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4.6 GEOLOGY, SOILS, AND SEISMICITY

This section characterizes the geology, soils, and seismic risks of the UC Davis campus and the three-county region. In addition, this section analyzes the potential seismic hazards and soil constraints associated with the implementation of the 2003 LRDP.

No concerns regarding geology, soils, seismicity, and mineral resources were expressed by commenters in response to the Notice of Preparation.

4.6.1 Environmental Setting

4.6.1.1 Geologic Overview

The campus is located within the Putah Creek Plain of California's Great Valley geomorphic province. The Great Valley province is approximately 400 miles long and 50 miles wide. The province is bounded by the Klamath Mountains on the north, the Coast Ranges on the west, the Tehachapi Range on the south, and the Sierra Nevada on the east. The Great Valley province is drained by the Sacramento and San Joaquin rivers, which join and flow out of the province through the San Francisco Bay.

The Putah Creek Plain lies within the southwestern Sacramento River Valley. The plain is underlain by Quaternary (less than two million years old) and Plio-Pleistocene (three to five million years old) alluvial sediments deposited by Putah Creek to a depth of up to 3,000 feet below the surface. The sedimentary rocks of the Great Valley Sequence lie below the alluvial deposits, between 3,000 and 17,000 feet below the surface (Wagner et al. 1981).

Except for the somewhat raised elevation along the levee adjacent to Putah Creek, the campus is topographically flat.

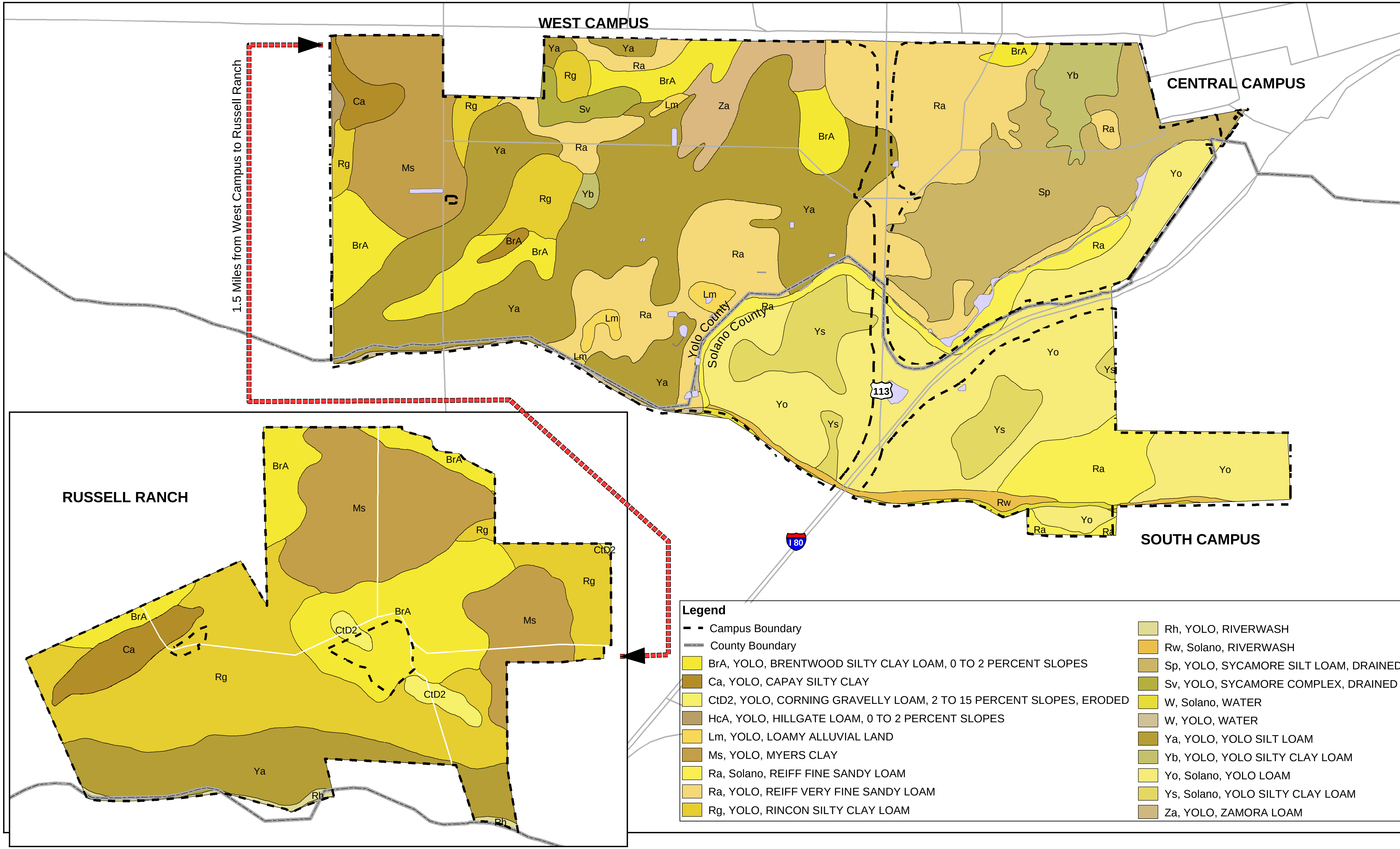
4.6.1.2 Soils

Figure 4.6-1 depicts the soil types that occur on the UC Davis campus and in the vicinity. These soils generally contain a high amount of silt and clay. As a result, the soils are moderately to slowly permeable and have slow runoff rates, minimal erosion hazards, and moderate to high shrink-swell potential.

Specific soils that occur on campus are characterized below:

- Brentwood Series: Found on alluvial fans. Exhibits moderately slow permeability, very slow runoff, minimal hazard of erosion, and high shrink-swell potential. Slow percolation places severe limitations affecting septic tank absorption fields. Brentwood soils are found on approximately 2 percent of campus lands, mostly west of County Road 98.
- Capay Series: Found on basin rims. Exhibits slow permeability, very slow runoff, minimal hazard of erosion, and high shrink-swell potential. Slow percolation places severe limitations affecting septic tank absorption fields. Flooding may also limit septic tank absorption fields in some Capay Series soils. Capay soils are found on approximately 9 percent of campus lands, primarily between Hopkins Road and County Road 98.

- Corning Series: Found on softly consolidated, mixed gravelly alluvium. Exhibits very slow permeability, moderate erosion hazard, and high shrink-swell potential. Slow percolation places severe limitations affecting septic tank absorption fields. Corning soils are found on Russell Ranch.
- Myers Series: Found on alluvial fans. Exhibits slow permeability, very slow runoff, minimal hazard of erosion, and moderate to high shrink-swell potential. Slow percolation places severe limitations affecting septic tank absorption fields. These soils are found on Russell Ranch.
- Rincon Series: Found on alluvial fans. Exhibits slow permeability, very slow runoff, minimal hazard of erosion, and moderate to high shrink-swell potential. Slow percolation places severe limitations affecting septic tank absorption fields. These soils are found on Russell Ranch.
- Reiff Series: Found on alluvial fans. Exhibits moderately rapid permeability, very slow runoff, minimal hazard of erosion, and high shrink-swell potential. There are only slight limitations affecting septic tank absorption fields. Reiff soils are found on approximately 26 percent of campus lands, primarily on the west campus and Russell Ranch.
- Sycamore Series: Found on alluvial fans. Exhibits moderately slow permeability, very slow runoff, minimal hazard of erosion, and high shrink-swell potential. Wetness, slow percolation, and/or flooding place severe limitations on septic tank absorption fields. Sycamore soils are found on the west and south campuses.
- Yolo Series: Found on alluvial fans. Exhibits moderately rapid permeability, very slow runoff, minimal hazard of erosion, and moderate shrink-swell potential. Slow percolation places moderate limitations affecting septic tank absorption fields. Yolo soils are found on approximately 50 percent of campus lands.
- Zamora Series: Found on alluvial fans. Exhibits moderately slow permeability, very slow runoff, minimal hazard of erosion, and moderate shrink-swell potential. Slow percolation places severe limitations affecting septic tank absorption fields. Zamora soils are found on approximately 3.7 percent of campus lands, to the north of Hutchison Road.
- Riverwash: Excessively drained, sandy, gravelly, or stony stream deposits. Exhibits very rapid permeability, very slow (when not flooded) runoff, and is subject to scouring and deposition. Flooding and poor filtering qualities place severe limitations on septic tank absorption fields. Riverwash is found in the Putah Creek channel.



Data provided by U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). Based on data originally published by U.S. Department of Agriculture, Soil Conservation Service, 1972.

1 inch equals 2,005 feet

URS

UC Davis LRDP EIR 28649327

Soils on UC Davis Campus

Figure 4.6-1

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Soil characteristics can make soils particularly suitable or particularly unsuitable for specific uses such as agricultural production, excavation, buildings with basements, and paving. Soils on campus are considered particularly suitable for agricultural, habitat, and recreation uses (NRCS 2002). The predominant soil constraint to construction on campus is soil shrink-swell potential (the potential for soil volume to change with a loss or gain in moisture). The moderate to high shrink swell potential found on all campus soils can cause damage to buildings, roads, and other structures. In addition, the slow permeability of many of the campus soils results in slow percolation of septic tank leachate. This can result in the failure of the absorption fields if the systems are not properly designed.

4.6.1.3 Seismicity

Faults. A series of low foothills, including the Dunnigan Hills, the Capay Hills, and the English Hills, lies west of the campus at the eastern base of the Coast Ranges. The presence of subsurface thrust faults within these regional foothills and within 100 miles of the campus indicates the potential for seismic ground shaking in the Davis region.

The closest known active faults (faults that have had surface displacement within the past 11,000 years) are the Green Valley (approximately 32 miles southwest of the campus), Hunting Creek (approximately 36 miles northwest), and Rogers Creek (approximately 47 miles southwest) faults (CDOC 1999). The San Andreas Fault is located approximately 67 miles to the southwest. The Davis region is not located within an Alquist-Priolo Fault Zone as defined in the Alquist-Priolo Earthquake Fault Zoning Act, which is designed to prohibit the construction of structures for human occupancy across active faults.

The 1994 Fault Map of California shows the East Valley fault approximately beneath the Russell Ranch portion of the campus (Jennings 1994). The fault is subsurface and its location is inferred, as it has not created any surface rupture. It is believed that the last movement along this fault occurred over 1.6 million years ago, and the fault is generally considered inactive (Harwood and Helley 1987). Because the East Valley Fault is subsurface, the date of the last movement along the fault is a general estimate. This fault is located deep beneath the ground surface, and although it could be the source of earthquakes and associated ground shaking, it would not cause ground surface rupture.

Seismic History. Numerous earthquakes have been felt on campus (major earthquakes occurred in 1892, 1906, and 1989). The greatest historical seismic event felt in Yolo County occurred in 1892, with the epicenter located along an unnamed fault in the vicinity of the English Hills between Winters and Vacaville. Available newspaper reports from the Davis vicinity reported that damage included fallen chimneys and cracked walls (Cowen, Cooper, and Cooper 1992).

Earthquake Ground Shaking. The magnitude of ground shaking due to an earthquake is typically presented as a percentage of the acceleration due to gravity ("g"). According to the California Geological Survey's Probabilistic Seismic Hazard Assessment for the State of California, the peak ground acceleration with a 10 percent probability of being exceeded in 50 years, is 0.2 to 0.3g on the central campus, increasing to 0.3 to 0.4g on the western portion of Russell Ranch (CDOC 1996). By comparison, in most parts of the San Francisco Bay Area, the peak ground acceleration is 0.5g or greater. Likely effects of ground shaking during a probable maximum intensity earthquake for the area could include structural damage to stucco, masonry walls, and chimneys, which could expose people to risks associated with falling objects and potential building collapse. The extent of these effects would be determined by the nature of underlying soil and rock materials, the structural characteristics and materials of affected buildings, the location of the epicenter and magnitude of the earthquake, and the duration of the ground motion (EIP Associates 1994).

Secondary Seismic Effects. Soils deposited in the Central Valley typically consist of loose alluvial deposits that could be susceptible to liquefaction and settlement. Liquefaction is a quicksand-type ground failure caused by ground shaking that is most likely to occur in low-lying areas of poorly consolidated, water-saturated sediments or similar deposits of artificial fill. Due to the generally low groundwater levels on the campus, liquefaction is unlikely. Settlement is the compaction of soil and alluvium caused by static loads (such as foundations for structures) or by ground shaking effects such as liquefaction. Due to the presence of compressible clay soils on campus, settlement has been identified as a building constraint in some areas on campus. However, building design (including shallow foundations and pier foundations) and replacement of soils under foundations with engineered fill can reduce the extent of settlement (Kleinfelder 1998, Wallace Kuhl Associates 1999 and 2002). Localized soil assessments will continue to be prepared for campus construction projects under the 2003 LRDP to identify any site-specific potential for secondary seismic effects, including liquefaction and settlement.

4.6.1.4 Subsidence

The Davis area has subsided approximately 2 feet in the last several decades due to groundwater pumping (City of Davis 2001). Results of an ongoing Yolo County subsidence study sponsored by the City of Davis, UC Davis, and other regional agencies were published in February 2003, which also indicate that subsidence is continuing in the county. This study was commenced in 1999 by establishing a network of stations throughout Yolo County. GPS equipment was used to measure terrestrial elevations at each of these stations in 1999. This was followed up by a second round of measurements in 2002 at the same stations. Comparison of the two data sets shows that subsidence is continuing, with approximately 2 inches of subsidence in the vicinity of the campus between 1999 and 2002 (D'Onofrio and Frame 2003). Subsidence can change the gradient of pipelines such as storm drains and sanitary sewers in which flow is gravity-driven, causing the flow to slow or reverse direction.

4.6.1.5 Regulatory Setting and Campus Compliance

The following guidelines addressing geologic, seismic, and soils hazards are applicable to the campus:

- California Building Code (CBC): The CBC (Title 24 California Code of Regulations) identifies the minimum standards for structural design and construction in California, including specific requirements for seismic safety.
- University of California Seismic Safety Policy: The policy requires the identification and correction of potential earthquake hazards in existing structures. The policy requires that UC contract with consulting structural engineers to examine existing buildings and other facilities to determine the adequacy of the structures to resist seismic forces. For buildings rated as Poor or Very Poor by the engineer, the policy requires that UC immediately take appropriate action, which

may include partial or total evacuation, temporary emergency measures, reductions in use, and/or reconstruction. Seismic rehabilitation projects are required to provide, as a minimum, a level of safety equivalent to that which would be established by compliance with the current seismic provisions of the CBC or local seismic requirements, whichever are more stringent. For new structures, the design and construction must, as a minimum, comply with the CBC or local seismic requirements. In addition, the policy requires design provisions for new structures not included in the CBC, including adequate anchorage of nonstructural building elements and a process for seismic design standard review.

The campus currently reviews and approves all draft building plans for compliance with these guidelines.

The University of California's Seismic Safety Policy requires the identification and correction of potential earthquake hazards in existing structures. In 1998, independent consultants conducted a seismic evaluation of campus structures (Rutherford & Chekene Consulting Engineers 1998). This study and earlier studies identified 12 structures on campus with poor or very poor University of California seismic safety ratings:

- Academic Surge, POOR*
- Architects & Engineers Barn, POOR*
- Bainer Hall, POOR*
- Briggs Hall, POOR*
- Chemistry 194, POOR*
- Recreation Hall, VERY POOR*
- Shields Library (Reading Room), POOR
- Telecommunications Building, VERY POOR*
- Thurman Laboratory (Veterinary Diagnostic Laboratory), POOR
- Toomey Field Stands and Press Box, VERY POOR
- Veterinary Medicine II, POOR*
- Walker Hall, POOR

Campus projects are currently under way or planned to correct the seismic deficiencies of all 12 buildings. Completion of projects indicated above with an asterisk is anticipated in 2005-06.

Since 1996, each department on campus has had a trained safety coordinator, who develops and maintains departmental emergency response plans to prepare administration, faculty, staff, and students to act in a responsible and coordinated manner during emergencies, including seismic emergencies. A copy of each department's emergency response plan is submitted to the UC Davis Emergency Preparedness Policy Group for annual review to ensure consistency with the campus-wide Emergency Operations Plan (Profita 2002).

The University of California also is subject to or complies with design and construction guidelines for campus plumbing and septic systems that ensure that they are seismically sound and appropriate for soil conditions, as follows:

- . California Plumbing Code (CPC): CPC (Title 24 California Code of Regulations) identifies minimum standards for the design and installation of safe and sanitary plumbing systems. The design and construction of campus projects must comply with these standards.
- Yolo County Guidelines for the Planning, Installation, and Maintenance of Septic Systems. The Yolo County Department of Health (YCDH) issues permits for installation of septic systems in Yolo County and provides guidelines, which those installing the systems must follow. Although UC Davis is not subject to building ordinances of local political jurisdictions and is not required to obtain permits from the YCDH for installation of septic systems, the campus follows the YCDH guidelines in the design and construction of septic systems.

4.6.2 Impacts and Mitigation Measures

4.6.2.1 Standards of Significance

The following standards of significance are based on Appendix G of the CEQA Guidelines. For the purposes of this EIR, the project would have a significant impact with regard to geology, soils, seismicity, and mineral resources if it would:

- Expose people or structures to potential substantial adverse effects involving strong seismic ground shaking
- Expose people or structures to potential substantial adverse effects involving seismic-related ground failure
- Result in substantial soil erosion or the loss of topsoil
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse
- Be located on expansive soil, creating substantial risks to life or property
- 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

  All of these issues except impacts from soil erosion and loss of top soil are addressed in the analysis in this section. The impacts from soil erosion and loss of top soil on water quality are addressed in Section 4.8 Hydrology and Water Quality (Volume II). The issue of project impact on top soil as it relates to agricultural resources is addressed in Section 4.2 Agricultural Resources (Volume I).

4.6.2.2 *CEQA Checklist Items Adequately Addressed in the Initial Study*

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.

  The UC Davis campus and the surrounding area are not located within an Alquist-Priolo Earthquake Fault Zone, and the closest known active fault rupture zones are over 30 miles away.

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides.

  The UC Davis campus and the surrounding area are characterized by flat topography and therefore would not be subject to landslides.

- Result in the loss of availability of a known mineral resource.

  Sand and gravel are important mineral resources in the region (CDOC 2000). However, natural gas is the only known or potential mineral resource that has been identified on campus. Natural gas can be extracted at wells placed considerable distances from deposits. Therefore, development under the 2003 LRDP would not impede extraction or result in the loss of availability of a known mineral resource.

4.6.2.3 *Analytical Method*

The potential for impacts associated with seismic ground shaking and seismic-related ground failure was evaluated through review of the California Division of Mines and Geology (CDMG) maps showing peak ground acceleration (CDOC 1996). Information on the engineering properties, liquefaction potential, and suitability for on-site sewage disposal systems of subsurface materials underlying the campus was obtained from the Yolo County Soil Survey and the CDMG's geologic map of the Sacramento Quadrangle (Wagner et al. 1981).

4.6.2.4 *2003 LRDP Impacts and Mitigation Measures*

LRDP Impact 4.6-1:	Implementation of the 2003 LRDP would not expose people and structures on campus to potentially adverse effects associated with seismic ground shaking or seismic-related ground failure.
Significance:	Less than significant
LRDP Mitigation:	Mitigation is not required.

The campus is located in a seismically active area that could experience ground shaking, liquefaction, and settlement. The peak ground acceleration for the main campus is estimated to be 0.2 to 0.3*g*, and 0.3 to 0.4*g* on the western portion of Russell Ranch. These seismic effects have the potential to dislodge objects from shelves and to damage or destroy buildings and other structures. People in the area would be exposed to these hazards.

The campus minimizes hazards associated with damage or destruction to buildings and other structures by reviewing and approving all draft building plans for compliance with the CBC, which includes specific structural seismic safety provisions. Also, the campus program to upgrade or replace existing buildings not adequately prepared to withstand seismic hazards diminishes the existing hazards. The campus also adheres to the University of California Seismic Safety Policy, which requires anchorage for seismic resistance of nonstructural building elements such as furnishings, fixtures, material storage facilities, and utilities that could create a hazard if dislodged during an earthquake. Campus EH&S provides guidance for preparing department-level Illness and Injury Prevention Plans that emphasizes methods for minimizing seismic hazards in laboratories, for example, by properly securing chemical containers and gas cylinders. Each department has a Safety Coordinator who develops and maintains a departmental emergency response plan. The departmental emergency response plans must be submitted to the Emergency Preparedness Policy Group for annual review to assure consistency with the campus Emergency Operations Plan, which includes seismic safety and building evacuation procedures. The emergency procedures incorporated into the departmental emergency response plans further reduce the hazards from seismic shaking by preparing faculty, staff, and students for emergencies. All of these procedures would continue to be implemented as new facilities are developed on campus under the 2003 LRDP. Therefore, this impact would be less than significant.

* * *

LRDP Impact 4.6-2:	Development under the 2003 LRDP could occur on a geologic unit or soil that is unstable or that would become unstable as a result of the project and could result in on- or off-site lateral spreading, subsidence, liquefaction, or collapse, but would not create potential risks to life or property.
Significance:	Less than significant
LRDP Mitigation:	Mitigation is not required.

The potential for liquefaction on the campus is generally low because the depth to groundwater is relatively large (30 to 80 feet, depending on the season). Furthermore, geotechnical investigations that address the potential for liquefaction, lateral spreading, and other types of ground failure are routinely performed for every applicable project. As a consequence of continued implementation of this procedure and compliance with the CBC and the University of California Seismic Safety Policy, this impact would be less than significant.

As discussed in Section 4.6.1.4, above, the Davis area subsided by approximately 2 inches between 1999 and 2002. Because the subsidence is regional, unlike local differential settlement, it would not affect building foundations. Subsidence can cause impact to utilities such as storm drains which rely on gradient for gravity-driven flow if the differential subsidence across the length of the pipeline causes the gradient of the pipelines to change direction. On the campus, the differential subsidence is about 0.4 inch per mile. Thus, over a period of 10 years, the gradient of a pipeline could change by as much as 4 inches per mile. Gravity-driven pipelines typically used for wastewater and storm water are designed with gradients between 0.5 and 1 percent (27 to 53 feet drop per mile). Given these gradients, the small potential change of about 4 inches per mile over a period of 10 years would not affect the functioning of existing and proposed storm drains or other utilities.

* * *

LRDP Impact 4.6-3:	Implementation of the 2003 LRDP could result in construction of campus facilities on expansive soil, but would not create potential risks to life or property.
Significance:	Less than significant
LRDP Mitigation:	Mitigation is not required.

Expansive soils are soils that are high in expansive clays or silts and that swell and shrink with wetting and drying, respectively. This shrinking and swelling can result in differential ground movement, which can cause damage to foundations. However, proper fill selection, moisture control, and compaction during construction can prevent these soils from causing significant damage. The soils in several areas of the UC Davis campus have a high shrink/swell potential and could, on a site-specific basis, have the potential to create risk to life or property. Campus policy requires compliance with the CBC, which includes provisions for construction on expansive soils. Complying with the provisions of the CBC requires that a geotechnical investigation be performed to provide data for the architect and/or engineer to responsibly design the project. The campus Office of Architects and Engineers requires geotechnical investigations for every applicable project managed by that office, and the UC Davis Standards and Design Guide incorporates guidelines for geotechnical investigations, including estimated settlement. Continued compliance with the CBC and continuation of current practices for development under the 2003 LRDP will ensure that this impact will be less than significant.

* * *

LRDP Impact 4.6-4:	Implementation of the 2003 LRDP could result in construction of septic tanks or alternative wastewater disposal systems in areas on campus where soils are not capable of adequately supporting them.
Significance:	Potentially significant
LRDP Mitigation 4.6-4:	Site-specific percolation testing or test borings shall be performed as part of the site analysis process at sites where septic tank disposal systems are proposed to determine if the soils are capable of adequately supporting them. The campus shall follow guidelines for septic system design provided in the Uniform Plumbing Code.
Residual Significance:	Less than significant

The campus wastewater treatment system serves most of the campus, although a few areas of campus, mostly on the west campus and Russell Ranch, are served by existing onsite septic disposal systems. Alterations to these systems and construction of new septic systems or alternative wastewater disposal systems could occur under the 2003 LRDP.

According to the Yolo County Soil Survey, the soils in many areas of the central and west campuses and Russell Ranch have slow permeability, which poses severe constraints on septic tank absorption fields. Water moves slowly in these soils, increasing the potential that absorption fields will fail. However, the limitations can be overcome by increasing the size of the absorption field or by using coarser backfill material. Furthermore, the Soil Survey data available for the campus extends only to a depth of 5 feet; placing the leach lines in deeper, more permeable strata may also be possible.

Currently, when septic tank disposal systems are installed on campus, the Office of Environmental Health and Safety reviews percolation tests or soil textures from test holes. Currently, septic systems designs follow guidelines provided in the Yolo County ordinance for onsite sewage disposal systems and the Uniform Plumbing Code (Kermoyan 2003). The potential impact resulting from construction of septic tanks under the 2003 LRDP can be mitigated to a less-than-significant level by implementing LRDP Mitigation 4.6-4, which ensures that the campus evaluates the suitability of soils for future septic tanks.

* * *

4.6.2.5 Cumulative Impacts and Mitigation Measures

LRDP Impact 4.6-5: Cumulative development, including the development on campus under the 2003 LRDP, could expose people or structures to potential adverse effects involving seismic ground shaking.

Significance: Less than significant

LRDP Mitigation: Mitigation is not required.

The broader geographic area of the analysis of cumulative impacts involving seismic ground shaking is all of Yolo and Solano counties. Development throughout Yolo and Solano counties would have to comply with the current seismic provisions of the CBC and local building codes. These state and local requirements are designed to ensure that structures developed in regions prone to significant ground shaking can withstand the likely stress that would result. Compliance with the CBC by the development community would ensure that cumulative effects involving seismic ground shaking are less than significant. It is reasonable to assume that all jurisdictions would enforce the seismic provisions of the CBC on new development and significant adverse impacts would be avoided.

* * *

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