectively, are likely too young to preserve paleontological resources (i.e., deposits that are less than 5,000 years old cannot, by definition, contain fossils). Late to middle Holocene sedimentary deposits (i.e., Qyf, Qya) are assigned a low paleontological sensitivity at the surface; however, these units grade downward into older, potentially fossiliferous deposits of early Holocene to Pleistocene age (e.g., Qof, Qvof) at unknown depths, that can only be estimated, based on regional geologic setting in the absence of additional data. Accurately assessing the boundaries between younger and older units in the UCR campus generally requires site-specific stratigraphic data, some form of radiometric dating, or fossil analysis from nearby sites. Conservative estimates of the depth at which paleontologically sensitive units may occur reduces potential for impacts to paleontological resources. The depths at which these units become old enough to yield fossils is highly variable but generally does not occur at depths of less than 3 to 5 feet. Sensitive units could occur at depths shallower than 5 feet near contact points with high sensitivity units. As discussed above, early Holocene to Pleistocene sedimentary deposits have the potential to preserve buried intact paleontological resources because these units have proven to yield scientifically significant vertebrate fossils in Riverside County and throughout California (Jefferson 2010; Paleobiology Database 2021; UCMP 2021). Consequently, areas mapped as Quaternary young (late to middle Holocene) sedimentary deposits (Qya, Qyf) are assigned a high paleontological sensitivity at depths greater than 5 feet.

Artificial fill (Qaf), mapped in the southern portion of the UCR campus, consists of recently compacted sediments related to prior development and as such, it is assigned no paleontological sensitivity.

As currently envisioned, development under the proposed 2021 LRDP would occur primarily in previously disturbed areas, adjacent to previously developed areas, surface parking areas, generally along North/South/East/West Campus Drive, and generally along University Avenue, Canyon Crest Drive, Big Springs Road, Aberdeen Drive, and West Linden Street. Additionally, development under the 2021 LRDP would primarily be infill development or expansion of already developed areas. New development may occur within the Agricultural/Campus Research, Student Neighborhood, Campus Support, and University Avenue Gateway designations.

However, paleontological resources may be encountered during any ground-disturbing activities associated with construction (e.g., grading, excavation, or other ground disturbing construction activity) in areas with high paleontological sensitivity and undisturbed soils. Construction activities may result in the destruction, damage, or loss of undiscovered scientifically important paleontological resources.

Therefore, development associated with the implementation of the proposed 2021 LRDP, including construction-related and earth-disturbing activities, could potentially damage or destroy fossils in these geologic units.

Adverse effects to unknown paleontological resources can only be determined once a specific project has been proposed, because the effects are highly dependent on both the individual project site conditions (in this case, the geologic setting) and the characteristics of the proposed ground-disturbing activity and whether the site has previously been developed. Ground-disturbing activities associated with development facilitated by the 2021 LRDP, particularly in areas that have not previously been developed, have the potential to damage or destroy paleontological resources that may be present on or below the ground surface in previously undisturbed areas of high paleontological sensitivity. Consequently, potential damage to or destruction of fossils could occur due to development under 2021 LRDP and impacts are considered **significant**.

Operation

Impacts related to the proposed 2021 LRDP potential to cause substantial adverse change in the significance of a unique paleontological resource or unique geologic feature are limited to construction associated with the implementation of the proposed 2021 LRDP, as analyzed above. **No operational impact** would occur.

Mitigation Measures

The following mitigation measures are recommended to reduce adverse construction impacts related to paleontological resources and unique geologic features to a less-than-significant level. These mitigation measures have been developed pursuant to CEQA and are proposed for construction activities occurring under the proposed 2021 LRDP.

MM GEO-1 Inadvertent Discovery of Paleontological Resources

If any paleontological resources are encountered during ground-disturbing activities, the contractor shall ensure that activities in the immediate area of the find are halted and that UCR is informed. UCR shall retain a qualified paleontologist to evaluate the discovery and recommend appropriate treatment options pursuant to guidelines developed by the Society of Vertebrate Paleontology, including development and implementation of a paleontological resource impact mitigation program by a qualified paleontologist for treatment of the particular resource, if applicable. These measures may include, but not limited to, the following:

- Salvage of unearthed fossil remains and/or traces (e.g., tracks, trails, burrows)
- Washing of screen to recover small specimens
- Preparation of salvaged fossils to a point of being ready for curation (e.g., removal of enclosing matrix, stabilization and repair of specimens, and construction of reinforced support cradles)

- Identification, cataloging, curation, and provisions for repository storage of prepared fossil specimens

MM GEO-2 Paleontological Resources Monitoring

UCR shall implement the following measures if projects are proposing earth-moving activities exceeding 5 feet below previously undisturbed alluvial-fan soils within "high paleontological sensitivity" (i.e., Qof and Qvof):

- Retain a qualified professional paleontologist to prepare and implement a Paleontological Resources Impact Mitigation Plan for the project. A qualified paleontologist is an individual who meets the education and professional experience standards as established by the SVP (2010), which recommends the paleontologist shall have at least a master's degree or equivalent work experience in paleontology, shall have knowledge of the local paleontology, and shall be familiar with paleontological procedures and techniques. The Paleontological Resources Impact Mitigation Plan shall describe mitigation recommendations in detail, including paleontological monitoring procedures; communication protocols to be followed in the event that an unanticipated fossil discovery is made during project development; and preparation, curation, and reporting requirements. Consolidated monitoring efforts (e.g., archaeological monitoring/tribal cultural/paleontological monitoring) may occur if the individual monitor has the applicable qualifications.
- Prior to the commencement of ground disturbing activities, the qualified paleontologist or their designee, shall conduct training for grading and excavation personnel regarding the appearance of fossils and the procedures for notifying paleontological staff if unanticipated fossils are discovered by construction staff. The Paleontological Worker Environmental Awareness Program shall be fulfilled at the time of a pre-construction meeting. In the event a fossil is discovered by construction personnel anywhere in the project area, all work in the immediate vicinity of the find shall cease and a qualified paleontologist shall be contacted to evaluate the find before re-starting work in the area. If it is determined that the fossil(s) is (are) scientifically significant, the qualified paleontologist shall complete the mitigation outlined below to mitigate impacts to significant fossil resources
- If paleontological resources are encountered during ground-disturbing activities, MM GEO-1 shall apply.

Significance After Mitigation

Mitigation Measures **MM GEO-1 and MM GEO-2** would reduce impacts to paleontological resources to a less-than-significant level by including an implementation program requiring paleontological resource studies for projects that involve ground disturbance in project areas mapped as high paleontological sensitivity at the surface (i.e., Qof, Qvof) or subsurface (i.e., Qyf, Qya) and implementation of further requirements to avoid or reduce impacts to such resources on a project-by-project basis.

4.7.4 Cumulative Impacts

Geologic and soils impacts are site-specific rather than regional in nature and any development on campus would be subject to, at minimum, uniform site development and construction and regulatory standards relative to seismic and other geologic conditions that are prevalent in the region, such as the CBC standards. As such, the geographic context for the analysis of cumulative geology and soils impacts is the cumulative project sites underlying soils and geologic units, as well as adjacent geologic features. The cumulative projects (see Table 4-1 in Section 4, *Environmental Impact Analysis*) include those that may occur as part of future development in accordance with the various jurisdictional General Plans, community plans, or specific plans that includes ground disturbance or construction of structures.

Seismic-related Hazards

Development in the City, as well as other area jurisdictions, is required to undergo analysis of geological and soil conditions applicable to the development in question, and restrictions on development would be applied in the event that conditions pose a risk to safety. As described above, UCR is not located in an Alquist-Priolo Earthquake Fault Zone, and all proposed campus development would be required to comply with the CBC and UC Seismic Safety Policy. Most of the existing residential structures in the region are substantially older than the new development proposed under buildout of the 2021 LRDP. Approximately 76 percent of the region's housing stock was built prior to 1990 (City of Riverside 2017). Therefore, most the region's housing stock does not incorporate modern Building Code safety requirements. The rest of the state's housing stock follows similar trends. Consequently, individuals moving from older residences into new structures proposed under the 2021 LRDP and under cumulative development projects would likely benefit from increased safety. Furthermore, any future development under the proposed 2021 LRDP would be subject to analysis and site-specific soil studies, which would minimize seismic risk associated with new buildings and other structures. Therefore, site-specific campus development would not compound the cumulative effect of geologic impacts with other cumulative projects due to the localized nature of impacts. The Project's contribution to cumulative effects associated with exposing people and property to ground shaking effects (Impact GEO-1) would be **less than significant (not cumulatively considerable)**.

Soil Stability Hazards

Development projects are required to undergo analysis of geological and soil conditions applicable to each development in question, and restrictions on development would be applied if conditions pose a risk to safety. As described above, UCR contains areas that could be subject to soil related hazards such as subsidence and liquefaction. Risks related to landslides and soil collapse are considered very low in the UCR campus. All proposed development would be required to comply with the CBC and UC Seismic Safety Policy. Most of the existing residential structures in the region are substantially older than the new development proposed under buildout of the 2021 LRDP. Approximately 76 percent of the region's housing stock was built prior to 1990 (City of Riverside 2017). Therefore, most the region's housing stock does not incorporate modern Building Code safety requirements. The rest of the state's housing stock follows similar trends. Consequently, individuals moving from older residences into new structures proposed under the 2021 LRDP and under cumulative development projects would likely benefit from increased safety. Furthermore, any future development under the LRDP would be subject to analysis and site-specific soil studies, which would minimize seismic risk associated with new buildings and other structures. Therefore, the Project's contribution associated with soil stability hazards (Impact GEO-2) would be **less than significant (not cumulatively considerable)**.

Paleontological Resources or Unique Geologic Features

The potential for impacts from individual developments is site-specific and depends on the location and extent of ground disturbance associated with each individual development proposal. Areas throughout the region would continue to develop, as described in the City's General Plan, County of Riverside General Plan, and the County of San Bernardino General Plan, and involve grading and excavation activities which would potentially encounter paleontological resources. All future development projects would continue to be subject to existing State and local requirements and projects may be subject to project-specific mitigation requirements under CEQA.

Development under the 2021 LRDP has the potential to encounter paleontological resources during any ground-disturbing activities associated with construction (e.g., grading, excavation, or other ground disturbing construction activity) in areas with high paleontological sensitivity and undisturbed soils. Construction activities may result in the destruction, damage, or loss of undiscovered scientifically important paleontological resources. Therefore, development associated with the implementation of the proposed 2021 LRDP, including construction-related and earth-disturbing activities, could potentially damage or destroy fossils in these geologic units. Therefore, the Project's contribution to cumulative impacts (Impact GEO-3) is considered cumulatively considerable without mitigation.

Compliance with Mitigation Measures **MM GEO-1 and MM GEO-2** would be required for proposed development under the LDRP; therefore, the proposed 2021 LRDP's contribution to cumulative impacts related to the destruction, damage, or loss of undiscovered scientifically important paleontological resources would be **less than significant with mitigation (not cumulatively considerable)**.

4.7.5 References

Bartlett, S.F. and Youd, T.L. 1992. Case of Histories of Lateral Spreads Caused by the 1964 Alaska Earthquake, in Case Studies of Liquefaction and Lifeline Performance During Past Earthquakes – Volume 2 United States Cases, edited by O'Rourke and Hamada.

California Department of Conservation (DOC). 2020. "UC Riverside." Earthquake Zones of Required Investigation. [GIS dataset]. https://maps.conservation.ca.gov/cgs/EQZApp/app/.

California Department of Water Resources. 2004. California's Groundwater Bulletin 118. Upper Santa Ana Valley Groundwater Basin, Riverside-Arlington Subbasin. Sacramento, CA. Updated February 27, 2004.

California Geological Survey (CGS). 2002. California Geomorphic Provinces, Note 36.

______. 2015. Fault Activity Map of California. https://maps.conservation.ca.gov/cgs/fam/

Jefferson, G.T. 2010. A catalogue of late Quaternary vertebrates from California. Natural History Museum of Los Angeles County Technical Report 7, p. 5-172.

Morton, Douglas and Miller, Fred. 2006. Geologic Map of the San Bernardino and Santa Ana 30' x 60' Quadrangles, California.

Norris, R.M., and R.W. Webb. 1990. Geology of California. John Wiley and Sons, Inc. New York.

Paleobiology Database. 2021. Online fossil locality database. https://www.paleobiodb.org/#/.

Riverside, City of. 2007. Riverside General Plan 2025 PEIR, Appendix E Geotechnical Report. Certified November 2007.

______. 2012. Section 5.6 Geology and Soils, Riverside General Plan 2025 Programmatic Environmental Impact Report. Riverside, CA. November 2012.

______. 2017. City of Riverside 2014-2021 Housing Element. Riverside, CA. Adopted October 10, 2017.

______. 2018. Riverside General Plan 2025 Public Safety Element. Riverside, CA. Amended February 2018.

Riverside Public Utilities (RPU). 2016. 2015 Urban Water Management Plan for Riverside Public Utilities Water Division. Prepared by Water Systems Consulting, Inc. Riverside, CA. June 2016.

Society of Vertebrate Paleontology (SVP). 2010. Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources. Society of Vertebrate Paleontology Impact Mitigation Guidelines Revision Committee.

University of California (UC). 2017. Seismic Safety Policy. Capital Asset Strategies and Finance Office. Oakland, CA. May 19, 2017. https://policy.ucop.edu/doc/3100156/.

University of California Museum of Paleontology (UCMP). 2020. UCMP online database specimen search portal, http://ucmpdb.berkeley.edu/.

University of California, Riverside (UCR). 2005. 2005 Long Range Development Plan Final Environmental Impact Report: Volume I, Draft EIR. Prepared by EIP Associates. Los Angeles, CA. November 2005.

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