

CHAPTER III: AFFECTED ENVIRONMENT

This chapter describes the resources that may be affected or cause an effect upon the proposal or alternatives.

Location and General Description of the Project Area

Hawaii Volcanoes National Park is located on the southern portion of Hawaii Island, State of Hawaii (see Figure 1). Located within the 333,000-acre national park are two of the world's most active volcanoes, Kilauea and Mauna Loa; Kilauea is within the project area. Crater Rim Drive is the primary road for access to the park headquarters and Kilauea summit areas. An average of 1.5 million visitors use the road within the proposed project area.

Crater Rim Drive is a NPS owned, 10.6-mile two-lane historic road of variable width. The 2.8 mile road segment, addressed by this EA, begins near its junction with State Highway 11 (just before the entrance station), and extends westward through the Kilauea Visitor Center/Volcano House developed area, and ends at the gate just west of the Jaggar Museum parking area. Crater Rim Drive is a Class 1 Public Use Park Road, a road “which constitute[s] the main access route, circulatory tour or thoroughfare for park visitors” (NPS 1984). Crater Rim Drive was designed to enhance the visitor experience in reaching and viewing the volcanic caldera, craters, and features in a guided way. Historically, much of the road segment within the project area was part of the main road around the island, used by general island traffic as well as people specifically visiting the park. The State Highway 11 bypass realignment project occurred in the early 1960s, which allowed for general island traffic to be routed away from Crater Rim Drive.

Crater Rim Drive is one of four historic roadways in the park. In 2006, the Hawaii State Historic Preservation Division concurred with the findings in the Cultural Landscape Inventory that documented potential eligibility for listing Crater Rim Drive on the National Register of Historic Places (National Register) as a contributing feature within a broader historic district. Since the end of its construction in 1942, segments of the road have been realigned and modified to repair damage from weathering, lava flows, and earthquakes. However, the road corridor and the majority of its associated features remain intact and still convey its historic layout and design intent as a “rim road” from which visitors view the caldera and park landscapes.

Crater Rim Drive: Junction with State Highway 11 to the Jaggar Museum

The two-lane Crater Rim Drive has an average paved width of 21 feet, with some sections as narrow as 18 feet and as wide as 26.5 feet. The road's paved width averages 23 feet-wide for the first mile (starting at State Highway 11), and 21 feet wide up to the gate just west of the Jaggar Museum parking area. The road surface condition is deteriorated; examples of this include cracking, patch deterioration and unevenness, raveling edges, and inconsistent pavement width. Along the 2.8 mile stretch of road addressed by the project, segments are narrow and have inconsistent widths with some steep shoulder drop-offs, making passage difficult for larger vehicles with longer wheelbases.

Turning off State Highway 11, vehicles begin their travel on Crater Rim Drive passing through the entrance station. Constructed in 1998, the entrance station is where entrance fees are collected. Two lanes of incoming traffic pass by the two entrance station booths and traffic then merges into one lane. Outbound traffic has one outgoing lane. Past the entrance station, there are numerous intersections along Crater Rim Drive that provide access to other park roads and parking areas for visitor and administrative uses such as the Kilauea Visitor Center/park headquarters, Volcano House, Volcano Art Center, Steam Vents, Kilauea Military Camp, and Jaggar Museum/Hawaiian Volcano Observatory.

Between the Volcano House and Steam Vents, Crater Rim Drive traverses a narrow passage, bounded on the north by a historic rough cut that exposes native stone (basalt) and on the south by a historic rock guardwall, with pavement now abutting the wall. At some points along this narrow passage, the road pavement narrows to a width of 18.5 feet, but the average paved width through this section is 22 feet. A 45-foot long tour bus has a standard width of 8.5 feet and driver mirrors extend 1-foot on both sides. Buses and other large vehicles must exercise caution when passing through this area. The speed limit in this area is 15 mph. Typically, vehicles travel slowly through this area, in part because of the road design.

Along approximately 1,450 feet of roadway in the Steam Vents area, there are two rows of historic stone shoulders, often hidden under the existing asphalt pavement. Some of this masonry is visible through the cracked and spalling asphalt, about 1 inch below the road surface. The stone masonry was constructed as shoulder reinforcement for the 1941 road. The road width between the stones at the time averaged 17 feet. Subsequent paving operations paved over the stones and they have become part of the roadway, bringing the current typical roadway width to 21 feet.

The road segment between Kilauea Military Camp and Jaggar Museum is approximately 8500 feet in length. It begins approximately at the first (east) entrance road to Kilauea Military Camp and continues southwest to the Jaggar Museum. Through this section the road width ranges from 18.5 to 26 feet.

The Crater Rim Drive and associated road features are deteriorating due to natural processes, lack of maintenance, traffic loads, and structural deficiencies. The NPS patches the road and overlays asphalt on one to two mile segments as routine cyclic maintenance. However, maintaining these current practices does not address the structural deficiencies that contribute to pavement deterioration as cracking migrates up into new pavement.

Pullouts & Parking Areas

Several informal (created by use rather than by design) pullouts are located along the 2.8 mile segment of Crater Rim Drive. They are usually located near park features or where cars and bicycles stop to allow for passing vehicles, taking photographs, consulting the map, or parking for ohelo berry picking. Parking at informal pullouts contributes to asphalt unraveling at the pavement edge, which has resulted in up to 4- to 6-inch drops along the shoulder area. When vehicles pull off the road, the drop in grade and change in road surface from pavement to gravel may cause vehicles to slide and fishtail. When vehicles accelerate to re-enter the road the

vehicle may again be affected by the gravel surface of the shoulder area and raised lip of the road pavement.

There are four parking areas along the 2.8 mile Crater Rim Drive segment that addressed in this EA. They are located at Kilauea Visitor Center, Volcano House, Steam Vents, and Jaggar Museum. Together they provide over 200 parking spaces for visitors.

The Kilauea Visitor Center parking area pavement is uneven and deteriorated, resulting in water ponding. The intersection at the west end of the parking area (between the Volcano House and the Volcano Art Center) is not accessible because of the grade and it lacks crosswalks. The Kilauea Visitor Center has minimal pathway lighting.

The Volcano House parking area provides public parking for the Volcano House. The parking area consists of angled and oversized parking stalls. The pavement is uneven and deteriorated resulting in water ponding. There is no parking stall or path to the Volcano House entrance that meets federal accessibility standards.

When the nine-space Steam Vents parking stalls are full, vehicles park along the road leading into and out off the parking area; frequently, vehicles are parked off the pavement. There is one accessible parking space. Bus parking is poorly marked, resulting in passenger vehicles using bus parking. The parking area pavement is adjacent to two steam vents and buses frequently stop there, blocking the view of the features.

The entrance to the Jaggar Museum parking area is also the entrance to the USGS Hawaiian Volcano Observatory employee parking area. This can be confusing to visitors, leaving them uncertain as to where to park for the museum. The historic parking area curb stones are high and vehicle bumpers regularly scrape on them. There are no accessible parking spaces. The parking area sidewalks do not meet accessibility standards because of their grade, width, and surface material. There is no sidewalk from the front of the east side of the parking area to the restrooms and museum. A social trail connecting these areas has developed in the vegetation.

Steam Vents Trail

The paved Steam Vents Trail begins at the Sulphur Bank Trail intersection with Crater Rim Drive and continues through the Steam Vents area until the trail ends approximately 300 feet before the first road into the Kilauea Military Camp.

Road Users

In 2008 approximately 504,463 vehicles used Crater Rim Drive, based on park fee data and traffic counters. Vehicles are classified as being either recreation based (carrying park visitors) or non-recreation based (employees working in the park, vendors, post office traffic). In 2008, 412,151 (82%) of these vehicles were recreation-based vehicles. Approximately 96 percent of recreation-based traffic (412,151 vehicles) were personal vehicles (cars, trucks, SUVs); 4 percent were commercial tour vehicles (taxis, 12-15 passenger vans, tour buses) with half of these being tour buses. Bicyclists and pedestrians also use Crater Rim Drive.

Approximately 92,312 non-recreation based vehicles (18% of all vehicles using Crater Rim Drive) accessed Crater Rim Drive in 2008. These were primarily employee personal vehicles; other non-recreational vehicles included delivery trucks and larger vehicles with longer wheel bases and heavier axle weights (e.g., vehicles used on a limited basis for projects such as road maintenance).

Natural Resources

Geologic Resources

The NPS *Management Policies* (NPS 2006a) state, "the NPS will preserve and protect geologic resources as integral components of park natural systems." Natural geologic processes, which include volcanic activity, will be allowed to proceed unimpeded.

Kilauea Volcano

The 2.8-mile Crater Rim Drive project segment is located on the northern and western sides of the Kilauea Caldera, one of the world's most active volcanoes. Adjacent to the project area, Kilauea is currently erupting at the Halemaumau Crater.

Volcanic Emissions (Vog)

The natural volcanic activity generates high levels of volcanic gases (vog), comprised primarily of carbon dioxide (CO₂), water vapor (H₂O), and sulfur dioxide (SO₂). Other smaller amounts of gases generated by volcanic activity include carbon monoxide (CO), hydrogen (H₂), hydrogen chloride (HCl), and hydrogen sulfide (H₂S). Factors that affect volcanic gas emission levels at a specific site are volcanic activity and wind conditions, with areas downwind of the activity the most susceptible to the volcanic gases.

Faults, Cracks, Lava Tubes, and Collapse Features

Crater Rim Drive traverses areas that are part of a system of concentric faults, cracks, lava tubes, and collapse features associated with the Kilauea Caldera. The features may be visible on the ground, located at a shallow depth, or located deeper. Ground surface cracks or collapses could open up unexpectedly, but generally this is more likely to happen during earthquakes. In 2005 and 2010 geotechnical studies were conducted along the 2.8 mile project area. These surveys, along with past work, have identified subsurface anomalies that may indicate the presence of subsurface features such as faults, cracks, and lava tubes (Federal Highway Administration-Central Federal Lands Highway Division, Khamis Harmay, Senior Geotechnical Engineer, Lakewood, CO, e-mail correspondence to Lisa Duwall, National Park Service Hawaii Volcanoes National Park, Hawaii National Park, HI, March 1, 2010).

Lava tubes may contain cultural, paleontological, and biological resources. The Federal Cave Protection Act of 1988, as amended (16 USC § 4301-4310) and the NPS *Management Policies* require the National Park Service to protect cave resources

Geothermal Resources

The NPS *Management Policies* (2006a) state that geothermal resources "will be protected, preserved, and managed as a critical component of the unit's natural resource systems, and for public education, interpretation, and scientific research." The 2.8 mile Crater Rim Drive segment passes through a geothermally active area, with the greatest concentration of activity in the Steam Flats area (which includes the Steam Vents area). An active subsurface geologic formation generates continuous vapor emissions (steam) through cracks in the ground. The ground in this area can be hot, reaching as high as 135 degrees near the surface. Rainwater continually drains into the cracks and is heated and released as steam; these cracks are referred to as steam vents. At the Steam Vents parking area, two steam vents are easily accessible to visitors. Both vents are rimmed with pipe railings and one vent is faced with unmortared stone along the top 3-feet.

Geologic Hazards

NPS *Management Policies* (2006a) state that geologic processes would be addressed during planning and other management activities in an effort to reduce hazards that can threaten the safety of park visitors and staff and the long-term viability of the park infrastructure. This project takes place in an area where geologic hazards exist; therefore they are addressed in this EA.

Kilauea Caldera

The 2.8-mile Crater Rim Drive project segment is located on the northern and western sides of the Kilauea Caldera, one of the world's most active volcanoes. Kilauea has been erupting at the Halemaumau Crater since March 2008. A portion of the Crater Rim Drive is closed because of the eruption. The 2.8 mile Crater Rim Drive segment that is proposed for rehabilitation is adjacent to the closed road. The closure begins at the gate just past the Jaggar Museum. The volcano is monitored by USGS Hawaiian Volcano Observatory staff. They would report changes in volcanic activity that might necessitate modification of staff and visitor activity in the area. The NPS has a Volcanic Event Contingency Planning Strategy (NPS 2008b) to address potential volcanic eruptions including notification of staff and the public and the evacuation of the area (NPS 2008b).

Volcanic Emissions (Vog)

The proposed project is in an area with volcanic emissions (vog) that are generated by the Kilauea volcano. The natural volcanic activity generates high levels of volcanic gases (vog), comprised primarily of carbon dioxide (CO₂), water vapor (H₂O), and sulfur dioxide (SO₂). Other smaller amounts of gases generated by volcanic activity include carbon monoxide (CO), hydrogen (H₂), hydrogen chloride (HCl), and hydrogen sulfide (H₂S). Factors that affect volcanic gas emission levels at a specific site are volcanic activity and wind conditions, with areas downwind of the activity the most susceptible to the volcanic gases. Vog levels can vary rapidly in a given area, as well as between areas.

The vog can be a health concern. The park brochure/map states that volcanic “fumes are hazardous to your health. Persons with heart or respiratory problems and infants, young children, and pregnant women are especially at risk and should avoid Halemaumau Crater and Sulphur Bank, and other areas where volcanic fumes are present.”

The park has an Air Quality Management Policy (NPS 2009). The policy governs when outdoor activities are recommended to be curtailed or areas closed because of poor air quality. The park’s air quality level is regularly monitored at the Kilauea Visitor Center and Jaggar Museum. The NPS operates an advisory program that informs the public of current sulfur dioxide levels in the park. The advisory is given every 15 minutes for each monitoring site on the park’s website at:

<<http://www.nature.nps.gov/air/webcams/parks/havoso2alert/havoalert.cfm>>.

Faults, Cracks, Lava Tubes, and Collapse Features

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Geothermal Resources

Geothermal resources are in and adjacent to the 2.8 mile Crater Rim Drive segment, with the greatest concentration in the Steam Flats area (which includes the Steam Vents area). An active subsurface geologic formation generates continuous vapor emissions (steam) through cracks in the ground. The ground in this area is hot, reaching as high as 135 degrees near the surface. Rainwater continually drains into the cracks and is heated and released as steam; these cracks are referred to as steam vents. At the Steam Vents parking area, two steam vents are easily accessible to visitors. Both vents are rimmed with pipe railings and one vent is faced with unmortared stone along the top 3-feet.

Vegetation

NEPA requires federal agencies to evaluate impacts of proposed actions on vegetation. Further, the NPS *Management Policies* state that the NPS “will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems” (NPS 2006a).

Baseline information, including the condition and composition of the vegetation within the project area was obtained from botanical surveys and reports. In 2005, a botanical survey was conducted of the project area (NPS, Belfield 2005). Vegetation along the Crater Rim Drive varies greatly from the eastern end of the project area at the entrance station to the western end of the project at the Jaggar Museum, in response to topography, rainfall, and soil changes. Botanical habitats along the 2.8-mile roadway range from rain forest at the entrance station and visitor center area to mesic forest and grasslands at the Kilauea Military Camp to open ohia woodlands and shrublands at the Jaggar Museum/Hawaiian Volcano Observatory.

The park's entrance station and Kilauea Visitor Center are located in a wet forest zone. Rain forests are typically located in high-frequency rainfall areas that have no distinct dry periods during the year (Stone and Pratt 1994). The rain forest in the project area is situated on the lower eastern flank of Mauna Loa and the windward or northeastern slope of Kilauea Caldera. This area receives the benefit of the moisture-laden northeast trade winds most of the year. Around the Kilauea Visitor Center and Volcano House, average annual rainfall is approximately 100 inches. The vegetation in this area is dominated by ohia and uluhe fern (*Dicranopteris linearis*).

The natural vegetation along Crater Rim Drive from the entrance station to the visitor center and Volcano House is highly disturbed by human activities. The adjoining lands are occupied by a number of visitor facilities including the buildings, parking areas, pedestrian walkways, and landscape lawns at the Kilauea Visitor Center and Volcano House. The NPS botanical survey found no federally listed endangered, threatened, species of concern, or rare native plants in this segment.

The Steam Vents, like the previous area, is highly disturbed by human activities including the parking area and trails. The area receives less rainfall and the vegetation is dramatically less dense and diversified. It is characterized as an open grassland that includes alien broomsedge and bush beardgrass as dominant species. Also present are native uluhe and sedges, and alien sword fern (*Nephrolepis exaltata*) (NPS 2003a). Scattered clusters of low stature ohia and wawaeiole (*Lycopodium cernuum*) are also in this area. There are patches of ash and cinder that are dominated by lichen, which grow within several feet of the thermal vents. These lichen are dominated by *Cladina skottsbergii* and *Stereocaulon*, especially *S. ramulosum*, *S. rocelloides*, and *S. vulcanii*. *Cladonia* (*C. oceanica*, *C. fimbriata*, and *C. "scabriuscula"*) and an unidentifiable species of *Diploschistes* are widespread in the area. These lichen communities are extremely sensitive to disturbance from human activity and can be locally extirpated from the site through repeated trampling. Parking off the pavement also affects dominantly non-native vegetation in the shoulder areas of the roads that lead to and from the Steam Vents parking area. The botanical survey found no federally listed endangered, threatened, species of concern, or rare native plant species in this segment.

Kilauea Military Camp borders one side of the proposed project area that is adjacent to the Steam Vents area. The camp landscape is highly altered with landscaped lawns. Stands of *Acacia koa* are found on both sides of the road in this area, in the camp as well as along the non-camp side of the road. Beyond the camp toward the Jaggar Museum/Hawaiian Volcano Observatory area, vegetation transitions into open ohia woodlands and native shrubs. The shrubs are

predominantly aalii (*Dodaea viscosa*), pukiawe (*Styphelia tameiameia*), and ohelo (*Vaccinium reticulatum*). The density of these species becomes sparser toward the Jaggar Museum/Hawaiian Volcano Observatory. The alien grasses broomsedge and bush beardgrass are found in this area. No federally listed endangered or threatened species and species of concern were located in this segment of Crater Rim Drive.

Near the Jaggar Museum, the vegetation consists of scattered ohia and shrubs predominantly of aalii, pukiawe, and ohelo. The threatened Hawaiian catchfly (*Silene hawaiiensis*) occurs extensively in the Jaggar Museum area and is also located between the Kilauea Overlook and Picnic Area and the Jaggar Museum. *Silene hawaiiensis* is the only federally listed endangered or threatened species and species of concern located in this segment of Crater Rim Drive and it is addressed as an impact topic under *Special Status Species*.

Wildlife

NEPA requires federal agencies to evaluate impacts of proposed actions on affected wildlife. Additionally, the NPS *Management Policies* require the maintenance of native ecosystems and communities.

Within the area affected by the proposed action, the inventory of existing wildlife is less diverse than in many other areas within the park. This is due in part to the high level of human activity and vehicular traffic that occurs within the road corridor and the somewhat inhospitable climatic and botanical conditions in the southwestern segment of Crater Rim Drive.

Mammals

All mammals occurring within the project area are alien species, except the Hawaiian hoary bat, which is discussed under *Special Status Species*. The four species of established *muridae* known from Hawaii, the roof (black) rat (*Rattus r. rattus*), Norway rat (*Rattus norvegicus*), Polynesian rat (*Rattus exulans hawaiiensis*), and European house mouse (*Mus domesticus*), are all likely to use resources especially within the developed areas between the entrance station and the Kilauea Military Camp. These predominantly commensal species are common around human habitation. The small Indian mongoose (*Herpestes auropunctatus*) and house cat (*Felis catus*) are also known to occur in the project area. These introduced alien predators are deleterious to the area's native ecosystems and organisms.

Amphibians

The coqui tree frog is a non-native amphibian. No established park populations have been confirmed and the park goal is to prevent populations establishing. In 2008 (most recent summary) 32 coqui were discovered in the park. The frogs enter the park primarily on vehicles, supplies, and plant materials arriving from infested places.

Coqui tree frogs pose a threat to Hawaii's island ecosystem. A thousand frogs can live on less than one acre of thickly vegetated land and eat large numbers of native insects and spiders. Coqui numbers are greatest at lower elevations around the island, especially where it is humid,

moist, and thick with vegetation. When every tree is occupied by one or two calling male frogs, those left without a “home” will venture outwards. They will cross pavement in the evenings if necessary to find unoccupied trees. They often take refuge on parked vehicles. If the vehicle starts moving the frog often stays with it.

The park’s standard operating procedure to limit coqui in the park includes decontaminating vehicles and equipment before coming to the park. In addition it is recommended that during the night, vehicles and equipment from infested areas be 1) parked/stored in an enclosed, coqui-free garage, and 2) a coqui-free buffer should be maintained around carports, homes, and other structures.

Birds

Between the entrance station and Steam Vents, several of the more abundant native Hawaiian endemic avian species are present, including the Hawaiian Amakihi (*Hemignathus virens*), Apapane (*Himatione sanguinea*), Omao (*Myadestes obscurus*), and occasionally Elepaio (*Chasiempis sandwichensis*). Numerous established alien species are commonly seen including the Japanese White-eye (*Zosterops japonicus*), Hwamei (*Garrulax canorus*), Common Myna (*Acridotheres tristis*), Northern Cardinal (*Cardinalis cardinalis*), House Finch (*Carpodacus mexicanus*), House Sparrow (*Passer domesticus*), Kalij pheasant (*Lophura leucomelana*), and Nutmeg Mannikin (*Lonchura punctulata*).

The Pacific Golden-Plover or kolea (*Pluvialis fulva*), a migratory shorebird, is regularly seen in the grassy or open areas of the park, including the grounds of the Kilauea Military Camp. This migratory shorebird winters in the Hawaiian Islands arriving annually in late July and leaving for their Arctic breeding grounds in late April. Bird diversity and densities decrease from Steam Vents to the Jaggar Museum, due in part to the xeric nature of the land and the lack of dense vegetation.

There are special status bird species (threatened and endangered species and species of concern) within the project area. They are discussed under special status species.

Special Status Species (Threatened and Endangered Species and Species of Concern)

Vegetation Special Status Species (Threatened and Endangered Species and Species of Concern)

Within the project area, there is one special status vegetation species (federally listed endangered or threatened species or species of concern) for which the potential impact may be greater than minor. Botanical surveys documented the presence of the threatened Hawaiian catchfly (*Silene hawaiiensis*). The *S. hawaiiensis* occurs extensively throughout the area from Kilauea Overlook to the Jaggar Museum, with populations recorded at the Kilauea Overlook and Picnic Area and the Jaggar Museum parking area (USGS BRD, Abbott & Pratt 1992; NPS, Belfield 2005).

Wildlife Special Status Species (Threatened and Endangered Species and Species of Concern)

Hawaiian Goose/Nene. The endangered Hawaiian goose or nene (*Branta sandvicensis*) is a visible resident species of the park, using the varied habitat along and adjacent to Crater Rim Drive on a seasonal basis. They are frequently found within and adjacent to the project area, using the area for foraging, nesting, breeding, and molting (during which, birds are flightless 4-6 weeks). They over fly the project area on a very regular basis, often twice daily, as they travel between feeding and roosting areas. Nene are particularly sensitive to stress during nesting, brooding, and molting, and therefore exhibit highly secretive behavior throughout this period. During this phase, nene are particularly difficult to locate, even if the area is surveyed by an experienced bird biologist. Generally, nesting, brooding, and molting occur from September through April; however, exact times may vary among the nene.

From the entrance station to the Kilauea Visitor Center, nene are infrequently sighted flying over the roadway. The habitat within this section is mostly forested and is not used by this species.

Nene are frequently observed flying over the road between the Kilauea Visitor Center and the Jaggar Museum (NPS, Misajon 2005c). The Kau Desert, which includes the Kilauea Military Camp to the Jaggar Museum, is used for nesting, brooding, molting, and foraging. The nene frequently forage on the Kilauea Military Camp front lawn and baseball field. Occasionally, pairs bring goslings to the Kilauea Military Camp grounds to forage.

The Crater Rim Drive section from the Kilauea Military Camp to the Jaggar Museum bisects nene nesting habitat (ohia/pukiawe/aalii sparse woodland and aalii/pukiawe sparse shrubland). The nene over-fly this area frequently, often two times a day. Nests and broods have been found within this area in the last several years, within audible and visual range of Crater Rim Drive. Pairs have been known to raise goslings here and molt on both sides of the road throughout this section. The area may be used for foraging throughout the year.

Hawaiian Hawk/Io. The Hawaiian hawk or io (*Buteo solitarius*), an endemic Hawaiian bird and a federally listed endangered species, is a resident species within the park. Potential habitat for nesting io occurs between the park entrance station and the Kilauea Visitor Center. No nests have been reported in this heavily trafficked area in the past.

Hawaiian Petrel and Band-rumped Storm Petrel. The Hawaiian petrel or uau (*Pterodroma sandwichensis*), federally listed as endangered, is a pelagic seabird that nests in upland areas of the park. The band-rumped storm petrel or akeake (*Oceanodroma castro*) is currently listed under State of Hawaii endangered species statutes, but is not on any federal list. Both species are known to over-fly the area. These seabirds are sensitive to glaring night-lights.

Hawaiian Hoary Bat. Hawaii's sole endemic terrestrial mammalian species, the Hawaiian hoary bat or opeapea (*Lasiurus cinereus semotus*), is a resident species within the park and has been identified near the area affected by the proposed action. It is federally listed as endangered.

Cultural Resources

The National Register of Historic Places (National Register) is the nation's official list of districts, sites, buildings, structures, and objects in both public and private ownership that are significant in American history, architecture, archeology, engineering, and culture. For the purposes of this EA, cultural resources are discussed under the categories of archeological resources, historic structures, cultural landscapes, and ethnographic resources.

Archeological Resources

The area of potential effect (APE) for archeological resources extends 20 meters (66 feet) beyond existing asphalt. The APE encompasses all project areas identified for ground disturbance and includes pullout rehabilitation, vehicles off pavement, staging areas, and equipment and material storage areas. Within the last decade, archeologists have completed several surveys that encompassed the Crater Rim Drive road corridor, as well as areas within the larger landscape surrounding the Kilauea Caldera (State Inventory of Historic Places [SIHP] site number 50-10-52-5502).

Between 2002 and 2007, surveys and detailed analysis were conducted on the northern rim of Kilauea Caldera, resulting in the discovery and documentation of a large lithic quarry site (SIHP 50-10-23647), which spreads across 1600 acres and consists of over 277 individual workshops. The quarry is eligible for the National Register (consensus Determination of Eligibility 1/25/10). Crater Rim Drive crosses through the middle of Site 23647. The site is within the project's area of potential effect, and may be affected by the proposed actions.

Two archeological surveys were conducted along the road corridor of Crater Rim drive. The first survey (NPS 2005b) focused on the section of road from Jaggar Museum to the Southwest rift zone. The survey area encompassed a 40 meter (131 feet) buffer on either side of the current road's center line. This buffer was selected to ensure an adequate area was surveyed and that all features near the current road were documented. The survey overlapped a portion of Site 23647, lithic quarry site. Outside of Site 23647's boundary, the survey resulted in the documentation of 38 historic features, all of which are directly associated with construction of the Crater Rim Drive, the development of the park, and the Civilian Conservation Corps (CCC).

The second archeological survey was initiated as part of a transportation project to establish a baseline for current use of park facilities. The survey was conducted along the road corridor and focused on existing pullouts (both formal and informal) and parking areas from Jaggar Museum east around Crater Rim drive past the Kilauea Visitor Center and up to the currently closed segment near the intersection of Crater Rim Drive and the Chain of Craters Road. The survey area was a 20 meter (66 ft) buffer on either side of the current road's center line. This buffer was selected because the previous 2005 road survey did not find many resources beyond that boundary. The greatest concentration of archeological features identified during this survey was directly associated with Site 23647, the lithic quarry site (NPS 2008).

Historic Structures and Cultural Landscapes

The National Register defines a historic district as “a geographically definable area, urban or rural, possessing a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united by past events or aesthetically by plan or physical development. A district may also include individual elements separated geographically but linked by association or history” (36 CFR 60.3(d)).

NPS 28 states that “In the broadest sense, a cultural landscape is a reflection of human adaptation and use of natural resources and is often expressed in the way land is organized and divided, patterns of settlement, land use, systems of circulation, and the types of structures that are built. The character of a cultural landscape is defined both by physical materials, such as roads, buildings, walls, and vegetation, and by use reflecting cultural values and traditions” (NPS 1998). There are four cultural landscapes within the project area of potential effect: 1) Crater Rim Historic District (Consensus Determination of Eligibility 2006), 2) Crater Rim Drive Historic District (Consensus Determination of Eligibility 2006), 3) Kilauea Administration and Employee Housing Historic District (Consensus Determination of Eligibility 2006), and 4) Kilauea Military Camp Historic District (Consensus Determination of Eligibility 1996). These districts contain numerous historic structures and associated landscape features.

The 2.8 mile project area is completely within the Crater Rim Drive Historic District. This district has the dual distinction of being eligible for the National Register as well as contributing to the National Register eligibility of the larger Crater Rim Historic District. The project area is also partially within the Kilauea Administration and Employee Housing Historic District and adjacent to the Kilauea Military Camp Historic District.

Crater Rim Historic District

The 5,000 acre Crater Rim Historic District includes National Register eligible properties and features (roads, trails, and buildings) that together contribute to the district's National Register significance (Consensus Determination of Eligibility 2006). The historic district is notable for its presentation of the resource to the visitors, for bringing visitors into the dynamic volcanic landscape, allowing them to experience active volcanism. According to the nomination, Crater Rim Historic District is significant at the state level under Criterion A, association with a historic event or pattern of events, for its association with early park planning at Hawaii National Park (the original park name) and with the Civilian Conservation Corps (CCC) program, and under Criterion C, distinctive architectural design, because its features exemplify the “Park Service Rustic” style and naturalistic landscape architecture perpetuated by the NPS in the period between the First and Second World Wars. The period of significance spans the years of 1916 to 1942, covering the years of primary park development, through the end of the CCC program. Crater Rim Drive and its associated road features and the relationship of the road to the landscape, including its physical location in association with Kilauea Caldera, contribute to the National Register eligibility of the Crater Rim Historic District.

Crater Rim Drive Historic District

The Crater Rim Drive Historic District, approximately 13 acres, is a historic designed landscape and it includes the road bed, cut slopes, and filled area, road pullouts, parking areas, and vegetation on cut or fill slopes. The road landscape is significant for its association with the park master planning in the 1920s and 1930s, and the Civilian Conservation Corps (CCC) improvements in the 1930s and 1940s. The period of significance was identified as 1916-1942. The road was the centerpiece of the park's first long-range master plan, and was designed according to naturalistic landscape design standards of the NPS between the First and Second World Wars. In keeping with the NPS road design practices, Crater Rim Drive was designed as a scenic drive to provide access to and enjoyment of the park landscape. The road design was rustic with narrow grass and gravel road shoulders or no shoulders where the road edge was bordered by steep rock embankments and lava terrain. The road design followed NPS standards for road widths and alignments that maximized driver experience while minimizing intrusion on the landscape (NPS 2006b). The road was designed to be subservient to the landscape, to harmonize with the natural setting and blend with its volcanic surroundings.

From 1932 to 1944, the Civilian Conservation Corps (CCC) undertook a number of projects to improve the function and safety of the road, including extending the existing road around the Kilauea Caldera and construction of stone masonry guardwalls along steep embankments, rock drainage ditches at various drainage-ways, rock embankments, and stone masonry culvert headwalls. By 1934 the Crater Rim Drive loop was complete. The shoulders at Steam Vents were constructed in 1941. Over the years the road has undergone repairs and improvements, and this continues to the present time. Some work has occurred as part of routine road maintenance and improvements, while other work was needed in response to special circumstances, such as when lava flows covered the road, earthquakes produced cracks in the pavement, and heavy World War II vehicles damaged road sections.

The development history for the present alignment of Crater Rim Drive is documented in various administrative records and construction drawings reviewed at the park's archives and obtained from the NPS Technical Information Center at the Denver Service Center. The 1999 Historic American Engineering Record HAER No. HI-47 describes the development and historic significance of Crater Rim Drive. In 2005, the Architectural Resources Group completed a historic road inventory and evaluation of Crater Rim Drive, recording, cataloging, and evaluating the roadway and its associated features. The evaluation found that the road and its individual features, including designed and natural elements, construction details, and landscaping elements contribute to the road's historic significance and integrity. The numerous road features comprising Crater Rim Drive contribute to the eligibility of the road as a National Register Historic District under National Register Criterion A (properties associated with events that have made a significant contribution to the broad patterns of history) and Criterion C (properties that embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic value, or that represent a significant distinguishable entity whose components may lack individual distinction). The features "embody the distinctive characteristics of a type, period, or method of construction: A National Park Service-engineered roadway. These features are not necessarily individually significant but taken as a whole, the entire road is considered a historic district" (Architectural Resources Group

2005). The Crater Rim Historic District retains integrity for its association with early park master planning, the CCC and its rustic design style. The State of Hawaii Historic Preservation Officer concurred with the findings of the Cultural Landscape Inventory (CLI) including the Determination of Eligibility for Listing on the National Register of Historic Places on September 26, 2006.

Crater Rim Drive Features

The following landscape characteristics and features contribute to the significance and integrity of the road corridor within the Crater Rim Historic District.

- Natural Systems and Features: Topography, geology, native vegetation, and ornamental vegetation planted during the period of significance;
- Spatial Organization: Orientations, symmetry, and axial alignment of the road and its alignment along the crater;
- Circulation Features: Crater Rim Drive including road character (width, materials, etc.), cuts and fills, shoulders, curbs, guardwalls, designed pullouts, parking areas, access loops, overlooks, guardwalls, ditches, headwalls, drainage inlets, barrier rock alignments, embankment treatment, and associated administrative or service roads;
- Associated buildings and structures: retaining walls, free-standing walls and fences;

Crater Rim Drive features include:

Intersections. Access to the Crater Rim Drive from a variety of feeder roads and trails are defining characteristics of the road, which relate to the road and to the greater circulation patterns within the park. There are intersections just past the entrance station, the Kilauea Visitor Center and the road to the employee housing and maintenance area; Volcano House, the Volcano Art Center and the Kilauea Visitor Center, the former Sulphur Bank Road and Trail, the intersection with the Steam Vents area and Steam Vents and Sulphur Bank Trail; Crater Rim Trail from Kilauea Military Camp and the intersections of Kilauea Military Camp; the intersection of the Mauna Loa Road; Kilauea Overlook and Picnic Area; Namakani Paio Trail; and the parking area for Jaggar Museum and the USGS Hawaiian Volcano Observatory.

Designed Parking Areas. Designed parking areas are typically comprised of built elements including lava rock curbs, raised walkways, median and planting strips, guardwalls, retaining walls, and crosswalks, and parking spaces. The absence of striped parking spaces in some of the areas in the park (e.g., Kilauea Overlook and Picnic Area, Halemaumau, and most parking turnouts) helps preserve the National Park Service goal of blending the built and natural environments.

Pullouts. Pullouts are dirt, gravel, and occasionally asphalt widened areas along the road shoulders. A barrier rock alignment is sometimes associated with a pullout. There are multiple pullouts. None were part of the original road design but have developed over time through visitor use. They function as parking for visitor exploration and as pullouts to allow passing vehicles.

Shoulders. Shoulder treatment ranges from narrow bands of pavement extending beyond the occasional white painted roadway edge lines to narrow dirt and grassy mowed strips adjacent to the roadbed. These narrow shoulder bands add to the rustic quality of the road's overall character. .

Rock Tiling / Lava Rock Shoulders. Lava rock road tiling was used to line unpaved, but graded and oiled gravel roads to help keep the roadway edge from unraveling due to erosion issues. Although modern pavement has obliterated much of this edge treatment, it is likely that it occurred in more places than are currently visible. Lava rock road tiling would have required a considerable amount of labor to install.

The Steam Vents road segment dates to 1941. In this area, dry-laid lava rock tiling edges the roadbed and shoulders. It appears beneath or adjacent to the present asphalt in several locations and is characterized by butt-jointed rocks that are rough-cut on the surface and edges that are exposed. In some places there is a small upright section of lava that may have served as an interior curbing to the larger tiles of stone. Currently vegetation grows between the joints of the cracked asphalt along the edging. Similar evidence of uniformly cracked asphalt edges, such as occurs near the Kilauea Visitor Center, could be an indication of underlying rock shoulders.

Drainage and Engineering Structures. Drainage issues on Crater Rim Drive are concerned with draining water off the roadbed itself, and, in some areas, moving water from the adjacent landscape away from the roadway. Simple ditches, grass lined, earthen, or hand-laid rubble-lined, parallel the road immediately adjacent to the narrow shoulders. These grass-lined and dirt ditches complement the narrow dirt and grassy shoulders, adding to the rustic quality of the road's overall character.

Some of the pipe culverts were built of concrete due to the corrosion action on corrugated steel from sulfur. The existing pipe culverts, both concrete and steel, appear to be laid in 5' sections and are 2' in diameter. It was not determined whether the concrete culverts were actually formed on site with local materials or built at another park location, or prefabricated outside the park. There are three of these features within the road corridor that relate specifically to the Mission 66 period of National Park Service development.

Lava Rock Barrier Rocks. This feature is found within the 2.8 mile segment. Barrier rock alignments consisting of native lava rocks of varying size are formed by placing individual boulders in a linear arrangement. Barriers are intended to discourage vehicles from driving off the road at pullouts or other places along the road. The method of restricting access or defining space can be documented through photographs that date back to the 1890's, which precedes the establishing of the park. Most of the park's rock barrier alignments indicate to the visitor that it is not permitted to travel beyond these barriers. This use differs from the NPS standard of using large native boulders as protective barriers or guardwalls which are semi-buried to resist impact as shown on the 1929 standard specifications.

Lava Rock Curbs. Quarried lava rock curbs are formed by 8" x 14" block rectangles. Curbs are butt-jointed; some are dry laid. Most of the parking areas exhibit one-course lava rock curbs. The shaping method used for these curbs varies, either saw cut or rough-hewn. The earliest

curbs appear to have been constructed without mortar, or the mortar is recessed for aesthetic purposes.

Lava Rock Guardwalls. Guardwalls around Crater Rim Drive are constructed according to National Park Service standard specification Type No. 2 Rubble Guardwalls. One of the three remaining guardwalls located on Crater Rim Drive is found just west of the Volcano House entrance intersection, heading towards Steam Vents.

The guardwalls parallel the roadway and are formed by alternating 6'-long crenellated sections with 12'-long lower connecting sections. The crenellated sections are regularly spaced and add visual character and a sense of rhythm to the wall. The individual rocks are large, roughly rectangular, and are shaped to fit the rocks surrounding it. The end rocks of each crenellated section are chamfered (no sharp edges). Each wall consists of the crenellated section, which is approximately 2' in height and 18" wide, and the lower connecting wall, which is 12' in length, and 1' in height. The walls are mortared and the joints are both transverse and longitudinal, about an inch to 1.5" in width, and usually recessed. The mortar color is generally dark. Recent repairs to the walls have used light colored mortar, which contrasts with the darker rock. Most of the lava rock used in guardwalls along Crater Rim Drive is fairly uniform in color, which indicates that the rock came from the same source or quarry. The footings appear to be minimal. This wall section is one of two of road-edge guardwalls that are built on top of rubble retaining walls that contain the fill beneath the roadbed. The guardwalls provide a visual warning to travelers that there is a drop-off at the edge of the road; however, the retaining wall is below the roadbed and the extent of the elevation change is not obvious. No additional protective railings are attached to these guardwalls.

Guardrails. Two examples of a simple wooden guardrail, NPS Standard Type No. 9, Wooden Guardrail, remain on Crater Rim Drive near the eastern entrance to Kilauea Military Camp. This type of guardrail is typical of the standard for a 1929 era road. Similar guardrails were replaced in other areas of the Crater Rim Drive; these two seem to be the only ones remaining.

Other Guardwalls. Other types of rock guardwalls without crenellations exist on Crater Rim Drive. One section found below (west of) the Volcano House entrance may have been a repaired section of wall adjacent to a formal Type No. 2 guardwall.

Retaining Walls. The retaining wall at the west corner of the former Volcano House site near the Kilauea Visitor Center parking area entrance is an existing feature on a 1938 base-plan drawing. This wall appears to be a good example of a retaining wall built in the early stages of development in the area, possibly as early as 1877 to 1933, but certainly prior to the CCC period of NPS construction.

Roadbed Retaining Walls. These walls are built of dry-laid rubble lava rock and range from 2' to 12' in height. The rocks are of smaller dimensions than those used in the guardwalls and could be classified as "cobbles." Moss and lichen uniformly grow on these walls. One of two NPS Standard Type No. 2 Guardwalls on Crater Rim Drive is associated with similar roadbed retaining walls, specifically the wall section below (west of) the Volcano House intersection.

Other Remnant Walls. Several examples of low, freestanding dry-laid walls remain along Crater Rim Drive. Two examples are located below (west of) and relate to the former Volcano House on the north side of Crater Rim Drive. The two cheek walls flanked a staircase that led from the former hotel to Crater Rim Drive below. Continuing directly across the road is another remnant wall that is related to a staircase and path to the nearby Crater Rim Trail. This axial connection from the former Volcano House site to the trail was probably formed as early as 1877 when the first structure was built on the site. The intersection of the footpath and the trail is marked by a concrete monument engraved with the date “Aug 1887” indicating the early establishment of this connection.

Kilauea Administration and Employee Housing Historic District

The Kilauea Administration and Employee Housing Historic District is eligible for listing in the National Register under the multiple property submission entitled “Hawaii National Park: Planning and Development through World War II” (Consensus Determination of Eligibility 2006). It is significant at the state level under Criterion A, association with a historic event or pattern of events, for its association with early park planning at Hawaii National Park and with the Civilian Conservation Corps (CCC) program, which provided the labor for constructing many of the park’s rustic structures. It is also significant at the state level under Criterion C, distinctive architectural design, because its contributing features exemplify the “Park Service Rustic” style. The period of significance spans from 1927 to 1942, covering the years of initial master planning efforts, development, and CCC involvement. Although some of the contributing features have been slightly altered, and non-contributing structures added, the district retains integrity and is considered eligible for listing as a historic district.

Crater Rim Drive passes through a portion of this historic district, which includes the Kilauea Visitor Center, Volcano Art Center, Volcano House, and the Ohia Wing (constructed as the park administration building in 1932 and added to the concession contract for the Volcano House in 1949. These buildings are within the first half mile of the 2.8 mile project area.

Kilauea Military Camp Historic District

The camp occupies roughly 50 acres of national park land adjacent to Crater Rim Drive, from mile 1.1 to 1.8, of the proposed project area. It was established in 1916 and was originally created to provide a rest and recreational area for the military; this continues as the primary mission today. The camp has served not only as a rest and recuperation area, but as a Japanese internment camp and a prisoner of war camp in World War II.

The property (buildings and grounds) was inventoried as part of the 1996 List of Classified Structures for Hawaii Volcanoes National Park. It was determined eligible as a National Register Historic District (Consensus Determination of Eligibility 1996).

Ethnographic Resources

Ethnographic resources are cultural and natural features of traditional importance to contemporary peoples and communities. “Traditionally associated peoples generally differ as a group from the park visitors in that they typically assign significance to ethnographic resources – places closely linked with their own sense of purpose, existence as a community, and development as ethnically distinctive peoples” (NPS 2006a). Ethnographic resources are subsistence and ceremonial locales and sites, structures, objects, and rural and urban landscapes assigned cultural significance by traditional users (NPS 1998).

The Kilauea Caldera and its associated sites, including the Steam Vents area, have been identified as Native Hawaiian sacred sites. The proposed project area is within and adjacent to these sites.

Park Operations

Park operations for the purpose of this analysis refer to the quality and effectiveness of the infrastructure and the ability to maintain the infrastructure. Park operations use the infrastructure to protect and preserve resources and to provide for a positive visitor experience.

The Crater Rim Drive and associated road features are deteriorating due to natural processes, lack of maintenance, traffic loads, and structural deficiencies. Road work is done by segment, based on available funding. The NPS patches the road and overlays asphalt on one to two mile segments as routine cyclic maintenance.

The 2.8 mile Crater Rim Drive segment is traveled daily by over 1000 people that work in the park.

Visitor Use and Experience

The NPS *Management Policies* (NPS 2006a) state that the enjoyment of park resources and values is part of the fundamental purpose of all parks and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. The importance of visitor use and experience is highlighted in Hawaii Volcanoes National Park’s purpose that states that the park will preserve, protect, and interpret the largest and most continuously active shield volcanoes in the United States and provide access to two of the most active volcanoes in the world.

A mission of the park is to provide opportunities for public education, enjoyment, and safe access to the park and its resources. The road segment proposed for rehabilitation receives the park’s highest and most concentrated visitor use. In the last 5 years recreation-based vehicles have brought between 1.3-1.7 million visitors annually into the park. Of these vehicles, the ratio of personal to commercial tour vehicles (96% vs. 4%) annually has remained the same. It is important to note, while commercial tour vehicles only make up 4 percent of the recreation-based *vehicle* traffic, they carry over 20 percent of the *visitors* into the park.

The typical travel pattern for recreation-based vehicles (under current summit eruption conditions) is to go from the entrance station towards the Jaggar Museum, return toward the entrance and just before it turn right and proceed to Thurston Lava Tube and Chain of Craters Road. Personal vehicles often stop at the Kilauea Visitor Center and Steam Vents on the way to and also coming back from the Jaggar Museum. Tour buses will often start by parking at Kilauea Visitor Center so passengers can lunch at the Volcano House, then proceed to the Jaggar Museum, stopping at Steam Vents on the return.

In a visitor use study conducted in 2007 visitors reported that they spend between 4-6 hours on average in the park, with overnight guests generally spending 2.5 days (NPS 2007). The same study reported the following statistics in relation to visitor use of Crater Rim Drive:

- 75% of visitors reported prior to arrival that they planned to drive Crater Rim Drive
- 17% of visitors reported driving Crater Rim Drive as the primary purpose of their visit
- 83% of visitors reported driving Crater Rim Drive on their visit

One of the primary experiences that visitors enjoy is the visual effect produced by traveling on Crater Rim Drive through forests, grasslands, and then lava fields. The experience provides a powerful overview and up-close experience of the park and its volcanic system. Crater Rim Drive, and its pullouts, overlooks, and trails, is designed to take visitors to the Kilauea caldera's major features. Since March 2008 a portion of Crater Rim Drive has been closed because of the ongoing eruption from Halemaumau Crater. Support facilities, such as the Kilauea Visitor Center and Jaggar Museum, are designed to enhance the visitor experience with educational and interpretive information.

Pedestrians and bicyclists travel on and adjacent to Crater Rim Drive. One trail they use is adjacent to the road in the Steam Vents area. The trail has deteriorated paving

Commercial Operations

Commercial Operations, as addressed in this EA, help the park to provide opportunities for visitor use and enjoyment.

Two concessioners (Volcano House and Hawaii Natural History Association), one special use permit (Kilauea Military Camp), and one cooperative agreement (Volcano Art Center) are located within the 2.8 mile project area. The Volcano House provides overnight accommodations (32 rooms), retail operation, and a food and beverage service, with most of the tour buses stopping at Volcano House for lunch. The Volcano House is temporarily closed but is expected to open before the project is complete. The Hawaii Natural History Association is dedicated to the support of the interpretive, educational, scientific, and historic mission of the National Park Service through the sale of educational items. It is located at the Kilauea Visitor Center and Jaggar Museum. Kilauea Military Camp operates under a special use permit. It is a Joint Services Recreation Center that is managed by the Army and has 90 overnight accommodations and other support facilities for their guests. A post office is located at Kilauea Military Camp. The Volcano Art Center is dedicated to the arts and environmental education and sells handmade art and crafts. It is located near the Kilauea Visitor Center.

There are 103 Commercial Use Authorizations (CUAs) that have been issued to individual business operators within the park, including four commercial tour bus companies and four commercial bike tour companies. Approximately 4% of the 412,251 recreation-based vehicles entering the park are commercial tour vehicles. Of these, approximately half are large tour buses, with the largest tour buses being 45 feet long by 10.5 feet wide, including mirrors. On an average day, there are nine, large tour buses that enter the park. The other CUAs come into the park in smaller vehicles such as cars and vans.

There are four CUA bike tour companies. On average there are 4 to 5 bike tours per week in the park. Each tour averages about 9 riders, plus guide and tender vehicle. Kilauea Overlook and Picnic Area is used for the staging area. All parking areas along the 2.8 miles of the project area can be used for letting vehicles pass when necessary. The informal pullouts are not large enough for a group of cyclists.