9

GEOLOGY AND SOILS

INTRODUCTION

The following section summarizes geology, soils, and seismicity of the Plan area. Included is a discussion of existing conditions and the constraints to development that these particular geologic, soils, and seismic conditions pose. Certain conditions, such as weak or erosive soils, may be practically mitigated through suitable grading, foundation engineering, drainage controls, and other measures, while the often unpredictable nature of geologic hazards (such as strong or violent seismic shaking from an earthquake) may only be mitigated to an acceptable standard or level of risk. Typical geologic- and soils-related constraints on development within the City of Ceres are related to moderate seismic shaking and the need to control erosion during construction.

The information presented below was drawn from the following sources:

(1) U.S. Geological Survey and California Geological Survey, Quaternary Fault and Fold Database for the United States (USGS, 2006);

(2) Eastern Stanislaus County Soil Survey (USDA, 1964);

(3) U.S. Department of Agriculture, Natural Resources Conservation Service Soil Survey Geographic (SSURGO) database for the Eastern Stanislaus Area, California, December 2007.

(4) California Division of Mines and Geology Probabilistic Hazards Assessment for the State of California (California Division of Mines and Geology 1996, revised 2002); and

(5) Review of the City of Ceres General Plan as well as other applicable ordinances and regulations.

EXISTING CONDITIONS

REGIONAL GEOLOGY

The Plan area is located in the San Joaquin Valley of the Great Valley geomorphic province of California. The Great Valley is a relatively flat alluvial plain that is in-filled with as much as six vertical miles of alluvial and marine sediment. This sediment has been deposited nearly continuously since the Jurassic period (160 million years ago). The Great Valley is bounded to the west by the Coast Ranges and to the east by the Sierra Nevada. The Coast Range is composed of deformed sedimentary and metamorphic rocks, and is broken by numerous faults. The Sierra Nevada is a tilted fault block dipping towards the southwest. It consists of pre-Tertiary igneous and metamorphic rocks.

Soils in the West Landing Specific Plan (WCSP) area include varieties of Dinuba sandy loam, Hanford sandy loam, and Tujunga sandy loam.[1]

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[1] U.S. Department of Agriculture, Natural Resources Conservation Service Soil Survey Geographic (SSURGO), Eastern Stanislaus Area, California, Dec. 2007. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

REGIONAL SEISMICITY

The City of Ceres is located in the seismically-active San Joaquin Valley region of California. The seismicity of this region is primarily related to the boundary between the Coast Ranges and the Great Valley, as well as the intersection of the Great Valley, Sierra Nevada, Coast Ranges, and Transverse Ranges geomorphic provinces.

Stanislaus County has a relatively low exposure to seismic activity. There are no known faults within the valley portion of Stanislaus County, including the City of Ceres. The only known active fault, the Tesla-Ortagalita Fault, is located in the Diablo mountains.[2]

Moderate to strong ground shaking (and resultant ground failure) resulting from nearby or distant earthquakes represents the greatest seismic hazard in the City of Ceres. The intensity of ground shaking at any particular site is a function of many factors including: (1) earthquake magnitude; (2) distance from the epicenter; (3) the duration of strong ground motion; (4) local geologic conditions (soil characteristics and topography); and (5) depth to bedrock.

Ceres was affected by the 1989 Loma Prieta quake, the 1983 Coalinga quake and the 1952 Tehachapi quake,[3] but no damage has occurred in or near Ceres as the result of a magnitude 5 or greater earthquake in the last 200 years.[4] The probabilistic seismic hazards assessment for the State of California concluded peak ground acceleration for the WCSP area to be straddling the boundary between 10 to 20 percent of the acceleration due to gravity and 20 to 30 percent, with a 10 percent probability of being exceeded during the next 50 years.[5] This would correspond to a Modified Mercalli Intensity of VI to VII, considered moderate to strong.[6] The implications of this rating scale are shown in **Table 9.1** below.

The Plan Area and the City of Ceres are not listed in the California Geological Survey List of Cities and Counties Affected by Alquist - Priolo Earthquake Fault Zones.[7] The California Building Code (2007) has established guidelines for seismic structural analysis for sites located near active seismic sources. Development under the Plan will need to be designed in conformance with current applicable residential standards for seismic stability as presented in the 2007 California Building Code, and the City of Ceres Municipal Code.

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[2] J. Laurence Mintier & Associates, *City of Ceres General Plan Final Environmental Impact Report,* November 12, 1996, page 8-1.

[3] City of Ceres, *City of Ceres General Plan,* 1994, page 7-1.

[4] Department of Conservation, Division of Mines and Geology, *Epicenters of and Areas Damaged by M≥5 California Earthquakes, 1800 to 1999*, 2000.

[5] California Division of Mines and Geology and United States Geological Survey, Probabilistic Seismic Hazards Assessment for the State of California, 1996 (http://www.consrv.ca.gov/cgs/rghm/psha/index.htm), accessed April 20, 2009.

[6] USGS, ShakeMap Scientific Background, http://earthquake.usgs.gov/eqcenter/shakemap/background.php , accessed on April 20, 2009.

[7] State of California, Department of Conservation, California Geological Survey, Table 4, Cities and Counties Affected by Alquist-Priolo Earthquake Fault Zones as of May 1999, http://www.consrv.ca.gov/CGS/rghm/ap/affected.htm, accessed April 20, 2009.

TABLE 9.1: MODIFIED MERCALLI EARTHQUAKE INTENSITY SCALE

Scale	Perceived Shaking	Effects
I		Not felt.
II		Felt by persons at rest, on upper floors, or favorably placed.
III		Felt indoors. Hanging objects swing. Vibration like passing of light trucks.
IV		Hanging objects swing. Vibration like passing of heavy trucks. Standing motorcars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.
V	Light	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
VI	Moderate	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Objects fall off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and poorly constructed or weak masonry cracked. Trees, bushes shaken (visibly, or heard to rustle).
VII	Strong	Difficult to stand. Noticed by drivers of motorcars. Hanging objects quiver. Furniture broken. Damage to poorly constructed or weak masonry. Weak chimneys broken at roofline. Fall of plaster, loose bricks, stones, tiles, and cornices. Some cracks in average unreinforced masonry. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged
VIII	Very Strong	Steering of motorcars affected. Damage to average masonry and partial collapse. Some damage to reinforced masonry, but not to that specially designed for seismic loading. Fall of stucco and some masonry walls. Collapse of chimneys, factory stacks, monuments, towers, and elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
IX	Violent	General panic. Poorly built or weak masonry destroyed; average unreinforced masonry heavily damaged, sometimes with complete collapse; reinforced masonry seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X	Very Violent	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI	Very Violent	Rails bent greatly. Underground pipelines completely out of service.
XII	Very Violent	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

g is gravity = 9.80 meters per second squared or 32 feet per second squared

PLAN AREA

Site Topography

The Plan area extends over primarily level terrain (regional land gradient is approximately 3 feet per mile downward to the southeast). The Plan area is currently dedicated to agricultural uses, with orchards and fields.

Soils

The Soil Conservation Service (now known as the Natural Resources Conservation Service (NRCS)) has mapped 30 different soil associations in the eight physiographic provinces in Stanislaus County. In the eastern portion of Stanislaus County, there are six physiographic provinces and 16 soil associations. The physiographic provinces in this area are recent alluvial floodplains, basin lands, young alluvial fans, moderately old fans, low alluvial terraces, and high alluvial terraces. However, the WCSP area is located entirely in the young alluvial fans physiographic province, as described below.[8]

Young Alluvial Fans

Soils in this physiographic province are members of the Hanford-Tujunga, Vernalis-Salado-El Solyo, Hilmar-Delhi, Dinuba-Hanford, Myers-Stomar, and Modesto-Chualar associations. Slopes are generally level. These soils are generally found adjacent to the floodplains and basin lands on both sides of the San Joaquin River. Erosion hazard is estimated to be low.[9]

The NRCS classifies soils into four hydrologic soil groups based on the soil's runoff potential:

Group A is sand, loamy sand or sandy loam types of soils. These soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. These soils have a moderate infiltration rate when thoroughly wetted and primarily consist of moderately drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. These soils have low infiltration rates when thoroughly wetted and primarily consist of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. These soils have the highest runoff potential and very low infiltration rates when thoroughly wetted. They primarily consist of clay soils with a high swelling potential and/or soils with a permanent high water table.

Soils within the study area range from A to C, with Type C soils accounting for approximately 28 percent of the soils, Type B soils accounting for 46 percent of the soils and Type A soils accounting for approximately 26 percent of the soils. The WCSP area would generally be considered to have moderate runoff potential.

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[8] Soil Conservation Service, California Soil Survey, Eastern Stanislaus County Area, September 1964, accessed through http://soils.usda.gov/survey/online_surveys/california/ on April 21, 2009.

[9] Ibid.

Groundwater

The WCSP area is located within the Turlock Sub basin of the San Joaquin Valley Groundwater Basin.[10] According to Bulletin 118, "The primary hydrogeologic units in the Turlock Sub basin include both consolidated and unconsolidated sedimentary deposits. The consolidated deposits include the Ione Formation of Miocene age, the Valley Springs Formation of Eocene age, and the Mehrten Formation, which was deposited during the Miocene to Pliocene Epochs. The consolidated deposits lie in the eastern portion of the sub basin and generally yield small quantities of water to wells except for the Mehrten Formation, which is…composed of up to 800 feet of [deposits]. "Unconsolidated deposits include continental deposits, older alluvium, younger alluvium, and flood-basin deposits… The continental deposits and older alluvium are the main water-yielding units in the unconsolidated deposits." Groundwater levels in the Modesto-Ceres area were generally declining until the Modesto Regional Water Treatment Plant began surface water deliveries in 1995.

Groundwater levels appear to have stabilized and recovered somewhat since then, but would be expected to fluctuate in response to seasonal and long-term balances in pumping and recharge. Data from shallow monitoring wells located north of the WCSP area indicate that groundwater levels from 2002 through 2007 ranged from 30 to 45 feet below ground surface. Static water levels measured in several City of Ceres wells in Spring 2008 ranged from 40 to 60 feet below ground surface. City wells generally produce 1,000 to 1,800 gallons per minute.

Slope Stability

Natural topography generally drops in the southwest direction with the elevation differences varying from 0-4 feet across the site. The Plan area is nearly flat, and slope stability is not expected to be an issue.

Soil Expansion

Soil expansion is a phenomenon in which clay and silt soils expand in volume as a result of an increase in moisture content, and shrink in volume upon drying.

Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variation in soil moisture content. Changes in soil moisture could result from a number of factors, including rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Changes in soil volume as a result of moisture fluctuations, including seasonal fluctuations, can cause damage to concrete slabs, foundations and pavements. Expansive soils are typically very fine grained with a high to very high percentage of clay. Special design commonly is needed in areas with expansive soils.

Expansive soils are generally identified by use of two types of soil tests. Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. The volume change is reported as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots.

[10] California Department of Water Resources, Bulletin 118, January 2006.

Atterberg limits testing, including liquid limit and plastic limit testing, is another type of physical properties test used to determine the plasticity index and the potential for soil expansion. Soils with plasticity indices (PI) of 12 and above are considered to be expansive.

The USDA soil survey for Eastern Stanislaus County indicates that soils at the Plan area exhibit low shrink-swell potential (linear extensibility rating of 1.5) and very low plasticity (PI = 0 to 4.5).

PRIMARY SEISMIC HAZARDS- SURFACE FAULT RUPTURE

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 initiated a program of mapping active and potentially active faults (faults with displacement within Quaternary time- the last 1.6 million years). According to the program, active faults must be zoned and development projects within the Earthquake Fault Zones (EFZ) investigated to establish the location and age of any faulting across the development site. The California Geological Survey has published EFZ maps. According to these maps, the proposed development is not located within an EFZ. The only such zones in Stanislaus County are located in the southwest-most portion of the county, approximately 30 miles southwest of the WCSP area.[11]

No known active or potentially active faults cross the Plan area. The nearest Quaternary fault to the WCSP area is the Ortigalita fault zone, Cottonwood Arm section, located approximately 27 miles southwest of the WCSP area. The next nearest Quaternary fault is the Greenville fault zone, Arroyo Mocho section, located approximately 30 miles west of the WCSP area.[12]

SECONDARY SEISMIC HAZARDS

In addition to the structural damage caused by ground shaking, there are other ground effects caused by shaking. These are known as ground failure effects and include liquefaction, settlement, lateral spreading, lurch cracking, and earthquake induced landslides.

Liquefaction potential within Ceres exists in low-lying areas comprising unconsolidated, saturated, clay-free sand and silts. Since there is no historic evidence to suggest that high ground shaking intensities are common, the risk of liquefaction in the Ceres area is relatively low.[13]

Settlement, or subsidence, is the compaction of soils and alluvium caused by ground shaking. It occurs irregularly and may be partly controlled by bedrock surfaces, old lakes, sloughs, swamps, and stream beds. The amount of compaction may range from a few inches to several feet. Irregular compaction is most widespread and extreme in major earthquakes. It may occur as much as 75 to 89 miles from the epicenter and may amount to several feet even at that distance. Compaction is most likely to occur in areas, such as Ceres, which are underlain by soft water-saturated low-density alluvial material. However, there is no known history of an earthquake-related subsidence problems in Ceres.[14]

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[11] California Division of Mines and Geology, California Geological Survey, *Special Publication 42 Fault-Rupture Hazard Zones in California*, Interim Revision 2007.

[12] U.S. Geological Survey and California Geological Survey, 2006, Quaternary Fault and Fold Database for the United States, accessed 4/1/2008, from USGS web site: http//earthquakes.usgs.gov/regional/qfaults/ .

[13] J. Laurence Mintier & Associates, *City of Ceres General Plan Final Environmental Impact Report*, November 12, 1996.

[14] J. Laurence Mintier & Associates, *City of Ceres General Plan Final Environmental Impact Report,* November 12, 1996.

Lurch cracking refers to fractures, cracks, and fissures produced by ground shaking, settling, compaction of soil, and sliding, and may occur many miles from the epicenter of an earthquake. These effects are characteristic of earthquakes large enough for significant ground motion to occur. The larger the earthquake magnitude, the more extensive the effect. This may damage streets, curbs, sewer, gas and water lines.

Lateral spreading is the horizontal movement or spreading of soil from a stream bank, the open side of a filled embankment, or the sides of a levee. Artificial fill areas which are improperly engineered or which have steep, unstable banks are most likely to be affected.

The potential for lurch cracking and lateral spreading is highest in areas where there is a high groundwater table, relatively soft and recent alluvium deposits, and where creek banks are relatively high. Conditions in Ceres create a very low potential for lurch cracking and lateral spreading.[15]

Earthquakes can also cause landsliding and slumping; however, since Ceres is mostly level, these are not considered to be problems, except along the steep banks of the Tuolumne River.[16]

REGULATORY SETTING

Disaster Mitigation Act of 2000

On October 30, 2000, the President of the United States signed into law the Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390). DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of requirements (Section 322). The new law emphasizes the need for state, tribal, and local entities to coordinate disaster mitigation planning and implementation efforts closely.

Section 322 continues the requirement for a State mitigation plan as a condition of disaster assistance, adding incentives for increased coordination and integration of mitigation activities at the State level through the establishment of requirements for two different levels of state plans: Standard and Enhanced. States that demonstrate an increased commitment to comprehensive mitigation planning and implementation through the development of an approved Enhanced State Plan can increase the amount of funding available through the Hazard Mitigation Grant Program (HMGP). Section 322 also established a new requirement for local mitigation plans, and authorized up to 7 percent of HMGP funds available to a state to be used for development of state, tribal, and local mitigation plans.

Provisions of the DMA 2000 include:

- Funding for disaster planning and mitigation.
- Development of experimental multi-hazard maps to better understand risk.
- Establishment of state and local government infrastructure mitigation planning requirements (Advance Infrastructure Mitigation [AIM]).

[15] J. Laurence Mintier & Associates, *City of Ceres General Plan Final Environmental Impact Report,* November 12, 1996.

[16] J. Laurence Mintier & Associates, *City of Ceres General Plan Final Environmental Impact Report,* November 12, 1996.

- Defining how states can assume more responsibility in managing the Hazard Mitigation Grant Program (HMGP).
- Adjusting ways in which management costs for projects are funded.
- Establishment of performance-based standards for mitigation plans and requiring states to have a program (AIM) to develop county government plans. Should counties fail to develop an infrastructure mitigation plan, their federal share of damage assistance would be reduced from 75 percent to 25 percent if there were recurrent damage to the same facility or structure in response to the same type of disaster.

Alquist-Priolo Earthquake Fault Zoning Act

The California Legislature passed the Alquist-Priolo Earthquake Fault Zoning Act in 1972 to mitigate the hazard of surface faulting to structures. The Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act addresses only the hazard of surface fault rupture, and is not directed toward other earthquake hazards. Local agencies must regulate most development in fault zones established by the State Geologist.

California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code Sections 2690-2699.6) addresses seismic hazards other than surface rupture, such as liquefaction and seismically-induced landslides. The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

California Building Code

Title 24 of the California Code of Regulations, also known as the California Building Standards Code, sets minimum requirements for building design and construction. In the context of earthquake hazards, the California Building Standards Code's design standards have a primary objective of assuring public safety and a secondary goal of minimizing property damage and maintaining function during and following seismic event.

City of Ceres General Plan

The following policies of the City of Ceres General Plan address seismic and geologic considerations, particularly as they affect new development:

7.A.1. The City shall require that new structures intended for human occupancy be designed and constructed according to Uniform Building Code Zone 3 requirements to minimize risk to the safety of occupants due to groundshaking.

7.A.2. City shall continue to support scientific geologic investigations which refine, enlarge, and improve the body of knowledge on active fault zones, unstable areas, severe groundshaking, and other hazardous conditions in the Ceres area.

7.A.3. The City shall require that new structures and alterations to existing structures comply with the current edition of the Uniform Building Code .

7.A.4. The City shall support ways to improve the structural safety and stability of older structures of designated historic significance while maintaining their historical character through the use of the State Historic Building Code.

7.A.5. The City shall continue to implement the Dangerous Building Code to address older buildings that may at risk for seismic or geologic hazards.

7.A.6. The City shall avoid siting of structures across soil materials of substantially different expansive properties.

IMPACT ANALYSIS

STANDARDS OF SIGNIFICANCE

Appendix G of the CEQA Guidelines provides that a project would involve a significant geologic or soils impact if it would:

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

    a. rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;

    b. strong seismic ground shaking;

    c. seismic-related ground failure, including liquefaction and seismic-induced landslides; and/or

    d. landslides.

2. Result in substantial soil erosion or the loss of topsoil.

3. Be located on a geologic unit or soil that is unstable (or that would become unstable as a result of the project) and which could potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

4. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1997), creating substantial risks to life and property.

5. Be located in areas where soils are incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

According to CEQA Guidelines, exposure of people or structures to potentially damaging or harmful geological hazards is considered a significant adverse impact. The analysis of geological hazards is based on the degree to which the proposed change in land use and new development would expose people and structures to harm from fault rupture, seismic ground shaking, slope failure, collapse of soils, volcanic activity or any other conceivable geological hazard attributable to a site location and type of development.

The potential severity of these impacts is evaluated in this section as it relates to the CEQA Guidelines for Geology, Soils, and Seismicity. Of primary concern are moderate seismic shaking, and soil erosion during construction phases.

RUPTURE OF A KNOWN SURFACE FAULT

The site is not located within an Alquist-Priolo Earthquake Fault Zone (EFZ), and there are no other faults mapped as crossing the site. (***no impact***)

SEISMIC GROUND SHAKING

Impact Geo- 1: **Seismic Ground Shaking.** Development of the Plan area as proposed could expose structures (including their future occupants) to potentially damaging seismic ground shaking.

The probabilistic seismic hazards assessment for the State of California concluded peak ground acceleration for the WCSP area to be straddling the boundary between 10 to 20 percent of the acceleration due to gravity and 20 to 30 percent, with a 10 percent probability of being exceeded during the next 50 years.[17] This would correspond to a Modified Mercalli Intensity of VI to VII, considered moderate to strong.[18]

Mitigation Measure

Geo-1: **Design-Level Geotechnical Investigation/Meet Seismic Design Standards. Each** development project applicant shall design structures and foundations to withstand expected seismic forces in accordance with the City of Ceres Municipal Code, and as adopted under it, the California Building Code. A design-level geotechnical investigation shall be performed for each development site by a registered geotechnical engineer or civil engineer with geotechnical experience. This investigation will more thoroughly describe site soil mechanics, allowing for seismic design in accordance with the City of Ceres Municipal Code and the California Building Code. The City of Ceres Building Division shall not issue building permits until seismic design criteria is reviewed and approved.

Implementation of mitigation measure **Geo-1** would reduce potential damage resulting from seismic shaking to an acceptable standard. In general, properly designed structures are expected to avoid collapse or irreparable damage when subject to strong seismic shaking and suffer only negligible damage in the event of moderate ground shaking. Implementation of this mitigation measure would reduce the potential impact associated with seismic ground shaking to a level of ***less than significant***.

SEISMIC-RELATED GROUND FAILURE

Impact Geo-2: **Seismically-Induced Ground Failure, Including Liquefaction and Densification.** Since the Plan area will be subject to moderate to strong seismic ground shaking during future seismic events, there is a risk of seismically-related

[17] California Division of Mines and Geology and United States Geological Survey, Probabilistic Seismic Hazards Assessment for the State of California, 1996 (http://www.consrv.ca.gov/cgs/rghm/psha/index.htm), accessed April 20, 2009.

[18] USGS, ShakeMap Scientific Background, http://earthquake.usgs.gov/eqcenter/shakemap/background.php , accessed on April 20, 2009.

ground failure. The potential for liquefaction, lurch cracking, lateral spreading and landsliding is relatively low. However, compaction is most likely to occur in areas, such as Ceres, which are underlain by soft water-saturated low-density alluvial material. These soils could potentially settle during seismically-induced ground shaking.

Since there is no historic evidence to suggest that high ground shaking intensities are common, the risk of seismic-related ground failure in the Ceres area is relatively low.[19] Liquefaction potential within Ceres exists in low-lying areas comprising unconsolidated, saturated, clay-free sand and silts and compaction is most likely to occur in areas, such as Ceres, which are underlain by soft water-saturated low-density alluvial material.

Mitigation Measure Geo-1: Implementation of mitigation measure Geo-1 will ensure design-level geotechnical investigation are performed for each development site and appropriate measures are included to ensure structures are built in accordance with the City of Ceres Municipal Code and California Building Code.

Development constructed under the proposed Specific Plan will be required to comply with the California Building Code, which contains seismic safety requirements and construction and design standards to reduce risks associated with subsidence and liquefaction. Implementation of mitigation measure Geo-1 will reduce the potential impact associated with seismically-induced ground failure to a level of ***less than significant***.

LANDSLIDES

The WCSP Area and surrounding areas are relatively flat and do not contain any steep slopes or other features that could result in landslide or mudflow hazards. Therefore, risks to people from landslides or mudflows would not result due to implementation of the proposed Specific Plan (***no impact***).

SOIL EROSION AND LOSS OF TOPSOIL

Impact Geo-3: **Soil Erosion and Loss of Topsoil.** During construction, site-grading activities will remove vegetative cover, disturb, and expose soil that could become mobilized by storm waters during construction activities. According to the Eastern Stanislaus County Soil Survey, the area surface soils are expected to have low erosion hazard. However, unprotected soils will erode during heavy seasonal rainstorms. The runoff from unprotected soil areas would include significant sediment loading that could cause increased turbidity and sedimentation in downstream receiving channels.

Earth-disturbing activities could result in erosion during construction. However, development projects in the Plan area would be required to obtain and comply with the State General Construction Activity Stormwater Permit, which requires use of Best Management Practices (BMPs) to prevent eroded soils and other contaminants from entering surface waters. In addition, dust control measures must be employed to ensure that dust and small particles do not contaminate adjacent properties or adversely affect air quality (see Impact Air-1 on page 6-21 of this EIR).

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[19] J. Laurence Mintier & Associates, *City of Ceres General Plan Final Environmental Impact Report*, November 12, 1996.

Mitigation Measure

Geo-3: **Erosion Control Plan/Stormwater Pollution Prevention Plan.** Development within the Specific Plan area shall comply with Central Valley Regional Water Quality Control Board guidelines applicable at the time of the issuance of any grading permit and shall adopt acceptable best management practices (BMPs) for control of sediment and stabilization of erosion on the subject site. Acceptable BMPs for the protection of water quality shall also be adopted. Development under the Specific Plan will be dependant upon approval of an Erosion Control Plan and a Stormwater Pollution Prevention Plan (SWPPP) as outlined below.

(1) Erosion Control Plan

An Erosion Control Plan shall be prepared and implemented for development projects in the Plan area. The plan shall be submitted to the City of Ceres in conjunction with the Project Grading Plan prior to start of construction, and a final report is required prior to final building acceptance.

The Plan shall include locations and specifications of recommended soil stabilization techniques, such as placement of straw wattles, silt fence, berms, and storm drain inlet protection. The Plan shall also depict staging and mobilization areas with access routes to and from the site for heavy equipment. The Plan shall include temporary measures to be implemented during construction, as well as permanent measures.

City staff or representatives shall visit the site during grading and construction to ensure compliance with the grading ordinance and plans, as well as note any violations, which shall be corrected immediately. A final inspection shall be completed prior to occupancy. Elements of this Plan may be incorporated into the SWPPP, where applicable.

(2) Stormwater Pollution Prevention Plan (SWPPP)

In accordance with the Clean Water Act and the State Water Resources Control Board (SWRCB), the Permittee shall file a SWPPP prior to the start of construction. The SWPPP shall include specific best management practices to reduce soil erosion. This is required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit, 99-08-DWQ) and is more fully described in Chapter 12: Hydrology under mitigation measure Hydro-1.

Implementation of the mitigation measure **Geo-3** will reduce the impact from erosion and loss of topsoil to a level of ***less than significant***.

UNSTABLE AND/OR EXPANSIVE SOILS

Impact Geo-4: **Geologic Hazards Related to Unstable or Expansive Soils.** Soil characteristics, such as expansive soils, which increase and decrease in volume in response to changes in water content, could create a geologic hazard. Geologic and soil conditions can vary from site to site. All soils have properties and characteristics such as erosion potential, shrink-swell behavior, and permeability that determine their suitability and constraints for building sites, grading, infrastructure, and drainage systems.

Because of its topography and water table, soils in Ceres do not typically exhibit any unusual qualities that require special foundations or engineering.[20] However, soils vary from site to site. Title 15, Buildings and Construction, of the City of Ceres Municipal Code incorporates the California Building Code into its building requirements to ensure that buildings are designed and sited properly to protect against geologic and unstable soils conditions. Compliance with these codes would require that appropriate features are incorporated into building design to minimize risk of damage due to geological hazards, including expansive soils. In order to determine which measures are necessary for a particular site, a geotechnical evaluation should be conducted.

Mitigation Measure Geo-1: Implementation of mitigation measure Geo-1 will ensure design-level geotechnical investigation are performed for each development site and appropriate measures are included to ensure structures are built in accordance with the City of Ceres Municipal Code and California Building Code.

Development constructed under the proposed Specific Plan will be required to comply with the City of Ceres Municipal Code and the California Building Code, which contain safety requirements and construction and design standards to reduce risks associated with unstable and expansive soils. Implementation of mitigation measure Geo-1 will reduce the potential impact associated with unstable and expansive soils to a level of ***less than significant***.

SOILS INCAPABLE OF SUPPORTING THE USE OF A SEPTIC SYSTEM

The Specific Plan includes expansion of the municipal sanitary sewage system to serve this area, and all new development as proposed would be served by this system. Therefore, the use of septic systems is not expected (***no impact***).

CUMULATIVE GEOLOGY AND SOILS IMPACTS

Strong seismic ground shaking, liquefaction and densification during seismic ground shaking and soil erosion during project construction and post construction are common impacts to projects located in the region. The Plan area would be one of numerous sites anticipated to undergo development/redevelopment in the vicinity and would contribute to a cumulative increase in sites facing these impacts. However, the project-specific contribution would be reduced by identified project-specific mitigation measures to a ***less than significant*** level with no additional mitigation required.

[20] City of Ceres, *City of Ceres General Plan,* 1994, page 7-2.

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