# ANALYSIS TOPICS: NATURAL RESOURCES

## Geology, Geohazards, and Soils

### *Affected Environment*

#### Regulatory Framework

The National Park Service (NPS) has several guiding principles with respect to the management of geologic resources. Geologic resources include geologic processes, shorelines, hazards, and unique geologic features. These guidelines are specified in the NPS *Management Policies 2006*. That document specifies that the NPS will, at a minimum: (1) assess the impacts of natural processes and human activities on geologic resources, (2) maintain and restore the integrity of existing geologic resources, (3) integrate geologic resource management into NPS operations and planning, and (4) interpret geologic resources for park visitors (NPS 2006a, section 4.8.1, 53). With a few exceptions, the management policies generally direct the NPS to allow natural geologic processes to proceed unimpeded; facilitate the continuance of natural shoreline processes; and protect geologic resources from human-induced impacts while minimizing the potential impacts of geohazards on visitors, staff, and developed areas (NPS 2006a).

##### *Yosemite Valley Geologic Hazard Guidelines Summary*

The 2012 Yosemite Valley Geologic Hazard Guidelines was developed by the NPS in response to advances in the scientific understanding of rock fall mechanisms, frequency and magnitude, and the recent release of a quantitative rock-fall hazard and risk assessment for Yosemite Valley (Stock et al. 2012b). This recently released study used a quantitative approach to establish a rock fall hazard line within Yosemite Valley, which was drawn to encompass 90 percent of the boulders that have fallen from the valley walls beyond the base of the talus (the zone of boulder accumulation). The position of the line was then adjusted inward or outward based on knowledge of: (1) past rock fall frequency derived from cosmegenic exposure dating of outlying boulders, combined with (2) estimates of future rock fall frequency using a 3-dimentional program (STONE) that simulates rock fall runout. The result of the adjusted hazard line is that areas beyond the rock fall hazard line have a 0.2% probability of boulder deposition in a given year, or a 10% probability of occurrence in 50 years. The study is the first to quantitatively evaluate rock fall hazards using spatial probability mapping that is similar to other, more common hazard maps, such as FEMA flood hazard zones and USGS maps of peak ground acceleration. The risk assessment then evaluated the occupancy of structures (in terms of number of occupants and the occupancy rate) within the rock fall hazard line so that structures could be assigned a risk metric, and be ordered by level of risk.

The quantitative rock-fall hazard and risk assessment for Yosemite Valley has allowed NPS managers to quantify the level of risk that was reduced by the 2008 closure of structures in Curry Village cabins (the action reduced the overall risk associated with structures in Yosemite Valley by at least 87 percent). It also allows NPS managers to form a rock fall hazard policy for the park that has a sound scientific basis. The 2012 Yosemite Valley Geologic Hazard Guidelines presents a comprehensive

policy direction for existing structures within the rock fall hazard line, based on their risk metric. In short, the policy establishes three classes of existing structures, from highest risk metric (i.e., above 6) to lowest risk metric (i.e., below 4); establishes a corresponding level of priority for removal, change of use, or repurpose; and outlines other important issues to be considered such as the importance of the structure's function and/or its historical status.

Importantly, under the new guidelines, the NPS has disallowed the placement all new structures or facilities within the rock fall hazard zone unless the facility is deemed critical, no practicable alternative exists, and life and safety risks to humans is low (e.g., a utility building). In cases where exceptions are made, the NPS commits to conducting a detailed project-specific hazard assessment. The geologic hazard guidelines also outline acceptable practices for siting of roads and trails, and placement of warning and/or closure signs.

#### *Soil Resources Policy*

The management of soil resources is described in the NPS *Management Policies 2006* and *Natural Resource Management Reference Manual #77*. These documents specify that the NPS will protect soil resources by preventing — or at least minimizing — adverse, potentially irreversible impacts on soils (NPS 2006a, section 4.8.2, 4).

### Geology

Yosemite National Park occupies approximately 1,170 square miles in the central portion of the Sierra Nevada. The Sierra Nevada is the highest and most continuous mountain range in California. The range is generally asymmetrical, with a gentle west slope and a steep east escarpment. Elevations approach sea level on the western side and reach about 14,000 feet above mean sea level at the crest.

The Sierra Nevada is essentially an uplifted block of the earth's crust that was tilted westward by normal faults on the eastern boundary. Granitic bedrock is widespread in Yosemite National Park and dominates a significant portion of the Sierra Nevada. The granitic rock formed deep in the earth as plutons of melted rock. About 100 million years ago, as the granitic rocks were formed, heated, and melted, they slowly migrated toward the earth's surface and began to cool, forming a subsurface body of solidified granitic rock called a batholith.

Between 100 million years ago and 65 million years ago, magma formation slowed and a long period of erosion began in the Sierra Nevada. Erosion removed the overlying rocks and exposed the underlying core of the granitic batholith. Eroded material was transported westward and filled the present-day Central Valley with deposits that are tens of thousands of feet thick. About 15 million years ago, the relief of the Sierra Nevada in the Yosemite region had gently rolling upland topography and a much lower elevation than the present-day range. The Merced River flowed westward at a gentle gradient through a broad river valley. Volcanic activity, prevalent in the northern Sierra Nevada from about 38 to 10 million years ago, deposited ash, filled valleys, buried streams, and altered river courses.

Mountain-building activity was reactivated about 25 to 15 million years ago, uplifting and tilting the Sierra Nevada to form its relatively gentle western slope and the more dramatic, steep eastern slopes. The uplift increased the gradients of the rivers and resulted in deeply incised river valleys.

Between 3 million years ago and 2 million years ago, snow and ice accumulated as glaciers at the higher alpine elevations and began to move westward down the mountain valleys. At least three major glacial periods occurred during the ice age in the Sierra Nevada and are known as the Pre-Tahoe (oldest), the Tahoe (intermediate), and the Tioga (youngest). The downslope movement of the ice masses cut and sculpted the valleys, cirques, and other glacially formed landforms throughout the Yosemite region and the Sierra Nevada. The depositional and erosional glacial features viewed today in Yosemite are primarily the result of the Tioga event, though the cumulative effects of the previous glaciations are responsible for the overall shape and character of the region.

The Tioga was the last glaciation event and began as late as 60,000 years ago, when the climate cooled sufficiently to allow small glaciers to form on erosional features sculpted by earlier glaciers. Throughout this period in the Yosemite area, the ice field grew and pushed fingers of ice into the major drainages on the west slopes, until it reached its maximum extent about 20,000 years ago. The Tioga glacier extended westward as far as Bridalveil Meadow and, when it receded, left behind features such as erratics (boulders carried by glacial ice), glacial till (rock debris transported by glaciers), and moraines. The Tioga glacial event left the landscape scoured and small basins filled with silt and sediment (Huber 1989).

### *Bedrock of Yosemite*

Granitic and metamorphic rocks dominate Yosemite National Park, with the granitic rocks being most abundant and metamorphic rocks constituting less than 5% of the area in the park (Huber 1989). The metamorphic rocks represent the older rock that the granitic plutons intruded. Granitic rocks form from the cooling and solidification of molten rock in the earth's crust.

The granitic batholith of Yosemite National Park is not monolithic, but rather was formed through a series of intrusive events over a period of 130 million years. The separate episodes of intrusion and solidification formed more than 100 discrete plutonic masses, making up several granitic rock types. The particular type of granitic rock is distinguishable by the varying mineral composition, texture, and percentages of primary minerals. Granitic rocks in Yosemite National Park include granite, granodiorite, and tonalite (Bateman 1992). **Figure 9-1** presents a longitudinal profile along the main stem and south fork of the Merced River, showing the major granitic intrusive suites, as well as the areas of metamorphic bedrock underlying the river corridor (SCS 2007). **Figure 9-2** shows representative valley cross sections of four different locations along the river that have different valley shapes (including the U-shaped valley on the upper Merced River and the V-shaped canyon of the Merced River Gorge).

### *Segment 1: Merced River Above Nevada Fall — Geology*

The upper reaches of the main stem of the Merced River are dominated by the interaction of a wild river flowing through granitic landscapes. This glaciated canyon is narrow, with steep gradients in some areas, and wider in other areas where the river flows at a gradual slope and forms a floodplain.

This textbook example of a glacier-carved canyon has been identified as a feature of the geologic outstandingly remarkable value (ORV).

The width of the river valley can range from 960 feet in the narrower, steeper sections to 2,600 feet in the wider areas. The Bunnell Cascades is an example of steep gradient flow in a relatively steep canyon; the Merced River through Little Yosemite Valley exemplifies a river flowing on a wider floodplain.

***Segment 2: Yosemite Valley — Geology***

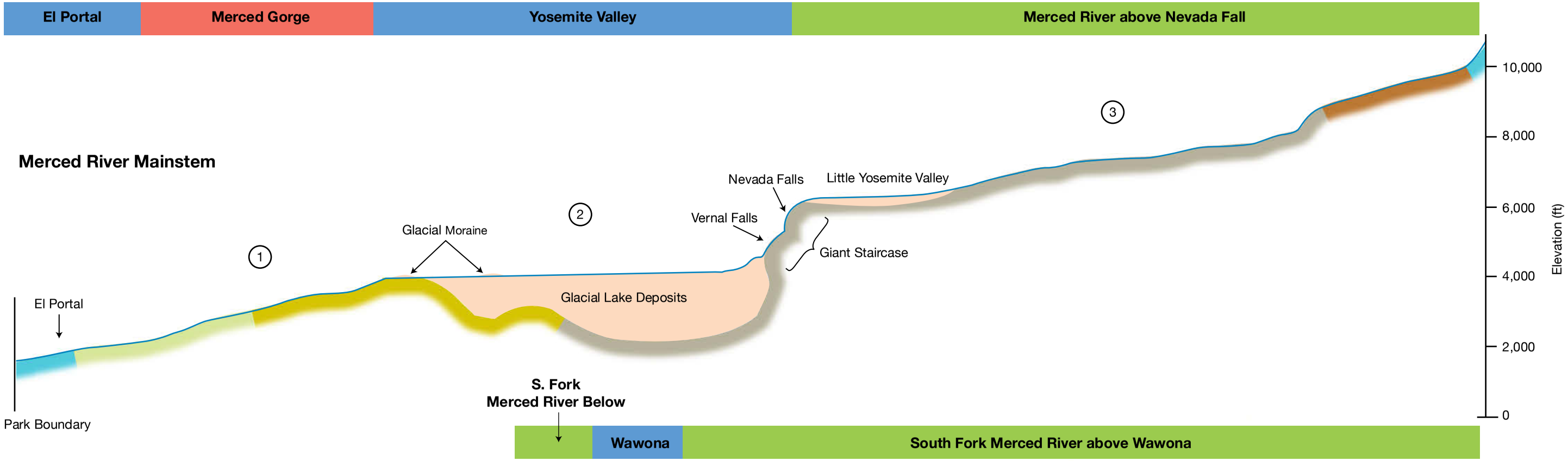
Yosemite Valley is primarily composed of granite and is glacially carved, with its floor ranging from 3,800 to 4,200 feet above sea level. The valley is oriented in an east-west direction, and its sides rise 1,500 feet to 4,000 feet above the essentially flat valley floor. Yosemite Valley — not including Tenaya Canyon or Little Yosemite Valley — is about 6.8 miles long and varies from a little under 0.5 mile wide to around 0.75 mile wide. The east valley branches into the Tenaya Canyon to the north and the Little Yosemite Valley to the south.

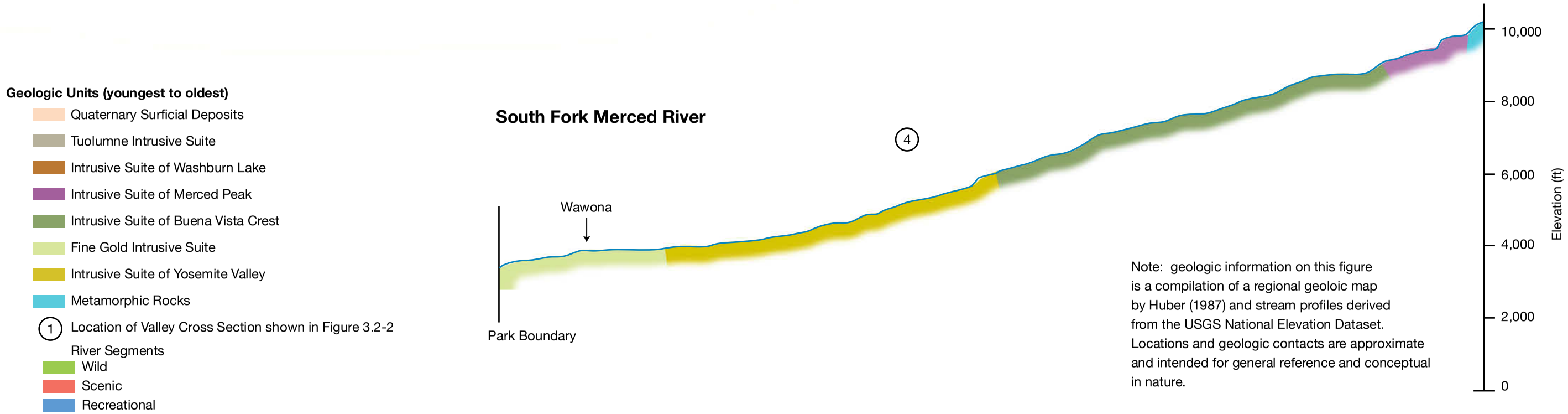
The downslope movement of the ice masses cut and sculpted the U-shaped valley that is present today (figure 9-2). Combined actions of these glaciers and local differences in the resistance of underlying granite rock to erosion resulted in the creation of what is known today as the Giant Staircase (figure 9-1). This geologic display includes the formations underlying Vernal Fall and Nevada Fall, and constitutes one of the finest examples of stair-step morphology in the country. Consequently, the Giant Staircase is considered one of the Merced River's geologic ORVs.

When glaciers melt, the rock debris they transport (till) is deposited in ridge-shaped landforms known as moraines. A *medial* moraine at the east end of Yosemite Valley was created when glaciers extending from Upper Merced and Tenaya canyons merged at the confluence of the two canyons. Two other prominent moraines were formed in Yosemite Valley after the last glacier (the Tioga) retreated about 15,000 years ago. A *terminal* moraine, marking the furthest extent of the glacier, lies just east of Bridalveil Meadow. The El Capitan moraine, lying further east, is a *recessional* moraine, formed after the leading edge of the glacier retreated up the valley from its farthest extent. The locations of these two moraines are shown in figure 9-1. After the last glacier melted, water flow dammed morainal material to form what is now referred to as the prehistoric Lake Yosemite (Matthes 1930). Stream deposits then filled in Lake Yosemite, adding to the 2,000-foot-thick sediment that underlies the present-day floor of Yosemite Valley and covers the glacially eroded granite rock below (Glazner and Stock 2010). The El Capitan recessional moraine has been identified as a feature of the geologic ORV.

***Segments 3 and 4: Merced Gorge and El Portal — Geology***

The Merced River Gorge begins at the west end of Yosemite Valley, where the gradient of the Merced River abruptly increases and the river enters the canyon. The gorge has remained an incised, V-shaped feature because the most recent glacial events did not extend down the Merced River beyond Yosemite Valley (figure 9-2). The granitic rocks in the Merced Gorge consist primarily of tonalite; the Bass Lake tonalite is the dominant bedrock feature. Among some of the oldest rocks found in the Sierra Nevada are those just east of and surrounding El Portal, in the walls of the Merced River canyon. These rocks are metamorphic and remnants of ancient sedimentary and volcanic rocks that




SOURCE: CDMG, 1962; Huber, 1987; USGS NED; USDA 2007

Merced River Comprehensive Management Plan and EIS

**Figure 9-1**

Schematic Longitudinal Profile and Bedrock Geology Along the Merced River Corridor

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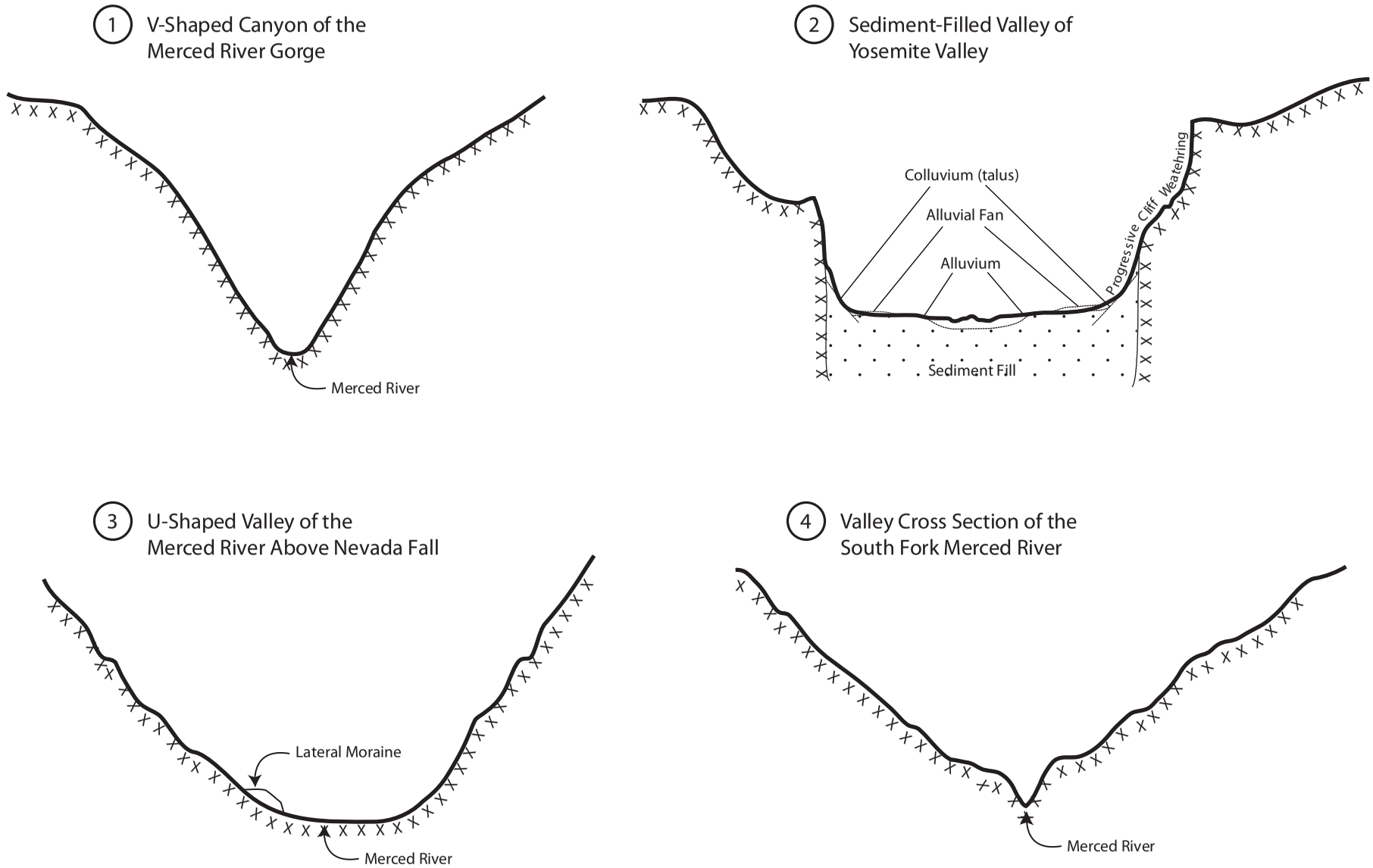


SOURCE: ESA; USGS NED

Merced River Comprehensive Management Plan and EIS

**Figure 9-2**

Representative Valley Cross Sections

were deformed and metamorphosed, in part by granitic intrusions (Huber 1989). This metamorphosed sedimentary rock (which includes banded chert) was once part of the ocean floor that covered the region about 200 million years ago (Huber 1989).

When the slope of river gradients get less steep, rivers lose the energy needed to transport large sediments and boulders. In such areas, bar-type deposits — such as the large boulder bar at the east end of El Portal — are built up. This rare boulder bar contains massive boulders measuring over a meter in diameter and weighing many tons. It is the combination of boulder availability, the steepness of the Merced River in the canyon, the major change in gradient and valley width at El Portal, and the size of the river's peak floods that enables the river to create such a boulder bar. This unique combination of factors has contributed to the boulder bar's designation a geologic ORV. As illustrated by the January 1997 flood, the Merced River continues to sort and build this bar, providing evidence in all seasons of the river's potential erosional and depositional ability.

#### *Segments 5, 6, 7, and 8: South Fork Merced River — Geology*

While there are no geologic ORVs or geologic management measures identified for Segments 5, 6, 7, or 8, a brief description of geology is nonetheless provided here for background. From its headwaters, the South Fork Merced River flows west at a relatively consistent gradient through a glaciated alpine environment and then enters a V-shaped, unglaciated river canyon below Wawona. Glaciation sculpted the upper reaches of the South Fork Merced River. Compared with the main stem, there is more variation of the bedrock regime along the South Fork Merced River. At the headwaters, the South Fork Merced River is in contact with metamorphic volcanic rocks, including ash flow deposits. As it flows westward, the South Fork Merced River contacts granitic rocks, metamorphic rocks near Gravelly Ford, and granite (similar to that found in Yosemite Valley) 8 miles east of Wawona. The geology west of Wawona in park boundaries is composed of the Fine Gold Intrusive Suite (i.e., granitic rocks). Wawona Dome, visible from the river, is an exfoliating granite dome with an elevation of approximately 6,900 feet above sea level. Upon entering Wawona, the South Fork Merced River cuts through the tonalite, a predominant granitic rock found along the southwest boundary of the park. The riverbed remains within tonalite, except for a short section underlain by metamorphic rocks near the park boundary. These rocks are among the oldest exposed along the South Fork Merced River.

### Geohazards

The Merced River flows through geologically active areas, where geologic and hydrologic forces continue to shape the landform. Geologic hazards associated with these forces, such as earthquakes and rock falls, present potentially harmful conditions to visitors, personnel, and facilities in Yosemite National Park.

#### *Regional Seismicity*

The Sierra Nevada range of Yosemite National Park is not considered an area of particularly high seismic activity. No active or potentially active faults have been identified in the mountain region of the park (CDMG 1997). However, Yosemite can undergo seismic shaking associated with earthquakes on fault zones on the east and west margins of the Sierra Nevada range, as it has done in the past.

These fault zones include the Foothills fault zone to the west, the volcanically active area in the Mono Craters-Long Valley Caldera area to the east, and the various faults in the Owens Valley fault zone, also to the east (CDMG 1996).

The Foothills fault zone, which includes the Melones Fault and Bear Mountain Fault, extends in a north-south direction in the foothills of the Sierra Nevada, approximately 30–50 miles west of Yosemite Valley. This fault zone has not experienced movement in the last 2 million years and thus is not considered active or potentially active (CDMG 1996).

The Mono Lake fault is located approximately 35 miles northeast of Yosemite Valley in the Mono Craters-Long Valley Caldera region. Since 1980, this area has experienced considerable seismic activity. Earthquakes have been attributed to movement on the Mono Lake fault (Sierra Nevada frontal fault) and movement associated with resurgent volcanic activity of the Long Valley Caldera. The Mono Craters last erupted 600 years ago. A 5.7-magnitude earthquake on the Mono Lake fault in October 1990 was felt as far west as Sacramento and the San Francisco Bay Area and caused landslides and rock falls at Tioga Pass and on the Big Oak Flat Road (McNutt et al. 1991). In September 2004, a swarm of earthquakes, with two greater than magnitude 5, occurred in the Adobe Hills north of Long Valley and just east of Mono Lake; the epicenter of the swarm is in the vicinity of the Hunton Valley fault system (CISN 2004).

The Owens Valley fault, located approximately 100 miles southeast of Yosemite Valley, has experienced movement in the last 200 years, and the California Geological Survey considers this fault active (CDMG 1997). The most notable earthquake felt in Yosemite National Park was the Owens Valley earthquake of March 26, 1872. The Owens Valley earthquake is estimated to have had a magnitude of 7.6 and was one of the largest earthquakes in U.S. history (Ellsworth 1990). This earthquake reportedly caused damage in the Sacramento and San Joaquin valleys and caused significant rock falls in Yosemite Valley (Wieczorek and Snyder 2004).

Although earthquakes that are felt by people in Yosemite National Park are relatively infrequent, they have occurred in the past and would likely occur in the future. Ground shaking typically is expressed in terms of peak ground acceleration as a percent of 1 g (g is acceleration due to gravity, or 980 centimeters — 32 feet — per second squared). The peak accelerations estimated in the Yosemite National Park region of the Sierra Nevada are between 0.1 and 0.2 g (CDMG 1999). Most people would likely feel this range of ground shaking, but structural damage would be negligible to slight in buildings constructed according to modern building standards.

***Rock fall***

Rock fall refers here to all slope movement processes, including rock fall, rockslide, debris slide, debris flow, debris slump, and earth slump. Rock falls that displace extremely large and catastrophic volumes of rock, referred to as rock avalanches, are rare events. Only six large rock avalanches— such as the prehistoric Mirror Lake and El Capitan rock avalanches discussed below — have occurred in Yosemite Valley in the past approximately 15,000 years (Wieczorek et al. 1998, 1999). However, many smaller rock falls occur yearly or seasonally, and can often go unnoticed when they occur far away from developed facilities in Yosemite NP (Wieczorek et al. 1998).

Rock falls can occur as a result of such processes as infiltration of water, the expansion and contraction of rock cause by diurnal and seasonal temperature variations, seismic shaking, or exfoliation. The processes cause concentric granitic plates, ranging in size from inches to several feet, to become dislodged from a granite cliff face. Many rock falls are associated with triggering events, such as earthquakes, rainstorms, or periods of warming that produce a rapid melting of snow. The magnitude and proximity of the earthquake, intensity and duration of the rainfall, and the thickness of the snowpack in relation to the pattern of warming all influence the triggering of rock falls. In a study of rock hazards, climatic factors (winter storms) were determined to be the most common trigger of rock fall (Wieczorak and Jaeger 1996). A more subtle trigger is the expansion and contraction that is caused by alternating freezing and thawing of water in the cracks of Yosemite's cliffs. This action weakens its structure and results in periodic rock falls. Rock falls that occur without a direct correlation to an obvious triggering event are probably associated with freeze/thaw action or the gradual stress release and exfoliation of the granitic rocks (Wieczorek et al. 1998).

Prehistoric Events. Rocks have become dislodged and fallen off the sheer granite cliffs throughout the geologic history of Yosemite. Evidence for past rock fall events in Yosemite can be traced back to the end of the last glaciation (Tioga). The retreat of the Tioga glacier left behind a Yosemite Valley that was relatively flat and free of talus, and provided for baseline conditions from which post-glacial rock falls could be measured (Stock et al. 2012b).[1] Over time, rock fall events ranging in size from small individual blocks of less than 1 cubic meter to rock avalanches of several million cubic meters resulted in abundant talus deposits at the base of almost all of the walls of Yosemite Valley. In some places, the extent of talus around the edge of the valley is estimated to be greater than 300 feet thick (Wieczorek and Jaeger 1996). Some of the larger prehistoric rock falls, such as the El Capitan and Mirror Lake rock avalanches, involved millions of cubic meters of rock and were sizable enough to have significantly altered the course of the Merced River (i.e., through full or partial damming of the river corridor). The El Capitan rock avalanche was so large that talus deposits extend more than 1,400 feet from the base of the wall across the valley floor.

Historic Events. One of the earliest historical descriptions of a rock fall event comes from famed writer and naturalist John Muir. Muir was in Yosemite Valley when the 1872 Owens Valley earthquake occurred:

> The Eagle Rock, a short distance up the valley, had given way, and I saw it falling in thousands of the great boulders I had been studying so long, pouring to the valley floor in a free curve luminous from friction, making a terribly sublime and beautiful spectacle—an arc of fire fifteen hundred feet span, as true in form and as steady as a rainbow, in the midst of stupendous roaring rock storm.

A database of historical rock fall and other slope movement events indicates that between 1857 and 2011, more than 910 events were recorded in Yosemite National Park (Stock et al. 2012a). A majority of these events were smaller, fragmental rock falls.

Current Frequency. The highest frequency of slope movements occur during the wetter and colder part of the year, mostly from November through April. Based on recent documentation (2006–2011),

[1] Talus refers to the accumulation of rock-fall generated boulders at the base of steep cliffs.

on average, approximately one rock fall occurs each week in Yosemite Valley, and a rock fall of approximately 10,000 cubic meters occurs each year (Stock et al. 2012b, Wieczorek 2002).

Hazards. Larger rock falls, though less common, may result in sudden wind gusts associated with large slabs of rock hitting the ground, which pose potential threats to human safety and possible property damage. Between 1857 and 2011, there were 15 fatalities and at least 85 injuries in Yosemite Valley from rock falls and other slope movement events (Stock et al. 2012b). Rock falls can also result in the damage and destruction of roads, trails, and buildings. Examples of such rock falls include the 1987 Middle Brother rock fall, the 1996 Happy Isles rock fall, the 1998–1999 Curry Village rock falls, and the 2008 Glacier Point rock falls. The 2008 Glacier Point rock fall, which represents Yosemite's most damaging historical event with regard to infrastructure, led the NPS to permanently close more than 200 buildings in the Curry Village area (Stock et al. 2012b).

***Segments 1 and 2: Merced River above Nevada Fall and Yosemite Valley — Geohazards***

Yosemite Valley is in the upper or middle portion of the canyon of the Merced River, which was deepened by several episodes of glacial erosion. The most recent Tioga glaciation extended east of Bridalveil Meadow, where the Merced River now meanders across the relatively flat valley. Except for large rock avalanches, the talus from rock fall and rockslide deposits seldom reaches the center of the valley. However, debris flows (which are very fluid in nature) can carry boulder debris far into the valley, even on moderately gentle slopes. Yosemite Valley narrows to the west of Bridalveil Meadow, and talus from rock falls and rockslides extends from the cliffs down to the banks of the Merced River.

Accumulating talus, ranging in size from small rocks to large boulders, forms slopes at the base of the sheer rock cliffs at the valley edge. The rock falls and associated talus slopes contribute to the natural topography and to the formation of soils on the valley floor. Rock falls from the sheer valley walls have, over time, created talus cones of debris spreading away from the edges of the cliffs. While the main mass of the rock falls have remained in the talus zone, air blasts and fly-rock (i.e., individual rocks and boulders projected further out from the main slide mass) have occasionally extended further into the center of the valley, causing one fatality, several serious injuries, and damage to park facilities (Wieczorek et al. 2000, Wieczorek et al. 2008).

To assess the risk of rock fall hazards in Yosemite Valley, Stock et al. (2012b) determined the likelihood of persons and/or structures being struck by boulders, including areas near the talus slopes and the adjacent outlying boulder zones. This rock-fall hazard zone is based on (1) observable, measurable evidence of previous rock falls in the form of the spatial distribution of outlying boulders; (2) the frequency of occurrence of outlying boulder deposition; and (3) simulated trajectories of potential future rock falls from computer modeling (Stock et al. 2012b). Stock et al. (2012b) used a statistical approach to develop a probabilistic rock-fall hazard line on the floor of Yosemite Valley. The line represents an approximately 1/500 annual exceedance probability, or put another way, an approximate 10% chance of a boulder going beyond the line in a 50-year period. In general, the limits of the rock-fall hazard zone (i.e., the 90th-percentile distances of outlying boulders) for the study regions range from 7 to 57 meters beyond the mapped base of talus slopes. The subsequent risk assessment focused on the inventory of buildings, structures, and other facilities, such as campsites, lodges, and amphitheaters, in the hazard zone where people congregate.

According to the risk assessment, following the 2008 closures of structures and lodging at Curry Village, the overall risk of casualties and structural damage from rock falls in Yosemite Valley was reduced by at least 87%. The 2008 closures in the Curry Village focused on areas determined to be at greatest risk at the time, but did not close all the visitor lodging and concessioner housing within the newly-established rock fall hazard line. Risks to people and structures from rock fall remains highest in Curry Village (including the concessioner residential area) which accounts for over half of the overall risk of casualties and structural damage from rock falls in Yosemite Valley. However, areas of significant risk also include (from greatest to least risk), (1) the tent cabins and campsites in the Camp 4 area, (2) the LeConte Memorial Lodge & Housekeeping Camp, and the (3) NPS housing and operations area in the northern portion of Yosemite Village.

In response to rock fall hazards, the NPS has developed the 2012 Yosemite Valley Geologic Hazard Guidelines with the intent of better protecting park visitors and staff by closing existing facilities under high risk and avoiding placement of new facilities in areas with a high potential for rock fall impact.

### *Segments 3 and 4: Merced Gorge and El Portal*

Significant incision of the Merced River has created the present-day relief of the canyon and a change of gradient of over 2,000 feet in just over 7 miles between Pohono Bridge to the park boundary. The canyon area has had many rock fall incidences, including rock falls that have occurred along El Portal Road. Of the 519 historical rock falls discussed above, most of the approximately 164 rock falls that did not occur in Yosemite Valley occurred in areas along El Portal Road in the Merced River Gorge (Stock et al. 2012a). The high incidence of rock falls is partly due to the steep, narrow configuration of the gorge, riverbank undercutting, and such historic human activity as the construction of El Portal Road. These events have been well documented (Wieczorek and Snyder 2004) and provide information regarding historic rockslide hazards along the Merced River Gorge and in areas where unstable rock slopes are known to pose a risk of future rock fall events. Rock-fall hazards are somewhat lower in the Merced River Canyon at El Portal compared to those in the Merced River Gorge, due to the generally lower angled slopes surrounding El Portal. Nevertheless, there are some areas of cliffs that are susceptible to rock fall events, especially on cliffs composed of highly fractured granitic and metamorphic rocks. Hazards associated with seismic groundshaking would affect El Portal in the same way they would the Merced River Gorge and elsewhere in Yosemite National Park.

### *Segments 5, 6, 7, and 8: South Fork Merced River — Geohazards*

As shown in figure 9-2, the South Fork Merced River, from the headwaters to the park boundary west of Wawona, is characterized by considerably less steep valley cross sections compared with the Merced River Gorge (Segment 3) and Yosemite Valley (Segment 2). Nevertheless, the primary geologic hazard present along these segments remains the threat of rock falls and debris flows or slides. Such hazards would be more likely close to steep slopes and could occur anywhere along the side-slopes of the Merced River corridor. Although less data has been collected regarding the occurrence of historic rock falls along the South Fork Merced River as compared with the main stem, given the similar underlying geology and less steep topography, the frequency and magnitude of slope failures is lower compared with the other river segments.

## Soils

All soils form as a result of the combined effect of several factors, including geologic parent material, climate, biologic activity, topographic position/relief, and time. In the park, topography is the most important factor contributing to soil differentiation. Topography influences surface runoff, groundwater, the distribution of stony soils, the separation of various-age alluvial soils, and the extent of glaciation, which exerts a first-order control on soil development and age (SCS 2007). More than 50 soil types are found in the park; general or local variations are the result of glacial history, microclimatic differences, and the ongoing influences of weathering and stream erosion/deposition (SCS 2007).

Soils of the Yosemite region are primarily derived from underlying granitic bedrock and are of similar chemical and mineralogical composition. Except for meadow soils, most soils above 6,000 feet are developed in glacial material (glacial soils) or developed in place from bedrock (residual soils). Glacial soils consist of a mixture of fine sand, glacial flour, and various-size pebbles and boulders (SCS 2007). Alluvial soils are developed along streams through erosion and deposition and tend to have sorted horizons of sandy material. Weathering processes break down talus to smaller-size particles that are then transported by water and eventually become deposited in alluvial fans or in stream channels. Various areas of Yosemite National Park have meadow soils consisting of accumulated clays, silts, and organic debris that are subjected to occasional flooding. Colluvial soils have developed along the edges of cliffs where landslides and rockslides have occurred and are composed of various-size rocks that have high rates of infiltration and permeability. The surface soil in Yosemite Valley, for instance, consists primarily of granitic sands in various stages of decomposition (SCS 2007).

Local moisture and drainage influence the organic content of the upper soil profile. Thick sedges and grasses have significantly contributed to the organic content of soils near ponds, lakes, and streams. Coniferous forest soils have a high organic content and are relatively acidic. Soils lacking organic accumulations are frequently a result of granitic weathering, consist largely of sand, and support only scattered plants tolerant of drought conditions (SCS 2007).

### *Segment 1: Merced River Above Nevada Fall – Soils*

Although soils in the upper main stem of the Merced River have not been examined in as much detail as those in the Yosemite Valley region, they are similar in chemical and mineralogical composition. Glacial history, weathering, fluvial process, and erosion contribute to the local variations in soil compositions. High country soils (excluding meadow soils) are typically glacial or residual, and alluvial soils can be found near streams. Glacial moraines and deposits cover areas above 6,000 feet.

### *Segment 2: Yosemite Valley — Soils*

Most of Yosemite Valley is an active floodplain of the Merced River. During Merced River flood events, alluvial soils are formed and removed as floodwaters deposit and erode material over the floodplain. The active flooding builds river terraces of fine- to coarse-textured sands. Old riverbeds of boulders and gravel may be buried under the terrace soils. Residual soils are scattered throughout Yosemite Valley where bedrock weathering has occurred. Glacial soils are associated principally with moraines. Colluvial soils have developed on the talus slopes along the edges of the valley floor. Valley

soil textures vary from fine sand to fine gravel. Most soils have a relatively undeveloped profile, indicating their relatively recent origin and young geologic age.

The Natural Resource Conservation Service identified 21 soil series/types in Yosemite Valley (SCS 2007). Each soil type has specific characteristics that influence plant growth, water movement, and land use capabilities, among other factors. Land use limitations are commonly associated with frequent flooding, a seasonally high water table, poor drainage, steep slopes, high rock concentration, and a poor soil structure. The El Capitan fine-sandy loam, found in and around El Capitan Meadow, is an example of a Yosemite Valley soil with physical constraints that limit land use due to occasional flooding.

***Segments 3 and 4: Merced Gorge and El Portal — Soils***

The soils in relatively flat potions of the Merced River Canyon at El Portal form from glacial and alluvial sediment deposition along the Merced River corridor, or from hillslope and colluvial deposition occurring locally near the base of canyon slopes near El Portal. The Merced Gorge, due to its narrow and steep shape, and the high energy flows of the Merced River, consists of boulders and cobbles, and generally does not support stable sedimentary deposits, or mature and fine-grained soils.

***Segments 5, 6, 7, and 8: South Fork Merced River — Soils***

Soils in the upper reaches of the South Fork Merced River are similar in chemical and mineralogical composition to those in the upper Merced River. Parent rock type, glacial history, weathering, fluvial process, and erosion contribute to the local variations in soil compositions. High country soils (excluding meadow soils) are typically glacial or residual, and alluvial soils typically form near streams.

Soils of the Wawona area are primarily residual on slopes and alluvial along the South Fork Merced River. Soil depth varies from 2 to 4 feet above bedrock; these soils are moderately to strongly acidic. The major soil types are mixtures of loam, sand, and silt, and are distinguished by the amount and type of rock fragments. Noted above, most soils are subject to erosion after disturbance or loss of vegetative cover. Such is the case at the Wawona Picnic Area and around the Wawona Campground, where heavy use along the South Fork Merced River is resulting in vegetation trampling and riverbank erosion.

## *Environmental Consequences Methodology*

The potential for impacts on geology and geologic features, including those identified as geologic/hydrologic ORVs, is considered negligible to nonexistent. Thus, impacts on geology and geologic features are not evaluated. This impact assessment considers the potential effects that geologic processes (i.e., geohazards) could have on visitors, employees, and facilities. It also considers the impact on sensitive soil resources (meadow and riparian soils).

Several assumptions regarding facility placement, geologic design parameters, and public safety were integrated into this assessment, as summarized below.

- Facility design would conform to the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2 only) and accepted building codes regarding seismic design parameters (in all segments).

- The potential for adverse impacts on life and property resulting from geologic hazards will always be present in Yosemite National Park.

- In the event of a rock fall, the NPS could close the affected area to protect visitor and employee safety. Rocks on roads would be removed, but rock fall talus in rivers would not be removed unless the talus dammed the river and flooding threatened utilities or facilities.

Potential impacts of each alternative are evaluated in terms of the context, intensity, and duration, as well as whether the impacts were considered beneficial or adverse with regard to soils, or public or facility safety.

- **Context.** The context of the impact considers whether the impact would be local, segmentwide, parkwide, or regional. For the purposes of this analysis, local impacts would be those that occur in a specific area in a designated segment of the river (i.e., 1–8). This analysis will further identify whether there are local impacts in multiple segments. Segmentwide impacts would consist of a number of local impacts in a single segment, or larger scale impacts that would affect the segment as a whole. Parkwide impacts would extend beyond the river corridor and the project area in Yosemite National Park. Regional impacts would extend to the Sierra Nevada as a whole.

- **Intensity.** The intensity of the impact considers whether the impact would be negligible, minor, moderate, or major.

  - ***Seismic Hazards and Rock falls***. Negligible impacts were effects considered not detectable and would have no discernible effect on park facilities or public safety. Minor impacts were those that would be present but not expected to have an overall effect on park facilities or public safety. Moderate impacts would be clearly detectable, and could have an appreciable effect on park facilities or public safety. Major impacts would have a highly noticeable influence on park facilities or public safety. The intensity of impacts for each alternative with respect to geohazards is determined relative to the existing levels of risk.

  - ***Soil Resources***. Impacts on soil resources consider the effects of park visitation and stock use (i.e., soil compaction and trampling) on a soil's function, integrity, and ability to support native plant growth. Mapping of compacted soils, bare ground, informal trails, and evidence of pack stock use, which was performed by the NPS (2011) and Cardno Entrix (2011), was used as the basis for identifying the intensity of existing impacts on soil resources. These studies focused on meadow and riparian soils considered most sensitive to human disturbance and compaction. In assessing impact intensities, it was assumed that Alternative 1 would result in the same or slightly greater impacts relative to existing conditions because park visitation is expected to continue at existing levels; and permits, quotas, and group size limitations for recreational activities would remain unchanged.

    In this analysis, negligible adverse impacts were identified in areas where human visitation and pack stock use occur, but where there would be no evidence of reduced soil function and where soils would continue to appear in their natural condition. Minor adverse impacts were identified in areas where informal trails and/or bare ground

(readily attributable to footprints, trampled ground, grazing, and/or hoof prints) would be present, but would consist of small patches or segments confined to the immediate periphery of developed facilities or formal trails. Moderate adverse impacts were identified in areas where informal trails and/or areas of bare ground would have appreciable and readily noticeable effects on soil quality and function. Informal trails would be long or networked and would physically segment sensitive soils. Evidence of pack stock use would be readily observable and fairly widespread. Major adverse impacts would occur in areas where intense visitation, pack stock use, grading, or excavation would cause large and contiguous areas underlain by sensitive soils to be permanently and irrevocably damaged. Beneficial impacts were identified where current or past adverse impacts on soils would be reversed or restored. For example, if existing conditions represent a minor adverse impact, reversal or restoration of that condition would represent a minor beneficial impact.

Actions involving new or reconfigured parking areas, utilities and transportation infrastructure, and/or visitor lodging and employee housing would also affect soil conditions. The intensity of impacts of such actions on soil resources would depend on the magnitude and extent of soil disturbance/excavation along with the degree of sensitivity of the soils being disturbed. Impacts would be negligible or minor where soils have been previously disturbed, compacted, paved over, or used as fill. Impacts would be moderate or major (depending on magnitude and extent of disturbance) where soils have not been previously disturbed and that currently support native vegetation.

- **Duration.** The duration of the impact considers whether the impact would occur in the short term or the long term. A short-term impact would be temporary in duration and would be associated with transitional types of impacts. A long-term impact would have a permanent effect on public safety and soil resources.

- **Type of Impact.** Impacts were evaluated in terms of whether they would be beneficial or adverse to soils in the Merced River corridor or on the impact of geologic processes with regard to public or facility safety. Beneficial impacts would limit the exposure of people and property to the potential effects from rock falls or earthquakes, or would restore currently affected soils to more natural conditions. Adverse impacts would be those that present an increased public or facility exposure to potential rock fall events and/or damage resulting from earthquakes or cause further harm to or damage soils.

## *Environmental Consequences of Alternative 1 (No Action)*

### All River Segments

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Continuation of current management would result in trampled vegetation and soil erosion and compaction in areas of high or concentrated visitor use, particularly those located outside of formal trails. These include informal trails throughout Yosemite Valley meadows, informal trails leading to archeological sites, and informal trails adjacent to scenic vista points. Continued Merced River access would result in increased erosion, removal of vegetation, and decreased soil stability. Fluvial mechanics resulting in bank erosion and loss of bank soil would also continue due to the presence of

riprap on riverbanks and infrastructure in the river channel. Riverbanks covered by riprap or otherwise armored, while locally protecting the soils from fluvial erosion, can often result in increased erosion downstream by changing the location and velocity of erosive flows. The intensity of impacts on soils from visitor use and administrative activities would vary widely based on location, the type/intensity of visitor and administrative activities, and individual soil characteristics. All segments (1–8) would have some degree of impacts on soils, ranging from negligible to moderate (see individual segment descriptions below).

***Impacts of Actions to Manage User Capacity, Land Use, and Facilities***

**Geohazards.** Under Alternative 1 (No Action), the potential for adverse impacts on visitors and park facilities from unstable rock slopes and seismic events would not change. Mass movement from unstable rock slopes would continue to result in periodic, though unpredictable rock falls and/or debris flows. In addition, seismic risks of injury to visitors and damage to facilities would occur in the developed portions of Yosemite National Park, such as Yosemite Valley, El Portal, and Wawona. In these areas, buildings and other facilities placed in saturated alluvial soil (e.g., in the floodplain of the Merced River) could be susceptible to secondary hazards from seismic groundshaking, such as liquefaction and seismically induced settlement. Earthquakes in the Sierra Nevada region would continue to expose visitors to injury in unstable buildings or to hazards caused by seismically triggered mass movement from rock slopes. These geologic hazards would continue to expose visitors and facilities to potential injury and/or damage, especially in established rock-fall hazard zones. Along the Merced River, rock falls can occur in the upper Wilderness reaches (Segment 1), along the edges of Yosemite Valley (Segment 2), in the Merced River Gorge (Segment 3) and in El Portal (Segment 4). Existing levels of public and facility exposure to geologic hazards along the South Fork Merced River (i.e., Segments 5, 6, 7, and 8) are somewhat less pronounced because hill slopes are less steep and because the level of visitor/recreational use is lower. Emergency preparedness systems, developed to respond to natural disasters in areas of heavy visitor use, would remain in place.

As discussed in the affected environment section, rock fall represents the greatest geologic hazard for visitors and facilities in Yosemite National Park, having caused about a dozen deaths, several dozen injuries, and periodic damage to roads and structures. Public risks to geologic hazards depend on numerous factors, such as where the future probably of rock fall is highest relative to where visitor serving, concessioner, and administrative facilities are located. For most segments (Segment 1, 3, 5, 6 and 8), Alternative 1 (No Action) would not appreciably increase or decrease exposure of visitors and facilities to existing levels of risk from geohazards because 1) type and severity of geologic hazards and associated risk to people and structures would remain the same, 2) levels of visitation would continue to be similar, and 3) no new visitor or administrative facilities would be constructed in hazardous areas. Therefore, Alternative 1 would result in segment-wide negligible long-term impacts with respect to geohazards.

However, implementation of the 2012 Yosemite Valley Geologic Hazard Guidelines and certain actions to manage user capacity, land use, and facilities within Segment 2, Segment 4, and Segment 7 would locally reduce existing levels of public exposure to geologic hazards (these are discussed below under the segment specific analyses).

**Soils.** Under Alternative 1, areas of high or concentrated visitor use would continue to be used at the same or similar levels, resulting in continued impacts on soil resources. Current use of well-developed and well-traveled areas in the park would continue to cause erosion and compaction. Areas of bare soil, compacted earth, and informal trail networks are likely to remain at the same locations and level of severity (as described segment by segment, below).

### Segment 1: Merced River Above Nevada Fall

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Soils are relatively intact in Segment 1, with several exceptions listed below. Most impacts on soils in Segment 1 are associated with soil compaction connected to foot traffic and pack stock use. Some meadow soils appear to be recovering from the effects of high levels of grazing. The NPS restricted pack stock grazing at several meadows east of Merced Lake in the 1990s, and the meadows exhibit signs that levels of bare ground are recovering to natural conditions. Long-term monitoring could substantiate the trends at these meadows. See Figure 8-7 and Figure 8-8 for maps identifying the meadows in Segment 1.

There are informal and formal maintained trails in the Merced Lake meadow (1.6 kilometers of informal trails), meadows around the Triple Peak Fork area, wetlands near Echo Valley and Merced Lake shore, and mineral springs between Merced Lake and Washburn Lake (Ballenger and Acree 2011). The Merced Lake meadow also contains areas of bare soils caused by visitor activities. Informal trails compact soils and fragment meadow habitat, and areas of bare soil preclude establishment of meadow habitat.

Administrative stock use have resulted in extensive trampled and grazed areas, manure, and roll pits in the meadow and surrounding forest at the Merced Lake East Meadow. In general, pack stock trampling can lead to a variety of negative effects, including reduction in vegetation cover, increases in bare soil, and changes in species composition, soil compaction, and impacts on stream morphology (Cole et al. 2004). Site-specific studies in this meadow found lower vegetation cover and higher bare-ground levels when compared with other subalpine meadows (Ballenger and Acree 2011). In 2011, the NPS enacted temporary "prototype management measures" at the site, which require packers to bring in feed to this site and discontinue grazing in the meadow. These measures are not part of a formal policy, and under Alternative 1, they are not guaranteed to continue in the future.

Meadow impacts associated with soil compaction would continue under Alternative 1, and comprehensive ecological restoration would not take place. Meadow soils in meadows east of Merced Lake, where pack stock grazing was discontinued in the 1990s, would continue to recover from the effects of high levels of pack stock grazing. There would be local, long-term, minor, beneficial impacts on soil resources at these meadows. Local, long-term, minor, adverse impacts to soil resources would continue at the extensive network of informal trails in the Merced Lake meadow, meadows around the Triple Peak Fork area, wetlands near Echo Valley and Merced Lake shore, the mineral springs between Merced Lake and Washburn Lake, and at Merced Lake East Meadow.

In a segmentwide context, soils are generally in their natural condition due to the absence of park facilities and the generally low level and intensity of visitor- and administrative-use impacts. On a segmentwide level, Alternative 1 would have long-term, minor adverse impacts on soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** The same kinds and amounts of use that exist today would be accommodated in Segment 1. For the same reasons described above, on a segmentwide level, Alternative 1 would have long-term, minor, adverse impacts on soil resources.

**Segment 1 Impact Summary:** Ongoing park resource management efforts would continue to have local, long-term, minor, beneficial impacts on Segment 1. On a segmentwide and local level, there would be long-term, minor, adverse impacts to soil resources due to the extensive network of informal trails at several discrete locations. Visitor use patterns would continue to result in segment-wide, long-term, minor, adverse impacts.

### Segment 2: Yosemite Valley

*Impacts of Actions to Protect and Enhance River Values*

**Soils.** Under Alternative 1, accelerated riverbank erosion and soil compaction would continue to occur, particularly between Clark's Bridge and Sentinel Bridge and areas easily accessible from adjacent roads. This includes concentrated visitor access areas, such as near Lower Pines and North Pines campgrounds, Housekeeping Camp, Swinging Bridge, Sentinel Beach, El Capitan, and Cathedral Beach picnic areas. Erosion would continue to occur in areas upstream and downstream of bridges (including Clark's Bridge, Stoneman Bridge, Housekeeping Bridge, Sentinel Bridge, El Capitan Bridge, and Pohono Bridge), and around some meander bends (Cardno Entrix 2011).

Under Alternative 1, current informal trails would remain in many of the Valley's meadows. Existing levels of bare ground (as exhibited in study plots) would remain or increase in meadows, with El Capitan and Sentinel meadows exhibiting the highest levels of bare ground (Cardno Entrix 2011). Cook's and Stoneman meadows (with boardwalks) would continue to have the lowest levels of bare ground (Cardno Entrix 2011). The stock trail directly below Happy Isles Bridge, directly adjacent to the Merced River, would continue to erode sediment into the river. However, under Alternative 1, the NPS would continue ecological restoration projects in several Yosemite Valley meadows and on the riverbank in certain places (per the settlement agreement). Specifically, the NPS would proceed with restoration projects at Bridalveil, Cook's, and El Capitan meadows, as well as riverbank restoration at North Pines Campground. These restoration projects would result in local, long-term, minor to moderate, beneficial impacts on soil resources. However, in other areas where restoration projects would not occur under Alternative 1 (e.g., Sentinel Meadow), there would continue to be local, long-term, minor to moderate, adverse impacts on soil resources via trampling and the existence of informal trails.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards:** NPS and its contractors would continue to conduct site-specific geologic analyses prior to the construction of buildings and other facilities to determine potential soil instability. Although rock fall and earthquakes are unavoidable, the NPS would continue to avoid locating facilities in areas with a relatively high risk of rock fall or other geologic events. In accordance with the 2012 Yosemite Valley Geologic Hazard Guidelines, no new facilities would be placed in the established rock fall hazard zone within the valley, and a number of existing structures under high rock fall risk in Curry Village will be closed, relocated, or repurposed. As part of the newly adopted policy, approved actions to be taken by the NPS include elimination or reduction of occupancy in five dormitories (housing concessioner employees) and five cabins (ten visitor lodging units), as well as the relocation of approximately 20 tent cabins outside the rock fall hazard zone.

Implementation of these guidelines under Alternative 1 (No Action) would reduce the overall rock fall hazard risk in Yosemite Valley by 95% compared to 2007 levels. This represents a greater reduction of risk than that of the Curry Village closures that have already occurred as a result of the 2008 Glacier Point Rock fall (that action reduced risk by 87 percent). For these reasons, Alternative 1 would result in local, long term, moderate, beneficial impacts with respect to exposure of park visitors to geohazards.

**Soils.** No new structures or facilities would be constructed under Alternative 1. Use levels and the day-to-day management of natural resources would generally continue as under existing conditions. Exceptions would be the *East Yosemite Valley Utilities Improvement Plan/EA* and the Wahhoga Indian Cultural Center, which are projects that would continue to cause local, short-term, minor, adverse impacts to soils during the construction phase. Camping areas, visitor facilities, formal parking, lodging, and employee housing would continue to be occupied at the same or similar levels and operated/managed in a similar manner. Informal parking could potentially increase. The NPS removed several facilities following the 1997 flood, leaving remnant fill soils. These sites include the Yosemite Lodge Former Cabins without Baths and the Upper River and Lower River campgrounds. Remnant fill soils and compacted soils would remain, precluding natural floodplain processes and riparian and meadow vegetation recruitment.

Overall, the presence of disturbed ground, construction-related fills, and the general coverage and density of developed facilities would continue to result in a segmentwide, long-term, moderate, adverse impact on soil resources.

**Segment 2 Impact Summary:** Implementation of the 2012 Yosemite Valley Geologic Hazard Guidelines and associated visitor use and facilities actions would result in local, long-term, moderate, beneficial impacts with respect to geohazards. Visitor use patterns and facilities would continue to have local and segmentwide, long-term, minor to moderate, adverse impacts on soil resources.

### Segments 3 and 4: Merced Gorge and El Portal

*Impacts of Actions to Protect and Enhance River Values*

**Soils.** At the Cascade Picnic Area in Segment 3, there is abandoned infrastructure including a picnic table-sized concrete block, surface concrete, asphalt and 1-2' base material (rock). Under Alternative 1, this concrete, asphalt and rock fill would continue to redirect/impede high river flows, and would continue to preclude development of a natural soil regime in that small area. In Segment 2, vehicles park under the drip line of valley oak trees in El Portal. This practice results in compacted soil under the trees, affecting root health, water uptake, and soil aeration. Under Alternative 1, development and soil compaction from vehicles and foot traffic in the vicinity would continue to limit recruitment of oak seedlings. The presence of abandoned infrastructure and informal parking under valley oak trees would continue to cause highly localized, long-term, minor, adverse impact in Segments 3 and 4. These minor impacts do not rise to the level of a segmentwide adverse impact because they are not consistent along the entirety of Segments 3 and 4.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards:** NPS and its contractors would continue to conduct site-specific geologic analyses prior to the construction of buildings and other facilities to determine potential soil instability. Although rock fall and earthquakes are unavoidable, the NPS would continue to avoid locating facilities in areas with a relatively high risk of rock fall or other geologic events. However, existing facilities in El Portal will remain at risk of damage in the unlikely event of a large earthquake, or in the event of a rockfall or landslide. Because the existing risk to visitors and facilities in El Portal from geohazards would remain unchanged under the No Action Alternative, Alternative 1 would result in no impact with respect to exposure of park visitors to geohazards.

**Segments 3 & 4 Impact Summary:** The parking of vehicles under the drip lines of valley oak trees within Segment 4 would continue to have a local, long-term, minor, adverse impact on soils supporting valley oak trees.

### Segments 5, 6, 7 and 8: South Fork Merced River

*Impacts of Actions to Protect and Enhance River Values*

**Soils.** Continuing impacts to soil resources from informal trailing, physical soil disturbance, and accelerated riverbank erosion would be concentrated in several discrete areas along the South Fork Merced River, including the Wawona Town Center, the Wawona Impoundment, the Wawona Campground and picnic area, and several cultural resource sites. In the town center, stresses to soil resources would continue to occur at the Wawona Hotel, golf course, and the Wawona store picnic area during periods of peak visitation because a lack of formal access points result in the loss of riparian vegetation, social trailing, and riverbank erosion. In addition, maintenance and usage of the Wawona Hotel causes impacts from construction, structures, roads, foot traffic (on and off paths), parking, utilities, and landscaping. The picnic area is adjacent to a moderately steep riverbank and river access at this point causes riparian vegetation trampling and minor erosion. In addition at the

Wawona Campground, minor riverbank erosion is present, and septic tanks and leach fields may be locally contaminating soils when their capacity is exceeded. These impacts are pronounced but highly localized, and continuation of current management is unlikely to substantially worsen the situation. Therefore, impacts (primarily due to continuing use/operation of the golf course, are considered local, long-term, moderate and adverse.

**Segments 5-8 Impact Summary:** Visitor use patterns would continue to result in local, long-term, minor, adverse erosion and soil resource impacts on Segment 7.

### Summary of Alternative 1 (No Action) Impacts

The NPS would adopt the 2012 Yosemite Valley Geologic Hazard Guidelines, reducing the hazard and risk to facilities in Segment 2, which would involve actions that in combination with the Curry Village closures from 2008, would reduce the risk to structures by about 95% compared to 2007 levels. Considering the unpredictable and unavoidable nature of rock fall and earthquakes and the history of their occurrence in Yosemite, there may continue to be parkwide, long-term, moderate, adverse impacts to public safety and facilities from geohazards. However, Alternative 1 would locally and incrementally decrease rock fall hazard risks in Yosemite Valley through implementation of the Geologic Hazard Guidelines.

Local, long-term, minor to moderate, adverse impacts on soil resources would continue in several areas in the park, including areas of concentrated riverbank use in Segment 2, as well as sensitive meadow soils in Segments 1 and 2. There would be a parkwide, long-term, minor, adverse impacts on soil resources because the moderate adverse soil impacts that have been identified are limited to specific areas (local), and are not otherwise continuous or widespread.

### Cumulative Impacts of Alternative 1 (No Action)

The discussion of cumulative impacts on geological resources is based on analysis of past, present, and reasonably foreseeable actions in the Yosemite region, in combination with the potential effects of Alternative 1. The projects identified below include only those projects that could affect geological resources in or in the vicinity of the Merced River corridor.

#### *Past Actions*

Past actions have resulted in a range of beneficial and adverse impacts on soils.

Beneficial impacts from past actions include improved soil conditions from habitat restoration and prevention of erosion around structures from removal of large wood. Substantial benefits to soils in the Merced River corridor have also occurred through implementation of management plans that limit or end grazing, concentrate visitor impacts to designated areas, and trail and roadway maintenance and rehabilitation actions that reduce the severity of soil erosion. Specific examples of past projects include the following:

- ***Restoration***: Cascades Housing Removal (including associated restoration work), Cook's Meadow Ecological Restoration, Fern Springs Restoration, Happy Isles Dam Removal, Happy

Isles Fen Habitat Restoration Project, Merced River Ecological Restoration at Eagle Creek Project

- ***Management and Planning*:** *South Fork and Merced Wild and Scenic River Implementation Plan* (BLM and US Forest Service 1991)

- ***Rehabilitation of Trails and Roadways*:** El Portal Road Improvement Project, Reconstructing Critically Eroded Sections of El Portal Road, Happy Isles to Vernal Fall Trail Reconstruction, Lower Yosemite Fall Project, Red Peak Pass Trail Rehabilitation, Yosemite Valley Loop Road Rehabilitation, Wawona Road Rehabilitation Project

Adverse impacts from past actions include increased exposure of visitors and employees to geohazards (rock falls and seismic events) from facility development, such as hotels, visitor centers, campgrounds, bridges, roads, maintenance structures, and utilities. Facility development also has contributed to adverse impacts on soil resources (compaction, soil removal, soil erosion, and construction-related fill). Specific examples of past projects include Curry Village Employee Housing; Curry Village Huff House Temporary Housing; Curry Village Temporary Guest Showerhouse; Yosemite Valley Ahwahnee Temporary Employee Housing; and the South Entrance Exit Lane Project.

***Present Actions***

Present actions contribute to similar beneficial and adverse impacts, as described for past actions, above.

Beneficial impacts from present actions are similar to those discussed for past actions. Specific examples of present projects include the following:

- ***Restoration*:** General Ecological Restoration

- ***Management and Planning*:** *Vegetation Management Plan*

- ***Rehabilitation of Trails and Roadways*:** Tioga Road Rehabilitations

- ***Rock fall Avoidance and Stabilization*:** Curry Village Rock-fall Hazard Zone Structures Project

Adverse impacts from present development actions are similar to those discussed for past actions. Specific examples of present projects include the following:

- ***Facility Development*:** Crane Flat Utilities, *East Yosemite Valley Utilities Improvement Plan/EA*, Wahhoga Indian Cultural Center, Parkwide Communication Data Network, NatureBridge Environmental Education Campus

***Reasonably Foreseeable Future Actions***

Reasonably foreseeable future actions would also have beneficial and adverse impacts.

Beneficial impacts from future actions are similar to those discussed for past and present actions. In addition, future actions include seismic upgrades and stabilization projects that would reduce the risk of harm from seismic events. Specific examples of future projects include the following:

- ***Rehabilitation of Trails and Roadways*:** Concessioner Parking Lot Restoration Project

Future management and planning activities may have both beneficial and adverse effects. For example, management plans may have beneficial impacts on soils from limiting access or designating areas for ecological restoration. However, management plans may also increase facility development based on visitor demand and growing population, which could have adverse impacts on soils or result in development in areas susceptible to rock falls. The NPS would continue its policy of avoiding placement of new structures in rock-fall hazard zones in Segment 2, as discussed in further detail in the 2012 Yosemite Valley Geologic Hazard Guidelines. In addition, removing closed/abandoned structures from rock fall hazard zones, as is being done under the Curry Village Rock-fall Hazard Zone Structures Project, would discourage uncontrolled visitor use of the hazardous area, thereby reducing rock fall hazard risks for park visitors. An example of a reasonably foreseeable management plan includes the *Yosemite Wilderness Stewardship Plan/EIS*.

#### *Overall Cumulative Impact*

Past and present projects and management plans that include the existence and maintenance of facilities in rock-fall hazard areas, when considered with Alternative 1, would still expose park visitors and employees to injury and damage from earthquakes and rock falls which is a parkwide, long-term, moderate, adverse impact. Continued stabilization and rehabilitation work, and policy restrictions from development in rock-fall hazard zones in Segment 2, would provide some local, long-term, moderate, beneficial impacts.

Cumulatively, a combination of adverse and beneficial impacts on soil resources would occur under Alternative 1. The net effect of these projects is difficult to anticipate, but would likely result in an overall balance between beneficial and adverse impacts. This balance of impacts would be considered a parkwide, long-term, negligible, adverse, cumulative effect.

## *Environmental Consequences to Actions Common to Alternatives 2–6*

### All River Segments

#### *Impacts of Actions to Protect and Enhance River Values*

**GeoHazards.** Biological resource actions include removing and restoring informal trails, and directing the public onto established trails and Merced River access points. In the long-term, these actions would result in a slight reduction in the geographic dispersal of visitors, because a greater number of visitors would be directed to established trails and river access points, and because informal trails would no longer be available for use following their removal and restoration. These actions would be performed primarily outside of the rock-fall hazard zone and would not involve installation or relocation of habitable structures. While the geographic distribution of public visitation to the park

may become less dispersed and more concentrated in established park facilities and along established trails, the type and level of public exposure to geohazards would remain similar to existing conditions. These ecological restoration actions would result in long-term, parkwide, negligible, adverse impacts on the public and park facilities from geohazards.

**Soils.** In the short-term, both biological resource actions (discussed for geohazards) and hydrologic/geologic resource actions (removing abandoned infrastructure and riprap in the floodplain) involve earth-moving activities that would include grading, excavation, and soil stockpiling. Without mitigation, these activities could result in localized, short-term, minor, adverse impacts on soil resources by temporarily increasing their erosion potential (from wind or rainwater runoff). Implementation of soil and stormwater management mitigation measures MM-GEO-1 and -2, and MM-HYD-1 (see Appendix C), would reduce the short-term impacts of restoration actions on soil resources, and result in local, short-term, negligible, adverse impacts on soil resources. Short-term restoration impacts on soils would be the same for Segments 1–8 under Alternatives 2–6; therefore, the restoration soil impact analysis for Alternatives 2–6 only describe the long-term impacts of restoration actions on soil resources.

In the long-term, both biological resource actions and hydrologic/geologic resource actions common to Segments 1–8 under Alternatives 2–6 would decompact and revegetate soils along informal trails, restore meadow habitat, remove abandoned infrastructure and riprap in the floodplain, stabilize riverbanks by using bioengineering techniques, and restore riparian vegetation. In addition, measures to direct the public onto established trails and existing Merced River access points would be implemented, thereby reducing the dispersal of the public in natural areas. These actions would result in a slight increase in foot traffic along established trails, while allowing soils along informal trails, in meadows, and along the floodplain in the park to recover their natural function and support native vegetation. Moreover, actions aimed at restoring the natural hydrology of the Merced River would result in reduced riverbank erosion and increased channel complexity through strategic placement of large wood. Removal of hardened banks (e.g., riprap, abandoned utilities, bridge footings) would promote stream channel complexity and restore natural processes.

In the local areas where these actions would be performed, they would have long-term, moderate, beneficial impacts on soil resources. In segmentwide and parkwide contexts, these actions would have a long-term, minor, beneficial impact on soil resources.

**Hydrologic/Geologic Resource Actions.** Specific projects to protect and enhance the river's hydrologic and geologic values that would occur across all segments under Alternatives 2-6 include removing 3,400 feet of riprap from the river bank and revegetating with riparian species, and replacing an additional 2,300 feet of riprap with bioengineered riverbank stabilization devices. Short term impacts of ecological restoration are discussed above. After earth-moving activities, these projects would result in reduced riverbank erosion and increased channel complexity. In the local areas where these actions would be performed, they would have long-term, moderate, beneficial impacts on soil resources. In segmentwide and parkwide contexts, these actions would have a long-term, minor, beneficial impact on soil resources.

### Segment 1: Merced River Above Nevada Fall

*Impacts of Actions to Protect and Enhance River Values*

**Soils.** Restoration actions would 1) relocate sections of trail through wetland in Echo Valley and mineral spring outflow between Merced Lake and Washburn Lake to less sensitive areas, 2) harden the trail along the wet sections of the Mist Trail to avoid trail widening, and 3) prevent trail creep along the John Muir Trail using fencing and boardwalks. Actions would also remove informal trails through sensitive high-elevation meadow habitat, reroute or install boardwalks for trails that fragment and incise high-elevation meadow habitat, and maintain trails adjacent to sensitive vegetation communities. These actions would reduce localized stresses on the soil resources present at high-elevation meadows and sensitive vegetation communities by reducing the level of soil trampling, and rerouting and/or maintaining trails in a manner that would discourage continuing visitor use impacts on soil resources. These actions would result in localized long-term, moderate, beneficial impacts on soil resources in high-elevation meadows and sensitive vegetation communities. In a segmentwide context, these actions would have a long-term, minor, beneficial impact on soil resources.

**Segment 1 Impact Summary**: Actions to protect and enhance river values within Segment 1 would result in a local, long-term, minor, beneficial impact on soil resources.

### Segment 2: Yosemite Valley

*Impacts of Actions to Protect and Enhance River Values*

**Soils**. Restoration actions in Segment 2 would, generally, restore meadow habitat, improve Merced River hydrology, restore the bed and banks of the river, and restore vegetation. These actions would allow soils to recover to their natural function (through decompaction and revegetation), reduce the potential for scour along the riverbanks, restore hydrologic processes, and protect bank soils from erosion.

Meadow and vegetation restoration actions would improve meadows currently disconnected from the floodplain by installing wide box culverts and formalizing or removing parking, removing unnecessary or abandoned infrastructure from meadows and riparian areas, removing old fills, decompacting soils and informal trails, and revegetating of areas formerly denuded of vegetation. These actions would allow soils to recover to their natural function (through decompaction and revegetation), and would also reduce the erosion susceptibility of soils in localized areas because flow paths would be less restricted.

The actions described above would, in many areas, allow soils to recover from past disturbances and would allow natural riverine and meadow processes to resume without interference from past and present human alterations. Soil compaction resulting from heavy visitor use would be further concentrated in areas that are already highly compacted or in resilient areas less sensitive to disturbance (e.g., boardwalks, paved trails, sandy beaches). Meadow and vegetation restoration actions listed above would, in combination, remove and restore 6 miles of informal trails in Yosemite Valley. The restoration actions associated with biological, riparian, and meadow values listed above would, at a minimum, seek to restore approximately 42 acres of meadow and riparian habitat.

However, implementation of the aforementioned restoration actions would not totally avoid adverse impacts on soil resources in Yosemite Valley. Restoration actions would generally redirect park visitors to fewer but formal trails and access points. As a result, crowded conditions during periods of peak visitation in the park may worsen. This would result in minor incremental increases in soil compaction on already compacted and denuded areas along formal trails. In addition, under such conditions, park visitors may be increasingly likely to disregard park rules, fencing and signage, and seek out alternative routes to popular destinations. During periods of peak visitation, it is uncertain whether long-term efforts to redirect park visitors away from informal trails would be fully successful. Nevertheless, even if partially successful, the restoration actions would largely result in a substantial reduction in the stressors adversely affecting soil type and quality in the Valley. Restoration actions would result in local, long-term, moderate, beneficial impacts on soil resources in Segment 2. In a segmentwide context, these restoration actions would result in long-term, minor, beneficial impacts on soil resources.

**Biological Resource Actions.** Specific projects to protect and enhance the river's biological values that would occur within Segment 2 under Alternatives 2-6 include: restoring 4.5 acres of riparian habitat in the area of Yosemite Lodge and 20 acres in the area of the Former Lower Pines Loop Campground; restoring impacted areas of Ahwahnee Meadow including through removal of tennis courts; formalizing areas for parking and river access along El Portal Road, between the intersection of Big Oak Flat road and Pohono Bridge; improving access and infrastructure at Cathedral Beach, Housekeeping Camp, and Bridalveil; constructing a boardwalk extension to reduce Sentinel Meadow trampling; fencing and vegetation management at Stoneman Meadow; relocation of parking from Devil's Elbow; and filling ditches not serving current operational need. These actions would reduce erosion and allow soils to recover to their natural functions which would result in a long-term, local, moderate, beneficial impact to soils.

**Hydrologic/Geologic Resource Actions.** Project specific actions include placing constructed logjams in the channel between Clarks and Sentinel Bridges; and removing the abandoned gauging station at Pohono Bridge, removing the footings and former river gauge base at Happy Isles, and restoring these areas to natural conditions. After construction, these projects would result in reduced riverbank erosion, increased channel complexity, reduced scour, and improved vegetative recruitment. In the local areas where these actions would be performed, they would have long-term, moderate, beneficial impacts on soil resources.

**Cultural Resource Actions.** Cultural resource actions common to Alternatives 2-6 would include rehabilitation of informal trails and parking in the vicinity rock art and rock shelters near Bridalveil Falls, fencing and/or restricting access to the archeologically significant large bedrock mortar (pounding rock) around Yosemite Falls Trail, restoration of impacted portions of Ahwahnee Meadow, and removal of abandoned infrastructure from the Bridalveil sewer plant to enhance oak recruitment. These actions would have local, long-term, negligible to minor, beneficial impacts with respect to geohazards and soil resources because the areas have already been impacted by visitor activities (i.e., vegetation removal and soil compaction), and involve no new structures within a rock fall hazard zone.

**Scenic Resource Actions.** Specific projects to protect and enhance the river's scenic values that would occur within Segment 2 under Alternatives 2-6 include: selective thinning of conifers and other vegetation in the vicinities of The Ahwahnee and Meadow, Bridalveil Falls and West Valley, Cooks and

Sentinel Meadows, Curry Village, El Capitan, Housekeeping Camp, Yosemite Lodge, and other areas of the Valley; restoring grassland and oak habitat in the areas of Bridalveil Straight; repairing riverbank erosion at Clark's Bridge; and addressing informal trails and trampling at the east end of El Capitan Meadow. These actions would restore natural meadow, riparian, and grassland habitat and soil functions, and therefore result in local, long-term, negligible, beneficial impacts on soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Facilities actions in Yosemite Valley would relocate, remove, repurpose, and retain a number of existing facilities. Construction of new facilities, if required for facilities that are relocated or removed, would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can reasonably be anticipated in the region. Further, facilities to be relocated would not be relocated into the rock-fall hazard zone, in keeping with the 2012 Yosemite Valley Geologic Hazard Guidelines. Facilities actions would result in a segmentwide, long-term, negligible, adverse impact with respect to geohazards.

Transportation actions all involve the circulation patterns of the general public along roadways, in parking lots, and shuttle stops. These actions would have minimal, if any, consequences with respect to public exposure to geohazards, including rock fall. While the Wilderness parking area is in the rock-fall hazard zone, transportation actions would formalize the area and apply sound design principles to the installation of proper drainage, but would not increase the size or capacity of the parking area. The transportation actions would not result in the construction of new facilities or actions that would increase the level of risk or exposure to geohazards. Transportation actions would result in a segmentwide, long-term, negligible, adverse impact with respect to geohazards.

**Soils.** Programmatic actions to manage user capacity, land use, and facilities common to all alternatives in Yosemite Valley would primarily occur in the East Valley campgrounds, the Curry Village area, and the Yosemite Lodge Area (e.g., Camp 4). The actions would involve:

- permanent removal of structures, including temporary employee housing (about 118 cabins) at Huff House and an old gas station at Camp 4,
- construction of 16 new dormitory-style buildings to provide permanent housing for 164 employees in Curry Village (to replace the cabins at Huff House),
- construction of 51 new campsites (35 at Camp 4 and 16 at Yosemite Backpackers Camp),
- construction of a new 41-space parking lot for the Camp 4 campground, and a new 25-space overflow parking lot on the south side of Northside Drive, and
- several actions to redesign high visitor use areas (e.g., Bridalveil Fall area), formalize visitor access, parking areas and shuttle stops (e.g., wilderness parking area, El Capitan area, Bridalveil Fall area, and Camp 4).

Construction, removal, demolition, and/or replacement of structures, pathways, parking areas and shuttle stops in all cases would locally cause short-term construction-related disturbances due to

excavation, grading, soil moving, and/or re-compaction. However, with several exceptions (discussed below) most of the disturbed areas would be within soils that have already experience disturbance through compaction, trampling, or development (roads, utilities and structures). In addition, for most of these projects, the NPS, as part of standard procedure, would require submittal of a Storm Water Pollution Prevention Plan, a Hazardous Materials Spill Prevention and Response Plan, and would require that NPS workers and/or its contractor(s) to incorporate standard resource protection measures prior to approval of any work for projects in the park, which are described under the project level analysis below (see Appendix C for a list of applicable mitigation measures).

In the Curry Village area, the facility actions would ultimately reduce the physical footprint used to accommodate employee housing because 16 new (higher-density) dormitories would be built to replace about 118 cabins (providing the space necessary for restoration actions). However, the physical footprint of both Camp 4 and the Backpackers Camp would be expanded substantially, and are likely to result in localized soil disturbances through trampling, compaction and installation of new camping facilities (pathways, bathrooms, bear boxes and tent pads) and parking lots. The new camping facilities would be located to avoid sensitive habitats (i.e., meadows) and soils, but would nevertheless cause soils to be permanently disturbed or experience stressors due to local increases visitor use levels (e.g., trampling and compaction). Following establishment of formal shuttle stops and removal of informal and overflow parking at the El Capitan, Bridalveil Fall and other areas, compacted soils in and around these high-use areas would be restored and in the future would experience fewer stressors as a result of heavy foot traffic from visitors entering and exiting vehicles.

Recreation actions would create an interpretive (nature) walk through Lower River Campground that emphasizes river-related natural processes, the park's ecological restoration work and what visitors can do to protect the Merced River. The interpretive walk would involve creation of a new, paved trail, which would have minor, adverse impacts on soil resources. The interpretive trail could have the indirect effect of encouraging visitors to stay on formal trails by raising awareness of the importance of preserving habitat. Improvement of wayfinding at Camp 6 and Happy Isles would help to prevent trampling. Recreation actions common to Alternatives 2–6 would locally disturb soils where the interpretive walk would be installed, but could indirectly result in beneficial impact on soil resources in Segment 2.

Depending on the location and type of action, actions to manage user capacity, land use, and facilities common to all alternatives would have both locally beneficial (where physical footprint of facilities would be reduced or where visitor management actions discourage trampling) as well as locally adverse impacts on soil resources (where actions would permanently disturb and/or remove native soils). Collectively, facilities actions common to Alternatives 2–6 would result in a segmentwide, long-term, minor, adverse impact on soil resources in Segment 2.

Transportation actions would involve formalizing shuttle stops and overflow parking that currently have impacts on sensitive communities (and, by extension, on the soils that support them); remediating the soils at the Wilderness parking lot; redesigning and formalizing existing parking to provide for proper drainage; and constructing new parking spaces. Current impacts on soil resources from overflow parking and informal shuttle stops are confined to peripheral areas in proximity to vehicle and shuttle parking locations. Following establishment of formal shuttle stops, compacted soil areas would be restored and in the future would experience fewer stressors as a result of heavy foot traffic from visitors entering and

exiting vehicles. Remediation of soils that are currently contaminated at the Wilderness parking lot would allow soils to be restored to their natural condition and support native vegetation. Formalizing and redesigning existing parking would reduce erosion by ensuring proper drainage design. New parking spaces would result in minor to moderate, adverse impacts on soil through compaction and paving, and the reduction in permeable surface area from parking spaces would increase erosion at the local level. Nevertheless, the transportation actions common to Alternatives 2–6 would in combination result in a segmentwide, long-term, minor, beneficial impact on soil resources.

**Camp 6 & Yosemite Village.** Actions in the Camp 6 and Yosemite Village areas that are common to Alternatives 2-6 involve: (1) the relocation of visitor vehicle services and concessioner general office functions to other buildings and the removal of the existing garage structure and concessioner general office; and (2) transportation actions that formalize parking and public movement in the Camp 6 and Village Sport Shop area. As part of these actions, informal parking along sentinel drive and several structures in the floodplain would be removed, thereby allowing underlying sensitive meadow soils to recover or be actively restored. These actions would have long-term beneficial impacts to soil resources as described above for actions to protect and enhance river values.

Building demolition and construction of transportation facilities in the Camp 6 area would involve the use of heavy machinery (e.g., tractors, heavy-duty trucks, and demolition equipment) and result in short-term local soil disturbances through soil compaction and mixing. The maximum amount of soil disturbance would vary by alternative, but in either of the cases would be at least 20 acres. Facility construction, demolition activities, and/or use of material and equipment staging areas could, in specific areas, result in the loss of soil function. However, most construction and demolition activities would occur in locations that are already developed, and use of undeveloped areas that have soils supporting native vegetation for purposes of construction-related parking, material and equipment staging, and/or construction/demolition activities would be avoided.

Further, the NPS, as part of standard procedure, would require submittal of a Storm Water Pollution Prevention Plan, a Hazardous Materials Spill Prevention and Response Plan, and would require that NPS workers and/or its contractor(s) to incorporate standard resource protection measures prior to approval of any work for projects in the park. Such measures include but are not limited to (1) fencing off or flagging sensitive areas and resources, (2) the inventory, salvage, and/or protection in place of native trees, shrubs, vines, grasses, and other native vegetative features, (3) persevering and stockpiling native topsoil for use in post-construction reclamation of temporarily disturbed areas, and (4) implementation of water quality management measures and hazardous materials spill prevention and response measures. Finally, work for projects on NPS land would not be allowed to proceed without demonstrating compliance with the following Federal and State permits, where applicable: (1) U.S. Army Corps of Engineers nationwide permits for activities affecting wetlands and waters of the U.S., (2) a technically-conditioned Certification issued by the California Regional Water Quality Control Board for construction-related activities affecting the Merced River, (3) the State Water Resources Control Board National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activities, and (4) the California Regional Water Quality Control Board Clean-Up and Abatement Order, No. 5 00-703, dated 2 August 2000, and a Time Schedule Order which directs Yosemite National Park to prevent discharges of untreated wastewater. See Appendix C for details of applicable mitigation measures.

For these reasons, actions common to Alternatives 2-6 in the Camp 6 and Yosemite Village areas would result in local, short-term, minor, adverse impacts on soil resources; but local, long-term, moderate, beneficial impacts through removal of infrastructure and parking from the meadow areas and floodplain.

**Yosemite Lodge & Camp 4.** Actions in the Yosemite Lodge and Camp 4 areas that are common to Alternatives 2-6 involve the removal of temporary employee housing and the reconstruction of new housing. Under all alternatives, the NPS Volunteer Office (former Wellness Center), post office, swimming pool, and snack stand would all be removed, and the convenience shop and nature shop would be re-purposed. While the ultimate magnitude and location of soil disturbance to occur as a result of the actions would be different than described above for the Camp 6 and Yosemite Village, the impact conclusion would be the same for the same reasons. The temporary soil disturbances as a result of facility construction and/or removal would be minimized by implementation NPS's standard procedures and compliance with the applicable Federal and State permits.

Actions common to Alternatives 2-6 in the Yosemite Lodge and Camp 4 areas would result in local, short-term, minor, adverse impacts on soil resources; but would have local, long-term, minor, adverse impacts through permanent disturbance of approximately 10 acres of previously undeveloped land.

**Segment 2 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1 through MM-HYD-5, as applicable (see Appendix C), actions to protect and enhance river values within Segment 2 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would also have long-term, local, negligible to minor, adverse impacts on soil resources; and local, long-term, negligible, adverse geohazards impacts.

### Segments 3 and 4: Merced Gorge and El Portal

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Restoration actions would involve developing best management practices for revetment construction and repair, and remove abandoned infrastructure from the floodplain. These actions would allow soils to recover to their natural condition and support native vegetation, and would also reduce erosion to the river channel by utilizing vertical retaining walls, instead of rip rap revetment, where possible. These actions would result in a net reduction in surface area taken up by pavement and compacted soils would be decompacted, allowing them to recover to their natural condition. Further, recontouring and revegetating the riparian buffer would improve hydrologic processes and reduce riverbank erosion. Parking located across Foresta Road at the El Portal NPS Maintenance and Administrative Complex would be formalized, maximized, and improved, allowing the informal parking area to be ecologically restored. Creation of a formal parking lot would result in short-term soil disturbance within an already impacted area; but overall, these actions would have a local, long-term, minor, beneficial impact on soil resources in Segments 3 and 4.

**Biological Resource Actions.** Project specific actions include removing development, asphalt, and imported fill from the Abbieville and Trailer Village areas and recontouring and revegetating the

150-foot riparian buffer. This action would allow soils to recover to their natural condition which would result in a local, long-term, minor, beneficial impact on soil resources.

**Hydrologic/Geologic Resource Actions.** Specific projects to protect and enhance the river's hydrologic and geologic resource values include restoring the Greenemeyer Sand Pit to natural conditions. This effort would help reestablish the site's natural soil character and function by removing fill materials and restoring the site's natural topography. The resulting impacts on soil resources would be local, long-term, minor, and beneficial.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Facilities actions would construct infill housing units in Old El Portal to address the removal of temporary housing in Yosemite Valley and build a restroom in Old El Portal. Construction of these facilities would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can be reasonably anticipated in the region. Facilities actions would result in a segmentwide, long-term, negligible, adverse impact with respect to geohazards in Segments 3 and 4.

**Soils.** Facilities actions involving the infill of new housing units and construction of a restroom facility would directly disturb soil resources in small discrete areas through installation and compaction, and could also lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the area affected would be small and localized, and the soils present in these areas are not particularly sensitive or unique (i.e., not in meadow or riparian areas). For these reasons, facilities actions would result in local, long-term, minor, adverse impacts on soil resources.

**Segments 3 & 4 Impact Summary:** With mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 3 & 4 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. Actions to manage user capacities, land use, and facilities would have long-term, local, minor, adverse impacts with respect to soil resources and geohazards.

### Segments 5, 6, 7 and 8: South Fork Merced River

*Impacts of Actions to Protect and Enhance River Values*

**Soils.** The park would improve Wawona Campground wastewater and refuse management and facilities, remove abandoned infrastructure, and undertake numerous site-specific management measures to counteract or minimize ongoing impacts on cultural resources. These actions would benefit soil resources by removing current stressors (e.g., parking and foot traffic) and restoring soil function (through decompaction and replanting). For these reasons, restoration actions would result in a local, long-term, minor, beneficial impact on soil resources.

**Biological Resource Actions.** Specific projects include delineating the picnic area near the Wawona Store and establishing a formal river access point and path. Hardened river-access points and the establishment of formal trails would directly affect soil processes through paving and compaction, and

would also potentially attract additional visitors to the riverbanks, which could lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the picnic area would be formalized and river access points and trails would be hardened to prevent vegetation impacts and river erosion by directing visitors away from informal trails and sensitive soils to more resilient areas. The resulting impact on soil resources would be local, long-term, minor and beneficial.

**Hydrologic/Geologic Resource Actions.** The park would address problems with the capacity of the existing leach field at the Wawona Campground by building a waste water collection system. A pump station above the Wawona Campground would be constructed to connect the facility to the existing waste water treatment plant. The new Wawona wastewater collection facilities would be built according to modern building codes. This action would have a segmentwide, negligible, adverse impact with respect to the exposure of people and park facilities to geohazards. The new Wawona wastewater collection facilities would directly disturb soil resources through facility installation and compaction, although soils in this area are neither sensitive nor unique (i.e., not in meadow or riparian areas).

**Cultural Resource Actions.** Specific projects including removal of seven campsites from the Wawona Campground would help restore soils to their natural condition which would result in local, long-term, moderate, beneficial impacts.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Facilities actions would build a new grounds maintenance facility, a wildland fire station, and a roads maintenance facility, and also rehabilitate the existing California Conservation Corps structure for potential re-use. Construction and rehabilitation of these structures would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can be reasonably anticipated in the region. Facilities actions would result in a segmentwide long-term, negligible, adverse impact with respect to geohazards in Segments 5, 6, 7, and 8.

**Soils.** Facilities actions would construct a new grounds maintenance facility, wildland fire station, and roads maintenance facility; replace restrooms next to the Wawona Store with larger restrooms; and remove staged materials, abandoned utilities, vehicles, and other items from portions of the Wawona maintenance yard that extend into the riverbank. New facilities would directly disturb soil resources in small, discrete areas through installation, compaction, and paving, and would also lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the area affected would be small and localized, and the soils present in the areas are not particularly sensitive or unique. The ecological restoration of the Wawona maintenance yard would restore the riparian buffer and native ecosystem adjacent to and in the riverbank. For these reasons, facilities actions would result in local, long-term, minor, adverse impacts on soil resources.

Recreation and transportation actions would remove roadside parking adjacent to the Wawona Store; increase the number of picnic benches adjacent to the Wawona Store; and install public recreational amenities, including a trail, restrooms, and waste disposal to facilitate and improve public access to the

Merced River at Wawona Swinging Bridge. The removal of roadside parking would decompact and improve soils conditions, while the installation of picnic benches adjacent to the Wawona Store could lead to further compaction of soils and greater susceptibility to erosion. The installation of public recreational amenities would directly disturb soil resources in small, discrete areas associated with facility installation, and may bring additional visitors to the riverbanks, which could lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the area affected would be small and localized, and the soils present in the area are not particularly sensitive or unique. Further, the establishment of a formal river access point would decrease erosion in the riverbank at a local level by directing visitors to hardened formal trails. For these reasons, recreation and transportation actions would result in local, long-term, minor, adverse impacts on soil resources.

**Wawona.** The redesign of a bus stop to accommodate visitor use would have local, long-term, negligible, adverse impacts on geohazards and soil resources as it would result in only a nominal (if any) increase in the developed area, and would not create new geohazards, or increase public risk or exposure to existing geohazards.

**Segments 5, 6, 7 and 8 Impact Summary:** With mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 5-8 would result in local, long-term, minor, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have local, long-term, minor adverse impacts on soil resources, and local, long-term, negligible, adverse, geohazards impacts.

### Summary of Impacts Common to Alternatives 2–6

In segmentwide and parkwide contexts, actions common to Alternatives 2–6 would result in long-term, negligible adverse impacts with respect to exposure of facilities and visitors to geohazards. Exposure to geohazards under Alternatives 2–6 is not completely avoidable, and park visitors, facilities, and workers would remain exposed to some level of risk from the adverse effects of rock fall and earthquakes, even if such risks are minimized through (1) implementation of proper building codes that ensure structures are designed to withstand the effects of an earthquake, and (2) the continuing practice of placing new or relocated park facilities outside of rock-fall hazard zones in Segment 2.

In addition, actions common to Alternatives 2–6 would result in short-term, minor, adverse impacts, and long-term, minor, beneficial impacts with respect to soil resources in both segmentwide and parkwide contexts. Soil excavations and disturbances associated with short-term construction activities for facility actions and interim disturbances necessary for restoration actions would briefly have minor adverse impacts on soil resources, provided mitigation measures MM-GEO-1 and 2, and MM-HYD-1 are implemented to minimize short-term soil erosion impacts to negligible.

In the long term, all restoration actions, numerous facility actions, and some transportation actions would have local, minor to moderate, beneficial effects on soil resources through decompaction and restoration of informal trails; removal of old fills, infrastructure, piping, and riprap in previously

developed campgrounds and riverbanks; meadow restoration; and potential public-access restrictions to allow natural processes to continue unimpeded.

The actions described above would result in a general reduction in the dispersal of park visitors; and may result in a greater density of people along formal trails and access points during periods of peak visitation. Nevertheless, public visitation to the park would continue to occur in the same general location, and therefore the type and level of public exposure to geohazards would remain similar. Under crowded conditions, fencing, signage, area closures, and informal trail removal might not fully eliminate continuing public impacts on soil resources outside of formal public access areas. The actions common to Alternatives 2–6 would nevertheless result in an appreciable reduction in current levels of adverse impacts on soil resources.

## *Environmental Consequences of Alternative 2: Self-reliant Visitor Experiences and Extensive Floodplain Restoration*

### All River Segments

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Visitor use management actions would implement a day-use reservation system that would require day use permits to enter the park and allow day use levels to be more closely managed. This visitor-use management measure would result in fewer daily park visitors and thus would decrease the overall exposure of park visitors to rock-fall hazards (13,900 visitors under Alternative 2 compared with 20,900 visitors under Alternative 1). These actions would result in parkwide, long-term, moderate beneficial impacts with respect to exposure of park visitors to geohazards.

**Soils.** Visitor-use management actions would implement a day-use parking permit system for the East Yosemite Valley. Management of day use in the park, especially during periods of peak visitation, may reduce the extent and severity of crowded conditions, and thus could result in less use of informal trails by visitors seeking alternative routes to popular destinations. However, the beneficial effects of the management action on soil resources would be difficult to quantify or distinguish from the beneficial effects of ecological restoration actions common to all alternatives and proposed under Alternative 2. Nevertheless, visitor use management actions would have a local, long-term, minor, beneficial impact on soil resources.

### Segment 1: Merced River Above Nevada Fall

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** The park would remove the Merced Lake East Meadow from grazing permanently and require all administrative pack stock passing through the Merced Lake Area to carry pellet feed. These actions would reduce overgrazing of the meadow, increase natural vegetative cover, and reduce potential erosion resulting from exposed soil. The resulting impact on soil resources would be local, long-term, negligible, and beneficial.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Overnight accommodation and restoration actions would convert Little Yosemite Valley camping area to dispersed camping and remove infrastructure, allow only limited dispersed camping at Merced Lake and remove supporting infrastructure, and discontinue designated camping at Moraine Dome and convert it to dispersed camping. The removal of minor structures would result in a local, long-term, negligible, beneficial impact with respect to visitor and facility exposure to geohazards.

**Soils.** In addition to those actions described for Geohazards, above, overnight accommodation actions would also reallocate Little Yosemite Valley zone capacity from 150 to 25 and trailhead quotas would be adjusted down, reducing the number of visitors. These actions together would have local, long-term, minor, beneficial impacts on soil resources by reducing the stresses on soils from visitor uses, overnight camping, and presence of infrastructure.

Pack stock used for administrative purposes would no longer graze on meadow vegetation near the Merced Lake Ranger Station. All administrative pack stock passing through the area would instead be required to carry pellet feed. This would help restore vegetative cover and reduce erosion potential. This would result in a local, long-term, negligible, beneficial impact on soil resources.

**Merced Lake High Sierra Camp.** Actions in the Merced Lake High Sierra Camp area proposed under Alternative 2 involve the conversion of the area to designated Wilderness, the closure of the Merced Lake High Sierra Camp, and the expansion of dispersed camping at Merced Lake Backpackers Camping Area into the High Sierra Camp footprint. These actions would not affect existing levels of public risk or exposure to geohazards, but would have a local, long-term, minor, beneficial impact on soil resources by reducing stresses on soils from visitor uses, overnight camping, and presence of infrastructure.

**Segment 1 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to manage user capacities, land use, and facilities within Segment 1 would result in a local, long-term, negligible, beneficial geohazard impact. These actions would also have a local, long-term, minor, beneficial impact on soil resources.

### Segment 2: Yosemite Valley

*Impacts of Actions to Protect and Enhance River Values*

**Soils.** Efforts to restore natural river processes that characterize low-gradient meandering river valleys, to enhance the free-flowing condition of the river, and to remove and decompact soils under former campgrounds would have beneficial effects on soil resources, particularly meadow soils, by removing past human alterations, restoring natural topographic contours, and allowing natural processes to operate unimpeded (e.g., seasonal meadow flooding). Restoration actions would result in the restoration of approximately 55 acres of meadow and riparian habitat, and 3,335 linear feet of roads and trails would be removed or relocated outside of the floodplain. Particularly where campsites and infrastructure in the floodplain would be removed, these local areas would experience substantial beneficial impacts with respect to soil resources, as these areas would be ecologically restored and soils

would begin to recover under continuing natural processes. Combined with the removal of informal trails (approximately 6 miles) and establishment of formal/resilient river access points, both of which are common to Alternatives 2-6, restoration actions associated with Segment 2 would result in local, long-term, moderate beneficial impacts with respect to soil resources. On a segmentwide level, impacts would be long-term, minor and beneficial.

**Biological Resource Actions.** Specific actions include rerouting trails at Ahwahnee Meadows; removing and restoring a portion of Northside Drive that bisects Ahwahnee Meadow (900 feet) and rerouting the bike path; removing 1,335 feet of Southside Drive that bisects Stoneman Meadow, re-alignment of the road, reconfiguring Curry Orchard parking lot, and extending the Stoneman Meadow boardwalk; removing development, asphalt, and fill material, and restoring 35.6 acres of floodplain at the former Upper and Lower River campgrounds; removing valley campsites and infrastructure from the 100-year floodplain and restoring 25.1 acres of floodplain and riparian habitat; and removing informal trails, reducing formal parking, and installing signage and fencing to redirect visitor traffic at El Capitan Meadow. The benefits of these actions are similar to those described above and include the restoration of soils to natural conditions. Restoration activities would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

**Hydrologic/Geologic Resource Actions.** Specific projects include relocating unimproved Camp 6 parking out of the 10-year floodplain and rerouting a portion of Northside Drive that bisects Ahwahnee Meadow; removing the Stoneman, Ahwahnee and Sugar Pine Bridges; and restoring these areas to natural conditions. These actions would improve soil conditions by removing asphalt and other imported materials and revegetating areas with native species, allowing soils to return to more natural conditions. Restoration activities would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Overnight accommodation and facility actions would affect the availability, location, and style of overnight accommodations in Yosemite Valley. In keeping with the 2012 Yosemite Valley Geologic Hazard Guidelines, no new campsites or lodging would be located in the rock-fall hazard zone. Tent and hard-sided cabins would be removed from floodplain and rock-fall hazard zones. These actions would avoid increased exposure of park visitors and facilities to rock fall and would reduce the number of structures subject to earthquake damage. Further, visitor-use management actions would result in a substantial reduction in both day and overnight visitors in the valley, and would lead to a general reduction in public exposure to rock fall events. Together, the overnight accommodation, visitor use management, and facilities actions would result in segmentwide, long-term, moderate, beneficial impacts with respect to exposure of park visitors and facilities to geohazards.

**Soils.** Facility actions would remove or reduce lodging and tent cabins in areas currently subject to natural hazards (including removal of tent cabins from the 100-year floodplain), remove existing buildings, construct new concessioner housing areas, and construct new parking spaces. The removal of buildings and tent cabins would improve soils conditions and allow for soils to support plant growth resulting in local, long-term, minor, beneficial impacts. New concessioner housing and parking would

directly affect soils through compaction and paving, and possibly increase pedestrian use of the area that would make soils more susceptible to erosion; thus, new facility development would result in local, long-term, minor, adverse impacts.

Transportation actions would construct, reroute, relocate, and formalize parking spaces. Construction of new parking spaces would directly affect soil resources in the area through installation, compaction, and paving. Parking spaces currently located in the 10-year floodplain would be removed and relocated, and soils beneath these areas would be restored to approximately their preconstruction condition. Relocated parking spaces would be equal or similar in size to current parking areas, would be designed and implemented to improve drainage and minimize runoff, and would not overlie sensitive or unique soils. Overall, parking spaces would be reduced in comparison to existing conditions and the use of informal overflow parking areas would reduced. Therefore, these actions would have a local, long-term, moderate, beneficial effect on soil resources.

Overnight accommodation actions would affect the availability, location, and style of overnight accommodations in Yosemite Valley, and would require an overall decrease in the number of overnight visitors. The overnight accommodation actions would generally result in a decrease in the number of substantial structures, since the total number of overnight accommodations would decrease, and new/relocated accommodations would be tent campsites. Further, several of the actions to manage user capacity, land use, and facilities would involve ecological restoration of disturbed or developed areas. The effects on soil resources of reducing overnight accommodations and restoring various areas would be beneficial because soil stresses (e.g., compaction and erosion) would be reduced with less visitor use, and restored areas would return soils to their preconstruction condition and allow them to support native vegetation. These actions would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

Visitor-use management actions would generally result in a substantial reduction in both day and overnight visitor use in the valley. These actions would result in a decreased potential for crowding and could reduce the level and intensity of informal trailing in the valley. These actions would have a segmentwide, long-term, minor, beneficial impact with respect to soil resources.

**Curry Village & Campgrounds.** Actions under Alternative 2 in Segment 2 include the construction of 78 hard-sided units at Boy's Town and the improvement of the Curry Orchard day-use parking area. In addition, campsites at the Lower, Upper, and North Pines Campgrounds would be removed from the Merced River floodplain (specific campground modifications are addressed in the context of actions to protect and enhance river values, above). Cabin construction at Boy's Town and the improvements planned for the Curry Orchard parking lot would require the use of heavy machinery (e.g., tractors, heavy-duty trucks, and demolition equipment) and result in local, short-term soil disturbances through soil compaction and mixing. Facility construction, demolition activities, and/or use of material and equipment staging areas could, in certain areas, result in the loss of soil function.

However, most construction and demolition activities would occur in locations that are already developed, and use of undeveloped areas that have soils supporting native vegetation would be avoided during construction. Nevertheless, it is estimated that the permanent disturbance area associated with these actions would amount to approximately 8.5 acres within the Curry Orchard

parking lot and Boy's Town. The three soil units mapped in this area are (1) the Happyisles-Half Dome complex, 5 to 15 percent slopes, mesic; (2) the Happyisles complex, 1 to 5 percent slopes, mesic; and (3) the Happyisles sandy loam, 0 to 3 percent slopes, somewhat poorly drained, mesic. These soil types typically support mixed conifers (i.e., ponderosa pine, incense cedar, and black oak) with an understory of grasses, shrubs, and ferns. These soils are relatively resilient to disturbance, especially compared to sensitive meadow soils. Much of the permanent disturbance area has already been subject to various levels of development and/or soil compaction due to the existing presence of structures, paved parking and roads, trails, and generally high levels of visitor and concessioner use. Like many of the actions involving permanent soil disturbances due to construction of new facilities, the local impacts would be more than offset by the beneficial impacts of actions to protect and enhance river values (discussed above). This is mostly because many of the actions involving construction of new facilities are for the purpose of accommodating or replacing the visitor-serving facilities, overnight accommodations, and infrastructure requiring removal under floodplain and meadow restoration actions.

Further, to address short-term construction-related impacts, the NPS, as part of standard procedure, would require submittal of a Storm Water Pollution Prevention Plan, a Hazardous Materials Spill Prevention and Response Plan, and would require that NPS workers and/or its contractor(s) to incorporate standard resource protection measures prior to approval of any work for projects in the park. Such measures include, but are not limited to: (1) fencing off or flagging sensitive areas and resources, (2) the inventory, salvage, and/or protection in place of native trees, shrubs, vines, grasses, and other vegetative features, (3) preserving and stockpiling native topsoil for use in post-construction reclamation of temporarily disturbed areas, and (4) implementation of water quality protection measures and hazardous materials spill prevention and response measures. Finally, projects NPS land would not be allowed to proceed without demonstrating compliance with the following Federal and State permits, where applicable: (1) U.S. Army Corps of Engineers nationwide permits for activities affecting wetlands and waters of the U.S., (2) a technically-conditioned Certification issued by the California Regional Water Quality Control Board for construction-related activities affecting the Merced River, (3) the State Water Resources Control Board National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activities, and (4) the California Regional Water Quality Control Board Clean-Up and Abatement Order, No. 5 00-703, dated 2 August 2000, and a Time Schedule Order which directs Yosemite National Park to prevent discharges of untreated wastewater.

For these reasons, actions under Alternative 2 in the Curry Village and Campgrounds areas would result in local, short-term, minor, adverse impacts on soil resources, but a local, long-term, minor, beneficial impact through removal of informal and paved parking areas and infrastructure from the meadow and floodplain.

**Camp 6 & Yosemite Village.** Actions under Alternative 2 in Segment 2 related to managing visitor use and facilities within the Camp 6 and Yosemite Village areas include removal of the Concessioner General Office, Concessioner Garage, Arts and Activities Center (former bank building), and repurpose of the Village Sport Shop as a visitor contact station; and measures to formalize and relocate parking facilities and Northside Drive outside the 10-year floodplain. The Camp 6/Village Center parking area would be formalized with 550 parking spaces by redeveloping part of the complex's existing footprint.

One hundred parking spaces would be added at Yosemite Village. Northside Drive would be rerouted south of the parking areas and outside of the 10-year floodplain. Fill material would be removed from the floodplain and the area's meadow and floodplain ecosystems would be restored. Relocation and construction of the parking areas and parts of Northside Drive that impact meadow areas would result in local, long-term, minor, adverse effects on soil resources, depending on site-specific conditions and project design.

Most construction and demolition activities would occur in locations that are already developed, and use of undeveloped areas that have soils supporting native vegetation would be avoided during construction. Nevertheless, it is estimated that the permanent disturbance area associated with these actions would amount to approximately 22 acres within the Camp 6/Village Center Parking Area. The three soil units mapped in this area are (1) the Happyisles complex, 1 to 5 percent slopes, mesic; (2) the Leidig fine sandy loam, 0 to 2 percent slopes, occasionally flooded, mesic; and (3) the Elcapitan fine sandy loam, 0 to 2 percent slopes, mesic. The Happyisles complex typically supports mixed conifers (i.e., ponderosa pine, incense cedar, and black oak) with an understory of grasses, shrubs, and ferns. The Leidig and Elcapitan soils are seasonally flooded and support a wide range in vegetation, from woodland to facultative hydrophytes with grasses and forbs as understory. The Leidig and Elcapitan soils are considered sensitive meadow/wetland soils; however, in this location have been disturbed by development and encroached upon by conifers. The Happyisles complex is relatively resilient to disturbance, especially compared to sensitive meadow soils.

Much of the permanent disturbance area has already been subject to various levels of disturbance and/or compaction due to the existing presence of structures, paved parking and roads, trails as well as generally high levels of visitor use. Like many of the actions involving permanent soil disturbances due to construction of new facilities, the localized impacts are more than offset by the beneficial impacts of actions to protect and enhance river values (discussed above). Further, to address short-term construction-related impacts, the NPS, as part of standard procedure, would require submittal of a Storm Water Pollution Prevention Plan, a Hazardous Materials Spill Prevention and Response Plan, and would require that NPS workers and/or its contractor(s) to incorporate standard resource protection measures prior to approval of any work for projects in the park. Such actions are more fully described above.

For these reasons, actions under Alternative 2 in the Camp 6 and Yosemite Village areas would result in local, short-term, minor, adverse impacts on soil resources, but a local, long-term, moderate, beneficial impact through relocation of park facilities to a greater distance from meadow areas and the Merced River floodplain.

**Yosemite Lodge & Camp 4.** Actions under Alternative 2 in Segment 2 related to managing visitor use and facilities within the Yosemite Lodge and Camp 4 areas include: (1) the conversion of Yosemite Lodge to a day-use facility and the addition of 250 parking spaces; (2) construction of a new comfort station; (3) redevelopment west of Yosemite Lodge to provide parking for additional 150 automobiles and 15 busses; (4) the conversion of Highland Court to a walk-in campground; and (5) the relocation of the pedestrian crossing at Northside Drive and Yosemite Lodge Drive to alleviate pedestrian/vehicle conflicts.

The type, level, and intensity of impacts to soil resources in this location are similar to those discussed above for the Curry Village area. The three soil units mapped in this area are (1) the Happyisles complex, 1 to 5 percent slopes, mesic; (2) the Leidig fine sandy loam, 0 to 2 percent slopes, occasionally flooded, mesic; and (3) the Elcapitan fine sandy loam, 0 to 2 percent slopes, mesic. Approximately 13 acres would experience permanent disturbance under this alternative. However, much like actions in the Curry Village area, the location of permanent disturbance would be within resilient soils and is, in most locations, already impacted by various levels of development, compaction, and visitor use.

For the same reasons discussed above for the Curry Village area, actions under Alternative 2 in the Yosemite Lodge and Camp 4 areas would result in local, short-term, minor, adverse impacts on soil resources, but a local, long-term, moderate, beneficial impact through relocation of park facilities farther from meadow areas and the Merced River floodplain.

**Segment 2 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 2 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would also have long-term, local, minor to moderate, beneficial impacts on soil resources, and a segmentwide, moderate, beneficial geohazards impact.

### Segments 3 and 4: Merced Gorge and El Portal

#### *Impacts of Actions to Protect and Enhance River Value*

**Soils.** Oak protection areas would be designated in the Odgers' fuel storage area and adjacent parking areas. Parking and new building construction would be prohibited within the dripline. A 2.25 acre oak recruitment area would be established near the fuel storage area, within which nonnative fill would be removed and decompacted, invasive species would be removed, and native understory plants would be planted. This action would benefit soil resources by removing current stressors (e.g., parking and foot traffic) and restoring soil function (through decompaction and replanting). This would have a long-term, local, moderate, beneficial impact on soils. In a segmentwide context, the actions would result in a minor, beneficial impact on soil resources.

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Facility, overnight accommodation, and transportation actions would install high-density housing units and campsites in Abbieville and Trailer Village, and Rancheria Flatt in El Portal. Construction of all new structures would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can be reasonably anticipated in the region. These actions would result in a long-term, local, negligible, adverse impact with respect to geohazards in Segments 3 and 4.

**Soils.** Overnight accommodation, transportation, and facility actions would install new campsites and high-density housing units in the Abbieville, El Portal Trailer Village, and Rancheria Flatt areas. The installation of these facilities would directly disturb soil resources in small discrete areas through installation, compaction, and paving, and would also lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the areas affected would be small and localized and, with regard to the former, the proposed facilities would be redeveloped within the existing footprint of the Abbieville and El Portal Trailer Village areas. Therefore, these actions would result in a long-term, local, minor, adverse impact on soil resources.

**Segments 3 & 4 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 3 & 4 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, adverse impacts on soil resources, and long-term, local, negligible, adverse geohazard impacts.

### Segments 5, 6, 7 and 8: South Fork Merced River

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Actions to protect and enhance river values include removal of the Wawona Golf Course. This action would allow soils to regrow vegetation and resume their natural function. The golf course represents a large and contiguous area where restoration would allow for native vegetation to return to the areas and is likely to result in significant benefits to both soil and water quality. The action would have a local, long-term, moderate beneficial impact on the soils in the floodplain.

**Biological Resource Actions**: Project specific actions include relocation of stock use campsites from a culturally sensitive area to Wawona Stables. This action would shift impacts associated with stock camping to an already disturbed area, resulting in a local, long-term, minor, beneficial impact.

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** Actions to manage user capacity, land use and facilities would eliminate stables and day rides from the Wawona stables, and relocate the stock use campground. Soil stresses (e.g., compaction and erosion) would be decreased due to the elimination of stable rides. These actions would have a local, long-term, minor, beneficial impact on soils in the Wawona area.

**Wawona Campground.** Facilities actions at the Wawona Campground would involve removal of 32 sites that are either within the 100-year floodplain or in culturally sensitive areas. Removal of campground infrastructure (such as bear boxes, sign posts, etc.) would temporarily cause a minor increase in soil disturbance; however, in the long-term these areas would recover from past visitor- and recreational-related stresses (such as continuing soil compaction at campsites and access roads). The areas in the floodplain would slowly recover to natural conditions under continuing natural processes. The overall long-term impact would be local, moderate, and beneficial.

**Segments 5, 6, 7 and 8 Impact Summary**: With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 5-8 would result in local, long-term, minor, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have local, long-term, minor-to-moderate beneficial impacts in specific areas. In a segmentwide context, these actions would have long-term, minor to moderate, beneficial impacts on soil resources.

### Summary of Impacts from Alternative 2: Self-Reliant Visitor Experiences and Extensive Floodplain Restoration

In segmentwide and parkwide contexts, Alternative 2 would result in long-term, minor to moderate, beneficial impacts with respect to exposure of facilities and visitors to geohazards. Adherence to applicable building codes (in all segments) and implementation of the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2) would ensure that new or relocated structures are designed to withstand an earthquake and are located outside of the rock-fall hazard zone. On a local level, such as the Curry Village area and Camp 4, Alternative 2 would result in long-term, moderate, beneficial impacts with respect to exposure of facilities and visitors to geohazards.

In addition, actions common to Alternatives 2–6 would result in short-term, minor, adverse impacts, and long–term, moderate, beneficial impacts with respect to soil resources in both segmentwide and parkwide contexts. Alternative 2 would generally result in a decrease in the level of park visitation and thus result in a general reduction in visitor impacts on soil resources from informal trailing and campground use and activities in sensitive floodplain areas, such as meadows and riparian zones. Visitors would be directed to formal routes and trails where soils are already paved, compacted, or otherwise affected. Also, the Wawona Golf Course would be removed and partially restored as a sprayfield for reclaimed water.

### Cumulative Impacts from Alternative 2: Self-Reliant Visitor Experiences and Extensive Floodplain Restoration

The relevant past, present and reasonably foreseeable future projects for the cumulative discussion are the same as those discussed for Alternative 1. Past and present projects and management plans, which include the existence and maintenance of facilities within rock fall hazard areas, when considered with Alternative 2, would still expose park visitors and employees to injury and damage from earthquakes and rock falls. Continued stabilization and rehabilitation work would reduce impacts in targeted areas, which would be a long-term, beneficial impact. Actions under Alternative 2 would adhere to applicable building codes (in all segments) and the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2 only). At a parkwide level, Alternative 2, in combination with past, present, and reasonably foreseeable future projects, would result in a negligible, adverse, cumulative effect with respect to exposure of park visitors and facilities to geohazards.

Cumulatively, a combination of adverse and beneficial impacts on soil resources would occur under Alternative 2. The net effect of these actions are difficult to anticipate, but would likely result in beneficial impacts (e.g., meadow/riparian restoration, removal of informal trails, directing of visitors away from sensitive areas) that would outweigh adverse impacts (which would generally be short term

or highly localized). Combined with the generally positive impacts of past, present, and reasonably foreseeable future projects, Alternatives 2 would result in a parkwide, minor to moderate, beneficial, cumulative impact.

## *Environmental Consequences of Alternative 3: Dispersed Visitor Experiences and Extensive Riverbank Restoration*

### All River Segments

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Visitor use levels under Alternative 3 would be less than those of Alternative 1 (13,200 visitors under Alternative 3 compared with 20,900 visitors under Alternative 2) and would decrease the overall exposure of park visitors to rock fall hazards under existing conditions. Therefore, these actions would result in parkwide, long-term, moderate beneficial impacts with respect to exposure of park visitors to geohazards.

**Soils.** Similarly, reduced visitation, especially during the peak season, may reduce the extent and severity of crowded conditions, and thus could result in less use of informal trails by visitors seeking alternative routes to popular destinations. Visitor use actions thus would have a local, long-term, minor, beneficial impact on soil resources.

### Segment 1: Merced River Above Nevada Fall

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** Overnight capacities for both Little Yosemite Valley and Merced Lake would be reduced under Alternative 3, thereby promoting dispersed camping. Concentrated camping areas would be converted to dispersed camping. This would reduce the potential for informal trails and vegetation trampling, thereby leading to improved soil character and integrity. As such, these actions would have a long-term, local, minor, beneficial impact on soil resources by resulting in a slight reduction in the stresses on soils from visitor uses, overnight camping, and presence of infrastructure.

Pack stock used for administrative purposes would graze on meadow vegetation near the Merced Lake Ranger Station in accordance with established grazing capacities. This would reduce overgrazing of the meadow, increase natural vegetative cover, and reduce potential erosion resulting from exposed soil. The resulting impact on soil resources would be local, long-term, negligible, and beneficial.

**Merced Lake High Sierra Camp.** Actions in the Merced Lake High Sierra Camp area proposed under Alternative 3 involve the conversion of the area to designated Wilderness, removal of all infrastructure from the Merced Lake High Sierra Camp, and use of the former camp area as a temporary stock camp. These actions would not affect existing levels of public risk or exposure to geohazards, but would have local, long-term, minor, beneficial impacts on soil resources by reducing stresses on soils from visitor uses and presence of infrastructure.

**Segment 1 Impact Summary: W**ith implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to manage user capacities, land use, and facilities within Segment 1 would result in local, long-term, minor, beneficial impact on soil resources.

**Segment 2: Yosemite Valley**

***Impacts of Actions to Protect and Enhance River Values***

**Soils**. Under Alternative 3, the Stoneman, Sugar Pine and Ahwahnee bridges and associated berms would be removed and restored to natural conditions. The multi-use trail on Sugar Pine and Ahwahnee bridges would be rerouted along the north bank of the Merced River. These sites would have reduced scour, more stable riverbanks, and improved vegetative recruitment. In the local areas where these actions would be performed, they would have long-term, moderate, beneficial impacts on soil resources.

Under Alternative 3, campsites and associated infrastructure located within 150 feet of the Merced River would be removed and restored to natural conditions. This would include campsites at Backpackers Camp, North Pines Campground, Upper Pines and Lower Pines campgrounds, and Yellow Pine Campgrounds. All tent-style lodging at Housekeeping Camp would be removed and the area would be repurposed as river access. Approximately 10.9 acres of riparian ecosystem would be restored at the site of the former Yosemite Lodge units and cabins (those that were damaged by the 1997 flood and subsequently removed). Methods for restoration would include recontouring, ditch removal, and decompaction.

Recontouring would involve use of a skid steer, loader, excavator, dozer, and dump truck to remove excavated material from the site. An excavator or dozer could be used to excavate depressions, cut-off channels, and oxbows. On steep riverbanks, an excavator or dozer could push soils and material down the slope of the bank to create a gentler slope, which would increase revegetation success. Whenever possible, native fill would be used from the restoration site. Where possible, ditches would be contoured and leveled using fill material already present in associated berms. Soil decompaction would involve breaking up soils either manually, by using special decompaction tools, or with heavy equipment that can support ripping tines, such as excavators, skid steer, and dozers. Small pockets of fill would at times be blended into the soil, as decompaction occurs, with an excavator or dozer with winged rippers. These actions would have a short-term, minor, adverse impact on soil resources due to the trampling of vegetation and compaction of soil by heavy equipment. After construction, restored areas would result in established vegetation that would be less likely to erode and improve soil function. The resulting impacts would be long-term, moderate, and beneficial.

Under Alternative 3, river access would be more formalized, leading to a reduction in streambank erosion and soil compaction. Visitors would be directed to more stable Merced River access points throughout the segment, and areas of compacted soils would be decompacted and restored. This would improve bank stability at river access points, thereby reducing erosion, though not to a measurable extent. This would result in a local, long-term, negligible, beneficial impact on soil resources.

**Biological Resource Actions.** Specific projects include rerouting trails at Ahwahnee Meadows; removing and restoring a portion of Northside Drive that bisects Ahwahnee Meadow (900 feet) and

rerouting the bike path; removing 1,335 feet of Southside Drive that bisects Stoneman Meadow, re-alignment of the road, reconfiguring Curry Orchard parking lot, and extending the Stoneman Meadow boardwalk; removing development, asphalt, and fill material, and restoring 35.6 acres of floodplain at the former Upper and Lower River campgrounds; removing valley campsites and infrastructure from within 150 feet of the river and restoring an additional 12 acres of riparian habitat; and removing informal trails and installing signage and fencing to redirect visitor traffic at El Capitan Meadow. The benefits of these actions include removal of past human alterations, soil decompaction, and restoration of natural topographic contours and soil function. As a result, these actions would have long-term, moderate, beneficial impacts with respect to soil resources.

**Hydrologic/Geologic Resource Actions.** Specific projects to protect and enhance the river's hydrologic and geologic values that would occur within Segment 2 under Alternative 3 include: relocating unimproved Camp 6 parking out of the 10-year floodplain; removing the Stoneman, Ahwahnee and Sugar Pine Bridges to enhance free-flowing condition; and restoring these areas to natural conditions. These actions would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** No new campsites or lodging would be located in the rock-fall hazard zone. Structures would be reduced since facilities would be removed from the valley, tent cabins would be removed from floodplain and rock-fall hazard zone. These actions would avoid increased exposure of park visitors and facilities to rock fall and would reduce the number of structures subject to earthquake damage. Further, visitor-use management actions would result in a substantial reduction in both day and overnight visitors in the valley, and would lead to a general reduction in public exposure to rock fall events. Together, the overnight accommodation, visitor use management, and facilities actions would result in segmentwide, long-term, moderate, beneficial impacts with respect to exposure of park visitors and facilities to geohazards.

**Soils.** Facility actions would remove or reduce lodging and tent cabins in areas currently subject to natural hazards (including removal of tent cabins from the 100-year floodplain), remove existing buildings, construct new concessioner housing areas, and construct new parking spaces. The removal of buildings and tent cabins would improve soils conditions and allow for soils to support plant growth resulting in local, long-term, minor, beneficial impacts. New concessioner housing and parking would directly affect soils through compaction and paving, and possibly increase pedestrian use of the area that would make soils more susceptible to erosion; thus, new facility development would result in local, long-term, minor, adverse impacts.

Transportation actions would construct, reroute, relocate, and formalize parking spaces. Construction of new parking spaces would directly affect soil resources in the area through installation, compaction, and paving. Parking spaces currently located in the 10-year floodplain would be removed and relocated, and soils beneath these areas would be restored to approximately their preconstruction condition. Relocated parking spaces would be equal or similar in size to current parking areas, would be designed and implemented to improve drainage and minimize runoff, and would not overlie sensitive or unique soils. Overall, parking spaces would be reduced in comparison to existing conditions and the use of informal

overflow parking areas would reduced. Therefore, these actions would have a local, long-term, moderate, beneficial effect on soil resources.

Overnight accommodation actions would affect the availability, location, and style of overnight accommodations in Yosemite Valley, and would require an overall decrease in the number of overnight visitors. The overnight accommodation actions would generally result in a decrease in the number of substantial structures, since the total number of overnight accommodations would decrease, and new/relocated accommodations would be tent campsites. Further, several of the actions to manage user capacity, land use, and facilities would involve ecological restoration of disturbed or developed areas. The effects on soil resources of reducing overnight accommodations and restoring various areas would be beneficial because soil stresses (e.g., compaction and erosion) would be reduced with less visitor use, and restored areas would return soils to their preconstruction condition and allow them to support native vegetation. These actions would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

Visitor-use management actions would generally result in a substantial reduction in both day and overnight visitor use in the valley. These actions would result in a decreased potential for crowding and could reduce the level and intensity of informal trailing in the valley. These actions would have a segmentwide, long-term, minor, beneficial impact with respect to soil resources.

**Curry Village & Campgrounds.** The park would retain 355 guest units at Curry Village. The park would remove campsites from Lower Pines (15), North Pines (34), and Upper Pines (2). In addition, the park would discontinue commercial day rides from the Curry Village Stables. These projects would permanently disturb approximately 8.5 acres of soils (Happyisles-Half Dome complex, Happyisles complex, and Happyisles sandy loam). As such, the specific projects proposed under Alternative 3 for the Curry Village and Campgrounds areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, minor, beneficial impacts through removal of informal and paved parking areas, and infrastructure from the meadow and floodplain.

**Camp 6 & Yosemite Village.** The park would reroute Northside Drive to the south of the Yosemite Village day-use parking area, reconfigure the lot to accommodate a total of 550 parking spaces north of the road, and install walkways leading to Yosemite Village. These projects would permanently disturb approximately 22 acres of soils (Happyisles complex, Leidig fine sandy loam, and Elcapitan fine sandy loam). As such, the specific projects proposed under Alternative 3 for the Camp 6 and Yosemite Village areas would result in short-term, minor adverse impacts on soil resources, but local, long-term, moderate, beneficial impacts through relocation of park facilities farther from meadow areas and the Merced River floodplain.

**Yosemite Lodge & Camp 4.** The park would move on-grade pedestrian crossing to west of the Northside Drive and Yosemite Lodge Drive, relocate the existing bus drop-off area to the Highland Court area to accommodate loading/unloading for 7 busses, and redevelop an area west of Yosemite Lodge to provide an additional parking for 150 automobiles and 15 tour busses. These projects would permanently disturb approximately 16 acres of soils (Happyisles complex). Specific projects proposed under Alternative 3 for the Yosemite Lodge and Camp 4 areas would result in local, short-term, minor, adverse impacts on soil resources, but long-term, minor, beneficial impacts through relocation of park

facilities to a greater distance from meadow areas and the Merced River floodplain and through consolidation of accommodations to fewer, less scattered locations.

**Segment 2 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 2 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would also have long-term, local, minor to moderate, beneficial impacts on soil resources; and long-term, segmentwide, moderate, beneficial geohazards impacts.

### Segments 3 and 4: Merced Gorge and El Portal

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Oak protection areas would be designated in the Odgers' fuel storage area and adjacent parking areas. Parking and new building construction would be prohibited within the dripline. A 2.25 acre oak recruitment area would be established near the fuel storage area, within which nonnative fill would be removed and decompacted, invasive species would be removed, and native understory plants would be planted. This action would benefit soil resources by removing current stressors (e.g., parking and foot traffic) and restoring soil function (through decompaction and replanting). This would have a long-term, local, moderate, beneficial impact on soils. In a segmentwide context, the actions would result in a minor, beneficial impact on soil resources.

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** High-density housing units would be constructed at Rancheria Flatt in El Portal. Construction of all new structures would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can be reasonably anticipated in the region. These actions would result in a long-term, local, negligible, adverse impact with respect to geohazards in Segments 3 and 4.

**Soils.** The installation of new housing at Rancheria Flatt would directly disturb soil resources in small discrete areas through installation, compaction, and paving, and would also lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the areas affected would be small and localized. Therefore, these actions would result in a long-term, local, minor, adverse impact on soil resources.

At Abbieville and El Portal Trailer Village, the park would remove or relocate existing housing and restore the floodplain. Sensitive soils along the floodplain would be restored to their preconstruction condition and would support native vegetation. These actions would have long-term, minor beneficial impact on soils at the local level.

**Segments 3 & 4 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within

Segment 4 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, adverse impacts on soil resources; long-term, local, negligible, adverse geohazard impacts.

### Segments 5, 6, 7, and 8: South Fork Merced River

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Actions to protect and enhance river values include removal of the Wawona Golf Course. This action would allow soils to regrow vegetation and resume their natural function. The golf course represents a large and contiguous area where restoration would allow for native vegetation to return to the areas and is likely to result in significant benefits to both soil and water quality. The action would have a local, long-term, moderate beneficial impact on the soils in the floodplain.

**Biological Resource Actions.** Project specific actions include relocation of stock use campsites from a culturally sensitive area to Wawona Stables. This action would shift impacts associated with stock camping to an already disturbed area, resulting in a local, long-term, minor, beneficial impact.

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils**. Actions to manage user capacity, land use and facilities would eliminate stables and day rides from the Wawona stables, and relocate the stock use campground. Soil stresses (e.g., compaction and erosion) would be decreased due to the elimination of stable rides. These actions would have a local, long-term, minor, beneficial impact on soils in the Wawona area.

**Wawona Campground.** Facilities actions at the Wawona Campground would involve removal of 27 sites that are either within the 100-year floodplain or in culturally sensitive areas. Removal of campground infrastructure (such as bear boxes, sign posts, etc.) would temporarily cause a minor increase in soil disturbance; however, in the long-term these areas would recover from past visitor- and recreational-related stresses (such as continuing soil compaction at campsites and access roads). The areas in the floodplain would slowly recover to natural conditions under continuing natural processes. The overall long-term impact would be local, minor to moderate, and beneficial.

**Segments 5-8 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 5-8 would result in local, long-term, minor beneficial impacts on soil resources. With mitigation, actions to manage user capacities, land use, and facilities would have local, long-term, minor to moderate, beneficial impacts on soil resources, and local, long-term, negligible, adverse geohazards impacts.

### Summary of Impacts from Alternative 3: Dispersed Visitor Experiences and Extensive Riverbank Restoration

In a segmentwide and parkwide context, Alternative 3 would result in long-term, minor to moderate, beneficial impacts with respect to exposure of facilities and visitors to geohazards. Adherence to

applicable building codes (in all segments) and implementation of the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2 only) would ensure that new or relocated structures are designed to withstand an earthquake and are located outside of the rock-fall hazard zone. On a local level, such as the Curry Village area, Alternative 3 would result in long-term, moderate, beneficial impacts with respect to exposure of facilities and visitors to geohazards.

Alternative 3 would generally result in a decrease in the level of park visitation and thus result in a general reduction in visitor impacts on soil resources from informal trail use, campground use, and other activities in sensitive floodplain areas such as meadows and riparian zones. Visitors would be directed to formal routes and trails where soils are already paved, compacted, or otherwise affected. For these reasons, actions under Alternative 3 would result in short-term, minor, adverse impacts (e.g., due to construction/grading), and long-term, moderate, beneficial impacts with respect to soil resources in both segmentwide and parkwide contexts

#### Cumulative Impacts from Alternative 3: Dispersed Visitor Experiences and Extensive Riverbank Restoration

Past and present projects and management plans, which include the existence and maintenance of facilities within rock fall hazard areas, when considered with Alternative 3, would still expose park visitors and employees to injury and damage from earthquakes and rock falls. Continued stabilization and rehabilitation work would reduce impacts in targeted areas, which would be a long-term, beneficial impact. Actions under Alternative 3 would adhere to applicable building codes (in all segments) and the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2 only). At a parkwide level, Alternative 3, in combination with past, present, and reasonably foreseeable future projects, would result in a negligible, adverse, cumulative effect with respect to exposure of park visitors and facilities to geohazards.

Cumulatively, a combination of adverse and beneficial impacts on soil resources would occur under Alternative 3. The net effect of these actions are difficult to anticipate, but would likely result in beneficial impacts (e.g., meadow/riparian restoration, removal of informal trails, directing of visitors away from sensitive areas) that would outweigh adverse impacts (which would generally be short term or highly localized). Combined with the generally positive impacts of past, present, and reasonably foreseeable future projects, Alternatives 3 would result in a parkwide, minor to moderate, beneficial, cumulative impact.

### *Environmental Consequences of Alternative 4: Resource-based Visitor Experiences and Targeted Riverbank Restoration*

#### All River Segments

##### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Alternative 4 would result in reduced park visitation (17,000 visitors compared with 20,900 visitors under Alternative 1) and would reduce the exposure of park visitors to geohazards

under existing conditions. Therefore, visitor use actions would result in a parkwide, long-term, moderate, beneficial impact with respect to the exposure of park visitors to geohazards.

**Soils.** A decrease in park visitation would reduce the potential for ongoing visitor use impacts on natural resources, such as creation of informal trails, trampling of vegetation, and increased bank erosion. However, visitor use numbers would only be slightly reduced compared with existing conditions, and more visitation would result than under Alternative 2. Nevertheless, these actions would have a local, long-term, minor, beneficial impact on soil resources.

### Segment 1: Merced River Above Nevada Fall

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** Overnight capacities for both Little Yosemite Valley and Merced Lake would be reduced under Alternative 4, thereby promoting dispersed camping. Concentrated camping areas would be converted to dispersed camping. This would reduce the potential for informal trails and vegetation trampling, thereby leading to improved soil character and integrity. Therefore, these actions would have a long-term, local, minor, beneficial impact on soil resources.

The park would remove the Merced Lake East Meadow from grazing permanently and require all administrative pack stock passing through the Merced Lake Area to carry pellet feed. These actions would reduce overgrazing of the meadow, increase natural vegetative cover, and reduce potential erosion resulting from exposed soil. The resulting impact on soil resources would be local, long-term, negligible, and beneficial.

**Merced Lake High Sierra Camp.** Actions in the Merced Lake High Sierra Camp area proposed under Alternative 4 involve the conversion of the area to designated Wilderness, the closure of the Merced Lake High Sierra Camp, and restoration of the former camp area to natural conditions. These actions would not affect existing levels of public risk or exposure to geohazards, but would have local, long-term, minor to moderate, beneficial impacts on soil resources by reducing stresses on soils from visitor uses, overnight camping, and presence of infrastructure.

**Segment 1 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to manage user capacities, land use, and facilities within Segment 1 would result in a local, long-term, minor to moderate, beneficial impact on soil resources.

### Segment 2: Yosemite Valley

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Under Alternative 4, the Sugar Pine and Ahwahnee bridges and associated berms would be removed and restored to natural conditions. The multi-use trail on Sugar Pine and Ahwahnee bridges would be rerouted along the north bank of the Merced River. These sites would have reduced scour and more stable riverbanks, more stable riverbanks, and improved vegetative recruitment. In the local

areas where these actions would be performed, they would have long-term, moderate, beneficial impacts on soil resources

Under Alternative 4, all campsites and associated infrastructure within the 100-year floodplain would be removed and restored to natural conditions. This would include campsites at Backpackers Camp, North Pines Campground, Upper Pines and Lower Pines campgrounds, Yellow Pine Campground, and tent-style lodging at Housekeeping Camp. Other facilities that would be removed from the 100-year floodplain include the select Yosemite Lodge infrastructure. Approximately 10.9 acres of riparian ecosystem would be restored at the site of the former Yosemite Lodge units and cabins (those that were damaged by the 1997 flood and subsequently removed). Meadow restoration would take place at Ahwahnee, El Capitan, and Stoneman meadows. Methods for restoration would include recontouring, ditch removal, and decompaction.

Recontouring would involve use of a skid steer, loader, excavator, dozer, and dump truck to remove excavated material from the site. An excavator or dozer could be used to excavate depressions, cut-off channels, and oxbows. On steep riverbanks, an excavator or dozer could push soils and material down the slope of the bank to create a gentler slope, which would increase revegetation success. Whenever possible, native fill would be used from the restoration site. Where possible, ditches would be contoured and leveled using fill material already present in associated berms. Soil decompaction would involve breaking up soils either manually, by using special decompaction tools, or with heavy equipment that can support ripping tines, such as excavators, skid steer, and dozers. Small pockets of fill would at times be blended into the soil, as decompaction occurs, with an excavator or dozer with winged rippers. These actions would have a short-term, minor, adverse impact on soil resources due to the trampling of vegetation and compaction of soil by heavy equipment. After construction, restored areas would result in established vegetation that would be less likely to erode and improve soil function. The resulting impacts would be long-term, moderate, and beneficial.

Under Alternative 4, Merced River access would be more formalized, leading to a reduction in streambank erosion and soil compaction. Visitors would be directed to more stable river access points throughout Segment 2, and areas of compacted soils would be decompacted and restored. This would improve bank stability at river access points, reducing erosion, though not to a measurable extent. This would result in a local, long-term, negligible, beneficial impact on soil resources.

**Biological Resource Actions.** Specific projects include removal of fill in trails at Ahwahnee Meadows; installing culverts beneath Northside Drive; removing 1,335 feet of Southside Drive that bisects Stoneman Meadow, re-alignment of the road, reconfiguring Curry Orchard parking lot, and extending the Stoneman Meadow boardwalk; removing asphalt and fill material, restoring topography of 19.7 acres of floodplain, and installation of box culverts or other similar design components at the former Upper and Lower River campgrounds; removing valley campsites and infrastructure from within 150 feet of the river and restoring an additional 12 acres of riparian habitat; and erecting fencing, signage, and boardwalks to redirect visitor traffic, and removing informal trails at El Capitan Meadow. The benefits of these actions include removal of past human alterations, soil decompaction, and restoration of natural topographic contours and soil function. As a result, these activities would have local, long-term, minor to moderate, beneficial impacts with respect to soil resources.

**Hydrologic/Geologic Resource Actions.** Specific projects to protect and enhance the river's hydrologic and geologic values that would occur within Segment 2 under Alternative 4 include: relocating unimproved Camp 6 parking out of the 10-year floodplain; removal of the Ahwahnee and Sugar Pine Bridges to enhance free-flowing condition; and restoring these areas to natural conditions. These actions would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** No new campsites or lodging would be located in the rock-fall hazard zone. Structures would be reduced since facilities would be removed from the valley, tent cabins would be removed from floodplain and rock-fall hazard zone. These actions would avoid increased exposure of park visitors and facilities to rock fall and would reduce the number of structures subject to earthquake damage. Further, visitor-use management actions would result in a substantial reduction in both day and overnight visitors in the valley, and would lead to a general reduction in public exposure to rock fall events. Together, the overnight accommodation, visitor use management, and facilities actions would result in segmentwide, long-term, minor to moderate, beneficial impacts with respect to exposure of park visitors and facilities to geohazards.

**Soils.** Facility actions would remove or reduce lodging and tent cabins in areas currently subject to natural hazards (including removal of tent cabins from within 150 feet of the river), remove existing buildings, construct new concessioner housing areas, and construct new parking spaces. The removal of buildings and tent cabins would improve soils conditions and allow for soils to support plant growth resulting in local, long-term, minor, beneficial impacts. New concessioner housing and parking would directly affect soils through compaction and paving, and possibly increase pedestrian use of the area that would make soils more susceptible to erosion; thus, new facility development would result in local, long-term, minor, adverse impacts.

Transportation actions would construct, reroute, relocate, and formalize parking spaces. Construction of new parking spaces would directly affect soil resources in the area through installation, compaction, and paving. Parking spaces currently located in the 10-year floodplain would be removed and relocated, and soils beneath these areas would be restored to approximately their preconstruction condition. Relocated parking spaces would be equal or similar in size to current parking areas, would be designed and implemented to improve drainage and minimize runoff, and would not overlie sensitive or unique soils. Overall, parking spaces would be reduced in comparison to existing conditions and the use of informal overflow parking areas would reduced. Therefore, these actions would have a local, long-term, negligible, beneficial effect on soil resources.

Overnight accommodation actions would affect the availability, location, and style of overnight accommodations in Yosemite Valley, and would accommodate an overall increase in the number of overnight visitors. A substantial number of campsites would be added to accommodate increased overnight visitation. However, overnight accommodation actions would also result in a decrease in the number of substantial structures. In addition, several of the actions to manage user capacity, land use, and facilities would involve ecological restoration of disturbed or developed areas. The effects on soil resources of increasing camping areas would be long-term, negligible to minor, and adverse. These impacts would likely be outweighed by the benefits of facilities removal and restoration throughout

the segment. The net effect of these actions would be local, long-term, minor to moderate, and beneficial with respect to soil resources.

Visitor-use management actions would contribute to an overall reduction in total daily visitation. These actions would result in a decreased potential for crowding and could reduce the level and intensity of informal trailing in the valley. These actions would have a segmentwide, long-term, minor, beneficial impact with respect to soil resources.

**Curry Village & Campgrounds.** The park would retain 355 guest units and construct a new 40 site campground at Curry Village. The park would remove campsites from Lower Pines (15), North Pines (34), and Upper Pines (2). In addition, the park would discontinue commercial day rides from the Curry Village Stables. These actions would permanently disturb approximately 8.5 acres of soil (Happyisles-Half Dome complex, Happyisles complex, and Happyisles sandy loam). As such, the specific projects proposed under Alternative 4 for the Curry Village and Campgrounds areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, minor, beneficial impacts through removal of informal and paved parking areas, and infrastructure from the meadow and floodplain.

**Camp 6 & Yosemite Village.** The park would improve the configuration of and on-grade pedestrian crossing at the Northside Drive-Yosemite Village Drive intersection, shift the parking area north and redevelop a portion of the former administrative footprint to accommodate 750 parking spaces, and install a three-way intersection connecting the parking lot to Sentinel Drive. These actions would permanently disturb approximately 27 acres of soil (Happyisles complex, Leidig fine sandy loam, and Elcapitan fine sandy loam. As such, actions under Alternative 4 in the Camp 6 and Yosemite Village areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, moderate, beneficial impact through relocation of park facilities farther from meadow areas and the Merced River floodplain.

**Yosemite Lodge & Camp 4.** The park would design a pedestrian underpass, relocate the existing bus drop-off area to the Highland Court area to accommodate loading/unloading for 7 busses, and redevelop an area west of Yosemite Lodge to provide an additional parking for 150 automobiles and 15 tour busses. These actions would permanently disturb approximately 16 acres of soil (Happyisles complex). As such, actions under Alternative 4 in the Yosemite Lodge and Camp 4 areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, moderate, beneficial impacts through relocation of park facilities farther from meadow areas and the Merced River floodplain.

**Segment 2 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 2 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would also have local, long-term, minor to moderate beneficial impacts on soil resources; and long-term, segmentwide, minor to moderate, beneficial geohazards impacts.

### Segments 3 and 4: Merced Gorge and El Portal

*Impacts of Actions to Protect and Enhance River Values*

**Soils.** Oak protection areas would be designated in the Odgers' fuel storage area and adjacent parking areas. Parking and new building construction would be prohibited within the dripline. A one- acre oak recruitment area would be established near the fuel storage area, within which nonnative fill would be removed and decompacted, invasive species would be removed, and native understory plants would be planted. This action would benefit soil resources by removing current stressors (e.g., parking and foot traffic) and restoring soil function (through decompaction and replanting). This would have a long-term, local, moderate, beneficial impact on soils. In a segmentwide context, the actions would result in a minor, beneficial impact on soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** High-density housing units would be constructed at Rancheria Flatt in El Portal. Construction of all new structures would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can be reasonably anticipated in the region. These actions would result in a long-term, local, negligible, adverse impact with respect to geohazards in Segments 3 and 4.

**Soils.** The installation of new housing at Rancheria Flatt would directly disturb soil resources in small discrete areas through installation, compaction, and paving, and would also lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the areas affected would be small and localized. Therefore, these actions would result in a long-term, local, minor, adverse impact on soil resources.

At Abbieville and El Portal Trailer Village, the park would remove or relocate existing housing and restore the floodplain. Sensitive soils along the floodplain would be restored to their preconstruction condition and would support native vegetation. These actions would have long-term, minor beneficial impact on soils at the local level.

**Segments 3 & 4 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 4 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, adverse impacts on soil resources; and long-term, local, negligible, adverse geohazard impacts.

### Segments 5, 6, 7 and 8: South Fork Merced River

*Impacts of Actions to Protect and Enhance River Values*

Biological Resource Actions: Project specific actions include relocation of stock use campsites from a culturally sensitive area to Wawona Stables. This action would shift impacts associated with stock camping to an already disturbed area, resulting in a local, long-term, minor, beneficial impact.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** Actions to manage user capacity, land use and facilities would eliminate stables and day rides from the Wawona stables, and relocate the stock use campground. Soil stresses (e.g., compaction and erosion) would be decreased due to the elimination of stable rides. These actions would have a local, long-term, minor, beneficial impact on soils in the Wawona area.

**Wawona Campground.** Facilities actions at the Wawona Campground would involve removal of 27 sites that are either within the 100-year floodplain or in culturally sensitive areas. Removal of campground infrastructure (such as bear boxes, sign posts, etc.) would temporarily cause a minor increase in soil disturbance; however, in the long-term these areas would recover from past visitor- and recreational-related stresses (such as continuing soil compaction at campsites and access roads). The areas in the floodplain would slowly recover to natural conditions under continuing natural processes. The overall long-term impact would be local, minor, and beneficial.

**Segments 5-8 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 5-8 would result in local, long-term, minor beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, beneficial impacts on soil resources, and long-term, local, negligible, adverse geohazards impacts.

### Summary of Impacts from Alternative 4: Resource-based Visitor Experiences and Targeted Riverbank Restoration

In segmentwide and parkwide contexts, Alternative 4 would result in long-term, minor to moderate, beneficial impacts with respect to exposure of facilities and visitors to geohazards. Adherence to applicable building codes (all segments) and implementation of the 2012 Yosemite Valley Geologic Hazard Guidelines (Segment 2 only) would ensure that new or relocated structures are designed to withstand an earthquake and are located outside of the rock-fall hazard zone. On a local level, such as the Curry Village area, Alternative 4 would result in long-term, moderate, beneficial impacts with respect to exposure of facilities and visitors to geohazards.

Alternative 4 would generally result in a decrease in the total level of park visitation but would increase the level of overnight accommodation compared with Alternative 1 (No Action). This would result in a general reduction in visitor impacts on soil resources from informal trail use and day use, though not necessarily from campground use. However, Alternative 4 would move the location of overnight accommodations away from sensitive meadow and riparian zones. While visitors would be directed to

formal routes and trails in many locations, visitor use impacts on soils in sensitive areas could continue. For these reasons, actions under Alternative 4 would result in short-term, minor, adverse impacts (e.g., due to construction/grading), and long-term, minor, beneficial impacts with respect to soil resources in both segmentwide and parkwide contexts.

### Cumulative Impacts from Alternative 4: Resource-based Visitor Experiences and Targeted Riverbank Restoration

Past and present projects and management plans, which include the existence and maintenance of facilities within rock fall hazard areas, when considered with Alternative 4, would still expose park visitors and employees to injury and damage from earthquakes and rock falls. Continued stabilization and rehabilitation work would reduce impacts in targeted areas, which would be a long-term, beneficial impact. Actions under Alternative 4 would adhere to applicable building codes (in all segments) and the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2 only). At a parkwide level, Alternative 4, in combination with past, present, and reasonably foreseeable future projects, would result in a negligible, adverse, cumulative effect with respect to exposure of park visitors and facilities to geohazards.

Cumulatively, a combination of adverse and beneficial impacts on soil resources would occur under Alternative 4. The net effect of these actions are difficult to anticipate, but would likely result in beneficial impacts (e.g., meadow/riparian restoration, removal of informal trails, directing of visitors away from sensitive areas) that would outweigh adverse impacts (which would generally be short term or highly localized). Combined with the generally positive impacts of past, present, and reasonably foreseeable future projects, Alternatives 4 would result in a parkwide, minor, beneficial, cumulative impact.

## *Environmental Consequences of Alternative 5: Enhanced Visitor Experiences and Essential Riverbank Restoration*

### All River Segments

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Visitor use actions under Alternative 5 would result in similar park visitation compared with existing conditions (19,900 visitors compared with 20,900 visitors). The exposure of park visitors to geohazards would continue to be similar to existing conditions; therefore, visitor use actions could result in parkwide, long-term, minor, adverse impacts with respect to visitor exposure to geohazards.

**Soils.** Visitor-use management actions would implement a day-use parking permit system for the East Yosemite Valley. Under Alternative 5, with visitation similar to that of Alternative 1 (No Action) the potential for ongoing visitor use impacts on soil resources, such as creation of informal trails, trampling of vegetation, and soil compaction would continue. However, management of day use in the park, especially during periods of peak visitation, combined with efforts to ecologically restore informal trails and areas of bare ground, to improve fencing, to install signage, and to formalize access to resilient riverbanks, which are common to Alternatives 2–6, would aid in reducing visitor impacts on

soils relative to Alternative 1. While visitor use levels in the park would remain at current levels, such use would have a lesser continuing impacts on soil resources through ecological restoration actions common to Alternatives 2–6. While the specific effects of the management actions on soil resources would be difficult to quantify or distinguish from the beneficial effects of restoration actions common to Alternatives 2–6, they would have a local, long-term, minor, beneficial impact on soil resources.

### Segment 1: Merced River Above Nevada Fall

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** Visitation within Segment 1 would not be expected to change appreciably under Alternative 5; wilderness access quotas would remain as under Alternative 1 (No Action) (150) and modifications to overnight accommodations would be nominal. The resulting impacts on soil resources would be similar to those of Alternative 1; local, long-term, minor, and adverse.

Pack stock used for administrative purposes would graze on meadow vegetation near the Merced Lake Ranger Station in accordance with established grazing capacities. This would reduce overgrazing of the meadow, increase natural vegetative cover, and reduce potential erosion resulting from exposed soil. The resulting impact on soil resources would be local, long-term, negligible, and beneficial.

**Merced Lake High Sierra Camp.** Actions in the Merced Lake High Sierra Camp area proposed under Alternative 5 involve retention of the Merced Lake High Sierra Camp, reducing the capacity to 42 beds, and replacing the flush toilets with composting toilets. These actions would not affect existing levels of public risk or exposure to geohazards, but would have local, long-term, negligible, beneficial impacts on soil resources by reducing stresses on soils from visitor use and presence of infrastructure.

**Segment 1 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to manage user capacities, land use, and facilities within Segment 1 would result in local, long-term, minor, beneficial impacts on soil resources.

### Segment 2: Yosemite Valley

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Under Alternative 5, the Sugar Pine Bridge would be removed and restored to natural conditions. The multi-use trail on Sugar Pine and Ahwahnee bridges would be rerouted along the north bank of the Merced River. These sites would have reduced scour and more stable riverbanks, and reduce visitor use pressures within riparian areas. This would result in a local, long–term, negligible, beneficial impact on soil resources. In the local areas where these actions would be performed, they would have long-term, moderate, beneficial impacts on soil resources

Under Alternative 5, all campsites and associated infrastructure within 100 feet of the ordinary high-water mark of the Merced River would be removed and restored to natural conditions. This would include campsites at Backpackers Camp, North Pines Campground, Upper Pines and Lower Pines campgrounds, Yellow Pine Campground, and tent-style lodging units at Housekeeping Camp.

Approximately 10.9 acres of riparian ecosystem would be restored at the site of the former Yosemite Lodge units and cabins (those that were damaged by the 1997 flood and subsequently removed).

Meadow restoration would take place at Ahwahnee, El Capitan, and Stoneman meadows. Methods for restoration would include recontouring, ditch removal, and decompaction.

Recontouring would involve use of a skid steer, loader, excavator, dozer, and dump truck to remove excavated material from the site. An excavator or dozer could be used to excavate depressions, cut-off channels, and oxbows. On steep riverbanks, an excavator or dozer could push soils and material down the slope of the bank to create a gentler slope, which would increase revegetation success. Whenever possible, native fill would be used from the restoration site. Where possible, ditches would be contoured and leveled using fill material already present in associated berms. Soil decompaction would involve breaking up soils either manually, by using special decompaction tools, or with heavy equipment that can support ripping tines, such as excavators, skid steer, and dozers. Small pockets of fill would at times be blended into the soil as decompaction occurs, using an excavator or dozer with winged rippers. These actions would have a short-term, minor, adverse impact on soil resources due to the trampling of vegetation and compaction of soil by heavy equipment. After construction, restored areas would result in established vegetation that would be less likely to erode and improve soil function. The resulting impacts would be long-term, minor to moderate, and beneficial.

Under Alternative 5, Merced River access would be more formalized, leading to a reduction in streambank erosion and soil compaction. Visitors would be directed to more stable river access points throughout Segment 2, and areas of compacted soils would be decompacted and restored. This would improve bank stability at Merced River access points, thus reducing erosion, though not to a measurable extent. This would result in a local, long-term, negligible, beneficial impact on soil resources.

**Biological Resource Actions.** Specific projects include removing fill and constructing a boardwalk over meadow and wet areas at Ahwahnee Meadows; removing asphalt and fill material, restoring topography of 35.6 acres of floodplain, and installation of box culverts or other similar design components at the former Upper and Lower River campgrounds; removing valley campsites and infrastructure from within 100 feet of the river and restoring an additional 6.5 acres of riparian habitat; and removing informal trails and erecting fencing, signage, and boardwalks to redirect visitor traffic, and selectively removing conifers to improve views at El Capitan Meadow. The benefits of these actions include removal of past human alterations, soil decompaction, and restoration of natural topographic contours and soil function. As a result, these activities would have local, long-term, minor to moderate, beneficial impacts with respect to soil resources.

**Hydrologic/Geologic Resource Actions.** Specific projects to protect and enhance the river's hydrologic and geologic values that would occur within Segment 2 under Alternative 5 include: relocating unimproved Camp 6 parking out of the 10-year floodplain; removal of the Sugar Pine Bridge to enhance free-flowing condition; and restoring these areas to natural conditions. These actions would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** No new campsites or lodging would be located in the rock-fall hazard zone. Structures would be reduced since facilities would be removed from the valley, tent cabins would be removed from floodplain and rock-fall hazard zone. These actions would avoid increased exposure of park visitors and facilities to rock fall and would reduce the number of structures subject to earthquake damage. Further, visitor-use management actions would result in a substantial reduction in both day and overnight visitors in the valley, and would lead to a general reduction in public exposure to rock fall events. Together, the overnight accommodation, visitor use management, and facilities actions would result in segmentwide, long-term, minor, beneficial impacts with respect to exposure of park visitors and facilities to geohazards.

**Soils.** Facility actions would remove or reduce lodging and tent cabins in areas currently subject to natural hazards (including removal of tent cabins from within 100 feet of the river), remove existing buildings, construct new concessioner housing areas, and construct new parking spaces. The removal of buildings and tent cabins would improve soils conditions and allow for soils to support plant growth resulting in local, long-term, minor, beneficial impacts. New concessioner housing and parking would directly affect soils through compaction and paving, and possibly increase pedestrian use of the area that would make soils more susceptible to erosion; thus, new facility development would result in local, long-term, minor, adverse impacts.

Transportation actions would construct, reroute, relocate, and formalize parking spaces. Construction of new parking spaces would directly affect soil resources in the area through installation, compaction, and paving. Parking spaces currently located in the 10-year floodplain would be removed and relocated, and soils beneath these areas would be restored to approximately their preconstruction condition. Relocated parking spaces would be equal or similar in size to current parking areas, would be designed and implemented to improve drainage and minimize runoff, and would not overlie sensitive or unique soils. Overall, parking spaces would be slightly increased in comparison to existing conditions and the use of informal overflow parking areas would reduced. Therefore, these actions would have a local, long-term, negligible, adverse effect on soil resources.

Overnight accommodation actions would affect the availability, location, and style of overnight accommodations in Yosemite Valley, and would accommodate an overall increase in the number of overnight visitors. A substantial number of campsites and a handful of additional lodging units would be added to accommodate increased overnight visitation. The effects on soil resources of increasing camping and lodging areas would be long-term, negligible to minor, and adverse. These impacts would be offset to some degree by the benefits of facilities removal and restoration throughout the segment. Nonetheless, the net effect of these actions would be local, long-term, negligible, and adverse with respect to soil resources.

Visitor-use management actions would contribute to an overall reduction in total daily visitation. These actions would result in a decreased potential for crowding and could reduce the level and intensity of informal trailing in the valley. These actions would have a segmentwide, long-term, minor, beneficial impact with respect to soil resources.

**Curry Village & Campgrounds.** The park would construct 98 hard-sided units at Boys Town, bringing the total number of new and retained units at Curry Village to 453. The park would remove campsites from Lower Pines (5), North Pines (14), and Upper Pines (2). In addition, the park would discontinue commercial day rides from the Curry Village Stables. These actions would permanently disturb approximately 8.5 acres of soil (Happyisles-Half Dome complex, Happyisles complex, and Happyisles sandy loam). As such, specific projects proposed under Alternative 5 for the Curry Village and Campgrounds areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, minor, beneficial impacts through removal of informal and paved parking areas, and infrastructure from the meadow and floodplain.

**Camp 6 & Yosemite Village.** The park would construct a pedestrian underpass and a traffic circle at the intersection of Northside and Yosemite Village Drives, shift the parking area north and redevelop a portion of the former administrative footprint to accommodate 850 parking spaces, and install a three-way intersection connecting the parking lot to Sentinel Drive. These actions would permanently disturb approximately 27 acres of soil (Happyisles complex, Leidig fine sandy loam, and Elcapitan fine sandy loam). As such, specific projects proposed under Alternative 5 for the Camp 6 and Yosemite Village areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, minor, beneficial impacts through removal of informal and paved parking areas and infrastructure from the meadow and floodplain.

**Yosemite Lodge & Camp 4.** The park would design a pedestrian underpass, relocate the existing bus drop-off area to the Highland Court area to accommodate loading/unloading for 3 busses, and redevelop an area west of Yosemite Lodge to provide an additional parking for 300 automobiles and 15 tour busses. These actions would permanently disturb approximately 18 acres of soil (Happyisles complex). As such, specific projects proposed under Alternative 5 for the Yosemite Lodge and Camp 4 areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, minor, beneficial impacts through removal of structures and infrastructure from the meadow and floodplain.

**Segment 2 Impact Summary**: With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 2 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would also have long-term, local, minor, beneficial impacts on soil resources; and long-term, segmentwide, minor, beneficial geohazards impacts.

### Segments 3 and 4: Merced Gorge and El Portal

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Oak protection areas would be designated in the Odgers' fuel storage area and adjacent parking areas. Parking and new building construction would be prohibited within the dripline. A 2.25 acre oak recruitment area would be established near the fuel storage area, within which nonnative fill would be removed and decompacted, invasive species would be removed, and native understory plants would be planted. This action would benefit soil resources by removing current stressors (e.g., parking and

foot traffic) and restoring soil function (through decompaction and replanting). This would have a long-term, local, minor, beneficial impact on soils. In a segmentwide context, the actions would result in a minor, beneficial impact on soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

Geohazards. High-density housing units would be constructed at Rancheria Flatt in El Portal. Construction of all new structures would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can be reasonably anticipated in the region. These actions would result in a long-term, local, negligible, adverse impact with respect to geohazards in Segments 3 and 4.

**Soils.** The installation of new housing at Rancheria Flatt would directly disturb soil resources in small discrete areas through installation, compaction, and paving, and would also lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the areas affected would be small and localized. Therefore, these actions would result in a long-term, local, minor, adverse impact on soil resources.

At Abbieville and El Portal Trailer Village, the park would remove or relocate existing housing and restore the floodplain. Sensitive soils along the floodplain would be restored to their preconstruction condition and would support native vegetation. These actions would have long-term, minor beneficial impact on soils at the local level.

**Segments 3 & 4 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 4 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, adverse impacts on soil resources; and long-term, local, negligible, adverse geohazard impacts.

### Segments 5, 6, 7 and 8: South Fork Merced River

*Impacts of Actions to Protect and Enhance River Values*

**Biological Resource Actions.** Project specific actions include relocation of stock use campsites from a culturally sensitive area to the Wawona Maintenance Yard. This action would shift impacts associated with stock camping to an already disturbed area, resulting in a local, long-term, minor, beneficial impact.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** Actions to manage user capacity, land use and facilities would eliminate stables and day rides from the Wawona stables, and relocate the stock use campground. Soil stresses (e.g., compaction and

erosion) would be decreased due to the elimination of stable rides. These actions would have a local, long-term, minor, beneficial impact on soils in the Wawona area.

**Wawona Campground.** Facilities actions at the Wawona Campground would involve removal of 13 sites that are either within the 100-year floodplain or in culturally sensitive areas. Removal of campground infrastructure (such as bear boxes, sign posts, etc.) would temporarily cause a minor increase in soil disturbance; however, in the long-term these areas would recover from past visitor- and recreational-related stresses (such as continuing soil compaction at campsites and access roads). The areas in the floodplain would slowly recover to natural conditions under continuing natural processes. The overall long-term impact would be local, minor, and beneficial.

**Segments 5-8 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 5-8 would result in local, long-term, minor beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, beneficial impacts on soil resources.

### Summary of Impacts from Alternative 5: Enhanced Visitor Experiences and Essential Riverbank Restoration

In segmentwide and parkwide contexts, Alternative 5 would result in long–term, minor, beneficial impacts with respect to exposure of facilities and visitors to geohazards. Adherence to applicable building codes (all segments) and implementation of the 2012 Yosemite Valley Geologic Hazard Guidelines (Segment 2 only) would ensure that new or relocated structures are designed to withstand an earthquake and are located outside of the rock-fall hazard zone. On a local level, such as the Curry Village area, Alternative 5 would result in long-term, minor, beneficial impacts with respect to exposure of facilities and visitors to geohazards.

Alternative 5 would generally maintain the current level of total park visitation but would increase the level of overnight accommodation. However, Alternative 5 would move the location of overnight accommodations away from sensitive meadow and riparian zones and concentrate them in wooded and previously disturbed locations, locally allowing sensitive soils to recover. While signage, fencing, and formal access points implemented under Alternatives 2–6 would direct visitors to formal routes and trails and away from sensitive soils and habitats, visitor use impacts on soils in sensitive areas could nevertheless continue to occur during periods of peak visitation. For these reasons, actions under Alternative 5 would result in short-term, minor, adverse impacts (e.g., due to construction/grading), and long-term, minor, beneficial impacts with respect to soil resources in both segmentwide and parkwide contexts.

### Cumulative Impacts from Alternative 5: Enhanced Visitor Experiences and Essential Riverbank Restoration

Past and present projects and management plans, which include the existence and maintenance of facilities within rock fall hazard areas, when considered with Alternative 5, would still expose park visitors and employees to injury and damage from earthquakes and rock falls. Continued stabilization

and rehabilitation work would reduce impacts in targeted areas, which would be a long-term, beneficial impact. Actions under Alternative 5 would adhere to applicable building codes (in all segments) and the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2 only). At a parkwide level, Alternative 5, in combination with past, present, and reasonably foreseeable future projects, would result in a negligible, adverse, cumulative effect with respect to exposure of park visitors and facilities to geohazards.

Cumulatively, a combination of adverse and beneficial impacts on soil resources would occur under Alternative 5. The net effect of these actions are difficult to anticipate, but would likely result in beneficial impacts (e.g., meadow/riparian restoration, removal of informal trails, directing of visitors away from sensitive areas) that would outweigh adverse impacts (which would generally be short term or highly localized). Combined with the generally positive impacts of past, present, and reasonably foreseeable future projects, Alternatives 5 would result in a parkwide, minor, beneficial, cumulative impact.

## *Environmental Consequences of Alternative 6: Diversified Visitor Experiences and Selective Riverbank Restoration*

### All River Segments

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** Alternative 6 would accommodate a slight increase in park visitation compared with existing conditions (21,800 visitors compared with 20,900 visitors). The exposure of park visitors to geohazards would continue to be similar to existing conditions; therefore, visitor use actions could result in parkwide, long-term, minor, adverse impacts with respect to visitor exposure to geohazards.

**Soils.** With visitation slightly higher that under present conditions, ongoing visitor use impacts on natural resources, such as creation of informal trails, trampling of vegetation, and increased bank erosion, would continue. However, restoration actions common to Alternatives 2–6 would ecologically restore many of the areas in the park, particularly in Segments 1, 2, and 4, by removing and ecologically restoring informal trails, restoring sensitive meadow and riparian habitats, and implementing fencing and directing visitor access to formal recreational areas and/or resilient areas. While the specific effects of the management actions on soil resources would be difficult to quantify or distinguish from the beneficial effects of restoration actions common to Alternatives 2–6, they would have a local, long-term, minor, beneficial impact on soil resources.

### Segment 1: Merced River Above Nevada Fall

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils.** Visitation within Segment 1 would not be expected to change appreciably under Alternative 6; wilderness access quotas would remain as under Alternative 1 (No Action) (150) and modifications to

overnight accommodations would be nominal. The resulting impacts on soil resources would be similar to those of Alternative 1; local, long-term, minor, and adverse.

Pack stock used for administrative purposes would graze on meadow vegetation near the Merced Lake Ranger Station in accordance with established grazing capacities. This would reduce overgrazing of the meadow, increase natural vegetative cover, and reduce potential erosion resulting from exposed soil. The resulting impact on soil resources would be local, long-term, negligible, and beneficial.

**Merced Lake High Sierra Camp.** Actions in the Merced Lake High Sierra Camp area proposed under Alternative 6 involve retention of the Merced Lake High Sierra Camp and replacing the flush toilets with composting toilets. These actions would not affect existing levels of public risk or exposure to geohazards, but would have local, long-term, negligible, beneficial impacts on soil resources by reducing stresses on soils from the presence of infrastructure.

**Segment 1 Impact Summary:** Actions to manage user capacities, land use, and facilities within Segment 1 would result in local, long-term, minor, beneficial impacts on soil resources.

### Segment 2: Yosemite Valley

#### *Impacts of Actions to Protect and Enhance River Values*

**Soils.** Under Alternative 6, all campsites and associated infrastructure within 100 feet of the ordinary high-water mark of the Merced River would be removed and restored to natural conditions. This would include campsites at Backpackers Camp, North Pines and Upper Pines campgrounds, Lower Pines and Yellow Pine campgrounds, and tent-style lodging units at Housekeeping Camp. Meadow restoration would take place at Ahwahnee, El Capitan, and Stoneman meadows. Methods for restoration would include recontouring, ditch removal, and decompaction. Recontouring would involve use of a skid steer, loader, excavator, dozer, and dump truck to remove excavated material from the site. An excavator or dozer could be used to excavate depressions, cut-off channels, and oxbows. On steep riverbanks, an excavator or dozer could push soils and material down the slope of the bank to create a gentler slope, which would increase revegetation success. Whenever possible, native fill would be used from the restoration site. Where possible, ditches would be contoured and leveled using fill material already present in associated berms. Soil decompaction would involve breaking up soils either manually, by using special decompaction tools, or with heavy equipment that can support ripping tines, such as excavators, skid steer, and dozers. Small pockets of fill would at times be blended into the soil as decompaction occurs, using an excavator or dozer with winged rippers. These actions would have a short-term, minor, adverse impact on soil resources due to the trampling of vegetation and compaction of soil by heavy equipment. After construction, restored areas would result in established vegetation that would reduce soil erosion and increase soil character and function. The resulting impacts would be long-term, minor to moderate, and beneficial.

Under Alternative 6, river access would be more formalized, leading to a reduction in streambank erosion and soil compaction. Visitors would be directed to more stable Merced River access points throughout the Segment 2, and areas of compacted soils would be decompacted and restored. This

would improve bank stability at river access points, thus reducing erosion, though not to a measurable extent. This would result in a local, long-term, negligible, beneficial impact on soil resources.

**Biological Resource Actions.** Specific projects include removing fill and constructing a boardwalk over meadow and wet areas at Ahwahnee Meadows; removing asphalt and fill material, restoring topography of 19.7 acres of floodplain, and installation of box culverts or other similar design components at the former Upper and Lower River campgrounds; removing valley campsites and infrastructure from within 100 feet of the river and restoring 6.5 acres of riparian habitat; and removing informal trails, installing viewing platforms and boardwalks, and selectively remove conifers to improve views at El Capitan Meadow. The benefits of these actions include removal of past human alterations, soil decompaction, and restoration of natural topographic contours and soil function. As a result, these actions would have local, long-term, minor to moderate, beneficial impacts with respect to soil resources.

**Hydrologic/Geologic Resource Actions:** Specific projects to protect and enhance the river's hydrologic and geologic values that would occur within Segment 2 under Alternative 6 include relocating unimproved Camp 6 parking out of the 10-year floodplain. These actions would result in local, long-term, moderate, beneficial impacts with respect to soil resources.

*Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Geohazards.** No new campsites or lodging would be located in the rock-fall hazard zone. Structures would be reduced since facilities would be removed from the valley, tent cabins would be removed from floodplain and rock-fall hazard zone. These actions would avoid increased exposure of park visitors and facilities to rock fall and would reduce the number of structures subject to earthquake damage. Further, visitor-use management actions would result in a substantial reduction in both day and overnight visitors in the valley, and would lead to a general reduction in public exposure to rock fall events. Together, the overnight accommodation, visitor use management, and facilities actions would result in segmentwide, long-term, negligible, beneficial impacts with respect to exposure of park visitors and facilities to geohazards.

**Soils.** Facility actions would remove or reduce lodging and tent cabins in areas currently subject to natural hazards (including removal of tent cabins from within 100 feet of the river), remove existing buildings, construct new concessioner housing areas, and construct new parking spaces. The removal of buildings and tent cabins would improve soils conditions and allow for soils to support plant growth resulting in local, long-term, minor, beneficial impacts. New concessioner housing and parking would directly affect soils through compaction and paving, and possibly increase pedestrian use of the area that would make soils more susceptible to erosion; thus, new facility development would result in local, long-term, minor, adverse impacts.

Transportation actions would construct, reroute, relocate, and formalize parking spaces. Construction of new parking spaces would directly affect soil resources in the area through installation, compaction, and paving. Parking spaces currently located in the 10-year floodplain would be removed and relocated, and soils beneath these areas would be restored to approximately their preconstruction condition. Relocated parking spaces would be equal or similar in size to current parking areas, would be designed and

implemented to improve drainage and minimize runoff, and would not overlie sensitive or unique soils. Overall, parking spaces would be increased in comparison to existing conditions and the use of informal overflow parking areas would reduced. Therefore, these actions would have a local, long-term, minor, adverse effect on soil resources.

Overnight accommodation actions would affect the availability, location, and style of overnight accommodations in Yosemite Valley, and would accommodate an overall increase in the number of overnight visitors. A substantial number of campsites and lodging units would be added to accommodate increased overnight visitation. Many of these actions would occur within previously disturbed areas, such as the area of former Yosemite Lodge units removed after being damaged by the 1997 flood. The effects on soil resources of increasing camping and lodging areas would be long-term, minor, and adverse. These impacts would be offset to some degree by the benefits of facilities removal and restoration throughout the segment. Nonetheless, the net effect of these actions would be local, long-term, minor, and adverse with respect to soil resources.

Visitor-use management actions would contribute to an overall increase in total daily visitation. These actions would result in a increase potential for crowding and could also increase the level and intensity of informal trailing in the valley. These actions would have a segmentwide, long-term, negligible to minor, adverse impact with respect to soil resources.

**Curry Village & Campgrounds.** The park would construct 98 hard-sided units at Boys Town, bringing the total number of new and retained units at Curry Village to 453. The park would remove campsites from Lower Pines (5), North Pines (14), and Upper Pines (2). In addition, the park would discontinue commercial day rides from the Curry Village Stables. These actions would permanently disturb approximately 8.5 acres of soil (Happyisles-Half Dome complex, Happyisles complex, and Happyisles sandy loam). As such, actions under Alternative 6 in the Curry Village and Campgrounds areas would result in short-term, minor, adverse impacts on soil resources, but long-term, minor, beneficial impacts through removal of informal and paved parking areas and infrastructure from the meadow and floodplain.

**Camp 6 & Yosemite Village.** The park would construct a pedestrian underpass and two roundabouts, shift the parking area north and redevelop a portion of the former administrative footprint to accommodate 850 parking spaces, and install a three-way intersection connecting the parking lot to Sentinel Drive. These actions would permanently disturb approximately 27 acres of soil (Happyisles complex, Leidig fine sandy loam, and Elcapitan fine sandy loam). Essential functions of the Concessioner General Office would be infilled into a re-modeled Concessioner Maintenance and Warehouse Building with a 4,000-square-foot addition. However, there would be no new permanent disturbance as the expansion would occur within a previously disturbed area. As such, specific projects proposed under Alternative 6 in the Camp 6 and Yosemite Village areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, minor, beneficial impacts through removal of informal and paved parking areas and infrastructure from the meadow and floodplain.

**Yosemite Lodge & Camp 4.** The park would design a pedestrian underpass, relocate the existing bus drop-off area to the Highland Court area to accommodate loading/unloading for 3 busses, and redevelop an area west of Yosemite Lodge to provide an additional parking for 300 automobiles and

15 tour busses. These actions would permanently disturb approximately 18 acres of soil (Happyisles complex). As such, actions under Alternative 6 in the Yosemite Lodge and Camp 4 areas would result in local, short-term, minor, adverse impacts on soil resources, but local, long-term, minor, beneficial impacts through removal of structures and infrastructure from the meadow and floodplain.

**Segment 2 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 2 would have long-term, local and segmentwide, minor to moderate, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would also have long-term, local, negligible, beneficial impacts on soil resources; and long-term, segmentwide, negligible, adverse geohazards impacts.

### Segments 3 and 4: Merced Gorge and El Portal

#### *Impacts of Actions to Protect and Enhance River Value*

**Soils.** Oak protection areas would be designated in the Odgers' fuel storage area and adjacent parking areas. Parking and new building construction would be prohibited within the dripline. A one-acre oak recruitment area would be established near the fuel storage area, within which nonnative fill would be removed and decompacted, invasive species would be removed, and native understory plants would be planted. This action would benefit soil resources by removing current stressors (e.g., parking and foot traffic) and restoring soil function (through decompaction and replanting). This would have a long-term, local, minor, beneficial impact on soils. In a segmentwide context, the actions would result in a minor, beneficial impact on soil resources.

#### *Impacts of Actions to Protect and Enhance River Values*

**Geohazards.** Facility, overnight accommodation, and transportation actions would install high-density housing units and campsites in Abbieville and Trailer Village, and Rancheria Flatt in El Portal. Construction of all new structures would be performed in a manner that is in compliance with the most recent version of the International Building Code, such that facilities would be designed to withstand the maximum peak ground accelerations that can be reasonably anticipated in the region. These actions would result in a long-term, local, negligible, adverse impact with respect to geohazards in Segments 3 and 4.

**Soils.** Overnight accommodation, transportation, and facility actions would install new campsites and high-density housing units in the Abbieville, El Portal Trailer Village, and Rancheria Flatt areas. The installation of these facilities would directly disturb soil resources in small discrete areas through installation, compaction, and paving, and would also lead to further compaction of soils and/or increased susceptibility to erosion through increased foot traffic. However, the areas affected would be small and localized and, with regard to the former, the proposed facilities would be redeveloped within the existing footprint of the Abbieville and El Portal Trailer Village areas. Further, because new campsites would be equal or similar in size to the removed Yellow Pine campsites, soils disturbed from new campsites would be offset within the segment by the ecological restoration of the removed

campsites. Therefore, these actions would result in a long-term, local, minor, adverse impact on soil resources.

**Segments 3 & 4 Impact Summary:** With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segment 4 would have long-term, local and segmentwide, minor, beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, adverse impacts on soil resources.

### Segments 5, 6, 7, and 8: South Fork Merced River

#### *Impacts of Actions to Protect and Enhance River Values*

**Biological Resource Actions.** Project specific actions include relocation of stock use campsites from a culturally sensitive area to Wawona Stables. This action would shift impacts associated with stock camping to an already disturbed area, resulting in a local, long-term, minor, beneficial impact.

#### *Impacts of Actions to Manage User Capacity, Land Use, and Facilities*

**Soils**. Actions to manage user capacity, land use and facilities would eliminate stables and day rides from the Wawona stables, and relocate the stock use campground. Soil stresses (e.g., compaction and erosion) would be decreased due to the elimination of stable rides. These actions would have a local, long-term, minor, beneficial impact on soils in the Wawona area.

**Wawona Campground.** Facilities actions at the Wawona Campground would involve removal of 13 sites that are either within the 100-year floodplain or in culturally sensitive areas. Removal of campground infrastructure (such as bear boxes, sign posts, etc.) would temporarily cause a minor increase in soil disturbance; however, in the long-term these areas would recover from past visitor- and recreational-related stresses (such as continuing soil compaction at campsites and access roads). The areas in the floodplain would slowly recover to natural conditions under continuing natural processes. The overall long-term impact would be local, minor, and beneficial.

**Segments 5-8 Impact Summary**: With implementation of mitigation measures MM-GEO-1 and -2, and MM-HYD-1, as applicable (see Appendix C), actions to protect and enhance river values within Segments 5-8 would result in local, long-term, minor beneficial impacts on soil resources. With mitigation, as applicable, actions to manage user capacities, land use, and facilities would have long-term, local, minor, beneficial impacts on soil resources, and long-term, local, negligible, adverse geohazards impacts.

### Summary of Impacts from Alternative 6: Diversified Visitor Experiences and Selective Riverbank Restoration

In segmentwide and parkwide contexts, Alternative 6 would result in and long–term, negligible, beneficial impacts with respect to exposure of facilities and visitors to geohazards. Adherence to applicable building codes (all segments) and implementation of the 2012 Yosemite Valley Geologic

Hazard Guidelines (Segment 2 only) would ensure that new or relocated structures are designed to withstand an earthquake and are located outside of the rock-fall hazard zone. On a local level, such as the Curry Village area, Alternative 6 would result in long-term, moderate beneficial impacts with respect to exposure of facilities and visitors to geohazards.

Alternative 6 would increase the current level of total park visitation and would substantially increase the level of overnight accommodations. However, overnight accommodations under Alternative 6 would generally be concentrated in wooded, developed, and/or previously disturbed locations, and campsites within the ordinary high-water mark of the Merced River would be relocated. Some areas currently recovering from past soil disturbances (e.g., Lower River Campground) would be redeveloped, thereby locally halting recovery of soils. However, on both segmentwide and parkwide levels, restoration actions common to Alternatives 2–6 would remove and ecologically restore informal trails, restore sensitive meadow and riparian habitats, and direct visitor access to formal recreational areas and/or resilient areas using fencing and signage. These measures would aid in properly managing increasing levels of visitor use and avoiding adverse affects on sensitive soil resources.

Despite restoration actions under Alternatives 2–6, adverse impacts on soils from informal trailing, soil compaction, and vegetation trampling may continue in localized areas under increasing levels of visitation and with increased overnight accommodations. Fencing and signage may not be able to effectively reverse or halt continuing adverse impacts on soils, especially during periods of peak visitation when conditions may become overcrowded. For these reasons, actions under Alternative 6 would result in short-term, minor, adverse impacts (e.g., due to construction/grading), and long-term, minor, adverse impacts with respect to soil resources in segmentwide and parkwide contexts.

### Cumulative Impacts from Alternative 6: Diversified Visitor Experiences and Selective Riverbank Restoration

Past and present projects and management plans, which include the existence and maintenance of facilities within rock fall hazard areas, when considered with Alternative 6, would still expose park visitors and employees to injury and damage from earthquakes and rock falls. Continued stabilization and rehabilitation work would reduce impacts in targeted areas, which would be a long-term, beneficial impact. Actions under Alternative 6 would adhere to applicable building codes (in all segments) and the 2012 Yosemite Valley Geologic Hazard Guidelines (in Segment 2 only). At a parkwide level, Alternative 6, in combination with past, present, and reasonably foreseeable future projects, would result in a negligible, adverse, cumulative effect with respect to exposure of park visitors and facilities to geohazards.

Cumulatively, a combination of adverse and beneficial impacts on soil resources would occur under Alternative 6. The net effect of these actions are difficult to anticipate, but would likely result in beneficial impacts (e.g., meadow/riparian restoration, removal of informal trails, directing of visitors away from sensitive areas) that would outweigh adverse impacts (which would generally be short term or highly localized). Combined with the generally positive impacts of past, present, and reasonably foreseeable future projects, Alternatives 6 would result in a parkwide, negligible, beneficial, cumulative impact.