

3.6 GEOLOGY AND SOILS

3.6.1 SETTING

The Monterey Bay region is characterized by coastal sea bluffs, sand dunes and river valleys, the Santa Cruz, Gabilan and Santa Lucia mountain ranges, and the Diablo range along the eastern border of the region. Most of the region is mountainous, with the highest elevation (5,860 feet above sea level) at Junipero Serra Peak. Several major earthquake faults pass through the region (including the San Andreas fault), and the area has a long history of seismic activity.

3.6.2 IMPACTS AND MITIGATION MEASURES

THRESHOLDS OF SIGNIFICANCE

Implementation of the three plans could have a significant environmental impact if it were to result in:

- The exposure of 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 exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving strong seismic ground shaking;
- The exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving seismic-related ground failure, including liquefaction;
- The exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving landslides;
- Substantial soil erosion;
- The loss of topsoil;
- Development 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;
- Development located on expansive soil, creating substantial risks to life and property; or

- Development 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.

Although adoption of the three plans would not, in and of itself, entail any impacts associated with geology or soils, construction of several of the projects identified in the financially constrained Action Element might be expected to entail adverse effects.

Seismic Hazards

Due to the presence of active fault systems within the region, transportation system improvement projects identified in the three plans may be subject to severe (magnitude 7.0+) earthquakes and associated ground shaking during their design life. Such shaking can cause severe damage to transportation facilities. Although a function of earthquake intensity, ground shaking effects can be greatly magnified by the underlying soils and geology, which may amplify shaking at great distances. It is difficult to predict the magnitude of ground shaking following an earthquake, as shaking can vary widely within a relatively small area. More damage from ground shaking would occur in areas underlain by thick, unconsolidated, fine-grained, water-soaked alluvial sediments than an area underlain by firm, dry, rigid bedrock.

Fault rupture can occur along (or immediately adjacent to) faults during an earthquake. Fault rupture is characterized by ground cracks and displacement that could endanger life and property. Damage is typically limited to areas close to the moving fault.

Bridge-type structures are most susceptible to earthquake ground shaking and fault rupture, although roadways may also be damaged by either phenomenon.

IMPACT 3.6.1: Increased Exposure to Seismic Hazards. In those instances where projects are proposed in proximity to known earthquake faults (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), construction of some of the transportation system improvement projects identified in the financially constrained Action Elements of the three plans could result in the increased exposure of people or structures to the risk of loss, injury or death involving fault rupture or other seismic hazards. Examples of projects which might involve such impacts may include (but are not necessarily limited to) road widenings, bridge improvements and the construction of new roadways or other transportation infrastructure. This could represent a **potentially significant environmental impact** associated with these types of projects.

RECOMMENDED MITIGATION MEASURE

MITIGATION MEASURE 3.6.1: Building Code Compliance/Avoidance of Known Earthquake Faults

Implementing agencies shall, where appropriate, ensure that all structures, including (but not limited to) roadway improvements, bridges and pedestrian/bike facilities, are designed and constructed to the latest geotechnical standards (including the UBC Zone 4 guidelines) to limit potential hazards to the public after project completion. In most cases, this will necessitate site-specific geologic and soils engineering investigations to exceed the code for high groundshaking zones.

Where transportation system improvement projects involve bridges or passenger stations, implementing agencies shall, where appropriate, ensure that such structures are placed in areas outside of fault rupture zones. If avoidance is not possible, detailed geologic and seismic studies must be completed to locate active or potentially active fault traces. Structures shall, where appropriate, then be placed outside of an appropriate setback distance.

RESULTING LEVEL OF SIGNIFICANCE

Implementation of these mitigation measures could reduce the impact to a level of less than significant.

Landslides

Transportation system improvement projects in areas of steep slopes (i.e., mountainous areas or streambanks) are subject to landslides, particularly when adjacent to areas of unstabilized cut or fill. Landslides (including rockfalls) can damage the facility itself and vehicles using the facility, and can put lives at risk. Landslides can cause temporary road closures to allow for cleanup and repair, which would necessitate detours that might cause temporary congestion on detour routes.

IMPACT 3.6.2: Increased Exposure to Landslides. Construction of some of the projects identified in the financially constrained Action Elements of the three plans could result in the increased exposure of people or structures to the risk of loss, injury or death involving landslides. Examples of projects which might involve such impacts may include (but are not necessarily limited to) the construction of new roadways and improvements to existing roadways that pass through hilly terrain. This could represent a **potentially significant environmental impact** associated with these types of projects.

RECOMMENDED MITIGATION MEASURE

MITIGATION MEASURE 3.6.2: Project-Specific Geotechnical Investigations

A. The implementing agency shall, where appropriate, require that design-level geotechnical analyses are prepared for all transportation system improvement projects, and that all recommendations contained in the geotechnical reports are incorporated into project design.

B. If a particular transportation system improvement project involves cut slopes over 20 feet in height, or is located in an area of bedded or jointed bedrock, the implementing agency shall, where appropriate, ensure that specific slope stabilization studies are conducted. Possible stabilization methods include buttresses, retaining walls and soldier piles.

RESULTING LEVEL OF SIGNIFICANCE

The implementation of site-specific slope stabilization measures and incorporation of other geotechnical recommendations could be expected to reduce potential impacts to a level of less than significant.

Soil Erosion

Soil erosion is the removal of soil by water and wind. The rate of erosion is estimated for four soil properties: texture, organic matter content, soil structure and permeability. Other factors that influence erosion potential include the amount of rainfall and wind, the length and steepness of the slope, and the amount and type of vegetative cover. The construction of structures and facilities on soils subject to erosion could result in increased erosion rates.

IMPACT 3.6.3: Increased Erosion and Loss of Topsoil During Construction. Construction of some of the projects identified in the financially constrained Action Elements of the three plans could result in increased soil erosion and loss of topsoil during construction. Examples of projects which might involve such impacts may include (but are not necessarily limited to) the construction of new roadways and the widening of existing roadways. This could represent a **potentially significant environmental impact** associated with these types of projects.

RECOMMENDED MITIGATION MEASURE

MITIGATION MEASURE 3.6.3: Grading and Erosion Control Plans

If a particular transportation system improvement project involving deep foundations or underground areas is located in an area of moderate or high erosion potential, the implementing agency shall, where appropriate, prepare a grading and erosion control plan that minimizes erosion and sedimentation prior to the issuance of grading permits. The grading and erosion control plan must include the following:

A. Methods such as retention basins, drainage diversion structures, spot grading, silt fencing/coordinated sediment trapping, straw bales and sand bags shall, where appropriate, be used to minimize erosion on slopes and siltation into waterways during grading and construction activities.

B. Graded areas shall, where appropriate, be revegetated within four weeks of grading activities with deep-rooted, native, drought-tolerant species to minimize slope failure and erosion potential. Geotextile binding fabrics shall, where appropriate, be used, if necessary, to hold slope soils until vegetation is established.

C. Exposed areas shall, where appropriate, be stabilized to prevent wind and water erosion using methods approved by the MBUAPCD. These methods may include the importation of topsoil to be spread on the ground surface in areas having soils that can be transported by the wind, and/or the mixing of highly erosive sand with finer-grained materials (silt or clay) in sufficient quantities to prevent its ability to be transported by wind. As a minimum, six inches of topsoil or silt/clay mixture is to be used to stabilize wind-erodible soils.

D. Landscaped areas adjacent to structures shall, where appropriate, be graded so that drainage is away from structures.

E. Grading on slope steeper than 5:1 shall, where appropriate, be designed to minimize surface water runoff.

F. Fills placed on slopes steeper than 5:1 shall, where appropriate, be properly benched prior to placement of fill.

G. Brow ditches and/or berms shall, where appropriate, be constructed and maintained above all cut and fill slopes, respectively.

H. Cut and fill benches shall, where appropriate, be constructed at regular intervals.

I. Retaining walls shall, where appropriate, be installed to stabilize slopes where there is a 10-foot or greater difference in elevation between the base of the proposed structure and adjacent lots.

J. Excavation and grading shall, where appropriate, be limited to the dry season of the year (typically April 15 to November 1, allowing for variations in weather) unless an approved erosion control plan is in place and all measures identified therein are in effect.

Additional measures which may be applied to reduce erosion during the construction of transportation system improvement projects include (but are not limited to) the following:

K. Limiting disturbance of soils and vegetation removal to the minimum area necessary for access and construction.

L. Confining all vehicular traffic associated with construction to the right-of-way or to designated access roads.

M. Limiting access routes and stabilizing access points.

N. Adhering to construction schedules designed to avoid periods of heavy precipitation or high winds.

O. Ensuring that all exposed soil is provided with temporary drainage and soil protection when construction activity is shut down during the winter periods.

P. Stabilizing denuded areas as soon as possible with seeding, mulching or other effective methods.

Q. Protecting adjacent properties with vegetative buffer strips, sediment barriers or other effective methods.

R. Delineating clearing limits, easements, setbacks, sensitive areas, vegetation and drainage courses by marking them in the field.

S. Stabilizing and preventing erosion from temporary conveyance channels and outlets.

T. Using sediment controls and filtration to remove sediment from water generated by dewatering or collected on-site during construction.

U. Informing construction personnel prior to construction and periodically during construction activities of environmental concerns, pertinent laws and regulations, and elements of the grading and erosion control plans.

RESULTING LEVEL OF SIGNIFICANCE

The effective implementation of grading and erosion control plans could reduce this impact to a level of less than significant.

Unstable Soils

Liquefaction potential is widespread throughout the region, particularly in lower-lying valleys overlaid by alluvium. Such areas are typically characterized by high groundwater, and is most prevalent in coastal areas.

Expansive soils have a clay content and mineralogy that renders them susceptible to volume increase upon absorption of water and volume decrease upon desiccation. Repeated cycles of wetting and drying of expansive soils can cause “shrink-swell” damage to roadways, foundations and concrete flatwork.

Compressible soils include soils with a high organic content, those with a low density and fine-grained porous texture, and uncompacted or poorly compacted fill. Soil “collapse” (also referred to as “hydroconsolidation”) is a term descriptive of the relatively rapid settlement of certain soils upon saturation. Soils prone to collapse include low-density, porous sands and silts deposited in an arid or semi-arid environment. The effect of soil compression or collapse is settlement of the ground surface with a resultant potential to damage foundations of structures and other improvements.

IMPACT 3.6.4: Construction on Unstable Soils. Construction of some of the projects identified in the financially constrained Action Element of the three plans on soils that are unstable (or that could become unstable as a result of such construction) could result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse, possibly resulting in substantial risks to life and property. Examples of projects which might involve such impacts may include (but are not necessarily limited to) the construction of new roadways and rail improvements along rail lines not currently used by trains. This could represent a **potentially significant environmental impact** associated with these types of projects.

RECOMMENDED MITIGATION MEASURE

MITIGATION MEASURE 3.6.4: Project-Specific Soils Analysis

A. If a particular transportation system improvement project is located in an area of moderate to high liquefaction potential, the implementing agency shall, where appropriate, ensure that such improvements are designed based upon appropriate soil studies. Possible design measures include deep foundations, removal of liquefiable materials and dewatering.

B. If a particular transportation system improvement project is located in an area of highly expansive, collapsible or compressible soils, the implementing agency shall, where appropriate, ensure that a site-specific investigation and appropriate design factors are implemented.

C. If a particular transportation system improvement project involving deep foundations or underground areas is located in an area of high groundwater potential, the implementing agency shall, where appropriate, ensure that appropriate construction techniques (i.e., dewatering, special water proofing and deeper foundations) are included in the design of the facility.

RESULTING LEVEL OF SIGNIFICANCE

Site-specific soil studies should be able to recommend appropriate mitigation measures which may reduce potential impacts to a level of less than significant.

Septic Suitability of Soils

None of the transportation system improvement projects identified in the financially constrained Action Elements of the three plans would be expected to require wastewater disposal in areas where

soils are incapable of adequately supporting the use of septic tanks or where sewers are not available for the disposal of wastewater.